CHAPTER 3: AFFECTED ENVIRONMENT

3 Affected Environment

3.1 Summary of Major Changes between the Draft and Final EIS

Several major changes were made to the Draft Environmental Impact Statement (EIS) and incorporated into this chapter of the Final EIS, based on public comments on the Draft EIS. These changes are (and Section where change was made):

1. Included an expanded discussion of climate change and its potential affects on Refuge resources (Section 3.3.1).

2. Included a discussion of past effects of seismic activity on the Tran-Alaska Pipeline System (TAPS; Section 3.3.2).

3. Added a new section on paleontological resources (Section 3.3.5).

4. Added a discussion of the water chemistry at several wetlands in priority parcels 1 and 15 (Section 3.3.6.2).

5. Added a section on water rights on the Refuge (Section 3.3.6.4).

6. Expanded upon the discussion of the Beaver Creek fishery (Section 3.4.5).

7. Added a discussion of International Treaty Obligations with respect to fish and wildlife and their habitats (Section 3.4.5.4).

8. Expanded upon the discussion of threatened and endangered species on the Refuge by including a discussion of polar bear occurrence on or near the Refuge (Section 3.4.8).

9. Expanded upon the discussion of fire management activities on the Refuge and especially near villages (Section 3.5.1.5).

10. Added a section on White Mountain National Recreation Area recreation opportunities (Section 3.5.1.6).

11. Added a description of wilderness units on the Refuge (Section 3.5.2.1).

12. Included information to the subsistence section of the EIS based on interviews with subsistence users in Beaver, Birch Creek, and Fort Yukon (Section 3.5.7).

13. Added a section on Traditional Knowledge based on interviews with subsistence users in Beaver, Birch Creek, and Fort Yukon (Section 3.5.7.6).

3.2 Introduction

This chapter provides an overview of the important resources of the physical, biological, and sociocultural environments that could potentially be affected by the project alternatives being considered in this Final EIS. Resource descriptions are restricted to the study area, which is the primary area of potential effect of the project alternatives. The limits of the study area are the same as the boundary of the Yukon Flats National Wildlife Refuge (Refuge), which is shown in each of the figures in this chapter along with the current landownership or status within the

Refuge. Similar figures, showing the locations of lands that would be exchanged under the Proposed Action and the alternatives, are presented in Chapter 4 for resources that might be affected. For the remainder of the document, the study area is referred to as the "Refuge." In a few instances, such as discussions regarding socioeconomics, a broader perspective is warranted and provided because project effects are likely to extend beyond the study area boundary.

Established in 1980 under the Alaska National Interest Lands Conservation Act (ANILCA), the Refuge contains 10.9 million acres, of which about 8.6 million acres are under Federal ownership; these lands are referred to in this document as Refuge lands. Within the exterior Refuge boundaries are also approximately 2.5 million acres of land selected by, or conveyed to, Native Corporations and Native allotment holders. Five villages, Beaver, Birch Creek, Chalkyitsik, Fort Yukon, and Stevens Village, are within the Refuge boundary. The Refuge is not connected with any outside road system; an unpaved road system is associated with each village.

3.3 Physical Resources

The Refuge, which encompasses most of the area known as the Yukon Flats, is situated in the northeastern part of the interior of Alaska south of the Brooks Range and north of the Crazy and White Mountains (**Figure 3-1**). It extends 220 miles east-west along the Arctic Circle from the Dalton Highway and TAPS in the west to within 30 miles of the Canadian border in the east, and about 120 miles north-south.

The Yukon River flows through the middle of the Refuge and is the Refuge's dominant physical feature. The Refuge contains lowlands associated with the upper Yukon River and its major tributaries, which form the Yukon Flats, and surrounding uplands and mountains (Williams 1962; Warhaftig 1965; Brabets et al. 2000).

The lowlands consist of marshy, lake-dotted flats and river drainages located mainly in the central portion of the Refuge. They are less than 600 feet in elevation above mean sea level and comprise about 48% of the Refuge (U.S. Fish and Wildlife Service 1987a). The northern part of the lowlands is made up of gently sloping outwash fans of the Chandalar, Christian, and Sheenjek rivers. The southern lowlands are a broad, flat outwash of the Yukon River. Rising above the flats are rolling, silt and gravel underlain terraces, which slope gradually upwards to surrounding uplands and mountains (Grissom 2001).

Uplands and highlands, which comprise about 52% of the Refuge (U.S. Fish and Wildlife Service 1987a), are found along the margin of the Refuge at elevations greater than 600 feet above mean sea level. These upland areas include portions of the Porcupine Plateau, the Hodzana Highlands, and the Yukon-Tanana Plateau. The Porcupine Plateau region covers much of the eastern and northeastern portions of the Refuge and consists of relatively low, gentle ridges and mountains with rounded or flat summits. The Porcupine River flows through the center of this region, and the Black and Little Black rivers drain rolling to steep uplands in the southern part of the region. The Hodzana Highlands lie northwest of the Yukon Flats and is a region with both rounded and rugged mountains with steep drainages. The Yukon-Tanana Plateau lies along the southern boundary of the Refuge and includes the northern edge of the White Mountains and Crazy Mountains. The Yukon-Tanana Plateau has rounded ridges and small mountains (Grissom 2001).

Proposed Land Exchange EIS

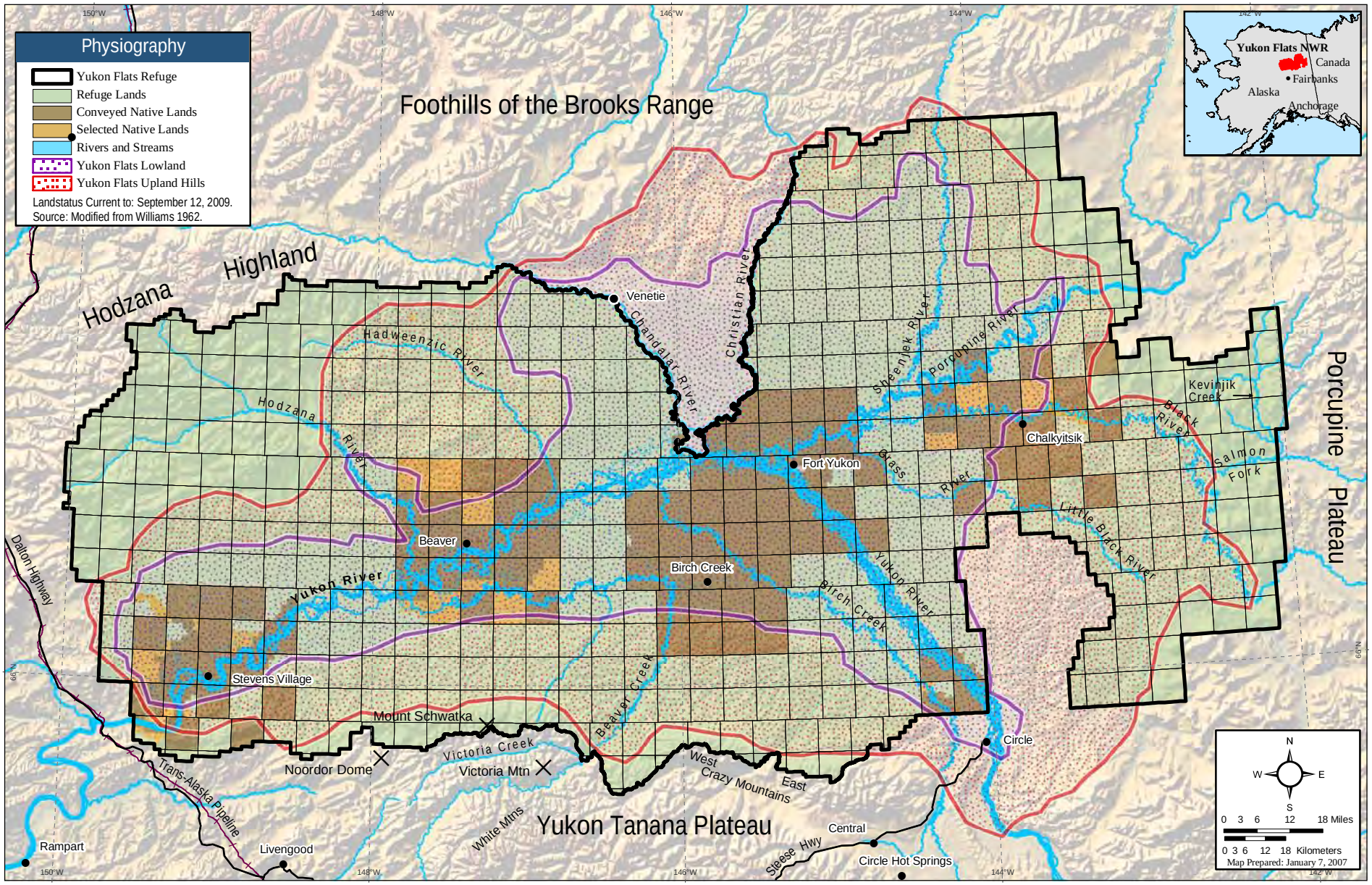
U.S. Fish & Wildlife Service

Figure 3-1

Physiography of the Yukon Flats Refuge

Yukon Flats National Wildlife Refuge

Alaska



3.3.1 Climate and Air Quality of Yukon Flats

3.3.1.1 Climate

The Refuge is located within the Yukon Flats Ecoregion, which has an extreme continental climate consisting of cold winters and warm, relatively dry summers, and has the highest fire frequency of any ecoregion in interior Alaska (Begét et al. 2006). Topographic barriers to the north (Brooks Range) and south (White and Crazy mountains), and the remoteness of the Yukon Flats from open ocean areas, tend to prevent the inland movement of moist maritime air masses, resulting in a continental climate with extreme winter and summer temperatures. The Refuge exhibits substantial seasonal fluctuations in day length (nearly 22 hours on June 21 and less than 4 hours on December 21) and temperature (-58 degrees Fahrenheit [ºF] in January to more than 91ºF in July), and a short growing season (135 days from early May to mid-September).

Climatic data recorded at Fort Yukon are representative of the climate over much of the lower elevations in the Refuge (**Table 3-1**). The Central weather station, at an elevation above 900 feet, is more representative of lands located at the higher elevations in the Refuge.

Topography generates important gradients in local climate as a result of strong temperature inversions (coldest air temperatures in valley bottoms and increasing temperatures with elevation) during the calm winter cold periods. Inversions can persist for weeks during winter. These air temperature inversions play a major role in maintaining permafrost in valley bottoms (Hinzman et al. 2006a) and affect air quality by trapping particulates, chemicals, and odors near the ground. Prevailing winds at Fort Yukon are generally north to northeast during high pressure systems, and west to southwest during low pressure systems.

Table 3-1 Average temperature, precipitation, snowfall, and snow depth at Fort Yukon and Central

Climate Statistics	Fort Yukon[1]		Central[2]	
	Temperature (degrees Fahrenheit)			
	Average Maximum	Average Minimum	Average Maximum	Average Minimum
January	-10.9	-27.8	-10.8	-28.6
February	-3.6	-23.4	-0.7	-22.5
March	14.7	-11.5	15.9	-13.5
April	34.8	9.0	38.0	10.2
May	56.1	32.1	57.2	31.0
June	70.9	47.9	70.3	43.7
July	73.2	51.2	72.2	46.8
August	66.3	44.7	66.4	41.0
September	50.6	32.1	52.4	29.2
October	27.2	12.4	27.4	10.6
November	1.3	-14.2	5.7	-12.2
December	-8.7	-24.6	-4.9	-23.1
Average annual temperature	31.0	10.7	32.4	9.4
Average annual total precipitation	6.6 inches		10.6 inches	
Average annual total snowfall	41.9 inches		53.8 inches	
Average annual snow depth	9 inches		8 inches	

Notes:

[1] Fort Yukon data from 1938 to 1990.
[2] Central data from 1962 to 2005.

Source: Western Regional Climate Center 2007.

Precipitation in much of the Yukon River Basin ranges from 10 to 30 inches annually and is directly related to topography; high rugged mountains receive the greatest amounts of precipitation and lowland areas receive the least. About half of the precipitation falls as snow from November through March, but snow may fall year-round in the mountains (Brabets et al. 2000). Although total precipitation during the growing season may be low, evaporation rates also are low because of the relatively short growing season (Hinzman et al. 2006a). Precipitation in interior Alaska is low in solutes, has a relatively high pH, and is relatively uninfluenced by human, locally derived air pollutants compared to the lower 48 states (Rozell 2000; Hinzman et al. 2006b). The relatively dry summer conditions are replaced by fall rain events, which can be heavy and sustained. The Refuge is large enough so that part of it may be in a drought, and another part may have above average rainfall (Grissom 2001).

Snowpack is generally minimal in the Interior due to low snowfall. Spring snowmelt is the primary source of groundwater recharge, with infiltration occurring through frozen ground, primarily in areas absent of ice-rich permafrost (Kane et al. 1978; Kane and Stein 1983; Brabets et al. 2000). Despite its minimal depth (average of 9 inches), the snowpack of interior Alaska is an excellent thermal insulator because winds are generally calm in winter, and winter rain-on-snow events are rare (Western Regional Climate Center 2007). The snowpack has a lower density and thermal conductivity than typical arctic or temperate snow (Adams and Viereck 1997). The Circle and Central weather stations report 25 to 60% more total precipitation but approximately the same total snowfall as the Fort Yukon station, suggesting that summer rainfall is greater in the surrounding highlands than in the Yukon River floodplain.

Climate Change

Climate change is any change in climate over time, whether due to natural variability or the result of human activity. Today, the warming of the climate is unequivocal, given the significant documentation of physical evidence, which has promoted increased acceptance in the scientific, social and political communities (Intergovernmental Panel on Climate Change 2007). In March 2008, the Alaska Climate Impact Assessment Commission, a directed committee from the Alaska State Legislature, completed an overview of projected impacts to state resources (State of Alaska 2008). The Service has prepared draft Climate Change Strategic and Five-Year Action plans (http://www.fws.gov/home/climatechange/) to guide Service policy nationwide regarding climate change; step down plans for the refuge system will prepared in the near future. These efforts are evidence that decision makers locally and nationally are recognizing the need to address climate change in future planning.

While average annual temperatures in the continental United States have risen 1.4 ºFahrenheit (F; 0.8 ºCelsius [C]) in the last 100 years, temperatures in Alaska have risen from 4 to 7 ºF (2 to 4 ºC) since 1950 (Houghton et al. 2001), with the greatest increase in interior Alaska during winter (Chapman and Walsh 1993; Weller et al. 1998). Warming in Alaska rose sharply beginning in 1977, concurrent with large scale Arctic atmosphere and ocean regime shifts (Weller and Anderson 1998; Parson et al. 2000). The growing season in Alaska has lengthened by 13 days since 1950 (Keyser et al. 2000). Precipitation in interior Alaska has been variable since 1900, but with a 30% average increase (both summer and winter) between 1968 and 1990 (Parson et al. 2000; Groisman and Easterling 1994).

Climate modeling is a valuable tool for predicting potential environmental changes. To “run” a model, scientists divide the planet into a 3-dimensional grid, apply basic equations, and evaluate the results. Atmospheric models calculate winds, heat transfer, radiation, relative humidity, and

surface hydrology within each grid and evaluate interactions with neighboring points. Future climate scenarios predict that the greatest temperature increases globally could occur in the north latitudes and that winter warming in the boreal forest could increase by 40% above the mean by 2100 (Houghton et al. 2001; Arctic Climate Impact Assessment 2004). Both U.S. and Canadian climate models indicate that although both temperature and precipitation in Alaska are projected to increase in the future, increased evaporation, due to extended growing seasons and increased temperature, is expected to offset gains in precipitation (Groisman et al. 2007; Houghton 2001; Parson et al. 2000; Stocks et al. 2000).

Projected environmental changes have the potential to impact resources on the Refuge. Impacts may include: alterations to hydrological systems and processes, including drying of wetlands and interruption of water flow; permafrost degradation; increased fire regimes (increased frequency, severity, area burned, extent, and longer fire seasons); increase in frequency, duration, and extent of stressors to forest health (insects and disease); altered treelines; a long term transition from coniferous to deciduous forests; earlier spring melt and changes in flood magnitude; changes in species' migration patterns, distributions, and physiologies; range shifts of invasive non-native species; effects to the prevalence and intensity of plant and animal diseases; effects to salmon habitat/stocks; adaptation required by subsistence users; and increased urbanization and economic pressures which promote habitat loss and fragmentation. The effects to fish from changes in river and stream flow, sedimentation, and temperature are largely unknown and may vary by species. Without a better understanding of the potential changes in hydrology associated with projected warmer temperatures and increased precipitation, it is difficult to predict the outcome of impacts to fish and their habitat, and to Refuge communities that rely significantly on salmon.

Greenhouse gases, which may contribute to global warming, have increased rapidly since the beginning of the industrial revolution in about 1750 AD. These include a 31% increase in carbon dioxide (CO_2), a 17% increase in nitrous oxides, and a doubling of methane concentrations (Intergovernmental Panel on Climate Change 2007). U.S. emissions of greenhouse gases in 2005 were about 7,150 million metric tons of carbon dioxide equivalent (CO_2e) emissions (Energy Information Administration 2006).

Alaska currently produces about 50 million metric tons of CO_2e emissions and is expected to produce about 60 million metric tons per year by 2020 (Alaska Department of Environmental Conservation 2007). About 5% of these emissions, or approximately 2.5 million metric tons, are from the oil industry at a production rate of about 864,000 barrels (bbls) per day and a refining capacity of 373,500 bbls per day.

Specific effects of climate change, including the cumulative effects, on Refuge resources are evaluated in the Environmental Consequences chapter. The potential for climate change to exacerbate impacts on Refuge resources under the alternatives is also discussed in the Environmental Consequences chapter.

3.3.1.2 Air Quality

Air quality in interior Alaska is considered to be relatively pristine (Rozell 2000; Hinzman et al. 2005; Blakesley 2007), but is affected by both natural and man-made emission sources. Natural sources include wildland fires and windblown dust. Man-made sources include stationary and mobile sources from vehicles and equipment, wood-burning stoves, and industrial facility emissions.

The Refuge is in an area that is considered to be in attainment for all criteria pollutants. The concentrations of regulated air pollutants are typically much lower than the maximum concentrations allowed under the National Ambient Air Quality Standards (NAAQS) and the Alaska Ambient Air Quality Standards (AAQS; **Table 3-2**). Air quality is regulated by State (Alaska Department of Environmental Conservation [ADEC]) and Federal (U.S. Environmental Protection Agency [EPA]) regulations, standards, and implementation plans established under the Clean Air Act. These air quality regulations require that proposed new sources, or modifications to existing air pollutant emission sources, undergo a permitting review before they are constructed or modified. This permitting review includes State- and Federal-enforced legal requirements to ensure air pollutant concentrations in ambient air remain within specific allowable levels. Depending on the source size, regulatory agencies would require a site-specific ambient air quality impact analysis of the projected emissions and emission control measures to ensure protection of air quality resources. If necessary, air quality permits issued by the State would contain a number of conditions to protect ambient air quality.

Arctic haze, ice fog, strong and persistent temperature inversions, and smoke from wildland fires can adversely impact air quality of the Yukon Flats. Arctic haze refers to the visible haze layers observed in arctic Canada and Alaska, far from any known sources of pollution. Evidence from meteorological studies indicates that the pollution comprising arctic haze originates in industrial regions of the world, mainly in Europe and Russia (Alaska Department of Environmental Conservation 2002). Arctic haze occurs during winter and early spring, when the arctic air mass covering the top of the globe expands into industrial areas and traps airborne contaminants within its circumpolar boundary. Even in haze conditions, pollutants are in low concentrations. The arctic air mass is cold, stable, and relatively dry, so there is limited opportunity for pollution to be removed from the air through rain or snowfall (Blakesley 2007).

Ice fog occurs when air temperatures are -30ºF or colder, when existing atmospheric water vapor or water vapor emitted into the atmosphere (e.g., from vehicle exhaust or generators) condenses onto small particles and forms droplets that freeze to form tiny ice crystals. Because of its origin, ice fog can be considered a type of air pollution in which the major pollutant is ice (Sechrist et al. 1989). Other than ice fog and arctic haze, few man-made pollution sources affect the Refuge. An October 15, 2007, review of the ADEC on-line air permits shows only two stationary sources (the Fort Yukon Long Range Radar site and the Gwitchyaa Zhee Utilities Company) within the Yukon Flats area operating combustion equipment that requires an ADEC air permit. Both of these sources operate under pre-approved emission limits for small stationary diesel engine installations (i.e., diesel engine driven electrical power plants), which hold potential emissions from this type of stationary source to less than 100 tons per year of nitrogen oxides.

The strong and persistent, ground-based temperature inversions known to occur in the Refuge inhibit atmospheric mixing and lead to accumulation of pollutants emitted below the inversion. Pollutants emitted in a region that has a strong inversion become trapped in the inversion, and travel and dilute very little. It is expected that localized areas of poor short-term air quality occur in the Refuge near pollution sources during strong and persistent, ground-based temperature inversions. This effect is expected to be most pronounced near population centers where emissions from combustion sources (wood-burning stoves, vehicles, and diesel-fired power generation) are concentrated.

Table 3-2 National and State of Alaska ambient air quality impact significance criteria (μg/m^3)

Pollutant	Averaging Period[1]	NAAQS and Alaska AAQS		PSD Increments[2]	
		Primary	Secondary	Class I	Class II
NO_2	Annual	100	100	2.5	25
CO	1-hour	40,000	NA	NA	NA
	8-hour	10,000	NA	NA	NA
PM_{10}	24-hour	150	150	8	30
	Annual	NA	NA	4	17
$PM_{2.5}$	24-hour	35	35	NA	NA
	Annual	15	15	NA	NA
SO_2	3-hour	NA	1,300	25	512
	24-hour	365	NA	5	91
	Annual	80	NA	2	20
Lead	Quarter	1.5	1.5	NA	NA
O_3	1-hour[3]	235	235	NA	NA
	8-hour[3]	157	157	NA	NA

Notes:

[1] Annual standards are never to be exceeded. Short-term standards (those other than annual or quarterly) are not to be exceeded more than once per year, except for O_3, PM_{10}, and $PM_{2.5}$ standards. For O_3, the expected number of days with ozone levels above the standard is not to be exceeded more than once per calendar year. For PM_{10}, the standard is attained when the 99th percentile concentration for the year is less than the standard. For $PM_{2.5}$, the standard is attained when the 98th percentile concentration for the year is less than the standard.

[2] PSD increments are the maximum amounts of pollutants allowed above a specified baseline concentration. Class I areas are predominantly large national parks and wilderness areas as of August 7, 1977.

[3] The 1-hour NAAQS will no longer apply to an area 1 year after the effective date of the designation of that area for the 8-hour ozone NAAQS. The effective designation date for most areas is June 15, 2004.

Key:

μg/m^3 = Microgram per cubic meter.
AAQS = Ambient Air Quality Standards.
CO = Carbon monoxide.
NA = Not applicable.
NAAQS = National Ambient Air Quality Standards.
NO_2 = Nitrogen dioxide.
O_3 = Ozone.
PM_{10} = Particulate matter less than 10 micrometers in diameter.
$PM_{2.5}$ = Particulate matter less than 2.5 micrometers in diameter.
PSD = Prevention of significant deterioration.
SO_2 = Sulfur dioxide.

The Refuge is an active fire-prone ecosystem, and the frequent fires affect air quality. In July 2004, the Yukon River Basin from the Canadian border to the Bering Sea filled with smoke from 40 fires that occurred on the Yukon Flats and numerous other fires in Alaska. The smoke was contained by a stagnant air mass held in place by an inversion, and smoke concentrations exceeded levels hazardous to human health for 53 days in Fairbanks. In addition to the health issues, the heavy smoke restricted travel. Elderly or sick people had to stay in the villages. The social support system in northern Alaska weakened, as no heavy air transport aircraft could service Fairbanks and remote villages for days to weeks. Another major fire occurred in 2005, but fewer smoke-related health and visibility problems were observed than during 2004. However, Fort Yukon was threatened by fire, and it almost became necessary to evacuate older villagers and those needing constant medical care (Patten 2007).

3.3.2 Geology and Geologic Hazards

The Refuge lies within the Yukon Flats Basin. Recent and Pleistocene Epoch (the last 160 million years) alluvial, alluvial fan, lacustrine (lake), glacial, and eolian (wind-blown) deposits cover most of the surface of the Yukon Flats Basin (Williams 1962). Seismic data and geophysical modeling using gravity and magnetic data indicate that there may be at least 15,000 to 20,000 feet

of Paleocene-Oligocene-Tertiary (65.5 million to 1.8 million years ago) sedimentary deposits in the basin (Doyon 2006a; Morin and Stanley 2006).

The Yukon Flats Basin is located at the juncture of two large fault systems, the Tintina Fault System and the Kaltag-Porcupine Fault Zone (**Figure 3-2**; Banet et al. 1987). The Tintina Fault System is a trend of right-lateral strike-slip faults that extends from the southwest corner of the Refuge about 260 miles south-southeastward into Canada. Displacement along individual faults varies, and movement may have occurred during the Lower Paleozoic to the Upper Cretaceous periods (about 250 to 145 million years ago).

The Kaltag-Porcupine Fault System is also composed of a series of right-lateral faults (Banet et al. 1987). The Kaltag-Porcupine Fault System, which generally trends east-northeast, may represent a former plate boundary that extended from the Bering Sea, across northern Canada, and terminated in Greenland. However, there is no clear evidence that the Kaltag-Porcupine Fault System is the extension of the Kaltag Fault, which originates in Norton Sound on the west coast of Alaska (Lane 1998). Movement along the Kaltag-Porcupine Fault System is postulated to have begun in the Early Cretaceous Period and continued through the Late Tertiary Period (145 million to 2 million years ago).

No faults classified as active have been confirmed in the Yukon Flats area, but Haeussler and Plafker (2003) show the Tintina Fault System as “potentially” active (or active during the last 2 million years). An active fault is one in which movement has occurred within the last 10,000 years (U.S. Geological Survey 2006b). Field evidence indicates an active trace of the Kaltag Fault near its northeastern end (Brogan et al. 1975). The nearest active fault to the Refuge is the Denali Fault located about 250 miles to the south. The last major earthquake that occurred on the Denali Fault was a 7.9-magnitude event in 2002.

Soil liquefaction and other ground effects were widespread over a large area of the Tanana Valley, but the northern extent of observed effects was close to the Tanana River (Kayen et al. 2004). In the Yukon Flats area the earthquake would have been felt as vibrations that rattled household objects such as dishes and picture frames (Ruppert 2007).

Although the TAPS crosses the Denali fault, the 2002 earthquake caused limited damage to the facility, despite strong ground motion, soil liquefaction, and ground deformation and movement along the fault (Hall et al. 2003). Ground motion approached the design criteria for the pipeline, and ground rupture consisted of 18 feet of lateral slip and 2 feet of vertical displacement on the north side of the fault. Liquefaction, which occurs when ground shaking during an earthquake causes earth materials to lose their ability to support loads, occurred at susceptible places along the pipeline. No buckling or wrinkling of the pipeline was detected and no spills occurred. A few vertical support members for aboveground portions of the line were damaged and the pipe moved on specially designed shifting supports. Damage was minimized through use of modern seismic design principles, and the response of the pipeline to the earthquake was within design requirements.

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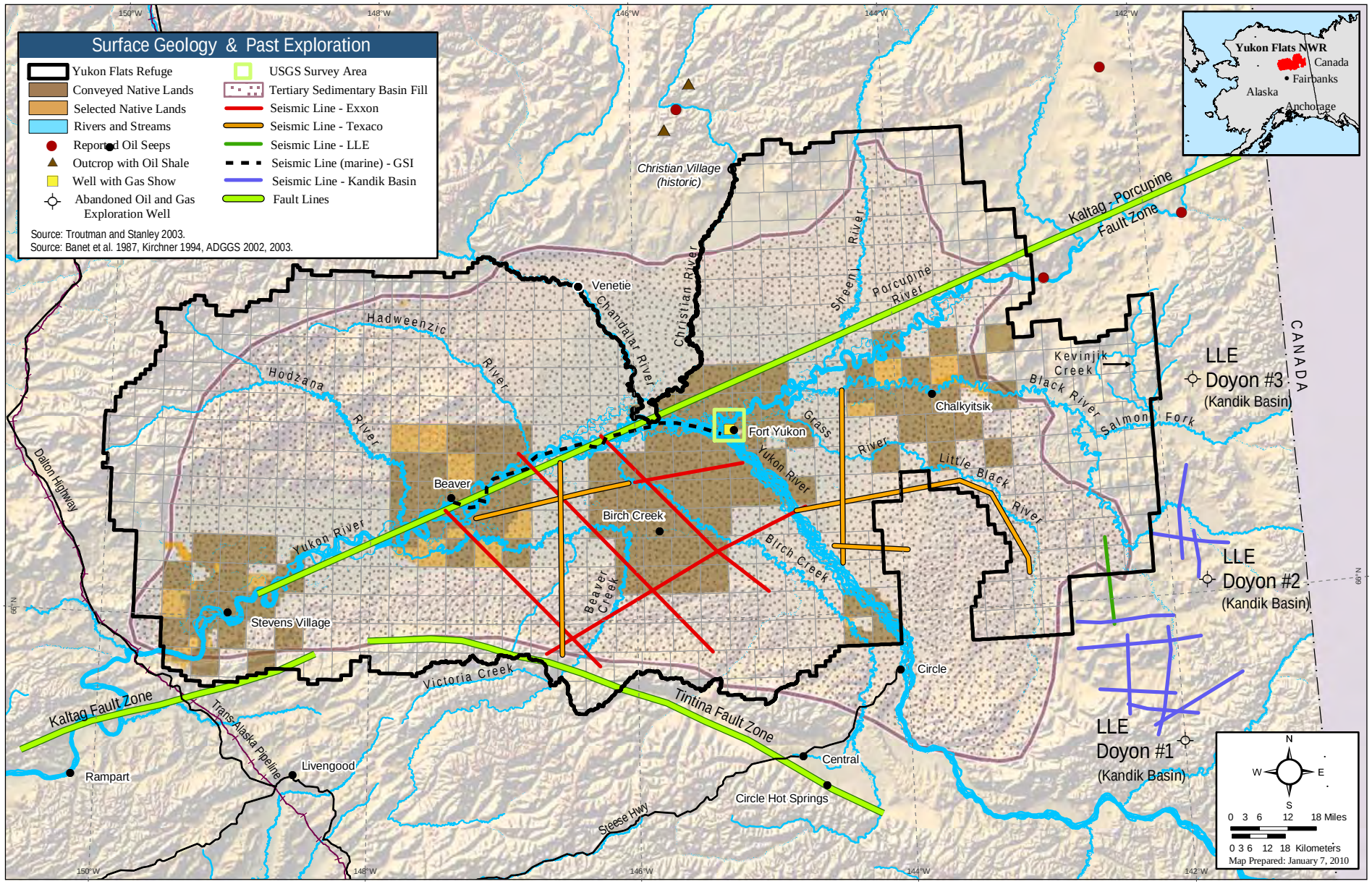
Figure 3-2

Surface Geology and Structure and Past Exploration in the Yukon Flats Refuge

Yukon Flats National Wildlife Refuge

Alaska



3.3.3 Oil, Gas, and Mineral Resources

Exploration for energy resources began in the upper Yukon River drainage in the early 20th century. Early observations of coal seams by explorers in the late 19th century prompted the U.S. Geological Survey (USGS) to conduct a survey of coal deposits in the Yukon Valley in 1902 (Collier 1903). In addition to investigating reported coal seams, Collier also attempted to identify gold placer potential, collect fossils, and otherwise describe and correlate the stratigraphy in close proximity to the Yukon River. The survey was conducted from the Canada border to the Yukon River Delta in the summer of 1902. Collier (1903) did not identify any coal seams along the Yukon River within the Yukon Flats.

Prior to World War II, the U.S. Government conducted many surveys of the upper Yukon River under the auspices of the USGS. These surveys were mainly concerned with exploration for precious and base metal mineral resources, basic geological mapping, and topographic mapping (Mertie 1937). After World War II, oil companies and the USGS began to take an interest in the potential oil resources of Alaska based on noncommercial discoveries of crude oil in the National Petroleum Reserve-Alaska (Bureau of Land Management 2005). In 1954, the USGS conducted airborne magnetometer studies in the major Alaska basins south of the Brooks Range, including the Yukon Flats Basin (Gates 1955). In 1955, an undisclosed oil company conducted geological field investigations in the area bounded by the Yukon River, Porcupine River, and the U.S.-Canada boundary (Gates 1956).

In the early and mid-1970s, geological and geophysical survey parties were reported to be active in the Yukon Flats-Kandik Basin areas (Day et al. 1974; Kugler 1976). Geophysical Services Incorporated conducted a 2-dimensional (2-D) seismic survey in the Yukon River between Beaver and Fort Yukon in 1970 (**Figure 3-2**). Seismic surveys were also conducted in the U.S. portions of the Kandik Basin just east of the Refuge. One line conducted by Louisiana Land and Exploration (LLE), in the area between the Yukon Flats Basin and the Kandik Basin, extended into the Refuge at the southeast corner (Ehm 1983).

In 1976, LLE completed an exploration well (LLE Doyon #1) on Doyon lands in the Kandik Basin east of the Refuge. The well was drilled as part of an exploration agreement with Doyon that resulted in two more exploratory wells in 1997 (LLE Doyon #2 and LLE Doyon #3) east of the Refuge in the Kandik Basin (Herrera 1977). The LLE Doyon # 1 well was drilled to a true vertical depth of 10,836 feet, and was plugged and abandoned in August 1976; no oil and gas shows were reported for this well (Alaska Oil and Gas Conservation Committee 2006). The LLE Doyon #2 was drilled to a depth of 9,123 feet, and the LLE Doyon #3 was drilled to 13,533 feet. No oil and gas shows were reported in the three tests performed on these wells (Petroleum News 2005).

Texaco conducted five 2-D seismic lines totaling about 178 miles in the southern and eastern parts of the Refuge in 1972 (Doyon 2006a). Exxon subsequently conducted five 2-D seismic survey lines totaling about 240 miles in southern portions of the Refuge in 1988. Some of these Exxon and Texaco survey lines were on the core lands. Data from five of the survey lines by Exxon totaling 240 miles and three of the lines by Texaco totaling 81 miles are now owned or licensed by Doyon. These seismic efforts have yielded important information about the basin structure, which provides encouraging implications for hydrocarbon accumulation in the Yukon Flats Basin (Doyon 2006a).

Rougeot Oil and Gas carried out oil and gas exploration on Venetie Tribal lands in the early 1980s (Native Village of Venetie 1981; Payne 2006). A single seismic line with a northwesterly bearing and terminating north of the historic village of Christian was shot on the east side of the Venetie Tribal lands (Payne 2006). This line is not shown on **Figure 3-2** as data are unavailable. The effort also involved investigation of reported oil shale and oil seeps in the area. Observations of surface outcrops indicated high levels of thermal maturity, but potential reservoir rocks had very low porosity.

In 2001, the Alaska Division of Geological and Geophysical Surveys, in cooperation with the Kansas Geological Survey, conducted a high-resolution, shallow reflection seismic survey in Fort Yukon. The survey was conducted along roads in the village as part of a study to assess potential coalbed methane resources for local power and heating needs (Clough 2001). Holes were drilled at Fort Yukon in 1994 and 2004; however, these borings were not drilled in the exploration of conventional hydrocarbon resources. The 1994 boring was drilled to obtain a core for paleoclimate research, and the 2004 boring was a re-entry into the 1994 hole to drill deeper and test for coalbed methane potential that could be used for local power and heating needs (Clough et al. 2006). Although the second boring encountered coal seams with gas (well with gas shown in **Figure 3-2**), the gas saturations encountered were low, and the investigator determined that large amounts of water would potentially have to be pumped from the coal seams to obtain reasonable gas production (Petroleum News 2005; Stanley et al. 2006). No other test borings have been drilled in the Yukon Flats Basin.

3.3.3.1 Evidence of Oil and Gas

Source Rock and Oil Seeps

One credible potential source rock has been identified that might be found in the Yukon Flats Basin. This potential source rock is an organic-rich oil shale reported to be from the Glenn Shale (Banet et al. 1987). This oil shale occurs opposite the mouth of the Nation River at the Yukon River approximately 90 miles southeast of the southeast corner of the Refuge. Test samples of the shale produced oil at a rate of 28 gallons per ton (Mertie 1937). The Glenn Shale may be equivalent to the Shublik Formation, an important source rock on the North Slope. The Glenn Shale may underlie the Tertiary section in the Yukon Flats Basin, and if so, it has the potential to generate hydrocarbons.

Tasmanite, a type of marine oil shale, has been found east of the Christian River, about 27 miles north of the historic Christian Village and about 55 miles north of Fort Yukon (**Figure 3-2**). Samples of the shale yielded from 60 to 144 gallons of oil per ton of rock (Troutman and Stanley 2004). No in-place outcrops of the shale are known, despite numerous efforts to find them. Because the oil shale is associated with igneous and sedimentary rocks of the Tozitna terrane with an igneous-metamorphic level of thermal maturity, it is considered an unfavorable geologic setting for the occurrence of oil (Troutman and Stanley 2004). The U.S. Bureau of Mines conducted mapping and sampling programs in 1944, 1976, and 1977 to assess reported oil shale on Venetie lands (Baggs and Blasko 1979). The surveys consisted of mapping, trenching, hand-auguring, and taking of samples for geochemical analysis. No bedrock oil shale deposits were found in place, and the analytical work was inconclusive.

Coal is a potential source rock for natural gas that may be present in coalbeds or may have migrated from coal into conventional reservoirs. A possible hydrocarbon show in the Yukon Flats Basin was encountered in a stratigraphic core hole drilled by the USGS near Fort Yukon in 1994.

An unidentified gas (presumed to be methane) was reported seeping out of a rock core with lignite beds that was taken from the bottom 30 feet of the hole, which was drilled to a total depth of 1,280 feet (Troutman and Stanley 2004). A deeper boring in the same location later yielded gas from coal core samples (Stanley et al. 2006). However, the well (well with gas shown in **Figure 3-2**) was located on village corporation lands that are not involved in the proposed land exchange.

Geochemistry

The thermal maturity of Yukon Flats Basin surface exposures was mapped in support of a USGS assessment of potential oil and gas resources (Crews et al. 2005). Thermal maturity is a measure of source rock potential to generate gas or oil. The results of the study indicated that surface Tertiary rocks were generally under-matured; however, a few samples along the Tintina Fault Zone exhibited moderate thermal maturities. These samples were postulated to have been buried and then brought back to the surface by movement along the fault. The general under-maturity indicates that oil generation would not occur, but at least in the shallower areas of the basin, gas generation is likely to occur from biogenesis (derived from organic decay). It is possible that deeper buried source rocks may be more thermally mature and generate oil and thermogenic gas where the organic material is converted to hydrocarbons by the action of heat and pressure.

3.3.3.2 Hydrocarbon Resource Assessments

USGS Assessments

The USGS issued an initial assessment of the oil and gas resources of Yukon Flats in 1989 in which the Yukon Flats Basin was placed into a group of interior basins referred to as the Tertiary Basin Play (Magoon 1989). All were characterized as having accumulations of Tertiary-aged rocks that had natural gas potential in anticlinal structures. The USGS estimated that over 1.0 trillion cubic feet of recoverable gas could be present in the Tertiary Basin Play. The assessment did not provide estimates for individual basins.

In 1995, the USGS issued oil and gas assessment of the interior Alaska basins, but this time the basins were included in what was referred to as the Central Alaska Province (Stanley 1995). Designation of the Central Alaska Province provided a geographic category to assess a number of different oil and gas plays. An oil and gas play has been defined by the USGS (1995) National Oil and Gas Assessment Team as “a set of known or postulated oil and (or) gas accumulations sharing similar geologic, geographic, and temporal properties, such as source rock, migration pathway, timing, trapping mechanisms, and hydrocarbon traps.” The former Tertiary Basin Play was renamed the Central Alaska Cenozoic Gas Play and considered hypothetical, as no commercial gas had been discovered in the play. The Cenozoic Gas Play was expanded to consider more than a dozen sedimentary basins in central Alaska. In this assessment, the USGS estimated that there was a mean of over 2.2 trillion cubic feet of technically recoverable gas. Technically recoverable means that the resource would be recoverable by existing technology.

In 2004, the USGS issued a new resource assessment for the Yukon Flats Basin after re-analyzing existing data and analyzing new data collected during magnetic and gravity surveys (Stanley et al. 2004). The USGS estimated the volume of technically recoverable undiscovered hydrocarbons in the Yukon Flats Basin to be a mean of 172.66 million barrels (MMbbls) of oil, 5.46 trillion cubic feet of gas, and 126.67 MMbbls of natural-gas liquids (**Table 3-3**). The USGS fact sheet on the assessment is provided in **Appendix F**.

The 2004 assessment used the concept of "Total Petroleum System" to evaluate the hydrocarbon potential of the basin. The Total Petroleum System concept has several geological elements that include:

- Source Rocks – Source rock maturation, hydrocarbon generation, and migration.
- Reservoir Rocks – Deposition of potential reservoirs and the properties of those reservoirs (ability for hydrocarbon fluids to migrate into and be produced from).
- Hydrocarbon Traps – The formation of traps, timing of hydrocarbon emplacement, and entrapment of hydrocarbons.

The assessment defined four units: Tertiary Sandstone Assessment Unit, Subthrust Assessment Unit, Crooked Creek Assessment Unit, and Coalbed Gas Assessment Unit. The Tertiary Sandstone Unit, which was assigned about 97% of the mean undiscovered gas resource and 96% of the mean undiscovered oil resource, encompasses the lowland area of the Refuge and most of the lands involved in the land exchange, including most of the core lands (Stanley et al. 2004; Till et al. 2006). Quantitative assessments of the Coalbed Gas Unit are planned for the future (Stanley et al. 2004).

Doyon Assessment

Petrotechnical Resources of Alaska LLC conducted an independent oil and gas resource assessment of the Yukon Flats Basin for Doyon (Doyon 2006a). They concluded that the basin contains an estimated 100 to 800 MMbbls of oil from structures in the southern part of the basin, an estimated 1 billion bbls of oil in the total basin, and an estimated 5.5 trillion cubic feet of gas. Their review indicated a possible structure is present in the southern part of the basin that has a potential minimum closure area (an oil field trap) of at least 30,000 acres. Because the recoverable resource is from a single structure, total hypothetical resources in the basin could be much higher. Given the lack of direct hydrocarbon indicators (verified hydrocarbon shows in drilled wells or commercial production), however, the assessment is highly speculative. The Doyon resource assessment suggested that the Yukon Flats Basin is similar to geological settings in China and India where prolific oil and gas production has occurred. These other basins are in rifted settings with thick sections of Cenozoic deposits composed of rocks derived from fluvial environments.

The USGS and Doyon oil and gas assessments differ because the USGS uses publicly available and publishable data and focuses on the mean volume, whereas industry assessments typically include proprietary information and focus on the high end of the estimated range of total undiscovered resources (expressed as F5 in **Table 3-3**). Still, only drilling can confirm the presence of oil and gas and refine the estimates.

Areas Identified as Having Potential for Oil and Gas

Oil and gas resources form at certain depths in the earth under certain conditions but may subsequently migrate laterally or upwards through the earth. Assessments based on gravity and magnetic surveys have enabled scientists to map the deeper areas of the basin where sedimentary fill is comparatively thick (Barnes 1977; Decker and Karl 1977; Ehm 1983; Morin 2002). Bedrock geologic data for the Yukon Flats Basin suggests that any technically recoverable oil and gas resources are likely to be in the deeper parts of the basin with the maximum amount of sedimentary fill. In 2006, the USGS (Till et al. 2006) re-mapped the limits of the Yukon Flats

Table 3-3 USGS estimates of undiscovered recoverable oil and gas resources in the Yukon Flats Basin

Assessment Unit[1]	Type[2]	MAS[3]	Prob[4] (0-1)	Total Undiscovered Resources											
				Oil (MMbbls)				Gas (BCFG)				Natural Gas liquids (MMbbls)			
				F95[4]	F50	F5	Mean	F95[4]	F50	F5	Mean	F95[4]	F50	F5	Mean
Tertiary sandstone	Oil	0.5	0.81	0.00	106.77	560.35	165.57	0.00	103.49	565.05	165.80	0.00	6.04	34.46	9.97
	Gas	3						0.00	4,629.17	12,862.56	5,117.36	0.00	98.15	295.67	112.51
Subthrust	Oil	0.5	0.24	0.00	0.00	3.39	0.61	0.00	0.00	3.36	0.61	0.00	0.00	0.20	0.04
	Gas	3						0.00	0.00	92.91	15.94	0.00	0.00	2.04	0.35
Crooked Creek	Oil	0.5	0.48	0.00	0.00	28.75	6.47	0.00	0.00	29.06	6.55	0.00	0.00	1.76	0.40
	Gas	3						0.00	0.00	714.96	156.36	0.00	0.00	15.89	3.42
Coalbed gas	Gas		Not quantitatively assessed												
Total				0.00	106.77	592.48	172.66	0.00	4,732.66	14,627.89	5,462.63	0.00	104.18	350.02	126.67

Notes:

[1] The Tertiary Sandstone Unit encompasses the lowland area of the Yukon Flats. The Subthrust, Crooked Creek, and Coalbed Gas units follow the Tintina Fault Zone curve and encompass the southern upland area of the Refuge.
[2] Accumulation type.
[3] Minimum accumulation size assessed is million barrels of oil and billion cubic feet of gas.
[4] Probability of at least one accumulation equal to or greater than the MAS. Results shown are fully risked estimates. For gas fields, all liquids are included under the natural gas liquids category; fractiles are additive only under the assumption of perfect positive correlation.
[5] F95 denotes a 95% chance of at least the amount tabulated. Other fractiles are defined similarly. Fractiles are additive only under the assumption of perfect positive correlation.
Shading indicates not applicable.

Key:
BCFG = Billion cubic feet of gas.
MAS = Minimum accumulation size.
MMbbls = Million barrels.
Prob = Probability.

Source: Stanley et al. 2004.

Basin using existing data and new data from magnetic and gravimetric surveys and other sources. This effort mapped a much larger area of the Yukon Flats Basin and Refuge as sufficiently deep to have potential for oil and gas generation than was the case when lands were selected for the proposed land exchange and the Agreement in Principle was negotiated. **Figure 3-3** shows those areas in the Refuge under which the basin is thought to be deep enough (>8,200 feet) to have generated oil and gas, plus surrounding areas where any generated oil and gas may have migrated. These two areas together represent the lands thought to hold potential for oil and gas resources that could be extracted. These areas identified as having potential for oil and gas total approximately 2.9 million acres, of which about 1.5 million acres are within areas where the basin is 8,200 feet or more deep (the remainder being areas to which oil may have migrated). Areas identified as having potential for oil and gas encompass the core lands as well as other lands involved in the land exchange that would be received by Doyon or the U.S. Fish and Wildlife Service (Service).

In 2007, new mapping was published for the Yukon Flats that suggested that the depth of sedimentary fill needed to generate hydrocarbons may be less (6,000 feet or more deep) than predicted during earlier mapping and that the area potentially containing oil and gas may be somewhat larger than the area shown in **Figure 3-3** (Rowan and Stanley 2007), and would encompass more of the area shown as sedimentary fill in **Figure 3-2**. Even if conditions are right for oil generation, many other factors influence whether hydrocarbons are trapped in high enough concentrations to make drilling profitable.

Coal

The Yukon Flats Basin is not designated as being within a coal province or coal field (Flores et al. 2003). In spite of the identification of coal in the subsurface and in outcrops, no information exists on the potential coal resource in the basin. The coals encountered in test holes drilled in 1994 and 2004 near Fort Yukon were lignitic coals at depths from 1,257 to 1,315 feet and from 1,875 to 1,920 feet, and were interpreted to be upper Tertiary in age (Clough et al. 2006). The Drew Mine in the Rampart area is the nearest locality to Yukon Flats where coal has been mined (Collier 1903; Gassaway and Abramson 1977a). The mine produced 1,000 tons of bituminous coal before closure in 1902.

Sand and Gravel Resources

Extensive alluvial, alluvial fan, terrace, and braided stream deposits associated with Refuge rivers and tributaries contain abundant gravel and can provide readily available aggregate for construction of permanent roads and pads. Williams (1962) described the gravel deposits as being available in large quantities in an unfrozen condition in or near the Yukon River and its tributaries, and in large quantities in the alluvial fans and related terraces of other larger rivers in the Yukon Flats. Away from the rivers, the gravel deposits are perennially frozen and under relatively thin depths of overburden ranging from 1 to 25 feet. Sand deposits, which also are commonly frozen, are found in the marginal upland, are relatively clean, and are generally beneath 5 to 10 feet of overburden. Sand and gravel resources in the Refuge and Alaska in general are poorly defined (Szumigala 2007).

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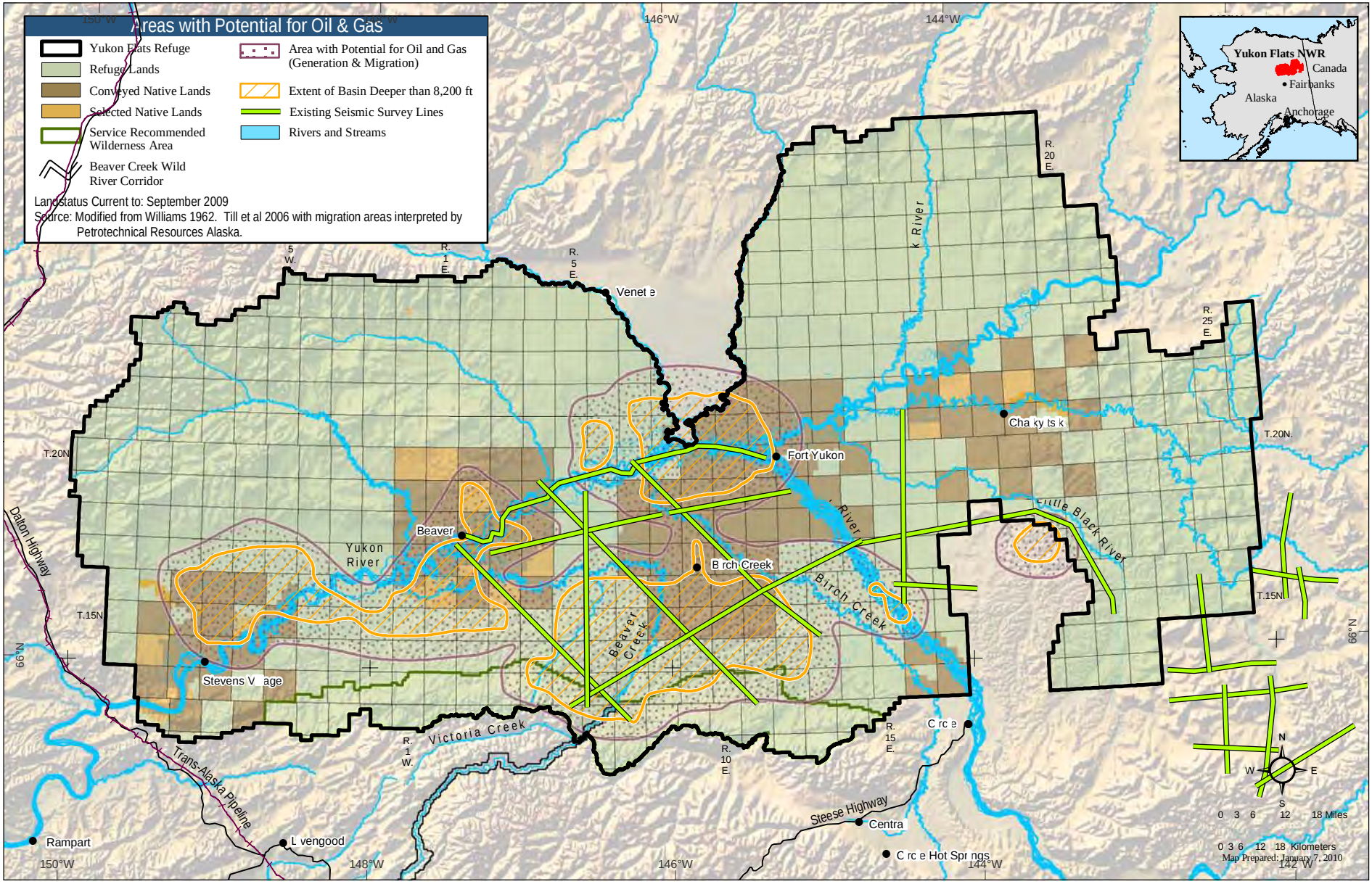
Yukon Flats National Wildlife Refuge, Alaska

Figure 3-3

Areas with Potential for Oil and Gas in the Yukon Flats Basin



Other Mineral Resources

Other than gold placers along the upper reaches of Birch Creek and a hot spring 20 miles northwest of Stevens Village, no identified occurrences or development of other mineral resources, including precious and base metal ore deposits and industrial rocks and minerals (excluding sand and gravel), are known in the Yukon Flats Basin (Eakins and Forbes 1976; Cobb 1977; Eberlein et al. 1977; Gassaway and Abramson 1977b; Motyka et al. 1983; Szumigala and Swainbank 1998; Pinney and Duenwald 2001). The Refuge is currently closed to mineral development.

3.3.4 Soil

Four soil orders, or general types of soils, are found in the Refuge, as described below. Soil types and characteristics help to determine types of vegetation found on the surface and the response of soils to surface and subsurface disturbances.

Entisols. Entisols, which are found over about 15% of the Refuge, are soils that have been formed recently and do not have much soil horizon development. They are found in areas of alluvium (sediments deposited by flowing water). Entisols are found in much of the Yukon Flats lowland or floodplain area (Brabets et al. 2000).

Gelisols. Gelisols, which are found over about 54% of the Refuge, have permafrost within about 40 inches of the surface and (or) have gelic materials within 40 inches of the soil surface and permafrost within about 80 inches of the soil surface. Gelic materials are mineral or organic soil materials that have evidence of frost churning in the active layer, where seasonal thaw occurs or in the upper part of the permafrost (Brabets et al. 2000). Gelisols are present in the upland areas of the Refuge.

Inceptisols. Inceptisols, which are found over about 16% of the Refuge, are newly formed soils that have a greater degree of soil horizon development than Entisols. Inceptisols and Entisols are the dominant soil orders in the lowland areas of the Refuge.

Inceptisols/Gelisols. These are Inceptisols that exhibit some of the characteristics of Gelisols and are classified as Inceptisols/Gelisols. These soils occupy about 15% of the Refuge.

3.3.4.1 Permafrost

Permafrost is defined as earth materials that remain frozen (below 32ºF) for at least 2 consecutive years (U.S. Permafrost Association 2006). The atmospheric climate is the main factor determining the existence of permafrost. However, the spatial distribution, thickness, and temperature of permafrost are highly dependent on the temperature at the ground surface. The temperature at the ground surface, although strongly related to climate, is influenced by several other environmental factors such as vegetation type and density, snow cover, drainage, and soil type (Natural Resources Canada 2007). Vegetation, which leads to deeper snow cover, and the large amount of water cover maintained by lakes and river channels are the main factors contributing toward maintaining warmer ground temperatures that can reduce the extent of permafrost. Another natural factor that affects permafrost is wildland fires. After a fire, the change in surface conditions results in soil warming and increased active depths. The soil may become well drained and may no longer have a perched water table. Thus, the hydrology changes and areas that were once wet may dry out (Brabets et al. 2000).

The Refuge is completely within an area mapped as discontinuous permafrost. The lowland area of Yukon Flats is probably underlain by thick permafrost, the base of which may be over 1,000 feet deep (Ferrians 1965). In the marginal upland areas, permafrost may be of variable thickness, down to a depth of 600 feet. Permafrost may be much thinner underneath major rivers. In a well drilled at Fort Yukon in 1954 (total depth 400 feet), the permafrost extended to a depth of 390 feet; however, the well was so close to the Yukon River that it is probably not representative of the entire Refuge area. The permafrost soils act as a barrier to infiltration and as a confining layer to aquifers.

3.3.5 Paleontologic Resources

The Refuge has never been surveyed for paleontological resources. The State of Alaska maintains a database of recorded sites with paleontological resources in the State (www.Alaskafossil.org). No sites have been recorded within the core lands, but several sites are to the south and west of the core lands and off the Refuge. Two sites to the south of the core lands contain Paleozoic and Triassic radiolarian faunas (site 81AWr130) and Ordovician-Devonian tabulates and bryozoans (site 79Tx601c). To the west are a cluster of localities including sites with Amphipora sp. of the Middle to early Late Devonian age (sites 70Ach30f, 69Ach231, and 69Ach233); and conodonts and crinoids from the early Devonian through middle Devonian age (site 85AW667).

3.3.6 Water Resources

The Refuge lies within the larger Yukon River Basin, which encompasses 330,000 square miles (mi^2) in northwestern Canada and central Alaska and is the fourth largest drainage basin in North America (Brabets et al. 2000). Because it drains relatively undisturbed terrain, and continuously suspends, transports, and re-deposits sediment, the Yukon River is still considered pristine (U.S. Geological Survey and Yukon River Inter-tribal Watershed Council 2007).

Surface water, as lakes, ponds, sloughs, and streams, is the dominant feature of the Refuge landscape (Trawicki 2000). The Service estimates that there are over 17,000 lakes and 7,100 miles of rivers within the Refuge; others have placed the estimate as high as 40,000 lakes depending on minimum lake size (U.S. Fish and Wildlife Service 1987a). Patterned with braided and meandering streams, numerous thaw and oxbow lakes, and meander scars, the Refuge is a relatively flat, marshy, basin floor. A 300-mile stretch of the Yukon River bisects the Refuge, creating the dominant terrain feature (Trawicki 2000). Major tributaries of the Yukon River within the Refuge include the Chandalar, Sheenjek, Hadweenzic, and Hodzana rivers (**Figure 3-4**). Tributaries of the Yukon River that are found in or near lands that would be involved in the land exchange include the Black River and Little Black River, Dall River, Grass River, Porcupine River, and Birch and Beaver creeks.

The water (hydrologic) cycle describes the continuous movement of water on, above, and below the surface of the Earth. Surface water bodies are connected to groundwater in most types of landscapes. As a result, surface water bodies are important parts of groundwater flow systems (Winter 1999). The movement of surface water and groundwater is controlled to a large extent by topography. In turn, the sources of water to, and losses of water from, the earth are controlled by climate.

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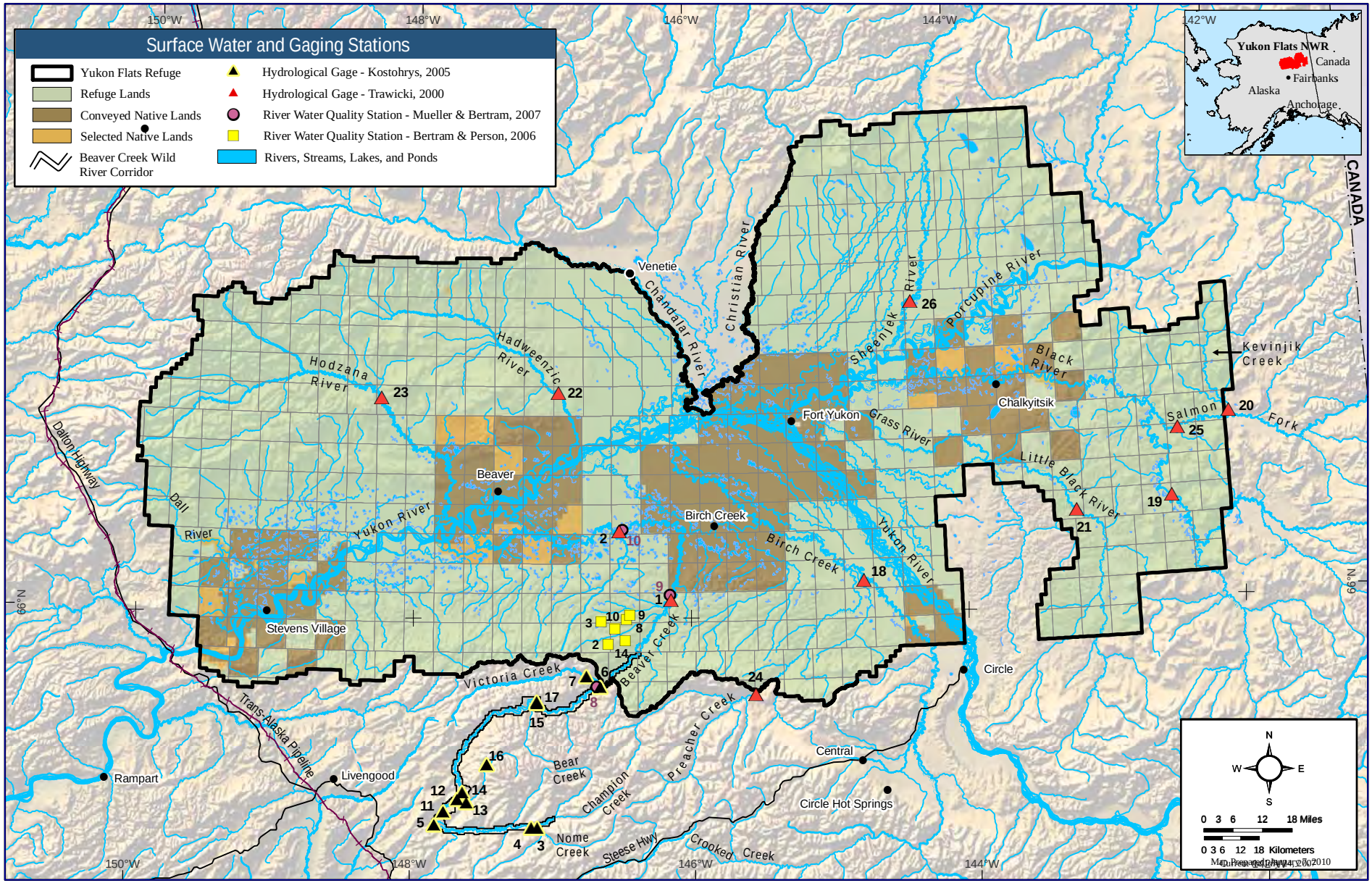
U.S. Fish & Wildlife Service

Figure 3-4

Rivers, Streams, Lakes, and Ponds of the Yukon Flats Refuge

Yukon Flats National Wildlife Refuge
Alaska



The hydrology of the Yukon Flats region is complex and not well studied. Approximately 52% of the Refuge is comprised of uplands and highlands that occupy periphery habitats to the wetlands. The hydrologic system of the region is likely a continuum as described in previous studies, in that regional groundwater flow systems are recharged in uplands and discharged in lowlands (Winter 1988). In addition to groundwater, hundreds of feeder streams channel water directly from upland and highland habitats to lowlands. Both closed and open basin lakes are found on the Refuge, and some have direct contact with groundwater (Heglund and Jones 2003). The following describes the hydrologic and water quality characteristics of surface and groundwater on the Refuge.

3.3.6.1 Surface Water Resources

The hydrologic cycle of the Yukon Flats is somewhat predictable and occurs in a chronological order: freeze-up, declining winter flows to baseflow conditions, break-up (often with ice jams, and overbank flooding), summer flows with storm and drought events, returning to freeze-up (Trawicki 2007a). The timing, magnitude, and duration of the hydrologic cycle vary annually due to weather and climatic conditions. River and lake ice conditions are a significant component of the hydrologic cycle on the Yukon Flats.

Beginning in October, the flows in Refuge rivers gradually decrease; the rivers experience their lowest flow in the winter when there is no surface runoff and inflow is primarily from groundwater. Depth of snowpack appears to have a significant impact on the minimum winter flow, as the lowest measured discharges have occurred during the winters with lower snow depths, especially when snow is below normal early in the winter. Conversely, the highest winter streamflows were measured during the periods of highest snowfall (Kostohrys 2005). Flows in some streams and tributaries can drop substantially, adversely impacting overwintering habitat for fish. Ice thickness can exceed 6 feet on some ponds.

Water inputs into Refuge tributaries are through snowmelt. Water discharge is much greater during snowmelt than during winter, even if snowfall and rainfall are below average. Most runoff occurs from May to September; however, the timing of runoff in the rivers differs, depending on the particular drainage basin characteristics (Brabets et al. 2000).

The Yukon River and some of its tributaries are prone to flooding, with some of the worst flooding in Alaska occurring along the Yukon River. The major flood hazard in the Refuge is from ice jams during spring break-up, although flooding from ice jams appears to have become less frequent than in the past (Brabets et al. 2000). Major floods due to ice jams have occurred at Fort Yukon in 1949, 1972, 1982, 1989 (Nakanishi and Dorava 1994), and 2009. Gauging stations were not installed along the Yukon River until the 1940s and 1950s, so the flood history before then is not well documented. Ice jams occur during spring thaw when broken ice collects in shallow or narrow points along the river channel or along sharp bends in the river. Water collects behind the ice jam and floods adjacent lands. Ice jams eventually break loose and discharge waters at high velocity, creating additional flooding conditions downstream.

Yukon River tributaries can also flood in the summer rainy season (Brabets et al. 2000). For instance, the White Mountains that border the southern boundary of the Refuge can discharge heavy runoff from precipitation in early summer that floods Beaver, Preacher, and Birch creeks (Bertram 2006a).

Bayha and Wolfe (1999) reviewed the hydrology of Refuge lakes. They discovered that lakes have differing biological, physical, and chemical properties and categorized them as lowland (shallow and productive during warmer months), foothill (deepest with low productivity), and

oxbow (intermediate depths that support overwintering of fish) lakes. Some lakes are part of defined drainages, others are recharged by sheetflow across the frozen taiga during spring break-up and by summer thunderstorms, and others are dependant on recharge from over-bank flooding of rivers plugged with ice jams and summer thunderstorms. Lake water level is typically low and static through the ice-covered portion of the year, with a rapid rise in May due to snowmelt followed by a decline throughout the summer to winter levels.

Using remote sensing, Riordan et al. (2006) found a substantial landscape-level decreasing trend in surface water and number of closed-basin ponds on the Refuge, despite there being no apparent decreasing trend in annual precipitation rates. The reduction in surface water and number of ponds is believed to be due to increased drainage to groundwater, as permafrost warms and makes the underlying soils more permeable to water, and increased evapotranspiration during warmer and longer growing seasons. The closed pond surface area showed a slight increase over time at higher elevations, while lower elevations had a decrease of more than 18%. In the long term, high flows experienced in the summer due to runoff may decrease, while base flows in the stream may increase through increased groundwater discharge to the streams (Brabets et al. 2000).

The Yukon River and Chandalar River are the sources of drinking water for residents of Stevens Village and Arctic Village, respectively.

Beaver Creek

Beaver Creek is the largest river within the core lands. Approximately 127 miles of Beaver Creek (16 miles within the Refuge) are designated as a National Wild River (see Section 3.5.2.2). The stream begins at the confluence of Bear Creek and Champion Creek in the White Mountains National Recreation Area (WMNRA), then flows 111 miles to the southern Refuge boundary, and then another 188 miles in the Refuge to its confluence with the Yukon River (**Figure 3-4**).

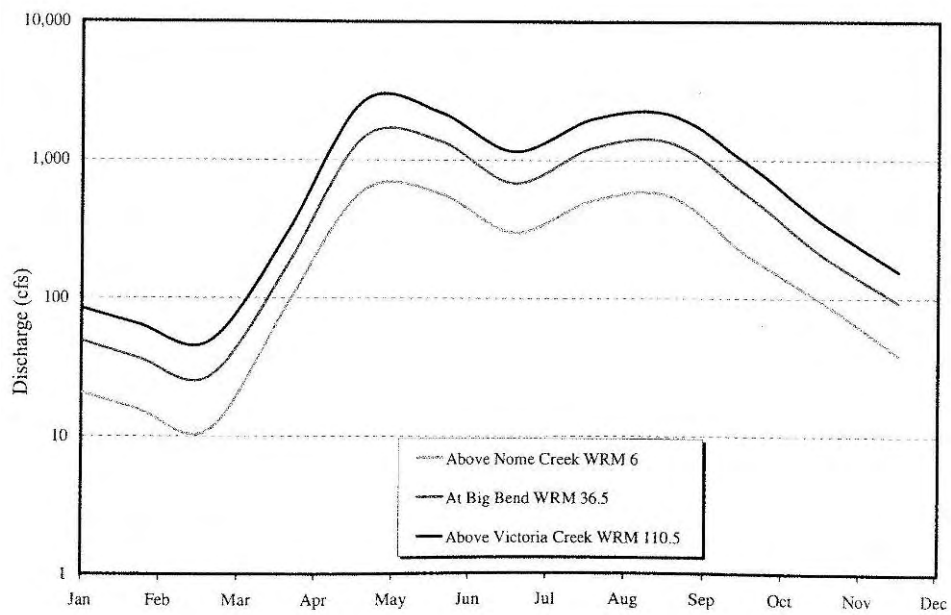
Beaver Creek is characterized by gradual reduction in gradient, lessening from 8 feet per river mile upstream to less than 2 feet per river mile downstream in the area of the proposed core lands. The width of the channel averages about 150 feet with water depths of 2 to 6 feet and scattered deep pools to 10 feet. Broad gravel bars with alders and willows occur frequently. The river bottom consists predominantly of gravels and sands with silt content increasing downstream. There is generally sufficient water depth for shallow-draft motorized boats (Bureau of Land Management and U.S. Fish and Wildlife Service 1983).

Kostohrys (2005) reported hydrologic data collected at gauges along Beaver Creek at the confluence with Nome Creek and at the Big Bend (both upstream of the Refuge), and on Beaver Creek's confluence with Victoria Creek (on Bureau of Land Management [BLM] lands), a few miles before Beaver Creek enters the Refuge. Beaver Creek exhibits bimodal high flow periods, with high flows occurring in May due to snowmelt and in August due to late summer rains (**Figure 3-5**). As with most interior and northern Alaska rivers, low flows are experienced in the winter. Kostohrys (2005) found that mean winter flows in upper Beaver Creek, where it enters the Refuge, were very low (minimum 0 cubic feet per second [cfs], mean 49 cfs, maximum 92 cfs) compared to months with high flows (2,665 cfs). However, winter flows were greater than expected, perhaps due to groundwater springs found in these upper reaches of Beaver Creek.

Lower Beaver Creek, just downstream of the core lands, flows out over the lowlands of the Refuge. River banks are steep, muddy, and up to 30 feet high. The substrate ranges from small gravel to silt. Vegetation along the river changes from willows and alder on the deposition side of

the channel to spruce, poplar, aspen, and birch on the upper bank (or cutbank/erosional side of the river). The river meanders with large U-bends and oxbow lakes. A gauge on lower Beaver Creek, approximately 15 miles west of Birch Creek Village (**Figure 3-4**), measured average flow rates for the period from 1994 to 1998 ranging from 250 cfs to 5,800 to cfs from May through September. Winter flow measurements in April on lower Beaver Creek from 1995 to 1998 ranged from 8 cfs to 79 cfs (Trawicki 2000).

Areas with water of sufficient depth and quality for fish in the winter (overwintering habitat) are thought to be limited and widely scattered. Lubinski (1995) used transmitters on grayling to identify fish overwintering areas in upper Beaver Creek and only found 12 such areas in about 40 miles of upper Beaver Creek located upstream of the Refuge. He found that overwintering areas were 0.1 to 4.6 feet deep and had 2 to 2.5 feet of ice cover. The upstream, steeper gradient portions of Beaver Creek have thinner ice with some open water stretches. The shallower gradient, lower parts of Beaver Creek have 100% ice cover in the winter with varying thicknesses of ice averaging 3 to 4 feet thick but up to 6 feet or more where stream overflow occurs (Trawicki 2007b).



From: Kostohrys 2005.

Figure 3-5 Monthly mean discharge hydrograph for Beaver Creek

Instream Flow Reservations

The Service has applied with the Alaska Department of Natural Resources (ADNR) for instream flow reservations for portions of Birch Creek, Beaver Creek, and for one lake within the land exchange area. The application on Birch Creek (Land Administration System [LAS] 24003) begins at the confluence with Preacher Creek and ends at the point at which it bifurcates into the lower and upper mouths of Birch Creek. The Service's application for an instream flow reservation on Beaver Creek (Land Administration System 24007) starts at its confluence with Victoria Creek and ends at the Yukon River. The BLM has been issued an instream flow reservation for Beaver Creek upstream of the Refuge (Land Administration System 11997). The Service also has filed water rights applications for Lake No. 153, which is located within proposed core exchange lands (Land Administration System 23662). The purposes of these flow

reservations are to maintain sufficient water quantity in the water bodies to protect fish and wildlife habitat, navigability, water quality, or recreation. Reservations generally set flow volumes (cfs) for rivers and set seasonal water levels (elevations) for lakes or wetlands. These reservations must be maintained, possibly limiting the use of water for other purposes. Although the Service's flow reservations on Beaver Creek are currently not adjudicated, in accordance with State law, should another entity request water rights for water usage, the Service's request to reserve certain portions of these waters would take precedence in the best interest of the public (Davis 2007). The Service plans to withdraw the application for water rights on the lake if the proposed land exchange with Doyon is approved (U.S. Fish and Wildlife Service 2005). The requested in-stream flow reservation application for Beaver Creek would not be withdrawn.

3.3.6.2 Surface Water Quality

Key components of water quality include dissolved oxygen, biological oxygen demand, turbidity, temperature, and pH. Dissolved oxygen is the amount of oxygen found in water. Biological oxygen demand is a measurement of the amount of oxygen used when organic matter in a body of water is degraded biologically. Bodies of water with high biological oxygen demand and low dissolved oxygen and no means to rapidly replenish the oxygen cannot sustain life, such as fish and algae. Turbidity is a measure of water transparency. Turbid waters with high amounts of silt and other sediments can be harmful to fish by fouling their gills and covering their eggs with sediment. The pH is a measure of water acidity, with waters having a lower pH (a pH of 7 is neutral) being more acidic than waters with a higher pH. Acidic waters can be harmful to aquatic life. Most aquatic life have adapted to a certain range of water temperatures, and both abnormally high and low temperatures can be harmful to aquatic life.

With few exceptions, water quality is generally considered good in waters of the Yukon River and the Refuge (Trawicki 2000; Heglund and Jones 2003; U.S. Geological Survey and Yukon River Inter-tribal Watershed Council 2007). However, some effects to water quality of the Yukon River Basin have been documented. These effects are due to atmospheric processes, gold placer mining, old military sites used during the Cold War, and sewage lagoons (Brabets et al. 2000). Currently the Yukon River drainage has few sources of pollution.

Historic gold placer mining operations in the Circle Mining District that began in 1893 have adversely affected water quality and natural stream morphology in the upper Birch Creek and Beaver Creek watersheds south of the Refuge in the past (Kennedy and Langley 2007). The USGS in cooperation with the BLM conducted an assessment of hydrology, water quality, and trace-element concentrations in the upper Birch Creek watershed near Central, Alaska, to provide baseline information for reclamation plan efforts (Kennedy and Langley 2007). Placer-mining operations have been responsible for generating large quantities of sediment and increasing concentrations of heavy metals downstream from mining activities (U.S. Environmental Protection Agency 1994). Moderate to high streamflows have resulted in high sediment loads from fine-grained materials from settling ponds and unvegetated unconsolidated tailings. The data collected in 2001 through 2005 from the mined lands in the Birch Creek watershed indicate that during low-flow conditions, the waters downstream of the mined areas show no substantial mining-related or sediment-related water- or sediment-quality problems (Kennedy and Langley 2007). Thus, current water quality in stream drainages with historic mining activities appears to be relatively good.

Placer mining has been conducted in the Birch Creek (Crooked Creek area) and Beaver Creek drainages south of the Refuge since the 1800s, and this has resulted in changes in water quality

and invertebrate densities that have persisted far downstream of the mining areas (Bureau of Land Management and U.S. Fish and Wildlife Service 1983). Weber (1986) reported that invertebrate densities were reduced by 87% 2 miles downstream from the mine sites, and 75% 50 miles downstream of the sites. The ADNR reported that turbidity levels in the drinking water at Birch Creek exceeded the turbidity limits by 1,400% in 1985 (U.S. Fish and Wildlife Service 1987a). The mining also resulted in elevated concentrations of toxic heavy metals in river sediments within the Refuge (U.S. Fish and Wildlife Service 1987a, 1990; Trawicki 2000). However, the current quality of Beaver Creek water is generally considered excellent.

Placer mining was conducted in Nome Creek, a tributary that enters Beaver Creek near Beaver Creek Wild River at River Mile 6, approximately 105 river miles (37 air miles) upstream of the Refuge, and placer mining may also have been conducted in Victoria Creek (**Figure 3-4**), which flows into Beaver Creek near the southern boundary of the Refuge (McGraw 2007). From the late 1800s to 1980, the headwaters of Nome Creek were extensively placer mined for gold, and most of the stream channel, associated floodplain, and riparian habitat were disturbed by dredge and earthmoving equipment. In 1991, the BLM initiated a project to realign the Nome Creek channel and restore riparian habitat. To date, approximately 10 miles of stream channel and 400 acres of floodplain have been reclaimed.

Surface water in Refuge watersheds has been sampled and analyzed for water quality and quantity (Brabets et al. 2000; Trawicki 2000; Heglund and Jones 2003; Bertram and Person 2005; Schuster 2006; Mueller and Bertram 2007). Dissolved sediments average less than 200 milligrams per liter (mg/L); streams in the Yukon Flats commonly carry less than 100 mg/L, while headwaters in the surrounding uplands may carry as much as 500 mg/L (U.S. Fish and Wildlife Service 1987a). The State of Alaska standard is 1,000 mg/L or less of total dissolved solids (sediments) for protection of aquatic life (Title 18 of the Alaska Administrative Code, Chapter 70, Water Quality Standards). Heglund and Jones (2003) studied 129 shallow lakes in the Refuge and found them to be fertile, with over 70% classified as eutrophic based nutrient content.

Within the Beaver Creek watershed are 601 lakes covering about 20 mi^2 of surface area (U.S. Fish and Wildlife Service 2005). Water quality data for Beaver Creek have been reported by Carufel (1988, 1990); Bertram and Person (2005); Mueller and Bertram (2007); and ENSR Corporation (now AECOM Environment; AECOM 2009). Carufel (1988, 1990) collected water quality data at seven sites along Beaver Creek in 1988 and 1989; six of these were located upstream of the Refuge, and one was located at the southern Refuge Boundary at the confluence with Victoria Creek. ENSR collected water quality data at eight sites along Beaver Creek. Sampling began at the confluence of Beaver Creek and Victoria Creek and continued downstream about 40 miles to the northern boundary of the core lands. Water temperature ranged from 43ºF near Victoria Creek to 59ºF at the northern survey boundary in June 2007, and from 35 to 46ºF in September. The pH ranged from 6.86 to 8.19 along the creek during the study. Dissolved oxygen ranged from 5.62 to 13.14 mg/L in June; results were similar in September. Turbidity was higher during June (range of 3.95 to 95.7 nephelometric turbidity units [NTU]) than September (1.93 to 6.32 NTU).

Table 3-4 provides baseline water data collected at six large lakes within the core lands (Bertram and Person 2005). Locations of these lakes are shown in **Figure 3-4**. Most lakes have summer surface waters not limited by oxygen saturation, dissolved oxygen levels in the bottom waters capable of supporting fish, conductivities that did not reflect chemically stratified waters, and water hardness levels indicative of soft water systems. The Service has not collected water chemistry data on the parcels that Doyon would trade to the Service. Corcoran (2005) studied the water chemistry of several wetlands near Priority parcels 1 and 15, as well as one other area.

Table 3-4 Water quality in Refuge lakes within the proposed core lands

Lake[1]	Surface Area (acres)	Average Depth of Lake (feet)	Location	Sample Depth (feet)	pH	Conductivity (µS/cm)	Temp (°C)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
2	124	9	WQ1	0	7.3	60	17.1	8.1	0.9
3	85	6	WQ1	0	7.2	109	17.6	8.1	0.6
			WQ1	23		101	7.1	3.2	4.5
			WQ2	0		103	17.1	7.8	
			WQ2	39		103	4.2	0.8	
8	49	13	WQ1	0	7.5	108	18.9	6.6	2.0
			WQ1	10		107	15.9	6.4	
			WQ2	0		106	18.4	6.5	
			WQ2	7		106	17.0	6.7	
9	48	29	WQ1	0	7.5	141	18.8	8.5	1.8
			WQ1	52		135	4.3	1.9	
			WQ2	0		141	19.0	8.2	
10	48	5	WQ1	0	7.2	125	16.2	7.0	2.1
			WQ1	13		125	15.4	5.6	
			Dam	0		138	16.4	5.7	
			WQ2	0		124	16.6	7.4	
			WQ3	0		126	17.6	7.7	
14	39	20	WQ1	0		120	17.4	7.8	
			WQ1	36		139	4.3	0.1	
			WQ2	0		126	17.0	8.0	
			WQ2	33		122	5.0	1.9	
			WQ3	0		129	17.6	7.8	
			WQ3	20		123	5.9	1.5	
			WQ4	0	7.8				1.0
			WQ4	36	6.2				10.8

Note:

[1] Locations of these lakes are shown in **Figure 3-4**.

Key:

ºC = Degrees Celsius.
mg/L = Milligram per liter.
µS/cm = MicroSiemen per centimeter. A term used to express a unit of electrical conductance.
NTU = Nephelometric turbidity unit.
Temp = Temperature.

Source: Bertram and Person 2005.

The pH for these wetlands ranged from 8 to 10. Total nitrogen ranged from 1.4 to 6.6 mg/L, and from 0.03 to 0.05 mg/L for total phosphorus.

Given that water quality baseline data in the Yukon River drainage and within the Refuge are limited, and the potential for future industrial development, the Service has begun to record dissolved oxygen, turbidity, conductivity, and pH at three locations along Beaver Creek (Mueller and Bertram 2007). **Figures 3-6** through **3-9** are examples of data collected at river gauging stations in 2006. The locations of these stations are shown in **Figure 3-4**.

3.3.6.3 Groundwater

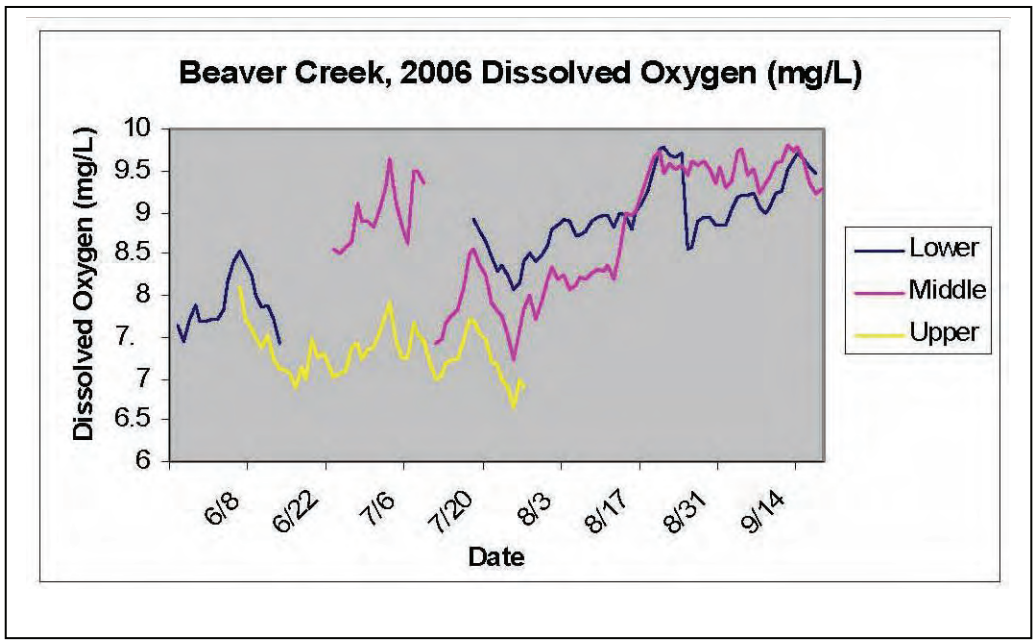
Groundwater is found beneath the ground surface in soil pore spaces and in fractures in rock formations. Groundwater occurs as liquid water flowing through shallow aquifers and as soil moisture, permafrost, immobile water in very low permeability bedrock, and deep geothermal or oil formation water. Groundwater interacts with surface water in nearly all landscapes (Winter 1999). Groundwater resources in the Yukon Flats Basin have not been studied or developed to any degree, given the abundance of surface water and the sparse human population. Communities within the Refuge draw their water from the surface waters or from shallow alluvial wells under the influence of surface water. Beaver, Birch Creek, and Chalkyitsik villages draw their water from wells projected beneath neighboring rivers.

Generally, groundwater quality is thought to be good. Groundwater in the Refuge can be locally contaminated near population centers such as Fort Yukon, Beaver, and Stevens Village. Contamination at Fort Yukon is related to Fort Yukon Long Range Radar Site and the former White Alice Communication Site (Yukon River Inter-Tribal Watershed Council 2002). The U.S. Air Force is in the process of cleanup at the Fort Yukon Long Range Radar Site. Additional sources of contamination at villages include sewage lagoons.

3.3.6.4 Water Rights

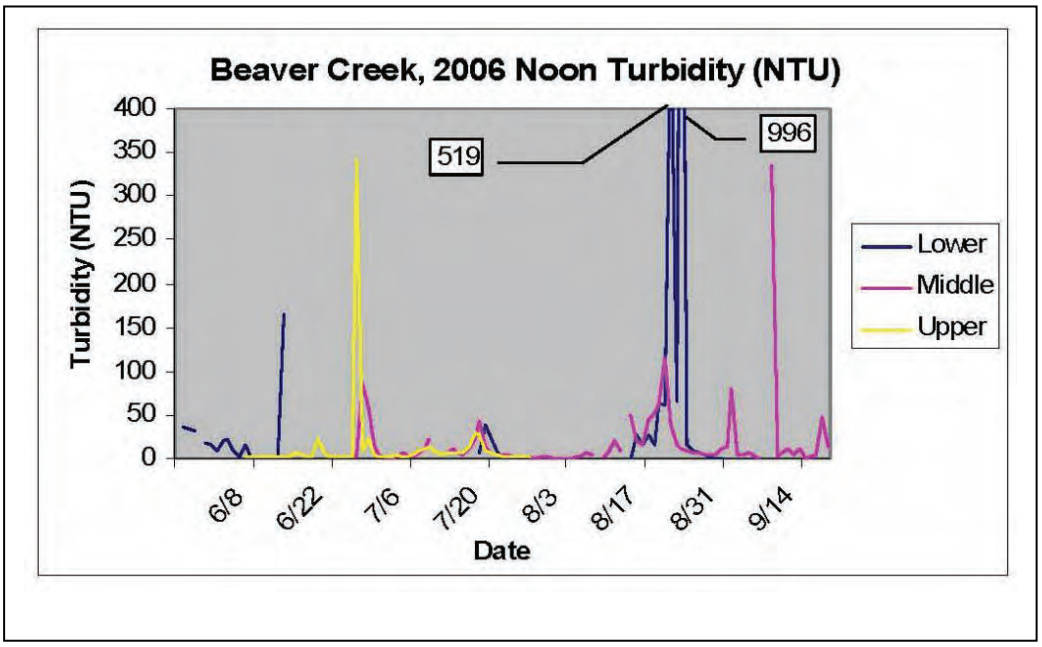
A water right is the legally protected right to use water for various beneficial uses. In Alaska, groundwater and surface waters are public resources managed by the State and subject to appropriation in accordance with the Alaska statutes and regulations (Water Use Act – Alaska Statute 46.15, and 11 Alaska Administrative Code 93). Water is reserved to the people for common use and is subject to appropriation and beneficial use and to reservation of instream flows and levels of water. The State issues water use rights and temporary authorizations for the use of water in significant amounts for various uses.

In addition to whatever water permits, rights, reservations and temporary water use authorizations the State may issue, the Yukon Flats Refuge has existing Federal Reserved Water Rights (FRWRs) to ensure that water resources are maintained and protected within the Refuge. These unquantified FRWRs were established under ANILCA in 1980. The Service must safeguard the water quality and necessary water quantity within the Yukon Flats Refuge for the purpose of conserving fish and wildlife populations and habitats in their natural diversity, as mandated by ANILCA and the Refuge Improvement Act of 1997. In addition to existing FRWRs, under State law the Service has also applied for lake elevation reservations for 34 lakes and instream flow reservations for 12 streams within the Yukon Flats Refuge. These water bodies include Beaver Creek and Lake No. 153 (See 3.3.6.1 Surface Water Resources – Beaver Creek and Instream Flow Reservations).



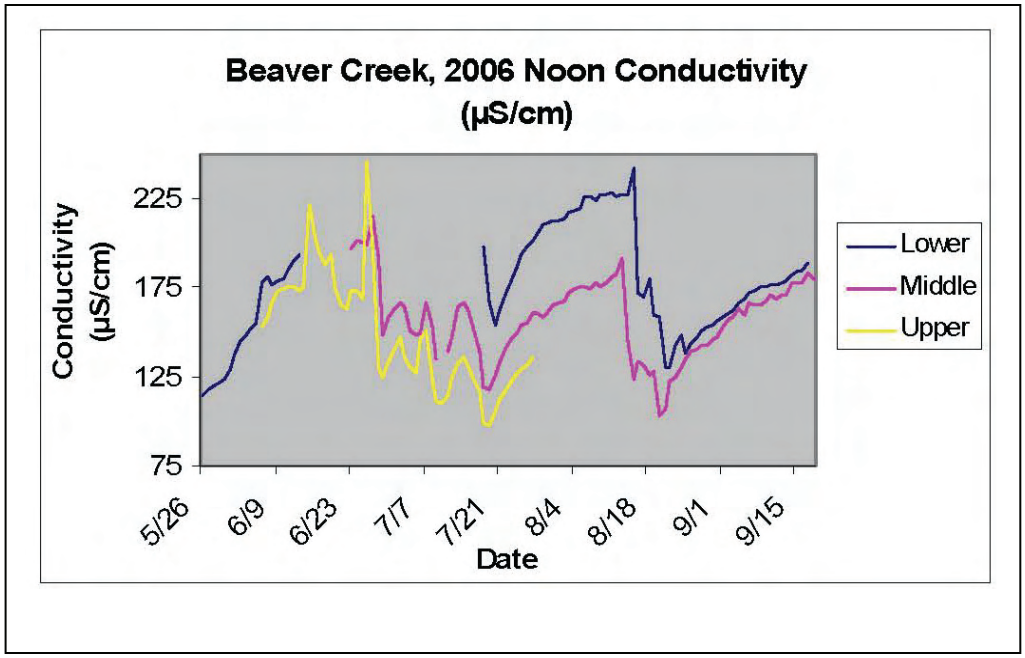
Source: Mueller and Bertram 2007.

Figure 3-6 Dissolved oxygen concentrations (mg/L) at three locations on Beaver Creek, Alaska, 2006



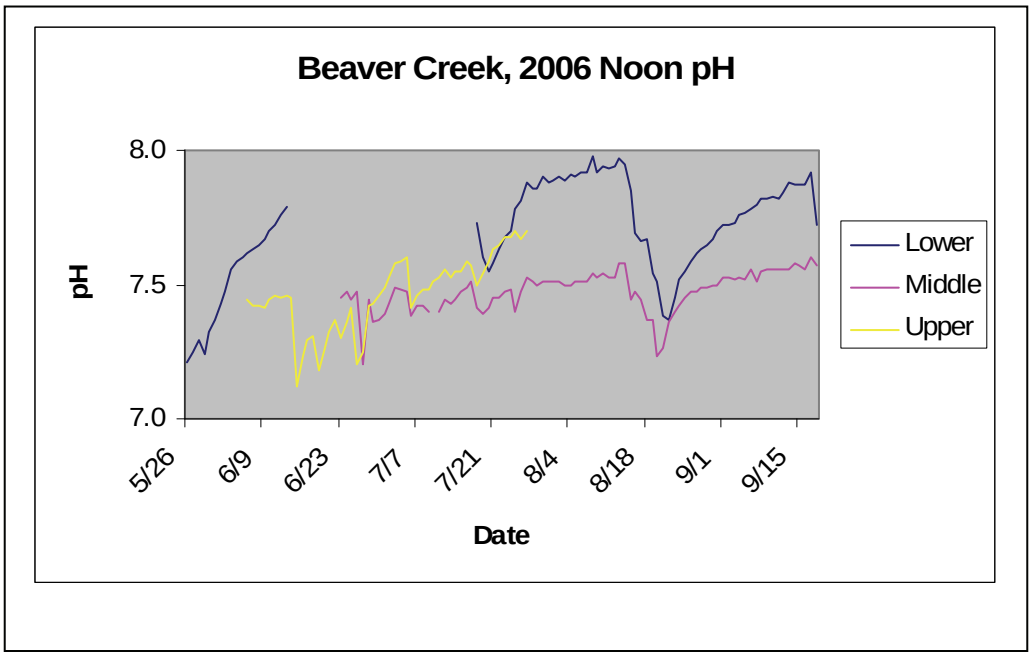
Source: Mueller and Bertram 2007.

Figure 3-7 Turbidity (NTU) at three locations on Beaver Creek, Alaska, 2006



Source: Mueller and Bertram 2007.

Figure 3-8 Conductivity (µS/cm) at three locations on Beaver Creek, Alaska, 2006



Source: Mueller and Bertram 2007.

Figure 3-9 pH at three locations on Beaver Creek, Alaska, 2006

3.4 Biological Resources

The following sections discuss the resources in the biological environment of the Refuge. Common and scientific names of plants and animals given in this EIS are provided in **Appendix B**.

3.4.1 Biological Integrity, Diversity, and Environmental Health

In 2001, the Service developed a refuge policy on Biological Integrity, Diversity, and Environmental Health (U.S. Fish and Wildlife Service 2001). Key components of this policy are as follows:

Biological Diversity. The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and communities and ecosystems in which they occur.

Biological Integrity. Biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities.

Environmental Health. Composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment.

The policy responded to a directive in the National Wildlife Refuge System (System) Improvement Act that requires the Secretary of the Interior to ensure the biological integrity, diversity, and environmental health of the System. The policy guides how the Service will manage habitats and species to meet this directive. The following provisions apply to the proposed land exchange (U.S. Fish and Wildlife Service 2005):

- 3.10.B(3). We strive to maintain populations of breeding individuals that are genetically viable and functional. We provide for the breeding, migrating, and wintering needs of migratory species. We also strive to maximize the size of habitat blocks and maintain connectivity between blocks of habitats, unless such connectivity causes adverse effects on wildlife or habitat (e.g., by facilitating the spread of invasive species).
- 3.17. How does this policy affect the acquisition of lands for the Service? We consider the mission, goals, and objectives of the System in planning for its strategic growth. We will take a proactive approach in identifying lands that are critical for maintaining or restoring the biological integrity, diversity, and environmental health of the System at all landscape scales. We will integrate this approach into all Service strategies and initiatives related to the strategic growth of the System. We will incorporate the directives of this policy when evaluating an area's potential contribution to the conservation of the ecosystems of the United States.

Refuge management is guided by the purposes for which the Refuge was established (as provided in ANILCA), the National Wildlife Refuge System mission, and other legal and policy guidance, including the Service's Biological Integrity, Diversity, and Environmental Health Policy and the Refuge Comprehensive Conservation Plan (CCP). The following sections describe the biotic and abiotic composition, structure, and function of the Refuge. These sections also cite numerous studies that have been conducted on the Refuge in recent years to better understand resource

conditions and to identify management activities needed to maintain resources in optimum condition.

3.4.2 Ecoregions

Ecoregions are geographic areas that are delineated and defined by similar climatic conditions, geomorphology, and soils (Bailey 1997, 2002). Because these factors are relatively constant over time and strongly influence the ecology of vegetative communities, ecoregions may have similar potentials and responses to disturbance (Clarke and Bryce 1997; Jensen et al. 1997). Ecoregions, therefore, provide a useful framework for organizing, interpreting, and predicting changes to vegetation following disturbance. A large majority of the Refuge is classified as the Yukon-Old Crow Basin Ecoregion (Nowacki et al. 2001). Climate in this ecoregion is continental, with extreme cold winter and hot summer temperatures and low annual precipitation (Gallant et al. 1995; Nowacki et al. 2001). Precipitation is not sufficient to maintain lake water levels in this area; however, the lakes are recharged during spring flooding that occurs when ice on the Yukon River breaks up (Gallant et al. 1995). Fire and flood disturbance regimes are a result of climate and topography, and are key ecological drivers of this ecoregion. The Yukon-Old Crow Basin Ecoregion was not glaciated during the Pleistocene and is composed of deep alluvium and eolian deposits of Pleistocene origin underlain by discontinuous permafrost (Williams 1962; Gallant et al. 1995; Nowacki et al. 2001; Chapin et al. 2006). The presence of discontinuous permafrost in this region creates numerous productive wetlands, shallow lakes, and ponds that support a wide variety of plant and animal species. Lands along the Refuge's southern boundary are within the Ray Mountain Ecoregion (Nowacki et al. 2001). A large portion of the proposed northern access pipeline right-of-way (ROW) is within this ecoregion. This area is characterized by a series of forested uplands and the White Mountains. Several townships discussed in Phase I under the consolidation part of the land exchange occur in this ecoregion (U.S. Fish and Wildlife Service 2005).

3.4.3 Wildland Fire

The average wildland fire size is 16,000 acres, and fires in the 1 to 25,000 acre size are common within the Interior Boreal Forest, including the Refuge (Marshall 2009). Wildland fire is an important agent of disturbance in the ecosystem, and an important determinant of the vegetation found in the Refuge. Fires result in a mosaic of different vegetation types and forest ages. When older forests burn, nutrients are released that result in increased plant productivity, and the resulting early successional stages of plant growth are important to many wildlife species. Climax and mature forest stages are uncommon in interior Alaska, as frequent fires maintain most forest stands in early to mid-successional stages (Dyrness et al. 1986). After a fire, the change in soil conditions and removal of vegetation result in soil warming and increased depth in the active layer above permafrost. The soil may become well drained and may no longer have a perched water table or support wetlands (Brabets et al. 2000).

Recently burned areas support early successional herbaceous forb communities dominated by fireweed. Grassland communities dominated by bluejoint and willow scrub follow in succession. Broadleaf forests succeed the willow stage in uplands, on south facing slopes, or on well-drained river terraces. However, paper birch stands succeed willow on east, west, and some north facing slopes and in flat areas. Mixed forest stands occur when spruce becomes established in the broadleaf stands. Forests dominated by spruce eventually replace the mixed stands on many sites (Viereck 1975; Viereck et al. 1986; Adams and Viereck 1997).

The fire season in the Refuge usually lasts from June through early August. Lightning is the main cause of wildland fires in the Alaskan interior. Since Refuge establishment in 1980, lightning has been responsible for 91% of the fires in the Refuge and 98% of the acres burned. The Refuge is in one of the most lightning-prone areas in Alaska, with up to 2,000 strikes in a 24-hour period (Grissom 2001). Other fires have been caused by humans, primarily from abandoned campfires.

The fire cycle is the average number of years between successive burns at a given location. Estimates of the natural fire cycle in Alaskan boreal forest range from 50 to 200 years, but the cycle varies with locale and vegetation (Heinselman 1978; Yarie 1981; Dyrness et al. 1986). Marshall (2009) calculated the average fire cycle in the Refuge to be 49 years based on the fire history from 1981 to 2009. Based on that cycle, an average of about 2% of the Refuge burns every year. However, different sites and vegetation types within the Refuge have demonstrably different fire cycles. Highly flammable sites, such as black spruce stands, burn more frequently than every 100 years, while lowlands along the Yukon River have a cycle of about 450 years. The steep broken terrain in the Hodzana uplands has a fire cycle of about 560 years, while rolling uplands with black spruces or stunted white spruce, such as the north slope of the White Mountains along the southern Refuge boundary, have a cycle of 70 to 100 years.

The number of fires and acres burned in the boreal forest also varies significantly between years and decades (Kelsall et al. 1977). Marshall (2009) reported that in the Refuge, within a 29-year period, there was one year with no fires or areas burned, some years with a few fires reaching moderate size, and 7 or 8 years with many large fires burning tens of thousands of acres. The extent of fires also varies with the current management policies. From 1950 to 1984, policies were in place that dictated suppression of all wildfires; about 56,000 acres burned in the Refuge annually during this period. In 1984, the policy was replaced with the current policy under which fires in many areas are allowed to burn. About 200,000 acres on the Refuge have burned annually since 1984 (Marshall 2009). Current fire management policies and practices in the Refuge are discussed in Section 3.5.1.5.

The 2004 Alaska fire season was the largest on record, with 1,700,000 total acres on the Refuge burned. Since 1981 60% of the Refuge has burned. Areas that have burned in the Refuge during the past several decades are shown in **Figure 3-10**.

3.4.4 Vegetation

The Refuge lies within the taiga, a subarctic, high latitude, circumpolar biome. The taiga is the region of boreal forest that is dominated by conifer trees and exists in cold, moist climates south of the tundra in the Northern Hemisphere. In North America, the taiga extends as a continuous belt of vegetation stretching from Canada's Atlantic coast, through the Northern provinces, and across to the western coast of Alaska. The taiga extends to the northern limit of the treeline, where it transitions to Arctic tundra (Elliott-Fisk 2000).

Land cover types in the Refuge were mapped by the USGS in 2006 as part of the National Land Cover Database (**Figure 3-11**). Ten land cover classes were identified (**Table 3-5**). The imagery used in the mapping effort was recorded in 1999 through 2002 and therefore predates the 2004 and 2005 fire seasons during which large portions of the Refuge, including the Beaver Creek area (core lands), were burned.

Evergreen (Spruce) Forest. Evergreen forests dominated by white or black spruce cover nearly 3.6 million acres or 33% of the Refuge. White spruce forests are typically found on well-drained soils, south-facing slopes, and along rivers and streams where permafrost is lacking. Understory components of white spruce forests include species of willow, birch, and alder. Also commonly found in white spruce forests are species of bearberry, high bush cranberry, forbs, mosses, and lichens. Black spruce forests occur on north-facing slopes and in areas where soil drainage is moderate to poor. Understory shrubs include species of willow, birch, and other heath shrubs. Poorly drained areas also support a variety of mosses, grasses, and sedges.

Deciduous Forest. Deciduous forests occur on about 1.9 million acres or 17% of the Refuge. They are typically found on floodplains or moderate- to well-drained soils, as well as recently burned areas. Dominant tree species include balsam poplar, paper birch, and quaking aspen. Understory growth includes willow, alder, prickly rose, and soapberry.

Shrub/Scrub. The shrub/scrub land cover type covers nearly 1.6 million acres or 15% of the Refuge. This cover type includes true shrubs, young trees in early successional stage, or trees stunted from environmental conditions. This cover type represents many areas in the Refuge that have burned in the recent past. Shrub/scrub communities are predominantly comprised of alder and willow.

Woody Wetlands. Woody wetlands cover about 1.4 million acres or 13% of the Refuge. Woody wetlands in riparian zones often consist of tall shrub thickets of willow and alder. In wetter swamp areas, alder and willow species remain dominant, but other shrubs also are common in the understory including dwarf birch, currant, high bush cranberry, and prickly rose. Herbaceous forbs, grasses, and sedges, as well as mosses, are usually present.

Table 3-5 National Land Cover Database classifications and approximate acreages of each land cover type present in the Refuge

Land Cover Type	Acres[1]	Percentage
Evergreen forest	3,588,000	32.8
Deciduous forest	1,859,500	17.0
Shrub/scrub	1,597,000	14.6
Woody wetlands	1,378,500	12.6
Mixed forest	1,345,500	12.3
Open water	470,500	4.3
Emergent herbaceous wetlands	229,500	2.1
Sedge/herbaceous	219,000	2.0
Barren land	131,500	1.2
Dwarf scrub	120,500	1.1

Note:

[1]Acres includes all Federal lands, conveyed Native lands, and selected village lands within the Refuge.

Source: U.S. Geological Survey 2007.

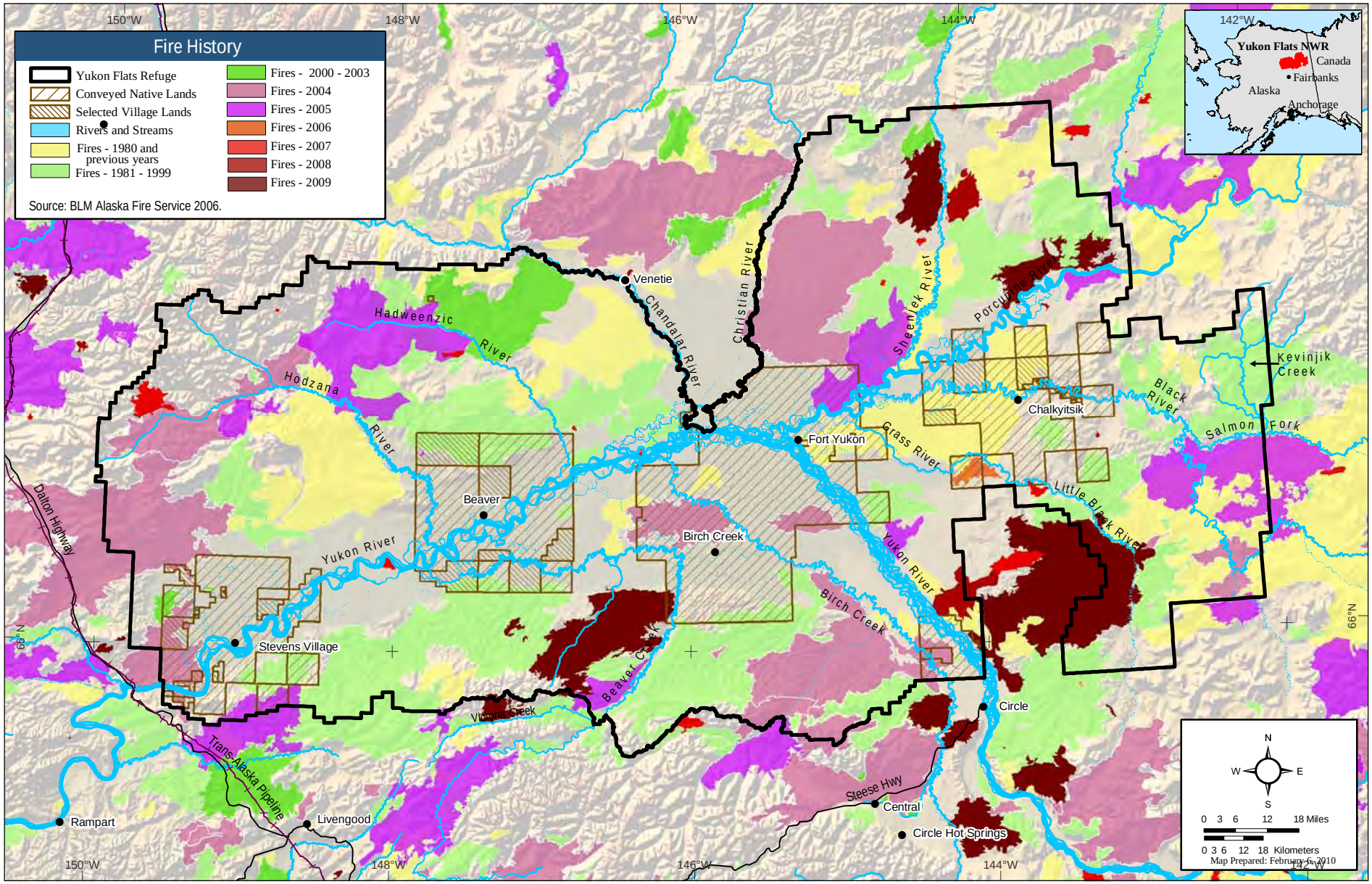
Proposed Land Exchange EIS

U.S. Fish & Wildlife Service

Figure 3-10

Fire History in the Yukon Flats Refuge

Yukon Flats National Wildlife Refuge
Alaska



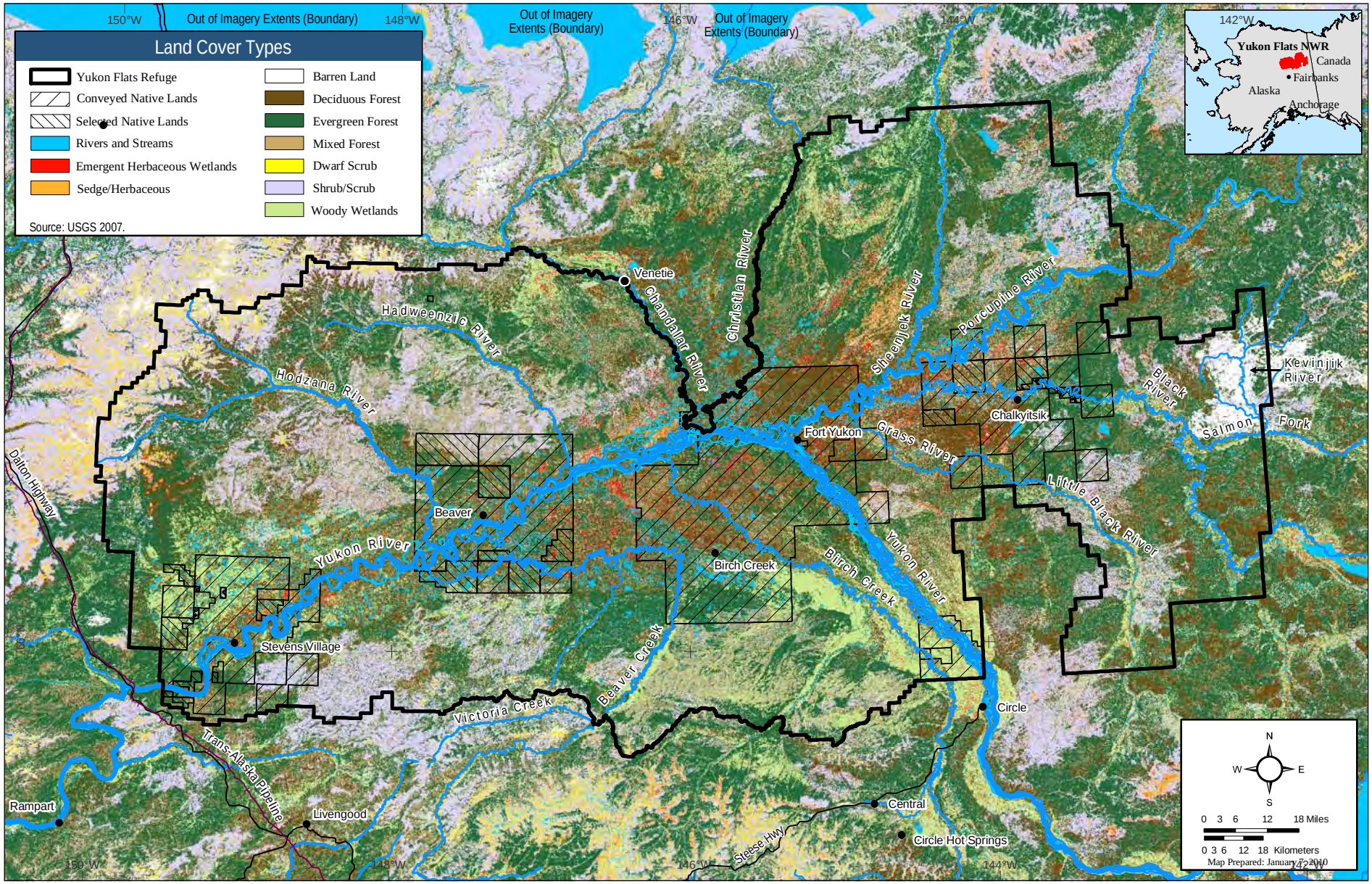
Proposed Land Exchange EIS

U.S. Fish & Wildlife Service

Figure 3-11

Land Cover Types in the Yukon Flats Refuge

Yukon Flats National Wildlife Refuge
Alaska



Mixed Forest. Mixed (deciduous and coniferous) forests comprise about 1.3 million acres or 12% of the Refuge. They commonly consist of quaking aspen, balsam poplar, or paper birch mixed with white spruce. The deciduous species also are found mixed with black spruce under certain site conditions. In addition to species of willow and alder, understory components often associated with mixed forests types include a variety of herbaceous and graminoid species such as bluebell, horsetail, and bluejoint.

Open Water. Open water comprises about 470,000 acres or 4% of the Refuge. This land cover type generally has less than 25% cover of vegetation.

Emergent Herbaceous Wetlands. Emergent herbaceous wetlands comprise about 230,000 acres or 2% of the Refuge. Wet sedge meadow or tussock communities are dominated by sedges. Some species of grasses, horsetail, dwarf shrubs, and mosses may be present as well.

Sedge/Herbaceous. Sedge/herbaceous areas, which comprise about 219,000 acres or 2% of the Refuge, are dominated by sedges and forbs (generally greater than 80% of total vegetation) as well as other grasses or grass-like plants. This land cover type includes sedge tundra and sedge tussock tundra.

Barren Land (Rock/Sand/Clay). Encompassing about 130,000 acres or 1% of the Refuge, this cover type includes areas of bedrock, scarps, talus, slides, volcanic material, and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total land cover in these areas.

Dwarf Scrub. This land cover type is found over about 120,000 acres or 1% of the Refuge. Several species of dwarf and prostrate willows, dwarf birch, mountain avens, and a variety of ericaceous shrubs are common in the highland scrub communities, but grasses, sedges, herbs, and nonvascular plants are often found with them (Viereck et al. 1992; Parker et al. 2003).

3.4.4.1 Vegetation in the Beaver Creek Watershed

The Beaver Creek watershed, which encompasses the core lands, is characterized by open evergreen (spruce) forests, with some areas of mixed forest. South facing ridges are often forested with quaking aspen along with prickly rose, kinnikinnik, lowbush cranberry, and fireweed. There also are expanses of tussock tundra composed of scattered stunted black spruce, dwarf birch, Labrador tea, bog blueberry, and sedge tussocks. A large portion of the watershed within the Refuge was burned by wildland fires in 1981 through 1999 and 2005 (**Figure 3-10**).

The shorelines of upland lakes range from smoothly transitioned, flat shorelines supporting mosses and grasses and grass-like plants with some forbs to abrupt, steep-sided bluffs (Bertram and Person 2005). Woody vegetation near lakes primarily consists of shrubs such as willow, shrub birch, and shrubby cinquefoil. On lakes with steep-sided margins, where soils are less stable and well drained, species of artemisia and bluegrass are common.

Several different habitat types are found in the upper Beaver Creek watershed. To the west, a series of bluffs provide drainage from higher elevations into Beaver Creek. Purple reedgrass, Pennsylvania cinquefoil, rockcress, and Gorman beardtongue are regularly found growing on these bluffs. Within the active floodplain of the creek, gravel bars support mixed communities of poplars, alders, willows, forbs, and grasses. Oxbow lakes in the floodplain support a variety of shoreline graminoid and forb species, as well as aquatic species of pondweed, smartweed, and

bur-reed in their shallow margins. Bogs and other wetlands consist of shrub, grass, forb, and moss species (Bertram and Person 2005).

In alpine regions of the White Mountains, plant communities consist of several species of grasses, dwarf shrubs, and forbs. Relative to the upland and Beaver Creek locations, highland communities are the most floristically diverse areas (Bertram and Person 2005).

Five plant species, Gorman's douglasia, Yukon stitchwort, carpet phlox, MacKenzie Valley mannagrass, and rannoch-rush, which are considered to be rare in the State, were observed during a survey of the core lands and the WMNRA just south of the Refuge boundary (Bertam and Person 2005). These plant species are secure globally but rare in the State. Carpet phlox is considered critically imperiled in Alaska. The Alaska Natural Heritage Program has reduced its rarity ranking of rannoch-rush from rare or uncommon to demonstrably secure in the State, with cause for some long-term concern. MacKenzie Valley mannagrass is considered imperiled in the State. Three of these plant species, Gorman's douglasia, Yukon stitchwort, and carpet phlox, were only observed in the White Mountains outside of the Refuge (Alaska Natural Heritage Program 2007). Rannoch-rush and MacKenzie Valley mannagrass were observed in wetlands adjacent to Beaver Creek.

During exotic/invasive plant surveys conducted in 2005 (south of the Refuge in the BLM WMNRA and on Refuge lands) and 2007 (Refuge lands; Vargas Kretsinger 2007), dandelion, lambsquarter, Kentucky bluegrass, and foxtail barley were encountered along Beaver Creek. Invasive plants are plants that are not part of (if exotic), or are a minor component of (if native), the original plant community or communities that have the potential to become a dominant or co-dominant species on the site if their future establishment and growth are not actively controlled by management interventions, or are classified as exotic or noxious plants under State or Federal law. Species that become dominant for only one to several years (e.g., short-term response to drought or wildland fire) are not invasive plants. Likely sources or introduction sites include private inholdings upstream of the Refuge on BLM-administered lands, Beaver Creek recreational river floaters, aircraft, and an access portage from Birch Creek.

3.4.4.2 Wetlands, Riparian Areas, and Floodplains

Through its National Wetlands Inventory program, the Service uses ecological characteristics to define wetlands (Cowardin et al. 1979). According to this protocol, the essential attributes of wetlands are the presence of wetland plants (hydrophytes), the presence of wet soils (hydric soils), or soil saturation or flooding. Wetlands generally include swamps, marshes, bogs, and similar areas (Title 22 of the Code of Federal Regulations [CFR], Part 328.3).

The Alaska Department of Fish and Game (2007c) defines riparian areas as "the land adjacent to a stream, pond, lake, or other waterway. This area includes the vegetation from the waters' edge through the shrub/forested upland near the waterway." The EPA defines a riparian area as "vegetated ecosystems along a water body through which energy, materials, and water pass." Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent water body. These systems encompass wetlands, uplands, or some combination of these two land forms. Riparian areas are not shown on National Wetland Inventory or national land cover maps for the Refuge, but their extent can be estimated in general terms based on length of the river bank.

A floodplain is flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding. It includes the floodway, which consists of the stream channel and adjacent

areas that carry flood flows, and the flood fringe, which are areas covered by the flood but which do not experience a strong current. Floodplains are areas of seasonally/temporarily flooded river bars where soil deposition and erosion are dynamic processes.

3.4.4.3 Distribution of Wetlands, Riparian Areas, and Floodplains in the Refuge

As part of their National Wetlands Inventory, the Service has mapped wetlands across large areas of the United States through the interpretation of high altitude aerial photographs. This wetland mapping is available for only 64% (about 6.7 million acres) of the Refuge, but most of the lowland areas have been mapped. The mapping indicates that extensive areas of wetlands occur in the Refuge; about 30% of the mapped portion of the Refuge was found to be wetland (**Table 3-6**). The distribution of wetlands within the mapped area is shown in **Figure 3-12**.

The marshy flats around the Yukon River have developed in deep, alluvial, glaciolacustrine deposits underlain by discontinuous permafrost. These poorly drained areas contain vast wetlands and concentrations of thaw lakes and ponds. Active floodplains often support diverse plant communities as previously described (Gallant et al. 1995).

Wetlands provide many useful functions and values. The various ponds, lakes, muskeg, and drainages of the Refuge regulate runoff through water storage in the active layer, slowly releasing water to streams over extended periods. However, because permafrost is impermeable to water, melting of the snowpack in spring can result in extensive surface flows and flooding across these wetlands (Woo 1988; Brabets et al. 2000). Net primary production, nutrient export, and food-chain support are important functions of wetlands. Wetlands also provide habitat for fish and wildlife and retain or distribute sediments, nutrients, and toxicants.

Boreal forest wetlands can transform or retain sediment and nutrients (Johnston 1993). At breakup, streams flood adjacent areas and create extensive wetland complexes that provide sites for suspended solids to settle. Sediment is trapped by riparian wetlands along the Yukon River. Heglund and Jones (2003) found the shallow lakes in the Yukon Flats to be some of the most nutrient-rich lakes in Alaska.

Table 3-6 Area of wetland, by wetland type, in the portion of the Refuge that has been mapped

Wetland Type	Acres Mapped[1]	Percent of Mapped Area[2]
Freshwater forested/shrub wetland	1,202,300	17
Freshwater emergent wetland	373,500	5
Lake	200,300	3
Riverine wetland	243,500	3
Freshwater pond	58,400	1
Other	21,150	<1
Total wetlands	2,099,150	30
Total area mapped	6,969,400	

Notes:

[1]Wetlands as mapped by the National Wetland Inventory.
[2]Approximately 64% (6,969,398 acres) of the Refuge has been mapped.

Source: U.S. Fish and Wildlife Service 2006.

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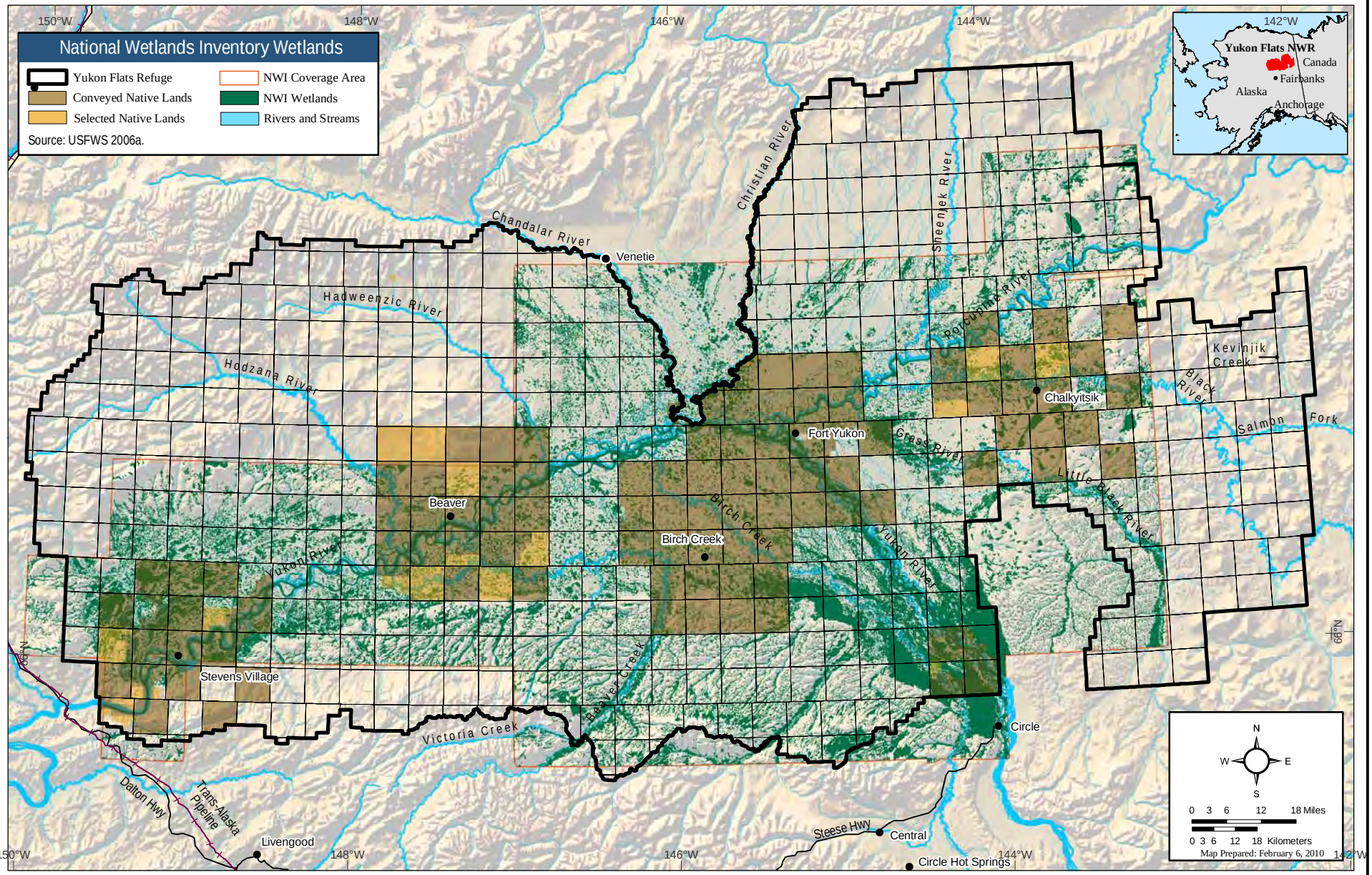
Yukon Flats National Wildlife Refuge

Alaska

Loctions of NWI Wetlands in the Mapped Portion of the Yukon Flats Refuge

Figure 3-12



Net primary production, nutrient export, and food-chain support are important functions of boreal forest wetlands. Boreal forest wetland production supplies the energy (plant biomass) on which animals exist (Elliot-Fisk 2000). Taiga wetlands support food chains, both through the herbivore-based trophic system (from living plant tissues to herbivores and their predators) and through the detritus-based trophic system (from dead plant tissue to invertebrates to their predators).

Wetlands provide important nesting and foraging habitat for waterbirds. Wetland habitat also is important to a variety of mammals, including beaver and muskrat, while riparian corridors provide good habitat for moose and provide migration corridors for movement by bears, wolves, and other animals (U.S. Fish and Wildlife Service 2005).

The habitat function of wetlands is their preeminent value as far as fish and wildlife resources are concerned. Subsistence uses of wetlands by Alaska Natives provide an additional reason to value wetland habitat.

Riparian areas serve many functions including:

- Trapping sediments and nutrients heading from hill-slopes to streams, improving stream water quality;
- Shading streams, lowering water temperature, and altering food sources by preventing the growth of algae;
- Protecting stream banks from collapse and reducing stream bank erosion, and allowing for a diversity of bank habitats to form;
- Providing a source of litter and snags to channels, which form critical habitat to stream animals;
- Providing food for terrestrial and aquatic animals, particularly in small streams; and
- Providing habitat for birds and mammals that live along the river.

If river bars remain intact for several years or more, early successional plant (shrub) communities can develop that are often very productive, and provide important habitat for foraging and resting moose, as well as food and cover for birds and small mammals. Over time, they may become wetland or upland habitat, and provide functions and values associated with those habitats, or they may degrade and become part of the river or stream and provide habitat for fish and other aquatic organisms.

3.4.5 Fish and Essential Fish Habitat

3.4.5.1 Fishery Resources

The U.S. Fish and Wildlife Service (1990) defines four general types of fish habitats within the Refuge: (1) the Yukon River main stem; (2) the sloughs and backwaters of the Yukon Drainage; (3) the streams and rivers that feed into the Yukon main stem; and (4) the lakes, ponds, and marshes of the Refuge. **Table 3-7** provides a summary of the fish species occurring in water bodies associated with the Yukon River and its tributaries.

A total of 19 species of fish (**Table 3-8**) have been documented to occur in the Refuge, 11 of which have been reported in Beaver Creek and adjacent wetlands in the vicinity, or upstream, of the Refuge (U.S. Fish and Wildlife Service 1990, 2005; AECOM 2009). These fish species fall into two major migratory categories: year-round resident species that undergo limited spawning migrations, and migratory species that seasonally travel great distances within the Yukon River

watershed. Resident species include Arctic grayling, burbot, lake chub, longnose sucker, northern pike, round whitefish, trout-perch, slimy sculpin, and Dolly Varden. Resident species typically inhabit deepwater areas of rivers and lakes during the winter and then migrate short distances to spawning grounds during the open-water season. The exception is the burbot, which spawns beneath ice during January and February. Migratory species include Pacific salmon (Chinook, chum, and coho), whitefish (broad whitefish, least cisco, humpback whitefish, and Bering cisco), Arctic lamprey, and inconnu or sheefish. Information on spawning period and habitat of key fish species that occur in the Refuge is provided in **Table 3-8**.

While spawning and feeding migrations may determine the large-scale temporal and spatial distribution of fish in the Refuge, numerous parameters govern fine-scale distribution. Water quality characteristics, such as dissolved oxygen levels, temperature, and turbidity, along with the physical makeup of streams and lakes, such as depth, current velocity, and substrate, may all influence the distribution of fish along distinct species-specific lines. Newly hatched and young fish of all species have limited long-distance mobility and may be temporarily confined to their respective spawning areas. For some species, passive drift may disperse young-of-the-year for considerable distances downstream. In general, the Yukon River and its tributaries serve as migration, feeding, and spawning habitats for many species and must be considered prime habitat for interior Alaska fishes.

Table 3-7 Primary fish species using the Yukon River, its major tributaries and associated water bodies

Water Body	Primary Fish Species
Dall River	Broad whitefish, humpback whitefish, least cisco, sheefish, burbot, northern pike, longnose sucker, Arctic grayling, and lake chub.
Hodzana River	Northern pike, Arctic grayling, round whitefish, broad whitefish, humpback whitefish, least cisco, and chum salmon.
Porcupine River	Chum, Chinook, and coho salmon; broad, humpback, and round whitefish; least and Bering cisco; sheefish; Arctic grayling; northern pike; burbot; and longnose sucker.
Birch Creek	Arctic grayling, slimy sculpin, round whitefish, longnose sucker, sheefish, chum salmon, burbot, and northern pike.
Beaver Creek	Longnose sucker, northern pike, chum salmon, Chinook salmon, round whitefish, humpback whitefish, least cisco, sheefish, Arctic grayling, burbot, and slimy sculpin.
Yukon River mainstem	All Refuge species.
Thaw lakes without river connections	Typically devoid of fish.
Deep-water thaw lakes	Northern pike.
Thaw lakes connected to rivers	Broad whitefish, northern pike, humpback whitefish, least cisco, and longnose sucker.
Oxbow lakes	Broad whitefish, northern pike, humpback whitefish, least cisco, and longnose sucker.

Sources: U.S. Fish and Wildlife Service 1990; AECOM 2009.

3.4.5.2 Beaver Creek Fishery

Several fish surveys have been conducted either within this watershed or in the upland lake systems that surround it. However, most of these surveys were focused specifically on Pacific salmon (Collin and Kostohrys 1998; Collin et al. 2002), Arctic grayling (Kretsinger 1986;

Fleming and McSweeney 2001), and northern pike (Bertram and Person 2005). Webb (1982) conducted fish surveys in Beaver Creek from the Refuge boundary at Victoria Creek upstream to Nome Creek and observed Arctic grayling, round whitefish, slimy sculpin, northern pike, longnose sucker, and sheefish. Carufel (1988, 1990) conducted fish surveys along the length of Beaver Creek, but reported catching only Arctic grayling and sighting Pacific salmon. Arctic grayling habitat observations were reported by Webb (1982, 1986) and Rhine (1985) as cited in Bureau of Land Management (1988).

ENSR conducted fish surveys at eight locations in Beaver Creek in the Refuge from Victoria Creek 40 miles downstream in June 2007 (AECOM 2009). The survey included the land exchange area and the portion of the Beaver Creek Wild River that is on the Refuge. ENSR found grayling to be the most abundant fish in the stream. Round whitefish, slimy sculpin, longnose sucker, humpback whitefish, least cisco, northern pike, arctic lamprey, and a juvenile Chinook salmon were also observed.

Bertram and Persons (2005) reported captures of northern pike at a number of locations in Beaver Creek in the area of the proposed core lands and in a number of lakes in the area, including the lakes identified as water quality stations in **Figure 3-4**. Northern pike have been reported in Beaver Creek near the confluence with Victoria Creek (Collin and Kostohrys 1998). Lake-resident pike likely represent distinct stocks, since many of the upland lakes are isolated with no accessible connection to nearby water bodies (U.S. Fish and Wildlife Service 2005). Recreational harvest of northern pike in Beaver and Nome Creeks is light to moderate (0 to 558 fish annually), compared to some of the more prominent rivers in the Yukon River drainage (Burr 2004). ENSR found northern pike distributed throughout Beaver Creek from near the confluence with Victoria Creek downstream 40 miles to the northern boundary of the core lands (AECOM 2009).

Small runs of both Chinook and chum salmon occur in Beaver Creek (Carufel 1990; Collin and Kostohrys 1998; Collin et al. 2002; AECOM 2009). The BLM (Collin and Kostohrys 1998; Collin et al. 2002) established a weir each year in 1996, 1997, 1999, and 2000 on Beaver Creek approximately 10 miles upstream of Victoria Creek and the Refuge boundary, and counted salmon as they migrated upstream through the weir. Chinook salmon, chum salmon, grayling, northern pike, and longnose suckers were observed passing through the weir. The numbers of observed salmon are indicated in **Table 3-9**.

Spawning has been observed in Beaver Creek in deep riffles at Wild River Mile Marker 110 near the confluence of Beaver and Victoria creeks (Carufel 1990). Chinook spawning activity also has been observed on the Refuge and at a number of locations upstream of the Refuge, and spawning chum salmon have been observed in this area as well (U.S. Fish and Wildlife Service 1990, 2005). Salmon have been observed in upper Beaver Creek upstream of the Refuge near Wild River Mile 16 and in headwater tributaries of Bear Creek and Champion Creek, although it was not mentioned whether fish were spawning (U.S. Fish and Wildlife Service 1988). Carufel (1990) reported observations of 35 spawning Chinook salmon in Beaver Creek just upstream of the Refuge, from the Victoria Creek confluence upstream for another 40 miles. During a 2006 BLM habitat and fish inventory of Victoria Creek, a juvenile Chinook salmon was observed upstream near Doyon's proposed southern route pipeline/road crossing. As a result of these findings, the BLM filed an extension to nominate Victoria Creek's upstream waters to the ADFG Anadromous Waters Catalogue. Webb (1982) reported that spawning habitat is in short supply over much of upper Beaver Creek upstream of the Refuge due to low winter water flows.

The BLM considers Beaver Creek Chinook salmon to be a "sensitive species." Sensitive species are species of concern to the agency that are not yet listed, proposed, or candidate species under Federal or State regulations. A species occurring on BLM-administered land may be designated as "sensitive" if agency management actions could significantly affect its conservation status. BLM policy is to provide these species with the same level of protection provided for candidate species in BLM Manual 6840.06 C, by ensuring that "actions authorized, funded, or carried out do not contribute to the need for the species to become listed." The complete criteria for designating a species as "sensitive" are listed in BLM Manual 6840.06.

Table 3-8 Spawning period and habitat of fish species on the Refuge

Species	Spawning Period	Spawning Habitat
Resident Species		
Arctic grayling	May and June	Small tributaries with gravel, rock, or sandy bottoms.
Northern pike	May and June	Heavily vegetated floodplains of rivers, marshes, and lakes where water flow is minimal.
Burbot	January and February	Beneath ice.
Lake chub	June and July	Inlet streams of lakes and shallow streams with gravel or rocky bottoms.
Longnose sucker	June and July	Inlet streams of lakes and shallow streams with gravel or rocky bottoms.
Round whitefish	Late September through October	Gravel river shallows and inshore areas of lakes.
Trout-perch	Spring and into summer	Shallow gravelly streams, sand, and gravel bars in shallow areas of lakes.
Slimy sculpin	Spring	Shallow water of rocky streams.
Alaska blackfish	May and June	Shallow vegetated lakes and ponds.
Dolly varden (stream-resident)	Fall	Inlet streams of moderate current and medium-to-large gravel, and gravel bottom lakes.
Migratory Species		
Chum salmon	Summer and fall	Summer: lower and middle portions of Yukon River system. Fall: spring-fed upwelling areas in upper river systems and sloughs.
Chinook salmon	July through September	Tributary streams throughout the Alaskan and Canadian section of the Yukon River.
Coho salmon	Mid-August to late September or early October	Widely scattered areas throughout the Yukon River drainage, predominantly in tributaries of the Tanana River drainage.
Sheefish	Late September through mid-October	Specific areas in Yukon River mainstem. They are alternate year spawners.
Broad whitefish	Fall	Streams with gravel beds.
Least cisco	Fall	Streams with gravel beds.
Humpback whitefish	Fall	Upstream spawning grounds.
Bering cisco	Fall	Upstream spawning grounds of unknown location.
Arctic lamprey	Late May to early July	Spawns in clear tributary streams of moderate flow.

Sources: Scott and Crossman 1973; Morrow 1980; Alaska Department of Fish and Game 1985; Rost 1986; Service 1990; Eiler et al. 2004; AECOM 2009.

Table 3-9 Salmon counted at a temporary weir set in Beaver Creek near the confluence with Victoria Creek 1996-2000

Year	Chinook Salmon		Chum Salmon	
	Counted	Peak	Counted	Peak
1996	192	July 9	654	July 22
1997	315	July 26	34	No peak
1999	128	July 27	75	July 8
2000	114	July 23	11	No peak

Sources: Callin and Kostohrys 1998; Collin et al. 2002.

Both the size and timing of salmon runs vary from year to year, but they generally occur during July and early August (**Table 3-9**). Pacific salmon runs appear correlated to hydrographic conditions, with peak periods of migration coinciding with periods of high water (Collin and Kostohrys 1998). Collin et al. (2002) reported a marked decline in the numbers of Pacific salmon observed in 1999 and 2000 from those recorded in 1996 and 1997 (Collin and Kostohrys 1998). However, the 2000 run was the lowest on record, and all fisheries (subsistence, personal use, sport and commercial) were either severely limited or closed. The abundance of Chinook, and especially chum, salmon runs returning to the entire Yukon drainage were above average between 2003 and 2006. However, stocks of both species have declined since 2007 and stocks did not meet escapement goals in Canada in 2008, although goals in Canada were met in 2009. The subsistence fishery for Chinook salmon was closed in 2008, and the commercial fishery was limited or closed in 2008 and 2009 (Alaska Department of Fish and Game 2007; 2009). There is no evidence that the small returns of salmon to Beaver Creek are in danger of extirpation, and no evidence that subsistence or recreational uses have affected these runs. The Beaver Creek weir project should be considered an inventory project rather than an assessment project, and stock status trends should not be associated with the weir data, given the fairly limited amount of data the project provides for evaluation.

Grayling is the most sought-after fish by recreational fishers using Beaver Creek (Collin and Kostohrys 1998). For many years, the Beaver Creek Arctic grayling population was considered a pristine, unexploited stock (Fleming and McSweeny 2001). Arctic grayling are one of the more dominant species in the Beaver Creek watershed, with density estimates ranging from 38 fish (>7 inches tail fork length) per mile in the upper 11-mile section of Nome Creek to 1,325 fish per mile in the upper 30.5 miles of Beaver Creek (Fleming and McSweeny 2001). Webb (1982) found that Arctic grayling spawning habitat may be available throughout Beaver Creek. Grayling comprised 60% of fish collected during surveys in June and September 2007 (AECOM 2009). Grayling were relatively evenly distributed along the length of the creek. Telemetry studies located 12 grayling overwintering sites in the middle reaches of Beaver Creek upstream of the Refuge (Lubinski 1995), and Webb (1982) identified an overwintering site at Wild River Mile 38 upstream of the Refuge. Investigations of overwintering habitat have not been conducted on Beaver Creek within the Refuge, but such areas are likely limited as stream flow can approach zero in the winter. However, Kostohrys (2005) found that winter flows near Victoria Creek were higher than expected due to groundwater discharge.

Headwater tributaries, such as Champion Creek, Bear Creek, and Quartz Creek, appear to serve as summer feeding areas for grayling but do not constitute major spawning areas (Rhine 1985 *cited in* BLM 1988; Kretsinger 1986). Fleming and McSweeny (2001) believed the upper watershed population to be at or near its carrying capacity. Grayling segregate by size along the

length of the creek, with smaller fish occupying the more downstream reaches, a pattern consistent with other interior grayling stocks (Hughes 1991). Arctic grayling are prized by fisherman accessing areas in the upper half of the drainage, including the mainstream of Beaver Creek and adjacent tributaries. The size-stratified distribution pattern could cause more intense recreational fishing pressure in the upper reaches of the watershed where the largest Arctic grayling reside (Fleming and McSweeny 2001).

3.4.5.3 Essential Fish Habitat

Fish species depend on healthy habitats to survive and reproduce. Various activities on land and in the water constantly threaten to alter, damage, or destroy these habitats. The National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS), regional Fishery Management Councils, and Federal and State agencies work together to address these threats by identifying Essential Fish Habitat (EFH) for federally managed fish species and developing conservation measures to protect and enhance these habitats. Areas designated as EFH contain habitat essential to the long-term survival and health of our nation's fisheries. EFH includes those habitats that support the different life stages of each managed species. A single species may use many different habitats throughout its life to support breeding, spawning, nursery, feeding, and protection functions. EFH encompasses those habitats necessary to ensure healthy fisheries now and in the future.

The only species of fish reported for the Yukon Flats region that are subject to EFH consideration are the three species of Pacific salmon (National Marine Fisheries Service 2005). Freshwater EFH for Pacific salmon includes all streams, lakes, ponds, wetlands, and other water bodies that have been historically accessible to Pacific salmon. Pacific salmon EFH in the fresh waters of Alaska includes virtually all coastal access streams south of about 70º North latitude (Bureau of Land Management and Mineral Management Service 2003). The waters of Beaver Creek are EFH for Chinook and chum salmon, and the main stem of the Yukon River and its tributaries are EFH for Chinook, chum, and coho salmon.

3.4.5.4 International Treaty Obligations

ANILCA Section 302(9)(B)(iii) states that one of the purposes for establishing the Refuge is to fulfill the international treaty obligation of the United States with respect to fish and wildlife and their habitats. The U.S./Canada Yukon River Salmon Agreement, an annex of the Pacific Salmon Treaty, focuses on salmon management issues, rebuilding salmon stocks, and maintaining productive habitat. The Agreement only indirectly addresses development concerns within the Habitat section of the Agreement. The Agreement states "respective water quality standards should be maintained and enforced;" and "productive capacity of the salmon habitat on both sides of the Alaska-Yukon border should be maintained in order to achieve the objectives of this Chapter.." The Agreement provides that should "water quality standards be degraded or productive capacity of the salmon habitat be diminished to a degree that affects the objectives established in this Chapter, the Yukon River Panel may recommend corrective actions which may include adjustments to fishing patterns, border escapement objectives and guideline harvest ranges."

3.4.6 Birds

Approximately 166 bird species have been recorded within the Refuge (Sowl 1998). A complete list of these species, along with information on their abundance and seasonal status, is provided in **Appendix G**. Most of these species inhabit the Refuge only during the summer breeding season

and migrate to wintering grounds in the lower 48 states, Mexico, and Central America. However, 21 species, including several species of grouse and ptarmigan, and several owl, woodpecker, and passerine species, are year-round residents of the Refuge (**Table 3-10**).

The Refuge has some of the highest nesting densities of waterfowl in North America (U.S. Fish and Wildlife Service 1987a). One of the purposes of the Refuge is to conserve waterfowl and their habitats; consequently the biological program has a strong focus on waterfowl inventory, monitoring, and research. Other important types of birds on the Refuge are other waterbirds (shorebirds, loons and grebes, gulls, and terns) and upland birds such as raptors and passerines.

Table 3-10 Year-round resident bird species on the Refuge

Species Name	Abundance	Species Name	Abundance
Spruce grouse	C	American three-toed woodpecker	C
Willow ptarmigan	U	Black-backed woodpecker	U
Rock ptarmigan	U	Gray jay	C
Ruffed grouse	C	Common raven	C
Sharp-tailed grouse	U	Black-capped chickadee	U
Great horned owl	C	Gray-headed chickadee	R
Northern hawk owl	U	Boreal chickadee	C
Great gray owl	U	Pine grosbeak	U
Boreal owl	U	White-winged crossbill	C
Downy woodpecker	U	Common redpoll	C
Hairy woodpecker	U		

Key:

C = Common (certain to be seen or heard in suitable habitat); R = Rare (seen only a few times a year); and U = Uncommon (present but not certain to be seen or locally distributed).

3.4.6.1 Waterfowl

The trumpeter swan, greater white-fronted goose, and Canada goose, and 20 duck species are known to nest on the Refuge. Other swan or goose species occasionally occur on the Refuge, but would be considered rare or accidental visitors to the Refuge. Numerous waterfowl studies have been conducted on the Refuge, predominantly in the wetland areas.

Waterfowl densities are generally highest on the central, low elevation wetlands of the Refuge where aquatic habitats are most abundant. Density estimates shown on **Figure 3-13** include waterfowl, grebes, and loons. Waterfowl densities in most townships in these areas range from approximately 1.1 to 22.0 birds per mi^2. In the upland areas along the southern portion of the Refuge, waterfowl densities are generally lower, ranging from 0.0 to 1.0 birds per mi^2. Bertram and Vivion (2000) surveyed eight townships in the southern portion of the Refuge and reported similar results. Most of the area surveyed was upland terrain ranging from 500 to 1,000 feet in elevation. The most abundant species were white-winged scoter and lesser scaup, both of which are diving species. Waterfowl surveys have not targeted much of the northern portion of the Refuge due to the sparseness of waterfowl habitat.

Waterfowl species that are common on the Refuge or are of special interest or concern are discussed in the sections that follow.

Swans

Trumpeter swan is the largest species of North American waterfowl. Once hunted for their feathers and skin, and greatly reduced in number, trumpeter swans have since benefited from habitat conservation and protection from shooting. The Refuge provides nesting habitat for trumpeter swans during the summer. They nest on a variety of freshwater marshes, ponds, lakes, and rivers, including beaver impoundments, where they defend territories (Johnsgard 1979). Swan surveys are conducted on the Yukon Flats every 5 years in late August. The number of trumpeter swans using the Refuge has increased steadily since the surveys were initiated in 1975 (**Table 3-11**). In 2005, 1,046 adults and 324 young trumpeter swans were observed in the Yukon Flats during aerial surveys, which was an increase from the 749 swans observed in 2000 and the 423 swans observed in 1995. Most swans occur in the central wetlands, particularly along Birch Creek and Beaver Creek, and in the western portion of the Refuge north of Stevens Village (**Figure 3-14**). Fewer swans occur in the uplands of the southern and northern portions of the Refuge.

Table 3-11 Trumpeter swans observed on the Yukon Flats Refuge during surveys conducted every 5 years from 1975 through 2005

Survey Year	Swans Observed in the Refuge Survey Area		
	Adults	Young	Total
1975	2	1	3
1980	2	4	6
1985	10	3	13
1990	66	27	93
1995	262	59	321
2000	791	197	988
2005	1,046	324	1,370

Source: Conant and Groves 2006.

Geese

Greater white-fronted goose and Canada goose are uncommon nesting species across the Refuge. However, Canada geese are common nesters on islands in the Yukon River and raise young in adjoining sloughs. The 2006 population index for Canada geese on the Refuge was 2,700 birds, but no index was reported for white-fronted geese (Conant and Groves 2006). Earlier population estimates of geese on the Refuge (1989 to 1991) ranged from approximately 2,600 to 3,400 Canada geese and from 1,100 to 4,500 white-fronted geese (Platte and Butler 1992). White-fronted geese are primarily associated with areas that have open, grassy, and shrub-fringed habitats near streams or ponds, while Canada geese use a variety of wetland habitats (Johnsgard 1979).

Dabbling Ducks

Dabbling ducks are species of surface feeding ducks that feed by tipping their tails up to reach aquatic vegetation and invertebrates in shallow areas of lakes, ponds, and marshes. Nesting occurs where there are grasses, sedge meadows, or on dry hillsides that have brush or tree cover, or sometimes in open woodlands near ponds or sloughs (Johnsgard 1979). Seven dabbling duck species are known to breed on the Refuge. In 2008, the most abundant dabbling duck species on the Refuge were American wigeon, green-winged teal, northern shoveler, northern pintail, and mallard (Mallek and Groves 2008).

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Yukon Flats National Wildlife Refuge

Alaska

Waterfowl and Waterbird Density by Township in Surveyed Areas of the Yukon Flats Refuge

Figure 3-13

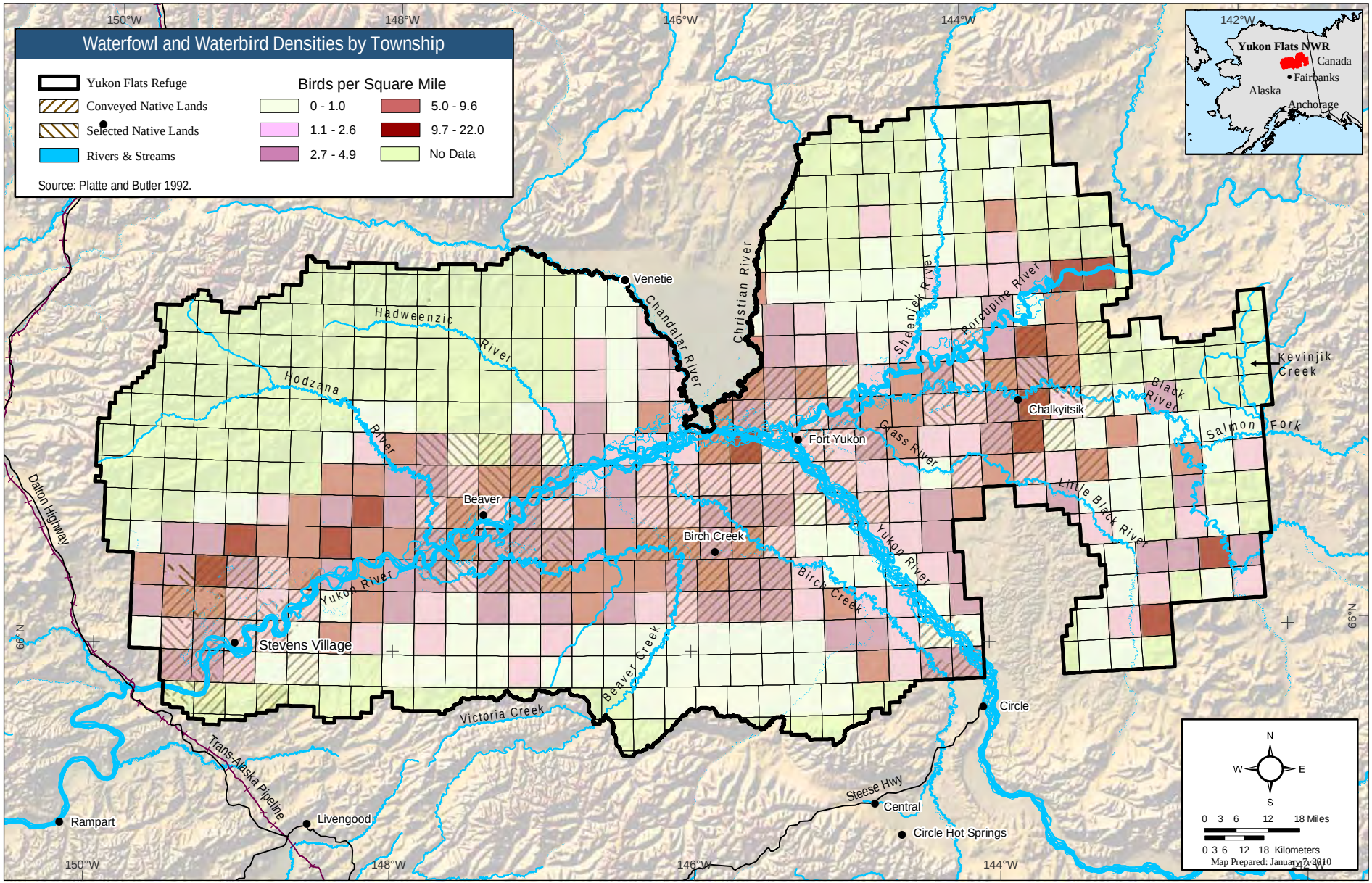

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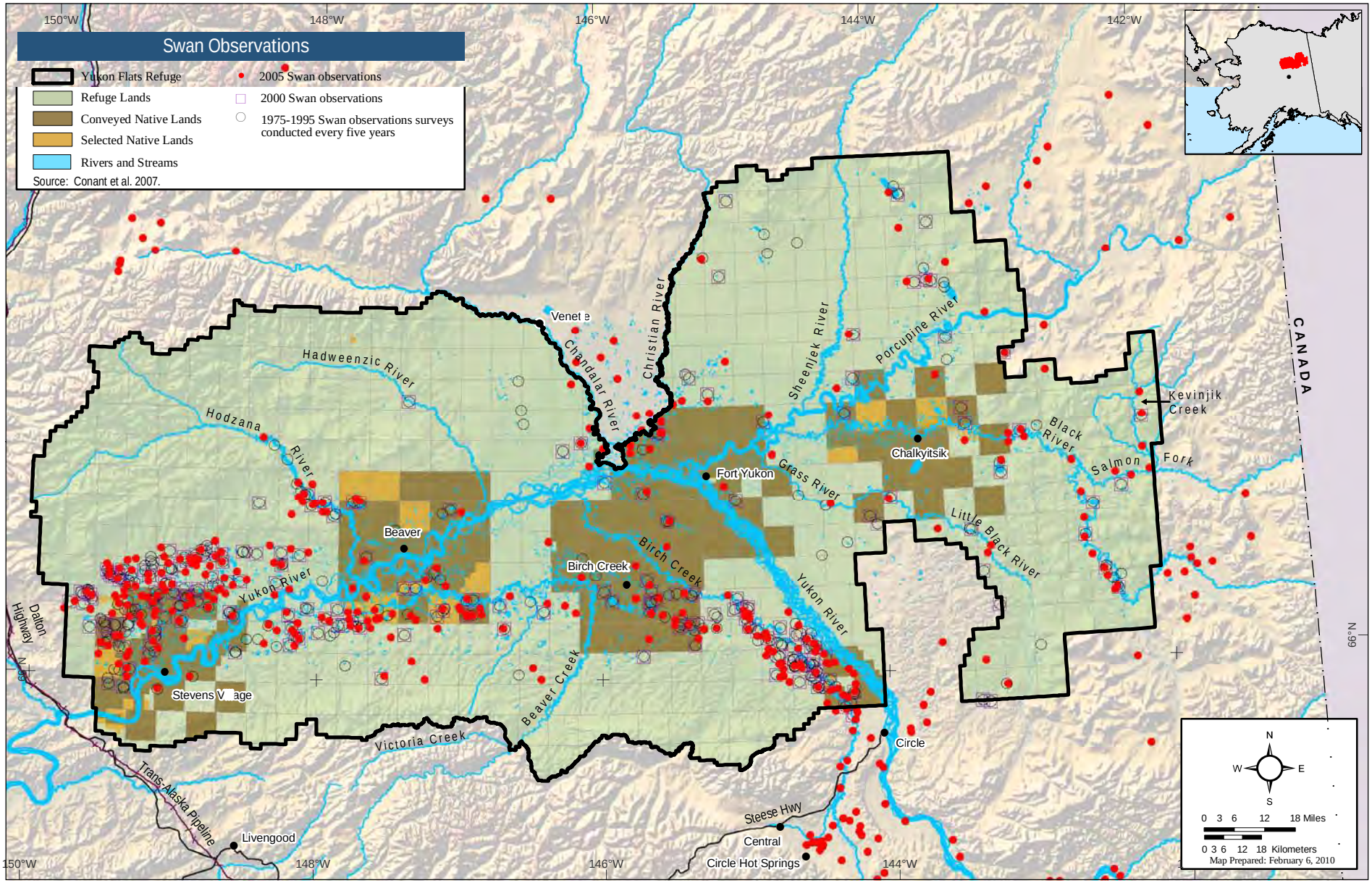
Figure 3-14

Locations of Swan Observations in the Yukon Flats Refuge, 1975-2005

Yukon Flats National Wildlife Refuge
Alaska



American wigeon arrive on the Refuge near the beginning of May (Lensink 1965), and most nest initiation occurs from May 31 to June 7 (Grand 1995). Clutch size varies from 3 to 12 eggs, although mean clutch size of about 8 eggs has been reported in several studies (Mowbray 1999). The 2008 population index of American wigeon in the Refuge was 319,900 birds (Mallek and Groves 2008). Greater densities of American wigeon were reported in the Yukon Flats area (11.1 birds per mi^2) than in other survey areas of Alaska during waterfowl breeding population surveys from 1957 to 1993 (Hodges et al. 1996). Wigeon favor shallow, semipermanent water areas surrounded by woodlands for breeding. They also use seasonal wetlands that typically occur on floodplain terraces, shorelines of lakes and ponds, or in isolated depressions (U.S. Fish and Wildlife Service 2007b). Wigeon feed on a variety of aquatic plants and graze along shorelines on grassy or sedge-covered meadows (Johnsgard 1979).

The average arrival date of green-winged teal on the Refuge is May 7 (Lensink 1965). The 2008 population index of green-winged teal in the Refuge was 95,900 (Mallek and Groves 2008). Green-winged teal broods are more abundant on the Refuge than broods of other duck species (Platte and Butler 1992). Greater densities of green-winged teal were reported in the Refuge area (7.0 birds per mi^2) than in other waterfowl survey areas in Alaska during waterfowl breeding population surveys from 1957 to 1993 (Hodges et al. 1996). Green-winged teal favor wooded ponds and nest in grasses, sedge meadows, and on dry hillsides having brush or tree cover (Johnsgard 1979; U.S. Fish and Wildlife Service 2007b). They feed on small seeds and invertebrates, and aquatic vegetation.

Most nest initiation by northern shovelers occurs between May 27 and June 2, although it can occur as early as May 10 (Grand 1995). The 2006 population index of northern shoveler in the Refuge was 159,644 birds, which was 38% of the estimated Alaska population (Conant and Groves 2006). The northern shoveler population has shown an increasing trend in Alaska since the 1960s (Hodges et al. 1996) and in North America since the mid-1990s (U.S. Fish and Wildlife Service 2009). Greater densities of northern shovelers were reported in the Yukon Flats area (0.8 bird per mi^2) than in other survey areas of Alaska during waterfowl breeding population surveys from 1957 to 1993 (Hodges et al. 1996). Shovelers prefer temporarily or seasonally flooded persistent emergent wetlands over wooded shorelines for nesting (U.S. Fish and Wildlife Service 2007b). Feeding is done near the surface, by straining out small plankton-sized organisms with the long lamellae of the oversized bill (Johnsgard 1979).

Northern pintails arrive on the nesting ground early, with a reported average arrival date on the Refuge of April 28 (Lensink 1965). Early nest initiation ranges from May 2 to 15, and mean nest initiation ranges from May 16 to 25 (Grand 1995). The 2008 population index of northern pintail on the Refuge was 152,200 (Mallek and Groves 2008). Northern pintail densities in the Yukon Refuge (15.2 birds per mi^2) were higher than pintail densities in most other survey areas of Alaska during waterfowl breeding population surveys from 1957 to 1993, although the greatest Alaskan densities were reported in Seward Peninsula and Kotzebue Sound areas (Hodges et al. 1996). Pintail favor shallow bog lakes, quiet rivers, and seasonal flooded wetlands (U.S. Fish and Wildlife Service 2007b). Waters that are lined with trees are often avoided, but pintails often use brushy and wooded thickets around sloughs. Aquatic vegetation and invertebrates are important food items (Johnsgard 1979).

Mallards, like northern pintails, arrive on the breeding grounds earlier than most other duck species, with an average arrival date of April 28 in the Refuge area (Lensink 1965). Mallards use a variety of habitats, including deep and shallow lakes, and emergent wetlands (U.S. Fish and Wildlife Service 2007b). Nest initiation begins on the Refuge as early as May 2, with a mean nest

initiation date near May 26 (Grand 1995). The 2008 population index of mallards on the Refuge was 122,600 (Mallek and Groves 2008). Mallards were the most abundant dabbling duck species reported in the Yukon Flats area in 1990 (Platte and Butler 1992). Greater mallard densities were reported in the Yukon Flats area (7.0 birds per mi^2) than in other survey areas of Alaska during waterfowl breeding population surveys from 1957 to 1993 (Hodges et al. 1996).

Other dabbling duck species occur on the Refuge in lower densities, including gadwall and blue-winged teal (Sowl 1998).

Diving Ducks

Diving ducks dive from the surface and feed underwater. Breeding has been documented on the Refuge for at least 13 diving duck species, although several other diving duck species also likely breed on the Refuge (Sowl 1998). Diving ducks tend to be found near larger bodies of water, including shallow lakes and ponds having low islands, moist sedge meadows, and brushy and woody cover along the shore. Areas with abundant invertebrates, such as aquatic insect larvae and amphipods, are most heavily used (Johnsgard 1979).

The lesser scaup is the most abundant diving duck species on the Refuge (Platte and Butler 1992; Mallek and Groves 2008). The 2008 population index for the Refuge was 211,200 birds (Mallek and Groves 2008). Lesser scaup nest primarily in boreal forest wetlands from Alaska through Manitoba and winter south to Mexico and Central America (Austin et al. 1998). Shallow lakes and ponds having low islands, moist sedge meadows, and brushy cover are preferred, especially if they support abundant invertebrates (Johnsgard 1979; U.S. Fish and Wildlife Service 2007b). Lesser scaup populations in North America have been declining in recent years (Afton and Anderson 2001; U.S. Fish and Wildlife Service 2003). In Alaska, interior scaup populations, which are primarily lesser scaup, have likely been declining since the 1960s (U.S. Fish and Wildlife Service 1999). Factors influencing this population decline are unknown but may include habitat change on the breeding ground (Corcoran 2005; Riordan 2005) or factors outside the breeding grounds that influence female survival and ability to successfully breed (Austin et al. 2006).

Lensink (1965) reported an average arrival date for scaup of May 12 for the Refuge area. Scaup nest later than other boreal forest waterfowl species, with a mean clutch initiation date on the Refuge of early to mid-June (Grand 1995; Corcoran 2005). Mean clutch size in a recent study on the Yukon Flats was 8.3 eggs (Corcoran 2005). In this study, predation was the primary cause of nest failure, with nest success along wooded creeks over twice as high as that on wetlands. Martin (2007) conducted scaup research on the Refuge from 2004 to 2007, and reported that breeding probability was 0.12 and was likely related to body mass.

All three species of scoter are known to breed on the Refuge (Sowl 1998). Of these, the white-winged scoter is by far the most abundant species on the Refuge, comprising 97% of scoters observed during surveys in 2005 (Mallek 2005). Surf scoters and black scoters are present in low numbers. The Refuge is likely the most important breeding and migration staging area for scoters in interior Alaska (U.S. Fish and Wildlife Service 1999). Scoters, like scaup, nest later than most other waterfowl species on the Refuge. Scoters favor freshwater ponds, lakes, or rivers in tundra or wooded country (Johnsgard 1979). On the Refuge, they use a variety of habitats, including deep and shallow lakes, and emergent wetlands (U.S. Fish and Wildlife Service 2007b).

The white-winged scoter population index on the Refuge for 2005 was 19,048 birds, which was 16% more than the previous 4-year mean (2001 to 2004, 16,430 birds; Mallek 2006). However, waterfowl breeding population surveys may suggest a possible declining trend of white-winged scoters regionwide in interior, boreal forest habitats (U.S. Fish and Wildlife Service 1999). Six white-winged scoters captured on the Refuge were tracked by satellite transmitter in 2002. In general, these birds moved into the Bristol Bay area during the winter, although one bird was tracked to lower Cook Inlet and Kodiak Island. During the summer, these birds moved back to the Refuge or to the Northwest Territories near the Anderson and Mackenzie rivers (Alaska Department of Fish and Game 2002).

Based on breeding ecology studies between 2002 and 2004, white-winged scoters on the Refuge nest in forest and scrub habitats, and generally avoided open grassland habitats (Safine 2005). The woody cover available in these habitat types may be important for nest concealment and reducing the probability of nest depredation. Mean scoter clutch size in the Safine (2005) study was 8.1 eggs, and the average nest initiation date was between June 7 and 11. Nest success through the laying and incubation period was 1 and 18% in graminoid and forest habitats, respectively.

The canvasback is the second most abundant diving duck species on the Refuge, based on 2008 aerial surveys, with a population index of 40,400 (Mallek and Groves 2008). According to waterfowl breeding population surveys from 1957 to 1993, canvasback densities in the Refuge (4.4 birds per mi^2) are greater than in other survey areas of Alaska (Hodges et al. 1996). In 2006, the Refuge was home to 48% of the estimated Alaska population. Lensink (1965) reported an average arrival date of May 10 for canvasbacks on the Yukon Flats. Early canvasback nest initiation dates on the Refuge have been observed from May 20 to May 22 (Grand 1995). Canvasbacks breed on deeper, more stable ponds and marshes than most other duck species (Mowbray 2002). They build large nest structures composed of loosely woven reeds and sedges at the water edge. Canvasbacks are omnivorous and feed on submerged and benthic vegetation and benthic invertebrates. On the Refuge, canvasbacks use a variety of habitats, including deep and shallow lakes, and emergent wetlands (U.S. Fish and Wildlife Service 2007b).

The ring-necked duck is the third most abundant diving duck species on the Refuge, based on 2006 aerial surveys, with a population index of 14,500 (Mallek and Groves 2008). Other diving duck species reported included goldeneye, bufflehead, and merganser, which occurred in smaller numbers. Diving duck species that are rare or uncommon breeding birds on the Refuge include redhead, harlequin duck, ruddy duck, and long-tailed duck (Sowl 1998).

3.4.6.2 Other Waterbirds

Shorebirds

Twenty-seven shorebird species occur on the Refuge, including 23 sandpiper and 4 plover species (Sowl 1998). Shorebirds use a variety of habitats for nesting and may forage in other types of habitat away from nesting areas. Wetlands on the Refuge provide critical spring and fall staging habitats for migrating shorebirds. In early May 2006, hundreds of shorebirds were observed daily at Long Lake just southwest of Beaver Village (Martin 2006).

Of the 23 sandpiper species on the Refuge, only 4 are considered common: lesser yellowlegs, solitary sandpiper, spotted sandpiper, and common snipe. These species are found in wetlands with shrub cover and in riparian zones (U.S. Fish and Wildlife Service 2007b). Only six other

sandpiper species are known to breed on the Refuge (**Appendix G**). All other sandpiper species on the Refuge occur only as migrants (Sowl 1998).

Of the four plover species, only the semipalmated plover is considered common on the Refuge, although both American golden-plover and killdeer are known to breed there as well (Sowl 1998).

Loons and Grebes

Three loon species occur on the Refuge: Pacific loon, common loon, and red-throated loon. Loons favor permanently flooded areas of lakes, ponds, and rivers where vegetation is lacking or sparse, and permanently to semipermanently flooded wetlands (U.S. Fish and Wildlife Service 2007b). Based on breeding population surveys in the Yukon Flats Basin from 1977 to 1993, densities of Pacific, common, and red-throated loons were estimated at 0.54, 0.16, and 0.03 birds per mi^2, respectively (Groves et al. 1996).

The total loon population on the Refuge was estimated at 19,760 birds in 1986 (Lanctot and Quang 1992) and between 9,360 and 18,000 birds from 1999 to 2006 (Guldager and Bertram 2007). Pacific loons accounted for 89 to 99% of the observed loons, common loons accounted for 1 to 11%, and red-throated loons accounted for less than 1%. Total loon density during these periods was estimated at 1.97 (Lanctot and Quang 1992) and 0.85 to 1.66 loons per mi^2 (Guldager and Bertram 2007), respectively (**Table 3-12**).

Pacific loon is the most abundant loon species in North America (Russell 2002) and was by far the most abundant loon species reported during aerial surveys of the Refuge (Lanctot and Quang 1992; Platte and Butler 1992; Guldager and Bertram 2007). During breeding pair surveys in the southern portion of the Refuge in upland habitats that included parts of the core lands, Pacific loons were observed on 29% of the lakes surveyed (Bertram and Vivion 2000). Most of the water bodies surveyed appeared deep enough to contain overwintering fish.

Common loons have been consistently reported in the Refuge during aerial surveys (Lanctot and Quang 1992; Platte and Butler 1992; Bertram and Vivion 2002a), although densities appear to be low in the southern portion of the Refuge (Bertram and Vivion 2000). Red-throated loons are apparently much less common on the Refuge than Pacific and common loons (Platte and Butler 1992; Lanctot and Quang 1992; Bertram and Vivion 2002a). Bertram and Vivion (2002a) reported a density of 0.01 red-throated loons per mi^2 in the southern portion of the Refuge. Groves et al. (1996) reported a declining trend in red-throated loon populations in Alaska between 1971 and 1993, although these declines apparently occurred in the western tundra rather than on the North Slope or in the boreal forests of interior Alaska (McCaffery 1998 *cited in* Barr et al. 2000).

Two grebe species, the horned grebe and the red-necked grebe, are common breeding birds on the Refuge (Sowl 1998). The Refuge population of horned grebes is estimated to be in the tens of thousands. During a horned grebe nest study conducted in 2005 at Long Lake, 33 miles southwest of Beaver Village, breeding pairs were observed along every 100 yards of shoreline (Bertram 2006a).

Table 3-12 Loon densities and population indices for the Refuge, 1988-2006

Year	Pacific Loon			Common Loon			Red-Throated Loon			All Loons	
	Density[1]	Population Index[2]	Percent[3]	Density[1]	Population Index[2]	Percent[3]	Density[1]	Population Index[2]	Percent[3]	Density[1]	Population Index[2]
1988	0.49	NC	NC	0.12	NC	NC	0	NC	NC	0.61	NC
1999	0.43	11,970	89	0.03	810	6	0	NC	0	0.48	13,500
2000	0.59	16,380	91	0.05	1,260	7	0.01	360	2	0.64	18,000
2001	0.44	12,420	91	0.03	810	6	0.02	450	3	0.49	13,680
2002	0.46	12,870	89	0.05	1,530	11	0	0	0	0.52	14,409
2003	0.53	14,850	93	0.03	900	6	0.01	180	1	0.57	15,930
2006	0.33	9,270	99	0.00	90	1	0.00	0.00	0	0.33	9,360

Notes:

[1] Number of loons per mi^2.
[2] Number of loons observed during the survey.
[3] Percentage of all loons observed during the survey.

Key:

NC = Not calculated due to small sample size.

Source: Guldager and Bertram 2006.

Gulls and Terns

Four gull species are known to occur on the Refuge, although only the mew gull and the herring gull are considered common. Arctic tern also is a common breeding species on the Refuge (Sowl 1998).

3.4.6.3 Upland Birds

Raptors

Raptors known to occur on the Refuge include two species of eagles, two species of hawks, four species of falcons, and six species of owls (**Appendix G**). Of the 19 species in this group, only red-tailed hawk and great-horned owl are considered common (Sowl 1998). Other raptor species are considered uncommon or rare, although all but snowy owl are known or likely to breed on the Refuge.

Red-tailed hawks breed throughout the lower 48 states, Mexico, and much of Canada and Alaska. The Refuge is located near the northern limit of their breeding range.

Great-horned owls breed throughout the United States and much of Canada to Mexico and Central and South America. Great horned owls are not migratory, and the Refuge is located near the northern limit of their range.

The peregrine falcon is an uncommon breeding species on the Refuge (Sowl 1998). Peregrine falcon numbers declined dramatically in the 1950s and 1960s because of exposure to dichloro-diphenyl-trichloroethane (DDT). The species was listed as endangered under the Endangered Species Act, but was removed from the list in 1999 after numbers recovered. The peregrine falcon has been reported as the most abundant nesting raptor on cliffs along the Porcupine River in the northeastern portion of the Refuge (Ritchie 1983). Peregrine falcons also have been observed along the lower Yukon River downstream from Stevens Village, the upper Salmon Fork on the Black River, Preacher Creek, and on Beaver Creek. In 2006, there were two documented breeding pairs of peregrine falcons on Beaver Creek. One pair was observed a few miles downstream of the confluence with Victoria Creek and outside of the core lands. The other pair was observed about 20 miles downstream from Victoria Creek and within the core lands. The Service currently inventories raptor nests on the upper Porcupine River; approximately seven peregrine falcon nests within the Refuge are monitored during this survey (Bertram 2006b).

Bald eagle nests have been observed near Beaver Creek and on the Yukon and Porcupine rivers. Bald eagles nest in trees with large stout branches capable of holding their large stick nests. Golden eagles are uncommon breeding birds on the Refuge (Sowl 1998). However, golden eagles have been reported as the second most abundant nesting raptor along the Porcupine River in the northeast portion of the Refuge (Ritchie 1983). Bald and golden eagles are protected under the Eagle Protection Act.

Passerines

Fifty-five passerine bird species occur on the Refuge (Sowl 1998, **Appendix G**). Passerines are small- to medium-size land birds that have feet well adapted for perching. They occur in a variety of habitats on the Refuge, with the most common birds attracted to recently burned, early succession habitats associated with lake edge (Bertram and Person 2005).

Annual breeding bird surveys were conducted on the Porcupine River about 10 miles northeast of Fort Yukon from 1994 to 2001. The most commonly observed bird species were Swainson's thrush, bank swallow, and alder flycatcher. These species favor shrub and deciduous tree wetlands and uplands (U.S. Fish and Wildlife Service 2007b). In another monitoring study between 1994 and 2001, the most common bird species at Marten Island on the Yukon River, and at a location about 20 miles southeast of Beaver Village near Beaver Creek, included Swainson's thrush, yellow-rumped warbler, dark-eyed junco, and American robin.

During a banding study at Canvasback Lake, approximately 33 miles southwest of Fort Yukon, common species captured between 1995 and 2001 were yellow warbler, yellow-rumped warbler, Swainson's thrush, American robin, common redpoll, Lincoln's sparrow, and northern waterthrush. These species favor shrub and woodland habitats (U.S. Fish and Wildlife Service 2007b). These species comprised approximately 73% of the total number of birds banded. An annual average of 633 birds and 26 species were banded. During another survey at Canvasback Lake in 1996, the most abundant species recorded were yellow warbler, Swainson's thrush, American robin, and yellow-rumped warbler.

The Service (Bertram and Person 2005) conducted bird surveys at nine locations in the southern portion of the Refuge in the area of the proposed core lands. The survey locations included two alpine sites, six lakeshore sites, and one site along Beaver Creek. A total of 1,231 birds representing 61 species were observed. Fewer birds and bird species were observed at the alpine sites. More species were observed at the Beaver Creek site than any other site. The most abundant passerine species were white-crowned sparrow, Swainson's thrush, and dark-eyed junco, with American robin and fox sparrow also common (Bertram and Person 2005). Rusty blackbirds were recorded at two locations, and olive-sided flycatcher, another species of concern, was reported at three locations (Rich et al. 2004; Bertram and Person 2005).

Grouse

Three grouse and two ptarmigan species are found on the Refuge, all of which are year-round residents (Sowl 1998). Spruce grouse and ruffed grouse are considered common on the Refuge, and willow ptarmigan and rock ptarmigan are considered uncommon (Sowl 1998). Sharp-tailed grouse are considered uncommon on the Refuge, although they may be common in some areas (Sowl 1998, Stephenson and Thomas 2004).

Woodpeckers

Four woodpecker species, downy woodpecker, hairy woodpecker, three-toed woodpecker, and black-backed woodpecker, occur year-round on the Refuge. A fifth species, northern flicker, is an uncommon breeding species on the Refuge that migrates out of the area after the breeding season. Only the three-toed woodpecker is considered common on the Refuge (Sowl 1998).

3.4.7 Mammals

Thirty-seven species of terrestrial mammals are known to occur within the Refuge. Additionally, two marine mammal species, beluga whale and harbor seal, have been recorded on the Yukon River within the Refuge, but these were rare observations. The discussion below focuses on the most conspicuous mammal species on the Refuge, as well as species of special interest. A complete list of mammal species found on the Refuge is provided in **Appendix G**.

More survey data have been recorded for moose, black bear, wolf, and Dall sheep than for other mammal species on the Refuge. Information on furbearers is available from work done in the 1980s and from anecdotal information collected during aerial surveys for other species. Limited small mammal collections have occurred in conjunction with fire studies, but little information is available on their abundance and distribution.

3.4.7.1 Moose

Moose habitat is abundant in the Refuge (Alaska Department of Fish and Game 2002). The prevalence of forest fires creates favorable foraging conditions for moose by promoting the establishment of deciduous shrubs stands. During spring break-up, ice scour and flooding disturbance events along the Yukon and its tributaries serve to maintain willow stands in productive, early successional states. The most common woody plants browsed by moose are various willows, including felt-leaf and Pacific willow, red-osier dogwood, balsam poplar, and aspen. Moose also forage seasonally on aquatic plants and forbs. Both upland and riparian habitats in the Refuge have high quality forage and constitute moose habitat. Relatively light snowpack (typically less than 2 feet deep) in the Refuge allows moose to forage without difficulty in the winter, and death from winter malnutrition is uncommon.

Aerial surveys to monitor moose in the Refuge have been conducted since 1962 (Bertram 2005). The surveyed area has been divided into eastern and western sections of Game Management Unit (GMU) 25D (**Figure 3-15**). Beginning in 1999, moose population surveys were standardized in the eastern and western survey areas, with sample units stratified into areas of high and low moose density. During 2004 and 2005, aerial moose population surveys were conducted in the Venetie survey area that includes Refuge land south of the Chandalar River (Stephenson and Thomas 2005). In 2006, additional lands in the Birch Creek region were surveyed in the central Refuge (Stephenson and Thomas 2006). In 2006, the Service conducted winter and fall surveys in the western survey area and extended the survey coverage to encompass lands involved in the proposed land exchange that had not been previously surveyed (Bertram 2007).

Eastern Survey Area – Since 1999, the average moose density in the eastern survey area has ranged from 0.13 to 0.34 moose per mi^2. The population trend increased from 2004 to 2005 and then decreased slightly in 2006. This increasing trend from 2004 to 2005 may be associated with several factors, including: (1) a reduction in the cow harvest and implementation of the Yukon Flats Cooperative Moose Management Plan, (2) a reduction in fall moose harvest due to low water conditions that precluded local boat access to hunting areas, (3) increased summer calf survival, and (4) sampling error and adjustments to the stratified sampling method used (Stephenson and Thomas 2005).

In 2006, the moose populations in the eastern Yukon Flats and the Birch Creek survey areas were estimated at 799 and 732 moose, respectively (Stephenson and Thomas 2006). As in previous surveys, moose abundance was generally greatest at low elevations north of the Yukon River and southeast of Fort Yukon, and in the vicinity of the Black and Porcupine rivers.

Western Survey and Exchange Survey Areas – The fall 2008 population estimate for the western survey area was 490 moose, or 0.22 moose per mi^2 (Lake 2008). The 2008 estimate of total moose was 15% greater than the November 2006 estimate of 417 (311 to 524). This difference was related to the numbers of calves, which were 54% greater than in November 2006. The trend (1999 to 2008) in numbers of total moose continues to be negative. It is difficult to determine a long-term trend as different survey methods were used prior to 1999. Based on a

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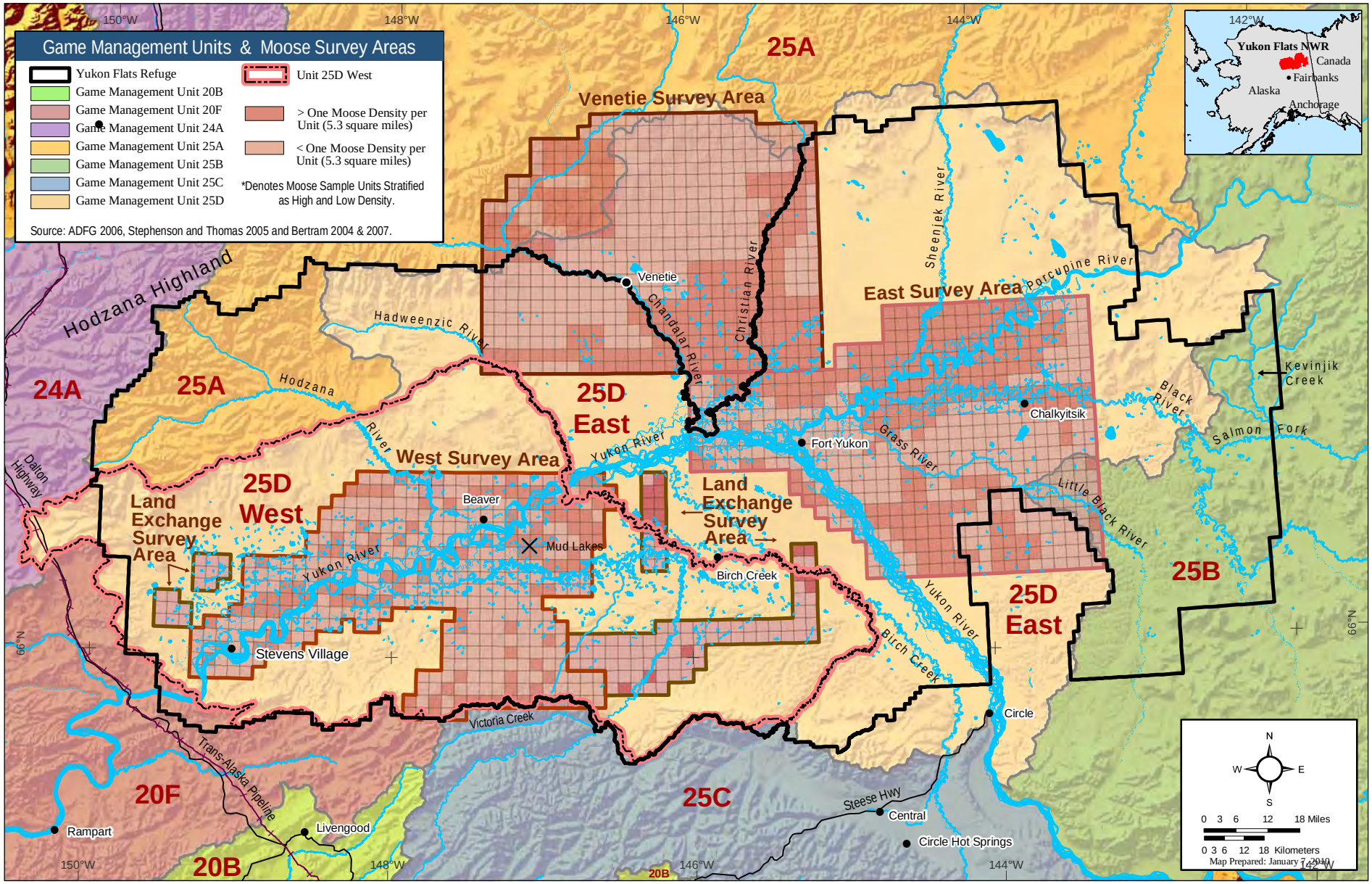
Figure 3-15

Game Management Units and 2006 Moose Survey Areas* in the Yukon Flats Refuge

Yukon Flats National Wildlife Refuge

Alaska



characterization of moose populations by Boertje et al. (2007), densities of moose in the western portion of the Refuge are currently low. This description is consistent with data from surveys conducted in the 1980s by the ADFG that were used to characterize the population then as low (Gasaway et al. 1992). Therefore, it is likely that numbers of moose in the western portion of the Refuge have been relatively stable at a low density since at least the 1980s. Based on metrics of moose health and productivity, quality habitat in this system does not seem to be limiting (Bertram and Vivion 2002; Boertje et al. 2007). It is most likely that moose are maintained at low densities in this system by predation (Gasaway et al. 1992). The declining trend in the western survey area moose population is likely the result of cow, calf, and yearling moose mortality. Bertram and Vivion (2002b) conducted a radiotelemetry study of moose in the western Yukon Flats survey area from 1998 to 2000 specifically to examine the cause of mortality to cow and calf moose. The results of this study suggested that a combination of low calf survival, adult mortality due to predation, illegal cow harvest, and low predator harvest all act to depress the moose population of the Yukon Flats.

A study to estimate the kill rate of wolves on moose was recently initiated in the western portion of the Yukon Flats in November 2008 (Lake et al. 2009). This study is the first to examine kill rates in a system with such a low prey density (0.20 moose/mi^2) and the presence of only a single prey species. Wolves were radio tracked daily during early February and March 2009 to locate kills. The estimated kill rate was 0.019 moose/wolf/day. This project is scheduled to be completed in 2010.

The Service conducted moose surveys in the Yukon Flats exchange lands in March (western exchange lands only) and November 2006 (all exchange lands) to estimate early and late winter moose abundance. The March 2006 population estimate for exchange lands in the western Refuge (578 mi^2 survey area) was 65 moose; the mean density estimate was 0.11 moose per mi^2. The November 2006 population estimate for exchange lands surveyed in the eastern and western Yukon Flats (1,108 mi^2 survey area) was 249 moose; the mean density estimate was 0.22 moose per mi^2. Of the land parcels proposed to be received by the Service in the proposed land exchange, approximately 63% include average to high moose densities in early winter, and all parcels have low densities of moose in late winter. Parcels proposed to be received by Doyon are characterized by low moose densities in both early and late winter.

3.4.7.2 Caribou

Caribou in Alaska are distributed in 32 herds that migrate between calving and wintering grounds (Alaska Department of Fish and Game 2005a). Herds use separate calving areas, although different herds may mix on wintering grounds. The ranges of caribou herds known to use lands within the Refuge in recent years are shown in **Figure 3-16**.

Caribou associated with the Porcupine and Central Arctic herds occasionally winter in the northern portions of the Refuge in the Venetie area (Wertz 2006); however, caribou use of northern areas of the Refuge is variable. During some winters, no caribou use this area; in other winters, several hundred to several thousand caribou may occupy the northern portions of the Refuge.

Preliminary studies of a small number of radio-collared caribou on BLM lands adjacent to the northwestern portion of the Refuge indicate a resident herd (Hodzana Caribou Herd) of approximately 1,000 caribou in this area (Craig 2006). These caribou are found on high tundra habitats on BLM lands and occasionally on adjacent Refuge lands. Caribou from this herd

apparently do not use the low elevation habitats of the Refuge. However, caribou are occasionally reported in low elevation habitats of the Refuge (Bertram 2004; Stephenson and Thomas 2004).

Resident caribou of the White Mountain Caribou Herd also occur along the southern portion of the Refuge in the White Mountains (**Figure 3-16**). The White Mountain Caribou Herd is comprised of approximately 700 animals, although the herd has contained as many as 1,200 animals in past years (Herriges 2006). The herd occurs most frequently south of the Refuge from the foothills north of Noodor Dome to West Crazy Mountain and Beaver Creek. On the Refuge, caribou from the White Mountain Herd occur most frequently north of the Victoria Creek drainage.

Preferred habitat for caribou consists of high alpine meadows and open subalpine forests, although in summer they often move to denser forests at lower elevation to seek shade and more succulent vegetation. In winter, caribou inhabit more open forests and higher elevation slopes where they feed on arboreal lichens. Sedge bogs, moss muskegs, and wet meadows also are commonly used by caribou (Snyder 1991).

3.4.7.3 Dall Sheep

Dall sheep inhabit steep mountain terrain where they occupy ridges, meadows, and steep slopes to feed and rest, and to escape predators. They are generally found at relatively high elevation, but sometimes occur in rocky gorges below timberline. Dall sheep often congregate at mineral licks, where they obtain salt and other critical minerals. A wide variety of plants are consumed by Dall sheep during the summer when forage is abundant. In the winter, forage is relatively scarce, and dry grasses, sedge stems, lichens, and mosses comprise the majority of the sheep's diet.

A small population of Dall sheep occurs in scattered groups in the White Mountains. The population is comprised of approximately 550 to 600 animals and has been steadily increasing over the last 20 years (Alaska Department of Fish and Game 2005b). A third of the population occurs on Mount Schwatka on the southern border of the Refuge and on Victoria Mountain, which is located just off the Refuge and east of Mount Schwatka (**Figure 3-16**). The remaining portion of the population is located south of Victoria Mountain in the WMNRA and the Steese National Conservation Area. Dall sheep in the White Mountains move from wintering grounds to lambing areas between late May and mid-June (Durtsche et al. 1990). Lambing generally occurs between May 15 and 30.

Movement to rutting areas usually occurs from late September to late October, and movement to wintering areas occurs in November and December. Recent radiotelemetry studies indicate that a majority of the sheep using Victoria Mountain are transient between Victoria Mountain and Mount Schwatka for much of the year and that sheep heavily use areas east of Mount Schwatka (Bertram 2006a). Lambing occurs on Victoria Mountain, the ridge complex in upper Jefferson Creek and upper Big Creek, which are located on the Refuge, and on Mount Schwatka. Sheep also use mineral licks near the headwaters of Jefferson Creek, and on Victoria and Beaver creeks. Nine mineral licks are known within the Mount Schwatka/Victoria Mountain area, two of which occur on the Refuge (Bertram 2006a).

Between 2001 and 2003, an average of 12 Dall sheep were taken annually by hunters (Alaska Department of Fish and Game 2005b). Other sources of mortality include poor weather conditions and predation.

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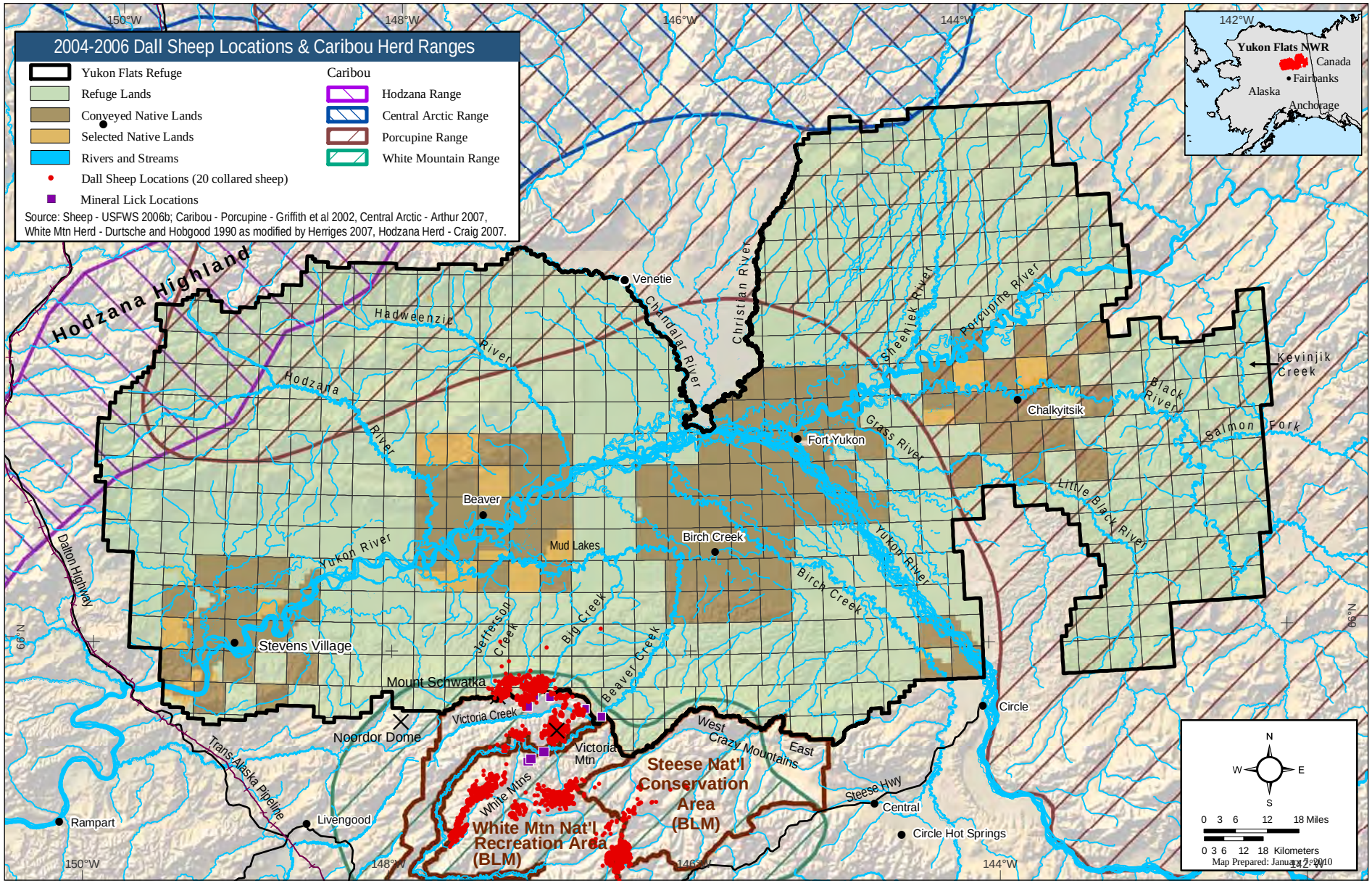
Yukon Flats National Wildlife Refuge

Alaska

Caribou Herd Ranges and Locations of Radio-collared Dall Sheep in the Yukon Flats Refuge

Figure 3-16



3.4.7.4 Bears

Both grizzly bears (also known as brown bears) and black bears occur on the Refuge. A polar bear was recorded in 2008 near Fort Yukon, but this record is extremely anomalous and does not reflect the traditional range of this species. Black bears are more common in the lowlands, while grizzly bears are more common at higher elevations. The grizzly bear population on the Refuge has not been studied. The number of grizzly and black bears in GMUs 25B and 25D (**Figure 3-15**) combined was estimated to be 587 animals, with a density of 2.2 bears per 100 mi^2 (Alaska Department of Fish and Game 2004).

An intensive study of black bears conducted by Refuge staff between 1995 and 1997 estimated the mean adult male home range at 71 mi^2 and the mean adult female home range at 6 mi^2 (Bertram and Vivion 2002c). The mean date of den entry in the fall was September 26, and the mean date of den emergence in the spring was May 2. Dens were located in well-drained soils and were typically 3 to 6 feet higher in elevation than adjacent wetlands, and between 100 and 300 yards from the nearest wetland (Bertram and Vivion 2002c). These results were similar to those reported for a black bear population on the Tanana Flats south of Fairbanks where no bear dens were located in marshes (Hechtel 1991). The density of black bears on the Refuge is probably similar to that of nearby black bear populations on the Tanana Flats (12 to 17 bears per 100 mi^2; Hechtel 1991) and along the Susitna River (23 bears per 100 mi^2; Miller 1994).

In a 1998 to 2000 study, bear predation was identified as a leading cause of moose calf mortality in the area (Bertram and Vivion 2002c). Increased harvest of both black and grizzly bears was recommended in the Yukon Flats Moose Management Plan to reduce predation on moose calves (Alaska Department of Fish and Game 2002).

ADFG harvest records report that an average of 3.5 grizzly bears have been harvested annually by hunters in the two units since 1990 (Alaska Department of Fish and Game 2004). Harvest records maintained by the Council of Athabascan Tribal governments (CATG) indicate that the annual subsistence harvest ranged from 32 to 143 black bears and from 5 to 33 grizzly bears between 2003 and 2005 (Council of Athabascan Tribal Governments 2003, 2005). The annual harvest of unreported species (not identified specifically as black or grizzly) of bear ranged from 27 to 24 between 2003 and 2004.

3.4.7.5 Wolf

Wolves occur in forest and tundra habitats throughout much of mainland Alaska. Wolves are common over much of the State, with densities as high as about 1 wolf per 25 mi^2 in favorable habitats. Wolves are social animals that live in packs ranging in size from only a few animals to 20 or 30, although the average pack contains 6 to 7 wolves (Alaska Department of Fish and Game 2005a). Habitat preference of wolves is primarily determined by the density and vulnerability of prey species, typically ungulates such as moose and caribou, but occasionally beaver, hare, and other small mammals. Vegetation type and the physical environment do not appear to be nearly as important as prey availability to wolves (National Research Council 1997).

The wolf density on the Refuge is low compared to other areas of interior Alaska and is likely related to low moose densities. During aerial surveys in the Yukon Flats in late March 2006, ADFG and the CATG reported 52 wolf groups containing from 1 to 12 animals and averaging 4.6 wolves per group (Alaska Department of Fish and Game and Council of Athabascan Tribal Governments 2006; **Figure 3-17**). The wolf population within GMU 25D, which includes most of

the Refuge, was estimated at approximately 191 to 203 animals, with an additional 7 groups including 25 to 26 wolves located in areas adjacent to the GMU 25D boundary.

Wolf density based on observed packs was 1 wolf per 82 to 87 mi^2. However, adding 10% to allow for undetected lone wolves would increase the maximum estimate to 252 wolves or 1 wolf per 75 mi^2. Wolf numbers in 2006 were generally similar to those recorded during the previous wolf survey in 2001.

3.4.7.6 Furbearers

Numerous furbearer species, including Canada lynx, red fox, marten, snowshoe hare, mink, wolverine, river otter, beaver, and coyote occur on the Refuge. Smaller furbearer species include short-tailed weasel, least weasel, muskrat, red squirrel, and northern flying squirrel.

Lynx are fairly common throughout much of the forested areas of Alaska, particularly where a mixture of vegetation types and an abundance of early successional growth support snowshoe hare and other lynx prey (Alaska Department of Fish and Game 2005a). Past surveys have noted lynx on the Refuge along the edges of burns (Stephenson et al. 1997), throughout the Yukon Flats with local pockets of abundance along some drainages (Alaska Department of Fish and Game and Council of Athabascan Tribal Governments 2000), and in most parts of the eastern Yukon Flats and Venetie study areas (Stephenson and Thomas 2004, 2005). During 2006, lynx and snowshoe hare were widespread and extremely abundant, with sightings of several individual lynx as well as groups as large as six (Alaska Department of Fish and Game and Council of Athabascan Tribal Governments 2006). The Black River region in the northeastern Refuge area is one of the most consistently productive lynx habitats in Alaska (U.S. Fish and Wildlife Service 1987a). In studies of lynx tracks by burn area, densities of lynx and snowshoe hare tracks were higher in the older Little Black River burn area (see **Figure 3-10**), which was characterized by mixed coniferous-deciduous forest with understories of willow and alder, than in the more recent Lone Mountain burn area.

The red fox is a common species on the Refuge, occurring in greatest densities in the Yukon Flats along river drainages in the central lake flats, and in the northwest area around Lone Mountain (Golden 1987). The red fox prefers broken country, extensive lowland marshes, and crisscrossed hills and draws (Jennings 1994). The arctic fox is a common species on the Arctic Coastal Plain of Alaska, but occurs only rarely in the Yukon Flats area.

Martens may be attracted to areas recovering from fire damage and have been reported in high densities in recently burned areas in upland terrain, including the Lone Mountain and Vundik Lake areas, south of Fort Yukon between Burman Lake and upper Discovery Creek, and at the large burn area near Lone Mountain (**Figure 3-10**; Stephenson 1992; Stephenson et al. 1997). In the Yukon Flats area, marten appear to be scattered in upland habitats (Stephenson and Thomas 2005; Alaska Department of Fish and Game and Council of Athabascan Tribal Governments 2000, 2006). Martens are probably fairly common on the Refuge, with highest densities in the general areas of Lone Mountain, the Hodzana River-Hadweenzic River drainages, and the southern portion of the Refuge from the west end of the White Mountains to the upper Little Black River, and intermediate densities in isolated locations outside the central lowlands (Golden 1987). Marten depend heavily on meadow voles and red-backed voles or mice, which are their primary food source over much of Alaska (Shepherd and Melchior 1994).

Beavers and muskrats are common in Yukon Flats wetlands (Golden 1987). Beavers occupy both wetland and riverine habitats, although their numbers within the Yukon Flats area may have

fluctuated over time because of trapping (Andersen and Fleener 2001). In some situations, beaver dams may inhibit the movement of fish, particularly during periods of low water (Andersen and Fleener 2001; Brown and Fleener 2001). During periods of high water or during flooding conditions, fish may be able to move around or over beaver dams.

Snowshoe hares are an important prey species, particularly for lynx. Snowshoe hare tracks have been observed throughout the Refuge in surveys for moose and wolves (Stephenson et al. 1997; Alaska Department of Fish and Game and Council of Athabascan Tribal Governments 2000; Stephenson and Thomas 2004). On the Refuge, higher densities of snowshoe hare tracks than those of other furbearers have been observed (Golden 1987). Areas of high snowshoe hare density based on track observations included the upper Black River-Little Black River region, the area between the Porcupine and Christian Rivers, the Hodzana River-Hadweenzic River drainages, and the southwestern portion of the Refuge between Lone Mountain and the White Mountains. The distribution of snowshoe hares is likely related to the presence of post-fire successional habitat with mosaics of vegetation types (**Figure 3-10**).

3.4.8 Threatened and Endangered Species

No federally listed threatened or endangered species of plants or animals are known to regularly occur on the Refuge. The polar bear, recently listed as a threatened species, is an incidental visitor. A polar bear was observed on the Refuge in March 2008, but the Refuge does not have any knowledge of historic occurrence of polar bear prior to the recent sighting.

During the open-water season, polar bears are usually associated with the pack ice of the Beaufort Sea, although they may be seen on land or swimming in open water considerable distances from the ice. During the fall open water period, polar bears commonly swim ashore and scavenge beached carcasses or the remains of bowhead whales taken by subsistence hunters (Klaxdorff and Proffitt 2003). The Beaufort Sea coastline, as well as river drainages and bluffs along lakes throughout National Petroleum Reserve – Alaska, provide important areas used by polar bears for resting, feeding, denning, and seasonal movements. In the last decade, the number of polar bears occurring along coastal areas of the Beaufort Sea has been increasing (Stirling and Andriashek 1992, Amstrup and Gardner 1994, Amstrup 2000). The reason for the increase in polar bears is unknown, but may be related to ice conditions. The USFWS (Schliebe et a1. 2004) recently compared the distance of the ice edge from shore (during fall months) with the number of polar bears observed on land. A significant correlation was found to exist: as distance to the ice edge increased, so did the number of bears observed on land. The potential for continued reduction in ice cover from global climate change could result in greater numbers of polar bears occurring along the coastline for protracted periods of time, thereby also increasing potential conflicts with human activity.

Polar bear maternal dens are less common along the Arctic Coastal Plain than along the coastal plain of the Arctic National Wildlife Refuge (Amstrup and Gardner 1994). Of 35 dens on the Arctic Coastal Plain of northern Alaska in 2001, all were found along bluffs or along river/creek drainages within 15 miles of the coast (Durner et al. 2003). Polar bear dens have been found on the Arctic Coastal Plain, along the coastal plain of the Alaska National Wildlife Refuge, and along riverbanks in northeast Alaska.

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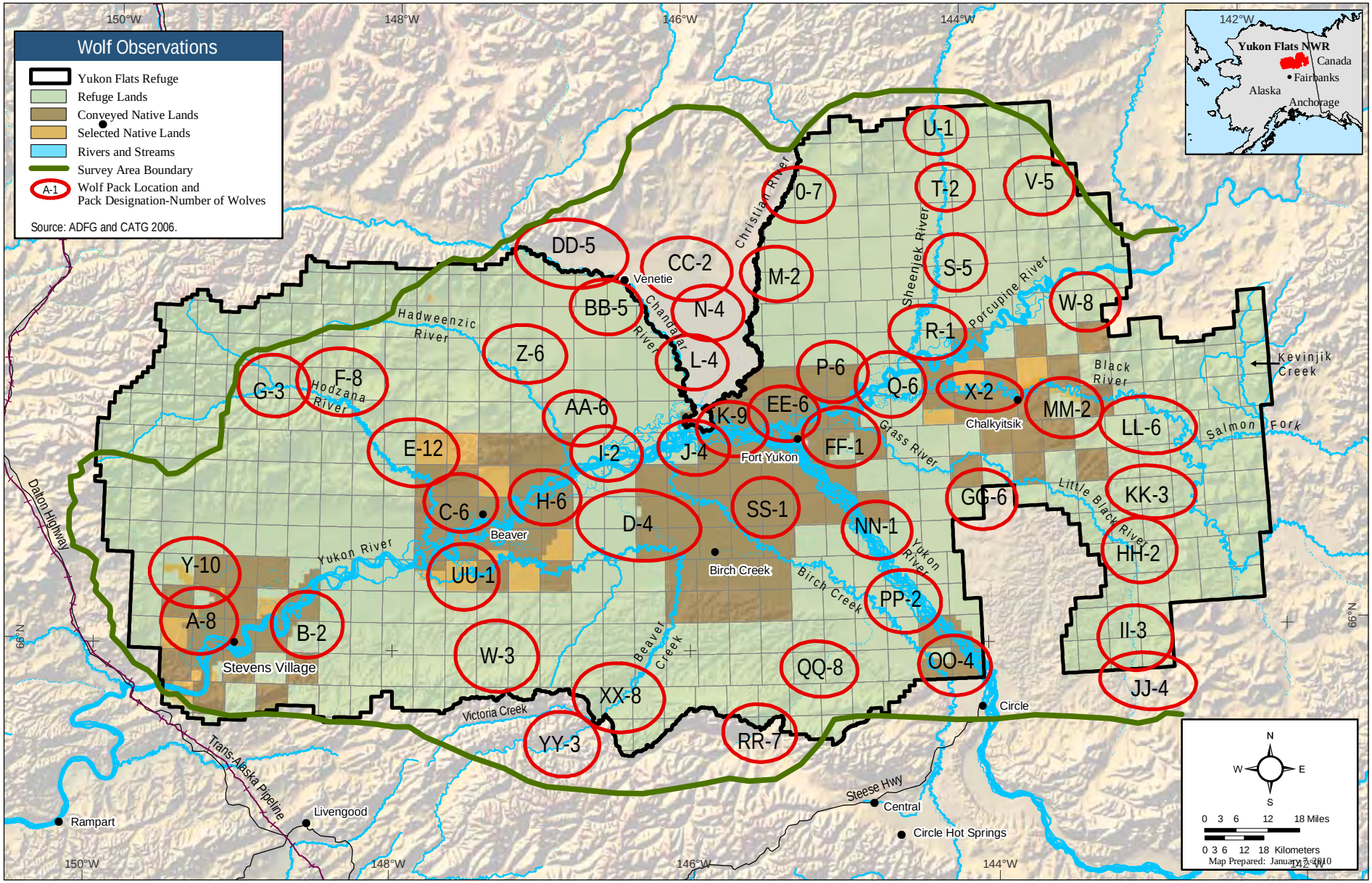
Figure 3-17

Distribution of Wolf Packs in the Yukon Flats Refuge, Spring 2006

Yukon Flats National Wildlife Refuge
Alaska



Polar bears prey primarily on ringed seals and bearded seals; they also take walruses and beluga opportunistically (Amstrup and DeMaster 1988). Additionally, they come to shore to scavenge on marine mammal carcasses during the fall open-water period.

Historically, polar bears were hunted for subsistence as well as by sport hunters. Between 1960 and 1972, subsistence and sport hunters combined harvested an average of 260 polar bears annually from the Beaufort Sea (Amstrup et al. 1986; Schliebe et al. 1995). In 1972, sport hunting in Alaska ended, and the subsistence harvest in the Beaufort Sea averaged 111 bears annually between 1980 and 1996 (Schliebe et al. 1995). Between 1995 and 2000, the average annual harvest from the Beaufort Sea stock was 32 bears (Angliss and Lodge 2002).

3.5 Sociocultural Resources

The following sections discuss the sociocultural resources of the Yukon Flats, including land uses, special areas, socioeconomics, cultural resources, subsistence, and human health.

3.5.1 Land Use and Recreation

3.5.1.1 Local Planning

The Refuge is not in an organized borough. However, several villages, including Stevens Village and Fort Yukon, have developed their own land use plans.

3.5.1.2 Landownership

While the Service is responsible for managing the land and wildlife resources of the Refuge for the benefit of the public, the Federal government does not own all of the land within the Refuge's exterior boundary. Native interests and other private parties own or have selected approximately 2,492,139 acres (22%) within the Refuge border. **Table 3-13** illustrates the breakdown of ownership within the Refuge boundary.

Landownership within the Refuge is illustrated on **Figure 3-18**. Passage of the Alaska Native Claims Settlement Act (ANCSA) significantly changed the landownership pattern in the region. When the Refuge was established 9 years later, the Refuge boundary included five villages and large blocks of private lands owned or selected by Doyon and six Native village corporations. Native corporations' lands are privately owned; the Service does not control uses of these lands.

Under the provisions of ANCSA, Doyon's selections in the Refuge were limited to even-numbered townships in even-numbered ranges, and odd-numbered townships in odd-numbered ranges. The result was a "checkerboard" landownership pattern around some villages. The checkerboard notably complicates the management of both public and private lands because of the breaks in ownership contiguity.

Federal and Native Corporation lands in Alaska include a large, unquantified acreage of submerged lands beneath streams, lakes, and ponds. Generally, ownership of lands beneath inland waters is determined in large part based on navigability of the water body, and navigability determination criteria are based on established Federal case law. If the water body is non-navigable, the upland landowner(s) have title to the bed of the water. If the water body is "navigable" as defined by Federal case law, the State of Alaska has title to the submerged lands, unless withdrawn and reserved by the United States before statehood. The State acquired lands

beneath "navigable waters" at statehood based on the Equal Footing Doctrine, the Submerged Lands Act of 1953, and the Alaska Statehood Act of 1958.

In 2006, the BLM completed navigability determinations for all water bodies on the proposed exchange lands. In total, the BLM determined that about 14,035 acres of submerged lands belong to the State of Alaska or other third-party interests and should be excluded from the proposed land exchange. The BLM's navigability determinations may be challenged in a Federal court of law if the land exchange proceeds. Generally, disputes over submerged landownership can be resolved in one of two ways: through quiet-title actions in Federal courts (judicial actions) or by Recordable-Disclaimer-of-Interest-in-Land (RDI) decisions by the U.S. Department of the Interior (administrative actions). An RDI is a legal document stating that the United States has no ownership interests in the land in question. The RDI process is an administrative process to clear title to submerged water bodies when the State and BLM concur that they were navigable at statehood and not withdrawn by a pre-statehood withdrawal. This can be a very time-consuming process.

If the land exchange proceeds, the State of Alaska may challenge the BLM's navigability determinations for the proposed land exchange area. The ADNR disagrees with BLM's conclusions that many of the large lakes in the land exchange area are non-navigable. In addition, the State has indicated it may assert ownership of submerged lands it currently considers non-navigable if it finds future evidence of navigability. The State of Alaska has requested that the BLM reconsider the navigability of contested water bodies to ensure that susceptibility, as well as actual use, was considered when making the determinations. If the proposed land exchange proceeds, submerged lands traded in the land exchange might subsequently be determined to belong to the State of Alaska (also see Section 1.4.5). Federal courts would determine whether the State of Alaska is the rightful owner.

Table 3-13 Landownership in the Yukon Flats National Wildlife Refuge – June 2006

Ownership	Acres[1]
Federal	8,444,256
Native Corporation (conveyed)	1,790,773
Native Corporation (selections)	488,611
Incorporated Native Village Lands	166,450
Native Allotments (conveyed/selected)[2]	46,305
Other patents[4]	2,110
Total	10,938,505

Notes:

[1] Acreage figures are calculated from Geographic Information System land status information derived from BLM Master Title Plats and may differ from actual surveyed acres.

[2] There are 292 acres of Native allotment selections that are in conflict with a village corporation conveyance and village selection. Conveyance to one allottee would require title recovery actions by the BLM.

[3] Includes ownership categories such as homesteads, trade and manufacturing sites, State of Alaska, etc.; 504 acres are uplands.

Source: Service Land Status Database as of July 2009.

Proposed Land Exchange EIS

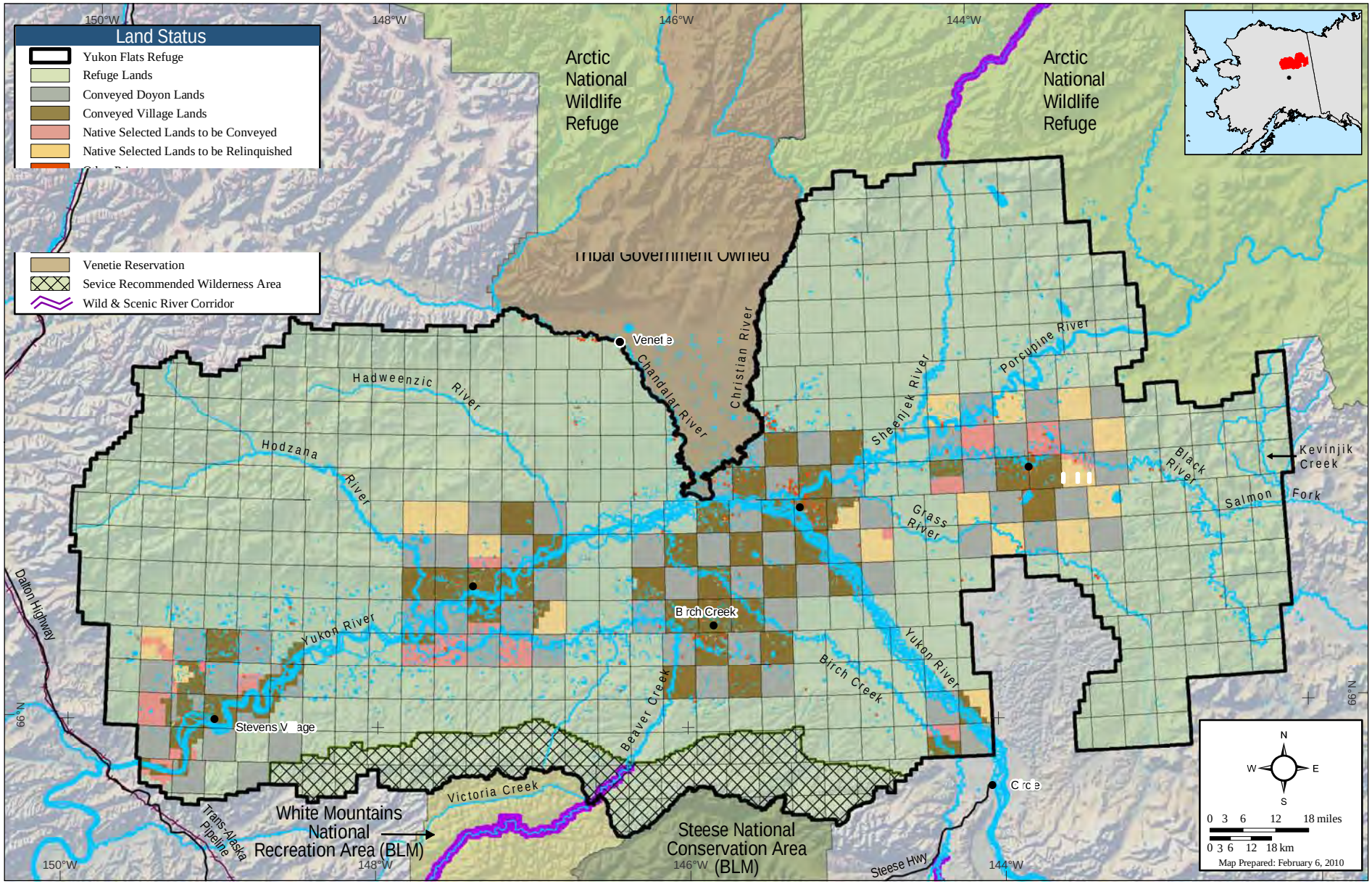
U.S. Fish & Wildlife Service

Figure 3-18

General Land Status in the Yukon Flats Refuge

Yukon Flats National Wildlife Refuge

Alaska



In the past, the State has filed quiet title actions and RDI applications for submerged lands within the Refuge. No quiet title actions have been filed for the proposed exchange lands. However, State ownership of submerged lands in the Porcupine River, including lands proposed for land exchange, was resolved by an RDI determination.

3.5.1.3 Land Use

Land use in the Refuge is of very low intensity. Nine rural communities are in or near the Refuge— Arctic Village, Beaver, Birch Creek, Central, Chalkyitsik, Circle, Fort Yukon, Stevens Village, and Venetie (**Figure 1-1**). Fort Yukon, near the center of the Refuge, is the largest with 570 residents; the others range in size from Birch Creek with 33 residents to Venetie with 184 residents (Alaska Department of Commerce and Community Economic Development [ADCCED; 2006). Approximately 1,335 people reside within these villages.

There are no major industries in the Refuge or surrounding area. Most uses revolve around natural resources, particularly subsistence harvest of fish and wildlife and some small-scale wood cutting, primarily for firewood. There are about 40 permitted cabins on Refuge lands (**Figure 3-19**). There are also five permitted cabins on Doyon lands, and many Native allotments have cabins and tent sites. Five occupied villages and several old village sites are located along rivers and streams within the Refuge boundary.

Recreational visitors to the Refuge participate in river floating, hunting and fishing, sightseeing, and winter sports such as back country skiing and dog sledding. Very little data are available on the level of recreational activity in the area, but the Service believes it to be light. Service and BLM records indicate that fewer than 200 people per year float the Refuge portion (16 miles) of the Beaver Creek Wild River (U.S. Fish and Wildlife Service 2005). Doyon and Village Corporation lands are not open to use by the general public. See Section 3.5.1.6, Recreation, for additional information on recreational activity.

3.5.1.4 Access

Access to and within the Refuge is limited. The primary, year-round access to the Refuge is by air, but watercraft access is available from late May to mid-September or early October via the Yukon River. No roads access the Refuge. The two nearest highways are the Steese Highway, which terminates at Circle, approximately 5 miles south of the Refuge boundary, and the James Dalton Highway (also known as the Haul Road), the access route to the North Slope, which passes very close to the southwestern-most boundary of the Refuge (**Figure 3-20**).

The regulations at 43 CFR 36.11(g) restrict the use of off-road vehicles within refuges. The definition of off-road vehicles in 50 CFR 36.2 excludes snowmachines, but includes air boats and air-cushion vehicles, along with motorized wheeled vehicles. Off-road vehicles may be allowed only on designated routes or areas within Intensive and Moderate management areas or by special use permit. There are no Intensive or Moderate management areas within the Yukon Flats Refuge.

Each of the nine villages in or near the Refuge has an airport. All are State-owned, except for those in Arctic Village and Venetie, which are Tribally owned. The main runways range from 4,000 feet long at Stevens Village to 5,810 feet long at Fort Yukon; all are gravel surfaced, and most have runway lights. Frequency of service varies, but several communities have scheduled air service, and air taxi services are also available. In addition to the airports, floatplanes land on water bodies during the summer months, and wheel planes land on gravel bars along the rivers to

access more remote areas of the Refuge. No areas of the Refuge are closed to landings by fixed-wing aircraft, but rotary-winged aircraft require a Refuge special use permit to access the Refuge (U.S. Fish and Wildlife Service 1987a).

The Yukon River is a primary freight artery to some communities during the summer months and a local "highway" when frozen in the winter. Heavy and bulky goods are delivered by barge to Beaver, Chalkyitsik, Circle, Fort Yukon, Venetie, and Stevens Village. Birch Creek received barge deliveries in the past. The rivers also provide transportation routes for small boats for fishing, hunting, and other travel purposes, both for business and pleasure.

The river systems provide relatively smooth routes between villages during the winter months. Most winter travel is accomplished with snowmobiles, although dog sleds were more common in the past. A few individuals in the Refuge communities still maintain dog teams.

As noted, except for roads within each community, no improved roads exist within the Refuge. However, historical trail routes (**Figure 3-20**), as well as easements and ROW claims, do exist. In addition, ANILCA ensures that rural residents engaged in subsistence uses will have reasonable access to subsistence resources on public lands, including allowances for the appropriate use of snowmobiles, motorboats, and other means of surface transportation traditionally employed for such purposes by local residents for subsistence purposes, subject to reasonable regulation.

ANCSA Section 17(b) Easements

Section 17(b) of ANCSA authorizes the Secretary of the Interior to reserve easements on lands conveyed to Native Corporations to guarantee access to public lands and waters. Easements across Native lands include linear easements (e.g., roads and trails) and site easements. Site easements are reserved for use as temporary campsites and "to change modes of transportation" (e.g., changing from a recreational boat to a small aircraft at a take-out site on a river).

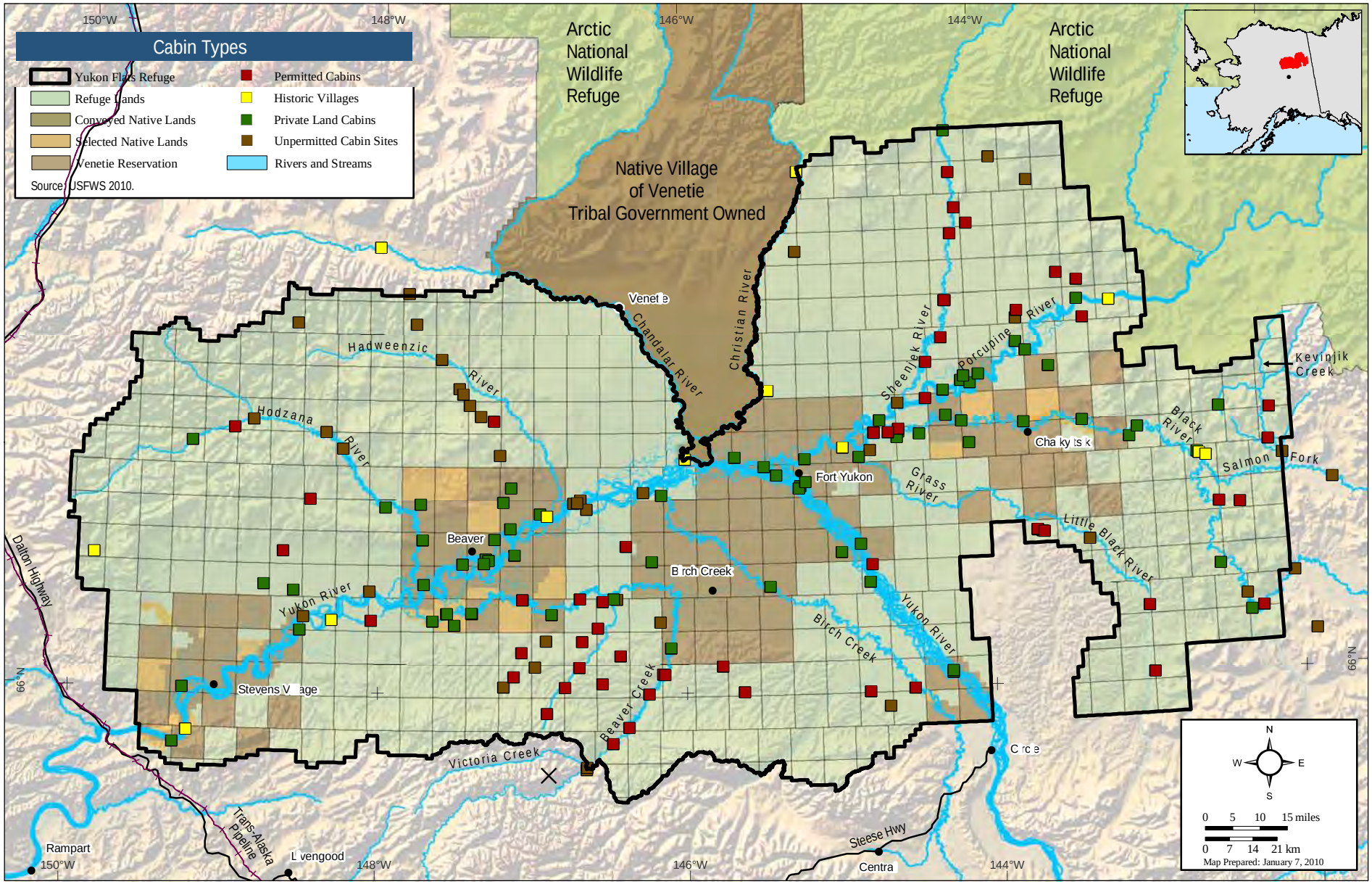
The Service is responsible for administering those public easements inside and outside Refuge boundaries that provide access to Refuge lands. Service authority for administering 17(b) easements is restricted to the lands within the easement. The size, route, and general location of 17(b) easements are identified on maps filed with conveyance documents. Conveyance documents also specify the terms and conditions of use, including the acceptable periods and methods of public access. Currently, there are 31 site easements and 58 trail easements in the Yukon Flats Refuge. If necessary to protect access to public lands and waters, additional easements may be reserved whenever lands are conveyed to Native Corporations.

Revised Statute 2477 Rights-of-Way Claims

The State of Alaska has identified numerous claims to roads, trails, and paths across Federal lands under Revised Statute (RS)-2477. This section of the Mining Act of 1866 (codified as 43 United States Code [USC] 932) states "the right-of-way for construction of highways over public lands, not reserved for public use, is hereby granted." The intent of the statute was to promote public highway construction as the western states were settled. RS-2477 was repealed in 1976, subject to valid existing claims.

Figure 3-19
Cabins in the Yukon Flats Refuge

Yukon Flats National Wildlife Refuge
Alaska



Identification of potential ROWs does not establish the validity of these claims nor the public's right to use them. The validity of all RS 2477 ROWs will be determined on a case-by-case basis, either through the courts or by legally binding documents. The State of Alaska has identified a total of 16 routes on the Refuge that may be claimed as ROWs under RS 2477 (**Figure 3-20**).

State-identified RS-2477 claims in the Refuge include Beaver to Caro (Route Number 27), Snowshoe to Beaver (189), Beaver to Chandalar (257), Circle to Fort Yukon (270), Nation River to Rampart House (446), Hickel Highway (450), Circle to Chalkyitsik (476), Fort Yukon to Christian (477), Fort Yukon to Beaver (478), Alfred Creek Trail (824), Twin Lakes to Jackson Lake (879), Alexander Village to Vehtenjerlow Lakes (881), Hodzana River Trail (1889), Caro to Fort Yukon (1644), Purgatory to Stevens Village (1897), and Lost Creek Trail (1898). The locations of these RS-2477 claims are shown as historic trails in **Figure 3-20**.

ANILCA Sections 1110 (a) and (b) Access Requirements

Section 1110(a) of ANILCA allows the use of snowmachines (during periods of adequate snow cover and frozen river conditions), motorboats, airplanes, and nonmotorized surface transportation methods for traditional activities and for travel to and from villages and homesites. Such access is subject to reasonable regulations to protect the natural and other values of the Refuge (43 CFR 36.11). Specific areas may be closed, in accordance with these regulations, to such uses. The Refuge manager is responsible for determining when snow cover is adequate to protect the underlying vegetation and soil from damage by snowmachine use.

Section 1110(b) of ANILCA ensures adequate and feasible access across a refuge, for economic or other purposes, for any person or entity that has a valid inholding. An inholding is defined as state or privately owned land, including subsurface rights underlying public lands, valid mining claims, or other valid occupancy that is within or effectively surrounded by public land. When a ROW permit is necessary under this provision (e.g., construction of permanent or long-term facilities), the Service reviews and processes the application in accordance with regulations at 43 CFR 36 and 50 CFR 29. These ROW permits are subject to terms and conditions as specified in the regulations.

3.5.1.5 Fire Management

Although wildland fire is often a cause for concern, it makes an integral contribution to the ecology of the Refuge. Therefore, whenever possible, fires are managed to maintain their natural role in the ecosystem. As a result, fires have created a mosaic of vegetation patterns and diverse wildlife habitats (**Figure 3-10**). The frequency and causes of wildland fire on the Refuge are discussed in Section 3.4.3. The Refuge, which is located in the BLM Alaska Fire Service Upper Yukon Zone, has an approved fire management plan that provides the framework for all Refuge fire management decisions.

The Refuge fire management plan, along with the Alaska Interagency Wildland Fire Management Plan, designates four levels of preplanned suppression response or wildland fire management options: Critical, Full, Modified, and Limited. The level of suppression applied to any particular area within the Refuge depends on the value of resources warranting protection. Approximately 89% of the Refuge has been designated Limited. Fires on Limited lands are typically allowed to burn with little to no resources being committed to fire suppression and management unless resources such as human life, site-specific values, or other lands that warrant higher levels of protection are being threatened. Fires on Modified management option areas are generally

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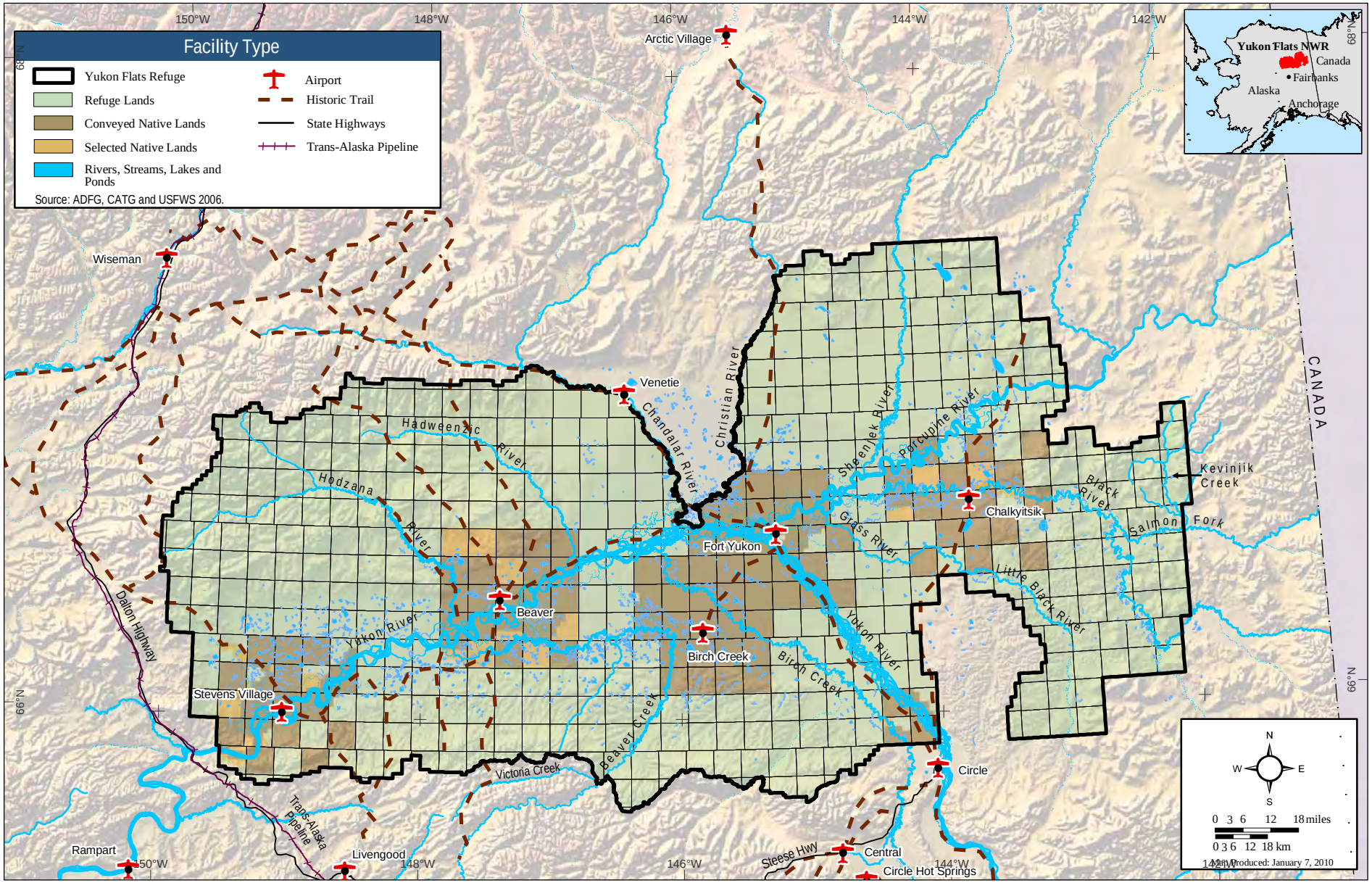
Figure 3-20

Transportation Facilities in the Yukon Flats Refuge

Yukon Flats National Wildlife Refuge
Alaska



allowed to burn late in the season when rains are expected within a reasonable period of time, but may be suppressed early in the fire season or if the season is especially dry. Full suppression generally occurs in proximity to private lands and/or lands with particular economic resources warranting protection. The Critical category has only been applied to areas within a few miles of villages in the Refuge.

Native lands receive fire suppression services from the Federal government at no cost under ANCSA(21e). This provision would also apply to the exchanged lands, based on provisions in Section 102 ANSCA Amendment of the Native American Technical Corrections Act of 2006. Fire suppression services on Service lands are the responsibility of the BLM-Alaska Fire Service, as described in Department of Interior Department Manual 620, Chapter 2.

3.5.1.6 Recreation

Recreational activities include fishing, hunting, and trapping. River boating, both recreational floating and transportation of people and goods, is one of the main modes of transportation within the Refuge in the summer and fall.

In 1980, the Service estimated that recreational use of the Refuge totaled fewer than 1,000 visitor days per year. Refuge staff estimated 500 visitor days of recreation use in the Refuge in 2003. Recreational use included fishing, hunting, berry picking, plant gathering, trapping, river floating, wildlife observation, environmental education and interpretation, and photography. Recreational visitation in 2004 and 2005 was believed to be lower than in 2003 due to the large number of wildfires in the area (Fox 2006).

Recreational visits on the Refuge are difficult to quantify because of its tremendous size and remoteness, and because only users with permits from the Refuge are required to report their use of Refuge lands and waters. Therefore, only users brought onto the Refuge by air taxi or on a guided excursion are reported. Most of the visitation to the Refuge reported in 2003 was in the Beaver Creek vicinity. During the summer of 2003, an air-taxi operator specializing in scenic flights used lakes within 10 miles of the proposed land exchange area to stop for 181 picnic lunches. Only one instance of winter recreation was recorded by the BLM in recent years: a man hiked from Fairbanks to Kaktovik on the Beaufort Sea and passed through the Refuge along the way (Cogley 2006).

Located just south of the Refuge and an hour's drive from Fairbanks, the BLM’s one-million-acre White Mountains National Recreation Area offers year-round recreational opportunities including hunting, fishing, and non-consumptive uses. Some areas are open to seasonal use of off-road vehicles, while other areas are closed to motorized use year-round. Summer visitors to the White Mountains pan for gold, fish, hike, and camp. The Nome Creek Road provides access to two campgrounds, trails, a gold-panning area, and a departure point for float trips on the Beaver Creek National Wild River. In winter, more than 250 miles of groomed trails provide access to areas that are difficult to reach in the summer months. A total of 12 public-use cabins facilitate multi-day trips for visitors traveling on skis, snowshoes, or by dog team or snowmobile.

The WMNRA receives considerably more public use than the Refuge, and logged a total of 37,665 visitor-use days during 2007 (Cogley 2006). A relatively small percentage of visitors use the remote northern portion of the WMNRA that abuts the Refuge. However, the BLM estimates that about two dozen visitors hike the Mt. Victoria or a portion of the Victoria Creek drainage each year. Other recreational activities include sheep and moose hunting and trapping.

3.5.1.7 River Floating

Most of the recreational use on the Refuge involves float trips on the boatable rivers, often combined with hunting expeditions. Beaver Creek and the Yukon River are the most commonly floated rivers in the Refuge because of their accessibility by road. Most float trips start outside the borders of the Refuge, but many finish at a termination point in the Refuge and a few terminate at the Dalton Highway. The most important attractions of the river-floating experience are the opportunity for a wilderness experience and solitude, self-reliance, and personal challenge. The Beaver Creek float from Nome Creek to the Yukon River Bridge is one of the longest (nearly 400 miles) wilderness floats accessible from the road system at both the put-in and take-out points. An estimated 80% of Beaver Creek float trips begin and end within the WMNRA. The BLM estimates that 200 to 400 people float the BLM portion of Beaver Creek each year (Cogley 2006).

3.5.1.8 Hunting

The Refuge is open to hunting, subject to State regulations (subsistence hunting is addressed in Section 3.5.7). Doyon and village corporation lands are not open to the general public. However, given the size and remoteness of Doyon and village corporation-owned lands, this is difficult to enforce. Residents have expressed concern about the increasing numbers of hunters in the Refuge competing for local resources (Stephen R. Braund and Associates [SRBA] 2007). Very little information is available on harvests from hunting in the area. One air-taxi service reported that it dropped off approximately 20 individuals for guided black bear hunting expeditions on an unnamed lake approximately 25 miles southwest of Fort Yukon in the Beaver Creek area in 2005 (Webster 2006). A big game hunting guide reported leading a group of four black bear hunters into the Beaver Creek corridor for a 2-week hunt in early June 2006 (Fox 2006).

A small number of non-local hunters travel into the Refuge by riverboat or airplane to hunt moose, bear, and other game species. Although moose is the most important game species on the Refuge, low moose population densities, hunting restrictions in the western half of the Refuge, and the expense involved in accessing the Refuge have limited non-local hunting opportunities (U.S. Fish and Wildlife Service 1987a). Moose hunting on federal land is currently closed in GMU 25D west, except for residents of the Yukon Flats (**Figure 3-15**).

Moose and Dall sheep hunting are popular within the WMNRA to the south of the Refuge. The number of Beaver Creek float trips spikes in September during the fall moose hunting season. A small number of Dall sheep hunters use the Mt. Schwatka area each fall.

3.5.1.9 Trapping

The 40 permitted cabins on the Refuge are permitted for trapping-related activities only. Several of these trappers have both a primary base cabin and line cabins along their traplines. Trappers access these cabins by snowmobile or ski plane. At least two trappers from Fairbanks access exchange lands during winter by ski plane. Three or four individual trappers use cabins or lands within the core land exchange area or halo lands. A few trappers use the Victoria Creek drainage on BLM lands to the south of the Refuge.

3.5.1.10 Other Recreational Activities

Sport fishing is allowed on the Refuge subject to Alaska fishing regulations. The majority of fish caught on the Refuge are Pacific salmon caught in set nets or fish wheels by local rural residents involved in non-recreational subsistence activities (subsistence fishing is addressed in Section 3.5.7). A small amount of fly-in fishing does occur, but most fishing is incidental to other

recreational activities such as river floating and hunting. The Dall River, because of its accessibility from the Dalton Highway, is the most used fishing river on the Refuge (U.S. Fish and Wildlife Service 1987a).

Numerous other recreation activities occur on the Refuge including photography, camping, hiking, wildlife viewing, and scenic flights, but these activities typically are secondary to river floating, trapping, hunting, and fishing (U.S. Fish and Wildlife Service 1987a).

3.5.2 Wilderness and Wild and Scenic Rivers

3.5.2.1 Wilderness

Like many other refuges, national parks, and national forests in Alaska, the Yukon Flats National Wildlife Refuge was established well after initial promulgation of the Wilderness Act of 1964. The Refuge was established under Section 302 of ANILCA in 1980. Section 1317 of ANILCA directed the Secretary of the Interior to review all lands in the new refuges for designation as Wilderness under the Wilderness Act within 5 years.

The Service completed its required Wilderness review for the Refuge in 1987, with the resulting document serving as both the CCP and wilderness review (U.S. Fish and Wildlife Service 1987a). The planning document and review were taken through the National Environmental Policy Act (NEPA) review process as well, with the document also serving as the EIS.

In the Wilderness review, the Service divided the publicly owned Refuge lands into five units based on hydrology and topography: the White Mountain Unit, the Hodzana River Unit, the Black River Unit, the Flats Unit, and the Sheenjek/Porcupine Unit. Some units were further divided into subunits. A brief description of each unit follows:

- The White Mountain Unit is approximately 1.4 million acres and situated along the southern Refuge boundary, extending from native-owned land by Stevens Village on the west to Circle on the east. The unit extends from the foothills of the White Mountains and the Crazy Mountains south to the crest of the mountain ranges that form the southern Refuge boundary. The unit is mountainous and rugged. Major rivers and tributaries in this unit include Beaver Creek, Birch Creek, and Preacher Creek. The unit was subdivided into a Mountain sub-unit (~650,000 acres) and an Upland sub-unit (~750,000 acres).
- The Hodzana River Unit is approximately 2.1 million acres on the northwest side of the Refuge. The unit encompasses the area commonly known as the Hodzana Highland, located north and west of Beaver and Stevens Village. Major rivers and tributaries in this unit include Hodzana River, Hadweenzic River, and Dall and Little Dall rivers.
- The Black River Unit is approximately 1.25 million acres and situated on the south east side of the Refuge, east of Chalkyitsik and northeast of Circle. The area is generally rolling hills forested with spruce and hardwoods. Major rivers and tributaries in the unit include the Black River and Little Black River.
- The Flats Unit is approximately 2.25 million acres and encompasses the Yukon River through the center of the Refuge. It is a lowland unit that consists of marshes, lakes, oxbows, sloughs and streams. The Flats Unit is split into three sub-units by large blocks of land in native ownership.

- The Sheenjek/Porcupine Unit is approximately 1.45 million acres in the northeastern portion of the Refuge. It is situated north of Fort Yukon and Chalkyitsik and extends to the Refuge boundary. The unit is bordered on the west by the Christian River and Venetie Tribal Land. Major rivers and tributaries include the Sheenjek River and Porcupine River.

All lands in each unit were evaluated for "Wilderness" suitability using seven criteria that were based on the definition of wilderness in the Wilderness Act: (1) size greater than 5,000 acres; (2) landownership by the Federal government with no encumbrances; (3) a high degree of natural integrity (primeval character); (4) apparent naturalness (unaffected by human activities); (5) outstanding opportunities for solitude (high degree of isolation from sights, sounds, and presence of others); (6) outstanding opportunities for primitive recreation; and (7) special or unique features. The Service concluded that all five units met the required levels of each of the seven Wilderness criteria.

The Wilderness Review/CCP evaluated five management alternatives that included Wilderness designation recommendations ranging from no lands within the Refuge to all Refuge lands (U.S. Fish and Wildlife Service 1987a). The preferred alternative in the Record of Decision recommended Wilderness designation for approximately 658,000 acres (8% of the Refuge) in the White and Crazy mountains along the southern Refuge boundary adjacent to the BLM WMNRA and the Steese National Conservation Area (**Figure 3-18**). This area is referred to in this document as the recommended-Wilderness area.

The CCP states that the white limestone outcroppings of the White Mountain Unit are the most special and unique feature distinguishing this scenic and rugged unit from the others. The CCP goes on to state that "though lacking prime waterfowl habitat, this area is truly outstanding in all other wilderness criteria and contains a unique combination of ecosystems within the Refuge."

Although ANILCA Section 1317(b) notes that "The Secretary shall conduct his review, and the President shall advise the U.S. Senate and House of Representatives of his [recommendations] in accordance with the provisions of §3(c) and §(d) of the Wilderness Act. The President shall advise the Congress of his recommendations with respect to such areas within 7 years from the date of enactment of this Act." No Secretary of the Interior to date has forwarded the Service's recommendation to the President of the United States; consequently, the recommendation has not been submitted to Congress for review and action (U.S. Fish and Wildlife Service 2005). As a result, the area currently receives the same management as other areas of the Refuge with the exception of the Beaver Creek Wild River.

3.5.2.2 Wild and Scenic Rivers

The Wild and Scenic Rivers Act of 1968, which set a national policy for preserving certain outstandingly remarkable rivers in free-flowing condition, was enacted 12 years before the Refuge was established. Section 10(a) of the Wild and Scenic Rivers Act states that wild and scenic rivers shall be managed in a manner that protects and enhances the values that caused them to be included in the National Wild and Scenic River System without limiting other uses that do not substantially impinge upon public use and enjoyment of those values. Portions of Beaver Creek, Birch Creek and the Sheenjek River are in the National Wild and Scenic River System; however, those portions of Birch Creek and Sheenjek River that are in the system are outside the Refuge (**Figure 3-18**).

Beaver Creek Wild River

When the Refuge was established by the passage of ANILCA in 1980, the Act included designation of a 127-mile-long segment of Beaver Creek as a component of the National Wild and Scenic River System. It was designated specifically as a "wild river." Beaver Creek is the only river segment in the Refuge that has been designated as a component of the National Wild and Scenic River System (**Figure 3-18**). Beaver Creek originates at the confluence of Champion Creek and Bear Creek in the White Mountains south of the Refuge and terminates at its confluence with the Yukon River inside the Refuge.

The river segment designated as "wild" begins at the creek's origin at the confluence of Bear Creek and Champion Creek, in Section 20, Township 7 North, Range 4 East, and continues downstream for 127 river miles through portions of WMNRA and the Refuge, ending at the location where it exits the north boundary of Section 1, Township 12 North, Range 6 East (**Figure 3-4**). The first 111 miles of the wild river segment are in the WMNRA and are managed by the BLM. The final 16 miles of the wild river segment are in the Refuge and are managed by the Service. The wild river segment includes Federal lands on either side of the stream. The width of this wild river corridor varies, but, as specified by ANILCA, it includes an average of not more than 640 acres per mile on both sides of the river.

As directed by ANILCA, the Service and the BLM jointly prepared a river management plan for the Beaver Creek Wild River (Bureau of Land Management and U.S. Fish and Wildlife Service 1983). The plan identified the following "outstandingly remarkable" values and conditions and listed them as long-term management objectives:

- Preserve the river and its immediate environment in its natural, primitive condition.
- Preserve the free-flowing condition of the waters.
- Protect the water quality and quantity.
- Provide high quality primitive recreational opportunities for present and future generations.
- Provide a variety of opportunities for interpretive, scientific, educational, and wildlands orientated uses.
- Assure protection of significant historic and archaeological values.
- Maintain and improve fish and wildlife habitat.

The plan also identified the following management actions, to be administered by the agencies on their respective river segments:

- Overland transportation systems within or across the river corridor may be authorized if it is determined that there are no economically feasible and prudent alternative routes.
- Access to mining claims located outside the river corridor prior to ANILCA, and with acceptable proof of discovery, would be managed under existing surface protection regulations.
- On Service-administered lands, off-road vehicle use by the public, other than snowmobiles, is prohibited; vehicles are restricted to those less than 1,500 pounds on BLM lands. The use of snowmobiles, motorboats, dog teams and other means of surface transportation traditionally employed by local rural residents engaged in subsistence uses is permitted within Alaska National Wildlife Refuges except at those times and in those areas restricted or closed by the Refuge Manager (50 CFR 36.12).

- A program would be established to monitor the effect of vehicle use within the river corridor.
- Agencies would work with the State of Alaska to identify all ROWs claimed pursuant to RS-2477 within the river boundaries.
- Use of motorized boats is permitted without specific authorization.
- Construction of new landing strips within the river corridor may be allowed if significant public need is identified.
- On Service-administered lands, the landing of fixed-wing aircraft is permitted without specific authorization, but helicopters must have specific authorization.
- Agencies shall cooperate with private landowners, mining operators, and the State of Alaska to ensure that mineral exploration and development on non-Federal lands that may affect the river corridor are developed to minimize adverse effects on the Beaver Creek Wild River.

Sheenjek Wild River

The Sheenjek River is a 227-mile-long tributary to the Porcupine River. With passage of ANILCA, Congress designated 160 miles of the upper Sheenjek River, located in the Arctic National Wildlife Refuge, as the Sheenjek Wild River (**Figure 3-18**).

ANILCA also directed the Department of Interior to study the lower segment of the Sheenjek, which flows through the Yukon Flats National Wildlife Refuge, for possible inclusion in the National Wild and Scenic River System. The Service and the National Park Service jointly prepared a Final Wild and Scenic River Study and Legislative EIS (National Park Service and U.S. Fish and Wildlife Service 1999). The preferred alternative, which was selected in the Record of Decision, was to designate the lower Sheenjek as a wild river (National Park Service and U.S. Fish and Wildlife Service 2000). To date, Congress has not acted on this recommendation, but if approved, the Sheenjek River would be a wild river from its headwaters in the Arctic National Wildlife Refuge to its mouth at the Porcupine River in the Yukon Flats National Wildlife Refuge.

As noted under Land Use, the State of Alaska may challenge BLM's navigability determinations for the proposed land exchange area. Thus, ownership and management of submerged lands and waters of Beaver Creek and the Sheenjek River may be unresolved at this time.

Porcupine River

The Porcupine River was designated by ANILCA as a study river under the Wild and Scenic Rivers Act. The National Park Service completed a draft study evaluating the river for inclusion in the National Wild and Scenic River System and recommended that this segment of the Porcupine River not be designated as a wild or scenic river.

3.5.3 Visual Resources

The Yukon Flats Refuge is striking in its vastness. The Yukon River flows through the center of the Refuge and drains a broad floodplain patterned with braided tributaries and pocked with lakes and ponds. The basin floor gently slopes up to the White Mountains to the south of the Refuge and the Brooks Range to the north. Beaver Creek is a clear sinuous river that flows out of the White Mountains and empties into the Yukon River. The White Mountains are scenic white

limestone mountains; rugged and isolated, they receive only limited use and remain virtually undisturbed by human development.

The affected environment consists mainly of geographic landmarks, Native villages, fishing and hunting grounds, lakes, wetlands, creeks, and riverway landscapes. The topography of the region is characteristic of flat to undulating lowlands, surrounding uplands, and encompassing highlands and mountains. The land cover is a mixture of spruce forests, white birch, quaking aspen, balsam poplar, shrubs, and bogs, including tussock tundra. Because of the flat to gently sloping topography of the majority of the Refuge landscape, and successional forests in many areas, views are principally composed of foreground to middle ground scenery elements that are consistent with recreation, hunting, and fishing. Foreground and middle ground are areas that can be seen from each travel route for a distance of up to 5 miles where management activities might be viewed in detail.

The extensive network of rivers and historic trails affords residents and visitors with viewing opportunities throughout the Refuge. Views along rivers and trails typically range from foreground (up to 0.5 miles from the viewer) to middle ground (up to 4 miles from the foreground) and background (area beyond the foreground-middle ground zone that can be seen from each travel route to the horizon or approximately 15 miles; it does not include areas in the background that are so far distant that the only thing discernible is the form or outline).

There are several “special designation areas” in the Yukon Flats region that are afforded special status to preserve certain outstanding values. Special designations in the region include the Beaver Creek Wild River (16 miles are within the Refuge) and Birch Creek Wild River (no section of Birch Creek within the Refuge holds special designation), and possibly the Lower Sheenjek River (99 miles within the Refuge), if designated in the future as a Wild River by Congress. These locations fit recognized standards for designation as areas of high aesthetic values. In addition, a portion of the Refuge bordered by the White and Crazy mountains has been recommended for Wilderness designation.

3.5.4 Hazardous Materials and Solid Waste

The Refuge has supported relatively limited human or industrial uses that may have introduced hazardous materials or solid wastes into the environment. Industrial activity has consisted of small-scale mining development, which began in the late 1880s after the discovery of gold on Birch Creek in 1893 (U.S. Fish and Wildlife Service 1987a), U.S. Department of Defense activities (Fort Yukon Long Range Radar Site), and limited investigations for coal and petroleum resources beginning in the 1940s (U.S. Fish and Wildlife Service 2005). There are no known hazardous materials release sites on the Refuge.

In general, surface and subsurface soil contamination has been documented in most of the villages within and adjacent to the Refuge. The contamination is typically gasoline, diesel, or fuel oil that has spilled or leaked at fuel storage and use facilities (individual underground or aboveground storage tanks, tank farms, generator buildings, and pipelines). Many spills are due to poor fuel storage and handling practices. At most locations, the majority of fuel has not been recovered and may pose a risk to groundwater resources used for drinking water.

Solid waste landfills are located in many Yukon Flats villages. There is no evidence of off-site contamination. Incidental use by visitors, and the local Alaska Native population for hunting, fishing, and travel, may have created additional solid and fuel waste on a small scale.

3.5.5 Socioeconomics

No subject causes more concern or confusion in the analysis of socioeconomic impacts than the selection of the appropriate geographic area of study. The specification of the study area is so important because, depending on how the geographic area is defined, certain economic effects would either be internal or external to the study area. Humans conduct activities at various levels of scale. These units of analysis can be based on different levels of social organization because everyday human activities can be based on geography, interests, kinship relationships, and political boundaries.

3.5.5.1 Overview

The geographic area considered for describing the affects on the socioeconomic environment consists generally of the communities within and just outside of the Refuge. Socioeconomic effects outside of this area are expected to be minimal because of the area's geographic isolation. Local residents within and near the Refuge principally reside in nine villages: Arctic Village, Beaver, Birch Creek, Central, Chalkyitsik, Circle, Fort Yukon, Stevens Village, and Venetie. Fort Yukon, the largest community in the Flats, functions as the sub-regional center. Brief summaries of the location, landscape, and infrastructure of each of these communities are provided in Section 3.5.5.1. These summaries are taken in large part from the Community Database Online of the Department of Commerce, Community, and Economic Development (Alaska Department of Commerce and Community Economic Development 2006b) and from a subsistence land use report prepared in 1983 by the ADFG.

These communities are located within a large portion of the State that is not incorporated as an organized borough. The State legislature, as the governing body, has oversight of services that would otherwise be provided by an organized borough, such as education, planning, and any zoning (Alaska State Constitution, Article X, Section 3 and 6, and Alaska Statute 29.03.010). In the unorganized borough, cities and Tribal organizations typically provide community services, while the State provides education through Regional Educational Attendance Areas. Fort Yukon is the only community in the Refuge with taxing authority, and the community has a 3% sales tax.

The affected villages are part of the Yukon-Koyukuk Census Area. Located in Alaska's interior and covering 148,258 mi^2, the Yukon-Koyukuk Census Area stretches from Canada's Yukon Territories to the lower Yukon River. The area is home to five national wildlife refuges, one of them being the Yukon Flats National Wildlife Refuge. Yukon-Koyukuk Census Area is Alaska's largest one but includes only 1% of the State's population. The population density of 0.1 person per mi^2 is one of the lowest in the State. The Alaska average is 1.1 people per mi^2. Alaska Natives, primarily Athabascan Indians, make up 63.3% of the total population in the census area. The percentage of Alaska Natives in the Yukon-Koyukuk Census Area is the seventh highest in the State. Alaska Natives represent 16.8% of Alaska's total population (Alaska Department of Commerce and Community Economic Development 2006a). Birth rates in this census area have declined dramatically since 1995 and by 1999 were equal to the statewide average. Death rates are higher than the State average. According to the U.S. Bureau of Census, the estimated population in 2004 was 6,334 individuals, a 2.7% decrease between April 1, 2000, and July 1, 2004. The population decreased 3.6% between 1990 and 2000 (Alaska Department of Commerce and Community Economic Development 2006a). According to the most recent information available, the population in 2006 was estimated at 5,860 and is forecast to grow to 5,899 by 2010 and then decrease to 5,766 by 2015 (Huntsinger 2007).

3.5.5.2 U.S. Bureau of Land Management

The BLM manages 83.5 million surface acres in Alaska. The BLM's Fairbanks District Office manages 58 million acres of public lands in northern Alaska including lands around the Refuge. The BLM's multiple-use mission is to sustain the health and productivity of public lands for the use and enjoyment of present and future generations. BLM accomplishes this by managing such activities as outdoor recreation, livestock grazing, mineral development, and energy production, and by conserving natural, historical, cultural, and other resources on public lands.

The BLM hires residents of Yukon Flats villages for temporary summer fieldwork and as fire fighters, where they work under interagency fire management agreements, fighting Refuge fires.

3.5.5.3 U.S. Fish and Wildlife Service

The Refuge office is located in Fairbanks, Alaska. There is no visitor center, nor are there any public facilities, on the Refuge itself. The proximity of the Refuge to Fairbanks allows Refuge staff to visit the area for day trips as required. The Service owns a cabin in Fort Yukon, which it uses as a base of operations, and another cabin at Canvasback Lake; the Service uses a number of sites across the Refuge as summer field season camps (Heuer 2006a). The Service contributes to local economies in the study area through cooperative agreements and contracts with Yukon Flats villages and through an annual funding agreement with CATG (Heuer 2006b).

3.5.5.4 Doyon, Limited

Doyon, the Native regional corporation for interior Alaska, is one of thirteen Native regional for-profit corporations established by Congress in 1971 under ANCSA. Doyon is the largest private landowner in Alaska and one of the largest private landowners in North America, with a land entitlement of 12.5 million acres and ownership of about 10 million acres (Mery 2006). Doyon's lands extend north to south from the Brooks Range to the Alaska Range, and east to west from about the Canadian border to Norton Sound.

Voting shares of stock were originally issued to 9,061 Alaska Natives who had a tie to the region. In March 1992, shareholders approved giving stock to Native children born between 1971 and 1992, missed enrollees, and elders who were age 65 by December 1992. Prior to the March 2007 shareholder meeting, Doyon had over 14,000 shareholders (Doyon 2006a). In March 2007, the corporation voted to issue an additional 100 shares to elder shareholders (65+ years old) and offer open enrollment to children born after 1971 in the fall of 2007 (Doyon 2006c).

According to the policy, Doyon annually distributes 50% of the average of the last 5 years' net profits in the form of distributions and contributions. In 2005, Doyon earned $12.23 million in after-tax net income on gross revenues of $80.5 million. Charitable contributions and shareholder dividends totaled more than $5 million (Doyon 2006a).

The Federal lands that would potentially be acquired by Doyon in the proposed land exchange would become ANCSA lands. Under Section 7(i) of ANCSA, Doyon is required to share 70% of revenues derived from natural resource development on Doyon's ANCSA lands with other ANCSA regional corporations, village corporations in the Doyon region, and Doyon shareholders not affiliated with Doyon village corporations (called "at large" shareholders). Half of the revenues remitted to each of the ANCSA regional corporations are required to be shared with their respective village corporation and at-large shareholders.

3.5.5.5 Tanana Chiefs Conference

Tanana Chiefs Conference (TCC) was formed in 1962 for the purpose of pursuing land claims and advocating for the betterment of member Tribes. Incorporated in 1972, TCC currently is a nonprofit Tribal consortium of 42 Athabascan villages. TCC supports a wide variety of services and programs including health- and family-centered services, economic development, public safety, Tribal governments, and self governance.

3.5.5.6 Council of Athabascan Tribal Governments

The CATG is an Alaska Tribal consortium composed of the Arctic Village Council, Beaver Village Council, Birch Creek Village Council, Canyon Village, Chalkyitsik Village Council, Circle Village Council, Gwichyaa Zhee Tribal government, Rampart Village Council, Stevens Village Tribal Council, Venetie Village Council, and Native Village of Venetie Tribal government. According to the CATG web page (www.catg.org), CATG is a "grassroots organization founded in 1985 on the principals of Tribal self-governance, working to empower and build capacity of local member Tribal governments to assume management responsibility of programs within their villages." The purpose of the CATG as mandated by their Constitution is:

> …to conserve and protect tribal land and other resources; to encourage and support the exercise of tribal powers of self government; to aid and support economic development; to promote the general welfare of each member tribe and its respective individual members; to preserve and maintain justice for all and, to otherwise, exercise all powers granted by its member villages and the purposes expressed in the preamble.

3.5.5.7 Population Trends and Other Demographics and Village Locations and Infrastructure

Information on key population and demographic trends for the communities located within and near the Refuge was compiled from U.S. census data and the Alaska Department of Commerce, Community, and Economic Development. The estimated population of study area communities included 1,335 individuals in 2005, a slight decrease from the 1,465 individuals counted at the time of Census 2000. None of the communities are very large; the smallest is Birch Creek with an estimated 2005 population of 33 individuals, and the largest is Fort Yukon with an estimated 2005 population of 570. **Table 3-14** and **Figure 3-21** show population trends for each community. The total population of the area has remained remarkably steady during the past 40 years, although individual communities exhibit some variability. In contrast, the population of the Yukon-Koyukuk Census Area as a whole dropped almost 23% (**Figure 3-22**). In 1990, the Yukon Flats communities accounted for approximately 14% of the population of the census area, but by 2000, area communities accounted for approximately 19% of the census area population. None of the villages exhibit a dominant trend over time except perhaps Chalkyitsik, which has been slowly losing population since the 1970 census. Although it appears that only Circle and Fort Yukon existed at the time of the 1900 census, this is probably an artifact of the way the census was taken in Alaska and the fact that many of the residents of this area lived a nomadic lifestyle.

Populations of small resource-dependent communities often exhibit variability, but what might appear to be a relatively small change in the population or the economy can have a much bigger impact than it would in a larger community. For example, if three individuals move from Birch Creek, everyone in the community would be aware of the change, but the addition of three individuals to the Fairbanks economy would not be noticed. Birch Creek closed its school because it did not meet the minimum number of students required.

Villages Located Inside the Refuge

The following sections briefly describe the infrastructure and available services in the Refuge villages. Capital projects currently planned and funded for these villages include a number of upgrades to sanitation facilities, power generation facilities, airports and roads, washeterias, and health clinics. Details on these projects can be viewed at the Alaska Department of Commerce, Community, and Economic Development Capital Projects Database Online at http://www.commerce.state.ak.us/dca/commdb/CF_RAPIDS.htm.

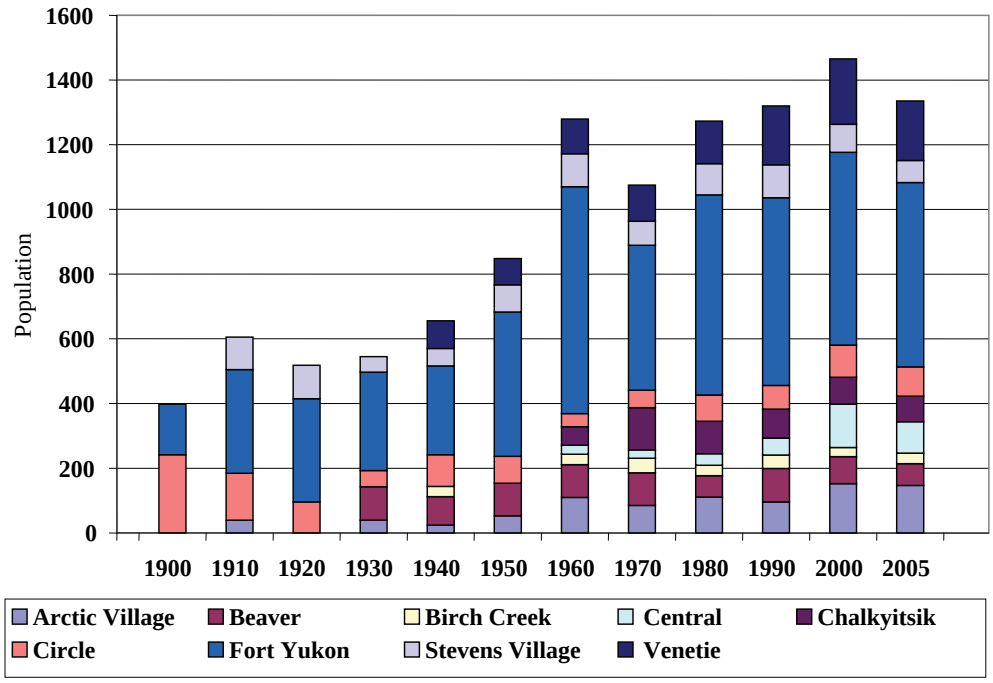
Beaver

The community of Beaver is located in the Refuge on the north bank of the Yukon River, approximately 60 air miles southwest of Fort Yukon and 110 miles north of Fairbanks (**Figure 1-1**). Gold discoveries in the Chandalar region in 1907 led to the founding of Beaver, which was established as the Yukon River terminus for miners heading north to the gold fields. Frank Yusada, a Japanese man who had traded at Point Barrow and prospected in the Brooks Range, established Beaver in 1910 or 1911 as a trading post at the end of the trail to Caro in the Chandalar River mining district that was completed by 1919 (Betts 1982). He called the place Beaver because of large numbers of beaver harvested along the Yukon River.

Table 3-14 Population of individual communities in the study area and the total population, 1900-2005

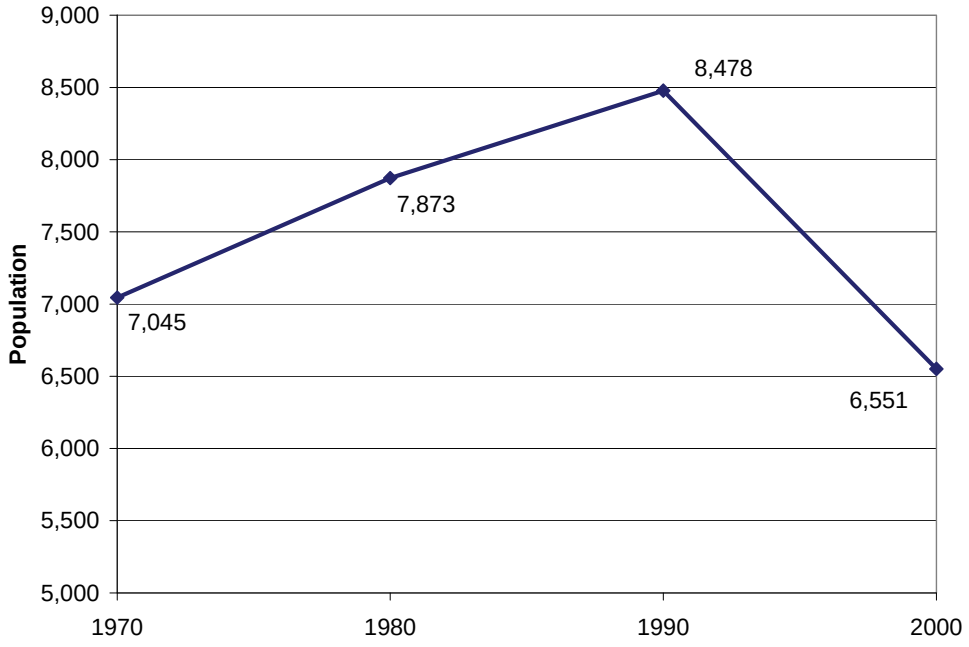
Year	Villages Located Inside of Refuge					Villages Located Outside of Refuge				Total
	Beaver	Birch Creek	Chalky-itsik	Fort Yukon	Stevens Village	Arctic Village	Central	Circle	Venetie	
2005	67	33	79	570	68	147	97	90	184	1,335
2000	84	28	83	595	87	152	134	100	202	1,465
1990	103	42	90	580	102	96	52	73	182	1,320
1980	66	32	100	619	96	111	36	81	132	1,273
1970	101	45	130	448	74	85	26	54	112	1,075
1960	101	32	57	701	102	110	28	41	107	1,279
1950	101	0	0	446	84	53	0	83	81	848
1940	88	32	0	274	54	24	0	98	86	656
1930	103	0	0	304	48	40	0	50	0	545
1920	0	0	0	319	103	0	0	96	0	518
1910	0	0	0	321	100	40	0	144	0	605
1900	0	0	0	156	0	0	0	242	0	398

Source: Alaska Department of Commerce and Community Economic Development 2006b.



Source: U.S. Census Bureau 2000.

Figure 3-21 Population of study area communities, 1900-2005



Source: U.S. Census Bureau 2000.

Figure 3-22 Population of Yukon-Koyukuk Census Area, 1970-2000

A new well and pumphouse were constructed in the village in 1997; residents haul treated water from this point. Residents use honey buckets for sewage disposal in all homes; the village operates a vehicle to haul wastes. Villagers rely on the washeteria for bathing and laundry. The washeteria and school use individual septic systems. The water tank, water treatment system, and washeteria were recently renovated, and a water and sewer master plan is underway (May 2003) to develop a piped water and sewer system. Beaver also has a new landfill (Alaska Department of Commerce and Community Economic Development 2006b).

The State owns a 3,954-foot-long by 75-foot-wide, lighted, gravel airstrip with daily air service. Fuel, store goods, and supplies are shipped to Beaver via air cargo or barge during the summer. Most residents use trucks and all-terrain vehicles (ATVs) within the town. Snowmobiles and dog teams are used during winter (Alaska Department of Commerce and Community Economic Development 2006b). The community is not connected to the road system.

Birch Creek

The community of Birch Creek is located in the Refuge along Lower Mouth Birch Creek, approximately 26 miles southwest of Fort Yukon, the nearest community (**Figure 1-1**). Birch Creek is near the center of the Yukon Flats. A vast network of lakes, sloughs, and creeks surrounds the community. While the area around the community is flat, the White Mountains are seen to the south. Local residents are Dendu Gwich'in Athabascans.

Water comes from Birch Creek and a slant well, and is treated and stored in an 80,000-gallon tank. Residents haul water from the water plant. No homes are plumbed; residents dispose of honey buckets in the sewage lagoon or use outhouses. The water intake, water treatment improvements, washeteria renovation, and sewage lagoon are new (Alaska Department of Commerce and Community Economic Development 2006b). The community needs funds to repair the water tank and foundation, built in 1979 (Alaska Department of Commerce and Community Economic Development 2006b). The landfill is near capacity, and a site has been selected to develop a new one.

Access to Birch Creek is primarily by the 4,000-foot-long by 75-foot-wide gravel, lighted, State-owned airstrip. A new cross-wind airstrip is under construction. Residents use ATVs, motor bikes, snowmobiles, and skiffs for fishing, hunting, and recreation. The village is no longer served by barges. A 26-mile winter trail connects Birch Creek Village to Fort Yukon (Alaska Department of Commerce and Community Economic Development 2006b). The community is not connected to the road system.

Chalkyitsik

The community of Chalkyitsik is located in the Refuge on the Black River about 50 miles east of Fort Yukon (**Figure 1-1**). The topography is nearly flat, but to the east the terrain rises slowly toward the rugged uplands near the headwater of the Black River. The Porcupine River is accessible by winter trail or by boat in summer. The community’s location near the interface of the Yukon Flats and upland areas to the east allows access to a variety of wild plant and animal resources (Alaska Department of Commerce and Community Economic Development 2006b).

Water is derived from a well under the Black River, treated, and stored in a 100,000-gallon tank. Residents haul water from the new water treatment plant/washeteria/clinic building and use honey buckets or outhouses for sewage disposal. No homes are plumbed. The village provides water to

the school. Because water is often inadequate, a second well has been funded. A feasibility study was completed to provide piped water and a sewer system to the school and 10 homes on the west side. A landfill relocation study is under way (Alaska Department of Commerce and Community Economic Development 2006b).

Access is primarily by air; the State owns a 4,000-foot-long by 90-foot-wide gravel runway. The Alaska Department of Transportation and Public Facilities (ADOTPF) anticipates that an airport improvement project would take place in the near future under the Aviation Improvement Program (Alaska Department of Transportation and Public Facilities 2006). Residents own ATVs, snowmobiles, and skiffs for fishing, hunting, and recreation. No roads connect Chalkyitsik with other villages or the state road system, although there is a winter trail to Fort Yukon. Chalkyitsik is accessible by small riverboat. Chalkyitsik no longer receives goods by barge service (Alaska Department of Commerce and Community Economic Development 2006b).

Fort Yukon

Fort Yukon is located in the heart of the Refuge at the confluence of the Yukon and Porcupine rivers, about 145 air miles northeast of Fairbanks (**Figure 1-1**). Its location on the Yukon River makes it an important transportation center as well as a focus for fishing.

Water is derived from two wells, and is treated and stored in a 110,000-gallon tank. A combination of piped water, water delivery, and individual wells serve households. Residents use a flush/haul system, septic tanks, honey buckets, and outhouses for sewage disposal (Alaska Department of Commerce and Community Economic Development 2006b). Approximately half of all homes are plumbed. The piped water system and household septic tanks were installed in 1984. The city has received funds to begin repairs to the piped water system and to construct a piped gravity sewer system to serve 250 residents and businesses (Alaska Department of Commerce and Community Economic Development 2006b).

Fort Yukon is accessible by air and barge during the summer months. Heavy cargo is brought in by barge from the end of May through mid-September. The river landing has a barge off-loading area but no dock. Residents use riverboats and skiffs for recreation, hunting, fishing, and other subsistence activities. The State owns a 5,810-foot-long by 150-foot-wide lighted gravel airstrip. Floatplanes use Hospital Lake, adjacent to the airport. Fort Yukon has 17 miles of local roads, and over 100 automobiles and trucks (Alaska Department of Commerce and Community Economic Development 2006b). The City Transit Bus system provides transport throughout the town. Snowmobiles and dog sleds are used on area trails or the frozen river. Fort Yukon is the largest community in the region (Alaska Department of Commerce and Community Economic Development 2006b). The community is not connected to the road system.

Stevens Village

Stevens Village is located in the Refuge on the north bank of the Yukon River, 17 miles upstream of the Dalton Highway bridge crossing, and 90 air miles northwest of Fairbanks (**Figure 1-1**). Residents haul treated river water from a central tap; some households use surface sources. Residents use honey buckets and outhouses for sewage disposal. No homes are plumbed. A sanitation Master Plan is under way, and washeteria improvements are under construction (Alaska Department of Commerce and Community Economic Development 2006b). A new landfill site and access road are in development.

Access to Stevens Village is primarily via the State-owned airstrip. The ADOTPF project to relocate the airport was completed in summer 2007 (Gardino 2007). The new airstrip is 4,000 feet long and 75 feet wide. Barges bring fuel in at least three times each summer; goods are offloaded at the barge landing. Residents use skiffs, ATVs, snowmobiles, and dog teams for recreation and subsistence fishing and hunting (Alaska Department of Commerce and Community Economic Development 2006b). The community is not connected to the road system.

Villages Located Outside of Refuge

Arctic Village

Arctic Village is located outside the Refuge on the east fork of the Chandalar River in a broad, relatively isolated valley, 100 miles north of Fort Yukon and 290 miles north of Fairbanks (**Figure 1-1**). The geography of Arctic Village differs from that of other villages in the study because of its location in a mountainous area north of the Refuge. The Arctic Village area encompasses 61.7 mi^2 of land and 8.1 mi^2 of water. The Gwich'in name for Arctic Village, Vashraii K'oo, translates as "steep bank creek." The Neets'aii (or Netsi) Gwich'in ("residents of the north side"), residents of Arctic Village, refer to themselves as mountain people rather than residents of the flats (Caulfield 1983).

Water drawn from the Chandalar River is treated and hauled from the washeteria. Arctic Village also has a well for community water supply. None of the homes are plumbed, although the school is plumbed. The village provides water to two school tanks; one holds 17,000 gallons and the other 7,000 gallons. The clinic hauls its own water. Honey buckets are disposed of by residents or outhouses are used. Feasibility studies are under way to examine alternatives for a safer water source, washeteria upgrades, and relocation of the landfill. The washeteria and school are the only facilities with running water. The village uses a small solar-powered system to provide some electricity. The Arctic Village landfill is near the airport (Alaska Department of Commerce and Community Economic Development 2006b).

Air transportation provides the only year-round access to Arctic Village. Ice fog frequently interferes with air service in winter months. The Tribal government owns and operates the 4,500-foot-long by 75-foot-wide gravel airstrip. Local transportation is by ATVs and snowmobiles, and five residents maintain dog teams (Alaska Department of Commerce and Community Economic Development 2006b). The community is not located on the road system. The Tribal Council for Arctic Village is combined with that of Venetie.

Central

The community of Central is located outside the Refuge on the Steese Highway about 125 miles northeast of Fairbanks and 28 miles southwest of Circle (**Figure 1-1**). Central has a cash economy based on providing seasonal support for mining operations in the area. A number of individuals live in the area only seasonally.

Approximately 25% of homes are occupied year-round and have individual wells, septic systems, and complete plumbing. Residents of the majority of summer-use homes haul water from local creeks or watering points at the local hotels and use outhouses. The landfill is located on ADNR land at mile 124.6 of the Steese Highway, which provides access to Fairbanks. Central Electric, Inc. provides electricity. Thirteen students attend the one local school (Alaska Department of Commerce and Community Economic Development 2006b).

Goods are delivered on a regular schedule by truck. The community is connected to the road system. A State-owned 2,700-foot-long by 60-foot-wide gravel airstrip is available. Residents use boats for recreation and fishing. Residents also use snowmobiles and dog sleds (Alaska Department of Commerce and Community Economic Development 2006b).

Circle

The community of Circle is located outside the Refuge on the south bank of the Yukon River at the edge of the Yukon Flats, 160 miles northeast of Fairbanks (**Figure 1-1**). It is at the eastern end of the Steese Highway.

Most homes haul treated well water from the washeteria/fire station or the school. Outhouses and honey buckets are used for sewage disposal. All homes lack plumbing facilities. A feasibility study and master plan are under way to examine infrastructure alternatives. The landfill is located at Mile 156.5 of the Steese Highway (Alaska Department of Commerce and Community Economic Development 2006b).

Circle has direct road access to Fairbanks by way of the Steese Highway. Barges deliver goods by the Yukon River during summer. Residents use ATVs, snowmobiles, and dog sleds for recreation and subsistence activities. The State owns a new 3,000-foot-long by 60-foot-wide, lighted gravel airstrip. Floatplanes land on the river (Alaska Department of Commerce and Community Economic Development 2006b).

Venetie

The community of Venetie is located outside the Refuge on the north side of the Chandalar River, 45 miles northwest of Fort Yukon (**Figure 1-1**). The terrain to the north of the community rises to the foothills of the eastern Brooks Range. Venetie Lake, located nearby, provides important waterfowl habitat. Historically, Venetie was an excellent place for fishing (Alaska Department of Commerce and Community Economic Development 2006b). Venetie is populated largely by descendants of the Neets'aii Gwich’in, and to a lesser extent the Gwichyaa and Dihaii Gwich’in (Alaska Department of Commerce and Community Economic Development 2006b).

Water is derived from a well near the Chandalar River, and then treated and stored in a tank. Residents haul water and use honey buckets. A circulating water utilidor system and 49 household service connections were constructed in 1980, but the east loop froze in 1981 and the west loop in 1982. Twenty-nine individual household septic tanks installed in 1980 also froze during their first winter of operation. Currently, only eight homes have functioning plumbing. A flush/haul system is under construction in Venetie; four homes are currently served. The Stanley Frank Washeteria and Water Treatment Plant uses a small solar-powered system to provide some electricity (Alaska Department of Commerce and Community Economic Development 2006b).

Access to Venetie is almost exclusively by air. The community is not connected to the road system. The Venetie Tribal Council owns and operates the 4,100-foot-long by 65-foot-wide dirt/gravel airstrip. The Chandalar River provides access by boat from May to October, but the water is too shallow for barge service (Alaska Department of Commerce and Community Economic Development 2006b). Residents use motor bikes, ATVs, snowmobiles, and dog teams for local travel.

Gender and Age

Gender and age statistics for the nine villages are listed in **Table 3-15**. In Alaska as a whole, 48.3% of the population is female, while 50.9% of the U.S. population is female. The Yukon Flats area also has more males than females except for Circle, where the population was split 50-50 at the time of the 2000 Census. In Beaver, approximately 39% of the population is female. In 2000, 45.7% of the Yukon-Koyukuk Census Area population was female (U.S. Census Bureau 2000). According to the Comprehensive Economic Development Strategy 2002-2007 by the Tanana Chiefs Conference (TCC; 2002): "There are complaints that there are not enough 'marriageable' women. This then causes young men to leave the community in search of wives. They may or may not return once their search is successful."

Age distribution gives an indication of whether the population of a community is generally young or old and growing or declining. One unique characteristic of the Refuge communities is the wide variety in median ages from community to community. Median age ranges from a very young 23.5 years in Arctic Village and 25 years in Venetie to 44.3 years in Central. The median age of a community can have implications for income. For example, areas with a higher median age may have more representation in jobs with longer years of experience, contributing to higher income levels. The median age in Alaska as a whole is 32.4 years.

Table 3-15 Population of selected age groups and genders at study area communities in 2000

Attribute	Villages Located Inside of Refuge					Villages Located Outside of Refuge			
	Beaver	Birch Creek	Chalky-itsik	Fort Yukon	Stevens Village	Arctic Village	Central	Circle	Venetie
Total Population	84	28	83	595	87	152	134	100	202
Male (%)	60.7	53.6	57.8	52.9	65.5	53.3	57.5	50	55.9
Female (%)	39.3	46.4	42.2	47.1	34.5	46.7	42.5	50	44.1
Median Age	29.3	33.5	33.3	31.9	35.2	23.5	44.3	34	25
Percent in Age Group									
Under age 5	7.1	-	8.4	6.9	5.7	7.2	7.5	9.0	9.9
Age 5 to 9	13.1	10.7	8.4	10.9	4.6	14.5	5.2	8.0	6.4
Age 10 to 14	10.7	3.6	6.0	11.4	11.5	15.1	3.0	10.0	10.9
Age 15 to 19	13.1	14.3	9.6	6.9	12.6	6.6	6.0	6.0	11.9
Age 20 to 24	1.2	14.3	8.4	7.6	3.4	7.9	2.2	6.0	10.9
Age 25 to 34	10.7	10.7	12.0	10.1	11.5	12.5	10.4	11.0	11.4
Age 35 to 44	21.4	17.9	16.9	17.3	19.5	16.4	17.2	16.0	16.3
Age 45 to 54	10.7	21.4	9.6	15.0	14.9	13.8	25.4	16.0	10.9
Age 55 to 59	-	3.6	3.6	5.2	4.6	3.3	9.0	11.0	1.5
Age 60 to 64	4.8	3.6	1.2	1.8	4.6	0.7	7.5	3.0	3.0
Age 65 to 74	6.0	-	10.8	4.9	2.3	0.7	3.0	3.0	4.0
Age 75 to 84	-	-	3.6	1.3	2.3	0.7	3.0	-	1.5
Age 85 and Over	1.2	-	1.2	0.7	2.3	0.7	0.7	1.0	1.5

Source: U.S. Census Bureau 2000.

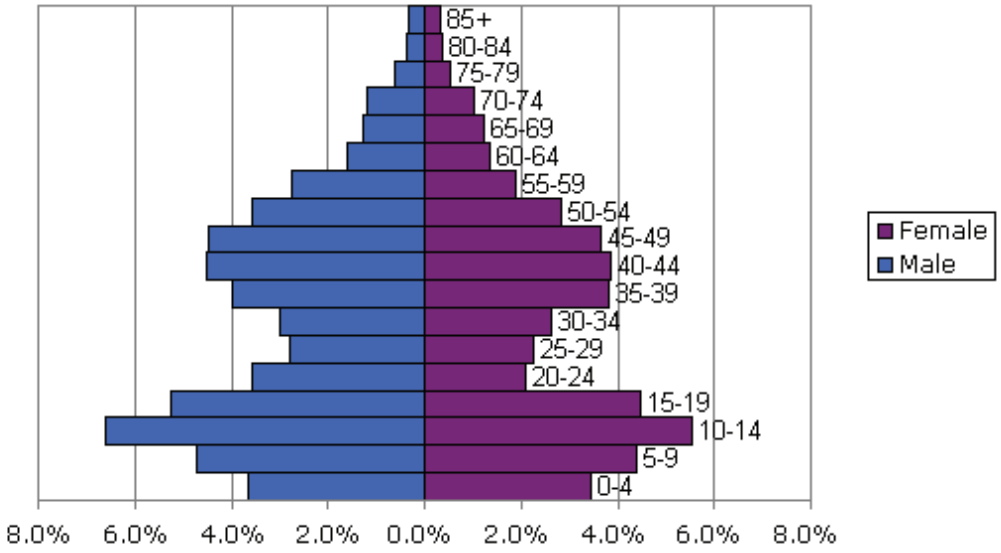
Figure 3-23 depicts age distribution for the larger Yukon-Koyukuk Census Area, expressed as a population pyramid to show patterns of population growth. The baby boom generation and their offspring, as reflected by the dumbbell shape on **Figure 3-23**, have been influential in driving the demand for schools, housing, and shopping, as well as the infrastructure to serve them. As the

baby boom generation ages, it will make different demands on society and local communities. The percentages of the populations in the 20 to 24, 25 to 29, and 30 to 34 years age categories are relatively small for the census area and many of its communities. It appears that individuals in these categories leave for educational and work opportunities, and perhaps return in their later years.

Table 3-15 and **Figure 3-23** also show that few individuals in older age categories reside in the study area communities. As pointed out by the Tanana Chiefs Conference report (2002): "Another important problem for the TCC region is the health care system for the Native elders. A significant aspect of any healthy community is the elder population that provides knowledge and support for the younger generations. However, due to transportation limitations, elders are unable to receive proper and much-needed health care in rural areas; therefore, most elders must move out of their home environment to senior centers located in the urban areas, often Anchorage rather than Fairbanks. Thus, the villages are missing an essential part of their community."

Educational Attainment

Various levels of educational attainment for the study area communities and Alaska as a whole are shown in **Table 3-16**. Economic theory views education as an investment in human resources or human capital, which enhances productivity in much the same way as investments in physical structures or equipment. Small rural communities often do not reap the benefits of increasing education because of limited job opportunities. When students leave the community for higher education, often they do not return to their local community. The "brain drain" is a problem for all of Alaska, but it seems to be a particular problem in some Yukon Flats area communities, as indicated by **Table 3-16** and **Figure 3-23**.



Source: Census 2000 analyzed by the Social Science Data Analysis Network.

Figure 3-23 Age distribution Yukon-Koyukuk census area in 2000

Educational attainment is one indicator of the kinds of human resources available in a community and the level of labor force preparation. In general, income increases with advancing educational attainment. The nine study area communities are part of the Yukon Flats School District headquartered in Fort Yukon, which serves students in a 59,000-mi^2 area. As of October 2005, 273 pupils were enrolled in the Yukon Flats School District. In October 2007, 267 were enrolled district wide. The population is primarily Gwich'in and Koyukon Athabascan Indians. At the time of the 2000 Census, the percent of individuals 25 years and over with a high school education or higher ranged from a low of 30.2% in Chalkyitsik to a high of 96.1% in Central. The Yukon Flats School District experiences one of the highest dropout rates in the State of Alaska (Alaska Department of Education and Early Development 2006).

Household Characteristics

Table 3-17 shows the number of households and family households in the study area communities, along with the average household size and average family size. At the time of the 2000 Census, an estimated 553 households were in the Refuge. The average household size ranged from 2.37 individuals in Chalkyitsik to 3.21 in Venetie. The average family size ranged from 2.63 in Birch Creek to 3.63 in Stevens Village. In Arctic Village, Birch Creek, and Venetie, half or more of households had individuals younger than 18 years of age. The smallest average household size was in Central, a mining community.

Housing Characteristics

The most comprehensive source of readily available information for housing is provided by the U.S. Census, as shown in **Tables 3-18** and **3-19**. According to the 2000 Census, the majority of the housing units in Refuge communities do not have a complete kitchen or bathroom, and many are without phone service and heat with fuel oil, kerosene, or wood (**Table 3-19**). Heating bills are a large component of the cost of living for anyone in rural Alaska. An article in the *Fairbanks Daily News-Miner* on December 31, 2005, reported that "the Yukon-Koyukuk School District was selling off surplus vehicles and school equipment to help pay its astronomical heating bill." The school district superintendent reported that the school district had already spent the $80,000 set aside for emergency maintenance (Campbell 2005).

Table 3-16 Educational attainment of population 25 years and over in study area communities in 2000

Location	Number	Percent High School Graduate or Higher	Percent Bachelor's Degree or Higher
Alaska	379,556	88.3	24.7
Arctic Village	62	75.8	32.3
Beaver	68	66.2	0
Birch Creek	13	84.6	0
Central	103	96.1	37.9
Chalkyitsik	43	30.2	4.7
Circle	40	52.5	0
Fort Yukon	367	69.2	13.1
Stevens Village	51	33.3	5.9
Venetie	103	48.5	3.9

Source: U.S. Census Bureau 2000.

Populations of Concern

Populations of concern are identified to determine the distributional impacts of a project or program among low-income, minority, and other protected populations from a community perspective. The following paragraphs provide information about populations of concern that are pertinent to an analysis of environmental justice.

Ethnicity and Race

The populations of eight of the nine study area communities are predominantly Alaska Native, ranging from a low of 7.5% of the population of Central to a high of 100% of the population of Birch Creek (**Table 3-20**). Only one individual reported that he or she was Black or African American, two individuals reported they were Asian, and six individuals reported they were "some other race." Twenty individuals reported a Hispanic or Latino ethnicity.

Income Distribution and Poverty Status

Figure 3-24 compares the Yukon-Koyukuk Census Area per-capita personal income, as a percentage of U.S. per-capita income, with that of Alaska and the Fairbanks North Star Borough. There is a large gap between the personal per-capita income of the Census Area compared to the State and the Fairbanks North Star Borough.

Table 3-17 Households in study area communities in 2000

Attribute	Villages Located Inside of Refuge					Villages Located Outside of Refuge			
	Beaver	Birch Creek	Chalky-itsik	Fort Yukon	Stevens Village	Arctic Village	Circle	Central	Venetie
Total number households	31	11	35	225	35	52	34	67	63
Family households (%)	61.3	72.7	48.6	60.9	45.7	59.6	67.6	49.3	76.2
Nonfamily households (%)	38.7	27.3	51.4	39.1	54.3	40.4	32.4	50.7	23.8
Households with individuals under 18 years of age (%)	48.4	54.5	31.4	42.2	34.3	50.0	38.2	14.9	55.6
Households with individuals 65 years of age and over (%)	19.4	0.0	28.6	15.6	17.1	5.8	11.8	9.0	20.6
Average household size	2.7	2.6	2.4	2.6	2.5	2.9	2.9	2.0	3.2
Average family size	3.4	2.6	3.3	3.4	3.6	3.6	3.5	2.8	3.6

Note: Nonfamily household refers to a householder living alone or with nonrelatives only.

Source: U.S. Census Bureau 2000.

Table 3-18 Housing characteristics in study area communities in 2000

Characteristic	Villages Located Inside of Refuge					Villages Located Outside of Refuge			
	Beaver	Birch Creek	Chalky-itsik	Fort Yukon	Stevens Village	Arctic Village	Central	Circle	Venetie
Total housing units	54	22	62	317	43	67	169	42	79
Occupied units	31	11	35	225	35	52	67	34	63
Vacant housing units	23	11	27	92	8	15	102	8	16
Seasonal	10	0	18	37	0	9	98	7	8
Owner occupied	20	7	28	162	25	34	49	24	49
Renter occupied	11	4	7	63	10	18	18	10	14
Average household size of owner-occupied units	2.80	2.71	2.14	2.76	2.64	3.06	2.31	2.92	3.39
Average household size of renter-occupied units	2.55	2.25	3.19	2.27	2.10	2.67	1.17	3.00	2.57
Median house valuation ($)	80,000	82,500	53,000	50,000	10,000	106,800	68,000	52,500	55,000
Median contract rent ($)	288	0	292	570	425	325	142	575	235

Note: The U.S. Census distinguished between units that are vacant on a seasonal basis (e.g., as for vacation, recreational, or subsistence use) versus "other vacant units" (including units that have been rented or sold but not occupied).

Source: U.S. Census Bureau 2000.

Table 3-19 Selected housing characteristics in study area communities in 2000

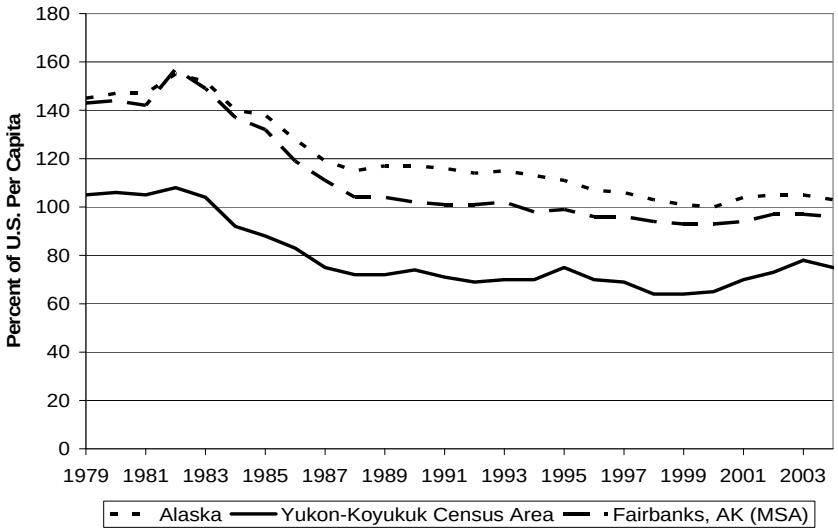
Characteristic	Villages Located Inside of Refuge					Villages Located Outside of Refuge			
	Beaver	Birch Creek	Chalky-itsik	Fort Yukon	Stevens Village	Arctic Village	Central	Circle	Venetie
Total housing units	54	22	62	317	43	67	179	42	79
Heat with fuel oil, kerosene, etc. (%)	56.8	100.0	34.4	60.8	34.3	20.8	57.6	7.1	4.5
Heat with electricity (%)	0	0	0	0.8	0	0	0	0	0
Heat with wood (%)	43.2	0	65.6	38.4	65.7	79.2	42.4	92.9	95.5
Lack complete plumbing (%)	100.0	100.0	100.0	54.0	91.4	89.6	78.2	100.0	100.0
Lack complete kitchen (%)	100.0	100.0	100.0	54.4	91.4	89.6	78.8	100.0	93.9
No telephone service (%)	45.9	80.0	15.6	24.9	22.9	16.7	22.7	35.7	18.2

Source: U.S. Bureau of Census, Census 2000, DP-4.

Table 3-20 Percent of population by race for the study area communities in 2000

Location	Population Number	One Race (%)	White (%)	Alaska Native or American Indian (%)	Two or More Races (%)
Arctic Village	152	94.1	7.9	86.2	5.9
Beaver	84	90.5	4.8	85.7	9.5
Birch Creek	28	100.0	0.0	100.0	0.0
Central	134	95.5	84.3	7.5	4.5
Chalkyitsik	83	100.0	2.4	97.6	0.0
Circle	100	91.0	14.0	76.0	9.0
Fort Yukon	595	97.3	10.8	86.1	2.7
Stevens Village	87	100	3.4	95.4	3.4
Venetie	202	95.5	3.5	92.1	4.5

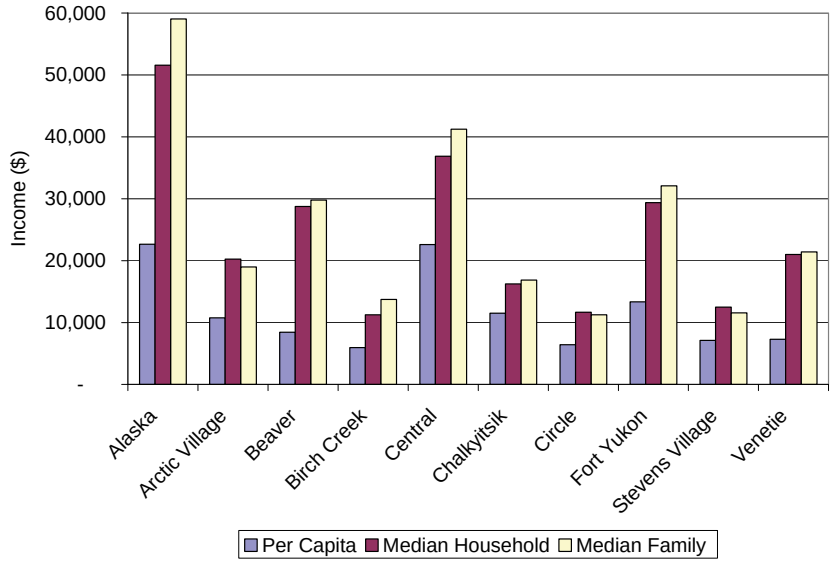
Source: U.S. Census Bureau 2000.



Source: U.S. Bureau of Economic Analysis accessed at http://www.bea.doc.gov/.

Figure 3-24 Per-capita personal income, percent of U.S., Alaska, Yukon-Koyukuk census area, and Fairbanks North Star Borough, 1979-2004

In Alaska, the poverty rate in 2007 was 8.9%, one of the lowest rates in the nation (U.S. Census Bureau 2007). The rate would be higher with a cost-of-living adjustment applied to the threshold, but lower if subsistence harvests were included as part of income. The percent of people living below the poverty level in study area communities is much higher than the percent for Alaska as a whole (**Table 3-21**). At the time of the 2000 Census, the percent of families considered to be living in poverty ranged from a low of 15.8% in Central to a high of 60% in Stevens Village. The poverty rate in the largest community in the study area, Fort Yukon, was 18%.



Source: U.S. Census Bureau 2000.

Figure 3-25 Per-capita, median household, and median family household income for study area communities in 2000

Table 3-21 Poverty status in 1999 for study area communities

Location	Families		Individuals	
	Number	Percent	Number	Percent
Alaska	10,270	6.7	57,602	9.4
Arctic Village	8	30.8	56	46.3
Beaver	0	0	15	11.1
Birch Creek	2	33.3	10	37.0
Central	6	15.8	31	22.5
Chalkyitsik	6	54.5	30	52.6
Circle	7	50.0	29	42.0
Fort Yukon	27	18.0	120	18.5
Stevens Village	9	60.0	52	61.2
Venetie	17	34.0	89	42.8

Source: U.S. Census Bureau 2000.

3.5.5.8 Local Economies and Employment

This section includes a brief discussion of the economy of each study area community from the Community Profiles of the ADCCED, followed by information on employment and the economic base, including unemployment, largest employers, size of the labor force, and employment by occupation, industry, and class of worker.

Descriptions of Local Economies

State and local government agencies, including the school districts, provide over 50% of the employment in the census area. According to U.S. Census data, government employment predominates in study area communities, except for Chalkyitsik and Central. Most of the private-sector jobs in the census area and Refuge are in services and are connected to Alaska Native organizations. The largest nonprofit corporation in the census area is the TCC. The TCC provides employment in health and social services. In most communities, full-time, year-round employment opportunities are limited to public education, local government, and various village organizations. Some residents are employed by Doyon outside of the Refuge (Alaska Department of Commerce and Community Economic Development 2006a).

Arctic Village

The economy of Arctic Village is subsistence-based. The school, clinic, village council, and stores are the primary employers. Seasonal employment includes construction, fire fighting, guiding, and conducting wildlife surveys for the Service. Some residents trap furbearers or sell firewood for income. The Tribe operates the washeteria and clinic (Alaska Department of Commerce and Community Economic Development 2006b). No business licenses are currently registered for Arctic Village (Alaska Department of Commerce and Community Economic Development 2007).

Beaver

The history of Frank Yasuda, the Japanese immigrant who founded the village with a group of Iñupiat, attracts tourists from Japan. A local resident caters to these visitors. Almost all Beaver residents are involved in subsistence activities. Poor fish returns since 1998 have significantly affected the community. Most wage employment is at the school, post office, clinic, and village council. Seasonal wages are earned through BLM fire fighting, construction jobs, trapping, producing handicrafts, or selling cut firewood (Alaska Department of Commerce and Community Economic Development 2006b). Beaver has five business licenses, but it is not known if all are active (**Appendix H**).

Birch Creek

Birch Creek's economy is heavily dependent upon subsistence. Wage income opportunities are extremely limited. BLM fire fighting, construction, and the village council provide employment. The community is conducting planning activities to expand the economy to include tourism and merchandising. The Tribe operates the washeteria and electrical service (Alaska Department of Commerce and Community Economic Development 2006b). No business licenses are currently registered for Birch Creek.

Central

Central has a cash economy based on providing seasonal support for mining operations in the area. The Circle District Museum attracts seasonal visitors. A number of individuals live in the area only seasonally. Subsistence and recreational activities provide food sources for the year-round residents. Fourteen business licenses are registered in Central (**Appendix H**).

Chalkyitsik

In Chalkyitsik, wage opportunities are limited and primarily part-time with the school district, village council, clinic, or State and Federal agencies. Seasonal work is found fire fighting for the BLM, making sleds and snowshoes, trapping, and handicrafts. Subsistence plays an important role in the village economy (Alaska Department of Commerce and Community Economic Development 2006b). Three business licenses are registered in Chalkyitsik (**Appendix H**).

Circle

Recreation attracts visitors to Circle seasonally. Circle Hot Springs was closed in October 2002. Some people live in the community only during summer months. Major employers include the school, clinic, village corporation, trading post, and post office. Almost all residents are involved in subsistence. Trapping and making of handicrafts contribute to family incomes (Alaska Department of Commerce and Community Economic Development 2006b). Six business licenses are registered in Circle (**Appendix H**).

Fort Yukon

City, State, and Federal agencies, CATG, Tribal government, and Gwichyaa Zhee Native Corporation are the primary employers in Fort Yukon. The school district is the largest employer. Winter tourism is becoming increasingly popular; Fort Yukon experiences spectacular Northern Lights. The BLM operates an emergency fire-fighting base at the airport. Trapping and Native handicrafts also provide income. Residents rely on subsistence foods (Alaska Department of Commerce and Community Economic Development 2006b). Fort Yukon has the largest number (28) of business licenses of any community in the study area (**Appendix H**).

Stevens Village

Stevens Village is heavily dependent upon subsistence activities. Some seasonal and part-time employment is provided by the school, clinic, village council, and stores, as well as BLM fire-fighting and construction work (Alaska Department of Commerce and Community Economic Development 2006b). Three business licenses are registered for Stevens Village (**Appendix H**).

Venetie

Venetie is heavily dependent on subsistence. Most employment is through the school, clinic, post office, store, and village council. The National Guard has used Venetie as a cold weather survival training school. The BLM seasonally employs residents as firefighters. Five residents were employed on the North Slope with PGS Onshore in the 2005/2006 winter season. The village is interested in developing a small mill to process local lumber for housing and other projects, and in promoting tourism. Cabins built with local logs could house visitors and provide space for arts and crafts, cultural activities, and a museum (Alaska Department of Commerce and Community Economic Development 2006a). One business license is registered for Venetie (**Appendix H**).

Village Economies

Subsistence activities are an important component of the local economy in each of the study area communities. The economies of Yukon Flats communities are characterized by few full-time jobs, limited opportunities to earn cash, and high participation rates in wild food harvests for

personal consumption. Subsistence is important to economic survival because average household incomes are well below those found in more urban areas. Household incomes are pieced together from a variety of income sources including seasonal or part-time jobs, such as fire fighting, along with Permanent Fund dividend checks and government transfers.

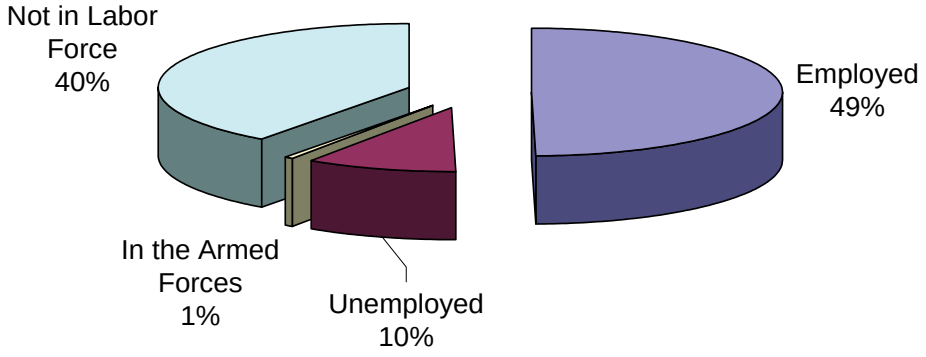
One of the paradoxes of subsistence is that cash is needed to engage in a subsistence lifestyle. According to a 1999 report by the National Research Council (NRC) on community development quota communities in Western Alaska, a household income of at least $20,000 to $25,000 per year is needed to engage in subsistence activities (National Research Council 1999). In the Yukon Flats, a large proportion of a household's cash income is used to purchase and maintain equipment such as boats, outboard motors, snowmobiles, and four wheelers.

The trapping harvest is poorly documented, but it has long been a source of cash income for residents of the Yukon Flats and an important component of the local economy. Some residents also use fur and hides to make parka ruffs, moccasins, or Alaska Native handicrafts for personal use and for sale. While incomes from trapping have been low in recent years, trapping still represents one of the few cash-earning options during the winter months in the Yukon Flats, and remains an integral part of the mixed subsistence-cash economy of the study area communities (Andersen 1993). For example, a 1992 study by Wolfe found that 33% of the households in Fort Yukon generated income from trapping and that the mean value of furs per trapping household was $7,549 (*cited in* Andersen 1993). In contrast, the same study found that almost 87% of households in Stevens Village engaged in trapping and that the mean value of furs per trapping household was $1,477.

An e-commerce project (www.ArcticWays.com) to facilitate the sale of traditional crafts from remote villages has been established. People use moose and caribou hides, wood, and other natural materials to make moccasins, vests, gloves, snowshoes, and fish spears for sale via the Internet. The Web site is based in Fort Yukon under the CATG.

Employment Status

Census data for employment status are presented on **Figure 3-26** and **Table 3-22**. If the labor force data are aggregated to include all nine of the study area communities, approximately 40% of individuals 16 years and over are not in the labor force, compared to 28% in Alaska as a whole.



Source: U.S. Census Bureau 2000.

Figure 3-26 Employment status, study area communities as a whole

Table 3-22 Employment status for study area communities, Census 2000

	Total for Study Area	Villages Located Inside of Refuge					Villages Located Outside of Refuge			
		Beaver	Birch Creek	Chalky-itsik	Fort Yukon	Stevens Village	Arctic Village	Central	Circle	Venetie
Population 16 years of age and over	1,045	86	18	47	449	62	76	113	50	144
In civilian labor force	617	67	2	17	289	36	54	58	25	69
Employed	530	55	2	17	237	36	45	50	19	69
Unemployed	101	12	0	0	52	14	9	8	6	44
In the Armed Forces	6	0	0	0	0	0	2	0	0	0
Not in labor force	426	19	16	30	160	26	20	55	25	75
Unemployment rate (%)	14.7	14.0	11.1	-	11.6	22.6	11.8	13.8	12.0	17.4

Source: U.S. Census Bureau 2000.

Unemployment

The unemployment rate for the study area as a whole in 2000 was around 14.7%, ranging from a low of 11.1% in Birch Creek to a high of 22.6% in Stevens Village (**Table 3-22**). The unemployment rate for Fort Yukon, the largest community with the most employment opportunities, was 11.6%.

While it would appear from **Figure 3-26** that almost 50% of the residents of the study area were employed in 2000, this information must be placed in context. Much of the employment reported to the census would be part-time and/or seasonal employment rather than full-time, year-round employment.

Normal measures of unemployment—people unemployed and actively seeking work—are misleading in rural Alaska, particularly in an area like Yukon Flats. Many individuals may not be actively seeking work because they know that only limited opportunities are available within their community, or they may not want full-time, year-round employment if it means they cannot continue to participate in subsistence activities.

Employment by Occupation

Figure 3-27 shows 2000 employment by occupation for study area communities as a whole, and **Table 3-23** shows the breakdown by community. Of the 491 jobs reported in 2000, the greatest percent (37%) were management or professional jobs, followed by sales and office jobs (22%). Of note in **Table 3-23** is that only six people reported farming, fishing, and/or forestry as their occupation.

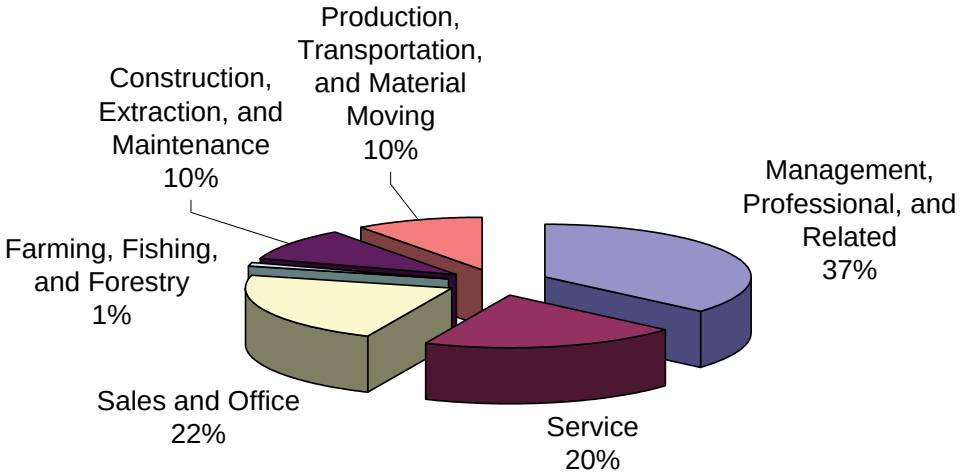
Table 3-24 shows the percent of private wage and salary workers, government workers, and self-employed workers for Alaska and each of the study area communities. Government workers (including Tribal governments) account for the majority of employment in most of the study area communities, compared to 26.8% of employment for Alaska as a whole.

The Alaska Department of Labor and Workforce Development also has information on the number of workers in the Yukon-Koyukuk Census area for occupations specific to the types of jobs needed for oil and gas development. **Table 3-25** shows worker counts and average wages by occupation for the year 2006.

Table 3-23 Number of workers by occupation, study area communities

Occupation	Study Area	Villages Located Inside of Refuge					Villages Located Outside of Refuge			
		Beaver	Birch Creek	Chalky-itsik	Fort Yukon	Stevens Village	Arctic Village	Central	Circle	Venetie
Management, professional, and related	179	13	0	6	91	10	28	12	5	14
Service	99	18	0	0	35	4	7	20	5	10
Sales and office	109	11	2	4	72	4	5	2	0	9
Farming, fishing, and forestry	6	0	0	0	6	0	0	0	0	0
Construction, extraction, and maintenance	49	1	0	2	21	0	0	14	7	4
Production, transportation, and material moving	49	12	0	5	12	4	5	2	2	7
Total	491	55	2	17	237	22	45	50	19	44

Source: U.S. Census Bureau 2000.



Source: U.S. Census Bureau, Census 2000, DP-3.

Figure 3-27 Percent employment by occupation, study area as a whole

Table 3-24 Class of worker, study area communities

Class	Villages Located Inside of Refuge					Villages Located Outside of Refuge				Alaska
	Beaver	Birch Creek	Chalky-itsik	Fort Yukon	Stevens Village	Arctic Village	Central	Circle	Venetie	
Private wage and salary workers (%)	47.3	0	64.7	33.8	45.5	15.6	62.0	10.5	25.0	64.9
Government workers (%)	52.7	100.0	35.3	63.3	54.5	64.4	20.0	89.5	75.0	26.8
Self-employed workers in own not incorporated business (%)	0	0	0	3.0	0	20.0	18.0	0	0	8
Unpaid family workers (%)	0	0	0	0	0	0	0	0	0	0.3
Total number of workers	55	2	17	237	22	45	50	19	44	281,532

Source: U.S. Census Bureau 2000.

3.5.6 Cultural Resources

Cultural resources are sites and materials of prehistoric Native American, historic non-Native, and historic Native origin. Cultural resources include, but are not limited to, archaeological sites, traditional cabin sites, camp sites, burial grounds, traditional cultural properties, sacred places, traditional subsistence harvest sites, and other traditional land use areas, landscapes, and place names. Place names and their associated narratives and lore reveal much about the historic and prehistoric peoples of the region, and are often associated with subsistence camps, types of resources used, cabins, activity areas, travel routes, and other places important to the history and culture of local residents. Analysis of place names can provide information about contemporary and historic land and resource use, distribution and seasonal availability of resources, resource harvest methods, environmental conditions, traditional band distributions, and aspects of the world view that shape perceptions and land resource patterns (Caulfield et al. 1983).

This cultural resource discussion relies on information from existing literature and database resources/inventories, including published place names inventories (e.g., Caulfield 1979; Caulfield et al. 1983), oral histories (e.g., University of Alaska Fairbank's Project Jukebox no date), the Alaska Heritage Resource Survey (AHRS) inventory (Alaska Department of Natural Resources and Office of History and Archaeology [ADNR OHA] 2006), the National Register of Historic Places (NRHP; National Park Service no date), reports on previous cultural resource investigations in the region (e.g., Bureau of Indian Affairs 14(h)(1) surveys, project-based surveys), and contemporary and historic accounts of the region (e.g., Prindle 1910; Hrdlička 1943). The location of documented cultural resources and a discussion of those resources are based on the AHRS inventory located at and maintained by the ADNR OHA (Alaska Department of Natural Resources and Office of History and Archaeology 2006). The AHRS is an inventory of all reported historic and prehistoric sites within the State of Alaska including objects, structures, buildings, sites, districts, and travel ways, with a general provision that they are over 50 years old.

Table 3-25 Worker count and average wage for selected occupations in the oil and gas development industry, Yukon-Koyukuk Census Area

Occupational Title	Worker Count 2006	Average Wage
Welders, cutters, solderers, and brazers	1	
Electricians	22	$25,679
Helpers—electricians	1	
Mechanics, mine machinery	6	
Truck drivers, heavy and tractor-trailer	78	
Truck drivers, light or delivery services	20	
Security guards	41	
Laborers and freight, stock, and material movers, hand	332	$3,582
Earth drillers, except oil and gas	10	
General and operations managers	57	$22,828
Construction managers	11	
Construction laborers	640	$8,274
Construction and related workers, and all other	2	
First-line supervisors/managers of construction trades and extraction workers	15	$52,224
First-line supervisors/managers of helpers, laborers, and material movers, and hand laborers	12	
Highway maintenance workers	19	
Water and liquid waste treatment plant and system operators	66	$14,136
Producers and directors	1	
Supervisors, protective service workers, all other	1	
First-line supervisors/managers of production and operating workers	13	
Service unit operators, oil, gas, and mining	9	
Operating engineers and other construction equipment operators	281	$28,437

Note: Wages are suppressed when there are fewer than five workers in an area/occupation combination and also suppressed when one employer employs half or more of the workers in a particular area/occupation combination.

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section, Occupation Database, 2006.

3.5.6.1 Cultural History of the Yukon Flats Region

This section provides a brief overview of the cultural history of the Yukon Flats region. More detailed information can be found in **Appendix I**, Cultural History of the Yukon Flats.

There are few documented prehistoric (before contact with non-Natives) sites in the Refuge (Alaska Department of Natural Resources and Office of History and Archaeology 2006). However, few cultural resource surveys have been conducted in the region, partially because of the challenging topography and the difficulty in excavating in wetlands and frozen soils. Additionally, there is a paucity of artifacts and archaeological features in interior Alaskan sites that has contributed to the lack of interest in interior Alaska archaeology by researchers (Shinkwin 1977, Workman 1996). Early sites in interior Alaska are known from the Tanana and Nenana river drainages south of the Yukon Flats (Dixon 1993); however, no early sites have been found in the Refuge. Based on the locations of prehistoric sites in the areas surrounding the Refuge, early cultural sites may be present along the Yukon and Porcupine rivers and in other parts of the Refuge. Bluffs, caves, and fluvial and lacustrine terraces and benches along the rivers

and sloughs are landforms with good potential for well-preserved early sites, as well as more recent archaeological materials (Thorson and Dixon 1984).

Prehistoric and historic (after contact with non-Natives) settlement patterns and activities within the mid-Yukon region varied depending on the season, geographic location, type of activity, and the social units involved. Athabascan peoples speaking the Gwich'in (formerly written Kutchin or Kutcha-Kutchin) language occupied a large portion of interior Alaska, including some portions of the Refuge, and the Yukon Territory in the late prehistoric and early historic periods (Slobodin 1981). Other groups residing in the region include the Koyukon, an Athabascan group, and the Iñupiat. In the mid-Yukon region, Athabascan peoples participated in the fur trade in the first half of the 19th century, trading furs at trading posts for items such as cooking implements, firearms and ammunition, metal tools, beads, and cloth. Trade was an important part of the economy, and several trails, such as the Swift River trail, were used for the purposes of trade (Caufield 1983).

Knowledge of the exact locations and distributions of Interior Athabascan and Iñupiat groups in the 19th century is limited because there are few written records, the groups moved frequently, and conflicts between Iñupiat and Athabascan people during the late prehistoric and early historic period resulted in changes to their residential areas.

The Russians had territorial claims in Alaska from 1741 to 1867. By the early 19th century, the Russian American Company was building trading posts as far up the Yukon River as Nulato to access new trade possibilities. At the same time, the British Hudson Bay Company was steadily establishing trading posts closer and closer to Russian territory along river drainages. The Hudson Bay Company established Fort Yukon at the confluence of the Porcupine and Yukon rivers, and operated in this area from 1846 until 1869, when the post was moved out of American territory (Caulfield 1983).

The purchase of Alaska by the United States in 1867 changed the ownership of the trading posts from the Russian America Company to Hutchinson, Kohl and Company, later known as the Alaska Commercial Company. The Alaska Commercial Company and other American fur and trading companies sought markets in the Yukon River district because the Yukon Flats was, and continues to be, an important furbearer habitat. By the end of the 19th century, however, elimination of competition on the Yukon River for furs caused prices to collapse and fur harvests to decrease substantially (VanStone 1979). A description of trapping in Fort Yukon and a map of that community's 1948-1949 traplines is included in Shimkin's (1955*) The Economy of a Trapping Center: The Case of Fort Yukon, Alaska*. Further discussion is included in a report on recent subsistence uses at Birch Creek, Beaver, and Fort Yukon (Stephen R. Braund and Associates 2007) and in Section 3.5.7. Participation in trapping has fluctuated throughout the 20th century based on wide variations in fur prices, the increase in trapping regulations, and the relative availability of furbearers and trapping areas (Caulfield 1983).

In 1897, the discovery of gold in the Klondike created a mass movement of people into the interior of the Yukon Territory that spilled down the Yukon River. Throughout the last 30 years of the 19th century, individual prospectors and small groups of men explored for gold throughout the mid and upper Yukon River region. During World War II, gold production was closed down as nonessential to the war effort. Since that time, mining activity has risen and fallen in response to gold prices and costs of operations under stricter environmental requirements.

The Yukon Flats are bordered by mountainous regions where mineral exploration took place. The Yukon Flats was more of a transportation corridor between mining districts than the site of any sustained exploration or development.

3.5.6.2 Overview of Documented Cultural Resources in the Refuge/Yukon Flats Region

Few cultural resources surveys have been conducted in the Refuge. Surveys along the Yukon River near Circle identified several prehistoric sites at Medicine Lake, on Birch Creek, and near Burnt Paw on the lower Porcupine River, as well as prehistoric and historic fish camps near Fort Yukon (West 1965).

Many prehistoric sites as well as historic cabins, tent frames, and caches were identified at Old John Lake near Arctic Village (Hall and McKennan 1973). Gwich'in caribou fences were documented in northwestern Alaska and the northern Yukon Territory between 1971 and 1973 (Warbelow et al. 1975). Andrews (1977) summarized the cultural resources of the Doyon region under provisions of ANCSA for the selection of cemetery and historical sites, and organized cultural resources in the region according to age: prehistoric (pre-1700), late prehistoric (1700-1850), and early historic (1850-1910). Construction of the TAPS from Prudhoe Bay to Valdez spurred archaeological surveys and excavations in advance of its construction (Cook 1977). Boraas (1970) and Derry (1977) identified several dozen sites that were located in alpine meadows, adjacent to chert outcrops, in the Tolovana and Livengood vicinity just outside of the study area. The route of the proposed natural gas pipeline through Alaska and Canada has been the subject of both literature reviews (Humphrey et al. 1975) and field surveys for cultural resources (Aigner 1978, 1979a, b, c; 1983).

Archaeological sites were identified along these linear routes, and at the material sources used for the construction and operation of the TAPS and North Slope Haul Road (now called the Dalton Highway). A survey along the upper reaches of the Porcupine River between 1978 and 1980 identified several archaeological sites (Dixon and Plaskett 1980). Mobley (1982) conducted a cultural resource survey at the village of Chalkyitsik and discovered archaeological materials that were thought to be some of the oldest known for the region. Mobley (2005) later returned to Chalkyitsik to survey for cultural resources for a planned airport expansion and material sources. A survey of the upper Beaver Creek drainage did not locate any prehistoric sites, although Will (1986) identified cabins and other features related to gold mining. Slaughter (1984) surveyed the Yukon River from the vicinity of Purgatory upstream to Fort Yukon, the lower reaches of the Porcupine, Sheenjek, and Christian rivers, and the Upper and Lower mouths of Birch Creek upstream to the vicinity of Birch Creek village, and documented abandoned and still used cabins, gravesites, subsistence campsites (hunting and fish camps), and hearths. P-III Associates conducted a reconnaissance survey along the Hodzana River and examined areas determined to be of high potential for cultural resources (Smith 1984). The survey resulted in the discovery of 12 sites, including prehistoric and historic sites. A pattern identified during the survey was that only recent historic sites were located on lowland terraces near the river and that prehistoric sites were located at higher elevations on the ridge systems overlooking the river valley. The Bureau of Indian Affairs and TCC have conducted various surveys of Native allotments in the area. As part of the proposed land exchange, McGraw (2006) conducted an archival and literature review, as well as interviews to identify cultural resources, on lands included in the proposed land exchange. During that survey, he documented several trapping cabins within the Beaver Creek Wild River corridor.

In 2005 and 2006 the Service conducted Burned Area Emergency Rehabilitation (BAER) surveys on the Refuge. The survey in 2005 focused on the Hodzana River (Burned Area Emergency Rehabilitation 2005). In 2006, four burned areas were examined (Burned Area Emergency Rehabilitation 2006). A number of historic sites were known in the target areas. The crew located and documented 14 previously unknown prehistoric sites, most on bluffs overlooking rivers. Seventeen historic sites were photographed and documented, 8 historic sites were destroyed by fire, and five known sites were not located.

In 2006, 197 sites listed in the AHRS files (AHRS sites) were reported to be located within the Refuge. Of these, 50 are identified as prehistoric (before contact with non-Natives), 106 are identified as historic (after contact with non-Natives), and the remainder have either not been assigned to a period or are modern (last 50 years) in age (Alaska Department of Natural Resources Office of History and Archaeology 2006). In addition to AHRS sites, more than 500 place names have been documented in the Refuge (Caulfield 1979; Caulfield et al. 1983; Matthew et al. 1999). According to Caulfield et al. (1983), place names can reveal:

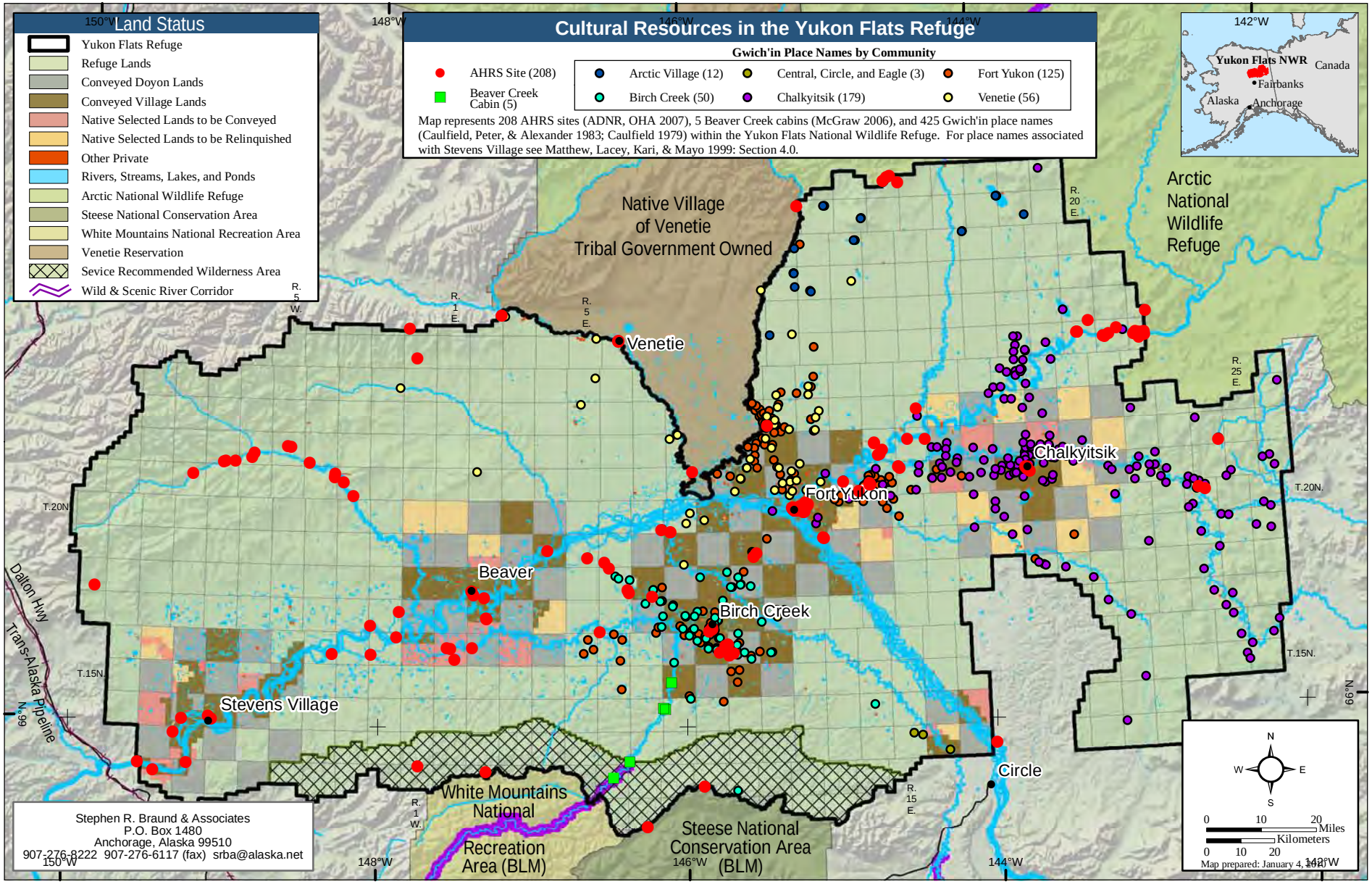
> "a detailed and complex array of data about contemporary and historic land and resource uses, distribution and seasonal availability of local resources, annual cycle of harvest activities, resource harvest methods, environmental conditions, traditional Native band distributions, and important aspects of a distinct world-view which shapes local perceptions and land and resource use patterns today."

The locations of these AHRS sites and place names, with the exception of those associated with Stevens Village, are shown in **Figure 3-28**. The distribution of documented sites represents areas where cultural resource investigations have occurred, not necessarily where cultural resources are most likely to be located. Undocumented cultural resources are likely to be found throughout the Refuge. River banks and lake shores were, and continue to be, locations for subsistence hunting activities, including permanent and temporary structures such as cabins, tents, tent platforms, fish drying racks, traplines, and trails. Other areas with a moderate to high probability of locating cultural resources would include the White and Crazy mountains area as well as in the vicinity of stream crossings, along lakeshores and rivers, in areas with well-drained soils, and in areas with good vantage points for spotting game; areas with known gold exploration and mining activity along creeks and streams such as Victoria Creek; loess-covered bluffs and overlook locations; uplands areas that are currently used for hunting; and established historic trails and travel routes, such as Alaska Road Commission trails and wagon roads with their associated shelter cabins and roadhouses.

The Service has conducted background and archival research, oral history interviews with Native and non-Native informants (McGraw 2006), village meetings, and Government-to-Government consultations and fieldwork to identify cultural resources within the core and halo areas of the land exchange area. The Service undertook analysis of the landforms, vegetation, and faunal resources of the land exchange area to identify high probability areas for survey (Corbett 2009) Many types of cultural resources, including sacred sites and traditional cultural properties, can only be identified with the assistance of knowledgeable parties. Field surveys were conducted in 2006 and 2008 and a number of historic sites were identified. Information on subsistence uses of the Refuge, including information about cultural resources, was recently collected (Stephen R. Braund and Associates, Inc. 2007). The Service is funding a project to conduct place names research in the Refuge as part of an ongoing effort to document the cultural resources of the land exchange area.

Proposed Land Exchange EIS
U.S. Fish & Wildlife Service
Yukon Flats National Wildlife Refuge, Alaska

Figure 3-28
AHRS Sites and Gwich'in Place Names in the Yukon Flats Refuge



Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222 907-276-6117 (fax) srba@alaska.net

During interviews with local subsistence users in Beaver, Birch Creek, and Fort Yukon, respondents identified camps, cabins, and other cultural resources (e.g., historic traplines or trails, burials, former villages, and place names) throughout the Refuge. A number of camps or cabins were identified as being at least 50 years old or had been used for multiple generations. Cultural resources identified by respondents are located along various waterways including the Yukon River, Birch Creek, and Beaver Creek, and inland from these waterways at varying distances. For maps depicting the locations of these cultural resources, see Stephen R. Braund and Associates, Inc. (2007). The only sites found within the land exchange area were historic cabins along Birch Creek.

3.5.7 Subsistence

For the purposes of this subsistence analysis, the study area includes the communities of Arctic Village, Beaver, Birch Creek, Central, Chalkyitsik, Circle, Fort Yukon, Stevens Village, and Venetie. Residents of these communities harvest subsistence resources that reside in or travel through the Refuge land exchange area.

3.5.7.1 Relevant Subsistence Regulations, Definition, and Description

The Refuge is comprised of private, State, and Federal lands. Therefore, State and Federal law regulates subsistence in the Refuge. Subsistence hunting and fishing in Alaska are regulated under a dual management system by the State of Alaska and the Federal government, which sometimes overlap depending on where the harvest occurs. The reason for the dual State and Federal management of subsistence in Alaska is described by the Service as follows:

> ANILCA, passed by Congress in 1980, mandates that rural residents of Alaska be given a priority for subsistence uses of fish and wildlife. In 1989, the Alaska Supreme Court ruled that ANILCA's rural priority violated the Alaska Constitution. As a result, the Federal government manages subsistence uses on Federal public lands and waters in Alaska – about 230 million acres or 60% of the land within the state. To help carry out the responsibility for subsistence management, the Secretaries of the Interior and Agriculture established the Federal Subsistence Management Program (U.S. Fish and Wildlife Service 2007).

The Alaska Board of Fisheries and the Alaska Board of Game create regulations that are enforced by the State for subsistence fishing and hunting on all Alaskan lands and waters as well as lands conveyed to ANCSA groups. The Federal Subsistence Board creates regulations that are enforced by the Federal government for subsistence fishing and hunting on Federal public lands, unconveyed ANCSA lands, and Federally reserved waters in Alaska. Regulations created by these State and Federal boards are based on use proposals, information and comments from the public, local advisory committees, agencies, and other interests.

State subsistence use law is based on Title 16 of Alaska Statute 16 and Title 5 of the Alaska Administrative Code, Chapter 99, and regulates State subsistence uses. Under State law, "'subsistence uses' means the noncommercial, customary and traditional uses of wild, renewable resources by a resident domiciled in a rural [sic] area for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of non-edible by-products of the fish and wildlife resources taken for personal or

family consumption, and for customary trade, barter, or sharing for personal or family consumption" (Alaska Statute 16.05.940[32]).

Federal subsistence law is based on Title VIII of the 1980 ANILCA Act and regulations found in 36 CFR 242.1 and 50 CFR 100.1. Under Federal law, "subsistence uses means the customary and traditional uses by rural Alaska residents of wild renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade" (Alaska National Interest Lands Conservation Act Title VIII Section 803).

The Alaska Federation of Natives describes subsistence as:

> the hunting, fishing, and gathering activities which traditionally constituted the economic base of life for Alaska's Native peoples and which continue to flourish in many areas of the state today. Subsistence is a way of life in rural Alaska that is vital to the preservation of communities, Tribal cultures, and economies. Subsistence resources have great nutritional, economical, cultural, and spiritual importance in the lives of rural Alaskans.… Subsistence, being integral to our worldview and among the strongest remaining ties to our ancient cultures, is as much spiritual and cultural, as it is physical (Alaska Federation of Natives 2005).

Subsistence activities could include hunting, fishing, trapping, wood gathering, and berry picking. Subsistence is part of a rural economic system, called a "mixed, subsistence-market" economy, wherein families invest money into small-scale, efficient technologies to harvest wild foods (Alaska Department of Fish and Game 2000). Fishing and hunting for subsistence provide a reliable economic base for many rural regions, and domestic family groups who have invested in fish wheels, gillnets, motorized skiffs, ATVs, and snowmobiles to conduct these important activities. Subsistence is not oriented toward sales, profits, or capital accumulation (commercial market production), but is focused toward meeting the self-limiting needs of families and small communities. Participants in this mixed economy in rural Alaska augment their subsistence production by cash employment. Cash from commercial fishing, trapping, and/or wages from public sector employment, construction, fire fighting, oil and gas industry, or other services provides the means to purchase the equipment, supplies, and gas used in subsistence activities. The combination of subsistence and commercial-wage activities provides the economic basis for the way of life so highly valued in rural communities (Wolfe and Walker 1987).

Subsistence uses are central to the customs and traditions of many cultural groups in Alaska, including the peoples of the Yukon Flats area. Their customs and traditions encompass sharing, redistribution networks, cooperative and individual hunting, fishing, and ceremonial activities. Subsistence fishing and hunting are traditional activities that help transmit cultural knowledge between generations, maintain the connection of people to their land and environment, and support healthy diet and nutrition in almost all rural communities. Interviews with residents of Beaver, Birch Creek, and Fort Yukon in 2007 documented a continued desire to protect their subsistence lifestyle. As one individual described,

> If I get hungry, I have to have a means of getting some food. Subsistence is important for our culture. We depend on that to stay lean and healthy. We depend on that for our livelihood. It's important that we hold on to

that, important that we don't lose that a little every year (Stephen R. Braund and Associates Birch Creek Interview February 2007).

The Alaska Department of Fish and Game (2000) estimated that the annual wild food harvest in the Interior area of Alaska is approximately 6,359,597 pounds or 613 pounds per person per year. Subsistence harvest levels vary widely from one community to the next. Sharing of subsistence foods is common in rural Alaska and can exceed 80% (Alaska Department of Fish and Game 2001). In Beaver and Fort Yukon, documented sharing, in terms of giving and receiving for all resources, was 78 to 97% in 1985 (Beaver) and 1987 (Fort Yukon). The ADFG did not provide sharing data for Birch Creek, the only other ADFG surveyed community.

Stephen R. Braund and Associates, Inc. conducted subsistence mapping and traditional knowledge interviews in Beaver, Birch Creek, and Fort Yukon in 2007 to update subsistence use information for those communities (Stephen R. Braund and Associates 2007). During this fieldwork, SRBA gathered last-10-year (1997-2006) subsistence use areas for the three communities and completed a Supplemental Baseline Study entitled *Subsistence Use Areas and Traditional Knowledge Study for Beaver, Birch Creek, and Fort Yukon, Alaska* (Stephen R. Braund and Associates 2007). In September 2007, both hardcopy and PDF versions of the report were sent to the local governments in each community for community review and comment (Beaver Traditional Council, Birch Creek Tribal Council, and Gwichyaa Zhee Gwich'in Tribal Government). The report contains information regarding the geographic extent of subsistence activities; baseline indicators related to use areas (success, duration and frequency of trips, travel method, and months used) and resource change (use, abundance, quality, distribution, and migration); and traditional knowledge about subsistence uses, the physical environment, and local fish and wildlife (current condition and change). During the interviews, residents expressed that subsistence continues to be an integral part of their lives and culture and an important source of food.

Relevant data from SRBA's 2007 report, including subsistence use area maps, traditional knowledge, and recent issues and concerns raised by local residents have been integrated into this EIS. To analyze potential impacts to residents' subsistence uses in Chapter 4, available subsistence use area data (including the data collected in 2007) were overlaid on maps showing the proposed land exchange scenarios. Land exchange overlaps with current subsistence use areas were analyzed as direct impacts, because they would occur at the same time and place as the action. Overlaps with traditional or "lifetime" subsistence use areas were analyzed as indirect impacts. Residents' observations about changes in subsistence resources and the physical and biological environment, as well as current concerns, were also integrated into the impact analysis where relevant.

3.5.7.2 Patterns of Subsistence Resource Use

Subsistence in the Refuge is characterized by the dependence of many communities on the fisheries of the Yukon River as well as the terrestrial mammals of the Yukon Flats and the uplands to the north and south. The advent of centralized communities and modern transportation has resulted in less need for seasonally occupied subsistence camps or cabins. Stephen R. Braund and Associates (2007) provided a discussion regarding the decreased dependence on trapping, partly due to the centralization of communities discussed above, and the resulting change in land use from broad overland use areas to extensive use areas focused along local rivers. Shimkin's (1955*) The Economy of a Trapping Center: The Case of Fort Yukon, Alaska* provides descriptions of trapping in Fort Yukon and a map of 1948-1949 traplines for the community. The prevalence

of trapping in Fort Yukon during that time led to extensive overland travel, ranging as far south as Central, and beyond Venetie to the north and Chalkyitsik to the east (Stephen R. Braund and Associates 2007). The subsequent decline in trapping activities has resulted in smaller overland use areas. However, residents continue to identify culturally and historically with these areas, and it is possible that a resurgence in trapping activities in the future could result in broader overland use. Other factors that may influence subsistence use areas include changes in climate and resource distribution. During interviews with local Beaver, Birch Creek, and Fort Yukon harvesters, residents observed that lower water levels have made some formerly used rivers and creeks inaccessible. Changes in the availability of local resources, whether they are closer or farther from communities, also affect how far residents travel for subsistence purposes. Changes in resource distribution may cause residents to return to traditional use areas or expand to new areas to harvest subsistence resources.

Continued access to subsistence areas using motorized transportation (boats, snowmobiles, and ATVs) requires a cash income of a magnitude that allows for the purchase of this equipment, as well as fuel, oil, and maintenance for this equipment. Some subsistence activities are easily pursued without the need for machinery, but the centralization of the population increases the competition for resources near the communities. Increasingly, subsistence users must rely on employment outside the communities for cash in the summers supplemented by year-round or part-time work in the communities, the Alaska Permanent Fund, Native Corporation dividends, and social programs. Local costs for imported (not obtained locally through subsistence harvests) foods and goods are prohibitive and dependent upon air and/or barge freight.

3.5.7.3 Traditional Knowledge and the Cultural Values of Subsistence

For centuries, survival in the subarctic has centered on the pursuit of subsistence foods and materials and the knowledge needed to find, harvest, process, store, and distribute the harvest. The survival of Athabascan cultures, including the Gwich'in and Koyukon peoples in this area, depended on the passing on of traditional knowledge of and beliefs about subsistence resources. This knowledge included observations of game behavior; how to use those observations to successfully locate and harvest game; appropriate times, methods, and tools for selecting, harvesting, and processing subsistence species; where to move family based groups at which season to ensure survival; and how hunters and their families should behave to ensure successful harvests in the future. Anthropologists call this suite of experiential and transmitted knowledge Traditional Knowledge, and call the subset of knowledge that includes specific observations about particular factors in their surroundings Traditional Ecological Knowledge.

The physical necessities for survival in the subarctic include food, water, clothing, shelter, and heat. The Gwich'in and Koyukon have, and continue to, rely primarily on fish and meat for food, including salmon, moose, caribou, and an array of other fish and smaller mammals and birds (VanStone 1974). Traditionally, the Gwich'in and Koyukon used harvested animal products in the construction of shelters, boats, dog packs and sleds; used hides for clothing, boat and tent covers; and sinew and hide as thread for sewing or line for lashing parts together. Gwich'in and Koyukon artisans used bone and antler for tools, sled runners, toggles, and handles, and may continue to use traditional materials in crafting utilitarian items such as the semi-lunate knife used primarily by women (Nelson 1974). Vegetable products also were important, such as spruce roots used for thread and rope; birch bark used for baskets and boat and house coverings; wood used for construction of houses, caches, and traps; and wood for cooking and heating fires. Willow, spruce, and birch were woods used in the manufacture of snowshoes, canoes, and sleds.

The Gwich'in and Koyukon peoples had interwoven systems of land use, subsistence resource harvests, and population movement between sequences of camps that ensured their survival in a demanding and highly variable environment. Cultural components of this system included cooperative harvests of caribou; cooperative construction of caribou fences; construction of salmon and other fish traps; management of lands and waterways through selective burning and beaver dam breaching; community potlatches for burials, funerals, and recognition of important life events; and the social obligation of the more successful providers to help the aged and less fortunate (VanStone 1974; Caulfield 1983; Caulfield et al. 1983; Andersen and Fleener 2001). The Gwich'in and Koyukon peoples of the Yukon Flats also had complex ideological relationships with the natural world around them in that all things had spirits that deserved respect. Failure to treat the spiritual components of the surrounding environment with the appropriate respect was believed to result in misfortune befalling the perpetrator, often in the form of subsistence harvest failures.

While the introduction of modern transportation and technology has led to changes in such things as more modern harvest methods and shorter trip duration, many aspects of subsistence have remained the same for residents of the Yukon Flats. During SRBA's fieldwork in Beaver, Birch Creek, and Fort Yukon, residents discussed the continued importance of traditional subsistence uses and methods, and expressed their desire to pass knowledge about the local environment, subsistence resources, and traditional uses and methods on to younger generations (Stephen R. Braund and Associates 2007).

3.5.7.4 Subsistence Access

Title VIII of ANILCA specifies that "rural residents engaged in subsistence uses shall have reasonable access to subsistence resources on the public lands" (Alaska National Interest Lands Conservation Act Title VIII Section 811). Regulations specific to Alaska National Wildlife Refuges also allow the use of "snowmobiles, motorboats, dog teams, and other means of surface transportation traditionally employed by local residents engaged in subsistence uses," with the caveat that the refuge manager can restrict the use of certain types of transportation on refuge lands when deemed necessary (50 CFR 36.12).

Doyon lands are private, and access is generally restricted to Doyon shareholders and their descendants and/or spouses. Doyon requires permits or leases from shareholders for woodcutting, fish camps, traplines, and the construction of cabins or other permanent structures (Doyon 1986). Subsistence hunting and fishing by Doyon shareholders on Doyon lands is subject to State subsistence regulations.

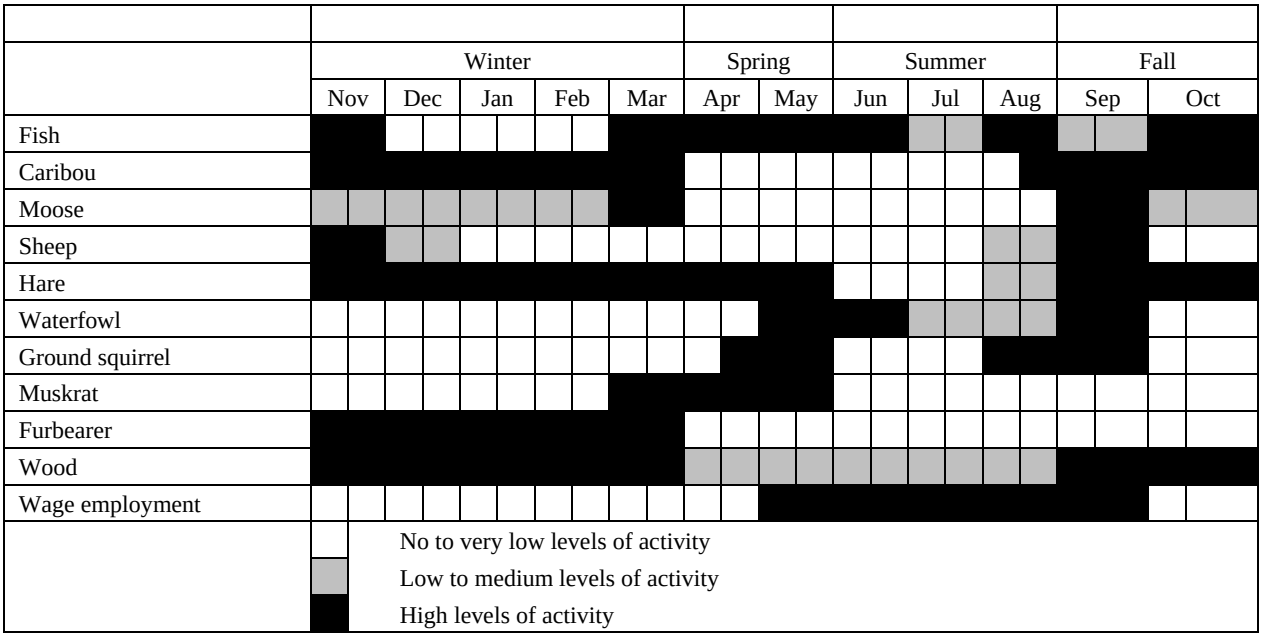
Snowmobiles, watercraft, and small aircraft provide access to traditional camps and allow users to work at seasonal and full-time jobs to support their subsistence pursuits. During SRBA interviews, residents reported accessing subsistence use areas primarily by boat, followed by snowmobile, foot, and ATV (Stephen R. Braund and Associates 2007). Canoe also was a popular method of transportation for Birch Creek residents for use in local lakes. Local rivers are major travelways for subsistence users both during ice-free months and in the winter. Residents also travel overland by snowmobile during the winter.

3.5.7.5 Communities

Community of Arctic Village

The most recent representation of a seasonal round of subsistence activities for Arctic Village is based on observations and interviews representing the period 1970 to 1982 (**Table 3-26**; Caulfield 1983). Spring began with the breakup of the river ice in late May to early June, and once the ice thinned, nets were set for whitefish, pike, grayling, and suckers, and muskrats and waterfowl were hunted in the lakes. Summer began with fishing by hook and line as well as nets for whitefish, pike, grayling, suckers, and lake trout. By mid-August, migrating caribou passed nearby, and berries became ripe enough for picking, processing, and storing. Fall began in mid- to late September. Caribou hunting continued during the fall and through the winter. Fishing with gillnets through the ice began and continued until the ice became too thick when emphasis changed to jigging through the ice. Residents hunted sheep in the nearby mountains, and fur trappers returned to their traplines to set and run them through March (Caulfield 1983).

Table 3-26 Annual cycle of seasonal activities for Arctic Village, 1970-1982



Source: Caulfield 1983.

Subsistence Harvests

Subsistence resource harvest data collected by the ADFG from 1993 to 1997, and moose, bear, and wolf harvest data collected by CATG in 2001 and 2002, are summarized in Tables J-1, J-2, and J-3 in **Appendix J**. Total subsistence harvest for residents of Arctic Village over this time period was 10,000 to 21,000 pounds, with caribou and moose constituting more than 90% of the harvest by weight in most years. Other important species included whitefish and in some years Dall sheep and ducks. Andersen and Jennings (2001) reported 437 total birds harvested in Arctic Village for the 2000 harvest year.

Subsistence Use Areas

Arctic Village subsistence harvest areas shown on **Figures 3-29, 3-30**, and **3-31** are based on data collected by Caulfield (1983). **Figure 3-29** includes lifetime subsistence use areas for fishing, furbearer hunting and trapping, and wildfowl hunting. The most widespread of these areas included traplines, usually set along a stream or slough to trap furbearing animals. Fur trapping made the greatest use of these lands. **Figure 3-30** depicts lifetime subsistence use areas for caribou hunting, sheep hunting, vegetation gathering, and fuel and structural materials gathering. **Figure 3-31** includes lifetime subsistence use areas for bear hunting, moose hunting, and small mammal hunting.

Community of Beaver

The seasonal round, as compiled by Sumida (1989) for the 1985 to 1986 study year, is depicted in **Table 3-27**. Once the river and lake ice began to break up in May, harvesters, en route to waterfowl hunting areas, set nets for pike and whitefish. Summer began with the arrival of king salmon, and users moved to or visited their fish camps to set up fish wheels and set gillnets in eddies along the river. Beaver residents harvested other fish, black bears, molting waterfowl, and eggs at this time. In the fall, Beaver residents hunted waterfowl, black bear, moose, caribou, ptarmigan, and grouse, and set nets and traps for whitefish, pike, burbot, suckers, and grayling. Winter began as the ice on the river became too thick to run nets and fish traps, and the traplines became the focus of travel.

Stephen R. Braund and Associates (2007) recorded the timing of residents' harvests for each resource in terms of the number of use areas reported by month for the 1997 to 2006 time period. Beaver residents reported participating in subsistence activities year-round, with the number of use areas peaking in May, August, and September.

Subsistence Harvests

Subsistence resource harvests for the community of Beaver are summarized in Tables J-4 through J-7 in **Appendix J** based on harvest data collected by ADFG, CATG, Busher and Hamazaki (2005), and Busher et al. (2007). Based on the 1985 data, the only study year with household participation rates, participation in the harvest and sharing within and between communities is high. Estimated total subsistence harvests ranged from 6,000 to 60,000 pounds over the reported years from 1985 to 1996. Moose and salmon (chum and Chinook) were the most important species by weight in most years, but whitefish, northern pike, geese, and ducks also were important components (>5%) of the harvest. Commercial and subsistence harvests in the Upper Yukon River have been subject to frequent closures in the 1990s and early 21st century because of low numbers of returning salmon (Alaska Department of Fish and Game 2005c). Andersen and Jennings (2001) reported 840 total birds harvested in Beaver during the 2000 harvest year.

Subsistence Use Areas

Subsistence use areas for the community of Beaver are shown on **Figures 3-32, 3-33**, and **3-34**. **Figure 3-32** depicts lifetime subsistence use areas compiled by Sumida (1989) for bear hunting, moose hunting, salmon fishing, and waterfowl hunting. **Figure 3-33** depicts lifetime subsistence areas for caribou hunting, furbearer trapping and hunting, and non-salmon fishing. These use areas are based on lifetime use subsistence harvest data collected in 1985 (Sumida 1989). **Figure**

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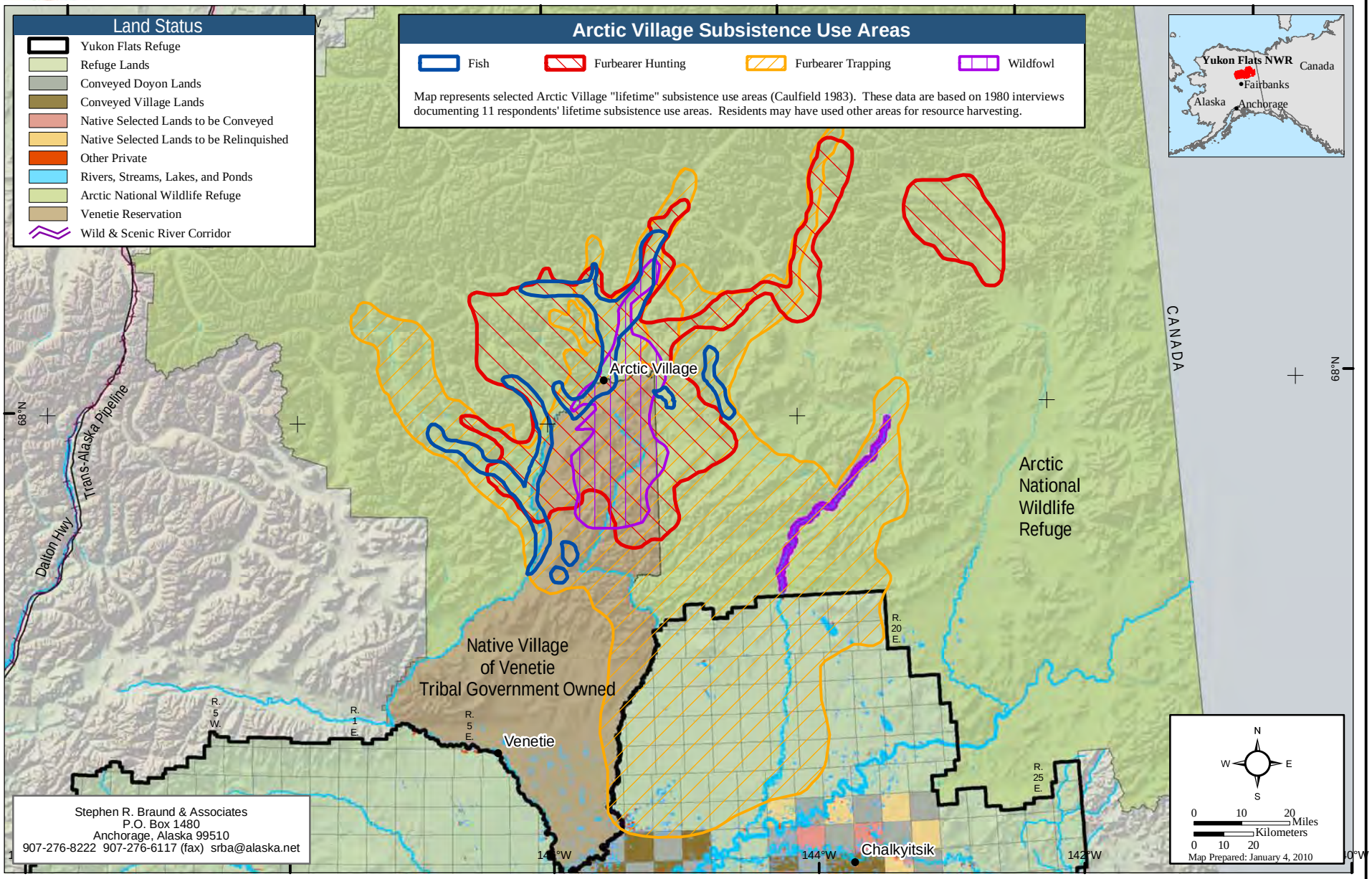
Arctic Village "Lifetime" Subsistence Use Areas for Fish, Furbearer Hunting, Furbearer Trapping, and Wildfowl

Figure 3-29



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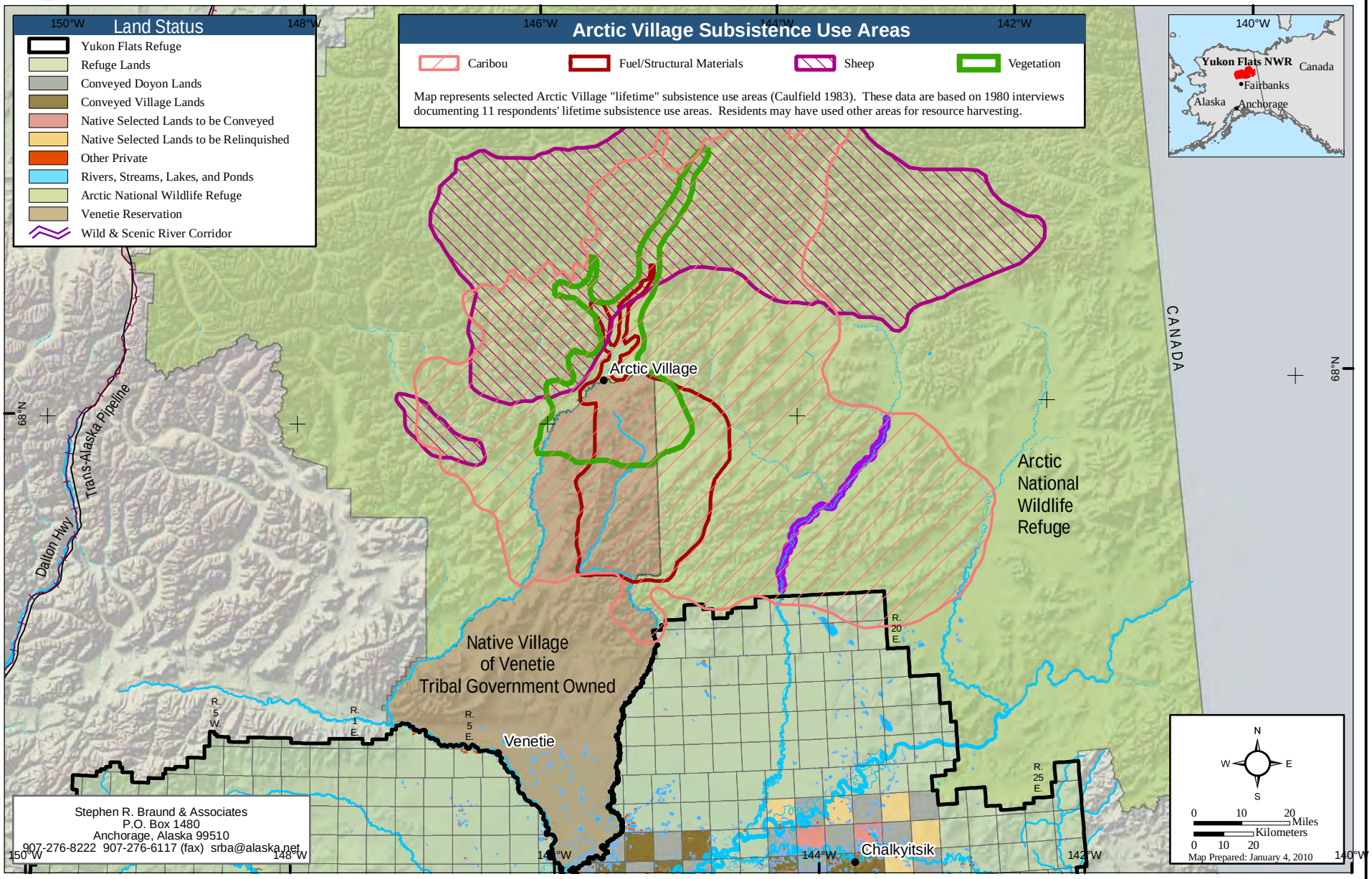
Arctic Village "Lifetime" Subsistence Use Areas for Caribou, Fuel/Structural Materials, Sheep, and Vegetation

Figure 3-30



Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222 907-276-6117 (fax) srba@alaska.net

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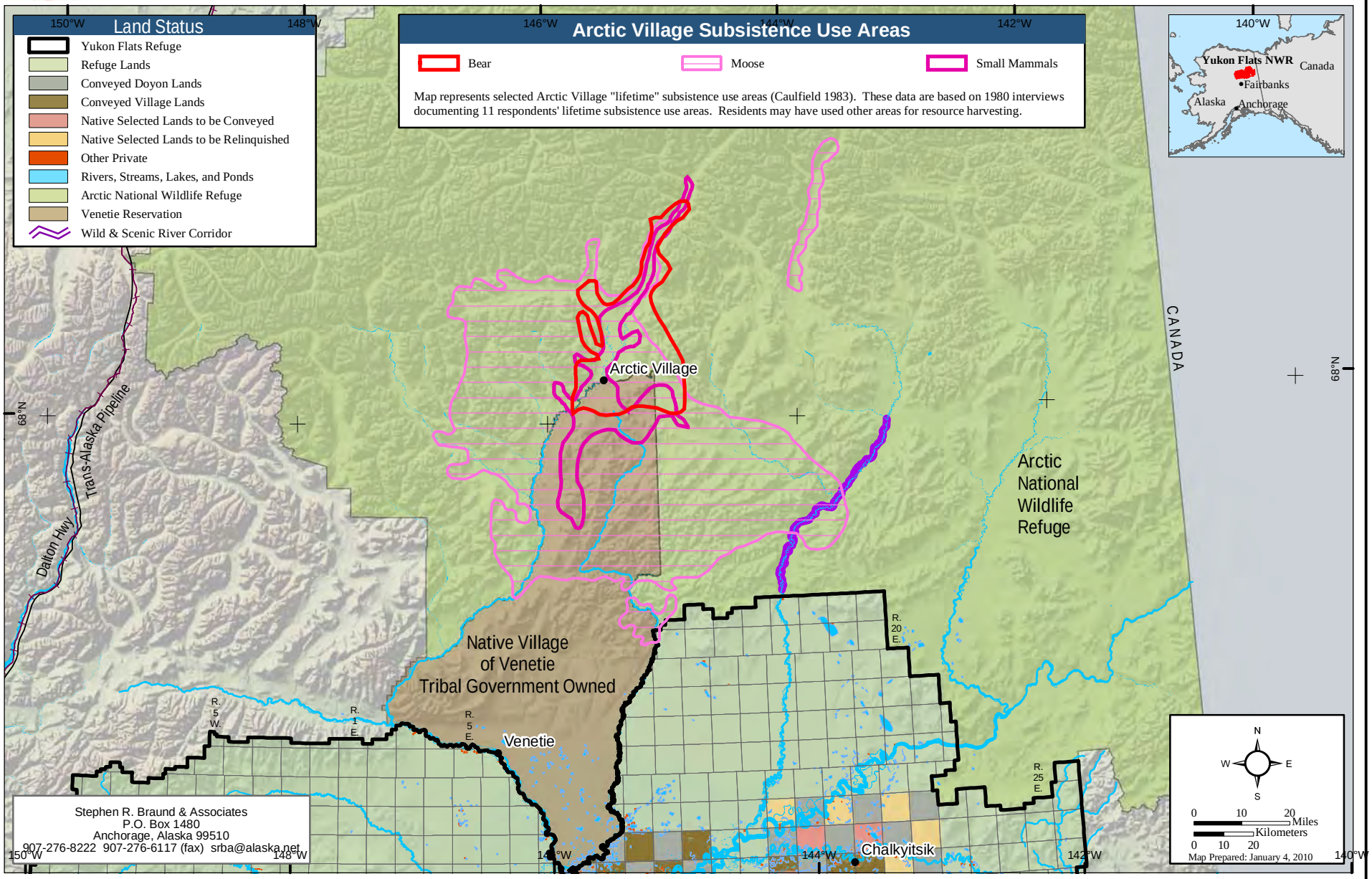
Arctic Village "Lifetime" Subsistence Use Areas for Bear, Moose, and Small Mammals

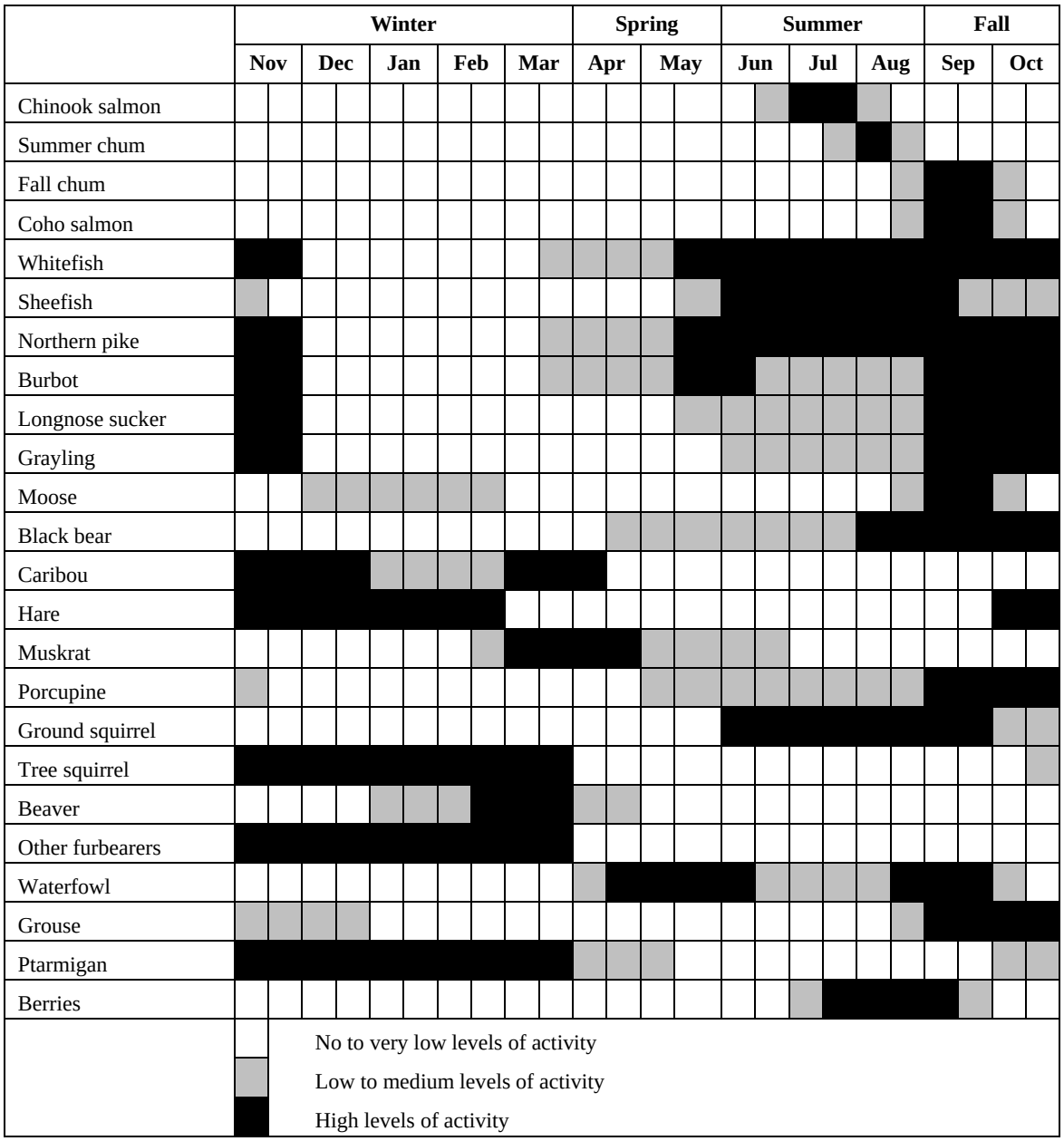
Figure 3-31



Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222 907-276-6117 (fax) srba@alaska.net

3-34 shows Beaver last-10-year subsistence use areas for all resources. Further description of these use areas, as well as maps showing use areas for individual resources, are provided in Stephen R. Braund and Associates (2007).

Table 3-27 Annual cycle of seasonal activities for the community of Beaver, 1980s



Source: Sumida 1989.

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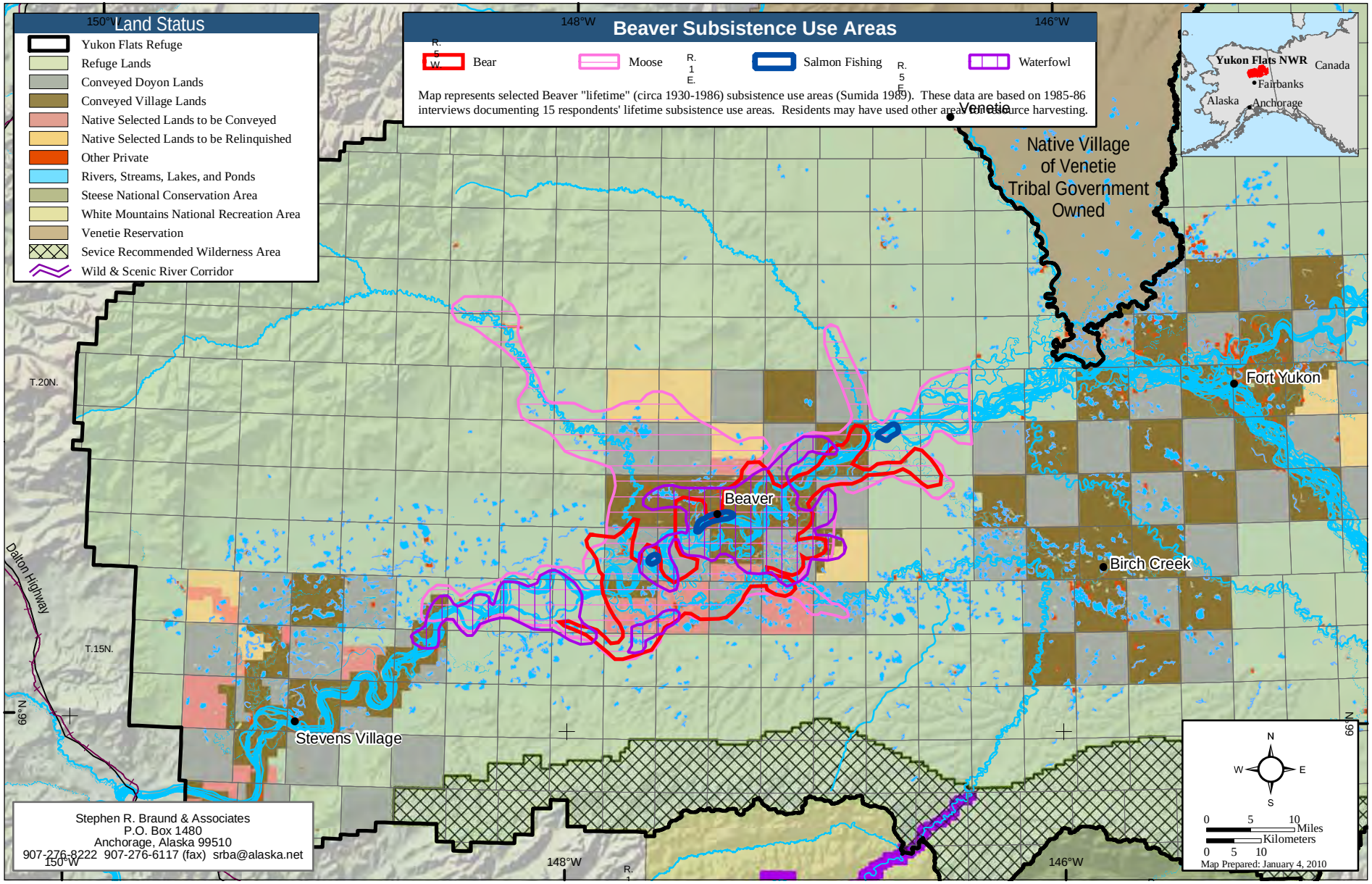
Beaver "Lifetime" Subsistence Use Areas for Bear, Moose, Salmon Fishing, and Waterfowl

Figure 3-32



Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222 907-276-6117 (fax) srba@alaska.net

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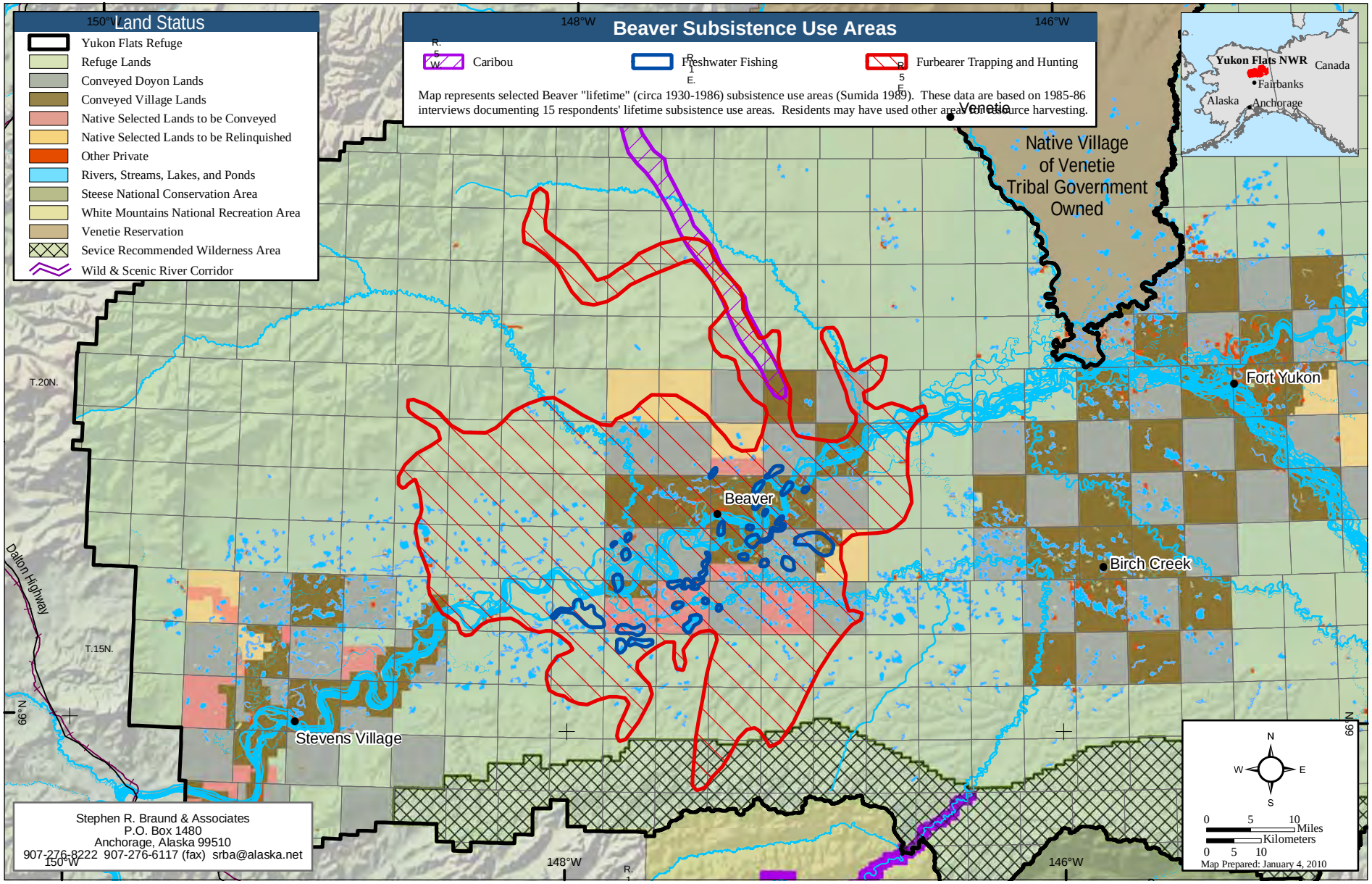
Beaver "Lifetime" Subsistence Use Areas for Caribou, Freshwater Fishing, and Furbearer Hunting and Trapping

Figure 3-33



Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222 907-276-6117 (fax) srba@alaska.net

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Figure 3-34
Beaver Subsistence Use Areas All Resources, 1997-2006

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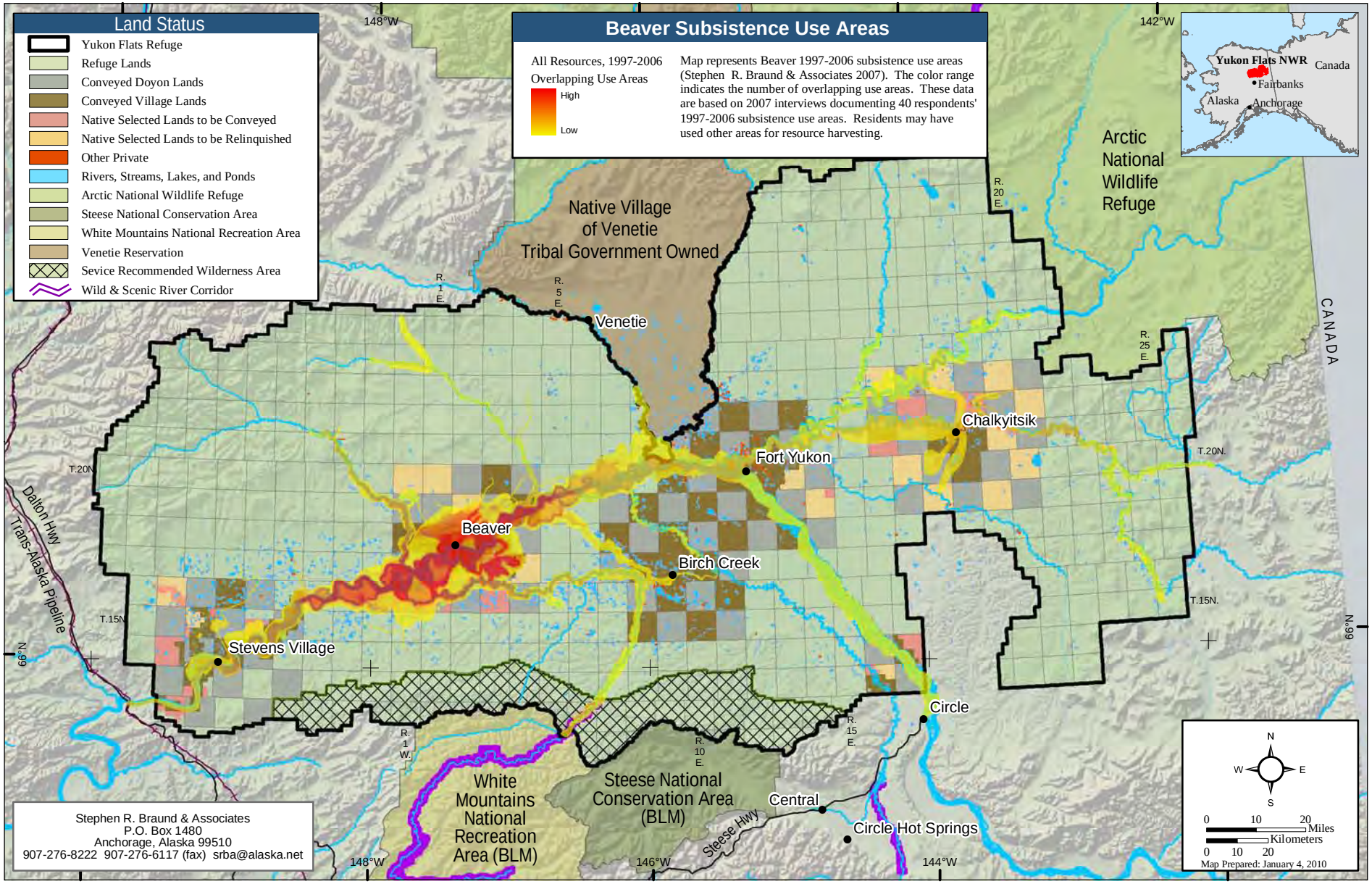


Community of Birch Creek

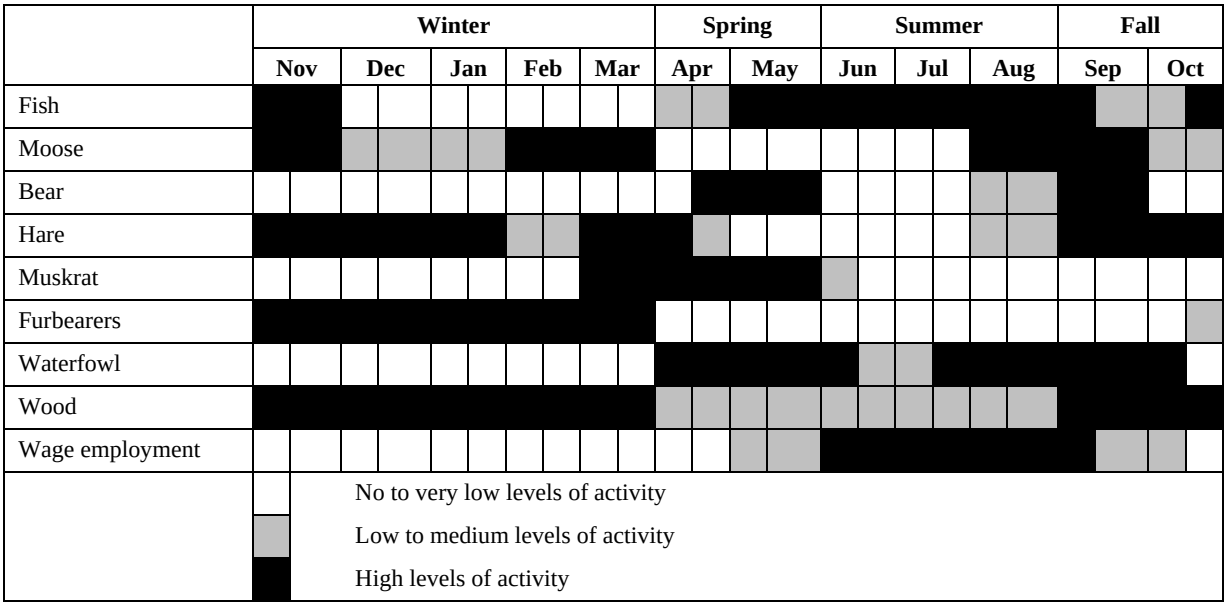
Table 3-28 depicts the annual cycle of subsistence activities at Birch Creek from 1970 to 1982 (Caulfield 1983). Spring began when the snow began to melt in April, and residents hunted waterfowl, black bears, and muskrat and set gillnets for whitefish, pike, and suckers. Black bears were hunted near camps or the community in late April and early May. Summer began when harvesters traveled to fish camps near the Yukon River, rebuilding and repairing camps and equipment and beginning the process of harvesting, drying, and preserving salmon for the year. Fishing for other fish species with gillnets, rod and reel, and jigs continued throughout the summer months. In the fall, residents hunted waterfowl, moose, and black bear; harvested berries; and set nets for whitefish, grayling, pike, and sheefish. In the winter, residents harvested fish under the ice with nets and jigging, trapped for furbearers, and harvested moose, grouse, and ptarmigan.

Residents continue to follow a similar seasonal round, as described in Stephen R. Braund and Associates (2007). During interviews, respondents reported accessing subsistence use areas throughout the year, with the peak number of use areas reported in the spring (May) and fall (August, September).

Subsistence Harvests

Based on the available data, Birch Creek subsistence harvests are presented for major species category and select species in Tables J-8 through J-11 in **Appendix J**. Total estimated subsistence harvests from 1994 to 1998 ranged from 3,600 to 22,000 pounds per year. Moose represented 39 to 88% of the harvest over these study years. Other important species contributing over 5% of the harvest included northern pike, Chinook salmon, and whitefish. Andersen and Jennings (2001) reported 1,091 total birds harvested in Birch Creek for the 2000 harvest year. Table J-11 presents subsistence salmon harvests at Birch Creek for the study years 1992 to 2003, and 2005 (Busher and Hamazaki 2005; Busher et al. 2007).

Table 3-28 Annual cycle of subsistence activities for the community of Birch Creek, 1970-1982



Source: Caulfield 1983.

Subsistence Use Areas

Caulfield (1983) compiled subsistence use areas from the lifetime recollections of interviewees for the period 1930 to 1982, before the advent of modern high-speed and highly reliable snowmobiles (**Figures 3-35** and **3-36**). **Figure 3-35** depicts lifetime use areas for furbearer trapping, moose hunting, small mammal hunting, vegetation gathering, and wildfowl hunting. **Figure 3-36** depicts lifetime use areas for furbearer hunting, bear hunting, fishing, and the gathering of fuel and/or structural materials. Stephen R. Braund and Associates gathered last-10-year (1997 to 2006) subsistence use areas from Birch Creek residents in 2007. These use areas for all resources are depicted in **Figure 3-37**. Use area data and descriptions for individual resources are available in Stephen R. Braund and Associates (2007).

Community of Central

Subsistence hunters in Central follow an annual cycle of seasonal activities similar to other communities in the area that is based on resource availability and subsistence harvest regulations. Trapping for beaver and muskrat occurs in the spring. Summer subsistence activities began with the arrival of Chinook salmon in mid-July as well as the harvest of other fish including whitefish, pike, grayling, sucker, sheefish, and burbot. Other subsistence activities that occurred during the summer included hunting moose, caribou, sheep, bear, grouse, ptarmigan, ducks, and hare; gathering plants and berries; and collecting firewood. In the fall, Central residents prepared for the winter months by canning fish, meats, and vegetables; cutting firewood; and arranging traplines. Subsistence continues into the winter months when some residents run traplines (Johnson et al. 1993).

Subsistence Harvests

No recent ADFG subsistence harvest data are available for Central (Alaska Department of Fish and Game 2001). However, subsistence harvest data are available for salmon for 1992 to 2003 and 2005 (Busher and Hamazaki 2005; Busher et al. 2007); reported Chinook and chum salmon subsistence harvests ranged from 27 to 358 fish over these years (Table J-12 in **Appendix J**).

Subsistence Use Areas

Little subsistence use area data are currently available for Central. Based on available information, **Figure 3-38** depicts subsistence locations used by residents of Central, Circle, and Eagle. The depicted subsistence use locations are based on data compiled by Caulfield (1979) and include the location of beaver harvest places, cabins, and muskrat harvest places. The depicted data do not differentiate between the communities; however, all of the cabins and harvest places are located near the community of Circle. A 1993 draft report funded by the National Park Service (Johnson et al. 1993) includes descriptions of subsistence activities in Central and reports data on trapline harvests at Sheep Creek, Porcupine, Woodchopper, Boulder Creek, Medicine Lake, Coal Creek, Ketchum Creek, the Yukon River, Deadwood, Circle Hot Springs, Birch Creek, Black River, Crooked Creek, Chena River, and the Charley River. Residents reported harvesting grayling, pike, burbot, and whitefish on the Kandik River, Albert Creek, Coal Creek, Birch Creek, Yukon and Charley rivers, and Medicine Lake. Moose and bear hunting occurred along roads, near residents' houses, and along local rivers, streams, and lakes (including Charley, Kandik, and Yukon rivers and Medicine Lake).

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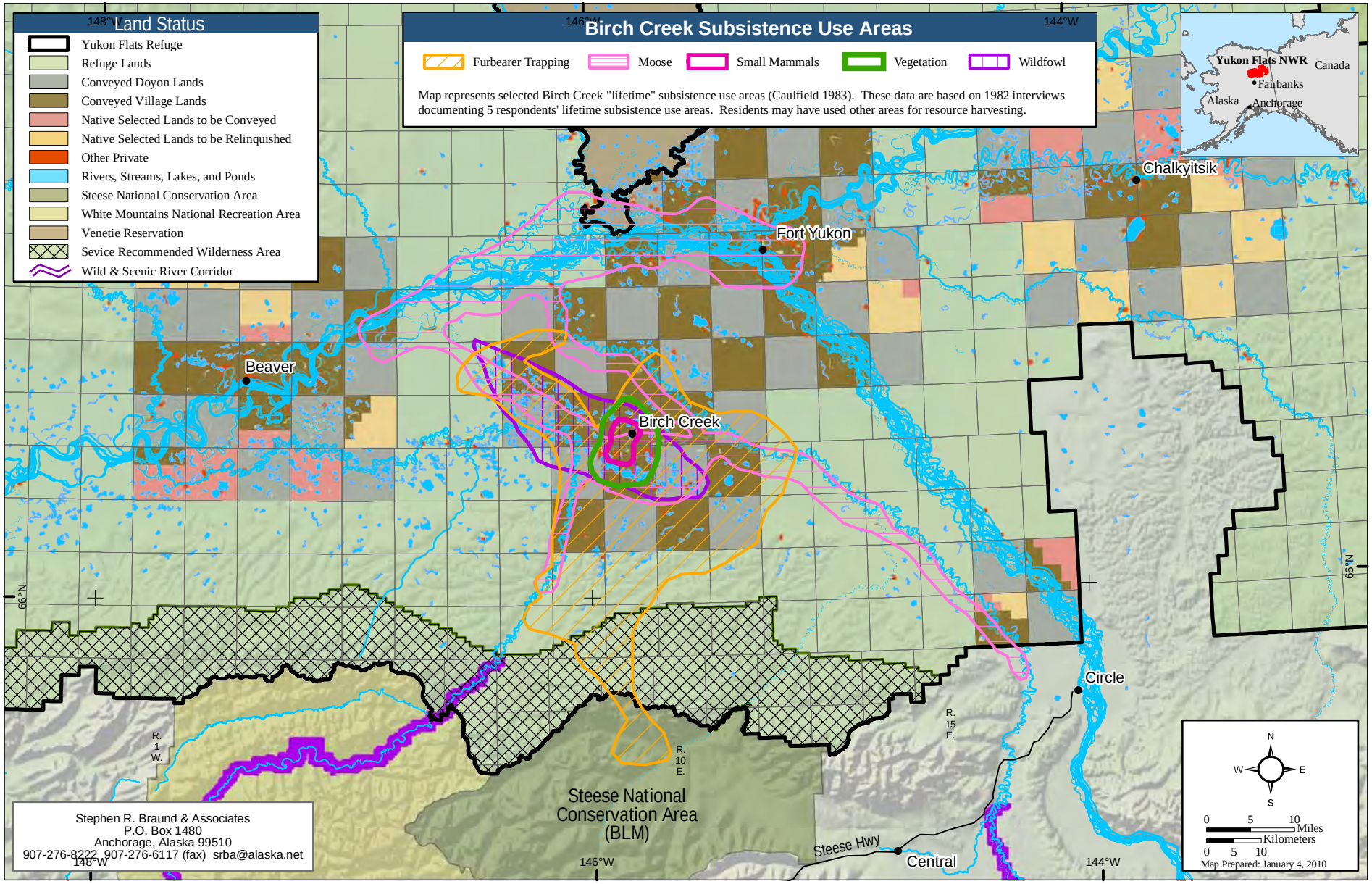
Birch Creek "Lifetime" Subsistence Use Areas for Furbearer Trapping, Moose, Small Mammals, Vegetation, and Wildfowl

Figure 3-35



Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222, 907-276-6117 (fax) srba@alaska.net

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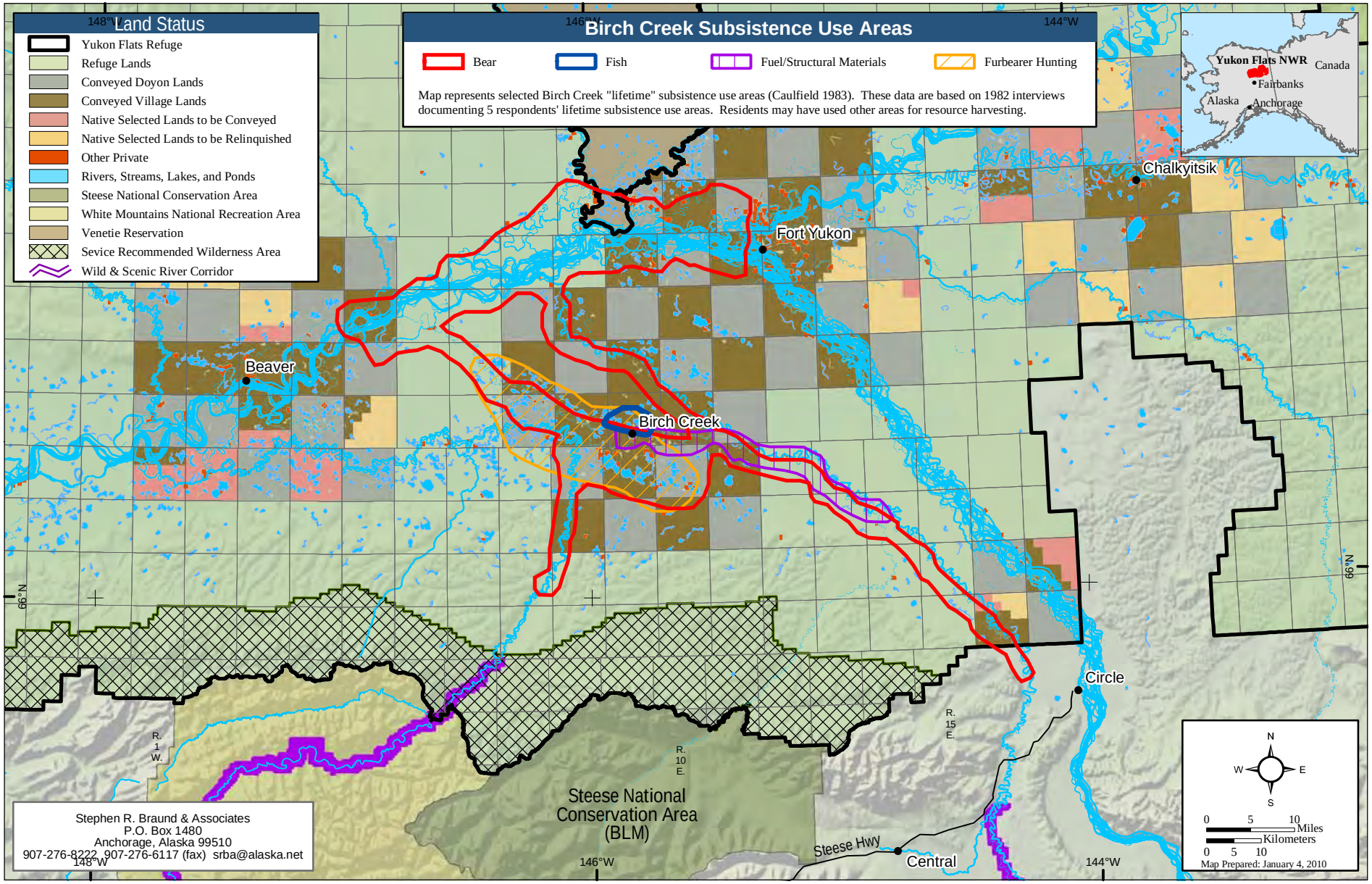
Birch Creek "Lifetime" Subsistence Use Areas for Bear, Fish, Fuel/Structural Materials, and Furbearer Hunting **Figure 3-36**



Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222, 907-276-6117 (fax) srba@alaska.net

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Figure 3-37
Birch Creek Subsistence Use Areas All Resources, 1997-2006

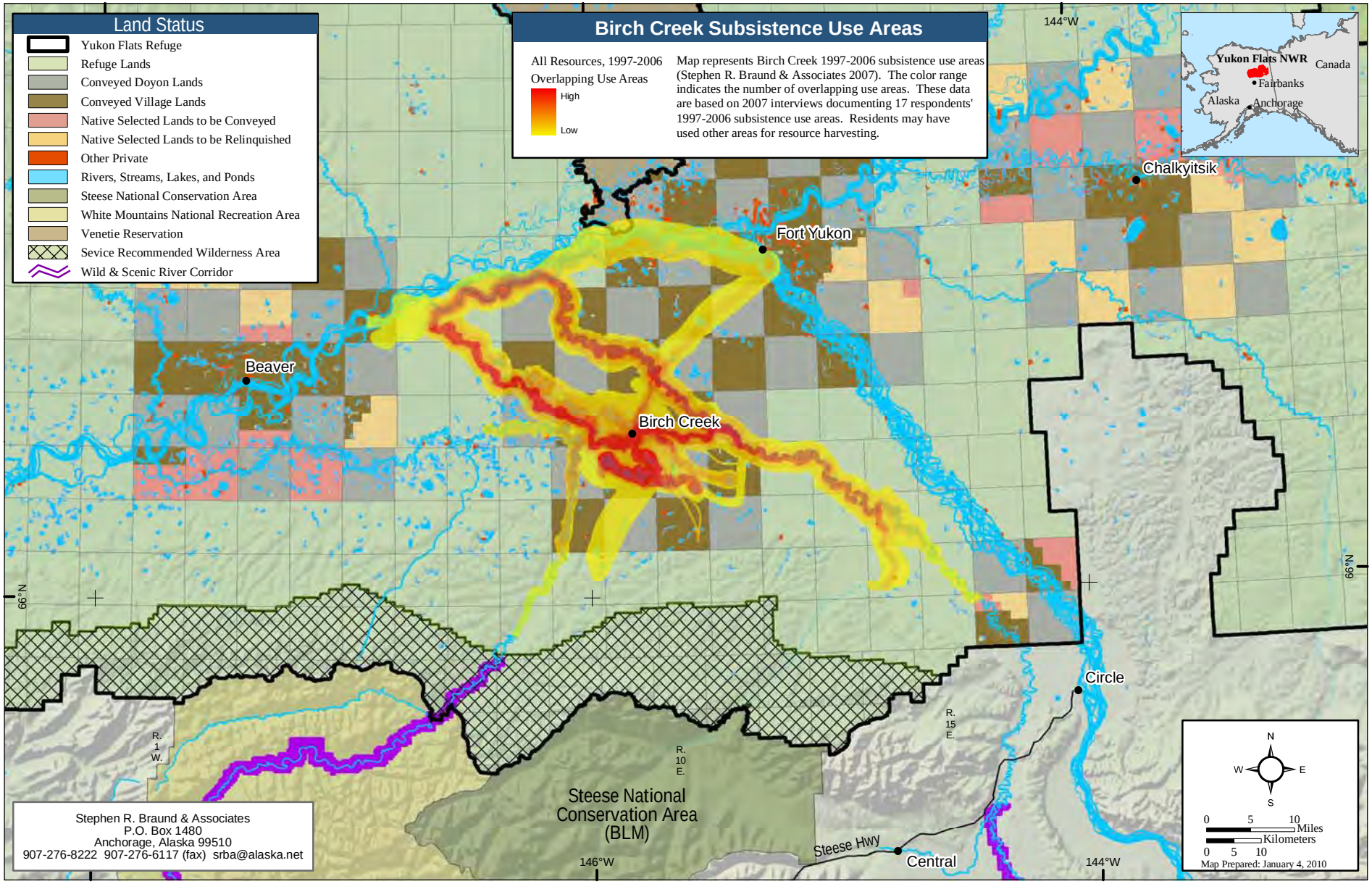

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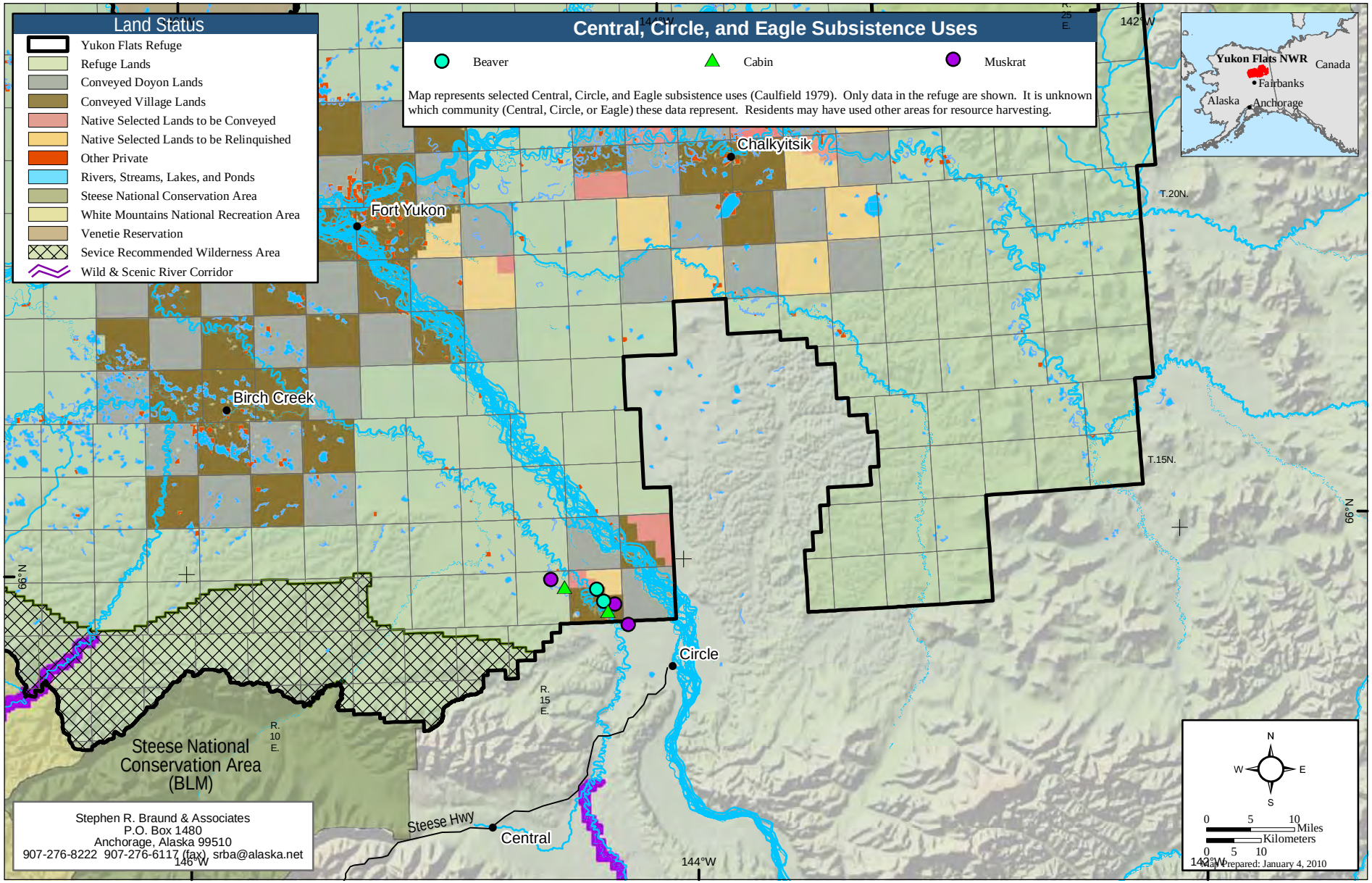
Figure 3-38
Central, Circle, and Eagle Subsistence Uses

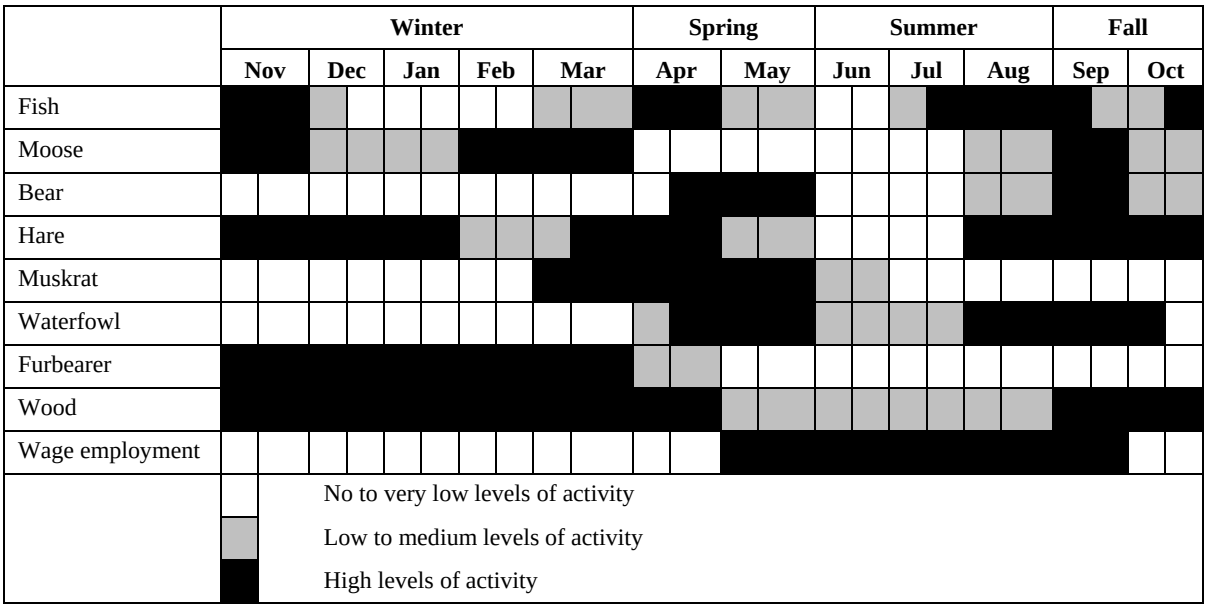
Yukon Flats National Wildlife Refuge, Alaska



Seasonal Round

Table 3-29 depicts the annual cycle of subsistence activities at Chalkyitsik from 1970 to 1982. Chalkyitsik harvesters relied on a suite of abundant, seasonally available subsistence resources. In the spring, Chalkyitsik residents netted fish and hunted muskrat, black bears, and migrating waterfowl. In the summer, residents harvested waterfowl, whitefish, pike, and salmon; tended gardens; harvested berries and plants; and harvested small game including grouse, ptarmigan, and hares. In the fall, Chalkyitsik residents hunted moose, caribou, and black bear; harvested waterfowl; and continued harvesting fish with gillnets, fish traps, and jigging or angling until the ice was too thick. In the winter, residents participated in ice fishing, trapping for furbearers, and hunting for moose and bear.

Table 3-29 Annual cycle of subsistence activities for the community of Chalkyitsik, 1970-1982



Source: Caulfield 1983.

Subsistence Harvests

Alaska Department of Fish and Game (2001) collected subsistence harvest data by household in Chalkyitsik for the years 1993, 1994, 1995, 1996, and 1997. Council of Athabascan Tribal Governments (2002, 2005) collected subsistence harvest data in 2001 and 2004 for moose, bear, and wolves. Busher and Hamazaki (2005) reported subsistence harvests of salmon in Chalkyitsik in 1992 to 2003, and Busher et al. (2007) reported the same data for 2005 in addition to harvest of non-salmon species. These subsistence harvest data are summarized in Tables J-13 through J-16 in **Appendix J**. Estimated total subsistence harvest from 1993 to 1997 ranged from 1,900 to 7,700 pounds (Alaska Department of Fish and Game 2001). Moose constituted 73 to 85% of the harvest; other important species representing 5% or more of the estimated harvest during some of these years included black bear, ducks, northern pike, and chum salmon. Annual total subsistence salmon harvests ranged from 30 to 1,750 fish from 1992 to 2003 and in 2005. No per-capita harvest data are currently available for Chalkyitsik (Alaska Department of Fish and Game 2001).

Andersen and Jennings (2001) reported a harvest of 568 total birds in Chalkyitsik for the 2000 harvest year.

Subsistence Use Areas

As shown on **Figures 3-39, 3-40,** and **3-41**, many resources were harvested along the rivers, lakes, sloughs, and streams of the eastern portion of the Yukon Flats during the period from 1930 to 1982 (Caulfield 1983). Many of these routes, depicting lifetime travel from 1930 to 1982, included visits to former camps and settlements along the rivers, portages, lakes, and trails of a large region of the eastern central interior. **Figure 3-39** depicts lifetime subsistence use areas for caribou hunting, furbearer trapping, small mammal hunting, and vegetation gathering. **Figure 3-40** depicts lifetime subsistence use areas for fishing, furbearer hunting, and moose hunting. **Figure 3-41** depicts lifetime subsistence use areas for bear hunting, fuel and/or structural material gathering, and wildfowl hunting.

Community of Circle

Johnson et al. (1993) provided a description of the cycle of subsistence activities in Circle, derived from interviews conducted in the community in 1992. The winter months consist mainly of trapping furbearers such as wolf, lynx, and marten. In the spring, residents trap for muskrat and beaver in local drainages. In the summer, residents fish for salmon (mainly Chinook and chum) and various species of non-salmon fish (pike, grayling, suckers, sheefish, and whitefish), in addition to harvesting plants and berries. The fall months are devoted to fishing for whitefish with nets and hunting moose and bear along local waterways. Waterfowl are harvested in the fall and sometimes in the spring along the Yukon River and around nearby lakes.

Subsistence Harvests

The Alaska Department of Fish and Game (2001) collected subsistence resource harvest data for Circle during 1993, 1994, 1995, 1996, and 1997. Subsistence harvest data for moose, bear, and wolves were collected by Council of Athabascan Tribal Governments (2002, 2003, 2005) during 2001, 2003, and 2004. These harvest data are summarized by year and by species in Tables J-17 through J-20 in **Appendix J**. The total estimated subsistence harvest for Circle ranged from 13,200 to 48,600 pounds per year from 1993 to 1997 (Alaska Department of Fish and Game 2001). Moose constituted 6 to 54% of the annual harvest by weight. Chinook and chum salmon represented 49 to 95% of the harvest. No other species comprised more than 5% of the harvest, although snowshoe hare, black bear, grouse, ducks, geese, beaver, whitefish, and sheefish were all harvested. Andersen and Jennings (2001) reported 444 total birds harvested by Circle residents in the 2000 harvest year. Busher and Hamazaki (2005) reported Chinook, chum, and coho salmon harvests for 1992 to 2003, ranging from 723 to 8,183 fish (Busher and Hamazaki 2005). According to Busher et al. (2007), Circle residents harvested 2,304 salmon in 2005.

Subsistence Use Areas

Limited information about subsistence use areas is available for residents of Circle. **Figure 3-38**, depicts subsistence locations in the Refuge used by residents of Central, Circle, and Eagle, based on data compiled by Caulfield (1979). These data include the locations of beaver harvest places, cabins, and muskrat harvest places. The depicted data do not differentiate between the communities; however, all of the cabins and harvest places are located near the community of

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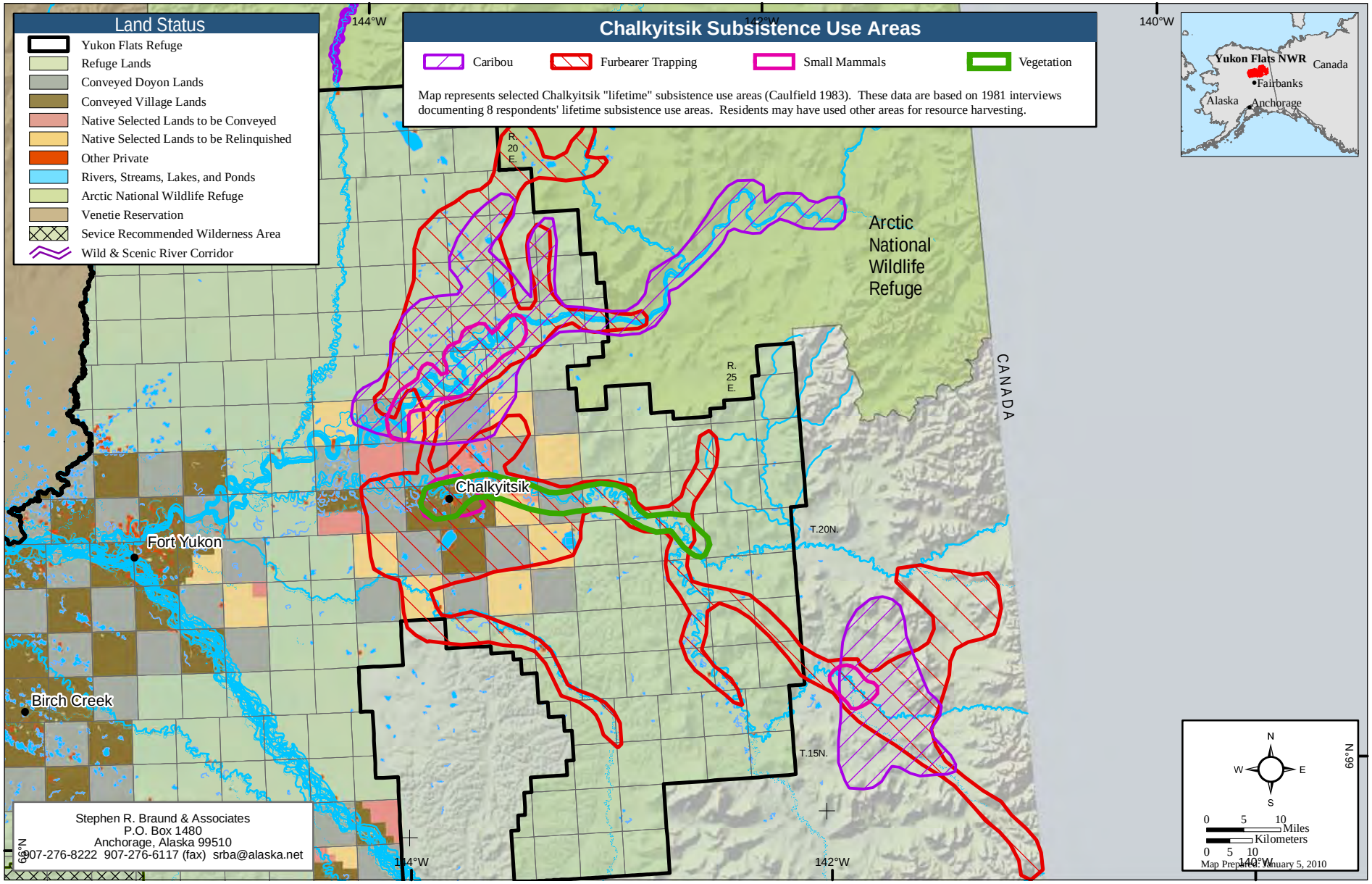
Chalkyitsik "Lifetime" Subsistence Use Areas for Caribou, Furbearer Trapping, Small Mammals, and Vegetation

Figure 3-39



Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222 907-276-6117 (fax) srba@alaska.net

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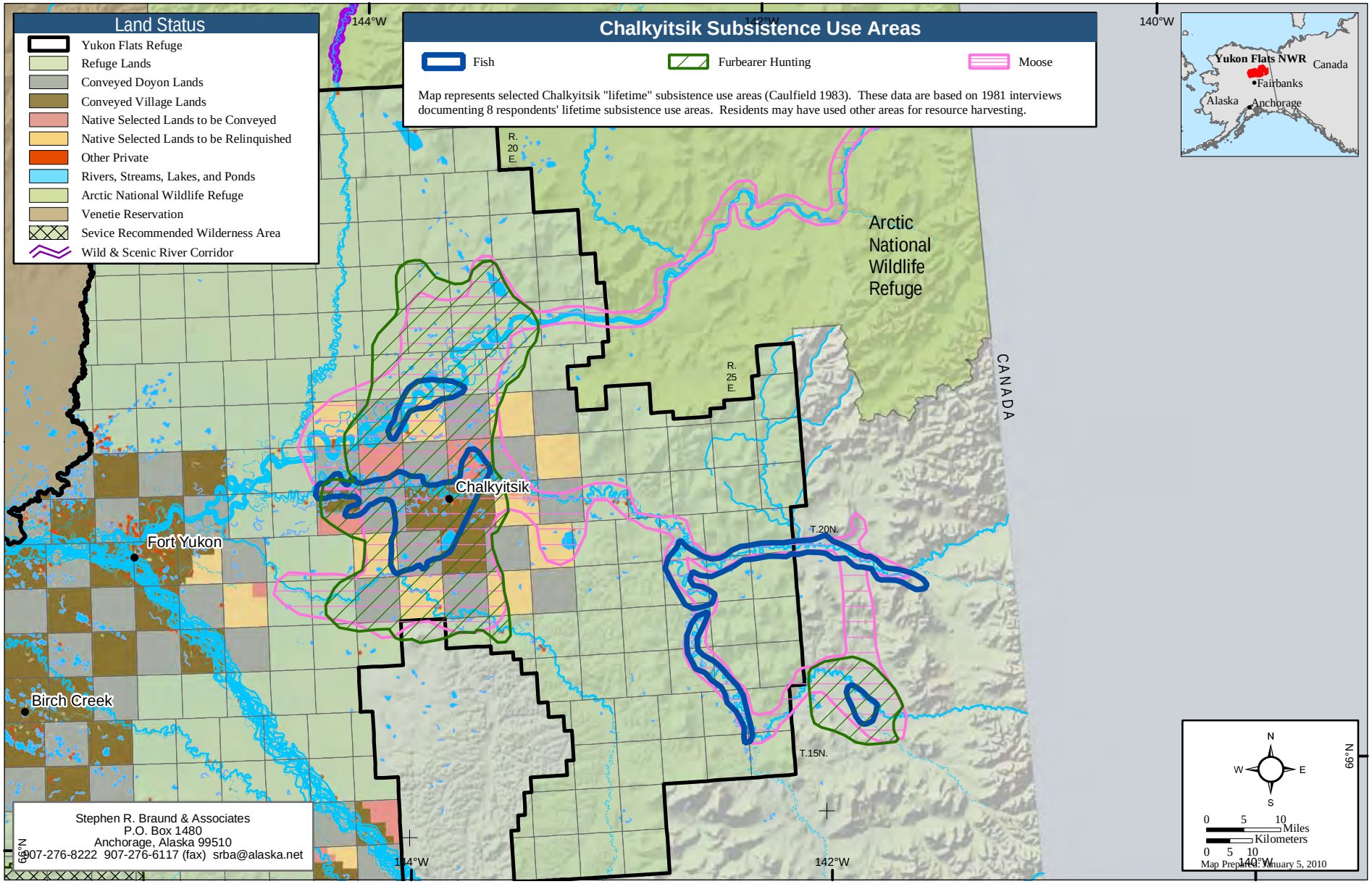
Chalkyitsik "Lifetime" Subsistence Use Areas for Fish, Furbearer Hunting, and Moose **Figure 3-40**



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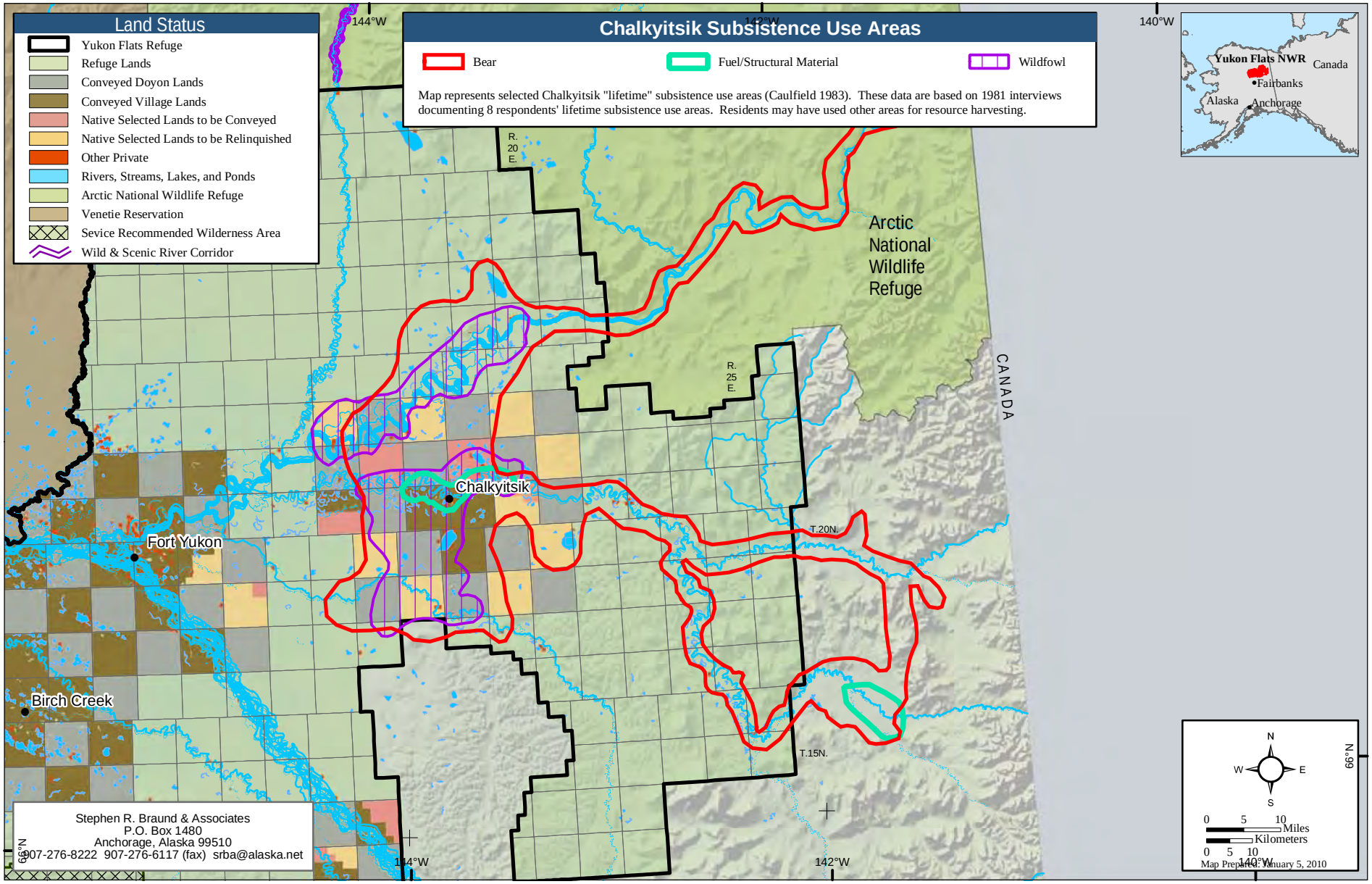
Chalkyitsik "Lifetime" Subsistence Use Areas for Bear, Fuel/Structural Materials, and Wildfowl

Figure 3-41



Circle. Johnson et al. (1993) provided written descriptions of subsistence use areas and noted current uses of the Yukon River (moose, bear, and waterfowl hunting; trapping; fishing), Birch Creek (trapping, fishing), Medicine Lake (fishing); and historic uses of Black River, Paddle Creek, and as far upriver as Kandik River, "if not farther" (Johnson et al. 1993). Participation in trapping reportedly had diminished by the time of the 1992 fieldwork, and researchers identified three active trappers in Circle. Residents continue to hunt moose and bear along local rivers and fish for salmon and other species of fish using fishwheels located in front of or downriver from the community.

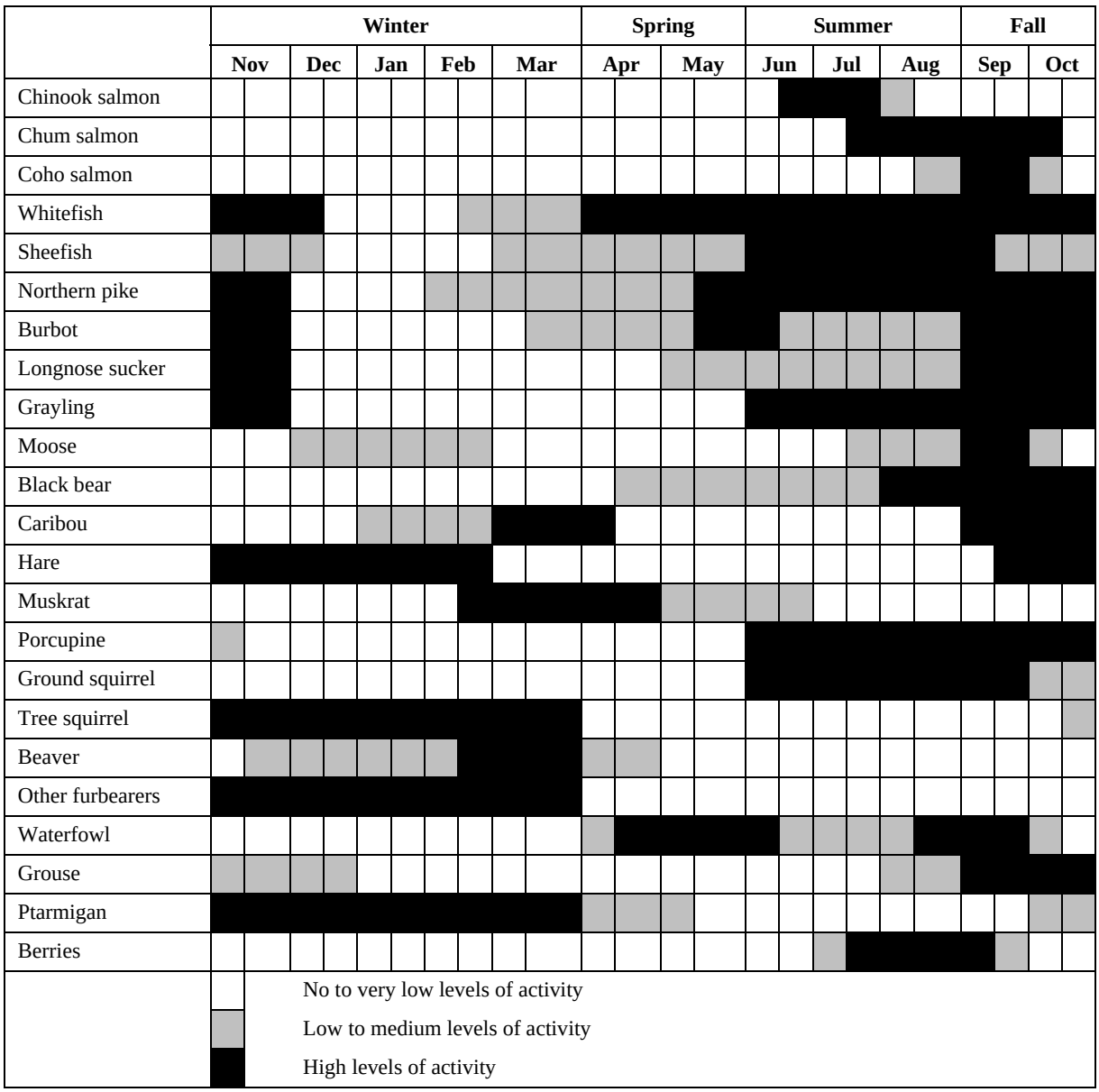
Community of Fort Yukon

Table 3-30 depicts the annual cycle of subsistence activities at Fort Yukon from 1970 to 1982 and 1986 to 1987 (Caulfield 1983; Sumida and Andersen 1990). With the exception of accommodating new technologies, regulatory constraints and local conditions, the seasonal round of Fort Yukon has not changed between Caulfield's 1982 study (1983) and Sumida and Andersen's 1987 study (1990). In the spring, residents participated in muskrat, goose, duck, and crane hunting, and net fishing for whitefish. In the summer, residents harvested Chinook salmon with gillnets or fish wheels near town or at fish camps, harvested pike and grayling, and small game, waterfowl, and game birds. In the fall, residents harvested late run chum and coho and berries; hunted moose, caribou, and black bear; and harvested other fish through the ice into the winter. Trapping occurred during the winter into the spring. The data in **Table 3-30** are similar to Stephen R. Braund and Associate's (2007) findings regarding the timing of resource hunting and harvesting for the time period of 1997 to 2006, with some minor variations.

Subsistence Harvests

The Alaska Department of Fish and Game (2001) collected subsistence harvest data for the community of Fort Yukon in 1987, 1993, 1994, 1995, 1996, 1997, and 1998. The Council of Athabascan Tribal Governments (2002, 2003, 2005) collected information on subsistence harvests in Fort Yukon for moose, bear, and wolves in 2001, 2003, and 2004. Busher and Hamazaki (2005) provided information on Fort Yukon subsistence salmon harvests from 1992 to 2003, and Busher et al. (2007) provided the same data for 2005. These subsistence harvest data are summarized by year and by species in Tables J-21 through J-24 in **Appendix J**. The majority of Fort Yukon households hunted, used, gave, and received these resources during the study years. Based on data collected by ADFG during the 1987 study year, participation rates are relatively high for households using, attempting to harvest, and successfully harvesting subsistence resources. No ADFG participation data are available for the 1993 to 1998 study years (Alaska Department of Fish and Game 2001). Estimates of total subsistence harvest ranged from 3,100 to 625,700 pounds (Alaska Department of Fish and Game 2001). Moose represented 16 to 48% of the harvest annually by weight during study years from 1987 to 1998. Chinook and chum salmon were very important components of the annual harvest ranging from 40 to 65% of the harvest. Geese and whitefish were the only other species groups that constituted more than 5% of the annual harvest. Other species harvested included snowshoe hare, black bear, beaver, lynx, ducks, geese, grouse, ptarmigan, and the longnose sucker. Andersen and Jennings (2001) reported 3,615 total birds harvested by Fort Yukon respondents in the 2000 harvest year. Based on data provided in Busher and Hamazaki (2005) and Busher et al. (2007), Fort Yukon residents harvested large quantities of chum and Chinook salmon and lesser quantities of coho salmon from 1992 to 2003 and in 2005 (**Table 3-30**).

Table 3-30 Annual cycle of subsistence activities for Fort Yukon, 1970-1982 and 1986-1987



Source: Sumida and Andersen 1990.

Subsistence Use Areas

Because residents of Fort Yukon are from diverse areas of the Yukon Flats, the village has a corresponding wide range of reported subsistence resource use and harvest areas (**Figures 3-42, 3-43,** and **3-44**). Subsistence use areas depicted on **Figures 3-42** and **3-43** are based on lifetime subsistence data compiled by Caulfield (1983) and Sumida and Andersen (1990). **Figure 3-42** depicts lifetime subsistence use areas for small mammal hunting, trapping, wildfowl hunting, vegetation gathering, and the gathering of fuel and/or structural materials. **Figure 3-43** depicts lifetime subsistence use areas for bear hunting, caribou hunting, fishing, furbearer hunting, and moose hunting. The subsistence use areas depicted in **Figure 3-44** were gathered for the 1997 to 2006 time period and represent use areas for all resources. Use areas for individual resources are available in Stephen R. Braund and Associates (2007).

Community of Stevens Village

The seasonal round, as recorded by Sumida (1988) in the early 1980s, is presented here as **Table 3-31**. Much like the other communities in the Yukon Flats region, residents harvested waterfowl, hunted muskrat and black bears, and set nets for whitefish in the spring. In the summer, residents harvested salmon and other fish as well as hunted ducks, black bear, porcupine, and muskrat. In the fall, residents hunted moose, bear, grouse, ptarmigan, and waterfowl. In the winter, residents harvested fish through the ice and trapped furbearers.

Subsistence Harvests

The Alaska Department of Fish and Game (2001) collected subsistence harvest data by household during 1984, 1993, 1994, 1995, and 1997. The Council of Athabascan Tribal Governments (2003, 2005) collected subsistence harvest data at Stevens Village for moose, bear, and wolf in 2003 and 2004 (**Table 3-31**). Busher and Hamazaki (2005) provided information on subsistence harvests of salmon. These subsistence data are summarized by year and by species in Tables J-25 through J-28 in **Appendix J**. Estimated total annual subsistence harvests in 1984 to 1997 ranged from 1,900 to 102,500 pounds (Alaska Department of Fish and Game 2001). Fish, primarily Chinook and chum salmon, but also whitefish and northern pike, constituted the majority (53 to 99%) of the estimated annual harvest during the study years from 1984 to 1997, except for 1997. Moose also were very important components of the harvest, composing 5 to 84% by weight. Other species that represented more than 5% of the harvest in some years included black bear, whitefish, and geese. Other species harvested included sheefish, northern pike, burbot, ducks, grouse, beaver, lynx, snowshoe hare, and berries. Busher and Hamazaki (2005) reported that the subsistence harvest of salmon by Stevens Village residents ranged from 526 to 6,027 fish in 1992 to 2003, and Busher et al. (2007) reported harvests of salmon totaling 2,258 fish in 2005. Andersen and Jennings (2001) reported that Stevens Village residents harvested 210 migratory birds in the 2000 harvest year.

Subsistence Use Areas

Sumida (1988) collected Stevens Village subsistence use area data for the 10-year period from 1974 to 1984 (Sumida 1988). These use areas are depicted on **Figures 3-45** and **3-46**. **Figure 3-45** depicts subsistence use areas for berries, furbearer trapping, and wood gathering. **Figure 3-46** depicts subsistence use areas for black bear hunting, moose hunting, and waterfowl hunting. The *Stevens Village Land Use Plan, Ethnogeography of Ancestral Lands, and Integrated Resource Management Plan* (Stevens Village Council 1999) identified lands "vital to the survival of the Stevens Village subsistence based economy" as lands located within the Yukon River, Yukon River, Rogers Creek, Old Lost Creek, Alfred Creek, and Dall Rivers watersheds. The lands are located within 0.5 mile on each side of these watersheds (Stevens Village Council 1999:32).

Community of Venetie

Table 3-32 depicts the annual cycle of subsistence activities at Venetie from 1970 to 1982 (Caulfield 1983). Like in other Yukon Flats communities, residents harvested waterfowl; hunted muskrats; set nets for whitefish, pike, and suckers; trapped ground squirrels; and harvested black bears in the spring. In the summer, residents harvested salmon; fished for whitefish, pike, suckers, burbot, trout, and grayling; participated in gardening, and plant and berry gathering; and hunted caribou. In the fall, residents harvested moose, caribou, salmon, whitefish, hares, black bear,

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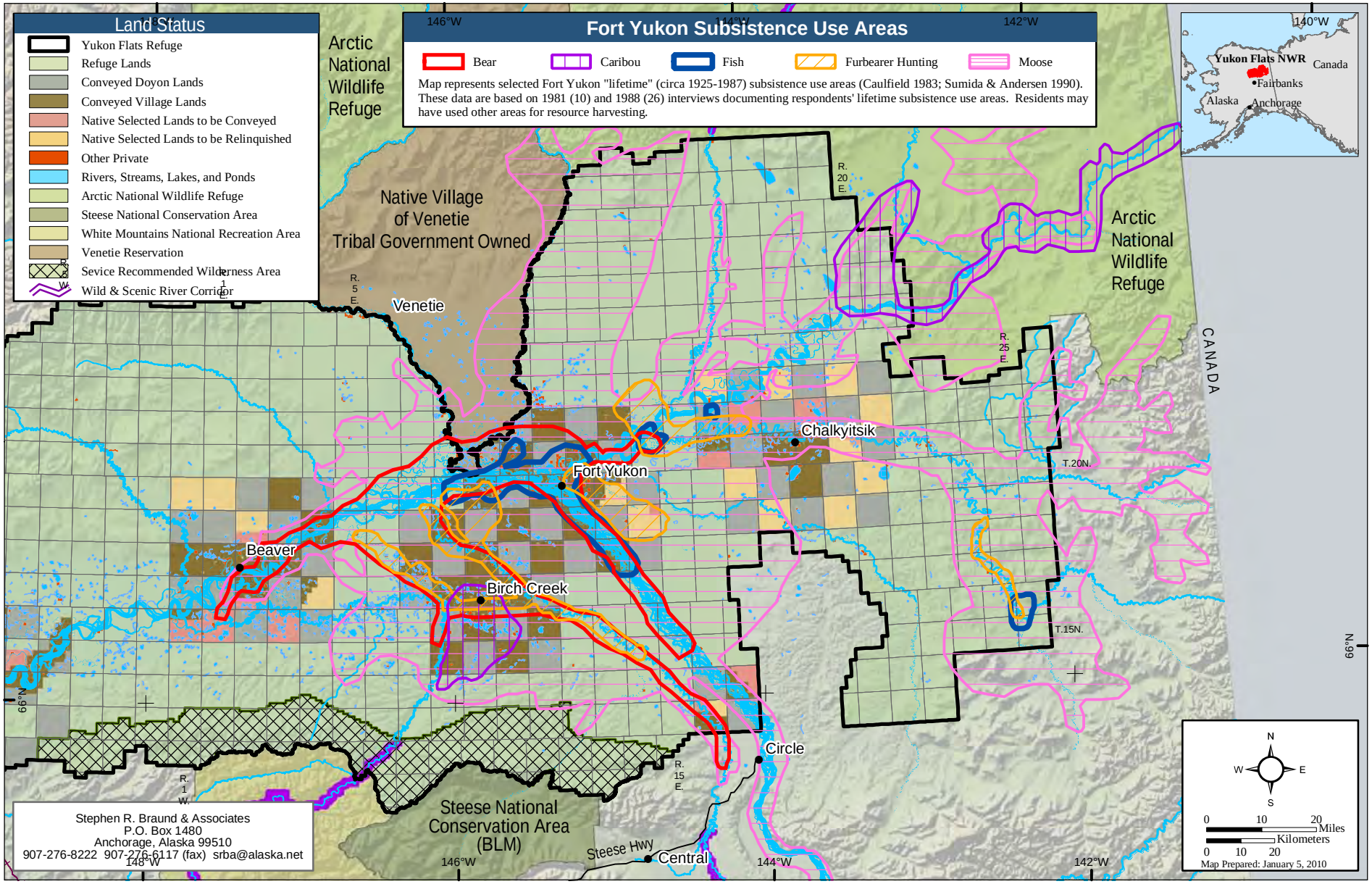
Fort Yukon "Lifetime" Subsistence Use Areas for Bear, Caribou, Fish, Furbearer Hunting, and Moose

Figure 3-42



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Fort Yukon "Lifetime" Subsistence Use Areas for Fuel/Structural Materials, Small Mammals, Trapping, Vegetation, and Wildfowl

Figure 3-43

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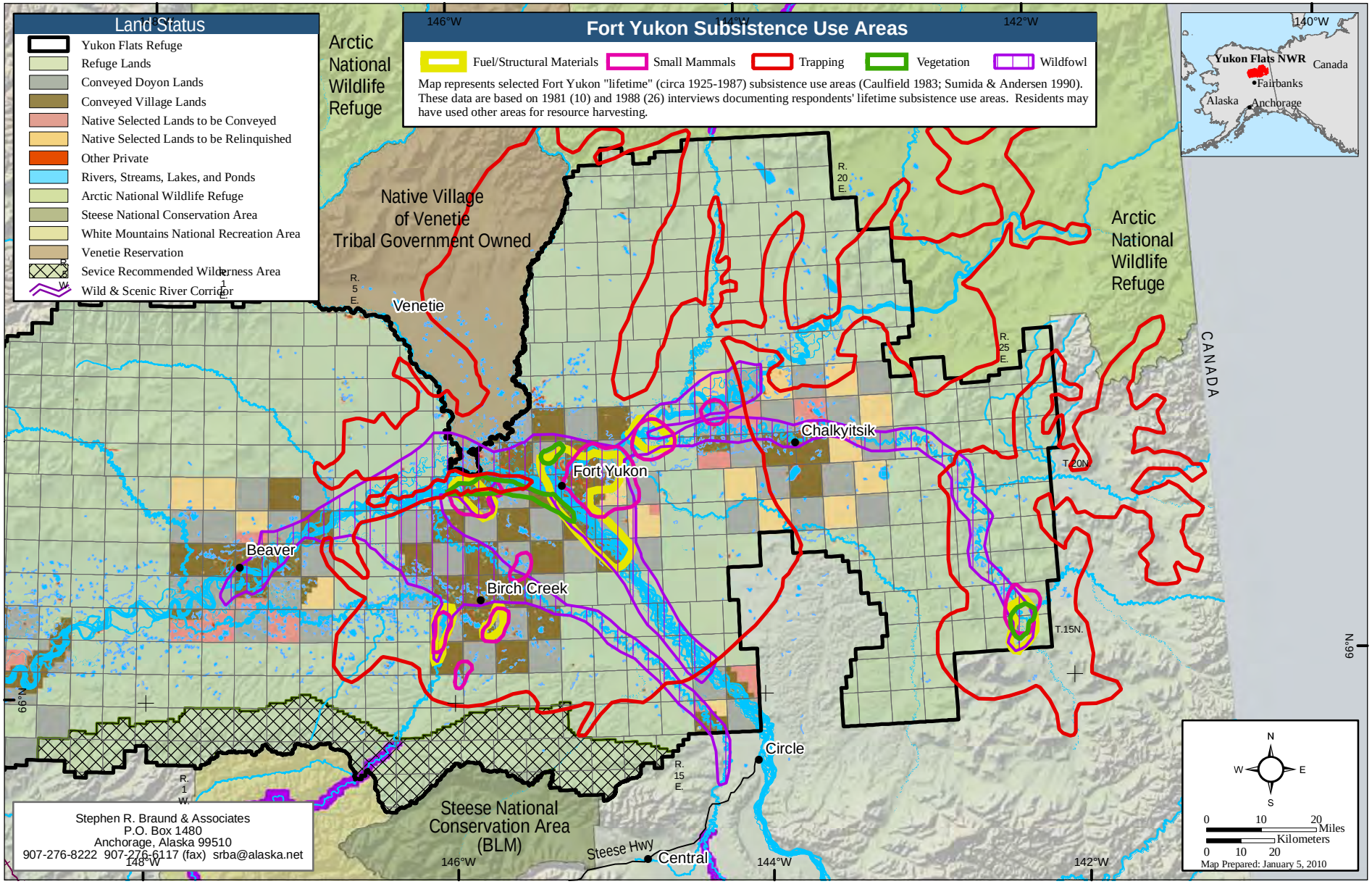

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Figure 3-44
Fort Yukon Subsistence Use Areas All Resources, 1997-2006

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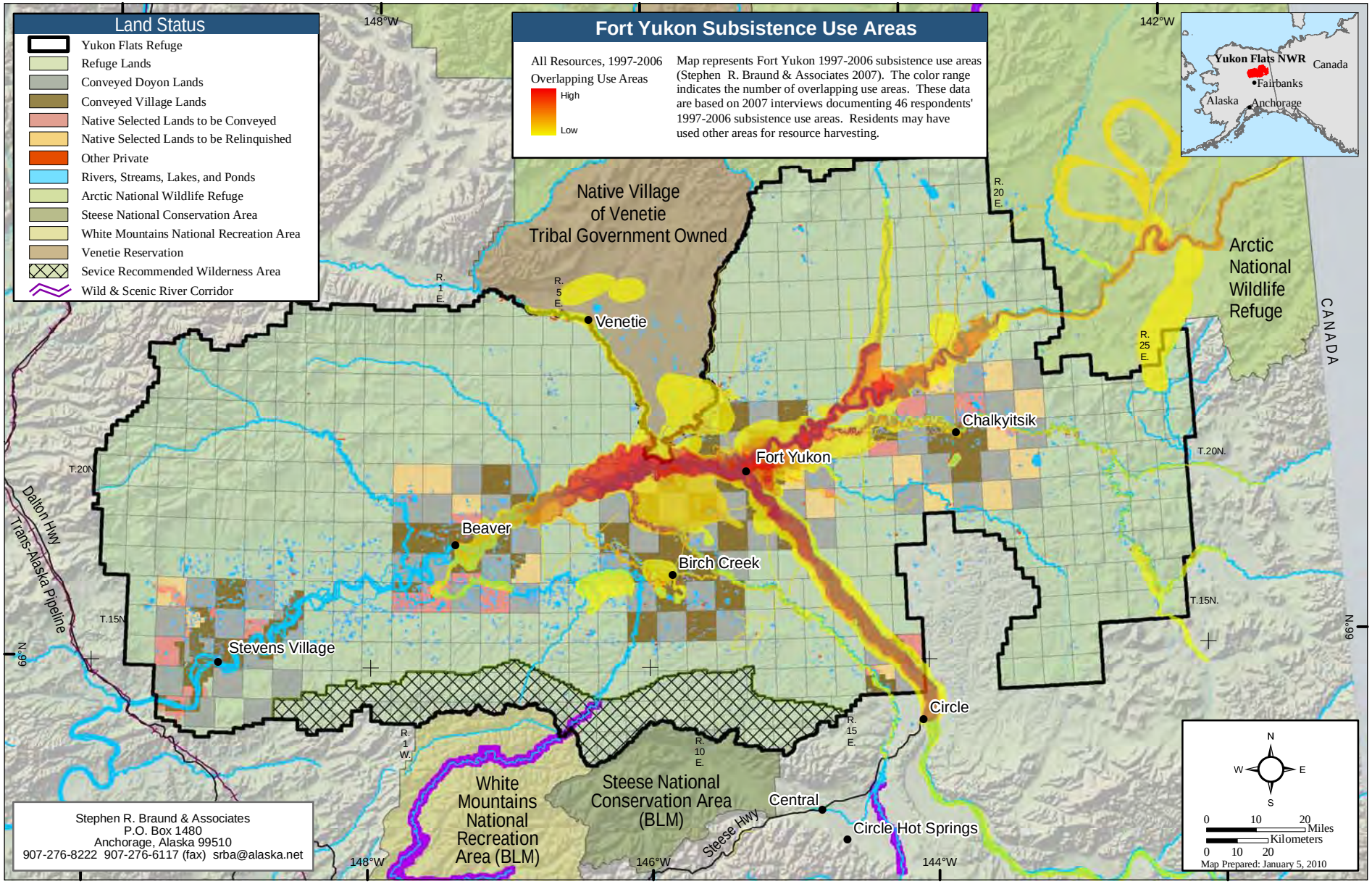
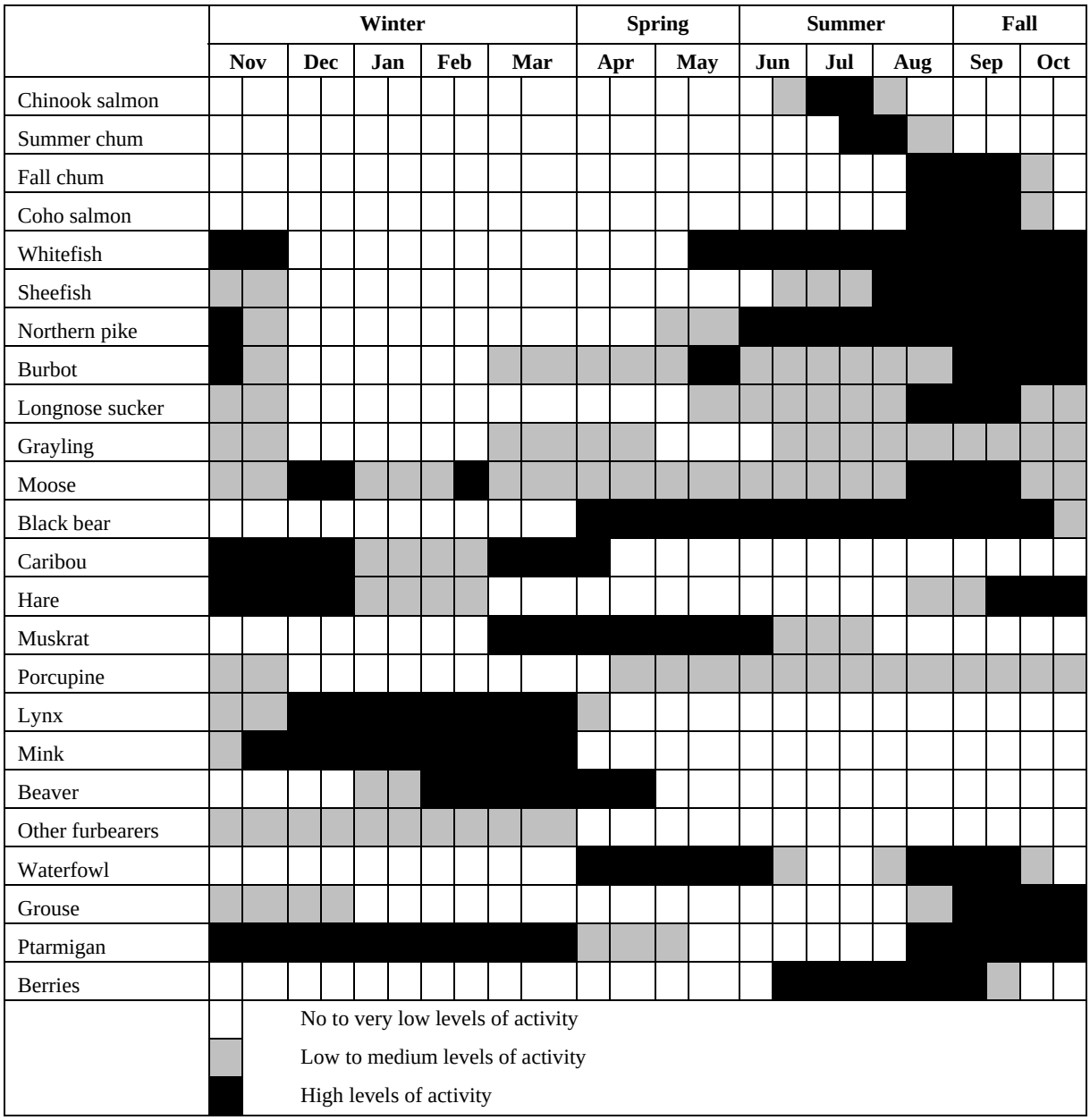


Table 3-31 Annual cycle of subsistence activities for Stevens Village, 1980s



Source: Sumida 1988.

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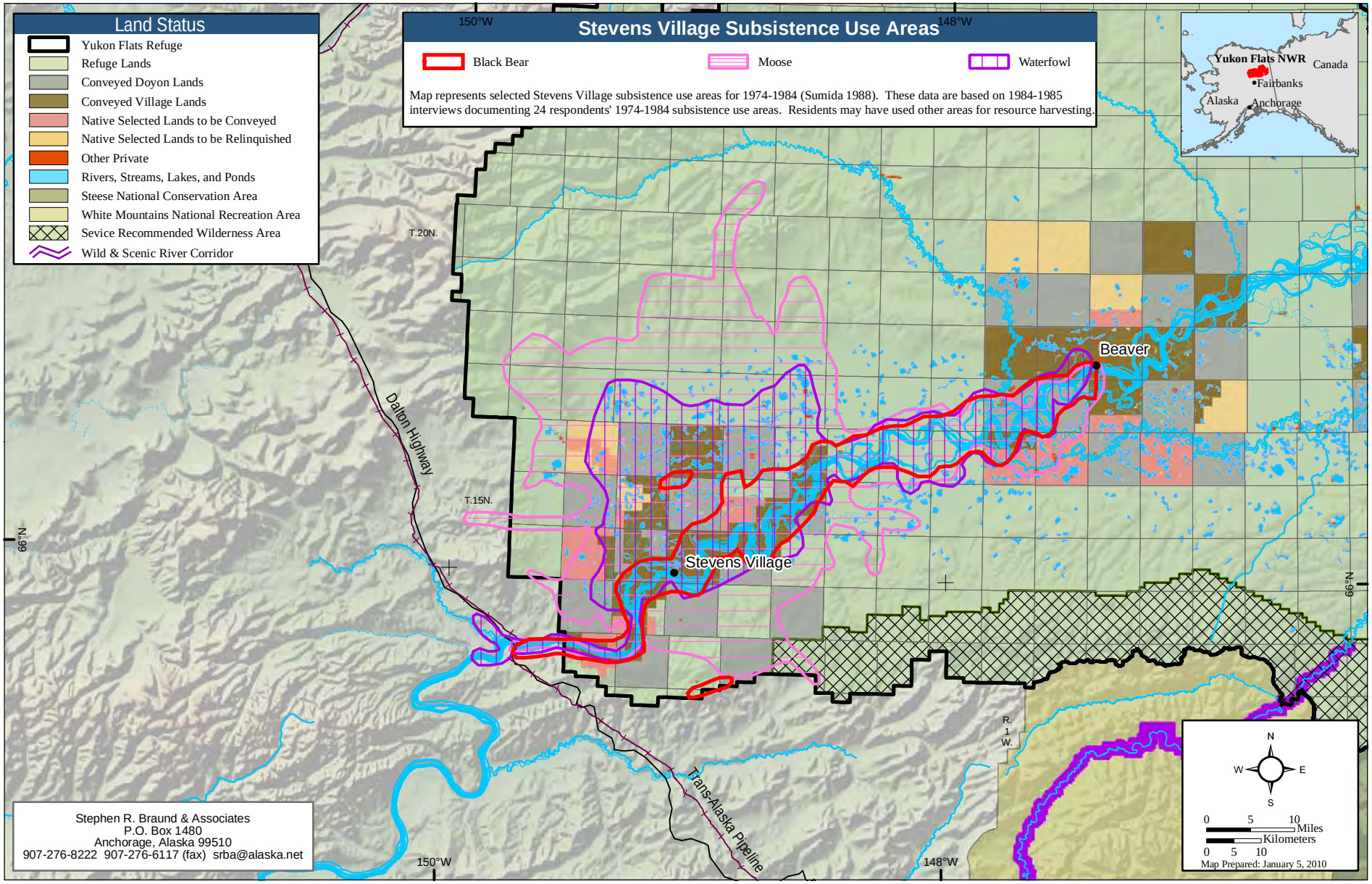
Stevens Village Subsistence Use Areas for Black Bear, Moose, and Waterfowl, 1974-1984

Figure 3-45



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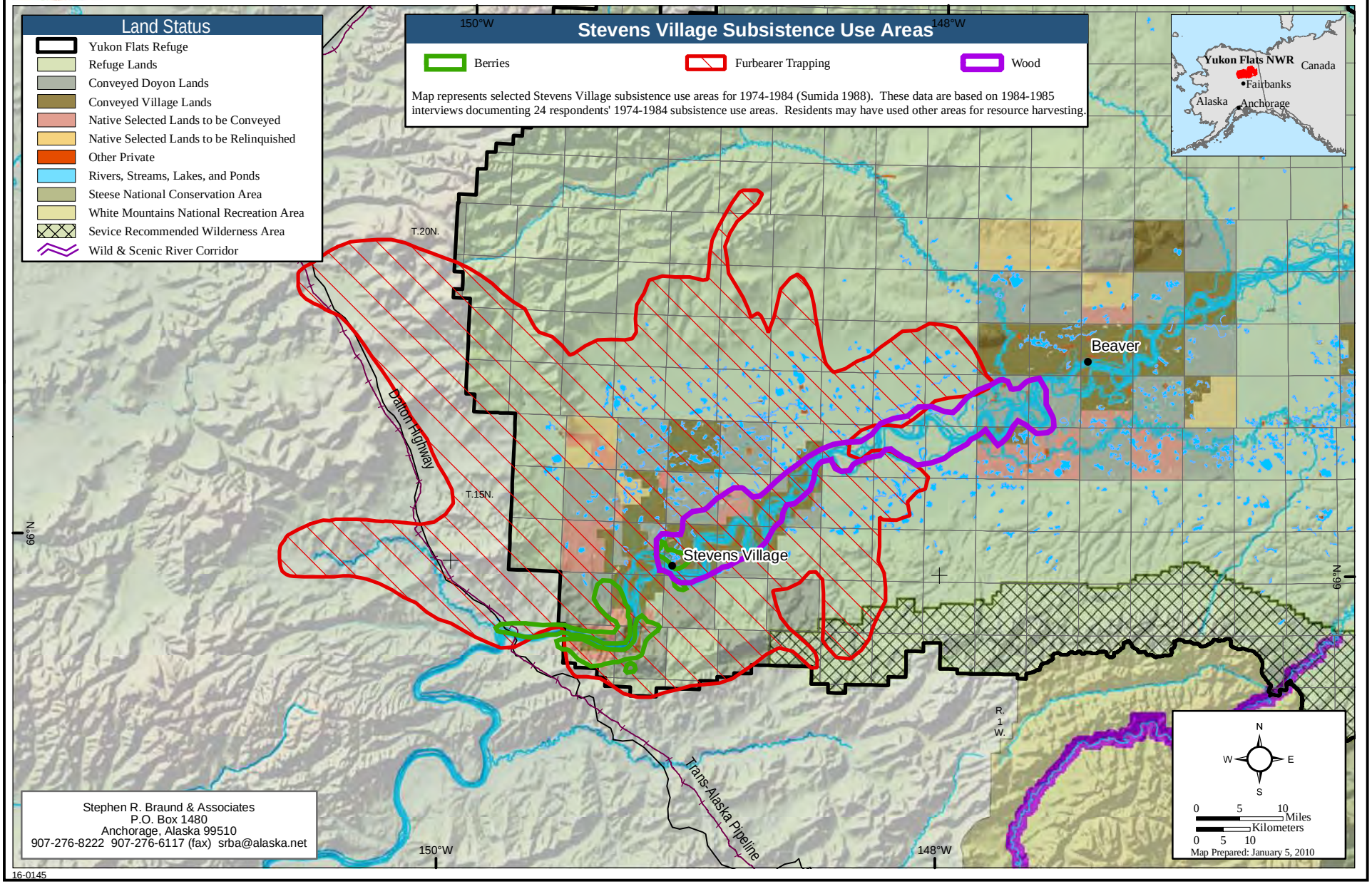
Stevens Village Subsistence Use Areas for Berries, Furbearer Trapping, and Wood, 1974-1984 **Figure 3-46**



Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222 907-276-6117 (fax) srba@alaska.net

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Table 3-32 Annual cycle of subsistence activities for the community of Venetie – 1970-1982

	Winter										Spring				Summer						Fall			
	Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct	
Fish																								
Caribou																								
Moose																								
Bear																								
Hare																								
Waterfowl																								
Ground squirrel																								
Furbearer																								
Wood																								
Wage employment																								

No to very low levels of activity

Low to medium levels of activity

High levels of activity

Source: Caulfield 1983.

ground squirrels, and grouse. In the winter, residents participated in trapping and harvested moose and caribou.

Subsistence Harvests

The Alaska Department of Fish and Game (2001) collected subsistence harvest data for Venetie in 1993, 1994, 1995, 1996, and 1997. The Council of Athabascan Tribal Governments (2002, 2003, 2005) provided subsistence harvest information for moose, bear, and wolf for 2003 and 2004. Busher and Hamazaki (2005) reported subsistence harvests of salmon by Venetie residents for the years 1992 to 2003, and Busher et al. (2007) provided the same data for 2005. No per-capita or household participation rate data are available for Venetie (Alaska Department of Fish and Game 2001). These subsistence data are summarized by year and by species in Tables J-29 through J-32 in **Appendix J**. Because much of the data are from years of noted resource failures, none of the study years are considered by ADFG to be "most representative" (Alaska Department of Fish and Game 2005c). Estimated total annual subsistence harvests ranged from 11,000 to 24,000 pounds (Alaska Department of Fish and Game 2001). Estimated moose harvest from 1993 to 1997 ranged from 26 to 94% of the total harvest.

Caribou were very important components of the harvest during some years (as much as 71% of harvest), but not others when no caribou harvest was reported. Fish, primarily chum salmon and whitefish, were important harvest components during some years, but not others, ranging from 0.1 to 40% of the harvest. Busher and Hamazaki (2005) reported that the salmon harvest ranged for 233 to 8,010 fish from 1992 to 2003, and Busher et al. (2007) reported a harvest of 1,860 fish in 2005. Andersen and Jennings (2001) reported that Venetie respondents harvested 2,078 migratory birds in the 2000 harvest year.

Subsistence Use Areas

Subsistence use areas for Venetie are shown on **Figures 3-47, 3-48**, and **3-49**. **Figure 3-47** depicts lifetime subsistence use areas for the harvest of fuel and/or structural materials, moose hunting, vegetation gathering, and wildfowl hunting. **Figure 3-48** depicts lifetime subsistence use areas for bear hunting, caribou hunting, sheep hunting, and small mammal hunting. **Figure 3-49** depicts lifetime subsistence use areas for fishing and furbearer hunting and trapping.

3.5.7.6 Traditional Knowledge

Because of their close and continuous connection with the surrounding environment, local subsistence users are in a unique position to observe biological and physical changes to the land. Stephen R. Braund and Associates' 2007 report includes traditional knowledge provided by Beaver, Birch Creek, and Fort Yukon residents regarding changes in resource, use, abundance, quality, migration/distribution, and habitat. In addition, the report includes residents' observations about changes in the physical and social environment. Traditional knowledge from residents in the study communities are also available in other reports, including Johnson et al.'s (2003) *Yukon-Charley Rivers National Preserve Contemporary and Historic Natural Resource Use Patterns Draft Final Report*, and a number of ADFG technical papers (Caulfield 1983; Sumida and Alexander 1985; Sumida 1989; Sumida and Andersen 1990). Matthew Gilbert wrote an article entitled *Crazy Weather* describing climate change and its effect on Gwich'in Athabascans (Gilbert 2006).

During interviews with Beaver, Birch Creek, and Fort Yukon residents in 2007, subsistence users stressed the continuing importance of subsistence to their cultural, spiritual, and physical well-being. As one individual put it,

> It's our way of life, and it's how we eat. It's our culture. It's how we grow. It's how my kids and their kids are going to eat and grow. We can say it's our culture, but it's [also] our food. And it's our way of life. (Stephen R. Braund and Associates Beaver Interview February 2007)

Subsistence Resources

The most common observation made by Beaver, Birch Creek, and Fort Yukon residents during SRBA's 2007 fieldwork was that the abundance of moose had declined (Stephen R. Braund and Associates 2007). Some individuals commented that as a result, their harvest success for moose had also declined. Residents primarily attributed the scarcity of moose to predators and an increase in outside sport hunters. Based on research conducted in Circle and Central in 1992, residents at that time were also concerned about the availability of moose and caribou, and similarly attributed the decreased availability to predators and outside hunters. At the time of the study in Circle and Central, residents noted that caribou had been migrating through the area for the past few winters, and a number of local hunters were able to harvest animals from that herd (Johnson et al. 2003).

In addition to noticing changes in moose populations, 20 or more respondents from Beaver, Birch Creek, and Fort Yukon reported changes in ptarmigan, waterfowl, and salmon (notably Chinook salmon; Stephen R. Braund and Associates 2007). The most common type of observation was a change in the abundance of these resources, including a decline in ptarmigan, black ducks (scoters), geese, and salmon. A substantial number of residents also noted changes in the quality of salmon, especially Chinook salmon. Residents reported noticing that the size of salmon had

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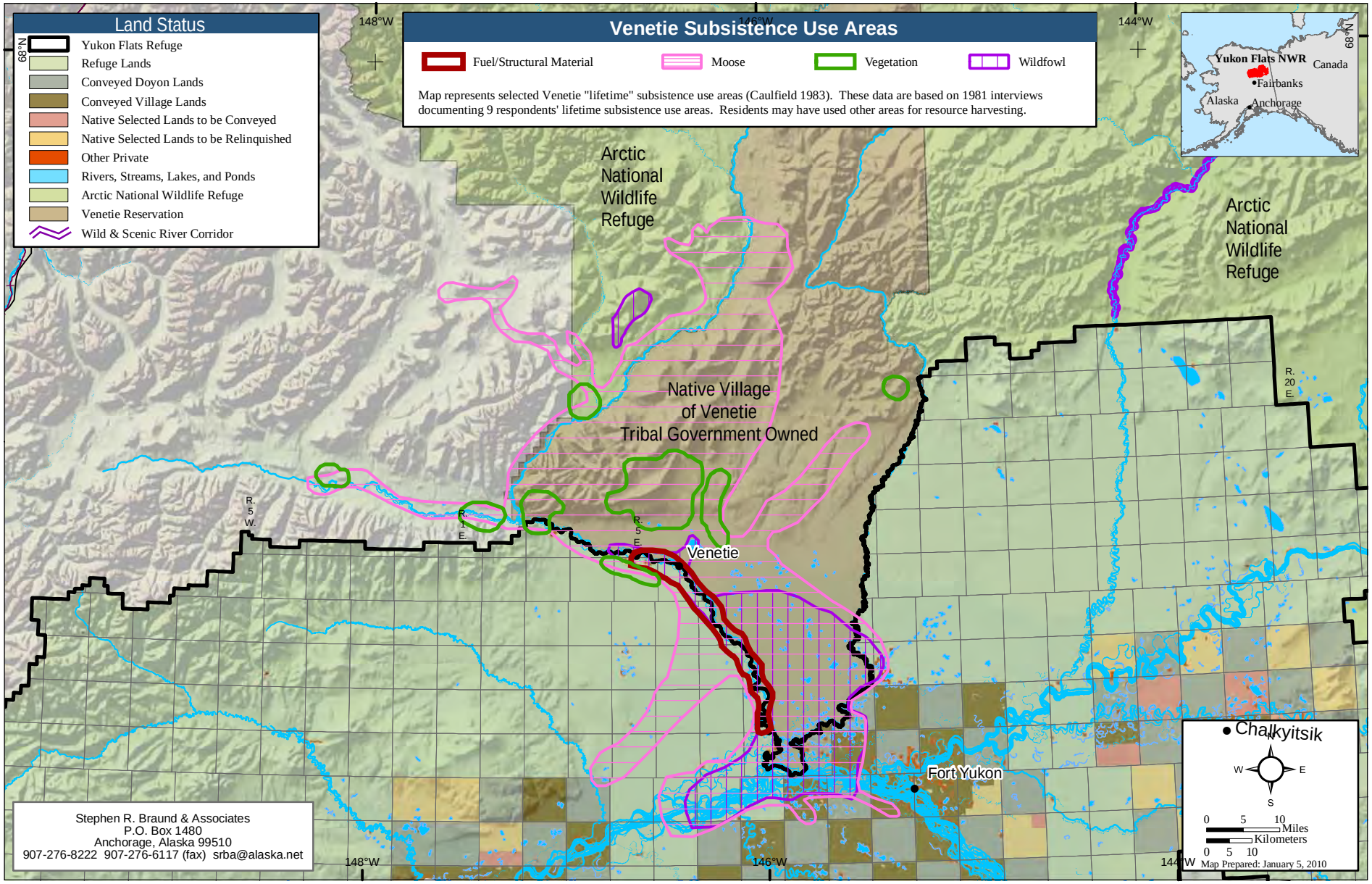
Venetie "Lifetime" Subsistence Use Areas for Fuel/Structural Materials, Moose, Vegetation, and Wildfowl

Figure 3-47



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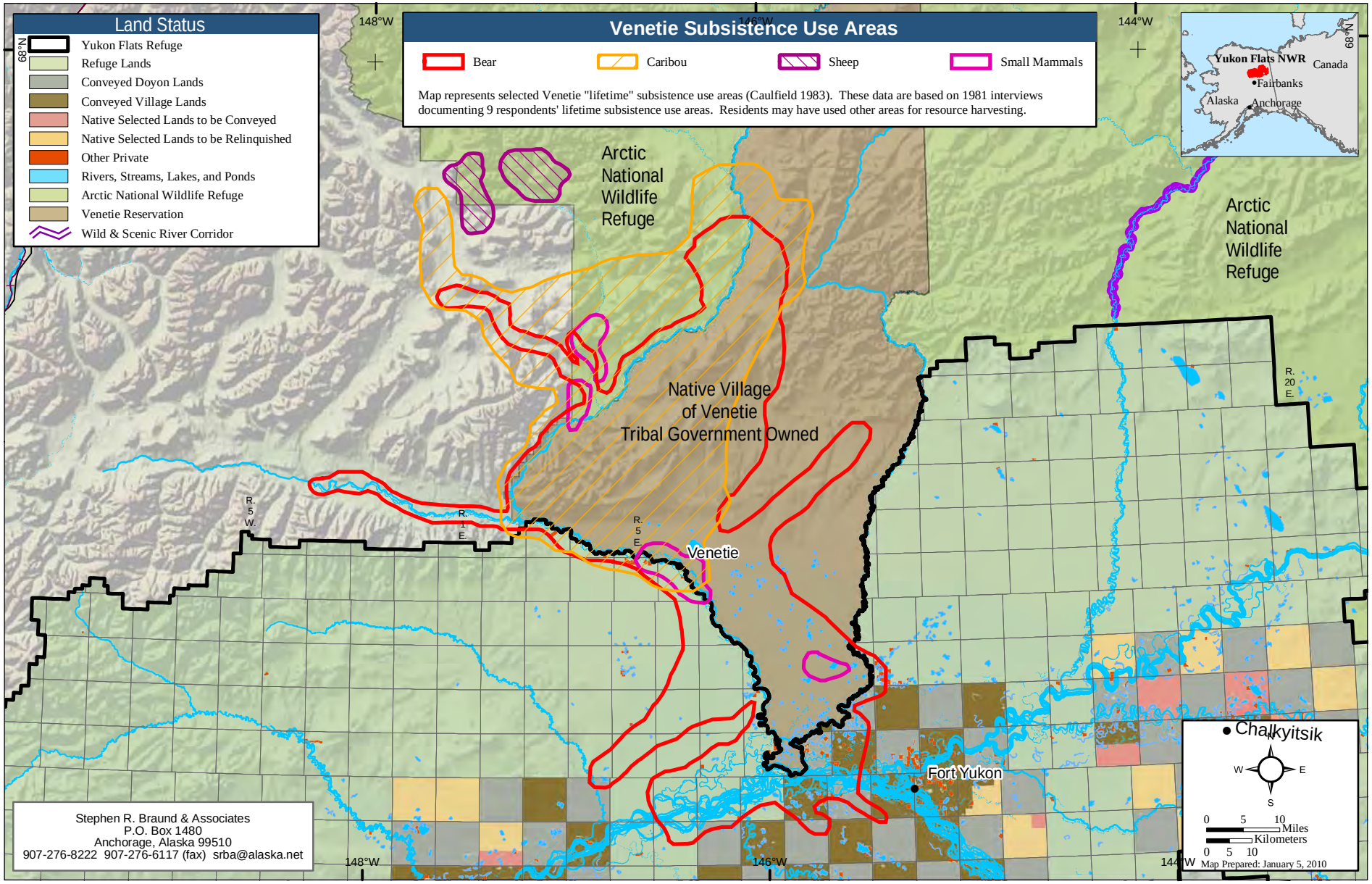
Venetie "Lifetime" Subsistence Use Areas for Bear, Caribou, Sheep, and Small Mammals **Figure 3-48**



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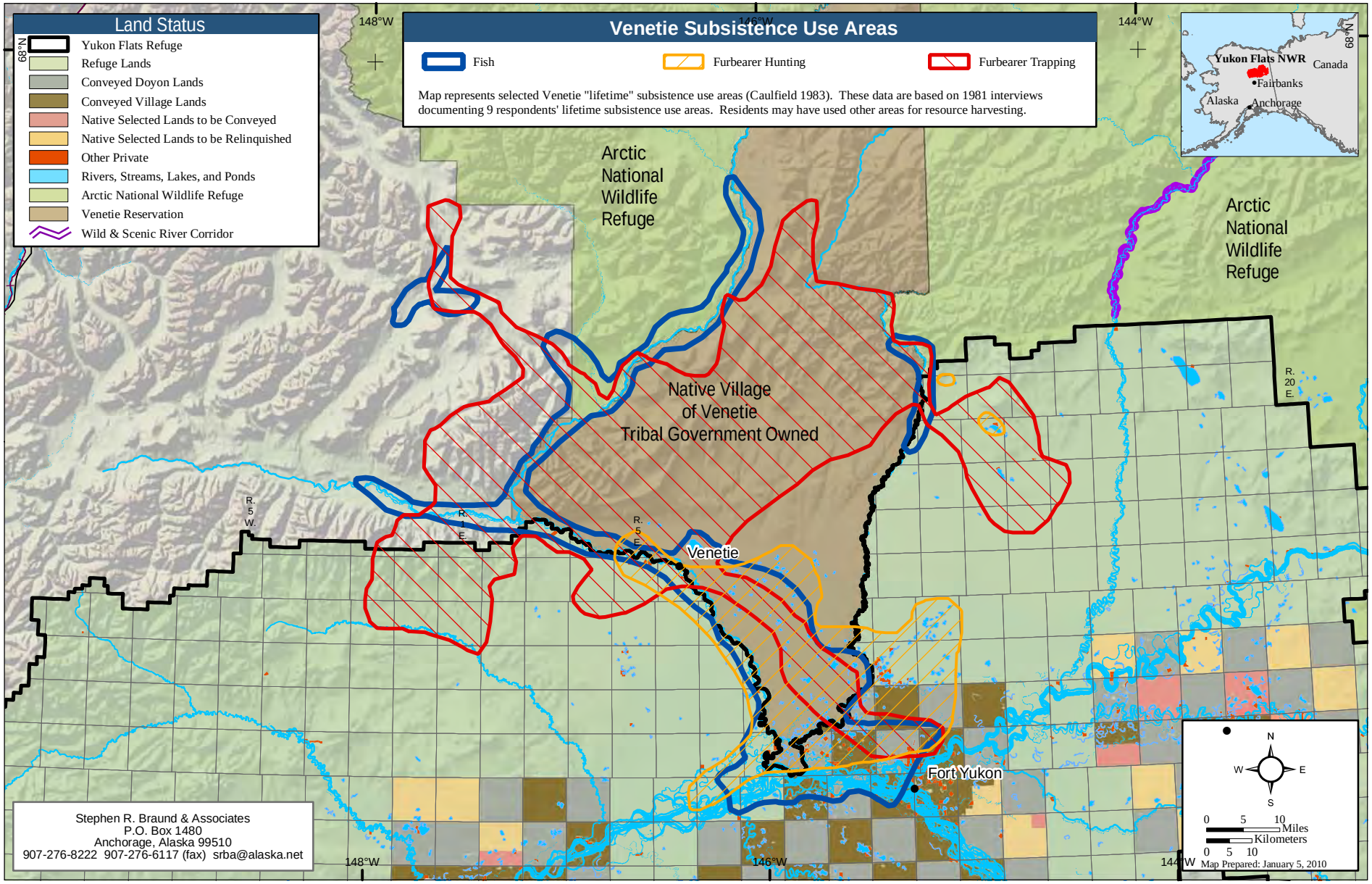
Venetie "Lifetime" Subsistence Use Areas for Fish, Furbearer Hunting, and Furbearer Trapping

Figure 3-49



decreased and that they were catching more salmon with sores or other physical abnormalities. During interviews in the early 1990s, residents from Central reported low populations of salmon and blamed the decline on commercial fishing and pollution (Johnson et al. 2003).

Uses of furbearing animals have declined significantly since the price of furs declined (Shimkin 1955; Caulfield 1983; Stephen R. Braund and Associates 2007). Caulfield (1983) noted that "The significance of trapping in the economy of the region appears to have declined somewhat from earlier years." Residents noted that resource distribution and abundance is always changing and is often cyclical. Subsistence use areas, harvest success, and the frequency of hunting trips often change over a person's lifetime in response to the availability of resources. As Caulfield (1983) noted,

> Economic uncertainty fostered by ecological constraints, limited involvement in the wage economy, and minimal alternative resources requires that access be maintained even to areas and resources not utilized for some time. The land and its resources provide security much like 'money in the bank,' when other alternatives are not available. It is in this sense, for example, that Arctic Village residents speak of the importance of sheep to their livelihood. While perhaps less than 10 sheep are currently taken in a year, Dall sheep are considered a vital component of an array of resources which may at any time become unobtainable. (Caulfield 1983:197)

Thus, although the uses of certain resources (such as furbearing animals) may decline over time, the importance of these resources and the lands on which they were historically harvested remains the same to local residents. The continuing availability of resources on traditional lands provides "security" in the event that other subsistence resources decline or move to different areas or, in the case of furbearers, local job opportunities become scarce and an alternate source of income is needed.

During SRBA's 2007 interviews, residents also provided their knowledge and observations regarding key resource habitat. Areas identified by residents as particularly important to the health and abundance of local resources include the Mud Lakes (near Beaver) and Three Lakes (near Birch Creek), as well as locations along the Sheenjek and Yukon rivers.

Climate, Watershed, and Air Quality

During interviews in 2007, Beaver, Birch Creek, and Fort Yukon residents provided observations about the physical environment, including changes in the watershed, weather, ice and snow conditions, and air quality. Residents in all communities consistently noted that water levels have been lower in recent years, affecting their travel to subsistence use areas. They also expressed concern that lower water levels could affect resource habitat (especially moose, waterfowl, and muskrat), and several people reported already noticing changes in species distribution due to shallower lakes.

Local residents continue to drink water from the Yukon River during certain times of the year when the water is adequately clear (springtime melting results in water too muddy for consumption). However, a number of residents reported that they had stopped drinking water directly from local rivers, or had resorted to boiling the water before drinking it, due to concerns of contamination. Residents from Birch Creek discussed effects on the local watershed and

wildlife due to upstream mining in the 1970s and 1980s. Residents indicated that silt from mining activities had ended up in local streams and lakes and affected the populations of fish, muskrat, and beavers, and vegetation.

Another common observation made by Beaver, Birch Creek, and Fort Yukon residents about changes in climate is that temperatures have been warmer overall in recent years and the weather has been unpredictable. The change in temperatures has resulted in thinner ice cover in the winter and has affected residents' winter travel. If lakes and rivers do not freeze adequately for snowmachine travel, winter use areas are limited.

Aside from isolated effects caused by wildfires and four-wheeler traffic, residents indicated that the air quality in the Yukon Flats Wildlife Refuge is good. The occurrence of wildfires, according to some, has increased in the Yukon Flats area. Residents observed that wildfires can temporarily affect wildlife distribution. Matthew Gilbert's paper entitled *Crazy Weather* summarizes residents' observations regarding the effects of climate changes on the subsistence uses of Gwich'in Athabascans (Gilbert 2006). As observed by local residents, a large fire in the interior in 2004 changed the distribution of local resources, affected caribou migration, and stunted berry growth.

Gilbert (2006) also reported on other subsistence-related changes caused by climate change. In Arctic Village, residents have observed that an increase in high brush and a decrease in lichen due to a lack of protective ice sheets has affected caribou migration and health and resulted in less harvest success for hunters. Fort Yukon residents have observed longer and earlier salmon runs, changes in moose availability, and earlier and shorter geese migrations, all reportedly related to climate change. Venetie residents are harvesting edible salmon, whereas in the past the salmon were of poor quality by the time they reached the Venetie area. Residents in all communities reported increased difficulty accessing subsistence resources either due to low water levels in their usual hunting drainages, or because the distribution of certain resources had changed due to warmer temperatures and changing habitat.

Other Observations and Relevant Concerns

During 2007 interviews in Beaver, Birch Creek, and Fort Yukon, residents discussed changes they had noticed in their communities related to subsistence. Respondents indicated that the introduction of snowmachines, freezers, and other technologies has made harvesting, transporting, and storing subsistence resources easier and more efficient.

Despite these changes, residents of these Yukon Flats communities stressed that traditional and culturally important aspects of village life remain. Residents still follow traditional rules regarding the harvest and use of subsistence resources, such as not wasting meat and only harvesting what one needs. The community potlatch is still a common event, and sharing is an important method of distributing foods within and among communities. Respondents reported giving harvested resources to family members, elders, households without subsistence providers, and to residents in other communities experiencing resource scarcity.

Residents of Beaver, Birch Creek, and Fort Yukon expressed concerns related to their subsistence lifestyle. Prevalent current concerns include the decline of moose in the area as well as the increasing effect of climate change on locals' subsistence activities and on the availability of various resources. Another major concern raised by residents is related to the increased presence of sport hunters in the region and the resulting increase in competition for local hunters. In their

Land Use Plan, Ethnogeography of Ancestral Lands, and Integrated Resource Management Plan, the Stevens Village Council also stressed their concerns about increased competition from sport hunters and fishermen, as well as the possibility of future development on or near their traditional lands. Regarding the effects of non-local hunting and fishing in the area, they noted:

> Impacts from sport hunting and fishing activities have inhibited Stevens Village tribal members' exercise of a subsistence economy as they are being crowded out. Tribal members, because of their customs, do not like to compete for land resources and they do not like to see outsiders impacting the land negatively. As a result they are forced to stay away from some of their traditional subsistence use areas such as the Dall River. Sport hunting and fishing place no value on the animals or fish except for "fun," profit, or perhaps in some cases, food. The killing of mammals, birds, and fish for any reason other than the need for food or clothing is contrary to the spiritual value inherent in each animal and inconsistent with Dinyee Hut'aane traditional ecosystem management practice. (Stevens Village Council 1999:27)

Sumida (1984) provides a description of concerns in Stevens Village at the time of the study. Residents had observed effects caused by the newly constructed Yukon River Bridge, which provided access to non-local hunters. The growing use of Dall River for recreational purposes was of special concern to the community, and residents had noted an increase in competition, effects on local fish and wildlife populations, and vandalism of private property.

Regarding the proposed Yukon Flats Land Exchange, Beaver, Birch Creek, and Fort Yukon residents expressed concern that the land exchange would result in increased opportunities for oil and gas development in the region and subsequently affect subsistence resources that they rely on, particularly waterfowl, fish, and moose. Residents were especially concerned that contamination related to drilling activities could reach waterways and lakes and result in long-term damage to the environment and wildlife:

> I worked for Doyon drilling and they had pipes all over and open pits that dirty up the water, and quality bird habitat depends on water. And [there will be] more people coming in. That is my concern. Yes, around this Birch Creek area, there are thousands of lakes that are a major bird habitat that could be affected. (Stephen R. Braund and Associates Fort Yukon Interview March 2007)

> If they do drill, or they do get oil, then I'm just worried about the breeding grounds around here for the ducks and geese, and the fish, because I think that's where their breeding grounds are. (Stephen R. Braund and Associates Beaver Interview February 2007)

Residents also discussed the possibility of an influx of outsiders to the region which could lead to increased competition for subsistence resources and negative social impacts:

> It will be real different after that happens; it will probably kill Birch Creek off. So many people coming in and money will be coming in and new roads all over the place; everything will change. (Stephen R. Braund and Associates Fort Yukon Interview March 2007)

> I am concerned about future oil spills and the roads. And that [road] will be right across there. And I think it is going to affect us – it definitely will – and bring more people to come in and more to come to work and then they live and come to Fort Yukon, because everything is here. (Stephen R. Braund and Associates Fort Yukon Interview March 2007)

Other residents voiced support for the land exchange and expressed hope that the project would bring much needed economic growth and job opportunities to the region:

> I am for that [land exchange], because I know for a fact that it's still going to happen. If we are opposed to it, we're not going to get anything out of it. So, if we go after it, we can at least get something out it…. This whole area [is critical]. But, this land over there, it belongs to the government, and they'll come in and drill if Doyon doesn't get a hold of it. So that's why we're trying to get a hold of it. If Doyon gets that land, we can benefit from it.
>
> I am for that oil drilling. If that Doyon wants to drill oil, I'm for that drilling. Of course, this village, we have no jobs around here. A lot of kids are running around here with no job, they're just bored. They need jobs. They move out of the village and then they come back and then they move out again. (Stephen R. Braund and Associates Fort Yukon Interview March 2007)

For further descriptions of concerns expressed by Beaver, Birch Creek, and Fort Yukon residents regarding subsistence and the proposed Yukon Flats Land Exchange, see Stephen R. Braund and Associates (2007).

3.5.8 Health

Health care services for villages in the study area are organized under the Alaska Tribal Health Compact, an umbrella agreement establishing terms and conditions of the relationship between Alaska Native Tribes or Tribal organizations and the U.S. Government through the Indian Health Service, a branch of the U.S. Department of Health and Human Services. Twenty-one Tribes and Tribal organizations belong to the Alaska Tribal Health Compact, including two Tribal organizations that serve communities in the study area: the TCC and the CATG.

Health care services are provided to the Yukon Flats area through the Interior Alaska Service Area of the Indian Health Service, with delivery split between TCC and CATG. Arctic Village, Beaver, Birch Creek, Chalkyitsik, Circle, Fort Yukon, and Venetie receive services primarily from CATG, and Stevens Village receives services primarily from TCC, through Title V Funding Agreements. Central is not federally recognized as a Tribe and does not receive services through the Indian Health Service (Indian Health Service 2004).

The CATG operates the Yukon Flats Health Center located in Fort Yukon. Services include primary ambulatory care, emergency care, dental services, community health aides, and a health education program. The CATG also provides mental health and substance abuse services to residents of Yukon Flats villages though the CARE behavioral health program (Indian Health Service 2004). The CARE program provides village-based counselors who are stationed in Fort Yukon, Venetie, Arctic Village, and Circle and travel to other villages on a monthly basis. The

CARE program also provides clinicians in Fort Yukon, school visits, support groups, and access to the services of the Alaska Psychiatric Institute through telemedicine (Council of Athabascan Tribal Governments 2007).

Community support is provided through the CATG Community Health Aide Program in Arctic Village, Beaver, Birch Creek, Circle, Fort Yukon, and Venetie (Council of Athabascan Tribal Governments 2007). Chalkyitsik and Stevens Village receive support from both TCC and the CATG (Indian Health Service 2007). The CATG provides dental care to Fort Yukon and scheduled visiting services to Arctic Village, Beaver, Birch Creek, Circle, and Venetie (Council of Athabascan Tribal Governments 2007).

A regional outpatient clinic is located within the Chief Andrew Isaac Health Center in Fairbanks, part of the Fairbanks Memorial Hospital. Inpatient care is provided under contract with the Fairbanks Memorial Hospital, and some specialty needs and conditions require that the patients be sent to the Alaska Native Medical Center in Anchorage. The TCC provides a variety of services in Fairbanks including optometry, dental care, environmental health support, family recovery, mental health care, and counseling (Indian Health Service 2004).

3.5.8.1 Existing Health Conditions

Health conditions in Alaska Native villages, including the villages in the study area, have improved in recent decades, with a marked decrease in infectious diseases as a result of higher childhood vaccination rates and development of water and sewer systems in rural communities. However, Alaska Natives still experience many health problems at a higher rate than the average U.S. resident, many of which are linked to behavioral or social problems. The State of Alaska Department of Health and Social Services estimated in 2000 that life expectancy for Alaska Natives is approximately 7 years shorter than for U.S. residents as a whole (Alaska Native Tribal Health Consortium 2002). Prevalent health problems in Alaska Native villages include substance abuse, mental health problems, tobacco use, cancer, and public safety. Birth and death rates are discussed in Section 3.5.5.1.

3.5.8.2 Substance Abuse and Mental Health

Between 1993 and 2002, alcoholism was the fourth leading cause of death for Alaska Natives, accounting for 1 of every 11 deaths. Alcohol was a factor in 85% of domestic violence cases and 80% of sexual assault cases between 2000 and 2003 (Alaska Native Health Board 2007). Fetal alcohol syndrome affected Alaska Native babies at 25 times the rate of non-Native babies between 1995 and 1999. Access to behavioral health services continues to be a problem for many Alaska Natives because of the remoteness of villages, and the suicide rate for Alaska Natives is 4.2 times the U.S. rate (Alaska Native Tribal Health Consortium 2002).

3.5.8.3 Tobacco Use and Cancer

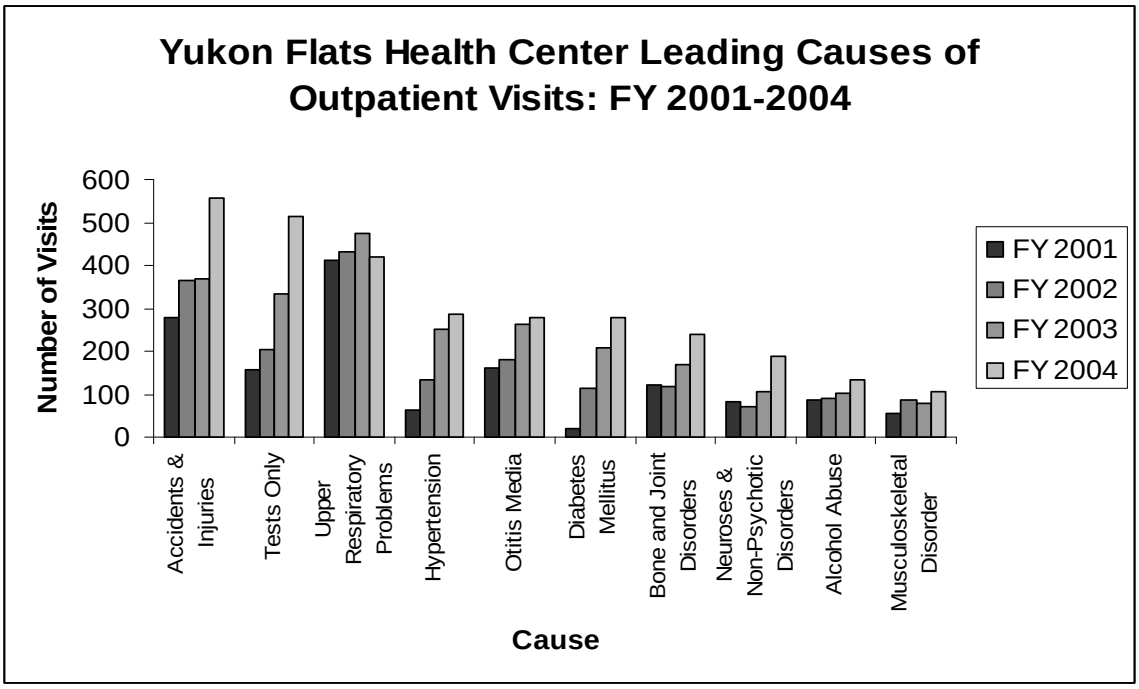
Adult smoking rates for Alaska Natives were between 40 and 50% over the past decade, more than twice the rates for non-Natives (Alaska Native Health Board 2007). These high smoking rates have contributed to cancer, diabetes, and a variety of circulatory, respiratory, and pulmonary diseases. The lung cancer rate for Alaska Natives in 2001 was 48% higher than the U.S. rate (Alaska Native Health Board 2007). Although State tobacco tax increases and tobacco prevention programs are showing some progress in cutting smoking rates, tobacco use and resulting diseases remain a major health issue in Alaska Native villages.

3.5.8.4 Public Safety

Improvements in public safety and law enforcement are needed in many Alaska Native villages. Alaska Natives suffer unintentional injury mortality at 3.3 times the U.S. rate (Alaska Native Tribal Health Consortium 2002), as well as disproportionately high rates of homicide, suicide, sexual assault, child abuse/neglect, and domestic violence. Village public safety officers (VPSOs), individuals trained as first responders to crimes and other threatening situations, are responsible for law enforcement and public safety in most villages. Many villages, however, lack a VPSO, and the Alaska Native Health Board estimated in 2005 that approximately three times the existing number of VPSOs is needed to ensure public safety.

3.5.8.5 Health Statistics

Health information is collected on a local level through CATG and TCC, and on a regional corporation and census area level by the State. The leading causes of outpatient visits to the Yukon Flats Health Center for all age groups in Fiscal Years 2001 to 2004 are shown in **Figure 3-50**. It should be noted that the number of outpatient visits for these leading causes has risen at a time when the population of the villages served by the Health Center has fallen.



Source: Indian Health Service 2007.

Figure 3-50 Leading causes of outpatient visits at the Yukon Flats Health Center