Chikuminuk Lake Hydroelectric Project

Interim Feasibility Report
Volume II – Existing Environmental Conditions

Prepared for:

HATCH™

April 2014

Nuvista

NUVISTA LIGHT & ELECTRIC COOPERATIVE, INC.

Chikuminuk Lake Hydroelectric Project
FERC No. 14369

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Table of Contents

Terms, Acronyms, and Abbreviations

Term	Definition
AAC	Alaska Administrative Code
ACS	Alaska Communications Services
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
AFFID	Alaska Freshwater Fish Index Database
AHRS	Alaska Heritage Resources Survey
ADNR	Alaska Department of Natural Resources
AKNHP	Alaska Natural Heritage Program
ANCs	Alaska Native Corporations
ANCSA	Alaska Native Claims Settlement Act of 1971
ANILCA	Alaska National Interest Lands Conservation Act of 1980
Applicant	Nuvista Light and Electric Cooperative, Inc.
ARLIS	Alaska Resources Library and Information System
ASTt	Arctic Small Tool Tradition
ATV	All-Terrain Vehicle
AVCP	Association of Village Council Presidents
AVSP	Alaska Visitor Statistics Program
AWC	Anadromous Water Catalog
BBAHC	Bristol Bay Area Health Corporation
BBNA	Bristol Bay Native Association
BBNC	Bristol Bay Native Corporation
BET	Bethel Airport
BLM	Bureau of Land Management
BMPs	Best Management Practices
CNIPM	Committee for Noxious and Invasive Plants Management
CDQ	Community Development Quota
CFR	Code of Federal Regulations
CIRI	Cook Inlet Regional Incorporated
CNIPM	Alaska Committee for Noxious and Invasive Plants Management
CTC	Curyung Tribal Council
DLG	Dillingham Airport
DPOR	Division of Parks and Outdoor Recreation
DO	Dissolved Oxygen
DOTPF	Alaska Department of Transportation and Public Facilities
EFH	Essential Fish Habitat
El.	Elevation (feet)
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FMP	Fishery Management Plans
GMUs	Game Management Units
GCI	General Communication Inc.

Term	Definition
Hatch	Hatch Associates Consultants, Inc.
ILP	Integrated Licensing Process
KCH	Kilbuck Caribou Herd
KFMA	Kuskokwim Fisheries Management Area
KNA	Kuskokwim Native Association
KWA	Kuskokwim Wilderness Adventures
Licensee	Nuvista Light & Electric Cooperative, Inc.
MMPA	Marine Mammal Protection Act of 1972
MBTA	Migratory Bird Treaty Act
MCH	Mulchatna Caribou Herd
NLCD	National Land Cover Dataset
NMFS	National Marine Fisheries Services
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NWI	National Wetlands Inventory
NWS	National Weather Service
NLCD	National Land Cover Dataset
NRCS	U.S. Department of Agriculture Natural Resources Conservation Service
NRHP	National Register of Historic Places
NPCH	Nushagak Peninsula Caribou Herd
Nuvista	Nuvista Light & Electric Cooperative, Inc.
NWR	National Wildlife Refuge
NWS	National Weather Service
ONC	Orutsararmiut Native Council
PMP	Probable Maximum Precipitation
SAVEC	Southwest Alaska Vocational Education Center
SCORP	Alaska Statewide Comprehensive Outdoor Recreation Plan
SHPO	State Historic Preservation Office(r)
SSI	Supplemental Security Income
TCP	Traditional Cultural Property
TDHA	Tribally Designated Housing Authorities
TDS	Total Dissolved Solids
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VPSO	Village public safety officer
YKHC	Yukon-Kuskokwim Health Corporation
Yukon Delta NWR	Yukon Delta National Wildlife Refuge
Y-K Delta	Yukon-Kuskokwim Delta

1 INTRODUCTION

1.1 Purpose

The purpose of this Interim Feasibility Report is to provide Nuvista Electric Cooperative (Nuvista) with the information necessary to assess the viability of the Chikuminuk Lake Hydroelectric Project (Project) and to identify additional information or studies required to complete a final feasibility report. The cost of electricity in southwestern Alaska is high, as most electricity is being generated by expensive diesel fuel. Previous studies have identified Chikuminuk Lake as a potential site for a hydroelectric dam, which would provide the Dillingham and Bethel region with less expensive renewable energy and energy storage. This study further investigates the suitability of locating a hydroelectric dam located on the Allen River at the outlet of Chikuminuk Lake. Two locations were studied and one site was ultimately selected to be most feasible based on lowest cost and least visual impact (Interim Feasibility Report (Report), **Volume I**. Hatch 2014)

This volume (**Volume II**) of the Report presents the results of environmental and social investigations by Hatch and its subconsultants. A comprehensive review of existing, relevant, and reasonably available information for various resource areas was completed. Subsequently a Gap Analysis was prepared to guide consultations with representatives from federal and state resource agencies, Native Alaska entities, and other individuals with knowledge about the geographic area and related environmental resources. **Volume II** presents the information gathered along with a summary of additional information needed in order to assess the feasibility of constructing the Project and providing a reliable source of renewable energy for the Dillingham and Bethel region.

1.2 Activities During 2012 and 2013

On March 2, 2012, Nuvista filed an application with the Federal Energy Regulatory Commission (FERC) for a preliminary permit for the project pursuant to section 4(f) of the Federal Power Act (FPA)[1] to study project feasibility. On August 14, 2012, FERC issued a preliminary permit to Nuvista, assigning it the project number P-14369.[2] [3]

Stakeholder outreach activities included contacting representatives from federal and state resource agencies, Native Alaska entities, and other individuals with knowledge about the geographic area and related environmental resources. Nuvista commenced baseline engineering and environmental field and office studies during 2012 and 2013 as summarized in **Table 1.2-1**.

[1] 16 USC 797(f) (2006)

[2] Order Issuing Preliminary Permit and Granting Priority to File License Application, Project No. 14369. August 14, 2012

[3] The sole purpose of the preliminary permit is to preserve the right of the permit holder to have the first priority in applying for a license for the project that is being studied. Because a permit is issued only to allow the permit holder to investigate project feasibility and to prepare a license application, it grants no land-disturbing or other property rights. Minor land disturbing activities associated with conduct of field studies are to be approved by the landholder and any resource agencies with jurisdiction over resources that may be disturbed. No construction is allowed.

Table 1.2-1 Summary of Accomplishments during 2012 and 2013 by Resource Category

DATES	CATEGORY	2012 FIELD & OFFICE STUDIES – DESCRIPTION
Mar/Apr 2012	All Categories	• Literature Search/Gap Analysis for all study categories • Reviewed prior project analyses and reports • Prepared baseline study plans in consultation with resource agencies
June 2012	Engineering & Pre-feasibility	• Conducted avalanche hazard evaluation of potential transmission corridor between Chikuminuk Lake and Bethel • Initial engineering site reconnaissance
June 2012	Geology & Soils	• Conducted site reconnaissance field trip
Jun/Sep 2012	Water Resources	• Conducted a stream gage installation field trip to the project vicinity. Installed two stream gages, one 3.4 miles up from the mouth of the Allen River and one near the outlet of Lake Chaulekuktuli on the Northwest Passage.
Jun/Sep 2012	Aquatic Resources	• Conducted four field trips: initial site reconnaissance and fish surveys and collections
Jun/Aug 2012	Instream Flow & Fish Passage	• Conducted three field trips: initial site reconnaissance and installation of four thermistors
May/Jun 2012	Wildlife and Botanical Resources	• Wildlife Resources - Raptor Surveys: Nest occupancy surveys were conducted in May & June; productivity surveys were conducted in July
Jun/Aug 2012	Wildlife/Botanical Resources	• Botanical Resources: unsuccessful attempts were made to acquire high-resolution imagery for mapping of vegetation, wetlands, and wildlife habitats
Jun/Aug 2012	Recreation Resources	• Conducted two field trips involving aerial reconnaissance flights and lake shore landings; and short hikes to gain understanding of recreation as the regional economic generator and project setting
Jun/Aug 2012	Aesthetic Resources	• Concurrent with Recreation Resources, gathered information regarding view points and aesthetic character of area during the two field trips involving aerial reconnaissance flights, lake shore landings, and short hikes.
June 2012	Cultural & Subsistence Resources	• Cultural Resources: Conducted site reconnaissance trip involving float plane over-flights, lake shore landings, and surveys • Subsistence Resources: Office study only; no field work
Jun/Aug 2012	Socioeconomics Resources	• Concurrent with Recreation Resources, acquired an understanding of recreation as the regional economic generator during two field trips involving aerial reconnaissance flights and lake shore landings; and short hikes. Acquired information through meetings in Bethel and Dillingham; and, discussions with Native Villages that would be affected by the proposed Project.
Oct 2012	Mapping - All Categories	• Conducted site reconnaissance field trip to establish locations to acquire satellite imagery of project area
Nov 2012-Dec 2014	Engineering & Pre-feasibility	• Office studies to establish the layout of project features in support of construction cost estimating and project economic analyses. Preparation of Interim Feasibility Report.
Oct 2013-Apr 2014	Water Resources	• Maintenance and collection of data of the two stream gages, one located at the mouth of the Allen River and the other near the outlet of Lake Chaulekuktuli on the Northwest Passage

Permits required to conduct the baseline studies were received from: State of Alaska Department of Natural Resources (ADNR) - Division of Parks and Outdoor Recreation (DPOR – Wood-Tikchik Park); Alaska Department of Fish and Game (ADF&G); and the Yukon Delta National Wildlife Refuge (NWR).

1.2.1 Overview of Environmental Baseline

EXISTING CONDITIONS

NATURAL ENVIRONMENT

RIVER BASIN DESCRIPTION

Chikuminuk Lake is part of the Tikchik lakes situated on the eastern slopes of the Kilbuck Mountains and the Wood River Mountains of the Kuskokwim Mountain Range located within Wood-Tikchik State Park. Together, the Upper and Lower Tikchik lakes systems constitute the headwaters of the Nuyakuk River, one of two major tributaries that join the Nushagak River near Koliganek and flow into Bristol Bay near Dillingham. Fed by precipitation, snowmelt, and small glaciers in the Wood River Mountains, the Tikchik lakes can be expected to buffer flood peaks, produce relatively slow rates of rise and fall in river water levels, and contribute to high base flows during dry periods and in the winter.

GEOLOGY & SOILS

The banks of the Allen River immediately downstream of the proposed powerhouse location are characterized by steep rock cliffs. About 1,000 feet downstream of the proposed powerhouse location the river exits the steep-walled canyon and cuts through a glacial outwash deposit. Here the banks transition from rock to terraced alluvial deposits consisting of re-worked glacial outwash.

The alternative transmission corridors under consideration would pass through a wide variety of geologic conditions. Mountainous areas of the corridor are primarily bedrock with some glacial deposits. Alluvial soils are present in the bottom of valleys. On the coastal plain the corridor is underlain by generally fine-grained unconsolidated soils. The coastal plain is underlain by moderately thick to thin permafrost. Locally, in close proximity to large water bodies, permafrost is absent.

WATER RESOURCES

Chikuminuk Lake has a number of significant bays and outcrop islands, is approximately 16 miles long and averages roughly 2.5 miles in width. The normal water surface elevation of the lake is approximately 613 feet. The 39-square mile lake covers approximately ten percent of the 353-square mile drainage basin above the dam site. Except at its western end, there are relatively few major streams entering the lake. During reconnaissance conducted in June 2012, glaciers appeared to be in strong recession in the basin, with current glacier extents being less than mapped extents, and moderate to low sediment loads being carried in glacial streams. Due to their small size and extent and the hydrologic influence of Chikuminuk Lake, the glaciers in the project basin are assumed to exert an extremely minor influence on basin hydrology.

Water in the Allen River and Chikuminuk Lake is not used for irrigation, domestic water supply, or industrial purposes. Because of dangerous rapids on the Allen River, Chikuminuk Lake is very rarely used as a staging point for longer boating trips. Subsistence use occurs, although it is thought to be quite limited. Most villagers using the lakes and rivers in the unit are from Koliganek, New Stuyahok and Ekwok.

FISH & AQUATIC RESOURCES

Fish surveys were not completed, and it is not known how far upstream anadromous fish are present in the Allen River. Native species known to inhabit Chikuminuk Lake and Lake Chauekuktuli include: native char, arctic grayling and lake trout. Sockeye salmon are present in Lake Chauekuktuli.

Overall, twenty-four species of resident and anadromous fishes have been observed in the Wood-Tikchik lakes system, including all five species of Pacific salmon. The Wood and Nuyakuk rivers have been estimated to account for upward of 20 percent of the total Bristol Bay sockeye salmon (*Oncorhynchus nerka*) escapement. Sockeye salmon have not been found in Lake Chikuminuk, most likely due to the presence of several potential fish migration impediments in the Allen River which limit the upstream extent of sockeye movement.

BOTANICAL RESOURCES

The most common plant community type in the mountainous region of the lake study area is low shrub scrub. Forested habitats appear to be relatively uncommon in the study areas, and are more likely to occur in the lowlands of the Yukon-Kuskokwim Delta region, along the lower portions of river and stream drainages in the West transmission corridor study area.

The AKNHP database indicates that eight rare vascular plant taxa have been collected in the regional search area. Two are wetland species that are more likely to occur in the Yukon-Kuskokwim lowlands within the West transmission corridor study area. The remaining six species occur throughout the lakes region of Wood-Tikchik State Park and are thus highly likely to occur near Chikuminuk Lake and mountainous areas immediately adjacent to the lake.

No fine-scale mapping of vegetation, wetlands, riparian, and littoral habitats specific to the lake study area or the transmission corridor alternatives has been conducted.

WILDLIFE RESOURCES

At least 37 species of terrestrial mammals have been documented or are considered likely to occur in the Project study area. These include moose, caribou, muskoxen, lack and brown bears, eleven species of furbearing carnivores, two species of hares, thirteen species of rodents, five species of shrews, and one bat species. The area around Chikuminuk Lake is considered general habitat for moose but is not considered a calving, winter, or rutting area; the Tikchik River east of Chikuminuk Lake is the closest winter range. However, no population estimate of moose is available for the project area. At least 131 species of birds have been observed or are considered likely to occur in the project area. This includes eleven species of raptors (eagles, hawks, falcons) and six species of owls that potentially breed in or migrate through the project area.

THREATENED & ENDANGERED SPECIES

There are no federally-listed candidate, threatened or endangered fish, plant or wildlife species, or designated or proposed critical habitat within the project vicinity.

RECREATION & LAND USE

Recreational use of Chikuminuk Lake very limited as it is accessible only by air. Recreation opportunities include hunting, camping, fishing, kayaking. The Lake Aleknagik Recreation Area Ranger Station reported an annual average of 16 visitors per year from 2004-2011.

The project would be located primarily within the Wood-Tikchik State Park and the Yukon Delta National Wildlife Refuge, which are protected by state and federal law. There are no State or Federally-protected river segments in the project area. No project lands are under study for inclusion in the National Trails System nor designated as, or under study for inclusion as, a national Wilderness Area.

AESTHETIC RESOURCES

There are no existing project facilities. The visual character of these proposed facilities will depend on the design developed.

CULTURAL RESOURCES

There are 51 cultural resource sites within the Project Study Area. There are no communities located in the immediate vicinity of Chikuminuk Lake. Nuvista has identified 23 Federally Recognized Tribes in the Bristol Bay and Calista Regions that may attach religious and cultural significance to historic properties within the project boundary or in the vicinity of the Project. These tribes are located within 21 communities and are represented by ANCSA Village Corporations as well as their respective Alaska Native Regional Corporation, i.e. Bristol Bay

Native Corporation or the Calista Corporation.

SOCIO-ECONOMIC RESOURCES
Rising energy fuel costs; high unemployment; Population of Calista and Bristol Bay region is approximately 32,000, with 6,000 in Bethel and 2,300 in Dillingham. Approximately 82 percent are Alaska Native. Subsistence is an important aspect of economy; most residents employed in state/local government.

2 PROJECT LOCATION, FACILITIES, AND OPERATION

2.1 Project Location

The proposed Chikuminuk Lake Hydropower Project (Project) would be located in the Chikuminuk Lake watershed approximately 118 miles southeast of Bethel, Alaska and 75 miles north of Dillingham, Alaska, as shown on **Figure 2.2-1**. Chikuminuk Lake is located within the Wood-Tikchik State Park within the eastern portion of the Kilbuck Mountains in the Kuskokwim Mountain Range about 20 miles northeast of Heart Lake Pass. The lake is part of a series of land-locked fiords and is approximately 16 miles long with an average width of about 2.5 miles. The natural normal pool elevation of Chikuminuk Lake is El. 613 with a surface area of about 24,640 acres. The lake's southeastern arm has a recessional moraine over shallow rock with a box canyon that forms the outlet to the Allen River. The box canyon is 60 to 80 feet deep and terminates in a protruding ridgeline about 2,500 feet downstream of the lake outlet. The Allen River flows to the southeast for approximately 11 miles to Lake Chauekuktuli. Currently, there are no dam or diversion structures at Chikuminuk Lake or on the Allen River. Access to the site is limited to floatplane or helicopter; there are no roads connecting Bethel or Dillingham to Chikuminuk Lake.

More information on the project location is presented in **Volume I**, Section 1.

Figure 2.1-1 Project Location

2.2 Proposed Project Facilities

The proposed Project would consist of a dam and reservoir, a tunnel leading to a powerhouse, transmission connections, and related facilities. Alternatives identified for study in relation to the proposed Project included:

- two concepts for the location and configuration of a dam,
- a range of reservoir inundation levels,
- the number and size of powerhouse units to provide an installed capacity in the range of 12 MW to 25 MW, and
- alignments for transmission of power to the load center(s), and access for construction and operation.

More detailed discussion of project alternatives is presented in **Volume I**, Section 1.

3 DESCRIPTION OF EXISTING ENVIRONMENT AND RESOURCES

3.1 Existing Environment

Nuvista identified information on the Project through its public outreach, informal agency meetings, literature search and baseline field studies as performed during 2012 and 2013. Descriptions of existing conditions include the following resource categories:

- 3.2 River Basin Description
- 3.3 Geology and Soils
- 3.4 Water Resources
- 3.5 Fish and Aquatic Resources
- 3.6 Botanical Resources
- 3.7 Wildlife Resources
- 3.8 Special Status Species
- 3.9 Recreation and Land Use
- 3.10 Aesthetic Resources
- 3.11 Cultural Resources
- 3.12 Socio-economic Resources

3.1.1 Available Information

Nuvista conducted a comprehensive literature search and gap analysis (**Appendix B**) that addressed each of the above-listed resources. Provided below are summaries of existing data and studies acquired to date. Information gained through this effort was used to identify early-start baseline field studies that began in 2012 and continued in 2013.

3.1.2 Potential Project Impacts and Issues

A preliminary listing of issues and potential adverse impacts that may be associated with the construction, operation or maintenance of the proposed Project is included within each resource of **Section 3**. This information is based on results of public outreach, informal agency meetings, literature search and baseline field studies performed during 2012 and 2013.

Should the project move forward, Nuvista anticipates additional identification and related discussion of issues and potential project-related effects will be developed during the FERC NEPA Scoping Process and associated FERC licensing efforts.

3.1.3 Protection, Mitigation or Enhancement

Nuvista expects that project-related effects would be identified during implementation of the formal studies program. Concurrent with the studies program, consultation with resource agencies and other interested entities regarding the proposed Project will begin to focus in on measures that could potentially be employed to protect environmental and cultural resources and to avoid any adverse impacts. Where that is not practicable, the consultations could lead to discussion of how to mitigate unavoidable significant adverse effects, or to enhance comparable resources present in the project area of effect.

3.2 River Basin Description

Chikuminuk Lake is part of the Tikchik lakes, a series of land-locked fiords situated on the eastern slopes of the Kilbuck Mountains and the Wood River Mountains of the Kuskokwim Mountain Range located within Wood-Tikchik State Park. Together, the Upper and Lower Tikchik lakes systems constitute the headwaters of the Nuyakuk River, one of two major tributaries that join the Nushagak River near Koliganek and flow into Bristol Bay near Dillingham. Fed by precipitation, snowmelt, and to a lesser extent by small glaciers in the Wood River Mountains, the Tikchik lakes can be expected to buffer flood peaks, produce relatively slow rates of rise and fall in river water levels, and contribute to high base flows during dry periods and in the winter.

Chikuminuk Lake is one of the three lakes of the Upper Tikchik lakes system. Flows draining from the two northernmost lakes of this system, Nishlik Lake and Upnuk Lake, bypass Chikuminuk Lake and flow via the Tikchik River directly into the Lower Tikchik lakes system at Tikchik Lake. The Allen River connects Chikuminuk Lake to Lake Chauekuktuli. Lake Chauekuktuli is the upper lake of the three lakes – Lake Chauekuktuli, Nuyakuk Lake and Tikchik Lake – that comprise the Lower Tikchik lakes system (see **Figures 3.2-1 and 3.2-2**).

3.2.1 Basin Area and Stream Lengths

The basin and sub-basin areas for Chikuminuk Lake and the Allen River as well as the basin areas for Lake Chauekuktuli and a major portion of that for the USGS Nuyakuk River gage are shown on **Figure 3.2-2**. **Figure 3.2-3** includes the basin area for the Nushagak River and indicates the relative size of the basins within the Tikchik lakes system relative to that of the entire Nushagak River basin. **Table 3.2-1** lists the areas of the relevant Nushagak River sub-basins, from the project basin to the mouth of the river at Bristol Bay.

Table 3.2-1 Key Nushagak River Sub-basin Areas

Basins	Area (mi^2)
Chikuminuk Lake (USGS Allen River Gage)	353.0
Allen River below Canyon Gage	365.0
Allen River Tributary	10.3
Allen River at Mouth	379.0
Lake Chauekuktuli (Northwest Passage Gage)[4]	612.0
Tikchik Lake (USGS Nuyakuk River Gage)	1,490.0
Nushagak River at Dillingham	13,700.0

Streams within the Nuyakuk River basin include the 11.6-mile long Allen River, which connects Chikuminuk Lake with Lake Chauekuktuli, the one-mile long (informally named) Northwest Passage, which connects Lake Chauekuktuli to Nuyakuk Lake, and the approximately 1,000-foot long Tikchik Narrows, which connects Nuyakuk Lake with Tikchik Lake (**Figure 3.2-2**). From Tikchik Lake, the Nuyakuk River joins the Nushagak River near Koliganek and flows into Bristol Bay near Dillingham. **Table 3.2-2** presents the stream lengths for these rivers.

[4] The Lake Chauekuktuli basin is similar to the Northwest Passage Gage basin; this gage is located a short distance below the outlet of Lake Chauekuktuli.

Table 3.2-2 Stream Lengths – Chikuminuk Lake to Bristol Bay

Stream	Length (mi)
Allen River to Lake Chauekuktuli	11.6
Northwest Passage to Nuyakuk Lake	1.0
Tikchik Narrows to Tikchik Lake	0.2
Nuyakuk River to Nushagak River	46
Nushagak River to Bristol Bay	285

Source: Nushagak River length obtained from USGS Water Fact Sheet, *Largest Rivers in the United States* (Open-File Report 87-242). All other river lengths measured by R&M Consultants from USGS maps.

3.2.2 Land and Water Use

3.2.2.1 Land Use

The Chikuminuk Lake Hydroelectric Project vicinity is sparsely populated and geographically diverse. Large areas of uninhabited wetland, river drainages and shrub tundra are separated by mountainous areas. The region's population centers tend to be located along major rivers, lakes and sheltered coastline. Bethel, with a population of 6,080 residents, is the 58,000 square-mile Yukon-Kuskokwim Delta and Calista region's largest community and lies within the Yukon Delta National Wildlife Refuge. Dillingham, with a population of about 2,300, is the largest community in the over 40,000 square-mile Bristol Bay region. Most communities are rural in character and a few settlements are used only as seasonal fishing and subsistence camps.

The largest tracts of land in this area are owned and managed by federal agencies, the State of Alaska and Alaska Native Corporations. Smaller properties are owned by local governments. Individuals and Alaska Native allotments also own small properties, some within federal or state-owned lands. The proposed Project would be located on a variety of land types: State of Alaska lands managed by the Alaska Department of Natural Resources (DNR) including the Wood-Tikchik State Park; federal lands within the Yukon Delta National Wildlife Refuge managed by the USFWS; Bureau of Land Management (BLM) lands; native lands; and private lands. **Sections 3.9 and 3.11** of this Volume provide further detail regarding the land uses in the project area and vicinity.

Wood-Tikchik State Park

At 1.6 million acres, Wood-Tikchik State Park is the largest state park in the United States (**Figure 3.2-1**). The proposed project dam site is located within a region of the Park designated by the state park's management plan as Wilderness (ADNR 2002). Named for its two systems of large, interconnected, clear water lakes, the park is characterized by its water based ecosystems. The State created a seven member park management council with five positions filled by local residents to represent the communities of Dillingham, Aleknagik, Koliganek, New Stuyahok and the Bristol Bay Native Association. This council ensured that area residents had a significant role in managing the park.

A total of 104 in-holdings in the park were claimed by Native residents of Bristol Bay under the 1906 Native Alaska Allotment Act. These totaled about 8,000 acres and ranged in size from 20 to 160 acres. Since these were also claimed by the state, the BLM was required to adjudicate land title and the issue was settled with a combination of about 25% relocating and swapping their in-holdings for State lands outside the park boundary and about 75% agreeing to conservation easements. Most of the Wood-Tikchik parcels affected were classified to allow subdivision into ten-acre lots, with no more than one five-acre commercial development site (Ketchum et al. 2003). This solution has limited large commercial development within the Park and ensured public access while protecting Native land claims.

Yukon Delta National Wildlife Refuge

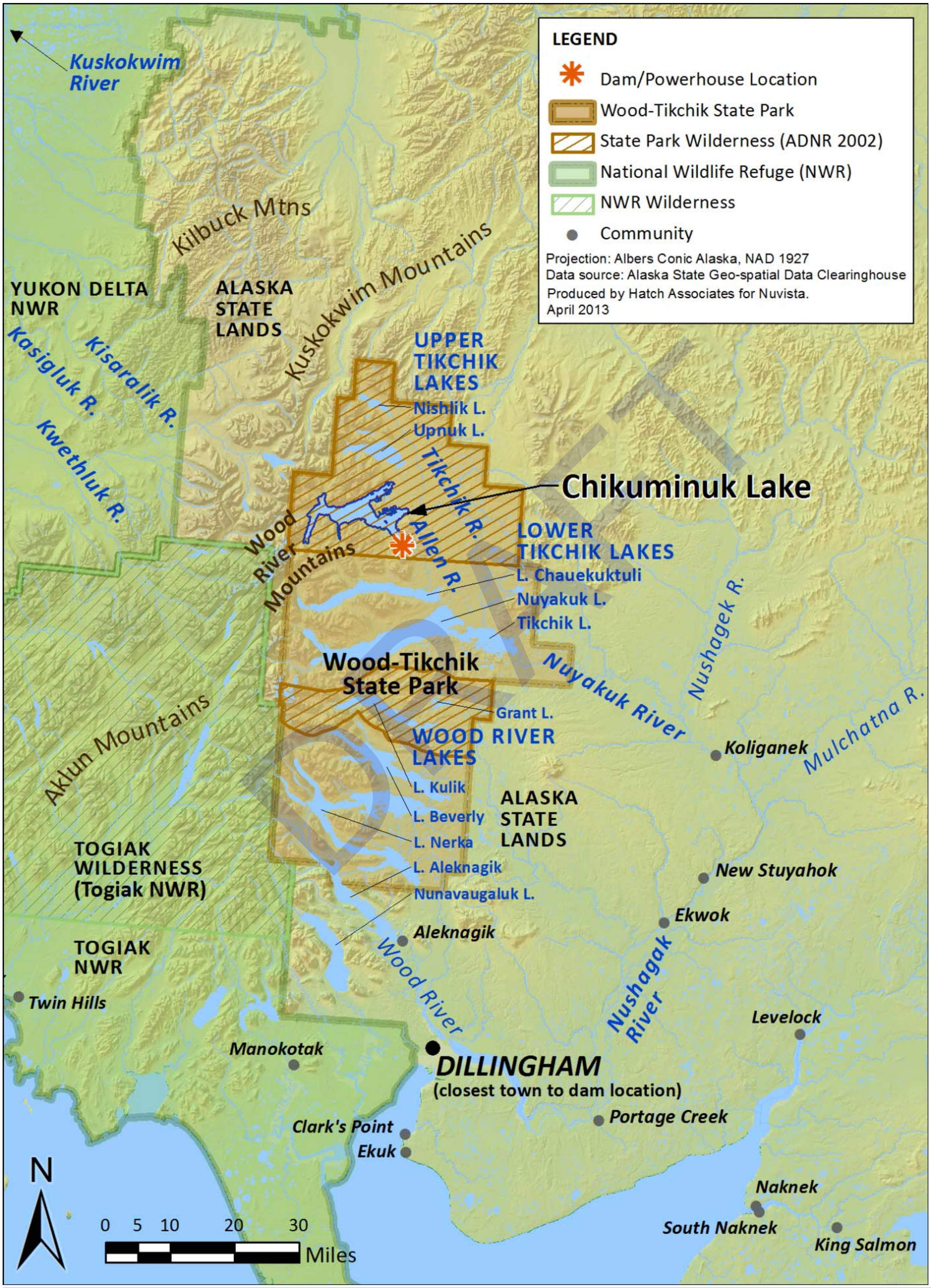
The Yukon Delta National Wildlife Refuge (NWR) **(Figure 3.2-1)** is the largest unit of the National Wildlife Refuge System, encompassing 19.2 million acres within the northern boreal zone of southwestern Alaska (Rudis 2009). The Yukon Delta NWR traces its history back to 1909, when President Theodore Roosevelt created a refuge to preserve the breeding grounds of native birds. In 1929, Nunivak Island was set aside as a refuge for birds, game and furbearing animals. In 1930, the small islands and all the lands under the waters surrounding Nunivak Island were added to the refuge. Additional lands were reserved in 1937, when President Franklin D. Roosevelt created the Hazen Bay Migratory Waterfowl Refuge. The Kuskokwim National Wildlife Range was established in 1960, and in 1961, it was enlarged and renamed the Clarence Rhode National Wildlife Refuge. On December 2, 1980, President Jimmy Carter signed the Alaska National Interest Lands Conservation Act (ANILCA), which consolidated and added to the existing ranges and refuges to create the Yukon Delta NWR. With the exception of several small additions to the refuge due to purchase or land exchange, the lands of the refuge were in the public domain prior to the refuge designation (USFWS 2012).

3.2.2.2 Water Use

Instream flow uses of the Allen River include fish, wildlife, riparian vegetation, passive recreation and the water required to maintain the aesthetic characteristics of the river itself. There are irrigation or industrial activity uses. The Allen River is the largest of six major tributaries that feed Lake Chauekuktuli, which has limited use as a water supply. Both the Wood River and Tikchik lake systems are in the Nushagak fishing district of the Bristol Bay region and are managed by the Alaska Department of Fish and Game (Weiland et al. 1994). The lakes of the Tikchik Lake system experience low to moderate sport fishing pressure and minor subsistence usage (Grumman Ecosystems Corporation 1971, 1972; ADNR 2002). Compared to the Tikchik lakes, the southern Wood River lakes have seen increasing sport fishing pressure and subsistence activities; the Wood River lakes area has navigable water, road access, and several lodges (Grumman Ecosystems Corporation 1971; Chihuly 1979).

In the Yukon Delta basin, substantial commercial and subsistence fishing for Chinook and chum salmon occurs near the confluence of the Kasigluk River with the Kuskokwim River (Wilson et al. 1982; Boyd and Coffing 2000) **(Figure 3.2-1)**. The Kwethluk River receives considerable subsistence and commercial fishing at its confluence with the Kuskokwim River; in the early 1980s it was described as having the most sport fishing pressure of the main Lower Kuskokwim tributaries (Wilson et al. 1982).

Figure 3.2-1 Wood-Tikchik Lakes Systems



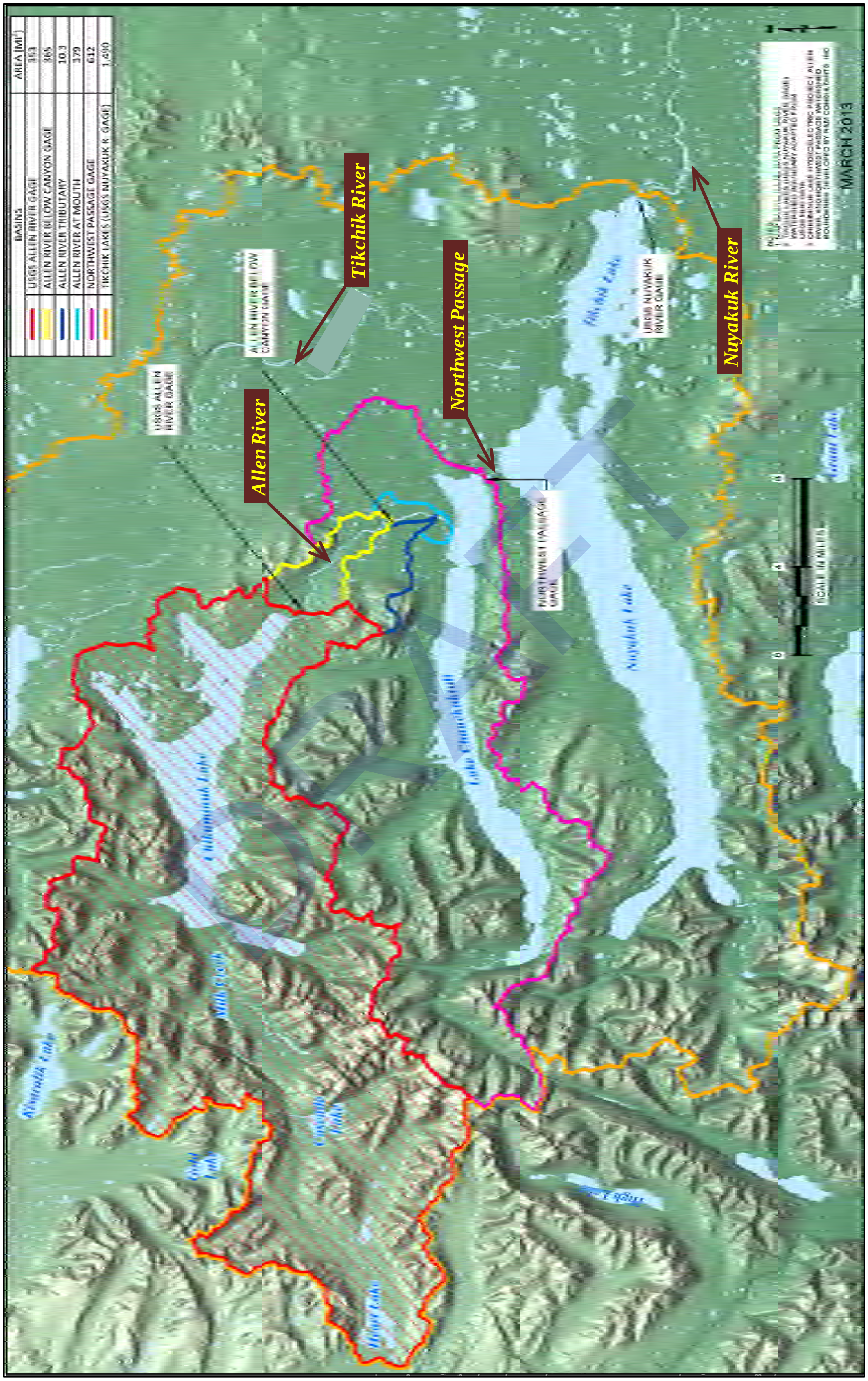


Figure 3.2-2 Tikchik Lakes (Nuyakuk River Gage) Sub-basins

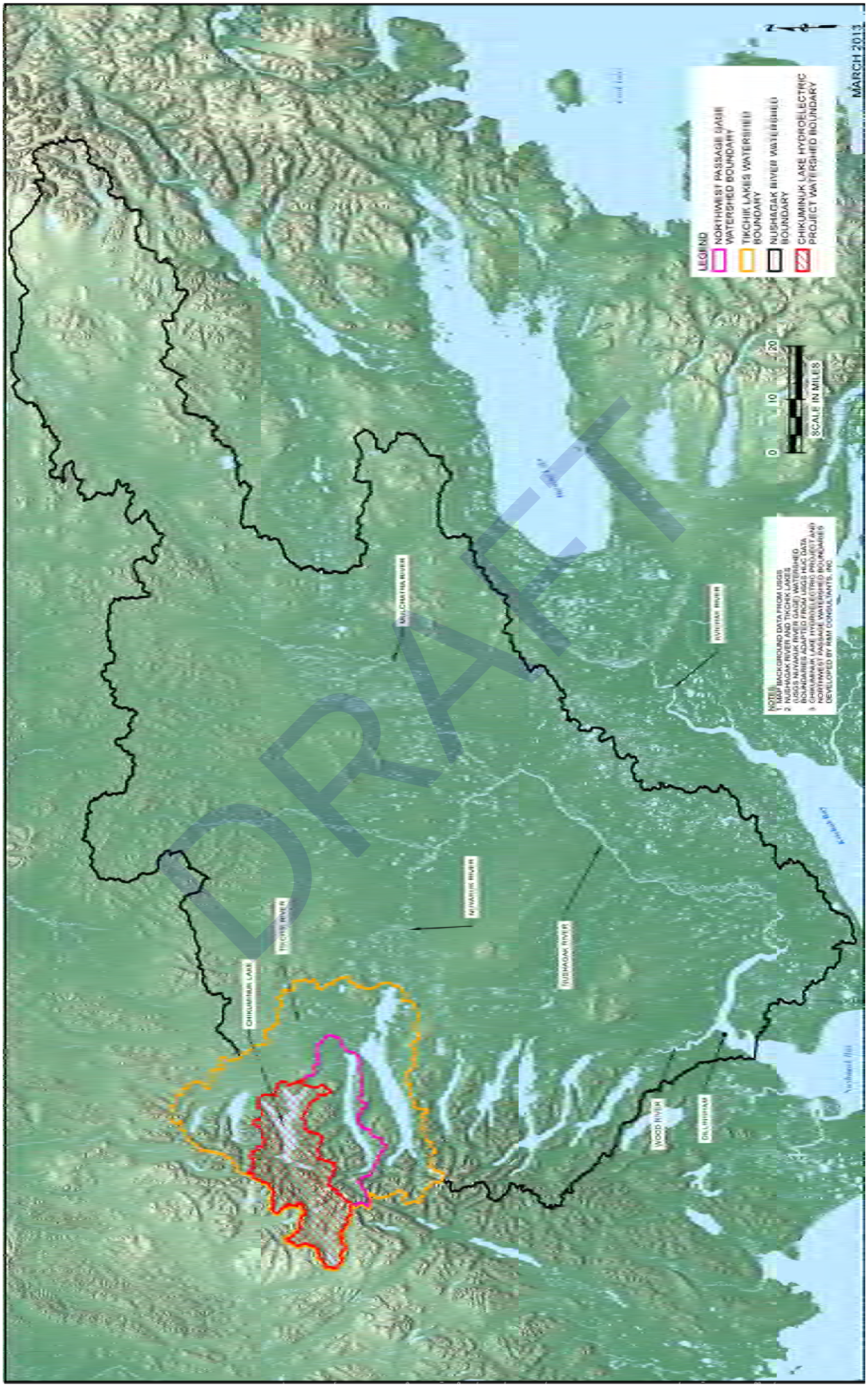


Figure 3.2-3 Tikchik Lake Sub-basins within Nushagak River Drainage Basin

3.2.3 Dams and Diversion Structures

No dams or diversion structures are present downstream of the proposed Project.

3.2.4 Tributary Rivers and Streams

The largest of several perennial tributaries that feed Chikuminuk Lake, Milk Creek, enters from the west and comprises close to half of the project basin by area. Milk Creek's headwaters are located at the outlet of Heart Lake and the creek drains several other lakes to the west of Chikuminuk including Cascade Lake (**Figure 3.2-2**). Most inlet streams to Chikuminuk Lake are as yet unnamed and have yet to be surveyed. The Allen River is the sole outlet of the lake and flows directly into Lake Chauekuktuli.

Approximately one mile upstream from the mouth of the Allen River, a prominent tributary (informally called the Allen River Tributary) enters river from the west. With the exception of this tributary, concentrated flows on both sides of the river appear to be limited to springs.

Overall, the Tikchik lakes strongly influence the hydrology of the rivers feeding the western branch of the Nuyakuk River. These lakes are connected by relatively short rivers, including the Allen River between Chikuminuk Lake and Lake Chauekuktuli, the informally named Northwest Passage connecting Lake Chauekuktuli with Nuyakuk Lake, and the Tikchik Narrows, joining Nuyakuk Lake to Tikchik Lake (**Figure 3.2-2; Table 3.2-2**). The Nuyakuk River is a major tributary to the Nushagak River, which, as one of the largest rivers in Alaska, flows into Bristol Bay from an expansive drainage basin **(Figure 3.2-3**).

3.2.5 Regional Climate

No separate climate data exists for the Allen River Watershed, and no readily or publicly available data exist for the Wood-Tikchik State Park. The National Weather Service (NWS) operates two long-term weather stations in the Bristol Bay region at Dillingham and King Salmon. The Dillingham weather station is the nearer of the two and is located at the Dillingham Airport, approximately 90 miles to the south of the project site. The U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) operates a number of snow (Snow Course) and precipitation telemetry (SNOTEL) sites in the Southwest Alaska region. The closest of these sites is located more than 100 miles from the Chikuminuk Lake project site.

Limited climate data may be available from research stations within the Wood River drainage. The School of Aquatic & Fisheries Science at the University of Washington (UW) maintains field stations at three lakes within the Wood River Lakes system – Lake Kulik, Lake Nerka, and Lake Aleknagik (WRCC 2012). Lake Kulik is located about 30 miles to the south of the project site, and is the closest of the three lakes to the project site (**Figure 3.2-1**).

A high elevation weather station was installed in 2008 on Mount Waskey in the Ahklun Mountains in the Togiak National Wildlife Refuge. The climate station was installed as part of an effort by the U.S. Fish and Wildlife Service and Northern Arizona University to inventory and monitor glaciers in western Alaska (NAU 2012). The site is located about 10 miles west of Lake Kulik, and approximately 40 miles southwest of the project site. High winds destroyed the Mount Waskey weather station during its first year of operation. Climate data from the UW research stations in the Wood River drainage and from the Mount Waskey weather station can be acquired and analyzed under a later project phase.

It is anticipated that the climate near the project site is similar to the climate in Dillingham, and observations during site visits conducted in the summer and fall of 2012 generally confirm this.

Dillingham lies within a climatic transition zone between a cool, moist maritime climate and a cold, dry continental climate (WRCC 2012). During the summer months, the maritime influence of Bristol Bay and the Bering Sea to the west and the Pacific Ocean to the south dominate the local weather patterns. Temperatures are mild; strong and persistent surface winds are common. Skies are frequently cloudy, precipitation is moderate to heavy, and periods of fog are common, particularly in the later part of the summer. During the winter months, a colder, drier climate dominates, with strong and persistent surface winds still common.

The weather station in Dillingham has been operated by the National Weather Service since February 1951. For the period of record, the mean annual temperature was 1 degree Celsius (^{o}C). The average maximum monthly temperature was 5^{o}C and the average minimum monthly temperature was –3^{o}C. December is typically the coldest month, with a long-term mean of –10^{o}C. The warmest temperatures usually occur in July, with a long-term mean of 13^{o}C. A record high temperature of 33^{o}C occurred in the summer of 1953 and a record low temperature of –47^{o}C occurred in the winter of 1989.

Mean annual precipitation at Dillingham is 26 inches. Most of the year's precipitation falls during the summer and fall, with approximately 50 percent of mean annual precipitation occurring between July and October. Winter precipitation is typically light to moderate, with a mean annual snowfall of 83 inches.

A weather station was operated by the NWS at Aleknagik from September 1958 to February 1973. Aleknagik is located 17 miles north of Dillingham. For the 1958–1973 time period, the average maximum monthly temperature in Aleknagik was 6^{o}C and the average minimum monthly temperature was –4^{o}C. A record high temperature of 31^{o}C occurred in the summer of 1963 and a record low temperature of –42^{o}C occurred in the winter of 1973.

3.3 Geology and Soils

3.3.1 Geological Features

The dam, powerhouse & related features, and those portions of the proposed transmission line alternatives to deliver power to Bethel from the Chikuminuk Lake Hydroelectric Project are located in the Ahklun Mountains. The Ahklun Mountains province is characterized by groups of rugged steep-walled mountains having sharp summits 2,000 to 5,000 feet in altitude. Numerous glacial lakes are present, and many are more than two miles long. Lake depths of more the 900 feet have been reported. The mountains generally drain west and south to Bristol Bay, and east to the Nushagak River.

Portions of alternative transmission line routes are located in the Yukon-Kuskokwim Coastal Lowland physiographic provinces of Alaska characterized by lake-dotted coastal plains (Wahrhaftig 1965). Meandering streams with very low gradient drain the area to Bristol Bay.

The geology of southwest Alaska includes a collection of three primary rock groups: 1) continental margin rocks associated with the northern Kuskokwim Mountains and southwestern Alaska Range; 2) tectonically accreted rock formations; and 3) younger sedimentary, volcanic, and plutonic rocks. These rock groups are variably overlain by recent, unconsolidated alluvial and glacial deposits, and by Quaternary extrusive deposits in localized areas.

Within the project area, continental margin rocks are primarily comprised of metamorphic rocks. Exposures of these rocks are limited to isolated locations of the Kuskokwim Mountains and in fault contacts with tectonically accreted rock terranes.

The tectonically accreted rock units have been subdivided by genetic relations collectively known as the Terranes of the Bristol Bay Region (Box et al. 1993), (Decker et al. 1994). In the project area units include the Nyack, Togiak, and Goodnews Terranes.

- The Nyack Terrane is mapped in the central portion of the Bethel quadrangle map and is located furthest west of the accreted terranes in the project area. The Nyack Terrane consists of volcanic and sedimentary rocks. Volcanic rocks of this terrane include andesite, basalt, and dacite. Sedimentary rocks typically consist of greywacke, siltstone, and conglomerate. The rocks are generally slightly altered.

- The Togiak Terrane extends from the south-central portion of the Bethel quadrangle in a northeastern direction to the northwest corner of the adjacent Taylor Mountain quadrangle. The Togiak Terrane consists of volcanic and volcaniclastic rocks. Near the project area volcanic rocks consist primarily of dacite, and volcaniclastic rocks consist of breccias. These rocks are weakly metamorphosed, and moderately to severely deformed.

- The Goodnews Terrane has been subdivided into several subterranes. Three subterranes occur in the project area; the Nukluk Subterrane, Kilbuck Subterrane, and the Tikchik Subterrane. The Nukluk and Kilbuk Subterranes are present in a localized portion of the east-central Bethel quadrangle. The Tikchik Subterrane is mapped surrounding Chikuminuk Lake within the western Taylor Mountain quadrangle and southeastern Bethel quadrangle. These terranes are structurally complex and to date, are not well defined. The Nukluk Subterrane consists primarily of chert, mudstone and basalt. The Kilbuck Subterrane consists of highly deformed metagranitic and metasedimentary rocks. The Tikchik Subterrane is a complex assemblage of clastic rocks, chert, limestone, pillow basalts, and mafic volcanic rocks.

In many parts of southwestern Alaska, the accreted terranes are overlain by a series of younger sedimentary rocks of the Kuskokwim Group. This unit is composed of sandstone, greywacke, conglomerate, and other sedimentary rock types. The rocks are regionally deformed into open folds.

Unconsolidated Quaternary deposits comprise the entire western portion of the project area and are present locally within the mountainous areas. Within the Kuskokwim River Lowlands, these deposits are primarily mapped as alluvial silt deposits, with some glacial outwash deposits occurring near the western edge of the mountains. Within the mountains, Quaternary deposits primarily consist of glacial till, which mantles most valley lowlands. Localized areas of recent alluvium and glacial outwash are also present in smaller deposits within the mountainous areas.

3.3.1.1 Permafrost

The region is considered to be underlain by isolated masses to relatively continuous thick permafrost in areas of predominantly fine-grained deposits (Ferrians 1965). In the mountainous areas the permafrost generally occurs in isolated masses either at considerable depth below the surface as relict permafrost, or near the surface as thin lenses at local sites where ground insulation is high and ground insolation (solar radiation received) is low. The coastal plain is underlain by moderately thick to thin permafrost. Locally, in close proximity to large water bodies, permafrost is absent.

3.3.2 Soil Types and Characteristics

The valley floor northeast of the canyon in the Allen River is covered with a series of glacial moraines. The thickness and characteristics of these glacial deposits are unknown, but they are generally expected to be coarse-grained. Where it was observable during summer 2012 site visits, the soils generally consisted of sand and gravel with cobbles and boulders. Generally, coarse-grained glacial and alluvial soils have a low to moderate erosion potential and moderate potential for slope instability, but may have a moderate to high potential for seepage and piping (migration of fines out of soil deposits due to groundwater action). Areas of fine-grained soils may exhibit higher potential for erosion and slope instability. The characterization of the soil deposits in the vicinity of the lake outlet would be an important part of future geotechnical studies.

3.3.3 Existing and Potential Geological and Soil Hazards

Erodible Areas: Soil deposits within the potential inundation area, particularly deposits on slopes, may be susceptible to erosion. The existing vegetation mat which helps in the reduction in erosion may be destroyed by a rise in lake level from the proposed project. Erosion could occur during periods of low water level in the lake when the inundation area is exposed. Other areas of potential erosion include any soil deposits which would be disturbed by construction activities.

Slope Instability: There is potential for slope instability in soil deposits within the inundation area. Soil deposits would become saturated and may lose strength, possibly resulting in landslides.

Seepage: Three areas of potential seepage from the raised lake level have been identified. These are the glacial moraine in the vicinity of the lake outlet, the saddle between Chikuminuk Lake and the Tikchik River, and the Y-shaped, unnamed valley (including two drainage divides) between Chikuminuk Lake and Lake Chauekuktuli.

3.3.4 Chikuminuk Lake and Allen River Geologic Characteristics

At the outlet of Chikuminuk Lake, the Allen River flows in a steep sided canyon with bedrock walls. The canyon is situated along the southwest side of a glacial valley approximately one-mile wide. Bedrock exposed on the canyon walls consist of chert, argillite and greywacke. The rock is foliated dipping from about 60° to 80° to the south-southeast (170° azimuth). The foliation is moderately to closely spaced (about 6 to 24 inches), and moderately persistent, with continuous discontinuities up to 30 feet in length observed in 2012. A less persistent and more widely spaced joint set was observed with a dip of 70° to 80° southwest (235° azimuth).

3.3.5 Transmission Corridor Geologic Characteristics

The alternative transmission corridors under consideration would pass through a wide variety of geologic conditions. The mountainous area corridors are primarily bedrock with some glacial deposits. Alluvial soils are present in the bottom of valleys. The coastal plain corridor is underlain by generally fine-grained unconsolidated soils. Peat deposits and permafrost are likely to be encountered in this area.

3.3.6 Reservoir Shorelines and Streambank Characteristics

The shoreline of Chikuminuk Lake is dominated by steep bedrock outcrops. Alluvial delta deposits are present at various locations around the perimeter of the lake, but are more numerous at the west end of the lake. The largest alluvial deposits are associated with Milk Creek at the far west end of the lake. No large areas of slope instability or large landslide deposits were identified in a reconnaissance-level aerial survey conducted in 2012.

The banks of the Allen River immediately downstream of the powerhouse location are characterized by steep rock cliffs. About 1,000 feet downstream of the proposed powerhouse location the river exits the steep-walled canyon and cuts through a glacial outwash deposit. In this area the banks transition from rock to terraced alluvial deposits consisting of re-worked glacial outwash.

3.3.7 Seismology

Southwest Alaska is characterized by low to moderate seismicity as compared to many other regions of Alaska (Page et al. 1991). The region is dominated by a series of north-northeast and northwest trending faults. The primary north-northeast fault is considered to be the Denali fault system, which includes the Togiak-Tikchik Fault. A number of faults run sub-parallel to this fault system, and a series of smaller faults run generally perpendicular to the larger and more continuous north-northwest trending faults. Between 1903 and 2010, only one earthquake with a magnitude greater than 5.0 has occurred within 100 miles of the project area. This earthquake occurred in 1903 and was located approximately 100 miles north of the dam/powerhouse site. It had an estimated magnitude of 6.9 (AEIC 2012). However, due to the limited number of seismographs in Alaska at that time, the location and magnitude estimates should be considered provisional at best.

3.4 Water Resources

3.4.1 Drainage Basin Overview

Chikuminuk Lake is the most southerly of the three lakes in the Upper Tikchik lakes system (**Figure 3.2-1**). The 39-square mile lake covers approximately ten percent of the 353-square mile drainage basin above the dam site (**Figure 3.2-3**). The lake, which has a number of significant bays and outcrop islands, is approximately 16 miles long and averages roughly 2.5 miles in width. The normal water surface elevation of the lake is approximately 613 feet.

Except at its western end, there are relatively few major streams entering the lake. Only two major streams were noted along the northern shore of the lake between the northwest and north arms of the lake during a site reconnaissance in June 2012. A number of major inflows were noted at the western end of the lake. Milk Creek, which drains approximately half of the Chikuminuk Lake basin and is the only named stream entering the lake, is by far the largest of these. Milk Creek is steep and flows within a canyon for a large portion of its length. Heart Lake lies at the headwaters of Milk Creek and has no westward draining outlet, contrary to what some past mapping has shown.

There are a number of small glaciers within the Milk Creek drainage, including the Chikuminuk Glacier, which occupy generally north-facing drainages in the southwest portion of the project basin. Glaciers are estimated to comprise much less than five percent of the area of the project basin. Fine-grained sediments derived from these glacial basins impart a milky quality to the waters of Milk Creek, giving the stream its name. In a site reconnaissance of the basin conducted in June 2012, glaciers appeared to be in strong recession in the basin, with current glacier extents being less than mapped extents, and moderate to low sediment loads being carried in glacial streams.

The glaciers of the Milk Creek basin appear to be the only glaciers in the Nuyakuk River system, although mapping shows the possible presence of a few very small glaciers in the headwaters of the Lake Chauekuktuli basin. Glaciers can exert a strong influence on basin hydrology. The hydrograph of a typical glacial stream shows a sudden and strong rise in flow in the spring as winter snow melts, followed by a continual rise into the middle of the summer, and then a gradual decline throughout the fall. Glaciers tend to decrease a basin’s annual and monthly variations in runoff and produce a delay of the maximum seasonal flow by storing spring meltwater and producing their peak meltwater volumes in late summer. However, because of their small size and extent and the hydrologic influence of Chikuminuk Lake, the glaciers in the project basin are assumed to exert an extremely minor influence on basin hydrology.

3.4.2 Water Quantity / Flow Records

The United States Geological Survey (USGS) operates or has operated in the past a sparse system of stream gages in the Nushagak River region. These gages include:

15302000	Nuyakuk River near Dillingham (May 1953 – September 1996, July 2002 – September 2004, and July 2007 - present; active)
15302500	Nushagak River at Ekwok (October 1977 – September 1993; discontinued)
15302800	Grant Lake Outlet near Aleknagik (July 1959 – July 1965; discontinued)
15302900	Moody Creek near Aleknagik (July 1968 – present; active)
15303000	Wood River near Aleknagik (September 1957 – September 1970; discontinued)
15303010	Silver Salmon Creek near Aleknagik (October 1984 – September 1989; discontinued)
15303011	Wood River Trib near Aleknagik (May 1990 – September 1993; discontinued)
15303150	Snake River near Dillingham (August 1973 – September 1983; discontinued)
15301500	Allen River near Aleknagik, Alaska (June 1963 – September 1966, and September 2011 – present; active)

A stream gage was installed by the USGS in 1963 on the Allen River near the proposed dam site. The gage (15301500 – Allen River near Aleknagik, Alaska) recorded stream discharge from June 23, 1963 to September 30, 1966. Only weekly average data are available for the 1966 water year. Thirteen field discharge measurements were made during the period from August 19, 1963 through August 30, 1966. The gage was located at an elevation of approximately 550 feet and had a contributory drainage basin estimated to be 353 square miles. The USGS began gaging the Allen River again very near the site of the original gaging station in September 2011 under an agreement with Nuvista, and there is a discontinuous record of approximately 5-1/2 years of data available for the gage.

The Allen River hydrograph shows two distinct peak flow periods: a large, well-defined snowmelt peak in the early summer and one or more rainfall-induced peaks in the late summer or fall. The snowmelt peak usually occurs between late June and early July, and typically represents the highest mean daily flow of the year. Flows gradually decrease in the late fall and through the winter, and do not rise again until snowmelt begins in the spring. For the discontinuous period of record from 1963 to 1966 and 2011 to 2013, the mean annual flow of the Allen River was approximately 1,400 cfs. The peak stream flow recorded during this period was 7,930 cfs, which occurred in September 1965.

The USGS has operated a gage on the Nuyakuk River near its origin at the outlet of Tikchik Lake since May 18, 1953 (15302000 – Nuyakuk River near Dillingham, Alaska). A discontinuous record of approximately 51 years of data is available for the gage. Gaging records are available for the periods of May 18, 1953 through September 30, 1996; July 1, 2002 through September 30, 2004; and July 1, 2007 to the present. The gage is located at an elevation of 325 feet. The drainage basin above the gage is estimated to be 1,490 square miles. The Nuyakuk River gage shows a hydrograph similar to that of the Allen River gage. An analysis of average daily streamflow data for the period of record has shown a characteristic hydrograph consisting of two distinct peaks: a snowmelt peak in the early summer and a rainfall-induced peak in the late summer or fall. Like the Allen River, the snowmelt peak on the Nuyakuk River usually occurs between late June and early July, and typically represents the highest mean daily flow of the year. Flows gradually decrease in the late fall and through the winter and do not rise again until snowmelt begins in the spring. For the period of record from 1953 to 2012, the mean annual flow of the Nuyakuk River was approximately 6,300 cfs. The peak stream flow recorded during this period was 32,200 cfs, which occurred in July 1977.

Nuvista, as part of the 2013 feasibility assessment, used a linear regression of data from the coincident period of record between the Allen River and Nuyakuk River gages to extend the record of the Allen River gage. The linear regression results for the ice-free period of May 25 through October 15 were applied to a 41-year period of record for the Nuyakuk River gage, beginning in 1963 and extending into 2013. For the ice-affected winter period of October 16 to May 24, the monthly averages for the discontinuous 5-1/2-year record for the Allen River gage were used, and are expected to better represent flows during the winter months. Mean monthly flows for both measured and extended record flows for the Allen River gage are presented in Table 3.4-1.

Table 3.4-1 Allen River Mean Monthly Flows – Measured vs. Extended Record (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Measured (1963–66, 2011-2013)	419	378	338	285	396	4,560	3,146	2,012	2,602	1,400	518	467	1,377
Record Extension (Nuvista 2013)	419	378	338	285	599	3,907	3,314	2,060	1,760	1,365	518	467	1,284

3.4.3 Nuvista Stream Gages

In September of 2012, Nuvista's water resources team conducted a stream gage installation field trip to the project vicinity. Two stream gages were installed and are now being maintained by Nuvista: one 3.4 miles up from the mouth of the Allen River (Allen River below Canyon near Aleknagik, Alaska) and one near the outlet of Lake Chauekuktuli on the Northwest Passage (Northwest Passage near Aleknagik, Alaska). The location of the gages can be seen in **Figures 3.2-3 and 3.4-1**.

Data have been retrieved from the two Nuvista gages. The period of record is September 14, 2012 – August 16, 2013 for the Allen River gage, and September 13, 2012 – May 24, 2013 for the Northwest Passage gage. The gage at the Northwest Passage malfunctioned and has produced no reliable data since May 24, 2013. A total of four discharge measurements have been made at each gage. The open-water discharge measurements, made in August 2012, September 2012 and August 2013, were used to create a rating curve for each gage site. The rating curves were applied to the stage data collected at the gages for the open-water season only (May 25-Oct 15), and a more conservative approach was applied to the ice-affected season using the USGS Allen River gage data. Existing and Proposed Uses

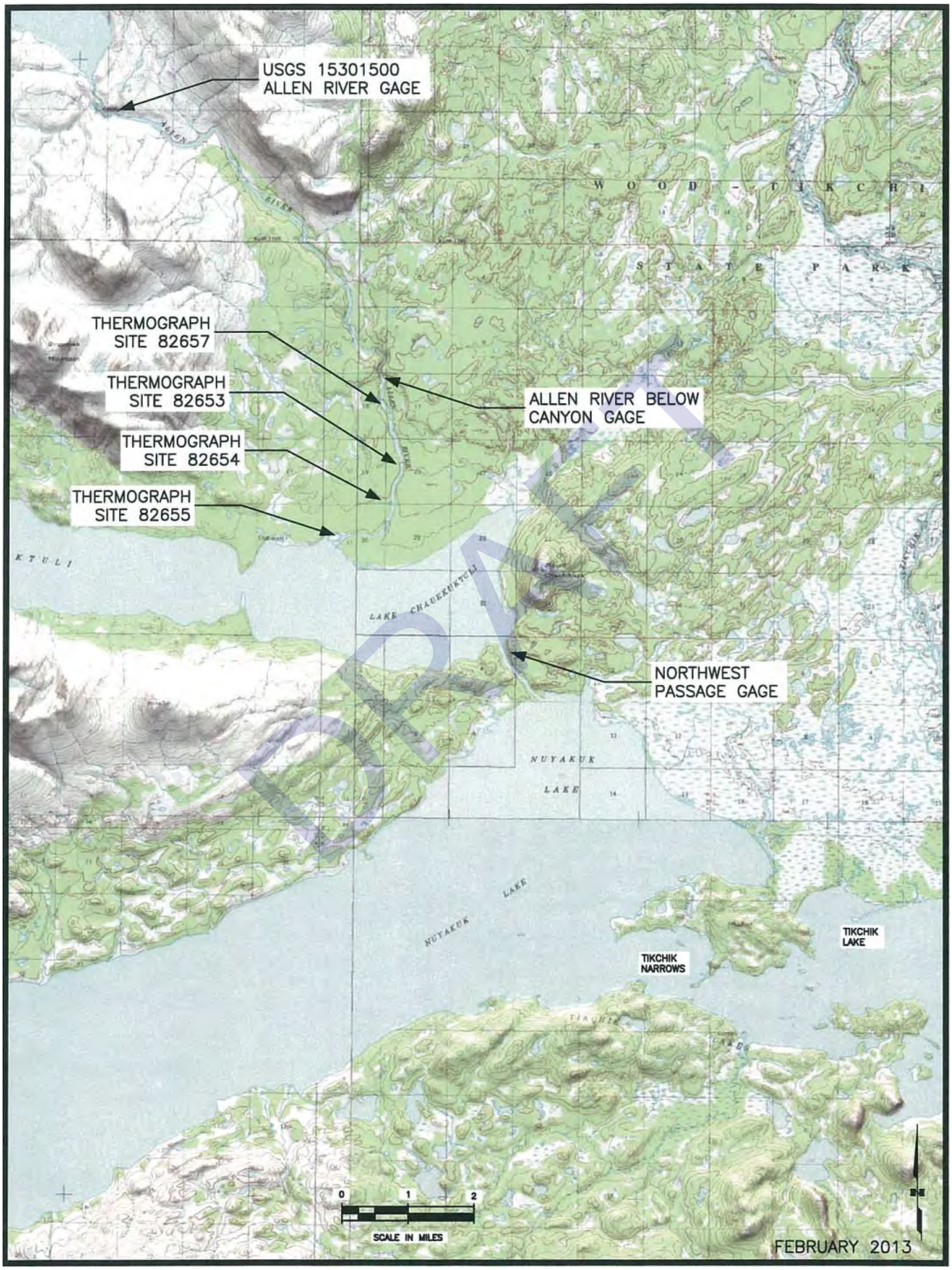
3.4.3.1 Existing Uses

Water in the Allen River and Chikuminuk Lake is not used for irrigation, domestic water supply, or industrial purposes. Chikuminuk Lake, the Allen River, as well as the other Upper Tikchik lakes and streams support arctic grayling, char, and lake trout. Because of dangerous rapids on the Allen River, Chikuminuk Lake is very rarely used as a staging point for longer boating trips. Subsistence use occurs, although it is thought to be quite limited. Most villagers using the lakes and rivers in the unit are from Koliganek, New Stuyahok and Ekwok. (ADNR 2002. See also Section 3.12.12, Subsistence Resources.)

3.4.3.2 Proposed Uses

No other uses of the water in the Allen River and Chikuminuk Lake are proposed beyond its use for hydroelectric generation as described herein.

Figure 3.4-1 Gage Sites and Thermograph Sites



3.4.4 Federal Standards

The Alaska Department of Environmental Conservation (ADEC) Division of Water manages the Water Quality Standards (WQS) program in Alaska (ADEC 2013). Current state standards are provided in the Alaska Administrative Code Title 18, Chapter 20, last amended on April 8, 2012 (ADEC 2012a). Standards approved by the state undergo EPA review to determine compliance with the Clean Water Act (CWA). An ADEC table provides a comparison between the state and federally approved water-quality standards (ADEC 2012b). Updates are available on the EPA Region 10 website, which outlines and describes changes to the WQS under recent EPA review, current EPA review, or expected to be submitted to EPA for review in the near future (USEPA 2013).

3.4.5 Seasonal Variations

3.4.5.1 Water Temperature and Dissolved Oxygen

Historical Water Temperature and Dissolved Oxygen Data

A very limited amount of water quality information is available for the project. The only quantitative data identified in a data gaps analysis for a study area that encompassed the Tikchik lakes were several water temperature measurements that were measured in the Allen River during August of 1982. What little other information was uncovered was qualitative in nature. Generally, statements like probably, could be, expected to be and are likely to be, preface most of the information available (Harza 1984). The limited information is described below.

The temperature of Chikuminuk Lake and the Allen River are identified as “cold” in several sources. The Wood-Tikchik State Park Management Plan states “the Tikchik lakes are deep, relatively cold, and low in nutrients” (ADNR 2002). The 1984 Harza Feasibility Study states: “the wintertime water temperatures in the Allen River are probably near 0°C through most of its length. Water entering Chikuminuk Lake is probably only slightly warmer, although it could be as warm as 3° to 4°C.” The summertime lake conditions are derived from a generalization about all subpolar lakes, stating they have a “temperature of about 4°C for only short periods.” Additionally, the Harza report includes a limited discussion about the temperature gradient in Chikuminuk Lake. Water entering the Allen River during the 1982 field visit was measured at 5°C and remained cold for the length of the river (Harza 1984).

Limnological studies and bathymetric charting were conducted during July 1964 in Lake Chauekuktuli, Nuyakuk Lake, and Tikchik Lake (Burgner and Reeves 1965). Only summary mean water chemistry values for the Tikchik lakes were reported, and these did not include temperature. Additionally, there is a paucity of historical information describing basic water chemistry, seasonal stratification and turnover, and bathymetry for Chikuminuk Lake.

Oxygen levels are expected to be high in Chikuminuk Lake and the Allen River, as cold waters usually have relatively high dissolved oxygen (DO) levels. Research conducted for the previously described data gap analysis did not identify any DO measurements for Chikuminuk Lake, the Allen River, or Tikchik lakes study area for comparison (Harza 1984).

2012 Water Temperature and Dissolved Oxygen Data

Water temperature data were gathered at several locations during baseline fish surveys conducted on Chikuminuk Lake and its tributaries in July and August of 2012 (Unpublished ABR, Inc. data, 2012). Lake and tributary stream temperatures ranged from 3.0°C to 3.6°C during early July sampling. Water temperatures in August ranged between 5.3°C and 7.5°C in several small channels of the Milk Creek delta. Temperatures of 6.9°C in the lake at the outlet of Milk Creek and 7.7°C in the center of Chikuminuk Lake were measured during this same period.

Temperature data are also collected at the USGS Allen River gage. Water temperatures varied from 4°C to 6°C in July 2012 before climbing to around 9°C in mid-August. Temperatures then fluctuated between 4°C and 8°C for much of the summer and fall before declining to around 2.5°C in mid-November.

Thermographs were installed at four locations in the lower Allen River in August (**Figure 3.4-1**). Preliminary results indicate that water temperatures followed a pattern similar to the USGS Allen River gage at three locations (82657, 82653, and 82654). However, the thermograph in the Allen River delta near Lake Chauekuktuli (82655) followed a different pattern (**Figure 3.4-2**). The delta thermograph decreased to 4°C in late August and early September when the stage recorded at the Allen River USGS gage (15301500) was low and the other three thermographs were reading above 8°C. The delta thermograph readings then increased to nearly match those at the upstream instruments for a brief period in late September, which corresponded to a high flow event that raised the stage at the USGS Allen River gage nearly two feet.

3.4.5.2 Other Physical and Chemical Parameters

Historical Water Quality Data

The only turbidity information identified in the data gap analysis efforts was a qualitative statement in the Wood-Tikchik State Park Management Plan that the waters of Chikuminuk Lake have the potential for high turbidity values based on the observation: "… glacial waters of Milk Creek, entering Chikuminuk Lake from the mountains to the west, impart a silty appearance to the lake's water" (ADNR 2002).

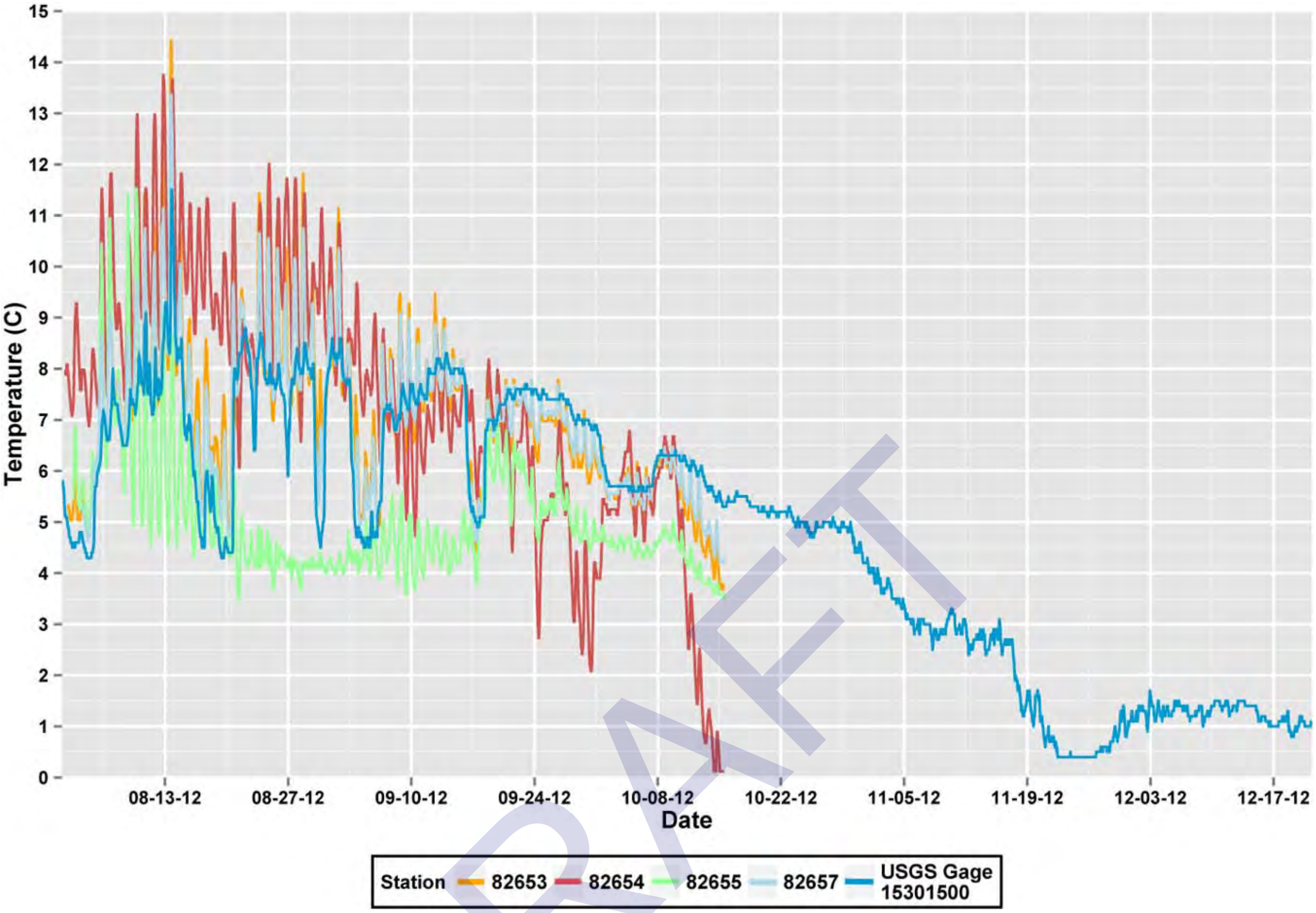
The Wood-Tikchik State Park Management Plan states that the Upper and Lower Tikchik lakes and groundwater were identified as having a low mineral content, with ranges from soft to moderately hard and a neutral or slightly alkaline pH (ADNR 2002). There were no other pH data identified for Chikuminuk Lake, the Allen River, or the study area.

No data were identified addressing dissolved metals present in Chikuminuk Lake, the Allen River, or surrounding water bodies.

One additional water quality data point was identified outside of the study area. A water sample was collected by a USGS field crew at Grant Lake, approximately 25 miles south of the study area, on April 20, 1960. The USGS Water Information System lists data for parameters including, but not limited to, pH, CO_2, nitrate, hardness, and dissolved solids. These data are limited to one sample that is over 40 years old.

Due to the lack of water quality data for Chikuminuk Lake and the Allen River, direct comparisons could not be made between existing conditions and federal and state of Alaska Water Quality Standards (18 AAC 70). Additionally, there was no known water quality information identified for similar lakes in the watershed.

Figure 3.4-2 Thermograph Data



No sediment data are available for Chikuminuk Lake and its major tributaries, the Allen River, or Northwest Passage. These waterbodies can be expected to experience some fluctuations in suspended sediment concentrations as a result of glacial melt and runoff from snowmelt or rainfall. Observations of stream and lake habitat during fish surveys conducted in July and August 2012 in the western portion of Chikuminuk Lake reflected these fluctuations. The Milk Creek delta and the surrounding lake habitat substrates are dominated by fine sediment. Tributaries in the southwest portion of the lake and southern shore of the main body of the lake provide habitat substrates of fine sediments, gravel, and cobbles. The eastern portion of Chikuminuk Lake nearshore habitat is composed primarily of clean gravel with very little fine sediment or other substrate types, indicating that most of the finer sediments carried into the lake from Milk Creek and other tributaries have settled out before the outlet to the Allen River.

2012 Water Quality Data

A single turbidity measurement was made at the outlet of Chikuminuk Lake in June of 2012. The outflow was noted to have extremely low turbidity. Observations made in June 2012 show that the sedimentation effect of glacially influenced Milk Creek does not extend further than approximately one mile to the east of its delta at the west end of Chikuminuk Lake.

Observations made in June 2012 when flows were at or near the annual peak showed clear water in the Allen River, Northwest Passage, and Tikchik Narrows. Chikuminuk Lake, Lake Chauekuktuli, and Nuyakuk Lake appear to serve as sediment sinks and are expected to allow most sediment carried by tributary streams to settle out except for organic particles and particles in colloidal suspension. This results in the rivers connecting the large lakes being relatively sediment-starved. As a consequence, fine-grained material in the stream bed of the Allen River has probably been winnowed away, leaving behind a coarse gravel and cobble lag that is only mobilized under extremely high flow conditions.

Ice Dynamics

Limited wintertime observations at the dam site suggest that the Allen River does not form a continuous ice cover near the proposed dam site and USGS 15301500 gage site, although shore ice is common. This may be due to the steepness of the channel, relatively mild winter temperatures, an influx of relatively warm groundwater, high winter base flows coming out of Chikuminuk Lake, or some combination of these factors. A continuous ice cover was observed in April 2013 on the lower Allen River between the lower Allen River gage and the mouth of the river at Lake Chauekuktuli. Open water was noted along the full length of the Northwest Passage on the April 2013 field trip, but significant shore ice accumulations were present along both banks of the river.

The lakes in the region form extensive ice covers. Breakup typically occurs in June after significant melting of the snowpack and of the in-place ice cover on lakes in the system. Lake ice can move down the rivers during breakup. Cobble ridges present on both sides of the channel of the Northwest Passage a short distance below the outlet of Lake Chauekuktuli are interpreted as ice push ridges. Regional observations of the Wood River below Lake Aleknagik suggest that ice does not move downstream until there has been significant in-place melting, and the ice floes are candled and rotten.

3.4.6 Reservoir Data

The existing Chikuminuk Lake surface area at elevation 613 feet is approximately 25,000 acres. Construction of the dam would raise the lake level to normal maximum elevation of 660 feet, with a corresponding increase of the surface area to about 34,000 acres; and the gross active storage capacity between El. 613 and El. 660 would be roughly 1,900,000 acre feet (Harza 1984, Exhibit 22). At its current water surface elevation of 613 ft, the shoreline length is approximately 87 miles, which would increase to approximately 100 miles at El. 660.

Detailed bathymetry data are not available for Chikuminuk Lake. However, Nuvista performed an initial bathymetry survey in 2012 with the use of kayaks and float planes. While the scope of this program was limited due to safety and time constraints, it confirmed that the main body of the lake is very deep, likely more than 500 feet deep over much of its area, with maximum depths greater than 600 feet (**Figure 3.4-3**).

The preferred dam site is located on the Allen River approximately 1.2 river miles downstream from the outlet of Chikuminuk Lake (see **Volume I**). The drainage area above the dam site is approximately 353 square miles.

Stacked storm beach ridges, which are interpreted to represent as many as a dozen previous and distinct lake levels, were noted at a few locations on the southern shore of Chikuminuk Lake during the June 2012 site reconnaissance. It is unknown if the current lake level is steadily decreasing and more of these storm ridges are being created at progressively lower elevations, if the lake level is generally rising and encroaching on the old ridges, or if the current level of the lake is relatively stable. Regardless, the relict storm ridges provide evidence of former lake levels that were higher than the present lake level.

3.4.7 Downstream Effects

The Allen River flows approximately 11.6 miles from its start at the outlet of Chikuminuk Lake to its delta along the northern shore of Lake Chauekuktuli. The drainage area of the Allen River at its mouth is approximately 379 square miles.

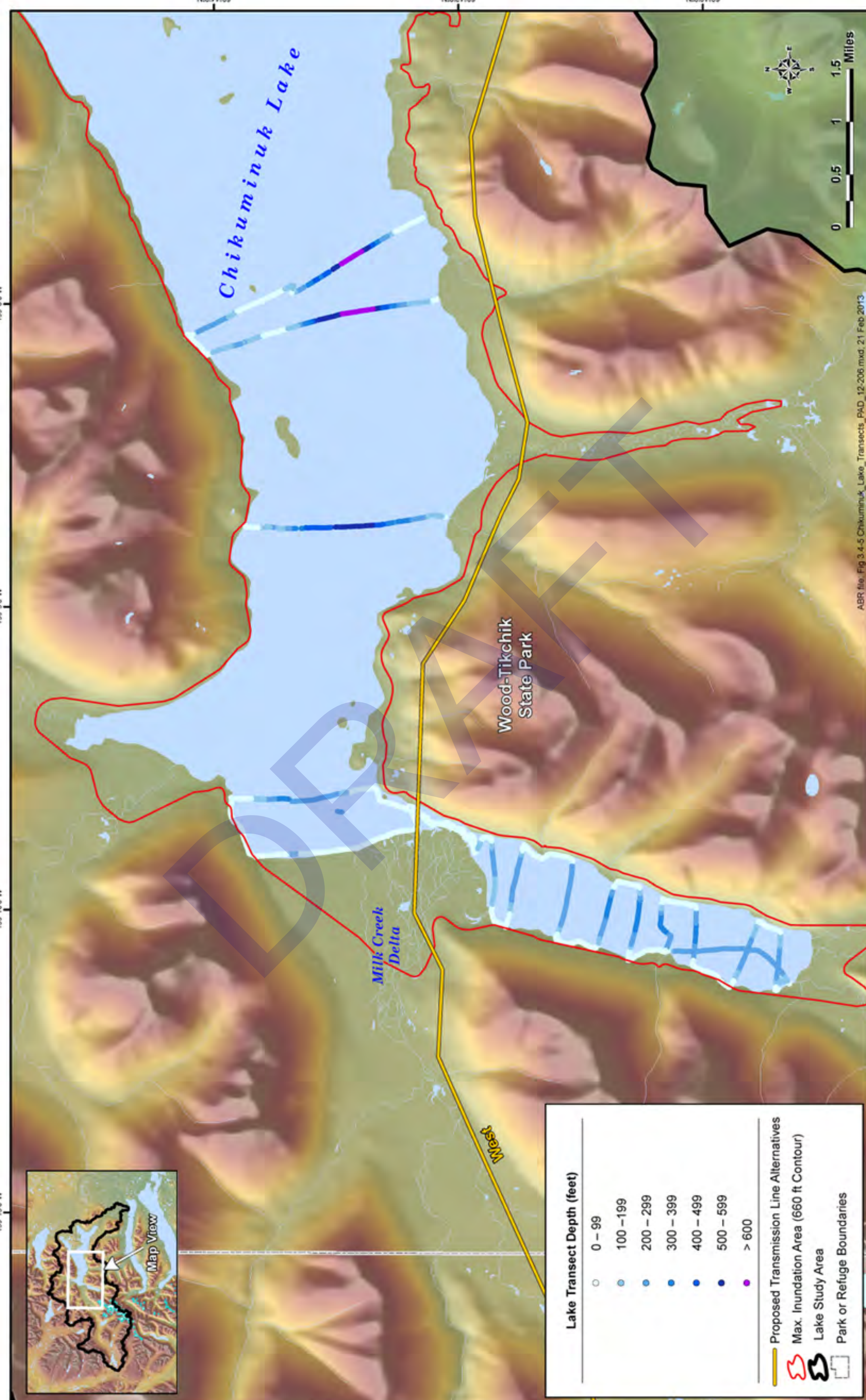


Figure 3.4-3 Chikuminuk Lake Bathymetry from 2012 Reconnaissance

The Allen River drops steeply over its entire length and accounts for a 298-foot change in elevation between Chikuminuk Lake and Lake Chauekuktuli, which sits at El. 315. The hydraulic path downstream from Lake Chauekuktuli, however, is much more gradual, taking in excess of 150 river miles to accomplish a 315-foot drop in elevation to Bristol Bay.

The Allen River has three sets of canyons. One canyon begins immediately below the outlet of Chikuminuk Lake and extends past the proposed dam site and to the site of USGS gage 15301500. A second canyon is present about midway down the length of the river, and a third canyon is present from approximately three to four miles above the river's mouth at Lake Chauekuktuli. The bed of the river appears to be composed of coarse gravel and cobbles, but is likely composed of bedrock and boulders in the canyons.

The cross-section of the river appears to be relatively uniform, with respect to both width and depth, except in the canyons. Side channels and braiding are rare to absent for much of the length of the river. Below the lower canyon, the river forms a split channel pattern with six or seven islands present two to three miles above the river's mouth. The channel pattern of the river remains fairly consistent along the lower two miles until near the river's mouth, where a deltaic distributary channel system is formed.

A prominent tributary (informally called the Allen River Tributary) enters the river from the west approximately one mile upstream from the mouth. With the exception of this tributary, very little in the way of concentrated flows have been noted entering the river from either side, although springs have been commonly noted on both sides of the river.

3.5 Fish and Aquatic Resources

The following description of fish and aquatic resources is based on the literature review and data gap analysis report for the Project (ABR 2012) as supplemented by baseline field studies performed by Nuvista in 2012.

Three distinct study areas were identified in the 2012 literature review and data gap analysis including:

- The Allen River extending downstream from the proposed Project facilities to its confluence with Lake Chauekuktuli;
- the Chikuminuk Lake basin or lake study area (**Figure 3.5-1**), where the inundation area and all Project facilities would be located; and
- The transmission corridor study area, comprising the proposed West Route (see **Volume I**) between Chikuminuk Lake and Bethel.

Other alternative transmission corridors as discussed in **Volume I** – including the Chikuminuk Lake to Dillingham corridor – were not under consideration during development of the gap analysis. Although this overview of fish and aquatic resources does not specifically cover the alternative transmission corridors, much of the general discussion regarding the likely presence of fish species there may apply.

3.5.1 Existing Fish Communities

The Wood-Tikchik State Park is noted for its 12 primary interconnected lakes; six each in the Tikchik lakes and Wood River lakes systems. As shown on **Figure 3.2-1**, the Tikchik system includes Nishlik Lake, Upnuk Lake, Chikuminuk Lake, Lake Chauekuktuli, Nuyakuk Lake and Tikchik Lake. The physiographic setting, hydrology, and water quality of the lakes, streams and rivers of the Tikchik system are described **Sections 3.2** and **3.4** of this report and the data gap analysis reports (R&M 2012a, 2012b; **Appendix B**). Relative to the Wood River system, considerably fewer studies have been conducted on the Tikchik lakes system leading to a paucity of site-specific background information. Of survey efforts that have been performed in the Tikchik system, the majority have occurred during the last ten years. Administered by ADF&G's Anadromous Waters Catalog (AWC) and Alaska Freshwater Fish Index (AFFI) programs, these studies over the last 10 years primarily documented anadromous and resident fish populations (ADF&G 2011) (**Figure 3.5-2**). Limited studies of lake trout have occurred in Heart Lake, Chikuminuk Lake, and Tikchik Lake (MacDonald 1996; Bosch et al. 1995; Walsh et al. 2006). In addition, the southern three lakes of the system, Chauekuktuli, Nuyakuk, and Tikchik lakes were surveyed in 1961 and 1962 for primary productivity, lake thermodynamics, bathymetry, and salmon spawning distributions (Burgner et al. 1969).

There has been little effort to fully characterize the presence or absence of resident species and habitat in Chikuminuk Lake and its inlet streams. Fish presence/absence, species composition and distribution, seasonal movements, feeding behavior, habitat use, and spawning behavior and locations have not been evaluated for the basin. Additionally, the upstream extent of fish presence and the location of potential barriers to fish passage in inlet streams are unknown. Nearshore lake benthic habitats in the basin that are important for macroinvertebrates and periphyton production and for their role as a food resource for fishes in the basin have not been described.

The adjacent Wood River lakes system that lies to the southwest, however, has a history of state, federal, and independent academic scientific fish studies (ABR 2012). The U.S. Fish and Wildlife Service (USFWS) started conducting surveys of sockeye salmon spawning and escapement in 1946, and ADF&G has monitored salmon escapement for over 60 years by visual means and, more recently, by sonar estimation (Marriott 1964; Nelson 1966, 1967; Dunaway and Sonnichsen 2001). The University of Washington Fisheries Research Institute (FRI) has conducted frequent studies of anadromous and resident fishes over the last 50 years focusing on the Wood River system. The FRI maintains three field stations throughout the Wood-Tikchik State Park, where past and current projects have collected data on primary productivity, bathymetry, and the climatology of the Wood

River system. Additional data associated with spawning distribution and age structure of sockeye salmon populations are widely available (Church 1963; Burgner and Reeves 1965; Rogers 1967; Burgner et al. 1969; Rogers 1973, 1977a, 1977b; Chihuly 1979; Rogers and Rogers 1998; Ruggerone et al. 2000; Schindler et al. 2005; Lin et al. 2011; McGlauflin 2011).

Overall, twenty-four species of resident and anadromous fishes have been observed in the Wood-Tikchik lakes system, including all five species of Pacific salmon (**Tables 3.5-1** and **3.5-2**) (Burgner and Reeves 1965; Grumman Ecosystems Corporation 1971; Rogers 1977a, 1977b; Page and Burr 1991; ADF&G 2011). The Wood and Nuyakuk rivers have been estimated to account for upward of 20 percent of the total Bristol Bay sockeye salmon (*Oncorhynchus nerka*) escapement (Grumman Ecosystems Corporation 1972). Past sockeye salmon spawning surveys conducted by the ADF&G have revealed that spawning occurs in several areas of Tikchik Lake, Tikchik River, Lake Nuyakuk, Lake Chauekuktuli, and in the lower Allen River (Weiland et al. 1994). Sockeye salmon have not been found in Lake Chikuminuk, most likely due to the presence of several potential fish migration impediments in the Allen River which limit the upstream extent of sockeye movement.

Table 3.5-1 Reported Fish Species within Wood-Tikchik Lake Systems

Common Name	Scientific Name	Life History
Pink salmon	*Oncorhynchus gorbuscha*	Anadromous
Sockeye salmon	*O. nerka*	Anadromous
Coho salmon	*O. kisutch*	Anadromous
Chum salmon	*O. keta*	Anadromous
Chinook salmon	*O. tshawytscha*	Anadromous
Rainbow trout	*O. mykiss*	Resident or Anadromous
Dolly Varden char	*Salvelinus malma*	Resident or Anadromous
Arctic char	*S. alpinus*	Resident
Lake trout	*S. namaycush*	Resident
Arctic grayling	*Thymallus arcticus*	Resident
Least cisco	*Coregonus sardinella*	Amphidromous
Humpback whitefish	*C. pidschian*	Amphidromous
Round whitefish	*Prosopium cylindraceum*	Resident
Pygmy whitefish	*P. coulteri*	Resident
Burbot	*Lota lota*	Resident
Northern pike	*Esox lucius*	Resident
Alaska blackfish	*Dallia pectoralis*	Resident
Arctic lamprey	*Lampetra japonica*	Anadromous
Alaskan brook lamprey	*L. alaskens*	Anadromous
Rainbow smelt	*Osmerus dentex*	Anadromous
Slimy sculpin	*Cottus cognatus*	Resident
Coastrange sculpin	*C. aleuticus*	Catadromous
Ninespine stickleback	*Pungitius pungitius*	Resident
Threespine stickleback	*Gasterosteus aculeatus*	Resident

Sources: ADF&G 2011, Grumman Ecosystem Corporation 1971b, Burgner and Reeves 1965.

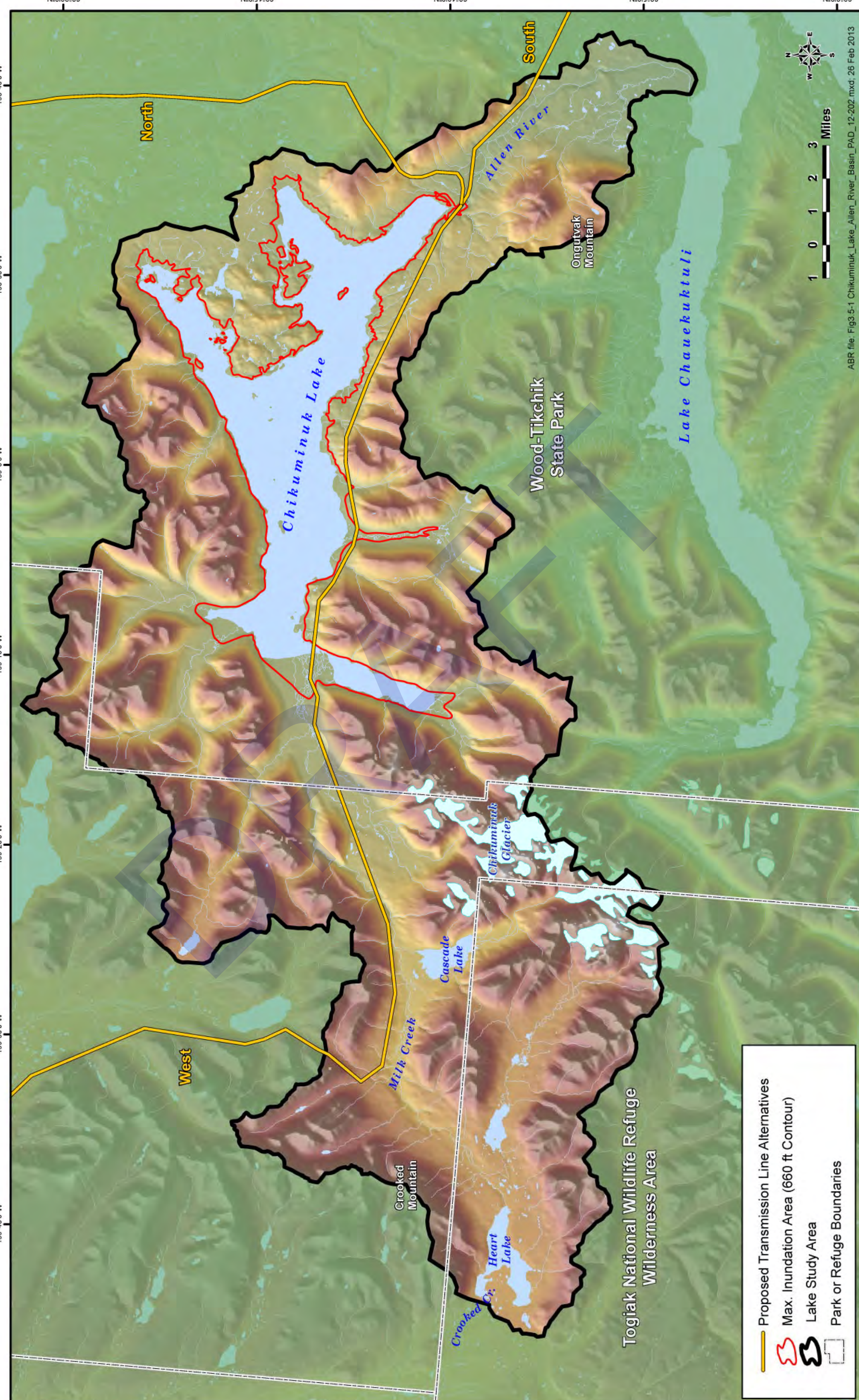
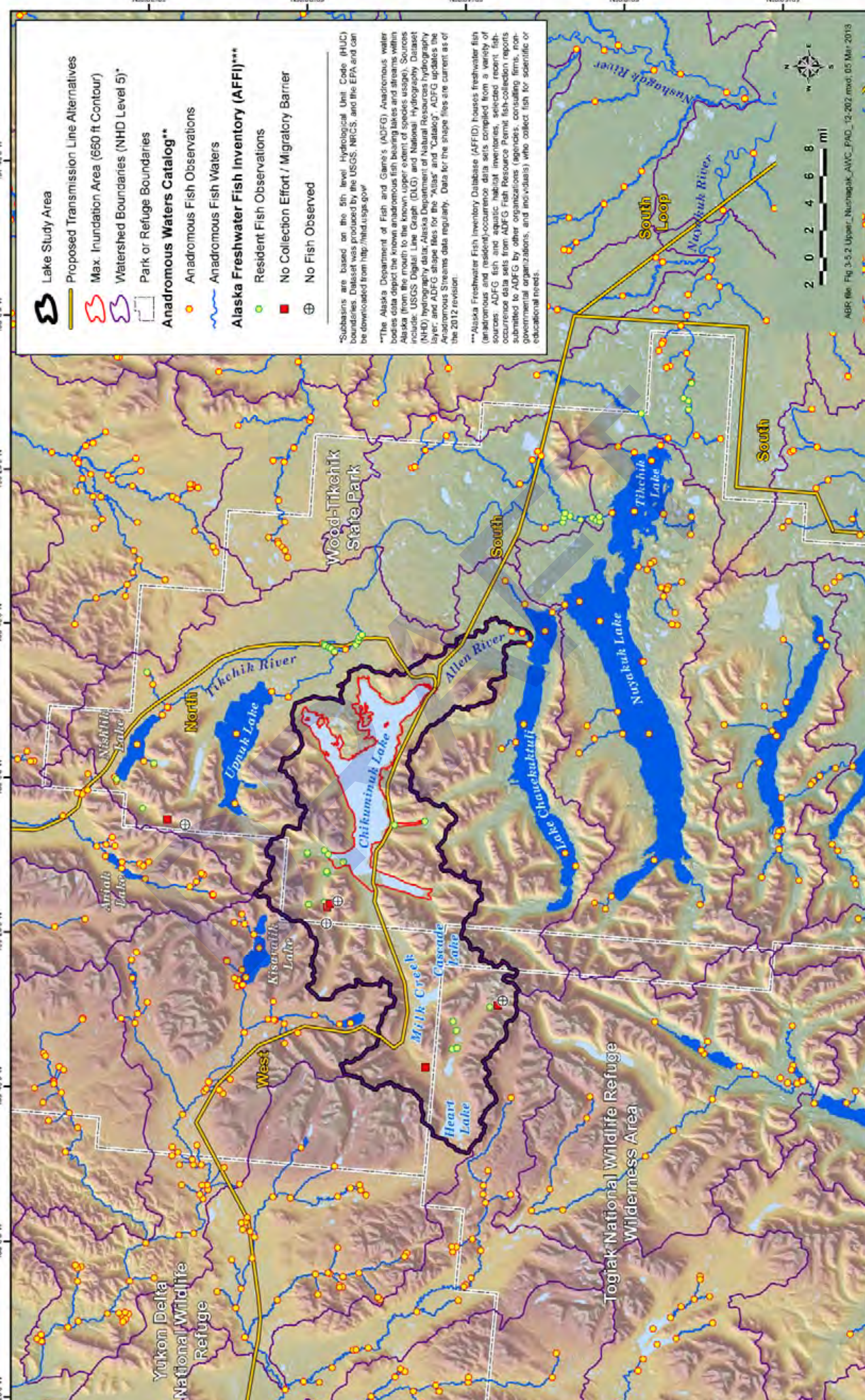


Figure 3.5-1 Chikuminuk Lake Fish and Aquatics Study Area

Figure 3.5-2 Upper Nushagak River System and Lower Kuskokwim River Fish Observations



Sources: ADF&G, Anadromous Waters Catalog, 2011. Alaska Freshwater Fish Inventory Program

Table 3.5-2 Anadromous and Resident Fish Species Identified within the Tikchik Lakes System

Waterbody [a]	Anadromous Species	Resident Species
Nishlik Lake	sockeye salmon, Dolly Varden [b]	
Upnuk Lake	sockeye salmon	arctic char
Tikchik River	sockeye salmon, Chinook salmon, coho salmon, chum salmon, pink salmon, arctic lamprey, Alaskan brook lamprey	arctic char, arctic grayling, lake trout, burbot, northern pike, round whitefish, slimy sculpin
Chikuminuk Lake		Dolly Varden[b], lake trout, slimy sculpin, ninespine stickleback
Allen River	sockeye salmon	
Chauekuktuli Lake	sockeye salmon	arctic char
Nuyakuk Lake	sockeye salmon, Chinook salmon, coho salmon, chum salmon, pink salmon, unspecified whitefish[c]	arctic char
Nuyakuk River	sockeye salmon, Chinook salmon, coho salmon, chum salmon, pink salmon, unspecified whitefish[c]	arctic char
Nushagak River	sockeye salmon, Chinook salmon, coho salmon, chum salmon, pink salmon, arctic lamprey, Alaskan brook lamprey unspecified whitefish[c]	arctic char, arctic grayling, rainbow trout, burbot, northern pike, round whitefish, slimy sculpin, longnose sucker, ninespine stickleback, threespine stickleback

[a] Lakes listed include species also observed in inlet streams. Major tributaries and connecting streams are listed separately.
[b] Dolly Varden are considered to exist as resident and anadromous populations (ADF&G 2011, Armstrong and Morrow 1980).
[c] Depending on species, may be resident or amphidromous.

Sources: ADF&G Anadromous Waters Catalog and Alaska Freshwater Fish Inventory.

Resident fish species are also abundant in Wood-Tikchik State Park. Rainbow trout (*Oncorhynchus mykiss*), arctic grayling (*Thymallus arcticus*), lake trout (*Salvelinus namaycush*), arctic char (*Salvelinus alpinus*), Dolly Varden (*Salvelinus malma malma*), and northern pike (*Esox lucius*) are all common sport fish found in waters within the area (ADNR 2002). In addition to popular sport fish, Burgner and Reeves (1965) collected humpback whitefish (*Coregonus pidschian*), pygmy whitefish (*Prosopium coulterii*), least cisco (*Coregonus sardinella*), round whitefish (*Prosopium cylindraceum*), lake trout, burbot (*Lota lota*), threespine stickleback (*Gasterosteus aculeatus*), ninespine stickleback (*Pungitius pungitius*), and slimy sculpin (*Cottus cognatus*) in combination across the two lake systems. Limited studies of Lake Trout (*Salvelinus namaycush*) have occurred in Heart Lake, Chikuminuk Lake, and Tikchik Lake (MacDonald 1996; Bosch et al. 1995; Walsh et al. 2006). In addition, Lake Chauekuktuli, Nuyakuk Lake, and Tikchik Lake were surveyed in 1961 and 1962 for primary productivity, lake thermodynamics, bathymetry, and salmon spawning distributions (Burgner et al. 1969).

3.5.2 Aquatic Habitat

Fish and aquatic habitat in the project area can be broadly categorized as stream and river (i.e., lotic or riverine) habitat or lake (i.e., lentic or lacustrine) habitat. The relative amounts of these habitats are determined by the physiographic characteristics of the area and geomorphic processes such as the ice, hydrologic, and sediment transport capacity of the system. Within lakes, habitat can be further categorized as littoral, pelagic, and benthic zones. Littoral zones are adjacent to the shoreline, interact with the riparian zone surrounding the lake, and may also have aquatic vegetation. The pelagic zone includes open water areas that are generally deep, while the benthic zone is the lowest level in a body of water and has interactions with sediment. In general, littoral habitat and the surrounding riparian habitat are the zones frequently affected by hydroelectric development because of changes in water surface elevations.

The Tikchik and Wood River lake systems result from land-locked fiords created during the advancement and recession of glaciers. All lakes of the Wood-Tikchik systems have been classified as temperate, deep (>98 ft maximum depth; i.e., >30 m) and generally nutrient poor (Grumman Ecosystems Corporation 1971, 1972). Shorelines are generally steep except in areas where tributaries have created deltas. None of the Tikchik lakes have been surveyed in detail. Consequently, the amount of littoral habitat potential affected by hydroelectric development is unknown. Two of the Tikchik lakes will be directly influenced by the Project, Lake Chauekuktuli which receives much of its inflow from the Allen River and will therefore be subjected to lake elevation changes in conjunction with flow regulation, and Lake Chikuminuk which drains into the Allen River and will be subjected to lake elevation changes due to dam construction and management of flow releases into the Allen River.

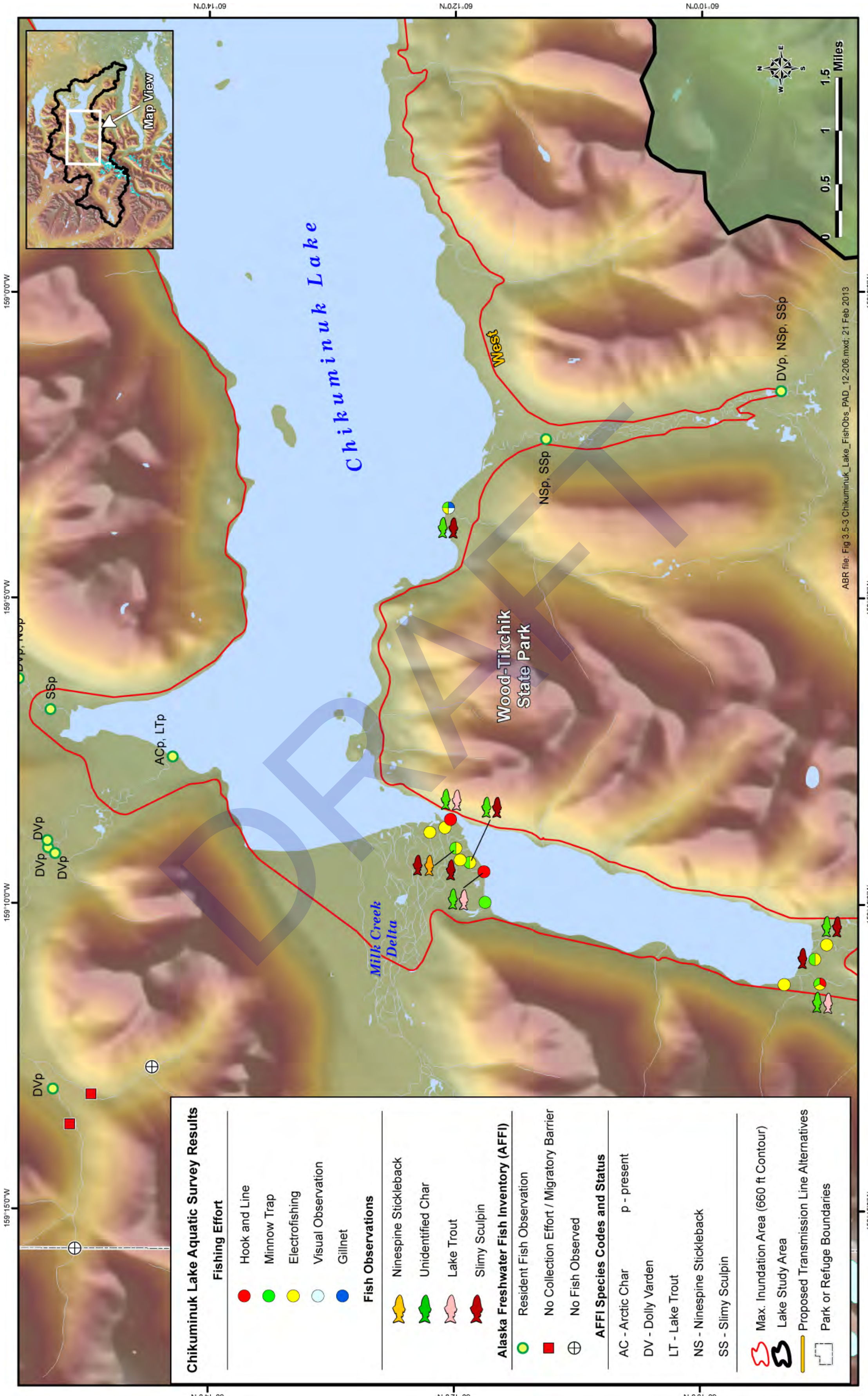
The natural normal pool elevation of Lake Chauekuktuli is El. 327 ft with a surface area of 20,288 acres. Lake Chauekuktuli is a deep lake with a maximum depth of 893 ft (272 m) and an estimated volume of 3.1 x 10^{11} ft^3 (8.9 km^3) (Yanagawa 1967). Littoral habitat is important to sockeye salmon in Lake Chauekuktuli since it contains areas used for spawning. Past sockeye salmon spawning surveys conducted by the ADF&G have revealed that spawning occurs in several areas of Tikchik Lake, Tikchik River, Lake Nuyakuk, Lake Chauekuktuli, and in the lower Allen River (Weiland et al. 1994).

Chikuminuk Lake is the third most northern of the principal Tikchik lakes and is approximately 16 miles long with a number of distinct bays and outcrop islands (Grumman Ecosystems Corporation 1971; Walsh 2006; ADF&G 2011). The natural normal pool elevation of Chikuminuk Lake is El. 613 ft with a surface area of about 24,640 acres. Except at its western end, there are relatively few major streams entering the lake. Only two unnamed major streams were noted during a June 2012 site reconnaissance along the northern shore of the lake between the northwest and north arms of the lake (**Photo 3.5-1**). These inflows appeared to be generally lower gradient compared to other streams on the north shore of Chikuminuk Lake. There are two large unnamed tributaries along the western portion of the southern shore of the main body of Chikuminuk Lake which are likely to provide significant fish habitat. These streams appear to be mostly low gradient (**Photo 3.5-2**). Four significant tributaries enter the southernmost portion of the southwest arm of the lake within an extended flood plain. The major inflow to the western end of the lake is Milk Creek, which drains approximately half of the Chikuminuk Lake basin (**Photo 3.5-3**). Heart Lake lies at the headwaters of Milk Creek.

Many of the smaller tributaries flowing into Chikuminuk Lake are high gradient streams in which only the lower reaches appear to provide habitats suitable for fish production. The upper reaches of these streams likely contain physical barriers to fish migration (e.g., steep cascades or falls); while seasonally high flows in these reaches would likely also create velocity barriers (**Photo 3.5-4**). Larger tributaries to the lake which can at minimum support seasonal fish populations for rearing and feeding are located primarily on the southern shore of the lake, in the northwest corner of the lake and in the southernmost portion of the southwest arm of the lake (**Figure 3.5-3**). Additional larger tributaries on the northeastern shore of the lake do not appear to have been previously surveyed (**Photo 3.5-5**). Preliminary bathymetric surveys conducted in the western portion of the main body of the lake indicate a depth of at least 640 feet, while the maximum depth in the southwest arm of the lake which is fed by Milk Creek is approximately 430 feet.

The large, deep lakes in the Tikchik basin, including Chikuminuk Lake, are sediment sinks that allow fine sediment delivered from upstream tributaries to settle out (see **Section 3.4**). Consequently, outlet rivers to these lakes such as the Allen River for Chikuminuk Lake are generally clear water systems that transport relatively low levels of fine sediment. Bedload and suspended load transport rates for the Allen River are unknown at this time. The Allen River, Chikuminuk Lake, and its major tributaries are likely to experience some seasonal changes in suspended sediment concentrations due to snow and glacial melt and runoff, and from rainfall events. There are numerous unnamed tributaries entering the Allen River, all of which are relatively small and unlikely to substantially affect flows in the river.

Figure 3.5-3 Resident Fish Observations in the Area of Upper Portions of Chikuminuk Lake



Aquatic habitat in the Allen River downstream of the proposed project has not been characterized. At an overall gradient of approximately 21 feet/mile (0.4%), the Allen River makes a relatively steep descent from its source in Chikuminuk Lake to its terminus in Lake Chauekuktuli. The upper 11 miles is higher gradient and the river tends to be more incised, situated within a canyon much of the way. The lower two miles is lower gradient and contains more depositional features such as point bars, islands and an alluvial delta at the confluence with Lake Chauekuktuli. Cursory inspection of aerial photo and videography indicate that cascade (**Photos 3.5-6** and **3.5-7**), riffle **(Photos 3.5-8** and **3.5-9**), run (**Photo 3.5-10**), and pool (**Photo 3.5-11**) meso-habitat types are represented. Although relatively uncommon, some lateral habitat that should provide good rearing habitat is also present, primarily in the lower two miles of the Allen River (**Photo 3.5-12**). Several deep pool areas exist within the canyon areas and provide excellent adult and juvenile feeding and holding habitats. These same areas are also likely used as overwintering habitats. In general, overwintering habitat for salmonids tends to include areas that are relatively deep, with large cobble or boulder cover (Bjornn and Reiser 1991). Beaver ponds and areas with upwelling were identified as being important overwintering areas in the Susitna River basin (Jennings 1985). While some of these features exist in the Allen River, as evidenced during aerial reconnaissance surveys in June and August, specific locations of these features have not been identified. The amount of suitable spawning habitat in the lower Allen River has also not been quantified but observations made during reconnaissance surveys completed in August indicate suitable spawning gravels are present in the river (e.g., **Photo 3.5-13**), primarily in locations proximal to shoreline areas as well as island complexes.

3.5.2.1 Potential Fish Passage Barriers

No sockeye presence or spawning has been observed and reported for Chikuminuk Lake. Consequently, it is generally concluded that anadromous fish cannot ascend three potential fish passage impediments due to high water velocities associated with steep cascades. Two are located in the middle section of the Allen River (e.g., **Photo 3.5-6**, at river mile 3.7), and one in the upper section of the Allen River (**Photo 3.5-7)**, at river mile 10.4. Nevertheless, there is some uncertainty about the factors limiting the distribution of sockeye salmon in the Allen River and to what extent potential impediments may be influenced by flow. The presence of barriers to fish passage of resident fish to tributaries of Chikuminuk Lake including Milk Creek and other unnamed inlet streams are also unknown.

3.5.2.2 Sediment, Ice, and Geomorphology

Fluvial geomorphic conditions are fundamental physical attributes that contribute to the quantity and quality aquatic species spawning and rearing habitats. Bedload and suspended load transport rates for the Allen River are unknown at this time. The Allen River, Chikuminuk Lake, and its major tributaries are likely to experience some fluctuations in suspended sediment concentrations as a result of glacial melt and runoff from snowmelt or rainfall. Observations of stream and lake habitat during fish surveys conducted in July and August 2012 in the western portion of Chikuminuk Lake reflected these fluctuations. The Milk Creek delta and the surrounding lake habitat substrates were dominated by fines resulting from glacial melt. Tributaries in the southwest portion of the lake and southern shore of the main body of the lake provide substrates composed of silts and sands, gravel and cobble. The portion of Chikuminuk Lake nearshore habitat is composed primarily of clean gravel with very little silt and sand or other substrate types. This would indicate that most of the finer sediments carried into the lake from Milk Creek and other tributaries have settled out before the outlet to the Allen River. This was visually apparent during the June 2012 aerial reconnaissance of the lake.

As previously noted, the large, deep lakes in the Tikchik basin, including Chikuminuk Lake, are sediment sinks that allow fine sediment delivered from upstream tributaries to settle out (**Section 3.4**). Consequently, outlet rivers such as the Allen River have relatively low levels of fine sediment. Furthermore, the Allen River for the first eight miles downstream of Chikuminuk Lake is high gradient and the floodplain is naturally limited due to local geology, which further reduces the opportunity for finer particles to settle. Most of the river channel is deeply incised through this section.

The presence of frazil ice, anchor ice, and continuous ice cover during the winter months can affect fish use in riverine habitats. Salmonids often redistribute to overwintering habitat near the onset of winter (Bjornn 1971). Limited wintertime observations suggest that the Allen River does not form a continuous ice cover near the proposed dam site and USGS 15301500 gage site, although shore ice is common (**Section 3.4**). This may be due to the steepness of the channel, an influx of relatively warm groundwater, high winter base flows coming out of Chikuminuk Lake, or some combination of these factors. Limited wintertime observations at the dam site suggest that the Allen River does not form a continuous ice cover near the proposed dame site, although shore ice is common.

Habitat utilization by salmonids can also change near the time of ice break-up in the spring (Jennings 1985). With the onset of warmer air temperatures during mid to late spring, the low-elevation snowpack melts first, causing the river discharge to increase. The rising water level puts pressure on the ice, causing fractures to develop in the ice cover. The severity of breakup is dependent upon the snow melt rate, the depth of the snowpack, and the amount of rainfall. Flooding and erosion that may occur during breakup are important factors influencing channel morphology. In addition, rising flows can make off-channel habitats accessible for rearing by emerging fry. Lake Aleknagik (elevation 37 feet), in the Wood River system is usually ice-free from early June to late October. It is the first of the lakes to breakup with the others following successively within a two week period (BLM 2005). Ice breakup on Lake Chauekuktuli and Chikuminuk Lake at elevations 315 ft and 613 feet, respectively, would likely follow shortly thereafter.

3.5.2.3 Water Temperature

Temperature is an important water quality parameter affecting the metabolic rates and behavior of salmonids (Bjornn and Reiser 1991). Water temperature affects the activity level of fish during overwintering periods and also the developmental rates of incubating eggs. A limited amount of water quality information is available for the project area as described in **Section 3.4**. The only historical quantitative data identified during gap analysis were several water temperature measurements from the Allen River during August of 1982. Harza (1984) indicated that water entering the Allen River during the 1982 field visit was measured at 5°C and remained cold for the length of the river. Additionally, there is a paucity of information describing basic water chemistry, seasonal stratification/ turnover, or bathymetry for Chikuminuk Lake. These variables, in addition to temperature, likely influence the seasonal movements of resident fishes within the lake and its tributaries for feeding and reproduction.

Continuous water temperature data collected during the summer of 2012 at four locations in the Allen River and one tributary to the Allen River are reported in **Section 3.4**. Preliminary results indicated temperatures declined rapidly during the second week of October for the tributary thermograph compared to those in the Allen River. The thermograph located at the mouth of the Allen suggested upwelling may be occurring, which tends to stabilize temperature fluctuations. The degree to which this may be influencing sockeye spawning in the area is unknown.

There are few historical records of water temperatures in Chikuminuk Lake or its tributaries, including Milk Creek. Harza (1984) collected limited baseline lake surface to depth temperatures on August 26, 1982. Temperatures ranged from 8.0°C at the surface to 4.5°C at 197 ft (60 m) depth. ABR biologists measured surface temperatures of 7.7°C on Chikuminuk Lake on August 5, 2012 (ABR, unpublished data). Harza did not report temperature data for inlet streams, but Nuvista collected minimal data from several small tributaries in early July and August 2012. Water temperatures in four tributaries on the southern shore of Chikuminuk Lake ranged between 3.0 and 3.4°C on July 5th and 6th of 2012. Temperatures in Milk Creek Delta measured 5.3°C in the main channel near its outlet to Chikuminuk Lake and 7.5°C in slack water side channels of the Delta on August 3, 2012.

3.5.2.4 Riparian Habitat

There are no previous riparian community studies or riparian baseline information specific to the Allen River or Chikuminuk Lake. Because of the isolated nature of the project site inside the Wood-Tikchik State Park, the riparian conditions along the lake shoreline and Allen River have been largely undisturbed. In protected valleys such as along the Allen River, dominant genera include willows, alders and cottonwoods (ADNR 2002). The riparian community is an important component to fish and aquatic resources that provides streambank stability, nutrients, and woody debris. Large woody debris (LWD) (logs, stumps, and branches) is an important component of stream ecosystems. It increases aquatic habitat diversity through the formation of pools, meanders, undercut banks, and backwater areas, aids in energy dissipation and in the deposition of spawning gravel, and it traps sediment and organic debris that can retain nutrients in the ecosystem and influence the development of riparian habitat communities.

3.5.2.5 Streamflow

Fish and other aquatic fauna such as aquatic insects, often have specific flow-related requirements of water depth and velocity, and substrate types (Gore and Judy 1981), that along with other physical factors determine the quantity and quality of habitat. Streamflow also influences fish passage and other physical characteristics such as water temperature, substrate size distribution, stream bed morphology, and riparian function. However, no basic aquatic habitat mapping of the project area or development of habitat-flow relationships have been accomplished to date for the Allen River. Consequently, how streamflow regulation may influence the quantity and quality of habitats in the Allen River is currently unknown.

In addition to the provision of spatial elements that define fish habitat, streamflow is also important for creating and maintaining these habitats. Such flows generally fall into the category of peak flows which typically occur as part of the natural runoff cycle associated with snowmelt and glacial melt processes. The peak flows in the Allen River are poorly understood because of the lack of a sufficiently long record of mean daily flows (**Section 3.4**).

Finally, groundwater flow can provide a substantial contribution in some systems to the overall flow in a river. The majority of flow in the Allen River comes directly from Lake Chikuminuk, although there are likely locations of groundwater inflow occurring over the entire extent of the river down to its mouth with Lake Chauekuktuli. The locations and magnitude of groundwater inflows to the river is currently unknown.

3.5.3 Federal and/or State Management of Fishery or Fish Habitat

3.5.3.1 Fishery

Most fish species of the project area are of management interest because of their use in subsistence and/or recreational activities and also their role in ecosystem dynamics. For these reasons, freshwater habitats for fish are protected by many state and federal water-quality and fish-habitat regulations. Because of their importance in commercial, sport, and subsistence harvest, anadromous fish (salmon, trout, and some whitefish populations) are of particular conservation interest, and development activities that could potentially affect anadromous fish waterbodies are regulated by the Alaska Department of Fish and Game (ADF&G), the Alaska Department of Natural Resources (ADNR), and the National Marine Fisheries Service (NMFS).

3.5.3.2 Habitat

The federal Magnuson-Stevens Fishery Conservation and Management Act (as amended by the Sustainable Fisheries Act of 1996) was passed by Congress to provide Fishery Management Plans (FMP) for the nation's important fisheries. The plans are administered by the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service which has created management plans for the five Pacific salmon species. As required by law, FMP's for anadromous species extend into freshwaters. Special provisions under this legislation are in place to protect Essential Fish Habitat (EFH) for fisheries that have a management plan (NMFS 2012). EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Specific areas of the major rivers, tributaries, lakes, and ponds that would be classified as sensitive anadromous fish spawning and rearing habitats will need to be identified as EFH for all waterbodies in the project area. Once EFH components are fully identified, steps to ensure minimal disturbance to these areas both during and after construction of the project will be required. Chief concerns during and after construction periods will be the minimization of effluent releases, eliminating any alterations to EFH connectivity, and monitoring for and eliminating any potential behavioral changes in anadromous fish caused by increased anthropogenic activity in these streams.

Alaska's Title 16 is the state regulatory statute devised to protect aquatic habitat important to anadromous and resident fish. Information on aquatic habitat important to anadromous fish is maintained by ADF&G in the "Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes" (ADF&G 2011) also known as the AWC. NOAA Fisheries Service generally refers to the ADF&G catalog when determining whether inland freshwater habitats warrant special protection under the Magnuson-Stevens Act. Because the AWC documents sockeye salmon in both the lower Allen River and Lake Chauekuktuli, the habitat in these waters is automatically afforded special protection as EFH.

3.5.4 Temporal and Spatial Distribution

3.5.4.1 Chikuminuk Lake

Chikuminuk Lake is the third most northern of the principal Tikchik lakes with a number of significant bays and outcrop islands (Grumman Ecosystems Corporation 1971; Walsh et al. 2006; ADF&G 2011). Milk Creek feeds Chikuminuk Lake from the west and is the largest of several perennial tributaries to the lake. Milk Creek's headwaters are located at the outlet of Heart Lake and the creek drains several other lakes to the west of Chikuminuk including Cascade Lake (**Figure 3.5-1**). Most inlet streams to Chikuminuk Lake are unnamed and have never been surveyed for fish. The Allen River is the sole outlet of the lake and flows approximately 13 miles (21 km) south into Lake Chauekuktuli.

Lake trout, arctic char, slimy sculpin, and ninespine stickleback have been documented in the Heart Lake system which includes Heart Lake, Cascade Lake, and Milk Creek, which drains into Chikuminuk Lake (Walsh et al. 2006). Chikuminuk Lake supports resident populations of lake trout, Dolly Varden, arctic char, slimy sculpin, and ninespine stickleback (Walsh et al. 2006; ADF&G 2011). In 2005, ADF&G documented a waterfall approximately 4.0 miles (6.5 km) northeast of Heart Lake on Milk Creek as part of the Alaska Freshwater Fish Inventory program (AFFI) and reported this as a fixed geological barrier to fish passage (**Figure 3.5-2**) (MacDonald 1996; ADF&G 2011). This suggests that fish passage from Chikuminuk Lake to Heart Lake is not possible.

Heart Lake was surveyed in 1984 and 1987 by the USFWS as part of a four-year study of 21 Togiak National Wildlife Refuge (NWR) lakes (MacDonald 1996). As part of this study, detailed bathymetry, fish sampling, plankton, and fish gut content data were collected. Discharge was also periodically recorded at the outlet of Heart Lake during genetic studies of lake trout (Walsh et al. 2006). This study investigated genetics for lake trout samples collected from a number of lakes, including Heart and Chikuminuk lakes, as a contribution to a study of the genetic relationships of lake trout populations within the Togiak NWR (Walsh et al. 2006). In 2005, a southern tributary to Chikuminuk Lake was sampled for fish presence/absence as part of the ADF&G AWC/AFFI program (ADF&G 2011; Wiedmer 2010).

Reconnaissance-level surveys were undertaken in 2012 to evaluate fish species composition in Chikuminuk Lake and its tributaries (ABR, unpublished data). One small tributary was surveyed on the southern shore of the main body of Chikuminuk Lake and four tributaries were sampled on the southwest leg of the lake during July 2012 (**Figure 3.5-3**). An additional five stream channels associated with the Milk Creek delta were visually surveyed in July and then electrofished and minnow trapped in August 2012. Lake trout fry and juveniles were present in small numbers in the lower gradient (<5%) reaches sampled during this time. Large schools of lake trout fry were visible in backwater sloughs of the Milk Creek delta in July but had dispersed by August sampling.

Adult lake trout were captured using hook and line at the southwestern-most portion of Chikuminuk Lake in July 2012 near the outlets to several tributaries in that area. Adult lake trout and arctic char were caught at the outlet of Milk Creek to Chikuminuk Lake (**Figure 3.5-3**). Sport fishing guides from nearby Tikchik Narrows Lodge have suggested the presence of large lake trout (>30 inches fork total length) in deeper portions of the lake in years past (Hodson 2012, pers. comm.). The survey team was unable to sample deeper waters in 2012 but nearshore hook and line sampling at the mouth of Milk Creek yielded nearly two dozen lake trout adults averaging approximately 17 inches in total length. Lake trout outnumbered the similarly sized arctic char by a ratio of 10:1 during hook and line surveys near the mouth of Milk Creek. Small numbers of sculpin (*Cottidea* spp.) were captured via electrofishing in the lower reaches of most of the tributaries to Chikuminuk Lake that were surveyed in July and August 2012. Ninespine sticklebacks were captured in minnow traps at the mouth of Milk Creek in August 2012.

Additional sampling carried out by ADF&G in August 2005 and by a group of researchers from ADF&G, USGS, and The Nature Conservancy in August 2010 occurred in one large tributary flowing into the south shore of the main body of Chikuminuk Lake as well several small tributaries in the northwest corner of the lake. These surveys found lake trout, Dolly Varden, arctic char, slimy sculpin, and ninespine stickleback (**Figure 3.5-3**).

The degree to which seasonal fish movement in and out of Chikuminuk Lake is possible from either its major inlet at Milk Creek or its major outlet at the Allen River is unclear. However anecdotal information provided by fishing guides in the region (Hodson 2012, pers. comm.) suggests that physical structures resulting in falls/cascades and/or channel constrictions resulting in velocity chutes exist in both streams and can impede or prevent upstream migration of fish. It is also unknown whether fish found in tributaries to Chikuminuk Lake are present seasonally or if overwintering habitat is available allowing fish occupancy year round.

3.5.4.2 Allen River

Sockeye salmon spawn in the lower reaches of the Allen River and along the shores of Lake Chauekuktuli (ADF&G 2011). The Anadromous Waters Catalog (AWC) depicts the upstream extent of sockeye salmon in the Allen River as roughly 1.9 miles (3.1 km) north of Lake Chauekuktuli. However, the most recent AWC nomination amendment occurred in 2011 and resulted in a slight extension of the observed upstream presence of sockeye in the Allen River (Wiedmer et al. 2010; ADF&G 2011).

Reconnaissance-level surveys were undertaken in 2012 to evaluate fish species composition and periodicity in the Allen River (ABR, unpublished data). Opportunistic minnow trapping, electrofishing and hook and line fishing surveys were conducted on the in the river as well as one of its tributaries and a series of springs near the lower section of the river, in late July and early September 2012. In addition, visual observations were made during August 2012 field reconnaissance surveys (R2 Resource Consultants 2012a, 2013). Sockeye salmon were observed in the outlet of the Allen River as it enters Lake Chauekuktuli and along its shoreline near the outlet of the Allen River from late July until early September during flights over the river. Several adult sockeye were observed in the lower Allen River during the August 1–3 field trip including a single observation upstream of the uppermost point noted in the AWC (**Figure 3.5-4**). However, no redds or spawning activity was observed in the river during that survey and no sockeye were observed in the river during the August 27–28 trip. Sockeye salmon were observed along the shoreline of Lake Chauekuktuli during both the August 1–3 and August 27–28 field trips.

Fishing guides at Tikchik Narrows Lodge (Hodson 2012, pers. comm.) have described a popular arctic grayling fishery in the lower Allen River from the mouth at Lake Chauekuktuli upstream to a canyon and a large set of rapids which preclude upstream boat travel (**Figure 3.5-4**). During the September surveys, several arctic grayling were captured within this section of the river using hook and line methods (ABR, unpublished data). Additionally, slimy sculpin, arctic grayling and unidentified juvenile char were caught in minnow traps and by electrofishing in the lower river and several small tributaries (**Figure 3.5-4**). Several juvenile arctic char were captured via minnow traps within a side slough complex located parallel to the river at the upper end of this segment (R2 Resource Consultants 2012a).

3.5.4.3 Transmission Corridor

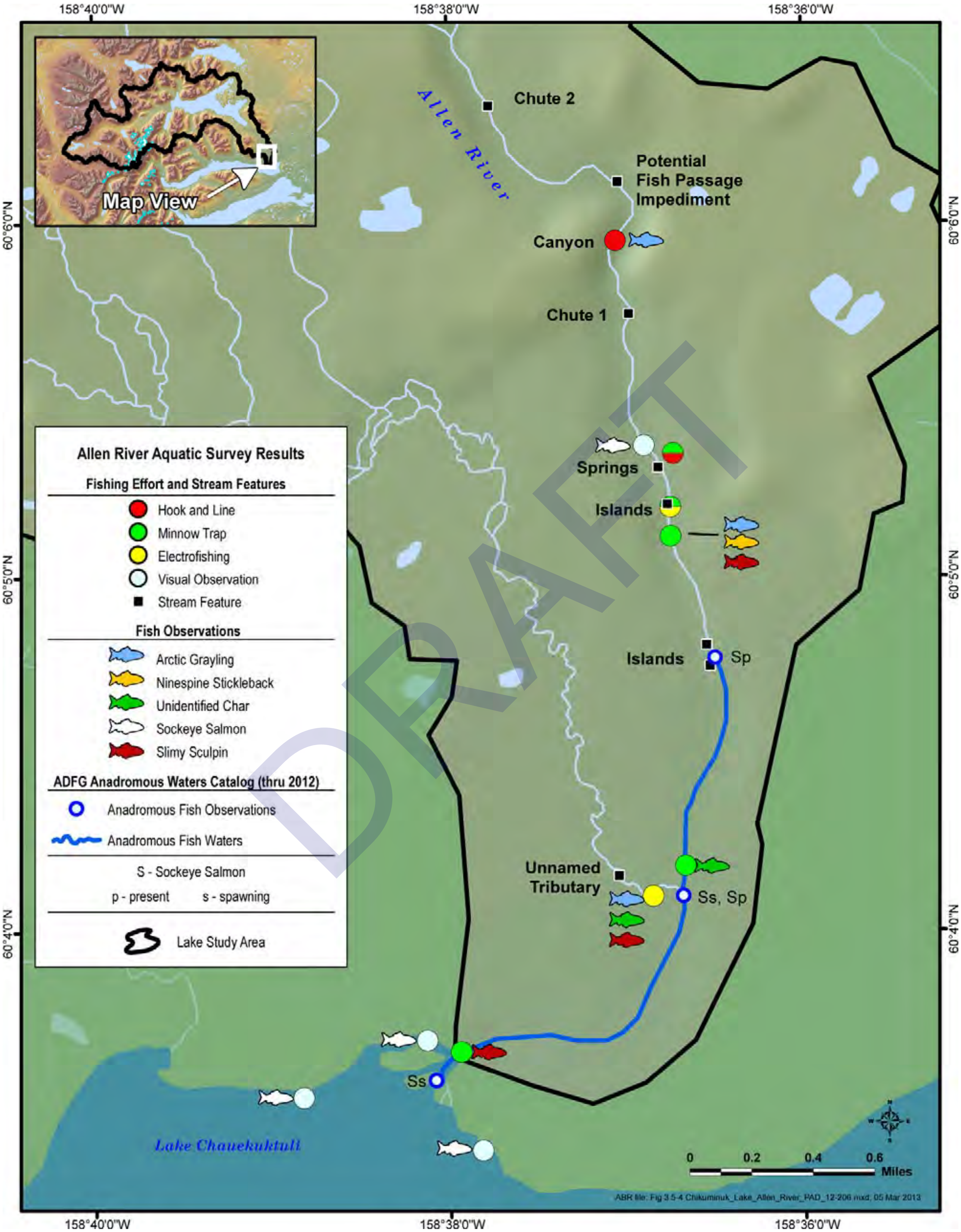
A literature review and gap analysis for fish and aquatics was conducted for the direct, West transmission route alternative between the hydropower development on Chikuminuk Lake and Bethel, which includes portions of the Kuskokwim River drainage. The major drainages of the Lower Kuskokwim River are the Aniak, Tuluksak, Kisaralik, Kasigluk, Kwethluk, and Eek rivers (**Figure 3.5-5**). This alternative would cross the Kisaralik, Kasigluk, and Kwethluk River watersheds (**Figure 3.5-5**). These rivers and associated tributaries have their headwaters in the Kilbuck and Ahklun mountains and flow through the northern portion of the Yukon Delta NWR, (Brown et al. 1985; USFWS 1988). All five species of Pacific salmon are found in the transmission corridor (**Table 3.5-3**) (Alt 1977; Wilson et al. 1982; Brown et al. 1985).

In addition to the five Pacific salmon, these waterways support up to 20 other species of anadromous, and resident fishes (**Figure 3.5-5**; **Tables 3.5-3** and **3.5-4**) (Alt 1977; Wilson et al. 1982; UFWS 1988). The extent to which individual species utilize the area's aquatic habitats for reproduction, rearing, and feeding varies widely on both spatial and temporal scales (**Table 3.5-4**). Salmon spawning in the Kisaralik River occurs principally between Quartz Creek (see **Figure 3.5-5**) and Nukluk Creek (about 25 river miles downstream from Quartz Creek), although coho and Chinook salmon also spawn in Kisaralik Lake, the headwaters of the river (Alt 1977; Faurot and Jones 1992; Buzzel 2010; ADF&G 2011). The river's mid-section is a popular sport fishing area for rainbow trout, arctic char, and arctic grayling (Harper et al. 1997). Commercial and subsistence fishing for Chinook and chum salmon occurs near the confluence of the Kisaralik River with the Kuskokwim River (Baxter 1981, 1982).

The major salmon spawning in the Kasigluk River occurs upstream of the confluence with Columbia Creek and continues into the headwaters of the system (ADF&G 2011). Rainbow trout are present in the Kasigluk drainage, although sport fishing for these and other non-salmon species, such as northern pike and arctic char, is less intensive than in the Kisaralik River (Alt 1977; Wilson et al. 1982). Substantial commercial and subsistence fishing for Chinook and chum salmon occurs near the confluence of the Kasigluk River with the Kuskokwim River (Wilson et al. 1982; Boyd and Coffing 2000).

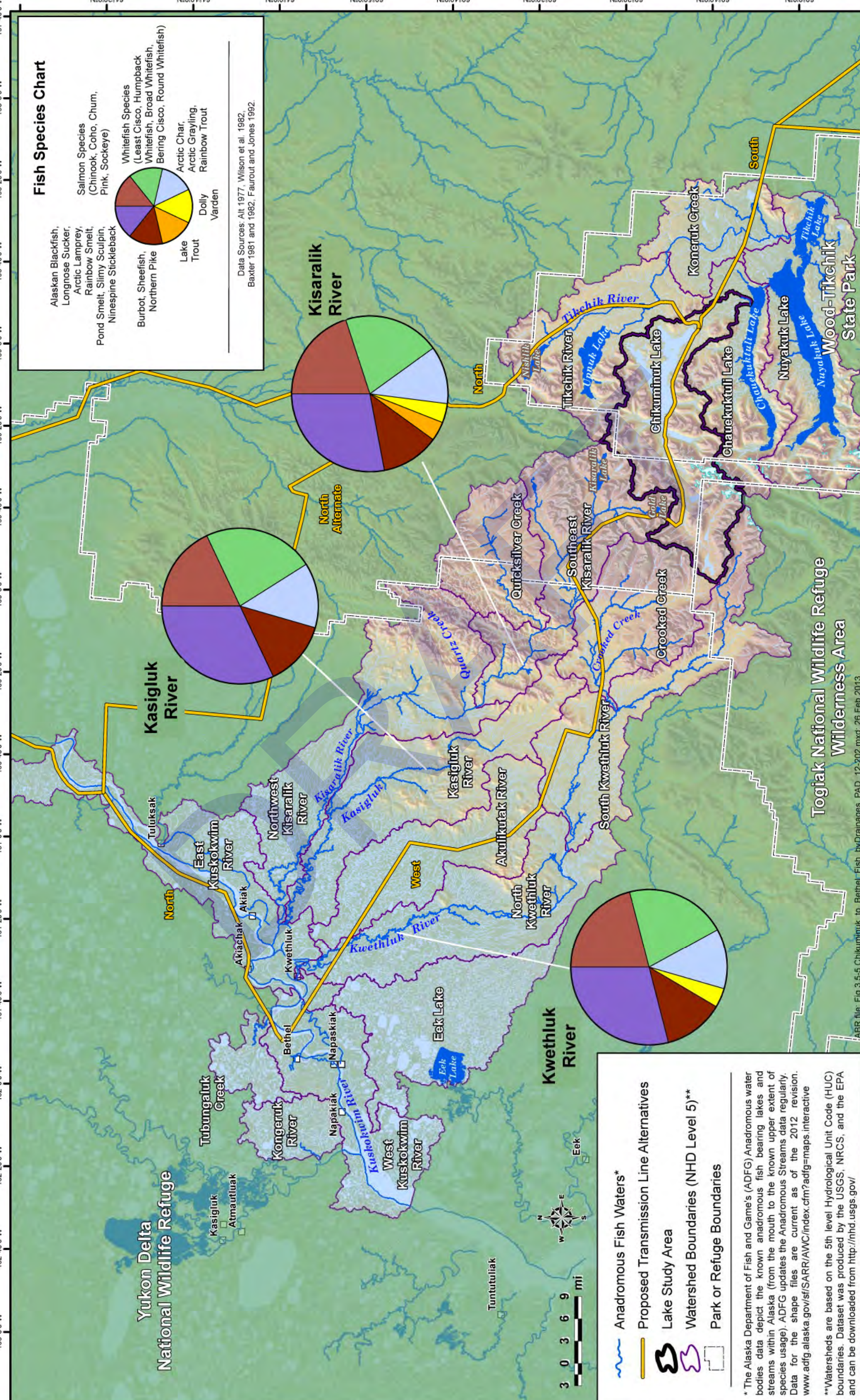
The Kwethluk River offers rearing habitat for all species of salmon, rainbow trout, arctic char, and arctic grayling. The braided, gravel-bottomed mid-section of the river provides habitat for spawning Chinook, coho, chum, and pink salmon, although all four species occur as far upstream as the headwaters of Crooked Creek (**Figure 3.5-5**) (Alt 1977; Wilson et al. 1984; Roettiger et al. 2004; ADF&G 2011). The Kwethluk receives considerable subsistence and commercial fishing at its confluence with the Kuskokwim River; in the early 1980s it was described as having the most sport fishing pressure of the main Lower Kuskokwim tributaries (Wilson et al. 1982).

Figure 3.5-4 Resident and Anadromous Fish Observations on Allen River



Sources: 2012 Reconnaissance trips
ADF&G Anadromous Waters Catalog, 2011

Figure 3.5-5 Study Area Drainage Basins and Fish Community Composition along West Transmission Route Alternative to Bethel



Sources: Alt 1977; Wilson et al. 1982; Baxter 1981, 1982; Farout and Jones 1992.

Table 3.5-3 Reported Fish Species in Major Drainages along West Transmission Route Alternative

Common Name	Scientific Name	Life History	Major Drainages
Pink salmon	*Oncorhynchus gorbuscha*	Anadromous	Kisaralik, Kasigluk, Kwethluk
Sockeye salmon	*O. nerka*	Anadromous	Kisaralik, Kwethluk
Coho salmon	*O. kisutch*	Anadromous	Kisaralik, Kasigluk, Kwethluk
Chum salmon	*O. keta*	Anadromous	Kisaralik, Kasigluk, Kwethluk
Chinook salmon	*O. tshawytscha*	Anadromous	Kisaralik, Kasigluk, Kwethluk
Rainbow trout	*O. mykiss*	Resident	Kisaralik, Kasigluk, Kwethluk
Dolly Varden	*Salvelinus malma*	Resident or Anadromous	Kisaralik, Kwethluk
Arctic char	*S. alpinus*	Resident	Kisaralik, Kasigluk, Kwethluk
Lake trout	*S. namaycush*	Resident	Kisaralik
Arctic grayling	*Thymallus arcticus*	Resident	Kisaralik, Kasigluk, Kwethluk
Least cisco	*Coregonus sardinella*	Amphidromous	Kisaralik, Kasigluk, Kwethluk
Humpback whitefish	*C. pidschian*	Amphidromous	Kisaralik, Kasigluk, Kwethluk
Broad whitefish	*C. nasus*	Amphidromous	Kisaralik, Kasigluk, Kwethluk
Bering cisco	*C. laurettae*	Amphidromous	Kisaralik, Kasigluk, Kwethluk
Round whitefish	*Prosopium cylindraceum*	Resident	Kisaralik, Kasigluk, Kwethluk
Burbot	*Lota lota*	Resident	Kisaralik, Kasigluk, Kwethluk
Sheefish	*Stenodus leucichthys*	Resident	Kisaralik, Kasigluk, Kwethluk
Northern pike	*Esox lucius*	Resident	Kisaralik, Kasigluk, Kwethluk
Alaska blackfish	*Dallia pectoralis*	Resident	Kisaralik, Kasigluk, Kwethluk
Longnose sucker	*Catostomus catostomus*	Resident	Kisaralik, Kasigluk, Kwethluk
Arctic lamprey	*Lampetra japonica*	Anadromous	Kisaralik, Kasigluk, Kwethluk
Rainbow smelt	*Osmerus dentex*	Anadromous	Kisaralik, Kasigluk, Kwethluk
Pond smelt	*Hypomesus olidus*	Resident	Kisaralik, Kasigluk, Kwethluk
Slimy sculpin	*Cottus cognatus*	Resident	Kisaralik, Kasigluk, Kwethluk
Ninespine stickleback	*Pungitius pungitius*	Resident	Kisaralik, Kasigluk, Kwethluk

Sources: ADF&G 2011; Faurot and Jones 1992; Baxter 1981, 1982; Wilson et al. 1982; Alt 1977.

In 1975 and 1976, ADF&G conducted detailed surveys of fish presence and utilization of the major tributaries of the Lower Kuskokwim River (i.e., Aniak, Tuluksak, Kisaralik, Kasigluk, and Kwethluk rivers) and Kuskokwim Bay (i.e., Eek, Kanektok, and Goodnews) (Alt 1977). Life history, habitat use, food availability, and age structure of anadromous and resident fishes of the area were extensively analyzed. Diets of arctic grayling, arctic char, and rainbow trout from several of the rivers of the Lower Kuskokwim River drainages were determined from gut content analysis. Of the major drainages of the Lower Kuskokwim River, the Kisaralik River has received the most attention because of a proposed hydroelectric project in the 1970s and its consideration for designation as a national Wild and Scenic River (NPS 1984; Brown et al. 1985; Faurot and Jones 1992; Harper et al. 1997; Buzzell 2010). Salmon runs in the major tributaries of the Lower Kuskokwim River and Kuskokwim Bay have been monitored by ADF&G since 1954 (Wilson et al. 1982). While the distribution of fish species is fairly well understood, in some cases, synthesis of fish and other aquatic resource information is lacking, particularly in headwaters associated with the Kisaralik, Kasigluk, and Kwethluk River watersheds. In addition, little information on the factors affecting these species' life histories, including habitat availability, food availability, fish migratory timing, and spawning behavior is available.

Table 3.5-4 Spawning Periodicity, Preferred Spawning Locations, and Life History Notes for Fish in Major Drainages of the Lower Kuskokwim River

Common Name	Spawning Activity		Life History Notes
	Period	Location	
Pink salmon	Jul	Lower sections of main rivers with suitable substrate	Limited odd/even year runs. Even years are the strongest
Sockeye salmon	Aug–Sep	Shallow tributaries and side channels w/ suitable substrate and lake connections	Limited runs; more common in the Kuskokwim Bay drainages
Coho salmon	Sep–Oct	Shallow tributaries and side channels with suitable substrate	Second most abundant salmon species in the Lower Kuskokwim River drainages
Chum salmon	Jul	Shallow tributaries and side channels with suitable substrate	Most common salmon species in the Lower Kuskokwim River drainages
Chinook salmon	Late Jun–Jul	Shallow tributaries and side channels with suitable substrate	Moderate runs in larger tributaries
Rainbow trout	Late May–early Jun	Shallow tributaries and side channels with suitable substrate	Widely dispersed and common in larger rivers and their tributaries. Overwinter in deep holes of larger rivers
Arctic char	Late May–early Jun	Shallow tributaries and side channels with suitable substrate	Widely dispersed with varied life histories. Stream and lake residents as well as anadromous stream populations
Lake trout	Sep–Oct	Shallower rocky areas of deep, upland lakes	Do not spawn in consecutive years
Arctic grayling	Late May–early Jun	Shallow tributaries and side channels with suitable substrate	Widely dispersed and found in good number in larger rivers, tributaries and connected lakes. Overwintering occurs in the Kuskokwim and mouths of larger tributaries
Least cisco	Sep–Oct	Slower waters of the mainstem Kuskokwim River	Widely distributes in low-lying lakes and in the lower reaches of larger tributaries
Humpback whitefish	Sep–Oct	Slower waters of the mainstem Kuskokwim River	Found in the lower reaches of larger tributaries to the Kuskokwim River
Broad whitefish	Sep–Oct	Slower waters of the mainstem Kuskokwim River	Mainly occur in the mainstem Kuskokwim, occasionally in the lower reaches of major tributaries
Bering cisco	Sep–Oct	Slower waters of the mainstem Kuskokwim River	Mainly found in the mainstem Kuskokwim and its downstream brackish waters
Burbot	Nov–Dec	Deep areas of the mainstem Kuskokwim River and major its tributaries	Found mainly in deeper, low-lying lakes and in the lower reaches of larger tributaries
Sheefish	Early Oct	Mainstem of the Kuskokwim River	Occasionally use tributaries of the Lower Kuskokwim River
Northern pike	Late May	Slow moving waters of interconnected lakes and larger tributaries of the mainstem Kuskokwim River	Likely overwinter in the mainstem of the Kuskokwim

Sources: ADF&G 2011, Faurot and Jones 1992, Wilson et al. 1982, Alt 1977.

Photo 3.5-1 View of northwest arm of Chikuminuk Lake. The broad floodplain in the distance was sampled by ADF&G in 2010.

Photo 3.5-2 Typical view of lower reach of streams on southern shore of Chikuminuk Lake.

Photo 3.5-3 View of broad floodplain associated with Milk Creek delta. The main channel of Milk Creek flows near the base of the mountain in the left of photo.

Photo 3.5-4 Looking west across the south shore of Chikuminuk Lake. Note the typical gradient of shoreline with lower reaches of streams available as fish habitat while upper reaches are higher gradient.

Photo 3.5-5 View of lower gradient northeast shore of Chikuminuk Lake. Few significant streams were seen flowing into this portion of lake during June 2012 reconnaissance surveys. No fish sampling has occurred in this portion of the lake to date.

Photo 3.5-6 Cascades in the Allen River at River Mile 3.7, thought to be at least a partial barrier to anadromous fish distribution.

Photo 3.5-7 Cascades in the upper Allen River near the proposed powerhouse at River Mile 10.4. This set of cascades likely poses a partial barrier to anadromous fish distribution.

Photo 3.5-8 Chikuminuk Lake outlet, preferred project features downstream of this view.

Photo 3.5-9 Representative riffle habitat in the Allen River.

Photo 3.5-10 Representative aerial photograph of run habitat in the Allen River.

Photo 3.5-11 Representative view of pool type habitat in the Allen River.

Photo 3.5-12 Representative photograph of lateral rearing habitat in the lower Allen River.

Photo 3.5-13 Representative photograph of potential spawning habitat in the lower Allen River

3.6 Botanical Resources

The following description of botanical resources, wetlands, riparian and littoral habitat is based on the literature review and data gap analysis report for the Chikuminuk Lake Hydroelectric Project (ABR 2012). The two study areas identified in the 2012 Biological Resources report were the Allen River/Chikuminuk Lake basin or lake study area, where the inundation area and all Project facilities would be located, and the West transmission corridor study area, comprising the West Route between Chikuminuk Lake and Bethel. Other alternative transmission line corridors discussed in **Volume I**, including the Chikuminuk Lake to Dillingham alternatives, were not under consideration during development of the gap analysis. Although this overview also does not specifically cover them, vegetation patterns are likely to be similar for many portions of alternative corridors. Further botanical literature review and data gap analysis studies are needed before additional routes are considered.

No vegetation or wetlands assessments or fine-scale mapping studies of vegetation or wetlands have been conducted within the Project study areas. Several regional or Alaska-wide (coarse-scale) vegetation and wetlands mapping efforts cover some or all of the study areas, but these map products do not provide the detail necessary to delineate vegetation and wetland types at the finer scales required for permitting the proposed Project.

3.6.1 Land Cover Types and Plant Species

3.6.1.1 Physiographic Relationships

Little information on vegetation, wetlands, and wildlife habitat types is currently available specific to the Project study areas. However, there are several vegetation-land cover reports focused on similar ecosystems relatively near the lake study area or the West transmission corridor study area, and it can reasonably be assumed that the vegetation in these study areas is at least roughly similar. In particular, several studies (Morsell et al. 1981; Wilson et al. 1982; NPS 1984a; and USFWS 1988) provide general information on vegetation types that have been identified around Lake Elva to the south in the Wood River lakes system, in the Kisaralik River drainage to the northwest, and in the southern portions of the Yukon-Kuskokwim Delta to the west. The following provisional sketch of the vegetation and land cover types likely to occur in the lake study area and West transmission corridor is based on information in those studies, on the authors' field experience in Wood-Tikchik State Park, the Ahklun Mountains, and the Yukon-Kuskokwim Delta, and a review of field photographs taken in the study areas by other consultants in September 2010.

The lake study area includes Alpine, Subalpine, Upland, Riverine, and Lacustrine physiographic zones. The West transmission corridor occurs primarily within Lowland physiography, but also includes vegetation types typical to the Subalpine, Upland, Riverine, and Lacustrine physiographic zones. The Alpine zone primarily includes barrens and glaciated terrain and mountain heath plant communities on mountain crests, upper slopes and ridgetops. The Subalpine zone is the most common physiographic region and includes the entire area surrounding Chikuminuk Lake, primarily steep slopes supporting tall shrub, mixed forb, and mountain heath vegetation types. Uplands include the lower forested slopes adjacent to Lake Chikuminuk mainly composed of coniferous forest. Riverine communities include open water and shrub vegetation types along the Allen River, in tributary inlets to Chikuminuk Lake, such as the Milk Creek delta, and along various streams in the upper basin. Lacustrine types include small ponds and lakes and associated shoreline littoral areas including Heart Lake, Cascade Lake, and primarily, Chikuminuk Lake.

The West transmission corridor descends from the mountainous region surrounding Chikuminuk Lake and crosses the Yukon-Kuskokwim (Y-K) Delta lowlands to Bethel. The landcover types found within the mountainous terrain are expected to be similar to the lake study area and the Y-K Delta lowlands will include a variety of types, predominantly wetland. Previous vegetation classification work in the Y-K Delta has focused on coastal areas near population centers and is not directly applicable to the West transmission corridor, which is expected to include a range of low shrub and herbaceous wet tundra types interspersed with numerous lakes, ponds, and streams.

3.6.1.2 Plant Community Descriptions

At the highest elevations in the mountains, on steep upper slopes and ridge crests surrounding Chikuminuk Lake, dry alpine barrens, unconsolidated boulder and fell-field terrain and snow and ice are common. Some sites are likely to be partially vegetated with dwarf vascular plants (<5% plant cover). Below the ridge tops on upper slopes, alpine barrens grade into alpine dwarf scrub. These areas likely are dominated by dwarf ericaceous shrubs such as *Arctostaphylos alpina*, *Empetrum nigrum*, *Vaccinium vitis-idaea*, *Loiseleuria procumbens*, and dwarf willows such *Salix arctica* and *S. rotundifolia*.

At lower elevations on middle and lower slopes, alpine dwarf scrub probably gives way to a broad band of alder (*Alnus* spp) scrub. The alders can be low (<1.5 m) or tall (>1.5 m) in height, and the understory may be composed of herbaceous species such as *Dryopteris expansa*, *Athyrium filix-femina*, *Calamagrostis canadensis*, *Spiraea stevenii*, and *Equisetum* spp. Alder scrub often dominates all the way to the bases of the mountain slopes, but occasional openings occur in the alder thickets, and these can be dominated by tall grasses (*Calamagrostis canadensis*), ferns (*Dryopteris expansa*, *Athyrium filix-femina*), and forbs.

The most common plant community type in the mountainous region of the lake study area is low shrub scrub. This type is likely to occur on well drained mesic sites. Low shrub scrub in the study area is occupies hummocky terrain and dominated by dwarf or very low-growing shrub birch (*Betula nana*) and ericaceous shrubs such as *Empetrum nigrum*, *Ledum decumbens*, *Vaccinium uliginosum*, and *Vaccinium vitis-idaea*. Natural depressions, toeslopes or other water gathering topography support wet sedge meadow plant communities. These areas would be strongly dominated by sedges (*Carex* and *Eriophorum* spp.) with associated dwarf shrubs and forbs. As the West transmission corridor descends to the Y-K Delta lowlands it passes through rolling foothills terrain that is dominated by mesic low shrub or tussock dominated plant communities. The low shrub communities typically have a high graminoid component composed of a variety of sedge species including *Carex aquatilis* and *Eriophorum vaginatum*. Shrubs are dominated by ericaceous types including *Empetrum nigrum*, *Ledum decumbens*, *Vaccinium uliginosum*, and *Vaccinium vitis idaea*. Shrub birch (*Betula nana*) and a variety of willow species (*Salix* spp.) are found along drainage channels in headwaters. The foothills give way to an open expanse of lowland plant communities typically dominated by wetland communities such as wet sedge meadow and aquatic marshes. The area is characterized by a discontinuous permafrost layer and plant communities are limited by the presence of persistent surface water where drainage is impeded by shallow frozen soil layers. Wet sedge meadows are dominated by aquatic sedge species including *Carex aquatilis*. The aquatic marsh communities may also support obligate forb species such as *Comarum palustre* and *Menyanthes trifoliata*.

Forested habitats appear to be relatively uncommon in the study areas, and are more likely to occur in the lowlands of the Yukon-Kuskokwim Delta region, along the lower portions of river and stream drainages in the West transmission corridor study area. Forests, especially broadleaf forests, probably occur only sporadically in patches in protected locations in the mountains and foothills. Open spruce forests, dominated by white (*Picea glauca*) or black spruce (*P. mariana*), mixed forests, and broadleaf forests all probably occur, primarily in the West transmission line corridor. Mixed forests likely would be composed largely of white spruce and balsam poplar (*Populus balsamifera*), and, to a lesser extent, Alaska paper birch (*Betula neoalaskana*). Broadleaf forests likely would be dominated by balsam poplar and less frequently by Alaska paper birch and aspen (*Populus tremuloides*). Associated understory plant species in spruce forests are likely to include *Ledum decumbens*, *Betula nana*, *Empetrum nigrum*, *Vaccinium uliginosum*, and *Vaccinium vitis-idaea*. Mixed forest and broadleaf forests likely would share some of the same understory species such as *Alnus* spp., *Rosa acicularis*, *Ribes triste*, *Viburnum edule*, *Spiraea stevenii*, *Epilobium angustifolium*, *Calamagrostis canadensis*, *Equisetum* spp., and *Rubus arcticus*.

Riparian floodplain areas are found along the Allen River, in tributary inlets to Chikuminuk Lake, such as the Milk Creek delta, and along various streams in the upper basin. Upper perennial streams found in the upper basin are high velocity high gradient systems with very little floodplain development whereas the lower perennial rivers listed above display a typical riverine successional community gradient which includes permanently flooded channels, riverine barrens, riverine graminoid meadow, and riverine low and tall willow. Plant communities are strongly dominated by willow species including *Salix pulchra*, *S. arbusculoides*, *S. barclayi*, and *S. richardsonii.*

Lakes and ponds occur throughout the study areas, and graminoid- and forb-dominated marshes occur along lake and pond margins where poor drainage is dictated by seasonal fluctuations in lake water levels. Graminoid-dominated marshes may be dominated by sedges (*Carex* and *Eriophorum* spp.) and grasses (*Calamagrostis canadensis*), with associated forbs such as *Comarum palustre* and horsetails (*Equisetum* spp.). Forb-dominated marshes may be dominated by species such as *Comarum palustre*, *Menyanthes trifoliata*, and *Hippuris tetraphylla*.

3.6.2 Rare and Invasive Plant Species

3.6.2.1 Rare Plants

Only one plant species in Alaska currently is listed under the federal Endangered Species Act (USFWS 2010). The Aleutian shield fern (*Polystichum aleuticum*), which is listed as endangered, is restricted to two islands (Adak and Atka) in the central Aleutian Island chain (USFWS 2010).

The State of Alaska does not list any plant species as endangered (ADFG 2010). Although no rare plant species in Alaska are protected by law, the Alaska Natural Heritage Program (AKNHP) tracks the status of plant taxa that are considered to be rare in Alaska. The AKNHP maintains a database with collection locality and habitat information for rare and/or endemic vascular plants in the state. To determine which of these rare plant taxa have the potential to occur in the lake study area or West transmission corridor study area, data were requested from AKNHP's spatially explicit database of rare species (AKNHP 2008, 2012a) for collections of rare plants that have been made in a broad region surrounding the Project study areas. The search area was 39,750 km^2 (15,347 mi^2) and included Wood-Tikchik State Park, the southern portion of the Kilbuck Mountains, the Ahklun Mountains, Bethel, and Dillingham. In this assessment of rare plant occurrences, only taxa with the rarer state rankings (S1 and S2) were considered. Taxa listed as S1 and S2 are categorized by the AKNHP as critically imperiled or imperiled, respectively, in Alaska, largely because few collections of these plants have been made in the state. For S1 species, five or fewer collections have been made in the state and/or there are very few remaining individual plants, and for S2 species, six to 20 collections have been made (Lipkin and Murray 1997).

Table 3.6-1 Rare Vascular Plant Taxa[a] Found Broadly from Dillingham to Bethel Including Wood-Tikchik State Park

Scientific Name	Common Name	No. of Collections	State Rank[b]	Global Rank[c]
Carex lapponica	Lapland sedge	1	S2	G4G5Q
Carex preslii	Presl's sedge	1	S1	G4
Draba chamissonis G. Don	Cape Thompson draba	1	S1Q	G3Q
Eleocharis kamtschatica	Kamchatka spikerush	3	S2S3	G4
Geum aleppicum	Yellow avens	3	S2S3	G5T5
Saxifraga adscendens ssp. *oregonensis*	Small saxifrage	2	S2S3	G5T4T5
Saxifraga nelsoniana ssp. *porsildiana*	Prosild's saxifrage	1	S2	G5T4
Thalictrum minus ssp. *kemense* (Fr.) Cajander	Hulten's meadow-rue	3	S2	GNR
Carex lapponica	Lapland sedge	1	S2	G4G5Q

[a] Data from the Alaska Natural Heritage Program's spatially explicit database of rare species (AKNHP 2008 and 2012a, 2012b).

[b] State rarity rankings: S1 = critically imperiled, S2 = imperiled, and S3 = vulnerable.

[c] Global rarity rankings: G2 = imperiled, G3 = vulnerable, G4 = apparently secure, G5 = demonstrably secure, T = rank of subspecies or variety, Q = indicates uncertainty about taxonomic status that may affect global rank and NR = no record.

3.6.2.2 Invasive Plants

Resource agencies have become increasingly concerned about the potential for invasive plant species to become established as a result of construction activities associated with new developments. As a result, the USFS, NPS, BLM, Alaska Natural Heritage Program, and other stakeholders formed the Alaska Committee for Noxious and Invasive Plants Management (CNIPM) and developed the Strategic Plan for Noxious and Invasive Plants Management in Alaska (Graziano 2011). The CNIPM has developed a statewide mapping program and provides internet updates regularly as new surveys are conducted (http://aknhp.uaa.alaska.edu/maps/akepic/) (AKNHP 2012b). The database was queried for information on invasive weed surveys in a wide area surrounding the lake and West transmission corridor study areas. Location information was obtained for seven invasive species: *Amaranthus retroflexus* (redroot pigweed), *Capsella bursa-pastoris* (shepherd's purse), *Cerastium fontanum* (big chickweed), *Crepis tectorum* (narrowleaf hawksbeard), *Leontodon autumnalis* (fall dandelion), *Matricaria discoidea* (pineappleweed), and *Rumex acetosella* (common sheep sorrel). All these species occurrences were found on disturbed surfaces in the villages of Dillingham and Kwethluk, both outside of the biological resources study areas. The study areas are largely undisturbed, but invasive species may be transported into these remote areas by float plane. While it is probable that invasive species are relatively rare within these study areas, the absence of invasive species data is also due to the lack of surveys undertaken in the area.

3.6.3 Plant Species Distribution and Wetland Delineation

3.6.3.1 Habitat Mapping and Use Assessment

The availability of habitats for wildlife often is assessed using a vegetation map but can be more accurately described by incorporating mapping data for physiography, landforms, and soil moisture with data on vegetation and land cover (Jorgenson et al. 2002; Schick and Davis 2008). As noted above, only coarse-scale vegetation mapping is available for the biological resources study areas; this information is not suitable to derive a wildlife habitat map that could be used to quantitatively evaluate the proposed Project's potential affect on habitats.

3.6.3.2 Wetland Mapping and Determination

No fine-scale mapping of vegetation, wetlands, riparian, and littoral habitats specific to the lake study area or the transmission corridor alternatives has been conducted. Wetlands in Alaska are classified using the three-parameter approach described in the U.S. Army Corps of Engineers Wetlands Delineation Manual (USACE 1987) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region Version 2.0 (USACE 2007). To be classified as a wetland, a site must be dominated by hydrophytic plants, have hydric soils, and show evidence of wetland hydrologic conditions (saturation or inundation of sufficient duration during the growing season). Only two sources (Whitcomb et al. 2009, USFWS 2012) describe wetlands in some portions of the lake and West transmission corridor study areas; both of those studies involved only coarse-scale mapping efforts.

3.7 Wildlife Resources

The following description of wildlife resources is based on the literature review and data gap analysis report for the Chikuminuk Lake Hydroelectric Project (ABR 2012). The two study areas identified and discussed in the 2012 report were the Chikuminuk Lake basin or lake study area (**Figure 3.5-1**), where the inundation area and all Project facilities would be located, and the West transmission corridor study area, comprising the West Route between Chikuminuk Lake and Bethel. Other alternative transmission corridors including the Chikuminuk Lake to Dillingham alternatives were not under consideration during development of the gap analysis. Although this wildlife resources overview also does not specifically cover them, much of the general discussion regarding likely species and habitat conditions in alternative transmission corridors may apply.

3.7.1 Mammals

At least 37 species of terrestrial mammals have been documented or are considered likely to occur in the Project study areas (**Table 3.7-1**). The mammal fauna in the project area includes three species of ungulates (hoofed mammals), two species of bears, eleven species of furbearing carnivores, two species of hares, thirteen species of rodents, five species of shrews, and one bat species (common and scientific names of mammals are provided in **Table 3.7-1**). Five other species of mammals recorded elsewhere in southwestern Alaska—Dall's sheep (*Ovis dalli*), water shrew (*Sorex palustris*), singing vole (*Microtus miurus*), taiga vole (*Microtus xanthognathus*), and collared pika (*Ochotona collaris*)—are not likely to occur in the project area or along any of the proposed transmission route alternatives because their distributions end farther east or north.

3.7.1.1 Moose

Moose habitat varies seasonally and geographically based on their requirements for forage, protection from predators, specific nutrients, and refuge from deep winter snow. Productive areas of shrub growth, especially willows (*Salix* spp.), provide high-quality forage; aquatic areas provide important nutrients such as sodium and early emerging, high-quality spring vegetation (MacCracken et al. 1993; Kellie 2005); and mature forests with closed canopies provide areas with lower snow depths in winter. In mountainous areas, moose often move to higher elevations during the rut in fall and early winter, but remain in low-elevation areas almost exclusively during winter, due to deep snow accumulations at higher elevations (Modaferri 1999). Snow deeper than about 70 cm limits moose mobility and covers many of the preferred forage species (Coady 1974; Collins and Helm 1997).

Moose have only recently moved into the Bristol Bay region, with the first reports occurring in the Wood-Tikchik area in the early 1900s (Grumman Ecosystems Corporation 1971). During surveys in 1970, moose were observed near upland ponds in the vicinity of Chikuminuk Lake (Grumman Ecosystems Corporation 1971). The Alaska Department of Fish and Game (ADF&G) began collecting data on moose in GMU 17 (see **Figure 3.7-1**) in 1971, a time at which moose were not abundant (Faro 1973, cited in Woolington 2010b). High harvest of moose of either sex by local residents was suspected to be a major factor in keeping the population low in that period (Woolington 2010b). In the last several decades, however, the moose population has grown substantially and extended its range westward into the Togiak River drainage. Moose are now common in the Wood-Tikchik area (Woolington 2010b). The Alaska Habitat Management Guide (ADF&G 1986) indicates that moose are distributed throughout the project area, with known winter and rutting concentration areas where some parts of the West transmission route alternative cross the upper Kisaralik River basin, the lower Kwethluk River valley and lower Kuskokwim River (**Figure 3.7-2**). Possible reasons for the increase in population include relatively mild winters, decreased harvest of cows, and increased use of caribou by local hunters as an alternative resource (Woolington 2010b).

The West transmission route alternative would be located largely in GMU 18, which coincides with the Yukon Delta NWR. Moose are thought to have first become established on the Yukon–Kuskokwim Delta in the 1940s.

The current population along the Kuskokwim River is small and still colonizing riparian habitat (Perry 2010b). The population in the area probably is limited by harvest rates. In 2004, the Lower Kuskokwim Fish and Game Advisory Committee asked the Board of Game to close moose hunting along the Lower Kuskokwim River for five years (Perry 2010b). In response, the Board established the Lower Kuskokwim Closed Area. Based on population surveys conducted by ADF&G, the moose population along the Lower Kuskokwim River increased from 0.1 moose per square mile in 2004 to 0.8 moose per square mile in 2008. Calf survival rates and bull:cow ratios were extremely high in the area. The tributaries of the Kuskokwim River also support small populations of colonizing animals from the mainstem Kuskokwim River (Perry 2010b).

The area around Chikuminuk Lake is considered general habitat for moose but is not considered a calving, winter, or rutting area; the Tikchik River east of Chikuminuk Lake is the closest winter range (BLM 2007). Based on the most recent moose surveys conducted by ADF&G in 2002 for eastern GMU 17B and in 2006 for western GMU 17B, an estimated 3,163 moose (±374 at 90% CI) inhabit GMU 17B, below the ADF&G management objective of 4,900–6,000 moose for the subunit (Woolington 2010b).

Moose have been expanding rapidly in the Togiak NWR. Aderman et al. (1995) estimated a density of 0.33 moose per square mile in the Togiak River drainage and Wood River Mountains west of the Wood River lakes system. In a recent study, 83 radio telemetry collars were deployed on female moose and it was reported that yearling moose in the Togiak NWR were among the heaviest on record, and that moose had very high rates of productivity, high calf survival, and high rates of calving for two-year-old moose (Aderman and Woolington 2011).

No population estimate of moose is available for the project area, either in the lake study area or in the West transmission corridor study area . Moose density will be related strongly to habitat distribution and abundance in the project area, so development of a GIS-based habitat map will be useful in identifying moose distribution.

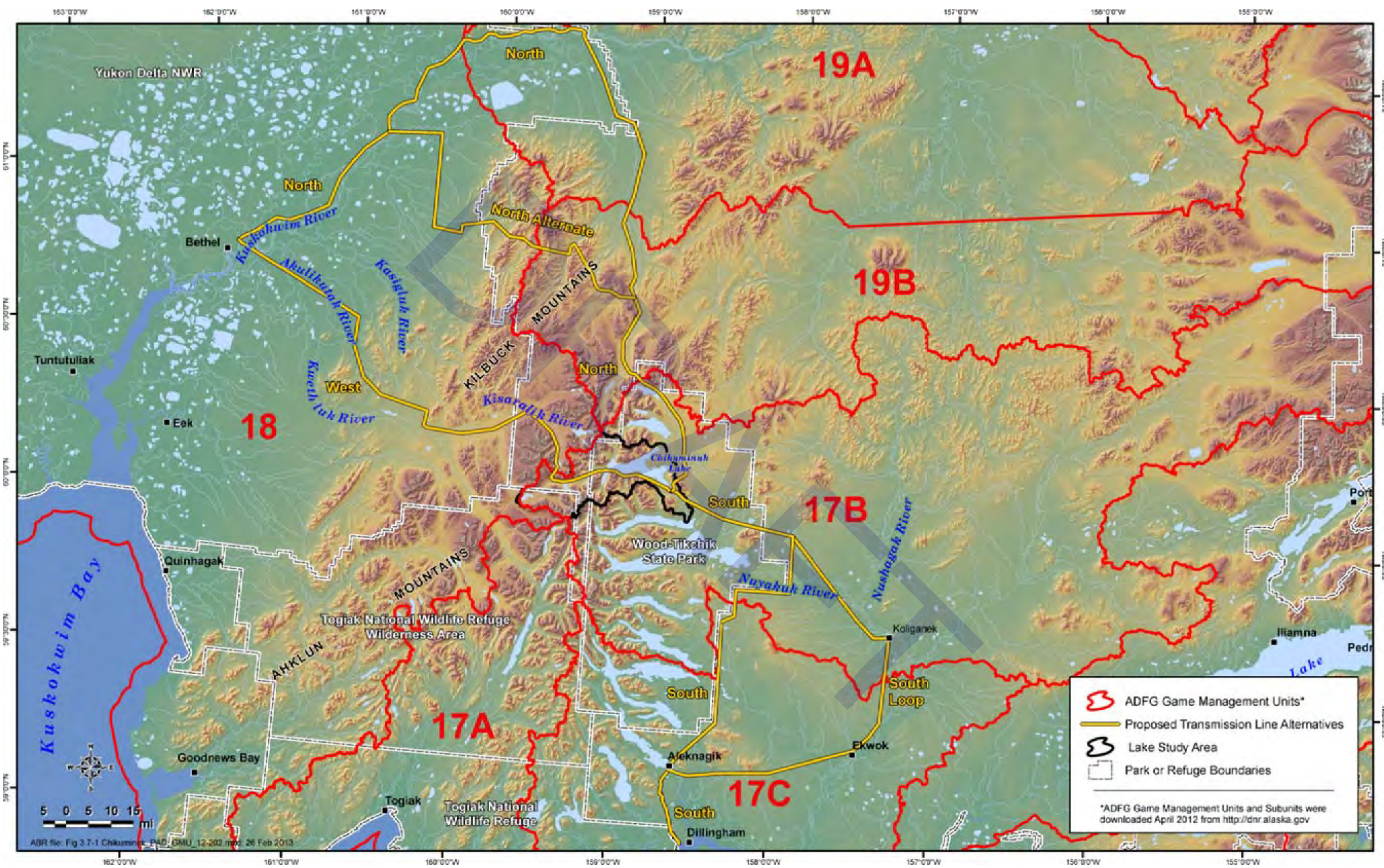
Table 3.7-1 Mammal Species Reported or Suspected to Occur in the Project Area

Common Name	Scientific Name
Cinereus shrew, masked shrew, common shrew	*Sorex cinereus*
Pygmy shrew	*Sorex hoyi*
Dusky shrew, montane shrew	*Sorex monticolus*
Tundra shrew	*Sorex tundrensis*
Alaska tiny shrew	*Sorex yukonicus*
Little brown bat, little brown myotis	*Myotis lucifugus*
Coyote	*Canis latrans*
Wolf	*Canis lupus*
Arctic fox*	*Alopex lagopus*
Red fox	*Vulpes vulpes*
Lynx	*Lynx canadensis*
River otter	*Lontra canadensis*
Wolverine	*Gulo gulo*
Marten	*Martes americana*
Ermine, short-tailed weasel	*Mustela erminea*
Least weasel	*Mustela nivalis*
Mink	*Neovison vison*
Black bear	*Ursus americanus*
Brown bear, grizzly bear	*Ursus arctos*
Moose	*Alces americanus*
Caribou	*Rangifer tarandus*
Muskox*	*Ovibos moschatus*
Hoary marmot	*Marmota caligata*
Arctic ground squirrel	*Spermophilus parryii*
Red squirrel	*Tamiasciurus hudsonicus*
Beaver	*Castor canadensis*
Northern red-backed vole	*Myodes rutilus*
Collared lemming	*Dicrostonyx groenlandicus*
Brown lemming	*Lemmus trimucronatus*
Tundra vole, root vole	*Microtus oeconomus*
Meadow vole	*Microtus pennsylvanicus*
Muskrat	*Ondatra zibethicus*
Northern bog lemming	*Synaptomys borealis*
Porcupine	*Erethizon dorsatum*
Snowshoe hare, varying hare	*Lepus americanus*
Tundra hare, Alaska hare	*Lepus othus*
Hoary marmot	*Marmota caligata*
Arctic ground squirrel	*Spermophilus parryii*

* West alternative transmission corridor.

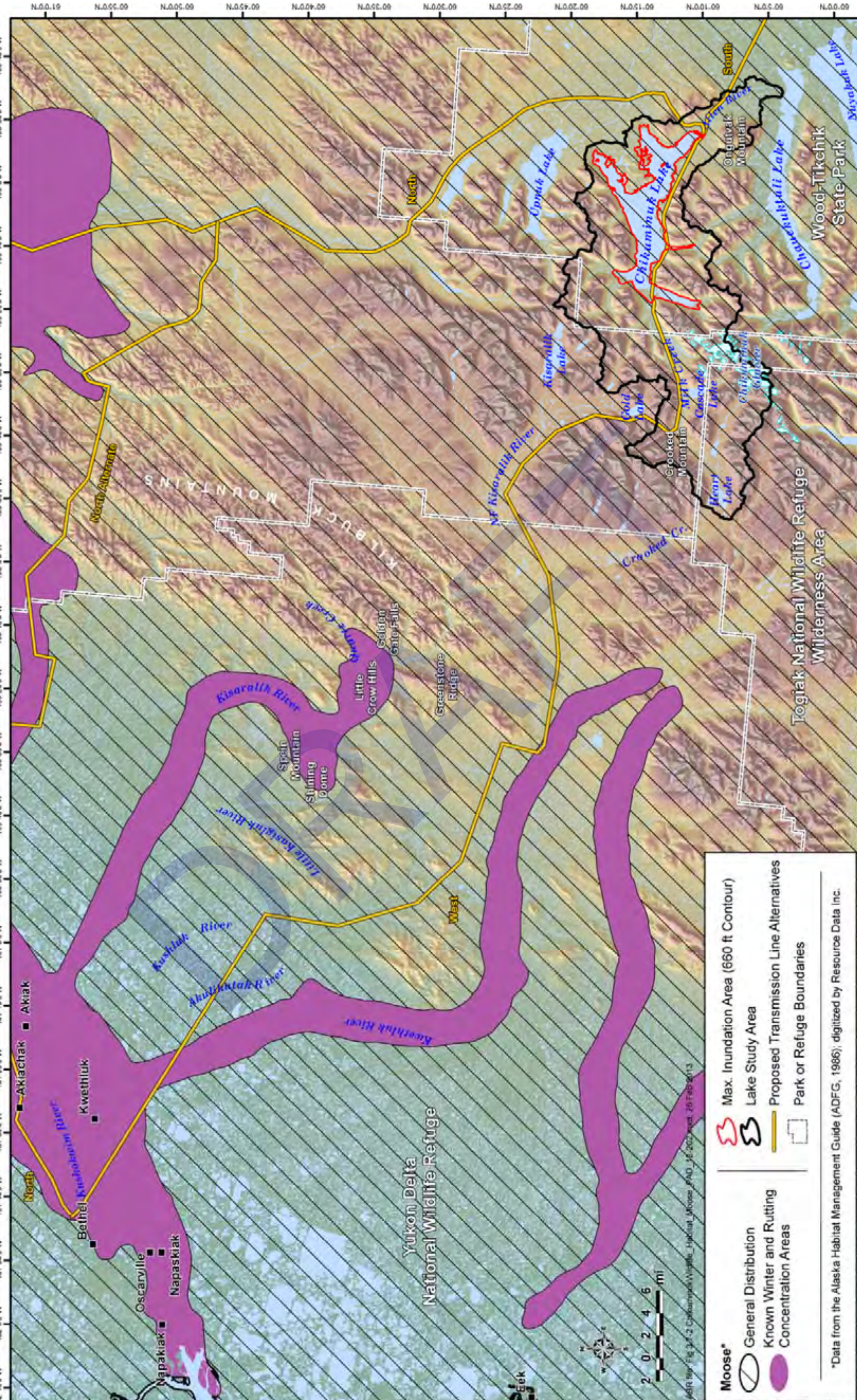
Sources: Grumman Ecosystems Corporation (1971), ADF&G (1973), Anderson 1978), USFWS (1986, 1988), Nolan and Peirce (1996), Parker et al. (1997), Peirce and Peirce (2000, 2005), Jacobsen (2004), Cook and MacDonald (2005), MacDonald and Cook (2009); continental modifiers of English names (e.g., *North American* river otter) have been dropped from this list.

Figure 3.7-1 Game Management Units (GMUs) in Southwestern Alaska and in the Wildlife Resource Study Areas



Source: ADF&G Game Management Units and Subunits from http://dnr.alaska.gov; accessed April 2012.

Figure 3.7-2 Moose Distribution and Habitats in the Project Area



Source: Data from the Alaska Habitat Management Guide (ADF&G 1986); digitized by Resource Data Inc.

3.7.1.2 Caribou

Caribou are highly mobile animals with the lowest net cost of locomotion measured for any species of terrestrial mammal (Fancy and White 1987). Their distribution and habitat selection vary seasonally in response to different forage availability, predation threats, and insect harassment levels. Caribou generally prefer tundra and other open areas where predators are visible, but they also can be found in spruce forest or other closed habitats in some seasons. In winter, caribou feed primarily in areas with abundant lichens and low snow depth and hardness, such as windswept ridge tops or coastal areas (Tucker et al. 1991; Saperstein 1993).

Caribou herds experience long-term population fluctuations and changing patterns of range use. A large number of caribou was present in southwest Alaska in the 1800s and was referred to as the Bering Seacoast Herd (Murie 1935; Skoog 1968; Hinkes et al. 2005). That herd apparently peaked in the 1860s and declined in the 1870s (Hinkes et al. 2005). Caribou were virtually absent from the Yukon–Kuskokwim Delta by 1880 but were still present in the Kilbuck Mountains (Petrof 1884, cited in Hinkes et al. 2005). Substantial numbers of caribou were reported in the Mulchatna River area in the early 1900s (Murie 1935).

The Yukon–Kuskokwim Delta also was used for reindeer herding starting in 1901. The reindeer population on the delta peaked at about 68,000 in 1930, with an unknown number of reindeer in the Mulchatna River drainage (Woolington 2003). However, the industry collapsed in the 1930s (Calista Professional Services and Orutsaramuit Native Council 1984, cited in USFWS 1988).

Only 1,000 caribou were estimated to be in the Mulchatna Caribou Herd (MCH) in 1949 (Woolington 2003). The herd grew slowly over the next two decades, reaching about 5,000 animals by 1965 (Skoog 1968). Herd growth accelerated rapidly during the 1980s and early 1990s, however, peaking at approximately 200,000 animals in 1996 (Taylor 1989; Van Daele 1995; Woolington 2009a). Since then, the herd has declined steeply, and was estimated at just 30,000 caribou in July 2008, the most recent census (**Figure 3.7-3**; Woolington 2009a). Adult female survival rates increased in 2010 (Demma et al. 2011), raising the prospect that the herd may rebound.

The caribou in the project area most likely all belong to the MCH, although several other herds have been described in southwest Alaska. The Kilbuck Caribou Herd (KCH) appeared to be a separate herd that used the Kilbuck Mountains and numbered an estimated 4,216 animals in 1993 (Valkenburg 1998), but the KCH evidently was assimilated by the MCH in the mid-1990s as the MCH expanded its range (Hinkes et al. 2005; Woolington 2009a). The Nushagak Peninsula Caribou Herd (NPCH) was introduced on the Nushagak Peninsula in 1988 and grew rapidly to over 1,000 caribou by 1994 (Hinkes and Van Daele 1996), peaked at about 1,429 in 1997, and then declined in size (Collins et al. 2003). The NPCH has remained in the Nushagak Peninsula area (Collins et al. 2003; Hinkes et al. 2005) and is therefore unlikely to occur in the project area. The Northern Alaska Peninsula Herd (NAPCH) wintered with the MCH between the Naknek River and western Iliamna Lake in the late 1980s, but has declined since and most of the herd has wintered south of the Naknek River since 2000 (Butler 2009).

During the 1980s, the MCH calved east of the lake study area, north of Lake Clark, whereas the KCH calved in the Kilbuck Mountains. In the mid-1990s, the MCH expanded west and assimilated the KCH (Hinkes et al. 2005) as it began using the Kilbuck Mountains. Today, the MCH range extends from Lake Clark in the east, across the Mulchatna and Nushagak drainages, throughout the Kilbuck Mountains to the Kuskokwim River on the west. Thus, the herd largely avoids the Wood River lakes and the lower Tikchik lakes systems (Hinkes et al. 2005; PLP 2011). Since 2000, the MCH has calved farther east and, judging from telemetry data, little calving has occurred near the proposed Project (PLP 2011). Over the past few years, the MCH separated into western and eastern herd segments. The western segment has wintered near the Kilbuck Mountains, with most calving occurring east of Wood-Tikchik State Park. Some calving also occurs west of Chikuminuk Lake. The eastern segment has remained between the Mulchatna River and Lake Clark, calving near Lime Village (Demma et al. 2011).

The lake study area lies within an area of high-density summer range use by the MCH in the last decade (2000–2010) and of medium-density autumn range use (PLP 2011). The winter distribution of the MCH has had two areas of high density since 1990, with the eastern segment wintering along the Kvichak River and western Iliamna Lake and the western segment along the western edge of the Kilbuck Mountains (PLP 2011). The lake study area was in an area of low-density use of winter range and spring range during 2000–2010 (PLP 2011). Although specific density information is not available for the lake study area, the general area surrounding the lake study area and the eastern portion of the West transmission corridor study area, where it lies in mountainous terrain, have experienced substantial use during all seasons over the last two decades, with the greatest use in recent years occurring during summer, somewhat less use occurring in autumn and spring, and little use during calving and winter (PLP 2011). The West transmission route alternative passes through an area used all year (PLP 2011).

In the past, the Tikchik lakes area and the area farther north have been used heavily as a travel corridor for seasonal movements between the Kilbuck Mountains and the eastern range of the MCH. Large numbers of MCH typically migrate past Aniak and Nishlik Lake during the fall and Nishlik Lake is used heavily by caribou hunters using floatplanes (AKDNR 2002). In the last few years, the western segment has spent much of the year west of the project area and has calved east of the project area, but the eastern segment of the herd has not used the project area (Demma et al. 2011). Therefore, caribou are expected to use the project area during migratory movements between seasonal ranges.

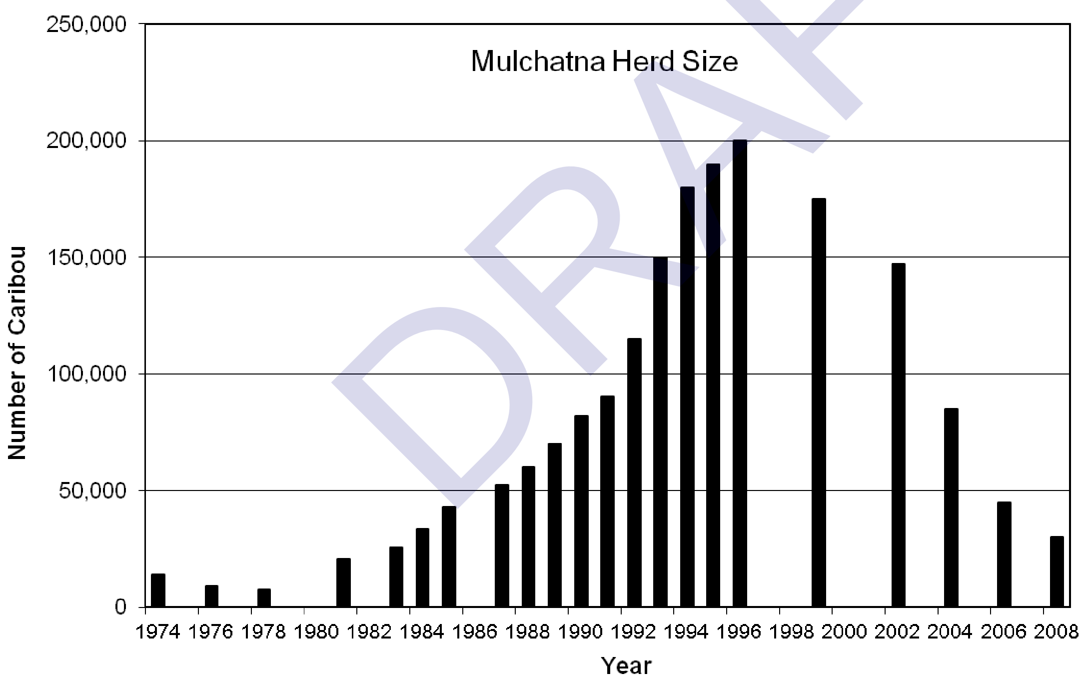


Figure 3.7-3 Estimated Population Size of the Mulchatna Caribou Herd, 1974–2008

Caribou are monitored by ADF&G through the use of periodic population estimates, counts of sex and age composition, and tracking of harvest statistics. A collaborative study is being undertaken by researchers from the University of Alaska, ADF&G, and the USFWS on the linkages between climate, nutrient cycling, vegetation, and caribou for the five southwestern Alaska herds, focusing especially on the Unimak Herd (Spalinger et al. 2011). ADF&G is studying MCH bull survival and recruitment, bull antler development and growth, and distribution of bulls (Demma et al. 2011). An ADF&G calf survival study is estimating calf survival and

Source: ADG&G surveys and censuses
Taylor 1989; Van Daele 1995; Woolington 2009a.

recruitment rates, and determining the cause of death for young calves. Preliminary results indicate that early calf mortality is largely due to an even mix of predation by wolves and bears (Demma et al. 2011).

Estimates of the seasonal density of caribou in the specific areas near the lake study area and along the West transmission route alternative are not available. Telemetry data for the MCH have been collected by ADF&G but a cooperative agreement with the Mulchatna Caribou Herd Technical Working Group would be necessary to access and analyze the data. The number of caribou in the area likely varies annually and seasonally.

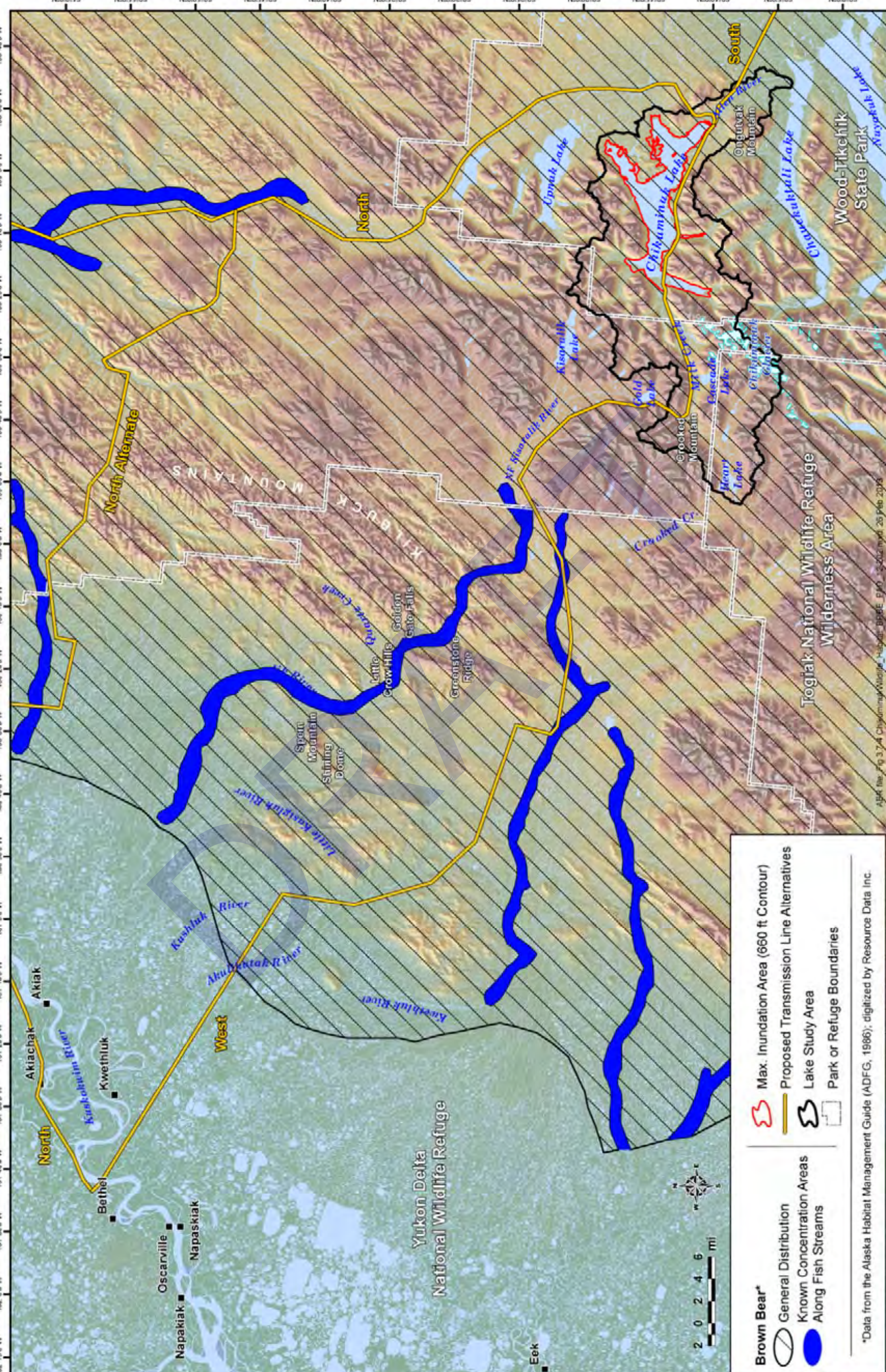
3.7.1.3 Brown Bear

Brown bears occur throughout the project area, although habitat occurs primarily in the mountainous terrain in the eastern portion of the West transmission corridor study area (Figure 3.7-4). Brown bears are mobile generalist species that use large home ranges to exploit seasonally abundant resources. Brown bears will often feed on a variety of vegetation, berries, salmon, ungulates, and small mammals. They often feed on arctic ground squirrels in the spring. Vegetation in coastal sedge meadows and mudflats supports very high densities of bears in early summer (Rode et al. 2001). Bears will also feed on moose and caribou calves and berries during the summer. By mid and late summer, brown bears congregate at salmon streams, where available. Brown bears in alpine areas of Kodiak Island fed heavily in sedge–forb meadows (Atwell et al. 1980). Brown bears are often found in open areas, but riverine and forested areas commonly are used as travel corridors, for hunting moose calves, and for feeding on salmon.

Brown bears usually den at high elevations in winter. Female bear dens on the Kenai Peninsula were located in high-elevation areas with steep slopes and away from human disturbance (Goldstein et al. 2010). The vegetation at denning locations in the Talkeetna Mountains was alpine tundra (52%), shrubs (alder, willow, or birch; 35%), tussock grass and rocks (13%; Miller 1990). On Kodiak Island, brown bears denned most often in alder–willow thickets at elevations ranging from 100 to 3,300 ft asl (Lentfer et al. 1972). Salmon are not present in Chikuminuk Lake, although they spawn in the lower Allen River, so summer brown bear densities in the lake study area are likely to be lower than in adjacent areas with anadromous streams.

Grumman Ecosystems Corporation (1971) reported 17 sightings of brown bears during field work in 1970, with the majority occurring near Chauekuktuli, Chikuminuk, and Upnuk lakes. Several bear dens were noted on well drained slopes near Upnuk Lake. Important brown bear denning areas have been identified around Agenuk Mountain, north of Nishlik Lake, and in the upper Youth Creek valley (AKDNR 2002). The brown bear habitat in GMU 17 is reported to be in excellent condition (Woolington 2009b). The brown bear harvest in GMU 17 has increased since the mid-1990s and 62% of reported brown bear harvest has come from GMU 17B in recent years (Woolington 2009b). Approximately 250 brown bears are estimated to inhabit the Kilbuck Mountains (Perry 2009). The density of brown bears in the Togiak NWR was estimated to be 40.4 bears/1,000 km^2 in 2003–2004 (Walsh et al. 2010), compared with 101 bears/1,000 km^2 in Katmai National Park and Preserve (Hamon et al. 2011), and 47.7–58.3 brown bears/1,000 km^2 in the area surrounding Iliamna Lake in 2009 (PLP 2011). Ruggerone et al. (2000) studied brown bear predation on spawning salmon in a tributary of Lake Aleknagik and found that bears could kill a large proportion of salmon when the run was small.

Figure 3.7-4 Brown Bear Distribution and Habitats in the Project Area



Source: Data from the Alaska Habitat Management Guide (ADF&G 1986); digitized by Resource Data Inc.

A long-term brown bear study conducted in the Kuskokwim Mountains provides a great deal of information for areas close to the lake and West transmission corridor alternative. During the period 1993–2003, Kovach et al. (2006) deployed radio-collars on 40 female brown bears in a study area including western Chikuminuk Lake and areas farther west, including much of the West transmission corridor. They reported a mean litter size of 2.0 cubs per female and survival rates of 90.1 to 97.2% for adult females, 48.2 to 61.7% for cubs of the year, and 73.3 to 83.8% for yearlings and two-year-olds. The population was estimated to be expanding during the first half of the study and declining during the second half of the study (Kovach et al. 2006). The home range of adult females ranged from 93 to 623 km² (Collins et al. 2005). During July, bears rested in alder and willow thickets when air temperatures were high (Van Daele et al. 2001). Bears occupied lower elevations in July and August when salmon were spawning and moved to higher elevations in September, probably reflecting selection for areas supporting arctic ground squirrels, berries, and caribou. Females with cubs were found at higher elevations than were females without cubs (Collins et al. 2005). Bears denned in areas of higher elevation (mean = 632 m): 71% in steep rocky areas and 13% in tundra habitats (Van Daele et al. 2001). Occupancy of winter dens generally began by mid-October and ended by mid-May (Collins et al. 2005). Individual bears showed fidelity to general denning areas, with an average distance between consecutively occupied dens of 4.5 km (SD = 3.1) between years. Bears were located farther from spawning streams when salmon escapement was low (Collins et al. 2005). Van Daele et al. (2001) also discuss some of the cultural barriers to brown bear management in the Kuskokwim Mountain area.

No population estimate or habitat use data are available on brown bears in the lake study area or the West transmission corridor study area.

3.7.1.4 Black Bear

Black bears avoid open habitats and select closed forest and scrub habitats (Holm et al. 1999). In areas where brown and black bears occur together, black bears typically avoid areas used consistently by brown bears, such as salmon-spawning streams. In such areas, there is an inverse relationship between brown bear density and the proportion of salmon in black bear diets (Belant et al. 2006) and black bears are largely herbivorous and frugivorous (Jacoby et al. 1999; Belant et al. 2006; Fortin et al. 2007). In the spring, black bears seek out emerging green vegetation such as horsetails (*Equisetum* spp.), grasses, and sedges (*Carex* spp.), which are high in protein and easily digestible. Bears begin to eat berries and fruit as they begin to ripen in midsummer and continue feeding heavily on berries and fruit throughout the fall to store up energy for winter dormancy. They also feed on newborn ungulate calves, carrion, insects, and salmon (when brown bears are not present). Black bear dens in the Yukon Flats were in well drained terrain in forested areas and 42% were located at the base of toppled or leaning trees (Bertram and Vivion 2002). Three cases of suspected predation of black bears in dens by grizzly bears were documented in the Yukon Flats (Bertram and Vivion 2002).

Black bears occur in the Chikuminuk Lake area but at lower densities than brown bears. Grumman Ecosystems Corporation (1971) reported three sightings of black bears along the eastern ends of Chikuminuk and Upnuk lakes. Black bears were observed near Iliamna Lake, albeit too infrequently to permit calculation of a density estimate (PLP 2011). There have been no research activities by ADF&G on black bears in GMU 17 but, based on incidental observations, they might be increasing in abundance (Woolington 2008). The greatest densities of black bear in GMU 17 are suspected to occur in spruce forest habitats along the upper Mulchatna, the upper Nushagak, and the Chichitnok rivers. Black bears are most frequently seen feeding on berries on open hillsides in the fall. Few black bears are expected to occur in GMU 18 west of the Kilbuck Mountains (ADF&G 1973).

Little is known about the abundance of black bears in the lake study area or West transmission corridor study area. The species will be restricted largely to forested habitats, so is unlikely to be numerous in the project area.

3.7.1.5 Muskox

Thirty-one muskoxen from Greenland were introduced on Nunivak Island in 1935 and 1936 and 31 muskoxen were translocated from Nunivak to Nelson Island in 1967 and 1968 (Jones and Perry 2011). The population on Nelson Island has fluctuated over time but reached a high of 561 animals in 2010. Some muskoxen emigrated from Nelson Island to the mainland and a minimum of 100 animals are thought to be scattered from the Kilbuck Mountains to the Andreafsky Mountains north of the Yukon River (Jones and Perry 2011). Illegal harvest may be keeping the mainland population from expanding (Jones and Perry 2011). Muskoxen are unlikely to occur near Chikuminuk Lake but are known to use the area that would be crossed by the West transmission line corridor.

Muskoxen are nonmigratory and must put on adequate supplies of body reserves during the snow-free period to survive the winter. They feed primarily on sedges and grasses and are typically found in river corridors, floodplains, and foothills. In winter they use areas of shallow, soft snow or windblown areas, where food is more accessible.

ADF&G monitors muskoxen distribution, population, and harvest in GMU 18. Three GPS collars were scheduled to be deployed on mainland muskoxen in 2011 (Jones and Perry 2011).

No estimate is available for the number of muskoxen that uses the West transmission corridor study area or how range use varies seasonally. Based on the low number of muskoxen using the mainland and the location of the West transmission route alternative, the project area is most likely used sporadically by a small number of animals.

3.7.1.6 Wolf

The wolf is a generalist species that uses most habitats from alpine tundra to lowland coastal wetlands, depending on the distribution and abundance of prey. Wolves feed on a variety of prey species, including moose, caribou, beavers, hares, porcupines, small mammals, and salmon. Wolves are common throughout the northern Bristol Bay region but the population fluctuates due to periodic rabies epizootics and fluctuations in the availability of prey species, especially caribou (Woolington 2009c). Moose, caribou, and possibly beaver are thought to be the main prey for wolves in the northern Bristol Bay region, but wolf packs do not appear to follow the movements of the MCH (Woolington 2009c).

A trapper questionnaire conducted in 2000–2001 indicated that in GMU 17, wolves were abundant and their population was increasing (Scott and Kephart 2002). The wolf population in GMU 17 was also thought to be increasing from 2005–2008. Woolington (2009c) estimated that 280 to 320 wolves in 16 to 22 packs inhabited GMU 17B in 2008. With the recent decline in caribou numbers in the area, wolf numbers also may have declined. Walsh and Woolington (2008) deployed four radio-collars (two GPS and two VHF collars) on wolves from two packs near the Nushagak Peninsula to determine how much time they spent near caribou of the NPCH, and additional wolves have been collared in recent years (Walsh and Woolington 2011). A study of wolves in Lake Clark National Park and Preserve found that the main prey species in that location was moose, but some packs also fed heavily on salmon when available. The packs that had large components of salmon in their diet had smaller territories (Mangipane 2011).

Little is known about the number of wolves and packs in the lake study area and along the West transmission route corridor.

3.7.1.7 Wolverine

Wolverines have large home ranges and take a broad range of foods, consisting mostly of small mammals and birds, but also including carrion and, occasionally, larger mammals (Pasitschniak-Arts and Larivière 1995). They occur at low densities and are sensitive to human disturbance (Pasitschniak-Arts and Larivière 1995; May et al. 2006). Wolverines in the middle Susitna River basin of south-central Alaska tended to use broad habitat categories (forest, scrub, rock/ice) in relation to availability, but changed elevations seasonally. They moved to higher elevations where arctic ground squirrels and other small mammals were available during summer and lower elevations where moose carcasses were available in winter (Whitman et al. 1986).

Wolverine density on the northern Kenai Peninsula, Alaska was estimated to be 3.0 wolverines/1000 km^2 (Golden et al. 2007). Wolverine numbers in GMU 18 were reported to be moderate to low but increasing; they are most abundant in the Kilbuck and Andreafsky mountains (Perry 2010a). Wolverine numbers in GMU 17 are thought to be stable (Woolington 2010a). A trapper questionnaire conducted in 2000–2001 indicated that wolverines were common in GMU 17 and their population was stable (Scott and Kephart 2002).

There is no specific information available on wolverine abundance in the lake or West transmission corridor study areas.

3.7.1.8 Beaver

The beaver is a keystone species whose presence and activities profoundly affect the distribution of aquatic and riparian habitats and the abundance of fish and other wildlife species in those habitats (Johnston and Naiman 1987; Mitchell and Cunjak 2007). The only aquatic habitats unsuitable for beavers are fast-moving streams and rivers and those with widely varying levels of water flow. Beavers prefer to forage on aspen, balsam poplar (cottonwood), and willow but also eat birch and alder (Jenkins and Busher 1979).

Beavers are reported to be common in all major drainages and most of the smaller tributaries in GMU 17. Beavers were observed commonly along the Kisaralik River (Boyce and Fristensky 1984). A trapper questionnaire from 2000–2001 indicated that beaver populations were abundant and increasing in GMU 17 (Scott and Kephart 2002). Beavers in GMU 18 are perceived to be abundant to overabundant, with villagers complaining that high densities of beavers are ruining favored fish habitat (Perry 2010a). Farther east, beavers are abundant in the area of the proposed Pebble mine project and lodges were found on most of the suitable ponds, lakes, and streams (PLP 2011).

Specific information is lacking on the number of active beaver lodges in the lake and West transmission corridor study areas.

3.7.1.9 Other Furbearers

Other species of furbearers in the Wood-Tikchik area include coyote, red fox, lynx, river otter, marten, ermine, least weasel, mink, and muskrat. In addition, the arctic fox may occur in low numbers in some areas along the West transmission route corridor where it crosses the Yukon–Kuskokwim Delta. Grumman Ecosystems Corporation (1971) reported that the most common furbearers in the Wood-Tikchik areas were beaver, muskrat, river otter, red fox, and wolverine.

River otter populations increased in GMU 17 during the 1980s and appear to have been stable since the 1990s (Woolington 2010a). Muskrats are reported to be rare in GMU 17, although they have been common in the past (Woolington 2010a). Coyotes have become common in GMU 17, with the highest densities occurring along the lower Nushagak River and on the Nushagak Peninsula (Woolington 2010a). Lynx have never been common in GMU 17, although their numbers increased in the early 1990s. Both lynx and snowshoe hare numbers were low during 2006–2009 (Woolington 2010a).

A trapper questionnaire conducted in 2000–2001 indicated that coyotes and muskrats were scarce but increasing in GMU 17; lynx were scarce and stable; ermine were common and stable; marten, mink, and hares were common and increasing; and red foxes and river otters were abundant and increasing (Scott and Kephart 2002). In the Kisaralik River drainage between Chikuminuk Lake and the Kuskokwim River, muskrats were recorded on the lower river, river otter tracks were common on the middle and lower river, mink tracks and red foxes were observed along the entire river (Boyce and Fristensky 1984; Brown et al. 1985).

In GMU 18, coyotes are reported to be at low densities but increasing. They are established along the Kuskokwim River and most tributaries (Perry 2010a). The arctic fox population is moderate and stable along the coast, but arctic foxes are rare inland (Perry 2010a). Red fox were reported to be moderate to abundant and be stable or increasing and have tested positive for rabies in GMU 18 (Perry 2010a). Marten were at low densities and stable, mink are plentiful, muskrat were reported to be at moderate and stable densities, and river otters are abundant in preferred riverine habitats (Perry 2010a).

Apart from presence/absence and general reports of relative abundance, little information is available on the populations of furbearers in the lake study area or the West transmission corridor study area.

3.7.1.10 Snowshoe Hare

Snowshoe hares follow a roughly ten-year population cycle with peaks followed by a precipitous crash. Predators such as lynx, coyotes, Northern Goshawks, and Great Horned Owls will show a similar numerical response, often with a lag period. Other small mammals also show cyclical patterns, possibly due to food competition or as alternative prey for predators. Snowshoe hares can remove a large proportion of the standing shrub biomass (Hodges 1999) and in locations where they are abundant, snowshoe hares have a large effect on the ecosystem.

Snowshoe hares actively select habitats with dense understory cover in boreal coniferous forest, avoiding young regrowth, clearings, and other open areas (Hodges 1999). Dense understory is more important than canopy closure and interspersion of different stand types may be preferred. They are more likely to use deciduous forest types in summer than in winter due to the greater cover afforded by leaves and may occur in areas of sparse cover mainly during darkness. Open areas may be used more when hare densities are high (Wolff 1980). Dense understories provide escape cover and thermal protection and were correlated with spring densities and overwinter survival in Maine (Litvaitis et al. 1985).

In south-central Alaska, snowshoe hares preferred white spruce forest, alder, and willow plant communities during winter and early spring. Pellets contained predominately spruce, willow, Labrador tea, and dwarf birch with lesser amounts of blueberry, horsetail, and unidentified forbs and grasses. Alder was not an important forage species even though it was abundant (MacCracken et al. 1988). Areas used in winters when hare densities are low may be critical habitat to maintain remnant populations until the subsequent population increase (Wolff 1980).

Snowshoe hare populations appeared to be moderate in GMU 17B from 2006–2009 (Woolington 2010a). Hare populations were not reported for GMU 18, but lynx populations were reported to be increasing (Perry 2010a).

No specific information is available on the occurrence or abundance of snowshoe hare in the project area.

3.7.1.11 Tundra Hare

The tundra hare, also called the Alaska hare, is an endemic species that is related to the arctic hare of northern Canada and Greenland (Waltari and Cook 2005). It occurs in tundra habitats along coastal western Alaska from the Baldwin Peninsula south to the Alaska Peninsula (Anderson 1978; Waltari and Cook 2005; MacDonald and Cook 2009). Tundra hare are discussed in **Section 3.8.2.2**.

No specific information describes the occurrence or abundance of tundra hare in the project area.

3.7.1.12 Small Mammals

Small mammals likely present in the Project study area include as many as five species of shrews, three species of squirrels and marmots, porcupines, and as many as seven species of mice, voles, and lemmings (**Table 3.7-1**).

Shrew distributions are related to invertebrate abundance, temperature, and moisture, and they appear to require adequate ground cover. Pygmy shrews prefer boreal habitats where both dry and wet habitats are found together in proximity to water (Long 1974). The cinereus shrew can be found in a wide variety of habitats but prefers moist areas within habitats, often near mosses (Whitaker 2004). The dusky shrew is found in montane and boreal habitats with dense ground cover — often in clearcuts with dense herbaceous ground cover (Smith and Belk 1996).

The Alaska tiny shrew, the smallest mammal in North America, was described as a new species (*Sorex yukonicus*) only in 1997, although Hope et al. (2010) have since concluded that it is conspecific with *S. minutissimus*, an Old World species. When he described the species, Dokuchaev (1997) listed only three locations where it had been recorded, but specimen records increased quickly as researchers looked for it elsewhere in the state. By the late 1990s and early 2000s, the species had been recorded over a broad area of interior, western, and northern Alaska. . The Alaska tiny shrew is discussed in more detail in **Section 3.8.2.2**.

Arctic ground squirrels live in arctic and alpine tundra, meadows, riverbanks, and lakeshore habitat. They prefer permafrost-free areas with loose soils, good visibility, and an adequate supply of low, early successional vegetation (MacDonald and Cook 2009). They survive the long winters by putting on large fat reserves during the summer and dropping their body temperature below the freezing point of water during winter hibernation (Barnes 1989; Buck and Barnes 1999). Arctic ground squirrels were reported to be common on the upper and middle Kisaralik River (Boyce and Fristensky 1984; Brown et al. 1985).

Red squirrels are abundant across much of boreal Canada and the northern and western United States but are largely restricted to coniferous forest, although they also may use mixed forest (Steele 1998). They prefer coniferous habitats for the abundant conifer seed, fungi, and interlocking canopies that allow for effective escape from predators and efficient foraging (Steele 1998).

Hoary marmots live in small colonies of two to 36 animals in areas above tree line with suitable vegetation for forage and rocky areas for escape cover. They feed on the leaves of herbaceous plants in early summer, flowers of herbaceous plants in midsummer, and herbs and forbs in late summer (Braun et al. 2011). In south-central Alaska, *Carex* species made up 78–91% of the total dry weight of the diet (Holmes 1984). Juvenile survival is strongly affected by winter climate, especially snow depth (Patil 2010).

The northern red-backed vole is one of Alaska's most ubiquitous and common mammal species, inhabiting forest, scrub land, alpine tundra, and riparian areas throughout much of the state (MacDonald and Cook 2009). They feed on fungi, berries, succulent green plants, and lichens (Bangs 1984). Northern red-backed voles have large interannual fluctuations in density that are strongly influenced by climate. Overwinter survival was influenced by winter severity and snow depth; food availability was influenced by green-up date; and early summer precipitation influenced survival of the first litter (Rexstad and Debevec 2002).

Tundra, or root, voles inhabit a wide variety of open herbaceous habitats at various elevations. Although they can be found in scrub land, tundra, grassland, and riparian areas, they are most abundant in wet sedge and grass–forb meadows and bogs (MacDonald and Cook 2009). In northern Alaska, tundra voles reach their highest densities in swales and watercourses with dense, wet meadows dominated by sedges (*Carex* spp. and *Eriophorum* spp.), their primary food plants (Bee and Hall 1956; Batzli and Henttonen 1990).

Brown lemmings are usually associated with wet sedge-grass meadow but move to higher ground when preferred areas are flooded (McDonald and Cook 2009). Collared lemmings are usually associated with higher, drier, rockier tundra and often associated with cotton-grass sedges (Bee and Hall 1956; McDonald and Cook 2009).

Grumman Ecosystems Corporation (1971) reported that arctic ground squirrels and hoary marmots were abundant in the Wood-Tikchik region. Trappers responding to an ADF&G questionnaire in 2000–2001 indicated that mouse and rodent populations were abundant and increasing in GMU 17 (Scott and Kephart 2002).

In their survey of small mammals in Wood-Tikchik State Park, Nolan and Peirce (1996) trapped meadow jumping mice, pygmy shrews, northern red-backed voles, cinereus shrews, dusky shrews, and ermines, and observed arctic ground squirrels and red squirrels. Peirce and Peirce (2000, 2005) captured eight species of small mammals in the Goodnews River drainage west of the project area: four species of shrew (cinereus, pygmy, Alaska tiny shrew, and tundra shrew) and four microtine rodents (tundra vole, northern red-backed vole, collared lemming, and brown lemming).

In 2003, the University of Alaska Museum conducted field surveys of small mammals for the federal Bureau of Land Management (BLM) north and west of Iliamna Lake and in the Kvichak and Nushagak river valleys (Jacobsen 2004). Seventeen species were documented with vouchered specimens: four species of shrews (cinereus, pygmy, montane, and tundra), river otter, marten, hoary marmot, arctic ground squirrel, red squirrel, meadow jumping mouse, northern red-backed vole, collared lemming, brown lemming, root vole, meadow vole, northern bog lemming, and porcupine. The most frequently captured small mammals were cinereus shrew, montane shrew, and northern red-backed vole. Small mammals were most diverse and abundant in scrub and forest habitats (Jacobsen 2004).

Specific information is lacking on the occurrence and abundance of small mammals in the lake study area and West transmission corridor study area.

3.7.1.13 Little Brown Bat

The little brown bat is the most widely distributed and common species of bat in Alaska and Canada, inhabiting areas with some degree of forest cover (van Zyll de Jong 1985; MacDonald and Cook 2009)

During summer 2012, Chikuminuk Lake Hydro Project field personnel reported that hundreds of little brown bats commonly occurred on summer evenings at the Tikchik Narrows Lodge, near the southern edge of the lake study area and lodge employees confirmed that they were a common occurrence there annually. Little else is known of their occurrence or abundance in the project area. The locations of winter hibernacula used by little brown bats are virtually unknown in most of Alaska. Little brown bats are discussed in more detail in Section 3.8.2.2.

3.7.2 Amphibians

Amphibians are of increasing conservation concern worldwide because of both widespread population declines and loss of local populations (Collins and Storfer 2003; McCallum 2007). Of the eight species of amphibians that occur in Alaska, only one inhabits southwestern Alaska — the wood frog, *Rana (Lithobates) sylvatica*, which is the most common amphibian in Alaska (MacDonald 2010). Wood frogs are discussed in more detail in **Section 3.8.2.3**.

3.7.3 Birds

The avian fauna in the project area includes 22 species of waterfowl (geese, swans, and ducks), 15 species of other waterbirds (loons, grebes, gulls, terns, and jaegers), 17 species of raptors (eagles, hawks, falcons), six species of owls, 21 species of shorebirds, and 56 species of landbirds (grouse, ptarmigan, kingfishers, woodpeckers, and passerines [songbirds]) **(Table 3.7-2)**. The lake and stream habitats within the project area are used by several species of waterfowl, shorebirds, and other waterbirds. Forest and scrub habitats are predominately occupied by landbirds and may support some tree-nesting raptors. Tundra habitats are predominantly occupied by shorebirds and some landbirds. Cliffs and bluffs along river corridors and rocky outcrops in the mountains are used by cliff-nesting raptors (Golden Eagles, Rough-legged Hawks, and falcons).

All migratory species of birds are protected under the federal Migratory Bird Treaty Act (MBTA); eagles are also protected under the federal Bald and Golden Eagle Protection Act. Both species of eagles occur in the project area. National guidance currently is being drafted by the USFWS for the preparation of eagle conservation plans for various types of development projects, including hydroelectric projects (J. Muir, USFWS, pers. comm.). In January 2011, the first such guidance was released in draft form for wind-energy development; guidance for hydroelectric projects is still in preparation. The impetus for eagle conservation plans is increasing concerns regarding "take" of eagles elsewhere in the state and nation (e.g., at wind turbines), which has resulted in increased scrutiny of anthropogenic influences on eagle populations.

3.7.3.1 Raptors and Owls

At least eleven species of raptors (eagles, hawks, falcons) and six species of owls potentially breed in or migrate through the project area (**Table 3.7-2**). The majority of past avian surveys have been performed in the West transmission corridor study area, mainly because the study area crosses a section of the Yukon Delta NWR and because the Kisaralik River, which lies within the eastern half of the study area, previously was considered for hydropower as well as for designation as a Wild and Scenic River (Wilson et al. 1982; NPS 1984a). Data are limited for the lake study area in the Wood-Tikchik State Park. Of the western drainages of the Kilbuck Mountains, the Kisaralik River has the most canyon development and supports the highest number and diversity of breeding cliff-nesting raptors, including Rough-legged Hawks, Gyrfalcons, and Golden Eagles (White and Boyce 1978; Mindell 1981, 1983; Weir 1982). Boyce and Fristensky (1984) concluded that if rivers were ranked in both density and diversity of nesting raptors, the Kisaralik River would rank highest in Alaska. Since then, studies largely have focused on monitoring Golden Eagle, Gyrfalcon, and Rough-legged Hawk territories identified along the middle Kisaralik River (McCaffery and Earnst 1989; McCaffery 1993; McCaffery et al. 2011).

Literature review for the project indicated that few data were available on nesting raptors in either the lake or West transmission corridor study areas (ABR 2012). To fill the data gap and to ensure that nesting raptors were avoided and not disturbed by Project activities, raptor surveys were conducted of virtually all suitable nesting habitat in the Allen River/Chikuminuk Lake basin (excluding the far western basin and areas inside the wilderness area of the Togiak National Wildlife Refuge) (**Figure 3.7-5**). In the 2012 raptor study area, 31 occupied raptor territories and five additional territories that may have been occupied (i.e., nests with unknown occupancy status >1.0 km from any other occupied nests) were identified (**Table 3.7-4; Figure 3.7-5**). Altogether, 119 stick nests were recorded, the majority of which were Golden Eagle nests (**Figure 3.7-5**; **Table 3.7-3**). Active and inactive nests of seven species of raptors (including Common Ravens) were identified in the 2012 survey area (**Figure 3.7-5**). Although not technically raptors, Common Ravens nests are included because they use (and often construct) cliff-ledge and stick nests, at sites that may harbor nesting raptors (eagles, falcons, hawks, and owls) in past or future years.

Table 3.7-3 Nest Success and Territory Occupancy for Raptors Located in the Raptor Study Area, 2012

Species	Occupied Nests: Incubating Pairs	Occupied Nests: Successful[a]	No. of Nestlings	No. of Occupied Territories	No. of Possible Territories
Golden Eagle	16	7	12	19	1
Bald Eagle	3	1	2	3	0
Rough-legged Hawk	4	1	3+	5	2
Gyrfalcon	2	1	2	2	0
Common Raven	2	1[c]	3	2	0
Unknown raptor	0	0	0	0	1
Total	**27**	**11**	**22+**	**31**	**4**

a Young ≥75% of fledging age (estimated by comparing with known-age photos); b Occupancy status of territories were unknown throughout the study; c Because fledging happens early with Common Ravens, success was confirmed at only one of the two nests.

Table 3.7-2 Bird Species Reported or Suspected to Occur in the Project Area

Common Name	Scientific Name	Status[a]
Greater White-fronted Goose	*Anser albifrons*	Breeder
Emperor Goose	*Chen canagica*	Visitant
Canada Goose	*Branta canadensis*	Breeder
Tundra Swan	*Cygnus columbianus*	Breeder
Gadwall	*Anas strepera*	Possible breeder
American Wigeon	*Anas americana*	Breeder
Mallard	*Anas platyrhynchos*	Breeder
Northern Shoveler	*Anas clypeata*	Breeder
Northern Pintail	*Anas acuta*	Breeder
Green-winged Teal	*Anas crecca*	Breeder
Canvasback	*Aythya valisineria*	Possible breeder
Ring-necked Duck	*Aythya collaris*	Visitant
Greater Scaup	*Aythya marila*	Breeder
Harlequin Duck	*Histrionicus histrionicus*	Breeder
Surf Scoter	*Melanitta perspicillata*	Possible breeder
White-winged Scoter	*Melanitta fusca*	Visitant
Black Scoter	*Melanitta americana*	Breeder
Long-tailed Duck	*Clangula hyemalis*	Breeder
Bufflehead	*Bucephala albeola*	Visitant
Common Goldeneye	*Bucephala clangula*	Possible breeder
Common Merganser	*Mergus merganser*	Breeder
Red-breasted Merganser	*Mergus serrator*	Breeder
Ruffed Grouse	*Bonasa umbellus*	Resident
Spruce Grouse	*Falcipennis canadensis*	Resident
Willow Ptarmigan	*Lagopus lagopus*	Resident
Rock Ptarmigan	*Lagopus muta*	Resident
White-tailed Ptarmigan	*Lagopus leucura*	Resident
Red-throated Loon	*Gavia stellata*	Breeder
Pacific Loon	*Gavia pacifica*	Breeder
Common Loon	*Gavia immer*	Breeder
Red-necked Grebe	*Podiceps grisegena*	Breeder
Osprey	*Pandion haliaetus*	Visitant
Bald Eagle	*Haliaeetus leucocephalus*	Breeder
Northern Harrier	*Circus cyaneus*	Breeder
Northern Goshawk	*Accipiter gentilis*	Resident
Red-tailed Hawk	*Buteo jamaicensis*	Visitant
Rough-legged Hawk	*Buteo lagopus*	Breeder
Golden Eagle	*Aquila chrysaetos*	Breeder
American Kestrel	*Falco sparverius*	Visitant
Merlin	*Falco columbarius*	Breeder
Gyrfalcon	*Falco rusticolus*	Resident
Peregrine Falcon	*Falco peregrinus*	Possible breeder
Sandhill Crane	*Grus canadensis*	Breeder
Black-bellied Plover	*Pluvialis squatarola*	Possible breeder
American Golden-Plover	*Pluvialis dominica*	Possible breeder
Pacific Golden-Plover	*Pluvialis fulva*	Possible breeder

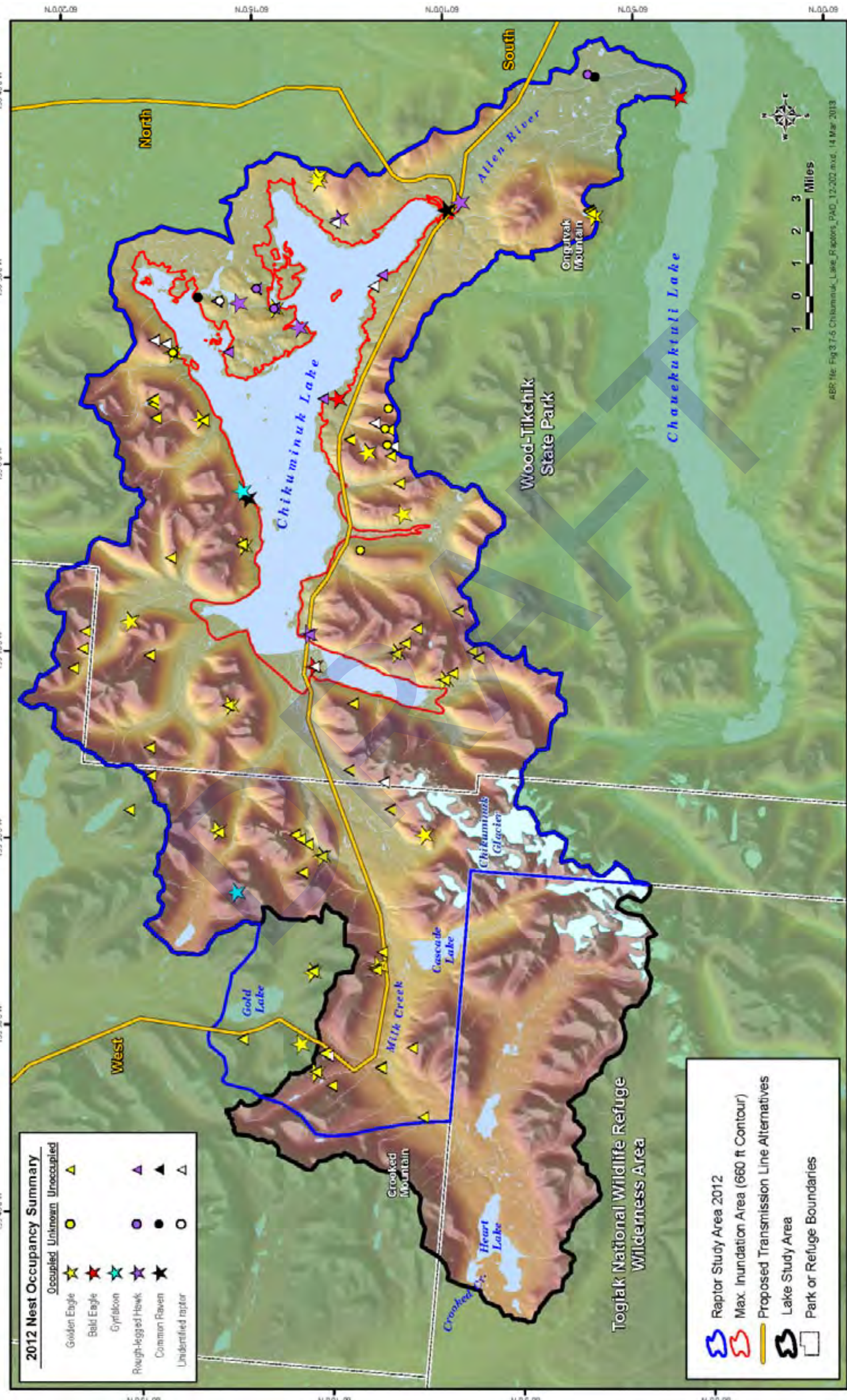
Common Name	Scientific Name	Status[a]
Semipalmated Plover	*Charadrius semipalmatus*	Breeder
Spotted Sandpiper	*Actitis macularius*	Breeder
Solitary Sandpiper	*Tringa solitaria*	Breeder
Wandering Tattler	*Tringa incana*	Breeder
Greater Yellowlegs	*Tringa melanoleuca*	Breeder
Lesser Yellowlegs	*Tringa flavipes*	Possible breeder
Whimbrel	*Numenius phaeopus*	Possible breeder
Hudsonian Godwit	*Limosa haemastica*	Visitant
Bar-tailed Godwit	*Limosa lapponica*	Possible breeder
Black Turnstone	*Arenaria melanocephala*	Migrant
Surfbird	*Aphriza virgata*	Breeder
Semipalmated Sandpiper	*Calidris pusilla*	Possible breeder
Western Sandpiper	*Calidris mauri*	Breeder
Least Sandpiper	*Calidris minutilla*	Breeder
Dunlin	*Calidris alpina*	Possible breeder
Wilson's Snipe	*Gallinago delicata*	Breeder
Red-necked Phalarope	*Phalaropus lobatus*	Breeder
Red Phalarope	*Phalaropus fulicarius*	Possible breeder
Black-legged Kittiwake	*Rissa tridactyla*	Visitant
Sabine's Gull	*Xema sabini*	Visitant
Bonaparte's Gull	*Chroicocephalus philadelphia*	Possible breeder
Mew Gull	*Larus canus*	Breeder
Herring Gull	*Larus argentatus*	Visitant
Glaucous-winged Gull	*Larus glaucescens*	Possible breeder
Glaucous Gull	*Larus hyperboreus*	Possible breeder
Arctic Tern	*Sterna paradisaea*	Breeder
Parasitic Jaeger	*Stercorarius parasiticus*	Visitant
Long-tailed Jaeger	*Stercorarius longicaudus*	Possible breeder
Great Horned Owl	*Bubo virginianus*	Resident
Snowy Owl	*Bubo scandiacus*	Migrant
Northern Hawk Owl	*Surnia ulula*	Resident
Great Gray Owl	*Strix nebulosa*	Resident
Short-eared Owl	*Asio flammeus*	Breeder
Boreal Owl	*Aegolius funereus*	Resident
Belted Kingfisher	*Megaceryle alcyon*	Breeder
Downy Woodpecker	*Picoides pubescens*	Breeder
Hairy Woodpecker	*Picoides villosus*	Possible breeder
American Three-toed Woodpecker	*Picoides dorsalis*	Resident
Olive-sided Flycatcher	*Contopus cooperi*	Possible breeder
Alder Flycatcher	*Empidonax alnorum*	Breeder
Say's Phoebe	*Sayornis saya*	Breeder
Northern Shrike	*Lanius excubitor*	Breeder
Gray Jay	*Perisoreus canadensis*	Resident
Black-billed Magpie	*Pica hudsonia*	Breeder
Common Raven	*Corvus corax*	Resident
Horned Lark	*Eremophila alpestris*	Breeder
Tree Swallow	*Tachycineta bicolor*	Breeder
Violet-green Swallow	*Tachycineta thalassina*	Breeder

Common Name	Scientific Name	Status[a]
Bank Swallow	*Riparia riparia*	Breeder
Cliff Swallow	*Petrochelidon pyrrhonota*	Breeder
Barn Swallow	*Hirundo rustica*	Possible breeder
Black-capped Chickadee	*Poecile atricapillus*	Resident
Boreal Chickadee	*Poecile hudsonicus*	Resident
American Dipper	*Cinclus mexicanus*	Resident
Ruby-crowned Kinglet	*Regulus calendula*	Breeder
Arctic Warbler	*Phylloscopus borealis*	Breeder
Gray-cheeked Thrush	*Catharus minimus*	Breeder
Swainson's Thrush	*Catharus ustulatus*	Breeder
Hermit Thrush	*Catharus guttatus*	Breeder
American Robin	*Turdus migratorius*	Breeder
Varied Thrush	*Ixoreus naevius*	Breeder
Eastern Yellow Wagtail	*Motacilla tschutschensis*	Breeder
American Pipit	*Anthus rubescens*	Breeder
Bohemian Waxwing	*Bombycilla garrulus*	Possible breeder
Lapland Longspur	*Calcarius lapponicus*	Breeder
Snow Bunting	*Plectrophenax nivalis*	Breeder
Northern Waterthrush	*Parkesia noveboracensis*	Breeder
Orange-crowned Warbler	*Oreothlypis celata*	Breeder
Yellow Warbler	*Setophaga petechia*	Breeder
Blackpoll Warbler	*Setophaga striata*	Breeder
Yellow-rumped Warbler	*Setophaga coronata*	Breeder
Wilson's Warbler	*Cardellina pusilla*	Breeder
American Tree Sparrow	*Spizella arborea*	Breeder
Savannah Sparrow	*Passerculus sandwichensis*	Breeder
Fox Sparrow	*Passerella iliaca*	Breeder
Lincoln's Sparrow	*Melospiza lincolnii*	Possible breeder
White-crowned Sparrow	*Zonotrichia leucophrys*	Breeder
Golden-crowned Sparrow	*Zonotrichia atricapilla*	Breeder
Dark-eyed Junco	*Junco hyemalis*	Breeder
Rusty Blackbird	*Euphagus carolinus*	Breeder
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	Possible breeder
Pine Grosbeak	*Pinicola enucleator*	Possible breeder
White-winged Crossbill	*Loxia leucoptera*	Possible breeder
Common Redpoll	*Acanthis flammea*	Breeder
Hoary Redpoll	*Acanthis hornemanni*	Possible breeder

Source: ABR 2012 and ABR unpublished data.

a Resident = individuals present all year and breed in the project area; breeder = breeding evidence has been documented; possible breeder = breeding evidence has not been documented but individuals have been recorded in the greater project area and appropriate nesting habitat is present; migrant = individuals present during spring or fall migration; visitant = individuals present occasionally, including molting, non-breeding, failed breeders, and post-breeding birds.

Figure 3.7-5 Occupied, Unoccupied and Unknown Status Raptor Nests Identified during Aerial Surveys in the Project Area, 2012



Bald and Golden eagles and their nests are protected by the Bald and Golden Eagle Protection Act. Both species occur in the project area but Golden Eagles are more common. Golden Eagles are known to nest along the western drainages of the Kilbuck Mountains, particularly where rivers cut through the foothills prior to entering the lowland wet tundra (White and Boyce 1978; Mindell 1981, 1983; Weir 1982; Boyce and Fristensky 1984; McCaffery and Earnst 1989; McCaffery 1993). Golden Eagles were the most numerous nesting raptor in the 2012 survey area with 19 occupied nests (plus one possibly occupied nest). Incubating birds were observed at 84% of occupied Golden Eagle territories in 2012. Prior to summer 2012, the mountains around Chikuminuk Lake had not been systematically surveyed for nesting raptors. Golden Eagles reportedly were seen soaring along ridgelines near Upnuk Lake and Chikuminuk Lake, but no effort was made to find nests and none were documented (Grumman Ecosystem Corporation 1971; Weir 1982). Weir (1982) suspected that the elevation of the cliffs at the headwaters of these rivers might be too high for raptor nests, including Golden Eagles.

In Alaska, Golden Eagles are migratory. They arrive on their breeding grounds in late February to early April and typically complete egg laying by mid-to-late April (Kessel 1989; Young et al. 1995; McIntyre and Adams 1999). Since they are primarily cliff-nesting birds, they breed near or above timberline in mountainous habitat dominated by rugged terrain (Petersen et al. 1991; Kochert et al. 2002). Golden Eagles build stick nests and maintain multiple nests within their territory, which they may use alternately from year to year (Kochert et al. 2002). Once pairs establish a territory, they tend to return to it; however, they may not lay eggs every year (Kochert et al. 2002). Whether or not eggs are laid is one of the most variable components of Golden Eagle reproduction and has been linked to the availability of spring prey, primarily snowshoe hare and ptarmigan (McIntyre 2002). Prey remains at nests along the Kisaralik and Tuluksak rivers indicated that Golden Eagles there were preying primarily on ground squirrels, ptarmigan, and snowshoe hare (Mindel 1983). Golden Eagles in interior Alaska leave breeding grounds in late September and early October and migrate to the western United States and northern Canada for the winter (McIntyre and Adams 1999; Kochert et al. 2002; McIntyre et al. 2008).

An approximate 45-kilometer stretch of the Kisaralik River from Upper Falls to the Little Crow Hills has been the most consistently surveyed area in the region and was periodically surveyed from 1977 to 2004 (White and Boyce 1978; Mindell 1981, 1983; Weir 1982; McCaffery and Earnst 1989; McCaffery 1993; McCaffery et al. 2011). Five to seven Golden Eagle nesting territories have been identified from Upper Falls downstream to the Little Crow Hills (Mindell 1981, 1983; McCaffery and Earnst 1989). In some studies, the survey area extended downstream to the confluence of Clear Creek, and included Quicksilver, Quartz, and Swift creeks, raising the total to 11 to 15 Golden Eagle territories in the area (Weir 1982; McCaffery 1993). McCaffery et al. (2011) surveyed a 339 km^2 corridor along the Kisaralik River from 2000 to 2004 and reported an average of about 15 territories. Nesting occupancy (number of territories containing a nesting bird/the number of known territories) along the Kisaralik River was highly variable among years and ranged from 40 to 80% (McCaffery and Earnst 1989). Despite those yearly fluctuations, the Golden Eagle population was thought to be stable between 1977 and 1993 (McCaffery 1993). The USFWS conducted a survey for raptors along the Kisaralik River in May 2012 (Travis Booms, Alaska Department of Fish and Game, pers. comm.). Results were not yet available.

At least a dozen Bald Eagle nests have been documented in the Wood-Tikchik lakes and Nushagak River region (Wright 2010). During resource inventory studies in 1970, Bald Eagles were seen on all the Wood-Tikchik lakes and one nest was found on the Tikchik River (Grumman Ecosystems Corporation 1971). During the late 1970s, one to three nests were found each year along the Kuskokwim River between Bethel and Tuluksak (Mindell 1983). Scattered Bald Eagle nests have been observed incidentally in such woodlands along the Eek, Kisaralik, and Kasigluk rivers (White and Boyce 1978; McCaffery and Earnst 1989; McCaffery 1993; Morgart 1998). Bald Eagles have also been observed flying near the Kwethluk River (Petersen et al. 1991). Three occupied Bald Eagle territories were identified in the 2012 raptor survey area (**Table 3.7-3**). Bald Eagles migrate through the Kilbuck Mountains and occur at low densities along the lower Kuskokwim River and the western river drainages of the

Kilbuck Mountains (Mindell 1983; Petersen et al. 1991; Wright 2010). Bald Eagles are present in the area from mid-April to mid-October (Petersen et al. 1991). They build large stick nests near water, often in the dominant tree of a stand, typically a large balsam poplar or white spruce (Mindell 1983; Ritchie and Ambrose 1996). The project area appears to be at the edge of the Bald Eagle's breeding range in Alaska (Buehler 2000). Although Bald Eagles are considered common breeders in Togiak NWR, nests are rare along the Kuskokwim River and its tributaries (Mindell 1983; Ritchie and Ambrose 1996; MacDonald 2003; Wright 2010). Mindell (1983) thought that suitable nesting habitat for Bald Eagles was not lacking in the region but that food availability might limit nesting. Salmon runs in the area may not start until late June or early July and waterfowl densities may not be high enough to provide an alternate prey base. Large trees suitable for nesting appear to be limited around the edge of Chikuminuk Lake and no known salmon runs enter the lake, potentially explaining the low densities of Bald Eagles in the lake study area. However, the Allen River does have large trees and a salmon run in its lower reaches.

Rough-legged Hawks are an Arctic nesting species that typically nests on coastal, riverine, and upland cliff substrates. In Alaska (Seward Peninsula), the earliest arrival date and subsequent nest-building periods are from late April to early May. The mean egg-laying dates are in the second week of May, but as early as late April (Bechard and Swem 2002). In this study area, Rough-legged Hawks were only found nesting in lower elevation habitats, by comparison with Golden Eagles. Of the 15 Rough-legged Hawk nests that were found in the study area, five (33%) were occupied during the study, seven (47%) nests were unoccupied, and three (20%) nests were of unknown occupancy.

Gyrfalcons are widely scattered residents throughout southwestern Alaska and are locally common breeders in several of the western drainages of the Kilbuck Mountains, including the Kisaralik River (Mindell 1983, Petersen et al. 1991). Between 1977 and 1993, four to six Gyrfalcon territories were identified along the Kisaralik River and Quicksilver Creek (Weir 1982; Mindell 1983; McCaffery and Earnst 1989; McCaffery 1993). Most were distributed along the central 28 km of river between Golden Gate Falls and Icebox Lake (McCaffery 1993). Gyrfalcons nested on cliffs in old Golden Eagle, Rough-legged Hawk, or Common Raven nests (Mindell 1983). Although not typically a tree-nesting species, one nest was found in a cottonwood tree near Quicksilver Creek (McCaffery 1993). Two Gyrfalcon territories were identified in the lake study area in 2012 (**Table 3.7-3**) and incubating birds were found in one of the occupied territories (50%). In southwestern Alaska, Gyrfalcons are primarily birds of the alpine zone that forage at the edge of subalpine dwarf scrub habitats (Petersen et al. 1991). Gyrfalcons nest on hillside rock outcrops and riverine cliffs as well as in trees where the forest follows the river into tundra biome (Cade 1960; Booms et al. 2008; McCaffery et al. 2011). Gyrfalcons are recognized as a species of conservation concern in southwest Alaska by the Alaska Boreal Partners in Flight Working Group (BPIFWG 1999).

Merlins are the only other falcon known to nest in the project area, preferring transitional scrub habitats at the edge of deciduous tree woodlands and subalpine willow–alder (Petersen et al. 1991). Merlins were not observed during 2012 field efforts in the project area.

Peregrine Falcons nest on cliffs along the upper Kuskokwim River between McGrath and Aniak, but have not been documented nesting along the lower Kuskokwim River and are considered very rare in the western drainages of the Kilbuck Mountains (Ritchie and Ambrose 1976; Dotson and Mindell 1979; Mindell 1983; Petersen et al. 1991). Only one Peregrine Falcon nest has been reported in the region (NPS 1984), and that observation has been questioned (McCaffery and Earnst 1989), the combined evidence suggesting that the 1981 nest was actually a misidentified Gyrfalcon nest. According to published literature, the last confirmed record of a Peregrine Falcon in the area was in 1979 when one was recorded calling along the Kisaralik River (Weir 1982). Although Peregrine Falcon populations in the 1970s were greatly reduced by pesticide contamination, significant population recovery occurred in interior Alaska during the late 1990s and early 2000s (Ritchie and Shook 2011) and it would therefore not be surprising to find this species nesting in the eastern portion of the project area (Ritchie and Shook 2011). No Peregrine Falcon nests were located in the 2012 survey area.

Riparian woodlands are common along the Kisaralik River (Brown et al. 1985) and appear to be dominant on the Allen River; such riparian areas likely provide some of the only trees in the region large enough to support tree-nesting raptors. Northern Goshawks are resident and nest along the Kisaralik River in spruce–cottonwood woodlands, typically in the forks of balsam poplar trees (Petersen et al. 1991). The project area appears to be at the western range limit of the breeding ranges of Red-tailed Hawks, American Kestrel, and Osprey (Buehler 2000; Poole et al. 2002; Smallwood and Bird 2002; Preston and Beane 2009). These species are not known to nest in the project area, however, scattered individuals of each species have been observed near riparian areas in the western drainages of the Kilbuck Mountains (Mindell 1981, 1983; Boyce and Fristensky 1984; Petersen et al. 1991).

Northern Harrier likely breed in the project area and have been recorded along the lower Kisaralik and Kwethluk rivers (Boyce and Fristensky 1984; McCaffery 1993). Nesting has been documented along the Tuluksak River in low and tall willow–scrub plant communities (Petersen et al. 1991).

Of the six species of owls that occur in the project area, all but the Snowy Owl are likely breeders (**Table 3.7-2**). Snowy Owls breed on coastal tundra and the Yukon-Kuskokwim Delta is at the southern limit of their breeding range in Alaska (Parmelee 1992). No evidence of breeding has been reported in the lake study area but Snowy Owls have been seen on heath tundra of the lower Kuskokwim River during summer and fall (Williamson 1957). Short-eared Owls have been observed but are uncommon along the lower tributaries of the Kilbuck Mountains in moist tussock tundra, which is considered a breeding habitat (Mindell 1983; Boyd and Fristensky 1984; Wiggins et al. 2006). Like Snowy Owls, however, Short-eared Owls in this region may be more common near coastal areas (Petersen et al. 1991). Both Snowy and Short-eared owls are migratory species and highly irruptive across their range depending on the abundance of microtine rodents, their primary prey (Parmelee 1992; Wiggins et al. 2006). Riparian spruce–cottonwood woodlands provide nesting and year-round habitat for Great Horned, Great Gray, and Boreal owls (Williamson 1957; Petersen et al. 1991). Great Gray and Boreal owls are recognized as species of conservation concern in southwest Alaska by the Alaska Boreal Partners in Flight Working Group (BPIFWG 1999). The Great Horned Owl is considered common in Kilbuck Mountains and western drainages, whereas the other two species are considered rare (Mindell 1983; Petersen et al. 1991). The Northern Hawk Owl is a year-round resident and uncommon breeder in the Kilbuck Mountains (Petersen et al. 1991). Northern Hawk Owls nest along the western drainages at the edges of riparian spruce and spruce–cottonwood woodlands and on well drained riverine terraces dominated by dwarf scrub vegetation (Mindell 1983; Petersen et al. 1991).

3.7.3.2 Waterbirds

The waterbirds treated in this section include waterfowl, loons, grebes, cranes, gulls, terns, and jaegers. Waterfowl comprise the largest group of waterbirds in the project area, including geese, swans, dabbling ducks, diving ducks, and seaducks. Waterfowl occupy lake, pond, wetland and river habitats and occur throughout the project area. Harlequin Ducks restrict their breeding habitat to fast-flowing rivers and streams; specific surveys for them have been conducted on the Kisaralik River and its tributaries (McCaffery and Harwood 1994; Morgart 1998). Loons and grebes breed on lakes, preferring those with islands or emergent vegetation. Common Loons, in particular, nest on fish-bearing lakes and are likely to occur on Chikuminuk Lake. Cranes, gulls, and terns use lake, pond, and wetlands in tundra habitats for foraging and nesting.

A few studies designed to determine the distribution and abundance use of waterbirds have been conducted within portions of the West transmission corridor study area. Waterfowl breeding population surveys have been conducted annually since 1957 in the Yukon Delta NWR (Mallek and Groves 2010). The aerial survey follows transect lines that are spaced approximately 800 meters apart and aligned to cover the largest possible number of waterbodies and wetlands. Only one of the eight transect lines of the Yukon Delta NWR survey falls within the project area; it runs parallel to and just east of the Kuskokwim River. Annual densities are calculated for each species of waterfowl for the entire survey area to determine breeding population estimates; all large waterbirds, including loons, grebes, cranes, gulls, terns, and jaegers are recorded. For the portion of the transect that occurs within the project area, USFWS survey data helps determine the presence of waterbirds (**Table 3.7-2**).

An expanded waterfowl breeding population survey, which was more intensive and covered a broader area than the USFWS surveys, was conducted in the Yukon Delta NWR over a four-year period (1989–1992) (Platte and Butler 1993). The east–west transects of this survey extended to the Kilbuck Mountains and probably covered all of the waterbodies and wetlands within the project area between the Kuskokwim River and the Kilbuck Mountains. Results from the expanded waterfowl survey concluded that dabbling duck densities were highest in coastal areas and on deltas while scoter, scaup, and Long-tailed Duck densities were highest in inland areas (Platte and Butler 1993). In 2004 and 2005, the transect lines of the expanded survey area were flown; only scoters, Greater Scaup, and Long-tailed Ducks were recorded (Stehn et al. 2006). Population estimates of those species from the 1989–1992 survey were compared with 2004–2005 estimates. Annual (1957–2011) and expanded (1993–1994) waterfowl breeding population surveys also have been conducted in the Bristol Bay region in the waterbodies and wetland habitats east of the project area (Platte and Butler 1995; Mallek and Groves 2010).

Surveys designed to determine the distribution and relative abundance of breeding Harlequin Ducks have been conducted along streams and rivers of the Kilbuck Mountains that occur in the West transmission corridor study area (McCaffery and Harwood 1994; Morgart 1998). Breeding pair surveys were conducted by helicopter of the Kisaralik and Kwethluk river drainages in 1994–1998 and a portion of the Eek River in 1994 (McCaffery and Harwood 1994; Morgart 1998). The density of Harlequin Ducks on the Kisaralik River in 1994 was about twice that of the Kwethluk River, and about half of all paired and unpaired birds occurred in 13 km of river between the mouths of Gold Creek and the North Fork Kisaralik River (McCaffery and Harwood 1994). About two-thirds of the Harlequin Ducks observed on tributaries of the Kisaralik River in 1994 occurred on Quicksilver Creek, Gold Creek, and the North Fork (McCaffery and Harwood 1994). Some annual variation occurred in the number of Harlequin Ducks on the Kisaralik River and its tributaries in 1995–1998, but overall the number remained high (Morgart 1998). Eight other species of waterfowl were observed on surveys for Harlequin Ducks in 1998, with Common and Red-breasted mergansers as the two other species most frequently seen (Morgart 1998). No surveys for Harlequin Ducks have been conducted on the Allen River or other inlet streams of Chikuminuk Lake in the lake study area.

Waterbirds were recorded incidentally during boat-based surveys along the Kisaralik River, many of which were conducted primarily for cliff-nesting raptors (Boyce and Fristensky 1984; Brown et al. 1985; Peterson et al. 1991). Most of these surveys were confined to the river corridor and conducted in July or August after birds had completed nesting. During these surveys breeding was documented or suspected for at least two species of geese, ten species of ducks, and two species of gulls (Boyce and Fristensky 1984; Peterson et al. 1991). A bird-habitat study conducted around Napaskiak in late May/early June of 1955 and 1956 documented the occurrence of breeding by loons, grebes, cranes, and many species of ducks (Williamson 1957).

Within the lake study area, a list of species was recorded during field activities in 1970 that served to assess the resource inventory of the Wood River–Tikchik area (Grumman Ecosystems Corporation 1971). The field visits occurred in July and August and did not document any evidence of waterbird breeding. Tikchik Lake was noted as having more waterfowl than other lakes in the Wood River–Tikchik area because it was generally shallower and more eutrophic, but no reference was made to Chikuminuk Lake or the surrounding area for the occurrence of waterfowl (Grumman Ecosystems Corporation 1971).

Tundra Swans are known to migrate through the project area in the fall (Peterson et al. 1991), but no migration studies have been done in the project area. Very little is known about the use of Chikuminuk Lake or other waterbody and wetland habitats by waterbirds during spring and fall migration.

No information was located on the use of Chikuminuk Lake by waterbirds and limited information exists on their use of the lakes and wetlands between the Kuskokwim River and the Kilbuck Mountains. Systematic aerial surveys for breeding waterfowl conducted annually by USFWS cover only the very western portion of the project area in the lower Kuskokwim River floodplain. A one-time aerial survey expanded the extent of coverage to include all of the lake and wetland habitats between the Kuskokwim River and the Kilbuck Mountains, but it occurred 20 years ago and most waterfowl populations have changed since then. Surveys are needed to document the current distribution, abundance, and habitat use of waterbirds within the project area during both the migration and breeding seasons.

Harlequin Ducks use rivers exclusively for breeding and currently are a species of management concern (USFWS 2009). Surveys for Harlequin Ducks were conducted along rivers of the Kilbuck Mountains in the mid-1990s and the Kisaralik River was found to support a high number of ducks during the pre-nesting season when pair bonds are being formed. No surveys were conducted along the Kisaralik River during the brood-rearing season to determine productivity. No information was located on the occurrence of Harlequin Ducks or any other waterbirds on the Allen River or other inlet streams to Chikuminuk Lake. Surveys are needed of rivers and streams within the project area to determine the current distribution and abundance of breeding Harlequin Ducks and other waterbirds.

3.7.3.3 Landbirds and Shorebirds

Excluding accidental occurrences during migration, at least 21 species of shorebirds and 56 species of landbirds (primarily passerines) have been recorded or are likely to occur in the Project area (**Table 3.7-2**). Ten species of shorebirds are confirmed breeders and another 9 species possibly breed in the Project area. In contrast, 47 species of landbirds are considered breeders and an additional nine species are possible breeders in the Project area. Both shorebirds and landbirds nest in a variety of habitats and probably occur throughout the Project area. In areas where studies were conducted, shorebirds were most commonly found using meadow habitats (wet, dwarf scrub, and grass) in both lowland and upland terrain and lacustrine and fluviatile waters and their shorelines (Wilson et al. 1982; Peterson et al. 1991). Landbirds utilize an array of habitats that are found in the Project area, ranging from rocky alpine barrens to lowland meadow, scrub, and forest patches (Wilson et al. 1982; Peterson et al. 1991).

Studies that have documented shorebird and/or landbird use in the Project area are limited. Within the lake study area, a list of species was kept during field activities in 1970 that served to assess the resource inventory of the Wood River-Tikchik area (Grumman Ecosystems Corporation 1971). The field visits occurred in July and August and did not document any evidence of bird breeding. Tikchik Lake was noted as having more shorebirds than other lakes in the Wood River-Tikchik area because it was generally shallower and more eutrophic, but no reference was made to Chikuminuk Lake or the surrounding area for the occurrence of shorebirds and landbirds (Grumman Ecosystems Corporation 1971).

Avian studies within the transmission line study area are primarily boat-based surveys, primarily for cliff-nesting raptors, that were conducted along the Kisaralik River, and only a few recorded the presence of shorebirds and landbirds (Boyce and Fristensky 1984; Brown et al. 1985; Peterson et al. 1991). The most comprehensive survey was conducted in 1985 as part of a general biological inventory of the Yukon Delta NWR (Brown et al. 1985). Birds were sampled by counting all individuals observed along transects (75 m or 100 m by 1,800 m) extending perpendicular from the river. Twenty-seven transects were completed, of which nine transects were in the Kisaralik Lake area, nine above the Upper Falls, and nine at Little Crow Hills below the lower falls on the river;

these locations all occur within the transmission line study area. The density and composition was summarized by species-group (shorebirds, passerines, waterfowl, and other) for each transect. Passerines were reported to be the dominant species group at the lower elevation transects while at the higher elevation transects, shorebirds and other birds were more common (Brown et al. 1985). The survey was conducted in August when all shorebirds and landbirds had finished nesting and rearing young; consequently, no evidence of breeding was found, although most bird species observed were assumed to have bred in the area.

Data on the occurrence of bird species were recorded during float trips on rivers of the Kilbuck and Ahklun mountains between 1952 and 1987 and were synthesized in detailed species accounts by Peterson et al. (1991). Relative abundance, seasonal occurrence, distribution, and habitat use are presented for each species. Species sightings from the Kisaralik River are included in Peterson et al. (1991) but specific location data are not given. Boyce and Fristensky (1984) recorded the occurrence of all birds species observed during a raptor survey of the Kisaralik River in 1984 and reported location information in township/range format. Most of their observations occurred from a boat while floating downriver and were biased towards conspicuous species.

No specific information exists on the distribution and abundance of shorebirds and landbirds within the project area. Systematic surveys are needed to determine the current distribution, abundance, and habitat use of the Project area by shorebirds and landbirds.

3.8 Special Status Species

This section identifies species with a special federal or state conservation designation that are known to occur in the project vicinity.

As of August 15, 2011, the Alaska Department of Fish and Game (ADF&G) no longer maintains a list of species of special concern. The ADF&G does maintain a Wildlife Action Plan (ADF&G 2006) that is supported through the State Wildlife Grant program. The Wildlife Action Plan outlines the conservation needs for hundreds of species, most of which are listed due to lack of knowledge, some of which are listed because of actual conservation concern due to restricted range or decreasing abundance. "Featured Species" listed in the Wildlife Action Plan include fish, mammals, and birds.

A memorandum of understanding (MOU) between FERC and USFWS (30 March 2011) tasks FERC to evaluate species published in the Birds of Conservation Concern (published and updated periodically by the Division of Migratory Bird Management; USFWS 2008, 2009) and other identified lists of priority migratory birds (BPIFWG 1999; Brown et al. 2001; Kushlan et al. 2002, 2006; Dunn et al. 2004; NAWMP 2004; ASG 2008). On the basis of the MOU definitions, 42 species of birds that occur or are suspected to occur in the project area have been identified as being of conservation and management concern. These species are described under Birds, below.

3.8.1 Federal Candidate, Threatened, and Endangered Species

There are no federally-listed Candidate, threatened or endangered fish, plant or wildlife species, or designated or proposed critical habitat within the project vicinity. Listed species in Alaska include Steller's eider (*Polysticta stelleri*) (threatened), Spectacled eider (*Somateria fischeri*)(threatened), Short-tailed albatross (*Phoebastria albatrus*) (endangered) , Northern sea otter (*Enhydra lutris kenyoni*) (threatened) SW DPS, Polar bear (*Ursus maritimus*) (threatened), Aleutian shield fern (*Polystichum aleuticum*)(endangered), Eskimo curlew (*Numenius borealis*)(endangered), Wood bison (*Bison bison athabascae*) (threatened). Candidate species include Kittlitz's murrelet (*Brachyramphus brevirostris*), Yellow-billed loon (*Gavia adamsii*), Pacific walrus (*Odobenus rosmarus divergens*).

Steller's and Spectacled eiders occur in coastal areas of the Yukon-Kuskokwim Delta and are not expected to occur in the project area. Kittlitz's murrelet, a Candidate species, nest in talus habitats similar to those occurring in the mountains surrounding Chikuminuk Lake. However, the distance to coastal feeding areas is too far and they are not expected to occur in the project area.

3.8.2 State Designated and Special Conservation Status Species

3.8.2.1 Plants

The AKNHP database indicates that eight rare vascular plant taxa with S1 and S2 rankings have been collected in the regional search area (**Table 3.6-1**). *Eleocharis kamtschatica* and *Carex lapponica* are both wetland species that are potentially more likely to occur in the Yukon-Kuskokwim lowlands within the biological resources study areas. The remaining six species all occur throughout the lakes region of Wood-Tikchik State Park and are thus highly likely to occur near Chikuminuk Lake and mountainous areas immediately adjacent to the lake.

3.8.2.2 Mammals

The Little Brown Bat, Collared Lemming, and Tundra Hare are the only terrestrial mammal species in the project area that occur as featured species in the ADF&G Wildlife Action Plan due to rareness, restricted range, population declines, or conservation concern (ADF&G 2006). The federal Bureau of Land Management (BLM) maintains lists of "sensitive species" (BLM 2010); two terrestrial mammals that occur in the project area – the Tundra Hare and the Alaska Tiny Shrew – are included on that list.

Little Brown Bat

The Little Brown Bat is included as a featured species in the ADF&G Wildlife Action Plan with a ranking by the Nature Conservancy as rare or in widespread decline (ADF&G 2006). The Little Brown Bat is the most widely distributed and common species of bat in Alaska and Canada, inhabiting areas with some degree of forest cover (van Zyll de Jong 1985, MacDonald and Cook 2009). During summer, Little Brown Bats roost in natural cavities, under loose bark, in rock crevices, in dead or hollow trees, and in buildings; females with young roost in communal maternity colonies numbering from a few bats to more than a thousand (van Zyll de Jong 1985). Little Brown Bats generally occupy caves during winter hibernation. The species has been found hibernating in caves in southeastern Alaska and has been recorded on Kodiak Island in February, but it is not known if bats in interior Alaska migrate to the south coast or hibernate elsewhere (Parker et al. 1997). The population of Little Brown Bats in the eastern United States is experiencing a precipitous decline due to mass mortality caused by white-nose syndrome and the eastern population has a high probability of regional extinction in coming decades (Frick et al. 2010). Concern has been expressed about the possibility of white-nose syndrome being transported to Alaska (Wright and Moran 2011).

Grumman Ecosystems Corporation (1971) reported Little Brown Bats in the Wood-Tikchik region but provided no supporting details. Nolan and Peirce (1996) observed a colony of Little Brown Bats occupying a cabin in summer on the Agulukpak River in Wood-Tikchik State Park, but did not report whether it was a maternity colony. Specimens have been collected near Iliamna Lake, King Salmon, and Sleetmute, on the Kuskokwim River (Parker et al 1997).

During the summer of 2012, Chikuminuk Lake Hydroelectric Project field personnel reported that hundreds of Little Brown Bats commonly occurred on summer evenings at the Tikchik Narrows Lodge, near the southern edge of the lake study area and lodge employees confirmed that they were a common occurrence there annually. Little else is known of their occurrence or abundance in the project area. The locations of winter hibernacula used by Little Brown Bats are virtually unknown in most of Alaska.

Collard Lemming

Despite its abundance and widespread distribution in tundra habitats, the Collared Lemming is included as a featured species in the ADF&G Wildlife Action Plan with a ranking by the Nature Conservancy as rare or in widespread decline (ADF&G 2006). Collared Lemmings may occur in mesic tundra habitats throughout the project area.

Tundra Hare

It is uncertain whether or not Tundra Hares occur in the project area, if so they would be primarily in tundra habitats in the West transmission corridor, which approaches the eastern edge of the southern portion of the species range in Alaska. Although not rare in appropriate habitats, the Tundra Hare is listed by the BLM as a Sensitive Species, presumably because of its restricted distribution. The Tundra Hare is a featured species in the ADF&G Wildlife Action Plan with a ranking by the Nature Conservancy as rare, restricted range, or recent and widespread declines (ADF&G 2006). The Tundra Hare, also called the Alaska hare, is an endemic species that is related to the arctic hare of northern Canada and Greenland (Waltari and Cook 2005). It occurs in tundra habitats along coastal western Alaska from the Baldwin Peninsula south to the Alaska Peninsula (Anderson 1978, Waltari and Cook 2005, MacDonald and Cook 2009). The species is listed on the mammal checklists for the Yukon Delta NWR (USFWS 1988) and Togiak NWR (USFWS 1986). Jacobsen (2004) reported seeing a Tundra Hare from the air while conducted research near Iliamna Lake and the Nushagak River but no location was given. No specific information describes the occurrence or abundance of Tundra Hares in the project area.

Alaska Tiny Shrew

The Alaska Tiny Shrew is listed by the BLM as a Sensitive Species, although the abundance and distribution of the species is largely unknown. The Alaska Tiny Shrew, the smallest mammal in North America, was described as a new species (*Sorex yukonicus*) in 1997, although Hope et al. (2010) have since concluded that it is conspecific with *S. minutissimus*, an Old World species. When he described the species, Dokuchaev (1997) listed only three locations where it had been recorded, but specimen records increased quickly as researchers looked for it elsewhere in the state. By the late 1990s and early 2000s, the species had been recorded over a broad area of interior, western, and northern Alaska. By 2007, the total number collected statewide had increased to 38 specimens from at least 22 locations (MacDonald and Cooke 2009), including the Togiak NWR (Peirce and Peirce 2000) and Lake Clark National Park and Preserve (Cook and MacDonald 2005). Early information on habitat affinities indicated that it occurred primarily in riparian habitats, but as trapping efforts expanded, it also was captured in scrub habitats. The Alaska Natural Heritage Program classifies the Alaska Tiny Shrew as "unrankable" globally (GU), presumably because little information is available; as "vulnerable" in the state (S3; AKNHP 2011), probably due to restricted range and relatively few populations; and it was listed as a sensitive species by BLM in 2010, presumably because of its S3 ranking by AKHNP.

3.8.2.3 Amphibians

The only amphibian that inhabits southwestern Alaska, the wood frog (*Rana [Lithobates] sylvatica)*, is the most common amphibian in Alaska (MacDonald 2010).

Wood Frog

Although not considered rare, resource management agencies have devoted more attention to inventorying and monitoring Wood Frog populations due to population declines of amphibians elsewhere in North America and to reports of physical deformities in wood frogs in Alaska (Anderson 2004). Despite its abundance and widespread distribution, the Wood Frog is included as a featured species in the ADF&G Wildlife Action Plan (ADF&G 2006) with a ranking by the Nature Conservancy as rare or in widespread decline.Wood frogs occur in a wide variety of habitats during the year. Mature adults congregate in wetland areas to breed in the spring (beginning in late April to early May) and then move into adjacent wetland and upland habitats, usually within a few hundred yards of the breeding areas, during the summer (MacDonald 2010). Beaver ponds provide high-value habitat for wood frogs (Stevens et al. 2006). Egg-laying occurs in small ponds or lakes in wooded or open habitats; wood frogs reportedly avoid egg predation by fish by selecting waterbodies that are free of fish (Gotthardt 2005). Birds, such as gulls, prey on frogs during the breeding season. Wood frog breeding populations may vary by a factor of ten and juvenile populations may vary by a factor of 100 among years (Berven 1990). Adult survival depends on rainfall, drought, and winter severity (Berven 1990; Anderson 2004). Wood frogs hibernate throughout the winter under snow cover in shallow depressions of compacted forest litter, entering hibernation as early as late August. The species is remarkable because of its ability to tolerate freezing during winter hibernation by producing cryoprotectant chemicals that act as a natural "antifreeze" to prevent cell disruption, allowing up to 65% of the water in their bodies to crystallize and their body temperature to drop as low as –12°C (MacDonald 2010).

In southwest Alaska, wood frogs have been recorded northwest of Iliamna Lake (Jacobsen 2004; PLP 2011) and southwest of Iliamna Lake near Kaskanak Creek (Jacobsen 2004). They also have been reported in Lake Aleknagik in the Wood River system and along the lower Kuskokwim and Yukon rivers (MacDonald 2010). About 50% of the waterbodies mapped for the proposed Pebble Mine Project northwest of Iliamna hosted wood frogs in the spring; deep ponds with aquatic vegetation and with hibernation habitat nearby were most likely to contain frogs (PLP 2011). The occurrence of wood frogs in the project area is suspected but unconfirmed.

3.8.2.4 Birds

Forty-two species of birds that occur or are suspected to occur in the project area have been identified as being of conservation and management concern (**Table 3.8-1**). This list of birds of conservation and management concern, is based on the 30 March 2011 memorandum of understanding (MOU) between FERC and the USFWS. The MOU states that bird species of concern within a proposed project area be identified from the USFWS Birds of Conservation Concern, published by the Division of Migratory Bird Management (USFWS 2008, 2009) and by other lists of priority migratory bird species, including the North American Waterbird Conservation Plan, United States Shorebird Conservation Plan, Partners in Flight Bird Conservation Plans, North American Waterfowl Management Plan, and Migratory Bird Treaty Act-listed gamebirds of management concern (BPIFWG 1999; Brown et al. 2001; Kushlan et al. 2002, 2006; Dunn et al. 2004; NAWMP 2004; ASG 2008). However, not all of the species in **Table 3.8-1** are considered uncommon or rare—the definition of species of concern in the MOU includes species that pose management challenges for various reasons, including population declines, small or restricted populations, dependence on restricted or vulnerable habitats, or overabundance to the point of causing ecological or economic damage. The MOU listing of birds of concern is largely similar to the listing of birds identified as featured species by the ADF&G Wildlife Action Plan due to rareness, restricted range, population declines, or conservation concern (ADF&G 2006).

Gyrfalcons

Gyrfalcons are widely scattered residents throughout southwestern Alaska and are locally common breeders in several of the western drainages of the Kilbuck Mountains, including the Kisaralik River (Mindell 1983, Petersen et al. 1991); therefore, it is likely that they also occur in the lake study area. In southwestern Alaska, they are primarily birds of the alpine zone that forage at the edge of subalpine dwarf scrub habitats (Petersen et al. 1991). Gyrfalcons nest on hillside rock outcrops and riverine cliffs as well as in trees where the forest follows the river into tundra biome (Cade 1960; Booms et al. 2008; McCaffery et al. 2011). Gyrfalcons are recognized as a species of conservation concern in southwest Alaska by the Alaska Boreal Partners in Flight Working Group (BPIFWG 1999).

Great Gray and Boreal Owls

Great Gray and Boreal owls are recognized as species of conservation concern in southwest Alaska by the Alaska Boreal Partners in Flight Working Group (BPIFWG 1999). Their status in the project area is unknown, however the distribution of both species is restricted to forested habitats, thus they may be uncommon in the lake study area.

Waterbirds

Sixteen species of waterbirds recorded in the project area are species of conservation or management concern (**Table 3.8-1**). Red-throated Loons are listed as a Bird of Conservation Concern by the USFWS because of declining population numbers (USFWS 2008). Five species of waterfowl that occur in the project area have been identified in the North American Waterfowl Management Plan as species of High Continental Priority (Cackling Goose, Lesser Canada Goose, Emperor Goose, Mallard, and Northern Pintail) and seven species are species of Moderately High Continental Priority (American Wigeon, Canvasback, Surf Scoter, White-winged Scoter, Black Scoter, Long-tailed Duck, and Common Goldeneye) (NAWMP 2004). Five of these waterfowl species of High or Moderately High Continental Priority also are considered Birds of Conservation Concern by the USFWS (**Table 3.8-1**). Additional waterfowl species listed as Birds of Conservation Concern are Greater White-fronted Goose, Harlequin Duck, and Greater Scaup. The status of these species in the project area is unknown.

Landbirds and Shorebirds

Currently, information on the use of the project area by landbirds and shorebirds of conservation and management concern is lacking. Ten shorebirds of conservation concern (American Golden-Plover, Solitary Sandpiper, Lesser Yellowlegs, Whimbrel, Hudsonian Godwit, Bar-tailed Godwit, Black Turnstone, Surfbird, Western Sandpiper, and Dunlin) and twelve landbirds of conservation concern (White-tailed Ptarmigan, Olive-sided Flycatcher, Northern Shrike, American Dipper, Gray-cheeked Thrush, Varied Thrush, Bohemian Waxwing, Blackpoll Warbler, Golden-crowned Sparrow, Rusty Blackbird, White-winged Crossbill, and Hoary Redpoll) probably occur in the project area, most as breeders (Dunn et al. 2004; ASG 2008; **Table 3.8-1**).

Table 3.8-1 Reported or Suspected Bird Species of Conservation and Management Concern

Common Name	USFWS BCC[a]	USFWS BMC[b]	NAWMP[c]	NAWCP[d]	ASG (USSCP)[e]	BPIF (PIF)[f]
Greater White-fronted		■				
Canada Goose – Cackling		■	■			
Canada Goose – Lesser			■			
Emperor Goose		■	■			
American Wigeon		■	■			
Mallard		■	■			
Northern Pintail		■	■			
Canvasback			■			
Greater Scaup		■				
Harlequin Duck		■				
Surf Scoter			■			
White-winged Scoter			■			
Black Scoter			■			
Long-tailed Duck			■			
Common Goldeneye			■			
White-tailed Ptarmigan						■
Red-throated Loon	■			■		
Gyrfalcon						■
American Golden-Plover					■	
Solitary Sandpiper	■				■	
Lesser Yellowlegs	■				■	
Whimbrel	■				■	
Hudsonian Godwit	■				■	
Bar-tailed Godwit	■				■	
Black Turnstone					■	
Surfbird					■	
Western Sandpiper					■	
Dunlin					■	
Arctic Tern	■			■		
Great Gray Owl						■
Boreal Owl						■
Olive-sided Flycatcher						■
Northern Shrike						■
American Dipper						■
Gray-cheeked Thrush						■
Varied Thrush						■
Bohemian Waxwing						■
Blackpoll Warbler						■
Golden-crowned Sparrow						■
Rusty Blackbird						■
White-winged Crossbill						■
Hoary Redpoll						■

[a] USFWS (2008) Birds of Conservation Concern.
[b] USFWS (2009) Birds of Management Concern; designated as “Game Bird Below Desired Condition”.
[c] North American Waterfowl Management Plan Committee (2004); designated as “High or Moderately High Continental Priority”.
[d] North American Waterbird Conservation Plan (Kushlan et al. 2002, 2006); designated as “Species of High Concern”.
[e] Alaska Shorebird Group (2008), an amendment to the US Shorebird Conservation Plan (2001); designated as “Species of High Concern”.
[f] Alaska Boreal Partners in Flight Working Group (1999); designated as “Watch List Species of Continental Importance”.

3.9 Recreation and Land Use

This section provides an overview of the existing recreational and land uses and opportunities in the Project boundary and includes a focused description of specific recreational uses and attributes of Chikuminuk Lake as well as recreation along potential transmission corridor routes and in relevant nearby areas.

As used in this resource review, the term "recreation" encompasses a diverse array of activities, including:

- Sport hunting[1] and sport fishing
- Non consumptive recreational activities – hiking, boating, wildlife viewing
- Activities by residents of the region, by residents from other parts of Alaska, and out-of-state visitors.

3.9.1 Description and Maps

For the purposes of this recreation and land use section, the Project boundary is defined as the land immediately surrounding Chikuminuk Lake as well as land along the potential transmission line corridors. This includes: land within the northern area of Wood-Tikchik State Park; villages, land and waters along the lower Kuskokwim River to the west in the Yukon-Kuskokwim (Y-K) Delta region; and lands, waters and villages along the Nushagak in the Bristol Bay region to the east. **Section 2** of this volume contains detailed maps of the project boundary and **Volume I** defines the transmission corridors. **Figure 3.9-1** provides an overview of the major land use designations within Southeast Alaska and **Figure 3.9-2** provides further detail of controlling land use designations surrounding Chikuminuk Lake and the three potential transmission line corridors to Bethel. The extension of the two potential transmission line corridors to Dillingham not shown on **Figure 3.9-2** both lie within Alaska State lands that are outside of the Wood-Tikchik State Park.

3.9.2 Current Use

3.9.2.1 Introduction

Chikuminuk Lake is located in a remote part of Southwest Alaska. The lake is a part of the Tikchik Lakes system, located in the northern zone of Wood-Tikchik State Park. Approximately 90 miles north of Dillingham and 118 miles southeast of Bethel, the area cannot be reached by car or boat. Air is the principal means of access, although locations within the project boundary are occasionally visited by snow machine, and rarely by someone coming on foot or on skis.

Southwest Alaska is world famous for its pristine river and lake systems, salmon runs, and sport fishing for salmon, rainbow trout and other species. **Figure 3.9-1** maps the region's protected lands. As a whole, the region has a well-developed sport fishing industry with many lodges, camps and guides. As a result of this distant, wilderness location, and because many other areas of Bristol Bay offer easier access and more diverse fishing and hunting opportunities, recreational use of the Chikuminuk Lake area is very limited. There are no developed facilities in the area, and Alaska State Parks estimates that about only nine people received permits to camp there in 2011 (see **Table 3.9-1**).

Recreation use may be somewhat higher in the vicinity of the potential alternative transmission line corridors west and/or south of the potential dam site. Transmission routing from the proposed Project to Bethel and/or Dillingham was the subject of consultation with the USFWS and Nuvista anticipates that there will be alternative transmission routes to consider if and when the project moves forward. These potential corridors are located near portions of several popular fishing rivers that currently support regular recreation activity, particularly the Kisaralik River to the northwest of the project site.

[1] For some people hunting and fishing are recreational activities, while for others the same activity is subsistence. A separate study has been prepared that addresses subsistence activities in the Chikuminuk region (**Appendix B**).

3.9.2.2 Recreational Use Trends in Alaska

Recreation is a very important part of life in Alaska; residents participate in wildlands recreation at twice the rate of the rest of the country, and the Alaska economy is heavily dependent on the tourism industry. Tourism is the state's second largest private sector employer, and the money generated by tourism is an important component of Alaska's economy (ADNR 2009).

Two sources of information provide statistics about the magnitude and character of statewide recreation and outdoor-oriented tourism activities. The State of Alaska's Division of Economic Development, Office of Tourism Development oversees the Alaska Visitor Statistics Program (AVSP), which collects extensive information on Alaska visitors. The most recent comprehensive survey was done in 2011 and includes visitor profiles, volume, preferences, and other information (ADCCED 2011). For information on the use patterns and preferences of Alaska residents, this report will also refer to the Alaska Statewide Comprehensive Outdoor Recreation Plan (SCORP), which is produced every five years by the Alaska Department of Natural Resources (ADNR 2009).

Wildlands recreation in Alaska includes a variety of activities, such as hunting, fishing, hiking, skiing, boating, ORV riding, wildlife viewing, recreational mining, dog mushing, and rafting. While areas open to wildland recreation are available all over the state, use is concentrated in the Railbelt[2] area (ADNR 2009). This is largely due to the ease of access for residents and travelers as well as the presence of numerous supporting facilities, such as campgrounds, trailheads, boat launches, and other facilities.

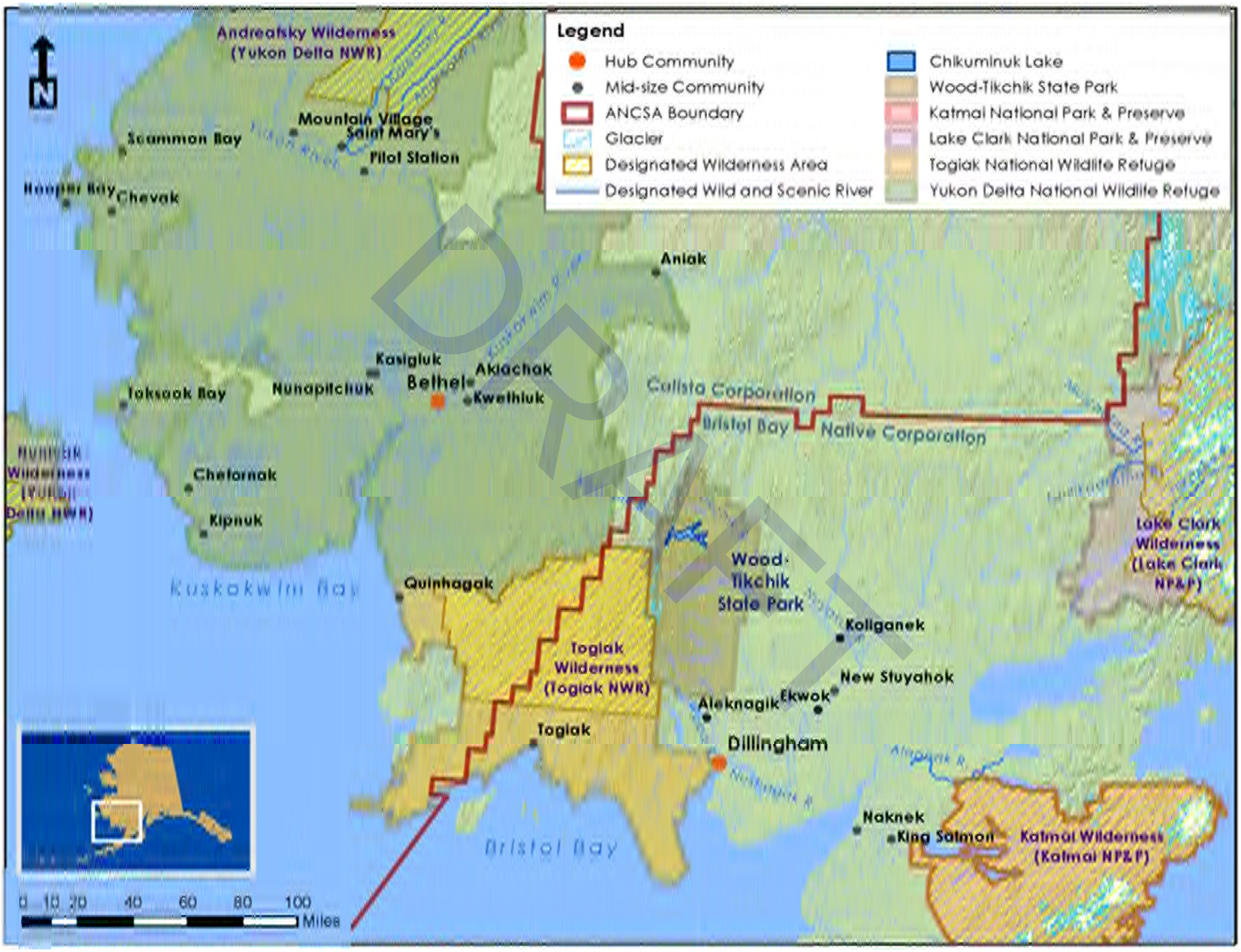
Resident Recreation Trends

Alaskans place a very high value on recreation. A 2009 survey conducted as a part of the Alaska SCORP identified that 96 percent of Alaska residents believe that parks and outdoor recreation are important or very important to their lifestyle. This number has remained consistently high over the past two decades. According to the survey, the top ten favorite activities are hiking, fishing, hunting, snowmachining, cross country skiing, camping, biking, ATV riding/four-wheeling, skiing/snowboarding and running (ADNR 2009).

Residents were also asked about their level of satisfaction with facilities. Information is summarized into three regions, with the Project included in the "Rural" region (see **Figure 3.9-3**). Of the three regions, the Rural residents are the least satisfied, citing a shortage or absence of facilities within their community or within an hour's travel time. All three regions (Railbelt, Southeast, and Rural) support improving the maintenance of existing facilities before developing new facilities (ADNR 2009).

[2] The SCORP defines three regions of Alaska: Railbelt, Southeast, and Rural. The Railbelt includes all rural and urban communities that are accessible on the road system, which includes 73 percent of the population of Alaska. Southeast Alaska includes the temperate coastline areas and communities in the southeast portion of the state with 12 percent of the population, and Rural Alaska encompasses the large remaining portion of the state, with 15 percent of the state's population.

Figure 3.9-1 Major Federal and State Protected Areas in Southwest Alaska



Source: Alaska Geo-spatial Data Clearinghouse (data)

Figure 3.9-2 Adjacent Land Use Management Areas

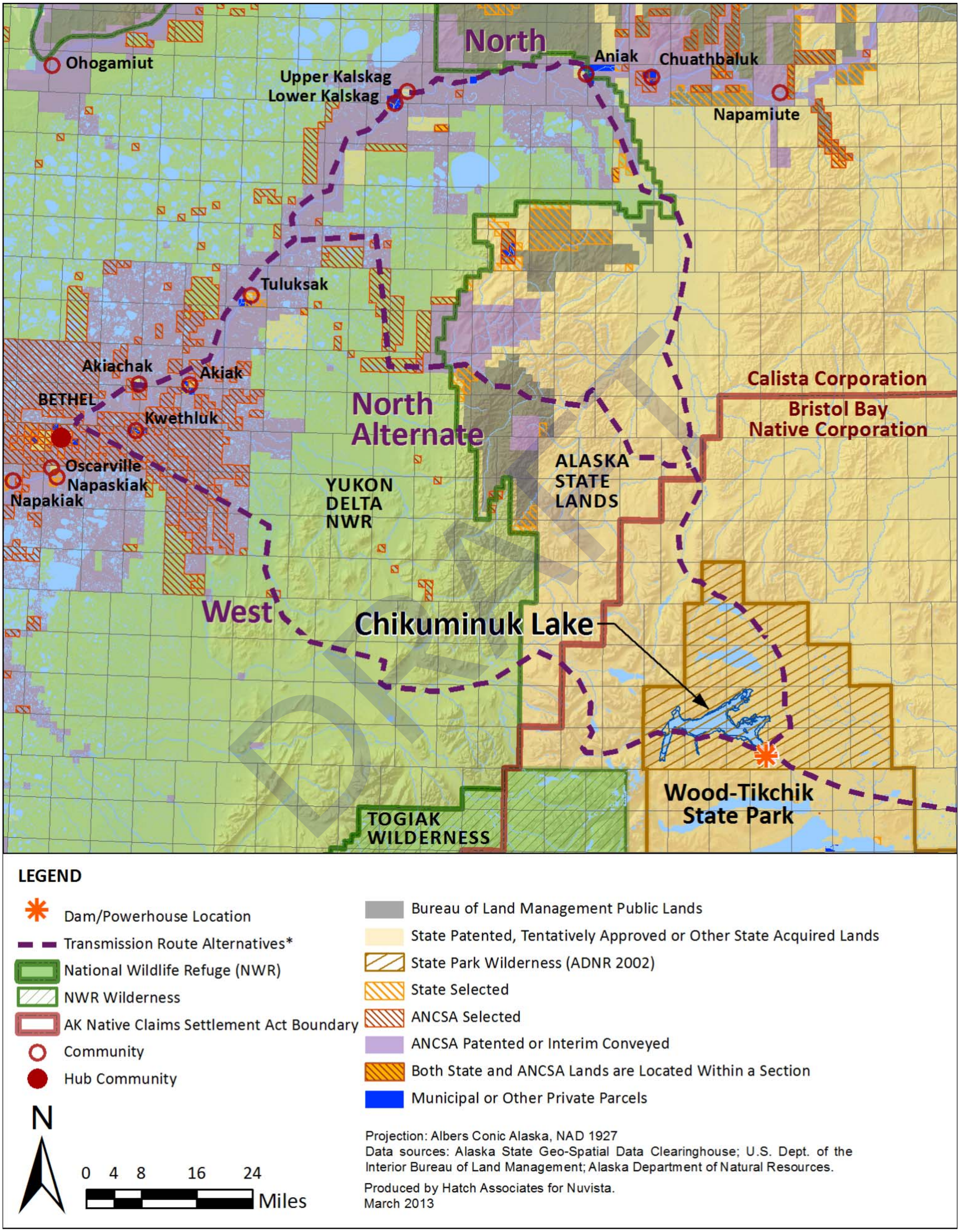


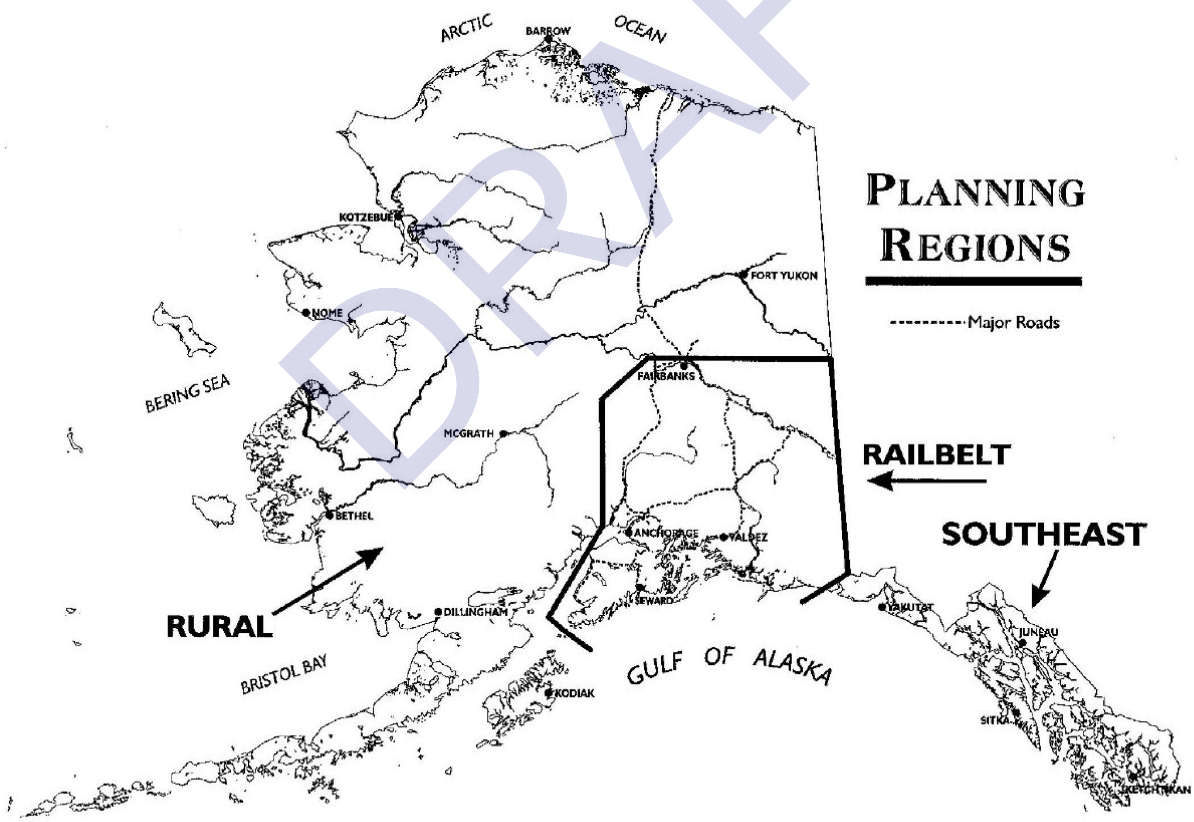
Table 3.9-1 Annual Visitation to Chikuminuk Lake and Allen River Area, Wood Tikchik State Park

Year	Total Visitors	Visitor Use Days[1]	Primary Reported Permitted Activities
2004	3	36	Camping, hunting
2005	4	40	Camping, hunting
2006	12	148	Camping, hunting
2007	31	362	Camping, fishing, hiking, kayaking, photography
2008	28	296	Camping, guided hunting, hiking, hunting, photography, rafting
2009	21	180	Camping, hiking, hunting, rafting
2010	16	158	Camping, hunting, kayaking
2011	9	105	Camping, guided sportfishing, hunting
Average	**16**	**166**	

[1] Visitor Use Days is defined as the sum of all visitors in each group multiplied by the length of the group's stay.

Source: Lake Aleknagik Recreation Area Ranger Station (2011)

Figure 3.9-3 Planning Regions as Defined in the Alaska SCORP



Source: Alaska DNR, SCORP (2009)

Rural Alaskans strongly support more facilities for the disabled, boat launches, off road vehicle trails, roadside toilets, RV dump stations, more recreational programs, more visitor centers, and improved maintenance of existing parks. They state that while facilities are crowded, that there are enough parks. Sport hunting, while also an important subsistence activity, is the favorite outdoor recreational activity among rural Alaska residents. Rural residents are also almost twice as likely as Railbelt residents to own hunting equipment, fishing equipment, ORV/ATVs, and snowmachines (ADNR 2009).

The survey also asked respondents about barriers to outdoor recreation. The most frequently cited answer was lack of funding for outdoor recreation facility development, maintenance, and supervised programs. Other significant barriers included access issues, a shortage of land available for development, a lack of connecting trails, and climate or seasonal conditions (ADNR 2009).

Statewide Visitor Recreation Trends

According to the 2011 report by the Alaska Visitor's Statistics Program (AVSP), there were approximately 1.56 million out-of-state visitors to Alaska between May and September in 2011. There was a dip in visitation in 2009-2010, although numbers have been steadily increasing since then and are expected to continue to increase in coming years. Travelers to Alaska are generally very happy with their experience, with 98 percent of visitors stating that they were satisfied or very satisfied with their trip (ADCCED 2011).

The majority of visitors (57 percent) were cruise ship passengers, with an additional 39 percent coming to Alaska by air and the remaining four percent arriving by highway or ferry. Just over three-quarters of the visitors were traveling for vacation and pleasure, followed by 14 percent traveling to visit friends or relatives and the last nine percent arriving for business-related purposes. One-hundred percent of cruise visitors, 18 percent of air visitors, and seven percent of highway/ferry visitors purchased multi-day packaged tours. The most popular non-cruise packaged tours were fishing lodge (44 percent), wilderness lodge (16 percent), adventure tour (13 percent), and motor coach tour (10 percent). Statewide, the average age of visitors was 50.7 years; for the southwest region, the average age was 52.4 years (ADCCED 2011). As the Alaska SCORP points out, this aging visitor population means that the demand for physically demanding activities is decreasing, while the demand for more easily accessible roadside opportunities such as resorts is increasing (ADNR 2009).

Of the planning regions shown in **Figure 3.9-4** as defined in AVSP, most visitors travel through Southeast and Southcentral Alaska. Southwest Alaska, which includes the Kodiak and the Bristol Bay planning region, receives much less visitation: four percent of out-of-state visitors passed through and two percent of visitors stayed overnight. The region did see a one percent increase in visitation from 2006 rates. Compared to the other Alaska regions, Southwest visitors stayed in the region the longest, with an average of 7.5 days. More than half of these visitors traveled to the island of Kodiak. Almost half of the visitors to the Southwest area were from the Western U.S., and 61 percent of these visitors were male (ADCCED 2011).

Table 3.9-2 shows the 2011 distribution of activities that visitors participated in during the summer season. Compared to statewide trends, visitors who traveled to the Southwest region were more likely to have gone wildlife viewing, fishing, and participated in cultural activities. Southwest visitors spent an average of $1,514 per person per trip, excluding transportation in and out of the state and any cruise package expenditures. This is about 50 percent more than the amount spent among all Alaska visitors. In the Southwest region, 49 percent of visitors who traveled to the area stayed in a hotel or motel during their Alaska trip, with another 30 percent having spent some time lodging on a cruise ship, 28 percent at a lodge, 22 percent in a private home, and eight percent wilderness camping. Southwest Alaska also seems to attract more repeat visitors than the rest of the state: half of visitors to the southwest said they were very likely to return to Alaska in the next five years, compared with 38 percent of visitors statewide. Three out of five had previously traveled to Alaska on vacation (ADCCED 2011).

Table 3.9-2 Visitor Activities, Southwest Alaska and Statewide, 2011

Activity	Statewide	Southwest Alaska
Wildlife Viewing	52	49
City Sightseeing Tour	39	18
Train Ride	38	n/a
Hiking or Nature Walk	38	38
Day Cruise	36	4
Museum Visit	27	21
Historical or Cultural Attraction	25	38
Fishing	20	41
Visit Friends or Relatives	19	23
Flightseeing	16	11
Camping	7	5
Kayaking or Canoeing	7	2
Rafting	6	<1
Total	**330**	**250**

Source: DCCED, *AVSP* (2011)

3.9.2.3 Importance of Recreational Opportunities and Existing Facilities to the Public

This and the following sub-sections review information on recreational use in the project boundary, which is located on both state-managed and federally-managed park and refuge areas. Additional information on existing and needed studies relating to recreational use in the project vicinity, are included in the Recreation and Aesthetics Data Gap Analysis (**Appendix B**).

A look at statewide recreation resources and activities provides a helpful reference point for evaluation of recreational use and resources within the project boundary. Alaska has extensive statewide recreational opportunities, largely in the form of undeveloped public land open for fishing, hunting and exploring on foot, ski, four- wheeler or snowmachine. Of Alaska's 366 million acres, 322 million acres are public lands. While most of this acreage is remote, the large majority of this land is open and available for public recreation. In fact, forty-six percent of Alaska, or 168 million acres, is explicitly designated for wildland recreation. For comparison, the state of California occupies about 100 million acres (ADNR 2009).

Alaska contains sixty percent of the U.S. national park acreage, the country's largest state park system, the nation's two largest national forests, and twenty-five rivers with a National Wild and Scenic River designation. The large quantity of publicly reserved lands is in part due to the Alaska National Interest Lands Conservation Act of 1980 (ANILCA), which protected over 100 million acres of Alaska federal lands and doubled the size of the country's national park and refuge system (ADNR 2009).

Figure 3.9-4 Planning Regions as Defined in the Alaska Visitor Statistics Program

Source: DCCED, *AVSP* (2011)

Statewide and Regional Recreation and Land Use

Land use in Alaska is unique compared to the rest of the contiguous United States. The federal government is the largest landowner and manages over half of the land, and the State of Alaska owns about a quarter of all acreage in the state. The remaining land is owned by Native Corporations with a very small amount owned by private individuals; these areas are generally not open to public recreation. Overall, the amount of public land available for recreation in Alaska is extensive; in fact, almost half the acreage in the state is designated for wildland recreation.

After purchasing Alaska in 1867, the federal government became the legal owner of nearly all the land in Alaska. The Alaska Statehood Act authorized the State of Alaska to receive over 103 million acres from the federal government. Approximately 95 percent of this land has been formally conveyed to the State. After the completion of this conveyance process, federal government holdings will be reduced to approximately 60 percent of land in Alaska, the majority of which is managed by the U.S. Fish and Wildlife Service (USFWS), the National Park Service (NPS), the U.S. Forest Service (USFS), and BLM. The State will be the second largest landowner and will own approximately 28 percent of land around the state. Land owned by Native Corporations, which encompasses about 11 percent of the state, is generally not open for public recreation without permission. Less than one percent of Alaska's land is held by private owners other than Native Corporations (ADNR 2009).

Approximately 82.4 million acres of these federal lands are designated as wilderness. Of land held by the State of Alaska, approximately 12 percent is under some form of legislative designation that protects or enhances wildland recreation, including designated state parks and state fish and game refuges. The State also owns about 65 million acres of tidelands, coastal submerged lands and lands under navigable waters, all of which have significant value for wildland recreation (ADNR 2009).

The Alaska Department of Transportation and Public Facilities (DOT/PF) is also a very important agency when it comes to recreation in Alaska. Most recreation occurs along the road system, which provides residents and visitors with access to public lands (ADNR 2009). Infrastructure and facilities are also disproportionately concentrated along the road system to meet this higher demand. Rural, off-road areas of the state see much less recreation due to the difficulty and expense of transportation.

Rural Alaska has considerable high-value recreation lands, although developed facilities such as campgrounds, trails, trailheads, cabins and boat launches are in short supply. In particular, Southwestern Alaska provides extensive off-the-beaten path experiences for recreationalists. These range from high end, luxurious wilderness fishing lodges to do-it-yourself hiking, floating, fishing or snowmachine adventures. For people from outside the region, considerable expense is required for all these activities. Many recreational activities also require substantial skill, experience and equipment. These realities significantly constrain the number of visitors that come into Southwest Alaska. Outdoor recreational activity by regional residents tends to be linked to subsistence, and the locations of such activity are highly controlled by access. Many residents travel by boat in the summer and by snowmachine in the winter.

Southwestern Alaska contains a diverse variety of outdoor recreational opportunities (**Figure 3.9-1**). The NPS manages two large parks in the region: Katmai National Park and Preserve and Lake Clark National Park and Preserve. Both Katmai and Lake Clark offer world-renowned sports fishing, bear viewing, and remote wilderness experiences in striking, largely undeveloped landscapes. The USFWS manages a number of National Wildlife Refuges in the region as well. The 19 million acre Yukon Delta National Wildlife Refuge (Yukon Delta NWR) consists of mostly flat delta lands extending out to the Bering Sea. This refuge was established to protect water resources and wildlife populations. There are 41 villages located within the refuge, many of which own land conveyed through the Alaska Native Claims Settlement Act (ANCSA) to village corporations (USFWS 2004). The slightly smaller Togiak National Wildlife Refuge to the south contains diverse landscapes and is home to eight local villages (USFWS 2004).

In addition to these federally protected lands there are five designated Wild and Scenic rivers in the region (**Figure 3.9-1)**. Andreafsky River is located in the northern part of the Yukon Delta NWR, Alagnak River starts in Katmai National Park, and the Chilikadrotna, Mulchatna and Tlikakila Rivers are located in the Lake Clark National Park and Preserve (National Wild and Scenic Rivers System 2012).

The State of Alaska manages recreational lands in southwest Alaska. Wood-Tikchik State Park is the largest state park in the country and the proposed Project would be within its boundaries. This 1.6 million acre park features two distinct lake chains and offers backcountry camping, birding, boating, fishing, hunting and rafting (ADNR 2002). There are no official land trails or trailheads, although several water routes are listed on the State Park webpage (ADNR 2011). The nearest Ranger Station and public access point is at Lake Aleknagik State Recreation Site, located at the southern end of Wood-Tikchik State Park in Aleknagik.

Southwestern Alaska offers some of the most productive salmon fishing in the country. Bristol Bay in particular contains a well-developed sportfishing industry with a variety of lodges, camps and guides. Popular Bristol Bay destinations include the Nushagak River, and much of the Wood-Tikchik Lake system. Sportfishing destinations on the Y-K Delta side include the Kisaralik, Kwethluk, Kasigluk, Akulikutak and Kuskokwim Rivers. These fishing locations all require either boat or floatplane transport.

There are many recreational hunting opportunities in the region as well. ADF&G oversees most of the recreational and subsistence hunting in southwest Alaska. Recreational hunting is generally not allowed on federal parklands, but it is permitted on federal preserve lands and refuges. Commonly hunted species include caribou, moose and some black bear (ADNR 2002).

Recreational Use in the Project Vicinity

Chikuminuk Lake is located in a remote part of Southwest Alaska; it is accessible only by aircraft. Wood-Tikchik State Park contains very few facilities and therefore encourages visitors to be self-sufficient and use “pack it in, pack it out” practices (ADNR 2002). There are a number of recreation opportunities in the park, including fishing, hunting, sightseeing, camping and watersports such as rafting and kayaking.

As a whole, the Bristol Bay region has a well-developed sportfishing industry with many lodges, camps and guides. See **Figure 3.9-5** for existing lodges and recreation sites. Lake Aleknagik State Recreation Site, the only official recreational access point, offers a ranger station, parking area, boat launch ramp and other facilities, although visitors are welcome to fly, hike, or boat into the more remote areas (ADNR 2011). Camping and rafting are both allowed throughout the park but several areas require permits, including Chikuminuk Lake. In an effort to reduce park user conflict and to avoid crowding, the park has a ten day camping limit per site, as well as group size limits and overall annual visitation limits. The park also has various restrictions on the use of motorized craft and equipment. Snowmachines are allowed throughout the park, and hovercraft and generators are allowed in all non-wilderness designated zones. Helicopters, airboats, and all-terrain vehicles are prohibited entirely within Wood-Tikchik State Park. Motorized boats are not permitted on Chikuminuk Lake (ADNR 2002).

Because many other areas of Bristol Bay offer easier access and more diverse fishing opportunities, recreational use of the Chikuminuk Lake area is very low. According to the Wood-Tikchik State Park Management Plan, the majority of use occurs between June 15 and the end of September, although a select number of local residents and Dillingham residents use the park year-round (ADNR 2002). The heavier use in the summer reflects the influx of visitors for hunting and fishing. Water recreation, including rafting and kayaking, are also popular activities in the park.

According to information shared by the State Park Ranger, a small number of visitors acquire a permit travel to the Chikuminuk Lake/Allen River area each year. Visitor information between 2004 and 2011 is summarized in **Table 3.9-1**. The most popular activities in this area were hunting and camping, and the average length of stay was 12 days. Between 2004 and 2011, 39 of the visitors were from Alaska, and 85 were from the Lower 48 states (WTSP 2012).

The West transmission route alternative would pass near several popular fishing rivers that currently support regular recreation activity, including the Kisaralik River. The downstream portion of this river is located within the Yukon Delta NWR. The Kisaralik River is the most heavily used recreational river in the Yukon Delta NWR. Local residents, mostly from Bethel, Akiachak, Akiak, and Tuluksak, use motor boats to sport fish on the lower Kisaralik River below Golden Gate Falls (Buzzell 2010). Visitors often combine sportfishing with raft float trips that start at Kisaralik Lake. Both visitors and residents sport fish the Kisaralik between the months of May to October, peaking in July (Buzzell 2010). At least two commercial outfitters provide floatplane transport, sportfishing and rafting support for visitors to the Kisaralik River (Buzzell 2010). The USFWS strongly restricts commercial activity on the river; recent attempts by commercial sportfishing businesses to obtain special-use permits to take customers down the river have been unsuccessful (Buzzell 2010).

According to the Yukon Delta NWR's Land and Conservation Plan there is relatively little recreational use on the refuge by people other than local residents (USFWS 2004). Alaska's Department of Community and Economic Development estimates that 500-800 visitors come to the Refuge annually, including school groups (USFWS 2004). This low number is largely due to the transportation costs required to recreate in the area and to a lack of supporting infrastructure, lodges, and facilities that provide resources to visitors.

The nearest community to the proposed dam site is Koliganek, located on the Nushagak River. The closest communities in the Calista region are the set of villages along the Kuskokwim River, starting from Tuluksak on the north extending downriver through Bethel and eight other smaller villages. Many of the residents in these villages use resources within the vicinity of the Project. It is important to note that for some individuals hunting and fishing are considered recreational activities, while for others the same activity is an important element of the subsistence lifestyle. Records of use at Chikuminuk and nearby areas are limited, and do not necessarily capture this distinction. **Section 3.12.12** addresses subsistence activities in the Chikuminuk region.

Sportfishing and Angling

Bristol Bay and Southwest Alaska in general, are world famous for sportfishing for salmon, rainbow trout and other species. As a whole, the region has a well-developed sportfishing industry with many lodges, camps and guides. Because many other areas of Bristol Bay offer easier access and more diverse fishing opportunities, recreational use of the Chikuminuk Lake area is very low. In contrast, the potential transmission line corridor running west of the proposed project site passes near several popular fishing rivers that currently support regular recreation activity.

For purposes of this sub-section, sportfishing is distinguished from subsistence fishing. The definition of sportfishing is recreational fishing done for enjoyment and as a supplemental food source, not as a primary food source. In contrast, subsistence fishing is done primarily for sustenance and trade.

According to the Wood-Tikchik State Park Management Plan, sportfishing attracts a number of visitors to Wood-Tikchik State Park each year. The top five species of fish caught in the park are arctic grayling, coho Salmon, Dolly Varden char, lake trout and sockeye salmon (ADNR 2002). Some of the park visitors choose guided fishing trips, while others choose to either camp in the park independently or use day access from Lake Aleknagik State Recreation Site. There are eight lodges within the Wood-Tikchik State Park, one of which is the Tikchik Narrows Lodge, located approximately 16 miles from the proposed dam site, on the peninsula that separates Nuyakuk and Tikchik Lakes (ADNR 2002; Agnew::Beck 2012).

Figure 3.9-5 Recreation Sites and Lodges in Wood-Tikchik State Park

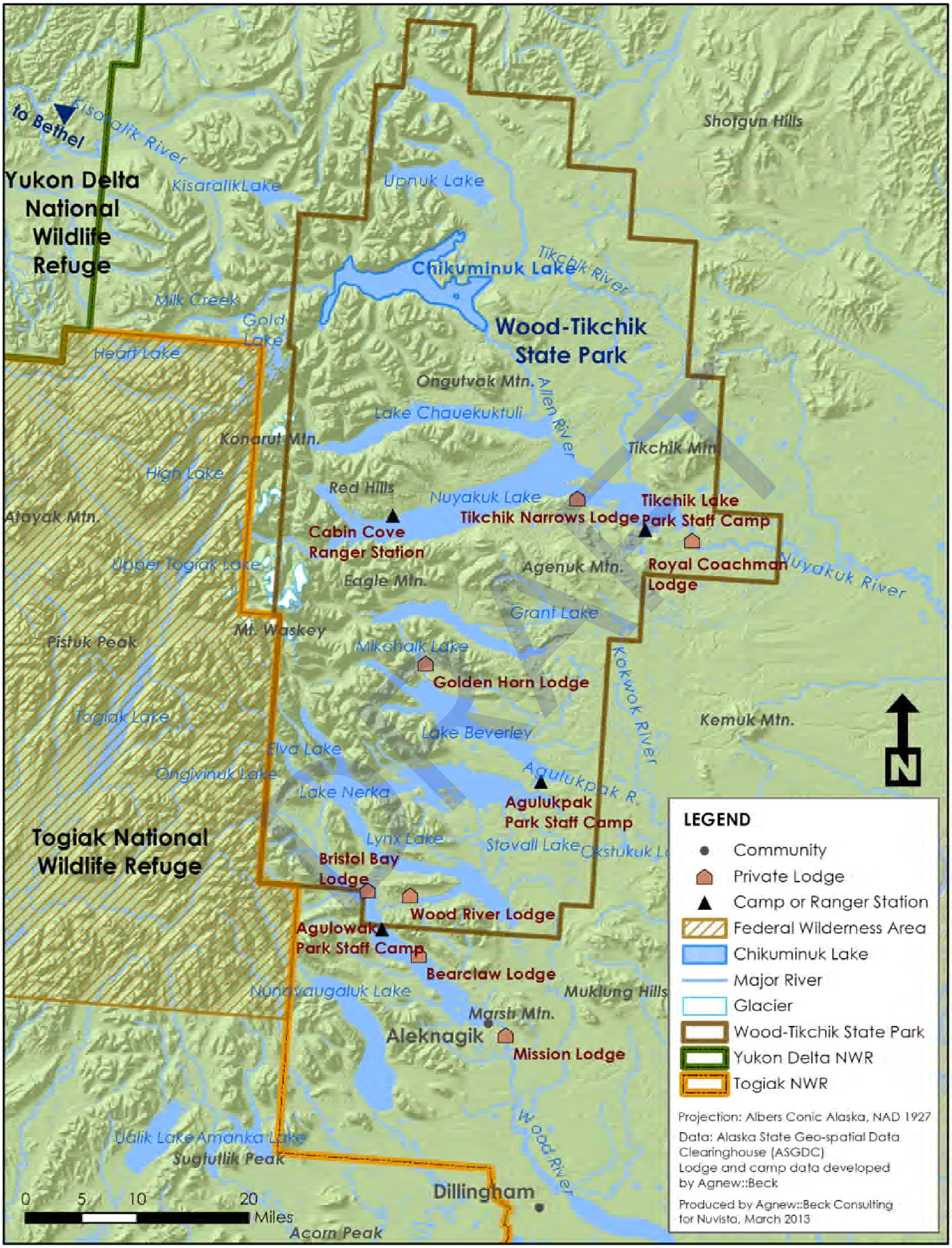


Table 3.9-3 Anglers per Year, Tikchik-Nuvakuk Lake System

Year	Number of Anglers
2000	737
2001	788
2002	579
2003	829
2004	867
2005	551
2006	425
2007	807
2008	836
2009	309
2010	416
Average	**649**

Source: ADFG (2011d)

Sport fishing activity is concentrated in the more accessible southern Tikchik-Nuyakuk Lakes system, which can be entered by boat from the road that connects Dillingham and Aleknagik Lake. **Table 3.9-3** shows the anglers per year that visited this area between 2000 and 2010 (ADF&G 2011d). Fishing interest at Chikuminuk Lake is minimal for several reasons. Salmon have not been found to make use of Chikuminuk Lake (ADNR 2002). In the past, local lodges would fly people to the lake, and then use skiffs with motors to troll for trout and other species. Since the area was closed to motorized use, this activity has ended. The net result of difficult access, remote location, lack of fish, and restrictions on the use of motors has led to very minimal fishing activity at the lake. State Parks visitor statistics supports this conclusion: of the visitors to the Chikuminuk Lake/Allen River area between 2004 and 2011, on average only 2.4 people participated in fishing activities each year (WTSP 2012).

To the degree that out-of-region visitors travel to the Yukon Delta NWR, the motivation is primarily tied to the region's fishing opportunities. Several rivers used for recreational fishing are located in the vicinity of the potential alternate transmission line West Route to Bethel are the Kisaralik, Kwethluk, Kasigluk, and Akulikutak Rivers, all of which drain into the Kuskokwim River in the south-central portion of the Yukon Delta NWR. The West Route to Bethel travels in the vicinity of the Kisaralik and would cross the Kasigluk, Akulikutak, and Kwethluk Rivers before crossing the Kuskokwim River and entering the city of Bethel.

The abundance of fish species in the Kuskokwim River drainage has made sportfishing a popular activity there. Sport fish found in these rivers include several species of salmon, Dolly Varden char, northern pike, arctic grayling and rainbow trout. The ADF&G has specific data on fish harvests and number of anglers for two Kuskokwim River tributaries: the Kisaralik and Kwethluk Rivers. According to this angler survey data, the frequency of sportfishing on the rivers has increased over the past ten years. Preliminary discussions with people familiar with the area suggest that these rivers are common destinations for fly-in anglers coming from lodges in Bristol Bay. However, commercial guides must obtain permits to take visitors into the Yukon Delta NWR. This reduces the number of guided parties that visit rivers in the refuge and, as a result, reduces the number of sport angler visits.

The Kisaralik River, which starts east of the refuge at Kisaralik Lake and joins with the Kuskokwim River just north of Bethel, is a relatively popular destination for fishing and float trips, and the most heavily used recreational river in the Refuge. According to ADF&G surveys conducted between 2000 and 2004, there was an average of 1,862 angler days per year along the Kisaralik River (ADF&G 2011e). Sport fishermen travel to the area to seek out a variety of species, including rainbow trout, Chinook salmon, Chum salmon, Arctic grayling, northern pike and sheefish. As there are very limited facilities along the river, most fishermen travel on float trips, either with guides or independently. Summaries of the angler days, salmon species catches and resident species catches are shown on **Tables 3.9-4, 5 and 6** respectively.

Table 3.9-4 Sportfishing Estimates – Angler Days, Kisaralik River, 2000–2010

Year[1]	Anglers	Days Fished
2000	373	2084
2001	274	1304
2002	358	2410
2003	368	1439
2004	334	2071
2005	326	1282
2008	552	2576
2009	362	2235
2010	483	2056
Average[2]	**381**	**1940**

[1] No 2006 or 2007 data is available

[2] Averages are rounded to the nearest integer

Source: ADFG (2011e)

Recreational Hunting and Trapping

The northern part of Wood-Tikchik State Park receives relatively limited recreational hunting use. Use was higher in the past, when caribou numbers were greater in this area (ADF&G 2011b). The ADF&G provides annual hunting reports based on the results of hunting permits sold or auctioned. This is the best data for understanding sport hunting in the area. However, this information is limited due to its broad geographic scope. Other sources of game population data include caribou and moose management reports, furbearer trapping reports, the Wood-Tikchik State Park Management Plan and information on the Yukon Delta NWR website.

Like sportfishing, recreational hunting and trapping is distinct from subsistence hunting and trapping. In Alaska, subsistence hunting takes precedence over sport hunting. If an animal population cannot be harvested under the principle of "sustained yield," sport hunting and trapping are restricted; a further distinction must be made between high priority and lower priority subsistence hunting, called a "Tier II" hunt (USFWS 2003). Both subsistence and sport hunters require permits from ADF&G. (see **Section 3.12.12.2**).

Table 3.9-5 Sportfishing Catch Estimates – Salmon Species, Kisaralik River, 2000–2010

Year[1]	Chinook Salmon	Coho Salmon	Sockeye Salmon	Pink Salmon	Chum Salmon
2000	10	199	0	0	13
2001	0	195	34	0	0
2002	46	167	0	0	0
2003	75	377	74	0	28
2004	58	226	22	0	0
2005	40	298	22	0	0
2008	148	807	171	23	31
2009	51	559	10	0	22
2010	0	172	0	0	24
Average[2]	**48**	**333**	**37**	**3**	**13**

[1] No 2006 or 2007 data is available

[2] Averages are rounded to the nearest integer

Source: ADFG (2011e)

The Project is located in ADF&G Game Management subunit 17B (shown in **Figure 3.7-1**), which covers the Nushagak River drainage upstream from and including the Mulchatna River drainage, and the Wood River drainage upstream from the outlet of Lake Beverley. This includes Chikuminuk Lake and the northern half of Wood-Tikchik State Park. **Table 3.9-7** displays available ADF&G hunting information between 2005 and 2010 for both residents and non-residents. The ADF&G data does not distinguish between subsistence and sport hunters in the general season hunt data.

Table 3.9-6 Sportfishing Catch Estimates – Resident Species, Kisaralik River, 2000-2010

Year[1]	Lake Trout	Dolly Varden (Arctic Char)	Rainbow Trout	Arctic Grayling	Whitefish	Northern Pike
2000	0	367	47	29	0	11
2001	37	320	0	64	0	0
2002	17	345	29	507	0	0
2003	0	432	21	280	0	0
2004	0	114	99	45	60	0
2005	0	246	78	346	0	247
2008	0	113	136	121	31	9
2009	10	232	0	90	0	0
2010	0	125	0	0	0	0
Average[2]	**7**	**255**	**46**	**165**	**10**	**30**

[1] No 2006 or 2007 data is available [2] Averages are rounded to the nearest integer Source: ADF&G (2011e)

Table 3.9-7 Hunting Reports for Game Management Unit 17B, 2005–2010

Year	2005	2006	2007	2008	2009	2010
All Caribou Hunters						
Residents	532	197	140	109	79	82
Non Residents	474	267	121	75	2	1
Unspecified	4	2	0	2	0	0
Total	**1018**	**468**	**267**	**186**	**83**	**84**
Successful Caribou Hunts						
Residents	378	96	62	43	36	38
Non Residents	252	163	76	32	0	0
Unspecified	1	1	0	1	0	0
Total	**636**	**261**	**142**	**76**	**37**	**38**
Moose Hunters						
Residents	108	197	214	206	208	133
Non Residents	211	193	166	117	75	79
Unspecified	133	1	3	0	2	3
Total	**453**	**395**	**387**	**324**	**288**	**215**
Successful Moose Hunts						
Residents	11	68	6	4	58	28
Non Residents	71	44	52	30	25	34
Unspecified	36	0	0	0	0	3
Total	**118**	**114**	**118**	**78**	**83**	**65**
Black Bear Hunters						
Residents	-	-	-	-	7	3
Non Residents	-	-	-	-	15	14
Unspecified	-	-	-	-	0	0
No Overlay	-	-	-	-	0	1
Total	**n/a**	**n/a**	**n/a**	**n/a**	**22**	**18**
Successful Black Bear Hunts						
Residents	-	-	-	-	1	1
Non Residents	-	-	-	-	7	7
Unspecified	-	-	-	-	0	0
Total	**n/a**	**n/a**	**n/a**	**n/a**	**8**	**8**

Source: ADF&G (2011a, 2011b, 2011c)

According to ADF&G, the most commonly hunted species in the Wood-Tikchik State Park are caribou, moose, and black bear (ADF&G 2011a; 2011b; 2011c). The Wood-Tikchik State Park Management Plan notes that most of the hunters that travel to the park are residents of Southwest Alaska (ADNR 2002). The plan indicates that brown bears are abundant in the area around Chikuminuk and Nuyakuk Lakes, although no records of brown bear hunting are available from ADF&G. Hunt data for caribou, moose, and black bear all show a decline in the number of hunters and their harvest since 2005. As the Mulchatna Caribou Herd has shifted locations and fallen in numbers, the number of caribou hunters has dropped dramatically, from 1,018 in 2005 to only 84 in 2010 (ADF&G 2011b). Moose populations are actually increasing in the park, although the number of moose hunters has fallen from 453 in 2005 to about half that number in 2010 (ADF&G 2011c). Data on the black bear hunt, though sparse, also shows a decline. Black bear hunt data has only been collected since 2009 with only 22 hunters that year and 18 the following year (ADF&G 2011a).

Hunting is listed as a trip activity more than any other form of recreation (including fishing, camping, hiking, climbing, boating, or floating) and is the most popular activity in the northern portion of the Park (ADNR 2002). The relatively large number of hunters every fall is a management issue for the State Park system. The heaviest use of the lakes occurs from the third week in August to mid-October. Nishlik, the northernmost Tikchik Lake, is the most heavily used, with nearly every sheltered bay used by floatplanes and supporting a hunting camp. Crowding of hunters and increasing amounts of camp refuse has spurred the Alaska State Parks to restrict the number of parties on the Upper Tikchik lakes (ADNR 2002).

Information on recreational hunting activity along the proposed transmission corridor is more difficult to obtain. The USFWS does not collect hunting and fishing data on refuge land. The Yukon Delta National Wildlife Refuge Land Conservation Plan is one of a very limited set of resources that references hunting in the Yukon Delta NWR. This plan notes that all Yukon Delta NWR lands are open to public use with certain restrictions on harvesting endangered species and trespassing on Native Alaskan land (USFWS 2004). However, the USFWS issues no regulations directly limiting hunter use of the refuge; rather, restrictions on the issuance of commercial guide permits may limit the number of commercial hunting guides and as a result, the number of recreational hunters visiting the refuge. From the conservation plan, it is evident that most hunting in the Yukon Delta NWR is by local residents for subsistence use (USFWS 2004).

Non-Consumptive Recreation

Non-consumptive recreation is outdoor recreation that does not include harvesting natural resources such as fish and game. These activities commonly include hiking, camping, wildlife viewing, kayaking or boating, and mountain climbing. Non-consumptive recreation is not common within the project boundary, but the area does offer characteristics (attractive landscapes, wilderness, and wildlife) that a small number of visitors enjoy each year. Existing data on non-consumptive recreation within the project boundary are sparse or non-existent.

Recreational use of Wood-Tikchik State Park is secondary to subsistence use, as determined by the State Legislature (ADNR 2002). Because of the park's remoteness, the most common uses in the park are subsistence or recreational fishing and hunting. The southern portions of the park, particularly Lake Aleknagik State Recreation Site, are used much more heavily by non-consumptive recreationalists (boaters and wildlife viewers). The northern part, including Chikuminuk Lake and the Allen River, receives few recreational visits because of its remote location and the expense of air charter. As stated earlier, most recreational visits are for sportfishing in the summer or hunting in the fall (ADNR 2002).

The proposed Project is located in the Tikchik Lakes Management Unit of the state park. The Wood-Tikchik State Park Management Plan notes that some non-consumptive recreational use occurs in this Management Unit (ADNR 2002). This plan states that the upper Allen River can be explored by foot from Chikuminuk Lake, and there are ample hiking opportunities in the unit because of its higher elevations and minimal brush. River floating is also popular in the unit, starting from Upnuk or Nishlik Lakes in the drainage north of Chikuminuk

Lake. The headwaters for the long and easily floated Tikchik River (ADNR 2011), which bypasses the Chikuminuk Lake / Allen River basin and joins the Nuyakuk River basin at Tikchik Lake is located within the Tikchik Lakes Management Unit. Due to the dangerous rapids at the Allen River outlet of Chikuminuk Lake, the lake itself is not used as a staging area for longer float trips.

As noted earlier, the Wood-Tikchik State Park Management Plan specifies that only six parties of up to ten individuals may be present on Chikuminuk Lake at one time. Along with a restriction on power boats and the area's remoteness, this suggests very little camping or other activities such as wildlife viewing or mountain climbing is done near the lake (ADNR 2002). The Wood-Tikchik State Park Ranger provided approximate numbers of visitors to the Chikuminuk Lake/Allen River area of the park and their primary activities. Between 2004 and 2011, visitors participated in non-consumptive activities including kayaking, camping, hiking, and photography; however, the primary uses of the area were hunting, fishing, and camping (WTSP 2012).

Information regarding non-consumptive recreation outside of Wood-Tikchik State Park (in the vicinity of potential transmission line alignments) is limited. Yukon Delta NWR sources and a variety of background reports on the Kisaralik River offer some background on non-consumptive recreational use outside of the State Park.

The Yukon Delta NWR Management Plan notes that there is very little non-consumptive recreation within the refuge, but it does not offer statistics to indicate the number or magnitude of this recreational use. This plan notes that in recent years regional and national publications have featured fishing and floating opportunities within the refuge, although it is unclear if this has resulted in increased visitation (USFWS 2004).

The Kisaralik River Final Summary Report provides historical information regarding recreational use on the Kisaralik River. Besides sportfishing and recreational hunting, the report also covers rafting, canoeing, and camping on the river. Camping is only mentioned in association with other recreational activities, but rafting and canoeing are covered fairly extensively. These activities are likely tied to hunting and fishing (Buzzell 2010).

The first recorded recreational raft trip down the Kisaralik River was in the summer of 1973, when two individuals from Bethel floated the river. These two individuals tried canoeing it the following summer, but lost everything and had to walk for fifty days to reach Bethel. After his float trip down the river in July 1978, David Dapkus of the U.S.-Heritage Conservation and Recreation Service reported that "The river offered good floating with a raft, kayak, or canoe for the intermediate to expert canoeist" (Buzzell 2010). Annual numbers of recreational canoeists, kayakers and rafters are not available; the USFWS does not collect such data on a regular basis. Most rafting data are provided to the Yukon Delta NWR from outfitters or guides permitted to run the river.

A 1984 National Park Service draft report titled *Kisaralik River, Alaska, Draft Wild and Scenic River Study,* noted that recreational travel down the river usually starts at Kisaralik Lake and occurs by canoe, kayak or raft, with occasional portages (NPS 1985). The report also noted that sportfishing is almost always combined with rafting. The number of float trips was low: eight to ten groups of four persons were reported to float the Kisaralik every year. Since 1997, the Yukon Delta NWR has halted commercial rafting on the river. Because the Yukon Delta NWR only keeps track of commercial guided tours, little or no data are available on float trips on the Kisaralik River from the Yukon Delta NWR.

A report titled *Kisaralik River System: Final Summary Report*, commissioned by ADNR, includes a table of non-guided raft traffic on the Kisaralik River from 1973–2008. Much of the information is provided by commercial guiding outfits and some from the Yukon Delta NWR. The Yukon Delta NWR only occasionally conducts studies to determine the number of non-guided raft groups; no data are available for many of these years, particularly since 2003. Available data indicate that the number of people and groups rafting the Kisaralik has grown since the 1980s. The largest number of people rafting on the river was recorded in 2001, when 123 people in 21 groups floated down the river. According to the report, today fewer than 100 people raft the Kisaralik each summer (Buzzell 2010).

Although commercial guiding of float groups is only allowable by permit, several businesses have been started in response to demand for gear and transportation to and from the river. Papa Bear Adventures and Kuskokwim Wilderness Adventures (KWA) are two major Kisaralik River float outfitters in the area. Together these two Bethel outfitters capture more than 95 percent of the rafting business on the Kisaralik. Other businesses that have outfitted rafters for trips down the Kisaralik include: Aniak Air Guides of Aniak, Renfros' Alaska Adventures of Bethel, and Frontier Outfitters of Anchorage. According to the manager of the Yukon Delta NWR, only Papa Bear and Renfros' Alaska Adventures have permits for guided drop-offs along the Kisaralik River within the Refuge (Buzzell 2010).

3.9.2.4 Formal and informal public access to lands and waters

Chikuminuk Lake is located in a remote part of Southwest Alaska, which is itself a remote part of the state. The lake is a part of the Tikchik Lakes system, located in the northern zone of Wood-Tikchik State Park. Approximately 90 miles north of Dillingham and 118 miles southeast of Bethel, the area cannot be reached by car or boat. Air is the principal means of access, although the area is occasionally visited by snow machine, and rarely by someone on foot or on skis.

3.9.2.5 Existing uses of land within and adjacent to the Project

The generation facilities for the proposed Project would be located within the Wood-Tikchik State Park, which is managed according to the 2002 Wood-Tikchik State Park Management Plan.

One of the proposed transmission line corridors would traverse the Yukon Delta NWR, which would be managed according to the 2004 Yukon Delta Land Conservation Plan. Adjacent recreation areas include the 4.2 million acre Togiak National Wildlife Refuge and parcels of state lands managed by various state agencies.

Sections 3.9.9, **3.9.10**, and **Section 3.12.2** contain additional information on land ownership and uses within the project area.

3.9.3 Buffer Zones

There are no existing shoreline buffer zones within the project boundary. There are currently no developed uses adjoining the shore of Chikuminuk Lake or its adjoining river banks, which is consistent with the specifications of the Alaska State Park wilderness zone designation.

3.9.4 Current and Future Needs

Current and future recreation needs are expressed through needs statements, goals, and objectives contained in various state and local planning documents; these are described below.

3.9.4.1 Alaska State Comprehensive Outdoor Recreation Plan (SCORP) (2009)

The Alaska State Comprehensive Outdoor Recreation Plan (SCORP) summarizes the recreational use patterns, preferences and needs of the State of Alaska. Four overarching were issues identified in the 2009-2014 Plan. The first was a lack of adequate funding. The state seeks to address this issue in a variety of ways, including encouraging reform to the Land and Water Conservation Fund Program, strengthening interagency communication and cooperation, promoting volunteer programs, organizing user groups, and developing alternate funding sources such as a matching grants program or a trails foundation. The second issue revolved around the close relationship between tourism and the Alaska economy: the plan seeks to "provide and promote high-quality, sustainable, safe and affordable recreational opportunities to keep pace with the rising demands, needs and diversity of Alaskans and visitors." The plan encourages increased cooperation and planning across the public and private sector, as well as improvements to facilities and the development of year-round tourist destinations and services. The third issue involves insufficient access to outdoor recreation opportunities. The plan acknowledges that while there are ample areas for outdoor recreation, there is a lack of access in the form of trails, facilities, and other supporting infrastructure that makes these recreation areas accessible to many residents. Outdoor recreation needs differed by region. Rural residents needed more facilities and access to outdoor recreation opportunities that Southeast or Railbelt residents. The last issue identified in SCORP is a shortage of community recreation facilities. The plan encourages the maintenance and/or addition of local facilities such as play fields, pools and parks (ADNR 2009), noting that facilities are needed more than land.

3.9.4.2 Wood-Tikchik State Park Management Plan (2002)

The 2002 Wood-Tikchik State Park Management Plan identifies a number of recreation-related goals and objectives. The first goal is to protect fish and wildlife resources of the park. The park aims to do so by identifying the acceptable level of disturbance to natural systems, by inventorying and monitoring fish and wildlife resources, by establishing park management units, and by establishing habitat management practices. The second goal is to support traditional subsistence use. The park aims to inventory subsistence uses, establish priorities for resource allocation, recommend acceptable harvest levels, and manage areas to mitigate potential conflicts between subsistence users and recreational users. The third goal is focused on providing for the outdoor recreational needs of visitors as appropriate to the park’s values and setting. In order to support recreational users, the park recognizes that it must define appropriate activities, apply management practices to maintain quality experiences for users, establish developments and facilities as appropriate, protect private property rights, and balance consumptive and non-consumptive park uses. The fourth goal is to protect, document, interpret, and manage areas of significant scientific, educational, visual, cultural, or historical value. In order to accomplish this, the plan recommends that areas are inventoried and defined, that visitors are taught these scientific and educational values through information programming, that park management encourages responsible off-site visitor interpretation and promotion, and that the park works to protect the archaeological, historical, and visual quality of park elements. The last goal of the Wood-Tikchik State Park Management Plan is to establish management practices that align with regional and statewide recreation and tourism demands (ADNR 2002). Within the land use chapter, the recreational development designation acknowledges the need to develop more recreation facilities, such as campsite and bathrooms, to minimize visitor impact.

3.9.4.3 Land Conservation Plan for the Yukon Delta National Wildlife Refuge (2004)

The Yukon Delta Land Conservation Plan lists a number of concerns and encourages that “Refuge management be cognizant of these issues when making decisions.” Of these issues, two are particularly relevant to recreation in the area: the first is concern over the loss of wilderness values, and the second is user group conflicts. The plan also discusses the potential for commercial tourism development on private lands within the refuge and acknowledges that if managed responsibly, these services and facilities could open up additional opportunities for public use of Refuge lands and waters (USFWS 2004).

3.9.4.4 Togiak National Wildlife Refuge Comprehensive Conservation Plan (2009)

The Togiak National Wildlife Refuge Comprehensive Conservation Plan was produced in 2009. The Togiak National Wildlife Refuge mission statement notes that the refuge was established to maintain healthy fish and wildlife populations within their natural ecosystems, and to encourage current and future generations to appreciate and participate in fish- and wildlife-dependent activities. The plan outlines goals to support this mission. These goals all emphasize that the refuge is to be maintained and protected in its natural state, which involves conducting an inventory of resources, establishing protection and management guidelines, and collaborating with subsistence users, visitors, and nearby stakeholders. The plan also introduces specific policies for managing the wilderness area that is located within the refuge, namely tighter restrictions on visitors and activities located within that area (USFWS 2001).

3.9.4.5 Dillingham Comprehensive Plan (2010)

The City of Dillingham's Comprehensive Plan Update & Waterfront Plan, adopted in 2011, includes recreation-related goals and strategies. One of the goals includes strengthening Dillingham's position as a premier tourism destination and moving into the role of the "gateway to Bristol Bay." The City hopes to accomplish this through improvements to downtown Dillingham's appearance, better marketing to potential visitors, a new community cultural center, improved recreational access (signage and trails), and by supporting locally-owned tourism businesses. The community would also like to see additional development and maintenance of indoor and outdoor areas and facilities for recreation. The plan recognizes the need for improved planning in order to support and fund these efforts (City of Dillingham 2011).

3.9.4.6 Bethel Comprehensive Plan (2011)

The City of Bethel produced an updated Comprehensive Plan in September 2011. The plan provides the City with direction for the next twenty-five years. One goal is to improve and support tourism and visitation through marketing, beautification of the downtown area, and improved facilities and trails, particularly in nearby parks. There are also a number of recreation goals in the comprehensive plan. Relevant goals include: expansion of the Bethel trail system, improvements to existing parks and open space, and construction of additional park and outdoor recreation facilities to meet the growing needs of Bethel residents and visitors (City of Bethel 2011).

3.9.4.7 Kisaralik River Management Plan (1997)

A management plan for the Kisaralik River was completed in 1997, but was unavailable from any state resource library at the time of writing. Preliminary research suggests that this plan is not actively consulted, or has been since it was superseded by subsequent management planning documents in the region. The study team recommends further research into whether this plan should be considered a relevant source.

3.9.4.8 Bristol Bay Area Plan

Produced in 2005 by ADNR's Department of Mining, Land and Water, the Bristol Bay Area Plan identifies management intent, guidelines, and land use designations for state lands located in the Bristol Bay area. The plan identifies few recreation-related goals, including a general statement supporting access to outdoor recreational opportunities on state lands. Recommended strategies include collaborating with communities to establish and support trails and parks, encouraging commercial development of recreational facilities with private enterprise when appropriate and protecting recreational resources such as access, viewsheds, and wildlife. The plan states that recreation opportunities should be available on less-developed land and water areas that serve multiple purposes, such as habitat protection or mineral resource extraction. The plan also includes a Recreation Management Plan for the Nushagak and Mulchatna Rivers, which are located to the east of Wood-Tikchik State Park. According to the plan, these rivers are to be managed to provide a mix of commercial and non-commercial use opportunities, to ensure the availability of public sites for the needs of all users, to protect habitat and natural resources, and to maintain options for additional future recreation management (ADNR 2005).

3.9.5 Shoreline Management Plans or Policies

There are currently no existing shoreline management plans or permitting processes in place for Chikuminuk Lake or its adjoining river banks. The shoreline of Chikuminuk Lake or its adjoining river banks are managed according to the specifications of the Alaska State Park wilderness zone designation as referenced above in **Section 3.9.2**.

Major water bodies located along the potential west transmission corridor (to Bethel) are the Kisaralik, Kwethluk, Kasigluk, and Akulikutak rivers, all of which drain into the Kuskokwim River in the south-central portion of the Yukon Delta NWR.

3.9.6 Protected River Systems

There are no State or Federally-protected river segments in the Project area.

3.9.6.1 River segment in the National Wild and Scenic River System

In the State of Alaska, there are 25 rivers and over 3,200 river miles that are protected under the National Wild and Scenic River designation. In addition, six State Recreation Rivers encompass 460 river miles. Southwest Alaska has five designated Wild and Scenic rivers. The closest to the Project is the Andreafsky River, located in the northern part of the Yukon Delta National Wildlife Refuge (National Wild and Scenic Rivers System 2012).

In 1980, the Kisaralik River was one of 12 Alaska rivers that ANILCA authorized to be studied for inclusion in the national wild and scenic rivers system. The NPS coordinated a multiple-agency study, which recommended that Congress not designate the Kisaralik River as a Wild and Scenic River. The study noted that the river met the basic eligibility requirements but was not suitable for inclusion due to opposition expressed by Alaska State Parks, local residents, and the USFWS. This opposition arose out of concern that the designation would bring heightened restrictions and regulation, and noted that most of the river is already protected due to its location within the Yukon Delta NWR (NPS 1985).

3.9.6.2 State-protected river segment

There are no State-protected river segments in the Project area.

3.9.7 National Trails Systems and Wilderness Areas

National Trails Systems

No project lands are under study for inclusion in the National Trails System nor designated as, or under study for inclusion as, a national Wilderness Area.

The State of Alaska has one designated National Historic Trail, the 938-mile Iditarod National Historic Trail, which follows a historic mail route from Seward to Nome (BLM 2012). The annual Iditarod Sled Dog race follows two alternating routes from Willow to Nome. There are no designated National Scenic Trails or National Historic Trails in the project vicinity, Y-K Delta or Bristol Bay regions.

Wilderness Areas

America's first federal wilderness areas were designated by Congress in 1964. Over 750 wilderness areas in the United States protect a combined 109 million acres (ADNR 2009); over half of this acreage is in Alaska. Several federally designated wilderness areas lie in the region: two located in the adjacent national wildlife refuges and two located in national parks to the east of Bristol Bay. The northern half of the Togiak NWR has been designated as wilderness. There is also a wilderness area in the northernmost part of the Yukon Delta NWR called the Andreafsky Wilderness, named for the river that runs through the area. Portions of both Katmai and Lake Clark National Park and Preserve are designated wilderness as well (NPS 2012a; 2012b).

The State of Alaska also has its own State Park wilderness designation, which is distinct from the federal designation. State park wilderness zones are established in order to maintain and protect an area's wilderness character and therefore these areas have tighter use and management restrictions than other state parklands (ADNR 1982). The project site is located in the northern third of Wood-Tikchik State Park, which is designated as a wilderness zone. Since large-scale man-made developments are discouraged in wilderness zones, the park's enabling legislation will need to be amended before any hydropower development moves forward at Chikuminuk Lake (ADNR 2002).

3.9.8 Regionally or Nationally Important Recreation Areas

Nationally Important Recreation Areas

As stated above, there are large blocks of protected federal and state lands in the region. Portions of the proposed Project would be located within the Wood-Tikchik State Park. A transmission route from the project powerhouse to Bethel and/or Dillingham is presently the subject of consultation with the USFWS. A potential transmission line corridor would traverse the Yukon Delta NWR. Adjacent recreation areas include the 4.2 million acre Togiak National Wildlife Refuge and parcels of state lands managed by various state agencies. The National Park Service manages two large parks in Southwest Alaska: Katmai National Park and Preserve and Lake Clark National Park and Preserve. Both Katmai and Lake Clark offer world-renowned sports fishing, bear viewing, and remote wilderness experiences in striking, largely undeveloped landscapes (NPS 2012a; 2012b).

Regionally Important Recreation Areas

The Bristol Bay region contains a small but significant sportfishing industry with a variety of lodges, camps, and guide services. Almost all of these fishing locations require either boat or floatplane transport. Most visitors fly through one of several hub communities in the area, which include Bethel, Kodiak, Dillingham and King Salmon.

In addition to public lands, certain private lands also support regional recreational and subsistence activities to local residents. The various Native village corporations in the area have selected large acreages as part of their entitlement under the Alaska Native Claims Settlement Act (ANCSA). Bristol Bay Native Corporation (BBNC), the parent regional Native corporation, also own large blocks in the area where locals derive subsistence and recreational enjoyment.

3.9.9 Non-Recreational Land Use and Management

The generation features of the Project would be located within the Wood-Tikchik State Park, which is managed according to the 2002 Wood-Tikchik State Park Management Plan; and three of the alternative transmission alignments under consideration are located partially within the Yukon Delta NWR. This section also considers the designation and use of the airspace above the project area for military operations.

Land use and management within the project boundary is largely focused on wilderness values and protection because the generation features of the Project are located within an area of Wood-Tikchik State Park designated as wilderness. Recreational use and management is secondary to wilderness preservation in this portion of the Park. The park was established to preserve and protect the natural habitat of the area along with access to subsistence and recreational activities. Three of the five alternative transmission alignments under consideration are located partially within the Yukon Delta NWR, which is predominantly managed for the protection of fish and wildlife resources. Following is a more detailed description of land use and management of Wood Tikchik State Park and Yukon Delta NWR.

3.9.9.1 Wood-Tikchik State Park

In the 1960s, the Wood River-Tikchik Lakes area was considered by the NPS for addition to the National Park System. However, the State of Alaska pre-emptively selected lands in the area and proposed a state park designation, largely due to concerns that federal action could diminish future opportunities for commercial, recreational, and resource development (including hydroelectric potential). After a variety of interagency studies examining the area's recreation potential and commercial fishery potential, Wood-Tikchik State Park was eventually established in 1978 and became the largest state park in the country at approximately 1.6 million acres (ADNR 1987). See **Figure 3.9-6**. The enabling legislation for the establishment of Wood Tikchik State Park states that "the primary purposes of creating the Wood-Tikchik State Park are to protect the area's fish and wildlife breeding and support systems and to preserve the continued use of the area for subsistence and recreational activities" (ADNR 2002). The State created a seven member park management council with five positions filled by local residents to represent the communities of Dillingham, Aleknagik, Koliganek, New

Stuyahok, and the Bristol Bay Native Association (BBNA). This council was created to ensure that area residents have a significant role in park management.

Wood-Tikchik State Park contains very few facilities and therefore encourages visitors to be self-sufficient and use "pack it in, pack it out" practices (ADNR 2002). There are a number of recreation opportunities in the park, including fishing, hunting, sightseeing, camping and watersports such as rafting and kayaking.

See **Figure 3.9-5** for existing lodges and recreation sites. Lake Aleknagik State Recreation Site, the only official recreational access point, offers a ranger station, parking area, boat launch ramp and other facilities, although visitors are welcome to fly, hike, or boat into the more remote areas (ADNR 2011). Camping and rafting are both allowed throughout the park but several areas require permits, including Chikuminuk Lake. In an effort to reduce park user conflict and to avoid crowding, the park has a ten day camping limit per site, as well as group size limits and overall annual visitation limits. The park also has various restrictions on the use of motorized craft and equipment. Snowmachines are allowed throughout the park, and hovercraft and generators are allowed in all non-Wilderness designated zones. Helicopters, airboats, and all-terrain vehicles are prohibited entirely within Wood-Tikchik State Park. Motorized boats are not permitted on Chikuminuk Lake (ADNR 2002).

The Upper Tikchik Lakes in the northern portion of the park are designated wilderness (**Figure 3.9-6**). Chikuminuk Lake is included in this area. The Wood-Tikchik State Park Management Plan states multiple factors that support this designation:

- The area receives limited recreational use;
- There is very little privately owned land;
- Wildlife (particularly brown bear and caribou) are concentrated in the area;
- Sportfishing potential is moderate compared to other regions of the park;
- Subsistence use is minimal;
- The remote wilderness setting of the area (ADNR 2011).

The Upper Tikchik Lakes have tighter restrictions than the rest of the park. These include restrictions on the number and frequency of visitors as well as use restrictions limiting motorized activity. Public facilities will only be constructed if absolutely necessary to resolve environmental degradation. Also included in the Management Intent, Guidelines for the Upper Tikchik Lakes is the following statement:

> "Hydropower development is incompatible with park purposes. The Division of Parks and Outdoor Recreation therefore does not have the authority to approve hydroelectric development at Chikuminuk Lake. Before Chikuminuk Lake can be considered for hydropower development, the enabling legislation must be amended" (ADNR 2011).

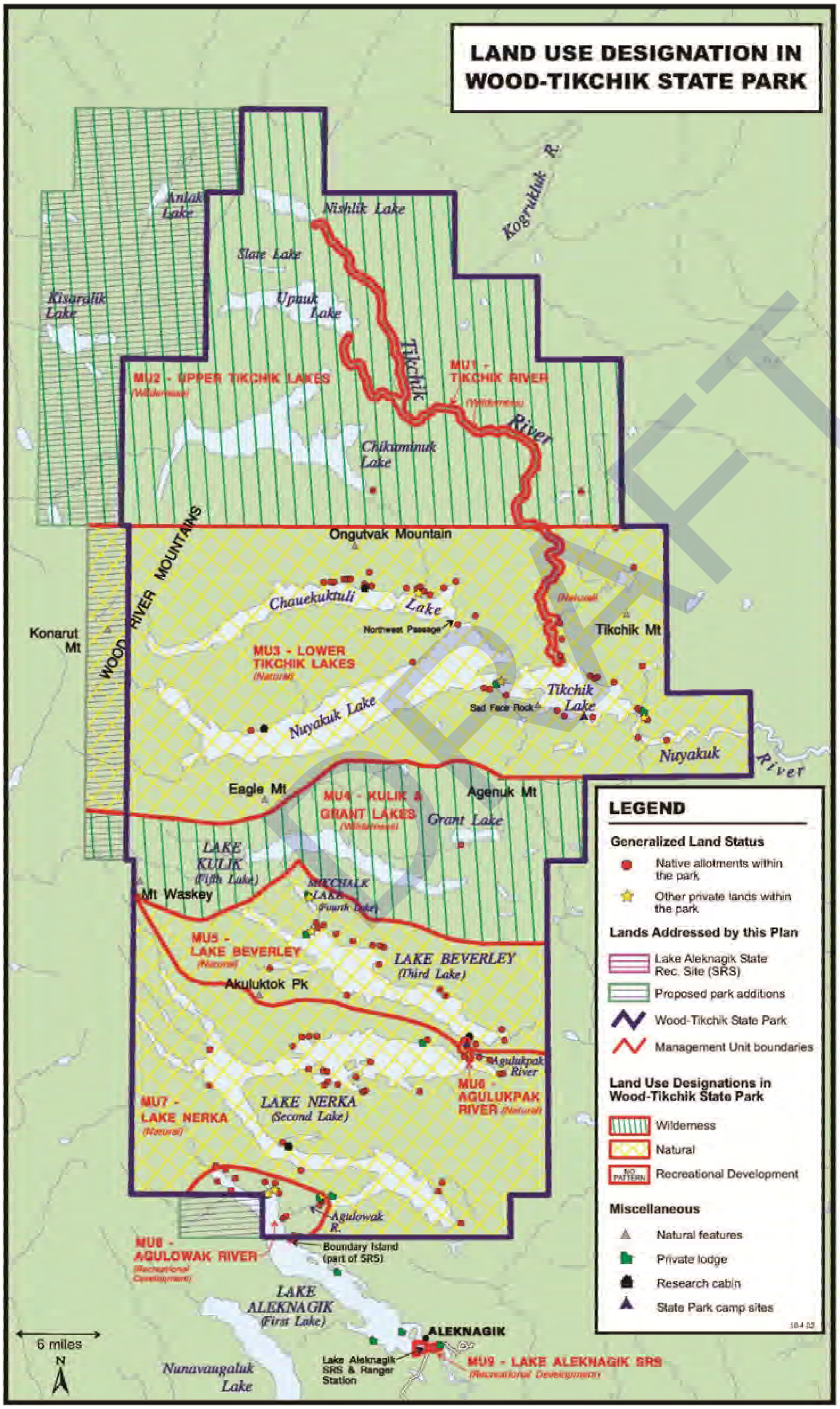
Currently, Nushagak Electric, Dillingham's electric provider, is studying the feasibility of two hydroelectric projects further south in Wood-Tikchik State Park. The Lake Elva and Grant Lake projects are authorized for study under the 2002 Wood Tikchik State Park Management Plan. The Lake Elva Project would be located at Elva Creek, which drains into Lake Nerka, approximately 36 miles north of Dillingham. The Grant Lake Project would be approximately 43 miles north of Dillingham on Grant Lake, which drains into Lake Kulik via the Grant River. Nuvista would coordinate with Nushagak Electric representatives as one of the transmission line alternatives proposed linking with these nearby potential projects.

3.9.9.2 Yukon Delta National Wildlife Refuge

The Yukon Delta National Wildlife Refuge (Yukon Delta NWR) is located to the west of the project site. The 19 million acre refuge is dominated by the two largest rivers in the Y-K Delta: the Yukon River and the Kuskokwim River. The majority of the refuge is a treeless wetland plain that provides habitat for an abundance of wildlife populations including millions of ducks, geese, and other migratory bird species. With nearly 25,000 Yup'ik

Eskimo living in more than 40 villages, the Yukon Delta NWR is also one of the most populated roadless areas in rural Alaska (USFWS 2004). Refuge management works closely with these villages to ensure that subsistence uses and community needs are protected (USFWS, 2004).

Figure 3.9-6 Land Use Designation in Wood-Tikchik State Park



Source: Alaska DNR, Wood-Tikchik State Park Management Plan (2002)

Recreation is not a primary intent of the refuge. However, the National Wildlife Refuge system recognizes compatible recreational activities as a priority public use on refuge lands. Consequently, compatible recreational activities such as hunting, fishing, wildlife observation, photography, and environmental education are generally encouraged and promoted on National Wildlife Refuges. The Yukon Delta NWR is open to hunting, although due to the low populations of big game and limited access, the area sees minimal recreational hunting. According to USFWS data, subsistence fishing far exceeds sport fishing use. Visitors occasionally venture to the area for wildlife observation, kayaking, rafting and photography, but due to the remote nature of the area and the challenge of transportation, these visitors are limited in number compared with more accessible locations around the state. Most non-local visitors fly into the refuge via small planes out of Bethel, where the refuge headquarters and visitor center are located (USFWS 2004).

The USFWS's Yukon Delta Land Conservation Plan lists a number of issues concerning the Yukon Delta NWR and encourages that refuge management be cognizant of these issues when making decisions. The concerns include various threats to healthy ecosystems (disruption of natural balance, fragmentation, habitat loss and displacement), preservation of wilderness values, and user group conflicts. The plan goes on to recommend some Resource Protection Priorities as required by the State of Alaska. These priorities identify private parcels along coastal zones, river corridors, nesting areas, and designated Wilderness areas that are considered high priority for resource protection (USFWS 2004).

3.9.10 Recreational and Non-Recreational Land Use and Management

There are five broad categories of land ownership that in many ways drive land use patterns in the study area. These are federal land; state land; Alaska Native Corporation land; local government and tribal land; and private lands and Alaska Native Allotments.

3.9.10.1 Federal Land

Large tracts of land are owned and managed by federal agencies, including the National Park Service and the U.S. Fish and Wildlife Service. There are two national parks in the study area (Lake Clark and Katmai National Parks) as well as two large national refuges (the Yukon Delta National Wildlife Refuge and the Togiak National Wildlife Refuge). Additionally, the Bureau of Land Management (BLM) owns large tracts of land in the study area. Most federal land is held in a manner meant to preserve its natural condition into the future.

3.9.10.2 State Land

Large tracts of land are owned and managed by the State of Alaska, including the Wood-Tikchik State Park. The State also owns land that is available for lease and/or development. Chikuminuk Lake is located in the 1.6 million acre Wood-Tikchik State Park, which was established in 1978.

3.9.10.3 Alaska Native Corporation Land

Significant portions of the region are owned by Alaska Native Corporations (ANCs) established by the Alaska Native Claims Settlement Act (ANCSA) in 1971. ANCSA conferred land to 13 for-profit regional corporations and approximately 200 village corporations. The Calista Corporation takes in the Calista Region, and the Bristol Bay Native Corporation is the ANSCA corporation for the Bristol Bay Region. Both ANCSA corporations own subsurface and surface rights to land that was either granted to the ANCs or that the ANCs selected through the ANCSA process. In instances where the village corporations own the surface rights, the regional corporation assigned to that region typically owns the subsurface rights. ANC land is private land that is available for development, preservation, or other activities as directed by the ANC so long as those activities are in alignment with local, state, and federal land use controls (Kijik Corporation 2011).

3.9.10.4 Local Government and Tribal Land

Within villages and local communities, some land has been conveyed to the local government for public services. In certain instances, the tribal government owns specific parcels. More often the local city government owns land for public facilities, and the local village corporation owns large portions of land within a village.

3.9.10.5 Private Lands and Alaska Native Allotments

Within communities throughout the study area, properties are held by individual residents and businesses. Many Alaska Natives hold title to individual parcels called Alaska Native allotments that were legally transferred prior to ANCSA. Parcels owned by individuals and allotments are typically located near villages and local communities, but can be found within national parks and state parks, particularly if they were granted under the federal Homestead Act or established as allotments prior to statehood and Alaska National Interest Lands Conservation Act (ANILCA). Private parcels located within conservation units are referred to as inholdings.

In 1978, there were 104 inholdings in the Wood-Tikchik State Park claimed by Native residents of Bristol Bay under the 1906 Native Alaska Allotment Act, totalling about 8,000 acres and ranging in size from 20 to 160 acres. Because these inholdings were also claimed by the state, the BLM was required to adjudicate land title. The issue was settled with a combination of relocation and conservation easements. Twenty-seven applicants exchanged their inholdings for State lands outside the park boundary. The remaining 77 pressed their land claims but agreed to conservation easements based on the strength of the original claim, the age of the applicant and the location of the parcel. A three-tier system was created:

- Tier 1 – The least restrictive, established a 25-foot wide pedestrian easement on land bordering lakes and rivers with no other restrictions.
- Tier 2 – Allows the subdivision of parcels into ten-acre lots, with no more than one five-acre commercial development site.
- Tier 3 – Similar to Tier 2, but with no commercial development (Ketchum et al. 2003).

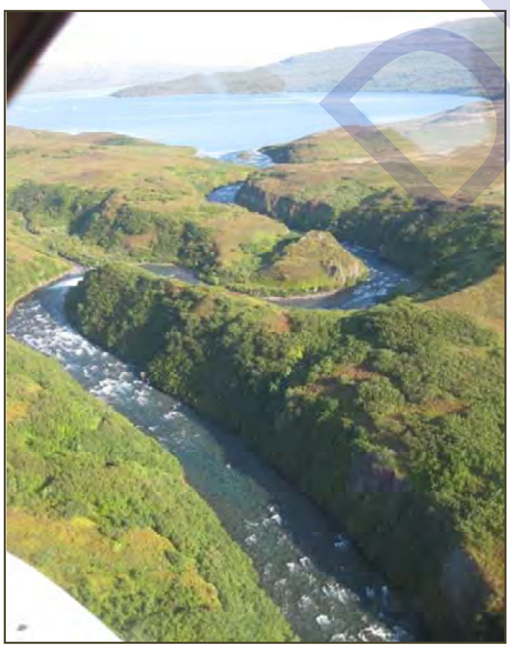
Most of the Wood-Tikchik parcels affected were classified as Tier 2. This solution limited large scale commercial development within the Park and ensured public access, while protecting Native land claims. However, there are growing pressures on the predominantly Native in-holders to sell their properties. Many are aging and may need additional funds for retirement or to cover medical expenses. Declines in the fishing industry during the 1990s and 2000s also increased the pressure on inholders to sell their land (Ketchum et al. 2003). To counteract these forces, the park has controlled the level of commercial use, encouraged the placement of covenants and conservation easements on the property prior to sale, and encouraged land exchanges, cooperative agreements or sales of inholdings to the state. The State has also instituted zoning within the park (ADNR 2002).

The Nature Conservancy and The Conservation Fund have also purchased inholdings within the Wood-Tikchik State Park to hold in trust. Some of these lands were transferred to the Nushagak-Mulchatna/Wood-Tikchik Land Trust (now known as the Bristol Bay Heritage Land Trust), which was formed by Bristol Bay residents to preserve salmon and wildlife habitat in the Nushagak Bay watersheds. These include lands in the Wood-Tikchik State Park and the Togiak National Wildlife Refuge (Ketchum et al. 2003; Bristol Bay Heritage Land Trust 2013). The Nature Conservancy of Alaska acquired a 110-acre parcel (USS 12058) at the headwaters of the Allen River on Chikuminuk Lake (ADNR 2013). This parcel was the only private inholding on Chikuminuk Lake, one of the most remote lakes in the northern reaches of Wood-Tikchik State Park.

3.10 Aesthetic Resources

This section provides a description of the visual characteristics of the lands and waters potentially affected by the proposed Project. The aesthetic resources study area broadly includes Chikuminuk Lake and the upper Allen River (**Photo 3.10-1**) in Wood-Tikchik State Park, as well as potential transmission line routes (see **Volume I** for a discussion of the transmission facilities). The description of the existing aesthetic resources within the project area is informed by published literature and site observations made by the project team during trips in June and August 2012.

Photo 3.10-1 Chikuminuk Lake and Upper Allen River



Above: Panoramic view of Chikuminuk Lake flowing into the Allen River, seen from the eastern shore looking west.

Left: Allen River S-curve located directly south of Chikuminuk Lake. This distinct visual feature is located close to the proposed dam site and would likely be significantly and permanently altered by the project.

Source: Agnew::Beck (June 2012)

3.10.1 Visual and Aesthetic Character and Quality of the Project Area

3.10.1.1 Regional Context

The visual context of southwest Alaska ranges from rugged mountainous terrain to rolling hills; winding, complex river systems; and marshy lowlands. Varied vegetation covers the region including tundra, low shrubs, and areas of spruce forests. The majority of the regional landscape is visually intact and has no apparent signs of human activity, primarily because it is extremely remote, even from long-settled villages. As stated on the official State of Alaska vacation and travel information website: "For those with a naturalist streak, few places on earth compare with the wonders of Southwest Alaska" (State of Alaska 2012). Visual disturbances and human development are limited to the rural communities dotted throughout the region. The communities are only accessible by air travel, roads are limited to each community, and there are no regional roadways.

3.10.1.2 Wood-Tikchik State Park

The proposed dam site and a portion of the transmission corridor route would be located in Wood-Tikchik State Park. Wood-Tikchik State Park, specifically the area around Chikuminuk Lake, is known for its wilderness scenery. Chikuminuk Lake, like the several other large lakes of Wood-Tikchik State Park, offers striking visual character with a broad expanse of water ringed by the varied hues of sub alpine vegetation. Rising from lake basins are many sharp edged, snow covered peaks. In contrast to other lakes in Wood-Tikchik State Park, this lake is located at slightly higher elevation and has a more alpine feel than the lakes located further downstream (A::B site visits 2012). Distinctive visual features in the Chikuminuk Lake area include the lake's varied colors, hues influenced by water depth; the sinuous canyon and rapids of the Allen River; and portions of the lake that have relatively complex shorelines and small islands.

3.10.1.3 Transmission Line and Corridors

There are no existing project facilities. The visual character of these facilities will depend on the proposed project design. Refer to **Volume I** for a discussion of proposed project facilities.

It is likely that the proposed transmission line would be a standard un-braced, H frame ranging from 70 to 90 feet tall. A typical H-frame transmission structure is shown in **Photo 3.10-2**. The number of structures required and distance between each structure is currently unknown and would be determined once a preferred transmission line route is selected. The Project would not likely develop a permanent road associated with the transmission line route; a 100-foot wide corridor right-of-way is anticipated. Five potential routes were identified for study – three traveling north and west from the proposed project dam site to Bethel and two traveling south to Dillingham (See **Volume I**). The visual environment of the most direct route to Bethel is described below, as it was the route studied in the gap analysis. Aesthetic study of the four additional routes was preliminary and is not included in this document.

<u>West Route Alternative from Proposed Project to Bethel</u>

The West route alternative to Bethel would travel northwest from the proposed dam site along the south shore of Chikuminuk Lake, entering the Kilbuck Mountain Range where Milk Creek flows into Chikuminuk Lake. The proposed transmission corridor winds through steep, rocky mountain peaks and proceeds down onto the foothills of the Kilbuck Mountains, through the marshy wetlands east of Bethel, and crossing the Kuskokwim River to reach the community of Bethel. The transmission line route would use areas of better drained soils and avoid recreational areas to the extent possible. The Kisaralik River is a popular subsistence fishing and recreational rafting and fishing river (USFWS 1993) that the transmission corridor will want to avoid.

The majority of the West route would pass through the Yukon Delta National Wildlife Refuge (Yukon Delta NWR). The following description, which gives a sense of the visual environment of the Refuge, has been compiled from the *Yukon Delta National Wildlife Refuge Fact Sheet* and *Yukon Delta Land Conservation Plan*

(USFWS 2002, 2004). The description of the Kisaralik River comes from the *Kisaralik River System: Final Summary Report* (ADNR 2010). Since the West route alternative would originate at Chikuminuk Lake and run to Bethel, the description below follows this same route, from the mountains near the lake to the marshy flat lands surrounding Bethel.

Photo 3.10-2 Example of Basic H-Frame Transmission Line

Source: HATCH Associates (2012)

The headwaters area of the Kisaralik River is swift-flowing with boulders strewn throughout the channel. The river then enters a wide tundra-covered glacial plain in the Kilbuck Mountains, opening into a broader valley flanked by 2,000 to 3,000 foot high mountains. The river is less than 100 feet wide at this point, and thick willow and willow brush line the riverbanks. The mountaintops have rounded ridges and steep slopes that sometimes wash into the river.

Near the Upper Falls, the river enters a canyon one-half to two miles wide with pinnacles, columns and bluffs as it continues to flow through the Kilbuck Mountains. Cottonwood, white spruce, and black spruce start to appear here. Large boulders are common, especially near the Upper Falls where at one point the river is forced into a channel only six feet wide.

At Golden Gate Falls, the river narrows again to only 25 feet wide and deepens to 15 feet between rock canyon walls that rise 25 feet on either side. Large boulders and three sharp bends make the waterfall a dramatic but dangerous section of the river. From Golden Gate Falls, the river becomes a braided channel with overhanging willow and alder along the banks. At this point the Kisaralik River bends to the north while the transmission line would continue in a west-westerly direction towards Bethel and into the terrain the Yukon Delta NWR is known for: broad, flat, delta marshlands.

By this point the Kisaralik River (and the potential transmission line route alternative) has traversed through four ecosystems of the Yukon Delta NWR: wet tundra, moist tundra, upland spruce/hardwood forest and alpine tundra. Most of the proposed west route alternative transmission corridor to Bethel is comprised of moist tundra characterized by low growing shrubs, herbs, grasses, and sedges rooted in a continuous mat of mosses and lichens (ADNR 2010; USFWS 2002, 2004).

Most of the land within the Yukon Delta NWR is a nearly flat, broad delta rising less than 100 feet in elevation. The final stretches of the two largest rivers in Alaska, the Yukon and Kuskokwim rivers, flow through the refuge.

These two rivers have created the vast delta landscape through the ancient meanderings which continue to shape the modern landscape. The terrain is dotted with literally thousands of ponds and wetlands, providing habitat for a range of resident and migratory bird and animal species. See **Photo 3.10-3** for several aerial views of the route described.

Photo 3.10-3 Selected Views of West Alternative Transmission Route to Bethel

Selected views of the proposed transmission line route between Chikuminuk Lake and Bethel, heading generally west, as seen from the air while flying along the proposed route.

Top to Bottom from Left: Kisaralik Lake and headwaters of the Kisaralik River; the Upper Kisaralik River winding through steep topography before flowing onto marshy lowlands; vast stretches of marshy and ponds; the shore of the Kuskokwim River; an aerial view of the city of Bethel.

Source: Agnew::Beck (June 2012)

3.10.1.4 Dam and Associated Infrastructure

There are no existing project facilities. The visual character of these proposed facilities will depend on the design developed. Refer to **Volume I** for a discussion of proposed project facilities.

3.10.1.5 Natural Water Features and Other Scenic Attractions

Chikuminuk Lake

Chikuminuk Lake, shown in **Photos 3.10-4, 5 & 6** is glacial in origin and very deep. Summer 2012 field study revealed the lake to be over 600 feet deep; the deepest portion extends below sea level (see **Section 3.4** for water resources). The lake is fed by a mix of glacial and clearwater streams. Vegetation in the vicinity of the lake is mainly low-growing tundra species with some willows, alders, and cottonwoods at lower elevations, in protected valleys (see **Section 3.6** for vegetation types). Roughly two-thirds of the lake is surrounded by rugged, rocky alpine peaks and ridges rising 3,000 to 4,500 feet along the north, south and west shores. These peaks hold snow through the summer, primarily in more shaded topographic ridges. Terrain in the eastern portion opens into the rolling to flat, broader landscapes of the upper Nushagak River drainage (Agnew:Beck 2012).

Photo 3.10-4 Potential Chikuminuk Lake Hydroelectric Dam Site, Facing Northwest

The proposed dam and powerhouse sites are located in the foreground; Chikuminuk Lake is visible in the upper section of the photo.

Source: Agnew::Beck (June 2012)

Photo 3.10-5 Chikuminuk Lake, Valley Along South Shore

Source: Agnew::Beck (June 2012)

During summer site visits the project team observed and documented three distinct lakeshore types as follows and illustrated in **Photo 3.10-7**:

- **Low Angle:** Shoreline rising at a low angle above the lake with gradual slope; higher water elevation would extend relatively far inland from the current lakeshore.
- **Steep Bank:** Steeply banked, generally uniform shoreline areas; higher water levels would move inland a relatively short distance from the current lake shore boundaries.
- **Complex:** Areas of more complex lake edge topography such as existing islands and bays; higher water levels would change the shoreline form, but may create new bays, new islands.

3.10.1.6 Allen River

The dam site would be located where Chikuminuk Lake flows into the Allen River. The Allen River at the eastern outflow of Chikuminuk Lake has rocky rapids with large boulders and tight turns. There is a visually distinct "s-curve" in the Allen River. Summer site visits afforded the opportunity to fly over the full length of the Allen River revealing the intricacies and bends of the river, views of the two different sets of rapids, and the unusual clarity of the water (Agnew:Beck 2012). See **Photo 3.10-1**.

3.10.1.7 Milk Creek

Milk Creek, flowing into Chikuminuk Lake on its western shore, also offers interesting visual features (**Photo 3.10-8**). The peaks along the south side of upper Milk Creek, roughly ten miles west of Chikuminuk Lake, are home to Chikuminuk Glacier (**Photo 3.10-9**) one of the few glaciers in southwestern Alaska. The glacial waters of Milk Creek enter Chikuminuk Lake from the Kilbuck Mountains and impart a silty turquoise appearance to the lake's water for a downstream distance of approximately ¼ of a mile.

Photo 3.10-6 Chikuminuk Lake, Northeastern Shore

Complex shoreline with islands, ponds and bedrock mounds concentrated on Chikuminuk Lake's northeastern shore.

Source: Agnew::Beck (June 2012)

3.10.2 Vantage Points for Viewing Natural Features

Although the proposed dam site and a portion of the associated facilities would be located on public lands (Wood-Tikchik State Park), there is no existing built infrastructure to designate a public vantage point.

There are no residents within the area of the dam site. The following communities may be able to view the transmission line corridor, depending on the route:

- **West Route to Bethel:** Bethel, Kwethluk, Napaskiak, Oscarville
- **North Route to Bethel:** Akiak, Akiachak, Bethel, Kwethluk, Napaskiak, Oscarville, Tuluksak, Upper and Lower Kalskag
- **Northern Alternate Route to Bethel:** Akiachak, Akiak, Bethel, Kwethluk, Napaskiak, Oscarville, Tuluksak
- **South to Grant Lake:** Aleknagik, Dillingham
- **South to Dillingham:** Dillingham, Ekwok, Koliganek, New Stuyahok

Aircraft travelers would be able to view the dam site and transmission corridor from the air. Depending on the location, the transmission line corridor may be viewed by boat travelers on the Kuskokwim River or by snowmachines, which are used for travel along the rivers during winter months.

Assumptions about the number of potential viewers can be made based on information presented primarily in **Sections 3.9** and **3.12**. These sections indicate that recreation and subsistence use in the vicinity of the Project is very low.

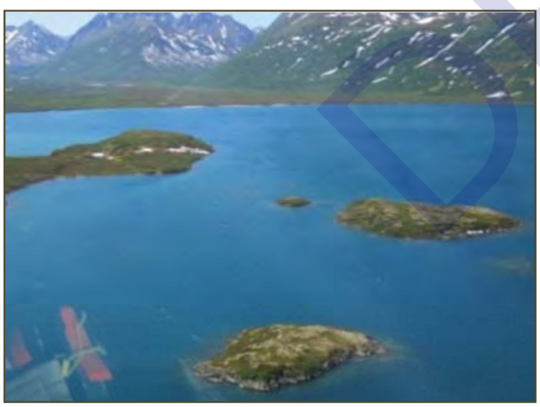
3.10.3 Federal Land Management Restrictions on Development

The project area would be located primarily within the Wood-Tikchik State Park and the Yukon Delta National Wildlife Refuge, which are protected by state and federal law, respectively. The Alaska Department of Natural Resources manages Wood-Tikchik State Park. The U.S. Fish and Wildlife Service manages the Yukon Delta National Wildlife Refuge. In addition, their managing entities have adopted and are guided by management plans. The following management policies are relevant to visual resources and aesthetics.

Photo 3.10-7 Example of Lakeshore Types, Chikuminuk Lake

Low Angle

Steep Bank



Complex

Source: Agnew::Beck (June 2012)

3.10.3.1 Wood-Tikchik State Park

One of the primary purposes for the establishment of Wood-Tikchik State Park was to protect the area's recreational and scenic resources. The 2002 *Wood-Tikchik State Park Management Plan* identifies as one of its goals (Goal 4) to "Protect, document, interpret and manage areas of significant scientific or educational value, visual quality, cultural or historic value and areas of special significance" (ADNR 2002). The goal specifies six objectives. Objective 4-6 directs park managers to "Define the park's landscape character and apply visual quality criteria to the park's management programs, developments and land use practices" (ADNR 2002).

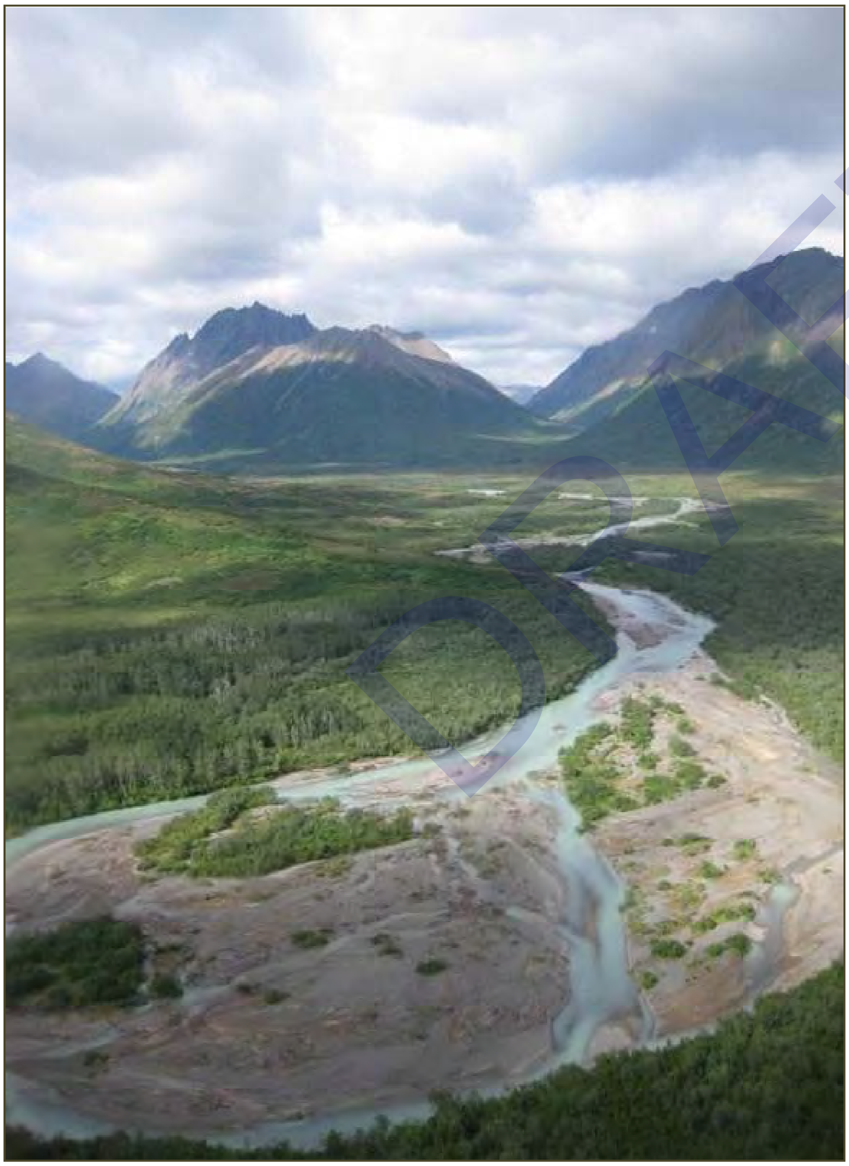
Portions of the proposed project site are located within a region of Wood-Tikchik State Park designated by the Management Plan as Wilderness. The Plan defines Wilderness areas as being

> "Established to promote, perpetuate, and where necessary, to restore the wilderness character of the land and its specific values of solitude, physical and mental challenge, scientific study, inspiration and primitive recreational opportunities…
>
> "Units designated Wilderness are designed to encompass areas large enough to offer visitors an experience where the sights and sounds of other users are minimized. They are managed to maintain the area's wilderness character including its landscape, vegetation and habitat. Resource modification can occur in these units only to restore the area to a natural state. Natural processes will continue with a minimal amount of human intervention to the extent that human safety and natural resources are protected…
>
> "Units designated Wilderness should have no man-made conveniences within their boundaries, except for the most primitive of trails, minimum trail maintenance, and signing…
>
> "Assessment of the aesthetic resources will need to focus on project impacts on wilderness character" (ADNR 2002).

3.10.3.2 Yukon Delta National Wildlife Refuge

As part of the National Wildlife Refuge System, the U.S. Fish and Wildlife Service is charged with conserving the fish, wildlife and habitats of the Yukon Delta National Wildlife Refuge for the benefit of present and future generations. Yukon Delta NWR is managed to conserve native fish and wildlife populations and their habitats, while providing sufficient opportunities for subsistence and compatible recreation activities. The USFWS works to preserve the wilderness values of the refuge and identifies several activities that can affect those values. The *Land Conservation Plan for the Yukon Delta NWR* mentions that “noise, permanent structures and other evidence of human presence can alter wilderness values” (USFWS 2004). The Refuge managers work to limit the amount of disturbance from human activities.

Photo 3.10-8 Milk Creek



Milk Creek drainage viewed from the air

Source: Agnew::Beck (June 2012)

Photo 3.10-9 Chikuminuk Glacier

Chikuminuk Glacier viewed from the air

Source: Agnew::Beck (June 2012)

3.11 Cultural Resources

3.11.1.1 Definition

For the purposes of the Data Gap analysis (Blanchard 2012) and the initial field study plans, the cultural resources study area (Project Study Area) was defined to include the following proposed project features: Chikuminuk Reservoir, the Dam and Powerhouse, related facilities, the proposed construction site, the Allen River, a small portion of Lake Chauekuktuli and five miles on either side of the West Route to Bethel.

3.11.1.2 Description

Geochronology

The geochronology of the Wood-Tikchik lakes region is relatively undeveloped. Two major tephra deposits, the ODLF Tephra (3,800-4,000 14C years B.P.) and the Aniakchak Tephra (3,430 ± 70 B.P.) are likely to be encountered in the Project Study Area (Begét et al. 1992; Fierstein 2007). VanderHoek (2009) asserts that the Aniakchak eruption would have had a significant impact on the ecological productivity in western Alaska and either killed or caused the relocation of Arctic Small Tool tradition (ASTt) populations living in western Alaska, leaving a cultural and ecological dead zone between Bering Sea Eskimos and Aleutian populations for more than 1,000 years.

Prehistory

The prehistory of southwest Alaska is poorly understood. Most of the known archaeological sites in the region are situated in or near coastal environments (Dumond 1962, 1981; Henn 1978; Larsen 1950; Oswalt 1952a; Shaw 1983). As a result, only an incomplete regional cultural chronology for southwest Alaska is possible at this time. The currently accepted chronology detailed in the Cultural Resources Data Gap (Blanchard 2012) and summarized below has been developed by Ackerman (1979b, 1980b, 1985, 1987, 1994a, b, 1996a, b, c, 2001, 2004, 2008a, b), Dumond (1962, 1981, 1984, 2000a, b), Henn (1978), Holmes (1986) and Shaw (1998).

Paleoindian Tradition (10,000 to 8,000 years ago) – The earliest Paleoindian Tradition sites with unequivocal artifacts are dated to ca. 10,000 years ago and are typified by the assemblage at Spein Mountain (10,050±90 B.P.) (BTH-00062 through BTH-00065), which is located within the Project Study Area (Ackerman 1996b, d, 2001). The Paleoindian Tradition in southwest Alaska is a non-microblade complex consisting of lanceolate and leaf shaped projectile points, bifacial knives, gravers, notches, various scrapers (including some on bifacial blanks), and flake knives (Ackerman 2001).

American Paleoarctic Tradition (10,000 to 7,000 years ago) – The American Paleoarctic Tradition appears to overlap the Paleoindian Tradition temporally (Anderson 1970; cf. West 1967 for an interior variant, the Denali Complex). American Paleoarctic tool kits include composite antler and stone projectiles, generally thought to have been used to hunt late Pleistocene-early Holocene fauna.

Northern Archaic Tradition (6,000 to 2,000 years ago) – The Northern Archaic tradition appears to represent the spread of a new boreal-forest oriented culture (Anderson 1988), although the presence of numerous sites in tundra areas may complicate this interpretation (Lobdell 1986; Schoenberg 1995). The defining artifact-type of the Northern Archaic is a somewhat asymmetrical side-notched biface reminiscent of projectile point styles from mid-latitude North America (Anderson 1968, 1988).

Arctic Small Tool Tradition (4,500 years ago to A.D. 900) – Arctic Small Tool tradition (ASTt) sites occur in an extensive zone stretching from the Bering Sea side of the Alaska Peninsula northward around Alaska, and through the Arctic Archipelago to Greenland. ASTt sites are known for the presence of tiny, finely-flaked stone tools, which may be associated with the introduction of the bow and arrow. Many archaeologists believe ASTt is the direct ancestor to modern Eskimo people in Alaska, the arctic regions of Canada, and Greenland (Dumond 1987a; Giddings 1967; Irving 1964); for another view see Gerlach and Mason (1992). The original ASTt definition has been expanded to include later cultures such as Choris, Norton, and Ipiutak (Gerlach and Edwin S. Hall 1988).

Norton Tradition (3,000 years ago to A.D. 1000) – The Norton tradition includes all post-Small Tool archaeological manifestations of Alaska usually termed Paleo-Eskimo, dating from ca. 1000 B.C. to 1000 A.D (Dumond 1982, 1987a, 2000a). Norton subsistence strategies were varied. Dumond (2000a) sees Norton people as predominantly river fishing folk who also engaged actively in the terrestrial hunting of caribou as well as in the coastal hunting of sea mammals.

Western Thule and Late Prehistoric/Protohistoric Eskimo (A.D. 900 to 1790) – The direct ancestors of the southwest Alaskan Yup'ik Eskimos were likely people of the Western Thule tradition. Typical artifacts include ground slate, chipped stone technology, heavy gravel-tempered pottery, snowshoes, hafted beaver-tooth knives, and birch bark baskets. Late prehistoric and protohistoric Eskimo subsistence was broad-based, with both interior and coastal resource exploitation. Data from the Naknek drainage suggests reliance on salmon and caribou, though some sea mammal remains occur (Dumond 1984).

Athabascan Tradition (2,000 years ago to present) – The Athabascan tradition is a prehistoric culture attributed to ancestors of the northern Athabascan Indians of Alaska, whose archaeological history precedes Euro-American contact (Cook 1968; Cook and McKennan 1970; Dixon 1985). It is important to note that the "Athabascan Tradition," in its archaeological denotation, refers to the archaeological culture. In common usage, the Athabascan Tradition continues to the present.

Early prehistoric Athabascan sites are characterized by subsurface housepit and cache features associated with a variety of flaked and ground stone, bone, and antler artifacts. Proto-historic (or late prehistoric) Athabascan sites include artifact assemblages predominately characterized by Native-made items with a small amount of non-Native trade goods (e.g. iron and glass beads) obtained through trade. Historic Athabascan sites (post-1850) generally have a mixture of log cabin and house pit dwellings affiliated with a greater percentage of Euro-American artifacts, and possible changes in site location in order to obtain these goods.

Ethnohistory

The Project is located in a region traditionally occupied by the Yup'ik Eskimo. The early cultural center of the Central Alaskan Yup'ik speaking peoples of southwest Alaska was the Bering Sea coast. This was primarily a maritime economy based on seal hunting, with some caribou hunting in the adjacent tundra. Approximately 3,800 radiocarbon years before present (B.P.), ancestral Eskimos (ASTt) moved south to occupy the Alaska Peninsula northwest of the Aleutian Range, displacing the previous Paleoindian occupants. Relatively little is known about this process (VanStone 1984b).

Before contact, Yup'ik peoples in the region practiced a central based seasonal mobility subsistence strategy. In this system, people spend part of each year wandering and the rest in a settlement of central base to which they may or may not return in subsequent years (VanStone 1971).

According to Van Stone (1984b), several Yup'ik groups inhabited the region at the time of contact. The Aglurmiut resided along the coast around Nushagak Bay and throughout much of the Alaska Peninsula (Dumond et al. 1975; VanStone 1967b). The Kiatagmiut occupied the entire Nushagak River, the lower Mulchatna River, and the area to the north, possibly including the Wood River Lake. The more northern Tikchik Lakes were within the territory of the Kusquqvagmiut, who also inhabited the Kuskokwim River as far inland as the modern village of Aniak. The Kusquqvagmiut occupied the village of Tikchik on Tikchik Lake. They may have controlled the lakes to the north, including Chikuminuk, but it is doubtful they utilized this area extensively. The Tuyuryarmiut occupied the banks of the Togiak River, its tributaries and the adjacent coast, between the Kusquqvagmiut and the Kiatagmiut (VanStone 1984b).

History

Explorations of Bristol Bay and the Nushagak River were undertaken by the Russian-American Company in the early nineteenth century in an effort to open the Alaskan interior to the fur trade. Between 1818 and 1836, the Russians established trading posts at the mouth of the Nushagak, on the middle Kuskokwim and the lower Yukon (VanStone 1959, 1967b). Following the establishment of a Russian Orthodox Church at the Aleksandrovski Redoubt in 1841, missionaries began to penetrate the Nushagak and Kuskokwim region. Little is known about the interaction between the interior Yup'ik and missionaries, but it was apparently extremely effective. By the end of the Russian era (1867), it is probable that most of the Yup'ik peoples in southwestern Alaska considered themselves to be Christians (VanStone 1964, 1984b).

Between 1818 and 1867, the fur trade with the Russian-American Company led Native peoples in western Alaska to alter their hunting efforts towards beaver, which had little or no food value, and away from subsistence game. As a result, Natives became dependent on the trading posts for the necessities of life. However, the process was slow among the Yup'ik, who did not become totally dependent on the global market until after the Americans purchased Alaska in 1867 (VanStone 1984b). The impact of the Russian fur trade was most prevalent on the Nushagak and the middle Kuskokwim, where beaver were plentiful. It was not until the turn of the twentieth century, when mink became a major trade item, that intensive fur trapping was undertaken in the Yukon delta region (Oswalt 1963).

With the sale of Alaska to the United States in 1867, an American firm, the Alaska Commercial Company, continued to operate the Russian trading centers. During this period, the variety of goods offered for trade increased considerably but the economic system of southwestern Alaska did not change significantly from the model established by the Russian trading posts until the commercial development of the Bristol Bay salmon fisheries in the 1880s (VanStone 1984b).

During the American period, the Russian Orthodox Church experienced competition from other churches including the Moravians, Episcopalians, Catholics and various evangelical protestant denominations (VanStone 1984b).

Despite the Klondike and Nome gold rushes, Natives in the Kuskokwim and Nushagak regions had little contact with miners during the late nineteenth and early twentieth century's (VanStone 1984b). One significant technology introduced to southwest Alaska by miners was the fish wheel, which was widely adopted along the Kuskokwim and Yukon Rivers and is still in use today (Oswalt 1978).

Beginning in Bristol Bay during the 1880s, commercial fishing came to have a significant impact on Native life. During the early years, most of the actual fishing was done by whites and the cannery work by imported Chinese and other laborers; Native peoples were considered to be poor workers due to prevailing ethnocentric attitudes. Gradually, some Natives were able to overcome this prejudice and get work in the canneries but, it was not until after WWII that Natives were allowed to participate fully in the industry. The Nushagak region was most directly affected by the development of the fishing industry, but residents from villages throughout southwest Alaska were attracted to Bristol Bay during the summer months when the canneries were opened. The canneries were important acculturation sites where Native peoples interacted not only with people from other Yup'ik groups, but also with people from different races and nationalities (VanStone 1984b).

Parks and Wildlife Refuges in the Vicinity of the Project

Chikuminuk Lake is located in the 1.6 million acre Wood-Tikchik State Park, which was established in 1978. When the park was created, 104 inholdings (totaling approximately 8,000 acres) were claimed by Native residents of Bristol Bay under the 1906 Native Alaska Allotment Act. Because these inholdings were also claimed by the state, the BLM was required to adjudicate land title. The issue was eventually settled with a combination of relocation and conservation easements. Twenty-seven applicants agreed to exchange their inholdings for

State lands outside the park boundary. The remaining 77 pressed their land claims but agreed to conservation easements based on the strength of the original claim, the age of the applicant and the location of the parcel. This solution limited large scale commercial development within the Park and ensured public access while protecting Native land claims. In order to limit commercial development, the State has encouraged the placement of covenants and conservation easements on inholdings prior to sale, and encouraged land exchanges, cooperative agreements or sales of inholdings to the state. The State has also instituted zoning within the park (Alaska Department of Natural Resources 2002; Ketchum et al. 2003).

Another factor in preventing the development of inholdings within the park has been the involvement of The Nature Conservancy and The Conservation Fund, which have purchased inholdings within the park to hold in trust. Some of these lands were transferred to the Nushagak-Mulchatna/Wood-Tikchik Land Trust (now known the Bristol Bay Heritage Land Trust), which was formed by Bristol Bay residents to preserve salmon and wildlife habitat in the Nushagak Bay watersheds (including lands in the Wood-Tikchik State Park and Togiak National Wildlife Refuge) (Ketchum et al. 2003; Nushagak-Mulchatna/Wood-Tikchik Land Trust 2012).

The 19.2 million acre Yukon Delta National Wildlife Refuge (Yukon Delta NWR) is located to the west of the Wood-Tikchik State Park, between Chikuminuk Lake and Bethel (Rudis 2009). A transmission line route from the proposed project powerhouse to Bethel and/or Dillingham is presently the subject of consultation with the USFWS and Nuvista anticipates that there will be alternative transmission routes to consider. One or more of the alternate transmission line routes would pass through the Yukon Delta NWR.

The origins of the Yukon Delta NWR trace back to 1909, when President Theodore Roosevelt created a refuge to preserve the breeding grounds of native birds. In 1929, Nunivak Island was set aside as a refuge for birds, game and furbearing animals. In 1930, the small islands and all the lands under the waters surrounding Nunivak Island were added to the refuge. Additional lands were reserved in 1937, when President Franklin D. Roosevelt created the Hazen Bay Migratory Waterfowl Refuge. The Kuskokwim National Wildlife Range was established in 1960, and in 1961, it was enlarged and renamed the Clarence Rhode National Wildlife Refuge. On December 2, 1980, President Jimmy Carter signed the Alaska National Interest Lands Conservation Act (ANILCA), which consolidated and added to the existing ranges and refuges to create the Yukon Delta NWR. With the exception of several small additions to the refuge due to purchase or land exchange, the lands of the refuge were federally owned prior to the refuge designation (U.S. Fish and Wildlife Service 2012b).

The Togiak National Wildlife Refuge (TNWR) is also located west of Chikuminuk Lake. In 1969, 265,000 acres of public lands were set aside as the Cape Newenham National Wildlife Refuge. In 1980, the Alaska National Interest Lands Conservation Act (ANILCA) expanded the Cape Newenham Refuge to 4.7 million acres and renamed it the Togiak National Wildlife Refuge. The northern 2.3 million acres of the refuge have been designated as a Wilderness Area (U.S. Fish and Wildlife Service 2012a).

3.11.2 Historic and Archaeological Sites

3.11.2.1 Research Methods

During the Data Gap analysis (Blanchard 2012), background research on historic properties was conducted for the preliminary Project Study Area. This involved a review of the Alaska Heritage Resource Survey (AHRS) and National Register of Historic Places (NRHP) databases and an examination of reports from previous research on file with the OHA. Northern Land Use Research Alaska, Inc.'s (NLURA) extensive library and the electronic card holdings at all libraries included in the Alaska Resources Library & Information System (ARLIS) was searched for published and unpublished materials concerning the culture history, history and previous archaeological research in the vicinity of the Project Study Area.

The Data Gap report (Blanchard 2012) identified the need to locate, examine and revaluate the records and collections from previous archaeological projects carried out in the Project Study Area. Archaeological survey and testing planned for the Project Study Area is intended to identify historic properties, determine their eligibility for listing on the National Register of Historic Places (NRHP), assess the effect of the Project on NRHP eligible properties and recommend mitigation measures for any adverse effects.

3.11.2.2 Cultural Resources in the Project Vicinity

The Alaska Heritage Resources Survey (AHRS) database shows 51 cultural resource sites within the Project Study Area covered in the 2012 cultural resources Data Gap report (Blanchard 2012). Twenty-six of these sites (51 percent) are classified as prehistoric, twenty-four (47 percent) are classified as historic, and one site (2 percent) does not have an accompanying description to the AHRS database entry. No paleontological sites or TCPs were identified.

Twenty-four of the 26 prehistoric sites have not been evaluated for their eligibility for listing on the NRHP, an essential step in the Section 106 process. Thirteen of the unevaluated prehistoric sites are relatively small lithic scatters, some containing as little as a single flake. Eight sites have a larger archaeological signature: TAY-0004 consists of three house pits; TAY-00007 is a large prehistoric workshop; four sites (BTH-00062, BTH-00063, BTH-00064, and BTH-00065) are associated with the Spein Mountain complex; and, Oovingiyuk (BTH-00130) is a late prehistoric village site. None of these sites have been evaluated for their eligibility for listing on the NRHP. Two sites, a prehistoric mound (possibly a midden) (TAY-00039) and a larger lithic scatter (TAY-00042), have been determined eligible for listing on the NRHP under Criterion D (Biddle 2003).

Fourteen of the twenty-four historic sites within the Project Study Area have not been evaluated for their eligibility for listing on the NRHP, an essential step in the Section 106 process. Seven historic sites (St. Sophia Church, Bethel (BTH-00011), the NWS Bethel Upper Atmosphere Facility (BTH-00121), the NWS Bethel Warehouse Building (BTH-00122), Building 601, a Fire Hose Storage Building (BTH-00124), Building 602, a Fire Hose Storage Building (BTH-00125), Building 603, a Fire Hose Storage Building (BTH-00126) and The Reindeer Service Warehouse (BTH-00144) have been determined ineligible for listing on the NRHP. The Bethel White Alice Communication System (BTH-00142) and the Old BIA School in Bethel (BTH-00143) have been determined eligible for listing on the NRHP. The First Mission House in Bethel (BTH-00013) is listed on the NRHP under Criterion A for its role in the religious life, education, exploration and settlement of Bethel, Alaska.

3.11.3 Existing Discovery Measures

A Data Gap analysis (Blanchard 2012) examined previous research in the vicinity of Chikuminuk Lake and along the West Route to Bethel. Similar studies will be completed for those transmission line routes deemed feasible. The existing discovery measures listed below are from the Data Gap report but provide an example of the existing discovery measures likely to be encountered for the alternate transmission line routes selected for further study.

3.11.3.1 Existing Discovery Measures for Chikuminuk Lake and the West Route to Bethel

Archaeological research in southwest Alaska began in 1931 (Hrdlička 1943) but the majority of work has focused on the more accessible coastal margins (Larsen 1950). In the 1960s, VanStone began a multi-year study of the early historic period along the Nushagak Drainage (VanStone 1967a, b, 1968a, b, 1970a, b, 1971, 1972, 1984b). This work has provided the bulk of current knowledge on the history and life ways of Native peoples in the Project Study Area at the time of contact.

Habitation sites on the Wood-Tikchik lake system are almost all located on outlet streams or along narrows (Dumond 1987b). VanStone identified a set of characteristics for identifying village sites occupied at the time of contact; these include a location along a riverbank or lakeshore, cleared areas covered with tall grass, easily identifiable house depressions and a general lack of extensive midden deposits. Referring specifically to the Wood Lakes, VanStone (1971) noted that all of the known sites were located at lake inlets or outlets. However, the location of historic sites does not appear to be a good predictor for the location of prehistoric sites since VanStone found few indications of prehistoric settlement during five years of field survey. He postulated that the location characteristics of prehistoric sites in the area might differ substantially from historic sites; that prehistoric sites could be overgrown and not easily visible from the air or by boat; that the area was uninhabited until relatively late in the prehistoric period; or, that the early sites were located along unstable riverbanks or lake shores and have eroded away (VanStone 1971). These hypotheses have yet to be tested in a systematic way.

In 1978, Ackerman surveyed sites in the Goodnews River Valley, Goodnews Lake, Kagati Lake and the Trail Creek-Kwethluk River Valley (Ackerman 1979a, b). The principal aim of these surveys was to establish a regional subsistence model using site locations, environmental contexts and known resource strategies, derived from ethnographic accounts. This model would then be used to locate evidence of sites occupied by Pleistocene hunters who hunted extinct fauna including mammoth, bison, horse and antelope. Artifacts from the glaciated zone indicated an initial occupation of perhaps as early as 10,000 radiocarbon years before present (B.P.) with continued occupation into the historic period. All the sites identified, with the exception of GDN-00094 at Kagati Lake, were surface scatters. Kagati Lake (GDN-00094) was a subsurface site that included microblade cores and typological association with sites dating to 9,000 years B.P., though no radiocarbon dates were taken. A side-notched point complex, associated with the Northern Archaic Tradition, was found at several sites along the upper fringes of Kwethluk, Goodnews and Nushagak Drainages.

In 1979, Ackerman conducted archaeological surveys to the east of Kagati Lake, to Nenevok Lake, north to the Trail Creek and Kwethluk River valleys, west along the Kwethluk and Kisaralik River Valleys, and north along the Aniak River valley to the Kuskokwim River lowlands. The 1979 efforts were an attempt to determine, through site location, a pattern of resource use over the last 10,000 to 15,000 years. Ackerman defined a set of activity areas, including lookout sites, kill sites, raw material sources and major manufacturing, processing and residential areas, that were of interest. The survey identified a number of sites in the Project Study Area (Ackerman 1980a, b).

Ten sites (BTH-00047 through BTH-00056) were small lithic scatters found along the North Fork of the Kisaralik River. Ackerman (1980a, b) notes that these sites are along a major caribou migration route, running east through the Taylor Mountains. Four additional sites were located between the North Fork and the Upper Falls of the Kisaralik River. Two lithic scatters (BTH-00058 and BTH-00059), located along the high bluffs overlooking the river canyon were interpreted as lookout sites. Two historic camp and cabin sites (BTH-00057and possibly BTH-00060) were also described. The historic sites had previously been identified by BLM archaeologist John Beck (Ackerman 1980b).

Near Spein Mountain, on a ridge 600 - 700 feet above the Kisaralik River, Ackerman (1980b) identified a major prehistoric site complex. On the western end of the ridge were thin scatterings of flakes (BTH-00062 and BTH-00065) interpreted as lookout points and two deflated areas (BTH-00063 and BTH-00064). The surface scatters included an assortment of parallel sided square and round based points, leaf shaped points, bifacial scarpers or adze blades, gravers on flakes, scrapers on flakes, whetstones, hammerstones, bifacial fragments and flakes.

Ackerman’s research strategy was based on two approaches: 1) a subsistence model with a heavy reliance on ecological data, and 2) a culture-historical model with support from historical sources and ethnographic studies. He concluded that topography and climate were important to both humans and the game they hunted. He noted that there were differences between the artifacts found in glacial and periglacial zones. He attributed these differences to glacial retreat. According to this theory, during the late Pleistocene/ early Holocene the periglacial zone, which included the foothills of the western Ahklun-Kilbuck Mountains, was used by herds of herbivores on their east–west migrations. As the glaciers retreated, the fault block valleys of the Ahklun-Kilbuck Mountains provided new east–west passages for migratory animals and opened new hunting sites. Ackerman concluded that there was a clear relationship between site distribution, topography and subsistence strategy related to the hunting of migratory animals in the area from the Pleistocene to the recent past (Ackerman 1980b)

In 1992, Ackerman returned to conduct more extensive testing at Spein Mountain (BTH-00062 through BTH-00065) the Nukluk Mountain site on the lower course of the Kisaralik River and the Ilnuk site on the Middle Holitna River. Eighty-five 1m x 1m units were excavated in BTH-00063. These excavations yielded bifaces, scrapers, knives, adzes, gravers on flakes, notched flakes and whetstones consistent with the Mesa Complex (part of the Paleoindian Tradition), which has been recorded at sites in the Brooks Range. A pit feature (Zone B) within the site included a fire pit; charcoal from this feature yielded an Accelerator Mass Spectrometry (AMS) date of 10,050± 90 B.P (Beta 64471 [CAMS-8281]). Pollen analysis suggests alpine tundra with shrubs but no tree forms. The percentage of grass pollen is much higher than that found naturally, even in lush grasslands, which may indicate that the grass was transported to the site (Ackerman 2001).

Little archaeological work has been done in the upper Wood-Tikchik lake system. In conjunction with his ethnohistorical research, VanStone (1968b) identified and excavated Tikchik Village (DIL-00001). In 1981, Ackerman surveyed the area around Chikuminuk Lake, identifying seven sites subsequently listed on the AHRS. Four sites (TAY-00005, TAY-00006, TAY-00008 and TAY-00009) consisted of a single flake or small lithic scatters. TAY-0010 was a small mound, interpreted as a midden or house pit debris. Test excavations revealed pottery shards (plain ware), a whetstone, and several chert chunks and retouch flakes. A charcoal sample from the unit provided a date of 630 ±60 B.P. (WSU-2657), indicating a late prehistoric occupation. TAY-00007 yielded a large amount of chert cores and debitage, a conical microblade core, two fragments of projectile points of non-local material, hammer stones and large amounts of charcoal (which was probably the result of a burn event). A radiocarbon date of 1945± 137 B.P. (WSU-2658) was obtained from the charcoal above the artifacts but may not accurately date the debris. The site was interpreted as a Norton site, but the conical microblade core is similar to those of the Kagati Lake Late Tundra tradition (circa 9000-6000 B.P.) indicating either an earlier occupation of the site or curation and relocation of the artifact (Ackerman in Biddle 2003).

In 2000, as part of the Section 106 process prior to sale, several surveys were undertaken by BIA archaeologists on the Hansen Native Allotment (AA-7179-C), at the mouth of Chikuminuk Lake. These surveys identified lithic materials on the east side of the Allen River within the original boundaries of TAY-00007, in an area identified by Ackerman in 1981 as a modern camp. In 2003, Biddle conducted surface surveys and test excavations on two prehistoric sites (TAY-00039 and TAY-00042) either wholly or partially within the Hansen Native Allotment. The sites included house depressions, hearth features, chert flakes and a biface preform. A charcoal sample from TAY-00039 was radiometrically dated to 640 ± 70 B.P. (Beta #185623), which is consistent with a Thule occupation of the site. The sites were determined to be eligible for listing on the NRHP under Criterion D for their potential to significantly add to the knowledge and understanding of prehistoric and historic Native life ways in southwest Alaska (Biddle 2003).

Although a number of sites have been identified within the Project Study Area in and around Bethel, this work has not always been exhaustive. For example, Oswalt (1980) located and described the community of Bethel (BTH-00014), the historic village sites of Mumtrekhlagamiut (BTH-00015) and Oovingiyuk (BTH-000130), the historic residential site of Kwigohok (BTH-00131) and the historic settlement, trading post and school at Oscarville (BTH-00132), but none of these sites have been systematically tested or evaluated for listing on the NRHP.

The Bethel White Alice site (BTH-00142) was examined in 1988 as part of a historical overview and inventory of the White Alice System (Reynolds 1988). It was re-examined by the US Army Corps of Engineers (USACE) during the development of a management plan for Cold War cultural resources in Alaska (Denfield 1994). The site has subsequently been determined eligible for listing on the NRHP.

A building assessment of the Old BIA School in Bethel (BTH-00143) was carried out by the BLM in 1991, prior to its transfer to the Bethel Native Corporation (BNC). This report concluded that the structure was eligible for listing on the national register under Criterion A (Bureau of Land Management 1991). The same year, the BNC conducted an assessment of the structure to calculate the cost to move or restore it (GDM 1991). The building has been determined eligible for listing on the NRHP.

In 1999, Chattey examined the surviving CAA/FAA structures in Bethel (BTH-00124, BTH-00125, BTH-00126 and BTH-00128) as part of a determination of eligibility for air navigation facilities constructed between 1940 and 1958 and recommended that they were not eligible for listing on the NRHP (Chattey 1999). OHA concurred with this recommendation.

In 2003, Hart Crowser and Associates examined the surviving National Weather Service (NWS) facilities in Bethel (BTH-00121 and BTH-00122) as part of a state wide inventory of NWS structures and recommended that they were not eligible for listing on the NRHP (Hart Crowser and Associates 2003). OHA concurred with this recommendation.

There is relatively little information on the history of research at three historic sites along the West Route to Bethel and in Bethel itself; the Reindeer Service Warehouse (BTH-00144), a small historic camp (BTH-00156) and Qip'acuk (BTH-00158). The only information so far located for these sites are the OHA files and BIA ANCSA Site Records. A historic campsite (BTH-00060) and a historic cabin (BTH-00061) were located by Ackerman (1980b) but they were not examined in detail. None of these sites have been systematically tested or evaluated for listing on the NRHP.

Van Stone (1967, 1968b, 1971) identified numerous historic Yup'ik settlement sites around Nushagak Bay and along the Nushagak and Wood Rivers. Oswalt (1980) identified historic settlements along the Kuskokwim River south of Bethel. Both VanStone and Oswalt recorded Native place names, which often include information on how people view, use and relate to the surrounding natural environment. They can contain descriptions of landforms, hydrology, vegetation, fauna, and other aspects of the local environment. Place names can also refer to past human history and activities such as gathering places, areas of trading, territorial boundaries, and spiritual places. As such, place names can provide a framework to understand continuity and change in past land use systems in the archaeological record.

No formally-defined TCPs were identified within the Project Study Area. By definition, TCPs are associated with repeated use/significance over multiple generations and long periods of time. Long term use can, but does not always leave evidence, in the form of material culture, visible in the archaeological record. Native place names can also be indications of a TCP's cultural significance. However, TCPs are primarily identified by the people to whom they are significant during the consultation process.

3.11.4 Indian Tribes

In Alaska, consultation occurs with 229 federally recognized tribes, thirteen Alaska Native Regional Corporations and approximately 200 Alaska Native Village Corporations created by the Alaska Native Claims Settlement Act (ANCSA). The Regional and Village Corporations are recognized as "Indian tribes" for some NHPA purposes.

There are no communities located in the immediate vicinity of Chikuminuk Lake. Nuvista has identified 23 Federally Recognized Tribes in the Bristol Bay and Calista Regions as listed in **Table 3.11-1** that may attach religious and cultural significance to historic properties within the project boundary or in the vicinity of the

Project. These tribes are located within 21 communities and are represented by ANCSA Village Corporations as well as their respective Alaska Native Regional Corporation, i.e. Bristol Bay Native Corporation or the Calista Corporation.

The identified tribes have unique histories, but are characterized by strong ties to the land and its resources, and in some cases, through strong kinship connections. The successful completion of the Consultation and Coordination phase of the Section 106 process will require the development of an efficient and effective consultation process that addresses the letter of the laws and regulations within the context of local custom and practice.

Table 3.11-1 Federally Recognized Tribes, Communities, and Village Corporations Affected by the Project

Federally Recognized Tribe	Community	Village Corporation
Bristol Bay Region		
Native Village of Aleknagik	Aleknagik	Aleknagik Natives Limited
Village of Clarks Point	Clark's Point	Saguyak Incorporated
Native Village of Ekuk	Dillingham	Choggiung Limited
Curyung Tribal Council	Dillingham	Olsonville, Incorporated
Ekwok Village	Ekwok	Ekwok Natives Limited
New Koliganek Village Council	Koliganek	Koliganek Natives Limited
New Stuyahok Village	New Stuyahok	Stuyahok Limited
Portage Creek Village	Portage Creek	N/A
Calista Region		
Akiachak Native Community	Akiachak	Akiachak, Limited
Akiak Native Community	Akiak	Kokarmiut Corporation
Village of Atmautluak	Atmautluak	Atmautluak, Limited
Orutsararmuit Native Village	Bethel	Bethel Native Corporation
Native Village of Napaimute	Bethel	Bethel Native Corporation
Native Village of Eek	Eek	Iqfijouaq Company
Kasigluk Traditional Elders Council	Kasigluk	Kasigluk, Incorporated
Organized Village of Kwethluk	Kwethluk	Kwethluk Incorporated
Native Village of Napakiak	Napakiak	Napakiak Corporation
Native Village of Napaskiak	Napaskiak	Napaskiak, Incorporated
Native Village of Nunapitchuk	Nunapitchuk	Nunapitchuk Limited
Oscarville Traditional Village	Oscarville	Oscarville Native Corporation
Native Village of Kwinhagak	Quinhagak	Qanirtuuq, Incorporated
Tuluksak Native Community	Tuluksak	Tulkisarmute Incorporated
Native Village of Tuntutuliak	Tuntutuliak	Tuntutuliak Land, Limited

Nuvista Light & Electric Cooperative (2012), Alaska Community Database Community Information Summaries (2012).

3.12 Socio-economic Resources

3.12.1 Introduction

The Project has the potential to affect the socioeconomic resources of communities in the Calista and Bristol Bay Regions.

3.12.1.1 Study Area Definition

For purposes of this socioeconomic overview, the primary study area consists of the Calista and the Bristol Bay portions of southwest Alaska. While other studies of southwest Alaska might include the Aleutian Islands and sometimes Kodiak Island, this report excludes the Aleutians and Kodiak. A map of this socioeconomic study area is provided as **Figure 3.12-1**. Different geographic areas are relevant to describe the subsistence activities in the vicinity of the Project, as discussed at the end of this section, 3.12.12 Subsistence Resources. As shown by **Figure 3.12-1**, the Calista portion of the primary socioeconomic study area includes the Bethel Census Area and the Wade Hampton Census Area. The Calista Region boundary is the same as that of the Calista Corporation, an Alaska Native regional corporation. The Bristol Bay portion of the socioeconomic study area includes the Dillingham Census Area, the Bristol Bay Borough, and the Lake and Peninsula Borough. The Bristol Bay Region's boundary is the same as the boundary for the Bristol Bay Native Corporation.

Within this primary socioeconomic study area, there are several ways that data are shown and analyzed. The geography used to summarize data is a function of data availability, as well as whether it is appropriate to show information on a larger scale or on a specific community scale. The five geographies used to summarize data are listed below.

- **Statewide**: statewide data is shown for comparison purposes.
- **Study Area**: data is shown for the study area (Southwest Alaska, defined as the Calista Region and the Bristol Bay Region).
- **Calista Region**: data is shown for the Census areas that make up the Calista Region: Bethel and Wade Hampton Census Areas.
- **Bristol Bay Region**: data is shown for the Census areas and boroughs that make up the Bristol Bay Region: Dillingham Census Area, Bristol Bay Borough and Lake and Peninsula Borough.
- **Communities**: in certain instances, data is shown at the community level. Bethel and Dillingham are described in more detailed because they are the two largest communities in the study area. Where appropriate, data is provided for an additional 13 communities, as a sample of smaller villages. In the future, as more is understood about the Project, other villages may be covered in greater detail.

3.12.1.2 Socioeconomics of Southwest Alaska

The story of southwest Alaska is one of both social and economic strengths and significant challenges. Regional strengths include the area's natural beauty, largely intact ecosystems, and the rich cultural traditions, which include Yup'ik, Cup'ik, Athabascan and Alutiiq cultures. Like much of rural Alaska, many of the communities possibly served by the proposed Project are experiencing the challenges associated with a lack of jobs and high unemployment. Rising energy and fuel costs have further hindered the economic viability of life in rural Alaska: most food, home heating fuel and other materials must be flown or shipped in from outside the region, leading to steady growth in the cost of living.

3.12.2 Calista Region Study Area

The Calista Region includes two primary rivers, which are the region's lifelines for transportation, food, and culture. To the north, the Yukon River travels from its headwaters in Canada nearly 2,000 miles to empty into the Bering Sea. The Kuskokwim River further south travels 700 miles from Alaska's interior to the Bering Sea. These rivers flow through a remote area, unconnected to the road system, that is nearly 58,000 square miles (approximately the size of Oregon). The region has been home to Native cultures for thousands of years. Today's regional population is approximately 25,000 in over 48 permanent communities and several seasonally occupied villages. (ADCCED 2012a).

The rich mix of subsistence resources on land, rivers and lakes, and at sea historically meant this region has had the largest concentration of rural communities in all of Alaska. Residents are primarily people of native decent (Yup'ik, Cup'ik and Athabascan) living a subsistence-based lifestyle, with hunting, fishing and gathering providing a large majority of their food (City of Bethel 2011a).

The Calista Region is divided into the Bethel and Wade Hampton Census areas. The Bethel Census Area is one of only 38 county-level census divisions of the United States where the most spoken language is not English and one of only three where it is neither English nor Spanish. Sixty-three percent of the population in the Bethel Census Area speaks a Yup'ik language at home, followed by English (ADCCED 2012a).

3.12.2.1 City of Bethel

Bethel is a second-class city, incorporated in 1957 (City of Bethel 2011a). The City of Bethel is located on the outer bank of the main channel of the Kuskokwim River, 40 miles inland from the Bering Sea. The city occupies approximately 44 square miles of land within the Yukon Delta National Wildlife Refuge and has a population of approximately 6,080 according to the 2010 U.S. Census (City of Bethel 2011a). Not connected to Alaska's road network, Bethel is about four hundred air miles from Anchorage; it is the largest town in southwest Alaska and the hub community of the region. Bethel is a particularly diverse and multi-cultural city among rural Alaska communities. In 2010, Bethel's population was about 65 percent Alaska Native/American Indian, 23 percent White (American), and also included people of Indian, Filipino, Chinese, Korean, Vietnamese, Native Hawaiian, Guamanian, Mexican, Puerto Rican and other Asian, Pacific Islander and Hispanic ethnicities (2010 census data, ADCCED 2012a). For cities, businesses, and individuals living in the villages in the region, Bethel is the major source for government, education, transportation, and health services, as well as a major shopping center for food, equipment, clothing, and other products. The remote villages, scattered throughout the region, range in size from less than 100 people to several with over 800 residents. Few villages are connected by road to one another; none to the rest of Alaska (City of Bethel 2011b).

3.12.3 Bristol Bay Region Study Area

Located in southwestern Alaska, the Bristol Bay Region consists of vast, diverse, largely roadless wilderness, punctuated by remote villages. Its boundaries extend from the village of Nondalton on the east, to Perryville on the south coast of the Alaska Peninsula—an area encompassing over 40,000 square miles. Bristol Bay villages are predominantly Alaska Native, including Yup'ik, Aleut/Alutiiq, and Dena'ina Athabascan. The Aleut/Alutiiq historically inhabited the communities on the Pacific Ocean side of the Alaska Peninsula, the Dena'ina Athabascan are from the areas surrounding Lake Clark and Iliamna Lake, and the Yup'ik traditionally inhabit the coastal villages of Bristol Bay (ADCCED 2012a).

Bristol Bay's rivers and streams support the world's largest sockeye salmon run, which has attracted people for centuries for subsistence, commercial and sport fishing. Because of the long history of commercial fishing and fish processing, people of many backgrounds have moved into the area, creating a tapestry of cultural influences, from Europe to Southeast Asia (City of Dillingham 2010).

3.12.3.1 City of Dillingham

Dillingham, incorporated in 1963, became a first-class city in 1972 (City of Dillingham 2010). Dillingham is the largest community in Bristol Bay with 2,329 people, and is the government, service and transportation hub for the region. Dillingham is the entry point for access to Togiak National Wildlife Refuge, Wood-Tikchik State Park and Walrus Island State Game Sanctuary. Government services, natural resources, fish and wildlife are the economic engines of the Bristol Bay and Dillingham areas, with the latter supporting commercial, subsistence and recreational activities (City of Dillingham 2010).

3.12.4 General Land Use Patterns

Southwestern Alaska is geographically diverse. The land consists primarily of relatively low-lying wetlands, lakes and shrub tundra, separated by mountainous regions and low hills. Much of the region's land is sparsely populated or uninhabited. Population centers tend to be concentrated along important rivers and lakes, or along the more sheltered portions of the Bering Sea coastline. These areas are characterized by rural development patterns. Bethel and Dillingham are the largest and most urbanized communities, while most of the region's communities are much more rural in character. A few settlements are only seasonally occupied and serve as fishing and subsistence camps.

There are five broad categories of land ownership that in many ways drive land use patterns in the study area. See **Section 3.9** for more detail about the primary land uses in the region.

3.12.4.1 Federal Land

Large tracts of land are owned and managed by federal agencies, including the National Park Service and the U.S. Fish and Wildlife Service. There are two national parks in the study area (Lake Clark and Katmai National Parks) as well as two large national refuges (the Yukon Delta National Wildlife Refuge and the Togiak National Wildlife Refuge). Additionally, the Bureau of Land Management (BLM) owns large tracts of land in the study area. Most federal land is managed in a manner meant to preserve its natural condition into the future.

3.12.4.2 State Land

Large tracts of land are owned and managed by the State of Alaska, including the Wood-Tikchik State Park. The State also owns land that is available for lease and/or development. Chikuminuk Lake is located in the 1.6 million acre Wood-Tikchik State Park, which was established in 1978 (see **Sections 3.9.9 and 3.9.10** for additional discussion of land ownership and use patterns in Wood-Tikchik State Park).

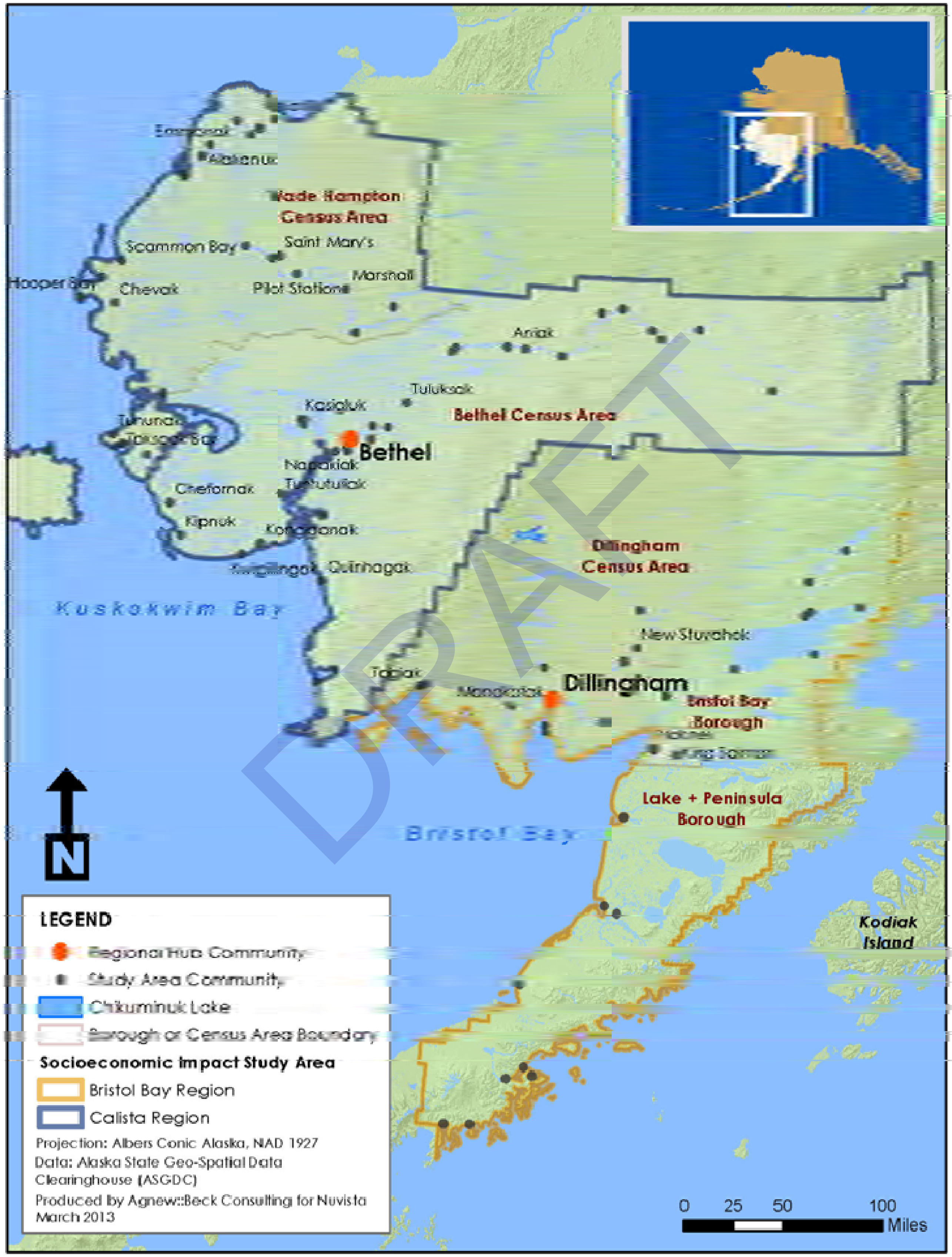
3.12.4.3 Alaska Native Corporation Land

Significant portions of the region are owned by Alaska Native Corporations (ANCs) established by the Alaska Native Claims Settlement Act (ANCSA) in 1971 (see also **Section 3.12.6.3**). ANCSA conferred land to 13 for-profit regional corporations and approximately 200 village corporations. The Calista Corporation takes in the Calista Region, and the Bristol Bay Native Corporation is the ANSCA Corporation for the Bristol Bay Region. Both ANCSA corporations own subsurface and surface rights to land that was obtained through the ANCSA land selection process. In instances where the village corporations own the surface rights, the regional corporation assigned to that region typically owns the subsurface rights. ANC land is private land that is available for development, preservation, or other activities as directed by the ANC so long as those activities are in alignment with local, state, and federal land use management requirements (Kijik Corporation 2011).

3.12.4.4 Local Government and Tribal Land

Within villages and local communities, some land has been conveyed to the local government for public services. In certain instances, the tribal government owns specific parcels. More often the local city government owns land for public facilities, and the local village corporation owns large portions of land within a village and the immediate surrounding area.

Figure 3.12-1 Socioeconomic Impact Study Area, Southwest Alaska



3.12.4.5 Private Lands and Alaska Native Allotments

Within communities throughout the study area, properties are held by individual residents and businesses. Many Alaska Natives hold title to individual parcels called Alaska Native allotments. Native Allotments continue to be investigated by the Bureau of Indian Affairs and transferred to the allotment applicants. Parcels owned by individuals and allotments are typically located near villages and local communities, but can be found within national parks and state parks. Private parcels within conservation units are referred to as inholdings.

In 1978, there were 104 inholdings in the Wood-Tikchik State Park claimed by Native residents of Bristol Bay under the 1906 Native Alaska Allotment Act, totaling about 8,000 acres and ranging in size from 20 to 160 acres. Because these inholdings were also claimed by the state, the BLM was required to adjudicate land title. The issue was settled with a combination of relocation and conservation easements. Twenty-seven applicants exchanged their inholdings for State lands outside the park boundary. The remaining 77 pressed their land claims but agreed to conservation easements based on the strength of the original claim, the age of the applicant and the location of the parcel. A three-tier system was created:

- Tier 1 – The least restrictive, established a 25-foot wide pedestrian easement on land bordering lakes and rivers with no other restrictions.
- Tier 2 – Allows the subdivision of parcels into ten-acre lots, with no more than one five-acre commercial development site.
- Tier 3 – Similar to Tier 2, but with no commercial development allowed (Ketchum et al. 2003).

Most of the Wood-Tikchik parcels affected were classified as Tier 2. This solution limited large scale commercial development within the Park and ensured public access, while protecting Native land claims. However, there are growing pressures on the predominantly Native landowners to sell their properties. Many are aging and may need additional funds for retirement or to cover medical expenses. Declines in the fishing industry during the 1990s and 2000s also increased the pressure on inholders to sell their land (Ketchum et al. 2003). To counteract these forces, the park has controlled the level of commercial use, encouraged the placement of covenants and conservation easements on the property prior to sale, and encouraged land exchanges, cooperative agreements or sales of inholdings to the state. The State has also instituted zoning within the park (ADNR 2002).

The Nature Conservancy and The Conservation Fund have also purchased inholdings within the Wood-Tikchik State Park to hold in trust. Some of these lands were transferred to the Nushagak-Mulchatna/Wood-Tikchik Land Trust (now known as the Bristol Bay Heritage Land Trust), which was formed by Bristol Bay residents to preserve salmon and wildlife habitat in the Nushagak Bay watersheds. These include lands in the Wood-Tikchik State Park and the Togiak National Wildlife Refuge (Ketchum et al. 2003; Bristol Bay Heritage Land Trust 2013). The Nature Conservancy of Alaska acquired a 110-acre parcel (USS 12058) at the headwaters of the Allen River on Chikuminuk Lake (ADNR 2013). This parcel was the only private inholding on Chikuminuk Lake, one of the most remote lakes in the northern reaches of Wood-Tikchik State Park.

3.12.4.6 Population Trends

Table 3.12-1 presents population figures for the Calista Region and the Bristol Bay Region. Between 2000 and 2010, the Calista population grew by 6.2 percent, while the Bristol Bay Region's population dropped by approximately 6.5 percent (U.S. Census 2010a).

There are three components that make up population change: births, deaths, and net migration. A region's population change is a function of the number of births, the number of deaths, and the number of people who move in and out of the region (net migration).

Table 3.12-1 Population Summary of Southwest Alaska by Region

Census Area	Population Change 2000–2010	Crude Birth Rates[1] 2009	Crude Death Rates[2] 2007–2009	Net Migration 2000–2010
Calista Region	**1,438**	**29.1**	**624.7**	**(3,758)**
Bethel Census Area	1,007	25.2	556.1	(2,375)
Wade Hampton Census Area	431	32.9	693.3	(1,383)
Bristol Bay Region	**(528)**	**19.8**	**684.3**	(1,373)
Bristol Bay Borough	(261)	13.4	694.0	(328)
Dillingham Census Area	(75)	24.7	560.4	(728)
Lake and Peninsula Borough	(192)	21.3	798.6	(317)
Calista and Bristol Bay Regions	**910**	**23.5**	**660.5**	**(5,131)**
Statewide	**83,299**	**16.3**	**515.6**	**22,609**

[1] Crude birth rates are live births per 1,000 people.
[2] Crude death rates are deaths per 100,000 people.

Source: U.S. Census 2010, Alaska Department of Vital Statistics, Alaska Permanent Fund 2010 migration data

In both regions, the crude birth rates (births per 1,000 people) were higher than the statewide average (ABVS 2012). See **Table 3.12-2**. High birth rates are the reason that the Calista Region realized a positive increase in population; the additional births offset negative net migration and deaths. In the Bristol Bay Region, higher birth rates were not sufficient to compensate for negative net migration and higher than average death rates.

Crude death rates (deaths per 100,000 people) for both regions were also higher than the statewide average. Health problems, high suicide and fatal injury rates, among other reasons for death, were part of the reason for higher death rates in these communities (ABVS 2012).

Table 3.12-2 Population Birth and Death Rates by Census Area

	Crude Birth Rates[1]			Crude Death Rates[2]	
Census Area	**1992**	**2000**	**2009**	**1999-01**	**2007-09**
Calista Region	**33.9**	**28.2**	**29.1**	**544.0**	**624.7**
Bethel Census Area	28.6	26.2	25.2	524.0	556.1
Wade Hampton Census Area	39.1	30.2	32.9	564.0	693.3
Bristol Bay Region	**24.1**	**14.6**	**19.8**	**713.6**	**684.3**
Bristol Bay Borough	12.1	12.7	13.4	596.4	694.0
Dillingham Census Area	29.7	18.5	24.7	515.7	560.4
Lake and Peninsula Borough	30.5	12.6	21.3	1,028.8	798.6
Calista and Bristol Bay Regions	**28.0**	**20.0**	**23.5**	**645.8**	**660.5**
Statewide	**20.0**	**15.9**	**16.3**	**457.8**	**515.6**
Difference (percentage)	**40%**	**26%**	**44%**	**41%**	**28%**

[1] Crude birth rates are live births per 1,000 people.
[2] Crude death rates are deaths per 100,000 people.

Source: Alaska Bureau of Vital Statistics

Net migration in both regions was negative over a ten-year period (see **Table 3.12-3**), a major cause of declining population in Bristol Bay and a reduced growth rate in the Calista Region (ADOWLD 2012c, 2012d). People in rural Alaska are moving to urban Alaska as well as to areas outside of Alaska in search of jobs, economic opportunity, better education, and a safer, healthier environment for raising children (ADOWLD 2010, 2012c.

Table 3.12-3 Net Migration in Southwest Alaska, 2000–2010

Census Area	Net Migration 2000 to 2010[1]
Calista Region	**(3,758)**
Bethel Census Area	(2,375)
Wade Hampton Census Area	(1,383)
Bristol Bay Region	**(1,373)**
Bristol Bay Borough	(328)
Dillingham Census Area	(728)
Lake and Peninsula Borough	(317)
Average, Calista and Bristol Bay Regions	(5,131)
Anchorage / Mat-Su	**22,609**

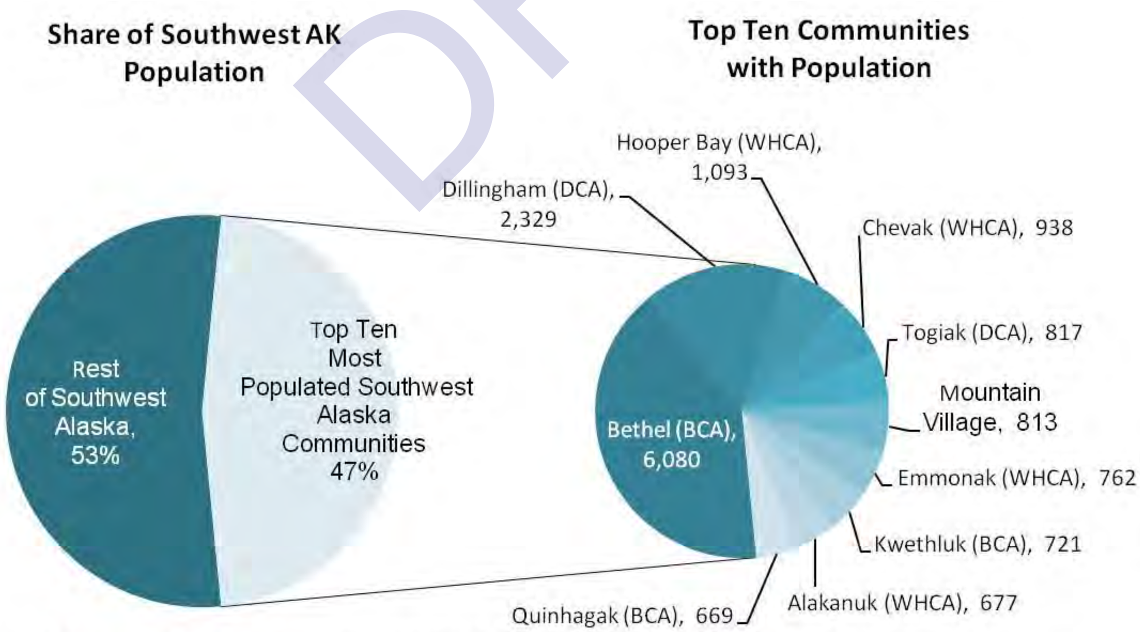
[1] Net migration is population change due to people moving into and out of a region (within Alaska and from other places)

Source: *Alaska Economic Trends*, April 2012

3.12.4.7 Population Size and Concentration

Approximately 32,000 people live in the combined Calista and Bristol Bay Regions; this comprises about five percent of Alaska's population. Seventy-seven percent of the southwest Alaska population resides in the Calista Region (**Figure 3.12-2**). Almost half the population in southwest Alaska (47 percent) is concentrated in ten communities, including the cities of Bethel and Dillingham, which are the two largest population centers in southwest Alaska (U.S. Census 2010a; ADCCED 2012a). Bethel has a population of approximately 6,080, according to the 2010 U.S. Census (City of Bethel 2011a). Dillingham's community has about 2,329 people.

Figure 3.12-2 Population Distribution by Census Area and Community



Note: Includes Wade Hampton Census Area (WHCA), Bethel Census Area (BCA), Bristol Bay Borough, Dillingham Census Area (DCA), and Lake and Peninsula Borough.
Source: U.S. Census 2010

Source: Port of Anchorage (2012)

Approximately 11,700 people live in the City of Bethel and the 13 villages selected for study. The average population of the 13 villages is 432 people and the communities range in size from 70 to just over 700 people, which suggests varying levels of infrastructure, as discussed further in this section. **Table 3.12-4** provides detailed population data for these 13 communities.

Table 3.12-4 Population in Selected Communities and Historical Trends, 1980–2010

	Population				Percent Change			
Community	1980	1990	2000	2010	1980–1990	1990–2000	2000–2010	1980–2010
Calista Region	**15647**	**19358**	**23034**	**24472**	**24%**	**19%**	**6%**	**56%**
Bethel Census Area	**10982**	**13567**	**16006**	**17013**	**24%**	**18%**	**6%**	**55%**
Akiachak	438	481	585	627	10%	22%	7%	43%
Akiak	198	285	309	346	44%	8%	12%	75%
Atmautluak	219	258	294	277	18%	14%	(6%)	26%
Bethel	3576	4674	5471	6080	31%	17%	11%	70%
Eek	228	254	280	296	11%	10%	6%	30%
Kasigluk	n/a	425	543	569	n/a	28%	5%	n/a
Kwethluk	454	558	713	721	23%	28%	1%	59%
Napakiak	262	318	353	354	21%	11%	0%	35%
Napaskiak	244	328	390	405	34%	19%	4%	66%
Nunapitchuk	n/a	378	466	496	n/a	23%	6%	n/a
Oscarville	56	57	61	70	2%	7%	15%	25%
Quinhagak	412	501	555	669	22%	11%	21%	62%
Tuluksak	236	358	428	373	52%	20%	(13%)	58%
Tuntutuliak	216	300	370	408	39%	23%	10%	89%
Subtotal 13 Villages and Bethel	6539	9175	10818	11691	40%	18%	8%	79%
Balance of Bethel Census Area	4443	4392	5188	5322	(1%)	18%	3%	20%
Wade Hampton Census Area	**4665**	**5791**	**7028**	**7459**	**24%**	**21%**	**6%**	**60%**
Bristol Bay Region	**5710**	**7090**	**8003**	**7475**	**24%**	**13%**	**(7%)**	**31%**
Bristol Bay Borough	1094	1410	1258	997	29%	(11%)	(21%)	(9%)
Dillingham Census Area	4616	4012	4922	4847	(13%)	23%	(2%)	5%
Lake and Peninsula Borough[1]	n/a	1668	1823	1631	n/a	9%	(11%)	n/a
Total Calista & Bristol Bay Regions	**21357**	**26448**	**31037**	**31947**	**24%**	**17%**	**3%**	**50%**
Statewide Population	**401851**	**550043**	**626932**	**710231**	**37%**	**14%**	**13%**	**77%**
Calista & Bristol Bay as % of State	**5%**	**5%**	**5%**	**4%**	**n/a**	**n/a**	**n/a**	**n/a**

[1] Included in Dillingham Census Area for 1980

Source: U.S. Census 1980–2010

3.12.4.8 Race/Ethnicity

The vast majority of the population in southwest Alaska (82 percent) is Alaska Native. As shown in **Table 3.12-5,** the population in the Calista Region is 87 percent Alaska Native, with a higher concentration of Alaska Natives (95 percent) in the Wade Hampton Census Area. In the Bristol Bay Region, approximately 65 percent of the population is Alaska Native. Statewide, the Alaska Native population makes up about 15 percent of the overall population (U.S. Census 2010a).

Table 3.12-5 Population (Percent) by Ethnicity and Race, Southwest Alaska, 2010

Census Area	Alaska Native & American Indian	White	African American	Asian, Native Hawaiian & Pacific Islander	Hispanic & Latino[1]	Two or More Races & Other
Calista Region	**87%**	**9%**	**0%**	**1%**	**1%**	**4%**
Bethel Census Area	83%	11%	0%	1%	1%	4%
Wade Hampton Census Area	95%	3%	0%	0%	0%	2%
Bristol Bay Region	**65%**	**23%**	**0%**	**1%**	**2%**	**11%**
Bristol Bay Borough	34%	48%	0%	1%	2%	17%
Dillingham Census Area	72%	18%	0%	1%	2%	9%
Lake and Peninsula Borough	65%	23%	1%	1%	3%	10%
Calista and Bristol Bay Regions	**82%**	**12%**	**0%**	**1%**	**1%**	**5%**
Statewide	**15%**	**67%**	**3%**	**6%**	**6%**	**9%**

[1] Hispanic or Latino Ethnicity is counted independent of race, and the Hispanic population generally identifies as White or Other Race. Total population percentages exceed 100%. This change was made in the 2010 Census.

Source: U.S. Census 2010

3.12.4.9 Age and Gender Distribution

Both the Calista Region and parts of the Bristol Bay Region have a young population relative to the state average (**Table 3.12-6**). The median age for the Bethel, Wade Hampton, Dillingham and Lake and Peninsula Borough Census Areas are all below the statewide average of 33.8; the Bristol Bay Borough's median age exceeds the state average. The Wade Hampton Census Area has the lowest median age of the five census areas, at 21.9 years. Population distribution also indicates a larger proportion of people under the age of 18, particularly in the Calista Region and parts of the Bristol Bay Region. Again, the Wade Hampton Census Area includes the highest proportion of younger people, at 42 percent of the population.

There is no significant difference in the gender distribution in southwest Alaska, both locally and regionally, relative to Alaska's population overall. Females make up about 47 percent and males make up about 52 percent of the population.

Table 3.12-6 Population (Percent) by Age Cohort and Sex, 2010

	Median	Population by Age (%)			Pop. By Sex (%)	
Census Area	**Age**	**Under 18**	**18 to 64**	**over 65**	**Female**	**Male**
Calista Region	**24.1**	**39%**	**55%**	**6%**	**47%**	**53%**
Bethel Census Area	26.2	37%	57%	6%	47%	52%
Wade Hampton Census Area	21.9	42%	53%	5%	47%	53%
Bristol Bay Region	**34.2**	**29%**	**64%**	**8%**	**47%**	**53%**
Bristol Bay Borough	42.8	23%	69%	8%	46%	54%
Dillingham Census Area	29.0	33%	60%	8%	48%	52%
Lake and Peninsula Borough	30.8	30%	62%	8%	47%	53%
Calista and Bristol Bay Regions	**30.1**	**33%**	**60%**	**7%**	**47%**	**53%**
Statewide	**33.8**	**26%**	**66%**	**8%**	**48%**	**52%**

Source: U.S. Census 2010

3.12.5 Economy

Alaska's economy is heavily dependent on the extraction and transportation of the state's vast natural resources: oil, natural gas, coal and minerals, as well as salmon, halibut, crab, other sea life, and historically, timber. The wealth and need for management generated by these resources has resulted in a very large government and non-profit sector in Alaska. While most of the administrative functions and support services for resource industries and government are located in Alaska's major urban areas, rural Alaska economies are dominated by these two sectors. Government (at the state, federal and local levels) and non-profit organizations provide the largest number of jobs in the study area regions. At the same time, the local people of rural Alaska remain closely tied to a subsistence lifestyle. The differences and occasional conflicts in these systems have produced a mixed cash-subsistence economy.

3.12.5.1 Subsistence

Though not a formal industry sector, subsistence is a very important aspect of the economy for rural Alaskan communities (Subsistence is discussed in detail in **Section 3.12.12**). In addition to providing food in a remote area with a high cost of living, subsistence activities are integral to the life and identity of many rural Alaska residents, particularly Alaska Native peoples. Traditionally, community members hunt, fish and gather foods, which are distributed throughout the community and region so that everyone is fed and cared for. As illustrated in **Table 3.12-7**, Lake and Peninsula Borough, Wade Hampton Census Area and Bethel Census Area are among the four boroughs/census areas in Alaska with the highest rates of subsistence harvest. Wade Hampton residents harvest more wild food per capita than any other region of the state (Wolfe 2004). Some workers choose to forego formal employment if it conflicts with subsistence harvest timing and opportunities.

Table 3.12-7 Average Yearly Wild Food Harvest per Resident by Census Area

Census Area	Annual Harvest per Resident (lbs.)
Wade Hampton Census Area	**698**
Northwest Arctic Borough	617
Lake and Peninsula Borough	**602**
Bethel Census Area	**592**
Nome Census Area	519
Yukon-Koyukuk Census Area	454
North Slope Borough	434
Yakutat Borough	398
Dillingham Census Area	**369**
Aleutians East Borough	315
Skagway-Hoonah-Angoon CA	243
Prince of Wales-Outer Ketchikan CA	212
Bristol Bay Borough	**211**
Sitka Borough	206
Aleutians West Census Area	206
Haines Borough	196
Wrangell-Petersburg Census Area	182
Kodiak Island Borough	169
Denali Borough	139
Valdez-Cordova Census Area	134
Southeast Fairbanks Census Area	116
Kenai Peninsula Borough	42
Ketchikan Gateway Borough	34
Matanuska-Susitna Borough	25
Juneau Borough	25
Fairbanks North Star Borough	21
Municipality of Anchorage	18

Interpreted as averaged figures of data gathered by the Alaska Department of Fish and Game from 1978–2003.

Source: Wolfe (2004)

3.12.5.2 Primary Industries

Approximately half of the study area's residents (46 percent in 2011) are employed in state or local government (**Table 3.12-8**). Other significant industries are Educational and Health Services; Trade Transportation and Utilities, and Commercial Fishing. Regional education and healthcare facilities are large employers in the hub cities of Dillingham and Bethel (e.g., BBAHC, YKHC, University of Alaska campuses) (ADOLWD 2012b). Schools and clinics in nearly every community also offer a source of year-round employment. Because most communities are remote (not on the road system), air taxis, air freight and barge services are also larger employers in the study area (City of Bethel 2011a).

In 2010, 1,798 people fished commercially in the study area. Residents of the study area (comprising the Bethel, Bristol Bay, Dillingham, Lake and Peninsula and Wade Hampton Census Areas) who hold commercial fishing permits make up about 20 percent (19.2 percent) of Alaska's total commercial fishing permit holders (**Table 3.12-9**). Non-residents account for 26 percent of all Alaska commercial fishing permit holders (Alaska Commercial Fisheries Entry Commission 2011).

Table 3.12-8 Residents' Employment by Industry, Southwest Alaska, 2010–2011

	Residents Employed				
	Bethel Census Area	**Bristol Bay Borough**	**Dillingham Census Area**	**Lake and Peninsula Borough**	**Wade Hampton Census Area**
Industries (2011)[1]	**8,021**	**499**	**2,134**	**786**	**3,414**
Natural Resources and Mining	140	7	28	27	66
Construction	151	36	47	29	65
Manufacturing	134	12	51	6	238
Trade, Transportation and Utilities	1,219	149	338	57	565
Information	86	19	33	10	23
Financial Activities	664	32	124	24	221
Professional and Business Services	122	11	33	82	31
Educational and Health Services	1,174	28	543	80	217
Leisure and Hospitality	84	28	59	12	45
State Government	371	22	119	9	55
Local Government	3,371	153	693	445	1,630
Other	504	2	63	5	253
Unknown	1	0	3	0	5
Commercial Fishing (2010)	**717**	**140**	**390**	**113**	**438**

[1] Does not include segments of the employed population working in industries that do not require unemployment insurance coverage: self-employment, agriculture and fisheries, unpaid caretakers and domestic staff.

Source: ADOLWD. Fishing data from Alaska Commercial Fisheries Entry Commission.

Table 3.12-9 Residents Holding Commercial Fishing Permits by Census Area, 2010

Region	Number of Permits	Percent of Alaskan Permits
Southwest Alaska (Calista and Bristol Bay Study Area)	**2,609**	**19.3%**
Bethel Census Area	1,070	7.9%
Bristol Bay Borough	163	1.2%
Dillingham Census Area	620	4.6%
Lake and Peninsula Borough	146	1.1%
Wade Hampton Census Area	610	4.5%
All Other Alaska Census Areas	**7,460**	**54.8%**
Non-Resident Permit Holders	**3,544**	**26.0%**
Alaska Total	**13,613**	**100.0%**
Selected Southwest Communities	**922**	**6.8%**
Akiachak	75	0.6%
Akiak	21	0.2%
Atmautluak	20	0.1%
Bethel	189	1.4%
Dillingham	227	1.7%
Eek	41	0.3%
Kasigluk	34	0.2%
Kwethluk	50	0.4%
Napakiak	40	0.3%
Napaskiak	28	0.2%
Nunapitchuk	40	0.3%
Oscarville	1	0.0%
Quinhagak	83	0.6%
Tuluksak	26	0.2%
Tuntutuliak	47	0.3%

Source: Alaska Commercial Fisheries Entry Commission

3.12.5.3 Employment and Public Assistance

The boroughs and census areas within the study area have higher rates of unemployment than the state as a whole, as shown in **Table 3.12-10** (ADOLWD 2012a).[1] Median and per capita income for the Lake and Peninsula Borough and Wade Hampton Census Area are lower than the national and state figures. See **Table 3.12-11**. The hub communities (Bethel, Dillingham, and King Salmon-Naknek) have the highest employment and income statistics in the study area, as most year-round jobs are in industries that tend to be based in hub communities (e.g., government, education, healthcare, transportation) (U.S. Census 2010b). The high median household and

[1] It is worth noting that unemployment is defined as the portion of the working age population (16 and older) in the labor force, not currently employed but actively seeking employment. There is another portion of the population not in the labor force: adults who have chosen not to work (e.g. stay-at-home parents), who cannot work (e.g. severely disabled or ill individuals), retired persons and those who have been unemployed for a long period of time and have been discouraged from further seeking work. The size of the labor force and the proportion of those not in the labor force also give some indication of the economic health of a region.

per capita incomes in hub communities are the result of the few, high-paying positions in these communities (e.g., government and medical professionals).

Table 3.12-10 Resident Employment and Unemployment by Census Area, 2010

Region	Total Population (2010)	Employment		Year-Round Employment		Unemployment Insurance Claimants	
		Individuals	% Total	Individuals	% Total	Individuals	% Total
Bethel Census Area	17,013	7,910	46.5%	4,588	27.0%	2,310	13.6%
Bristol Bay Borough	997	493	49.5%	317	31.8%	81	8.1%
Dillingham Census Area	4,847	2,160	44.6%	1,306	26.9%	483	10.0%
Lake and Peninsula Borough	1,631	760	46.6%	395	24.2%	224	13.7%
Wade Hampton Census Area	7,459	3,415	45.8%	1,697	22.8%	1,306	17.5%
Alaska	**710,231**	**305,105**	**43.0%**	**212,543**	**29.9%**	**57,170**	**8.0%**

Source: ADOWLD

Table 3.12-11 Income and Poverty Rates, Southwest Alaska

	Median Household Income[1]	Per Capita Income	Households Below Poverty Level	Households Receiving Public Assistance[2]
Census Areas / Boroughs				
Bethel Census Area	$52,214	$18,584	18.6%	41.6%
Bristol Bay Borough	$84,000	$31,260	5.0%	6.1%
Dillingham Census Area	$60,800	$22,597	18.1%	23.2%
Lake and Peninsula Borough	$40,909	$15,161	21.4%	13. 0%
Wade Hampton Census Area	$37,955	$11,269	31.4%	60.2%
Communities				
Bethel	$86,935	$29,220	7.8%	20.4%
Dillingham	$74,828	$34,156	13.2%	9.2%
Akiachak	$39,167	$12,996	27.6%	66.4%
Akiak	$35,833	$13,400	21.9%	45.2%
Atmautluak	$45,536	$11,596	15.2%	63.8%
Eek	$17,350	$10,626	27.9%	70.4%
Kasigluk	$40,851	$11,355	25.7%	63.5%
Kwethluk	$40,625	$14,522	18.0%	49.4%
Napakiak	$37,250	$11,023	34.1%	61.9%
Napaskiak	$57,917	$15,263	10.8%	37.3%
Nunapitchuk	$38,281	$12,321	22.5%	52.3%
Oscarville	$57,813	$9,973	54.7%	100.0%
Quinhagak	$30,833	$10,422	38.9%	82.9%
Tuluksak	$35,417	$7,767	32.8%	87.1%
Tuntutuliak	$34,464	$10,349	36.6%	73.5%
Alaska	**$66,521**	**$30,726**	**9.5%**	**11.8%**
United States	**$51,914**	**$27,334**	**13.8%**	**10.0%**

[1] Income given in 2010 inflation-adjusted dollars.
[2] "Public Assistance" includes public assistance income, food stamps (EBT) and SNAP benefits.

Residents of the study area utilize a relatively high level of public assistance. With the exception of the Bristol Bay Borough (6.1 percent), the remaining census areas in the study area all have higher (and in some cases much higher) rates of public assistance than either state or national levels (11.8 and 10.0 percent, respectively). At 23.3 percent, the U.S. Census Bureau estimates that households in the Dillingham Census Area have received double the state and national rate of Supplemental Security Income (SSI), cash public assistance income, or Food Stamps/SNAP in the past 12 months (U.S. Census 2010b). That percentage goes up to 41.6 percent for the Bethel Census Area and 60.2 percent for the Wade Hampton Census Area. The percentage of total personal income comprised of non-labor earnings (including State of Alaska Permanent Fund Dividend, Native Corporation dividends, government assistance, etc.) is also higher in the study area than the state as a whole, as shown in **Table 3.12-12**.

Table 3.12-12 Components of Residents' Personal Income by Census Area

Income Category	Bethel	Bristol Bay Borough	Dillingham	Lake and Peninsula Borough	Wade Hampton	State of Alaska
Payroll jobs and self-employment	64.3%	65.6%	67.9%	61.4%	47.9%	70.3%
Dividends, interest and rental earnings[1]	6.4%	14.5%	12.1%	16.8%	5.8%	13.8%
Personal current transfer receipts[2]	29.3%	19.9%	20.0%	21.9%	46.4%	15.9%
Total personal Income	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

[1] "Dividends, interest and rent" is defined as money earned from investments, PFD, Native Corporation dividend
[2] "Personal current transfer receipts" is defined as government retirement and disability insurance benefits, Medicare/Medicaid, unemployment insurance, etc.
Source: U.S. Department of Commerce, Bureau of Economic Analysis: Regional Economic Information System

Public assistance can and does provide a needed support in a region with little industry and few existing formal year-round employment opportunities. However, it can also create a disincentive to work beyond a certain amount each year. Income eligibility for public assistance can penalize families that earn more than the maximum income for eligibility to receive the benefits.[2] From having access to subsidized housing and an income that can support the family (especially with subsistence inputs for food), a family that earns more than the income limit can find themselves with a net decrease in household income without the public assistance supports (Haley and Fisher 2012). In an area with an extremely high cost of living, this loss of income can significantly impact the family's welfare (Fried and Shanks 2011).

Households' economic situation is also affected by the role of subsistence activities in rural Alaska life. Subsistence activities can require substantial periods of time spent away from school or employment. If there is an option to receive supplemental income that allows a family or individual to work fewer hours and spend that time pursuing subsistence activities, then socially there is an incentive to take advantage of it (Wolfe 2004)...

3.12.6 Governance and Taxation

There are numerous local and tribal entities with jurisdiction over some portion of the study area. Including local government and Alaska Native organizations, there are over 200 entities with a role in directing policy, implementing projects, raising funds, and providing services to the 31,000 residents who call these two regions home (ADCCED 2012a). Coordination and outreach among all these entities can be challenging due to the sheer

[2] The work requirements for receiving public assistance in Alaska have been waived in rural villages because there are so few jobs (Haley and Fisher 2012).

magnitude of the number of entities that are involved; similarly, acquiring the resources needed to sustain all these entities is an ongoing challenge. Coordination among entities is critical for effective local governance. To provide revenue, almost half of the cities and both boroughs in the two regions levy some type of local tax structure within their community. These communities are collecting revenue to assist in project implementation and service provision. Many other entities do not have taxation powers or do not currently levy taxes, relying on other sources of public funds.

3.12.6.1 Local Government

As shown in **Table 3.12-13**, there are 78 communities in the Calista and Bristol Bay Regions; 45 of those communities are incorporated first and second class cities under Alaska state law (ADCCED 2012a). Bethel is a second-class city, incorporated in 1957, and Dillingham, originally incorporated in 1963, became a first-class city in 1972 (City of Bethel 2011a; City of Dillingham 2010). Two boroughs have incorporated in the Bristol Bay Region: Bristol Bay Borough (containing Naknek and King Salmon) and the Lake and Peninsula Borough. Eleven school districts provide education services to the 31,000 residents in the two regions (ADEED 2012).

Table 3.12-13 Summary of Local Government Entities, Southwest Alaska

	Communities	Incorporated Cities[1]	Incorporated Boroughs	School Districts	Total Local Government Entities
Calista Region	**47**	**30**	**0**	**7**	**37**
Bethel Census Area	34	18	0	4	22
Wade Hampton Census Area	13	12	0	3	15
Bristol Bay Region	**31**	**15**	**2**	**4**	**21**
Bristol Bay Borough	3	0	1	1	2
Dillingham Census Area	10	9	0	2	11
Lake and Peninsula Borough	18	6	1	1	8
Total, Calista and Bristol Bay Study Area	**78**	**45**	**2**	**11**	**58**

[1] Includes first and second class cities.

Source: DCCED Community Database

3.12.6.2 Taxation and Revenue

The State of Alaska has no statewide personal income tax, sales tax, or property tax. A corporate income tax is levied but the large majority of state tax revenue is derived from the state's royalty share of the revenue from oil and gas development on state owned land on the North Slope of Alaska. Communities often share the revenue from oil and gas development with the state through projects funded in the state capital budget as well as services provided through the state operating budget. Another major source of funding is through the federal government, which provides about $3 billion in revenue to the state each year, and is passed through to communities for services and projects. Federal funds through Alaska Native and American Indian programs are also a major source of revenue in the two regions (AOMB 2012).

In terms of local tax revenue, many communities in Alaska levy local taxes to raise funds for services and projects. The Calista and Bristol Bay Regions are no different. As shown in **Table 3.12-14**, approximately, 44 percent of the cities and boroughs (34 in total) levy some type of tax according to the following categories:

Property Tax

The Bristol Bay Borough and the City of Dillingham levy a property tax at an average rate of 13 mils per thousand dollars in assessed value. Most communities do not have property tax. Property tax is not assessed on Native

Allotments. Other property-tax exemptions include exemption from paying local or borough taxes because the federal housing program paid for construction.

Sales Tax

Thirty cities within the Calista and Bristol Bay Regions levy a sales tax within their boundaries. Rates range from two to six percent. Eleven of the 13 communities in the Wade Hampton Census Area levy a sales tax. Sales tax revenues are substantial in hub communities; outside of the regional hub communities, sales tax produces modest but still important revenues. Emmonak, for example, one of the larger Calista villages, generated $208,432 in sales tax in 2011; Napakiak, a much smaller community, generated $49,597 in 2011. Some regional communities with sales tax on the books (Nondalton, Nightmute, and Scammon Bay) do not generate any sales tax revenue (ADCCED 2012).

Special Taxes

Both the Bristol Bay Borough and the Lake and Peninsula Borough levy special taxes, primarily related to tourism activities (hotel, guiding, and fishing). The Bristol Bay Borough levies a ten percent bed tax and a four percent fish tax, while the Lake and Peninsula Borough levies a two percent raw fish tax, a six percent bed tax, and a guide/lodge tax. Other significant special taxes include a ten percent bed tax and ten percent alcohol tax levied by the City of Dillingham, as well as a 12 percent bed tax, six percent alcohol tax, and six percent gaming tax levied by the City of Bethel. Four additional communities (Saint Mary's, Aleknagik, Egegik, and Pilot Point) levy a special tax, including a bed tax, raw fish tax, and an alcohol tax (ADCCED 2012a).

Overall, communities in the Calista and Bristol Bay Regions collect about $18 million annually from local taxes, 60 percent of which is derived from taxes collected by the City of Bethel and the City of Dillingham. On average, both regions collect about $577 annually per person in local taxes. However, the amount collected per capita ranges from about $135 in the Wade Hampton Census Area to $3,500 per capita in the Bristol Bay Borough (ADCCED 2012a).

Table 3.12-14 Summary of Tax Revenues, Southwest Alaska

	Communities	Communities Levying Taxes	Communities Levying Taxes (%)	Annual Revenue (2010)	Annual Revenue Per Capita (2010)
Calista Region	**47**	**22**	**47%**	**$7,358,902**	$301
Bethel Census Area	34	11	32%	$6,350,584	$373
Wade Hampton Census Area	13	11	85%	$1,008,318	$135
Bristol Bay Region	**31**	**12**	**39%**	**$11,072,338**	$1,481
Bristol Bay Borough	3	1	33%	$3,489,220	$3,500
Dillingham Census Area	10	5	50%	$5,649,122	$1,165
Lake and Peninsula Borough	18	6	33%	$1,933,996	$1,186
Total, Calista & Bristol Bay	**78**	**34**	**44%**	**$18,431,240**	$577

[1] Includes first and second class cities.
[2] Includes property, sales, and special taxes (bed tax, fish tax, guide tax, alcohol tax, or gaming tax) at the borough or city level.

Source: DCCED Community Database

3.12.6.3 Alaska Native Entities and Governance

Tribal governments, regional non-profits and other Alaska Native organizations are a critical component of community governance in the Calista Region and the Bristol Bay Region. There are 106 Alaska Native organizations involved in governance in the Calista Region and 65 entities in the Bristol Bay Region for a total of approximately 170 entities (**Table 3.12-15**). Each Alaska Native community is typically served and/or represented by each of the following organizations.

Tribal Government

Nearly every community in the study area region has a federally designated tribe that makes policy, provides services, and implements projects in the community. In the Calista Region there are 47 tribal governments, which is the same number of communities. In the Bristol Bay Region, there are 29 tribal governments for 31 communities. Both Bethel and Dillingham also have tribal councils that operate within distinct but co-located boundaries with the city governments: Orutsararmiut Native Council (ONC) in Bethel and Curyung Tribal Council (CTC) in Dillingham (ADCCED 2012a; City of Bethel 2011a; City of Dillingham 2010).

Alaska Native Corporations

In 1971 the Alaska Native Claims Settlement Act (ANCSA) was passed by Congress, a landmark piece of legislation that established Alaska Native Corporations (ANCs) on behalf of Alaska's original peoples. ANCSA established over 200 village corporations and 12 regional corporations throughout the state, plus one regional corporation for Alaska Natives who had migrated out of Alaska (see **Section 3.12.4.3**). ANCs were granted land to assist in capitalizing their for-profit corporations, which are run for the benefit of their shareholders. Shareholders are Alaska Native and members of the village or region within which the corporation was founded, as of the date of ANCSA. Most regional corporations, and many village corporations, implement shareholder service programs, including scholarships, job training, and other programs. Many also provide an annual dividend to shareholders in order to share in profits from the corporation's activities. The level of profitability, and therefore dividend amount, varies significantly between corporations and can significantly contribute to household income (see **Section 3.12.4.3**). Village and regional corporations are governed by a board of directors.

In the Calista Region, there are 39 village corporations, and Calista is the regional corporation for that area. In the Bristol Bay Region, there are 25 village corporations, and Bristol Bay Native Corporation (BBNC) is the regional corporation serving the area. Bethel is home to the Bethel Native Corporation, and Choggiung Ltd. represents Dillingham, Ekuk and Portage Creek.

Regional Organizations

Each region is served by a regional non-profit with the responsibility of providing an array of health, social service and economic development services to communities and individuals. Among the regional entities in the Calista Region are the Association of Village Council Presidents (AVCP) and the Kuskokwim Native Association (KNA). In the Bristol Bay Region, the regional non-profit is the Bristol Bay Native Association (BBNA). Both regions have health systems, described in the public facilities section that follows (3.12.8.5).

Also present in both regions are the Community Development Quota (CDQ) organizations: the Bristol Bay Economic Development Corporation, and in the Calista Region, the Coastal Villages Corporation. These entities work to expand and diversify regional economies, and are funded through a portion of offshore fishing revenues. In the Calista Region, Coastal Villages operates a fishing fleet and processing facilities.

Tribally Designated Housing Authorities (TDHAs)

The TDHAs are designated to provide and assist Alaska Native communities with quality affordable housing. Communities are typically served by one regional housing authority, but many have opted to provide housing themselves through their tribal government. In the Y-K Delta, there are 15 communities in which the tribal government provides housing, and the Association of Village Council Presidents Regional Housing Authority provides housing to the remaining communities in the region. For Bristol Bay, the Bristol Bay Housing Authority provides housing to all but seven communities, which provide that service through their tribal government (ADCCED 2012a).

Table 3.12-15 Summary of Alaska Native Organizations, Southwest Alaska

	Number of Communities	Tribal Governments	Village Corporations	Regional Corporations[1]	Regional Non-profits[1]	Tribally Designated Housing Authorities[2]	Regional Health Corporations[1]	Total Organizations
Calista Region	**47**	**47**	**39**	**1**	**2**	**16**	**1**	**102**
Bethel Census Area	34	34	26	-	-	10	-	70
Wade Hampton Census Area	13	13	13	-	-	6	-	32
Bristol Bay Region	**31**	**29**	**25**	**1**	**1**	**8**	**1**	**54**
Bristol Bay Borough	3	3	2	-	-	-	-	5
Dillingham Census Area	10	10	10	-	-	-	-	20
Lake and Peninsula Borough	18	16	13	-	-	-	-	29
Total, Both Regions	**78**	**76**	**64**	**1**	**1**	**24**	**1**	**167**

[1] Port Alsworth is shown in the Cook Inlet Regional Incorporated (CIRI) boundary, the Cook Inlet Tribal Council, and Southcentral Foundation boundary.

[2] Counts of tribally designated housing authorities (TDHAs) include regional housing authorities and instances when the tribal government serves as the TDHA.

Source: U.S. Census 2010

3.12.7 Housing

Housing in rural Alaska differs significantly from urban Alaska and most of the United States in terms of quality, vacancy levels and occupancy. **Tables 3.12-16 and 3.12-17** summarize the two regions' vacancy rates, housing tenure and average household size. Vacant seasonal units make up about 21 percent of housing stock in the study area but only nine percent of the housing stock statewide. More homes in the study area are used for seasonal activities. The homeowner vacancy rate is very low in the study area (less than two percent in most cases) compared to the state homeowner vacancy rate, which is about 6.6 percent. The homeowner vacancy rate is the number of vacant homes that are for sale divided by the total number of units that are owner occupied. In contrast, the rental vacancy rate in the study area is higher than the state as a whole. The rental vacancy rate is the number of rental units that are available for rent divided by the total number of rental units (U.S. Census 2010a).

The number of people living in the housing units is higher, on average, than the state as a whole. Average household size in the study area ranges from 2.3 to 4.3. For the state as a whole, the average household size is about 2.65. These trends are more pronounced when looking at average family size (statewide average is 3.21 and study area communities range from 2.9 to 4.7) (U.S. Census 2010a).

Table 3.12-16 Housing Unit Vacancy by Census Area, 2010

Census Area	Occupied	Vacant Seasonal	Vacant For Rent or Sale	Vacant Others Reasons	Total
Calista Region	**6,396**	**859**	**278**	**569**	**8,102**
Bethel Census Area	4,651	616	241	411	5,919
Wade Hampton Census Area	1,745	243	37	158	2,183
Bristol Bay Region	**2,539**	**1,893**	**231**	**235**	**4,898**
Bristol Bay Borough	423	425	56	65	969
Dillingham Census Area	1,563	646	129	89	2,427
Lake and Peninsula Borough	553	822	46	81	1,502
Total, Both Regions	**8,935**	**2,752**	**509**	**804**	**13,000**
Statewide	**258,058**	**27,901**	**11,278**	**9,730**	**306,967**

Source: U.S. Census 2010

Table 3.12-17 Housing Tenure by Census Area, 2010

	Vacancy Rate		Housing Tenure			
Census Area	Homeowner[1]	Rental[2]	Percent Owner Occupied	Percent Renter Occupied	Average Household Size	Average Family Size
Calista Region	**0.5%**	**6.0%**	**65%**	**35%**	**3.9**	**4.5**
Bethel Census Area	0.9%	8.3%	58%	42%	3.6	4.2
Wade Hampton Census Area	0.1%	3.6%	72%	29%	4.3	4.7
Bristol Bay Region	**1.2%**	**15.0%**	**58%**	**42%**	**2.8**	**3.3**
Bristol Bay Borough	2.6%	15.1%	52%	48%	2.3	2.9
Dillingham Census Area	0.7%	13.4%	60%	40%	3.1	3.7
Lake and Peninsula Borough	0.3%	16.4%	64%	37%	2.9	3.4
Calista & Bristol Bay Regions	n/a	n/a	n/a	n/a	n/a	n/a
Statewide	**6.6%**	**1.7%**	**63.1%**	**36.9%**	**2.65**	**3.21**

[1] The homeowner vacancy rate is the proportion of the homeowner inventory that is vacant and for sale. It is a percentage computed by dividing the total number of vacant units for sale by the sum of owner-occupied units, vacant units for sale, and vacant units that have been sold but are unoccupied. Units vacant for other reasons are not included.

[2] The rental vacancy rate is the proportion of the rental inventory that is vacant and for rent. It is computed by dividing the total number of vacant units for rent by the sum of renter-occupied units, vacant units for rent, and vacant units that have been rented but are unoccupied. Units vacant for other reasons are not included.

Source: U.S. Census 2010

There is a need for additional housing to meet demand. Demand for additional housing is a function of the need to replace homes that are in poor quality and the need to alleviate overcrowding. According to the two-part housing assessment released in 2009 by the Alaska Housing Finance Corporation, approximately one-third of homes in the Calista Region are considered overcrowded and one third are in need of major repair (AHFC 2009). In Bristol Bay, overcrowding impacts 16 percent of the homes and about 21 percent are in major disrepair. Taken together, these two trends indicate a need for about 3,671 new housing units in the study area. **Tables 3.12-18 and 3.12-19** provide additional detail.

Table 3.12-18 Housing Stock Characteristics in Southwest Alaska, 2009

Region	% Units Overcrowded[1]	% in Poor Condition	% with Difficulty Maintaining Heat in Winter
Calista Region	31%	27%	87%
Bristol Bay Region	16%	21%	n/a
Cook Inlet Region (Anchorage)	2%	7%	10%

[1] An overcrowded home is defined as one which provides less than 200 square feet per person.
Source: AHFC Alaska Housing Assessment (2009)

Table 3.12-19 Housing Stock Needs in Southwest Alaska, 2009

	Alleviate Overcrowding	Replace Poor-Quality Units	Excess Units for Current Market (neg.)	Total Units Needed
Calista Region	2,378	402	0	**2,780**
Bristol Bay Region	710	248	(67)	**891**
Cook Inlet Region (Anchorage)	3,002	1,158	0	**4,160**

Source: AHFC Alaska Housing Assessment (2009)

Most village housing traditionally has been constructed through regional programs using federal funding. In recent years funding has declined, populations have grown, and much of the housing stock has deteriorated. New models for building and rehabilitating housing are being explored, driven by the need to reduce household energy use and to establish systems where owners would invest both money and "sweat equity" to construct new or rehabilitate existing homes.

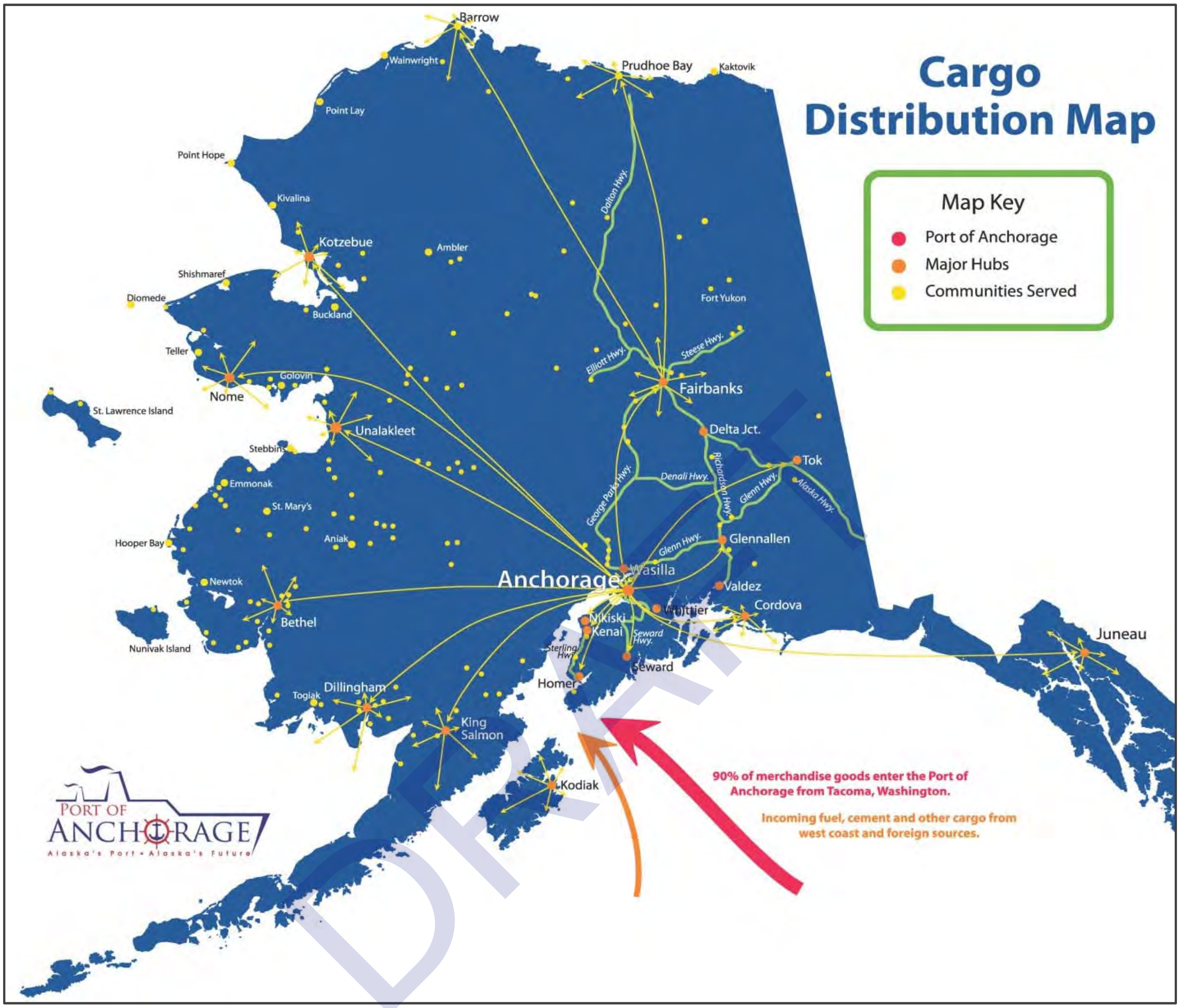
3.12.8 Transportation

Alaska's size and geography limit the extent of the road network. Most of Alaska cannot be accessed by roads. Bethel in the Calista Region and the Dillingham-Aleknagik and King Salmon-Naknek communities in Bristol Bay each have a small road network, but the hub communities' roadway system is localized and does not connect with other regional communities. Most freight and travel in the region are routed through these hub communities by air or barge. Without air and water transport, southwest Alaska travel and freight delivery would be severely limited.

3.12.8.1 Statewide Transportation System

The size, geography and climate of Alaska make transporting people and cargo challenging in all seasons. Alaska's road system primarily connects Anchorage, Fairbanks and the Kenai Peninsula to each other (known as the Railbelt) and to the contiguous 48 states and Canada by way of the year-round, all-weather Alaska Highway. Most regions of the state have limited road networks and otherwise rely on water, air and (during the winter months) ice for transportation between communities. The Alaska Marine Highway System connects the communities in southcentral Alaska with southeast Alaska. The Kuskokwim River and other inland waterways freeze over during the winter months, providing ice roads for snow machines, cars, pickup trucks and (depending on the strength and stability of the ice) heavier freight vehicles (City of Bethel 2011). See **Figure 3.12-3** for a map of major transportation routes.

Figure 3.12-3 Primary Air, Land and Water Cargo Distribution Routes in Alaska



Source: Port of Anchorage (2012)

3.12.8.2 Southwest Alaska Transportation Network

Southwest Alaska's transportation network has developed around hub communities, through which most passenger flights and air or water cargo shipments pass on their way out to the surrounding communities. Routine travel between regional hubs and their associated service-area communities is customarily by air, snow machine, ATV or skiff, depending on the season. Most cargo such as food, fuel and other items to and within the region comes by air or by oceangoing vessel, which then transfers cargo for barging up river systems. While both regions rely heavily on commercial and charter air service year-round, communities along Bristol Bay and the Gulf of Alaska are generally better positioned to utilize ocean transport. Most communities in the Calista Region rely on river transport, including Bethel (City of Bethel 2011a; City of Dillingham 2010).

3.12.8.3 Bethel as Transportation Hub

Bethel has long been the central transportation node of the Calista Region, due in part to U.S. military investment in air and communications infrastructure during World War II and the Cold War. Bethel also has a local road system with 26 miles of primarily gravel roads, as well as the Kuskokwim ice road, plowed and maintained each winter by Bethel and other communities along the 28-mile route (ONC and City of Bethel 2010). Water and sewer trucks are heavy users of local roads, which create high maintenance costs for the city. Additionally, the roads are stressed due to yearly freezing and thawing, which necessitates re-surfacing the roads at least every five years. Many residents do not own cars or trucks, and consequently walk or use taxis, ATVs or snow machines or (where available) public transit to travel in town (City of Bethel 2011a, 2011b).

In 2010, the Bethel Airport (BET) was the third-busiest airport in Alaska, serving as the connecting point for passengers and freight within the region and to Anchorage. By 2011, Bethel had slipped behind Juneau and moved to the position of fourth busiest airport in the State. The airport is state-owned and operated with two paved and one gravel runway (City of Bethel 2011a). The airport has seen a slight decrease in operations in recent years, but the Alaska Department of Transportation and Public Facilities (DOT/PF) is currently upgrading the facilities according to its Airport Improvement Program (ONC and City of Bethel 2010).

During months when the Kuskokwim River and Bay are navigable, the Port of Bethel is active with freight and barge shipments as well as small boats from villages up- and downriver. Managed by the City in cooperation with the Army Corps of Engineers, the port includes a cargo dock, petroleum port for fuel shipment and storage, a small boat harbor, float plane beach and seawall for mooring barges and tugs. The river channel is relatively shallow, limiting the size and weight of vessels that can reach Bethel; shipments further upriver must be loaded onto smaller, lighter vessels, typically barges. Fuel shipments for Bethel and surrounding villages arrive at the petro port. Crowley and Delta Western are the primary carriers, and Crowley also owns a tank farm at the port with 15 million gallon storage capacity (City of Bethel 2011a).

Possible future expansion of Bethel Airport and the Port of Bethel are both constrained by surrounding land uses. The port faces an additional threat: Bethel is situated on an eroding river bank, and recent movement of the Kuskokwim River suggests that it may shift in coming years, cutting off Bethel's access to the main channel (City of Bethel 2011a; ONC and City of Bethel 2010).

3.12.8.4 Dillingham and King Salmon–Naknek as Transportation Hubs

Dillingham functions as a hub community for the Bristol Bay Region and is accessible only by air or ocean, by way of Nushagak Bay. Like Bethel, Dillingham serves as a regional center for government, healthcare, transportation and other services (City of Dillingham 2010). King Salmon and Naknek have regional transportation functions as well, including jet service to King Salmon from Anchorage. All three communities are at the center of Bristol Bay's salmon fishing and fish processing industries, as well as the primary access point for tourism and recreation in Wood-Tikchik State Park, the Togiak National Wildlife Refuge and the region's other wilderness areas. There are 45 miles of mostly gravel roads in the City of Dillingham, as well as several trails for snowmobiles and ATVs (City of Dillingham 2010).

Dillingham Airport (DLG) is owned by the State of Alaska; passenger service is offered by two commercial airlines and several charter services. The Dillingham airport currently has a single paved runway, with an additional crosswind runway prioritized in the facility's airport master plan. The airport has struggled with declining passenger travel in recent years (City of Dillingham 2010). The State of Alaska Division of Lands also owns and manages a seaplane base.

The city benefits from its all-tide dock that is reasonably protected from the full force of Bristol Bay waves and weather. This is the only port in the region whose operation is not dependent on tidal movement. The port and adjoining small boat harbor are owned by the City of Dillingham, annexed by special referendum on April 10, 2012. The port is utilized for transporting cargo (including regular shipments directly from Seattle), the point of origin for commercial fishing fleets, and private vessels. Its downtown location is both an asset and a detriment, constraining potential expansion of the port and causing congestion between freight shipments and fishing vessels (City of Dillingham 2010).

King Salmon and Naknek are linked by a 15-mile road and rely on each other's transportation infrastructure for cargo delivery. Both communities have air access, but only King Salmon is serviced by jet. King Salmon has a state-owned airport (a former Air Force base) with two paved runways. There are scheduled jet flights and charter services to and from Anchorage. A seaplane base is also located at Lake Brooks, within the Katmai National Park to the east (ADCCED 2012a).

Naknek has two airports: the private Tibbetts Airport, and the state-owned Naknek Airport, which has two runways. Naknek has a borough-operated cargo dock which serves as the primary Bristol Bay port. A stretch of the Naknek River is also designated for float planes. King Salmon obtains its cargo through Naknek's harbor. (ADCCED 2012a).

3.12.9 Public Facilities and Services

The size and geography of the two regions render most centralized infrastructure impractical and expensive. Public services (including utilities, health care and schools) tend to be managed locally or among small groups of communities. Approximately 40 separate utilities provide electricity to the Calista and Bristol Bay Regions. (Energy is discussed in more detail in **Section 3.12.10.**) Most local cities and some tribal governments provide sewer, water, and landfill services. The type of service provided ranges from piped systems to hauled services. Public safety programs at the state level (State Troopers, Village Safety Patrol Officer, and State Fire Marshal) provide limited services in communities in the study area. Some communities have local public safety staff and volunteers to serve residents. The study area is primarily served by two non-profit Alaska Native healthcare corporations: Yukon-Kuskokwim Health Corporation (YKHC) and Bristol Bay Area Health Corporation (BBAHC). Eleven school districts serve the communities within the study area.

3.12.9.1 Electric Utilities

Most of southwest Alaska's energy needs are met through 40 separate utilities (18 in the Calista Region and 22 in the Bristol Bay Region) that primarily use diesel fuel to power electrical generators (ADCCED 2012a). The Alaska Village Electrical Cooperative (AVEC) provides power to 25 villages in southwest Alaska. Most other communities are powered through a municipal utility or a local cooperative, with a few private utilities providing services, such as the Bethel Utilities Corporation (AEA 2012b). Two of the larger utilities are the privately owned Bethel Utilities Corporation in Bethel and the Nushagak Electric Cooperative in Dillingham (City of Bethel 2011b). (Electricity is discussed in more detail in **Section 3.12.10.**)

3.12.9.2 Water, Sewer, and Landfill Services

Responsibility for provision of water and sewer services varies by community. One or both services may be provided by the city government, village council, school or left to individual households. Landfill management is typically provided by the city or tribal government, with some communities' landfills operated by fish processing companies. Bethel residents are served by a combination of above-ground water and sewer pipes and a haul truck system. The existing pipes and waste treatment facility are aging and many will need replacement in the near future. The City has considered installing underground pipes, a costly option due to the presence of permafrost soils. Dillingham is also served by an aging water and sewer system, with several capital improvement projects identified as priorities, particularly replacement of the sewage treatment facility serving the downtown area. Depending on the community's size, location and resources, the villages of southwest Alaska may have shared infrastructure, wells and septic systems or honey buckets managed by individual households (ADCCED 2012a).

3.12.9.3 Public Safety

Most communities have some form of public safety and emergency services. In hub communities, a local police department may be in place and in villages and smaller communities, the village public safety officer (VPSO) is often present. The VPSO is a state program that provides a law enforcement presence in some of Alaska's smallest communities. Locally based emergency responders or volunteer fire department are also present in many communities. Responders in rural Alaska must be prepared to handle medical, fire and public safety incidents, as well as maritime accidents, hazardous material spills (typically fuel), and to perform effectively even if they are supported by limited infrastructure. The Alaska State Troopers maintain posts in Bethel, Aniak, St. Mary's, Emmonak, Dillingham, King Salmon and Iliamna. Most communities have volunteer-only fire responders, including Dillingham. Bethel has seven paid staff with additional volunteer firefighters and EMTs. State of Alaska fire marshals are also sent to remote communities to investigate fire incidents (ADCCED 2012a).

3.12.9.4 Telecommunications

The telecommunications network in rural Alaska is limited, but in recent years, telecom companies such as General Communications, Inc. (GCI) and Alaska Communications Services (ACS) have made significant infrastructure investments across the state. Cellular service is typically provided by GCI or ACS, while landline telephone and Internet services are offered by local carriers. Dillingham is served by the Nushagak Cooperative (the same entity that provides electricity); Bethel is served by United Utilities, Inc., which also serves most of the other Calista communities (AEA 2012b; ADCCED 2012a).

3.12.9.5 Health and Social Services

The systems of healthcare and social services are, like other infrastructure in Alaska, designed to provide communities with adequate support while overcoming significant geographic and cost challenges.

The healthcare system in Alaska is a dual system, in which care is provided through a general care network and through the tribal health system. Each ANCSA region has a non-profit Native Health Corporation (in addition to a for-profit Native Corporation), which provides care to the tribal members in its region through a system of regional healthcare centers/hospitals, sub-regional clinics that offer specialty care and laboratory services, and village clinics that provide basic primary, emergency and preventative care. Village clinics are often staffed by a Community Health Aide/Practitioner. Primary care physicians and specialized healthcare services (e.g., dentistry, eye care) are either provided through sub-regional and regional facilities (village residents must travel to the services) or on an itinerant basis (the doctor travels to area villages).

Yukon-Kuskokwim Health Corporation (YKHC) is headquartered in Bethel and provides healthcare for communities in the Calista Region. YKHC manages five sub regional clinics in Aniak, St. Mary's, Emmonak, Hooper Bay and Toksook Bay that offer some specialty care and laboratory services, and a total of 47 village clinics funded through the Community Health Aide Program that provide basic primary, emergency and preventative care (YKHC 2012).

Bristol Bay Area Health Corporation (BBAHC) is based in Dillingham and serves Dillingham and 34 villages with a similar system to YKHC, including Kanakanak Hospital, sub-regional clinics in Togiak and Chignik, and health clinics in other smaller communities. Both Bethel and Dillingham provide emergency medevac services (air ambulance), as well as more specialized behavioral health care for adults and youth (BBAHC 2012). Southcentral Foundation, a non-profit based in the Cook Inlet region serves nine communities in eastern Bristol Bay with a sub-regional clinic in Iliamna (ADCCED 2012a).

The closest community with health care facilities near the project site is Koliganek, approximately 60 miles away by air, but the nearest full-service hospitals would be in Dillingham (85 miles away) and Bethel (100 miles away).

The Yukon-Kuskokwim Delta Regional Hospital is a 50-bed facility located in Bethel and is managed by YKHC (YKHC 2012a).

As with other services, hub communities offer additional resources for their residents and those of surrounding villages. Several villages have community centers focusing on youth and elders, and larger communities may have additional state-funded resources such as the Office of Children's Services in Aniak and St. Mary's. Bethel is home to several social service providers including the Tundra Women's Coalition, a shelter and resource center for women and families suffering domestic violence. Bethel is also a cultural hub for its region and houses the Yup'iit Piciryarait Cultural Center and Museum, which houses documents, artifacts, educational and language programs to preserve and celebrate Yup'ik culture. Dillingham is home to a senior center, the Valerie Larson Family Resource Center and a number of health services, public assistance and crisis support programs managed by the Native health organization, non-profits and state agencies (City of Bethel 2011a; City of Dillingham 2010).

3.12.9.6 School Districts

Eleven school districts serve both regions (see **Table 3.12-20**). In small villages, schools are often one of a few (or perhaps the primary) public buildings in the community and serve multiple purposes, including providing shelter, heat and fresh water in an emergency. Bethel, the largest community in the Lower Kuskokwim School District, has a regional high school, which serves multiple communities, as well as an alternative boarding school; many of the district's communities have K-12 schools, depending on their distance from Bethel. Dillingham City School District has a single elementary school, combined middle and high school and an alternative school. School enrollment in both regions generally follows demographic trends: Bristol Bay schools' enrollment is shrinking, while most Calista Region schools are growing or maintaining their size. There have been a few recent school closures in the region. Pitkas Point on the lower Yukon River and Clark's Point school in Bristol Bay have had to close their doors because they have not had the enrollment threshold required by a 1999 law which reduces operational funds to districts when schools fall to nine students or fewer (ADEED 2012; DCCED 2012a).

Table 3.12-20 School Enrollment by District, Southwest Alaska

District	Total K-12 Enrollment as of October 1				% Change
	2001	2008	2010	2011	2001–2011
Calista Region	**7,502**	**7,597**	**7,600**	**7,659**	**2.09%**
Iditarod Area School District[1]	573	281	324	331	(42.23%)
Kashunamiut School District	320	314	302	312	(2.50%)
Kuspuk School District	435	339	348	345	(20.69%)
Lower Kuskokwim School District[2]	3,671	3,977	4,025	4,041	10.08%
Lower Yukon School District	1,909	2,063	1,973	2,002	4.87%
St. Mary's School District	150	177	176	182	21.33%
Yupiit School District	444	446	452	446	0.45%
Bristol Bay Region	**1,969**	**1,644**	**1,601**	**1,584**	**(19.55%)**
Bristol Bay Borough School District	239	145	160	149	(37.66%)
Dillingham City School District	539	502	481	482	(10.58%)
Lake and Peninsula Borough School	429	371	335	330	(23.08%)
Southwest Region School District	762	626	625	623	(18.24%)
Total Calista and Bristol Bay Regions	**9,471**	**9,241**	**9,201**	**9,243**	**(2.41%)**

[1] Most of this district is located in the adjoining Yukon-Koyukuk Census Area

[2] This district includes Bethel and several surrounding villages

Source: Department of Early Education and Development, 2012

In addition to primary and secondary education, the region offers a robust early childhood education program through Head Start. Head Start is a free, federally funded comprehensive early childhood program for children, ages three to five, and their families. Head Start serves children in their communities. The Bristol Bay communities of Dillingham, New Stuyahok, Manokotak and Togiak have Head Start programs run by Bristol Bay Native Association. In the Calista Region, the Rural Alaska Community Action Program (RurAL CAP) operates about 25 head start sites in communities (RurAL CAP 2012).

In addition to childhood education, Calista and Bristol Bay Regions are served by University of Alaska Fairbanks, with Kuskokwim Campus in Bethel and Bristol Bay Campus in Dillingham. Each region also has a vocational learning center with industry-specific training courses, including the Southwest Alaska Vocational Education Center (SAVEC) in King Salmon and Yuut Elitnaurviat in Bethel (City of Bethel 2011a; SAVEC 2012).

3.12.10 Energy Cost and Usage

Despite Alaska's abundant supply of and economic dependence on energy resources, the current infrastructure in many areas of the state makes energy (electricity, heating and transportation fuel) very expensive (Kohler and Schutt 2012). Rural Alaskans pay significantly higher costs than in urban areas, as the primary source of fuel is diesel for both heating and electricity (via generator). Steadily rising oil and transportation costs have dramatically increased the cost of living in rural Alaska, greatly impacting the viability of rural communities. Nearly all (non-subsistence) food items, household goods and other materials are transported to the region and among individual communities by air and barge, necessitating an effective surcharge on nearly all purchased goods that rises as the cost of fuel increases. High energy costs also limit subsistence activities, which usually require fuel for boat, ATV, and/or snow machine transportation to and from subsistence areas. High costs of electricity and fuel drive up the costs of providing public facilities and services (e.g., schools, hauled water/sewer). As these costs rise, communities are pressured to increase taxes and revenue from other sources of public funding.

Table 3.12-21 illustrates the high cost per gallon of fuel oil a household must pay to heat and power their home. In the last five years, the percent of household income spent on energy (heat, electricity and transportation) increased from 40 percent to between 60 and 75 percent for a rural family (ADCCED 2010, 2012b). Of that large proportion, approximately 20 to 35 percent is paid for electricity (AEA 2012a).

3.12.10.1 Energy Costs

In response to and in anticipation of rising electricity costs for rural residents, the State of Alaska created the Power Cost Equalization (PCE) program in 1985 in conjunction with several capital projects for energy infrastructure. The PCE program is administered by the Alaska Energy Authority (AEA) with total funding appropriated by the legislature and paid out to individual utilities across the state (City of Bethel 2011b). The PCE subsidy is intended to bring residential electric rates (cents per kWh) for rural Alaskans closer to that paid by urban residents. Urban price is defined as the average price paid in Anchorage, Fairbanks and Juneau; this is currently 14.39 cents per kWh. The law sets a maximum ceiling rate of $1.00 per kWh. Utility costs eligible for subsidies are fuel expenses, transportation and non-fuel expenses such as salaries, insurance, taxes, parts and supplies, and interest. In addition, a qualifying utility must meet required efficiency and line loss standards, or the PCE payment is reduced to reflect those standards (City of Bethel 2011b; AEA 2012b). The PCE has been an effective means of reducing families' energy bills, but as noted above, electricity is not the primary energy-related cost for residential customers (AEA 2012a).

Table 3.12-21 PCE-Adjusted Electrical and Fuel Oil Costs, 2011

Community	PCE-adjusted Residential Electricity (¢/kWh)	Price of Fuel Oil for PCE-eligible utilities ($/gal)
Calista Region		
Akiachak	27.61¢	$3.36
Akiak	30.41¢	$4.58
Atmautluak	38.49¢	$3.36
Bethel	15.62¢	$4.62
Eek	20.96¢	$3.44
Kasigluk	20.53¢	$3.46
Kwethluk	25.04¢	$3.46
Napakiak	42.00¢	$3.46
Napaskiak	17.10¢	$3.59
Nunapitchuk	20.53¢	n/a
Oscarville	15.62¢	$4.62
Quinhagak	20.69¢	$3.28
Tuluksak	28.30¢	$2.93
Tuntutuliak	41.54¢	$3.32
Bethel Census Area Range	*17.10¢ to 42.00¢*	*$2.93 to $4.58*
Wade Hampton Census Area Range	*20.36¢ to 34.17¢*	*$2.71 to $3.35*
Bristol Bay Region		
Dillingham	19.25¢	2.58
Bristol Bay Range	*13.42¢ to 70.85¢*	*$2.64 to $6.67*
Anchorage Rate (Chugach Electric)	12.96¢	n/a

Source: Alaska Energy Authority FY11

Residential customers' consumption rate is subsidized up to 500 kWh per household per month; community facilities (excluding state- or federally funded organizations) also receive a subsidy for consumption up to 70 kWh per resident per month (with a cap based on the community's population). See **Table 3.12-21** for residential PCE costs for selected communities and the range of rates in each region. Qualifying facilities are determined by the individual utility. In Bethel, for example, the Bethel Utilities Corporation allows for the City of Bethel to receive a PCE subsidy of approximately $200,000 per year (City of Bethel 2011b).

Private businesses are not subsidized and pay full electrical rates. The current Nushagak Electric and Telephone Cooperative (Dillingham) commercial rate is 24.36 cents per kWh, and the current commercial rate of Bethel Utilities Corporation is 43.50 cents per kWh (AEA 2012b).

3.12.10.2 Energy Use

A recent report by the Alaska Energy Authority indicates that while rural Alaskan households have greater energy use per square foot for space heating than urban homes, rural housing units tend to be much smaller than their urban counterparts and use less energy overall (AEA 2012a). Poorly insulated housing and extremely cold winters also contribute to higher energy needs in rural Alaska, particularly the Calista Region, where a majority of residents report difficulty keeping their homes sufficiently heated in winter. Electricity use is also relatively low in rural communities. Bethel residents' homes, on average, do not significantly differ in size than those of other areas, but almost all households heat their homes using fuel oil and therefore spend the greatest portion of energy expenditures on heating, not electricity. Cooking and other major appliances consume a majority of total electricity used. Among non-residential buildings in Bethel, offices have the highest annual energy use, but foodservice establishments have the highest intensity of use (energy per square foot). Residents of rural villages devote an even larger share of energy expenditures to heating homes and community facilities, suggesting relatively lower electricity consumption (AEA 2012a).

3.12.11 Other Capital Projects

There are other large capital projects, including mining operations, on the horizon for this region which, if approved and put into operation, would have profound impacts on the Bristol Bay and Calista Regions. The projects are located in different areas within the region but would create significant new demand for energy and transportation infrastructure in Southwest Alaska. The mines would also create employment in the region, but may also have negative environmental impacts which could affect residents' quality of life, the health of the commercial fishing industry and traditional subsistence activities. The Chikuminuk Lake Hydroelectric Project has no ties to these projects, beyond the fact that it is occurring in the same region.

3.12.11.1 Proposed Mining Projects Near the Study Area

Pebble Mine is the short name for a proposal to mine for copper, gold and other minerals in the remote, eastern portion of the Bristol Bay watershed. As of April 2014, the Pebble Mine project faces considerable opposition and the EPA is currently reviewing potential ecological impacts (Pebble Partnership 2012).

Donlin Creek Mine, located near Crooked Creek along the Kuskokwim River, while currently under less public scrutiny than Pebble Mine, is another significant proposed mineral extraction operation. The primary deposit is gold, with potentially other minerals of value (Donlin Gold 2012).

The TNR Gold Group has also proposed development of other mining operations in the area. The Shotgun Ridge/Winchester claims are directly north of Wood-Tikchik State Park and represent a potentially sizeable gold deposit. The Iliamna claim, near the community of the same name in Bristol Bay appears to be similar to the copper and gold deposits at Pebble (TNR 2012). Nyac Gold LLC leases property roughly 60 miles east of Bethel and is sampling for gold.

3.12.12 Subsistence Resources

3.12.12.1 Subsistence Overview and Study Area Definition

The following description of subsistence resources is based on the literature review and data gap analysis report prepared for the Project (NLUR 2012). The two study areas identified and discussed in the 2012 report were the Bristol Bay region, where the project dam and Chikuminuk Lake impoundment area are located, and the Yukon-Kuskokwim Delta (Y-K Delta), which is crossed by the West Transmission Route to Bethel. As described at the beginning of this Socioeconomic Resources section, the Project straddles the boundary between the Bristol Bay Region and the Calista Region. The subsistence resources study area encompasses the geographic regions used by the subsistence literature, which share a similar border to that of the Calista and Bristol Bay Regions, but are defined by Southwest Alaska's two largest watersheds: the Yukon-Kuskokwim Delta and the Bristol Bay watershed. The West Route to Bethel traverses portions of the Yukon Delta National Wildlife Refuge (Yukon Delta NWR) from the Ahklun Mountains west to Bethel. Other alternative transmission corridors as discussed in **Volume I** of this report, including the Chikuminuk Lake to Dillingham alternatives, were not under consideration during development of the gap analysis.

The Subsistence Resources Study Area has high per capita uses of wildlife resources, including subsistence, commercial, and sport harvests of fish and wildlife. In both regions households harvest a wide range of large and small land mammals, anadromous and resident fish, marine mammals, marine invertebrates, migratory birds, and plant products. **Table 3.12-22** lists the major subsistence resource categories and species harvested in the Study Area.

Table 3.12-22 Major Subsistence Resource Categories and Species Harvested

Resource Category	Example Species	Notes
Salmon	Chinook, chum, coho, pink, sockeye	Spawning sockeye salmon, landlocked salmon also harvested.
Freshwater Fishes	Arctic grayling, blackfish, northern pike, smelt, whitefishes, trout, Dolly Varden	Harvested throughout the year.
Marine Fishes	Various cods, pollock, herring, halibut, flounders, burbot	Little harvest effort in Study Area communities, but people travel to harvest or receive in exchanges.
Large Land Mammals	Caribou, moose, brown bear, black bear, muskox	Dall sheep, mountain goat not present in the Study Area.
Small Land Mammals/Furbearers	Beaver, coyote, foxes, hares, river (land) otter, lynx, marmot, marten, mink, muskrat, porcupine, squirrels, weasel, wolf, wolverine	Some species used for both food and furs; others for fur only.
Marine Mammals	Seals, sea otter, Steller sea lions, Whales (beluga)	Little harvest effort in Study Area communities, but people travel to participate in hunts.
Marine Invertebrates	Clams (various species), crabs, mussels, scallops, shrimp	Little harvest effort in the Study Area, but received in gifts and exchange.
Birds and Eggs	Migratory birds (ducks, geese, swans, cranes), seabirds, loons; resident birds (grouse, ptarmigan)	Duck, geese, and seabird eggs collected.
Wild Plants/Other	Berries (blackberry, cranberry, blueberry, salmonberry), wild spinach, wild celery, ferns, mushrooms, other greens, grasses, firewood	Grasses used for handicraft items. Freshwater used for drinking.

Source: Compiled from various ADF&G Division of Subsistence Reports and CSIS

Subsistence harvests have a long customary and traditional time depth, with important underlying social and cultural importance attached to the harvesting, processing, and sharing of wildlife resources among extended networks of relatives. Rural Alaska's economy is a dual subsistence and cash economy. Income from commercial fishing, full-time, part-time and seasonal wage employment, fur trapping, transfer payments and other sources provides cash, which is used to purchase equipment and supplies used to harvest wildlife resources. This mixed cash-subsistence economy is characterized by small communities, substantial wild food harvests for local consumption, a domestic mode of production based on family–kinship organization rather than corporate business entities, a seasonal cycle of food production activities, non-commercial distribution networks involving wild foods and some cash transactions, and traditional systems of land use and occupancy. Studies of the rural economy found that "successful families in rural areas combine jobs with subsistence activities and share wild food harvests with cash-poor households who cannot fish or hunt, such as elders, the disabled, and single mothers with children" (Fall 2012:3).

The Alaska Department of Fish and Game–Subsistence Division (ADF&G-SD) has undertaken research about subsistence uses of wildlife resources since its establishment in 1978. Research results consistently demonstrate that hunting and fishing provide a large share of the food supply in rural Alaska. Per capita and household harvests of large and small land mammals, fish, marine mammals, migratory birds, and plant products are higher in the Project’s two regions than in urban areas of Alaska, and higher than in many other regions designated rural under Alaska’s subsistence priority system.

A best estimate is that 38.3 million pounds of wild foods are taken annually by residents of rural Alaska, or about 316 pounds per person per year for rural residents. This compares to approximately 13.8 million pounds per year harvested by Alaska's urban residents, or about 23 pounds per person per year for urban residents. Fish comprise 55 percent, by weight, of subsistence foods taken annually. Ninety-five percent of rural households statewide consume subsistence-caught fish (Fall 2012). Within the Kuskokwim Fisheries Management Area (KFMA), approximately 75% of the region’s 4,500 households are located in the Kuskokwim River drainage. The largest community in the region is Bethel, with approximately 1,900 households. A 2004 survey found an estimated total salmon harvest of 65,332 salmon, totaling 695,637 pounds (Simon et al. 2007). Other Kuskokwim River communities report subsistence salmon harvests of 650 pounds per capita (Coffing 2001). Subsistence salmon may be taken with gillnets, beach seines, hook and line (rod and reel), hand line, or fish wheels, and by spear in some drainages. A distinguishing feature of the subsistence economy is that, while cash and current technologies (firearms, boats, motors, etc.) are utilized for harvesting and processing, there is a primary economic, social, and cultural reliance on fish and game resources which is integrated into the community’s economic and social fabric in a mutually supportive fashion. Subsistence harvesters have participated in subsistence activities for many generations, and tend to harvest subsistence resources in the traditional areas surrounding their communities.

It is difficult to place an exact dollar value on subsistence products, as they do not circulate in the market economy, with some exceptions such as trapping furbearers and bartering some fish and fish products. A simplistic “replacement value” of $3.50 to $7.00 per pound for rural Alaska wild food harvests results in an estimated $134 to $268 million dollars annual value for subsistence harvests.

3.12.12.2 Applicable Laws and Regulations

Under Alaska State law, “subsistence” refers to the practice of taking wild fish or game for subsistence uses (AS 16.05.258). Defined in Alaska State law as the “non-commercial customary and traditional uses” of fish and wildlife, subsistence uses include the following:

- Food
- Customary trade, barter, and sharing
- Homes and other buildings
- Fuel
- Clothing
- Tools and home goods
- Transportation
- Handicrafts

State law protects customary and traditional uses of fish and game resources, and the State must provide a reasonable opportunity for those uses before providing for recreational or commercial uses. To decide if a fish stock or game population is associated with customary and traditional uses, state regulation directs the Board of Game and the Board of Fish to consider eight factors, called the Eight Criteria (5 Alaska Administrative Code (AAC) 99.010(b), Boards of fisheries and game subsistence procedures). The Eight Criteria are summarized as follows:

- The length and consistency of use of the resource;
- A pattern of use that occurs on a regular seasonal basis;
- A pattern of use that is characterized by efficiency and economy of effort and cost;
- An area in which the pattern of use occurs;
- Traditional methods of handling, preparing, preserving, and storing used in the past, but not excluding recent advances;
- A pattern that includes the handing down of knowledge, skills, and values and lore from generation to generation;
- Traditional patterns of distribution and exchange including customary trade, barter, and gift-giving; and
- A pattern that includes the use of, and reliance upon, a wide diversity of fish and game that provides substantial economic, cultural, social, and nutritional elements of the subsistence way of life.

Communities that do not demonstrate meeting these criteria are designated “nonsubsistence areas” under Alaska State law. These “nonsubsistence areas” are typically urban, and may include areas on the rural-urban fringe “where dependence upon subsistence is not a principal characteristic of the economy, culture, and way of life of the area or community” (AS 16.05.258(c) and 5 AAC 99.015). To date, the following nonsubsistence areas have been identified by the Joint Board of Fisheries and Game—the Anchorage-Kenai-Mat-Su area, Fairbanks-Delta, Prudhoe Bay, Juneau, Ketchikan, and Valdez.

Federal law defines “subsistence” as the customary and traditional uses of fish and wildlife and other renewable resources for food, clothing, shelter, and handicrafts (ANILCA, Title VIII). Like State law, Federal law defines the subsistence use of fish and wildlife resources as customary and traditional use. The Federal Subsistence Board determines which fish stocks and wildlife populations have been customarily and traditionally used for subsistence. These determinations identify a specific community’s or area’s use of specific fish stocks and wildlife populations. For areas managed by the National Park Service where subsistence uses are allowed, the determinations may be made on an individual basis. Like the State, the Federal Subsistence program uses eight factors to determine customary and traditional use. These Federal Eight Factors are very similar to the Eight Criteria used by the State.

Under State management, this is called the “Tier II” process for game harvests. Tier II is an allocation system to distinguish and identify those individuals most dependent on a particular fish stock or wildlife population among all subsistence users. Tier II gives priority to users based on: 1) customary and direct dependence and 2) availability of alternative resources. There are no Tier II hunts presently authorized in the project area.

ANILCA Section 810 requires federal agencies to analyze the impacts of actions on subsistence. The analysis is required when a federal agency is determining whether to withdraw, reserve, lease or otherwise permit the use, occupancy, or disposition of public lands, such as lands within a national wildlife refuge in Alaska. If this evaluation concludes with a finding that a Proposed Action or its alternatives would result in a significant restriction to subsistence uses and needs, and the agency wishes to proceed, further procedural requirements of Section 810 must be initiated. ANILCA requires that this evaluation include findings on three specific issues:

- The effect of such use, occupancy, or disposition on subsistence uses and needs;
- The availability of other lands for the purpose sought to be achieved; and;
- Other alternatives that would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes (16 United States Code [USC] § 3120).

Having briefly outlined governmental definitions of subsistence and some of the related legislation and regulations, it should be pointed out that many Alaska Natives do not like the term subsistence, feeling that it does not adequately describe the importance of wild foods to Alaska Native culture. As the anthropologist Richard Nelson (1982:229) observes:

> ...Aside from the economics, there are other very important dimensions that reinforce the Native people's dependency upon subsistence. Our studies of Koyukuk villages find that food from the land provides much more than subsistence alone – indeed it is the focal point of Koyukon culture. Native food is a source of psychological well being, it comprises a matrix of social and ceremonial events and it is a vital component in traditional religious practices.

Robert J. Wolfe, long-time research director with ADF&G-SD, defines it most succinctly as the "production and distribution of wild resources for local use and small-scale exchanges in Alaska" (Wolfe 2009:163).

In 1986 the state amended its statutes to match ANILCA by limiting subsistence uses to rural residents. However, the Alaska Supreme Court ruled in McDowell v. Alaska (785 P.2d 1 (Alaska 1989)) that the rural preference violated the equal access clauses of the Alaska Constitution. This meant that the state could not provide the rural preference for rural residents required by ANILCA. Because Alaska law no longer provided for the rural resident preference required by ANILCA, the federal government moved to take over management of subsistence hunting on Federal public lands on July 1, 1990 (USDOI, FWS 1992). A separate question involving whether the state or federal government would manage subsistence fishing on navigable waterways complicated management of subsistence fishing. The Ninth Circuit Court of Appeals ruled in Katie John v. United States that federal agencies have jurisdiction under ANILCA to manage subsistence fishing in navigable waters in which the federal government has reserved water rights, in addition to waters running over federally owned submerged lands.

3.12.12.3 Research Methods

Subsistence information comes from a range of sources in the biological and social sciences literature. Three categories of subsistence research studies include baseline community studies, resource-specific harvest issue studies, and ongoing monitoring studies. These three types of studies are conducted by researchers from federal, state, local, non-profit, and native agencies and organizations, academic-based researchers, and independent contractors. Collaboration across agencies and between organizational types is common in subsistence research. As noted in the subsistence data gap report (Stern and Phillips 2012), baseline information is not available for most of the communities in the study area, or is dated. Resource-specific harvest issue studies are available that cover some species or species groups, but not for all species or communities. Finally, ongoing monitoring studies are largely confined to annual salmon fisheries harvests (commercial, subsistence, and sport), and the voluntary system of hunter harvest reporting for big game and furbearer species. Subsistence research is guided by the research principles adopted by the Alaska Federation of Natives in 1993 and the Interagency Research Policy Committee in 1990. These principles include community approval of research designs, informed consent and anonymity of participants, community review of draft study findings, and sharing study findings with each study community when research is completed.

Descriptions of subsistence resources, harvest activities, harvest area maps, and other information used to prepare this section come from previous reported research in the Y-K Delta and Bristol Bay Regions. No new studies of subsistence were conducted to prepare this section. Data comes from the review of existing, relevant, and reasonably available information used during preparation of the subsistence data gap report prepared for the Project in 2012 (Stern and Phillips 2012).

3.12.12.4 Regional Subsistence Activities

The seasonal round of subsistence activities varies from region to region of the State depending largely upon the availability of different resources in different regions—coastal versus inland, arctic versus interior Alaska, and so forth. With adjustments for regionally available resources, the following description (Coffing 1989) could apply to all communities within the Subsistence Resources Project Study Area. Subsistence is carried out throughout the year, based on seasonal timing of runs of fish, availability of subsistence species, weather, and employment, among other factors. Many subsistence species are seasonal migrants and may only be available for short periods of the year. Smelt are usually the first migratory fish to arrive after breakup, generally in late May. Long handled, fine-mesh dipnets are used to sweep up the fish from river banks or drifting boats. Smelt are boiled, eaten fresh, and preserved by smoking.

Salmon fishing occupies most people's efforts throughout the summer, depending upon whether they are both commercial and subsistence fishers. Salmon camps along the major rivers, their tributaries, and the coast typically consist of a wood cabin, tent platform, fish drying racks, smokehouse, and sometimes a steam bath. Set gill nets and drift gill nets of various sizes are used, depending upon the target species, and regulations. Salmon are eaten fresh, cut into strips and smoked, split and smoked whole, and buried to preserve them for later use. Some may be canned or frozen. Summer is also a time of year when more wage employment opportunities are available in construction, longshoring at the Bethel or Dillingham port, or outside the region.

During the summer season, rod and reel fishing for pike, grayling, and trout continues, and whitefish may be netted in channels and sloughs. Berry picking for salmonberries, blueberries, and other plants and greens takes place as berries ripen. Late summer runs of coho salmon may be targeted if the earlier Chinook, sockeye, and chum salmon runs were inadequate for household needs. Late August is the start of moose hunting season. Hunters travel by boat up the Kwethluk, Gweek, Kisaralik, and Kuskokwim Rivers, sometimes as far upstream as McGrath. In the Bristol Bay Region, fall hunting takes place along the major river systems and tributaries; Wood, Nushagak, Mulchatna, and Nuyakuk are closest to the project area. During the fall moose hunt, other resources may be harvested, including black and brown bear, beaver, muskrat, otter, grouse, ducks, cranes, geese, freshwater fish and berries. Wood for firewood and logs for construction may also be gathered and floated downstream to be processed. During mid- to late August, people may also visit mountain camps to harvest parka squirrel, caribou, brown bear, beaver, porcupine, moose, and fish. In the Kuskokwim River drainages, after the fall harvest, skins of bear, caribou, or sealskins brought along for the purpose were stretched over a wooden frame and keel, and the family and harvest were floated downriver to their home communities. The decline in the numbers and distribution of the Mulchatna Caribou Herd (MCH) has limited caribou hunting over the past several decades.

As freezeup approaches, fishing for whitefish, burbot, and sheefish continues. Blackfish traps are set beginning in October, and after freezeup, gill nets set under the ice may harvest more whitefish, burbot, pike, and occasionally salmon. Furbearers such as beaver, fox, otter, and mink are trapped starting in November and continuing throughout the winter. Short daylight hours, harsh weather, and the social activities in the community for the Protestant Christmas (December 25th), New Year, and Russian Orthodox Christmas in December and January keep many people in the community. February sees some hunters searching for brown bear. In late winter and early spring, people fish for pike and other fish by jigging through the ice.

Some families fly to traditional camps in the mountains near the headwaters of the Kwethluk, Kisaralik, Aniak, and Nushagak Rivers in spring, where they fish, hunt, and trap for a few weeks. Return to home communities by bear-skin boat (*angyaaqatiit*) occurred as in the fall. Other families may travel to coastal communities where they hunt sea animals with relatives. Harvest efforts focus on seal and walrus; occasionally, beluga may also be harvested. By mid-April, waterfowl begin to arrive in large numbers. Their arrival is a welcome change in diet for fresh meat, as the previous summer's supply of dried fish or smoked salmon may be running low.

Snow machines or all-terrain vehicles (ATVs, or "four wheelers") are used to haul aluminum skiffs to narrow open-water channels. There the open water allows hunters to use outboard motors to travel to spring camps and hunting areas along the rivers. Muskrats are hunted along the way. May is the month for preparing for another subsistence and commercial fishing season; people are busy mending nets, repairing boats, and motors, and gearing up for the start of another cycle of the subsistence year.

3.12.12.5 Subsistence Activities in the Project Vicinity

This seasonal subsistence pattern described above for the region takes place in all the communities in the study area, with variations depending upon local conditions. The Chikuminuk Lake drainage does not currently support known subsistence activities. Historically, people from both the Bristol Bay and Kuskokwim River sides of the Ahklun Mountains utilized the area for hunting, trapping, fishing, and travel between the two regions. The proposed West transmission route to Bethel is an area which currently supports subsistence activities, and has seen substantial subsistence uses in the past.

Species Harvested

Subsistence species harvested in the Project Study Area include salmon and non-salmon fish, large and small land mammals, migratory and resident birds, marine mammals, marine invertebrates, and flora such as berries, greens, mushrooms, basket-making grasses and wood.

Fish. Five species of salmon are harvested: Chinook (king), coho (silver), chum (dog), pink (humpy), and sockeye (reds). Methods used to harvest salmon include gill nets (both drift and set nets) and rod and reel. Subsistence regulations allow for a wide variety of legal gear types that include gill nets, beach seines, fish wheels, pot, longline, fyke net, dip net, jigging gear, spear or lead. Subsistence fish are also removed from commercial catches. Salmon are processed in a wide variety of traditional and modern methods. These include drying and smoking, half-drying and freezing, freezing, salting, and canning and jarring. Dry weather with sufficient winds to dry cut and hung salmon on drying racks is essential. Wet weather or no wind may result in loss of all or part of a subsistence salmon harvest. Salmon are also eaten fresh—cooked by frying, baking, boiling, and steaming. Drying salmon properly is heavily influenced by summer weather.

Non-salmon species harvested include herring, herring roe, rainbow smelt, halibut, lamprey, stickleback, Alaska blackfish, burbot, Dolly Varden, lake trout, Arctic grayling, pike, sheefish, suckers, rainbow trout, broad whitefish, humpback whitefish, round whitefish, and cisco. Harvest and preservation methods for non-salmon species are similar but also include dipnets, and rakes for herring roe. Winter harvest of blackfish under frozen water bodies includes the use of traditional grass and wood-woven basket traps (Fienup-Riordan 2007).

Large Land Animals. Large game harvests include black bear, brown bear, moose, and caribou. Muskoxen are found in the southwestern portion of Game Management Unit 18 (GMU 18, the Y-K Delta), but few Natives hunt them. Dall sheep are not present in the Ahklun Mountains which form the boundary between GMU 18 to the west, and GMU 17 to the east. Harvest efforts are typically high for households attempting to harvest large land animals, but harvest success rates vary from year to year, and household to household. When harvested, large land animals are shared widely within the community. Large land animals are harvested using firearms, but prior to the introduction of firearms they were hunted with bow and arrow, spears, lances, pit traps, drive fences and corrals (for caribou), and snares. Methods of access to hunt and transport large land animals include hiking overland, boats with outboard motors, snow machines, four-wheelers (ATVs), and for a very few, aircraft. Low water in late summer and early fall may hamper access to moose and fall caribou hunting areas. Snow cover and safely frozen water bodies facilitate travel by snow machine for winter caribou hunting. Seasons and bag limits for large game may be set by both state and federal regulations within the study area.

Hunting for large game, such as caribou and especially moose, is a cooperative effort. Hunting parties include related men, and sometimes include women. Women related to the hunters are the primary processors and complete the processing once the meat is back in the community. Field dressing methods include gutting, skinning, and cutting up the meat into large pieces (back, neck, leg, ribs, etc.). Preservation methods include drying, freezing, canning, making jerky, and eating fresh. Hides of caribou and moose may be used for sleeping pads while camping. Organs, including the liver, kidneys and heart are eaten as well as the tongue. Long bones are cracked and marrow extracted. Antlers, hooves, claws, and teeth are used in handicraft production and for tools. A young hunter's first animal harvest, especially a bear or other large game, is distributed to other households. A portion is sometimes reserved for a feast to commemorate the young hunter's success. Hunting, especially for bear, is still governed by beliefs and taboos to protect the hunter, placate the spirit of powerful animals, and assure hunting success.

Small Land Animals/Furbearers. A variety of small land animals are harvested throughout the year. Furbearers such as wolf, fox, coyote, wolverine, marten, and weasel are harvested solely for their fur. Furbearers may be sold to a fur buyer, or used for local production of clothing and articles of decoration. Other small land animals, including mink, otter, muskrat, beaver, lynx, and parka squirrel have value for both their fur and for food. Porcupine and snowshoe hare yield both food and raw materials for handicraft items—porcupine quills, and rabbit skins. Small land animals are caught with traps and snares. Firearms may also be used but furs are less valuable if shot than if trapped. Mink, land otter, and muskrat harvests occur underwater by drowning the animals using traditional *taluyet* (funnel trap). Seasons and bag limits vary, but most furbearer trapping takes place in early to mid-winter, when pelts are prime. The level of effort put into trapping depends upon numerous factors including the price of furs and the cost of trapping, which includes factors such as the price of fuel and traps, as well as wear and tear on snow machines due to snow cover and distances travelled to tend to traplines. Trapping represents an incremental use of existing equipment, land areas, and knowledge and skills used for other subsistence pursuits (Wolfe 1991).

Marine Mammals. Most of the Subsistence Resources Study Area communities are located along rivers, not along the coast. As a result, harvests of marine mammals by Study Area community residents occur primarily when people travel to coastal communities to hunt with relatives. Marine mammals harvested include several species of seals, sea lions, walrus, whales, porpoises and dolphins, and polar bears. Large whales such as bowhead and gray whales, and polar bears are not found in the Study Area. Harvests of marine mammals occur rarely in the rivers, when beluga or an occasional seal move upriver from the ocean. Marine mammal harvests are restricted to Alaska Natives by the 1972 federal Marine Mammal Protection Act for subsistence uses, and for use of by-products in handicraft items.

Kwethluk exemplifies a riverine community with marine mammal use. Baseline information on Kwethluk indicates that people received seal oil and meat in trade or as gifts from relatives living in coastal communities. Sixty-eight percent of the community households received seal oil (Coffing 1991:72). During April, some Kwethluk hunters fly to Eek, Kwigillingok, or Kipnuk to hunt seal and walrus with their relatives. Hunters haul boats to the edge of shorefast ice with snow machines. Seals are the targeted species but walrus are taken if the opportunity presents itself. Coffing mapped the subsistence harvest use areas of Kwethluk residents for ringed seal, spotted seal, bearded seal, and walrus and reported hunting effort, total number harvested and pounds of meat harvested in the 1985-1986 study year (1991:71). New Stuyahok, a riverine community in the Nushagak River drainage, reported no marine mammal harvests in 2005, yet half the households reported using marine mammal products (CSIS database).

Research on the annual subsistence harvests of harbor seals and Steller sea lions, conducted by the ADF&G Division of Subsistence, has been underway for nearly 20 years. Annual reports on harvests are available through survey year 2008 (Wolfe et al. 2009). The communities nearest to the Subsistence Resources Study Area are the South Bristol Bay drainage communities of Egegik, King Salmon, Levelock, Naknek, South Naknek, Pilot Point, and Port Heiden with an estimated total Native population of 951; and the North Bristol Bay communities of Aleknagik, Clark's Point, Dillingham, Manokotak, Togiak, and Twin Hills with an estimated Native population of 2,952 (U.S. Census 2000 cited by Wolfe et al. 2009b:9). Aleknagik reported harvest of seals, walrus, and one beluga in 1998, as well as one fourth of the households reporting use of seal oil in 1998. Clark's Point reported nine harbor seals taken in 2008 (CSIS database).

Marine Invertebrates. Marine invertebrates is a major resource category which includes various species of shellfish such as clams, cockles, mussels, and scallops, as well as crabs, octopus, and shrimp. Most of the Study Area communities are not located adjacent to marine waters. As one would expect, the reported harvest levels are low for this resource category. The 2005 Koliganek harvest study found only seven percent of responding households which had used marine invertebrates (clams) in the study year (SRB&A 2012). The 1998 Akiachak baseline harvest study found only four percent of reporting households which had used clams (Coffing et al. 2001).

Birds and Eggs. This resource category includes migratory, and non-migratory (resident) birds, and their eggs. The category includes numerous species of ducks, geese, swans, cranes, ptarmigans, grouses, seabirds, shorebirds, grebes, and loons. The harvest of migratory and resident birds, and their eggs is a small resource category by weight in most household annual harvests, around one percent to four percent in a statewide 1990 overview of available data (Wolfe et al. 1990); but it is an important category by tradition and for its nutritional value (Naves 2012). Yukon-Kuskokwim Delta area harvests were 16.1 pounds of birds per person harvesting or 5.3 birds per person. Harvests occur in spring, summer, and fall, and for non-migratory species such as ptarmigan and grouse in winter. Contemporary harvesting is done with firearms, snares, and in some communities with occasional communal drives into nets for molting birds. Traditional methods included bolas, nets, scoops, and bow and arrow. Birds are eaten fresh or frozen for later use. Preparation methods include roasting, baking, and boiling in soups and stews. Feathers and other parts are used in handicrafts. Other traditional uses include bird-skin clothing and hats, ornamentation, and rattles.

Migratory Birds. Migratory bird harvest surveys in Alaska are conducted on a rotating community, sub region, and regional schedule through a cooperative harvest survey conducted by the Alaska Migratory Bird Co-Management Council (AMBCC) and the Alaska Department of Fish and Game, Division of Subsistence. The latest available report for the 2010 harvest year shows that the 22 surveyed communities in the Y-K Delta region harvested an estimated 75,584 ducks, 43,371 geese, 4,511 swans, 2,879 cranes, and some 1,800 seabirds, shorebirds, loons and grebes (Naves 2012:43). The Y-K Delta region harvested some 26,965 bird eggs of all species (Naves 2012:34). Data are not presented on a community by community basis but are aggregated at the region and sub-region levels. The Lower Kuskokwim region includes Aniak, Upper Kalskag, Lower Kalskag, Upper Kalskag, Tuluksak, Akiak, Akiachak, Kwethluk, Napaskiak, Napakiak, Atmautluak, Nunapitchuk, Oscarville, and Kasigluk. Bethel is its own sub region.

The latest published harvest information for Bristol Bay is from the 2009 harvest year, due to the survey rotation schedule for regions (Naves 2011). The Bristol Bay Region average annual yearly bird harvest was 36,205 birds between 2004 and 2009. Ducks contributed an average of 38 percent of the harvest over these years, ptarmigans and grouses 33 percent, and geese 18 percent. In the Southwest Bristol Bay sub region, egg harvests varied during the 2004 to 2009 period. It declined from 54,437 eggs in 2004, to 25,118 eggs in 2007, before rebounding to 37,630 eggs in 2008 (Naves 2011:68). The Southwestern Bristol Bay sub region includes Aleknagik, Clarks Point, Egegik, Ekwok, Igiugig, Iliamna, King Salmon, Kokhanok, Koliganek, Levelock, Manokotak, New Stuyahok, Newhalen, Nondalton, Pedro Bay, Pilot Point, Port Heiden, South Naknek, Togiak, and Twin Hills. Similar to Bethel, Dillingham is its own sub region within the Bristol Bay region for survey purposes.

Resident Birds. Resident bird harvest information is collected during the annual AMBCC and ADF&G-SD surveys. In 2010, the Y-K Delta communities harvested some 14,569 ptarmigans and grouses (Naves 2012:43).

Estimated resident bird harvests for the Southwest Bristol Bay sub region were 4,177 in 2004, 10,050 in 2005, 8,201 in 2006, 2,748 in 2007, and 11,086 in 2008. For the Dillingham sub region, the numbers are 5,235 in 2005, 3,861 in 2007, and 2,358 in 2008. Dillingham was not surveyed in 2006 or 2009 (Naves 2011:67).

Wild Plants and Other Subsistence Resources. Berries, plants, and other flora subsistence resources are harvested throughout the year depending upon seasonal availability, abundance, and timing with other subsistence pursuits. Berry picking throughout the summer and early fall periods occurs when berries are ripe for harvest. Groups of women and children most often harvest berries, although men may also participate. Berries are eaten fresh, frozen, baked into other goods, and fermented in pokes of seal oil. Medicinal uses are known for many plant species. High to moderate percentages of households use, try to harvest, harvest, give and receive berries and other plants. Species of subsistence interest include berries such as blueberries, crowberries (locally called blackberries), cloudberries (locally called salmonberries), and cranberries.

Grass baskets produced for home use and the handicraft market are made from beach grasses. Driftwood, used for a variety of purposes, remains an important resource, particularly in the Y-K Delta, lower Kuskokwim River, and along the rivers of the Nushagak drainage. Uses of driftwood in some cases is species specific, including heating, smoking salmon, fuel for sauna or steam baths, drying racks, model boats, masks, utensils and doll faces. In the past, driftwood was also used for kayaks, arrows and bows, snowshoes, dog sleds and house frames. Driftwood is harvested opportunistically when it passes by, or collected deliberately, lashed into rafts, and taken downstream to the community for use. Driftwood used as a primary heating source has declined throughout the region (Wheeler and Alix 2004:2).

Community Information

Subsistence information is typically organized by community. The community study approach has a long tradition in social science research. A small community is studied ethnographically as being representative of larger regional culture. In addition to the work done by ADF&G-SD, there are a number of ethnographic and social impact studies that have been done in the Project Study Area in connection with planned onshore and offshore resource development. Published work includes Oswalt's 1955–1956 study of Napaskiak (Oswalt 1963), as well as several Minerals Management Service (MMS) socioeconomic studies including Village Economies in Rural Alaska (Petterson et al. 1988), and Bristol Bay Subsistence Harvest and Sociocultural Systems Inventory (Endter-Wada et al. 1992). Wolfe (2009) provides an overview of subsistence in Alaska while reviewing the MMS socioeconomics research program.

In the Y-K Delta region of the Study Area, only a few community baseline studies have been conducted. Additional studies are underway, and older studies are being updated (see **Section 3.12.12.6**). Recent environmental baseline studies research in the Bristol Bay drainage (SRB&A 2012) has resulted in a number of communities that have current, high quality subsistence harvest information including household and community sharing patterns, harvest search and use areas, and traditional environmental knowledge (TEK) about environmental and resource changes over time. VanStone's earlier research into the changes in settlement patterns during the historic period in the Nushagak River drainage provides some historic subsistence related information (VanStone 1967, 1984a, 1984b).

Over time, there has been a research shift from baseline, community-oriented studies to more issue-specific studies (fish, non-salmon species, large land mammals, marine mammals, and waterfowl) and to annual harvest monitoring studies. The shift to issue-specific or species-specific studies and monitoring efforts is driven by regulatory and management issues, such as changes in the International Migratory Bird Treaty, and declining salmon stocks. The lack of baseline studies for a specific community handicaps efforts to characterize that community's subsistence harvest practices, except by extrapolation from other, similarly situated communities. Baseline studies conducted 10 to 30 years ago enable researchers to update those studies using comparable methodologies. This results in having two or more data points over time, enabling researchers, management agencies, and not least, the community itself to identify trends and changes.

Subsistence Mapping

Subsistence mapping is used to document the locations of harvest efforts over time. Maps also reflect English and Native language place names which reveal cultural information about travel routes, subsistence harvest locations, camps and cabins, traplines, habitat, and perceptions of the landscape.

Several maps show historic subsistence uses of the Chikuminuk Lake area. Michael Coffing's (1991:75) ADF&G study of subsistence uses in Kwethluk included a mapping component showing areas used by Kwethluk residents for subsistence hunting, fishing, and gathering from 1920 to 1987 for all resource categories. The information from Coffing's map is provided in **Figure 3.12-4**. Kwethluk residents reported hunting black and brown bear, caribou, furbearers, and small game hunting and trapping within the Chikuminuk Lake drainage during the 1920–1987 period (Coffing 1991).

Schichnes and Chythlook (1991:65) investigated subsistence resources use in the communities of Ekwok, Koliganek, New Stuyahok, and Portage Creek. The Koliganek resource harvest area encompasses the Upnuk and Chikuminuk lake drainages and downstream to the Nushagak River. The Nuyakuk Lake and River and Tikchik Lake and River were utilized and trips were sometimes made to Lake Chauekuktuli and Chikuminuk Lake for unspecified harvesting activities (1991:64).

Subsistence use area maps available for Akiachak residents show use of the lower Kisaralik River and upper Kuskokwim River tributaries—the Kogrukluk River drainage and the Hoholitna River drainage—for fishing (Coffing et al. 2001). Use area maps depict trout fishing areas (arctic grayling, Dolly Varden, Lake trout, and rainbow trout), "other fish" fishing areas (whitefish, cisco, smelt, blackfish, pike, burbot, sheefish, sucker, lamprey, and stickleback) and subsistence salmon fishing areas used by Akiachak residents, 1988–1987. Seven Akiachak residents provided map information for 1988–1997 depicting caribou, moose, bear and other resource harvesting areas. The maps show use of Kisaralik and Kwethluk River drainages up to the Ahklun Mountains, and upper Kogrukluk River but not crossing over the drainage divide into the Upnuk Lake, Chikuminuk Lake drainage.

Koliganek residents use the areas adjacent to the major river systems, the Nushagak, Mulchatna, Nuyakuk, and King Salmon Rivers to access subsistence harvest areas. Land and water areas along these rivers, areas in Nushagak Bay, and portions of the Wood River and Tikchik Lakes system are used for subsistence harvests. A total of some 3,529 square miles of land was utilized during the 1996 to 2005 time period for Koliganek subsistence mapping studies. One map shows use of the eastern two-thirds of the Chikuminuk Lake and Allen River area for furbearers in the 1963-1983 period (SRB&A 2010:58, Map 19-data from ADF&G 1985). Another map shows a use area along the northern shore of Chikuminuk Lake for fishing-all species and again, for non-salmon fish during the period 1996-2005 (SRB&A 2010:66, 85). Trout fishing was carried out along the northern shore of Chikuminuk Lake. The length of the Nuyakuk River and the entirety of lakes Nuyakuk, Chauekuktuli, Chikuminuk, Upnuk, Nishlik and Slate are mapped as subsistence use areas for fishing for the 1963 to 1983 period, as are the Nushagak and King Salmon rivers.

The area used by Koliganek residents for furbearer harvests from 1963 to 1983 is presented in **Figure 3.12-5**.

Figure 3.12-4 Kwethluk Subsistence Harvest Area, 1920–1987

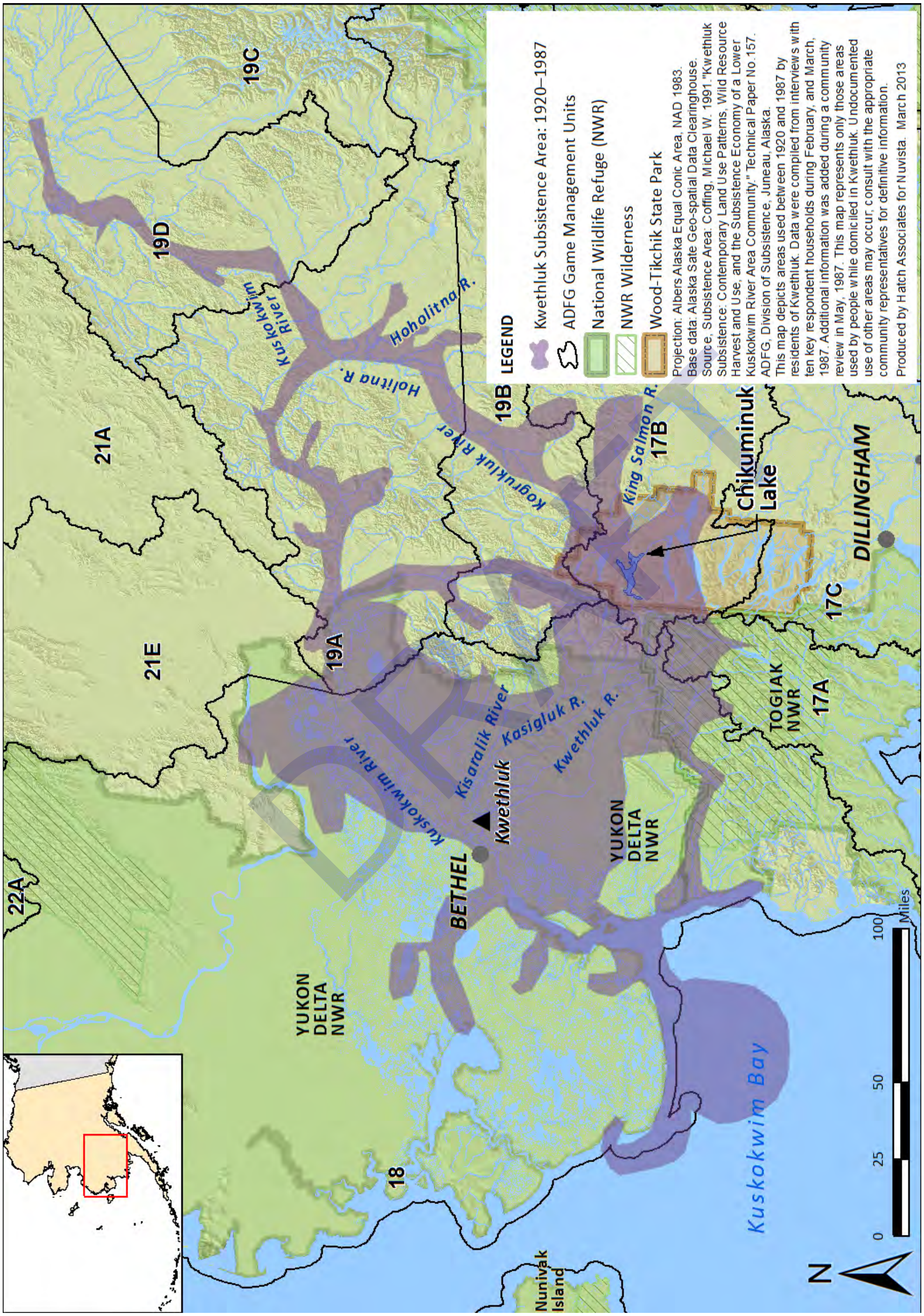
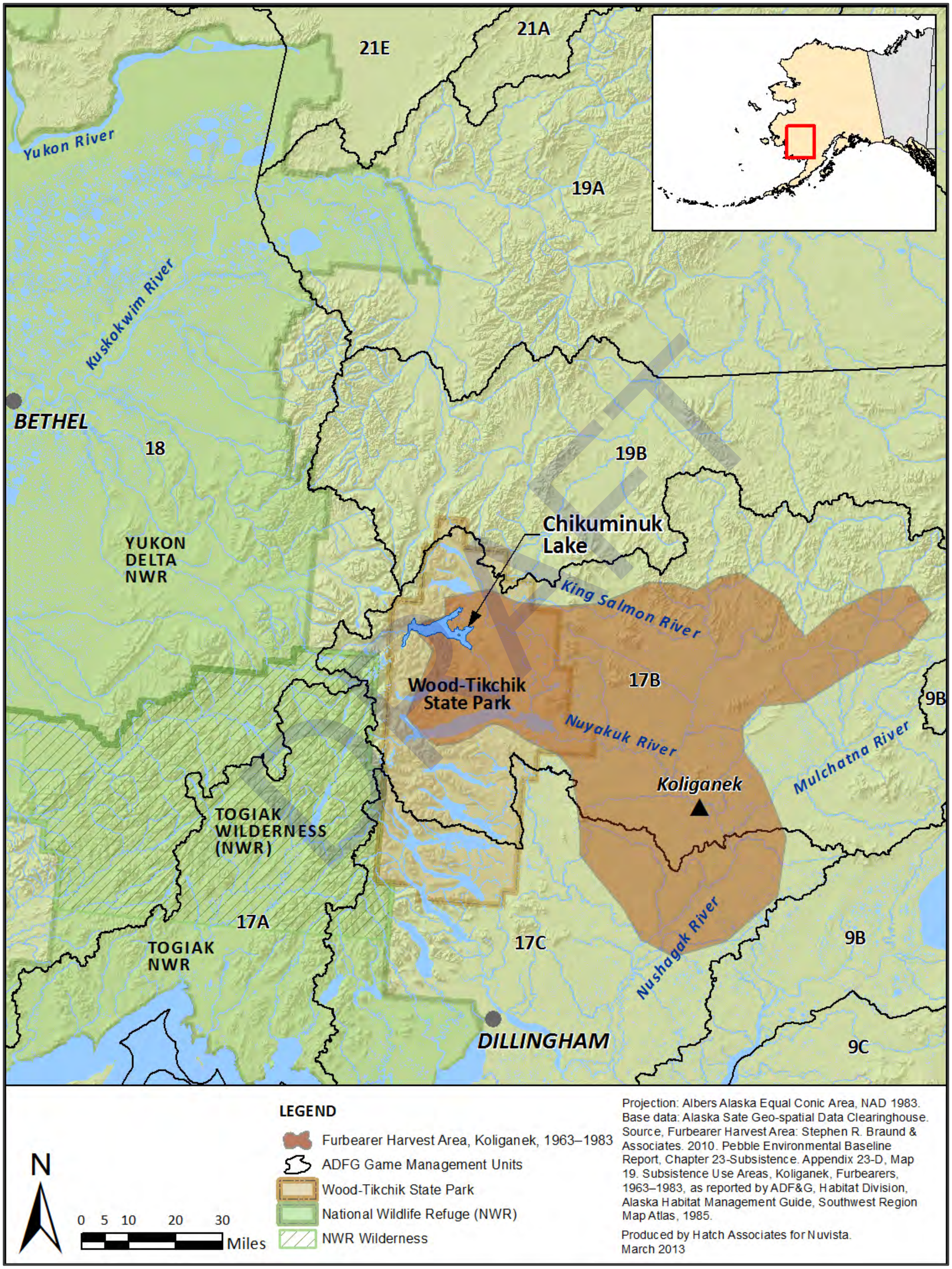


Figure 3.12-5 Koliganek Subsistence Use Areas, Furbearers, 1963–1983



Subsistence Harvests

Subsistence harvests per household and per capita are high in rural Alaska subsistence areas. Research information on resource harvest and use patterns consistently shows high levels of household and individual participation in subsistence activities, and high degrees of sharing of subsistence products among households as evidenced by numbers of resources given away and received. Akiachak households attempted to harvest as many as 69 different resources during a recent 1998-1999 study year. On average, Akiachak households attempted to harvest 37 types of wild resources, successfully harvesting an average of about 36 resource types (Coffing et al. 2001:27; table 9; figure 6).

In the 1985-1986 baseline study at Kwethluk, Coffing (1991) found that moose constituted 90 percent of the total pounds edible weight harvested of big game species, with brown bear constituting the next largest category. Caribou was an important big game animal in some years. The study year was at a time when the Mulchatna-Kilbuck caribou herd was at the lower end of its population size, at approximately 20,000 caribou. Even though small numbers of caribou were calving in the Kilbuck Hills, their numbers were probably so low as to not support a reliable, yearly harvest effort. Coffing describes a subsistence seasonal pattern in the 1900 to 1930s period when men and older boys traveled from Kwethluk eastward to the Kuskokwim Mountains trapping furbearers, especially beaver, and hunting ground squirrels in the Togiak Lake, Tikchik Lakes, and upper Aniak and Holitna River drainages. Moose, caribou, and brown bear were harvested opportunistically during these trapping expeditions. Beaver and moose were rare west of the Kuskokwim Mountains until the 1930s. Men sometimes traveled to Dillingham in late spring to sell their furs, before returning to Kwethluk across the Kuskokwim Mountains (Coffing 1991:31). Fienup-Riordan (2007:159-164) describes the construction of shallow-draft, wood-framed bearskin boats (*angyaaqatiit*) to make the one-way journey downstream from the mountains after hunting, trapping, and trading travels.

Baseline information from Kwethluk in the 1980s, currently being updated by ADF&G-SD, indicated that people received seal oil and meat in trade or as gifts from relatives living in coastal communities. Sixty-eight percent of the community households received seal oil (Coffing 1991:72). Koliganek data also show 64 percent of respondents reporting use of marine mammal products, including meat, oil, and skins. During April, some Kwethluk hunters fly to Eek, Kwigillingok, or Kipnuk to hunt seal and walrus with their relatives. Hunters haul boats to the edge of shorefast ice with snow machines. Seals are the targeted species, but walrus are taken if the opportunity presents itself. Coffing mapped the subsistence harvest use areas of Kwethluk residents for ringed seal, spotted seal, bearded seal, and walrus and reported hunting effort, total number harvested and pounds of meat harvested in the 1985-1986 study year (1991:71).

A characteristic of the subsistence economy is the high degree of participation in subsistence harvest efforts, and the distribution of harvested items through networks of relatives. This kin-based harvesting, processing, and sharing is found throughout the subsistence-cash based economies in rural Alaska (Wolfe 2004). Community studies gather this information.

Kwethluk provides a representative example of the degree of participation in subsistence and distribution of subsistence harvests. **Table 3.12-23** presents information from the Kwethluk baseline study in the 1980s (Coffing 1991) showing the percentages of household (HH) participation in subsistence harvests, and the percentages of households giving away and receiving subsistence harvest products. The four columns on the right present information on estimated harvest totals, the estimated pounds total harvested by the community and the average pounds harvested per household, and per capita. (Fieldwork for an updated baseline study of Kwethluk is complete, but the analysis and final report are not yet available from ADF&G-SD.)

As noted above, rural communities tend to have high per household and per capita harvest rates of salmon and other fish. Data from Kwethluk show this pattern with 2,045 pounds of salmon harvested per household, and

Table 3.12-23 Household Subsistence Harvests, Kwethluk

Resource	Percent HH Attempting to Harvest	Percent HH Harvesting	Percent Giving Away	Percent Receiving	Estimated Harvest	Estimated Pounds Harvested	Avg. Lbs Harvested per HH	Per Capita Lbs Harvested
KWETHLUK-ALL RESOURCES	**100**	**100**			**429,627**	**429,627**	**3,835.96**	**836.13**
Fish	**89.9**	**89.9**			**367,068**	**367,068**	**3,277.39**	**714.38**
Salmon[1]	*69.6*	*69.6*	(6)	(6)	*25,149*	*229,063*	*2,045.2*	*445.8*
Non-Salmon	*87.4*	*87.4*	*63.6*	*71.9*	*138,005*	*138,005*	*1,232.19*	*268.58*
Land Mammals	**83.5**	**70.9**	**53.4**	**80.6**	**2,732**	**34,525**	**308.26**	**67.19**
Large Mammals	*63*	*33.9*	*31.5*	*72.3*	*48*	*26,000*	*232.15*	*50.6*
Black Bear	15.5	3.4	3.4	37.3	4	567	5.06	1.1
Brown Bear	17.4	8.2	8.2	24.8	9	1,847	16.49	3.59
Caribou[2]	4.9	2.4	0	27.7	3	328	2.93	0.64
Moose	63	29	29	63.1	33	23,258	207.66	45.26
Small Mammals[3]	*77.7*	*67.5*	*45.1*	*57.3*	*2,684*	*8,524*	*76.11*	*16.59*
Marine Mammals	**11.6**	**11.6**	**11.6**	**70.9**	**4,095**	**4,,095**	**36.56**	**7.97**
Birds and Eggs	**75.2**	**68.5**	**50**	**66.5**	**6,506**	**10,550**	**94.2**	**20.53**
Migratory Birds	*71.8*	*68.5*	*39.7*	*64.1*	*2,651*	*6,694*	*59.77*	*13.03*
Other Birds	*57.3*	*50.6*	*35.4*	*25.2*	*3,856*	*3,856*	*34.43*	*7.5*
Grouse	14.1	14.1	6.3	2.9	144	144	1.29	0.28
Ptarmigan	54.9	48.1	35.4	25.2	3,712	3,712	33.14	7.22
Vegetation	**93.3**	**93.3**	**44.2**	**60.2**	**2,558**	**13,390**	**119.55**	**26.06**
Berries[4]	*76.3*	*76.3*	*30.1*	*55.4*	*2,250*	*13,285*	*118.61*	*25.85*
Plants/Greens /Mushrooms[5]	*45.2*	*45.2*	*0*	*2.4*	*210*	*105*	*0.94*	*0.2*
Wood	*62.2*	*62.2*	*28.1*	*12.7*	*20 cords*			

Notes:

(1) Salmon harvest data was gathered from all salmon-harvesting households therefore harvest quantities are known.
(2) Kilbuck caribou herd was closed to hunting.
(3) Some furbearers, such as fox, are not eaten.
(4) Conversion factor is species-specific. Species harvested: salmonberries, blueberries, blackberries, cranberries.
(5) Species: Tea plants, Greens.
(6) Virtually all households used salmon. Data on giving and receiving of salmon were not obtained.

Source: ADF&G website, Kwethluk 1986 data (Coffing 1991).

446 pounds per capita. Akiachak data from a 1998-1999 study found harvests averaging 5,887.1 pounds per household, and a community per capita harvest of 1,328 pounds (Coffing et al. 2001:29). Data from a 2005 study at Koliganek show a similar high per household and per capita harvest pattern for salmon with 2,139 pounds harvested per household, and 899 pounds per capita. Koliganek households harvested an average of 14 different kinds of resources during the study year, and used an average of 21 kinds of resources giving away on average nine kinds of resources, receiving about eight kinds (Krieg et al. 2009:114).

3.12.12.6 Existing and Ongoing Studies

The data gap report compiled available information about subsistence in the Study Area (Stern and Phillips 2012). The data gap report identified existing baseline community information of varying quality and recency available for Quinhagak and New Stuyahok (Wolfe et al 1984), Nunapitchuk (Andrews 1989), Tuluksak (Andrews and Peterson 1983), Kwethluk (Coffing 1991), Bethel (Wolfe et al. 1986), Koliganek, New Stuyahok, and Ekwok (Schichnes and Chythlook 1991), Clarks Point (Seitz 1996) and a Bristol Bay Regional overview (Wright et al. 1985). Comprehensive subsistence harvest surveys were completed for the middle Kuskokwim River communities of Aniak, Chuathbaluk, Crooked Creek, Lower Kalskag, Upper Kalskag, Red Devil, Sleetmute, and Stony River with an available report (Brown et al. 2012). A report is expected from ADF&G-SD for 2011 surveys at Akiak, Georgetown, Kwethluk, Napaimute, Oscarville, and Tuluksak. An ethnography project on the Yukon salmon disaster with data from Emmonak, Marshall, Nulato, Beaver, and Eagle may have insights on challenges for Kuskokwim River communities. Comprehensive subsistence harvest surveys were conducted in 2012 at Napakiak, Napaskiak, McGrath, Takotna, Nikolai, Russian Mission, Anvik, and Galena. A comprehensive subsistence harvest survey was planned for Bethel in 2012 to 2013.

Beginning in the 1990s, some ADF&G-SD efforts shifted towards species-specific and issue-specific research, and to ongoing monitoring efforts in response to management changes and biological concerns. Walker and Coffing (1993) surveyed subsistence salmon harvests in 36 communities in the Kuskokwim Fisheries Management Area. Annual statewide subsistence salmon and non-salmon harvest surveys are ongoing with data reported for both the Y-K Delta and the Bristol Bay drainages (Fall et al. 2011—see annual reports listed in the subsistence data gap report).

Harvest information and subsistence uses for selected years for various large land mammals such as brown bear, black bear, moose, and musk-ox (Holen et al. 2005) are available for selected communities in the Study Area.

Subsistence harvests of certain marine mammals (harbor seals and sea lions) are available annually starting in 1992 (Wolfe and Mishler 1993). These harvest surveys also include information on other marine mammal species in some years. Reports are available from 1993 to date.

The searchable Community Subsistence Information Survey (CSIS) database available online contains the quantitative data from all of the ADF&G-SD technical papers prepared since 1978. Reports prepared by other agencies include research sponsored by the Minerals Management Service (MMS, now the Bureau of Ocean Energy Management Regulation and Enforcement-BOEMRE) to identify and evaluate the socioeconomic impacts of offshore oil and gas exploration and development and the effects of harvest disruptions.

Annual harvest reports for big game species requiring big game tags and reports to ADF&G are ongoing and are reported by Division of Wildlife Conservation’s Survey & Inventory (S&I) reports.

4 PRELIMINARY ISSUES AND STUDIES LIST

4.1 Resource Issues

This section includes a preliminary list of resource issues to be addressed in an environmental review for the Project. Effects on natural resources can accrue from construction, operation, and maintenance of project facilities. These include the environmental effects of the dam, spillways, generation facilities, transmission lines, construction access, temporary housing, waste disposal, staging areas, and other appurtenant facilities/structures. This list is not intended to be exhaustive or final, but contains those project issues identified to date.

4.1.1 General Issues

The potential for climate change may result in issues affecting multiple resources. For example, effects of climate change upon resources within the project boundary may be difficult to assess given the current best available science. Nuvista would investigate relevant and pertinent information available to assess how the Project may influence climate change processes.

4.1.2 River Basin Description Issues

An estimate of Probable Maximum Precipitation (PMP) is required for the computation of the Probable Maximum Flood for dam spillway design. Preliminary PMP estimates presented in the 2011 Kisaralik River and Chikuminuk Lake Reconnaissance and Preliminary Hydropower Feasibility Study (MWH 2011) used rainfall estimates presented in the 1963 National Weather Bureau Technical Paper No. 47 (TP-47) and the 1983 NWS Hydrometeorological Report No. 54 (HR-54). These two publications present rainfall estimates based primarily on pre-1960 datasets. Since the submittal of the 2011 MWH study, both TP-47 and HR-54 have been superseded by NOAA Atlas 14: Precipitation-Frequency Atlas of the United States (NOAA 2012). Updated preliminary design flood estimates would be calculated using the precipitation values presented in Atlas 14 or a more recent Atlas if available.

4.1.3 Geology and Soils Issues

Issues to be addressed in order to fully assess the effects of project construction, operation, and maintenance on geologic resources include the following:

- Erosion Processes
  - Changes to shorelines and terraces resulting from fluctuations in lake levels and stream flows caused by project operations (i.e. storage, pulse flows, minimum flows);
  - Effects on vegetation and soils resulting from clearing, grading and other construction activities;
- Sediment Supply and Transport
  - Sediment deposition in Chikuminuk Lake
  - Sediment supply and transport in Allen River, Tikchik River, Lake Chauekuktuli
  - Aquatic areas affected by construction and presence of transmission facilities.
  - Spawning gravels and bedload characteristics
- Seismic hazards on project facilities and transmission lines
- Potential for seepage, piping and erosion in Allen River, Tikchik River, Lake Chauekuktuli from raising Chikuminuk Lake levels
- Changes in fluvial geomorphic processes

4.1.4 Water Resource Issues

Issues to be addressed in order to fully assess the effects of project construction, operation, and maintenance on water resources include the following:

- Water quality – Changes to temperature, turbidity, total dissolved solids, suspended solids, dissolved oxygen, pH, metals, and chemical/nutrient characteristics, and total dissolved gas in Chikuminuk Lake and Allen River.
- Water quantity
  - Existing and projected future Allen River flow regime, including minimum instream flow releases, flood, pulse, and base flow conditions, peaking operations, the existing flow regime of the Allen River, including the timing, magnitude, and duration of flows.
  - Elevation of Lake Chauekuktuli due to flow regulation of Allen River.
- Ice processes within Chikuminuk Lake and the Allen River.

4.1.5 Fish and Aquatic Resource Issues

Issues to be addressed in order to fully assess the effects of project construction, operation, and maintenance on fish and aquatic resources include the following:

- Inundation
- Fish habitat connectivity between Chikuminuk Lake, Allen River and other tributaries; habitats in deltas within Chikuminuk Lake due to inundation.
- Mortality of fish passing through turbines (i.e. turbine mortality).
- Stranding and trapping fish due to daily flow fluctuations in the Allen River.
- Lake and river aquatic productivity changes due to such factors as:
  - Flow changes in the Allen River,
  - Water quality changes (e.g. Total Dissolved Gas, pH, nutrients, etc.),
  - Alterations to the littoral, pelagic, and benthic zones,
  - Changes in fluvial geomorphic processes
- Modification to the temperature profile of Lake Chikuminuk Lake and Allen River. Riparian and stream habitats in Chikuminuk Lake, Allen River, and streams in the transmission corridor.

4.1.6 Botanical Resource Issues

Issues to be addressed in order to fully assess the effects of project construction, operation, and maintenance on botanical resources include the following:

- Wetlands, vegetation, and wildlife habitats, including rare plant populations
- Altered hydrologic regimes on wetlands, wetland functions, riparian vegetation, and riparian succession patterns in the Allen River.
- Potential introduction of invasive plant species.
- Potential exposure to environmental contaminants.
- Potential changes in solar radiation and temperature moderation, and erosion and dust deposition on the distribution and composition of vegetation and wetland communities within and adjacent to Project features.

4.1.7 Wildlife Resource Issues

Issues to be addressed in order to fully assess the effects of project construction, operation, and maintenance on wildlife (mammal, amphibian, and avian) populations and habitats include the following:

- Potential changes to wildlife movements, including any physical and behavioral blockage and alteration of wildlife movement patterns and access to important habitats (e.g., moose wintering range, caribou foraging and calving areas, etc.)
- Potential changes to mortality rates due to habitat alteration or loss from altered hydrologic regimes such as fluctuating water levels and ice conditions in Chikuminuk Lake Allen, with an emphasis on big game species.
- Changes in distribution, habitat use, and abundance caused by increased human presence (i.e. hunting and trapping, vehicular use, noise, etc.).
- Changes to Bald and Golden Eagle roosting, nesting, rearing, and foraging habitats and availability.
- Changes to nesting, rearing, and foraging habitats of migratory “bird species of concern.”
- Potential avian collision and electrocution on Project transmission lines.
- Potential habituation and attraction of scavengers.
- Effects of sport and subsistence hunting facilitated by enhanced public awareness.
- Potential exposure to hazardous materials.

4.1.8 Rare, Threatened, and Endangered Species Issues

There are no federally-listed or candidate threatened or endangered species in the Project area. The eight rare vascular plant taxa with S1 and S2 rankings in the AKNHP database may be encountered during botanical investigations and all occurrences would be documented.

- Potential effects to Golden and Bald eagle nests in project site.
- Potential effects on the use of Chikuminuk Lake and wetlands by waterbirds of conservation concern.
- Potential effects to shorebirds and landbirds of conservation concern within the Project area.

4.1.9 Recreation and Land Use Issues

Issues to be addressed in order to fully assess the effects of project construction, operation, and maintenance on recreation and land use include the following:

- Non-consumptive recreation (boating, hiking, wildlife observation, camping).
- Recreation use due to presence of construction workers.
- Hunting, trapping and sport fishing opportunities.
- Changes in ice processes that affect the timing and extent of wintertime use of Chikuminuk Lake.
- Effects on river access and navigation within and downstream of the reservoir due to changes in the flow regime of the Allen River.
- Changes to level of management required for recreation activities.

4.1.10 Aesthetic Resources Issues

Issues to be addressed in order to fully assess the effects of project construction, operation, and maintenance on aesthetic resources include the following:

- Changes to views in the study area.

4.1.11 Cultural Resources Issues

Issues to be addressed in order to fully assess the effects of project construction, operation, and maintenance on cultural resources include the following:

- Effects to cultural resource sites including those determined eligible for listing on the National Register of Historic Places (NRHP).
- Effects due to increased human use on traditional spiritual areas and other traditional uses.

4.1.12 Socio-economic Resources Issues

Issues to be addressed in order to fully assess the effects of project construction, operation, and maintenance on socio-economic resources include the following:

- Effects to regional and local economic conditions due to project power output (i.e., lower cost / stable-priced energy).
- Changes to area resident populations, lifestyle and quality of life.
- Changes to demand on community services and facilities, including health and human services, law enforcement, emergency services, education, etc.
- Demand for housing.
- Changes to fishing, hunting, material gathering, and other subsistence activities.
- Effects on local workforce (i.e. changes in job opportunities related to the existing power distribution system, increases in household income due to greater employment opportunities, and reduction in unemployment in regional communities).
- Effects on direct and indirect commercial opportunities related to recreation, including fishing, hunting, and trapping, and commercial non-consumptive uses.
- Changes in tourism and tourism-related employment.

4.1.13 Tribal Resources Issues

Protection of any archaeological, cultural, or historic properties/sites are identified above at 4.1.11 Cultural Resources Issues; and issues related to subsistence use of resources would be covered in 4.1.12 Socio-economic Resource Issues

4.2 Studies and Information Acquisition

4.2.1 General Requirements

The potential for climate change may require studies to assess the effects upon multiple resources over the requested 50-year term for the Original License in Nuvista's license application for the Project.

4.2.2 Geology and Soils Studies

- Conduct geotechnical investigations to evaluate the potential for seepage and piping from the reservoir.
- Evaluate and establish designs for project excavations, including development of plans for borrow sites.
- Develop detailed descriptions of geologic conditions, characteristics and features following further study of transmission alternatives.

4.2.3 Water Resources Studies

- Continue stream gaging program.
- Acquire at least three additional discharge measurements at each gage site for rating curve development – March or April low flow measurement, June high flow measurement, July – September intermediate flow measurement.
- Conduct winter observations of Allen River and Northwest Passage during March / April low flow measurement field trip.
- Collect sediment and water quality data.
- Install staff gages in Lake Chauekuktuli, and Nuyakuk and Tikchik Lakes in order to document hydrologic changes in the system between the upper Allen River gage and the Nuyakuk River gage.

- Develop reservoir filling information during future phases of project development, as hydrologic information becomes more complete and project features and operation are better defined.

4.2.4 Fish and Aquatic Resources Studies

- Conduct fish, habitat, and spawning surveys in Chikuminuk Lake and the Allen River.
- Conduct bathymetric survey and lake-turnover analysis of Chikuminuk Lake.
- Conduct salmon movement survey.
- Collect data for and prepare a 1-D Hydraulic model to determine flow/habitat relationships for salmon in the Allen River.
- Prepare a habitat model of the Allen River system with preliminary Weighted Usable Area curves for each target species.
- Water temperature monitoring.
- Assess fish passage barriers.
- Assess instream flows needed for the riparian community.

4.2.5 Botanical Resources Studies

- Conduct a quantitative analysis of affected wetlands, vegetation types, and habitat types following completion of the project description and after vegetation, wetlands, and wildlife habitat maps are completed (after 2014).
- Obtain recent and high-quality, digital ortho-photography of the study area to serve as the basis for wetland, vegetation, and habitat mapping.
- Design a field sampling program to complete a wetlands functional assessment.
- Conduct field studies to ground-truth the aerial photography interpretation and to determine boundaries of wetland, vegetation and wildlife habitat types.
- Using the completed habitat map, assess habitat values and potential Project affects for the wildlife species of concern.
- Conduct literature review and field surveys in the Project area to determine the occurrence and distribution of rare plant species.
- Conduct literature review and field surveys in the Project area to determine the occurrence and distribution of invasive species.

4.2.6 Wildlife Resources Studies

Mammals

- Conduct moose surveys.
- Conduct caribou surveys.
- Conduct aerial surveys for bear dens to provide data on the abundance and distribution of bear dens in the Project area.
- Collect data on seasonal concentration areas for bears (e.g., spring foraging and fall berry areas), recorded incidentally during other surveys.
- Survey winter furbearer tracks, with a focus on wolverines.
- Compile ADF&G furbearer harvest records.
- Conduct an aerial survey of active beaver lodges to assess the current conditions for this species.
- Establish data-sharing agreements with ADFG and USFWS biologists, where possible.

Avian

- Conduct aerial surveys for nesting large raptors.
- Conduct waterbird surveys and include aerial surveys for migrant and nesting waterbirds (waterfowl, loons, grebes, gulls, and terns).

- Conduct ground-based surveys for brood-rearing waterbirds in the proposed inundation area.
- Conduct land-based migration counts for all migrating birds (focusing on raptors, and waterfowl) along the preferred transmission corridor alternative, including radar studies to determine flight paths and elevation of both diurnal and nocturnal migrants.
- Survey Harlequin Ducks.
- Conduct ground-based point-count surveys for breeding shorebirds and landbirds.
- Conduct a literature review and gap analysis, focusing on bird movements for each transmission corridor alternative once alternative routes have been developed and shape files are available.

4.2.7 Rare, Threatened, and Endangered Species Studies

Collect the following types of data necessary to describe baseline conditions for species of conservation concern and to evaluate potential impacts:

- Conduct aerial surveys for large nesting raptors, including Bald and Golden eagles, Gyrfalcons (a species of conservation concern) and Peregrine Falcons (recently delisted).
- Conduct surveys to document the current distribution, abundance, and habitat use of waterbirds of conservation concern within the Project area during both the migration and breeding seasons.
- Conduct surveys of rivers and streams within the project area to determine the current distribution and abundance of breeding Harlequin Ducks and other waterbirds. Harlequin Duck surveys would occur in 2015 (or later).
- Conduct systematic surveys to determine the current distribution, abundance, and habitat use of the project area by shorebirds and landbirds of conservation concern.
- Conduct a literature review and gap analysis once alternative routes have been selected focusing on the movements of birds of conservation concern for each transmission corridor alternative.

4.2.8 Recreation and Land Use Studies

- Continue research regarding types and amounts of recreation use and trends, and recreation potential in the project vicinity; in particular expand research to include the proposed transmission line routes.
- Conduct more detailed recreation value assessment including shoreline mapping and change analysis due to inundation of reservoir.
- Conduct recreation use survey and continued interviews with knowledgeable users regarding past, current and likely future recreation use; including surveys of lodge owners, air taxi operators and guides.
- Quantify economic impact of visitor/tourism industry on local economy – recreation linkage with socioeconomics.
- Identify need for new recreational opportunities and/or new or modified management strategies in the project area in consultation with resource agencies and interested participants.

4.2.9 Aesthetic Resources Studies

- Inventory and photograph the visual environment (character, quality, integrity) including images for each major season and in different lighting conditions.
- Identify initial key viewing areas and viewpoints, with special consideration of the locations of current and likely recreation use areas, and specific structural elements of the Project, including areas of cut-and-fill, dam structure height and features, and transmission tower placement.
- Consult with landowners, lodge operators, guiding outfits, and interested parties regarding potential Project effects to the visual environment.
- Develop Project viewshed model and use to help identify major viewsheds from public viewing areas.
- Prepare visual simulations of dam structures and transmission lines.

4.2.10 Cultural Resources Studies

- Relocate, obtain GPS waypoints, and test known AHRS sites in the project study area.
- Conduct excavations at TAY-010 and TAY-004.
- Conduct pedestrian survey and subsurface testing on prominent land forms surrounding Chikuminuk Lake.
- Conduct surveys and subsurface testing of prominent land forms along the shores of Chikuminuk Lake inundation area.
- Conduct aerial and pedestrian surveys for ice patch archaeology in the vicinity of Chikuminuk Lake and along the West Route to Bethel.
- Conduct aerial reconnaissance of the proposed Transmission Line route(s) to identify locations for future pedestrian survey and subsurface testing.
- Identify locations with a potential to contain material suitable for palynological testing.
- Conduct archival research, in addition to the fieldwork, on existing collections from sites located in the vicinity of the Project.
- Conduct additional background research on viable transmission and ice road routes once they are identified.

4.2.11 Socio-economic Resources Studies

- Conduct interviews with key community members (business owners, public institutions, etc.) to refine and gather data on socioeconomic conditions.
- Conduct special analysis of rural migration trends and energy costs.
- Conduct analysis of subsistence use of lands and waters, including fishing, hunting, and material gathering.
- Identify any adverse effects on subsistence use during Project construction and operation.
- Determine when and if input-output economic model should occur. (Use the results of initial rate study to conduct input-output analysis to measure the full economic impact of new electricity rates to the communities served.)

4.2.12 Tribal Resources

- Investigations and analysis of Native Alaskan archaeological, cultural, and historic properties would be accomplished under 4.2.11 Cultural Resources Studies. Assessment of adverse effects on subsistence use during Project construction and operation would be accomplished under 4.2.12 Socio-economic Resources Studies.

4.3 Waterway Plans

Section 10(a) of the Federal Power Act, 16 U.S.C. § 803(a)(2)(A), requires FERC to consider the extent to which a project is consistent with Federal or state comprehensive plans for improving, developing, or conserving a waterway affected by the Project. On April 27, 1988, FERC issued Order No. 481, a revising Order No. 481, issued October 26, 1987, establishing that FERC will accord FPA Section 10(a)(2)(A) comprehensive plan status to any Federal or state plan that:

- Is a comprehensive study of one or more of the beneficial uses of a waterway or waterways;
- Specifies the standards, the data, and the methodology used; and
- Is filed with the Secretary of the Commission.

FERC currently lists 67 comprehensive plans for the state of Alaska. **Table 4.3-1** lists potentially relevant plans that may be useful in the future licensing proceeding for characterizing desired conditions. The most current listing of the Commission's List of Comprehensive Plans is from December 2012.

Table 4.3-1 Qualifying Federal and State Comprehensive Waterway Plans Potentially Relevant to the Project

Resource	Comprehensive Plan
Aquatic Resources	Alaska Department of Fish and Game. 2011. Alaska Anadromous Waters Catalog – Western Region. Anchorage, Alaska. June 1, 2011.
Recreation	Alaska Department of Natural Resources. Alaska's Outdoor Legacy: Statewide Comprehensive Outdoor Recreation Plan (SCORP): 2009-2014. Anchorage, Alaska.
Aquatic Resources	U.S. Fish and Wildlife Service. Undated. Fisheries USA: the recreational fisheries policy for the U.S. Fish and Wildlife Service. Washington, D.C.
	Kisaralik River Management Plan

4.4 Resource Management Plans

In addition to the qualifying federal, state, and tribal comprehensive waterway plans listed above, some resource agencies have developed resource management plans to help guide their actions regarding specific resources of jurisdiction. The resource management plans listed in **Table 4.4-1** may be relevant to the Project and may be useful in the licensing proceeding for characterizing desired conditions.

Table 4.4-1 Resource Management Plans Potentially Relevant to the Project

Resource	Comprehensive Plan
Aquatic, Botanical, Water, Wildlife, Recreation	Alaska Department of Natural Resources. 2002. Wood-Tikchik State Park management plan. Anchorage, Alaska. October 2002.
	U.S. Fish and Wildlife Service. 1988. Yukon Delta National Wildlife Refuge: Comprehensive conservation plan. Anchorage, Alaska. January 1988.
	U.S. Fish and Wildlife Service. Undated. Fisheries USA: the recreational fisheries policy for the U.S. Fish and Wildlife Service. Washington, D.C.
	Alaska Department of Fish and Game. 2011. Alaska Anadromous Waters Catalog – Western Region. Anchorage, Alaska. June 1, 2011.
Recreation	Alaska Department of Fish and Game. 1989. Northwest area plan for state lands. Fairbanks, Alaska. February 1989.
	Alaska Department of Fish and Game. 1988. Kuskokwim area plan for state lands. Anchorage, Alaska. May 1988.
	Alaska Department of Natural Resources. Alaska's Outdoor Legacy: Statewide Comprehensive Outdoor Recreation Plan (SCORP): 2009-2014. Anchorage, Alaska.
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Appendix A – Literature Cited

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Appendix B – List of Environmental Reports

The following list includes the reports prepared by various environmental and engineering firms regarding the study of the proposed Chikuminuk Lake Hydroelectric Project. A copy of these reports can be obtained by contacting Nuvista Light and Electric Cooperative, Inc.

ABR

2012 Biological resources in the Chikuminuk Lake Hydroelectric Project area: Literature review and gap analysis. Report for Nuvista Light & Electric Cooperative, Inc., Anchorage, AK, by ABR, Inc.—Environmental Research & Services, Fairbanks, AK.

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2013 Chikuminuk Lake Hydroelectric Project Evaluation of Alternative Transmission Routes Chikuminuk Lake to Bethel. Report for Nuvista Light and Electric Cooperative, Inc. Anchorage, AK.

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