Copper River Basin Landscape Assessment and Management Plans

FINAL REPORT

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Acknowledgments

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Introduction

Copper River Ahtna Intertribal Natural Resource Conservation District (CRITR) was awarded a USDA Natural Resources Conservation Service (NRCS) Conservation Innovation Grant (CIG) to develop an ecologically-based landscape assessment across all of Ahtna lands in southeast Alaska. CRITR was established to link the two land-owning corporations Ahtna, Inc., and Chitina Native Corporation, with the Ahtna Tribes to promote stewardship of subsistence resources including an integrated approach to food production through habitat enhancement, biomass energy production, and wildfire protection. CRITR serves 8 tribal communities and Ahtna, Inc. as a tribal consortium and community-based organization.

To achieve the objectives of a sustainable and integrated approach to land management, CRITR recognized the need for an ecologically-based landscape assessment to inform future goals for land management. Further, important ecological tools to support the landscape assessment, such as ecological site descriptions, had not been developed for this region. Ecological site descriptions are used in landscape assessments to help describe natural ecological processes and native ecosystem diversity (Haufler et al. 1996) which can in turn be used to inform management decisions for subsistence food production, sustaining wildlife habitat, and biomass energy production. Important outputs of this project are the development of management plans for the Ahtna lands surrounding each of the 8 tribal communities. These plans will also include wildfire planning at landscape scales. Wildfire has been aggressively suppressed in this region for the past 40 years resulting in more homogenous vegetation conditions when compared to the historically diverse vegetation mosaic produced by naturally occurring wildfires. Less diverse vegetation types and structures can result in reduced moose habitat quality. Each of the management plans were informed by the results of the landscape assessment and integrate the objectives of expanding the role of wildfire in desired outlying areas, improving moose habitat, producing biomass for use by the nearby communities, and protecting high value caribou habitat. An additional objective to support the carbon sequestration program of Ahtna, Inc. was added towards the end of the project. This report summarizes the results of the landscape assessment and presents the management plans for each of the 8 tribal communities and surrounding Ahtna lands.

Objectives

The primary objectives of this project include:

1. Conducting an ecologically-based landscape assessment for the region that includes Ahtna lands;
2. Developing an ecological site classification as the foundation for evaluating vegetation changes and wildlife habitat quality;
3. Developing management plans for each of the 8 tribal communities and the larger Ahtna, Inc. landholdings to:
   - Improve moose habitat through mechanical treatments;
   - Evaluate and recommend an expanded use of prescribed burning or let-burn wildfire areas;
   - Increase opportunities for moose harvest through selection of habitat improvement areas to attract moose into accessible sites;
   - Produce biomass through mechanical treatments for use as a local fuel;
   - Protect caribou habitat quality and berry production areas;
   - Maintain ecosystem integrity within the project area, and;
   - Support carbon sequestration goals.

Project Area

The Ahtna Traditional Use Territory consists of 26,589,244 acres or 41,500 square miles which encompasses the Copper River, Upper Susitna River, Upper Matanuska River, Upper White River and the headwaters of several watershed flowing north from the Alaska Range into the Tanana River. The Traditional Use Territory contains the 18,639,897 acre Ahtna Regional Corporation boundary established under the Alaska Native Claims Settlement Act (ANCSA) of 1971. Figure 1 shows both boundaries and their location in Alaska relative to the major river basins and population centers.

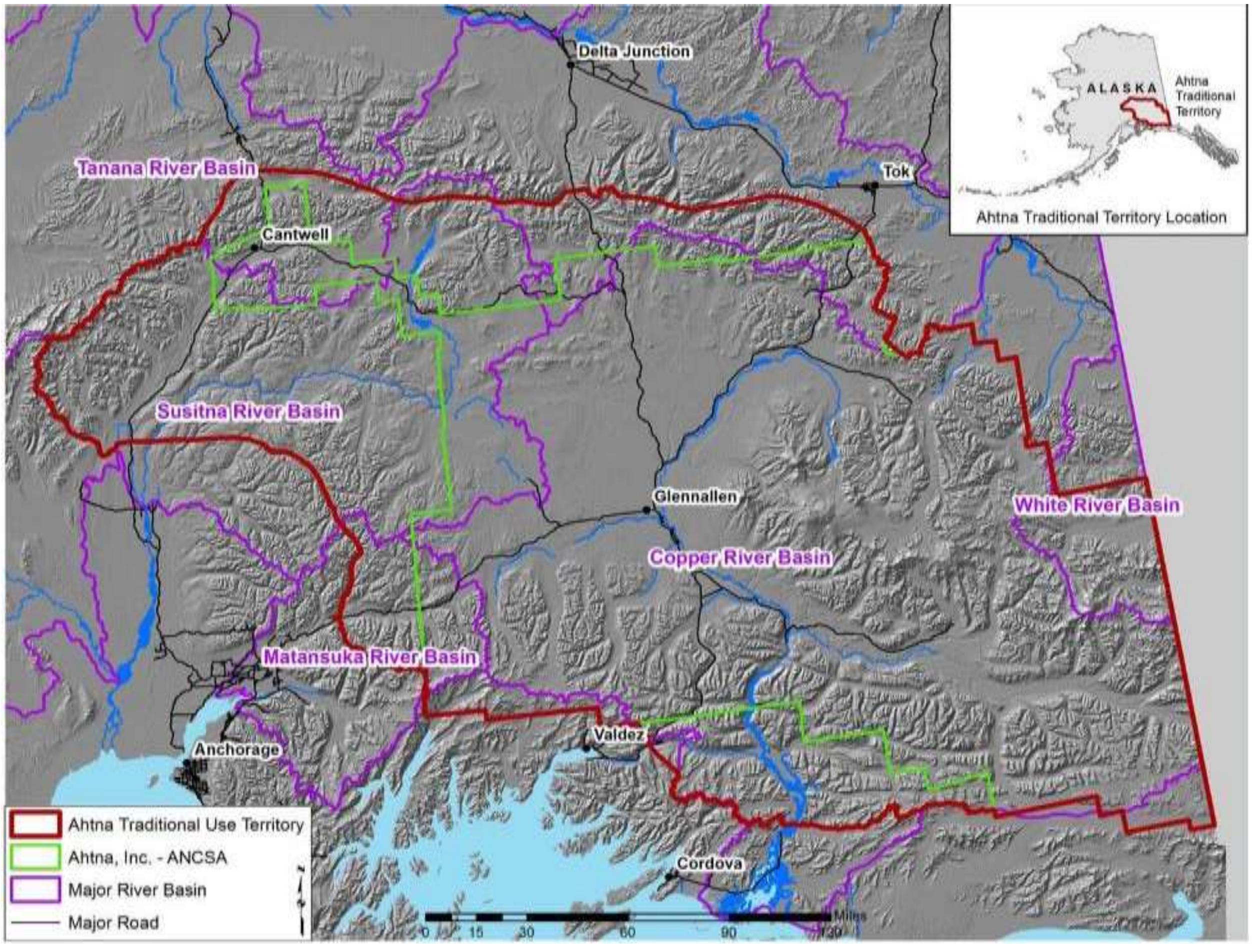


Figure 1. Ahtna Traditional Use Territory and Ahtna Regional Corporation boundary in Alaska.

Surface land ownership in the area is divided among several Federal agencies, the State of Alaska, Ahtna, Inc., Chitina Native Corporation, other native corporations, municipal government, and individual, private landowners. Figure 2 identifies surface ownership in the Ahtna Traditional Use Territory. Table 1 displays surface ownership by acreage for each landowner.

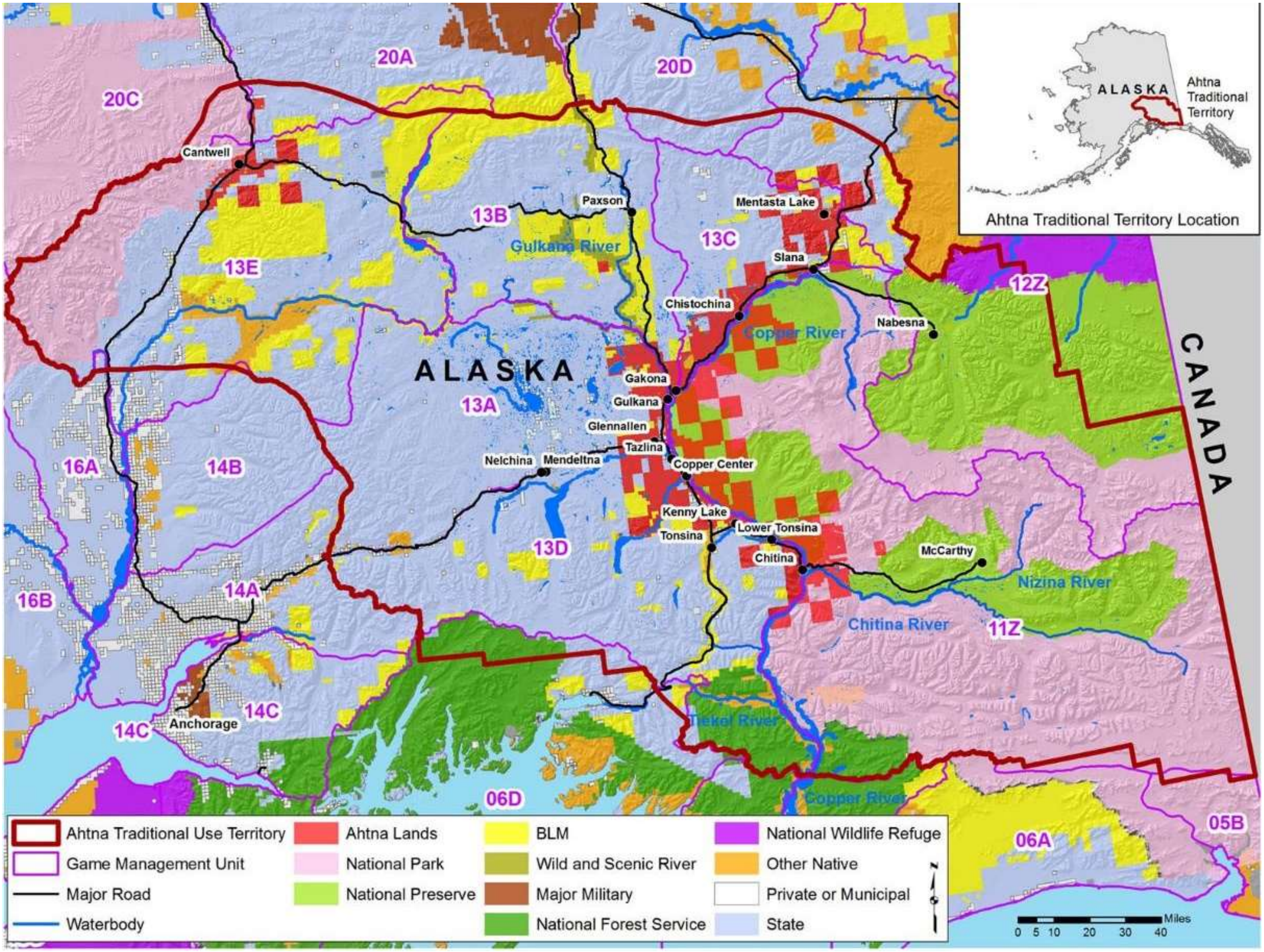


Figure 2. Surface land ownership in the Ahtna Traditional Use Territory.

Table 1. Surface landownership by acreage for each landowner in the Ahtna Traditional Use Territory.

Landowner	Acres
Ahtna, Inc.	1,470,422
Ahtna, Inc. - Selected Lands	224,278
Chitina Native Corporation	105,782
Other Native Corporation	402,917
Native Allotments	32,988
Bureau of Land Management	2,924,640
United States Forest Service	817,447
National Park Service	12,504,014
United States Fish and Wildlife Service	143,663
Municipal Land	262
State of Alaska	11,012,926
Private	375,887

Land management and planning objectives vary based on the missions, needs, and goals of each landowner. Federal land managers within the project area include Bureau of Land Management (BLM), US Forest Service (USFS), US Fish and Wildlife Service (USFWS), and National Park Service (NPS). In addition, the Natural Resource Conservation Service (NRCS) provides assistance for land management on both private and public land.

NPS is the largest surface landowner in the project area. Their mission (specifically Wrangell St. Elias and Denali National Parks and Preserves) is to ensure NPS lands are properly administered for the enjoyment and education of the people, to protect their natural environment, and to assist state and local governments and citizen groups in the development of park areas. The specific mission of Wrangell St. Elias is, "preserve and protect ecological integrity and heritage resources of a vast ecosystem in southcentral Alaska, while providing for public use in a wilderness setting. Wrangell St. Elias, at 13.2 million acres, was specifically designated to encompass an area large enough to include a diverse range of scenery, high latitude biomes, and landscape-scale processes where man is considered an integral part of the ecosystem. Ecosystem integrity and carefully planned public use is essential so there is opportunity for the continuation of subsistence lifestyles, future scientific investigations, interpretation of natural forces, and the inspiration and solitude of wilderness experience for present and future generations. Compatible public uses and increased access, where appropriate, will be promoted to the extent that the quality of the experience and the natural and cultural resources are maintained." The specific mission of Denali is, "protect intact, the globally significant Denali ecosystems, including their cultural, aesthetic, and wilderness values, and ensure opportunities for inspiration, education, research, recreation and subsistence for this and future generations."

The state of Alaska is the second largest landowner and is primarily managed by the Department of Natural Resources, Division of Forestry. The mission of the Division of Forestry is to develop, conserve, and enhance Alaska's forests to provide a sustainable supply of forest resources for Alaskans. This is done by, "protecting water quality, fish and wildlife habitat, and other forest values through appropriate forest practices and administration of the Forest Resources and Practices Act; managing a wildland fire program on public, private, and municipal lands; encouraging development of the timber industry and forest products markets; conducting timber sales for personal and commercial use and for fuel-wood; administering the Community Forestry, Conservation Education, Forest Health, and Stewardship programs; and giving technical assistance to forest landowners.

BLM is the third largest landowner and their mission is to sustain the health, diversity, and productivity of public lands for the use and enjoyment of present and future generations. This is accomplished through multiple-use management objectives that strive to strike a balance between healthy, sustainable ecosystems, the protection of natural, cultural, and historical resource values, and a wide range of public values and uses.

The USFS is the fourth largest landowner (Chugach National Forest) in the region and their mission "is to sustain the health, diversity, and productivity of the Nation's forests to meet the needs of present and future generations. The USDA Forest Service provides leadership in the protection, management, and use of the Nation's forest, rangeland, and aquatic ecosystems. Our ecosystem approach to management integrates ecological, economic, and social factors to maintain and enhance the quality of the environment to meet current and future needs. Through implementation of land and resource management plans, the agency ensures sustainable ecosystems by restoring and maintaining species diversity and ecological productivity that helps provide recreation, water, timber, minerals, fish, wildlife, wilderness, and aesthetic values for current and future generations of people."

Ahtna, Inc. and Chitina lands combined represent the fifth largest landowner(s) in the region at 1,800,482 acres, when including lands selected for transfer from Federal ownership to Ahtna, Inc. ownership. Their objectives for land management have been discussed previously

The Tetlin National Wildlife Refuge is located in the northeast corner of the planning area and represents a small (<1%) portion of the overall planning region. The mission of the USFWS (specifically Tetlin National Wildlife Refuge) "is to conserve fish and wildlife populations and habitats in their natural diversity, to provide interpretation and environmental education to the public and to provide subsistence hunting opportunities to rural inhabitants

While not a landowner, the NRCS provides an important technical assistance role in land management for this region. The mission of the NRCS is to help people help the land. The NRCS endeavors to, "improve the health of our Nation's natural resources while sustaining and enhancing the productivity of American agriculture. We achieve this by providing voluntary assistance through strong partnerships with private landowners, managers, and communities to conserve, protect, restore, and enhance the lands and waters upon which people and the environment depend." The NRCS is an important partner for public and private entities in implementing conservation practices and other on the ground management.

Geology

The geology of the Ahtna Traditional Use Territory was described in part in the Copper River Basin Soil Survey. Rocks in the area consist of schist, greenstone, graywacke, shale, and sandstone and andesite bedrock of Pleistocene age occurs in the southcentral part of the area. During Pleistocene glaciations (35,000 to 9,000 BP) glaciers covered the entire basin floor. During much of the glaciation period, ice dammed the channel of the Copper River through the Chugach Mountains forming a large proglacial lake in the central basin. "Lacustrine sediments deposited in the lake partially buried older glacial features. Over time, the lake level fluctuated widely, and eventually drained completely approximately 9,000 years ago (Ferrians, Nichols, and Williams 1983)." Following retreat of the glaciers and drainage of the lake, permafrost formed in many lacustrine and glacial deposits. In addition, rivers incised canyons in the lacustrine and glacial sediments, and loess began to accumulate. Tarr and Martin (Tarr and Martin 1913) provided a detailed description of the geology of the Copper River Basin, noting that nearly all of the basin was derived from glacial deposits that are 500- 700 ft. deep and in some places more than 1000 ft. deep. They reported some locations containing clay deposits likely deposited from glacial lakes, while other areas supported sand dunes deposited from windblown sands. Some areas supporting loess or eolian silt contain imbedded vegetation indicating that deglaciation occurred at least 700-1000 years ago.

Climate

The climate of the area was described in the Copper River Basin Soil Survey. This report stated: "The climate of the Copper River basin is subarctic continental characterized by long cold winters and short warm summers. Mean January temperature is -10 °F (-23 °C); daily low temperatures of -50 °F (-46 °C) or less occur frequently during the winter and may last for two or more weeks. Mean July temperature is 56 °F (13 °C); daily high temperatures on occasion exceed 85 °F (30 °C). Although the daily minimum temperature in summer averages in the forties, freezing temperatures have been recorded in every month…. the length of the growing season varies greatly from year to year. Mean annual precipitation across the basin ranges from 8 to 17 inches (23 to 41 cm). Of this, about 38 percent is received as rain during the growing season, which lasts from early June through the end of August. Thunderstorm activity is common during the early summer. During many years, a lack of precipitation in May and June results in a soil moisture deficit during the period of plant emergence. Average annual snowfall is 47 inches (119 cm) at Old Edgerton Farms in the Kenny Lake area and 49 inches (124 cm) at Glennallen. Although snowfall varies greatly from year to year, at least 1 inch (2.5 cm) of snow is on the ground an average of 180 days per year. Continuous sunlight and twilight occur from early June through mid-July. Day length at the winter solstice is less than 5 hours long. Prevailing wind at Gulkana airfield is from the southeast at 6.8 miles per hour (10.9 km per hour)."

Soils

Limited mapping has been done for soils in the Copper Data. Figure 3 displays both existing soil mapping and projected soil mapping to be completed by NRCS in coming years. Additional information about soil texture and soil drainage can be found in the individual village planning sections.

Permafrost

A significant factor influencing the vegetation in the landscape is the occurrence of permafrost under some of the project area. The Copper River Basin Soil Survey described the role of permafrost as "Permafrost, or perennially frozen ground, underlies most of the Copper River basin. The depth at which it occurs and its ice content varies widely. Permafrost characteristically occurs as ice crystals disseminated throughout the soil. Although not extensive near the soil surface, massive ice wedges and lenses do occur in the subsoil in some areas. A perched water table and saturated conditions are common above the permafrost during the summer due to restricted drainage. The fire history of the site and the thickness of the insulating organic layer on the soil surface control depth to permafrost and water table, in part. Disturbance of the organic layer usually results in increased soil temperatures and a lowering of the permafrost level. As permafrost thaws, a large volume of water is released. Variation in the ice content of the permafrost and the rate of thawing results in differential subsidence of the soil surface and slumping on steeper slopes. The occurrence of permafrost requires special consideration when selecting lands for clearing and agriculture and during construction of roads and buildings."

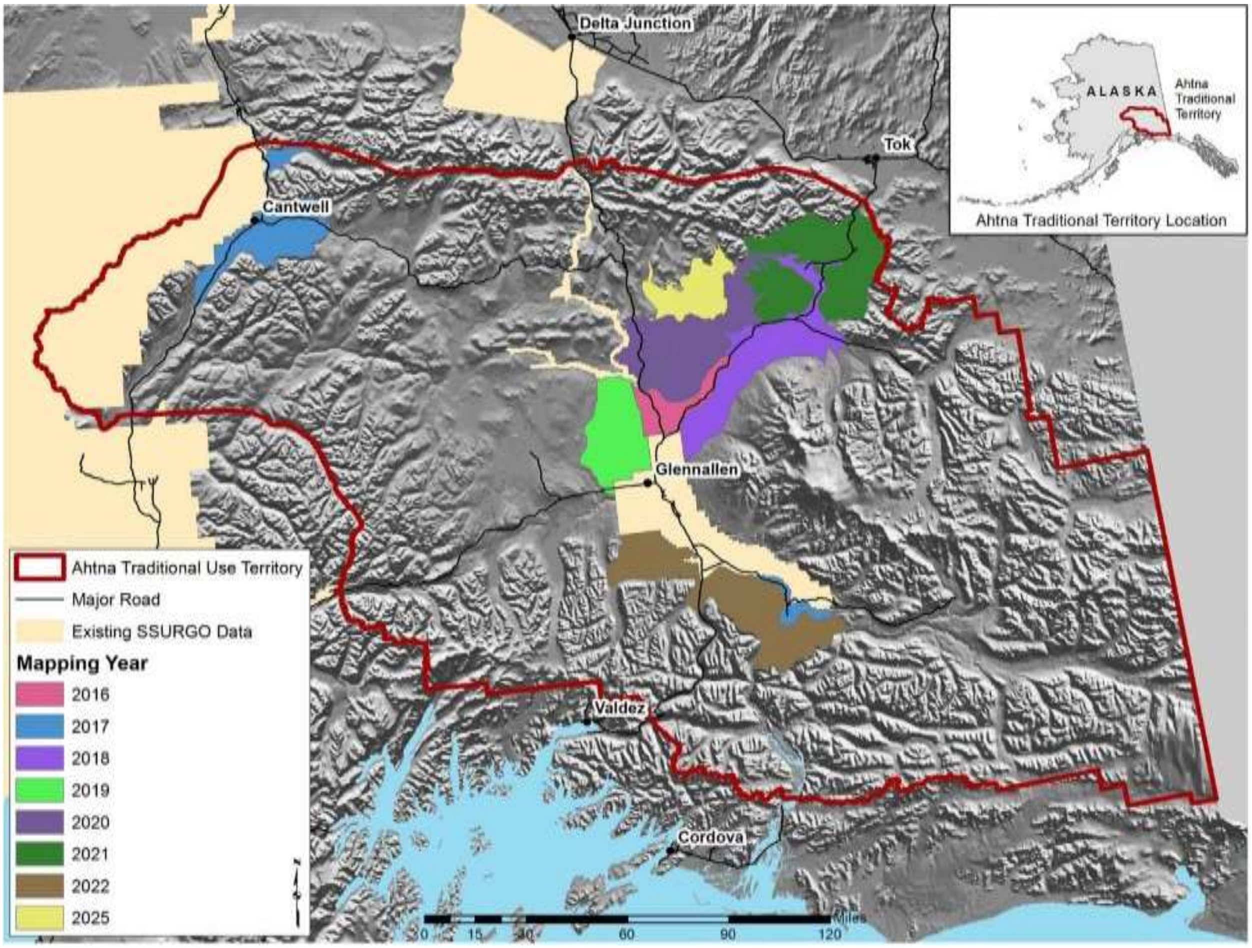


Figure 3. Existing and proposed soil mapping in the Ahtna Traditional Use Territory. Data from NRCS, Palmer Office.

Vegetation Description

The Copper River Basin Soil Survey provided a general description of the vegetation occurring in the Tazlina project area. It stated: "The vegetation of the survey area is boreal forest, similar to elsewhere in Interior Alaska. Boreal forest consists of a mosaic of vegetation types reflecting the combined effects of landform, topographic position, soil type, and the occurrence of past fires. The Copper River basin has a long history of frequent wildfires. Between 1900 and 1950, an average of 10,000 acres burned annually, although this average has been reduced with improved fire protection measures (Barney 1969) (Figure 4). High-intensity crown fires that typically kill entire stands characterize the natural fire regime (Viereck and Schandlemeier 1980). Stands are then replaced through natural regeneration. Forest types on productive well-drained sites include white spruce, mixed white spruce-aspen, mixed white spruce-balsam poplar, aspen, and, in the southern end of the survey area, mixed white spruce/paper birch. Stunted black spruce and white spruce forests of low productivity occur on north facing slopes and cold, wet sites with shallow permafrost. Following forest fires, willow shrub dominates most sites until eventually replaced by forest vegetation. Where topographic and soil conditions inhibit tree growth, shrub and herbaceous vegetation develop. Seasonally flooded riverwash on the floodplains of major rivers supports dense alder shrub. Willow and ericaceous shrub occupy bogs, fens, and narrow drainages. Wet sedge meadows are common on the margins of lakes and ponds. Steppe vegetation, characteristic of semi-arid areas elsewhere in northeastern Asia and northwestern North America (Murry et al. 1983), is found on steep south-facing terrace escarpments."

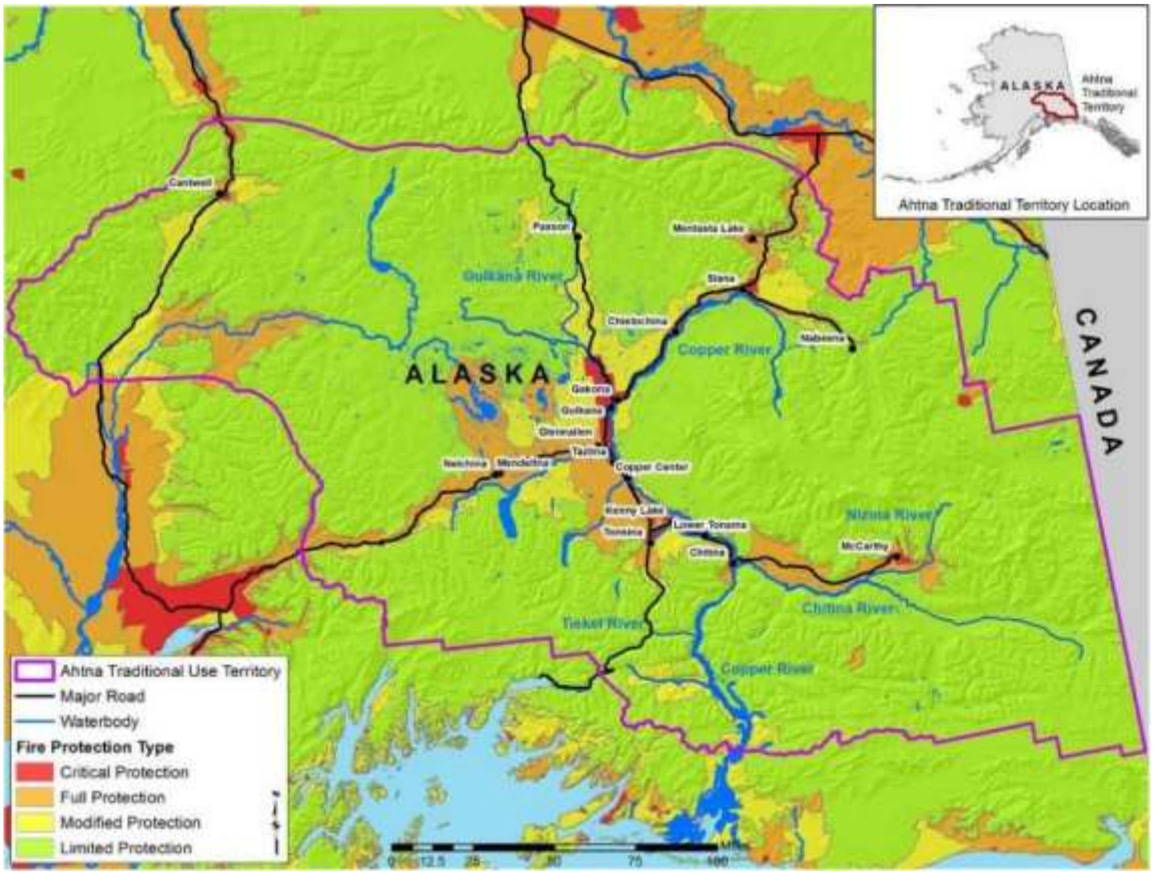


Figure 4. Current fire protection classes in Ahtna Traditional Use Territory. Data from Alaska Interagency Coordination Center.

Disturbance Factors

As mentioned in reference to permafrost and vegetation, fire is a disturbance factor influencing the plant and animal ecology in the project area. Although the level of fire occurring in this southcentral Alaska landscape is substantially less than occurs in more interior areas of Alaska north of the Alaska Range, fire is still a significant disturbance to plant and animal communities when it occurs. Lynch et al. (2004) estimated mean fire return intervals for the Copper River Basin as between 150-210 years, substantially longer than for many other areas of Alaska. Figure 5 displays the average density of lightning strikes in the project area for the period 1986 to 2014. Figure 6 shows the type and location of fire starts for the period 1940 to 2014. Both of these figures illustrate the contrasting density gradients resulting from the much higher numbers of lightning strikes and lightning caused fires close to the Alaska Range and the lower numbers in the more southerly portions of the Copper River Basin.

On most sites, fire serves to set back vegetation succession. It can also burn off the organic material at the ground surface, including peat that can occur on many sites. This can influence the thermal layer protecting the underlying permafrost on some sites, causing it to melt (thermokarst) and change the underlying site conditions through this process. In addition to fire, riparian areas are also influenced by flooding and ice events. These serve to set back succession of vegetation in riparian areas, and can also change the underlying site conditions, particularly in the case of significant flooding events. Insects and disease are another disturbance factor influencing ecosystems in the Copper River Basin. Figure 7 displays areas that have been disturbed by fire or insects for the period 1989 to 2010.

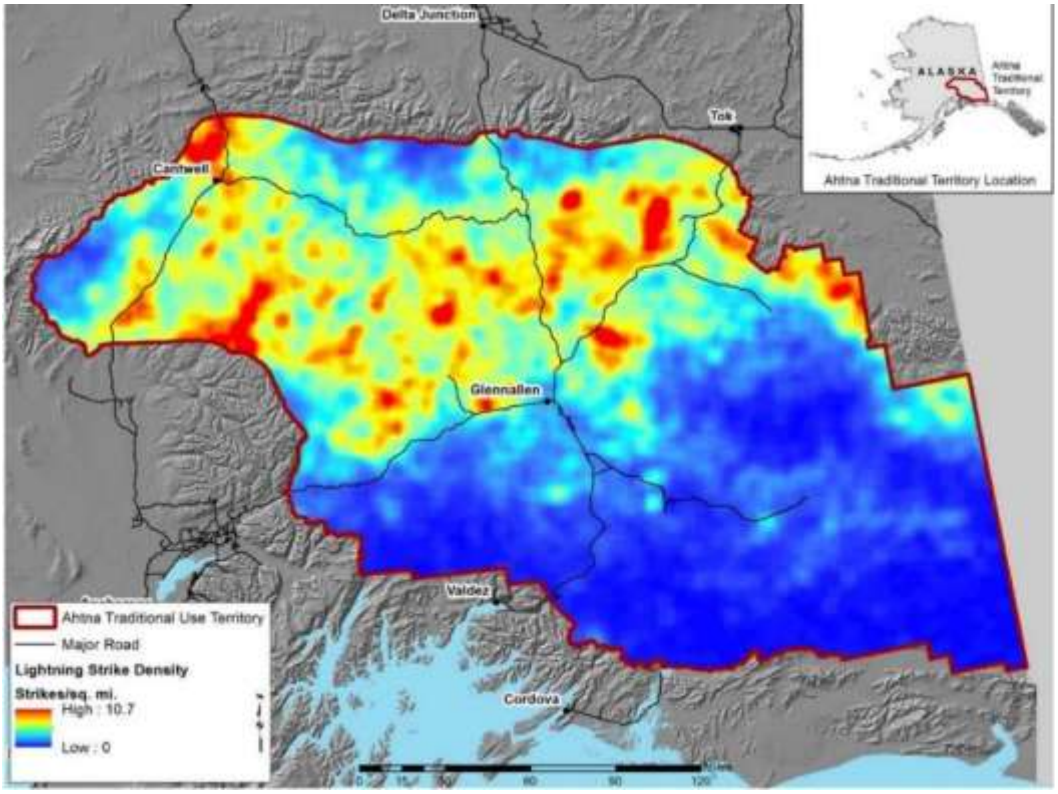


Figure 5. Lightning strike density for the period 1986 to 2014, in the Ahtna Traditional Use Territory. Data from Alaska Interagency Coordination Center.

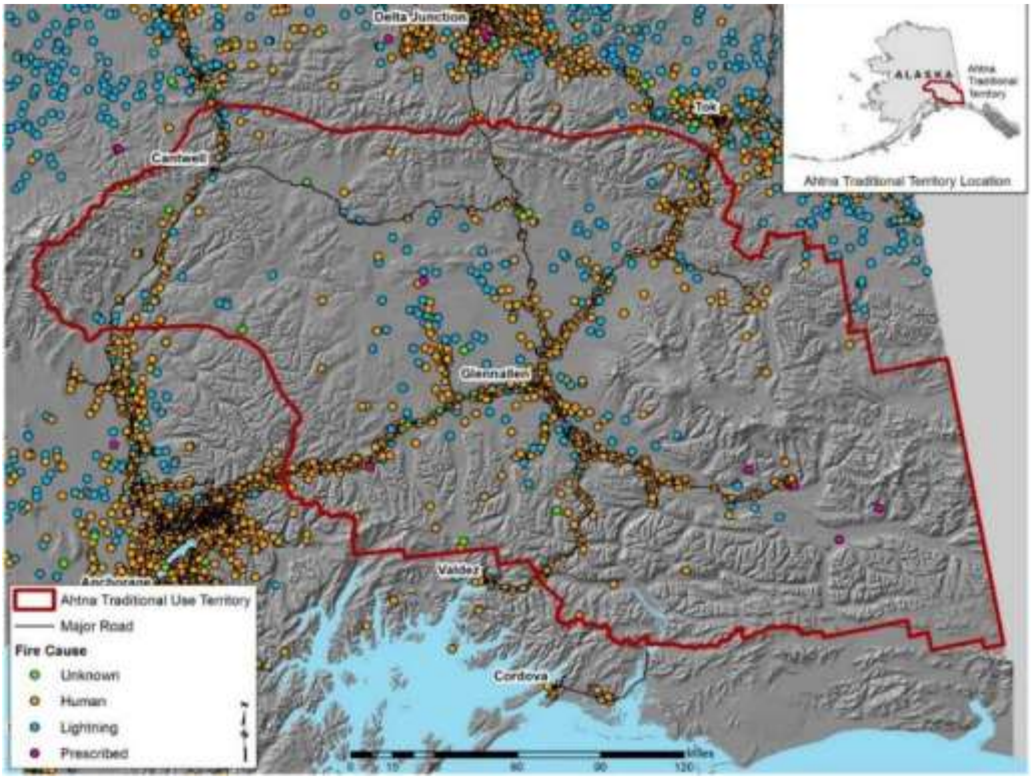


Figure 6. Fire start locations for the period 1940 to 2014, in the Ahtna Traditional Use Territory. Data from Alaska Interagency Coordination Center.

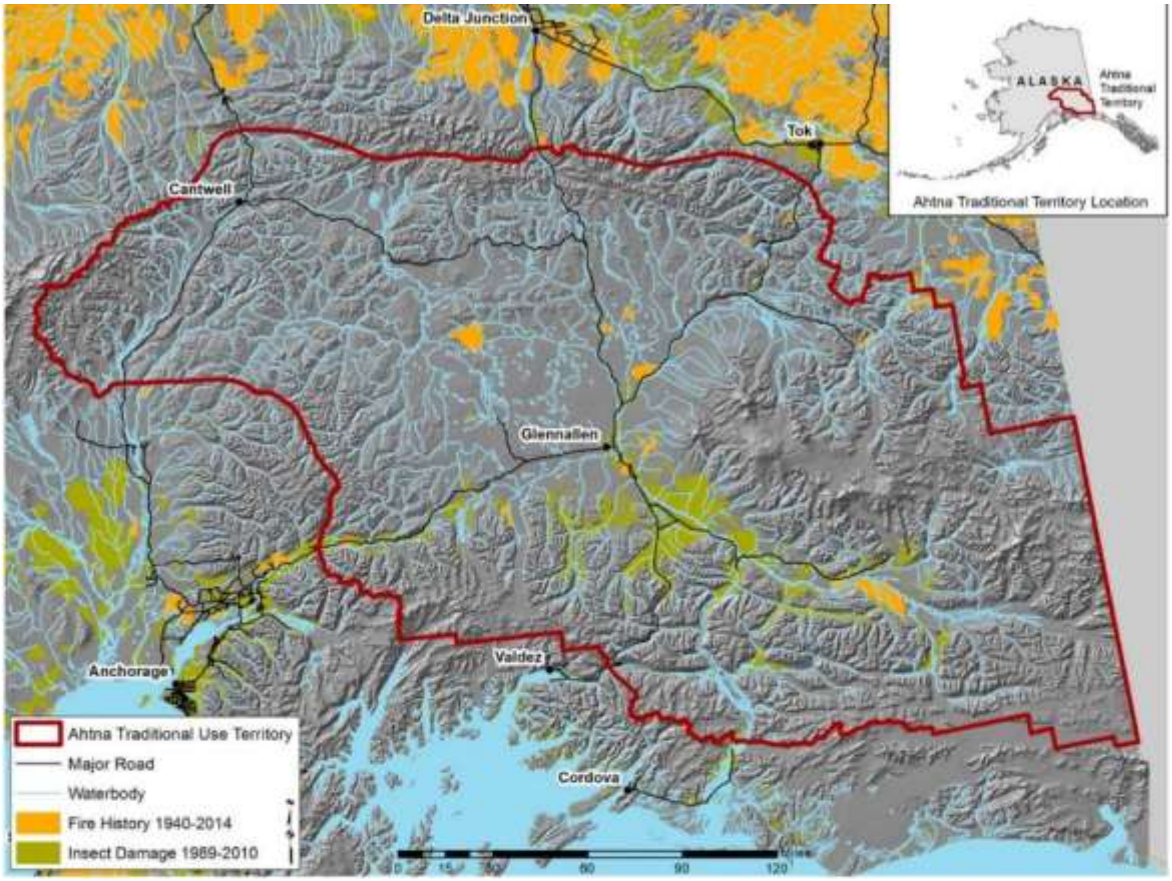


Figure 7. Wildfire occurrence for the period 1940 to 2014 and insect damage for the period 1989 to 2010, in the Ahtna Traditional Use Territory.

Ecosystem Diversity

A landscape assessment was conducted for the project area to describe and quantify ecosystem diversity for terrestrial and riparian and wetland systems. To support this effort, an ecosystem-based landscape classification system was developed and mapped in a GIS for use by CRITR and Ahtna. An ecosystem is considered a specific plant community defined by abiotic setting as well as its species composition and structure in response to normal successional and/or disturbance processes, and is thus a very specific description of a repeating vegetation community and its associated abiotic environment. Ecological site is a term frequently used by land managers and landscape ecologists to classify and delineate the abiotic environment and will be used in this assessment for that purpose. Disturbance class will be the term used to classify and delineate the species composition and structure for a vegetation community in response to typical successional and/or disturbance processes occurring on an ecological site. The combination of a single ecological site with a single disturbance class will be referred to as an ecosystem and all of the ecosystems occurring in a defined ecoregion will be referred to as the ecosystem diversity for that ecoregion. The following sections provide more detail on ecological sites, disturbance classes, and ecoregions for the Ahtna Traditional Use Territory landscape assessment, as well as a tool used to describe and quantify this ecosystem diversity within an ecoregion.

Ecoregions

The Ahtna Traditional Use Territory was divided into discrete ecoregions using Natural Resources Conservation Service's (NRCS) Major Land Resource Areas (MLRA's) (https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ak/soils/surveys/?cid=nrcs142p2_035911) (Figure 8). Ecosystem diversity frameworks were developed separately for each of these MLRA's. The ecosystem diversity was then characterized within each MLRA using vegetation data specific to that MLRA and for each ecological site found within the MLRA such as described for disturbance class.

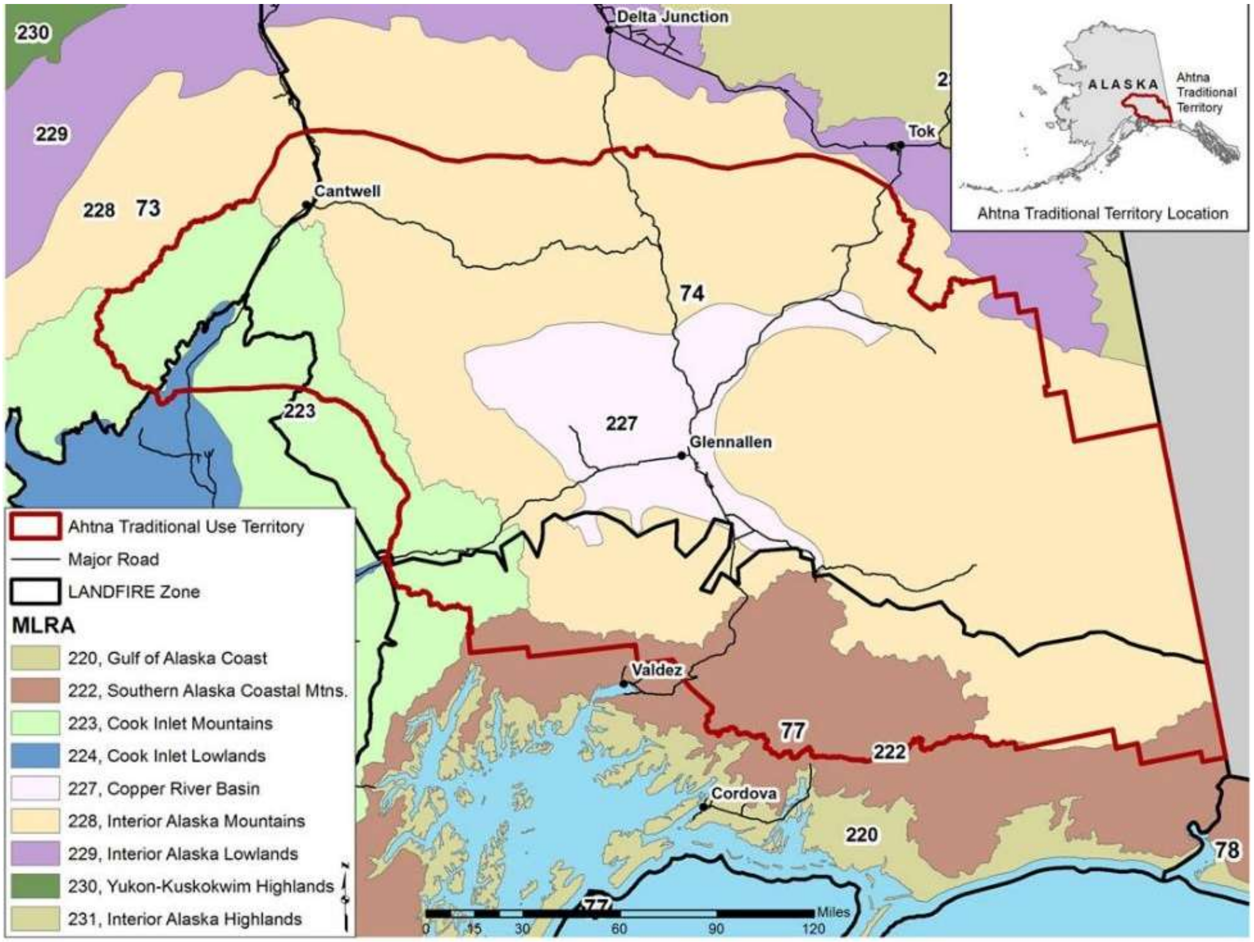


Figure 8. LANDFIRE zones and NRCS Major Land Resource Area (MLRA) in the Ahtna Traditional Use Territory.

Ecological Sites

Several different types of existing classification systems were considered for use as ecological sites in this assessment. We selected the biophysical setting classification used in LANDFIRE as it could be applied across the entire project area which included 26.5 million acres of the Ahtna Traditional Use Territory in Southcentral Alaska. LANDFIRE described each biophysical setting (BpS) within delineated ecoregions and then developed coarse maps of the locations of each ecological site. A number of inaccuracies were discovered in the LANDFIRE mapping of the ecological site designations and corrections were made where we could identify obvious errors to produce an improved map. The ecological site classification was stratified by both LANDFIRE zone and NRCS MLRA as shown in Figure 8. For the remainder of this report, ecological site will be used in place of biophysical setting (BpS) as a more generic term to classify the abiotic setting.

Disturbance Class

Once the classification of ecological sites was defined and mapped within each MLRA, ecological site state and transition models were used to classify and describe disturbance classes among each specific ecological site. Due to the differences in successional and disturbance processes influencing terrestrial, grass and shrub, and riparian and wetland systems, a different ecosystem diversity framework was developed for each of these 3 systems. The ecosystem diversity frameworks applied to each of the MLRAs occurring in the Ahtna Traditional Use Territory and surrounding landscape, are provided in a later section.

To classify and describe existing conditions, disturbance class was then mapped to the extent possible with existing remotely-sensed data and information. While LANDFIRE has mapped existing disturbance classes, its accuracy was found to be insufficient for this project. Instead, we used existing vegetation mapping developed by the Wrangell-Saint Elias National Park (WRST NP) for the eastern portion of the project area and existing vegetation mapping developed by Michael Fleming and hosted by the Geographic Information Network of Alaska (GINA) for the western portion (Figure 9), and created a decision tree in Microsoft Access to crosswalk these classifications of vegetation to disturbance classes. In addition, existing vegetation mapping from Alaska Department of Natural Resources (AK DNR) and soil data from the NRCS (SSURGO) was used to further define the vegetation classification. An example of the crosswalk decision tree for an upland forested ecological site is shown in Figure 10.

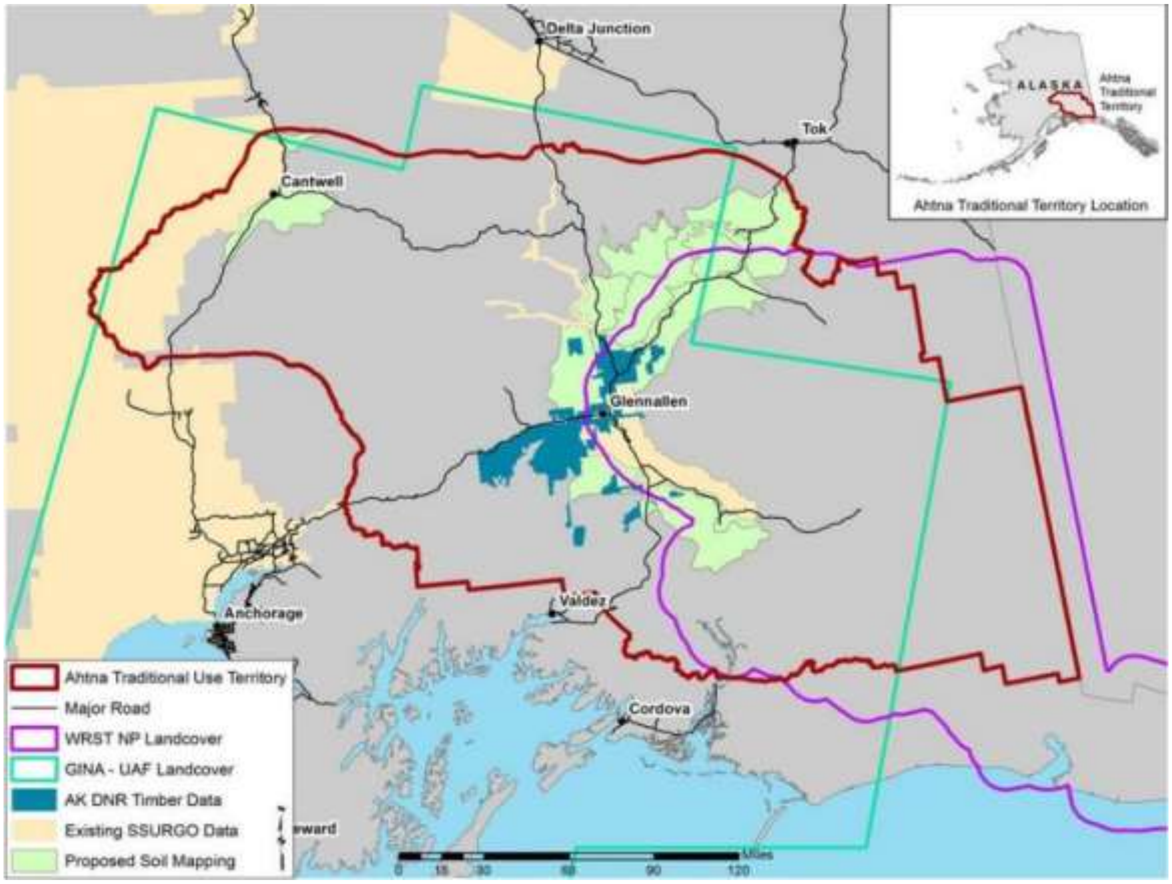


Figure 9. Data sources for existing vegetation data used to determine disturbance class in the Ahtna Traditional Use Territory. See text for description of data sources.

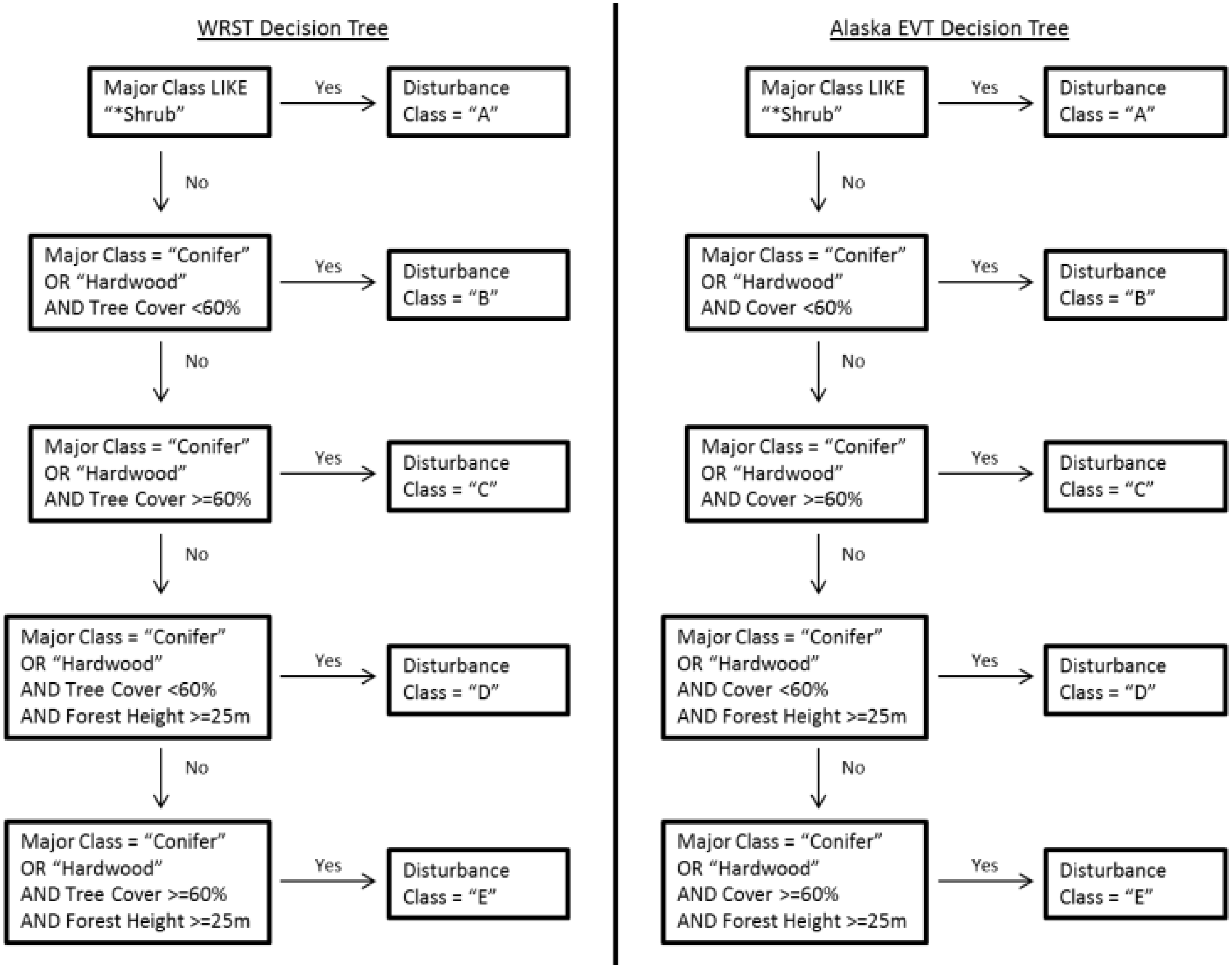


Figure 10. Example decision tree for ecological site 16790 (White Spruce-Hardwood – SubBoreal). The primary difference between WRST and Alaska EVT is that tree cover was estimated from plot data in WRST and only total cover was available from LANDFIRE for Alaska EVT.

Ecosystem Diversity Framework

A tool called the ecosystem diversity framework was used in this project to illustrate and capture all of the ecosystem classification components for an ecoregion. The framework is presented in a matrix format and the primary ecosystem classification components are represented by the intersection of ecological site, structure/sizeclass, and canopy cover. The combination of structure/sizeclass and canopy cover in the framework represents the disturbance class (i.e., A, B, C, D, and E; from LANDFIRE). The matrix “cells” in the framework represent the total ecosystem diversity for the defined ecoregion. To reduce the complexity and provide more consistency within a framework, four ecosystem diversity frameworks were developed for each ecoregion to represent upland forested, upland grass and shrub, riparian forested, and riparian grass and shrub systems.

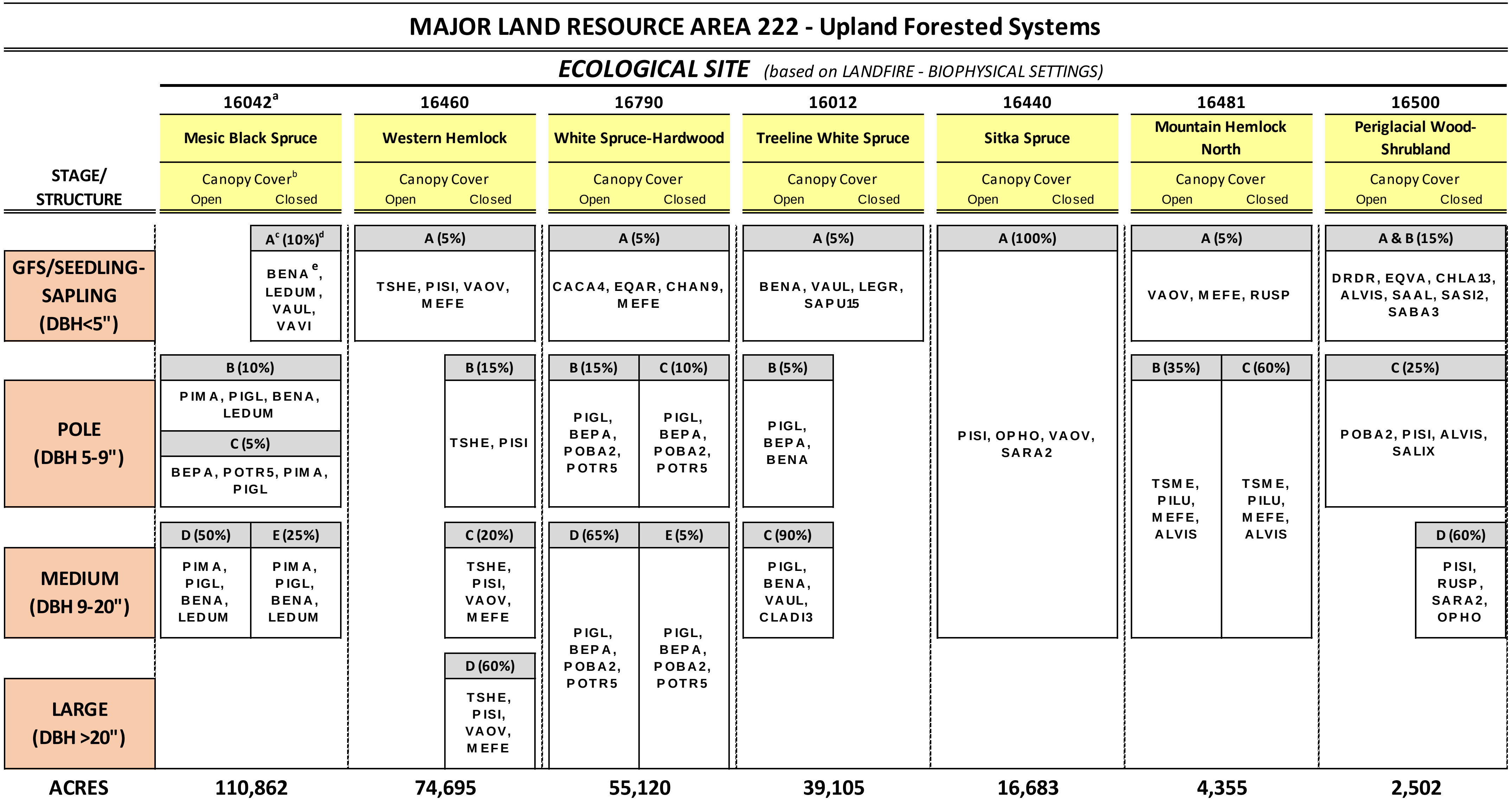
The ecosystem diversity framework includes the following important labeling and classification definitions with references to supporting tables:

a. Ecological sites are labeled using ecological site codes as developed for LANDFIRE. See Appendix A, Table A-1 for code definitions. Only those ecological sites with greater than 10,000 acres in the targeted ecoregion, were included in the ecosystem diversity framework. Table A-1 provides a complete list of ecosystems and the number of acres in each MLRA for the project area.
b. Canopy cover class is defined as Open = 10 to 59% and Closed ≥ 60%
c. Disturbance class codes are A, B, C, D, and E and represents the combination of structure/sizeclass and canopy cover class as defined by LANDFIRE for disturbance processes occurring on an ecological site. Structure/sizeclass definitions are provided in the framework, where applicable.
d. Estimated average historical amounts (%) of an ecosystem (ecological site x disturbance class) within an overall ecological site, are provided based on the results of LANDFIRE models.
e. Each ecosystem also includes the primary plant species expected to occur due to the combination of an ecological site and disturbance class. Due to space limitations, species codes are used (Source: PLANTS.gov) as defined in Appendix A, Table A-2 for reference.

The total acres of each ecological site occurring in an ecoregion are presented below each ecological site column. To estimate the average number of historical acres, multiply the total acres by the historical percentages for each disturbance class within an ecological site. The ecosystem diversity framework is also used to quantify the estimated amounts of today’s ecosystem diversity for comparison to estimated historical amounts. Historical estimates are compared with today’s estimates and are presented in the discussions of reference conditions and current conditions using the best available information.

Upland Forested Ecosystem Diversity

An ecosystem diversity framework for upland forested systems occurring in the Ahtna Traditional Use Territory are provided for MLRA 222, MLRA 223, MLRA 227, and MLRA 228 in figures 11, 12, 13, and 14, respectively. Tree canopy cover greater than or equal to 10% was required to qualify as forested conditions. On average, upland forested systems are not influenced seasonally or longer by the presence of surface or subsurface water to support riparian or wetland vegetation. In addition, only ecological sites representing greater than 10,000 acres within an ecoregion were included in the frameworks. Within the Ahtna Traditional Use Territory, 5.65 million acres are classified as upland forested systems. The primary disturbance processes on these sites are wildfire, insects, and disease and all of these occur concurrently and influence frequency and severity. In the following sections, a more detailed description of each ecological site and its disturbance processes was developed using LANDFIRE, unless otherwise noted with additional citations in the text.



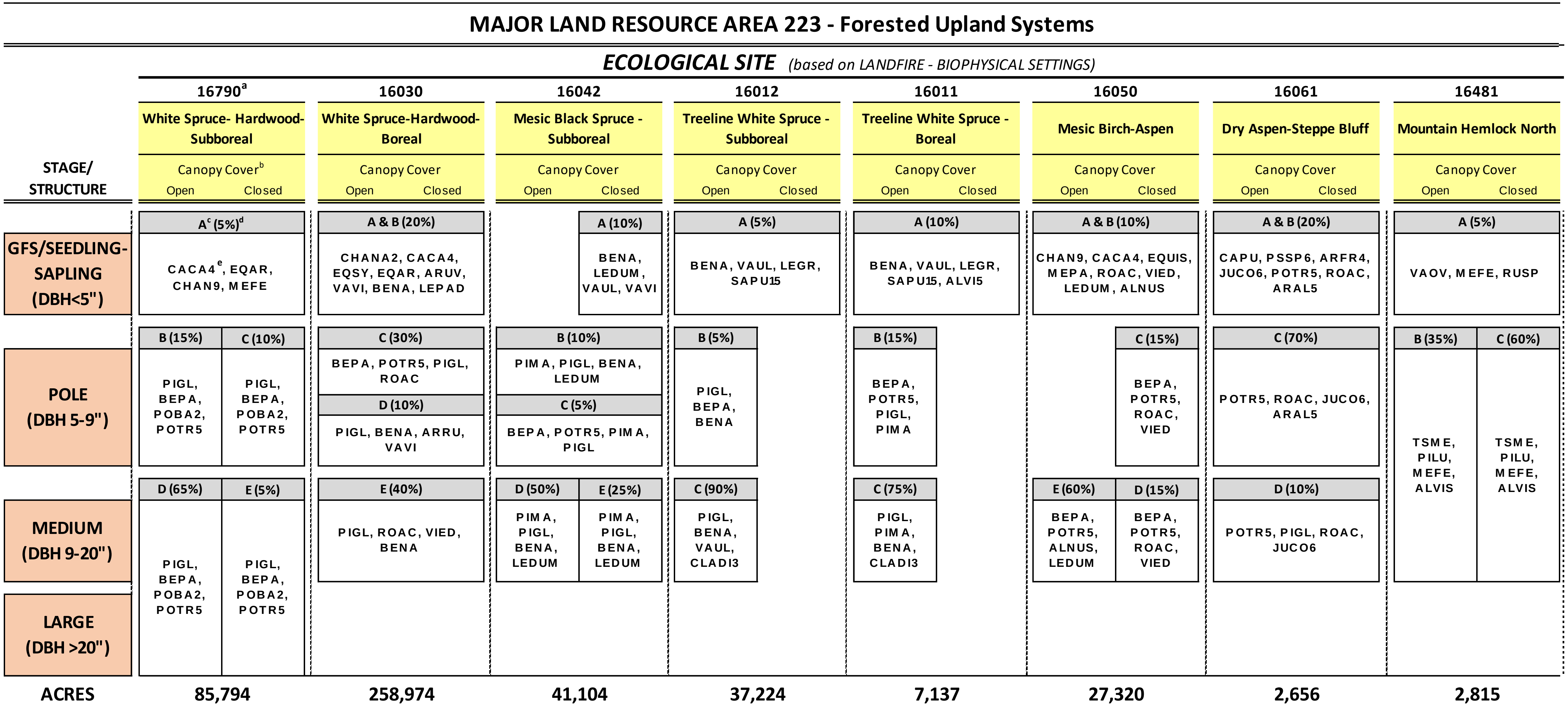
MAJOR LAND RESOURCE AREA 222 - Upland Forested Systems

ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

	16042[a]		16460		16790		16012		16440		16481		16500	
	Mesic Black Spruce		**Western Hemlock**		**White Spruce-Hardwood**		**Treeline White Spruce**		**Sitka Spruce**		**Mountain Hemlock North**		**Periglacial Wood-Shrubland**	
STAGE/ STRUCTURE	Canopy Cover[b]		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover	
	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed
GFS/SEEDLING-SAPLING (DBH<5")		A[c] (10%)[d] BENA[e], LEDUM, VAUL, VAVI	A (5%) TSHE, PISI, VAOV, MEFE		A (5%) CACA4, EQAR, CHAN9, MEFE		A (5%) BENA, VAUL, LEGR, SAPU15		A (100%) PISI, OPHO, VAOV, SARA2		A (5%) VAOV, MEFE, RUSP		A & B (15%) DRDR, EQVA, CHLA13, ALVIS, SAAL, SASI2, SABA3	
POLE (DBH 5-9")	B (10%) PIMA, PIGL, BENA, LEDUM C (5%) BEPA, POTR5, PIMA, PIGL			B (15%) TSHE, PISI	B (15%) PIGL, BEPA, POBA2, POTR5	C (10%) PIGL, BEPA, POBA2, POTR5	B (5%) PIGL, BEPA, BENA				B (35%) TSME, PILU, MEFE, ALVIS	C (60%) TSME, PILU, MEFE, ALVIS	C (25%) POBA2, PISI, ALVIS, SALIX	
MEDIUM (DBH 9-20")	D (50%) PIMA, PIGL, BENA, LEDUM	E (25%) PIMA, PIGL, BENA, LEDUM		C (20%) TSHE, PISI, VAOV, MEFE	D (65%) PIGL, BEPA, POBA2, POTR5	E (5%) PIGL, BEPA, POBA2, POTR5	C (90%) PIGL, BENA, VAUL, CLADI3							D (60%) PISI, RUSP, SARA2, OPHO
LARGE (DBH >20")				D (60%) TSHE, PISI, VAOV, MEFE										
ACRES	**110,862**		**74,695**		**55,120**		**39,105**		**16,683**		**4,355**		**2,502**	

Figure 11. Ecosystem diversity framework for MLRA 222 – upland forest ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

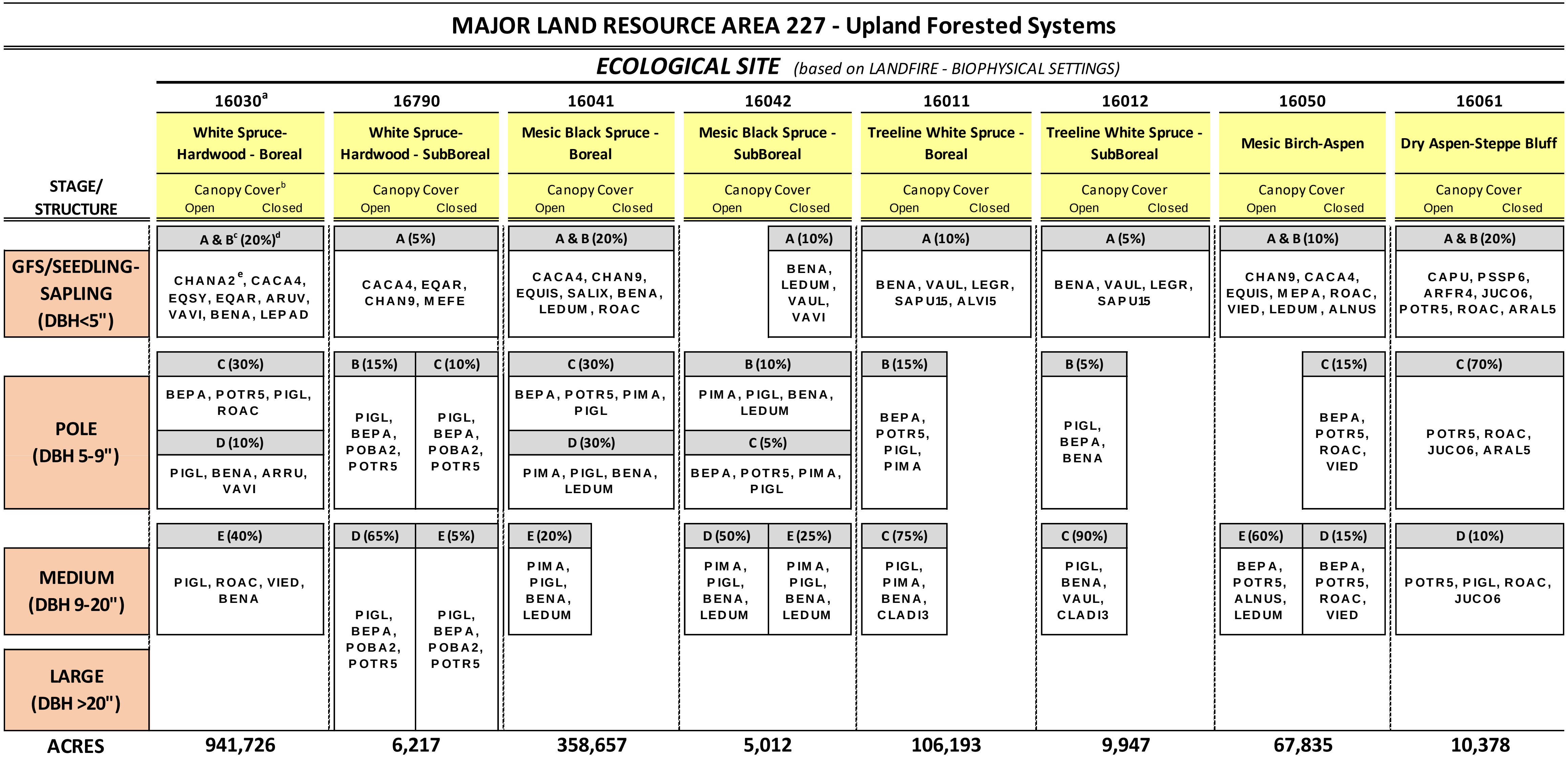
MAJOR LAND RESOURCE AREA 223 - Forested Upland Systems



ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

STAGE/ STRUCTURE	16790[a]		16030		16042		16012		16011		16050		16061		16481	
	White Spruce- Hardwood-Subboreal		White Spruce-Hardwood-Boreal		Mesic Black Spruce - Subboreal		Treeline White Spruce - Subboreal		Treeline White Spruce - Boreal		Mesic Birch-Aspen		Dry Aspen-Steppe Bluff		Mountain Hemlock North	
	Canopy Cover[b]		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover	
	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed
GFS/SEEDLING-SAPLING (DBH<5")	A[c] (5%)[d] CACA4[e], EQAR, CHAN9, MEFE		A & B (20%) CHANA2, CACA4, EQSY, EQAR, ARUV, VAVI, BENA, LEPAD			A (10%) BENA, LEDUM, VAUL, VAVI	A (5%) BENA, VAUL, LEGR, SAPU15		A (10%) BENA, VAUL, LEGR, SAPU15, ALVI5		A & B (10%) CHAN9, CACA4, EQUIS, MEPA, ROAC, VIED, LEDUM, ALNUS		A & B (20%) CAPU, PSSP6, ARFR4, JUCO6, POTR5, ROAC, ARAL5		A (5%) VAOV, MEFE, RUSP	
POLE (DBH 5-9")	B (15%) PIGL, BEPA, POBA2, POTR5	C (10%) PIGL, BEPA, POBA2, POTR5	C (30%) BEPA, POTR5, PIGL, ROAC D (10%) PIGL, BENA, ARRU, VAVI		B (10%) PIMA, PIGL, BENA, LEDUM C (5%) BEPA, POTR5, PIMA, PIGL		B (5%) PIGL, BEPA, BENA		B (15%) BEPA, POTR5, PIGL, PIMA			C (15%) BEPA, POTR5, ROAC, VIED	C (70%) POTR5, ROAC, JUCO6, ARAL5		B (35%) TSME, PILU, MEFE, ALVIS	C (60%) TSME, PILU, MEFE, ALVIS
MEDIUM (DBH 9-20")	D (65%) PIGL, BEPA, POBA2, POTR5	E (5%) PIGL, BEPA, POBA2, POTR5	E (40%) PIGL, ROAC, VIED, BENA		D (50%) PIMA, PIGL, BENA, LEDUM	E (25%) PIMA, PIGL, BENA, LEDUM	C (90%) PIGL, BENA, VAUL, CLADI3		C (75%) PIGL, PIMA, BENA, CLADI3		E (60%) BEPA, POTR5, ALNUS, LEDUM	D (15%) BEPA, POTR5, ROAC, VIED	D (10%) POTR5, PIGL, ROAC, JUCO6			
LARGE (DBH >20")																
ACRES	**85,794**		**258,974**		**41,104**		**37,224**		**7,137**		**27,320**		**2,656**		**2,815**	

Figure 12. Ecosystem diversity framework for MLRA 223 – upland forest ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.



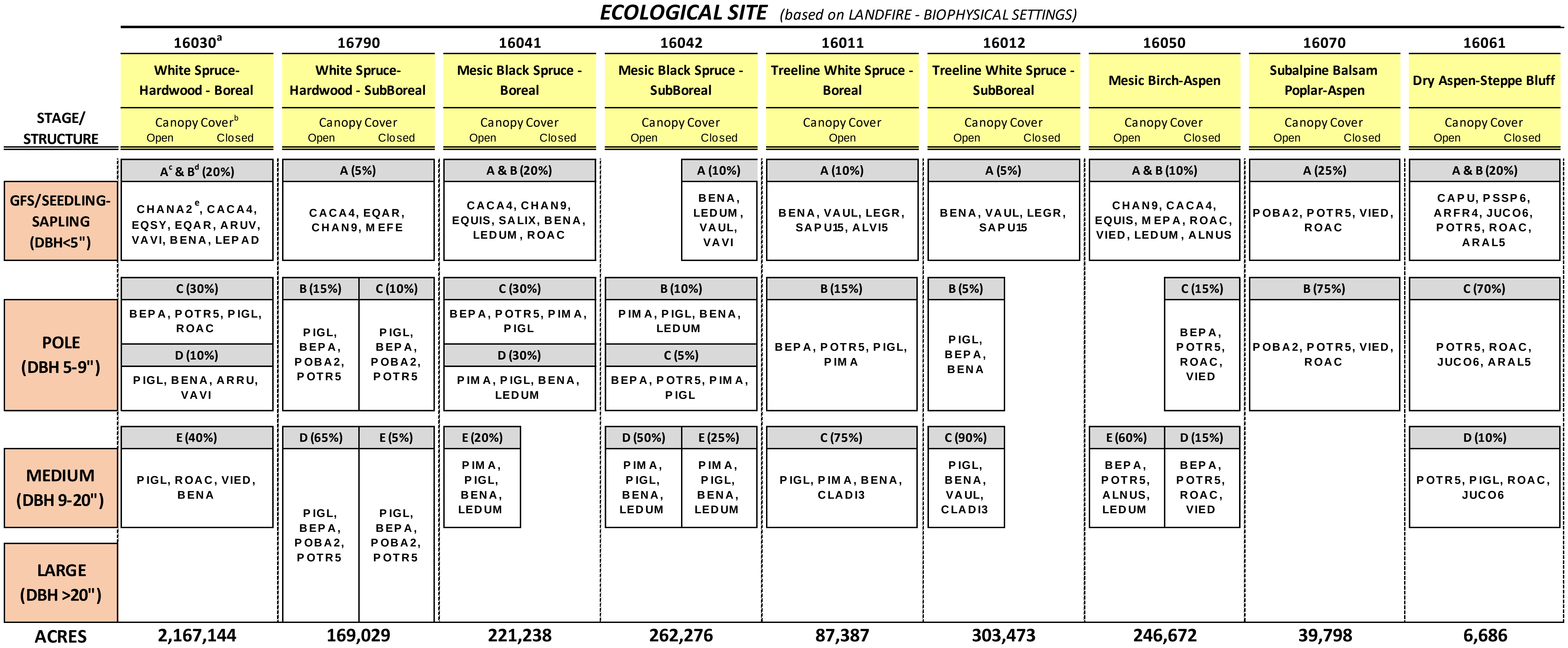
MAJOR LAND RESOURCE AREA 227 - Upland Forested Systems

ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

STAGE/ STRUCTURE	16030[a]		16790		16041		16042		16011		16012		16050		16061	
	White Spruce-Hardwood - Boreal		White Spruce-Hardwood - SubBoreal		Mesic Black Spruce - Boreal		Mesic Black Spruce - SubBoreal		Treeline White Spruce - Boreal		Treeline White Spruce - SubBoreal		Mesic Birch-Aspen		Dry Aspen-Steppe Bluff	
	Canopy Cover[b]		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover	
	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed
GFS/SEEDLING-SAPLING (DBH<5")	A & B[c] (20%)[d] CHANA2[e], CACA4, EQSY, EQAR, ARUV, VAVI, BENA, LEPAD		A (5%) CACA4, EQAR, CHAN9, MEFE		A & B (20%) CACA4, CHAN9, EQUIS, SALIX, BENA, LEDUM, ROAC			A (10%) BENA, LEDUM, VAUL, VAVI	A (10%) BENA, VAUL, LEGR, SAPU15, ALVI5		A (5%) BENA, VAUL, LEGR, SAPU15		A & B (10%) CHAN9, CACA4, EQUIS, MEPA, ROAC, VIED, LEDUM, ALNUS		A & B (20%) CAPU, PSSP6, ARFR4, JUCO6, POTR5, ROAC, ARAL5	
POLE (DBH 5-9")	C (30%) BEPA, POTR5, PIGL, ROAC D (10%) PIGL, BENA, ARRU, VAVI		B (15%) PIGL, BEPA, POBA2, POTR5	C (10%) PIGL, BEPA, POBA2, POTR5	C (30%) BEPA, POTR5, PIMA, PIGL D (30%) PIMA, PIGL, BENA, LEDUM		B (10%) PIMA, PIGL, BENA, LEDUM C (5%) BEPA, POTR5, PIMA, PIGL		B (15%) BEPA, POTR5, PIGL, PIMA		B (5%) PIGL, BEPA, BENA			C (15%) BEPA, POTR5, ROAC, VIED	C (70%) POTR5, ROAC, JUCO6, ARAL5	
MEDIUM (DBH 9-20")	E (40%) PIGL, ROAC, VIED, BENA		D (65%) PIGL, BEPA, POBA2, POTR5	E (5%) PIGL, BEPA, POBA2, POTR5	E (20%) PIMA, PIGL, BENA, LEDUM		D (50%) PIMA, PIGL, BENA, LEDUM	E (25%) PIMA, PIGL, BENA, LEDUM	C (75%) PIGL, PIMA, BENA, CLADI3		C (90%) PIGL, BENA, VAUL, CLADI3		E (60%) BEPA, POTR5, ALNUS, LEDUM	D (15%) BEPA, POTR5, ROAC, VIED	D (10%) POTR5, PIGL, ROAC, JUCO6	
LARGE (DBH >20")																
ACRES	941,726		6,217		358,657		5,012		106,193		9,947		67,835		10,378	

Figure 13. Ecosystem diversity framework for MLRA 227 – upland forest ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

MAJOR LAND RESOURCE AREA 228 - Upland Forested Systems



ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

STAGE/ STRUCTURE	16030^a		16790		16041		16042		16011	16012		16050		16070		16061	
	White Spruce-Hardwood - Boreal		White Spruce-Hardwood - SubBoreal		Mesic Black Spruce - Boreal		Mesic Black Spruce - SubBoreal		Treeline White Spruce - Boreal	Treeline White Spruce - SubBoreal		Mesic Birch-Aspen		Subalpine Balsam Poplar-Aspen		Dry Aspen-Steppe Bluff	
	Canopy Cover^b		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover	Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover	
	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Open	Closed	Open	Closed	Open	Closed	Open	Closed
GFS/SEEDLING-SAPLING (DBH<5")	A^c & B^d (20%) CHANA2^e, CACA4, EQSY, EQAR, ARUV, VAVI, BENA, LEPAD		A (5%) CACA4, EQAR, CHAN9, MEFE		A & B (20%) CACA4, CHAN9, EQUIS, SALIX, BENA, LEDUM, ROAC			A (10%) BENA, LEDUM, VAUL, VAVI	A (10%) BENA, VAUL, LEGR, SAPU15, ALVI5	A (5%) BENA, VAUL, LEGR, SAPU15		A & B (10%) CHAN9, CACA4, EQUIS, MEPA, ROAC, VIED, LEDUM, ALNUS		A (25%) POBA2, POTR5, VIED, ROAC		A & B (20%) CAPU, PSSP6, ARFR4, JUCO6, POTR5, ROAC, ARAL5	
POLE (DBH 5-9")	C (30%) BEPA, POTR5, PIGL, ROAC D (10%) PIGL, BENA, ARRU, VAVI		B (15%) PIGL, BEPA, POBA2, POTR5	C (10%) PIGL, BEPA, POBA2, POTR5	C (30%) BEPA, POTR5, PIMA, PIGL D (30%) PIMA, PIGL, BENA, LEDUM		B (10%) PIMA, PIGL, BENA, LEDUM C (5%) BEPA, POTR5, PIMA, PIGL		B (15%) BEPA, POTR5, PIGL, PIMA	B (5%) PIGL, BEPA, BENA			C (15%) BEPA, POTR5, ROAC, VIED	B (75%) POBA2, POTR5, VIED, ROAC		C (70%) POTR5, ROAC, JUCO6, ARAL5	
MEDIUM (DBH 9-20")	E (40%) PIGL, ROAC, VIED, BENA		D (65%) PIGL, BEPA, POBA2, POTR5	E (5%) PIGL, BEPA, POBA2, POTR5	E (20%) PIMA, PIGL, BENA, LEDUM		D (50%) PIMA, PIGL, BENA, LEDUM	E (25%) PIMA, PIGL, BENA, LEDUM	C (75%) PIGL, PIMA, BENA, CLADI3	C (90%) PIGL, BENA, VAUL, CLADI3		E (60%) BEPA, POTR5, ALNUS, LEDUM	D (15%) BEPA, POTR5, ROAC, VIED			D (10%) POTR5, PIGL, ROAC, JUCO6	
LARGE (DBH >20")																	
ACRES	2,167,144		169,029		221,238		262,276		87,387	303,473		246,672		39,798		6,686	

Figure 14. Ecosystem diversity framework for MLRA 228 – upland forest ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

Treeline White Spruce Woodland - Boreal Ecological Site (16011)

This ecological site covers an estimated 199,970 acres of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this site covers an estimated 15,813 acres. It is primarily found north of the Alaska Range, but occurs in pockets throughout the Copper River Basin. This site occurs at the elevational limit of tree growth and can occur as a fairly thin band in the transition zone between forested and grass/shrub types. Fire is the primary disturbance to this ecological site, with a mean fire return interval estimated at 100 years.

For approximately the first 24 years following disturbance, this ecological site falls within an herbaceous and shrub vegetation class. Shrubs typically will resprout following fire and white spruce (*Picea glauca*) begins to re-establish from seeds that come from adjacent stands or remaining trees. The shrub layer is dominated by *Betula nana*, with *Vaccinium uliginosum*, *Ledum groenlandicum* and *Salix pulchra* being common. In some stands *Alnus viridis* may be the dominant shrub. The dominant ground cover is usually feathermoss or *Cladina* spp. This class was estimated to have historically occurred on 10% of this ecological site, however this amount may be lower in the Copper River Basin with the lower amounts of fire occurring in this landscape compared to other areas in Alaska supporting this ecological site such as north of the Alaska Range.

For the period of 25-69 years post disturbance there are two possible successional paths for this type. The first path (occurring in 4% of stands) is dominated by a hardwood or white spruce-hardwood forest. In this class, *Betula papyrifera* and *Populus tremuloides* gain canopy dominance over the shrubs. In some cases, canopy dominance is shared with white spruce. Forest canopy cover is generally between 10-25%. Eventually hardwoods begin to die out and white spruce gains canopy dominance. The hardwood class was estimated to historically occur on 15% of this ecological site.

The second successional path from the herbaceous and shrub class is directly to a white spruce dominated class. This is the most common successional path for this ecological site and is the climax vegetation class for this type. This class is dominated by white spruce with canopy cover from 10-25%. The understory includes a variety of low shrubs, herbs, and mosses. As the stand ages, lichens (primarily *Cladina* spp.) become more prevalent. This state was estimated to occur across 75% of this ecological site under historical fire regimes.

Vegetation plots for the Treeline White Spruce Woodland-Boreal ecological site were sampled by Ahtna in the planning landscape. The results of this sampling are presented in Table 2. Both the hardwood and white spruce dominated classes have a total carbon availability of 91.2 tons/acre and an annual production of 0.064 tons/acre. There are approximately 44 tons of biomass available per acre. Photos depicting different vegetation stands in the Treeline White Spruce Woodland-Boreal ecological site are found in Figures 15-17.

Table 2. Vegetation characteristics expressed as mean and standard deviation (parenthesis) for canopy cover (% Cover), trees per acre (TPA), and basal area from plots sampled in the Treeline White Spruce Woodland-Boreal ecological site within the project area. Structure definitions include GFS=grass/forb/shrubs; Seed/Sapling=trees <5" DBH; Dwarf Shrub=shrubs < 1 m in height; Medium Shrub=shrubs 1-3 m in height; Tall Shrub=shrubs >3m in height; Pole=trees 5-9" DBH; Medium=trees 9-20" DBH; Large=trees >20" DBH; HWD= hardwood dominated.

ECOSYSTEM	STAGE/ STRUCTURE	DWARF SHRUB	MEDIUM SHRUB	TALL SHRUB	LICHEN	SEED/ SAPLING	POLE	MEDIUM	LARGE	SEED/ SAPLING	POLE	MEDIUM	LARGE
		% Cover (StDev)				TPA (StDev)				Basal Area (StDev)			
16011-A	GFS	11.5 (13.4)	30.5 (11.6)	21.1 (11.8)	0.1 (0.7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
16011-B	POLE-HWD	0 (0)	5.0 (0)	50.5 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Figure 15. Example of ecosystem 16011-A in Ahtna Traditional Use Territory (LANDFIRE Photo).

Figure 16. Example of ecosystem 16011-C in Ahtna Traditional Use Territory (LANDFIRE Photo).

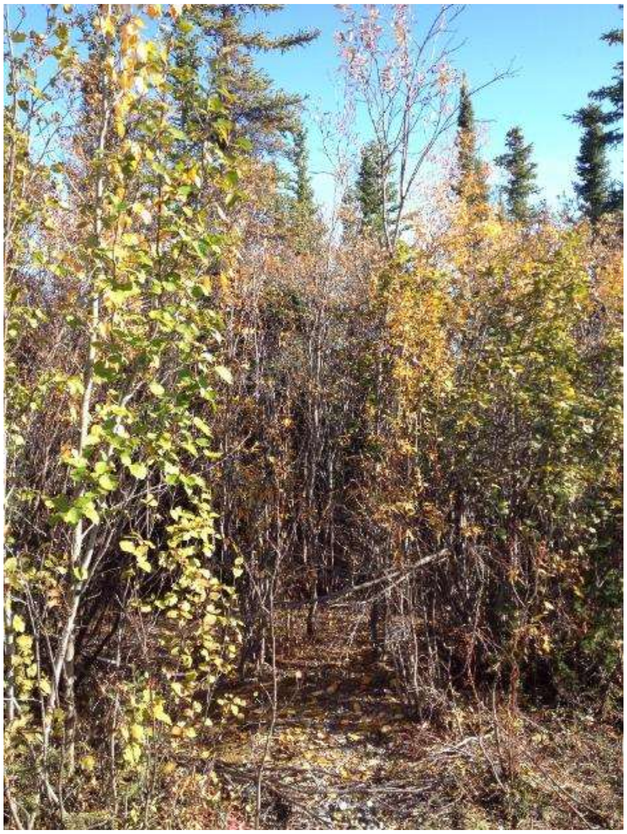


Figure 17. Example of ecosystem 16030-B in Ahtna Traditional Use Territory.

Treeline White Spruce Woodland – Sub-boreal (16012)

This ecological site covers an estimated 386,651 acres of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 28,297 acres. This ecological site is primarily found south of the Alaska Range, and occurs throughout the Copper River Basin. This type occurs at the elevational limit of tree growth and can occur as a fairly thin band in the transition zone between forested and grass/shrub types. Fire is the primary disturbance to this ecological site, with a mean fire return interval estimated at 300 years. Spruce bark beetles are also a disturbance factor, especially where fires are more restricted. Spruce bark beetle outbreaks have been reported and mapped in the Copper River Basin.

For approximately the first 24 years following disturbance this type falls within an herbaceous and shrub vegetation class. Shrubs typically will resprout following fire and white spruce (*Picea glauca*) begins to reestablish from seeds that come from adjacent stands or remaining trees. The shrub layer is dominated by *Betula nana*, with *Vaccinium uliginosum*, *Ledum groenlandicum* and *Salix pulchra* being common. In some stands *Alnus viridis* may be the dominant shrub. The dominant ground cover is usually feathermoss or *Cladina* spp. This class was estimated to have historically occurred on 5% of this ecological site.

For the period of 25-69 years post disturbance there are two possible successional paths for this type. The first path (occurring in 4% of stands) is dominated by a hardwood or white spruce-hardwood forest. In this class, *Betula papyrifera* and *Populus tremuloides* gain canopy dominance over the shrubs. In some cases, canopy dominance is shared with white spruce. Forest canopy cover is generally between

10-25%. Eventually hardwoods begin to die out and white spruce gains canopy dominance. The hardwood historically occurred on 5% of this ecological site.

The second successional path from the herbaceous and shrub class is directly to a white spruce dominated class. This is the most common successional path for this ecological site and is the climax vegetation class for this type. This class is dominated by white spruce with canopy cover from 10-25%. The understory includes a variety of low shrubs, herbs, and mosses. As the stand ages, lichens (primarily *Cladina* spp.) become more prevalent. This state was estimated to occur across 90% of this ecological site under historical fire regimes.

Both the hardwood and white spruce dominated classes have a total carbon availability of 91.2 tons/acre and an annual production of 0.064 tons/acre. There are approximately 44 tons of biomass available per acre.

White Spruce Hardwood - Boreal (16030)

This ecological site covers an estimated 3,346,867 acres of the Ahtna Traditional Use Territory, and is the dominant ecological site in the project area. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 482,283 acres. Fire is the primary disturbance to this ecological site, with a mean fire return interval estimated at 150 years, but with considerable variation. Spruce beetle may also be a disturbance factor, especially where fires are more restricted. Spruce beetle outbreaks have been reported and mapped in the Copper River Basin.

Following fire, an herbaceous disturbance class will occur for approximately 5 years depending on fire severity. Common species include: *Chamerion angustifolium*, *Calamagrostis canadensis*, *Equisetum sylvaticum, E. arvense, Geocaulon lividum, Mertensia paniculata and Pyrola* ssp. (Viereck et al. 1992). This disturbance class was estimated to have historically occurred on 5% of this ecological site, however this amount may be lower in the Copper River Basin with the lower amounts of fire occurring in this landscape compared to other areas in Alaska supporting this ecological site such as north of the Alaska Range.

A shrub and sapling disturbance class will typically occur from 5-29 years post-fire. Common shrubs include *Rosa acicularis, Viburnum edule, Betula nana, Ledum palustre ssp. Decumbens, L. groenlandicum, Vaccinium vitis-idaea, V. uliginosum, Empetrum nigrum,* and also trembling aspen saplings (Viereck et al. 1992). With low severity fire, plants may regenerate from underground propagules, while with high severity fire establishment from seeding will occur. Sites with high amounts of regenerating aspen will be high quality foraging areas for moose. This disturbance class is estimated to have historically occurred on 15% of this ecological site, but again may be lower in the Copper River Basin due to lower amounts of fire. Peters et al. (2005) reported that white spruce regeneration in mixed hardwood sites was influenced by whether a site burned in a year with high amounts of masting by white spruce. They found that when a site burned concurrent with a masting year, substantially more white spruce regenerated on the site than if a fire occurred 1-3 years prior to a masting year. However, Peters et al. (2005) studied initial versus delayed regeneration of white spruce and found little relationship between fire and masting as a major influence on whether a site had initial regeneration or delayed regeneration of white spruce. They suggested that fire severity played an important role in addition to other finer scale site factors.

An intermediate disturbance class occurring from 30-129 years post-fire is a mixed hardwood and spruce type. It has a mix of white spruce, black spruce, and aspen, with spruce increasing in dominance as it overtakes aspen which will be getting more decadent. With senescence of the hardwoods, spruce will dominate, with 25-70% canopy cover. This state is estimated to have occurred on up to 30% of the ecological site. When this state is dominated by hardwoods the total carbon availability is 83.6 tons/acre with an annual carbon production of 0.76 tons/acre. There are approximately 41 tons of biomass available per acre. When this state is dominated by spruce the total carbon availability is 91.2 tons/acre with an annual carbon production of 0.064 tons/acre. There are approximately 44 tons of biomass available per acre.

A mature forest state generally occurs >130 years post-fire. This state is characterized by stands of spruce, primarily white spruce but can be mixed with black spruce. The understory includes *Rosa acicularis, Viburnum edule, Shepherdia canadensis, Vaccinium vitis-idaea, Arctostaphylos spp., Linnaea borealis, Chamerion angustifolium and Geocaulon lividum*. On some sites, increasing cover of lichens will occur, specifically various *Cladina* species, which can provide good foraging habitat for caribou. Feathermoss may occur on some sites, particularly following low severity fire, and may keep lichen abundance at lower amounts, but it is less characteristic on this setting than in wetter ecological sites. This state was estimated to have occurred across 40% of this ecological site under historical fire regimes. This state has a total carbon availability of 141.6 tons/acre with an annual carbon production of 0.34 tons/acre. There are approximately 68.3 tons of biomass available per acre.

Vegetation plots for the White Spruce Hardwood-Boreal ecological site were sampled by Ahtna in the planning landscape. The results of this sampling are presented in Table 3. Photos depicting different vegetation stands in the White Spruce Hardwood-Boreal ecological site are found in Figures 18 and 19.

Table 3. Vegetation characteristics expressed as mean and standard deviation (parenthesis) for canopy cover (% Cover), trees per acre (TPA), and Basal Area from plots sampled in the White Spruce Hardwood -Boreal ecological site within the project area. Structure definitions include GFS=grass/forb/shrubs; Seed/Sapling=trees <5” DBH; Dwarf Shrub=shrubs < 1 m in height; Medium Shrub=shrubs 1-3 m in height; Tall Shrub=shrubs >3m in height; Pole=trees 5-9” DBH; Medium=trees 9-20” DBH; Large=trees >20” DBH; HWD= hardwood dominated; CON=Conifer dominated.

ECOSYSTEM	STAGE/ STRUCTURE	DWARF SHRUB	MEDIUM SHRUB	TALL SHRUB	LICHEN	SEED/ SAPLING	POLE	MEDIUM	LARGE	SEED/ SAPLING	POLE	MEDIUM	LARGE
		---------------------% Cover (StDev) --------------------				---------------------- TPA (StDev) ----------------------				-------------------- Basal Area (StDev) ------------------			
16030-A	GFS	6.6 (6.9)	24.2 (27.0)	11.5 (14.4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
16030-B	SEED/SAP	9.1 (9.8)	30.9 (20.7)	19.0 (18.4)	0 (0)	1601.3 (1019.5)	0 (0)	0 (0)	0 (0)	31 (9.8)	0 (0)	0 (0)	0 (0)
16030-C	POLE-HWD	8.2 (12.4)	10.8 (12.5)	9.2 (7.4)	0 (0)	620 (0)	280 (0)	0 (0)	0 (0)	95.1 (0)	74.0 (0)	0 (0)	0 (0)
16030-D	POLE-CON	5.3 (9.8)	26.2 (26.3)	11.2 (13.2)	0 (0)	636.9 (562.8)	175 (111.5)	6 (0)	0 (0)	57.8 (32.2)	41.6 (24.9)	4.0 (1.0)	0 (0)
16030-E	MEDIUM	17.4 (23.3)	39.4 (29.0)	13.8 (16.2)	0.4 (1.0)	462.1 (365.3)	219.1 (120.2)	77.2 (51.6)	17.5 (10.6)	102.6 (47.1)	93.7 (45.5)	57.0 (42.1)	93.1 (91.3)


Figure 18. Example of ecosystem 16030-C in Ahtna Traditional Use Territory.


Figure 19. Example of ecosystem 16030-E in Ahtna Traditional Use Territory.

Mesic Black Spruce- Boreal (16041)

This ecological site occurs across an estimated 579,483 acres of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 125,045 acres. It is characterized by black spruce as the dominant overstory species, but with white spruce also occurring on many sites (Nature Serve 2008). The shrub component is typically *Rosa acicularis, Betula nana, Ledum* spp., *V. uliginosum, Vaccinium vitis-idaea* and *Empetrum nigrum* while the predominant herbaceous species include *Calamagrostis canadensis, Chamerion angustifolium* and *Equisetum* spp. (Nature Serve 2008). Fire is the primary disturbance factor typically resetting the successional process. This ecological site may be difficult to distinguish from the White Spruce Hardwood Boreal Forest type when white spruce occurs mixed with black spruce on mesic black spruce sites.

Early disturbance classes and successional processes are very similar to those of the White Spruce Hardwood Boreal Forest ecological site. Where aspen occurs in younger stands, good foraging areas for moose may be provided. These disturbance classes were estimated to have historically occurred on 20% of this ecological site. Mid successional stages (30-119 years) are dominated by either black spruce which may be mixed with some white spruce with feathermoss occurring in the understory, or occurring as a mixed hardwood and black spruce forest. Tree cover typically ranges from 50-70%. These two states were estimated to have each historically comprised 30% of this ecological site. When this state is dominated by hardwoods the total carbon availability is 83.6 tons/acre with an annual carbon production of 0.76 tons/acre. There are approximately 41 tons of biomass available per acre. When this state is dominated by spruce the total carbon availability is 91.2 tons/acre with an annual carbon production of 0.76 tons/acre. There are approximately 44 tons of biomass available per acre.

Late successional conditions (>120 years old) contain open, old black spruce with tree cover generally less than 60%, with some sites mixed with white spruce. Understories vary from tall or short shrubs, herbaceous species, or mosses and lichens. On some sites, where feathermoss has not predominated in the understories, lichens can increase over time. These sites may become high quality sites for caribou forage. Late successional conditions were estimated to historically occur on 20% of this ecological site. This state has a total carbon availability of 131.1 tons/acre with an annual carbon production of 0.46 tons/acre. There are approximately 63 tons of biomass available per acre.

Vegetation characteristics of the Mesic Black Spruce-Boreal ecological site for the planning landscape are listed in Table 4. Photos depicting different vegetation stands in the Mesic Black Spruce-Boreal ecological site are found in Figures 20-23.

Table 4. Vegetation characteristics expressed as mean and standard deviation (parenthesis) for canopy cover (% Cover), trees per acre (TPA), and Basal Area from plots sampled in the Mesic Black Spruce - Boreal ecological site within the project area. Structure definitions include GFS=grass/forb/shrubs; Seed/Sapling=trees <5” DBH; Dwarf Shrub=shrubs < 1 m in height; Medium Shrub=shrubs 1-3 m in height; Tall Shrub=shrubs >3m in height; Pole=trees 5-9” DBH; Medium=trees 9-20” DBH.

ECOSYSTEM	STAGE/ STRUCTURE	DWARF SHRUB	MEDIUM SHRUB	TALL SHRUB	LICHEN	SEED/ SAPLING	POLE	MEDIUM	SEED/ SAPLING	POLE	MEDIUM
		---------- % Cover (StDev) ----------				---------- TPA (StDev) ----------			---------- Basal Area (StDev) ----------		
16041-B	SEED/SAP	12.9 (15.0)	23.4 (19.9)	11.5 (10.5)	6.5 (16.0)	971.8 (478.9)	10 (0)	0 (0)	25.1 (2.5)	2.06 (0)	0 (0)
16041-D	POLE	14 (18.5)	57.1 (31.9)	14.6 (14.7)	2.2 (5.7)	929 (719.7)	135.4 (78.3)	0 (0)	56.1 (34.9)	29 (18.9)	0 (0)
16041-E	MEDIUM	22.1 (26.7)	58.8 (31.8)	12.2 (15.2)	1.6 (3.9)	632.6 (351.9)	212.3 (110.6)	47.2 (31.7)	84.5 (39.7)	68.51 (40.1)	29.1 (20.9)

Figure 20. Example of ecosystem 16041-B in Ahtna Traditional Use Territory (LANDFIRE Photo).

Figure 21. Example of ecosystem 16041-C in Ahtna Traditional Use Territory.

Figure 22. Example of ecosystem 16041-D in Ahtna Traditional Use Territory (LANDFIRE Photo).

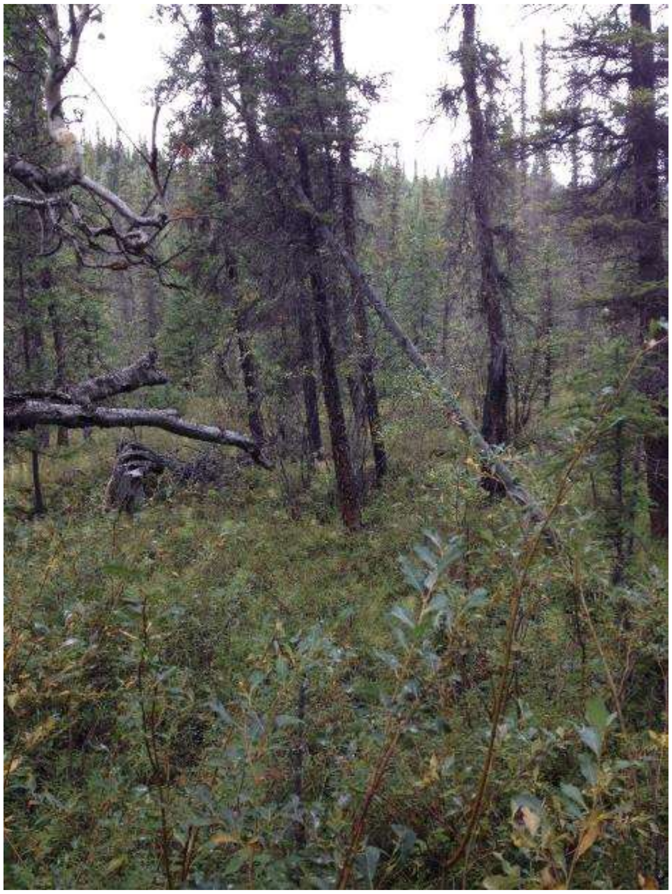


Figure 23. Example of ecosystem 16041-E in Ahtna Traditional Use Territory.

Mesic Black Spruce- Sub-boreal (16042)

This ecological site occurs across an estimated 410,832 acres of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 54,545 acres. This type is typically found south of the Alaska Range. Both black spruce and white spruce are share canopy dominance in mature stands (Nature Serve 2008). The shrub component is typically *Betula nana, Ledum spp., V. uliginosum, Vaccinium vitis-idaea* and *Empetrum nigrum* (Nature Serve 2008). Fire is the primary disturbance factor typically resetting the successional process. The fire return interval is estimated to be around 170 years with a longer interval than boreal sites due to the reduced prevalence of lightning strikes in this area. This ecological site may be difficult to distinguish from the White Spruce Hardwood Boreal Forest type when white spruce occurs mixed with black spruce on mesic black spruce sites.

Early disturbance classes and successional processes are very similar to those of the White Spruce Hardwood Boreal Forest ecological site. Where aspen occurs in younger stands, good foraging areas for moose may be provided. Early successional stages occur from 0-14 years following disturbance and occurred on 10% of the historical landscape.

Mid successional stages (15-75 years) are dominated by either black spruce which may be mixed with some white spruce, or occurring as a mixed hardwood and black spruce forest. Tree cover typically ranges around 60% cover. These two states were estimated to have each historically comprised 30% of this ecological site. When this state is dominated by hardwoods the total carbon availability is 83.6 tons/acre with an annual carbon production of 0.76 tons/acre. There are approximately 41 tons of biomass available per acre. When this state is dominated by spruce the total carbon availability is 91.2 tons/acre with an annual carbon production of 0.064 tons/acre. There are approximately 44 tons of biomass available per acre.

Late successional conditions (>75 years old) also result in two different stand types. The first consists of open, spruce with tree cover generally less than 60%, with some sites mixed with white spruce. Understories vary from tall or short shrubs, herbaceous species, or mosses and lichens. These sites may become high quality sites for caribou forage with the spread of *Cladina* lichen species. This type comprised 50% of historical landscapes in this ecological site. This state has a total carbon availability of 83.6 tons/acre with an annual carbon production of 0.76 tons/acre. There are approximately 41 tons of biomass available per acre.

The second stand type is a closed mature spruce forest. Canopy cover ranges between 60% and 70%. The understory includes various tall shrubs, low shrubs, herbs, mosses, and lichens. This type comprised 25% of historical landscapes in this ecological site. This state has a total carbon availability of 131.1 tons/acre with an annual carbon production of 0.46 tons/acre. There are approximately 63 tons of biomass available per acre.

Mesic Birch Aspen Forest- Boreal (16050)

This ecological site occurs on an estimated 338,288 acres of rolling hills and side slopes of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 84,159 acres. Soils are well drained glacial till, loess, and colluvium (Nature Serve 2008). These sites tend to be warmer and drier than white spruce dominated ecological site sites, and are dominated by aspen in the Copper River Basin with balsam poplar an associated species. Canopy cover ranges from 25-90%. Understory species include *Alnus* spp*., Ledum* spp., *Vaccinium vitisidaea, Betula* *nana, Rosa acicularis, Viburnum edule* and *Equisetum* spp. with feathermoss common as well. Fire is a primary disturbance factor, but tends to occur at longer fire return intervals than spruce stands. This ecological site can serve as a fire break under certain conditions. Leaf miner may be an additional disturbance factor to aspen stands. Seral stages may be difficult to distinguish from those of the White-Spruce Hardwood- Boreal ecological site.

Following fire, herbaceous species including *Chamerion angustifolium, Calamagrostis canadensis, Equisetum sylvaticum, E. arvense, Mertensia paniculata* and *Geocaulon lividum* can occur along with aspen that is propagating from suckers (Viereck and Schandelmeier 1980). This state, lasting approximately 5 years, is estimated to occur on 5% of the ecological site, but again may be less in the Copper River Basin due to the reduced amounts of fire in this landscape. Shrub cover then tends to dominate from 5-14 years post-fire and historically occurred on 5% of this ecological site. Shrubs can include *Alnus* spp., *Ledum* spp., *Vaccinium vitis-idaea, Betula nana, Rosa acicularis, Shepherdia canadensis* and *Viburnum edule* along with aspen. This state may provide good forage habitat for moose.

From 15-49 years, hardwoods, principally aspen but sometimes with balsam poplar, will become the overstory with the shrub species maintaining in the understory. This state was estimated to have historically occupied 15% of the ecological site. Hardwoods mature from 50-99 years, with this state estimated to have occurred on 15% of the ecological site. This state will still maintain a shrub and feathermoss understory. Stands >100 years post-fire historically occurred on 60% of the ecological site and contain old and dying aspen, with resprouting of aspen around dead trees. For all states within this ecological site the estimated available carbon is 129.2 tons per acre with annual carbon production of 1.82 tons per acre. Available biomass is approximately 64 tons per acre.

Vegetation characteristics of the Mesic Birch Aspen Forest-Boreal ecological site for the planning landscape are listed in Table 5. Photos depicting different vegetation stands in the Mesic Birch Aspen Forest-Boreal ecological site are found in Figures 24-26.

Table 5. Vegetation characteristics expressed as mean and standard deviation (parenthesis) for canopy cover (% Cover), trees per acre (TPA), and Basal Area from plots sampled in the Mesic Birch Aspen Forest - Boreal ecological site within the project area. Structure definitions include Seed/Sapling=trees <5" DBH; Dwarf Shrub=shrubs < 1 m in height; Medium Shrub=shrubs 1-3 m in height; Tall Shrub=shrubs >3m in height; Pole=trees 5-9" DBH; Medium=trees 9-20" DBH; Large=trees >20" DBH; OPEN=canopy cover 10-59%, CLOSED=canopy cover >60%.

ECOSYSTEM	STAGE/ STRUCTURE	DWARF SHRUB	MEDIUM SHRUB	TALL SHRUB	LICHEN	SEED/ SAPLING	POLE	MEDIUM	LARGE	SEED/ SAPLING	POLE	MEDIUM	LARGE
		% Cover (StDev)				TPA (StDev)				Basal Area (StDev)			
16050-B	SEED/SAP	2.6 (4.1)	9.1 (14.0)	15.8 (18.1)	0 (0)	250 (0)	0 (0)	0 (0)	0 (0)	12.27 (0)	0 (0)	0 (0)	0 (0)
16050-C	POLE	1.6 (2.9)	38.6 (29.7)	7 (5.7)	0 (0)	712 (314.4)	152 (49)	7 (0)	0 (0)	54.1 (13.4)	29.9 (8.9)	4.28 (0)	0 (0)
16050-D	MEDIUM-OPEN	0 (0)	60 (0)	0 (0)	0 (0)	2615 (0)	115 (0)	65 (0)	0 (0)	151.8 (0)	100 (0)	80 (0)	0 (0)
16050-E	MEDIUM-CLOSED	19.3 (30.1)	55.5 (31.9)	18 (30.0)	0 (0)	274.3 (289.2)	131 (84.5)	59.4 (35.3)	6 (4.2)	61.8 (32.5)	60.4 (31.8)	42.5 (24.5)	15.1 (6.9)

Figure 24. Example of ecosystem 16050-B in Ahtna Traditional Use Territory.

Figure 25. Example of ecosystem 16050-C in Ahtna Traditional Use Territory (LANDFIRE Photo).

Figure 26. Example of ecosystem 16050-D in Ahtna Traditional Use Territory.

White Spruce Hardwood – Sub-boreal (16790)

This ecological site covers an estimated 392,000 acres of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 26,289 acres. Fire is rare in this ecological site, with a mean fire return interval estimated at 600 years, but with considerable variation. Spruce bark beetles are a major disturbance factor as well. Spruce bark beetle outbreaks occur every 50 years on average and result in a thinning of the overstory spruce canopy.

Following fire, an herbaceous and shrub disturbance class will dominate from years 0 to approximately year 29. Common herbaceous species include *Calamagrostis canadensis*, *Equisetum arvense, Dryopteris expansa* and *Gymnocarpium dryopteris*. Common shrub species include *Menziesia ferruginea*, *Alnus viridis* ssp. *sinuata*, *Vaccinium ovalifolium*, *Oplopanax horridus*, *Vaccinium vitis-idaea* and *Linnaea borealis* (Viereck et al. 1992). Some white spruce, aspen, and birch seedlings may be present depending on fire severity. Sites with high amounts of regenerating aspen will be high quality foraging areas for moose. This disturbance class was estimated to have historically occurred on 5% of the ecological site.

An intermediate disturbance class occurring from 30-129 years post-fire is a mixed hardwood and spruce type. There are two pathways for this time frame with one resulting in a more closed canopy (60-100% cover) and the other a more open canopy (25-60% cover). Both classes contain a mix of white spruce, aspen, birch, and poplar with spruce increasing in dominance as it overtakes the hardwoods which become more decadent over time. Common understory species include *Rosa acicularis*, *Equisetum* spp. and *Linnaea borealis*. The closed class is estimated to have occurred on 10% of the ecological site historically, and the open class occurred on 15% of the ecological site. Both stand types contain an estimated 83.58 tons of carbon per acre with an annual carbon production of 0.76 tons per acre. Biomass averages approximately 41 tons per acre.

A mature forest state generally occurs >130 years post-fire. This disturbance class also includes two pathways consisting of open and closed stands. Both pathways are characterized by stands of white spruce, with occasional remnant hardwoods. The understories are composed of a variety of tall shrubs, low shrubs, herbs, mosses, and lichens. The open state has tree canopy cover <60% and occurred on 65% of the ecological site historically. The closed state has canopy cover >60% and occurred across 5% of this ecological site under historical fire regimes. Both stand types contain an estimated 109.46 tons of carbon per acre with an annual carbon production of 1.28 tons per acre. Biomass averages approximately 54 tons per acre.

Historical Reference Versus Todays Conditions

The landscape model results developed by the LANDFIRE team makes it possible to calculate the estimated acres in each ecosystem within an ecological site's historical reference conditions. These conditions were expected to have occurred prior to human changes to fire regimes. While the ability to control wildfire in Southcentral Alaska may be limited, more targeted efforts surrounding communities and human development may have caused significant shifts in the amounts and diversity of disturbance classes occurring in these areas. Table 6 shows a comparison of historical reference conditions versus todays conditions in terms of both acres and percentages, for each upland forest ecological site and disturbance class occurring in the Ahtna Traditional Use Territory (ecological sites >10,000 acres). The numbers in parenthesis represent the acres and percentages for Ahtna lands only. Significant differences in historical versus todays conditions are apparent. These numbers should be viewed with caution as inaccuracies in both the estimated historical amounts and in the amounts of current disturbance classes may be amplifying these differences and have not been evaluated.

Table 6. A comparison of historical reference conditions versus todays conditions in terms of both acres and percentages, for each upland forest ecological site and disturbance class occurring in the Ahtna Traditional Use Territory (ecological sites >10,000 acres). The numbers in parenthesis represent the acres and percentages for Ahtna lands only. N/A = not applicable

		Ecological Site													
		16011		**16012**		**16030**		**16041**		**16042**		**16050**		**16790**	
		Treeline White Spruce Woodland - Boreal		**Treeline White Spruce Woodland - Sub-boreal**		**White Spruce Harwood - Boreal**		**Mesic Black Spruce - Boreal**		**Mesic Black Spruce - Sub-boreal**		**Mesic Birch-Aspen Forest - Boreal**		**White Spruce Hardwood-Sub-boreal**	
Disturbance Class		**Hist.**	**Today**	**Hist.**	**Today**	**Hist.**	**Today**	**Hist.**	**Today**	**Hist.**	**Today**	**Hist.**	**Today**	**Hist.**	**Today**
A	**Acres**	19,997 (1,581)	35,598 (3,314)	19,333 (1,415)	110,954 (6,069)	167,343 (24,115)	83,435 (13,479)	28,974 (6,252)	11,645 (3,958)	41,083 (5,455)	104,317 (11,185)	16,914 (4,208)	174,611 (56,085)	19,600 (1,581)	179,005 (14,581)
	%	10	18 (21)	5	29 (21)	5	3 (3)	5	2 (3)	10	25 (21)	5	52 (67)	5	46 (56)
B	**Acres**	29,995 (2,372)	164,236 (12,486)	19,333 (1,415)	275,262 (22,183)	502,030 (72,343)	1,016,782 (94,989)	86,923 (18,757)	72,474 (13,514)	41,083 (5,455)	233,369 (31,674)	16,914 (4,208)	161,932 (27,577)	39,200 (2,629)	192,760 (10,477)
	%	15	82 (79)	5	71 (78)	15	30 (20)	15	12 (11)	10	57 (58)	5	48 (33)	10	49 (40)
C	**Acres**	149,977 (11,560)	136 (3)	347,986 (25,467)	435 (18)	1,004,060 (144,685)	2,241,061 (372,812)	173,845 (37,514)	50,920 (7,675)	20,542 (2,727)	72,136 (11,274)	50,743 (12,624)	0 (0)	58,800 (3,943)	18,846 (1,112)
	%	75	<1 (<1)	90	0 (0)	30	67 (77)	30	9 (6)	5	18 (21)	15	0 (0)	15	5 (4)
D	**Acres**	N/A		N/A		334,687 (48,228)	0 0	173,845 (37,514)	444,125 (100,106)	205,416 (27,272)	971 (107)	50,743 (12,624)	731 (173)	254,800 (17,086)	1,274 (81)
	%	-		-		10	0 (0)	30	77 (80)	50	<1 (<1)	15	<1 (<1)	65	0.3 (<1)
E	**Acres**	N/A		N/A		1,338,747 (192,913)	5,589 (905)	115,897 (25,009)	319 (50)	102,708 (13,636)	38 (4)	202,973 (50,495)	1,014 (208)	19,600 (1,314)	115 (12)
	%	-		-		40	<1 (<1)	20	<1 (<1)	25	<1 (<1)	60	<1 (<1)	5	<1 (<1)

Upland Grass and Shrub Ecosystems

An ecosystem diversity framework for upland grass and shrub systems occurring in the Ahtna Traditional Use Territory are provided for MLRA 222, MLRA 223, MLRA 227, and MLRA 228 in figures 27, 28, 29 and 30, respectively. Within the Ahtna Traditional Use Territory there are 5.3 million acres that are classified as upland grass and shrub ecological site. Upland grass and shrub ecological sites have less than 10 percent tree cover and have vegetation that is not influenced by the presence of surface or subsurface water. These sites typically occur in areas that are not capable of supporting trees due to elevation, soil depth, climate, or frequent disturbance. Disturbance classes within a given ecological site are defined by the disturbance processes, the size and cover of the vegetation, and the plant species present. In upland grass and shrub ecological site the primary disturbance types are wildfire, avalanches, and wind. In grass and shrub ecological site certain disturbances such as avalanches or wind can also keep taller vegetation such as large shrub and trees from establishing. Disturbances such as wildfire return a system from a shrub to a grass state. In addition, to qualify as upland systems vegetation on these ecological sites would not be influenced by the presence of surface or subsurface water for periods of time, on average, sufficient to support riparian or wetland conditions. Only ecological sites representing greater than 10,000 acres in an ecoregion were included in the frameworks. In the following sections, a more detailed description of each ecological site and its disturbance processes was developed using LANDFIRE, unless otherwise noted with additional citations in the text.

MAJOR LAND RESOURCE AREA 222 - Upland Grass-Shrub Systems

ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

STAGE/ STRUCTURE	16520[a] **Subalpine Alder-Salmonberry**	16430 **Alpine Dwarf-Shrubland**	16102 **Mesic Scrub Birch-Willow**	16080 **Avalanche Slope Shrubland**
	Canopy Cover[b] Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed
GRASS-FORB	**A[c] (2%)[d]** CACA4[e], CHAN9, VEVI, HEMA80	**A (100%)** EMNI, PHAL4, CAMA11, LUNO	**A (5%)** FEAL, HIAL3	**A (70%)** CACA4, CHAN9, ATFI, DREX2
SHRUB	**B (98%)** ALVIS, RUSP, SARA2, OPHO		**B (95%)** BENA, VAUL, LEPAD, SALIX	**B (30%)** ALVIS, SALIX, SARA2, SPST3
ACRES	**208,290**	**112,029**	**109,084**	**1,944**

Figure 27. Ecosystem diversity framework for MLRA 222 – Upland grass-shrub ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

MAJOR LAND RESOURCE AREA 223 - Upland Grass-Shrub Systems

ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

	16351[a]	16102	16090	16310	16280	16430	16110	16450	16120	16290	16800
	Alpine Ericaceous Dwarf-Shrubland	**Mesic Scrub Birch-Willow**	**Mesic Subalpine Alder**	**Alpine Dwarf-Shrub Summit**	**Low Shrub-Tussock Tundra**	**Alpine Dwarf Shrubland**	**Mesic Bluejoint Meadow**	**Alpine Mesic Herbaceous Meadow**	**Dry Grassland**	**Tussock Tundra**	**Avalanche Slope Shrubland**
STAGE/ STRUCTURE	Canopy Cover[b] Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed
GRASS-FORB	**A[c] (100%)[d]** CATE11[e], EMNI, VAUL, DRIN4	**A (5%)** FEAL, HIAL3	**A (5%)** CACA4, CHAN9, ATFI, DREX2	**A (100%)** VAUL, EMNI, VAVI, DRYAS	**A (10%)** ERVA4, CABI5, CACA4, ARCTA	**A (100%)** EMNI, PHAL4, CAMA11, LUNO	**A (100%)** CACA4, CHANA2, HEMA80, ATFI	**A (100%)** CAMA11, GEER2, SACA14, VASI	**A (100%)** FEAL, FERU2, CAPU, BRINA	**A (85%)** ERVA4, CABI5	**A (30%)** CACA4, CHAN9, ATFI, DREX2
SHRUB		**B (95%)** BENA, VAUL, LEPAD, SALIX	**B (95%)** ALVIS, SALIX, SARA2, SPST3		**C (15%)** BENA, SALIX, ERVA4, PECA60 **B (75%)** BENA, SALIX, ERVA4, CABI5					**B (15%)** CHCA2, VAOX, ERVA4, CABI5	**B (70%)** ALVIS, SALIX, SARA2, SPST3
ACRES	**312,775**	**220,823**	**126,769**	**105,327**	**83,884**	**50,432**	**20,077**	**17,377**	**15,009**	**4,533**	**3,415**

Figure 28. Ecosystem diversity framework for MLRA 223 – Upland grass-shrub ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

MAJOR LAND RESOURCE AREA 227 - Upland Grass-Shrub Systems

<table>
<tr><th></th><th colspan="14"><i>ECOLOGICAL SITE</i> <i>(based on LANDFIRE - BIOPHYSICAL SETTINGS)</i></th></tr>
<tr><th></th><th colspan="2">16102[a]</th><th colspan="2">16280</th><th colspan="2">16351</th><th colspan="2">16290</th><th colspan="2">16330</th><th colspan="2">16110</th><th colspan="2">16090</th></tr>
<tr><th></th><th colspan="2">Mesic Scrub Birch-Willow</th><th colspan="2">Low Shrub-Tussock Tundra</th><th colspan="2">Alpine Ericaceous Dwarf-Shrubland</th><th colspan="2">Tussock Tundra</th><th colspan="2">Alpine Mesic Herbaceous Meadow</th><th colspan="2">Mesic Bluejoint Meadow</th><th colspan="2">Mesic Subalpine Alder</th></tr>
<tr><th rowspan="2">STAGE/ STRUCTURE</th><th colspan="2">Canopy Cover[b]</th><th colspan="2">Canopy Cover</th><th colspan="2">Canopy Cover</th><th colspan="2">Canopy Cover</th><th colspan="2">Canopy Cover</th><th colspan="2">Canopy Cover</th><th colspan="2">Canopy Cover</th></tr>
<tr><th>Open</th><th>Closed</th><th>Open</th><th>Closed</th><th>Open</th><th>Closed</th><th>Open</th><th>Closed</th><th>Open</th><th>Closed</th><th>Open</th><th>Closed</th><th>Open</th><th>Closed</th></tr>
<tr><td>GRASS-FORB</td><td colspan="2">A[c] (5%)[d]
FEAL[e], HIAL3</td><td colspan="2">A (10%)
ERVA4, CABI5, CACA4, ARCTA</td><td colspan="2" rowspan="2">A (100%)
CATE11, EMNI, VAUL, DRIN4</td><td colspan="2">A (85%)
ERVA4, CABI5</td><td colspan="2" rowspan="2">A (100%)
CABI5, BENA, ARAL2, EMNI</td><td colspan="2" rowspan="2">A (100%)
CACA4, CHANA2, HEMA80, ATFI</td><td colspan="2">A (5%)
CACA4, CHAN9, ATFI, DREX2</td></tr>
<tr><td>SHRUB</td><td colspan="2">B (95%)
BENA, VAUL, LEPAD, SALIX</td><td>C (15%)
BENA, SALIX, ERVA4, PECA60</td><td>B (75%)
BENA, SALIX, ERVA4, CABI5</td><td colspan="2">B (15%)
CHCA2, VAOX, ERVA4, CABI5</td><td></td><td>B (95%)
ALVIS, SALIX, SARA2, SPST3</td></tr>
<tr><td>ACRES</td><td colspan="2">89,588</td><td colspan="2">73,551</td><td colspan="2">9,602</td><td colspan="2">7,890</td><td colspan="2">4,299</td><td colspan="2">1,952</td><td colspan="2">1,938</td></tr>
</table>

Figure 29. Ecosystem diversity framework for MLRA 227 – Upland grass-shrub ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

MAJOR LAND RESOURCE AREA 228 - Upland Grass-Shrub Systems

ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

STAGE/ STRUCTURE	16102[a]	16351	16430	16280	16090	16310	16080	16290	16520	16330	16110	16120
	Mesic Scrub Birch/Willow	Alpine Ericaceous Dwarf-Shrubland	Alpine Dwarf Shrubland	Low Shrub-Tussock Tundra	Mesic Subalpine Alder	Alpine Dwarf-Shrub Summit	Avalanche Slope Shrubland	Tussock Tundra	Subalpine Alder-Salmonberry	Alpine Mesic Herbaceous Meadow	Mesic Bluejoint Meadow	Dry Grassland
	Canopy Cover[b] Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed
GRASS-FORB	A[c] (5%)[d] FEAL[e], HIAL3	A (100%) CATE11, EMNI, VAUL, DRIN4	A (100%) EMNI, PHAL4, CAMA11, LUNO	A (10%) ERVA4, CABI5, CACA4, ARCTA	A (5%) CACA4, CHAN9, ATFI, DREX2	A (100%) VAUL, EMNI, VAVI, DRYAS	A (70%) CACA4, CHAN9, ATFI, DREX2	A (85%) ERVA4, CABI5	A (2%) CACA4, CHAN9, VEVI, HEMA80	A (100%) CABI5, BENA, ARAL2, EMNI	A (100%) CACA4, CHANA2, HEMA80, ATFI	A (100%) FEAL, FERU2, CAPU, BRINA
SHRUB	B (95%) BENA, VAUL, LEPAD, SALIX			C (15%) BENA, SALIX, ERVA4, PECA60 B (75%) BENA, SALIX, ERVA4, CABI5	B (95%) ALVIS, SALIX, SARA2, SPST3		B (30%) ALVIS, SALIX, SARA2, SPST3	B (15%) CHCA2, VAOX, ERVA4, CABI5	B (98%) ALVIS, RUSP, SARA2, OPHO			
ACRES	**2,344,241**	**944,326**	**487,028**	**359,659**	**212,862**	**142,722**	**40,101**	**28,100**	**27,776**	**15,155**	**4,615**	**4,541**

Figure 30. Ecosystem diversity framework for MLRA 228 – Upland grass-shrub ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

Boreal Mesic Scrub Birch-Willow Shrubland (16102)

This ecological site occurs across an estimated 2,712,003 acres of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 128,705 acres. The system occurs on well-drained sites and often is found in the subalpine. The shrub layer is usually dominated by *Betula nana* with *Vaccinium uliginosum*, *Ledum decumbens*, *Salix pulchra*, or *Salix barclayi* may be common or dominant. Dwarf shrubs like *Empetrum nigrum* and *Vaccinium vitis-idea* are often found in the low shrub layer. Herbaceous species are often scarce but occasionally include *Festuca altaica* and *Hierochloe alpina*. These vegetation types occur on mesic sites on mid to upper slopes, above tree line and on terraces and sideslopes. The soils are mineral with a well-decomposed organic layer 5-30cm thick (Viereck et al. 1992, NatureServe 2008). Fire is the primary disturbance with rapid resprouting of shrubs following fire. In some cases, woodlands near timberline may be converted to this type following fire (Pegau 1972). Fire return intervals are likely >100 years.

Fire severity determines the successional pathway for these stands. High severity fire results in herbaceous dominated stands, typically consisting of *Festuca altaica* and *Hierochloe alpina*. This state persists for longer than 5 years with high severity fire and may dominate for up to 4 years with low to moderate severity fire. This state can occur on up to 5% of the ecological site, but is likely less common in the Copper River Basin due to reduced fire frequency.

The shrub state is by far the most common, occurring 95% of the time in this ecological site. Due to relatively low fuels this state can persist >300 years before fire would return it to the herbaceous class. Sites are typically dominated by *Betula nana*. *Betula glandulosa*, *Vaccinium uliginosum*, *Ledum decumbens*, *Salix pulchra*, or *Salix barclayi* may be common or dominant (Viereck 1979, Viereck et al. 1992). Dwarf shrubs like *Empetrum nigrum* and *Vaccinium vitis-idea* are often found in the low shrub layer. Trees may begin to encroach the shrubland given enough time post-disturbance.

Vegetation characteristics of the Boreal Mesic Scrub Birch-Willow Shrubland ecological site for plots sampled in the planning landscape are listed in Table 7. A photo depicting a late successional vegetation stand in the Boreal Mesic Scrub Birch-Willow Shrubland ecological site is found in Figure 31.

Table 7. Vegetation characteristics expressed as mean and standard deviation (parenthesis) for canopy cover (% Cover), trees per acre (TPA), and Basal Area from plots sampled in the Boreal Mesic Shrub Birch-Willow Shrubland ecological site within the project area. Structure definitions include GFS=grass/forb/shrubs; Dwarf Shrub=shrubs < 1 m in height; Medium Shrub=shrubs 1-3 m in height; Tall Shrub=shrubs >3m in height.

ECOSYSTEM	STAGE/ STRUCTURE	DWARF SHRUB	MEDIUM SHRUB	TALL SHRUB	LICHEN
		-----------------------% Cover (StDev) ---------------------			
16102-B	GFS	6.67 (12.01)	44.73 (21.02)	14.85 (12.92)	1.15 (6.44)


Figure 31. Example of ecosystem 16102-B in Ahtna Traditional Use Territory (LANDFIRE Photo).

Boreal Low Shrub Tussock Tundra (16280)

This ecological site occurs across an estimated 508,039 acres of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 37,200 acres. These sites usually have permafrost present and contain a surface peat layer 10-40 cm thick (Viereck et al. 1992). Fire is the primary disturbance with return intervals varying widely between sites (Viereck and Schandelmeier 1980). As a generalization the mean fire return interval is considered 200 years.

Following fire, an herbaceous disturbance class will dominate from years 0 to approximately year 14. *Eriophorum* spp. and *Carex* spp. regrow from rhizomes and shrubs begin to resprout from rootstock. In some stands *Calamagrostis* spp. and *Acrtagrostis* spp. dominate following fire. Under historic disturbance regimes this state occupied 10% of the ecological site.

An intermediate disturbance class occurring from 15-80 years post-fire is a low shrub and tussock type. The tussocks are dominated by *Eriophorum* spp. and *Carex* spp. with common shrubs including *Betula nana*, *Salix* spp. and *Vaccinium uliginosum*. Lichens also begin to reestablish in this state, but have cover <25%. This state represented 75% of the ecological site under historical conditions. A photo depicting this succession stage is found in Figure 32.

The climax class in this ecological site is distinguished by the cover of lichen species. In most stands this occurs 80+ years post-fire. Lichen species have total cover >25%. Herbaceous and shrub species present in earlier states remain common. This state represented 15% of the ecological site under historical conditions. A photo depicting this succession stage is found in Figure 33.

Figure 32. Example of ecosystem 16280-B in Ahtna Traditional Use Territory (LANDFIRE Photo).

Figure 33. Example of ecosystem 16280-C in Ahtna Traditional Use Territory (S. Yeats Photo).

Boreal Alpine Dwarf-Shrub Summit (16310)

This ecological site occurs across an estimated 243,966 acres in the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 16,485 acres. This shrub system occurs on exposed, windswept summits and ridges in alpine and subalpine areas of Alaska (Viereck et al. 1992). The sites have sparse cover due to the exposed nature. Common shrubs include *Dryas integrifolia*, *Vaccinium uliginosum*, *Empetrum nigrum*, *Vaccinium vitis-idaea*, *Diapensia lapponica*, *Loiseuria procumbens*, *Salix arctica*, *Salix rotundifolia*, *Salix reticulata*, *Arctostaphylos rubra* and *Arcostaphylos* alpina. Exposed rock and lichens can be abundant. Herbaceous species include *Hierochloe alpina*, *Polygonum bistorta*, *Anemone* spp., *Festuca* spp. and *Luzula* spp (Viereck et al. 1992). There is little disturbance in this system with the shrub communities representing a stable climax and specific plant distribution being controlled by wind desiccation and a short growing season.

Due to the relatively stable nature of this ecological site there is only one state. This is a shrub state with typical shrub cover <50% and interspersed with exposed rocks and lichen. The dominant species are listed in the previous paragraph.

Vegetation characteristics of the Boreal Alpine Dwarf-Shrub Summit ecological site for plots sampled in the planning landscape are shown in Table 8. A photo depicting a vegetation stand in the Boreal Alpine Dwarf-Shrub Summit ecological site is found in Figure 34.

Table 8. Vegetation characteristics expressed as mean and standard deviation (parenthesis) for canopy cover (% Cover), trees per acre (TPA), and Basal Area from plots sampled in the Boreal Alpine Dwarf-Shrub Summit ecological site within the project area. Structure definitions include GFS=grass/forb/shrubs; Dwarf Shrub=shrubs < 1 m in height; Medium Shrub=shrubs 1-3 m in height; Tall Shrub=shrubs >3m in height.

ECOSYSTEM	STAGE/ STRUCTURE	DWARF SHRUB	MEDIUM SHRUB	TALL SHRUB	LICHEN
		-----------------------% Cover (StDev) ---------------------			
16102-B	GFS	6.7 (12.0)	44.7 (21.0)	14.9 (12.9)	1.2 (6.4)

Figure 34. Example of ecosystem 16310-A in Ahtna Traditional Use Territory (LANDFIRE Photo).

Boreal Alpine Ericaceous Dwarf Shrubland - Complex (16351)

This ecological site occurs across an estimated 1,219,920 acres in the Ahtna Traditional Use Territory. This is a dwarf shrub system that occurs from subalpine to alpine locations throughout Alaska. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 71,357 acres. This ecological site typically occurs in alpine valleys and sideslopes, as well as low summits and ridges. Sites are usually well-drained and mesic to somewhat dry. These sites often retain snow late into the growing season which greatly influences moisture availability along with growing season length.

This ecological site supports a wide range of dwarf shrub species, but *Ericaceous* or *Dryas* (especially *Dryas integrifolia* and/or *Dryas octopetala*) typically dominate. Other dwarf shrubs that commonly occur include *Empetrum nigrum*, *Vaccinium uliginosum*, *Harrimanella stellariana*, and *Arctostaphylos* spp. Other shrubs that may be common include *Betula nana*, *Diapensia lapponica*, *Dryas octopetala*, *Ledum palustre* ssp. *decumbens*, *Vaccinium vitis-idaea*, *Salix reticulata*, *Salix phlebophylla*, *Salix rotundifolia*, *Salix arctica* and *Oxytropis nigrescens*. Common herbaceous species include *Hierochloe alpina*, *Arnica lessingii*, *Carex bigelowii*, *Carex microchaeta*, *Senecio lugens*, *Minuartia arctica*, *Anemone parviflora*, *Ligusticum mutellinoides* ssp. *alpinum*, *Castilleja elegans*, *Poa arctica*, *Trisetum spicatum*, *Silene acaulis*, *Saxifraga* spp., *Campanula lasiocarpa*, *Anemone parviflora*, *Senecio lugens* and *Polygonum bistorta*. *Cassiope* and *Harimanella* tundra sites occur on terrain that is well protected by snow in the winter, and often remains snow covered until the middle of the growing season (Viereck et al. 1992).

These sites are not typically impacted by fire. The primary form of disturbance is continual wind, resulting in sites that are relatively stable over time. A site is categorized into this ecological site due to having >20% cover of dryas dwarf shrubs and >25% total lichen cover. There is only one state in this ecological site due to the vegetative stability.

Vegetation characteristics of the Boreal Alpine Ericaceous Dwarf-Shrubland – Complex ecological site for plots sampled in the planning landscape are shown in Table 9. A photo depicting a vegetation stand in the Boreal Alpine Ericaceous Dwarf-Shrubland – Complex ecological site is found in Figure 35.

Table 9. Vegetation characteristics expressed as mean and standard deviation (parenthesis) for canopy cover (% Cover), trees per acre (TPA), and Basal Area from plots sampled in the Boreal Alpine Ericaceous Dwarf Shrubland ecological site within the project area. Structure definitions include GFS=grass/forb/shrubs; Dwarf Shrub=shrubs < 1 m in height; Medium Shrub=shrubs 1-3 m in height; Tall Shrub=shrubs >3m in height.

ECOSYSTEM	STAGE/ STRUCTURE	DWARF SHRUB	MEDIUM SHRUB	TALL SHRUB	LICHEN
		------------------------% Cover (StDev) ---------------------			
16351-A	GFS	50.0 (35.3)	34.6 (36.9)	12.5 (19.1)	3.2 (9.6)

Figure 35. Example of ecosystem 16351-A in Ahtna Traditional Use Territory (LANDFIRE Photo).

Alpine Dwarf Shrubland (16430)

This ecological site occurs across an estimated 645,781 acres in the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 31,778 acres. This herbaceous and shrub ecological site occurs on a variety of sites in subalpine and alpine habitats. Within the alpine zone snow cover can persist nearly year round, resulting in sites with a high proportion of exposed rock and soil.

This ecological site represents several existing vegetation types so species composition is highly variable. Shrub species may include: *Artemisia arctica*, *Cassiope mertensiana*, *Empetrum nigrum*, *Harrimanella stelleriana*, *Luetkea pectinata*, *Loiseleuria procumbens*, *Phyllodoce aleutica*, *Phyllodoce glanduliflora*, *Salix arctica*, *Salix reticulata*, *Salix rotundifolia*, *Sibbaldia procumbens*, *Vaccinium uliginosum* and *Vaccinium vitisidaea*. Herbceous species may include: *Aconitum delphiniifolium*, *Anemone narcissiflora*, *Astragalus alpinus*, *Athyrium filix-femina*, *Carex macrochaeta*, *Castilleja unalaschcensis*, *Chamerion angustifolium*, *Chamerion latifolium*, *Calamagrostis canadensis*, *Geranium erianthum*, *Lupinus nootkatensis*, *Minuartia arctica*, *Nephrophyllidium crista-galli*, *Saxifraga bracteata*, *Saxifraga bronchialis*, *Silene acaulis*, *Sanguisorba canadensis*, *Senecio triangularis*, *Valeriana sitchensis*, *Veratrum viride* and *Viola* spp.

The lack of vegetation at these sites due to soil disturbances, snow avalanches, and wind disturbance results in a scarcity of fire and only a single described state. There can be variation among the vegetative species listed in the preceding paragraph.

Vegetation characteristics of the Alpine Dwarf-Shrubland ecological site for plots sampled in the planning landscape are shown in Table 10. A photo depicting a vegetation stand in the Alpine Dwarf-Shrubland ecological site is found in Figure 36.

Table 10. Vegetation characteristics expressed as mean and standard deviation (parenthesis) for canopy cover (% Cover), trees per acre (TPA), and Basal Area from plots sampled in the Alpine Dwarf Shrubland ecological site within the project area. Structure definitions include GFS=grass/forb/shrubs; Dwarf Shrub=shrubs < 1 m in height; Medium Shrub=shrubs 1-3 m in height; Tall Shrub=shrubs >3m in height.

ECOSYSTEM	**STAGE/ STRUCTURE**	**DWARF SHRUB**	**MEDIUM SHRUB**	**TALL SHRUB**	**LICHEN**
		------------------------% Cover (StDev) ----------------------			
16430-A	GFS	74.6 (43.6)	20.7 (24.2)	10.2 (14.1)	1.4 (5.9)

Figure 36. Example of ecosystem 16430-A in Ahtna Traditional Use Territory (LANDFIRE Photo).

Historical Reference Versus Todays Conditions

The landscape model results developed by the LANDFIRE team makes it possible to calculate the estimated acres in each ecosystem within an ecological site's historical reference conditions. These conditions were expected to have occurred prior to human changes to fire regimes. Table 11 shows a comparison of historical reference conditions versus todays conditions in terms of both acres and percentages, for each upland grass and shrub ecological site and disturbance class occurring in the Ahtna Traditional Use Territory (ecological sites >10,000 acres). The numbers in parenthesis represent the acres and percentages for Ahtna lands only. Significant differences in historical versus todays conditions are apparent. These numbers should be viewed with caution as inaccuracies in both the estimated historical amounts and in the amounts of current disturbance classes may be amplifying these differences and have not been evaluated.

Table 11. A comparison of historical reference conditions versus todays conditions in terms of both acres and percentages, for each upland grass and shrub ecological site and disturbance class occurring in the Ahtna Traditional Use Territory (ecological sites >10,000 acres). The numbers in parenthesis represent the acres and percentages for Ahtna lands only. N/A = not applicable

		Ecological Site									
		16102		**16280**		**16310**		**16351**		**16430**	
		Boreal Mesic Scrub Birch-Willow Shrubland		**Boreal Low Shrub Tussock Tundra**		**Boreal Alpine Dwarf-Shrub Summit**		**Boreal Alpine Ericaceous Dwarf Shrubland - Complex**		**Alpine Dwarf Shrubland**	
Disturbance Class		**Hist.**	**Today**	**Hist.**	**Today**	**Hist.**	**Today**	**Hist.**	**Today**	**Hist.**	**Today**
A	**Acres**	135,600 (6,435)	336,463 (29,747)	50,804 (3,720)	186,195 (23,621)	243,966 (16,485)	243,966 (16,485)	1,219,920 (71,357)	1,219,920 (71,357)	645,782 (31,778)	645,782 (31,778)
	%	5	12 (23)	10	37 (64)	100	100	100	100	100	100
B	**Acres**	2,576,403 (122,269)	2,375,540 (98,547)	381,030 (27,900)	262,882 (10,229)	N/A		N/A		N/A	
	%	95	88 (77)	75	52 (28)	-		-		-	
C	**Acres**	N/A		76,206 (5,580)	58,963 (3,326)	N/A		N/A		N/A	
	%	-		15	12 (9)	-		-		-	

Riparian and Wetland Ecosystem Diversity

An ecosystem diversity framework for riparian and wetland systems occurring in the Ahtna Traditional Use Territory are provided for MLRA 222 (Figures 37 and 38), MLRA 223 (Figures 39 and 40), MLRA 227 (41 and 42), and MLRA 228 (Figures 43 and 44). Riparian and wetland systems have vegetation that is influenced by the presence of surface or subsurface water either year-round or seasonally. These sites occur along rivers and lakes and over sites with shallow permafrost. Within the Ahtna Traditional Use Territory there are 2.5 million acres that are classified as riparian and wetland ecological sites. Disturbance classes within a given ecological site are defined by the disturbance processes, the size and cover of the vegetation, and the plant species present. In riparian and wetland systems the primary disturbance types are flooding, thermokarst, and wildfire. Thermokarst occurs in areas underlain with permafrost and is a result of heaving caused by freezing and thawing. Wildfire occurs less frequently in riparian and wetland systems but will occur in stands of dwarf black spruce. In general, disturbance returns a forested successional state to a grass/shrub/seedling state. Only ecological sites representing greater than 10,000 acres in an ecoregion were included in the frameworks. In the following sections, a more detailed description of each ecological site and its disturbance processes was developed using LANDFIRE, unless otherwise noted with additional citations in the text.

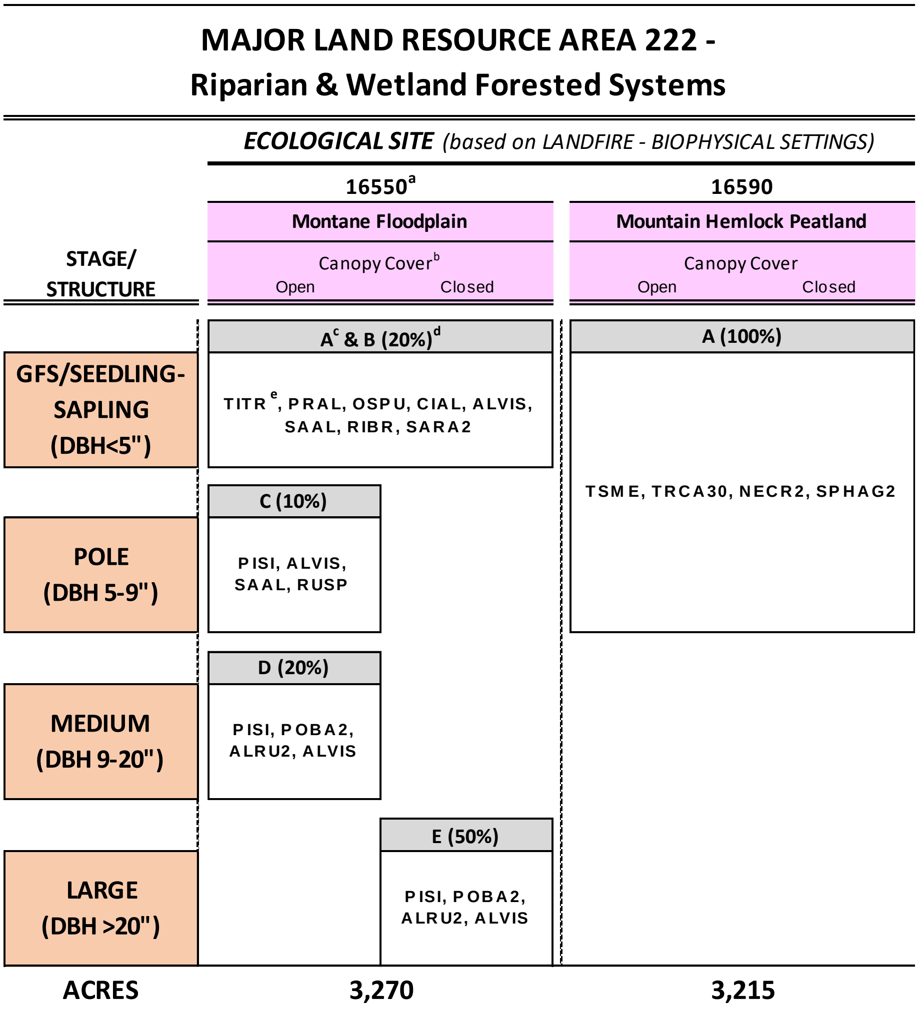
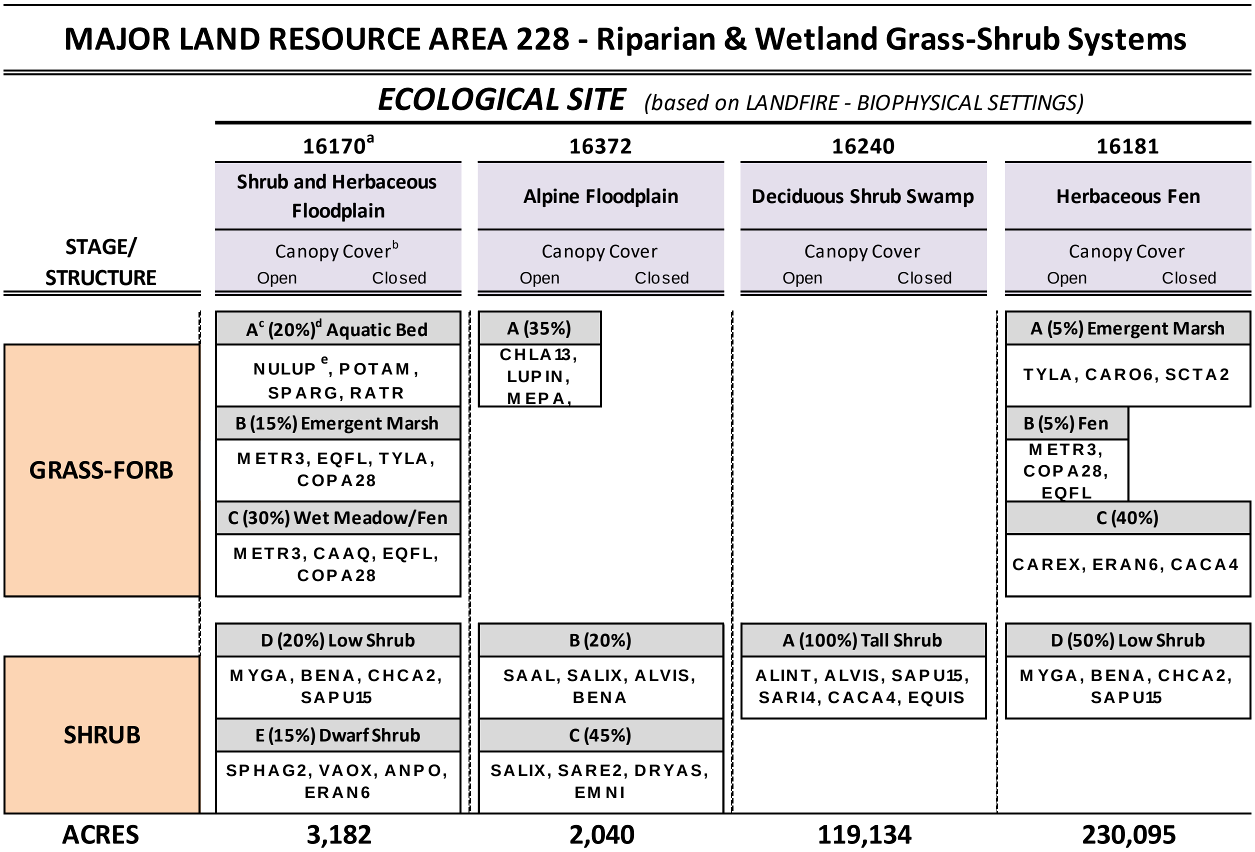


Figure 37. Ecosystem diversity framework for MLRA 222 – Riparian/wetland forested ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.



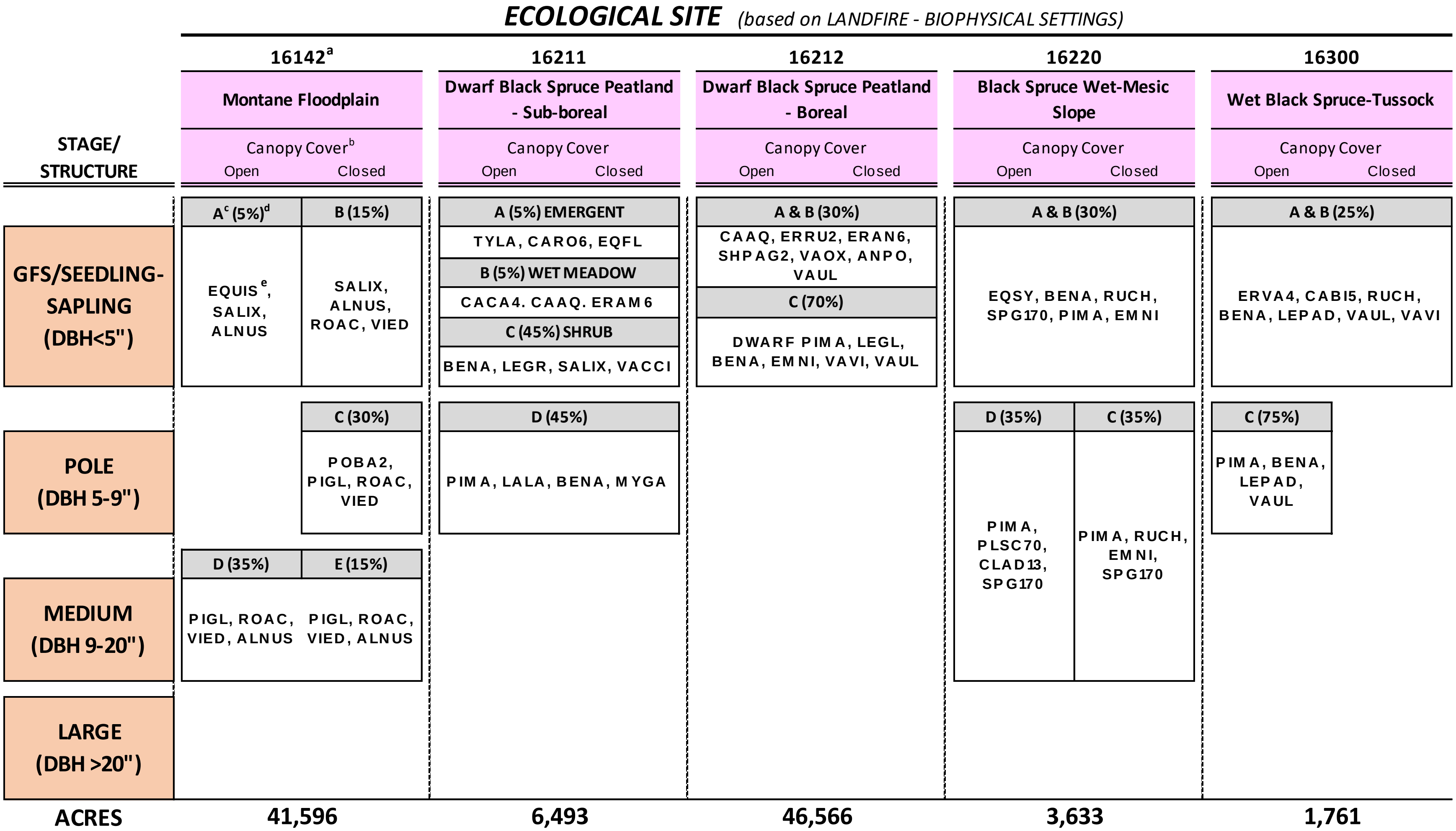
MAJOR LAND RESOURCE AREA 228 - Riparian & Wetland Grass-Shrub Systems

ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

STAGE/ STRUCTURE	16170[a] Shrub and Herbaceous Floodplain Canopy Cover[b] Open Closed	16372 Alpine Floodplain Canopy Cover Open Closed	16240 Deciduous Shrub Swamp Canopy Cover Open Closed	16181 Herbaceous Fen Canopy Cover Open Closed
GRASS-FORB	A[c] (20%)[d] Aquatic Bed NULUP[e], POTAM, SPARG, RATR	A (35%) CHLA13, LUPIN, MEPA,		A (5%) Emergent Marsh TYLA, CARO6, SCTA2
	B (15%) Emergent Marsh METR3, EQFL, TYLA, COPA28			B (5%) Fen METR3, COPA28, EQFL
	C (30%) Wet Meadow/Fen METR3, CAAQ, EQFL, COPA28			C (40%) CAREX, ERAN6, CACA4
SHRUB	D (20%) Low Shrub MYGA, BENA, CHCA2, SAPU15	B (20%) SAAL, SALIX, ALVIS, BENA	A (100%) Tall Shrub ALINT, ALVIS, SAPU15, SARI4, CACA4, EQUIS	D (50%) Low Shrub MYGA, BENA, CHCA2, SAPU15
	E (15%) Dwarf Shrub SPHAG2, VAOX, ANPO, ERAN6	C (45%) SALIX, SARE2, DRYAS, EMNI		
ACRES	3,182	2,040	119,134	230,095

Figure 38. Ecosystem diversity framework for MLRA 222 – Riparian/wetland grass-shrub ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

MAJOR LAND RESOURCE AREA 223 - Riparian & Wetland Forested Systems



ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

	16142[a]		16211		16212		16220		16300	
	Montane Floodplain		**Dwarf Black Spruce Peatland - Sub-boreal**		**Dwarf Black Spruce Peatland - Boreal**		**Black Spruce Wet-Mesic Slope**		**Wet Black Spruce-Tussock**	
STAGE/ STRUCTURE	Canopy Cover[b]		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover	
	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed
GFS/SEEDLING-SAPLING (DBH<5")	A[c] (5%)[d] EQUIS[e], SALIX, ALNUS	B (15%) SALIX, ALNUS, ROAC, VIED	A (5%) EMERGENT TYLA, CARO6, EQFL B (5%) WET MEADOW CACA4. CAAQ. ERAM6 C (45%) SHRUB BENA, LEGR, SALIX, VACCI		A & B (30%) CAAQ, ERRU2, ERAN6, SHPAG2, VAOX, ANPO, VAUL C (70%) DWARF PIMA, LEGL, BENA, EMNI, VAVI, VAUL		A & B (30%) EQSY, BENA, RUCH, SPG170, PIMA, EMNI		A & B (25%) ERVA4, CABI5, RUCH, BENA, LEPAD, VAUL, VAVI	
POLE (DBH 5-9")		C (30%) POBA2, PIGL, ROAC, VIED	D (45%) PIMA, LALA, BENA, MYGA				D (35%) PIMA, PLSC70, CLAD13, SPG170	C (35%) PIMA, RUCH, EMNI, SPG170	C (75%) PIMA, BENA, LEPAD, VAUL	
MEDIUM (DBH 9-20")	D (35%) PIGL, ROAC, VIED, ALNUS	E (15%) PIGL, ROAC, VIED, ALNUS								
LARGE (DBH >20")										
ACRES	**41,596**		**6,493**		**46,566**		**3,633**		**1,761**	

Figure 39. Ecosystem diversity framework for MLRA 223 – Riparian/wetland forested ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

MAJOR LAND RESOURCE AREA 223 - Riparian & Wetland Grass-Shrub Systems

ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

STAGE/ STRUCTURE	16372[a]	16170	16181	16240
	Alpine Floodplain	**Shrub-Herbaceous Floodplain**	**Herbaceous Fen**	**Deciduous Shrub Swamp**
	Canopy Cover[b] Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed
GRASS-FORB	A[c] (35%)[d] CHLA13[e], LUPIN, MEPA, CREL	A (20%) - Aquatic Bed NULUP, POTAM, SPARG, RATR	A (5%)-Emerg. Marsh TYLA, CARO6, SCTA2	
		B (15%) Emergent Marsh METR3, EQFL, TYLA, COPA28	B (5%) Fen METR3, COPA28, EQFL	
		C (30%) Wet Meadow/Fen METR3, CAAQ, EQFL, COPA28	C (40%) CAREX, ERAN6, CACA4	
SHRUB	B (20%) SAAL, SALIX, ALVIS, BENA	D (20%) Low Shrub MYGA, BENA, CHCA2, SAPU15	D (50%) Low Shrub MYGA, BENA, CHCA2, SAPU15	A (100%) Tall Shrub ALINT, ALVIS, SAPU15, SARI4, CACA4, EQUIS
	C (45%) SALIX, SARE2, DRYAS, EMNI	E (15%) - DwarfShrub SPHAG2, VAOX, ANPO, ERAN6		
ACRES	**4,534**	**2,174**	**85,805**	**17,557**

Figure 40. Ecosystem diversity framework for MLRA 223 – Riparian/wetland grass-shrub ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

MAJOR LAND RESOURCE AREA 227 - Riparian & Wetland Forested Systems

ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

STAGE/ STRUCTURE	16141[a]		16150		16160		16211		16220		16300	
	Montane Floodplain		Large River Floodplain		Riparian Stringer		Dwarf Black Spruce Peatland - Boreal		Black Spruce Wet-Mesic Slope		Wet Black Spruce-Tussock	
	Canopy Cover[b]		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover		Canopy Cover	
	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed
GFS/SEEDLING-SAPLING (DBH<5")	A[c] (5%)[d] EQUIS[e], SALIX, ALNUS	B (20%) SALIX, ALNUS, ROAC, VIED	A (5%) EQUIS, SALIX, POBA2, LUPIN	B (10%) SALIX, ALNUS, POBA2, ROAC	A (10%) SALIX, ALNUS, CAREX, CACA4		A (5%) EMERGENT TYLA, CARO6, EQFL B (5%) WET MEADOW CACA4. CAAQ. ERAM6 C (45%) SHRUB BENA, LEGR, SALIX, VACCI		A & B (30%) EQSY, BENA, RUCH, SPG170, PIMA, EMNI		A & B (25%) ERVA4, CABI5, RUCH, BENA, LEPAD, VAUL, VAVI	
POLE (DBH 5-9")		C (40%) POBA2, PIGL, ROAC, VIED	C (50%) POBA2, PIGL, ROAC, VIED, ALNUS		B (40%) BEPA, PIGL, PIMA, ALNUS		D (45%) PIMA, LALA, BENA, MYGA		D (35%) PIMA, PLSC70, CLAD13, SPG170	C (35%) PIMA, RUCH, EMNI, SPG170	C (75%) PIMA, BENA, LEPAD, VAUL	
MEDIUM (DBH 9-20")	D (25%) PIGL, ROAC, VIED, ALNUS	E (10%) PIGL, ROAC, VIED, ALNUS	D (25%) PIGL, ROAC, VIED, ALNUS	E (10%) PIGL, ROAC, VIED, ALNUS	C (40%) PIGL, BEPA, POBA2, PIMA							
LARGE (DBH >20")												
ACRES	**259,882**		**3,491**		**2,497**		**673,384**		**8,062**		**18,384**	

Figure 41. Ecosystem diversity framework for MLRA 227 – Riparian/wetland forested ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

MAJOR LAND RESOURCE AREA 227 - Riparian & Wetland Grass-Shrub Systems

ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

STAGE/ STRUCTURE	16170[a] Shrub and Herbaceous Floodplain Canopy Cover[b]: Open – Closed	16240 Deciduous Shrub Swamp Canopy Cover: Open – Closed	16181 Herbaceous Fen Canopy Cover: Open – Closed
GRASS-FORB	A[c] (20%)[d] Aquatic Bed NULUP[e], POTAM, SPARG, RATR		A (5%) Emergent Marsh TYLA, CARO6, SCTA2
	B (15%) Emergent Marsh METR3, EQFL, TYLA, COPA28		B (5%) Fen METR3, COPA28, EQFL
	C (30%) Wet Mead/Fen METR3, CAAQ, EQFL, COPA28		C (40%) CAREX, ERAN6, CACA4
SHRUB	D (20%) Low Shrub MYGA, BENA, CHCA2, SAPU15	A (100%) Tall Shrub ALINT, ALVIS, SAPU15, SARI4, CACA4, EQUIS	D (50%) Low Shrub MYGA, BENA, CHCA2, SAPU15
	E (15%) DwarfShrub SPHAG2, VAOX, ANPO, ERAN6		
ACRES	**8,549**	**4,301**	**1,127**

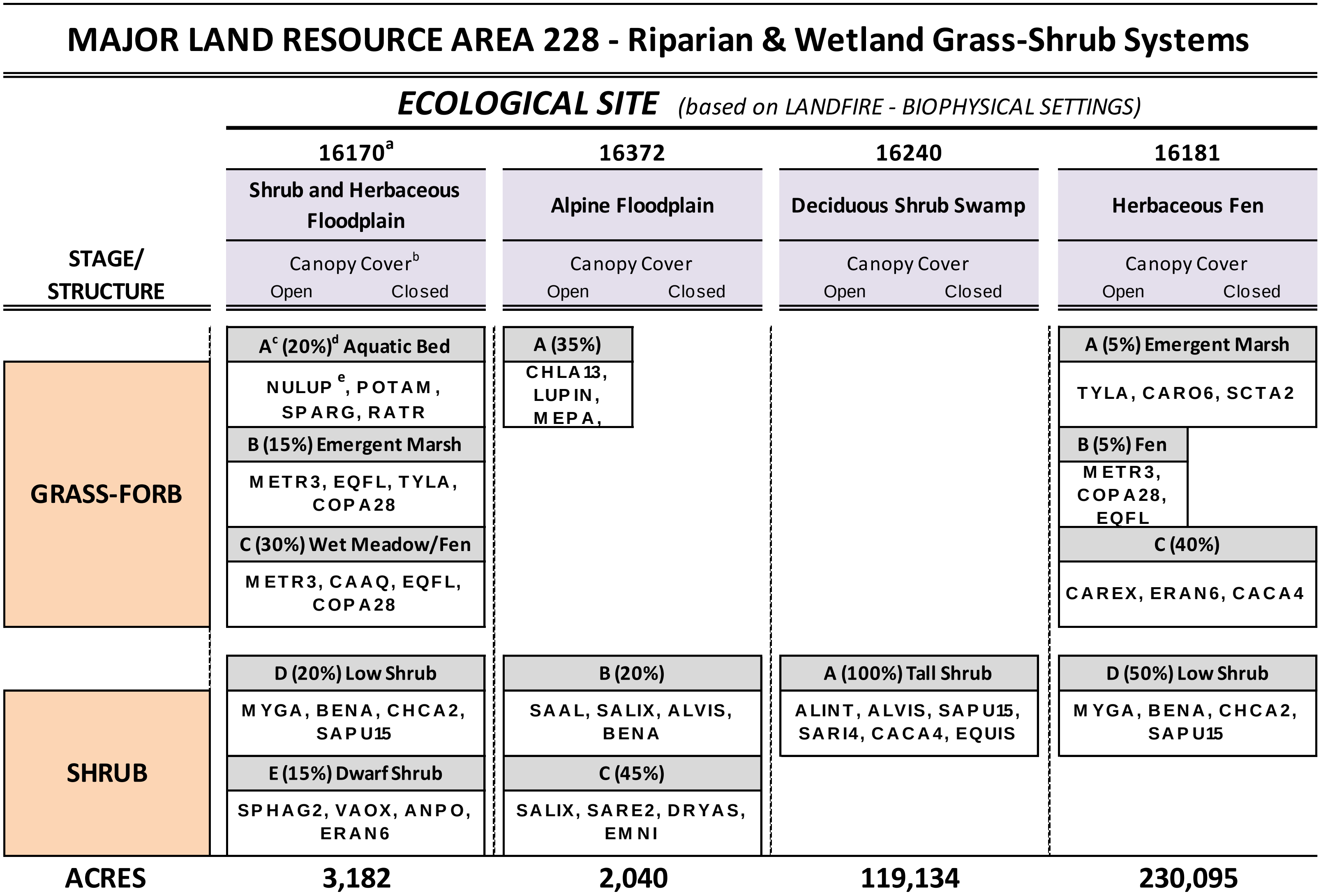
Figure 42. Ecosystem diversity framework for MLRA 227 – Riparian/wetland grass-shrub ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

MAJOR LAND RESOURCE AREA 228 - Riparian & Wetland Forested Systems

ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

STAGE/ STRUCTURE	16141[a] Montane Floodplain - Boreal Canopy Cover[b] Open Closed	16142 Montane Floodplain - Subboreal Canopy Cover Open Closed	16150 Large River Floodplain Canopy Cover Open Closed	16160 Riparian Stringer Canopy Cover Open Closed	16211 Dwarf Black Spruce Peatland - Boreal Canopy Cover Open Closed	16212 Dwarf Black Spruce Peatland - Subboreal Canopy Cover Open Closed	16220 Black Spruce Wet-Mesic Slope Canopy Cover Open Closed	16300 Wet Black Spruce-Tussock Canopy Cover Open Closed
GFS/SEEDLING-SAPLING (DBH<5")	**A[c] (5%)[d]** EQUIS[e], SALIX, ALNUS **B (20%)** SALIX, ALNUS, ROAC, VIED	**A (5%)** EQUIS, SALIX, ALNUS **B (15%)** SALIX, ALNUS, ROAC, VIED	**A (5%)** EQUIS, SALIX, POBA2, LUPIN **B (10%)** SALIX, ALNUS, POBA2, ROAC	**A (10%)** SALIX, ALNUS, CAREX, CACA4	**A (5%) EMERGENT** TYLA, CARO6, EQFL **B (5%) WET MEADOW** CACA4. CAAQ. ERAM6 **C (45%) SHRUB** BENA, LEGR, SALIX, VACCI	**A & B (30%)** CAAQ, ERRU2, ERAN6, SHPAG2, VAOX, ANPO, VAUL **C (70%)** DWARF PIMA, LEGL, BENA, EMNI, VAVI, VAUL	**A & B (30%)** EQSY, BENA, RUCH, SPG170, PIMA, EMNI	**A & B (25%)** ERVA4, CABI5, RUCH, BENA, LEPAD, VAUL, VAVI
POLE (DBH 5-9")	**C (40%)** POBA2, PIGL, ROAC, VIED	**C (30%)** POBA2, PIGL, ROAC, VIED	**C - HARD (50%)** POBA2, PIGL, ROAC, VIED, ALNUS	**B (40%)** BEPA, PIGL, PIMA, ALNUS	**D (45%)** PIMA, LALA, BENA, MYGA		**D (35%)** PIMA, PLSC70, CLAD13, SPG170 **C (35%)** PIMA, RUCH, EMNI, SPG170	**C (75%)** PIMA, BENA, LEPAD, VAUL
MEDIUM (DBH 9-20")	**D (25%)** PIGL, ROAC, VIED, ALNUS **E (10%)** PIGL, ROAC, VIED, ALNUS	**D (35%)** PIGL, ROAC, VIED, ALNUS **E (15%)** PIGL, ROAC, VIED, ALNUS	**D (25%)** PIGL, ROAC, VIED, ALNUS **E (10%)** PIGL, ROAC, VIED, ALNUS	**C (40%)** PIGL, BEPA, POBA2, PIMA				
LARGE (DBH >20")								
ACRES	**248,119**	**169,773**	**23,427**	**3,106**	**515,641**	**173,703**	**83,545**	**28,868**

Figure 43. Ecosystem diversity framework for MLRA 228 – Riparian/wetland forested ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.



MAJOR LAND RESOURCE AREA 228 - Riparian & Wetland Grass-Shrub Systems

ECOLOGICAL SITE *(based on LANDFIRE - BIOPHYSICAL SETTINGS)*

STAGE/ STRUCTURE	16170[a] Shrub and Herbaceous Floodplain	16372 Alpine Floodplain	16240 Deciduous Shrub Swamp	16181 Herbaceous Fen
	Canopy Cover[b] Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed	Canopy Cover Open Closed
GRASS-FORB	A[c] (20%)[d] Aquatic Bed NULUP[e], POTAM, SPARG, RATR B (15%) Emergent Marsh METR3, EQFL, TYLA, COPA28 C (30%) Wet Meadow/Fen METR3, CAAQ, EQFL, COPA28	A (35%) CHLA13, LUPIN, MEPA,		A (5%) Emergent Marsh TYLA, CARO6, SCTA2 B (5%) Fen METR3, COPA28, EQFL C (40%) CAREX, ERAN6, CACA4
SHRUB	D (20%) Low Shrub MYGA, BENA, CHCA2, SAPU15 E (15%) Dwarf Shrub SPHAG2, VAOX, ANPO, ERAN6	B (20%) SAAL, SALIX, ALVIS, BENA C (45%) SALIX, SARE2, DRYAS, EMNI	A (100%) Tall Shrub ALINT, ALVIS, SAPU15, SARI4, CACA4, EQUIS	D (50%) Low Shrub MYGA, BENA, CHCA2, SAPU15
ACRES	**3,182**	**2,040**	**119,134**	**230,095**

Figure 44. Ecosystem diversity framework for MLRA 228 – Riparian/wetland grass-shrub ecosystems. See the Ecosystem Diversity Framework section for a discussion of the frameworks components and Appendix A for definitions.

Montane Floodplain Forest and Shrubland- Boreal (16141)

This ecological site is estimated to occur on approximately 498,246 acres of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 73,647 acres. It typically occurs on well drained sand or cobble without permafrost. Floods are the primary disturbance to this site, depositing alluvium that is then invaded by various species. Early seral species include balsam poplar and white spruce along with *Alnus viridi*, *Alnus incana*, *Salix barclayi* and *Salix alaxensis* (Boggs 2000, Shephard 1995, Thilenius 1990). This site may burn, but fire return intervals are typically >300 years, with flooding being the primary disturbance unless oxbows or other changes have isolated this type away from an active riverine system.

Following alluvial deposition, herbaceous species emerge from seeds including ***Lupinus*** spp., ***Hedysarum*** spp., ***Equisetum*** spp. and *Salix* spp. By year 5 willows and balsam poplar are typically well established and shrub cover may be up to 40%. From year 5-29, willows and alders will predominate along with balsam poplar saplings and white spruce as an understory species. This state may comprise 20% of the ecological site, as flooding continues to provide disturbance to floodplain settings. This state can provide valuable foraging sites for moose.

The next state, occurring from 30-149 years historically represented 40% of the ecological site and is characterized by closed canopies of mature balsam poplar mixed with white spruce. At later ages, the balsam popular may start to die increasing shrub understories that may become restricted to shade tolerant species under the younger, dense canopy. This state has a total carbon availability of 109.46 tons/acre with an annual carbon production of 1.28 tons/acre. There are approximately 54 tons of biomass available per acre.

Late seral conditions (>150 years post flood establishment) historically comprised 20% of the ecological site. This state is comprised of increasing dominance of white spruce that will occur in open canopies. On some sites, a closed canopy of white spruce may develop, favoring feathermoss in the understory. This state has a total carbon availability of 141.6 tons/acre with an annual carbon production of 0.34 tons/acre. There are approximately 68 tons of biomass available per acre.

Vegetation characteristics of the Montane Floodplain Forest and Shrubland-Boreal ecological site for the planning landscape are listed in Table 12. Photos depicting different vegetation stands in the Montane Floodplain Forest and Shrubland-Boreal ecological site are found in Figures 45 and 46.

Table 12. Vegetation characteristics expressed as mean and standard deviation (parenthesis) for canopy cover (% Cover), trees per acre (TPA), and Basal Area from plots sampled in the Montane Floodplain Forest and Shrubland - Boreal ecological site within the project area. Structure definitions include Seed/Sapling=trees <5" DBH; Dwarf Shrub=shrubs < 1 m in height; Medium Shrub=shrubs 1-3 m in height; Tall Shrub=shrubs >3m in height; Pole=trees 5-9" DBH; Medium=trees 9-20" DBH; Large=trees >20" DBH; OPEN=canopy cover 10 to 59%; CLOSED= canopy cover >60%.

ECOSYSTEM	STAGE/ STRUCTURE	DWARF SHRUB	MEDIUM SHRUB	TALL SHRUB	LICHEN	SEED/ SAPLING	POLE	MEDIUM	LARGE	SEED/ SAPLING	POLE	MEDIUM	LARGE
		% Cover (StDev)				TPA (StDev)				Basal Area (StDev)			
16141-A	SEED/SAP-OPEN	18 (0)	21 (0)	18 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
16141-B	SEED/SAP-CLOSED	2.8 (3.2)	3.3(3.2)	58 (2.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
16141-D	MEDIUM-OPEN	10 (0)	6.7 (0)	0 (0)	0 (0)	210 (0)	170 (0)	60 (0)	0 (0)	91.6 (0)	88.9 (0)	57.2 (0)	0 (0)
16141-E	MEDIUM-CLOSED	13.8 (8.8)	42.5 (3.5)	28.8 (12.4)	0 (0)	410 (410.1)	90 (14)	25 (21.2)	10 (0)	61.9 (15.3)	48.0 (0.7)	31.0 (2.7)	32.9 (0)

Figure 45. Example of ecological site 16141-C stand in Ahtna Traditional Use Territory.

Figure 46. Example of ecological site 16141-D stand in Ahtna Traditional Use Territory.

Montane Floodplain Forest and Shrubland- Sub-boreal (16142)

This ecological site is estimated to occur on approximately 204,372 acres of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 18,898 acres. It typically occurs on well drained sand or cobble without permafrost. Floods are the primary disturbance to this site, depositing alluvium that is then invaded by various species. Early seral species include balsam poplar and white spruce along with *Alnus viridis* ssp*. sinuata, Alnus incana* ssp*. Tenuifolia, Salix barclayi and Salix alaxensis* (Boggs 2000, Scott 1974, Shephard 1995, Thilenius 1990, Viereck 1966). This site may burn, but fire return intervals are typically >300 years, with flooding being the primary disturbance unless oxbows or other changes have isolated this type away from an active riverine system.

Following alluvial deposition, herbaceous species emerge from seeds including ***Lupinus*** spp., ***Hedysarum*** spp., *Equisetum* spp. and *Salix* spp. By year 5 willows and balsam poplar are typically well established and shrub cover may be up to 40%. This state historically comprised 5% of the ecological site.

From year 5-29, willows and alders will predominate along with balsam poplar saplings and white spruce as an understory species. This state may comprise 15% of the ecological site, as flooding continues to provide disturbance to floodplain settings. This state can provide valuable foraging sites for moose. Common shrubs include *Alnus viridis* ssp. *sinuata, Alnus incana* ssp. *tenuifolia*, *Salix barclayi* and *Salix alaxensis*. On dryer sites *Shepherdia canadensis*, *Dryas octopetala*, *D. integrifolia* and fruticose lichens (*Steroucaulon* spp.) may be more dominant.

The next state, occurring from 30-149 years historically represented 30% of the ecological site and is characterized by closed canopies of mature balsam poplar mixed with white spruce. At later ages, the balsam popular may start to die leading to increasing shrub understories that may become restricted to shade tolerant species under the younger, dense canopy. These shrub species include *Rosa acicularis* and *Viburnum edule*. An alternative mid-seral stage is comprised of closed stands of white spruce. These stands occur in the absence of balsam popular regeneration following disturbance. Feather moss is often dominant in the understory. Approximately 15% of the ecological site was in this state historically. Both of these states have a total carbon availability of 109.46 tons/acre with an annual carbon production of 1.28 tons/acre. There are approximately 54 tons of biomass available per acre.

Late seral conditions (>150 years post flood establishment) historically comprised 35% of the ecological site. These conditions occur as white spruce gains dominance over balsam popular. This results in a mixed-age spruce stand with a relatively open canopy between 25% and 60% cover. This state has a total carbon availability of 141.6 tons/acre with an annual carbon production of 0.34 tons/acre. There are approximately 68 tons of biomass available per acre.

Boreal Herbaceous Fen – Sub-boreal (16181)

This ecological site occurs across an estimated 311,353 acres in the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 22,287 acres. This wetland system occurs in permafrost free areas throughout Alaska. It is typically found in drainages and along pond margins. In early successional states sites may be semi-permanently flooded, and seasonal flooding is common in wetter states. In later successional states, soils are saturated for a portion of the growing season. Due to the wet nature of these sites fire is extremely rare. The primary factor driving succession is hydrology and the associated changes in water level or frequency. Major distributions to a site hydrology can also cause a site to transition to a different ecological site.

The earliest state in this ecological site is a freshwater marsh, dominated by *Typha latifolia* and *Carex rostrata*. Other species that may dominate include *Carex utriculata*, *Schoenoplectus tabernaemontani*, *Arctophila fulva*, *Eleocharis* palustris, *Myriophyllum spicatum*, *Menyanthes trifoliata*, *Comarum palustris*, *Hippuris vulgaris*, and *Equistem fluviatile* (Jorgenson 1999). The state usually only lasts for a few years before transitioning to the next state.

The second state, which commonly occurs in years 3 to 5, is herbaceous fen. Commons species include *Menyanthes trifoliata*, *Comarum palustre*, *Equisetum fluviatile*, *Potentilla palustris*, and *Carex aquatilis*. The state is steady with frequent flooding, while increased water levels will return site to earlier state, and drying will move it to a later state.

The third state is a wet meadow and occurs from 6 to 25 years. Dominant species may include *Carex aquatilis*, *Carex livida*, *Carex chordorrhiza*, *Carex lasiocarpa*, *Eriophorum angustifolium*, *Calamagrostis canadensis*, *Comarum palustre*, *Menyanthes trifoliata*, *Equisetum fluviatile*, and *Equisetum palustre*. Shrubs can be a minor component of this state and include *Myrica gale*, *Alnus incana* spp. *tenuifolia* and *Salix* spp (NatureServe 2008). As conditions continue to become drier this site will move to a later state, while wetter conditions may return it to an earlier state.

The climax state is a low shrub peatland and occurs beyond 26 years. Common species include *Ledum palustre*, *Ledum groenlandicum*, *Betula nana*, *Rubus chamaemorus*, *Oxycoccus microcarpus*, *Myrica gale*, *Calamagrostis canadensis*, *Carex aquatilis*, *Comarum palustre*, *Salix fuscescens*, *Salix pulchra*, *Empetrum nigrum* and *Chamaedaphne calyculata*. *Sphagnum* spp. and/or brown mosses may be common in the ground layer (DeVelice et al. 1999, Jorgenson et al 2003). This state is stable in the absence of disturbance. Wetter conditions will cause it to transition back to an earlier state.

Vegetation characteristics of the Boreal Herbaceous Fen – Alaska Sub-Boreal Complex ecological site for plots sampled in the planning landscape are shown in Table 13. Figure 47 is an example of a stand in the Boreal Herbaceous Fen – Alaska Sub-Boreal Complex ecological site.

Table 13. Vegetation characteristics expressed as mean and standard deviation (parenthesis) for canopy cover (% Cover), trees per acre (TPA), and Basal Area from plots sampled in the Boreal Herbaceous Fen – Sub-Boreal ecological site within the project area. Structure definitions include GFS=grass/forb/shrubs; Dwarf Shrub=shrubs < 1 m in height; Medium Shrub=shrubs 1-3 m in height; Tall Shrub=shrubs >3m in height.

ECOSYSTEM	STAGE/ STRUCTURE	DWARF SHRUB	MEDIUM SHRUB	TALL SHRUB	LICHEN
		------------------------% Cover (StDev) ----------------------			
16181-A	WET MEADOW	0.5 (1.6)	1.2 (2.1)	0.9 (2.0)	0 (0)
16181-D	GFS	2.2 (2.6)	24.2 (26.8)	1.5 (2.8)	0 (0)

Figure 47. Example of ecological site 16181-B stand in Ahtna Traditional Use Territory (LANDFIRE Photo).

Dwarf Black Spruce Peatland- Boreal (16211)

This ecological site covers an estimated 1,175,753 acres of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 315,538 acres. It occurs in valley bottoms and poorly drained floodplains on acidic soils with well-developed peat (LANDFIRE 2009, Nature Serve 2008).

Van Cleve et al. (1983) described taiga forests of interior Alaska, and stated that the role of fire was the predominant influence on vegetation patterns and compositions. Hollingsworth et al. (Hollingsworth et al. 2006) reported that "species composition of mature black spruce forests in interior Alaska results from the complex interaction of landscape and fire history, soil pH, paludification, permafrost, and topographic position." Van Cleve et al. (1983) stated that after severe fires where the forest floor was consumed, deciduous vegetation, specifically aspen and birches would take over previous black spruce sites, while black spruce could maintain its composition following lower severity fires. They reported that the productivity of black spruce sites generally increased for at least 10-20 years following fire as soil temperatures were increased with reductions in organic layers.

Barrett et al. (2011) reported that high severity fire in black spruce that left <10 cm of an organic layer increased the likelihood of a stand shifting from being spruce dominated to hardwood dominated. They found that this also increased the likelihood of the melting of permafrost under the site. They estimated that of the black spruce areas that burned in 2004, 39% could experience either a reduction in permafrost or a shift to deciduous vegetation. Similarly, Bernhardt et al. (2011) found that fire severity was the most important contributor to post-fire plant communities, being more important than pre-burn site moisture or soil pH.

Hollingsworth et al. (2013) found that fire severity accounted for the greatest percentage of post-fire vegetation variability in black spruce stands followed by soil pH and then an environmental gradient associated with elevation and assumed climate differences. Johnstone et al. (2009) found that black spruce could reestablish on sites that experienced low severity fires while deciduous species established on sites with higher fire severities where the organic layer was largely removed. Johnstone et al. (2011) clarified that it is the influence of fire on the organic layer as opposed to the influence on the overstory vegetation that largely drives the post-fire response of the plant community in black spruce forests. Thus, fire severity in black spruce should be considered the degree to which the organic layer on the forest floor is impacted by the fire, not just the impacts on the overstory plant community.

Shenoy et al. (2011) found that the effects of fire on the organic layer persisted for at least the first two decades following high severity fires, with deciduous trees maintaining their dominance on severely burned sites while black spruce gained increasing dominance on sites where the organic layer was not as disturbed. Turetsky et al. (2010) reported that mosses displayed a unimodal response following fire in boreal forests, peaking in amounts 30-70 years post-fire. Mann et al. (2012) speculated that given the shift in species composition from black spruce dominated stands to deciduous stands following severe fire, major changes to black spruce forests and associated ecosystem services such as carbon storage are likely with predicted climate change. Similarly, Scheffer et al. (2012) reported that climate change may cause massive shifts in boreal biomes as a consequence of changing fire frequencies and severities.

The Dwarf Black Spruce Peatland- Boreal ecological site typically occurs on permafrost. This is maintained by the thick layer of peat on the soil surface. This layer of peat keeps the site cool, reduces decomposition, and insulates the permafrost. Viereck et al. (1983) reported that these black spruce sites are nutrient poor and unproductive with these characteristics caused by the low soil temperature and high soil moisture. If severe fire occurs removing the layer of peat, the site may warm and melt the permafrost (thermokarst). This can cause the site to lower, changing it to a wetland-marsh system. On some sites, over time, the peat will again rebuild, and can lead to the permafrost reforming. With the rise of the site with freezing, the Black Spruce site may be reestablished, however, there are numerous possible pathways for these marsh systems to follow (LANDFIRE 2009).

Fire return intervals are estimated to be >150 years in the Copper River Basin. Where peatland persists, the site will first be a low shrub peatland with *Ledum groenlandicum, L. palustre, Andromeda polifolia, Vaccinium uliginosum*, *Salix* spp., *Betula nana,* and *Empetrum nigrum* as primary species. This can persist up to 74 years and historically occupied 45% of the ecological site. Sites >75 years, dominated by dwarf black spruce, were estimated to historically occur on >45% of this ecological site. This ecological site has very minimal carbon with stands containing up to 22 tons per acre and annual carbon production of 0.01 tons per acre. Estimates of biomass have not been done for this ecological site.

Vegetation characteristics for the Dwarf Black Spruce Peatland-Boreal ecological site are listed in Table 14. Figure 48 is an example of a stand in the Dwarf Black Spruce Peatland-Boreal ecological site.

Table 14. Vegetation characteristics expressed as mean and standard deviation (parenthesis) for canopy cover (% Cover), trees per acre (TPA), and Basal Area from plots sampled in the Dwarf Black Spruce Peatland - Boreal ecological site within the project area. Structure definitions include Seed/Sapling=trees <5" DBH; Dwarf Shrub=shrubs < 1 m in height; Medium Shrub=shrubs 1-3 m in height; Tall Shrub=shrubs >3m in height; Pole=trees 5-9" DBH; Medium=trees 9-20" DBH.

ECOSYSTEM	STAGE/ STRUCTURE	DWARF SHRUB	MEDIUM SHRUB	TALL SHRUB	LICHEN	SEED/SAPLING	POLE	MEDIUM	SEED/ SAPLING	POLE	MEDIUM
		------------------------ % Cover (StDev) --------------------				----------------- TPA (StDev) ----------------			------------- Basal Area (StDev) ------------		
16211-B	WET MEADOW	4.2 (8.4)	14.9 (27.3)	3.7 (9.8)	1.4 (5.0)	1232.1 (550.5)	0 (0)	0 (0)	37.9 (18.8)	0 (0)	0 (0)
16211-C	POLE	14.1 (20.3)	27.5 (33.1)	5.4 (9.5)	1.2 (3.0)	889 (432.7)	210.1 (162.7)	38.7 (20.6)	65.8 (27.4)	37.9 (29.3)	28.4 (14.5)

Figure 48. Example of ecological site 16211-B stand in Ahtna Traditional Use Territory (LANDFIRE Photo).

Dwarf Black Spruce Peatland- Sub-boreal (16212)

This ecological site covers an estimated 219,354 acres of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 29,498 acres. It occurs in valley bottoms and poorly drained floodplains on acidic soils with well-developed peat and permafrost is generally absent (Nature Serve 2008). The primary disturbance in these systems is changes in hydrology. Over time, thickening peat layers support low shrubs and eventually dwarf black spruce.

For the first 50 years following disturbance, such as the melting of permafrost, or other hydrology changes an herbaceous disturbance class dominates. Conditions range from marsh to sedge meadow to sphagnum-dominated poor fen. Common species include *Carex aquatilis*, *C. rariflora*, *C. limosa*, *C. utriculata*, *Eriophorum russeolum*, *E. angustifolium*, *Sphagnum* spp., *Calamagrostis canadensis*, and *Equisetum fluviatile*. Under historical conditions this state represented 10% of the ecological site.

As the peat layer thickens the sites move towards a dwarf shrub disturbance state. This can last up to 300 years. Common species include *Vaccinium oxycoccus*, *V. uliginosum*, *Andromeda polifolia*, *Ledum groenlandicum*, *Betula nana*, *Empetrum nigrum*, *Carex microglochin*, *C. rotundata*, *C. rariflora*, *C. lasiocarpa*, *C. limosa*, *C. livida*, *C. williamsii*, *Eriophorum brachyantherum*, *E. angustifolium* and *Drosera* spp. *Sphagnum* spp. form an abundant ground layer. This state was present across 20% of the ecological site historically.

The climax state for this ecological site is a dwarf black spruce bog. Tree cover ranges from 10-60%. Dominant understory species include *Ledum groenlandicum*, *Betula nana*, *Empetrum nigrum*, *Vaccinium vitis-idaea*, *V. uliginosum*, *Chamaedaphne calyculata*, *Carex* spp., *Eriophorum angustifolium*, and *Sphagnum* spp. Under historical conditions this state represented 70% of the ecological site.

Black Spruce Wet-Mesic Slope (16220)

This ecological site covers an estimated 93,318 acres of the Ahtna Traditional Use Territory. On Ahtna Incorporated and Village controlled lands this ecological site covers an estimated 18,119 acres. It occurs on north-facing slopes underlain by permafrost. Soils are poorly drained and acidic with a well-developed peat layer (NatureServe 2008). The dominant overstory vegetation is black spruce and the primary disturbance in these systems is fire. The mean fire return interval is 170 years, with considerable variation between sites. Since this type occurs on slopes, fire spread is possible, despite saturated soils.

From years 0-19 following fire the stand is a grass/shrub disturbance type. Common shrubs include *Ledum groenlandicum*, *Ledum palustre*, *Betula nana*, *Empetrum nigrum*, *Vaccinium vitis-idaea* and *V. uliginosum*. Herbs include *Equisetum sylvaticum*, *Rubus chamaemorus* and *Carex* spp. Mosses include *Sphagnum* spp., *Pleurozium schreberi*, and *Polytrichum* spp. On some sites, *Alnus* spp. and *Salix* spp. may be present. Black spruce seedlings are present in the understory. Under historical conditions this state represented 10% of the ecological site.

By years 20-40 post fire the stand transition to a tree disturbance type. The class is dominated by seedling/sapling black spruce. The shrubs listed above are still present, but occur under a closed tree canopy. This state was present across 20% of the ecological site historically.

By 40+ years post fire the stand is dominated by pole-sized black spruce. Many of the shrub species have begun to senesce due to the closed tree canopy. This class has the highest probability of stand replacing fire due to the high amount of fuel present on the site. Under historical conditions this state represented 35% of the ecological site. This state has a total carbon availability of 71.4 tons/acre with an annual carbon production of 0.37 tons/acre. There are approximately 34 tons of biomass available per acre.

As the black spruce mature the canopy becomes more open and lichen species become more prevalent. Lichen species include *Cladina arbuscula*, *C. rangiferina* and *Nephroma articum*. Mosses include *Pleurozium schreberi*, *Polytrichum* spp., *Hylocomium splendens* and *Dicranum* spp., as well as *Sphagnum* spp. Low shrubs, including *Vaccinium vitis-idaea*, *V. uliginosum* and *Ledum groenlandicum*, are often present in the understory. The increasing lichen cover can make these stands important for wintering caribou. This state was present across 35% of the ecological site historically. This state has a total carbon availability of 36.8 tons/acre with an annual carbon production of 0.22 tons/acre. There are approximately 18 tons of biomass available per acre.

Historical Reference Versus Todays Conditions

The landscape model results developed by the LANDFIRE team makes it possible to calculate the estimated acres in each ecosystem within an ecological site's historical reference conditions. These conditions were expected to have occurred prior to human changes to fire regimes. Table 15 shows a comparison of historical reference conditions versus todays conditions in terms of both acres and percentages, for each riparian and wetland ecological site and disturbance class occurring in the Ahtna Traditional Use Territory (ecological sites >10,000 acres). The numbers in parenthesis represent the acres and percentages for Ahtna lands only. Significant differences in historical versus todays conditions are apparent. These numbers should be viewed with caution as inaccuracies in both the estimated historical amounts and in the amounts of current disturbance classes may be amplifying these differences and have not been evaluated.

Table 15. A comparison of historical reference conditions versus todays conditions in terms of both acres and percentages, for each riparian and wetland ecological site and disturbance class occurring in the Ahtna Traditional Use Territory (ecological sites >10,000 acres). The numbers in parenthesis represent the acres and percentages for Ahtna lands only. N/A = not applicable

Disturbance Class		Ecological Site											
		16141		**16142**		**16181**		**16211**		**16212**		**16220**	
		Montane Floodplain Forest and Shrubland - Boreal		**Montane Floodplain Forest and Shrubland - Sub-boreal**		**Boreal Herbaceous Fen - Sub-boreal**		**Dwarf Black Spruce Peatland - Boreal**		**Dwarf Black Spruce Peatland - Sub-boreal**		**Black Spruce Wet-Mesic Slope**	
		Hist.	**Today**	**Hist.**	**Today**	**Hist.**	**Today**	**Hist.**	**Today**	**Hist.**	**Today**	**Hist.**	**Today**
A	**Acres**	24,912 (3,682)	229,695 (7,392)	10,219 (945)	131,731 (10,965)	15,568 (1,114)	80,407 (7,433)	58,788 (15,777)	41,330 (11,957)	21,935 (2,950)	20,551 (2,556)	9,332 (1,812)	21,174 (3,894)
	%	5	46 (10)	5	64 (58)	5	26 (33)	5	4 (4)	10	9 (9)	10	23 (22)
B	**Acres**	99,649 (14,729)	69,359 (9,565)	30,656 (2,835)	43,702 (3,887)	15,568 (1,114)	84,582 (2,852)	58,788 (15,777)	82,177 (13,102)	43,871 (5,900)	103,061 (8,971)	18,664 (3,624)	33,389 (4,616)
	%	20	14 (13)	15	21 (21)	5	27 (13)	5	7 (4)	20	47 (30)	20	36 (26)
C	**Acres**	199,298 (29,459)	31,844 (4,232)	61,312 (5,669)	22,441 (2,828)	124,541 (8,915)	1,708 (334)	529,089 (141,992)	169,149 (29,386)	153,548 (20,648)	95,742 (17,971)	32,661 (6,342)	3,533 (536)
	%	40	6 (6)	30	11 (15)	40	1 (2)	45	14 (9)	70	44 (61)	35	4 (3)
D	**Acres**	124,562 (18,412)	155,539 (48,277)	71,530 (6,614)	5,752 (1,022)	155,676 (11,143)	144,656 (11,684)	529,089 (141,992)	883,097 (261,027)	N/A		32,661 (6,342)	35,223 (9,083)
	%	25	31 (66)	35	3 (5)	50	46 (52)	45	75 (83)	-		35	38 (50)
E	**Acres**	49,825 (7,365)	11,809 (4,188)	30,656 (2,835)	746 (182)	N/A		N/A		N/A		N/A	
	%	10	2 (6)	15	<1 (1)	-		-		-		-	

Management Plans

Tribal Village Local Plans

The Ahtna Traditional Use Territory includes 7 tribal villages that merged to form Ahtna, Inc. along with the Chitina Native Corporation. Figure 49 shows the 8 tribal villages and their planning regions. Each planning region will be discussed in detail in the following section. Additional detail on the unique biotic and abiotic conditions found in these planning regions will be discussed in more detail for each relevant village.

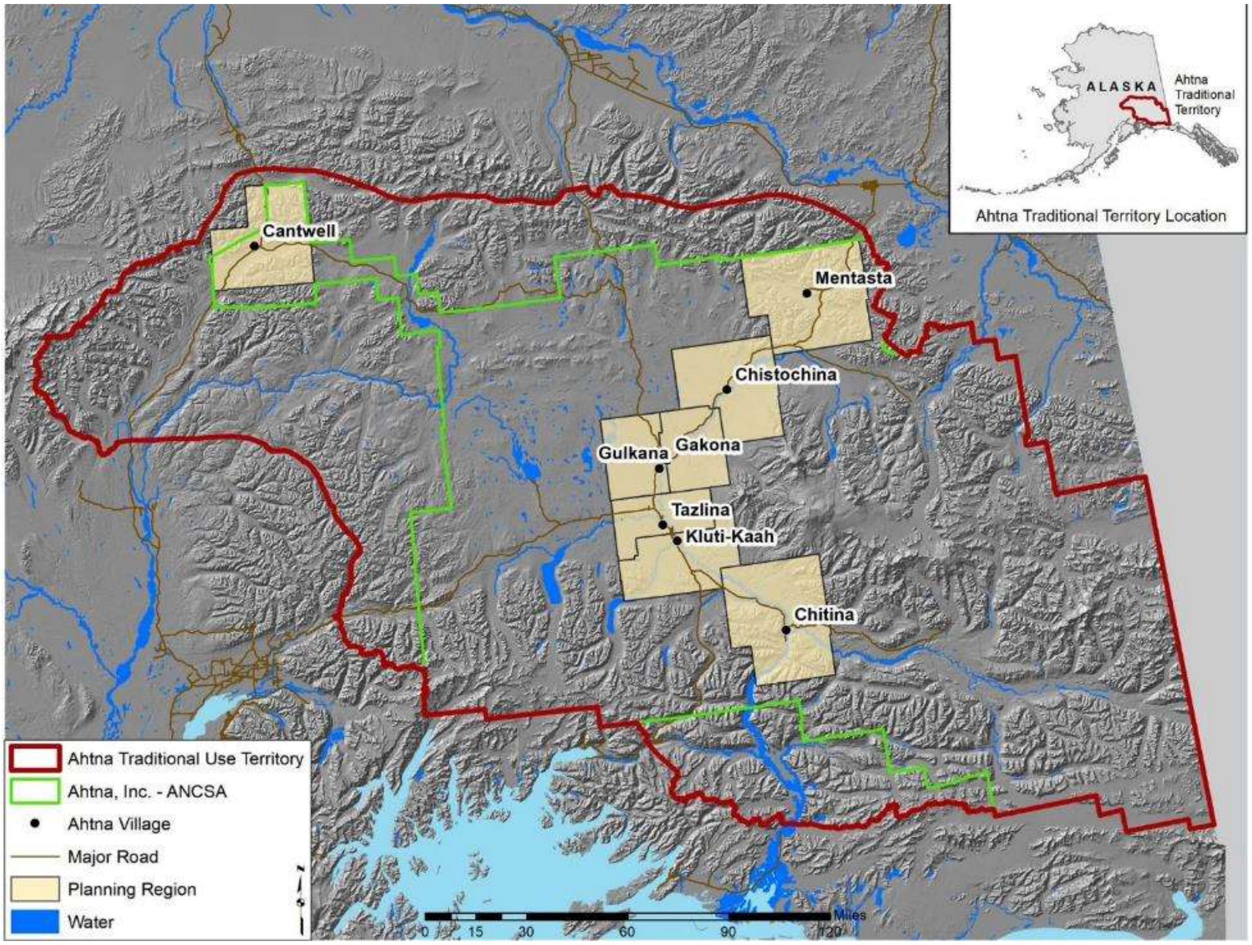


Figure 49. Village planning regions in the Ahtna Traditional Use Territory.

Methods

Moose and Caribou Models

Mapping ecosystem diversity seamlessly across a landscapes allows the development of ancillary models such as moose and caribou habitat suitability indices. These models use a habitat suitability index to depict the quality of moose and caribou habitat within the Ahtna Traditional Use Territory. A full description of the moose model including methods and results for the entire project area can be found in Appendix B. A full description of the caribou model including methods and results for the entire project area can be found in Appendix C. In addition, maps of moose and caribou results particular to each village planning region can be found in the relevant portion of each village plan.

Berry Production Areas

Ecological sites with the potential to produce desirable species of berries for harvest by shareholders were identified. Based on consultation with Ahtna shareholders the most desirable berry species were: wild raspberries (*Rubus idaeus*), blueberries (*Vaccinium* spp.), crowberries (*Empetrum* spp.), highbush cranberries (*Viburnum edule*), and cloudberries (*Rubus chamaemorus*). Ecological sites were then further identified as to the disturbance classes most likely to support berry production. While numerous factors can influence where berry-producing vegetation occurs, the combination of ecological sites and disturbance class allowed for the identification of areas with higher probabilities of finding good berry production.

Improvement Areas – Vegetation Treatment Sites

Improvement area treatment site selection focused on two types of treatments: 1) increasing the amount of moose forage and providing increased opportunities for the harvest of moose in the fall, and 2) improving the condition of timbered stands, improving access to stands, and providing biomass and firewood to neighboring communities. Moose browse improvements are intended to increase the foraging quality of a stand primarily by increasing the productivity of preferred willow species. This is usually accomplished by crushing or cutting mature willows to encourage regrowth and/or site scarification to stimulate willow seeding, sprouting and regeneration. Timber stand improvements are mainly intended to increase the growth rates and quality of timber, particularly in white spruce stands. Treatments consist of removing portions of the overstory along with diseased and misshapen trees to improve stand health and release remaining trees for increased growth. These treatments can also generate biomass and firewood for local communities.

The primary selection criteria for improvement areas were similar for both types of treatments and include the following:

1. A treatment site must be owned by Ahtna, Inc.
2. A treatment site must have existing access in the form of a road or trail.
3. A treatment site must have productive soils well suited to management activities.
4. A treatment site must have high potential for willows for moose habitat objectives or white spruce if for timber stand improvement; this was determined based on the mapped ecosystem vegetation characteristics.
5. Avoid high quality caribou habitat as both moose browse treatments and timber stand improvements could impact caribou forage (primarily lichen).
6. Avoid high quality berry production sites.
7. Avoid creating openings greater than 40 acres, which includes adjoining vegetation conditions, to avoid negative impacts to proposed or existing moose habitat quality.

Treatment areas may also be selected to add to the existing Primary Line of Defense (PLOD). The PLOD is intended to provide predetermined boundaries around areas of high values at risk to wildfire such as residential, recreational, or commercial structures. PLOD boundaries are selected to maximize tactical efficacy, accessibility, ease of identification from the ground or air, and potential firefighter safety when fighting wildfires.

Within a community it is also important to create defensible space around structures. By reducing fuels around structures the rate and intensity of advancing wildfire is reduced. Defensible space also provides more room for firefighters to work and protects surrounding forest land from a structure fire. The defensible space is usually defined as an area a minimum of 30 feet around a structure that has been cleared of all flammable brush or vegetation. For additional information visit www.firewise.org.

Based on all of the above stated criteria, 62 treatment sites totaling nearly 2,000 acres were identified across the 8 tribal village planning regions. Detailed information on specific treatment sites for each village can be found in the appropriate village planning region section and Appendix D. While specific treatment methods will be evaluated for their appropriateness for each sites, in general specific treatment for moose habitat improvement could include several mechanical methods designed to stimulate growth of preferred moose browse species such as willow, or potentially prescribed fire. Treatments for fuel mitigation would use similar methods, but are designed to reduce the amounts of flammable material in the PLOD and provide opportunities for defensive actions to counter an approaching fire. Treatment options are described in the Management Treatments section.

Cantwell Village Management Plan

The Cantwell Village planning region encompasses an area of 480,794 acres. Figure 50 displays the overall planning area along with associated infrastructure. Land ownership patterns within the planning region and the surrounding area are shown in Figure 51. Ahtna, Inc. is the primary landowner with 25.6% (123,231 acres) of the land in this area.

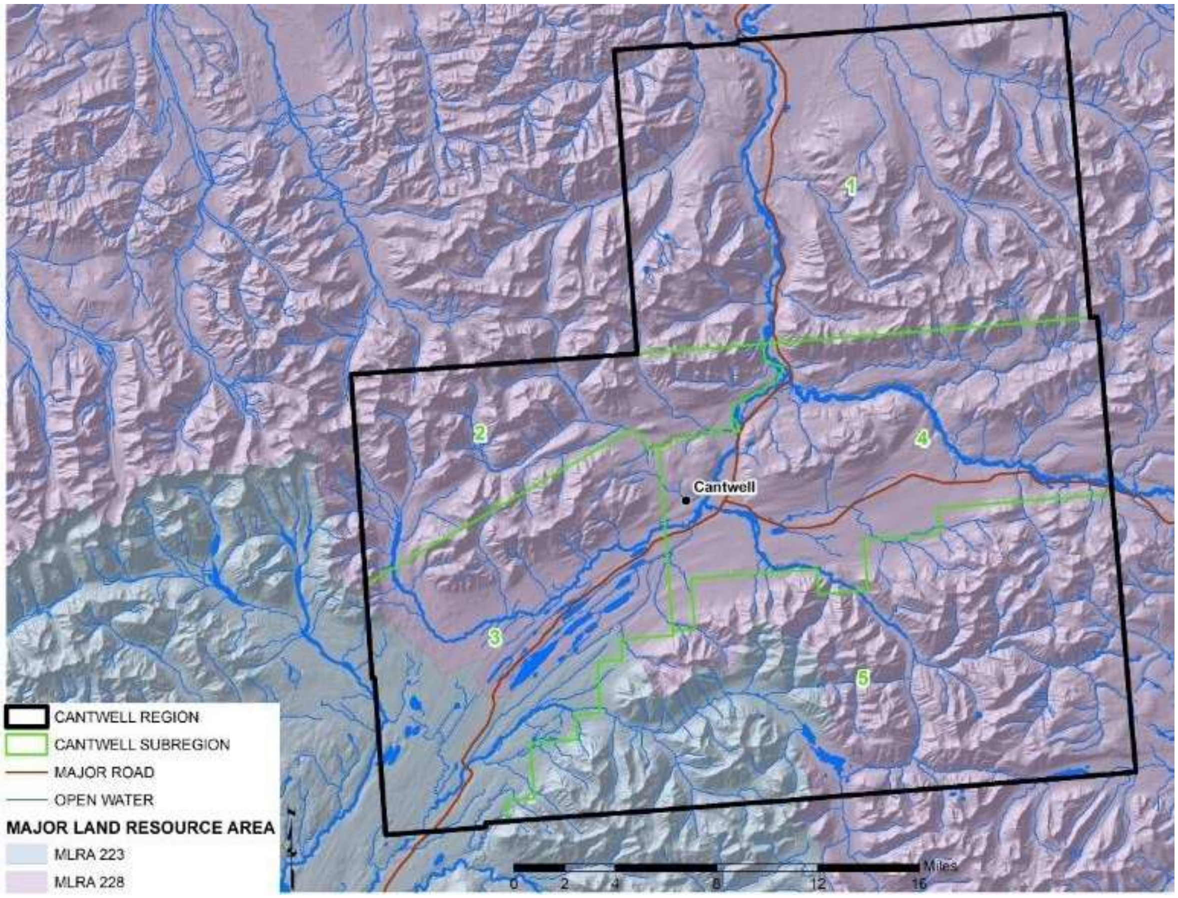


Figure 50. Overview of the Cantwell Village planning region.

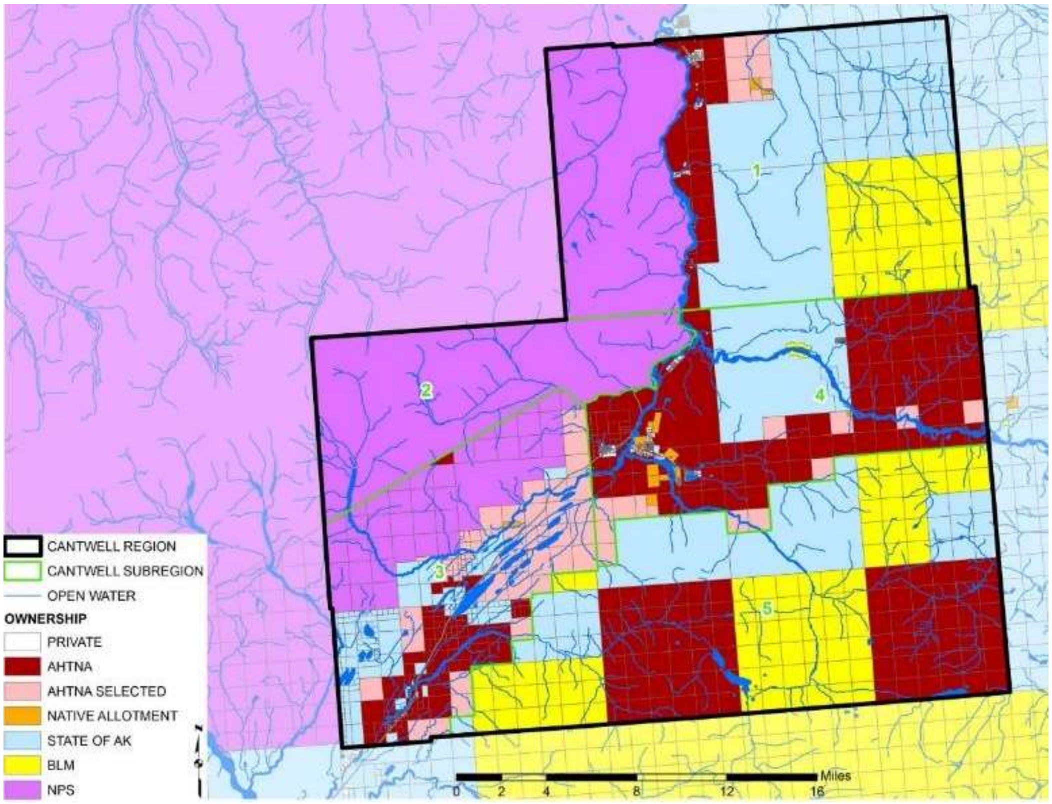


Figure 51. Landownership patterns in the Cantwell Village planning region.

Planning Area Description

The geology of the Cantwell area was described in the Denali National Park Area Soil Survey. Rocks in the area consist of shale, andesite, schist, diorite, conglomerate, and limestone. The region around Cantwell is known as the Alaska Mountains Section and consists of steep alpine talus slopes and more gentle slopes locally flanked by glacial deposits. Surrounding the steep mountain slopes are rounded low mountains, plateaus, glacial plains, and hills. Running throughout these raised features are braided glacial-fed rivers and clear water streams with adjacent flood plains, alluvial fans, and terraces. There are soil materials of three main types. These are gravelly colluvium, drift, and loamy and gravelly alluvium. A major fault line, the Denali fault system, bisects the area running from east to west.

The location of the Cantwell area causes it to fall on the border between two major climatic areas of Alaska. Areas to the north have a sub-arctic continental climate, while areas to the south are transitional maritime- continental. The climate for these two types in the area was describe in the Denali National Park Area Soil Survey. "Based on climatic summaries from the Western Regional Climate Center, the sub-arctic continental climate characteristic to Interior Alaska consists of long cold winters and short warm summers. Mean minimum January air temperature at Minchumina along the northwest border of Denali Park are -12.6 °F (-24.8 °C) and the mean maximum July temperature is 71.6 °F (22 °C). Total precipitation is relatively low, totaling 12.8 inches (32.5 cm). The dry characteristic of the interior climatic zone is best understood by comparing total annual precipitation to water loss (evapotranspiration). Annual precipitation and potential evapotranspiration estimates for Minchumina are reported as 12.8 inches (32.5 cm) and 17.9 inches (45.4 cm) (Patric and Black 1968) and represent an annual moisture deficit of 5.1 inches (12.9 cm). Winter snow cover, an important insulator against subzero winter air temperatures, is relatively low, averaging only 18.1 inches (46 cm) during March.

The transitional maritime-continental climate of Southcentral which includes the Southcentral Mountains and Cook Inlet Lowlands Sections is characterized as a blend of the mild, moist maritime influences of the coastal zone of the Gulf of Alaska and the cold, dry continental influences of Interior Alaska. Mean minimum January air temperature at Talkeetna, outside the southern border of Denali Park, is 1.8 °F (-16.8 °C) and the mean maximum July temperature is 67.8 °F (19.9 °C) and permafrost is generally absent. Average precipitation at Talkeetna is over double that of the Minchumina station, at 27.9 inches (70.9 cm), owing to the more significant marine influence. Annual precipitation and potential evapotranspiration estimates for Talkeetna, the nearest available recording station is 27.9 inches (70.9 cm) and 18.7 inches (47.5 cm) (Patric and Black 1968) and represents a surplus of 9.2 inches (23.4 cm)."

Weather measurements from Cantwell indicate the area's location between these two climatic types. Minimum January air temperature is -8.7 °F (-22.6 °C) and maximum July temperature is 66.2 °F (19.0 °C). The mean annual precipitation is 17.0 inches (43.2 cm) and the March snow cover averages 30 inches (76.2 cm).

Soil texture in the Cantwell area is shown in Figure 52 and soil drainages is shown in Figure 53.

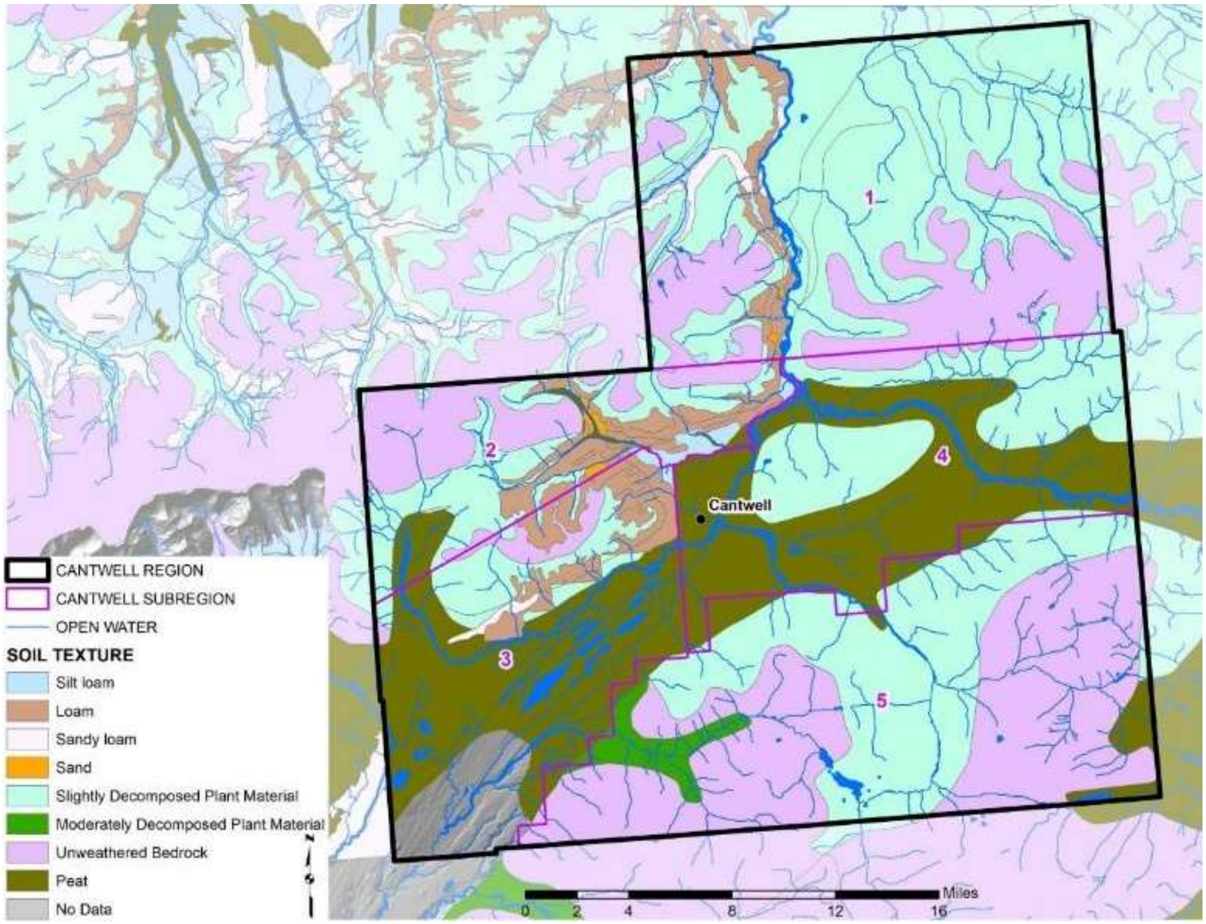


Figure 52. Soil texture in the Cantwell Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK651 and NRCS STATSGO database for Alaska.

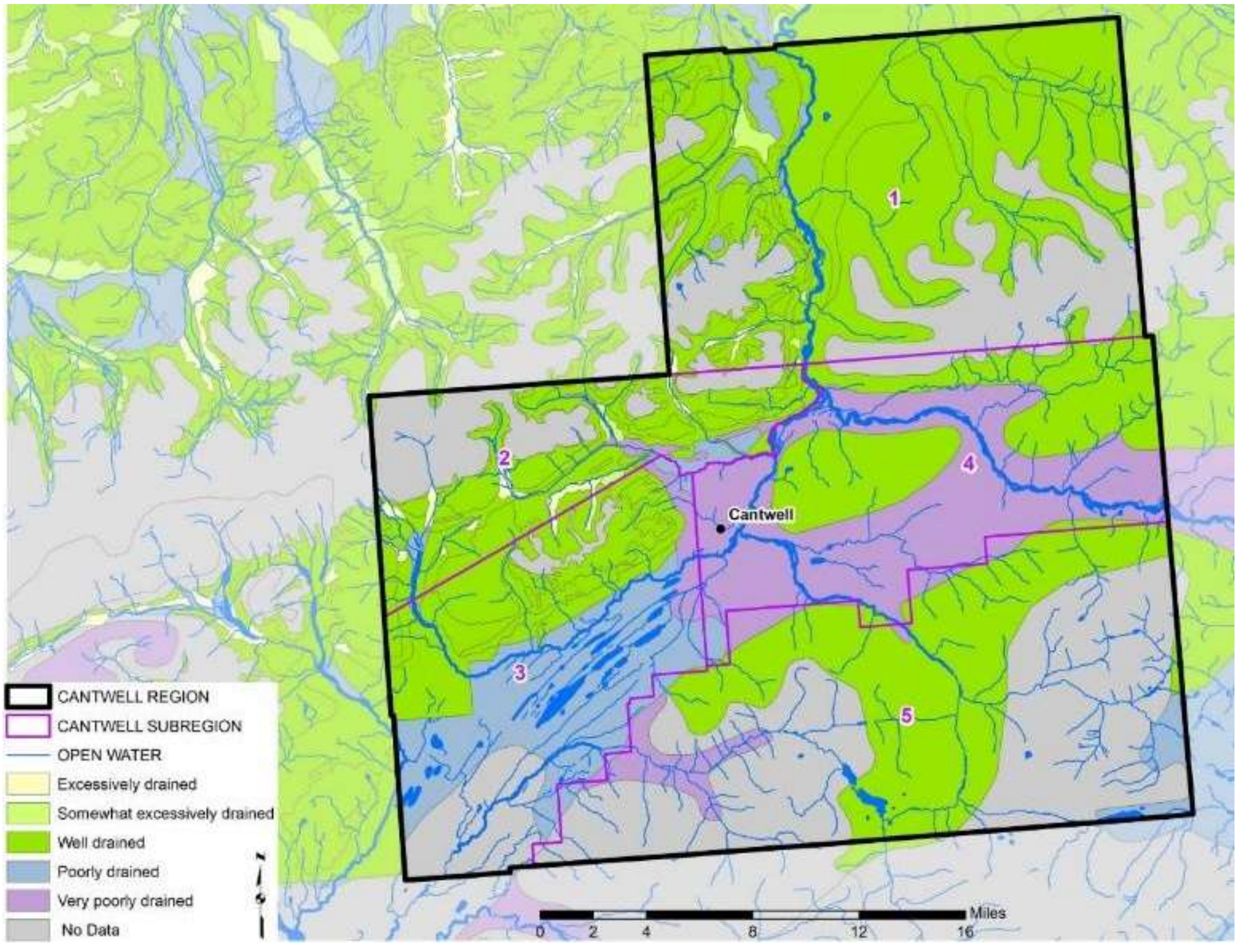


Figure 53. Soil drainage in the Cantwell Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK651 and NRCS STATSGO database for Alaska.

A significant factor influencing the vegetation in the landscape is the occurrence of permafrost under some of the project area. Permafrost is extensive on loamy textured soils within the boreal biome and is only occasionally observed in gravelly alpine soils. The Copper River Basin Soil Survey described the role of permafrost as: “Permafrost, or perennially frozen ground, underlies most of the Copper River basin. The depth at which it occurs and its ice content varies widely. Permafrost characteristically occurs as ice crystals disseminated throughout the soil. Although not extensive near the soil surface, massive ice wedges and lenses do occur in the subsoil in some areas. A perched water table and saturated conditions are common above the permafrost during the summer due to restricted drainage. The fire history of the site and the thickness of the insulating organic layer on the soil surface control depth to permafrost and water table, in part. Disturbance of the organic layer usually results in increased soil temperatures and a lowering of the permafrost level. As permafrost thaws, a large volume of water is released. Variation in the ice content of the permafrost and the rate of thawing results in differential subsidence of the soil surface and slumping on steeper slopes. The occurrence of permafrost requires special consideration when selecting lands for clearing and agriculture and during construction of roads and buildings.” Permafrost considerations should be evaluated in other management decisions including selection of areas for moose habitat improvements. Figure 54 displays the occurrence of permafrost in the Cantwell project area as interpreted from the soil survey information.

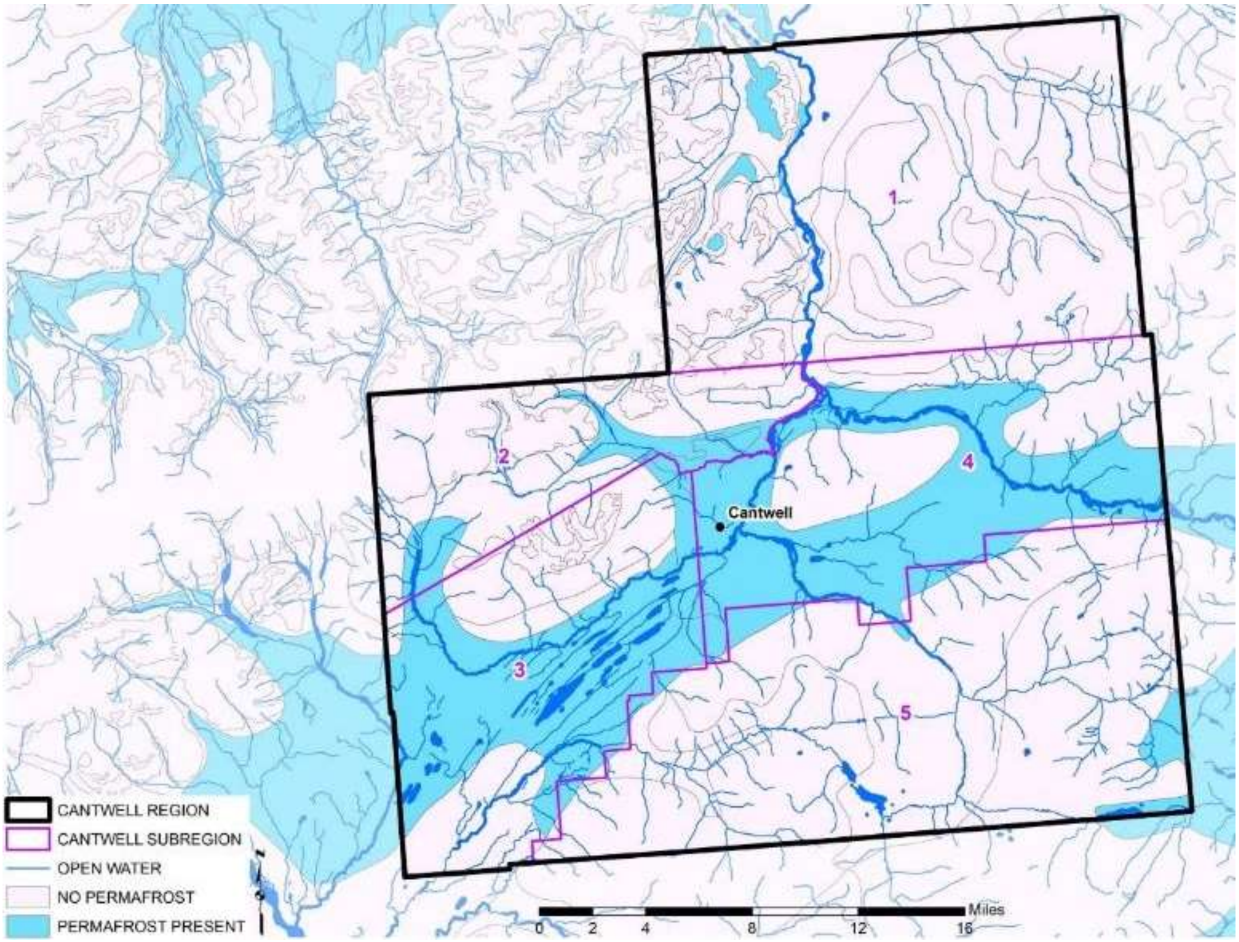


Figure 54. Permafrost in the Cantwell Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK651 and NRCS STATSGO database for Alaska.

The Denali National Park Area Soil Survey provided a general description of the vegetation occurring in the Cantwell area. It stated: "General patterns of vegetation in the study area are the result of two major influences: the elevation gradient of the Alaska Range, and the different climactic regions north and south of the range. Much of the Denali Park is above tree line, and almost one-sixth is non-vegetated ice and rocky mountain slopes. In the vegetated zone, harsh conditions at high elevations limit plant communities to dwarf shrubs and herbaceous meadows in nivation hollows. Medium or tall shrubs are found lower down the slopes and these grade into forests or woodlands on well-drained substrates at lower elevations. Poor drainage at all elevations, because of glacial drift or permafrost, limits productivity. In lowlands, wet woodlands, shrubs, and herbaceous communities are found in a mosaic of fens, bogs, marshes and muskegs. Mountain vegetation of the Alaska Mountains Section is dominated by white mountain avens (*Dryas octopetala*) - dwarf ericaceous shrubs, which grade into medium-sized shrubs dominated by shrub birch and ericaceous shrubs such as blueberry (*Vaccinium uliginosum*), Labrador tea (*Ledum palustre* ssp. *decumbens* and *L. groenlandicum*) and crowberry (*Empetrum hermaphroditum*). On cooler, more northerly aspects these shrubs sometimes have high percentages of sedge and other herbaceous vegetation. Warmer low slopes, especially in the Kantishna Hills and Park headquarters areas, support white spruce/mixed scrub woodlands."

As mentioned in reference to permafrost and vegetation, fire is a primary disturbance factor influencing the vegetation ecology in the planning region. Figure 55 shows the fire history of the Cantwell area along with current fire protection zones. Although the level of fire occurring in this southcentral Alaska landscape is substantially less than that occurring in more interior areas of Alaska north of the Alaska Range, fire is still a significant disturbance when it occurs. However, there have been no recorded fires within the planning area since 1940. When fire does occur it serves to set back succession. It can also burn off the organic material at the ground surface, including peat that can occur on many sites. This can influence the thermal layer protecting the underlying permafrost on some sites, causing the permafrost to melt (thermokarst) and changing the site conditions through this process. Riparian areas are also influenced by flooding and ice events. These serve to set back succession of vegetation in riparian areas, and can even shift site conditions, particularly in the case of significant flooding events.

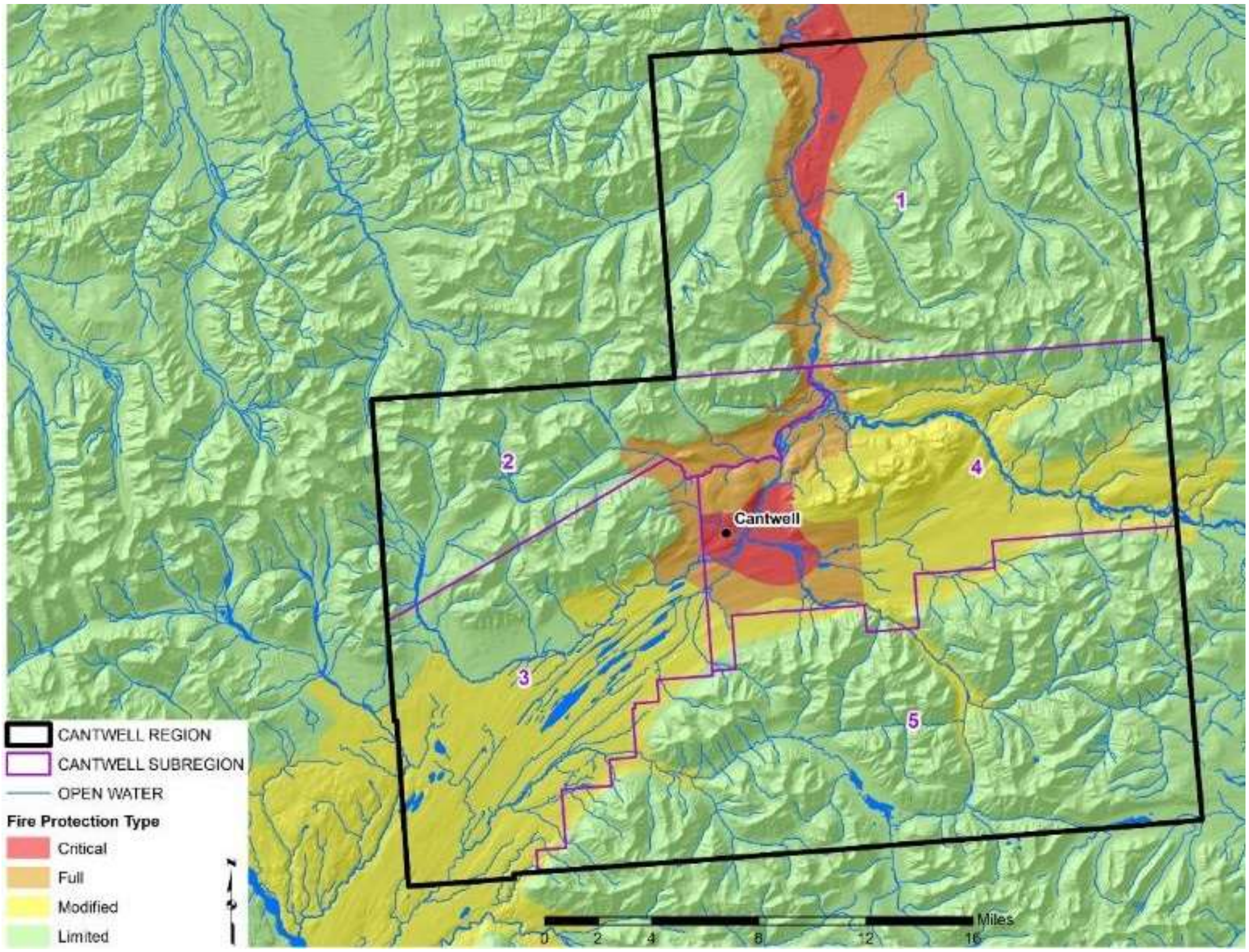


Figure 55. Current fire protection classes and fire history since 1940 in the Cantwell Village planning region. Data from Alaska Interagency Coordination Center.

Landscape Assessment Results

Ecosystem Diversity

The ecological sites present within the Cantwell Village planning region are displayed in Figure 56. Table 16 displays the acres for each ecosystem (i.e., ecological site and disturbance class). Figure 57 represents the ecosystem diversity for the Cantwell Village planning region.

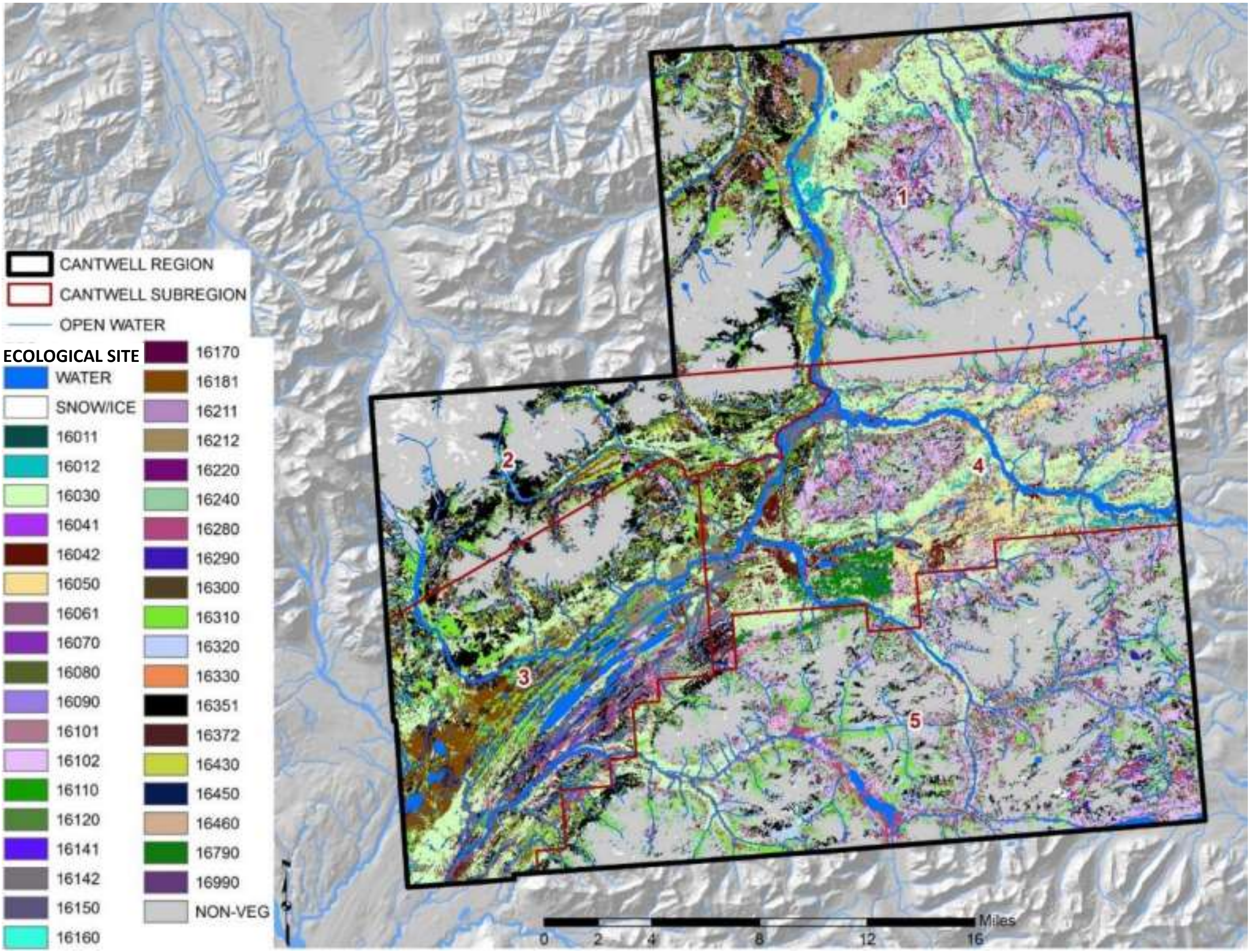


Figure 56. Ecological sites occurring in the Cantwell Village planning region.

Table 16. Ecosystems present in the Cantwell Village planning region and their associated acres. The ecological site vegetation label is provided for reference.

Ecosystem Code	Ecological Site Label	Acres
11	Open Water	7691.5
12	Perrennial Ice-Snow	3830.3
16011_A	Treeline White Spruce-Boreal	149.7
16011_B	Treeline White Spruce-Boreal	152.8
16012_A	Treeline White Spruce-SubBoreal	2380.7
16012_B	Treeline White Spruce-SubBoreal	3056.8
16012_C	Treeline White Spruce-SubBoreal	6.2
16030_A	White Spruce-Hardwood-Boreal	2816.0
16030_B	White Spruce-Hardwood-Boreal	40844.2
16030_C	White Spruce-Hardwood-Boreal	20555.8
16030_E	White Spruce-Hardwood-Boreal	42.0
16041_A	Mesic Black Spruce-Boreal	43.1
16041_B	Mesic Black Spruce-Boreal	218.4
16041_C	Mesic Black Spruce-Boreal	47.6
16041_D	Mesic Black Spruce-Boreal	102.7
16041_E	Mesic Black Spruce-Boreal	0.4
16042_A	Mesic Black Spruce-SubBoreal	4385.6
16042_B	Mesic Black Spruce-SubBoreal	3574.6
16042_C	Mesic Black Spruce-SubBoreal	1511.2
16042_D	Mesic Black Spruce-SubBoreal	6.4
16042_E	Mesic Black Spruce-SubBoreal	1.3
16050_A	Mesic Birch-Aspen	1284.8
16050_B	Mesic Birch-Aspen	3483.8
16050_E	Mesic Birch-Aspen	0.7
16061_B	Dry Aspen-Steppe Bluff	0.9
16070_A	Subalpine Balsam Poplar-Aspen	4.7
16070_B	Subalpine Balsam Poplar-Aspen	0.7
16080_A	Avalanche Slope Shrubland	170.6
16080_B	Avalanche Slope Shrubland	610.3
16090_A	Mesic Subalpine Alder	1543.0
16090_B	Mesic Subalpine Alder	5924.2
16102_A	Mesic Scrub Birch-Willow	4254.0
16102_B	Mesic Scrub Birch-Willow	40223.9
16110_A	Mesic Bluejoint Meadow	1534.3
16110_B	Mesic Bluejoint Meadow	0.9
16120_A	Dry Grassland	2732.8
16141_A	Montane Floodplain-Boreal	1180.5
16141_B	Montane Floodplain-Boreal	570.9
16141_C	Montane Floodplain-Boreal	180.1
16141_D	Montane Floodplain-Boreal	2.7
16141_E	Montane Floodplain-Boreal	0.4
16142_A	Montane Floodplain-Subboreal	8255.7
16142_B	Montane Floodplain-Subboreal	3542.1
16142_C	Montane Floodplain-Subboreal	2145.2
16142_D	Montane Floodplain-Subboreal	52.7
16142_E	Montane Floodplain-Subboreal	9.6
16150_A	Large River Floodplain	125.2
16150_B	Large River Floodplain	24.9
16150_C	Large River Floodplain	23.1
16150_D	Large River Floodplain	1.1
16150_E	Large River Floodplain	1.3
16160_A	Riparian Stringer	7.1
16160_B	Riparian Stringer	76.5
16160_C	Riparian Stringer	0.9
16170_A	Shrub and Herbaceous Floodplain	19.3
16170_B	Shrub and Herbaceous Floodplain	2.2
16170_D	Shrub and Herbaceous Floodplain	6.0
16170_E	Shrub and Herbaceous Floodplain	6.2
16181_A	Herbaceous Fen	4145.9
16181_B	Herbaceous Fen	5291.7
16181_C	Herbaceous Fen	0.9
16181_D	Herbaceous Fen	8453.7
16211_A	Dwarf Black Spruce Peatland-Boreal	436.6
16211_B	Dwarf Black Spruce Peatland-Boreal	968.8
16211_C	Dwarf Black Spruce Peatland-Boreal	1528.3
16211_D	Dwarf Black Spruce Peatland-Boreal	627.4
16212_A	Dwarf Black Spruce Peatland-Subboreal	1200.9
16212_B	Dwarf Black Spruce Peatland-Subboreal	8162.3
16212_C	Dwarf Black Spruce Peatland-Subboreal	4074.1
16220_A	Black Spruce Wet-Mesic Slope	233.7
16220_B	Black Spruce Wet-Mesic Slope	753.7
16220_C	Black Spruce Wet-Mesic Slope	92.7
16220_D	Black Spruce Wet-Mesic Slope	154.3
16240_A	Deciduous Shrub Swamp	2845.5
16240_B	Deciduous Shrub Swamp	2.0
16280_A	Low Shrub-Tussock Tundra	3927.7
16280_B	Low Shrub-Tussock Tundra	8763.5
16280_C	Low Shrub-Tussock Tundra	3496.0
16290_A	Tussock Tundra	195.0
16290_B	Tussock Tundra	1220.9
16300_A	Wet Black Spruce-Tussock	129.9
16300_B	Wet Black Spruce-Tussock	654.1
16300_C	Wet Black Spruce-Tussock	43.4
16310_A	Alpine Dwarf Shrub Summit	37204.0
16310_B	Alpine Dwarf Shrub Summit	1.3
16320_A	Alpine Talus and Bedrock	24014.0
16320_B	Alpine Talus and Bedrock	3858.6
16330_A	Alpine Mesic Herbaceous Meadow	1472.5

Table 16, continued. Ecosystems present in the Cantwell Village planning region and their associated acres. The ecological site vegetation label is provided as well.

Ecosystem Code	Ecological Site Label	Acres
16330_B	Alpine Mesic Herbaceous Meadow	0.2
16351_A	Alpine Ericaceous Dwarf-Shrubland	49075.2
16351_B	Alpine Ericaceous Dwarf-Shrubland	21.6
16372_A	Alpine Floodplain	797.5
16372_B	Alpine Floodplain	1802.3
16372_C	Alpine Floodplain	158.3
16430_A	Alpine Dwarf Shrubland	6277.1
16450_A	Alpine Mesic Herbaceous Meadow	560.0
16450_B	Alpine Mesic Herbaceous Meadow	0.4
16790_A	White Spruce-Hardwood-SubBoreal	3897.3
16790_B	White Spruce-Hardwood-SubBoreal	963.9
16790_C	White Spruce-Hardwood-SubBoreal	149.7
16790_D	White Spruce-Hardwood-SubBoreal	1.6
16790_E	White Spruce-Hardwood-SubBoreal	0.7
31	Barren Rock-Sand-Clay	123829.5

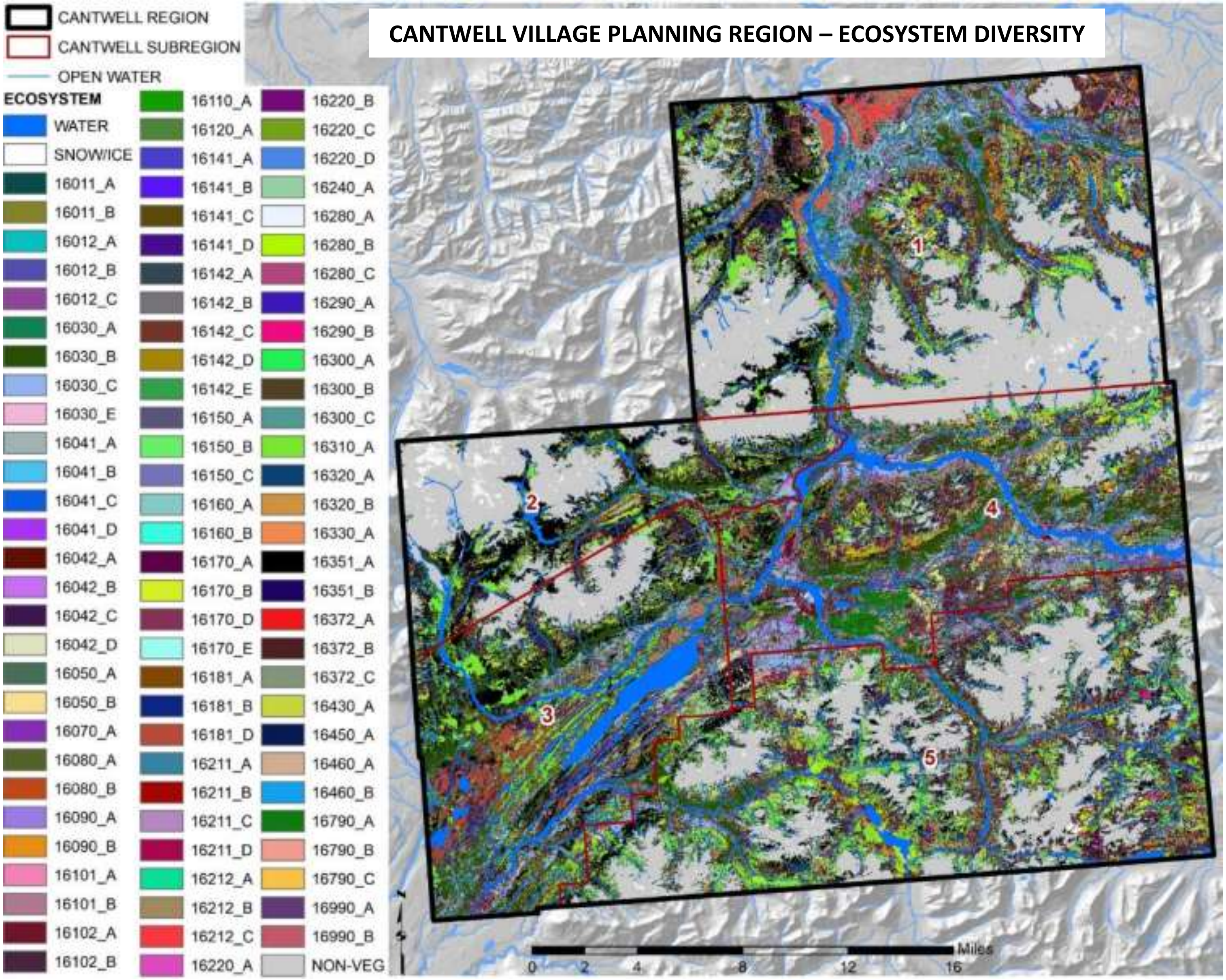

CANTWELL VILLAGE PLANNING REGION – ECOSYSTEM DIVERSITY

Figure 57. Ecosystem diversity for the Cantwell Village planning region.

Berry Production Areas

Figure 58 shows the areas identified with the highest potential for berry production. It may be desirable to avoid disturbances to these areas, but verifying the actual presence of good berry production is recommended on a site by site basis.

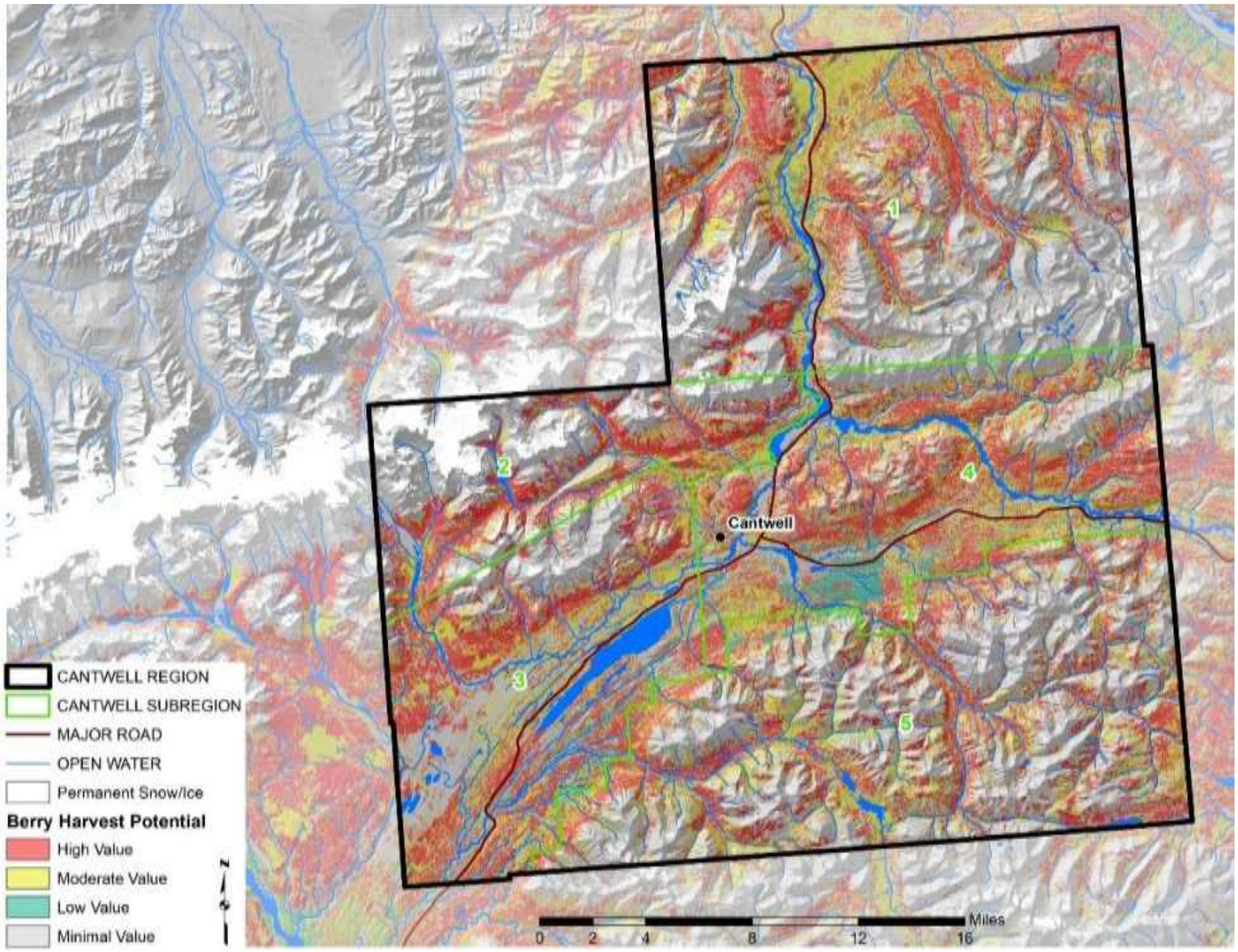


Figure 58. Potential berry production values in the Cantwell Planning region.

Moose and Caribou Habitat Quality Assessment - Model Results

Moose

Ecosystem-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 240 to 242. Landscape-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 243 to 245. A complete description of the moose habitat quality models can be found in Appendix B.

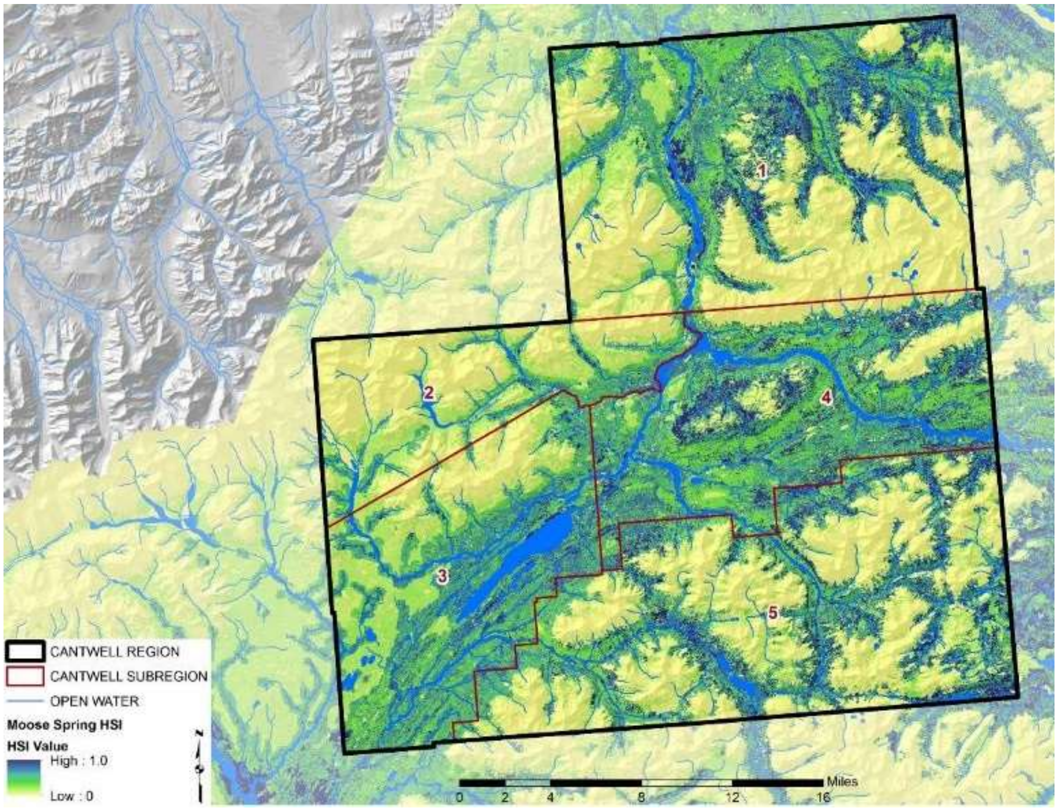


Figure 59. Results of the ecosystem-scale model outputs for moose spring habitat quality.

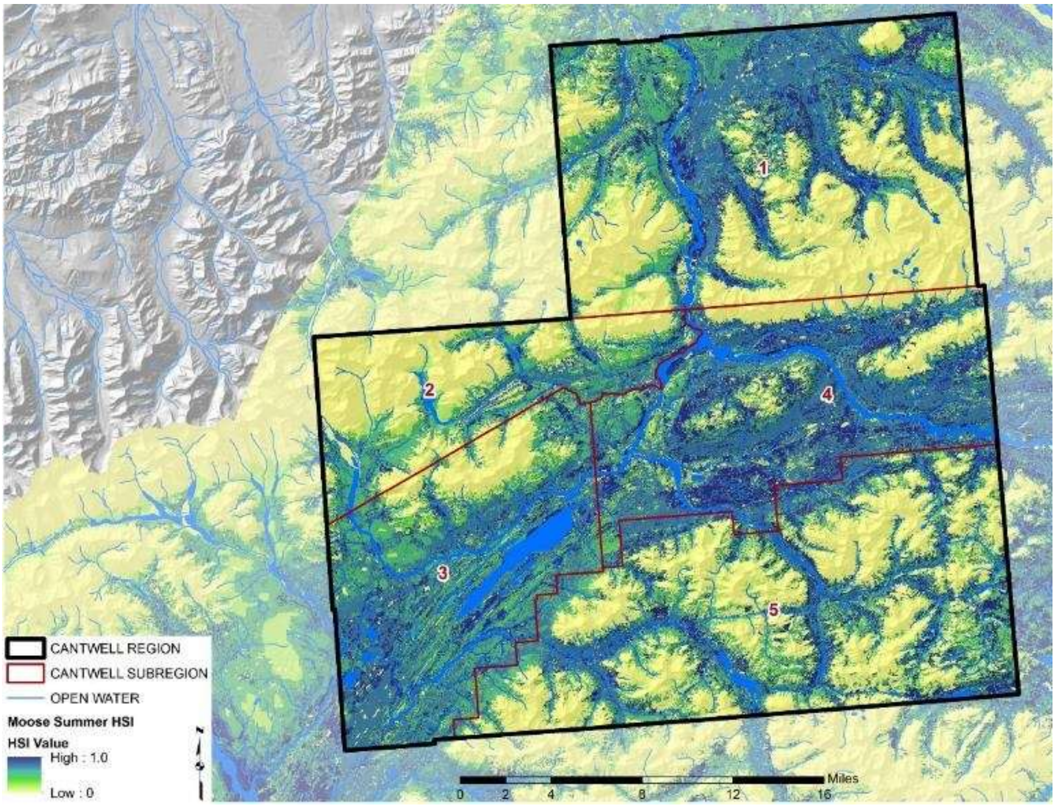


Figure 60. Results of the ecosystem-scale model outputs for moose summer habitat quality.

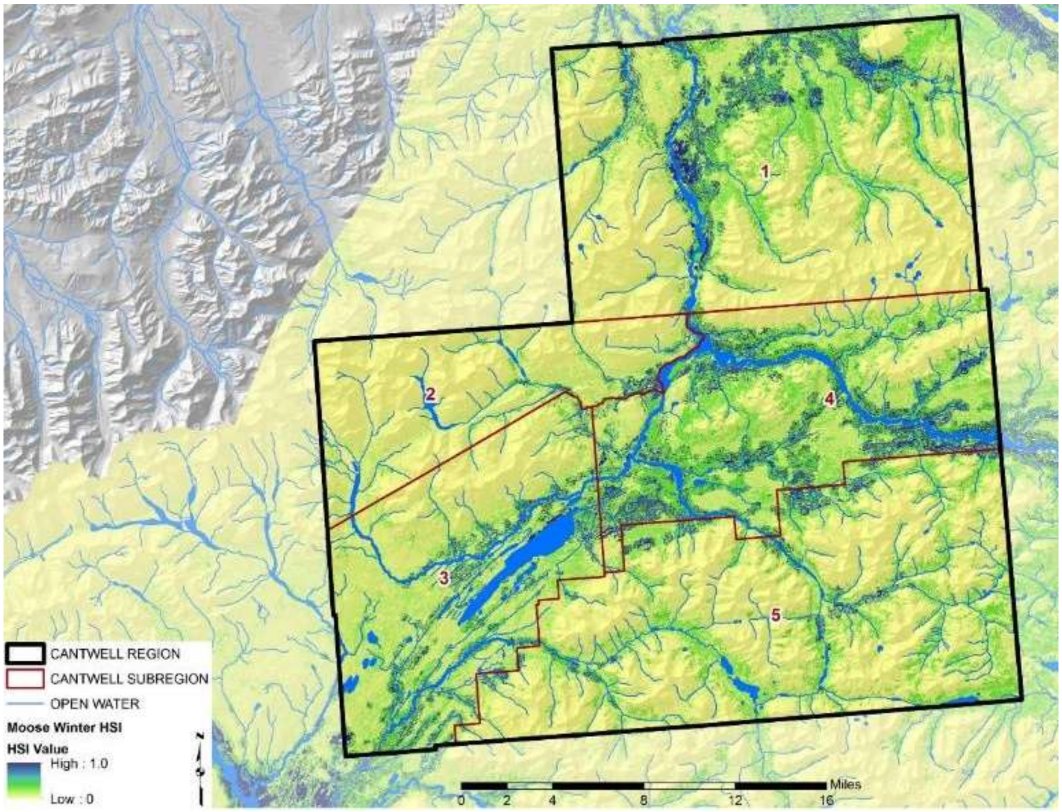


Figure 61. Results of the ecosystem-scale model outputs for moose winter habitat quality.

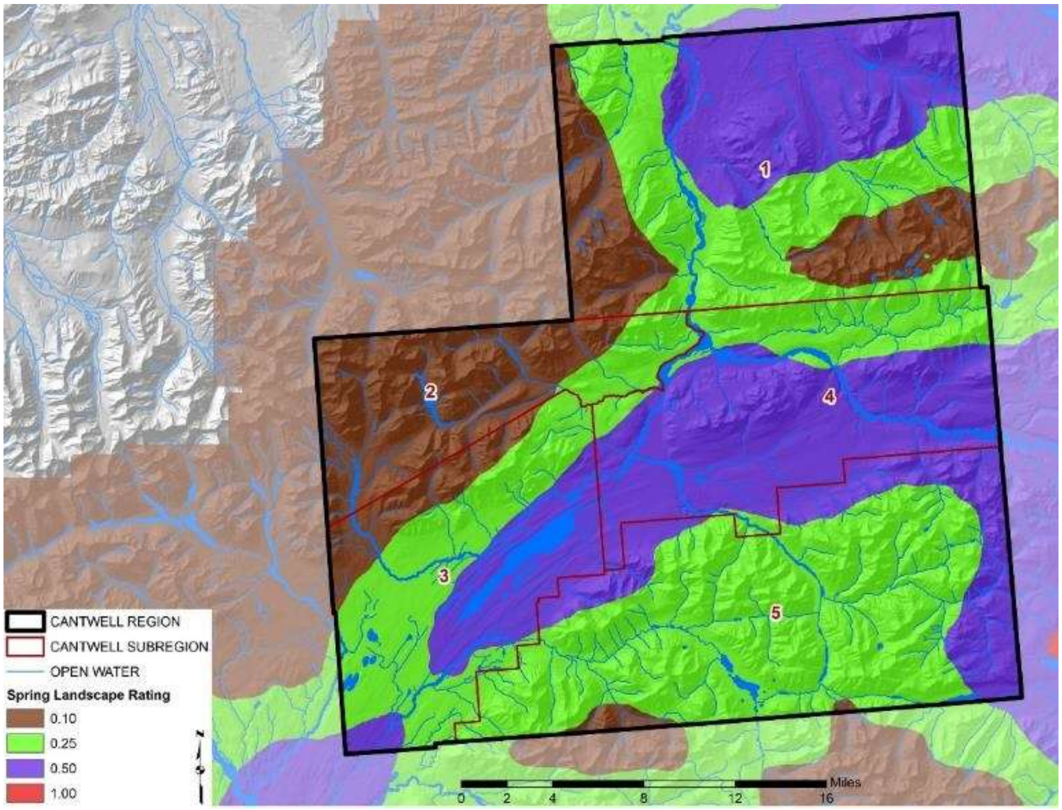


Figure 62. Results of the landscape-scale model outputs for moose spring habitat quality.

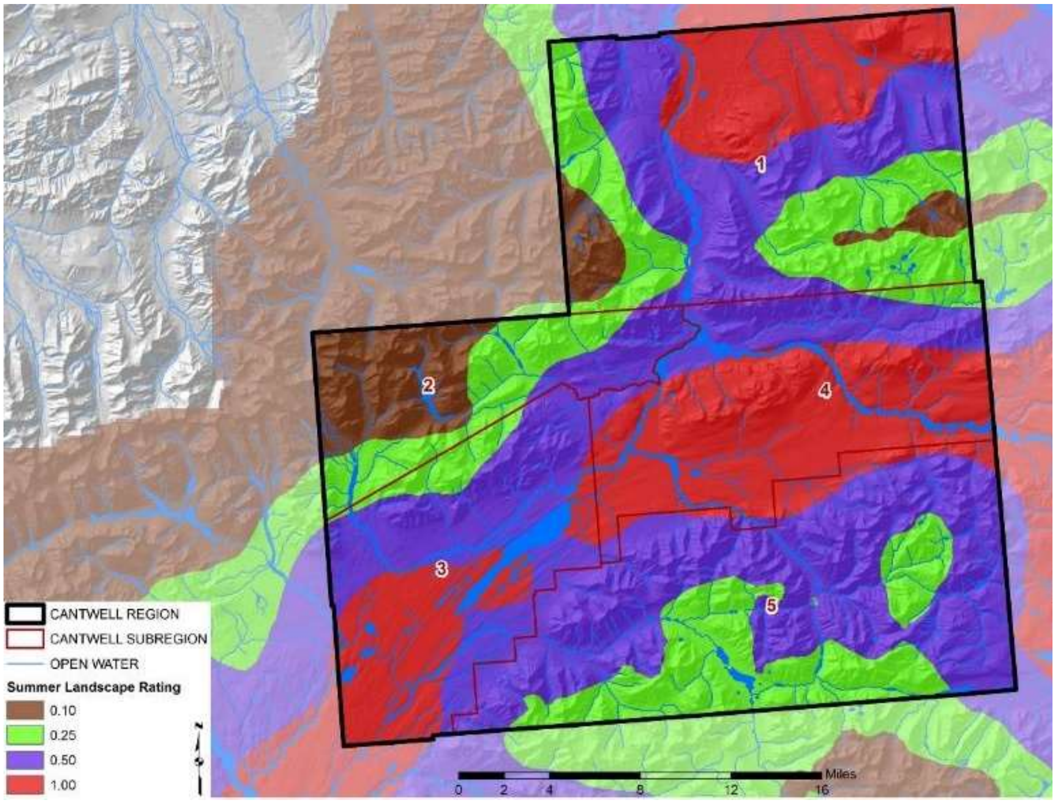


Figure 63. Results of the landscape-scale model outputs for moose summer habitat quality.

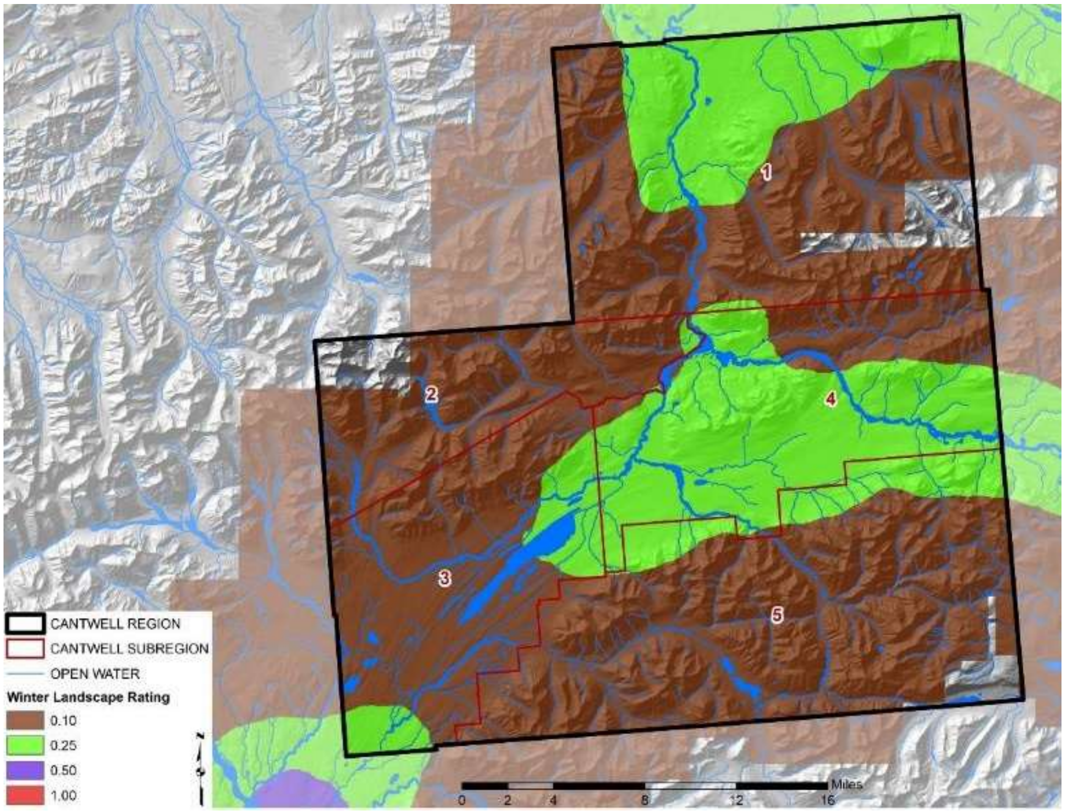


Figure 64. Results of the landscape-scale model outputs for moose winter habitat quality.

Caribou

Ecosystem-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 65 and 66. Landscape-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 67 and 68. A complete description of the caribou habitat quality models can be found in Appendix C.

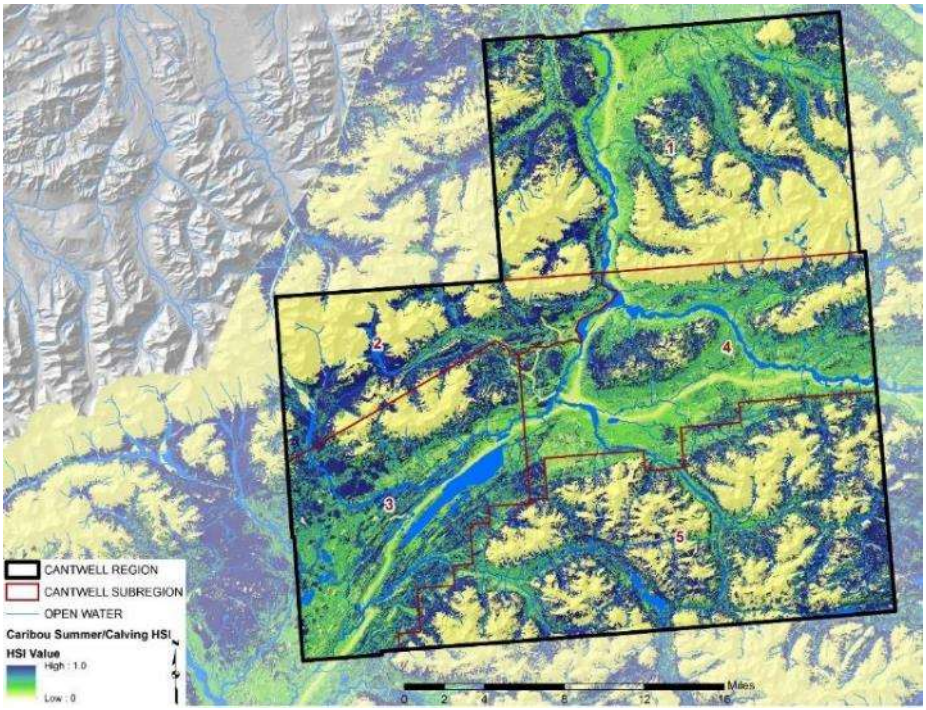


Figure 65. Results of the ecosystem-scale model outputs for caribou summer/calving habitat quality.

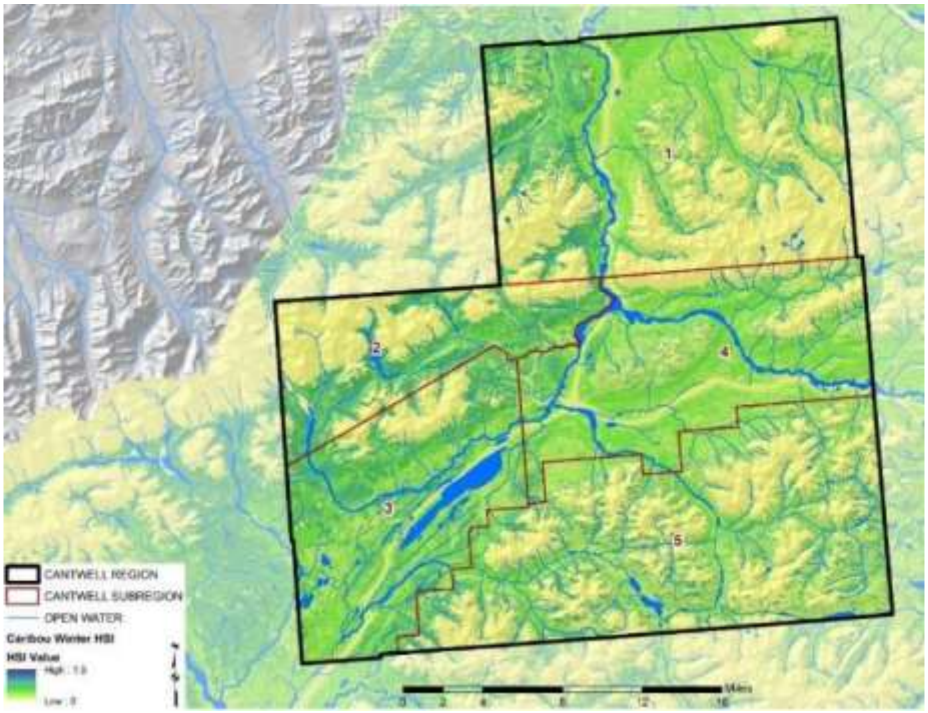


Figure 66. Results of the ecosystem-scale model outputs for caribou winter habitat quality.

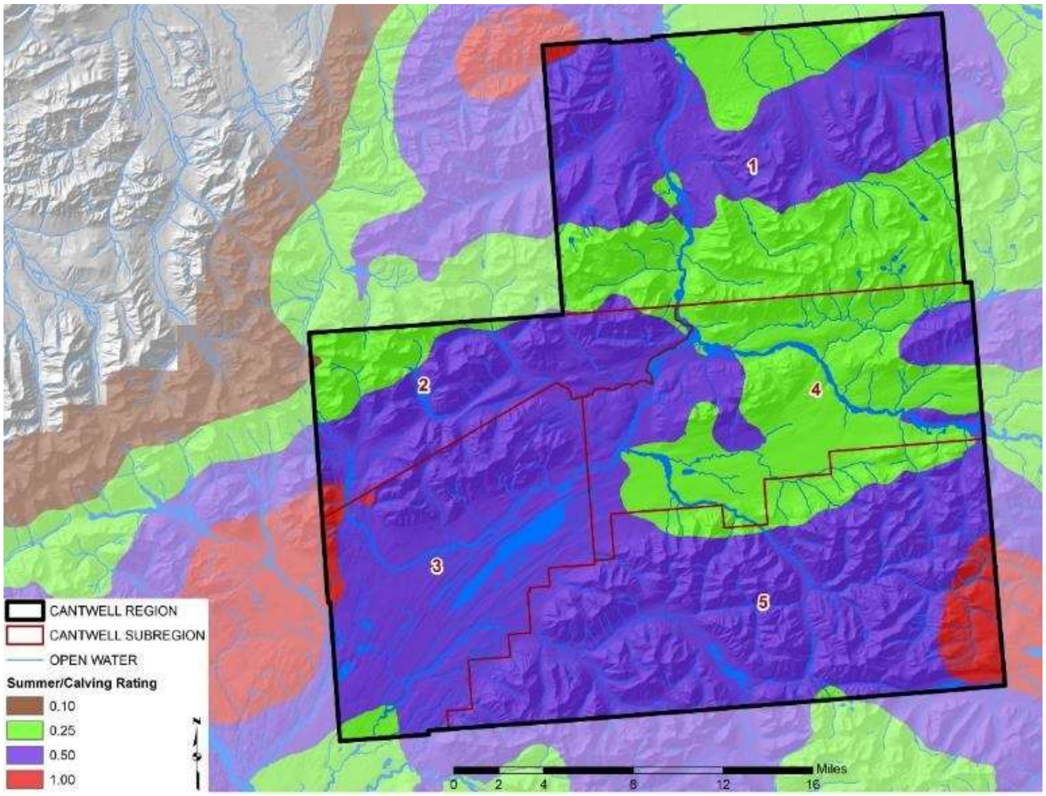


Figure 67. Results of the landscape-scale model outputs for caribou summer/calving habitat quality.

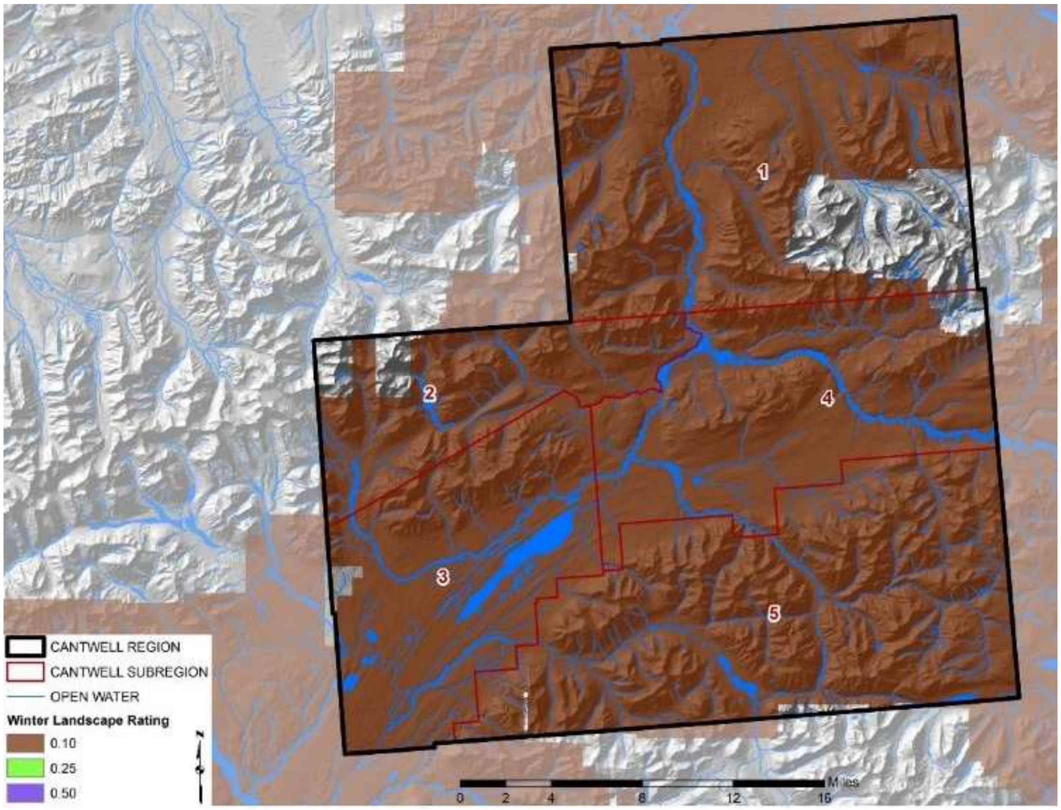


Figure 68. Results of the landscape-scale model outputs for caribou winter habitat quality.

Cantwell Village Vegetation Treatment Sites

Using the previously discussed criteria to evaluate for potential vegetation treatment sites, figure 69 identifies the location of proposed treatment sites for the Cantwell Village planning region. Figures 70-75 provide these same locations at greater resolution. Appendix C provides a detailed vegetation description of each of these sites. Treatment sites ranging from approximately 17-62 acres in size were identified and are summarized in Table 17 by primary ecosystem, size and the primary treatment objective which typically included timber stand improvement, biomass production, or moose browse enhancement objectives. The table also displays an estimate of the total biomass of all standing above ground biomass. This estimate is not tonnage of usable biomass for energy but the total of all stems regardless of size. However, stands on the higher end of the total amount will typically have larger trees and are a candidate for biomass energy production.

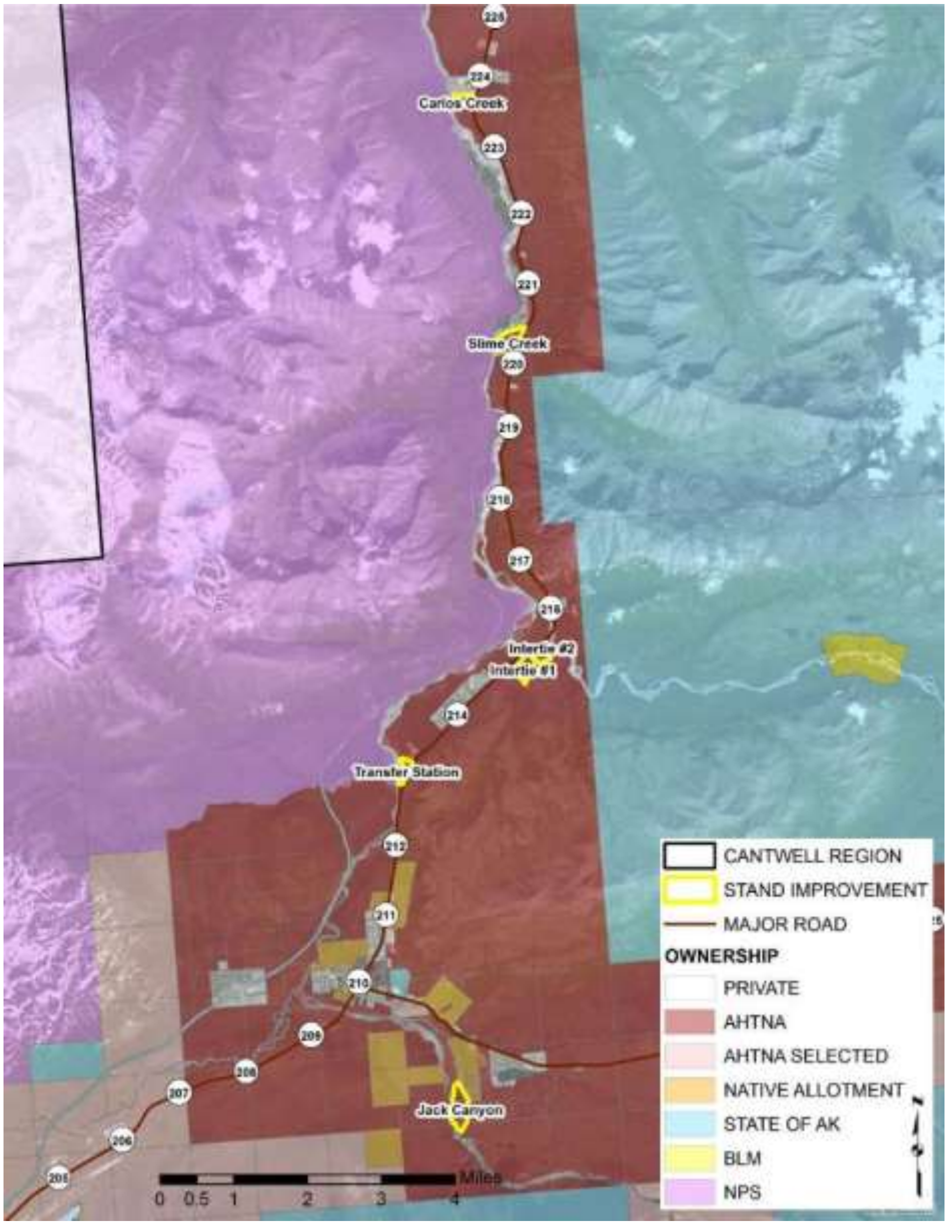


Figure 69. Overview of potential vegetation treatment sites identified for the Cantwell Village planning region. Highway mile posts are provided for reference.

Figure 70. Slime Creek and Carlos Creek treatment sites in the Cantwell Village planning region showing surface land ownership. Highway mile posts are provided for reference.

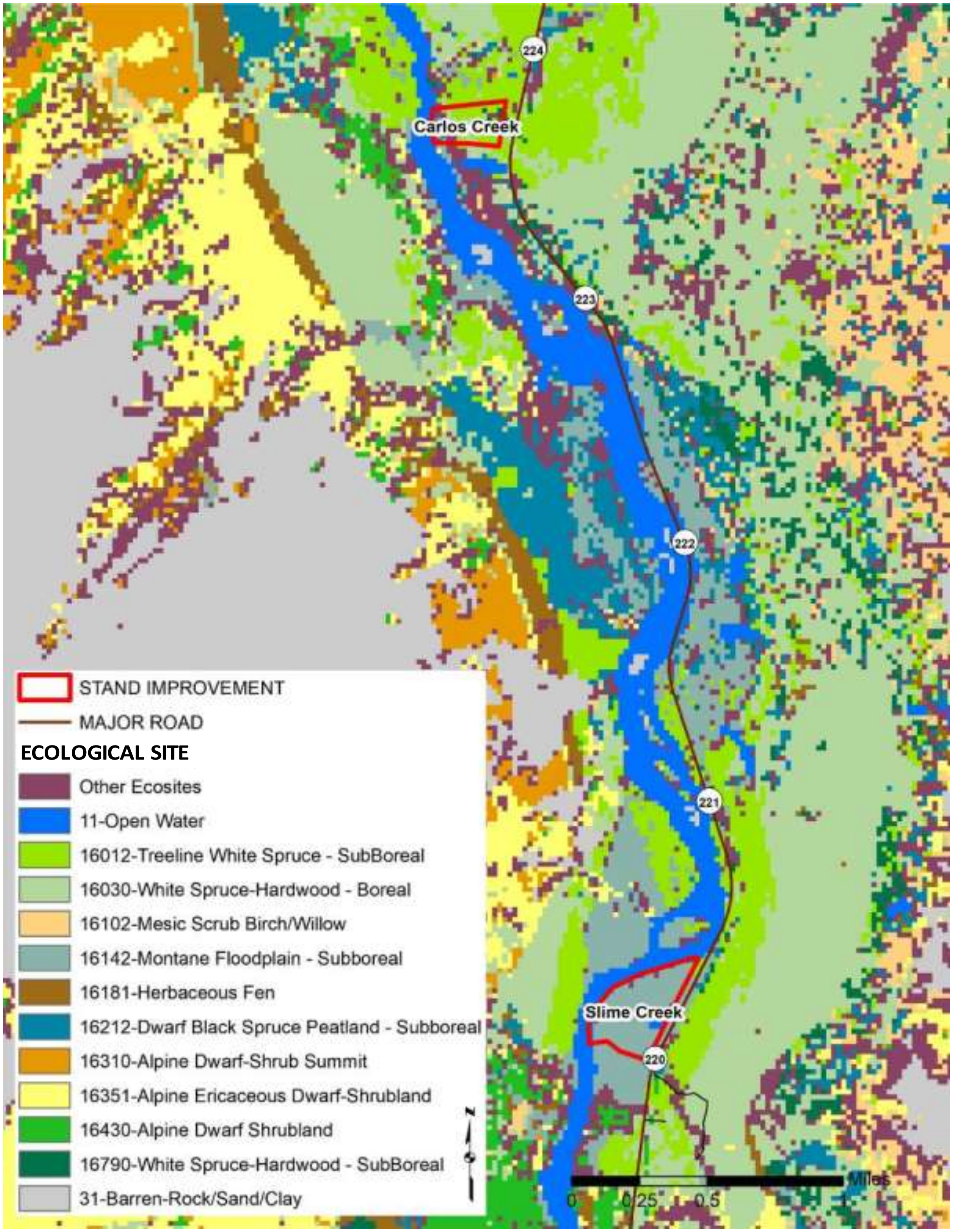


Figure 71. Map of two proposed treatment sites (Slime Creek and Carlos Creek) in the Cantwell Village planning region and ecological sites.

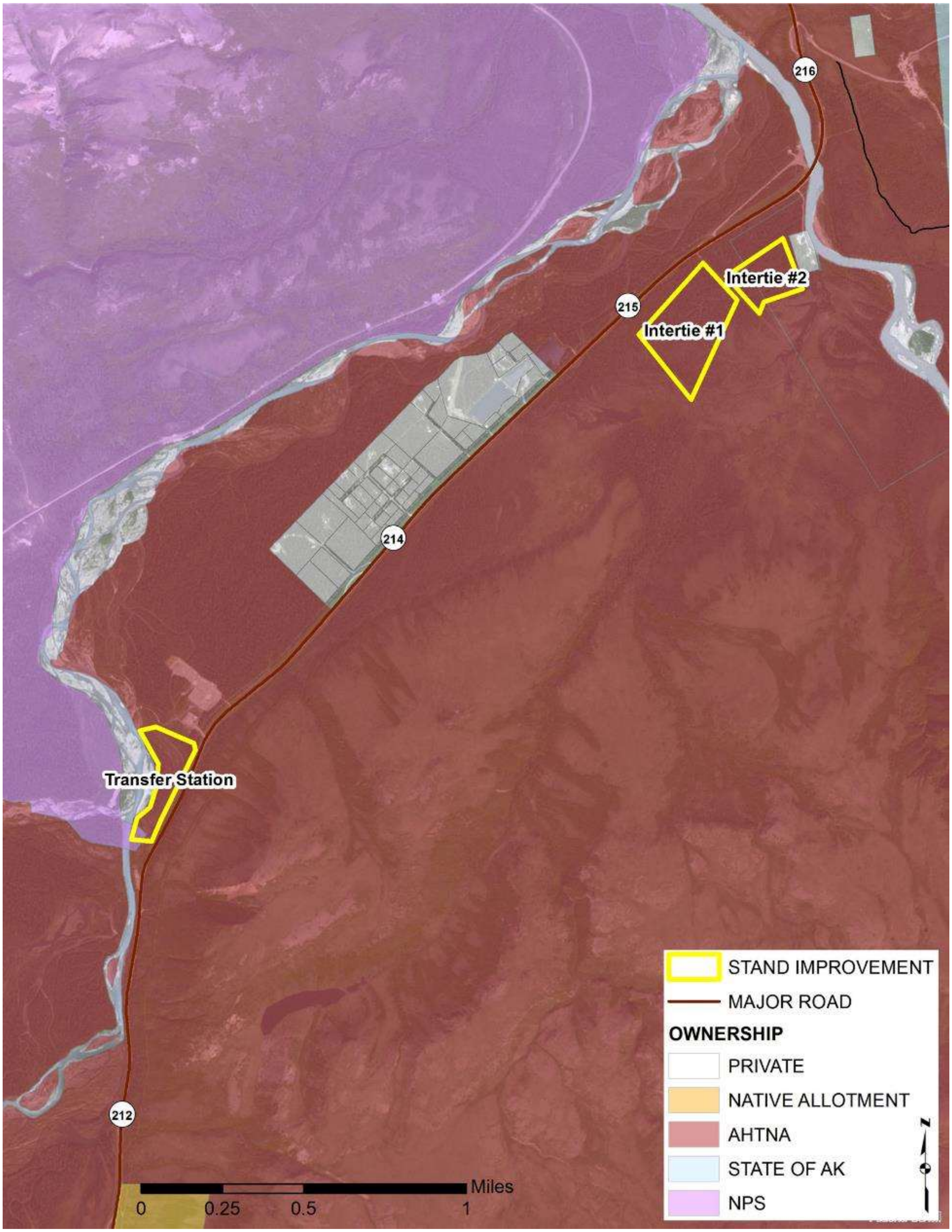


Figure 72. Map of three proposed treatment sites (Intertie #1, Intertie #2, and Transfer Station) in the Cantwell Village planning region and surface land ownership.

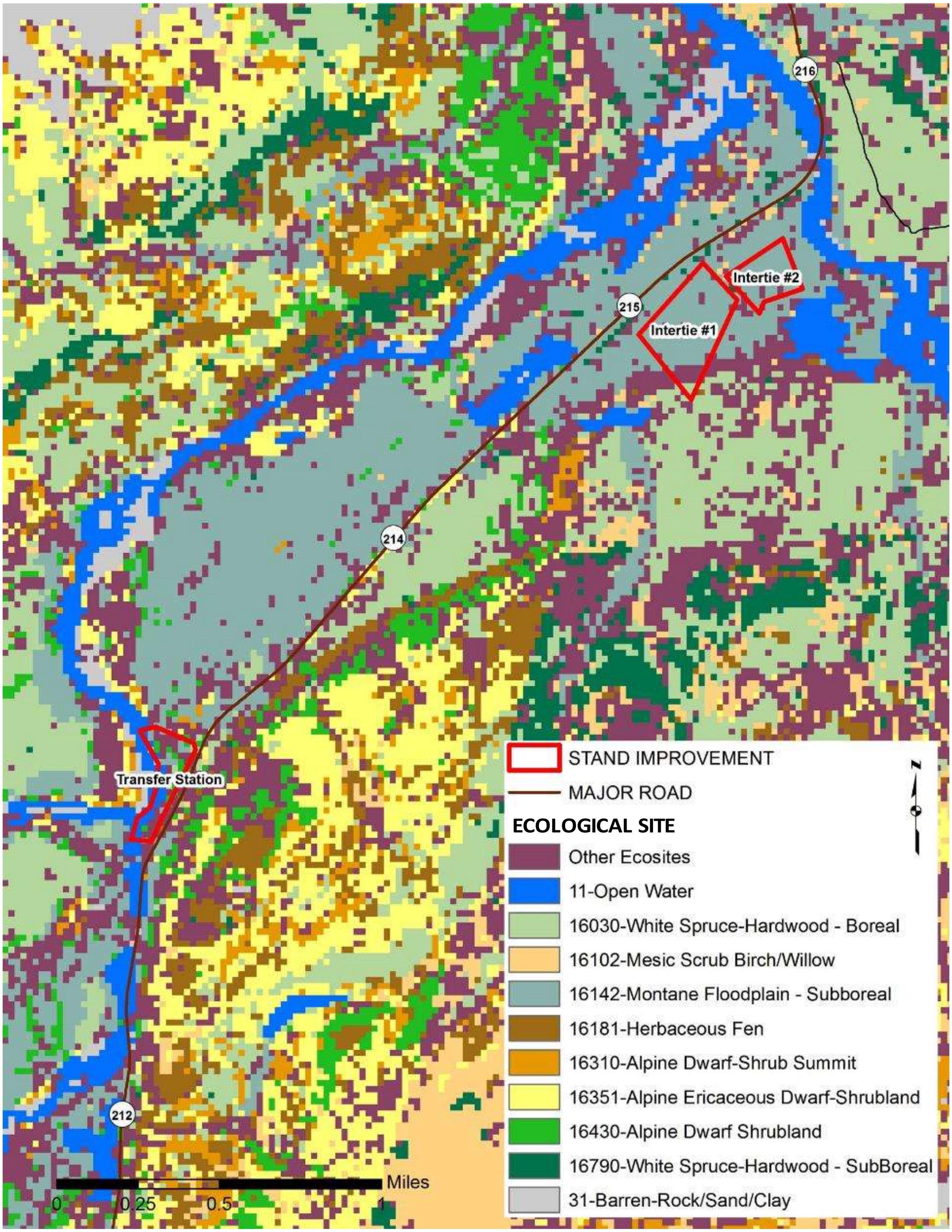
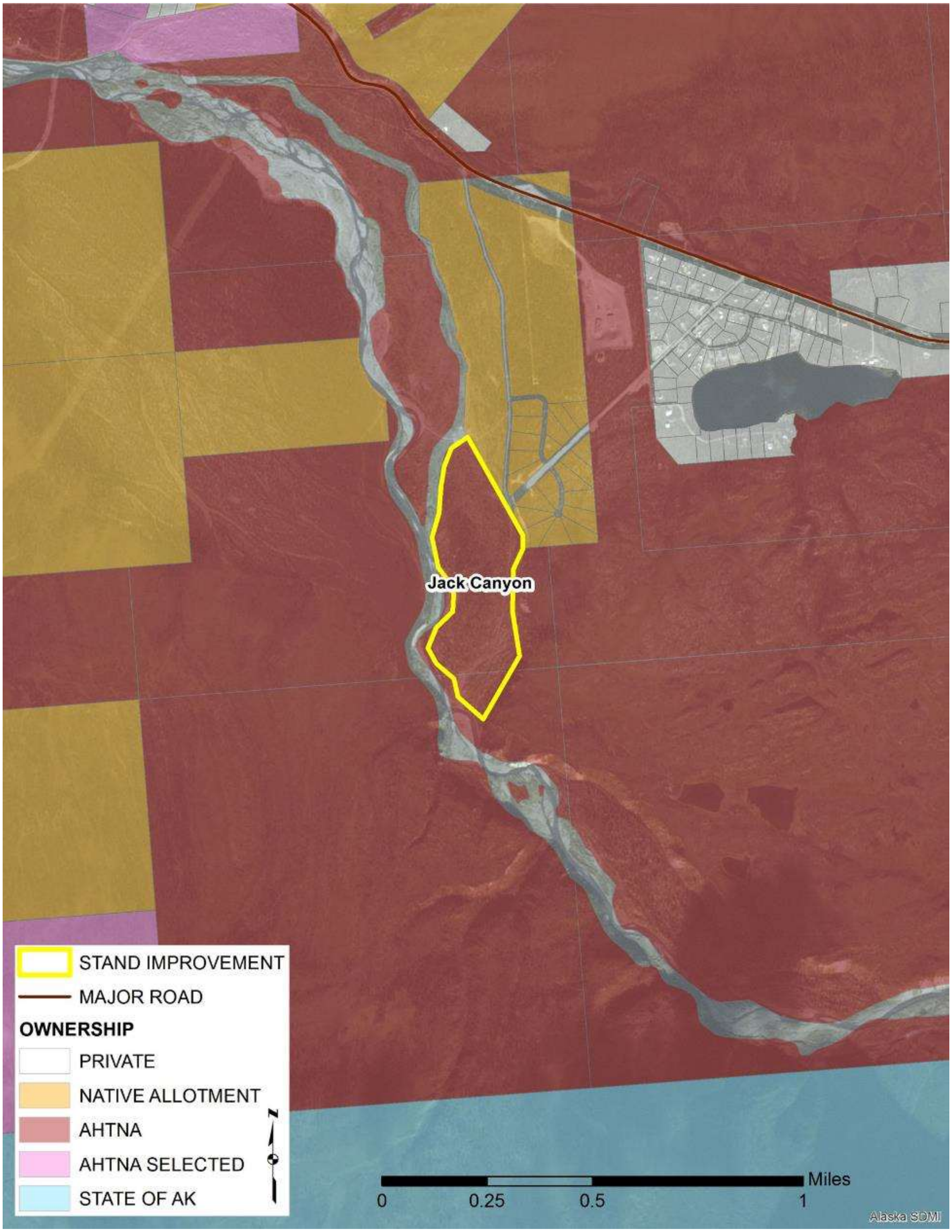


Figure 73. Map of three proposed treatment sites (Intertie #1, Intertie #2, and Transfer Station) in the Cantwell Village planning region and ecological sites.

Figure 74. Map of Jack Canyon proposed habitat improvement site in the Cantwell Village planning region showing surface land ownership.



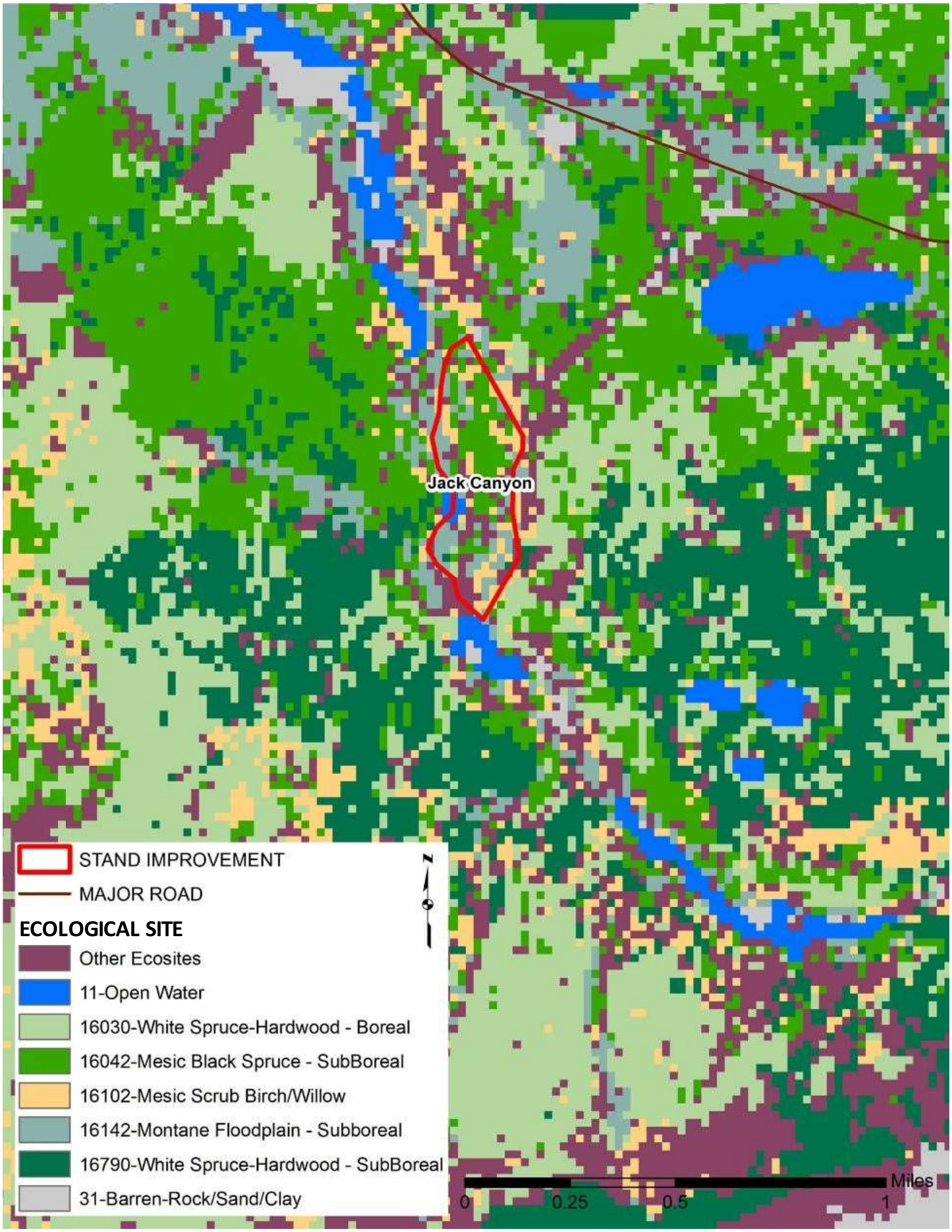


Figure 75. Map of Jack Canyon proposed treatment site in the Cantwell Village planning region and ecological sites.

Table 17. Vegetation treatment sites in the Cantwell Village planning region and their primary ecosystem type, treatment goal, size (acres), and total biomass (tons).

Treatment Site Name	Ecosystem Code	Primary Treatment Goal	Acres	Biomass (tons)
Carlos Creek	16012_A	Moose Browse	23.8	394.5
Intertie #1	16142_A	Moose Browse	39.6	663.5
Intertie #2	16142_A	Moose Browse	17.0	471.3
Jack Canyon	16042_A	Moose Browse	61.6	607.3
Slime Creek	16142_A	Moose Browse	50.4	189.6
Transfer Station	16042_B	Moose Browse	18.4	352.4

Chistochina Village Management Plan

The Chistochina Village planning region encompasses an area of 483,068 acres. Figure 76 displays the overall planning area along with associated infrastructure. Ownership of this and the surrounding area is shown in Figure 77. Land ownership patterns are varied in this area with Ahtna, Inc. owning 37.4% (180,488 acres) of the land.

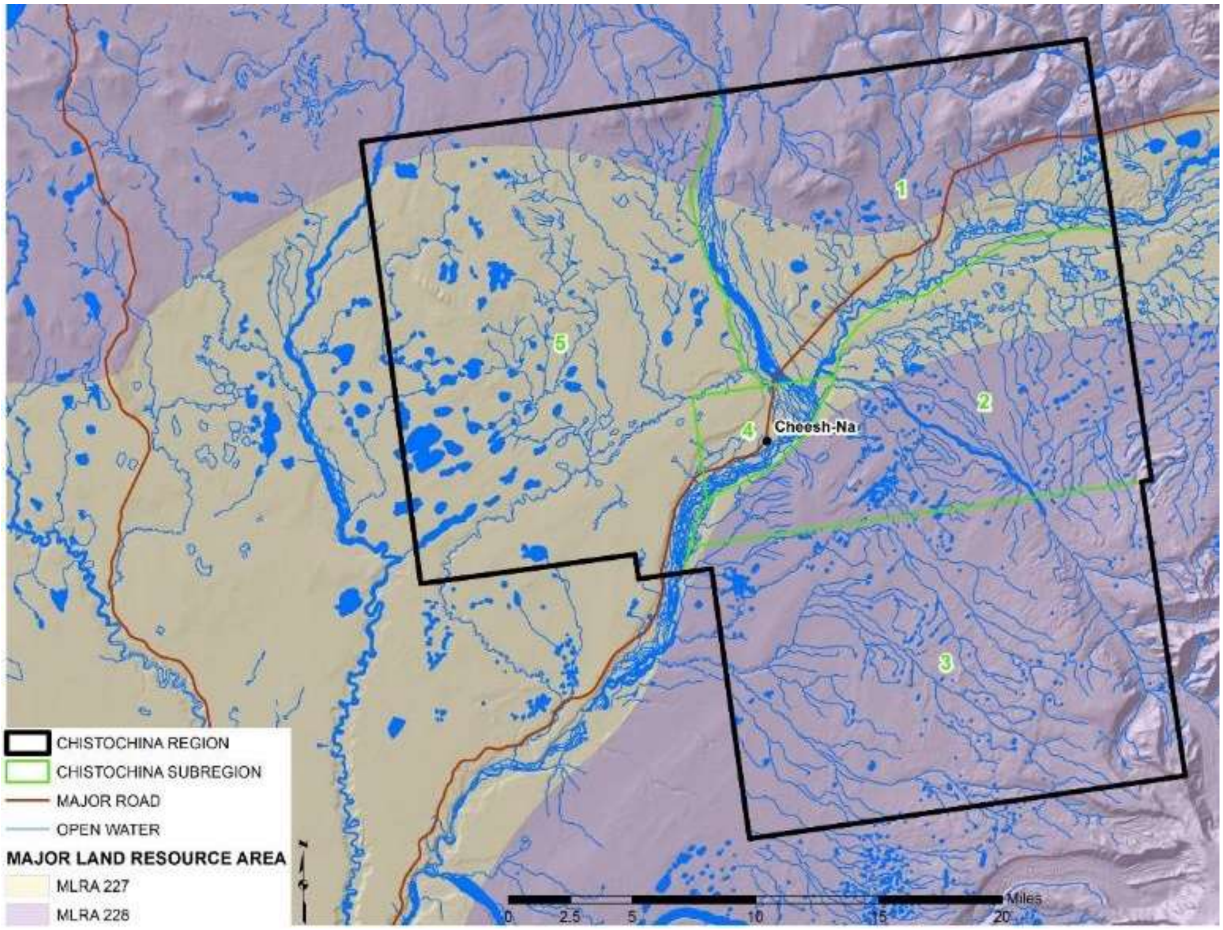


Figure 76. Overview of the Chistochina Village planning region.

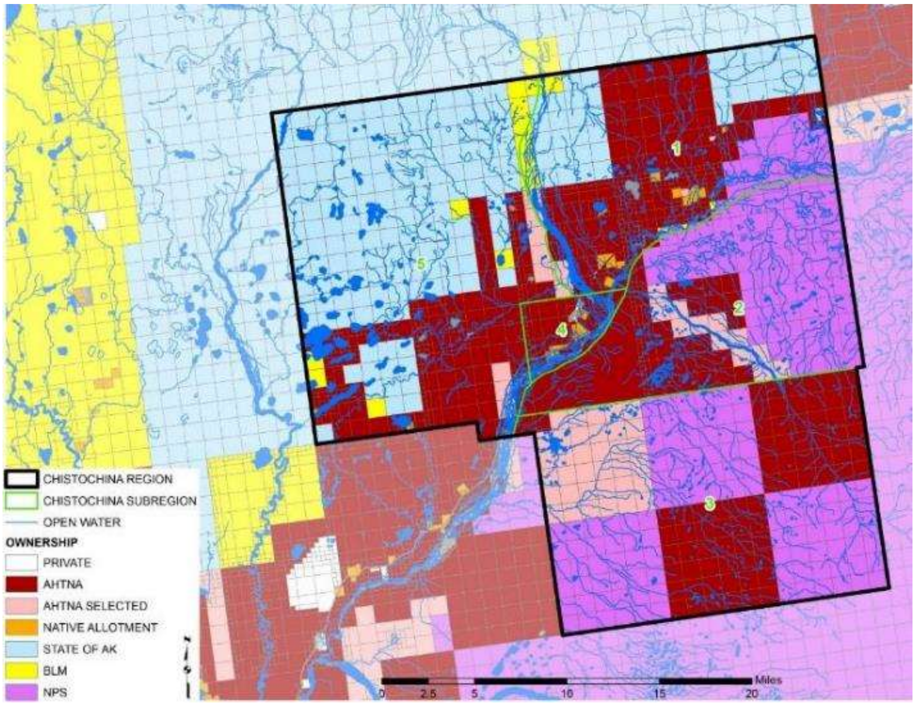


Figure 77. Land ownership patterns in the Chistochina Village planning region.

Planning Area Description

A description of the general geology, climate, soils, permafrost, and vegetation is found in the Project Area description earlier in this report. Figures 78, 79, and 80 show information specific to Chistochina planning area for soil texture, soil drainages, and permafrost, respectively.

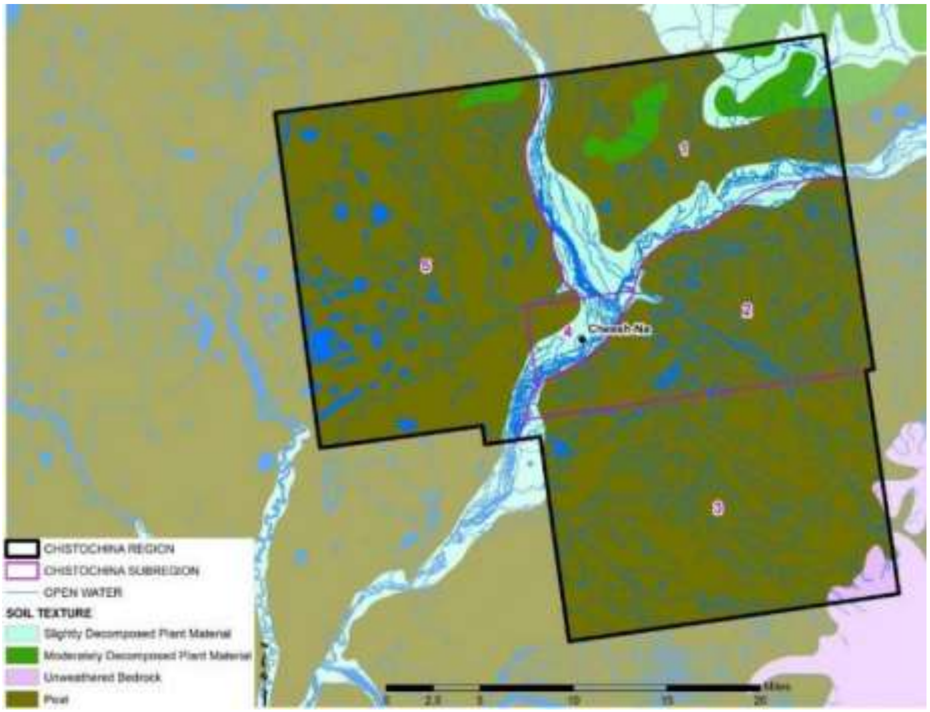


Figure 78. Soil texture in the Chistochina Village planning region. Data from NRCS STATSGO database for Alaska.

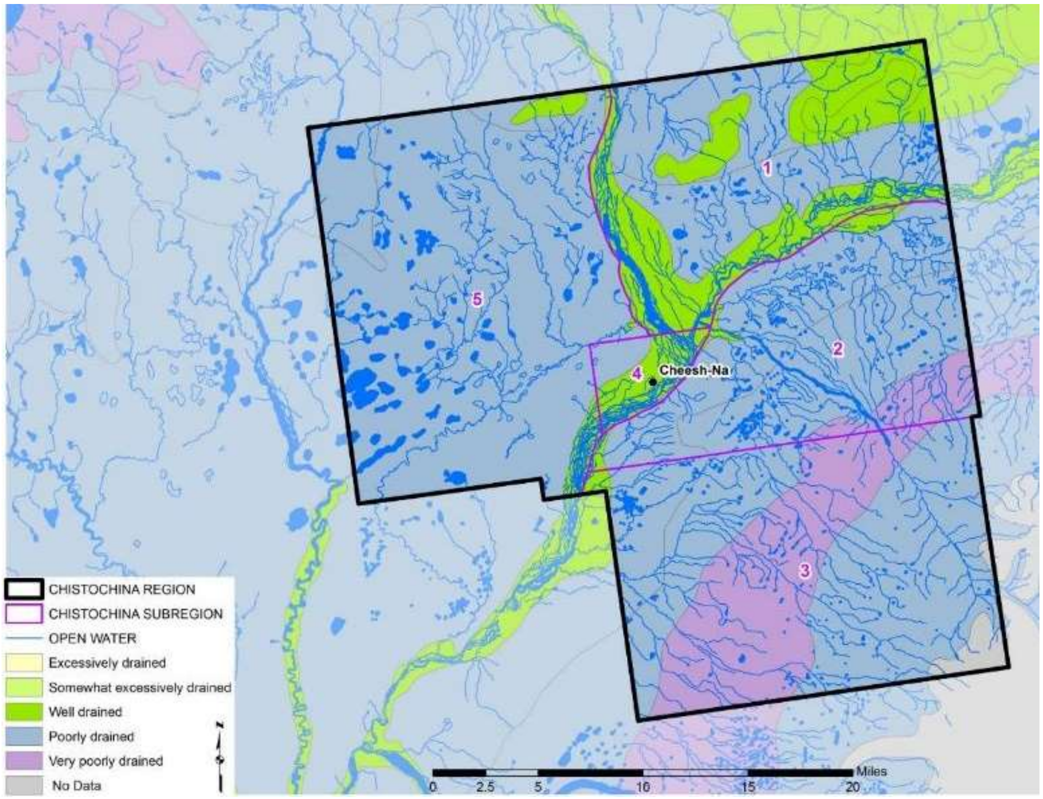


Figure 79. Soil drainage in the Chistochina Village planning region. Data from NRCS STATSGO database for Alaska.

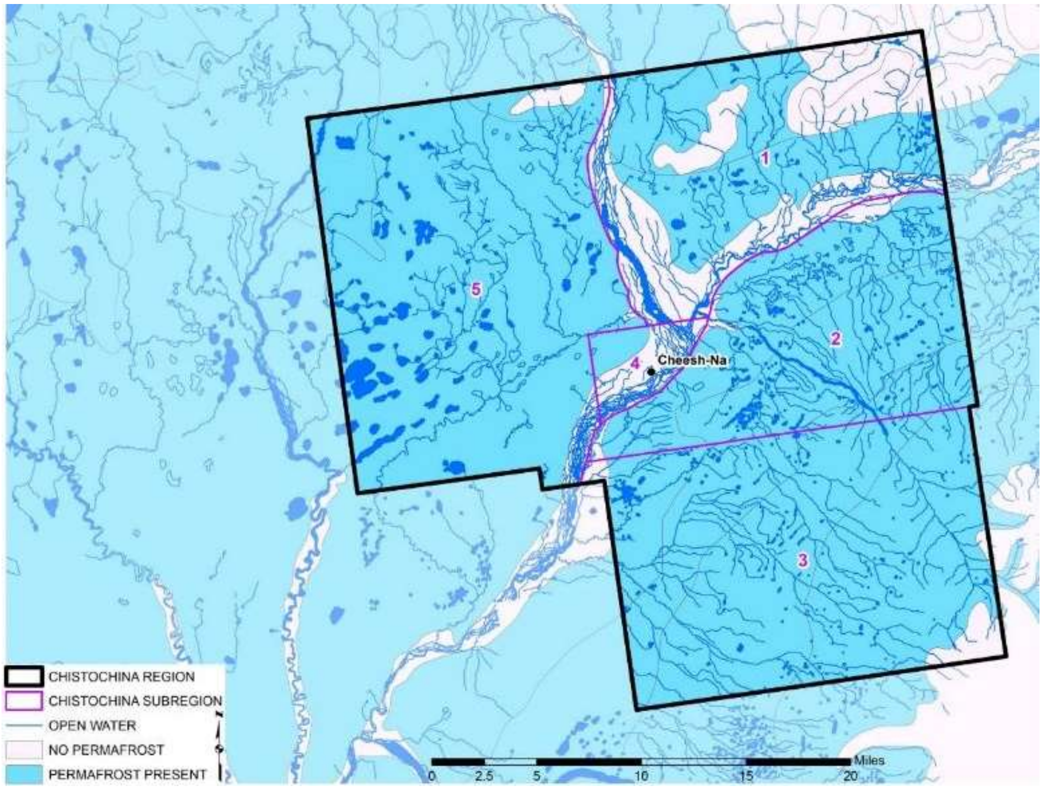


Figure 80. Permafrost in the Chistochina Village planning region. Data from NRCS STATSGO database for Alaska.

Fire is the primary disturbance factor influencing the vegetation ecology in the Copper River Basin. Figure 81 shows the fire history of the Chistochina area along with current fire protection zones. Although the level of fire occurring in this southcentral Alaska landscape is substantially less than that occurring in more interior areas of Alaska north of the Alaska Range, fire is still a significant disturbance when it occurs. When fire does occur it serves to set back succession. It can also burn off the organic material at the ground surface, including peat that can occur on many sites. This can influence the thermal layer protecting the underlying permafrost on some sites, causing the permafrost to melt (thermokarst) and changing the site conditions through this process. Riparian areas are also influenced by flooding and ice events. These serve to set back succession of vegetation in riparian areas, and can even shift site conditions, particularly in the case of significant flooding events.

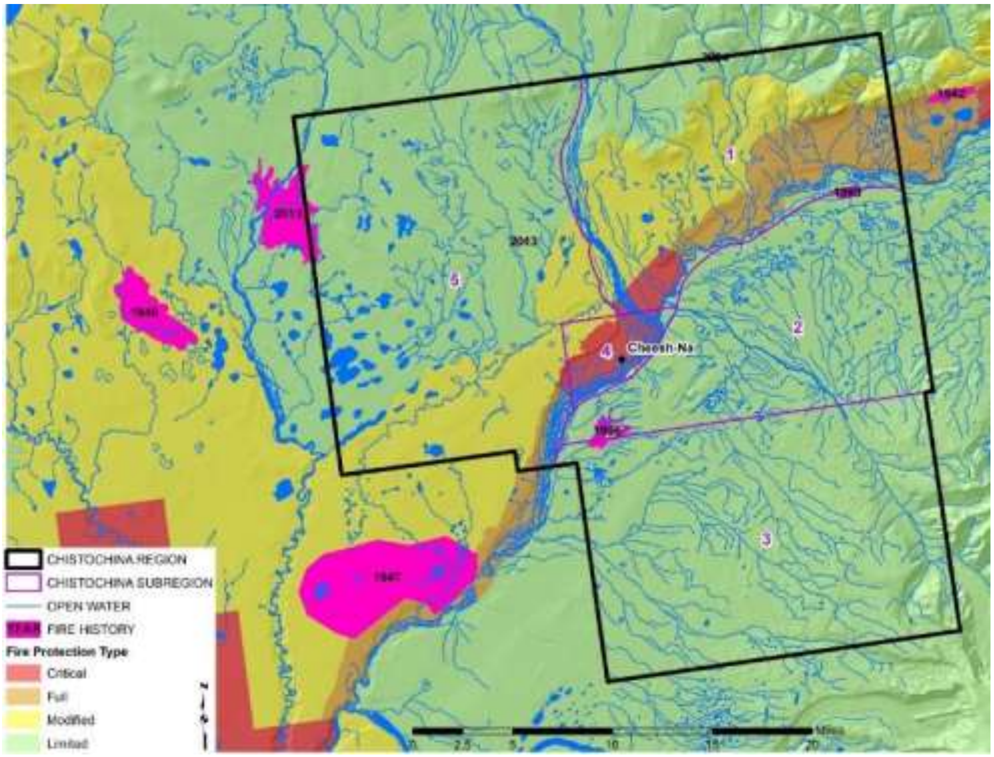


Figure 81. Current fire protection classes and fire history since 1940 in the Chistochina Village planning region. Data from Alaska Interagency Coordination Center.

Landscape Assessment Results

Ecosystem Diversity

The ecological sites present within the Chistochina Village planning region are displayed in Figure 82. Table 18 displays the acres for each ecological site setting and disturbance class. Figure 83 is a map of ecosystem diversity (represented by ecological site and disturbance class) in the Chistochina Village planning region.

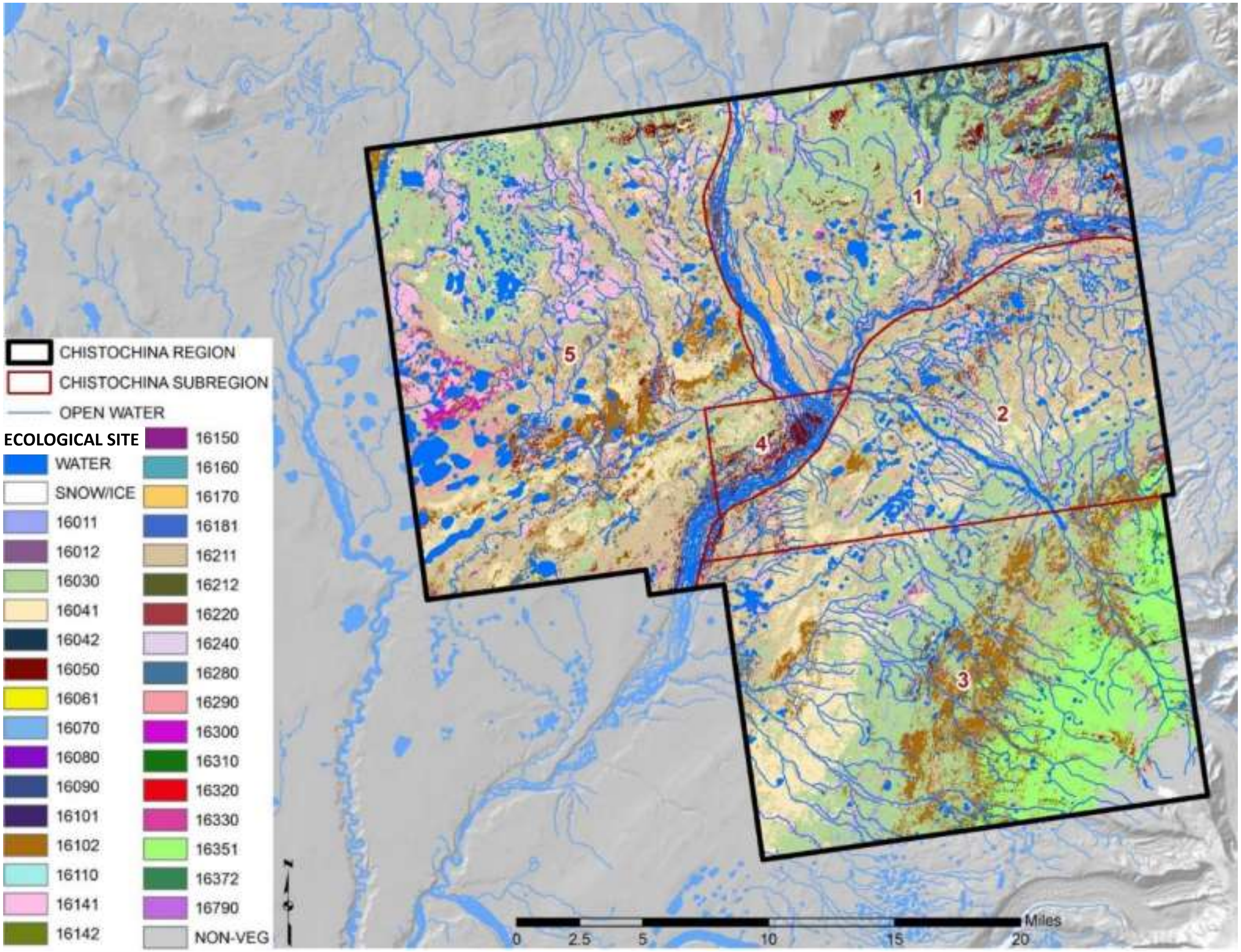


Figure 82. Ecological sites occurring in the Chistochina Village planning region.

Table 18. Ecosystems mapped in the Chistochina Village planning region and their associated acres. The ecological site vegetation label is provided as reference.

Ecosystem Code	Ecological Site Label	Acres	Ecosystem Code	Ecolgocal Site Label	Acres
11	Open Water	14805.5	16142_B	Montane Floodplain-Subboreal	285.8
12	Perrennial Ice-Snow	221.7	16142_C	Montane Floodplain-Subboreal	64.3
16011_A	Treeline White Spruce-Boreal	1067.9	16142_D	Montane Floodplain-Subboreal	554.7
16011_B	Treeline White Spruce-Boreal	1748.2	16142_E	Montane Floodplain-Subboreal	68.3
16012_A	Treeline White Spruce-SubBoreal	161.2	16150_A	Large River Floodplain	339.6
16012_B	Treeline White Spruce-SubBoreal	283.6	16150_B	Large River Floodplain	116.3
16012_C	Treeline White Spruce-SubBoreal	0.2	16150_C	Large River Floodplain	141.0
16030_A	White Spruce-Hardwood-Boreal	1720.4	16150_D	Large River Floodplain	1.1
16030_B	White Spruce-Hardwood-Boreal	27374.6	16150_E	Large River Floodplain	1.1
16030_C	White Spruce-Hardwood-Boreal	72610.4	16160_A	Riparian Stringer	455.7
16030_E	White Spruce-Hardwood-Boreal	65.8	16160_B	Riparian Stringer	198.6
16041_A	Mesic Black Spruce-Boreal	1858.6	16160_C	Riparian Stringer	10.7
16041_B	Mesic Black Spruce-Boreal	9368.2	16170_A	Shrub and Herbaceous Floodplain	2352.5
16041_C	Mesic Black Spruce-Boreal	4584.0	16170_B	Shrub and Herbaceous Floodplain	228.4
16041_D	Mesic Black Spruce-Boreal	49652.1	16170_C	Shrub and Herbaceous Floodplain	26.7
16041_E	Mesic Black Spruce-Boreal	46.3	16170_D	Shrub and Herbaceous Floodplain	54.7
16042_A	Mesic Black Spruce-SubBoreal	432.8	16170_E	Shrub and Herbaceous Floodplain	864.9
16042_B	Mesic Black Spruce-SubBoreal	884.0	16181_A	Herbaceous Fen	167.2
16042_C	Mesic Black Spruce-SubBoreal	384.1	16181_B	Herbaceous Fen	75.8
16042_D	Mesic Black Spruce-SubBoreal	0.7	16181_C	Herbaceous Fen	13.6
16050_A	Mesic Birch-Aspen	11740.2	16181_D	Herbaceous Fen	190.1
16050_B	Mesic Birch-Aspen	3770.9	16211_A	Dwarf Black Spruce Peatland-Boreal	3117.3
16050_D	Mesic Birch-Aspen	136.6	16211_B	Dwarf Black Spruce Peatland-Boreal	5480.0
16050_E	Mesic Birch-Aspen	95.2	16211_C	Dwarf Black Spruce Peatland-Boreal	16183.9
16061_A	Dry Aspen-Steppe Bluff	10.2	16211_D	Dwarf Black Spruce Peatland-Boreal	99363.4
16061_B	Dry Aspen-Steppe Bluff	98.5	16212_A	Dwarf Black Spruce Peatland-Subboreal	45.4
16061_C	Dry Aspen-Steppe Bluff	155.7	16212_B	Dwarf Black Spruce Peatland-Subboreal	189.3
16061_D	Dry Aspen-Steppe Bluff	171.5	16212_C	Dwarf Black Spruce Peatland-Subboreal	572.4
16070_A	Subalpine Balsam Poplar-Aspen	123.2	16220_A	Black Spruce Wet-Mesic Slope	318.5
16070_B	Subalpine Balsam Poplar-Aspen	298.0	16220_B	Black Spruce Wet-Mesic Slope	410.5
16080_A	Avalanche Slope Shrubland	84.1	16220_C	Black Spruce Wet-Mesic Slope	46.5
16080_B	Avalanche Slope Shrubland	203.3	16220_D	Black Spruce Wet-Mesic Slope	661.0
16090_A	Mesic Subalpine Alder	403.2	16240_A	Deciduous Shrub Swamp	292.2
16090_B	Mesic Subalpine Alder	1278.1	16240_B	Deciduous Shrub Swamp	55.8
16102_A	Mesic Scrub Birch-Willow	13847.4	16280_A	Low Shrub-Tussock Tundra	9859.7
16102_B	Mesic Scrub Birch-Willow	22257.1	16280_B	Low Shrub-Tussock Tundra	2296.9
16110_A	Mesic Bluejoint Meadow	184.1	16280_C	Low Shrub-Tussock Tundra	233.1
16110_B	Mesic Bluejoint Meadow	0.2	16290_A	Tussock Tundra	1386.6
16141_A	Montane Floodplain-Boreal	11640.6	16290_B	Tussock Tundra	569.8
16141_B	Montane Floodplain-Boreal	4896.7	16300_A	Wet Black Spruce-Tussock	220.2
16141_C	Montane Floodplain-Boreal	2009.6	16300_B	Wet Black Spruce-Tussock	428.3
16141_D	Montane Floodplain-Boreal	23976.9	16300_C	Wet Black Spruce-Tussock	2077.4
16141_E	Montane Floodplain-Boreal	2071.6	16310_A	Alpine Dwarf-Shrub Summit	656.3
16142_A	Montane Floodplain-Subboreal	13.3437	16310_B	Alpine Dwarf-Shrub Summit	11.6

Table 21, continue. Ecosystems mapped in the Chistochina Village planning region and their associated acres. The ecological site vegetation label is provided as reference.

Ecosystem Code	Ecological Site Label	Acres	Ecosystem Code	Ecolgocal Site Label	Acres
16320_A	Alpine Talus and Bedrock	1209.8	16372_B	Alpine Floodplain	2.2
16320_B	Alpine Talus and Bedrock	53.2	16372_C	Alpine Floodplain	1.3
16330_A	Alpine Mesic Herbaceous Meadow	96.7	16430_A	Alpine Dwarf Shrubland	0.4
16330_B	Alpine Mesic Herbaceous Meadow	22.7	16790_A	White Spruce-Hardwood-SubBoreal	5.6
16351_A	Alpine Ericaceous Dwarf-Shrubland	29101.3	16790_B	White Spruce-Hardwood-SubBoreal	0.7
16351_B	Alpine Ericaceous Dwarf-Shrubland	896.3	31	Barren-Rock-Sand-Clay	14102.3
16372_A	Alpine Floodplain	9.34059			

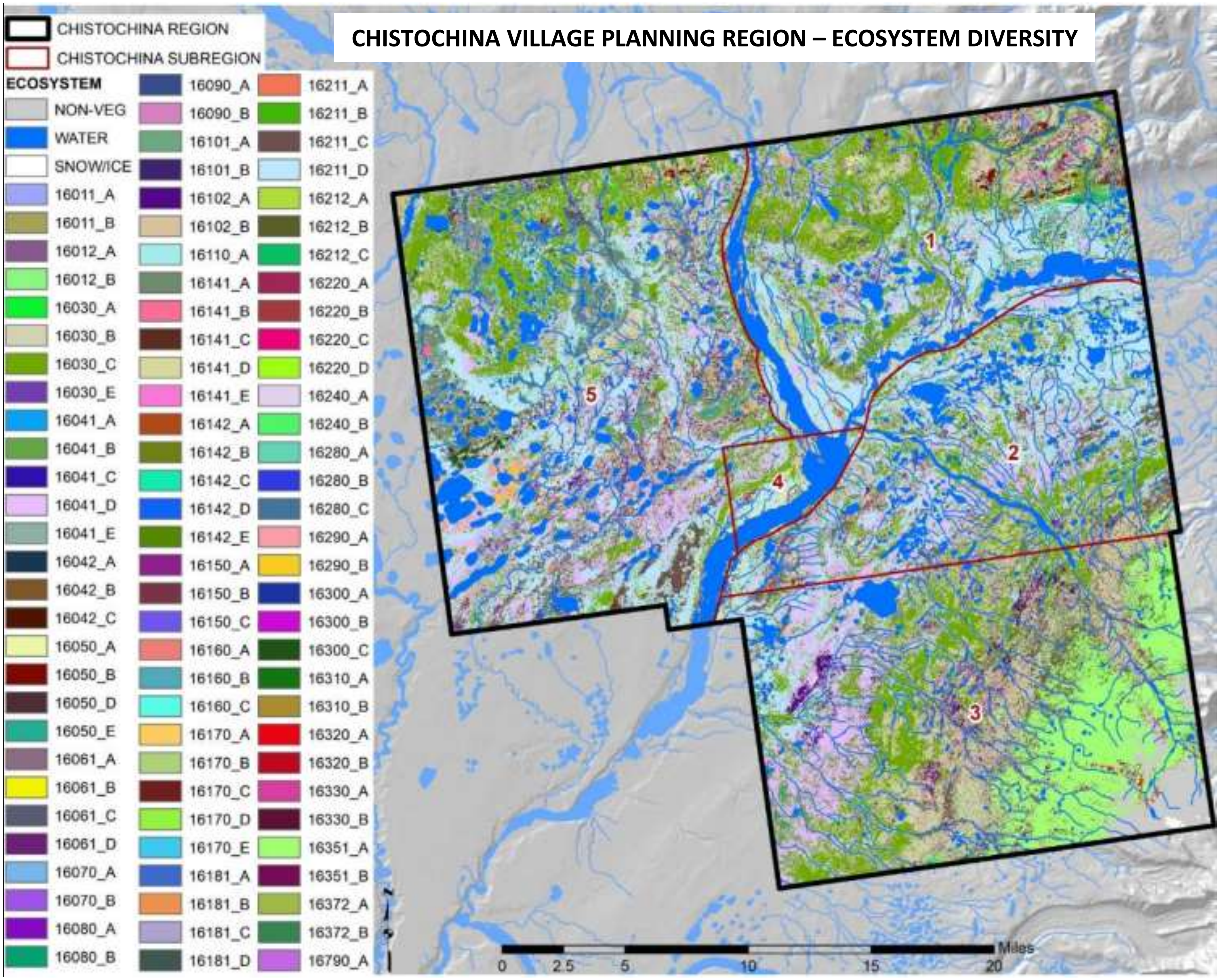


Figure 83. Ecosystem diversity for the Chistochina Village planning region. See Appendix A for ecosystem code definitions.

Berry Production Areas

Figure 84 shows the areas identified with the highest potential for berry production. It may be desirable to avoid disturbances to these areas, but verifying the actual presence of good berry production is recommended on a site by site basis.

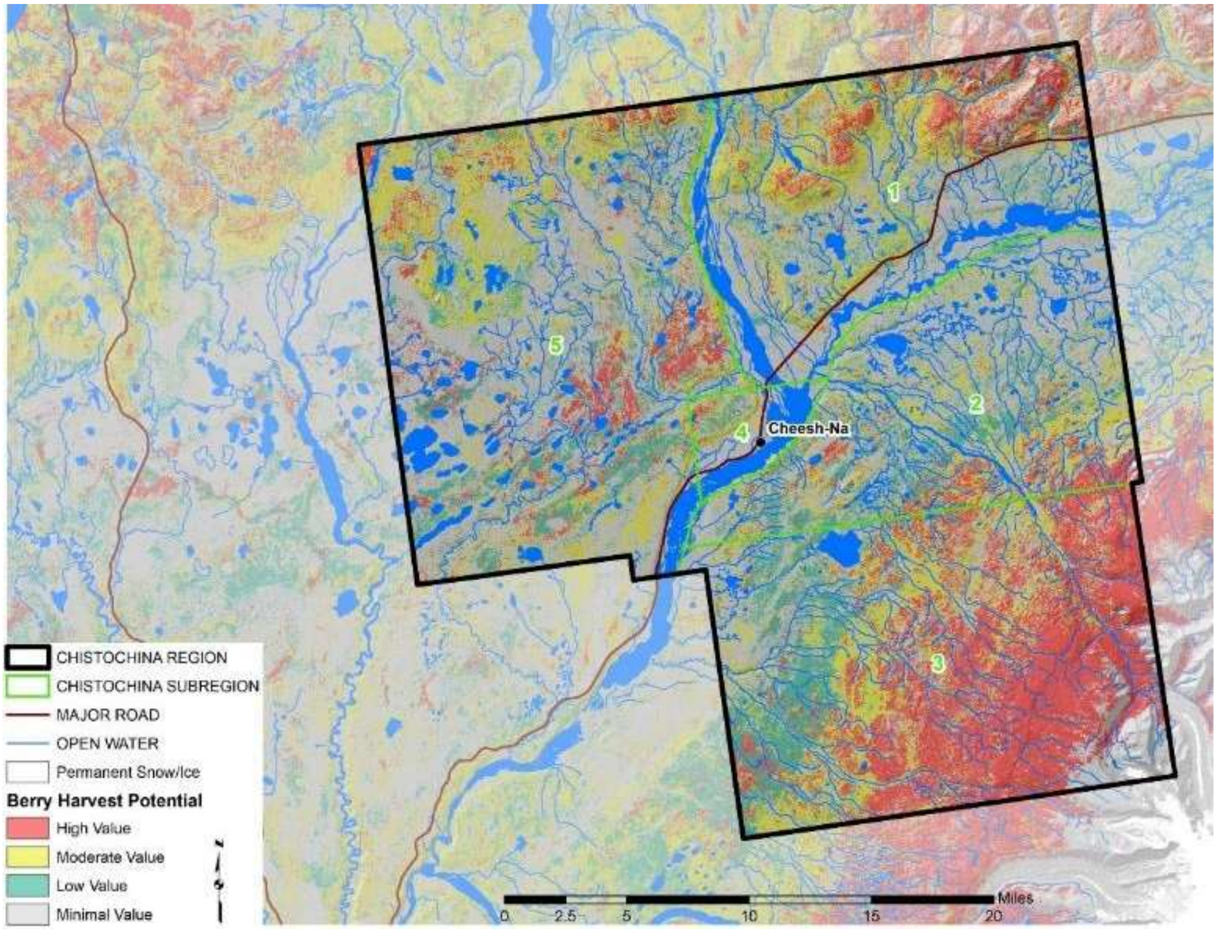


Figure 84. Potential berry production values in the Chistochina Village planning region.

Moose and Caribou Habitat Quality Assessment - Model Results

Moose

Ecosystem-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 85 to 87. Landscape-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 88 to 90. A complete description of the moose habitat quality models can be found in Appendix B.

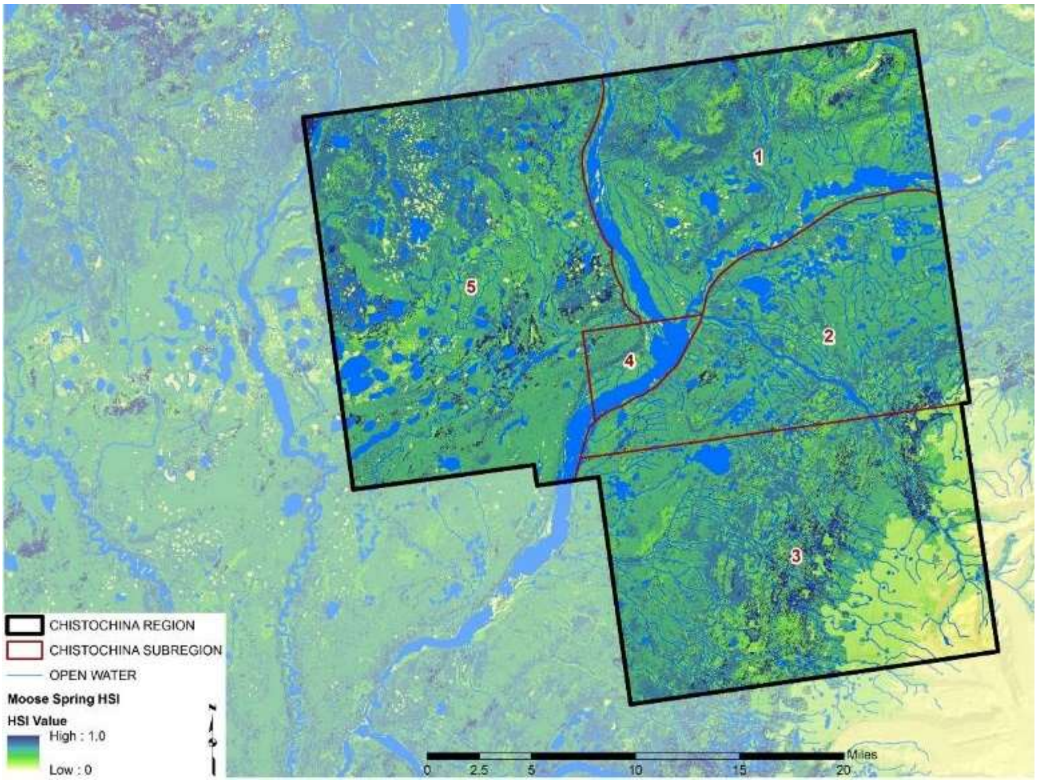


Figure 85. Results of the ecosystem-scale model outputs for moose spring habitat quality.

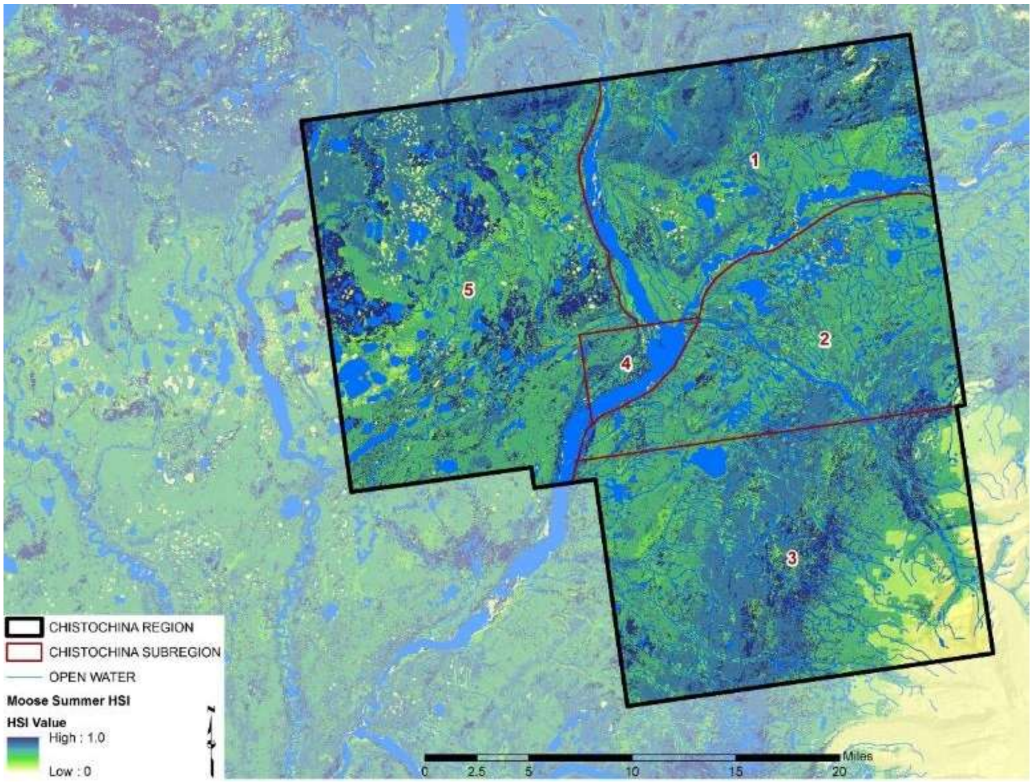


Figure 86. Results of the ecosystem-scale model outputs for moose summer habitat quality.

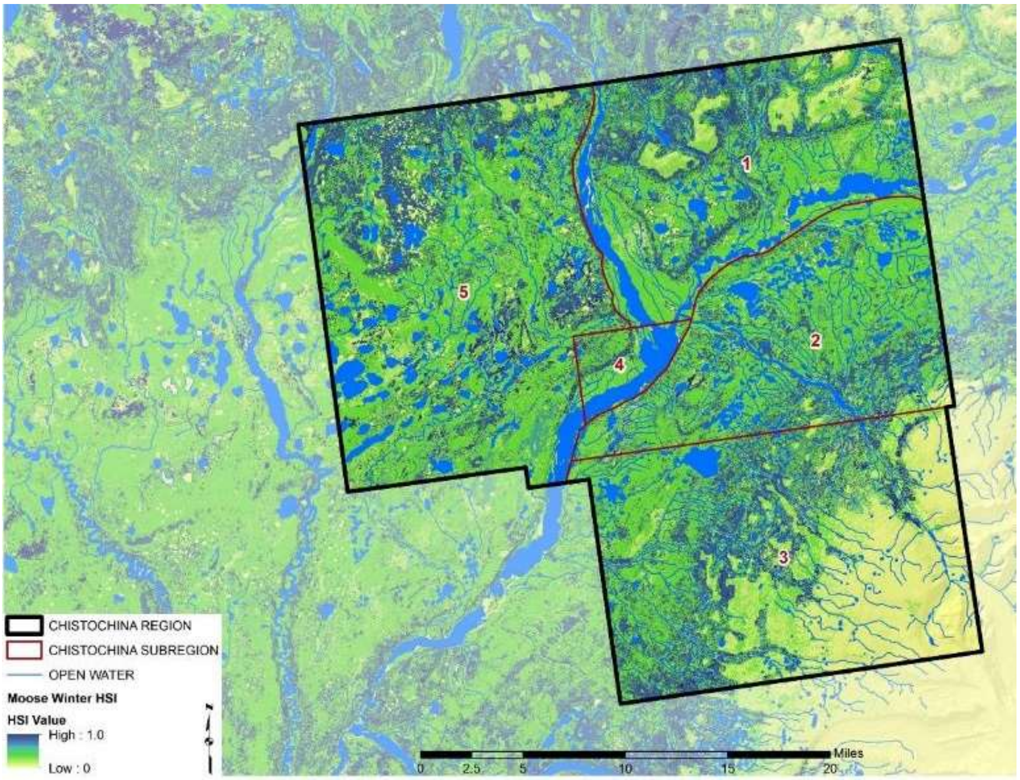


Figure 87. Results of the ecosystem-scale model outputs for moose winter habitat quality.

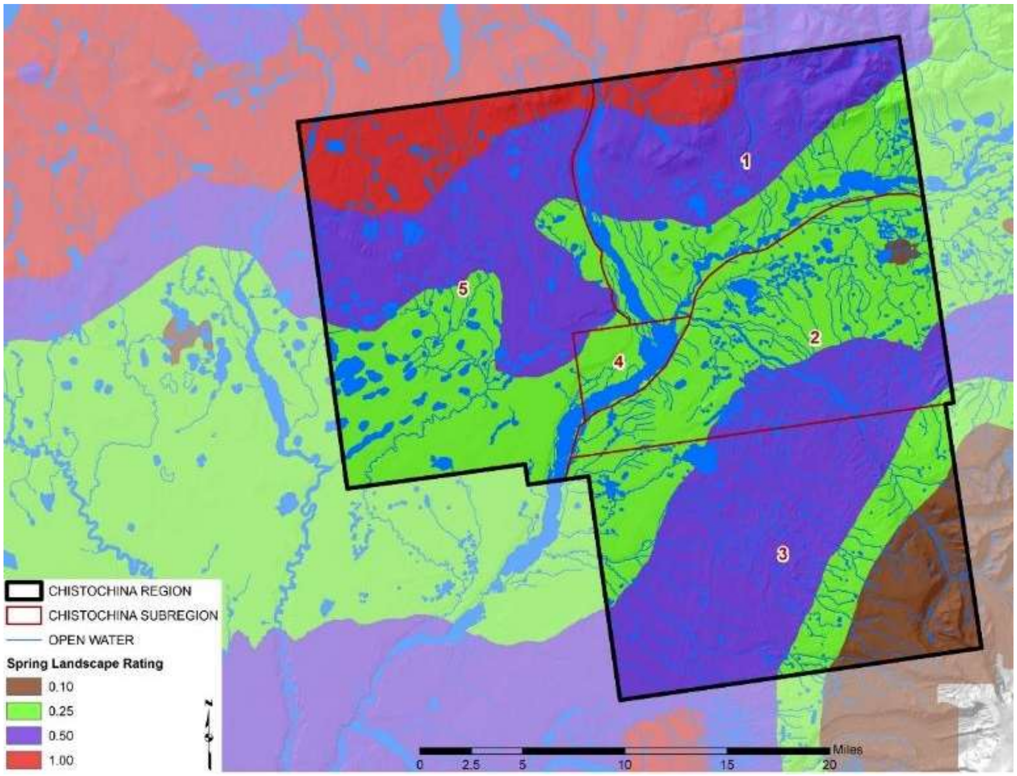


Figure 88. Results of the landscape-scale model outputs for moose spring habitat quality.

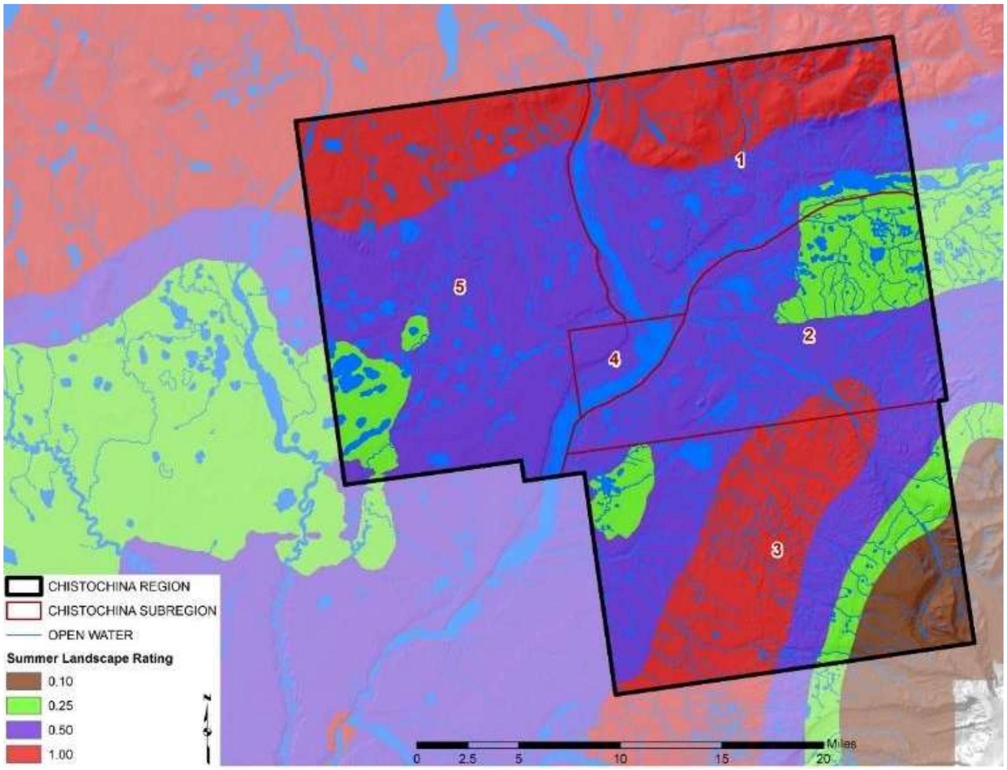


Figure 89. Results of the landscape-scale model outputs for moose summer habitat quality.

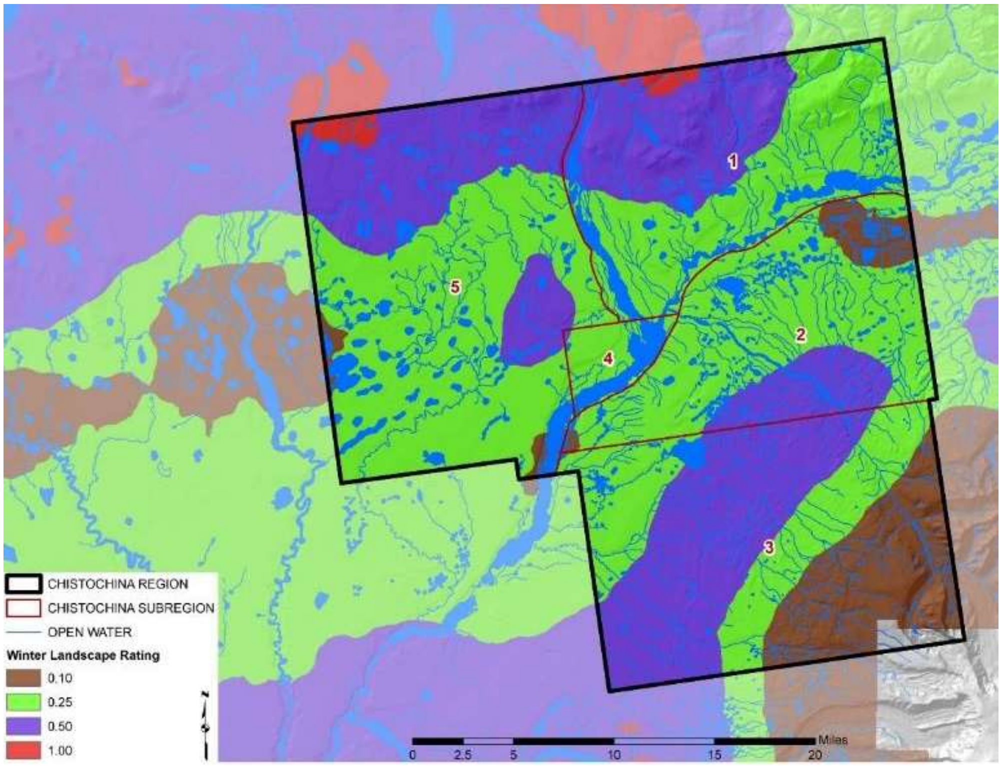


Figure 90. Results of the landscape-scale model outputs for moose winter habitat quality.

Caribou

Ecosystem-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 91 and 92. Landscape-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 93 and 94. A complete description of the caribou habitat quality models can be found in Appendix C.

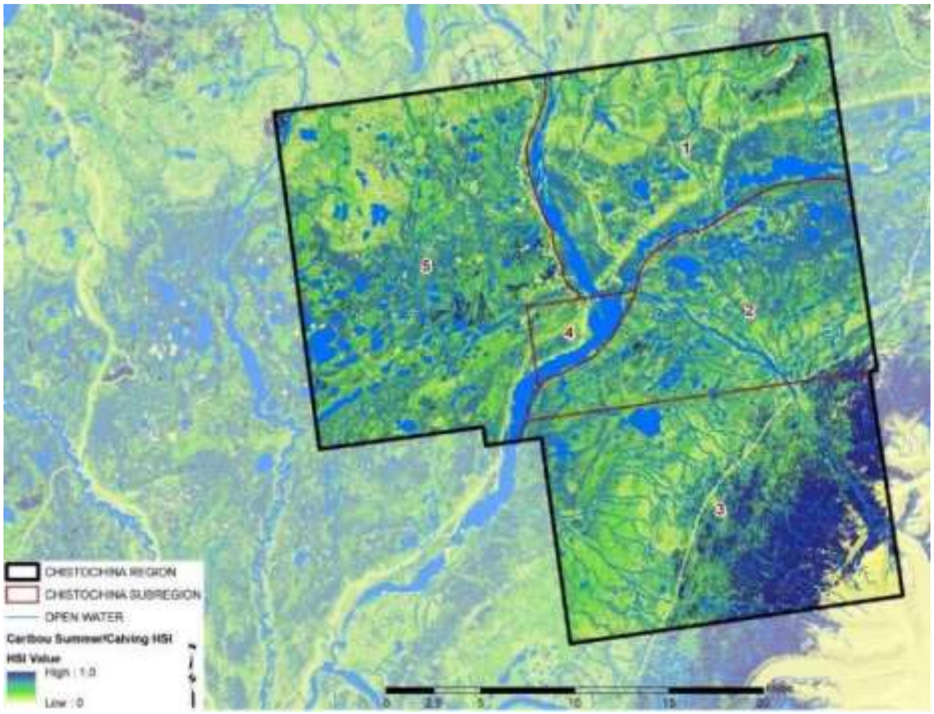


Figure 91. Results of the ecosystem-scale model outputs for moose summer/calving habitat quality.

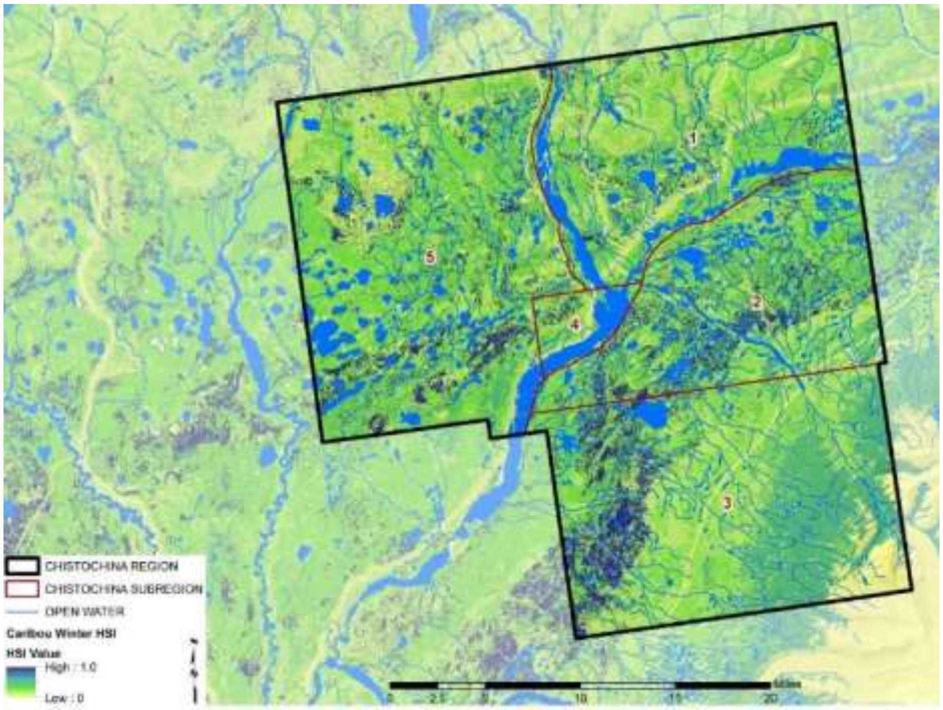


Figure 92. Results of the ecosystem-scale model outputs for caribou winter habitat quality.

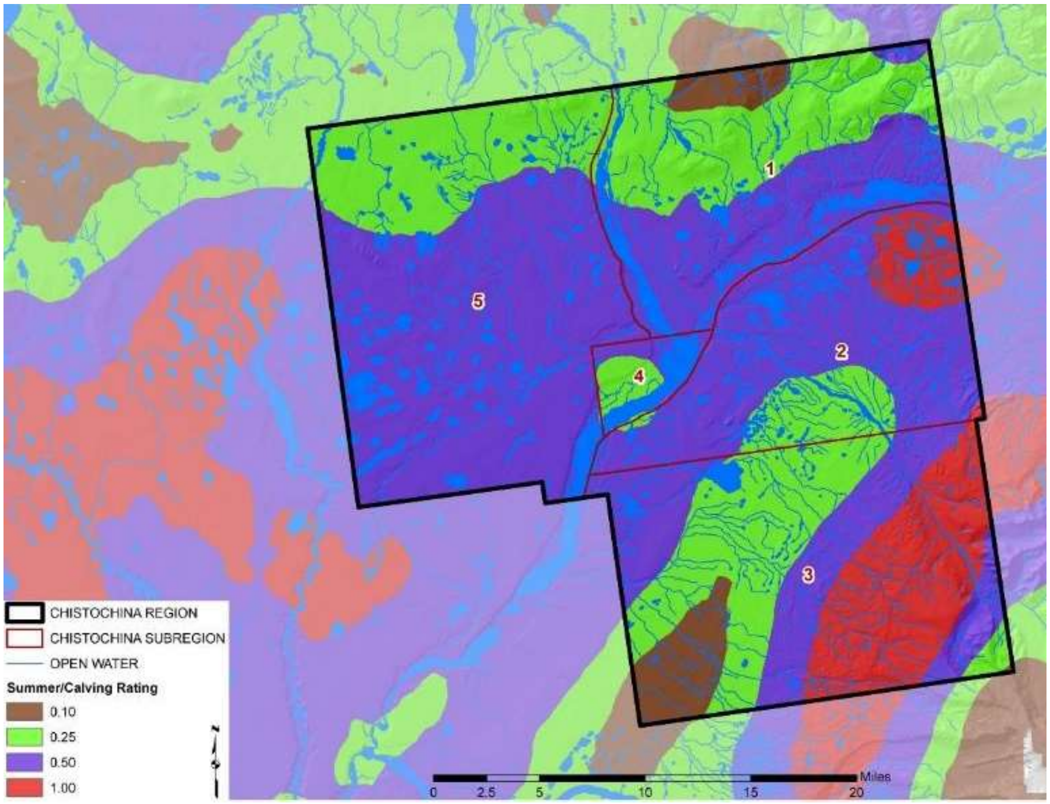


Figure 93. Results of the landscape-scale model outputs for caribou summer/calving habitat quality.

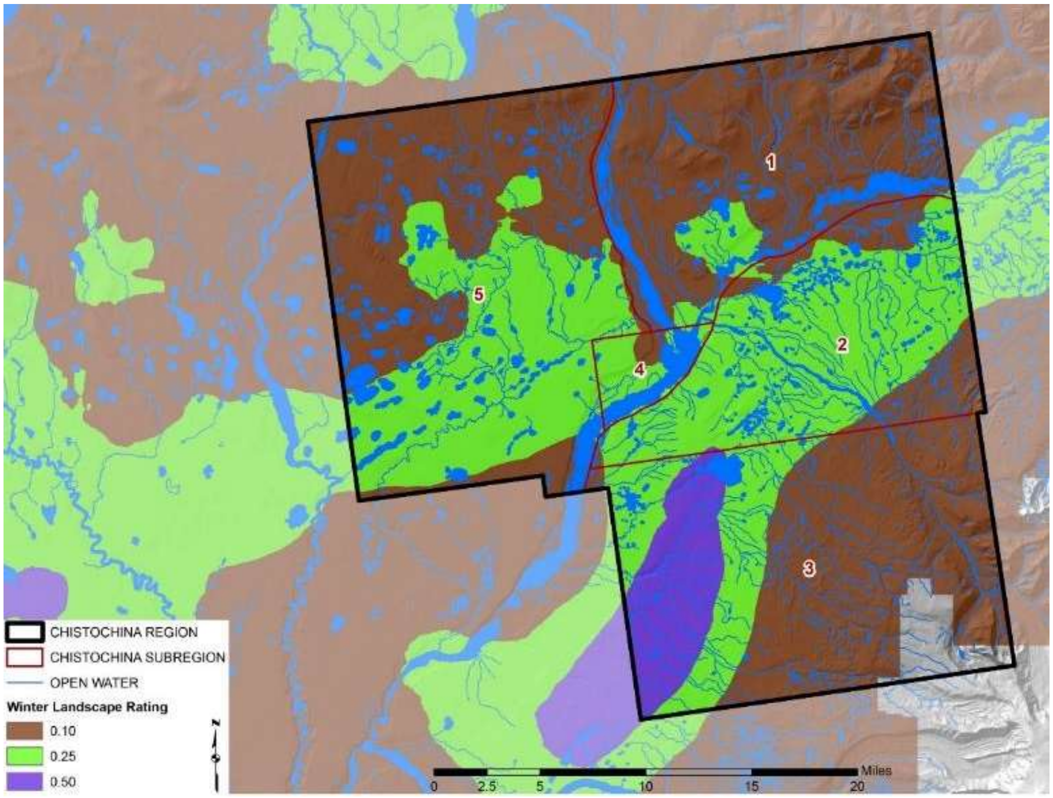


Figure 94. Results of the landscape-scale model outputs for caribou winter habitat quality..

Chistochina Village Vegetation Treatment Sites

Potential treatment sites identified in the Chistochina area are displayed in figure 95. Based on all of the stated criteria, a number of sites were located for designated treatments. Figures 96-99 depict the locations of these areas. Appendix C provides a description of each of these sites. Sites ranging from approximately 16-55 acres in size were identified and are listed in Table 19. This table gives the site size and the treatment goal of primarily timber stand improvement and biomass production or moose browse enhancement. The table also displays an estimate of the total biomass of all standing above ground biomass. This estimate is not tonnage of usable biomass for energy but the total of all stems regardless of size. However, stands on the higher end of the total amount will typically have larger trees and are a candidate for biomass energy production.

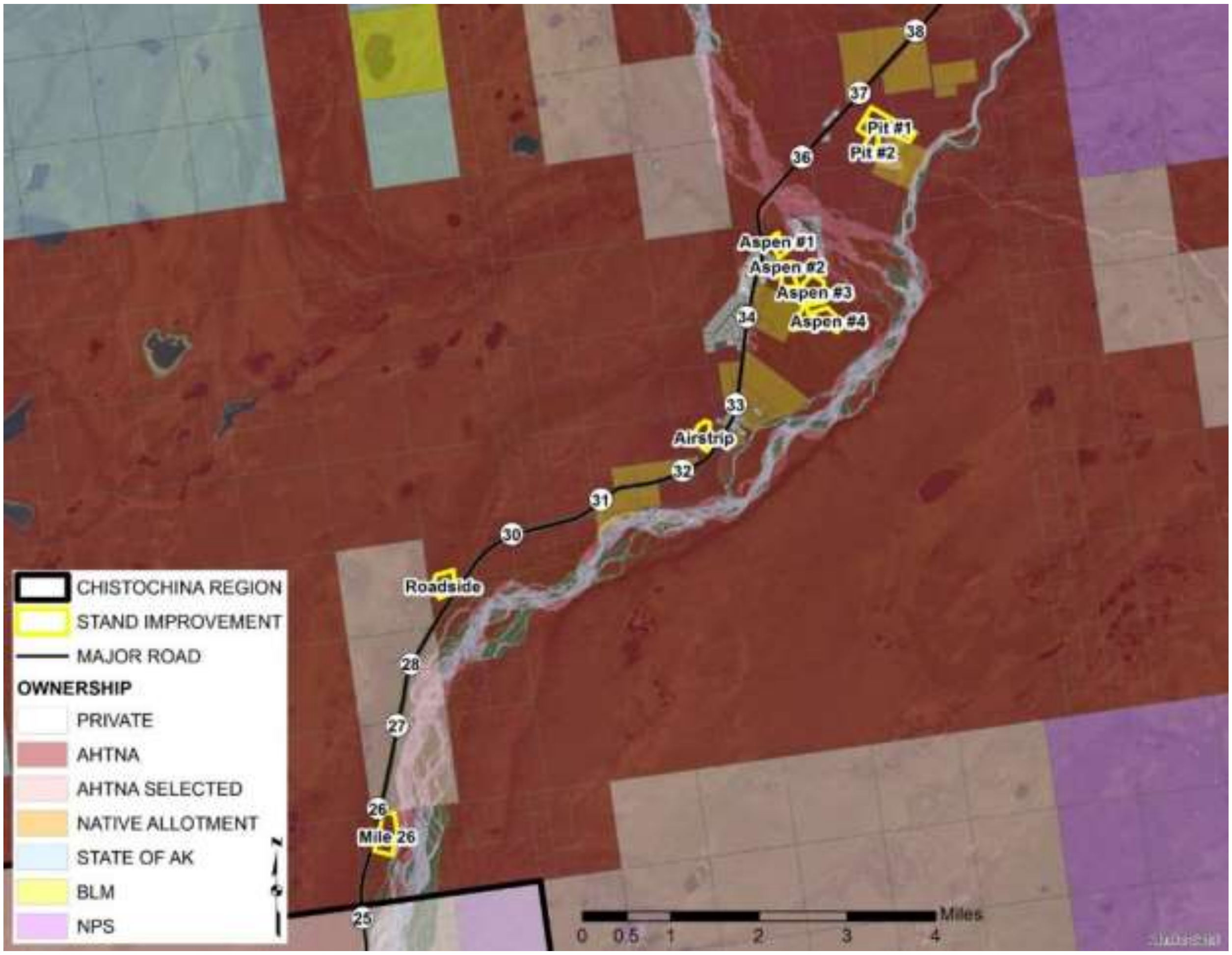


Figure 95. Overview of recommended treatment sites in the Chistochina Village planning region.

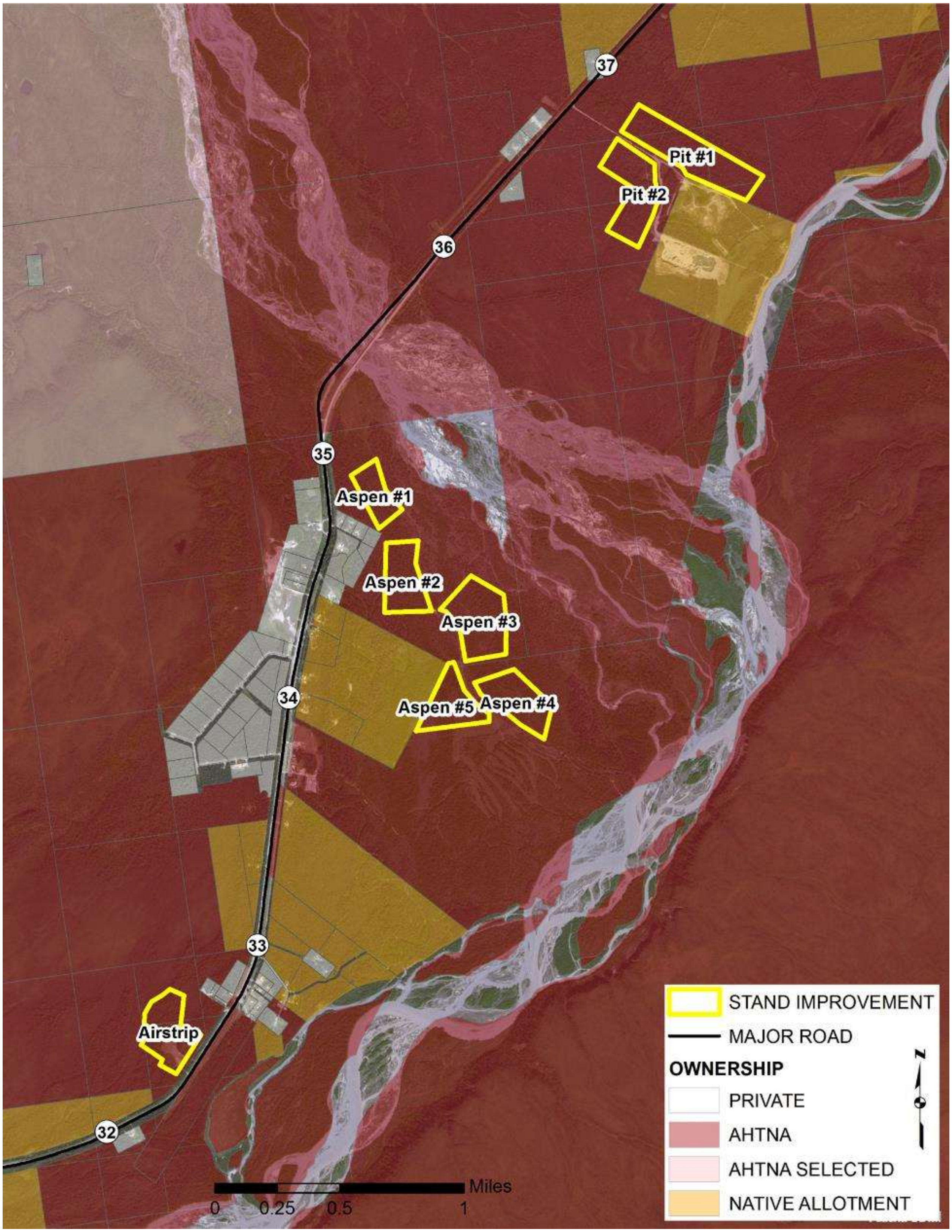


Figure 96. Map of three proposed treatment areas (Airstrip, Aspen, and Pit) in the Chistochina Village planning region showing surface ownership and aerial imagery.

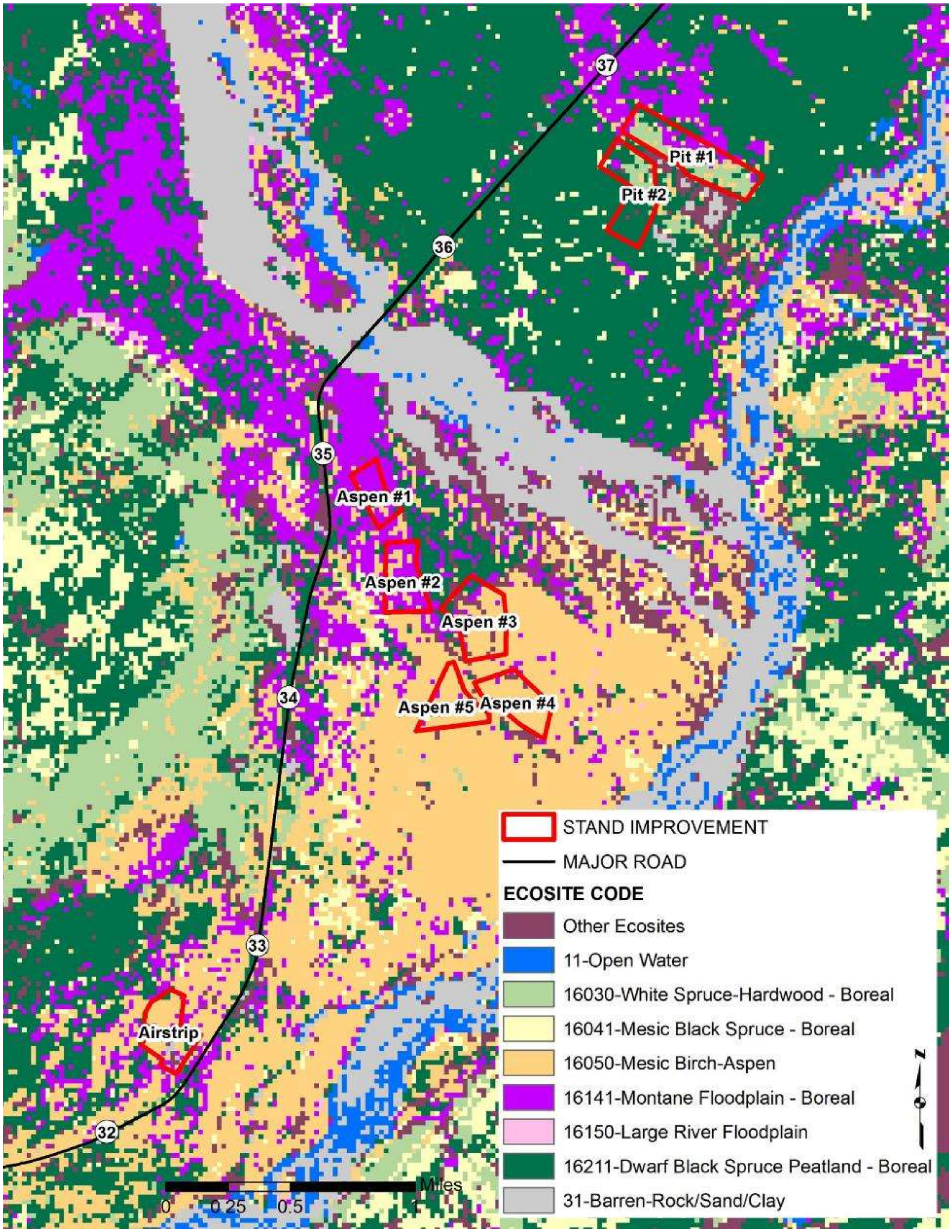


Figure 97. Map of three proposed treatment areas (Airstrip, Aspen, and Pit) in the Chistochina Village planning region showing ecological sites.

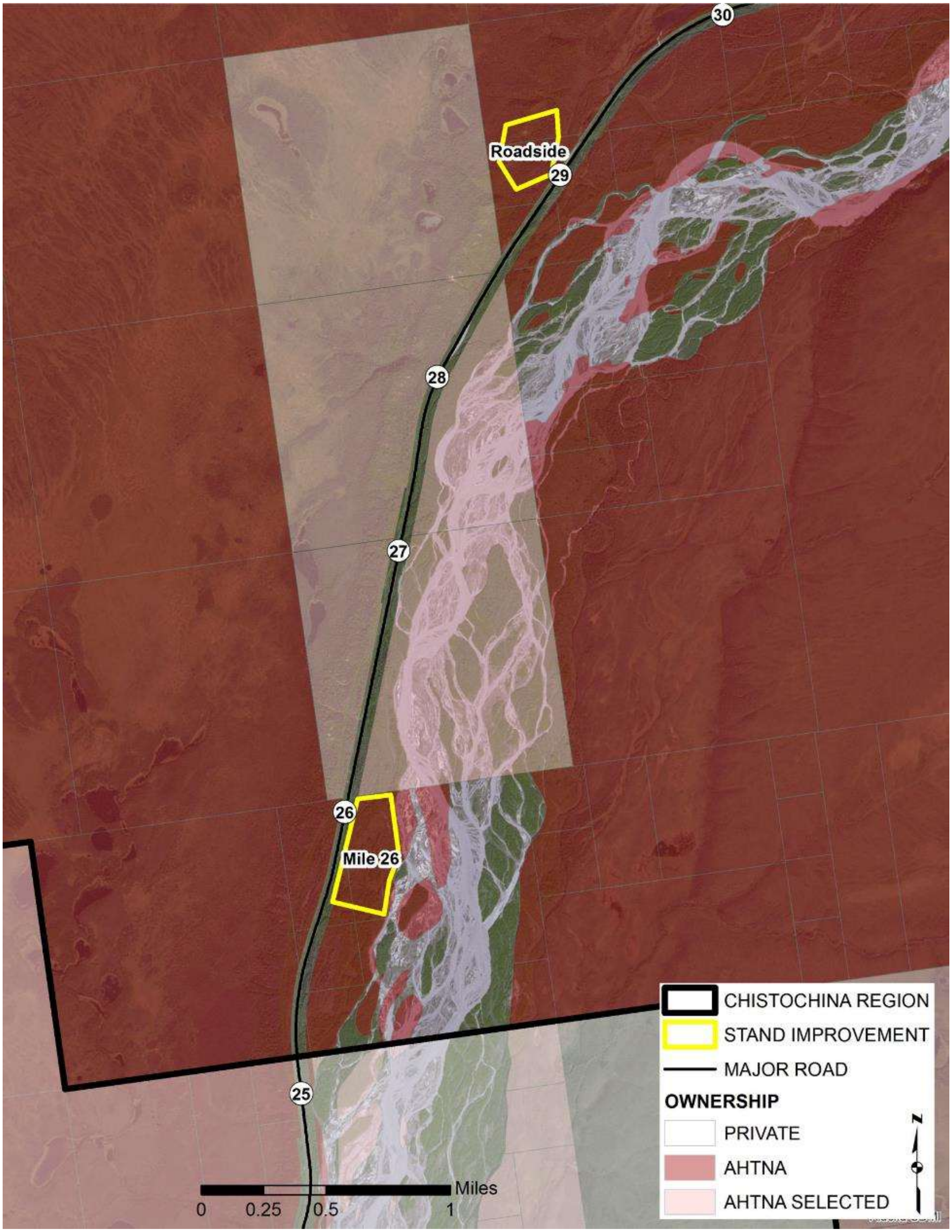


Figure 98. Map of two proposed habitat improvement areas (Roadside and Mile 26) in the Chistochina Village planning region showing surface ownership and aerial imagery.

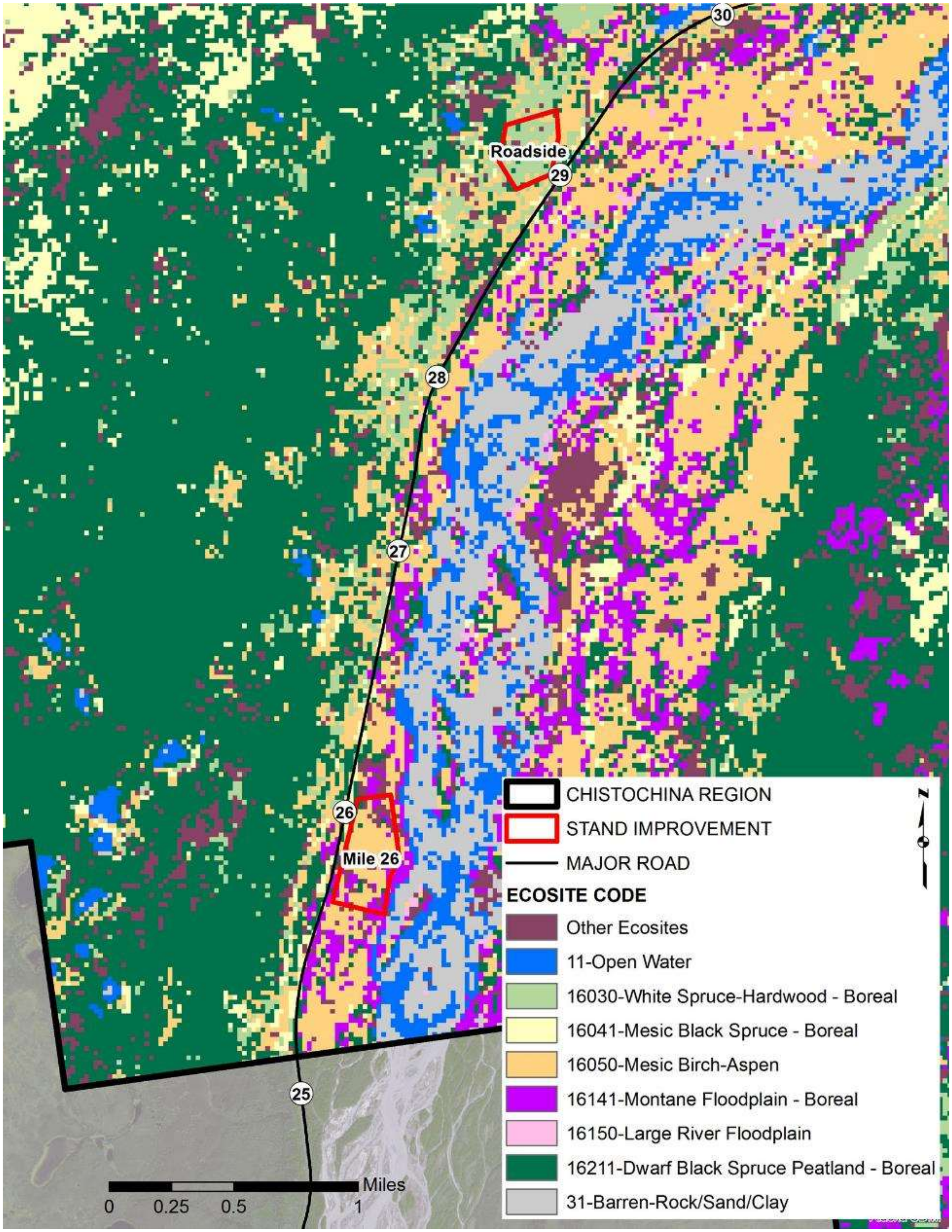


Figure 99. Map of two proposed habitat improvement areas (Roadside and Mile 26) in the Chistochina Village planning region showing ecological sites.

Table 19. Vegetation treatment sites in the Chistochina Village planning region and their primary ecosystem type, treatment goal, size (acres), and total biomass (tons).

Treatment Site Name	Ecosystem Code	Primary Treatment Goal	Acres	Biomass (tons)
Airstrip	16050_A	Moose Browse	28.9	110.3
Aspen #1	16141_A	Timber/Browse	16.2	10.0
Aspen #2	16141_A	Timber/Browse	26.1	3.1
Aspen #3	16050_A	Moose Browse	37.2	37.5
Aspen #4	16050_A	Moose Browse	27.4	39.5
Aspen #5	16050_A	Moose Browse	24.6	39.2
Mile 26	16050_A	Moose Browse	55.4	8.5
Roadside	16030_C	Timber/Browse	34.3	1111.1

Chitina Village Management Plan

The Chitina Village planning region encompasses an area of 641,032 acres. Figure 100 displays the overall planning area along with associated infrastructure. Ownership of this and the surrounding area is shown in Figure 101. As Figure 101 displays, land ownership patterns are varied in this area with Ahtna owning 39.7% (254,179 acres) of the land. In addition, Chitina Native Corporation owns 16.5% (105,698 acres) of the planning region.

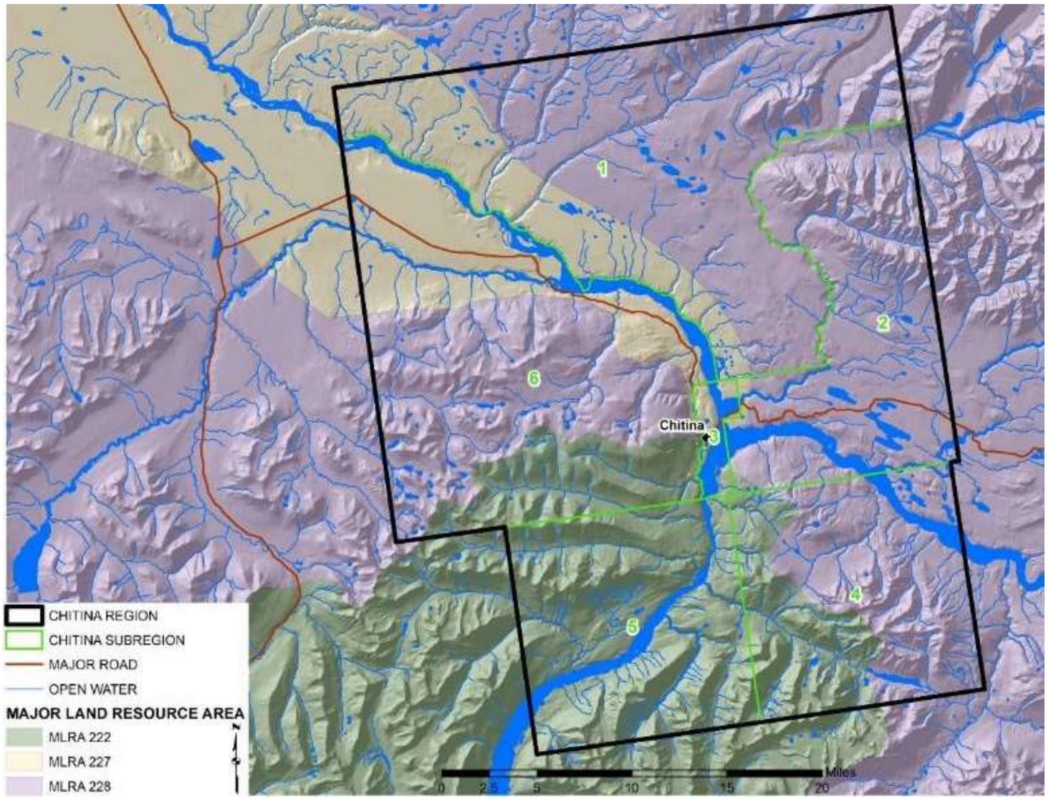


Figure 100. Overview of the Chitina Village planning region.

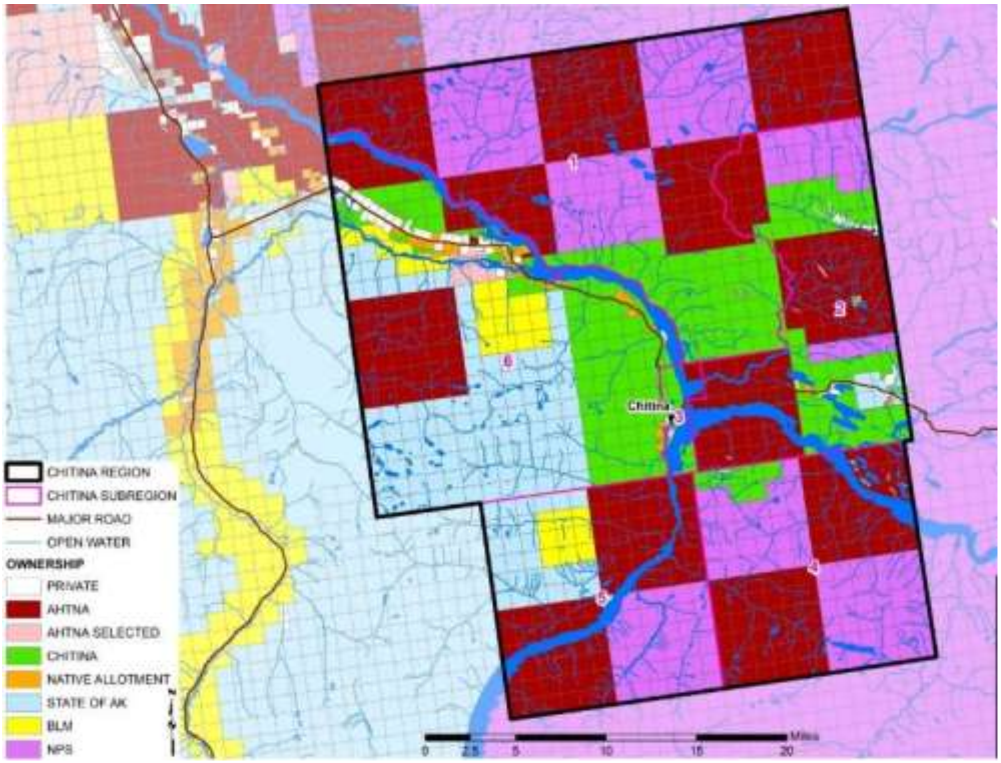


Figure 101. Land ownership patterns in the Chitina Village planning region.

Planning Area Description

The geology of the Chitina area was described previously based on the information from the Copper River Basin Soil Survey.

The Chitina area has a continental climate resulting from an influx of warm, moist air coming up the Copper River from the Gulf of Alaska. This makes it unique from the sub-arctic continental climate found in much of the Copper River Basin. The climate in Chitina is characterized by long, cool winters and relatively warm summers. High winds are frequent due to the pressure gradient between coastal areas and the interior region of the Copper River Basin.

The average minimum temperature in January is -16.8 °F (-27.1 °C); daily low temperatures of -50 °F (-46 °C) or less occur frequently during the winter and may last for two or more weeks. The average maximum temperature in July is 66.8 °F (19.3 °C) and on occasion exceed 85 °F (30 °C). Although the daily minimum temperature in summer averages in the forties, freezing temperatures have been recorded in every month resulting in a varied growing season length each year. Mean annual precipitation is 11.0 inches (27.9 cm) with 33% being received as rain during the growing season (June-August). Average annual snowfall is 26 inches (66.0 cm).

Soil texture in the Chitina project area is shown in Figure 102 and Figure 103 displays soil drainages.

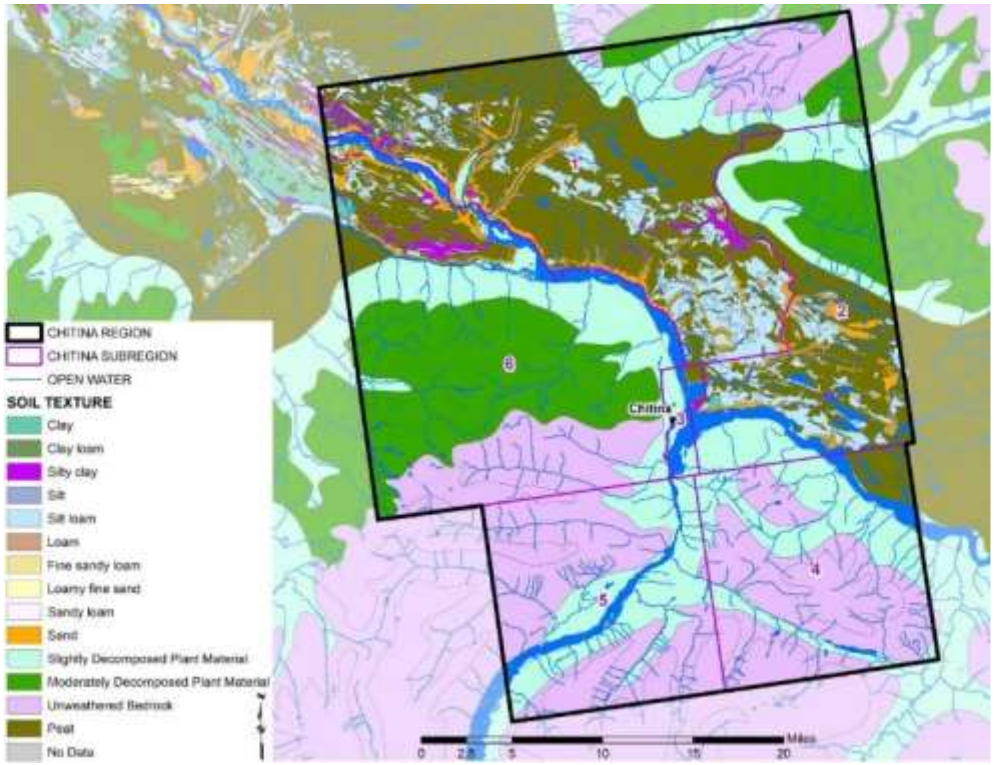


Figure 102. Soil texture in the Chitina Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

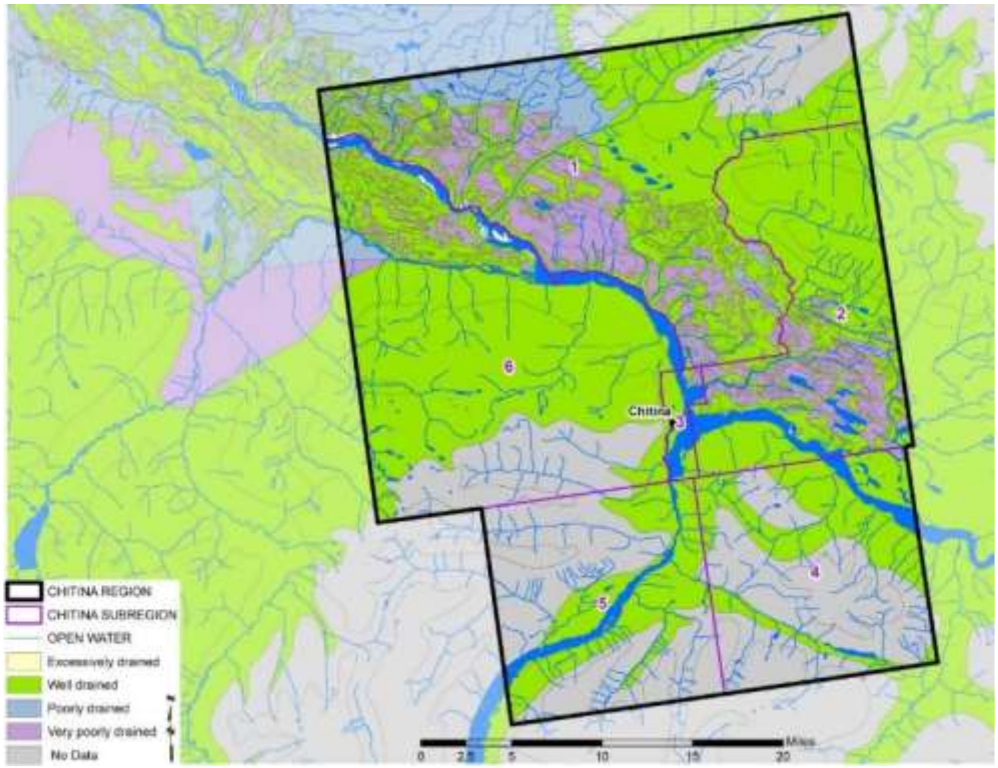


Figure 103. Soil drainage in the Chitina Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

Figure 104 displays the occurrence of permafrost in the Chitina project area as interpreted from the soil survey information.

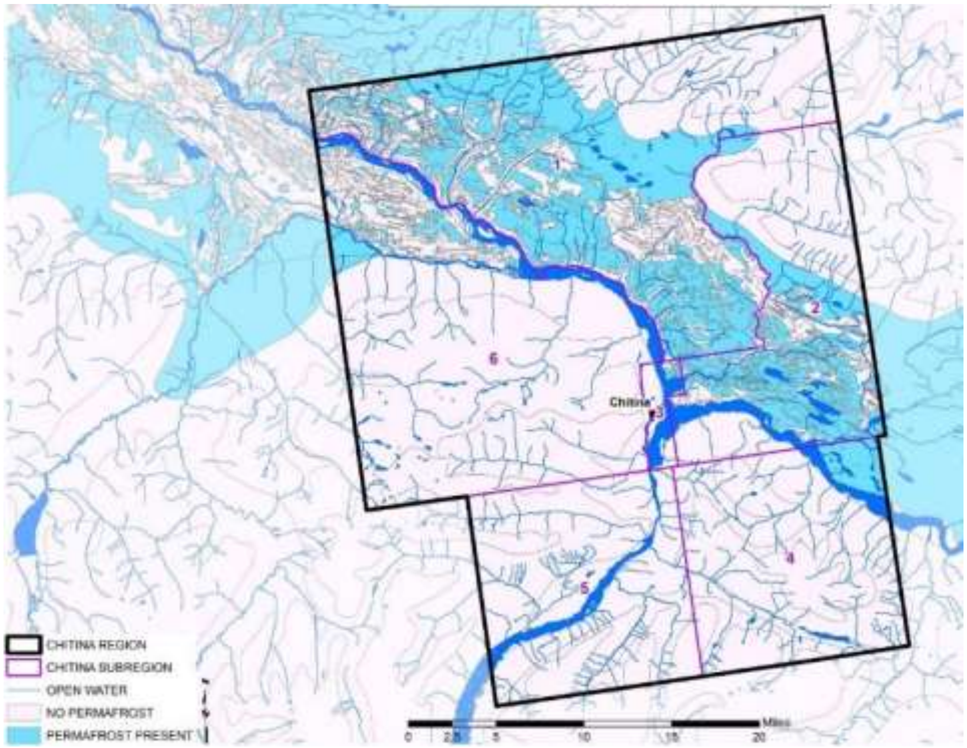


Figure 104. Permafrost in in the Chitina Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

Fire is a major disturbance factor influencing the vegetation ecology in the project area. Figure 105 shows the fire history of the Chitina area along with current fire protection zones. While only one large fire has occurred since 1940 in the project area, fire is still a significant disturbance when it occurs. When fire does occur it serves to set back succession. It can also burn off the organic material at the ground surface, including peat that can occur on many sites. This can influence the thermal layer protecting the underlying permafrost on some sites, causing the permafrost to melt (thermokarst) and changing the site conditions through this process. Riparian areas are also influenced by flooding and ice events. These serve to set back succession of vegetation in riparian areas, and can even shift site conditions, particularly in the case of significant flooding events.

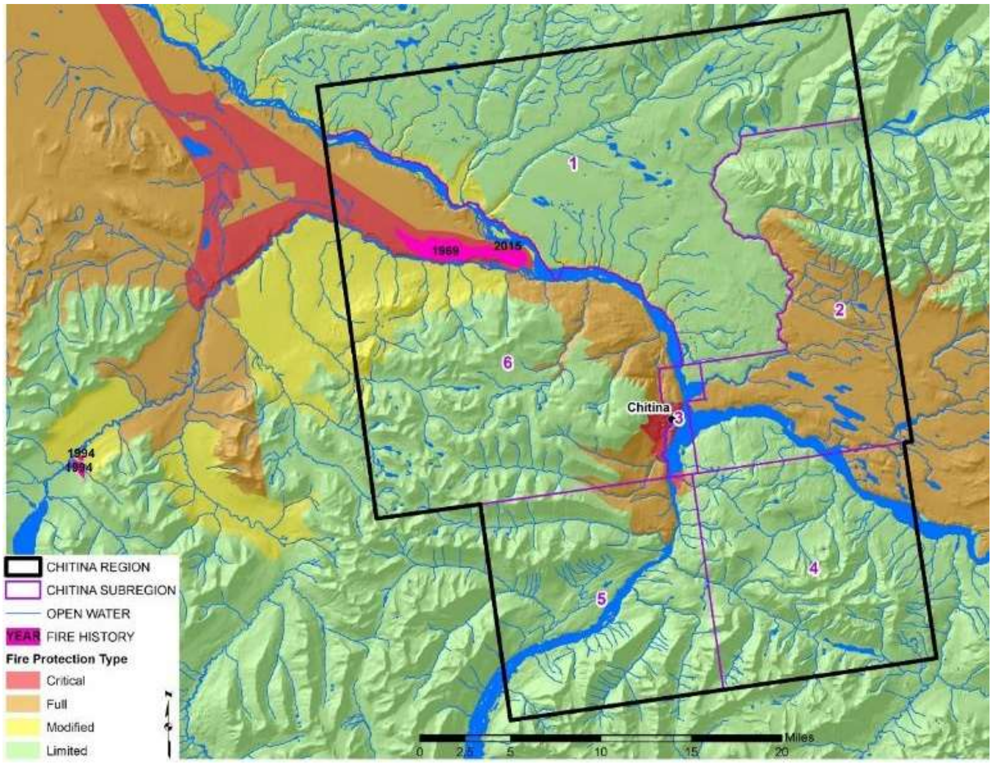


Figure 105. Current fire protection classes and fire history since 1940 in the Chitina Village planning region. Data from Alaska Interagency Coordination Center.

Landscape Assessment Results

Ecosystem Diversity

The ecological sites present within the Chitina Village planning region are displayed in Figure 106. Table 20 displays the acres for each ecological site and disturbance class. Figure 107 is a map of ecosystem diversity (represented by ecological site and disturbance class) in the Chitina Village planning region.

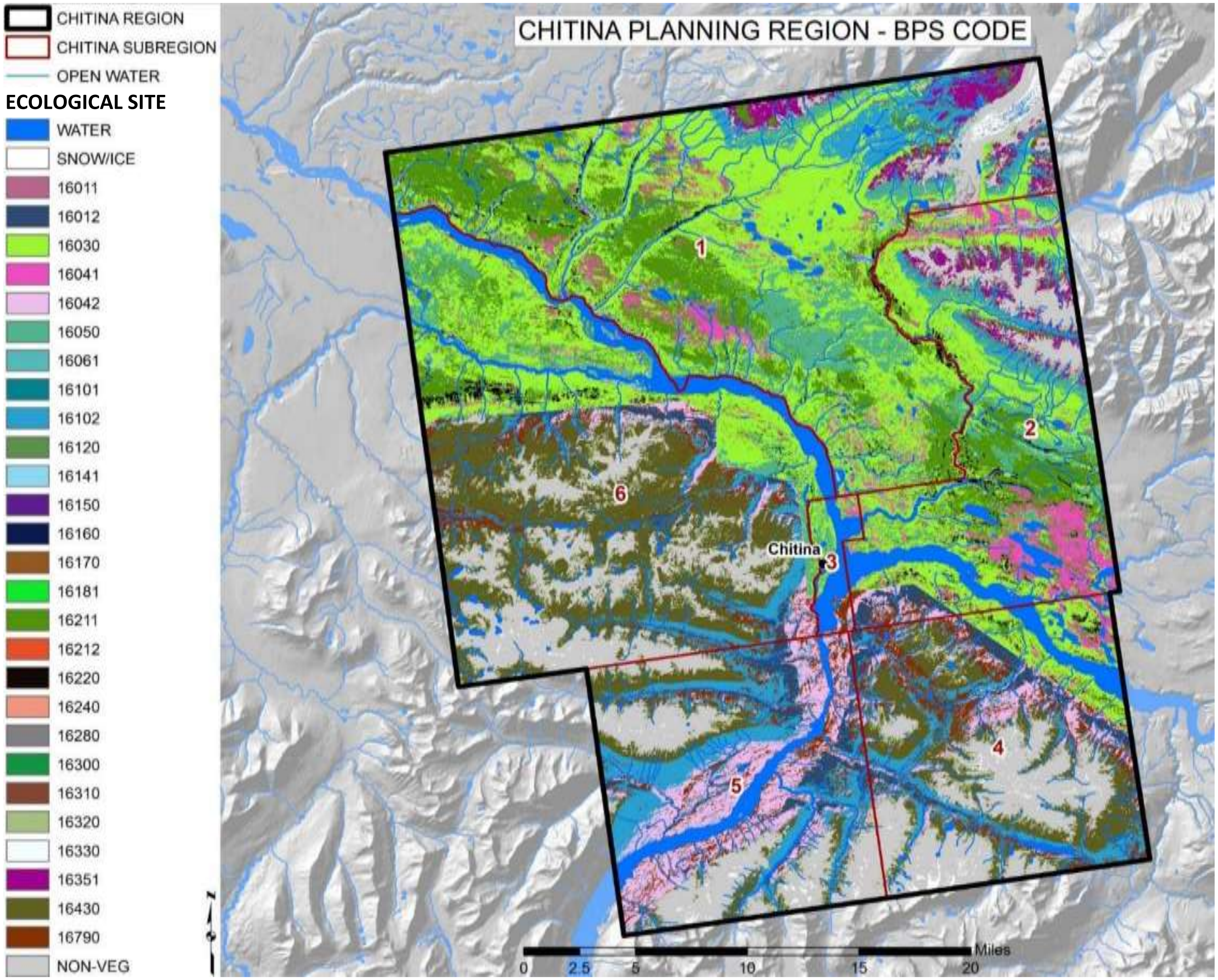


Figure 106. Ecological sites occurring in the Chitina Village planning region.

Table 20. Ecosystems present in the Chitina Village planning region and their associated acres. The ecological site vegetation label is provided as reference.

Ecosystem Code	Ecological Site Label	Acres
11	Open Water	17723.3
12	Perrennial Ice-Snow	3879.2
16011_A	Treeline White Spruce-Boreal	151.7
16011_B	Treeline White Spruce-Boreal	733.5
16011_C	Treeline White Spruce-Boreal	0.2
16012_A	Treeline White Spruce-SubBoreal	1827.4
16012_B	Treeline White Spruce-SubBoreal	12358.0
16012_C	Treeline White Spruce-SubBoreal	8.2
16030_A	White Spruce-Hardwood-Boreal	2795.7
16030_B	White Spruce-Hardwood-Boreal	19679.1
16030_C	White Spruce-Hardwood-Boreal	107901.2
16030_E	White Spruce-Hardwood-Boreal	308.7
16041_A	Mesic Black Spruce-Boreal	812.9
16041_B	Mesic Black Spruce-Boreal	3682.2
16041_C	Mesic Black Spruce-Boreal	2921.8
16041_D	Mesic Black Spruce-Boreal	16317.1
16041_E	Mesic Black Spruce-Boreal	4.9
16042_A	Mesic Black Spruce-SubBoreal	4424.8
16042_B	Mesic Black Spruce-SubBoreal	20517.5
16042_C	Mesic Black Spruce-SubBoreal	7410.4
16042_D	Mesic Black Spruce-SubBoreal	45.4
16042_E	Mesic Black Spruce-SubBoreal	1.6
16050_A	Mesic Birch-Aspen	22760.8
16050_B	Mesic Birch-Aspen	15929.3
16050_D	Mesic Birch-Aspen	37.8
16050_E	Mesic Birch-Aspen	69.4
16061_A	Dry Aspen-Steppe Bluff	95.9
16061_B	Dry Aspen-Steppe Bluff	343.8
16061_C	Dry Aspen-Steppe Bluff	423.0
16061_D	Dry Aspen-Steppe Bluff	746.8
16070_A	Subalpine Balsam Poplar-Aspen	0.2
16090_A	Mesic Subalpine Alder	0.7
16102_A	Mesic Scrub Birch-Willow	13391.5
16102_B	Mesic Scrub Birch-Willow	43089.5
16110_A	Mesic Bluejoint Meadow	1.6
16110_B	Mesic Bluejoint Meadow	0.2
16120_A	Dry Grassland	3.6
16120_B	Dry Grassland	0.7
16141_A	Montane Floodplain-Boreal	489.7
16141_B	Montane Floodplain-Boreal	1225.0
16141_C	Montane Floodplain-Boreal	607.6
16141_D	Montane Floodplain-Boreal	6634.3
16141_E	Montane Floodplain-Boreal	487.5
16142_A	Montane Floodplain-Subboreal	0.4
16142_B	Montane Floodplain-Subboreal	0.4
16142_C	Montane Floodplain-Subboreal	0.2
16142_D	Montane Floodplain-Subboreal	0.9
16150_A	Large River Floodplain	486.6
16150_B	Large River Floodplain	100.5
16150_C	Large River Floodplain	221.5
16150_D	Large River Floodplain	11.1
16150_E	Large River Floodplain	1.1
16160_A	Riparian Stringer	3.8
16160_B	Riparian Stringer	6.0
16170_A	Shrub and Herbaceous Floodplain	2.4
16170_B	Shrub and Herbaceous Floodplain	0.2
16170_C	Shrub and Herbaceous Floodplain	0.2
16170_D	Shrub and Herbaceous Floodplain	1.8
16170_E	Shrub and Herbaceous Floodplain	2.7
16181_A	Herbaceous Fen	12.2
16181_B	Herbaceous Fen	4.2
16181_C	Herbaceous Fen	2.0
16181_D	Herbaceous Fen	62.7
16211_A	Dwarf Black Spruce Peatland-Boreal	2843.3
16211_B	Dwarf Black Spruce Peatland-Boreal	2707.2
16211_C	Dwarf Black Spruce Peatland-Boreal	3593.2
16211_D	Dwarf Black Spruce Peatland-Boreal	57194.2
16212_A	Dwarf Black Spruce Peatland-Subboreal	2.4
16212_B	Dwarf Black Spruce Peatland-Subboreal	0.4
16212_C	Dwarf Black Spruce Peatland-Subboreal	3.6
16220_A	Black Spruce Wet-Mesic Slope	1386.2
16220_B	Black Spruce Wet-Mesic Slope	1058.4
16220_C	Black Spruce Wet-Mesic Slope	359.8
16220_D	Black Spruce Wet-Mesic Slope	5594.3
16240_A	Deciduous Shrub Swamp	55.8
16240_B	Deciduous Shrub Swamp	6.9
16280_A	Low Shrub-Tussock Tundra	2142.3
16280_B	Low Shrub-Tussock Tundra	268.9
16280_C	Low Shrub-Tussock Tundra	24.9
16290_B	Tussock Tundra	0.2
16300_A	Wet Black Spruce-Tussock	8.5
16300_B	Wet Black Spruce-Tussock	17.6
16300_C	Wet Black Spruce-Tussock	7.3
16310_A	Alpine Dwarf-Shrub Summit	1412.9
16310_B	Alpine Dwarf-Shrub Summit	222.0
16320_A	Alpine Talus and Bedrock	13007.7
16320_B	Alpine Talus and Bedrock	209.7
16330_A	Alpine Mesic Herbaceous Meadow	7.6

Table 20, continued. Ecosystems present in the Chitina Village planning region and their associated acres. The ecological site vegetation label is provided as reference.

Ecosystem Code	Ecological Site Label	Acres	Ecosystem Code	Ecolgocal Site Label	Acres
16351_A	Alpine Ericaceous Dwarf-Shrubland	11226.1	16620_A	Emergent Marsh	0.2
16351_B	Alpine Ericaceous Dwarf-Shrubland	483.3	16790_A	White Spruce-Hardwood-SubBoreal	18801.3
16430_A	Alpine Dwarf Shrubland	70254.8	16790_B	White Spruce-Hardwood-SubBoreal	9383.5
16430_B	Alpine Dwarf Shrubland	5725.3	16790_C	White Spruce-Hardwood-SubBoreal	1097.3
16520_A	Subalpine Alder-Salmonberry	0.2	16790_D	White Spruce-Hardwood-SubBoreal	91.6
16520_B	Subalpine Alder-Salmonberry	0.2	16790_E	White Spruce-Hardwood-SubBoreal	12.7
16550_A	Montane Floodplain	0.2	31	Barren-Rock-Sand-Clay	101067.9

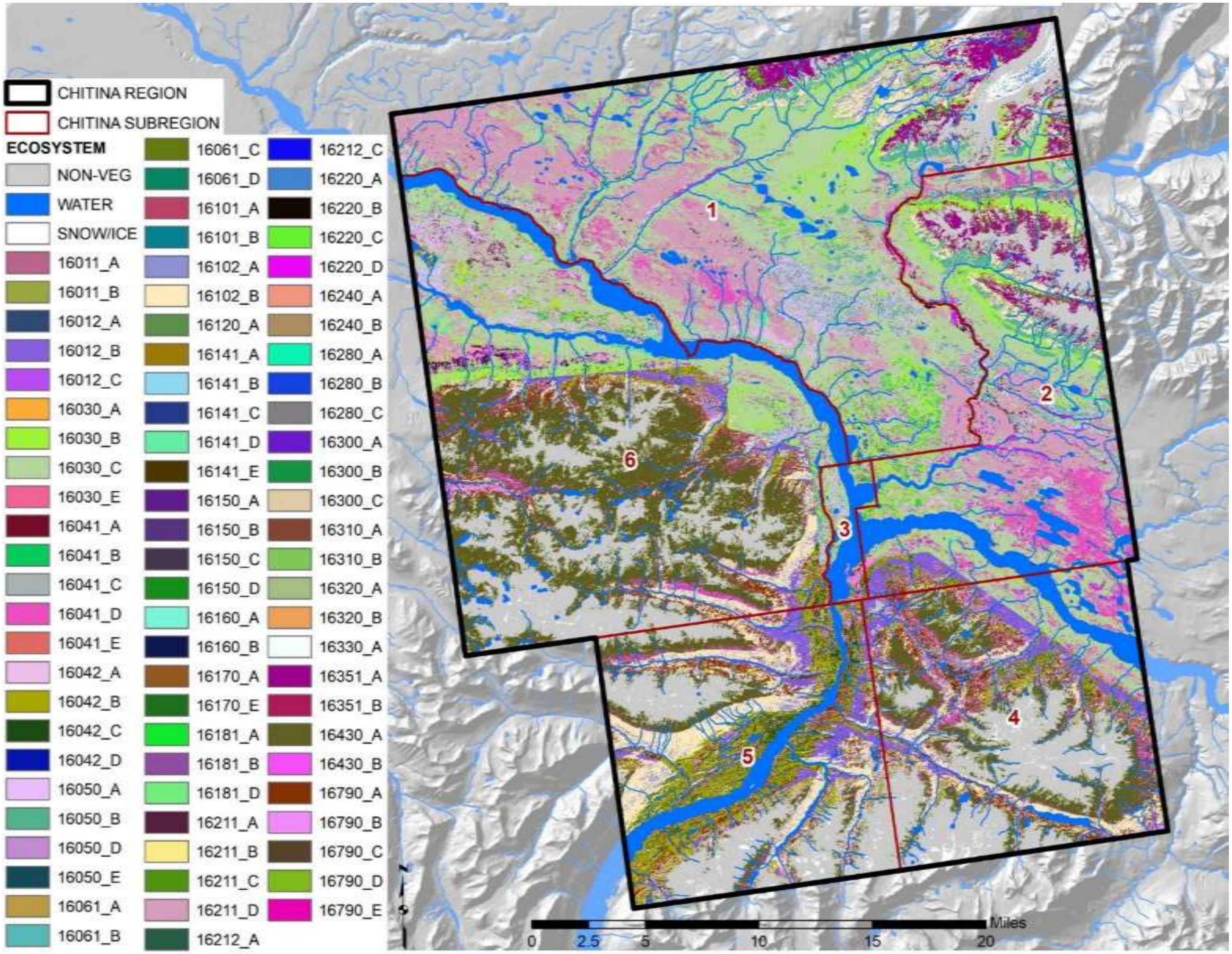


Figure 107. Ecosystem diversity in the Chitina Village planning region. See Appendix A for ecosystem code definitions.

Berry Production Areas

Figure 108 shows the areas identified with the highest potential for berry production. It may be desirable to avoid disturbances to these areas, but verifying the actual presence of good berry production is recommended on a site by site basis.

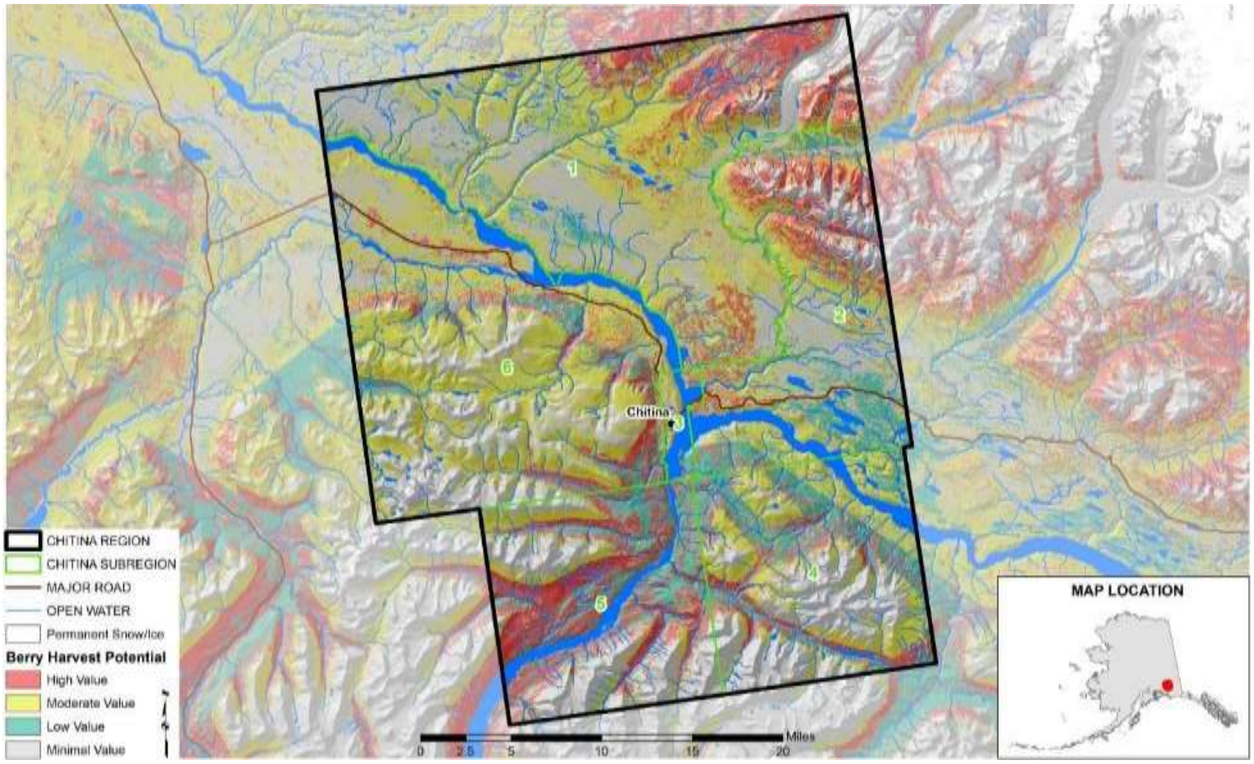


Figure 108. Potential berry production values in the Chitina Village planning region.

Moose and Caribou Habitat Quality Assessment - Model Results

Moose

Ecosystem-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 109 to 111. Landscape-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 112 to 114. A complete description of the moose habitat quality models can be found in Appendix B.

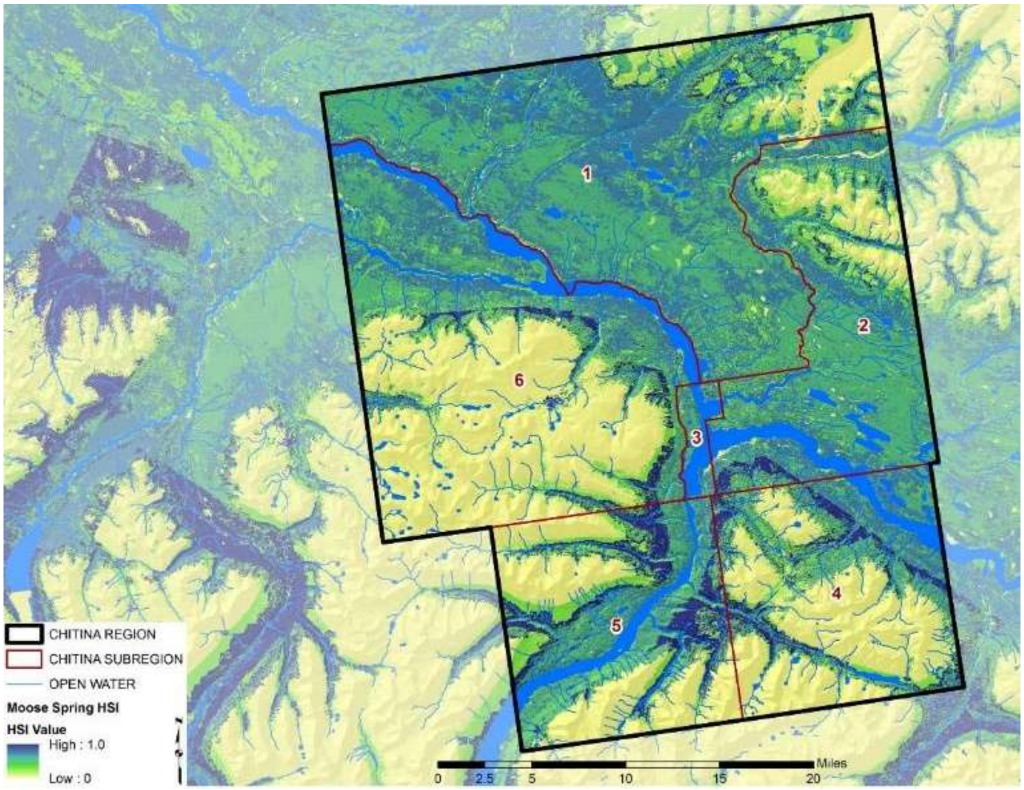


Figure 109. Results of the ecosystem-scale model outputs for moose spring habitat quality.

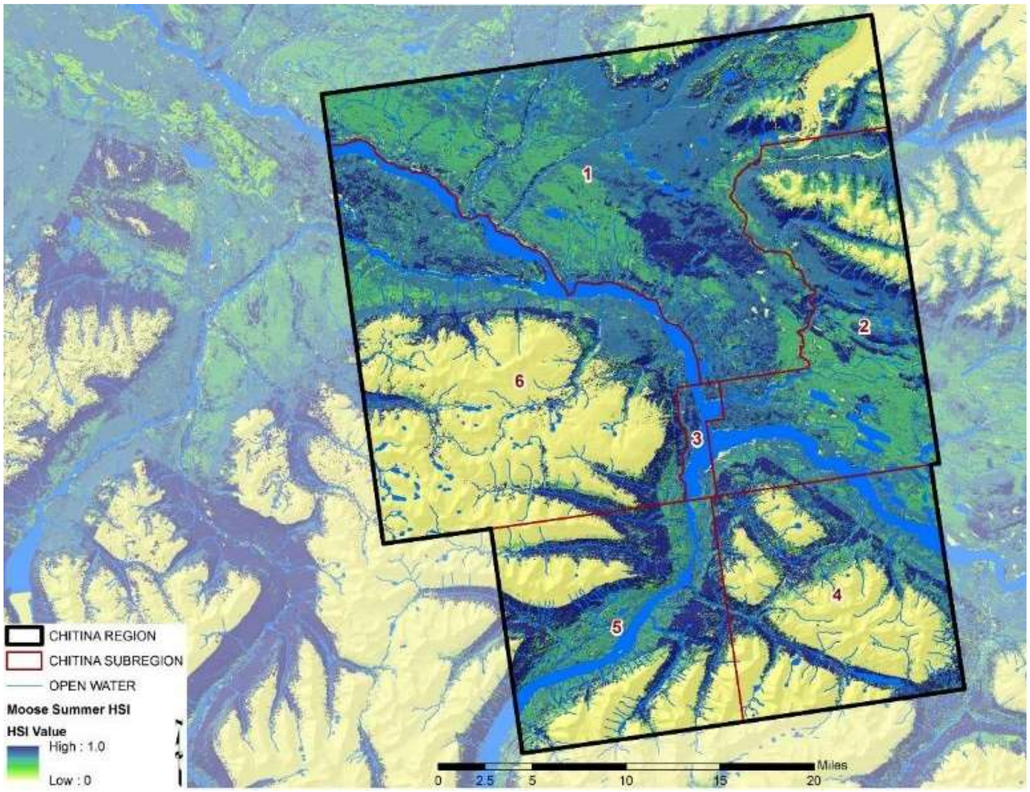


Figure 110. Results of the ecosystem-scale model outputs for moose summer habitat quality.

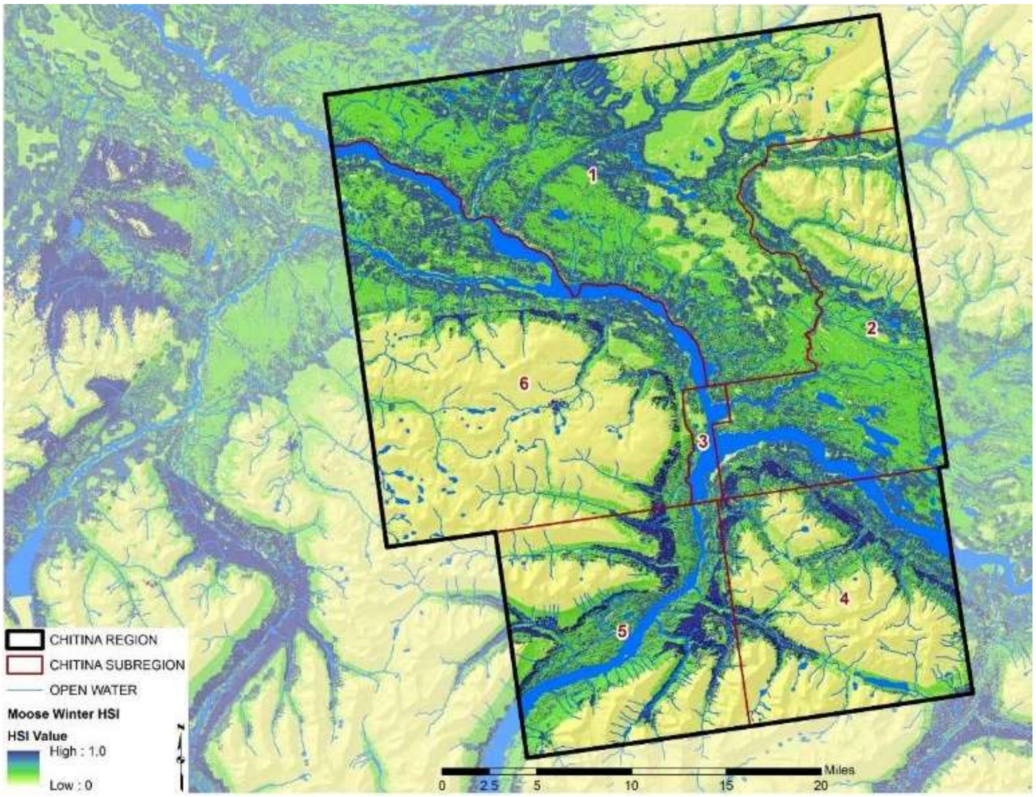


Figure 111. Results of the ecosystem-scale model outputs for moose winter habitat quality.

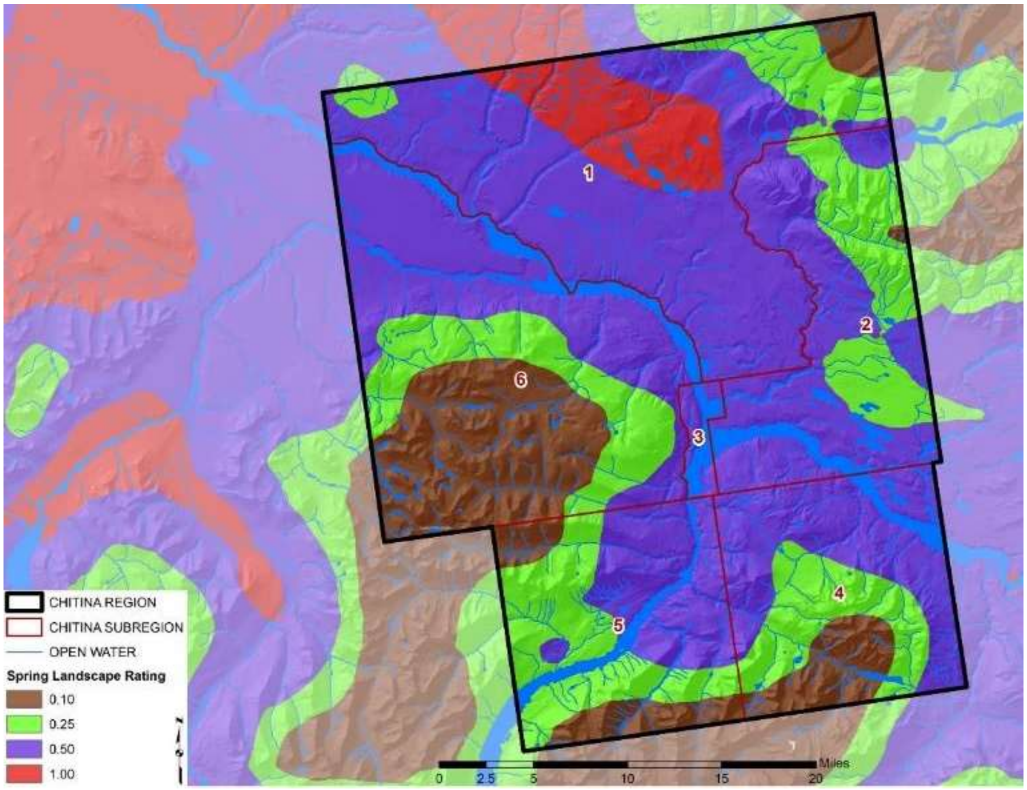


Figure 112. Results of the landscape-scale model outputs for moose spring habitat quality.

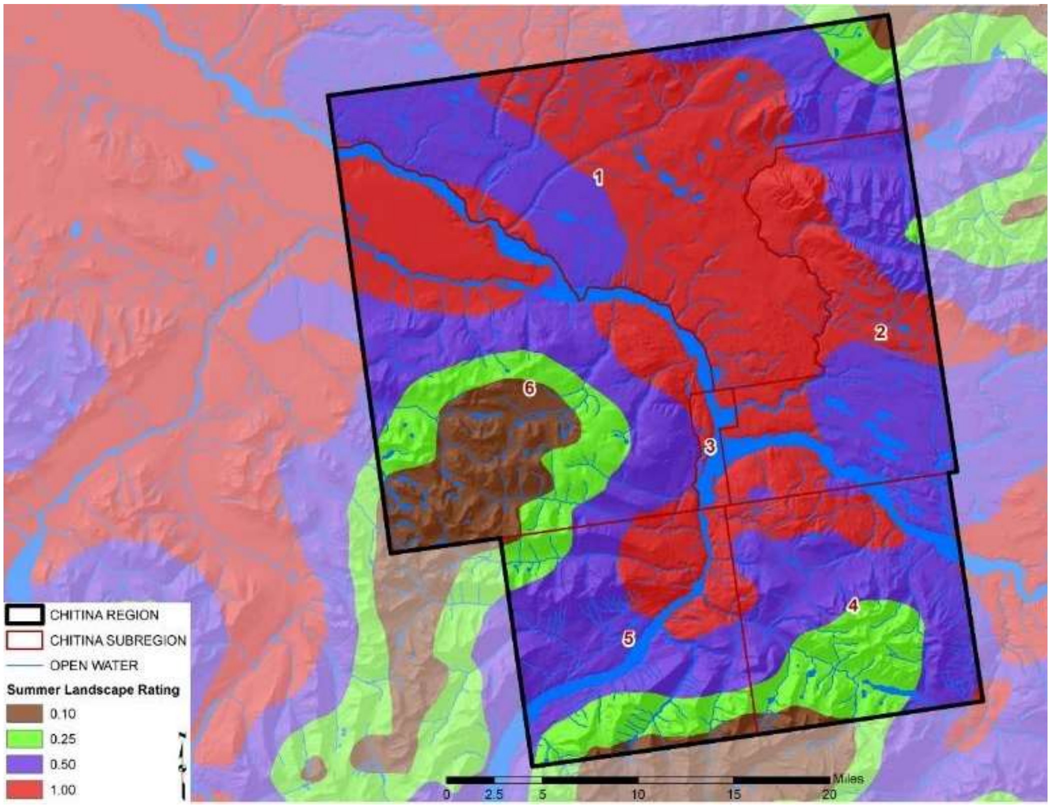


Figure 113. Results of the landscape-scale model outputs for moose summer habitat quality.

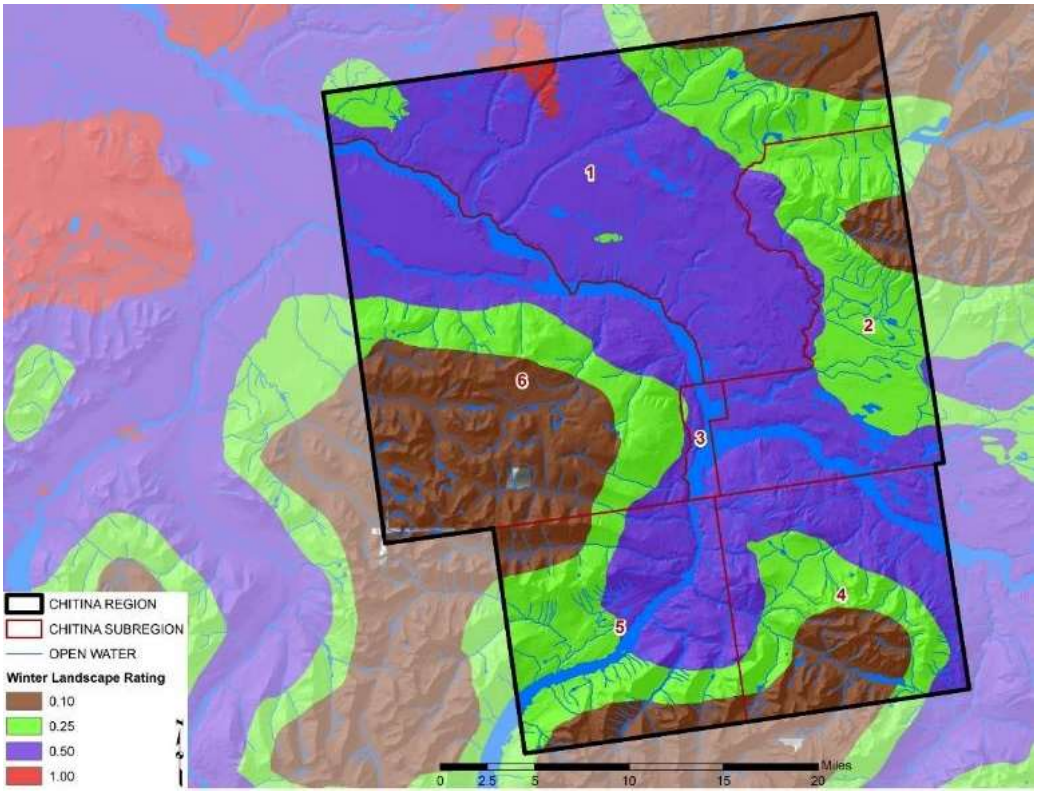


Figure 114. Results of the landscape-scale model outputs for moose winter habitat quality.

Caribou

Ecosystem-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 115 and 116. Landscape-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 117 and 118. A complete description of the caribou habitat quality models can be found in Appendix C.

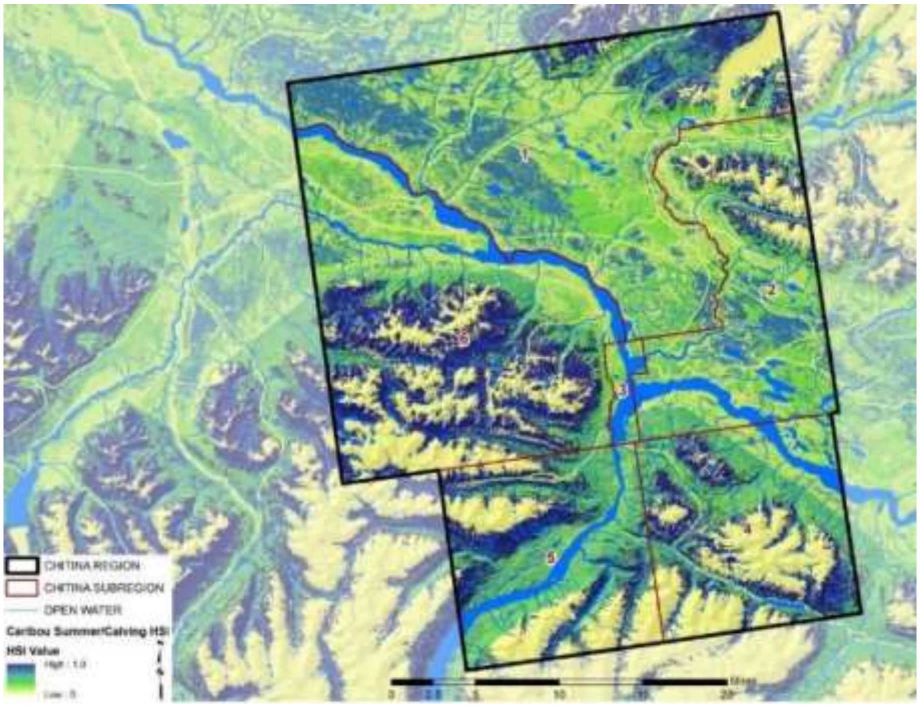


Figure 115. Results of the ecosystem-scale model outputs for caribou summer/calving habitat quality.

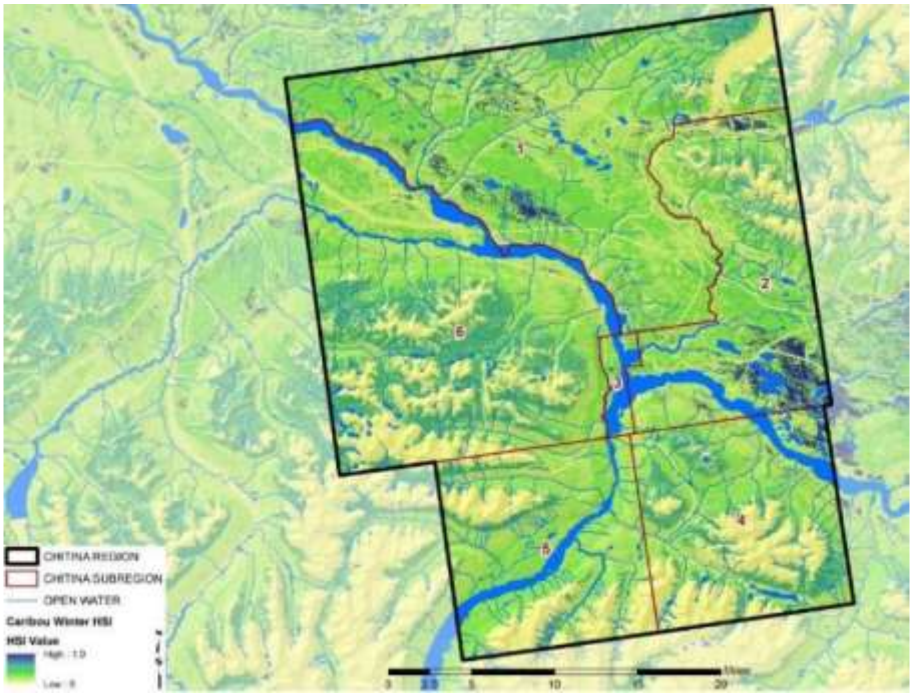


Figure 116. Results of the ecosystem-scale model outputs for caribou winter habitat quality.

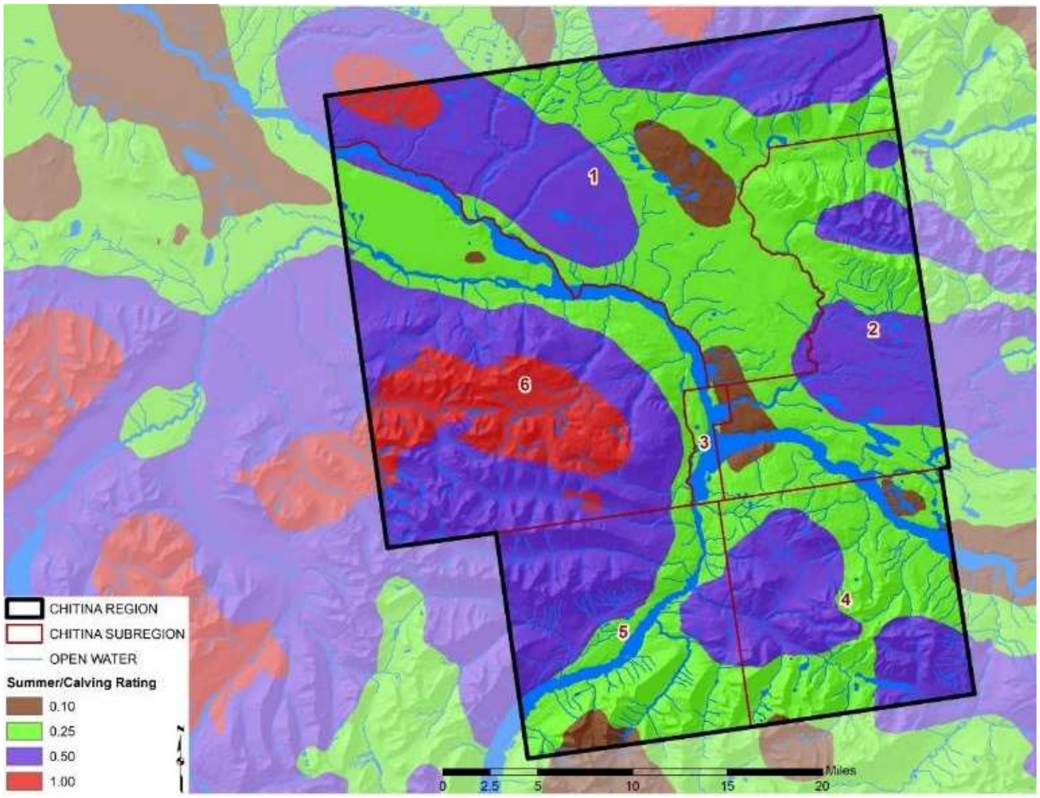


Figure 117. Results of the landscape-scale model outputs for caribou summer/calving habitat quality.

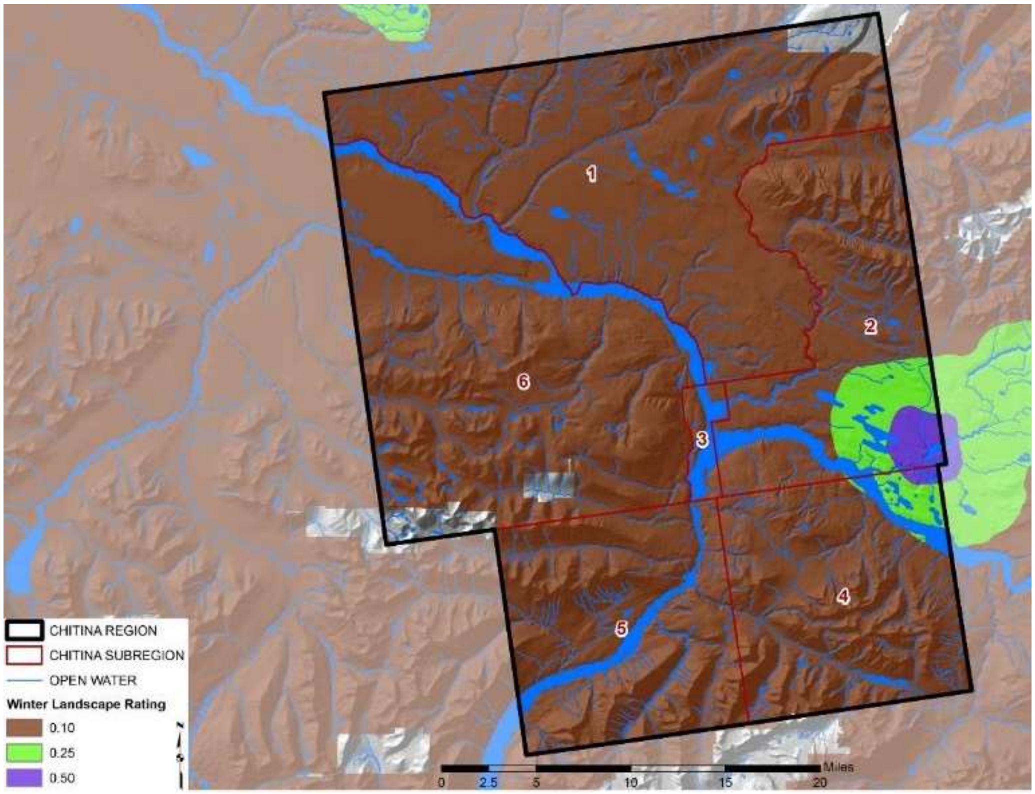


Figure 118. Results of the landscape-scale model outputs for caribou winter habitat quality.

Chitina Village Vegetation Treatment Sites

Potential treatment sites identified in the Chitina area are displayed in figure 119. Based on all of the stated criteria, a number of sites were located for designated treatments. Figures 120-123 depict the locations of these areas. Appendix C provides a description of each of these sites. Sites ranging from approximately 7-46 acres in size were identified and are listed in Table 21. This table gives the site size and the treatment goal of primarily timber stand improvement and biomass production or moose browse enhancement. The table also displays an estimate of the total biomass of all standing above ground biomass. This estimate is not tonnage of usable biomass for energy but the total of all stems regardless of size. However, stands on the higher end of the total amount will typically have larger trees and are a candidate for biomass energy production.

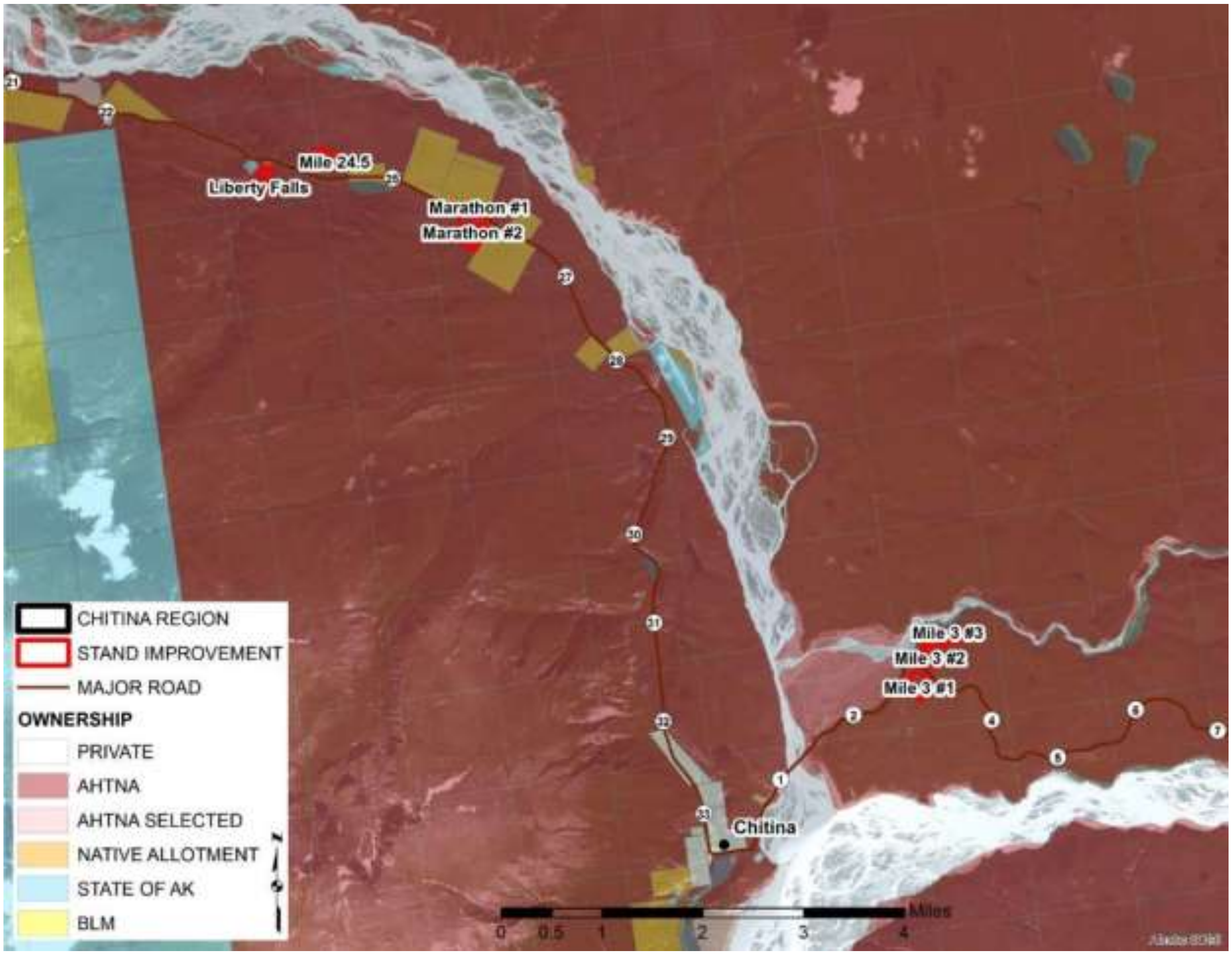


Figure 119. Overview of recommended treatment sites in the Chitina Village planning region.

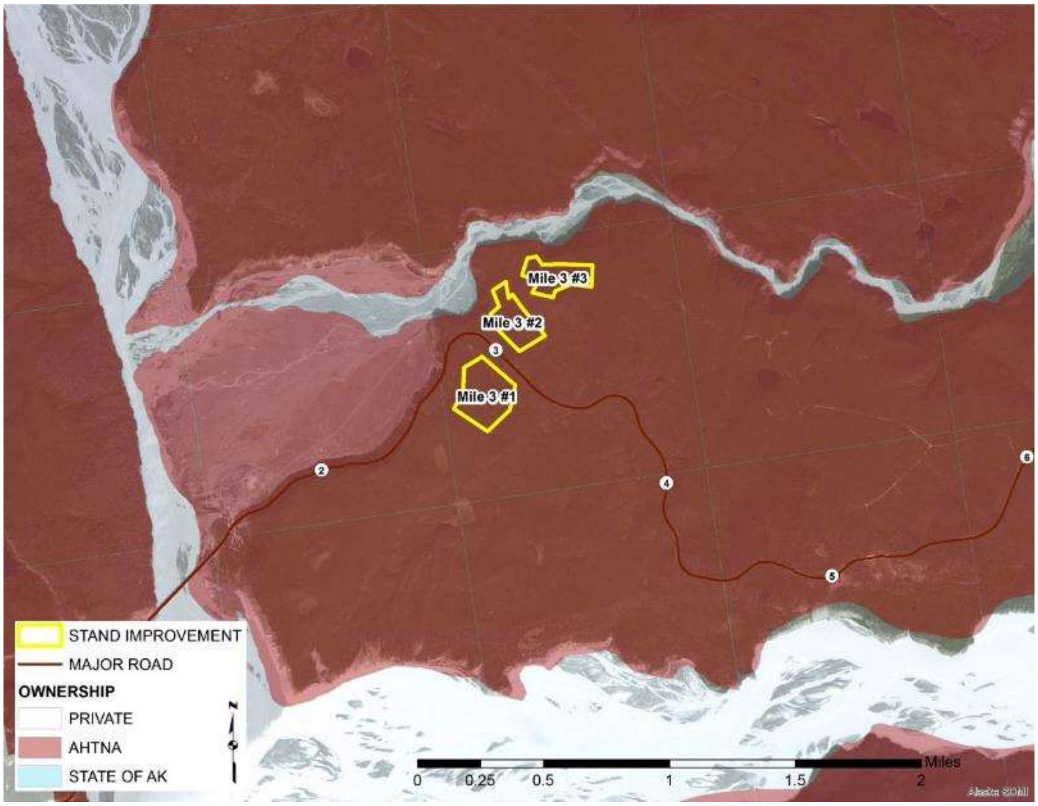


Figure 120. Map of proposed treatment areas (Mile 3 #1,#2, and #3) in the Chitina Village planning region showing surface ownership and aerial imagery.

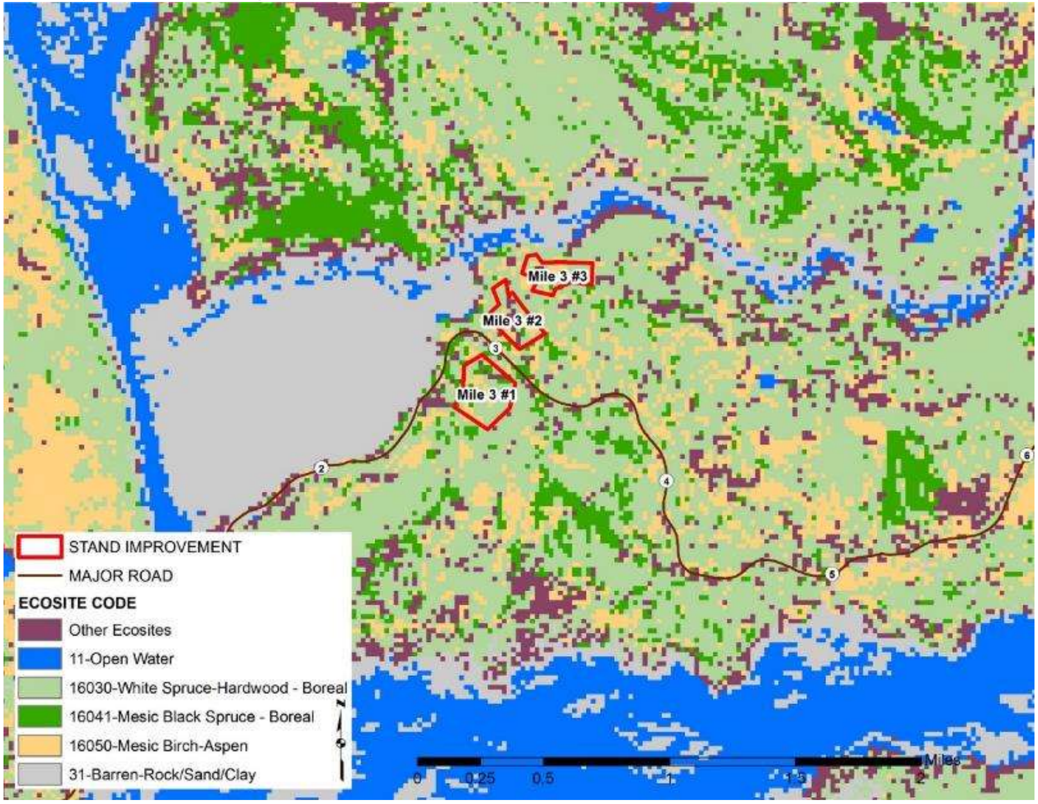


Figure 121. Map of proposed treatment areas (Mile 3 #1,#2, and #3) in the Chitina Village planning region showing ecological sites.

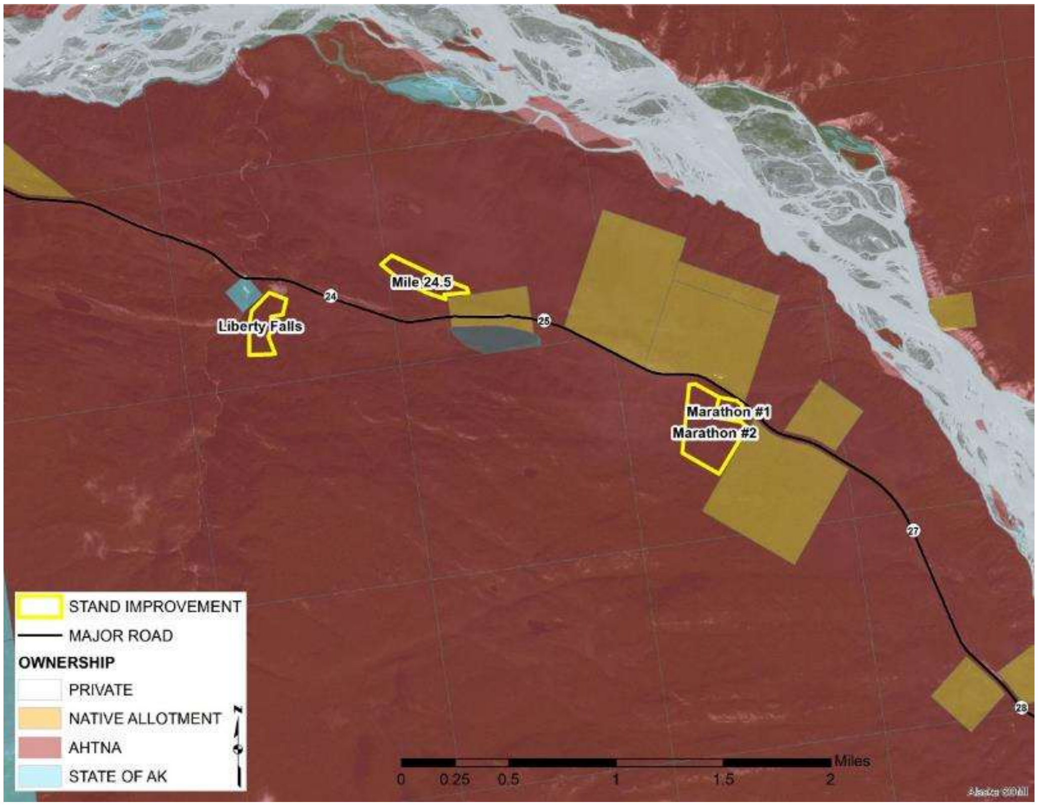


Figure 122. Map of proposed habitat improvement areas (Liberty Falls, Mile 24.5, and Marathon #1 and #2) in the Chitina Village planning region showing surface ownership and aerial imagery.

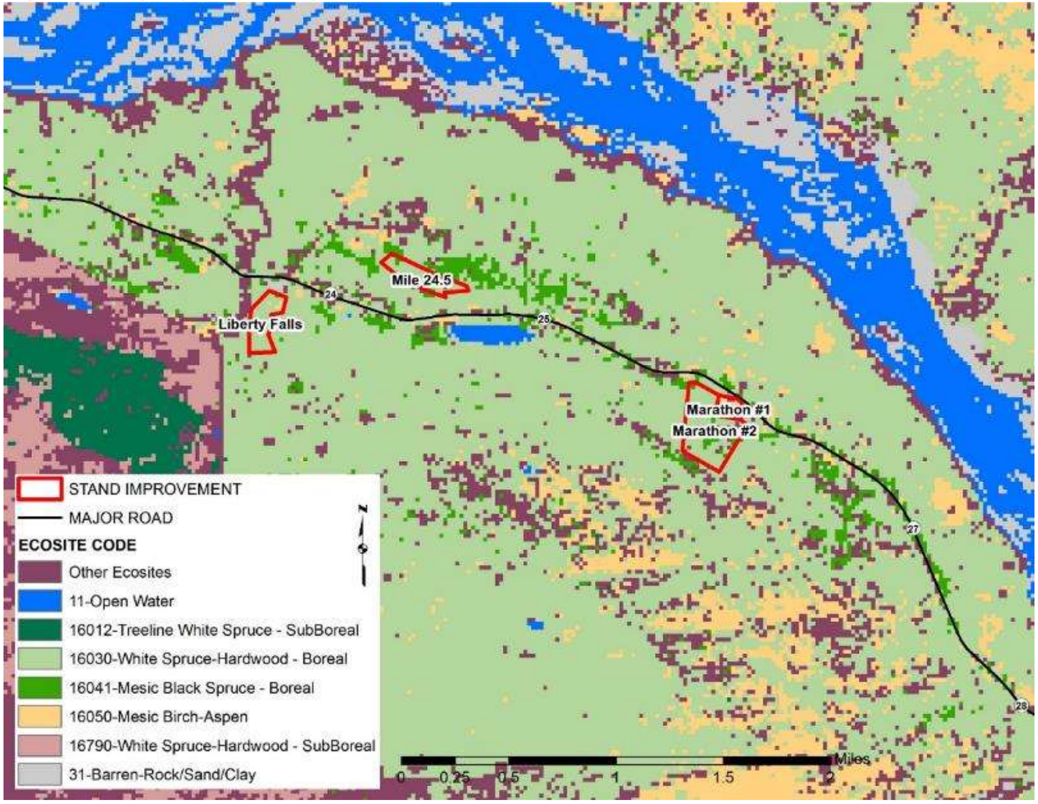


Figure 123. Map of proposed habitat improvement areas (Liberty Falls, Mile 24.5, and Marathon #1 and #2) in the Chitina Village planning region showing ecological sites.

Table 21. Vegetation treatment sites in the Chitina Village planning region and their primary ecosystem type, treatment goal, size (acres), and total biomass (tons).

Treatment Site Name	Ecosystem Code	Primary Treatment Goal	Acres	Biomass (tons)
Liberty Falls	16030_C		19.6	862.6
Mile 24.5	16030_C		19.1	90.7
Marathon #1	16030_C		6.9	2062.3
Marathon #2	16030_C		46.0	865.9
Mile 3 #2	16030_B	Moose Browse	17.8	239.8
Mile 3 #3	16030_B		16.9	253.4
Mile 3 #1	16030_C	Moose Browse	28.1	172.0

Gakona Village Management Plan

The Gakona Village planning region includes an area of 641,274 acres. Figure 124 displays the overall planning area along with associated infrastructure. Ownership of this and the surrounding area is shown in Figure 125. As Figure 125 displays, land ownership patterns are varied in this area with Ahtna owning 42.0% (269,100 acres) of the land.

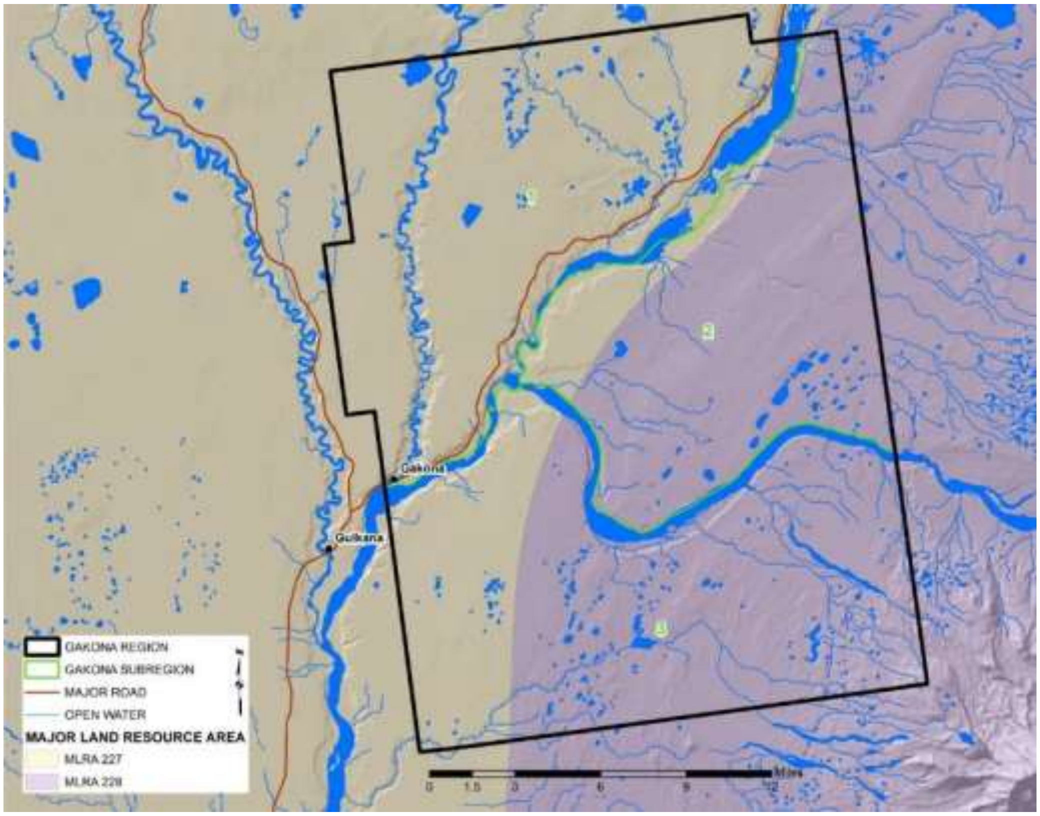


Figure 124. Overview of the Gakona Village planning region.

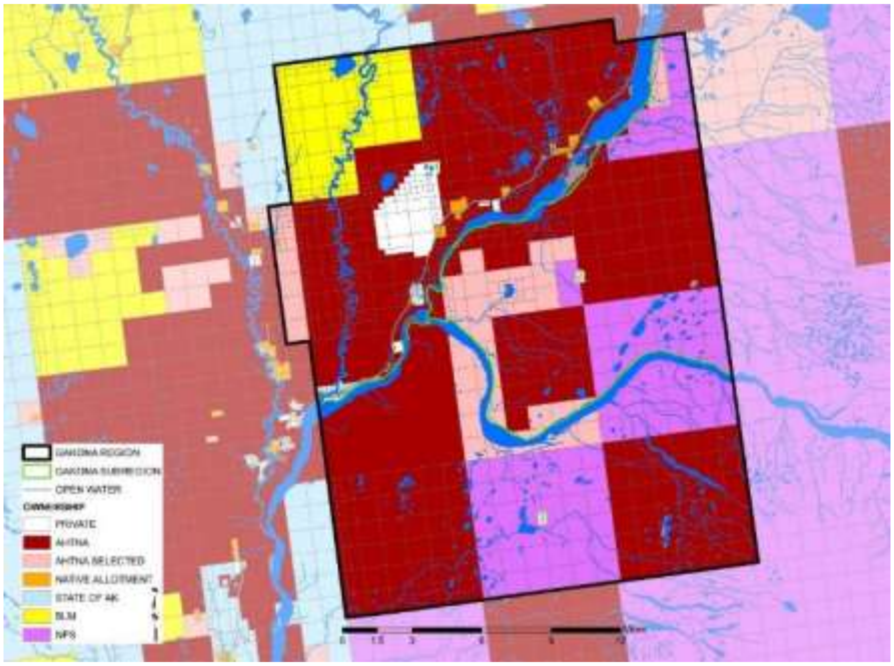


Figure 125. Land ownership patterns in the Gakona Village planning region.

Planning Region Description

A description of the general geology, climate, soils, permafrost, and vegetation is found in Chapter 1 of this report. Figures showing these features specific to the Gakona Village planning region are displayed below. Soil texture in the Gakona area is shown in Figure 126 and Figure 127 displays soil drainages. Permafrost in the Gakona area is shown in Figure 128.

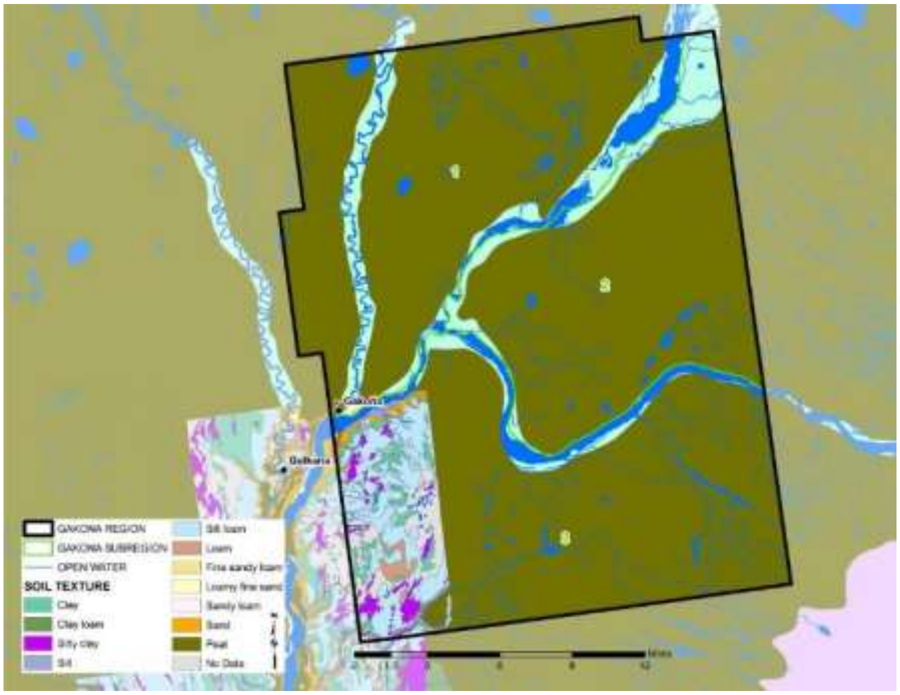


Figure 126. Soil texture in the Gakona Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska

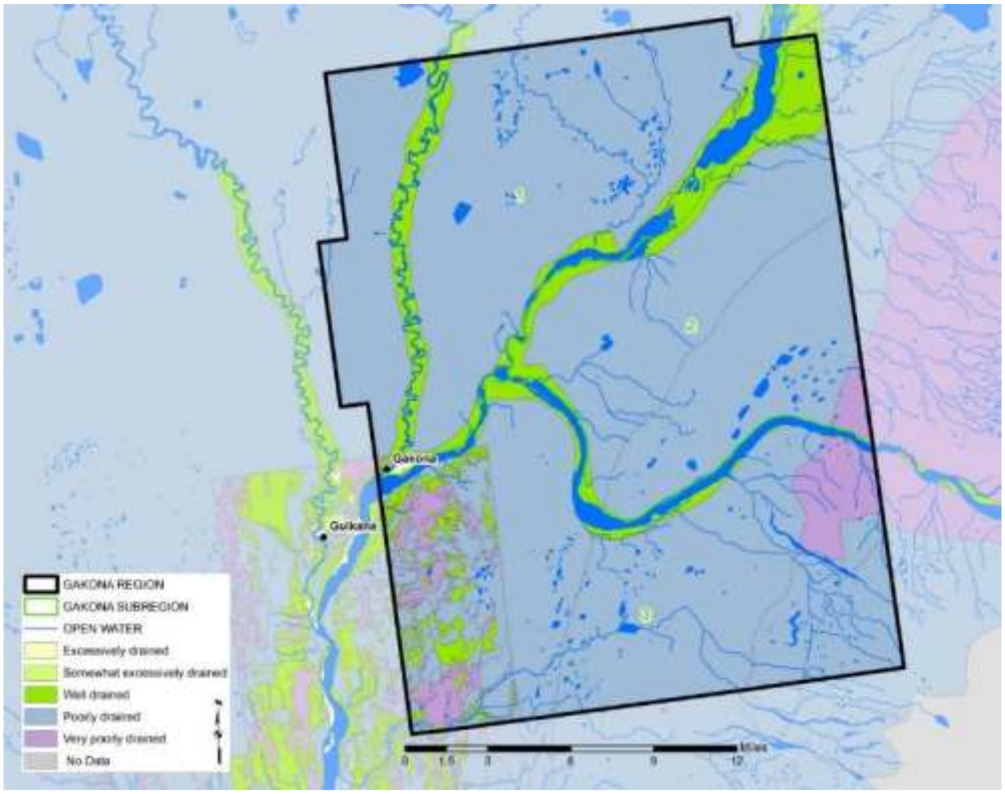


Figure 127. Soil drainage in the Gakona Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

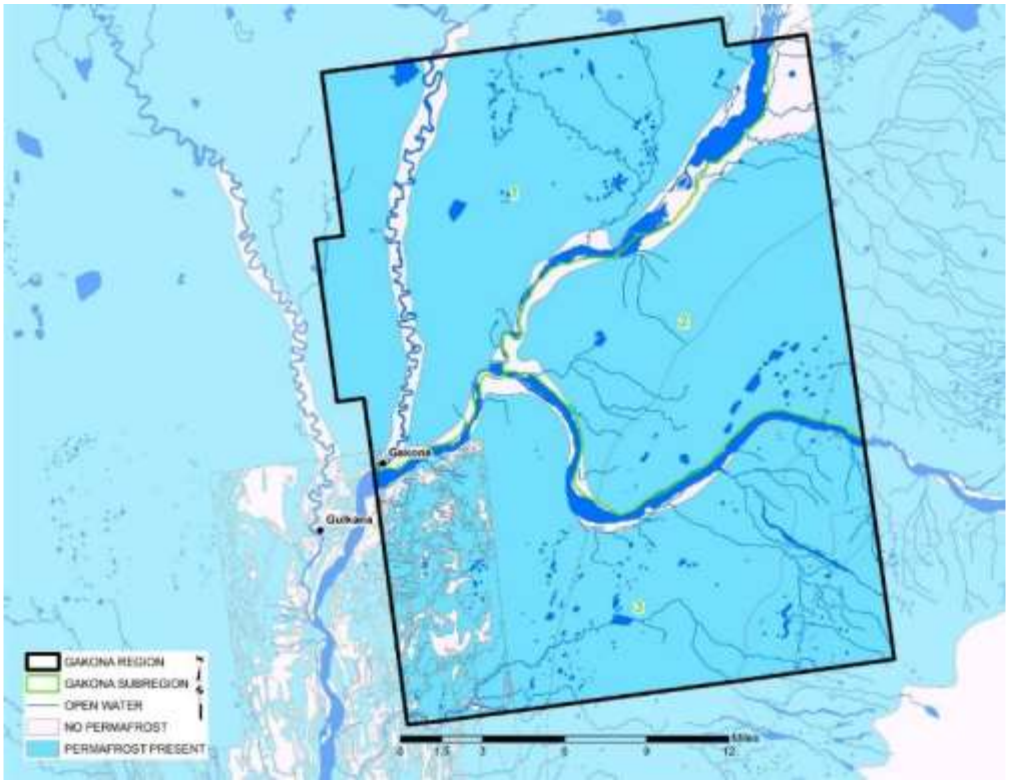


Figure 128. Permafrost in the Gakona Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

Fire is the primary disturbance factor influencing the vegetation ecology in the Copper River Basin. Figure 129 shows the fire history of the Gakona area along with current fire protection zones. Although the level of fire occurring in this southcentral Alaska landscape is substantially less than that occurring in more interior areas of Alaska north of the Alaska Range, fire is still a significant disturbance when it occurs. However, there has not been a large fire in the project area since 1947. When fire does occur it serves to set back succession. It can also burn off the organic material at the ground surface, including peat that can occur on many sites. This can influence the thermal layer protecting the underlying permafrost on some sites, causing the permafrost to melt (thermokarst) and changing the site conditions through this process. Riparian areas are also influenced by flooding and ice events. These serve to set back succession of vegetation in riparian areas, and can even shift site conditions, particularly in the case of significant flooding events.

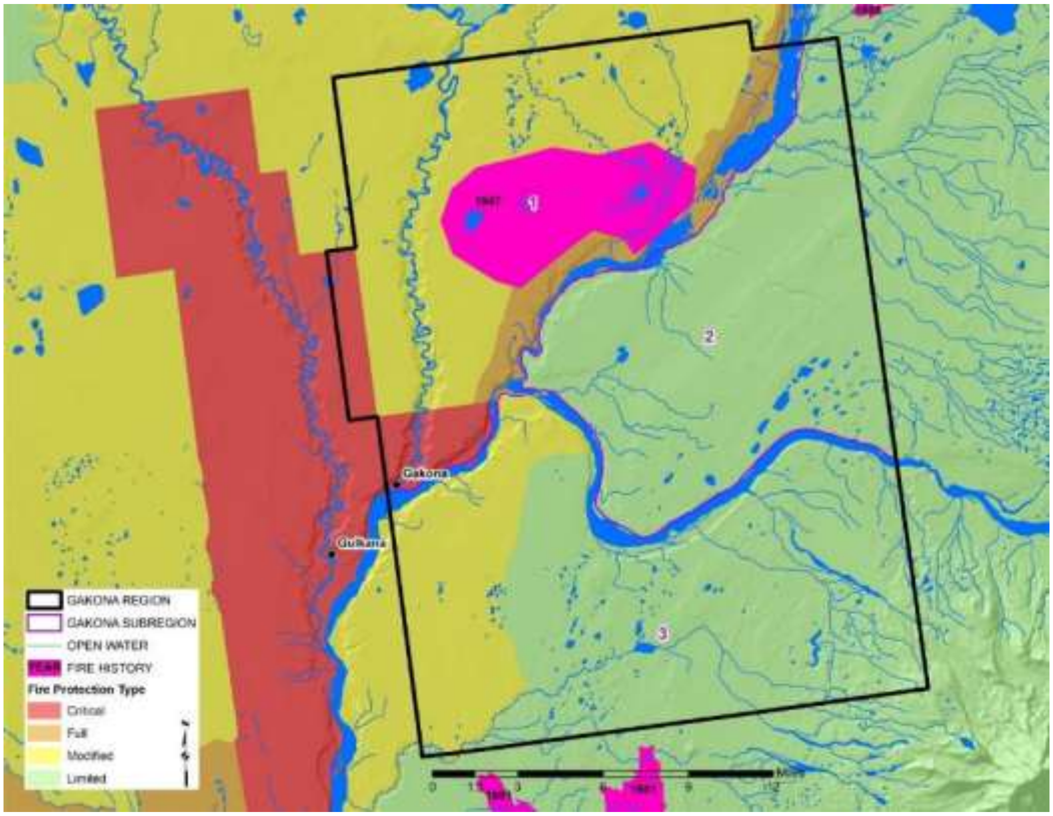


Figure 129. Current fire protection classes and fire history since 1940 in the Gakona Village planning region. Data from Alaska Interagency Coordination Center.

Landscape Assessment Results

Ecosystem Diversity

The ecological sites present within the Gakona Village planning region are displayed in Figure 130. Table 22 displays the acres for each ecological site setting and disturbance class. Figure 131 is a map of ecosystem diversity (represented by ecological site setting and disturbance class) in the Gakona Village planning region.

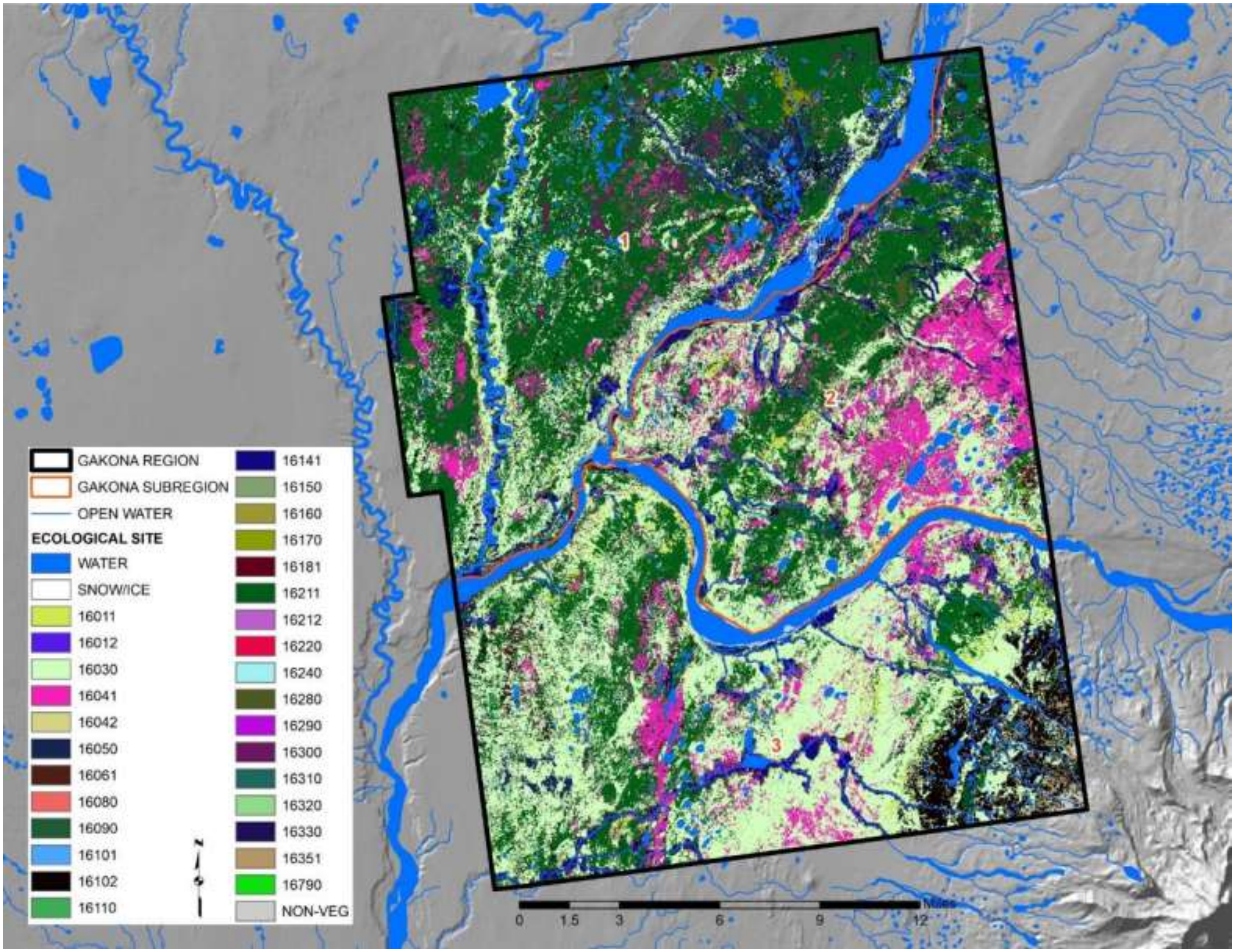


Figure 130. Ecological sites in the Gakona Village planning region. Data from LANDFIRE.

Table 22. Ecosystems mapped in the Gakona Village planning region and their associated acres. The ecological site vegetation label is provided as reference.

Ecosystem Code	Ecological Site Label	Acres
11	Open Water	6267.8
12	Perrennial Ice-Snow	39.6
16011_A	Treeline White Spruce-Boreal	554.7
16011_B	Treeline White Spruce-Boreal	3570.8
16011_C	Treeline White Spruce-Boreal	0.7
16012_A	Treeline White Spruce-SubBoreal	7.8
16012_B	Treeline White Spruce-SubBoreal	10.2
16030_A	White Spruce-Hardwood-Boreal	3060.4
16030_B	White Spruce-Hardwood-Boreal	9997.1
16030_C	White Spruce-Hardwood-Boreal	72372.9
16030_E	White Spruce-Hardwood-Boreal	73.6
16041_A	Mesic Black Spruce-Boreal	1065.5
16041_B	Mesic Black Spruce-Boreal	2198.8
16041_C	Mesic Black Spruce-Boreal	937.6
16041_D	Mesic Black Spruce-Boreal	23704.6
16041_E	Mesic Black Spruce-Boreal	6.0
16042_A	Mesic Black Spruce-SubBoreal	0.4
16042_B	Mesic Black Spruce-SubBoreal	5.3
16042_C	Mesic Black Spruce-SubBoreal	0.9
16050_A	Mesic Birch-Aspen	9714.0
16050_B	Mesic Birch-Aspen	1659.5
16050_D	Mesic Birch-Aspen	10.2
16050_E	Mesic Birch-Aspen	15.1
16061_A	Dry Aspen-Steppe Bluff	46.7
16061_B	Dry Aspen-Steppe Bluff	222.0
16061_C	Dry Aspen-Steppe Bluff	160.3
16061_D	Dry Aspen-Steppe Bluff	844.0
16080_A	Avalanche Slope Shrubland	4.9
16080_B	Avalanche Slope Shrubland	21.3
16090_A	Mesic Subalpine Alder	108.5
16090_B	Mesic Subalpine Alder	203.7
16102_A	Mesic Scrub Birch-Willow	4214.8
16102_B	Mesic Scrub Birch-Willow	7426.2
16110_A	Mesic Bluejoint Meadow	270.4
16110_B	Mesic Bluejoint Meadow	1.3
16141_A	Montane Floodplain-Boreal	803.7
16141_B	Montane Floodplain-Boreal	1539.2
16141_C	Montane Floodplain-Boreal	608.7
16141_D	Montane Floodplain-Boreal	10135.7
16141_E	Montane Floodplain-Boreal	459.2
16150_A	Large River Floodplain	381.0
16150_B	Large River Floodplain	40.9
16150_C	Large River Floodplain	113.4
16150_D	Large River Floodplain	4.225505
16150_E	Large River Floodplain	0.4
16160_A	Riparian Stringer	13.1
16160_C	Riparian Stringer	0.7
16170_A	Shrub and Herbaceous Floodplain	846.7
16170_B	Shrub and Herbaceous Floodplain	61.8
16170_C	Shrub and Herbaceous Floodplain	4.0
16170_D	Shrub and Herbaceous Floodplain	17.3
16170_E	Shrub and Herbaceous Floodplain	307.8
16181_A	Herbaceous Fen	25.1
16181_B	Herbaceous Fen	3.3
16181_C	Herbaceous Fen	0.4
16181_D	Herbaceous Fen	13.8
16211_A	Dwarf Black Spruce Peatland-Boreal	3723.8
16211_B	Dwarf Black Spruce Peatland-Boreal	3661.1
16211_C	Dwarf Black Spruce Peatland-Boreal	8313.8
16211_D	Dwarf Black Spruce Peatland-Boreal	77256.0
16212_A	Dwarf Black Spruce Peatland-Subboreal	0.4
16212_B	Dwarf Black Spruce Peatland-Subboreal	2.0
16212_C	Dwarf Black Spruce Peatland-Subboreal	2.7
16220_A	Black Spruce Wet-Mesic Slope	53.8
16220_B	Black Spruce Wet-Mesic Slope	19.8
16220_C	Black Spruce Wet-Mesic Slope	12.7
16220_D	Black Spruce Wet-Mesic Slope	269.5
16240_A	Deciduous Shrub Swamp	351.6
16240_B	Deciduous Shrub Swamp	14.0
16280_A	Low Shrub-Tussock Tundra	4927.8
16280_B	Low Shrub-Tussock Tundra	1065.9
16280_C	Low Shrub-Tussock Tundra	116.8
16290_A	Tussock Tundra	23.8
16290_B	Tussock Tundra	18.9
16300_A	Wet Black Spruce-Tussock	250.2
16300_B	Wet Black Spruce-Tussock	870.7
16300_C	Wet Black Spruce-Tussock	1518.3
16310_A	Alpine Dwarf-Shrub Summit	34.9
16320_A	Alpine Talus and Bedrock	1140.4
16320_B	Alpine Talus and Bedrock	32.7
16330_A	Alpine Mesic Herbaceous Meadow	14.0
16330_B	Alpine Mesic Herbaceous Meadow	1.1
16351_A	Alpine Ericaceous Dwarf-Shrubland	878.9
16351_B	Alpine Ericaceous Dwarf-Shrubland	23.8
16790_A	White Spruce-Hardwood-SubBoreal	5.1
16790_B	White Spruce-Hardwood-SubBoreal	5.8
31	Barren-Rock-Sand-Clay	8564.4

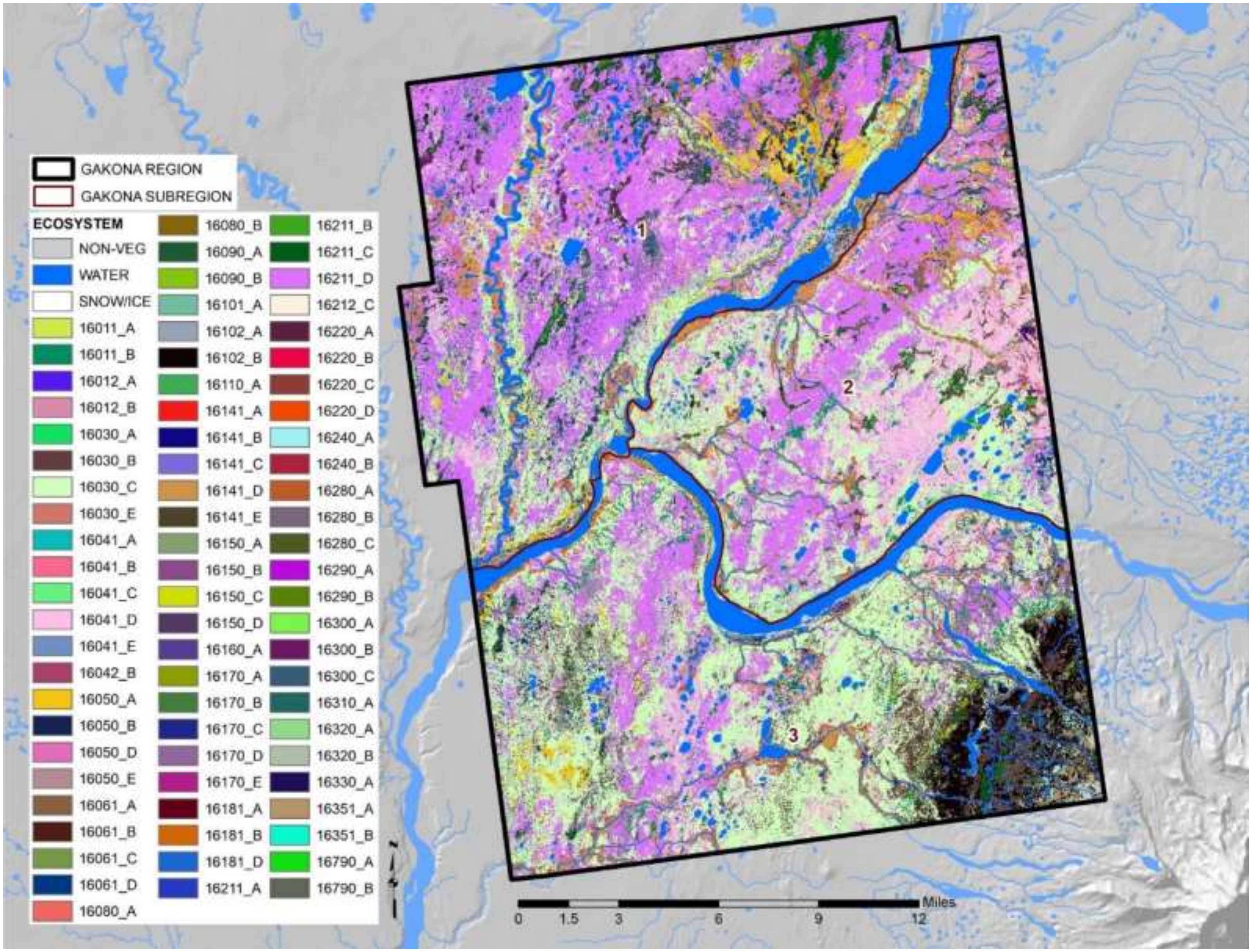


Figure 131. Ecosystem diversity in the Gakona Village planning region. See Appendix A for ecosystem code definitions.

Berry Production Areas

Figure 132 shows the areas identified with the highest potential for berry production. It may be desirable to avoid disturbances to these areas, but verifying the actual presence of good berry production is recommended on a site by site basis.

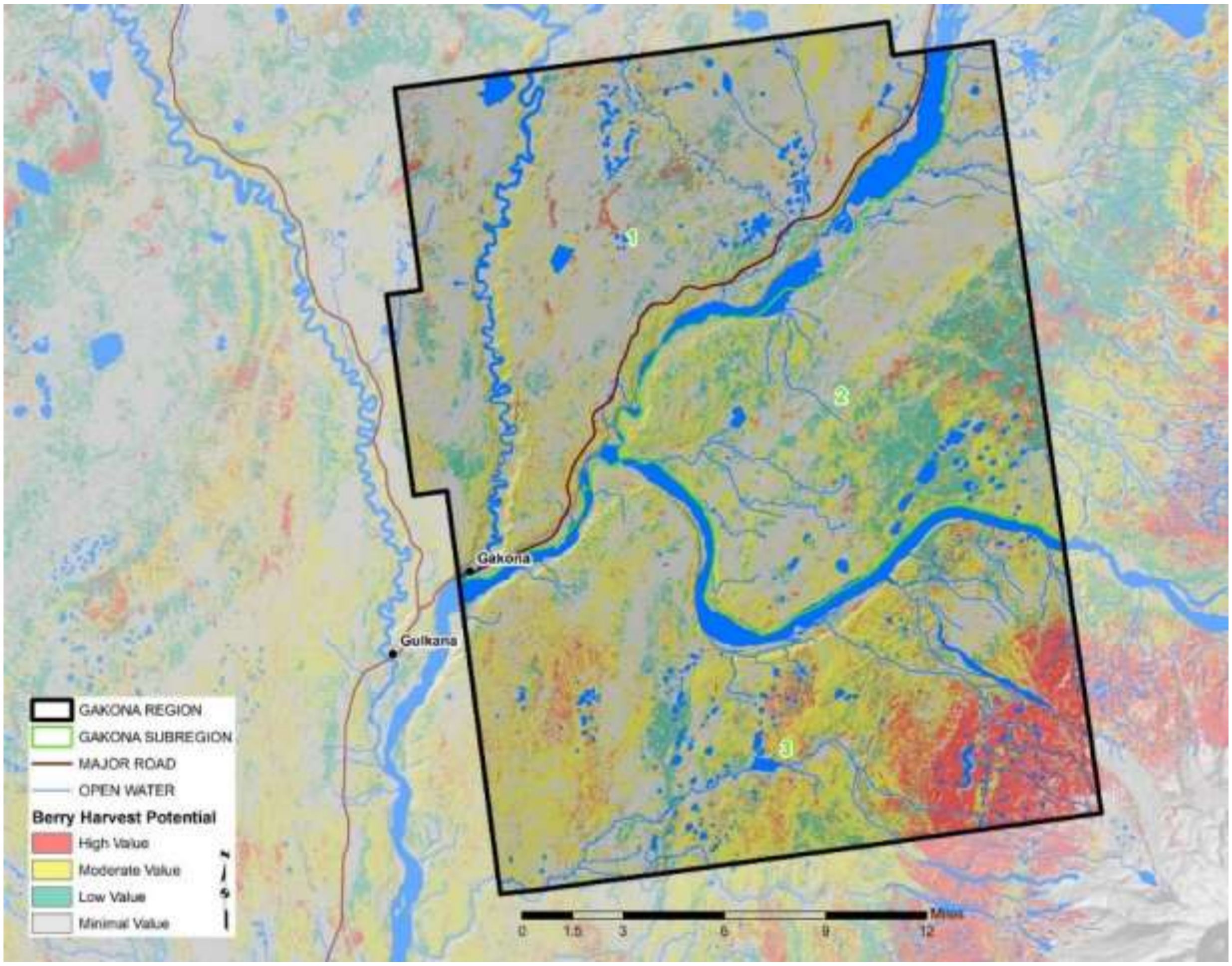


Figure 132. Potential berry production values in the Gakona Village planning region

Moose and Caribou Habitat Quality Assessment - Model Results

Moose

Ecosystem-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 133 to 135. Landscape-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 136 to 138. A complete description of the moose habitat quality models can be found in Appendix B.

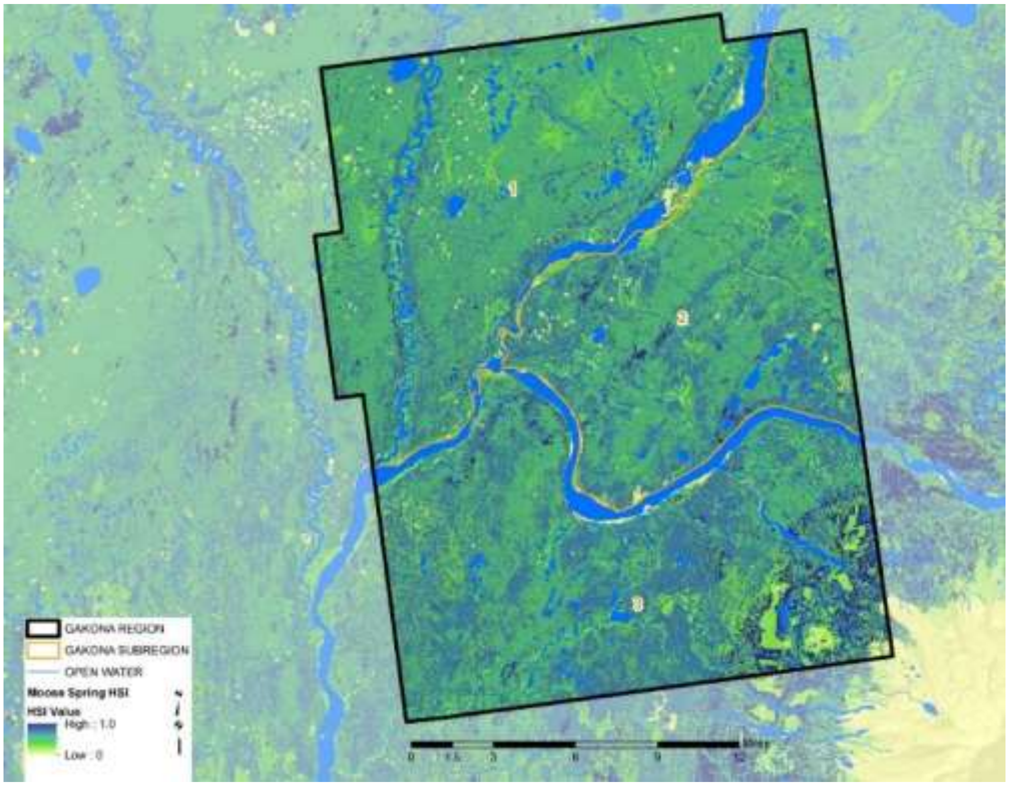


Figure 133. Results of the ecosystem-scale model outputs for moose spring habitat quality.

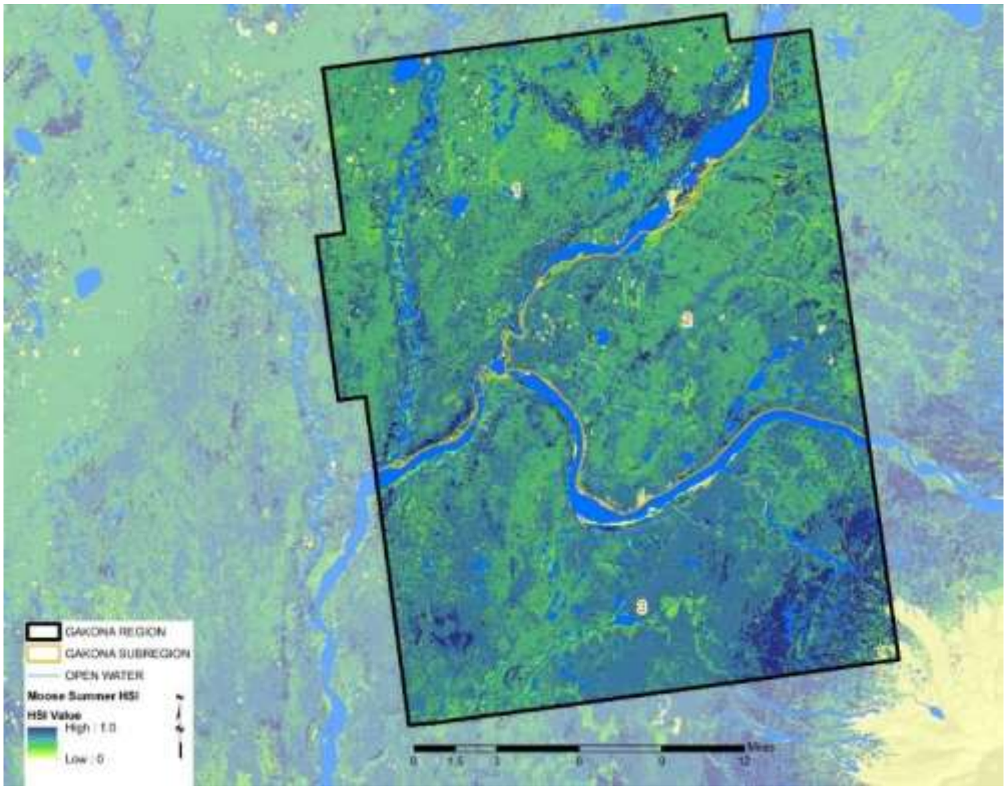


Figure 134. Results of the ecosystem-scale model outputs for moose summer habitat quality.

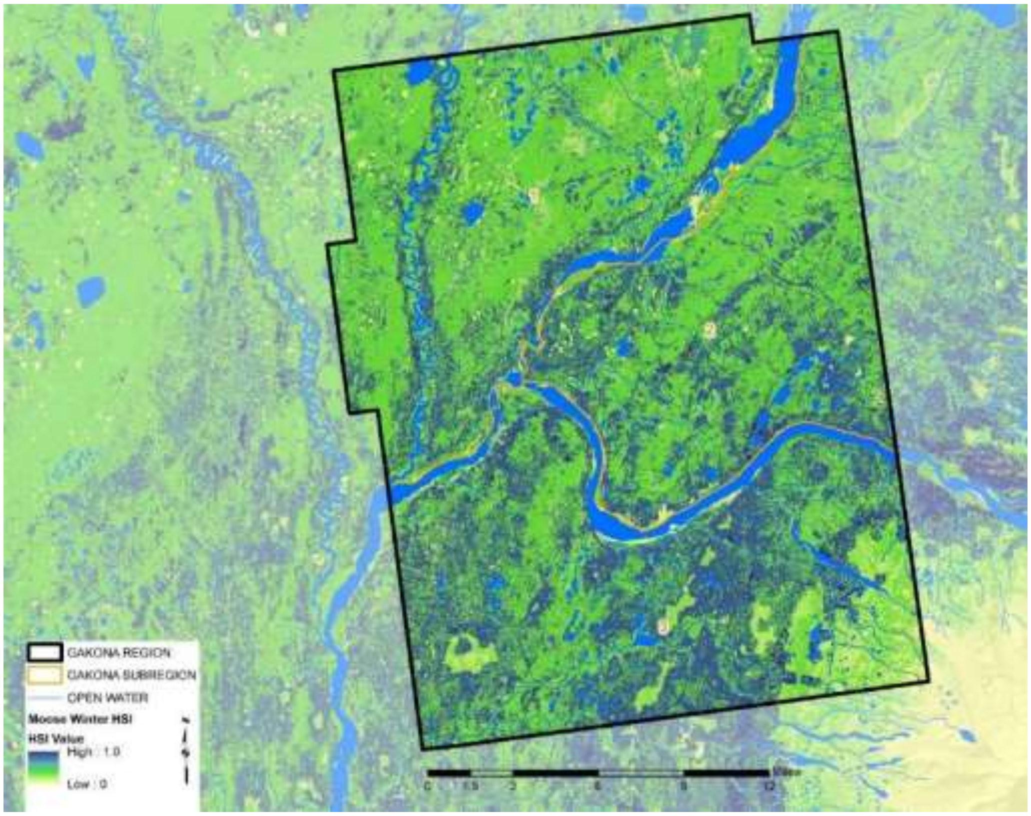


Figure 135. Results of the ecosystem-scale model outputs for moose winter habitat quality.

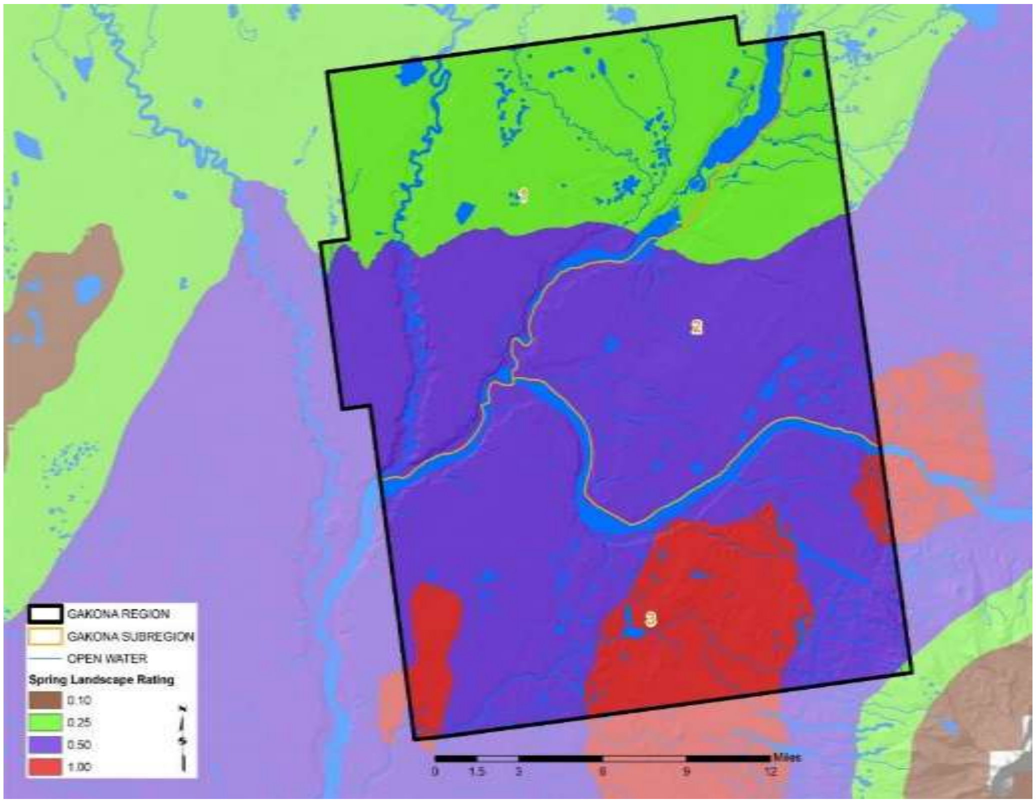


Figure 136. Results of the landscape-scale model outputs for moose spring habitat quality.

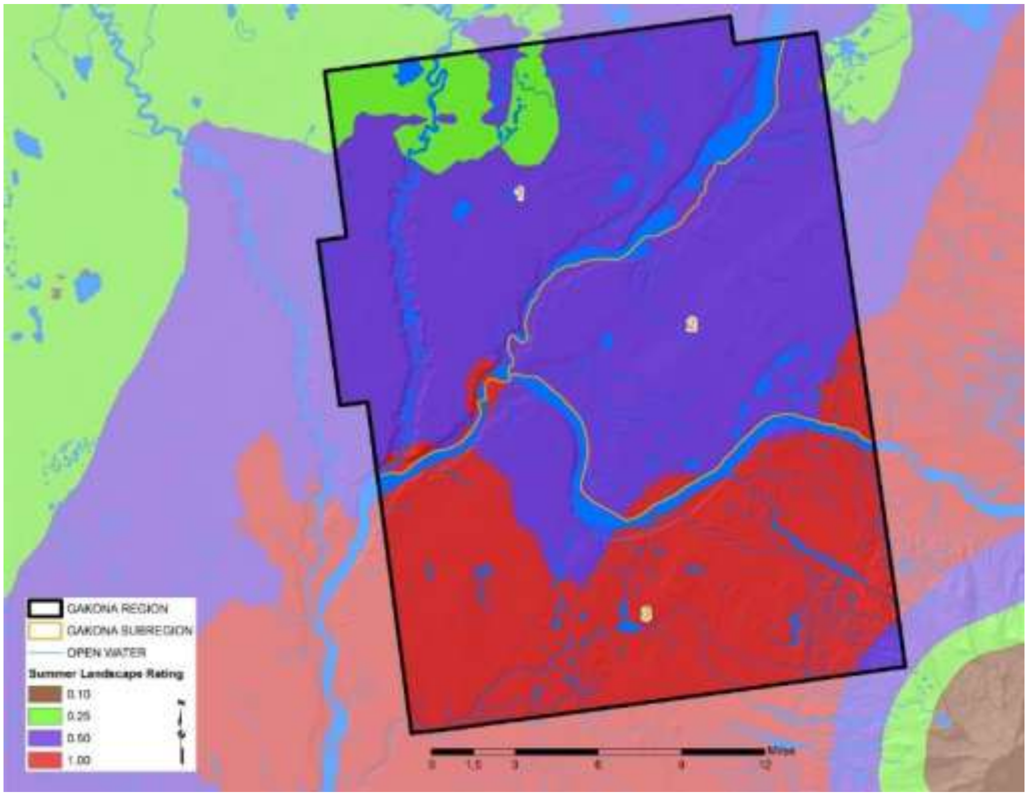


Figure 137. Results of the landscape-scale model outputs for moose summer habitat quality.

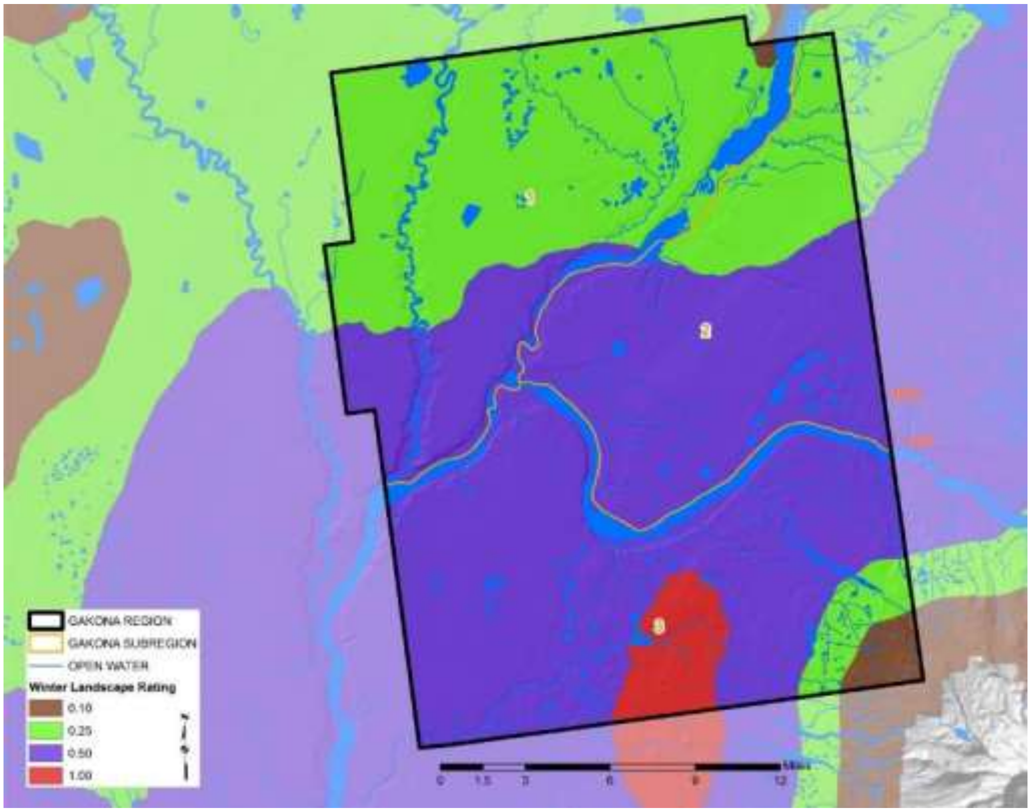


Figure 138. Results of the landscape-scale model outputs for moose winter habitat quality.

Caribou

Ecosystem-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 139 and 140. Landscape-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 141 and 142. A complete description of the caribou habitat quality models can be found in Appendix C.

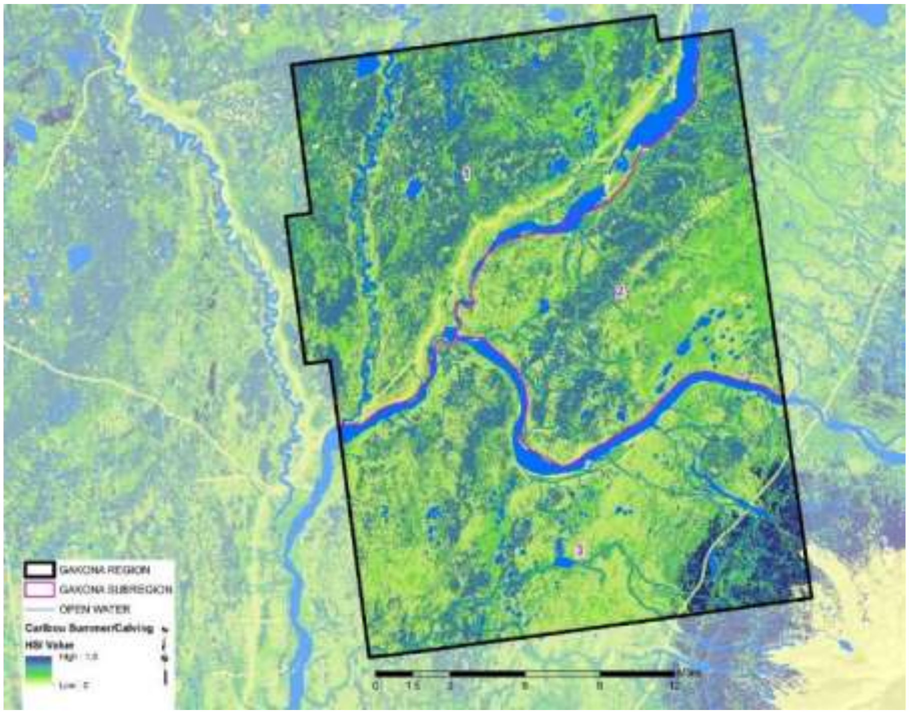


Figure 139. Results of the ecosystem-scale model outputs for caribou summer/calving habitat quality.

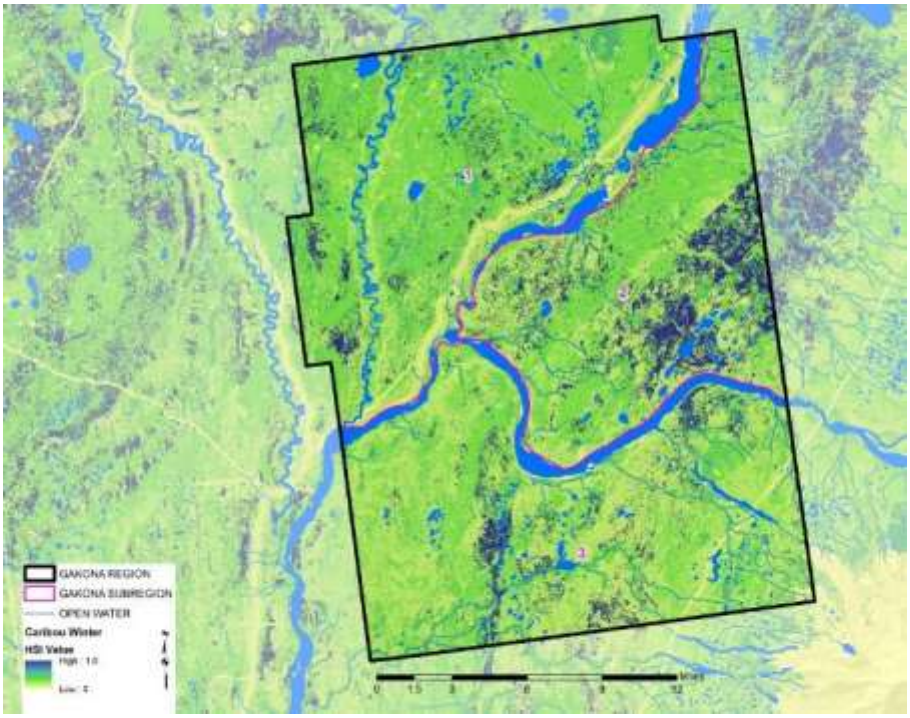


Figure 140. Results of the ecosystem-scale model outputs for caribou winter habitat quality.

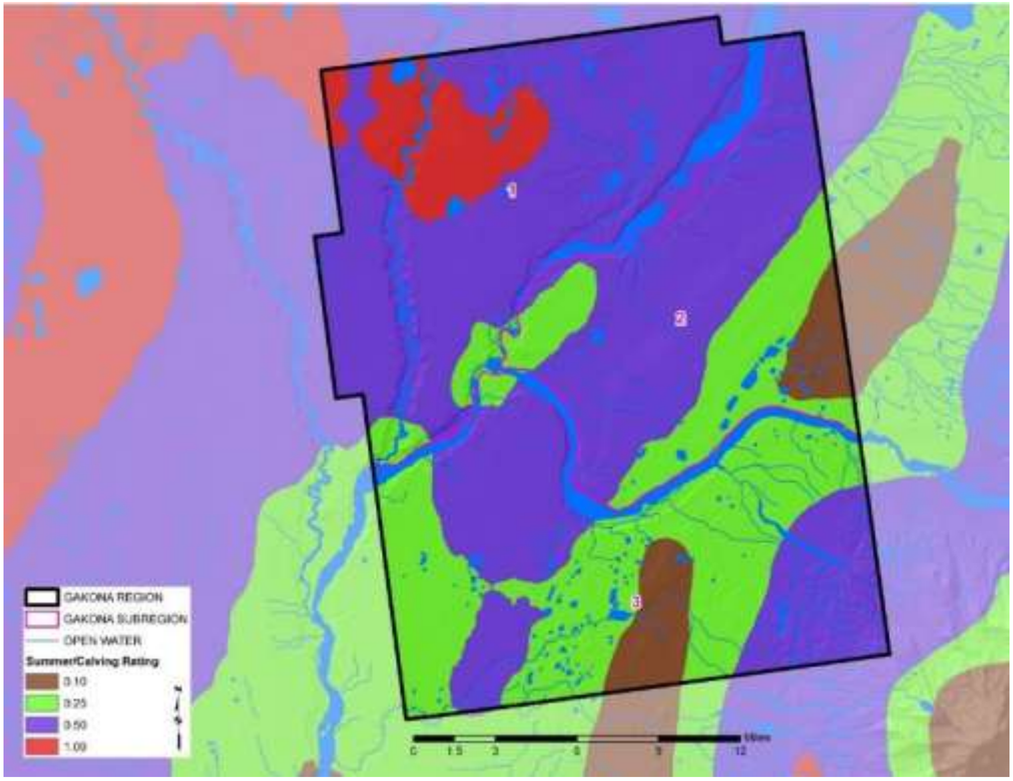


Figure 141. Results of the landscape-scale model outputs for caribou summer/calving habitat quality.

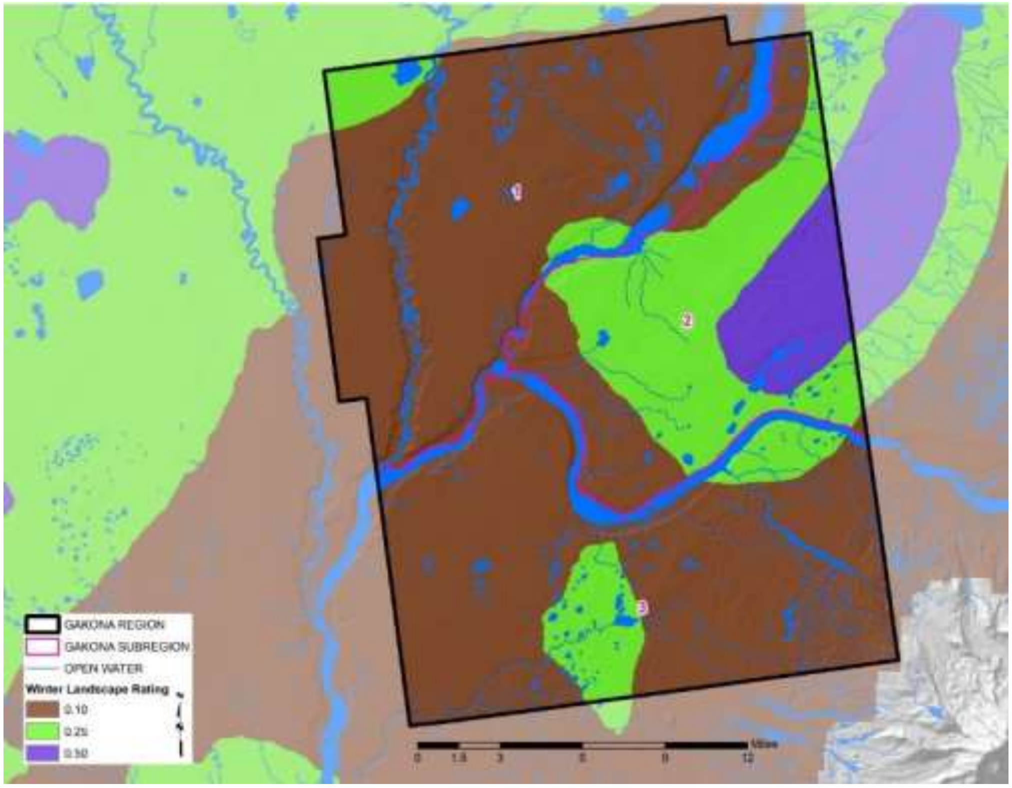


Figure 142. Results of the landscape-scale model outputs for caribou winter habitat quality.

Gakona Site Vegetation Treatment Sites

Potential treatment sites identified in the Gakona area are displayed in figure 143. Based on all of the stated criteria, a number of sites were located for designated treatments. Figures 144-149 depict the locations of these areas. Appendix C provides a description of each of these sites. Sites ranging from approximately 9-39 acres in size were identified and are listed in Table 23. This table gives the site size and the treatment goal of primarily timber stand improvement and biomass production or moose browse enhancement. The table also displays an estimate of the total biomass of all standing above ground biomass. This estimate is not tonnage of usable biomass for energy but the total of all stems regardless of size. However, stands on the higher end of the total amount will typically have larger trees and are a candidate for biomass energy production.

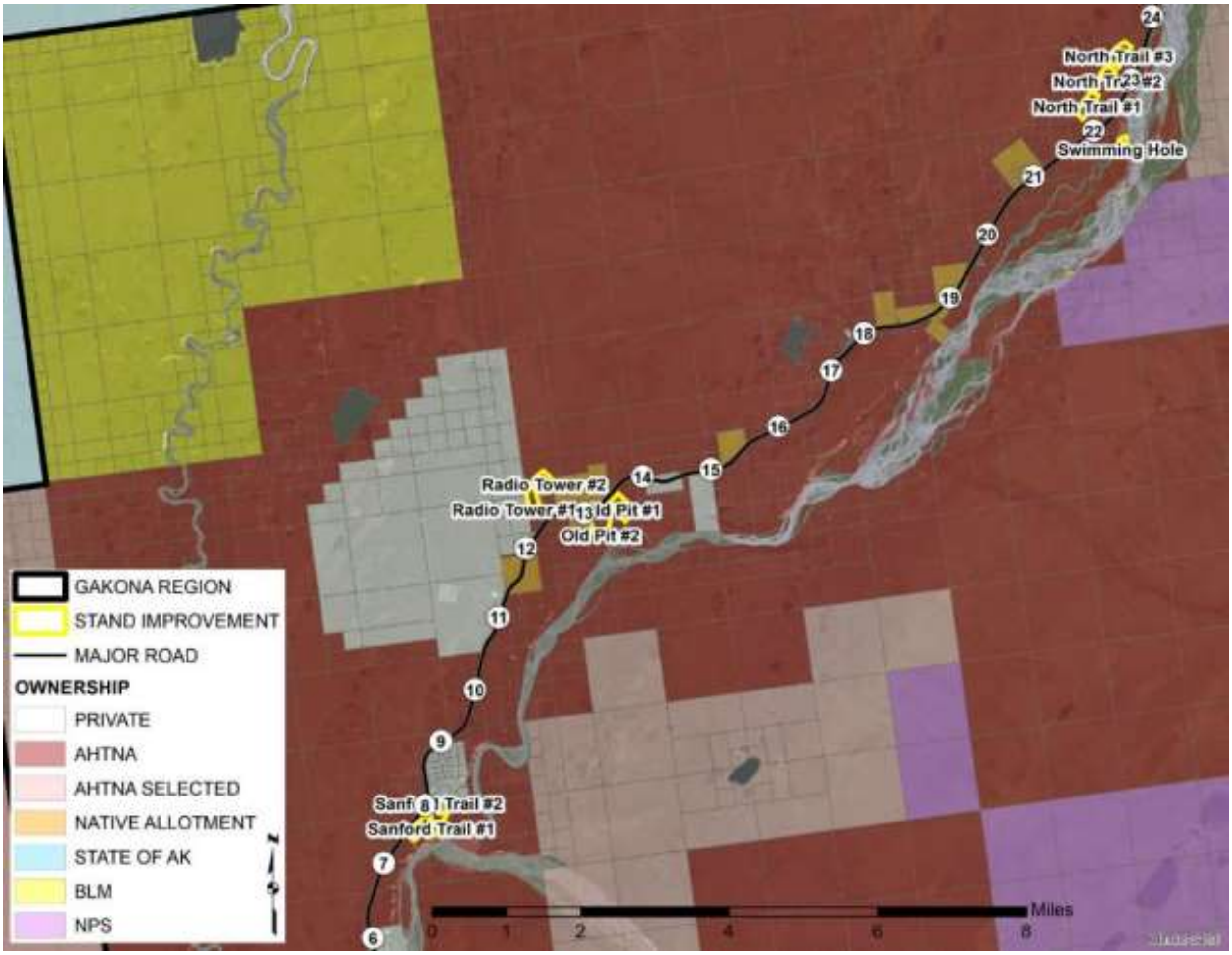


Figure 143. Overview of recommended treatment sites in the Gakona Village planning region.

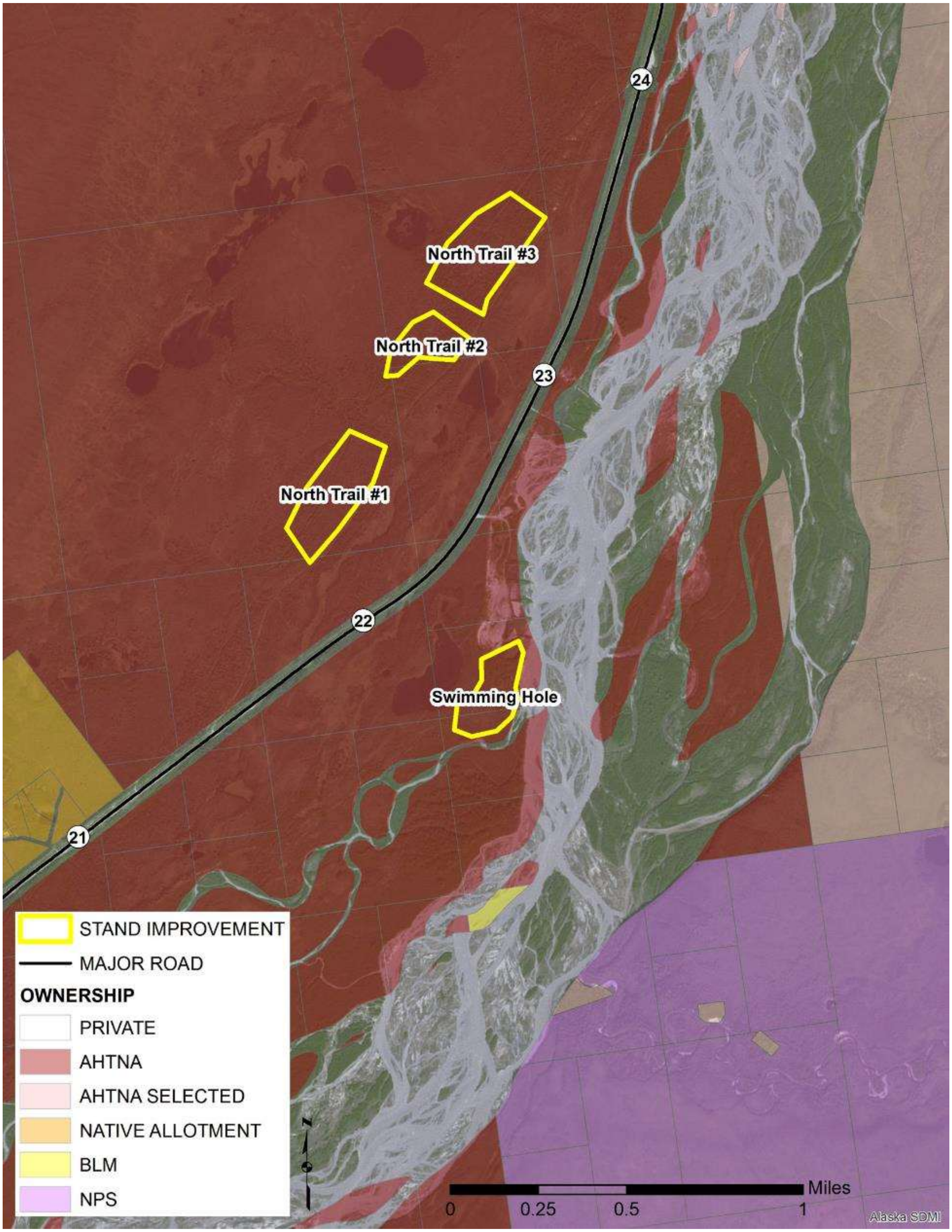


Figure 144. Map of proposed treatment areas (Swimming Hole and North Trail #1,#2, and #3) in the Gakona Village planning region showing surface ownership and aerial imagery.

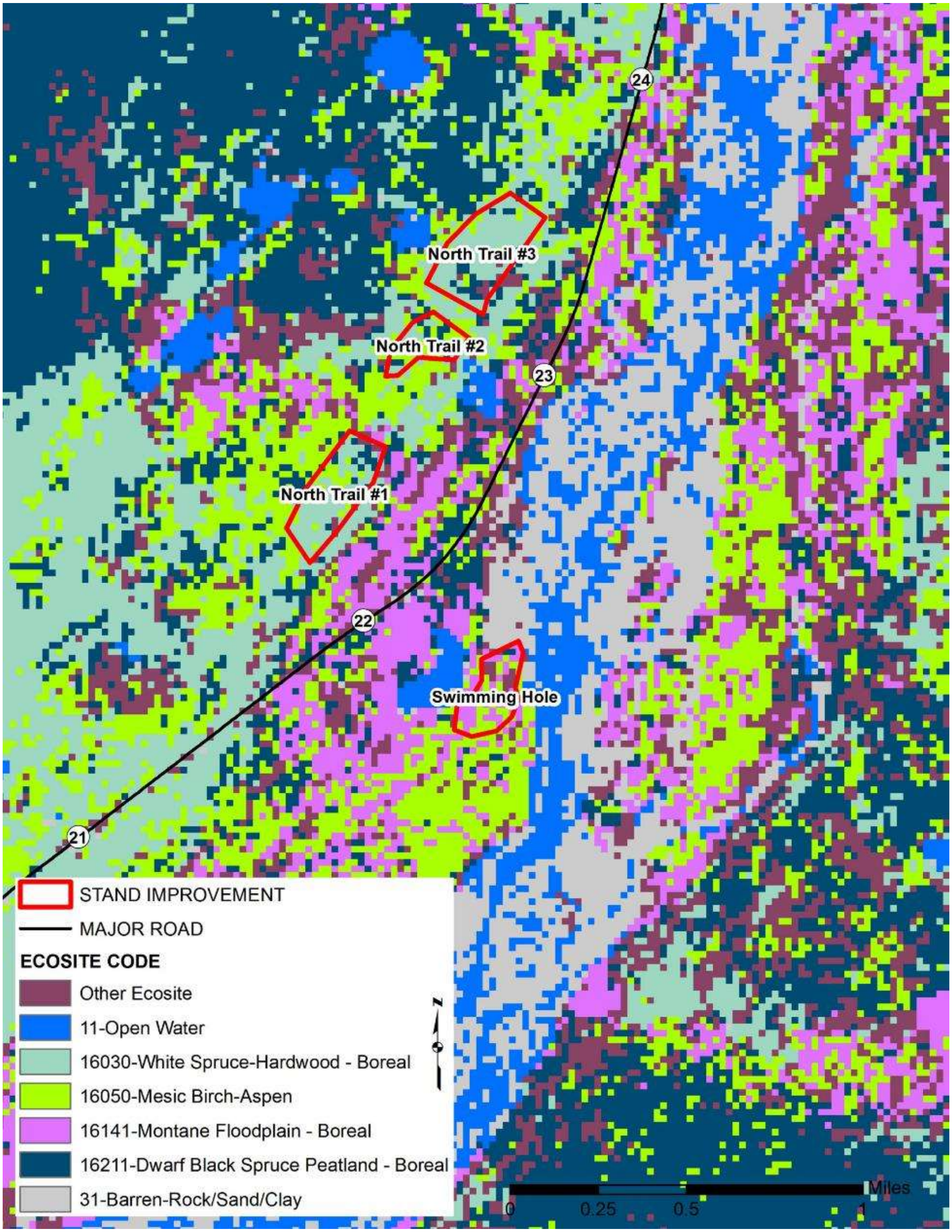


Figure 145. Map of proposed treatment areas (Swimming Hole and North Trail #1,#2, and #3) in the Gakona Village planning region showing ecological sites.

Figure 146. Map of proposed habitat improvement areas (Radio Tower #1 and #2 and Old Pit #1 and #2) in the Gakona Village planning region showing surface ownership and aerial imagery.

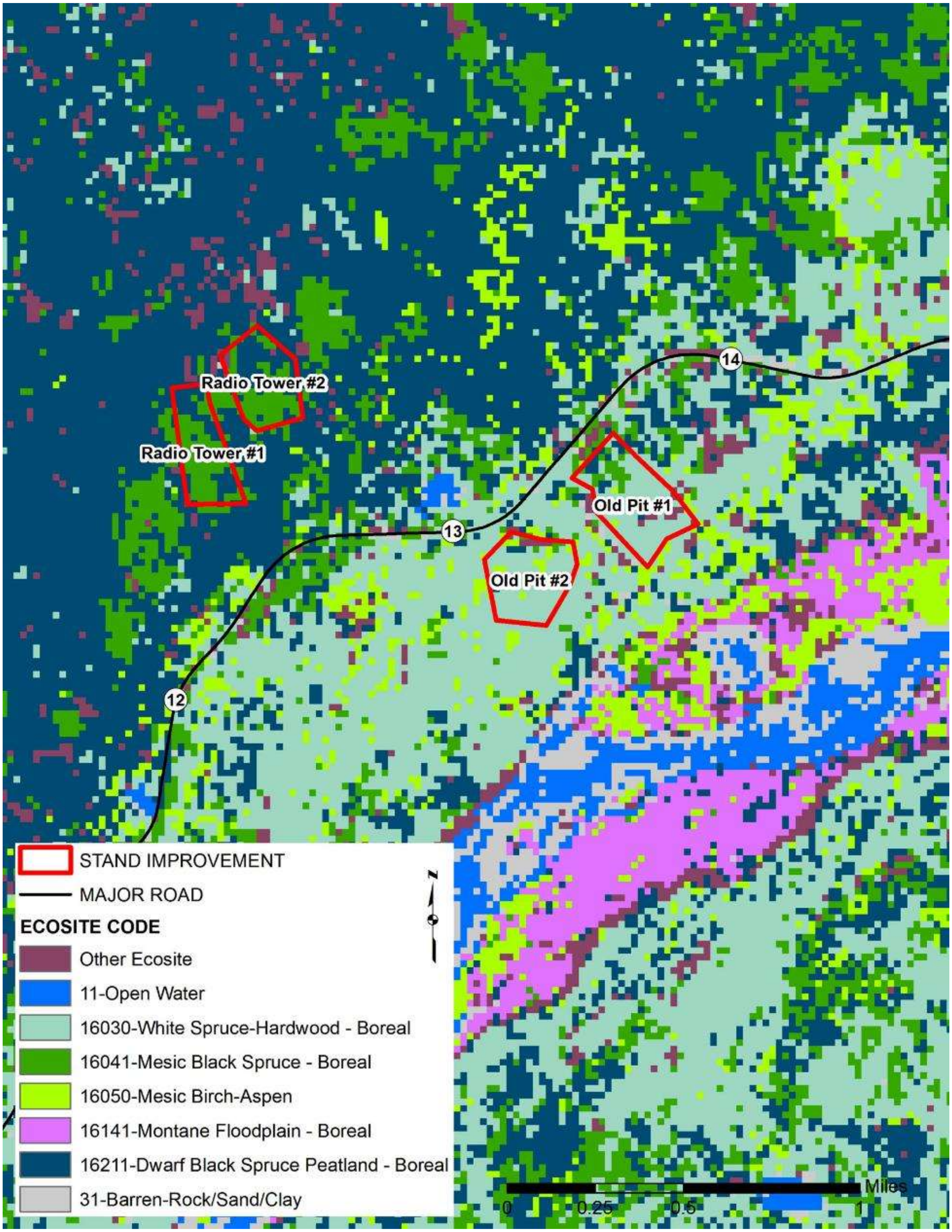


Figure 147. Map of proposed habitat improvement areas (Radio Tower #1 and #2 and Old Pit #1 and #2) in the Gakona Village planning region showing ecological sites.

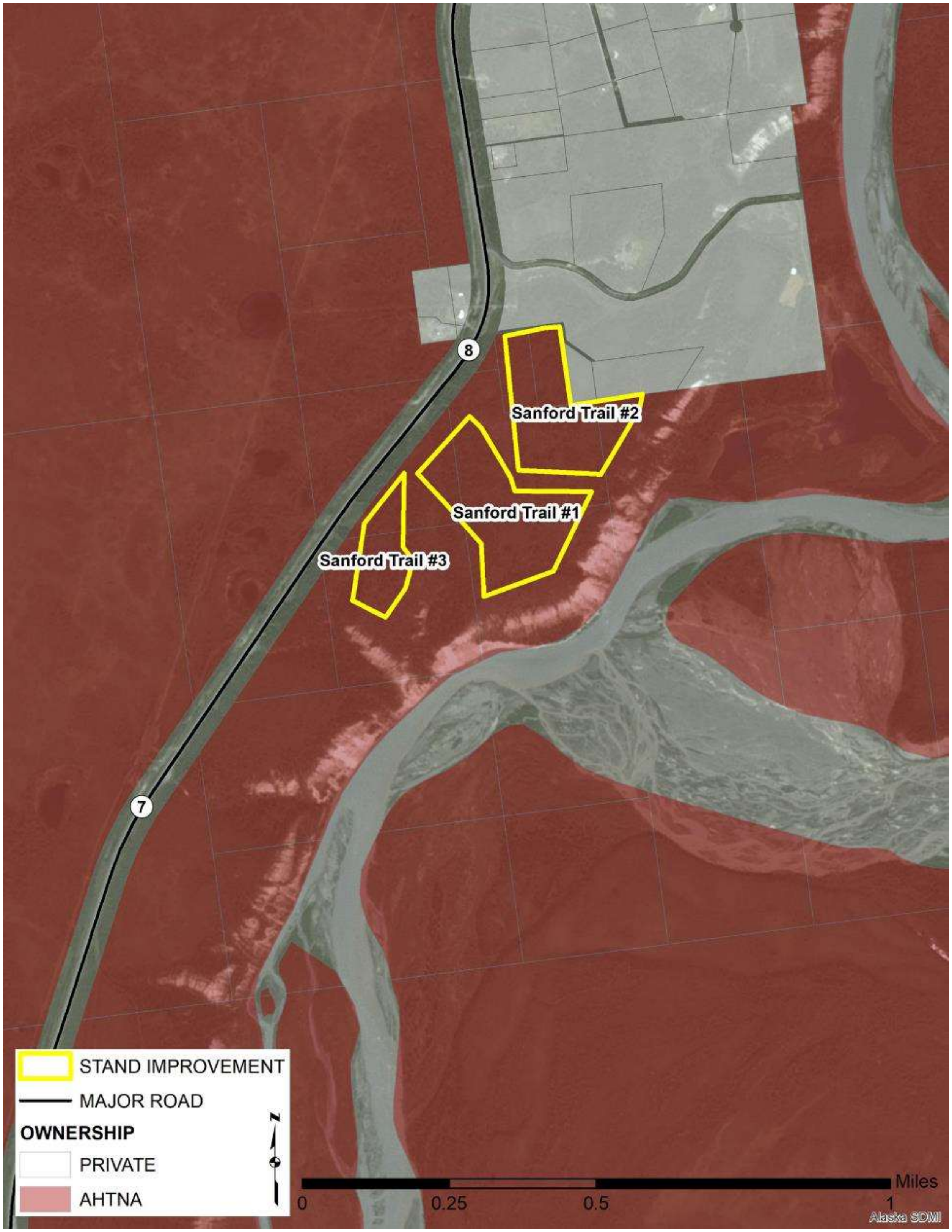


Figure 148. Map of proposed habitat improvement areas (Sanford Trail #1, #2, and #3) and proposed PLOD in the Gakona Village planning region showing surface ownership and aerial imagery.

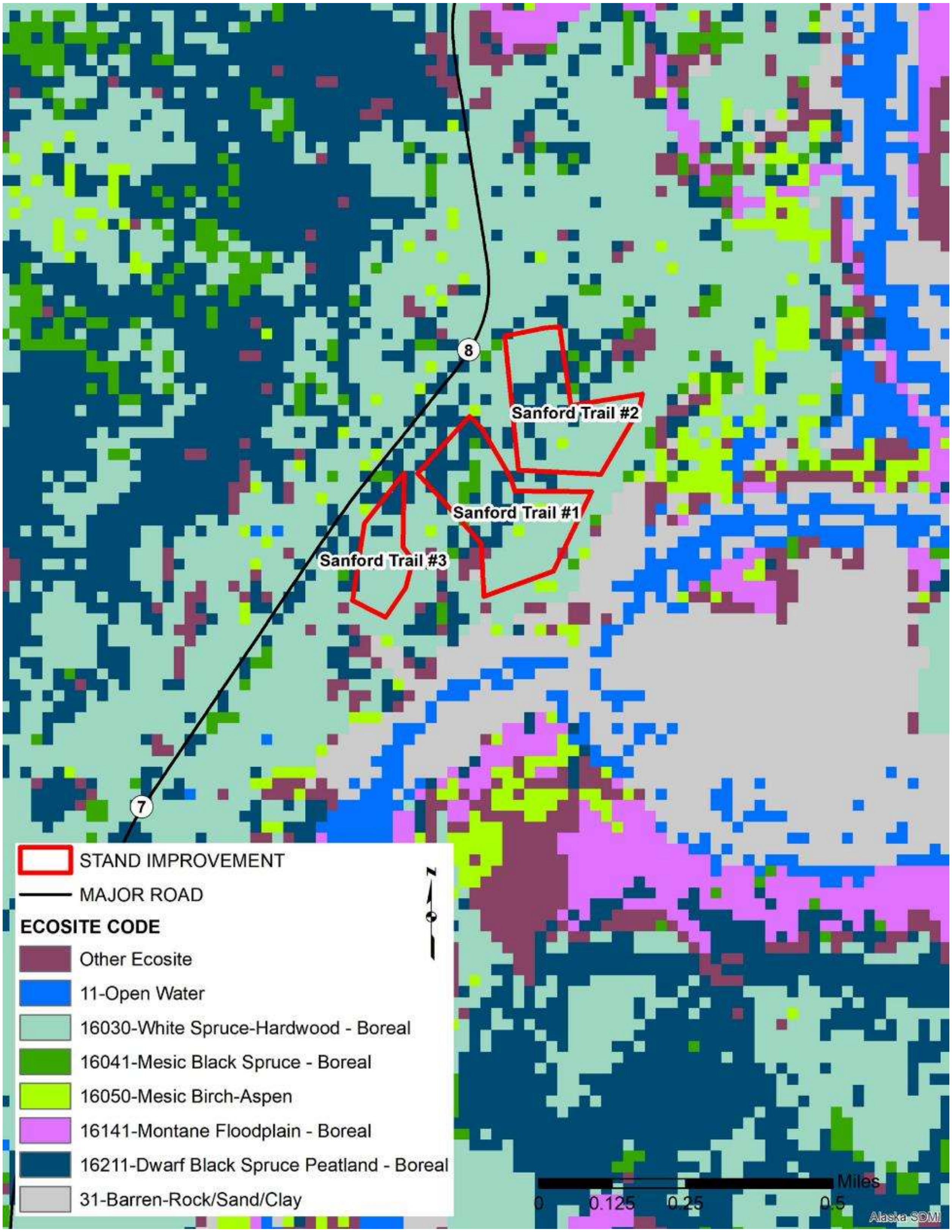


Figure 149. Map of proposed habitat improvement areas (Sanford Trail #1, #2, and #3) and proposed PLOD in the Gakona Village planning region showing ecological sites.

Table 23. Vegetation treatment sites in the Gakona Village planning region and their primary ecosystem type, treatment goal, size (acres), and total biomass (tons).

Treatment Site Name	Ecosystem Code	Primary Treatment Goal	Acres	Biomass (tons)
North Trail #1	16030_C	Timber Imp/Browse	30.6	845.5
North Trail #2	16030_C	Timber Imp/Browse	14.2	672.4
North Trail #3	16030_C	Timber Imp/Browse	36.0	626.4
Old Pit #1	16030_C	Timber Improvement	38.9	1270.2
Old Pit #2	16030_C	Timber Improvement	33.1	269.4
Radio Tower #1	16041_D	Moose Browse	27.9	404.2
Radio Tower #2	16041_D	Moose Browse	29.0	445.2
Sanford Trail #1	16030_C	Timber Improvement	25.3	411.6
Sanford Trail #2	16030_C	Timber Improvement	21.8	435.4
Sanford Trail #3	16030_C	Timber Improvement	9.3	138.7
Swimming Hole	16141_A	Moose Browse	19.6	515.8

Gulkana Village Management Plan

The Gulkana Village planning region includes an area of 270,781 acres. Figure 150 displays the overall planning area along with associated infrastructure. Ownership of this and the surrounding area is shown in Figure 151. As Figure 151 displays, land ownership patterns are varied in this area with Ahtna owning 43.5% (117,806 acres) of the land.

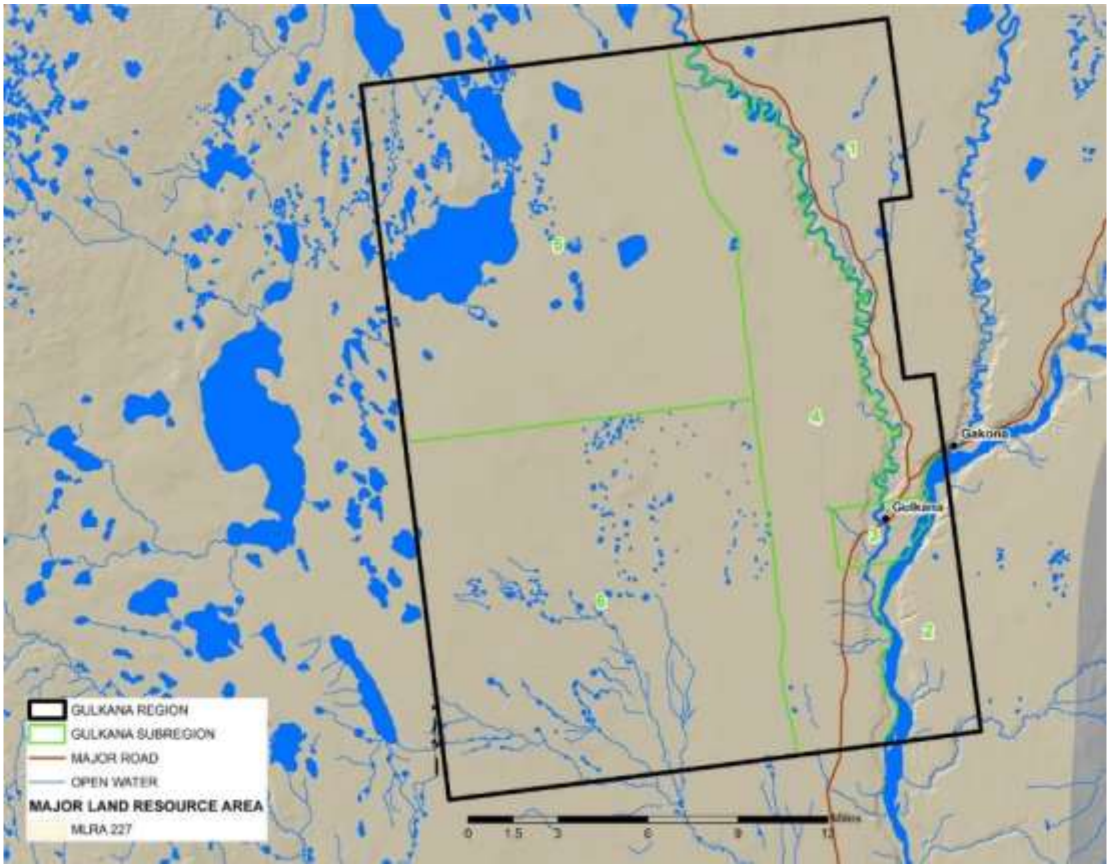


Figure 150. Overview of the Gulkana Village planning region.

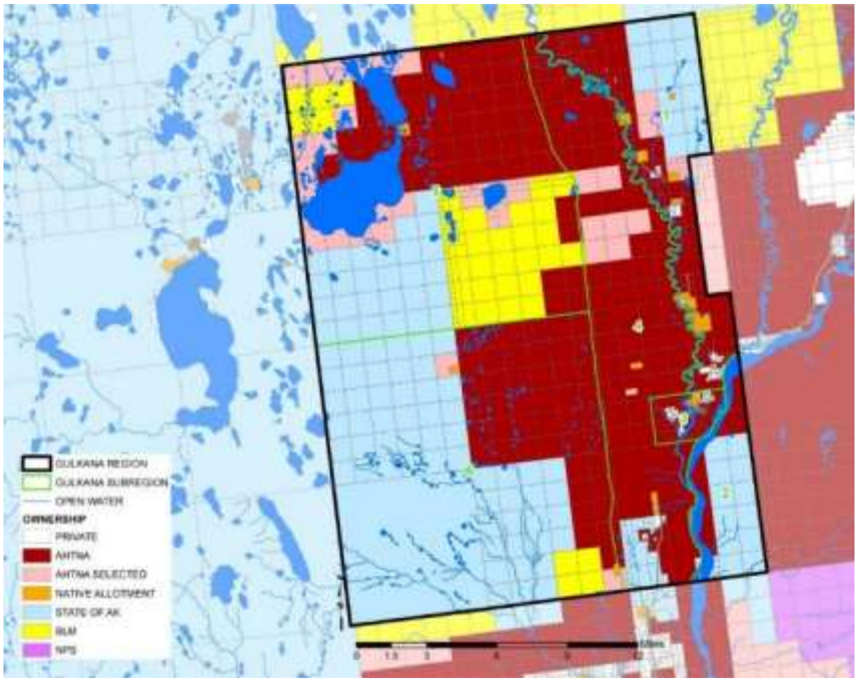


Figure 151. Land ownership patterns in the Gulkana Village planning region.

Planning Region Description

A description of the general geology, climate, soils, permafrost, and vegetation is found in the Project Area description of this report. Additional geo-climatic information more specific to the Gulkana Village planning region are provided in figures 152, 153, and 154, as soil texture, soil drainage, and permafrost, respectively.

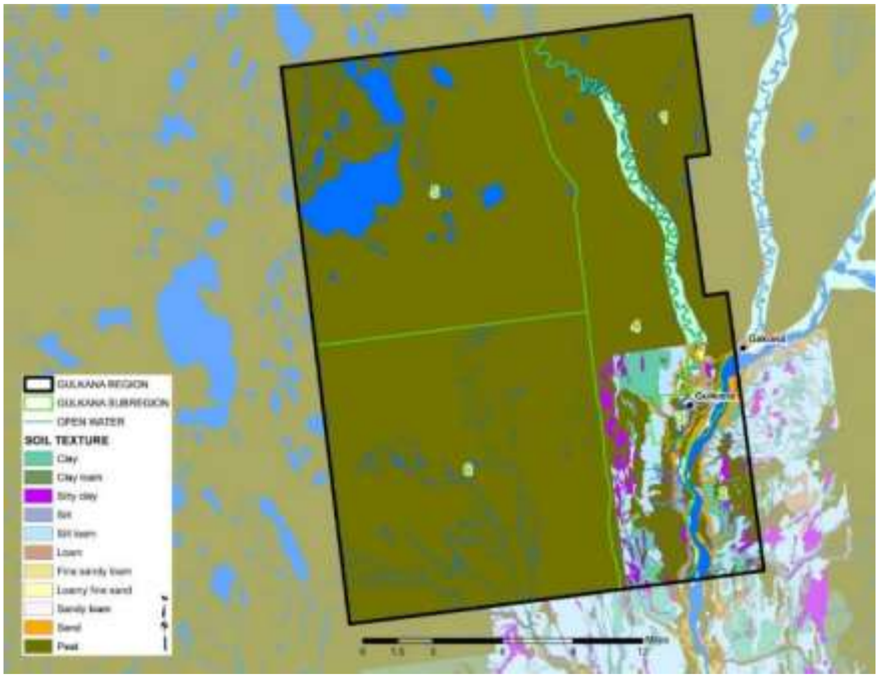


Figure 152. Soil texture in the Gulkana Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

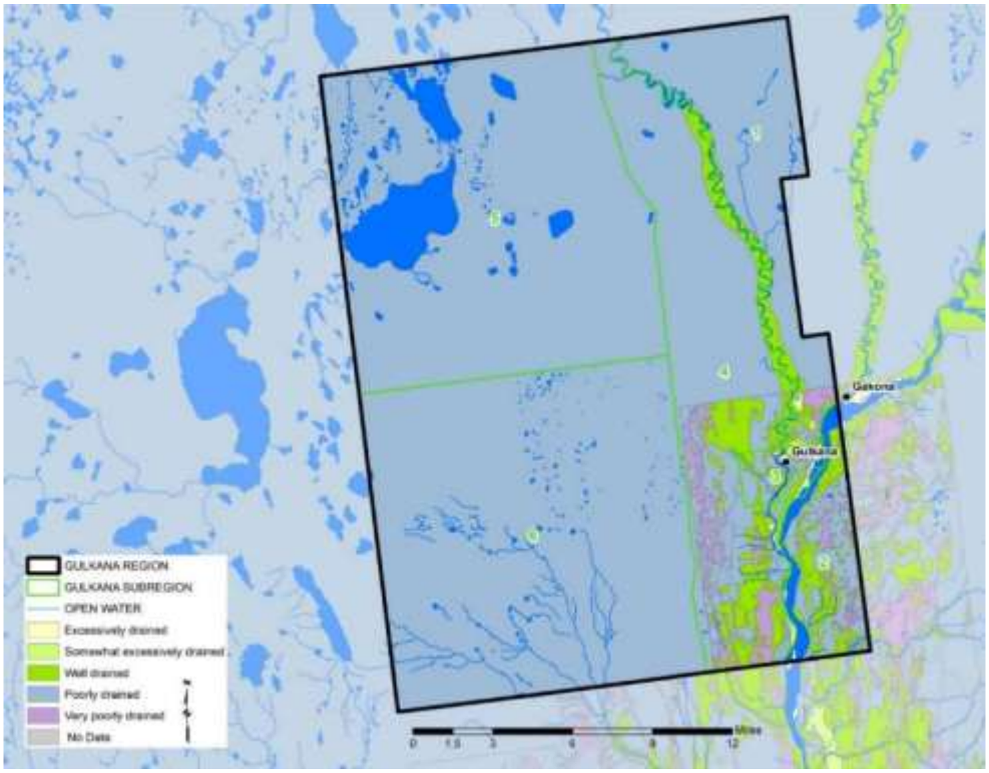


Figure 153. Soil drainage in the Gulkana Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

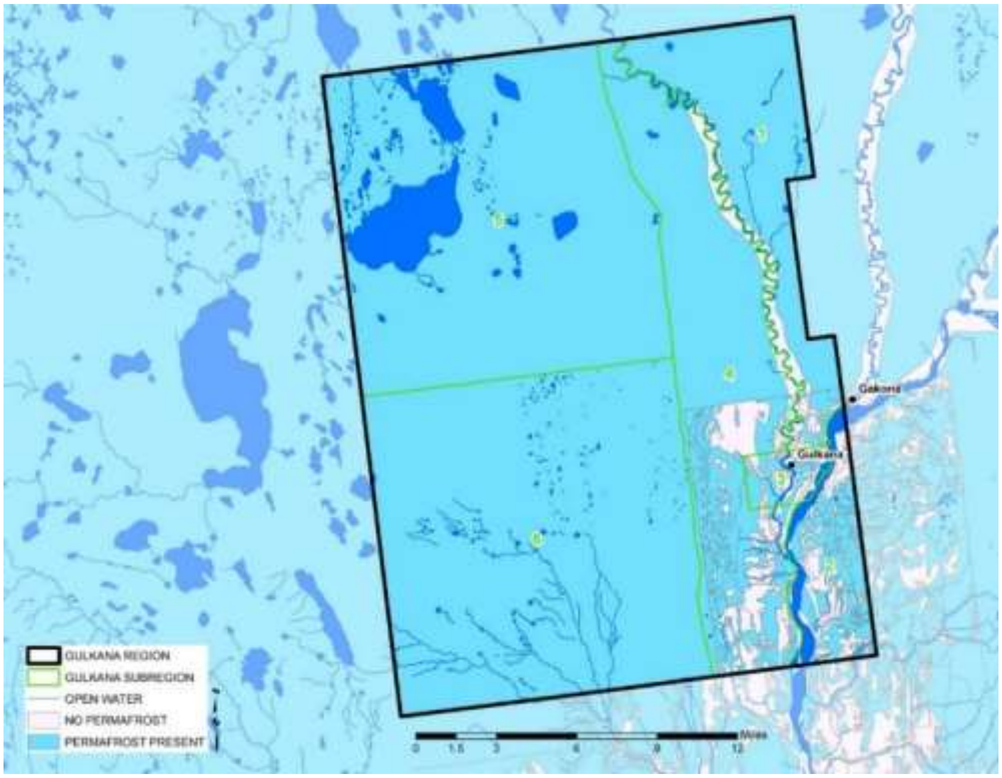


Figure 154. Permafrost in the Gulkana Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

Fire is the primary disturbance factor influencing the vegetation ecology in the Copper River Basin. Figure 155 shows the fire history of the Gulkana area along with current fire protection zones. Although the level of fire occurring in this southcentral Alaska landscape is substantially less than that occurring in more interior areas of Alaska north of the Alaska Range, fire is still a significant disturbance when it occurs. However, there has not been a large fire in the project area since 1940. When fire does occur it serves to set back succession. It can also burn off the organic material at the ground surface, including peat that can occur on many sites. This can influence the thermal layer protecting the underlying permafrost on some sites, causing the permafrost to melt (thermokarst) and changing the site conditions through this process. Riparian areas are also influenced by flooding and ice events. These serve to set back succession of vegetation in riparian areas, and can even shift site conditions, particularly in the case of significant flooding events.

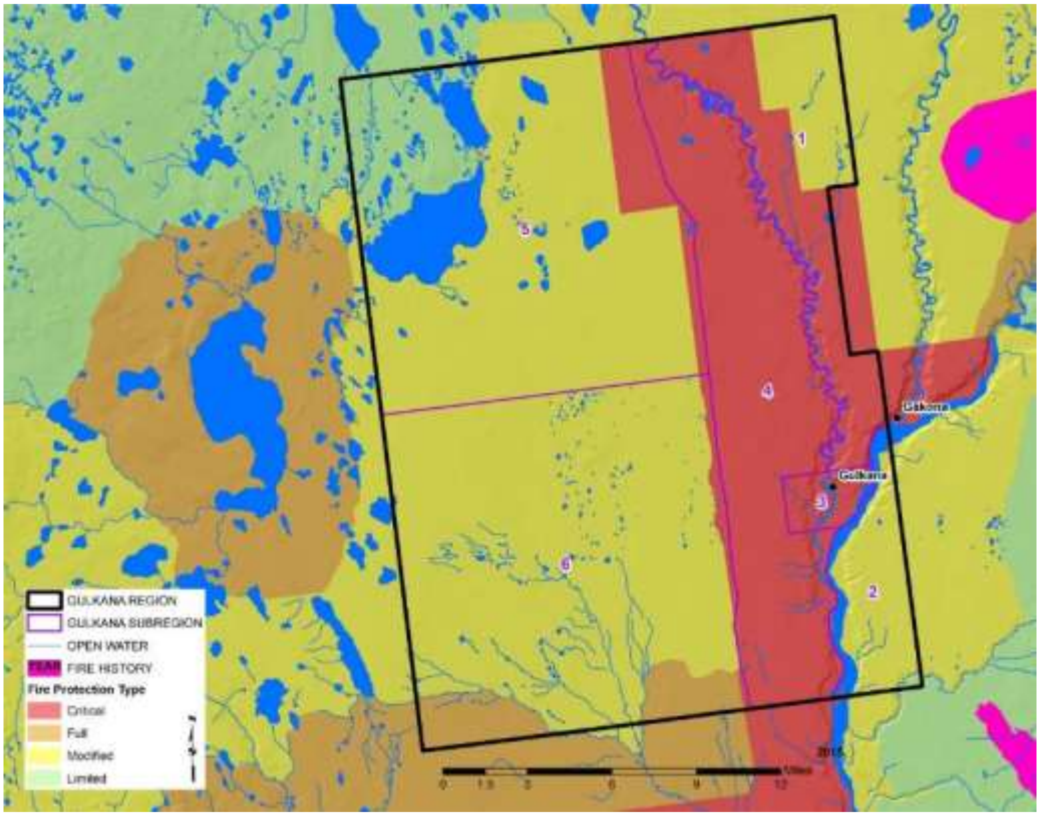


Figure 155. Current fire protection classes and fire history since 1940 in the Gulkana Village planning region. Data from Alaska Interagency Coordination Center.

Landscape Assessment Results

Ecosystem Diversity

The ecological sites present within the Gulkana Village planning region are displayed in Figure 156. Table 24 displays the acres for each ecological site setting and disturbance class. Figure 157 is a map of ecosystem diversity (represented by ecological site setting and disturbance class) in the Gulkana Village planning region.

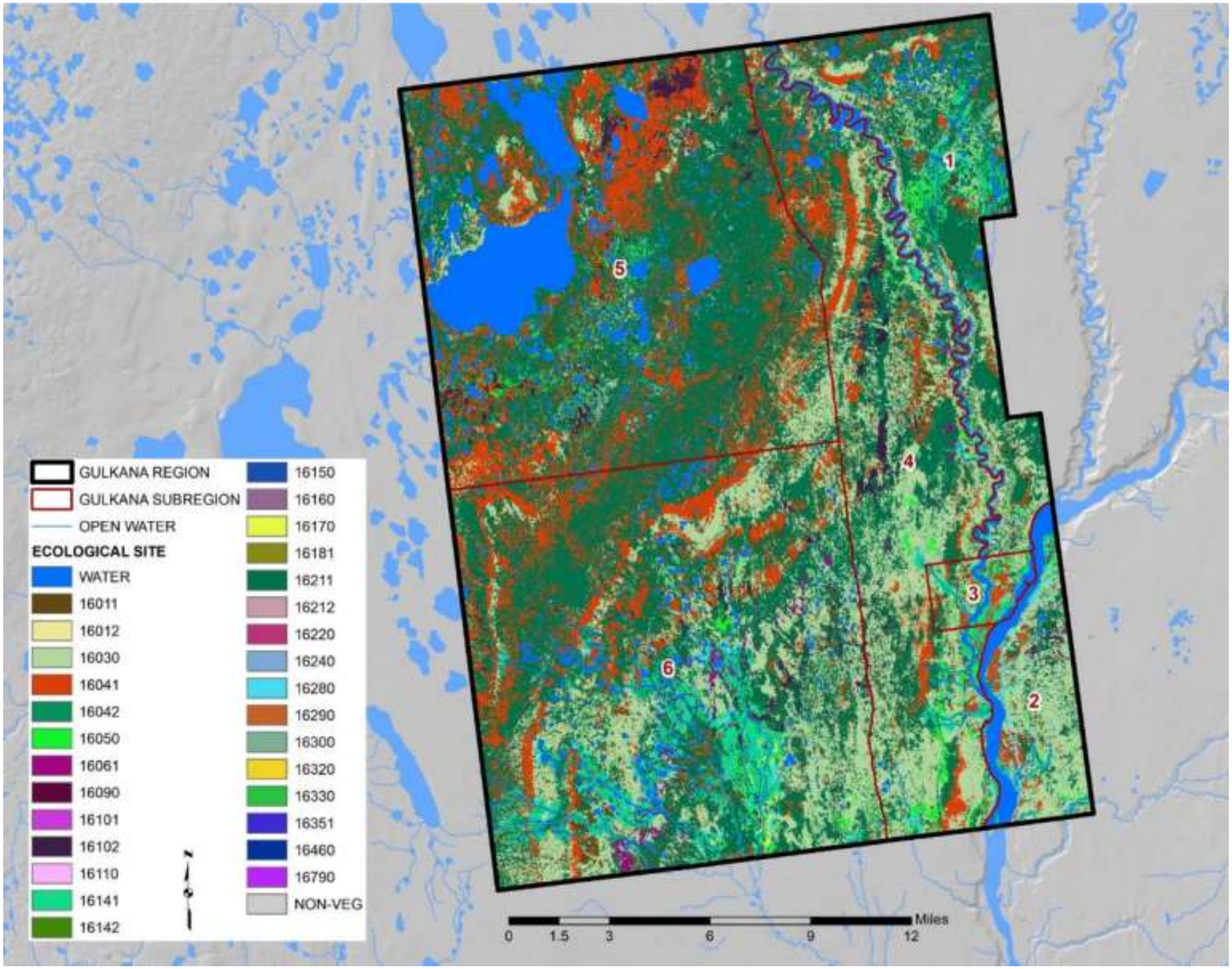


Figure 156. Ecological sites in the Gulkana Village planning region. See Appendix A for ecological site code definitions.

Table 24. Ecosystems mapped in the Gulkana Village planning region and their associated acres. The ecological site vegetation label is provided as reference.

Ecosystem Code	Ecological Site Label	Acres
11	Open Water	17174.0
16011_A	Treeline White Spruce-Boreal	122.8
16011_B	Treeline White Spruce-Boreal	1962.9
16011_C	Treeline White Spruce-Boreal	0.2
16012_A	Treeline White Spruce-SubBoreal	0.4
16012_B	Treeline White Spruce-SubBoreal	11.8
16030_A	White Spruce-Hardwood-Boreal	2690.1
16030_B	White Spruce-Hardwood-Boreal	4325.6
16030_C	White Spruce-Hardwood-Boreal	49907.4
16030_E	White Spruce-Hardwood-Boreal	102.3
16041_A	Mesic Black Spruce-Boreal	887.4
16041_B	Mesic Black Spruce-Boreal	2016.9
16041_C	Mesic Black Spruce-Boreal	829.5
16041_D	Mesic Black Spruce-Boreal	40404.1
16041_E	Mesic Black Spruce-Boreal	9.6
16042_A	Mesic Black Spruce-SubBoreal	2.2
16042_B	Mesic Black Spruce-SubBoreal	37.1
16042_C	Mesic Black Spruce-SubBoreal	2.2
16050_A	Mesic Birch-Aspen	4527.7
16050_B	Mesic Birch-Aspen	706.3
16050_D	Mesic Birch-Aspen	7.8
16050_E	Mesic Birch-Aspen	19.1
16061_A	Dry Aspen-Steppe Bluff	62.5
16061_B	Dry Aspen-Steppe Bluff	181.9
16061_C	Dry Aspen-Steppe Bluff	75.4
16061_D	Dry Aspen-Steppe Bluff	1454.2
16090_A	Mesic Subalpine Alder	42.3
16090_B	Mesic Subalpine Alder	11.3
16102_A	Mesic Scrub Birch-Willow	2845.5
16102_B	Mesic Scrub Birch-Willow	4893.6
16110_A	Mesic Bluejoint Meadow	39.6
16141_A	Montane Floodplain-Boreal	3936.2
16141_B	Montane Floodplain-Boreal	920.3
16141_C	Montane Floodplain-Boreal	808.0
16141_D	Montane Floodplain-Boreal	6162.1
16141_E	Montane Floodplain-Boreal	721.2
16150_A	Large River Floodplain	120.3
16150_B	Large River Floodplain	14.2
16150_C	Large River Floodplain	31.8
16150_D	Large River Floodplain	2.4
16160_A	Riparian Stringer	0.9
16160_B	Riparian Stringer	12.7
16170_A	Shrub and Herbaceous Floodplain	213.7
16170_B	Shrub and Herbaceous Floodplain	23.8
16170_C	Shrub and Herbaceous Floodplain	6.4
16170_E	Shrub and Herbaceous Floodplain	186.6
16181_A	Herbaceous Fen	125.9
16181_B	Herbaceous Fen	6.2
16181_C	Herbaceous Fen	1.1
16181_D	Herbaceous Fen	17.6
16211_A	Dwarf Black Spruce Peatland-Boreal	3920.2
16211_B	Dwarf Black Spruce Peatland-Boreal	2680.7
16211_C	Dwarf Black Spruce Peatland-Boreal	5205.2
16211_D	Dwarf Black Spruce Peatland-Boreal	104302.1
16212_A	Dwarf Black Spruce Peatland-Subboreal	3.3
16212_B	Dwarf Black Spruce Peatland-Subboreal	2.2
16212_C	Dwarf Black Spruce Peatland-Subboreal	37.8
16220_A	Black Spruce Wet-Mesic Slope	29.6
16220_B	Black Spruce Wet-Mesic Slope	8.7
16220_C	Black Spruce Wet-Mesic Slope	35.6
16220_D	Black Spruce Wet-Mesic Slope	216.6
16240_A	Deciduous Shrub Swamp	16.5
16280_A	Low Shrub-Tussock Tundra	3219.4
16280_B	Low Shrub-Tussock Tundra	262.2
16280_C	Low Shrub-Tussock Tundra	71.2
16290_A	Tussock Tundra	115.2
16300_A	Wet Black Spruce-Tussock	34.2
16300_B	Wet Black Spruce-Tussock	149.0
16300_C	Wet Black Spruce-Tussock	846.0
16320_A	Alpine Talus and Bedrock	261.5
16320_B	Alpine Talus and Bedrock	2.4
16330_A	Alpine Mesic Herbaceous Meadow	6.7
16351_A	Alpine Ericaceous Dwarf-Shrubland	11.3
16790_A	White Spruce-Hardwood-SubBoreal	27.6
16790_B	White Spruce-Hardwood-SubBoreal	40.3
16790_C	White Spruce-Hardwood-SubBoreal	7.3
31	Barren-Rock-Sand-Clay	735.5

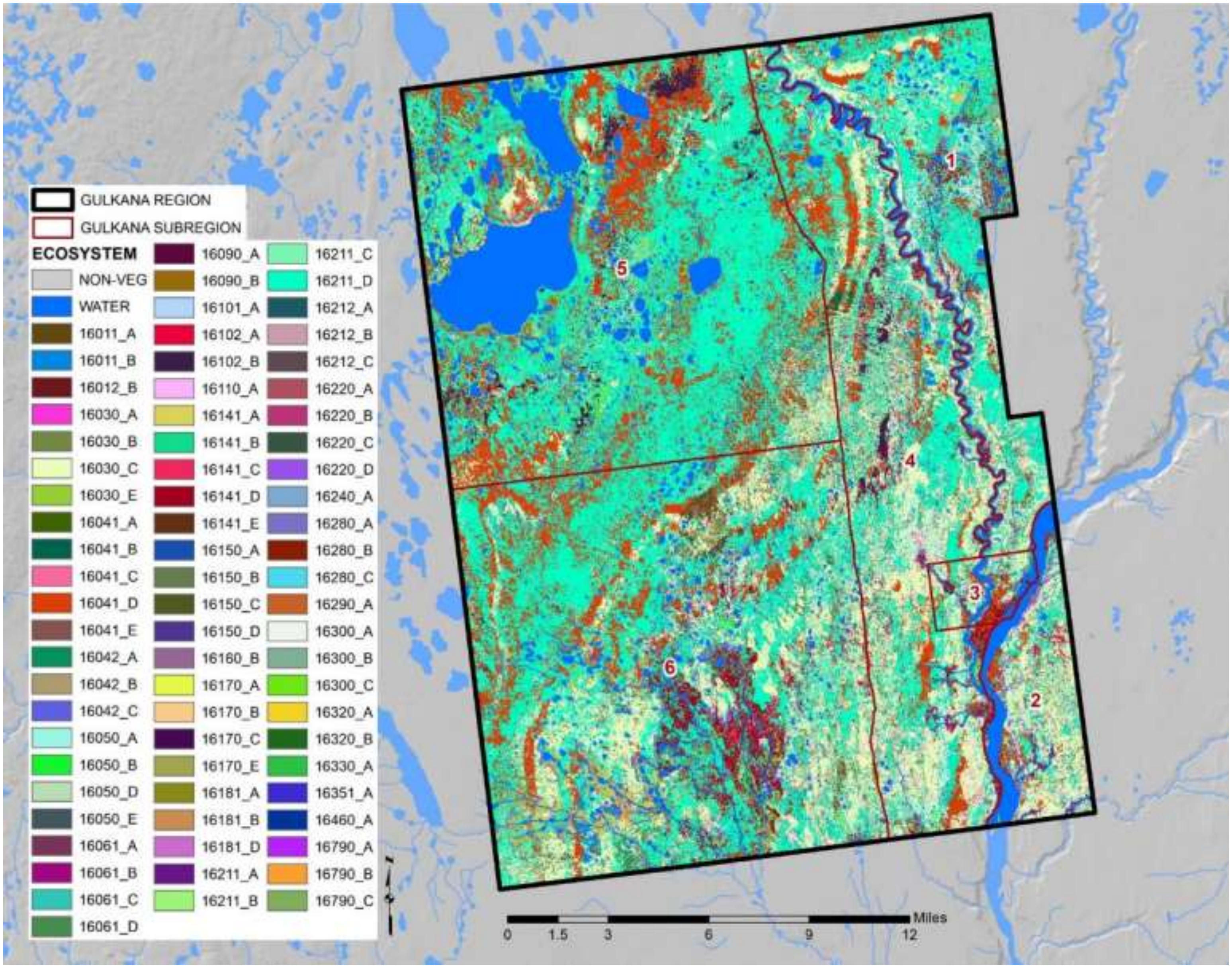


Figure 157. Ecosystem diversity for the Gulkana Village planning region. See Appendix A for ecosystem code definitions..

Berry Production Areas

Figure 158 shows the areas identified with the highest potential for berry production. It may be desirable to avoid disturbances to these areas, but verifying the actual presence of good berry production is recommended on a site by site basis.

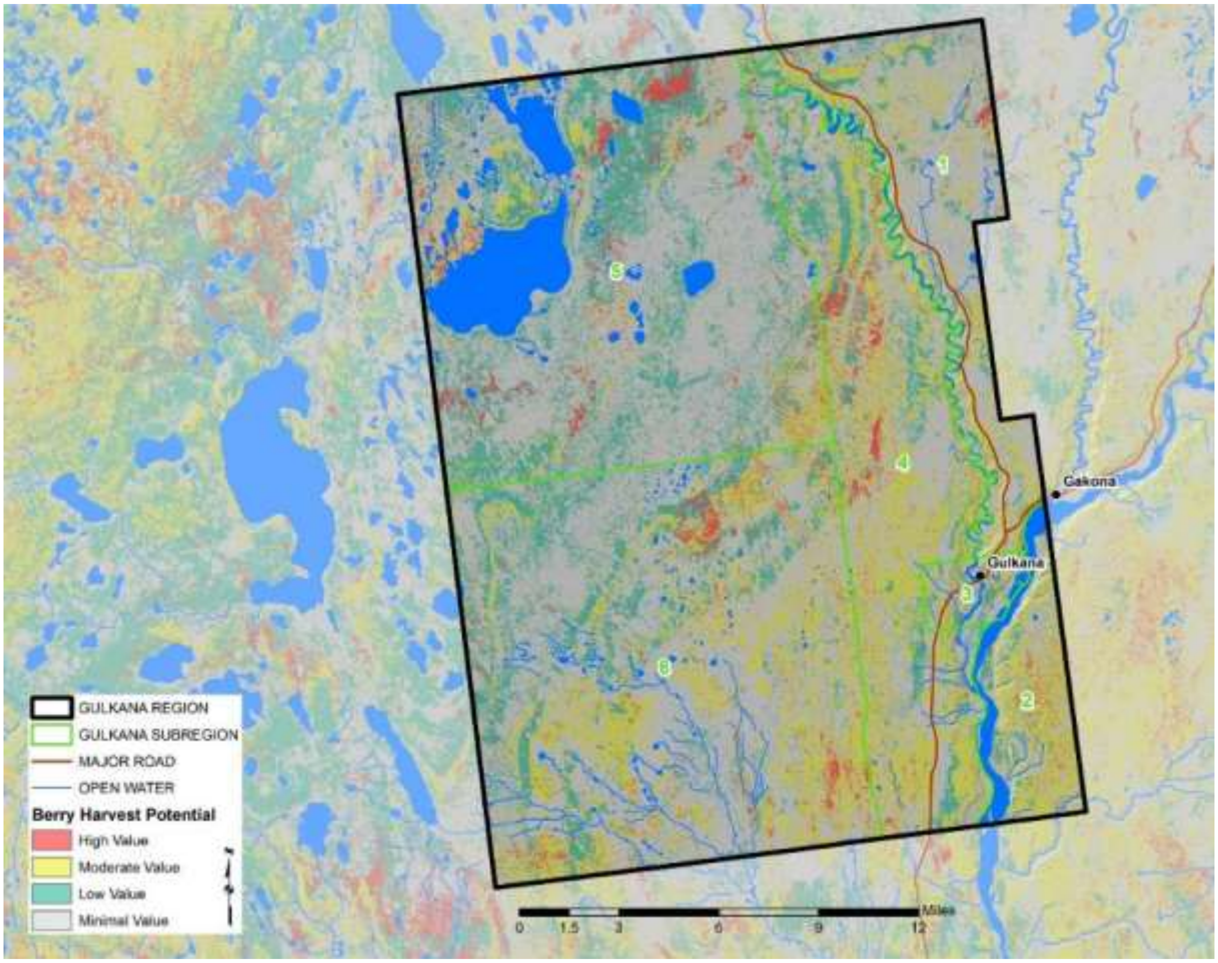


Figure 158. Potential berry production values in the Gulkana Village planning region.

Moose and Caribou Habitat Quality Assessment - Model Results

Moose

Ecosystem-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 159 to 161. Landscape-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 162 to 164. A complete description of the moose habitat quality models can be found in Appendix B.

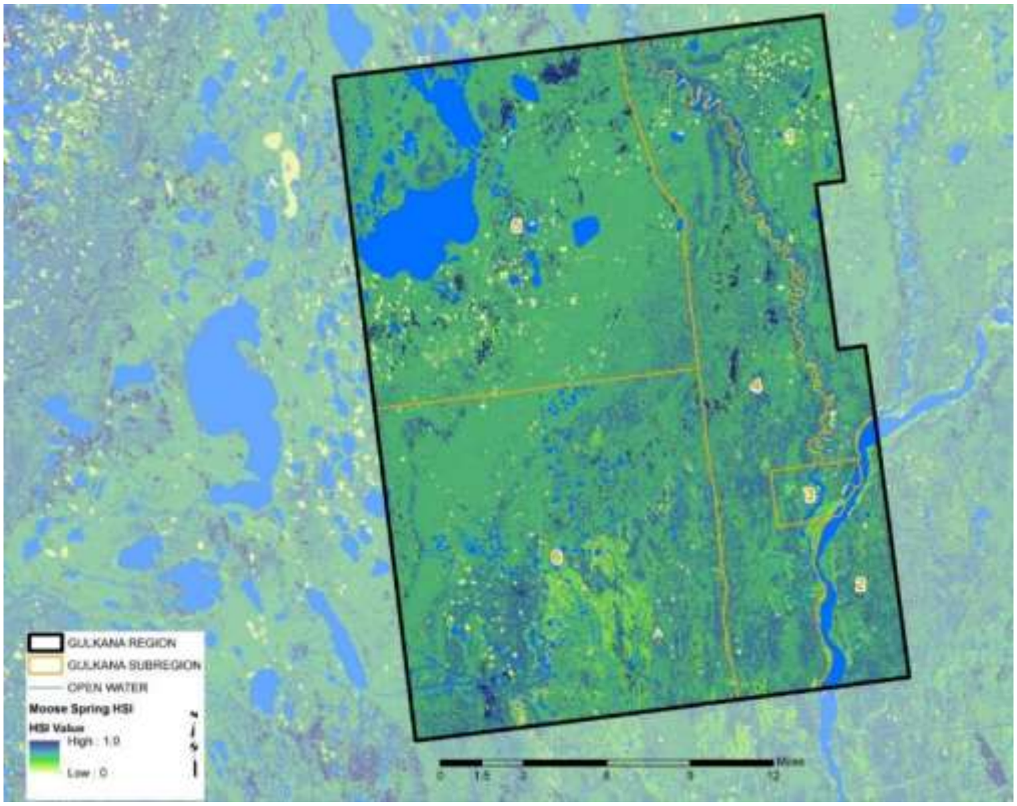


Figure 159. Results of the ecosystem-scale model outputs for moose spring habitat quality.

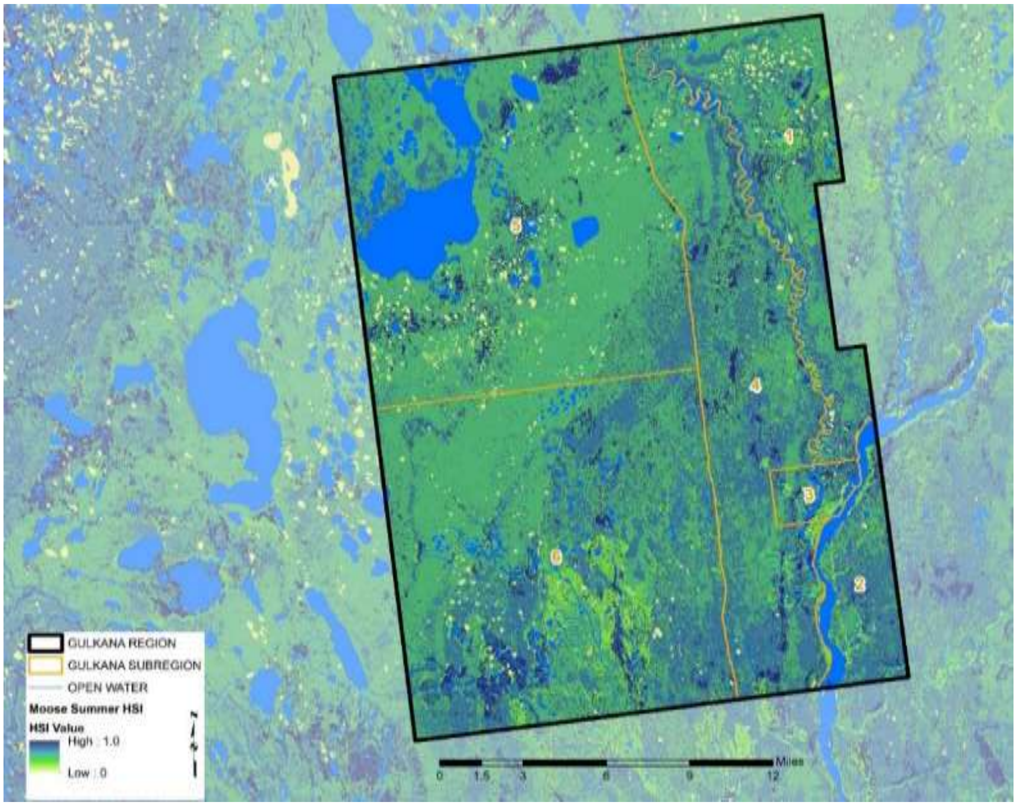


Figure 160. Results of the ecosystem-scale model outputs for moose summer habitat quality.

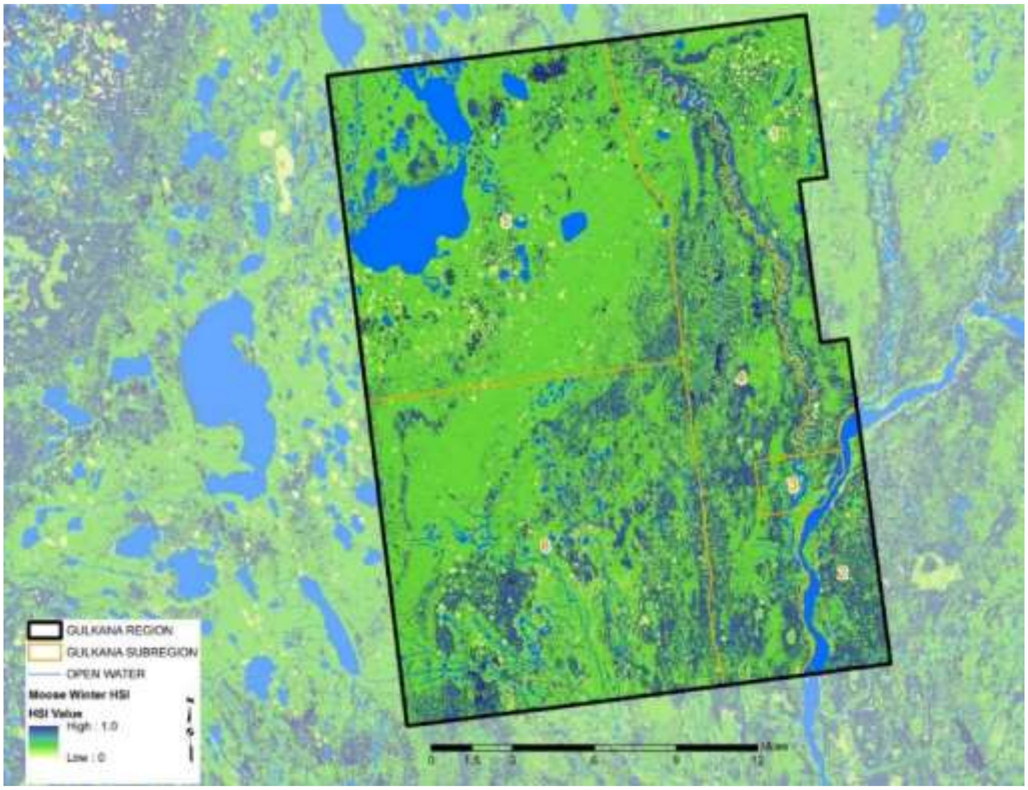


Figure 161. Results of the ecosystem-scale model outputs for moose winter habitat quality.

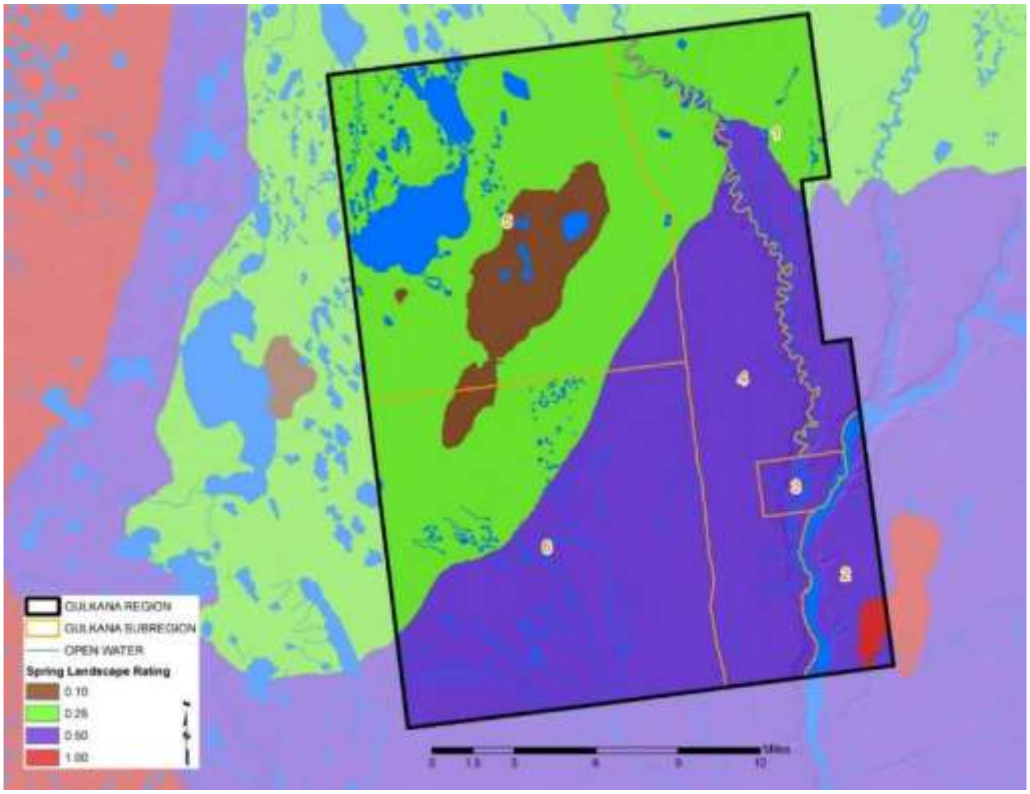


Figure 162. Results of the landscape-scale model outputs for moose spring habitat quality.

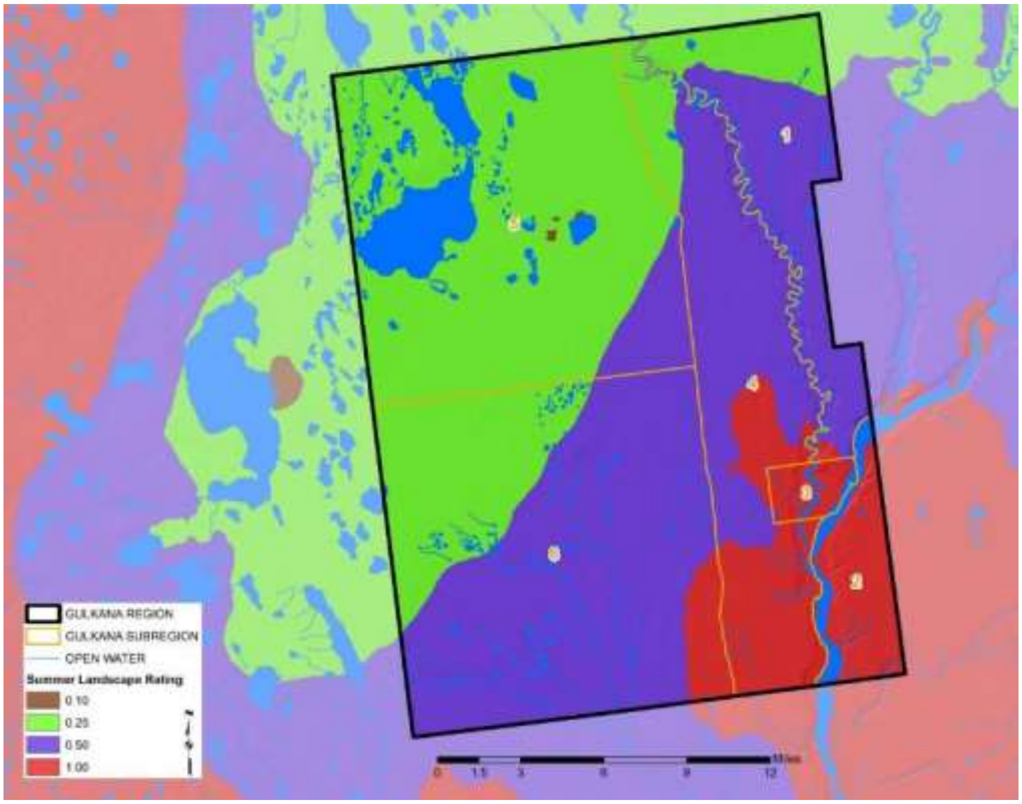


Figure 163. Results of the landscape-scale model outputs for moose summer habitat quality.

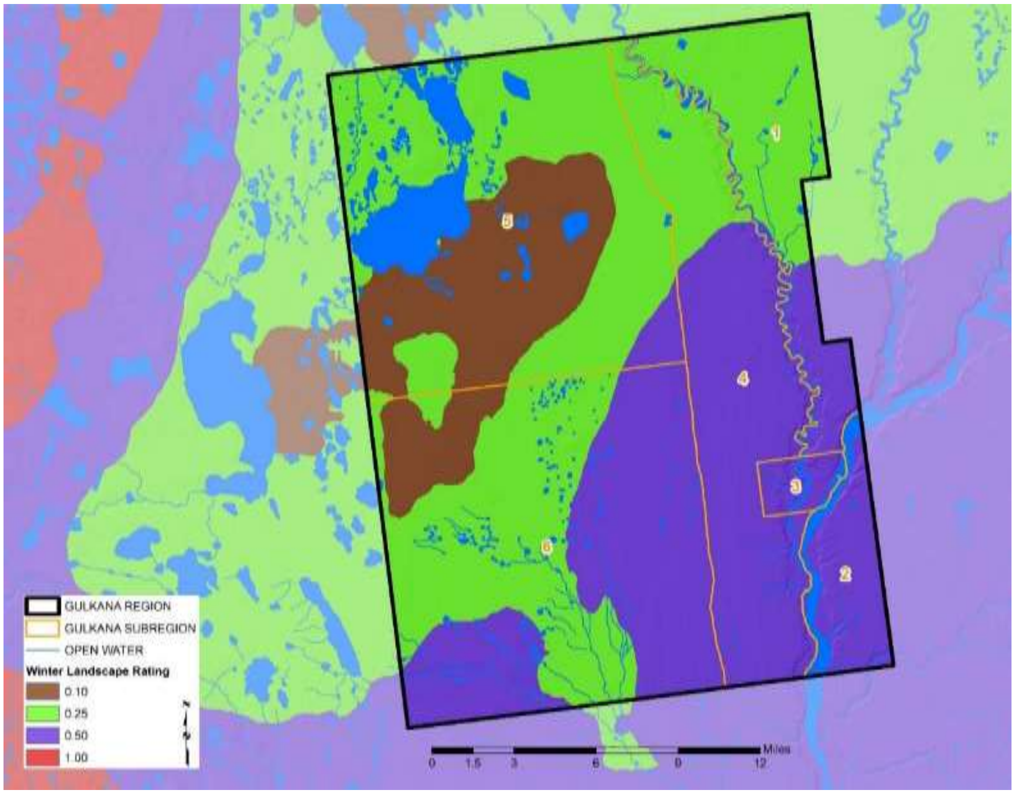


Figure 164. Results of the landscape-scale model outputs for moose winter habitat quality.

Caribou

Ecosystem-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 165 and 166. Landscape-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 167 and 168. A complete description of the caribou habitat quality models can be found in Appendix C.

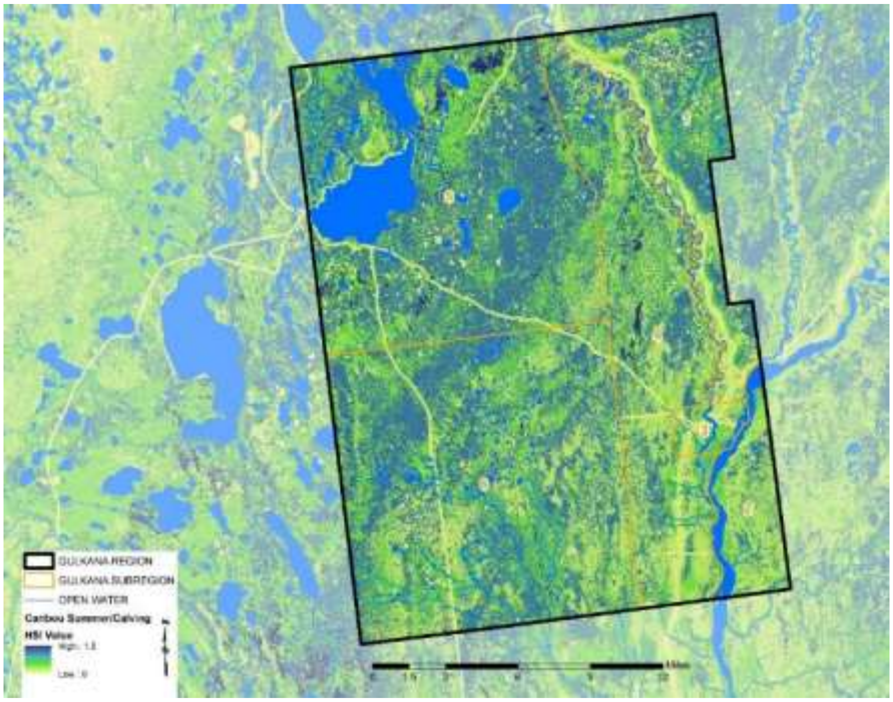


Figure 165. Results of the ecosystem-scale model outputs for caribou summer/calving habitat quality.

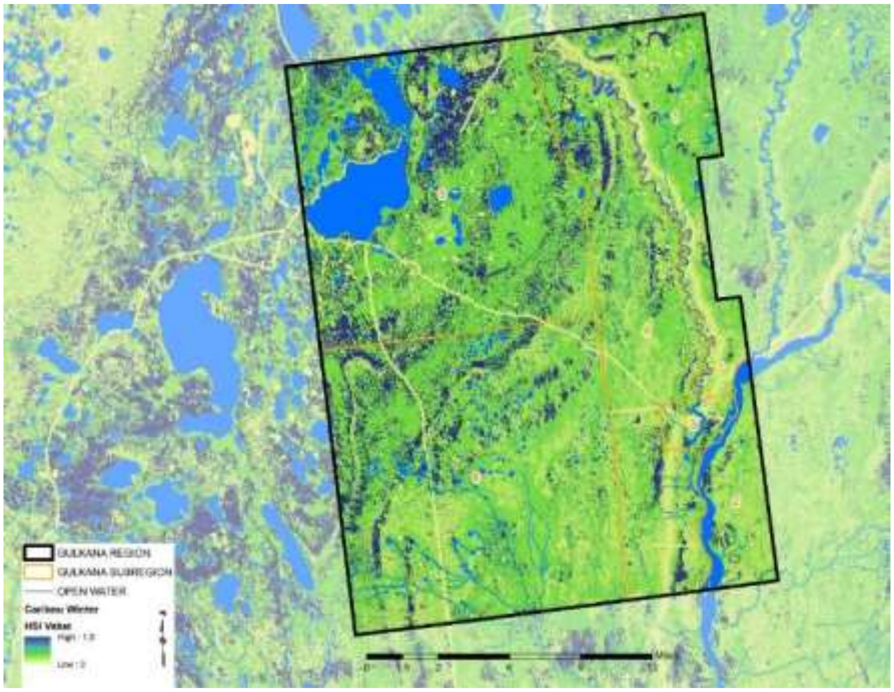


Figure 166. Results of the ecosystem-scale model outputs for caribou winter habitat quality.

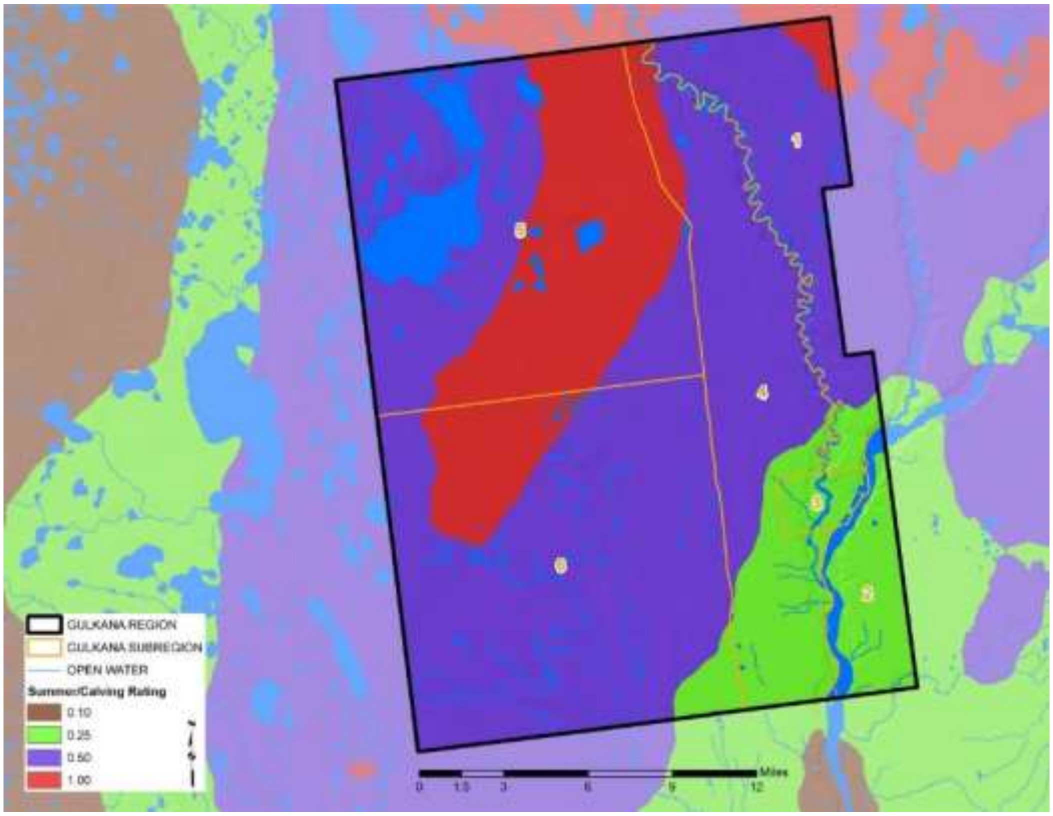


Figure 167. Results of the landscape-scale model outputs for caribou summer/calving habitat quality.

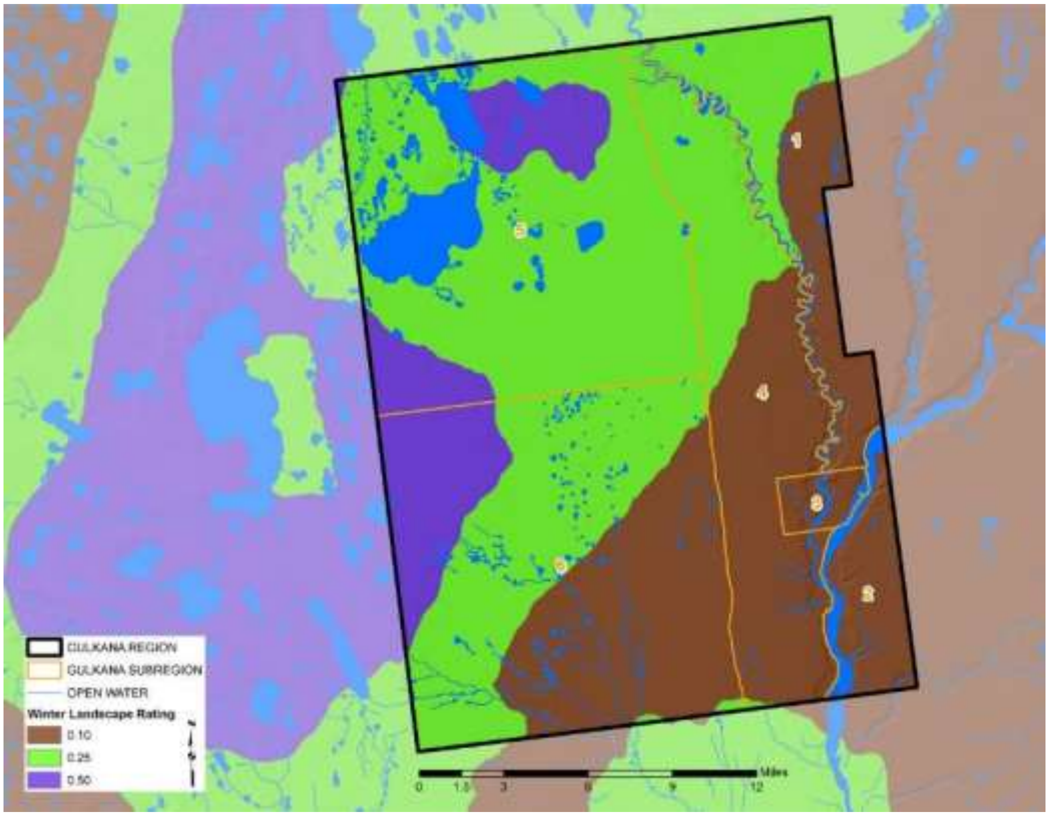


Figure 168. Results of the landscape-scale model outputs for caribou winter habitat quality.

Gulkana Site Improvement Areas

Potential treatment sites identified in the Gulkana area are displayed in figure 169. Based on all of the stated criteria, a number of sites were located for designated treatments. Figures 170-177 depict the locations of these areas. Appendix C provides a description of each of these sites. Sites ranging from approximately 9-53 acres in size were identified and are listed in Table 25. This table gives the site size and the treatment goal of primarily timber stand improvement and biomass production or moose browse enhancement. The table also displays an estimate of the total biomass of all standing above ground biomass. This estimate is not tonnage of usable biomass for energy but the total of all stems regardless of size. However, stands on the higher end of the total amount will typically have larger trees and are a candidate for biomass energy production.

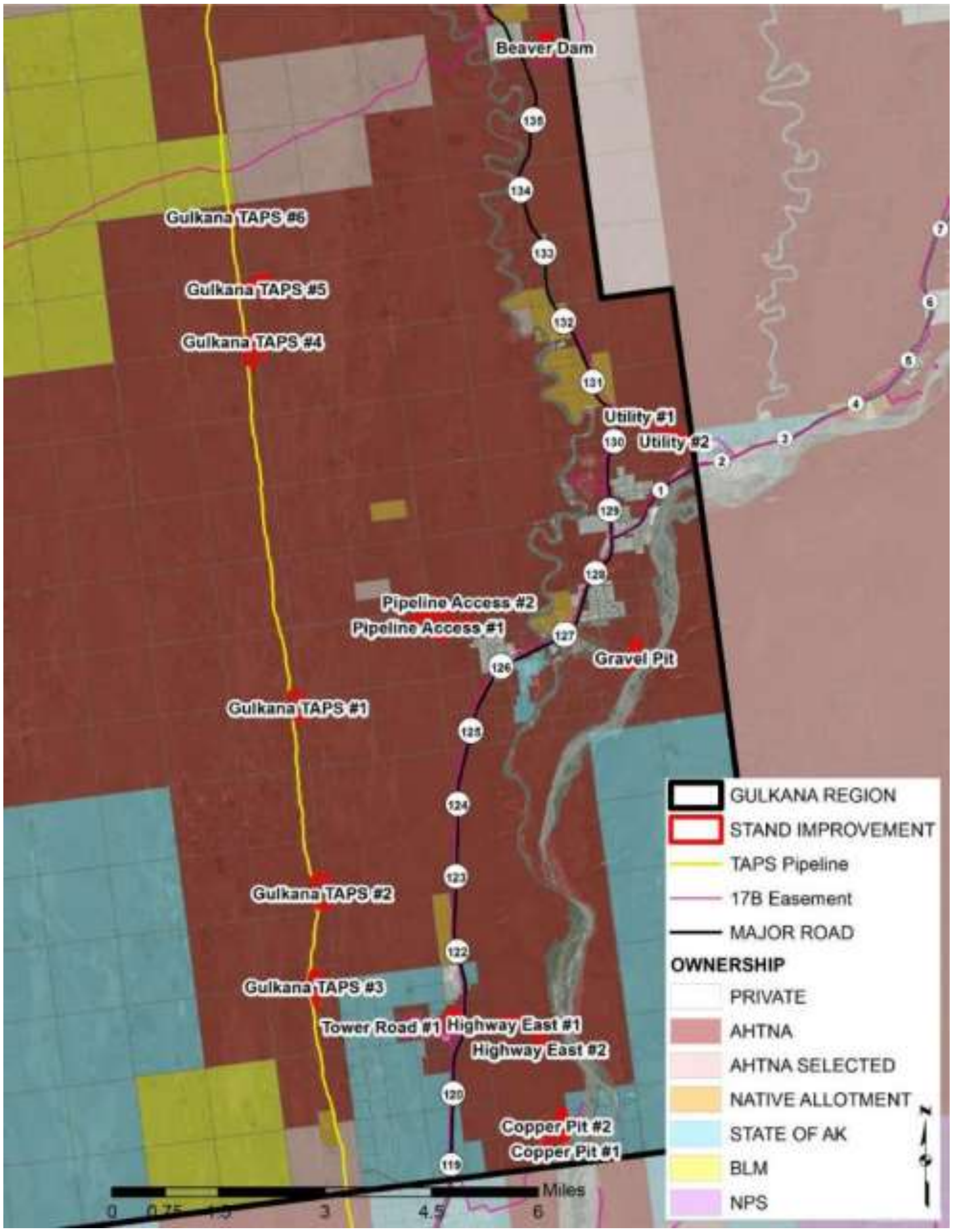


Figure 169. Overview of recommended treatment sites in the Gulkana Village planning region.

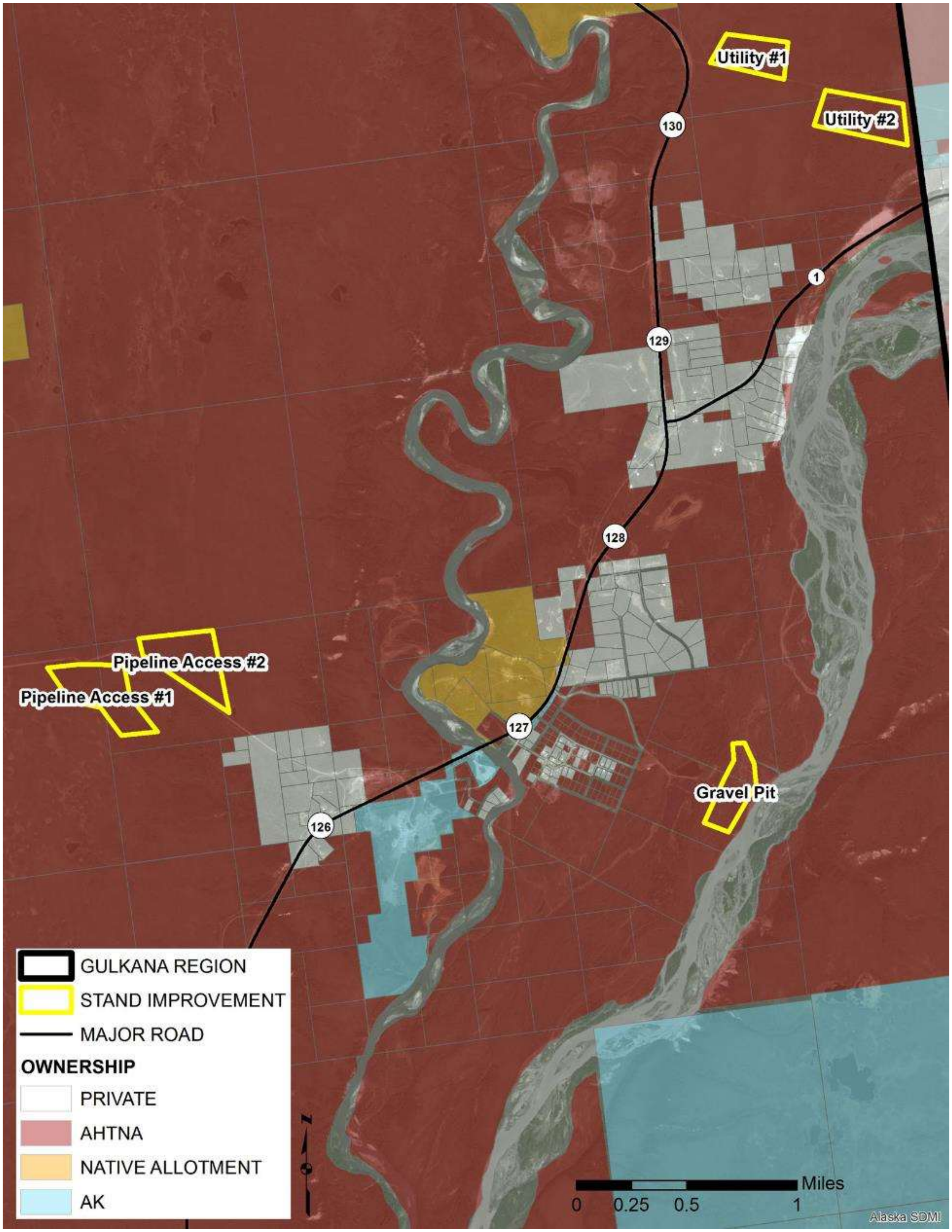


Figure 170. Map of proposed treatment areas (Utility #1 and #2, Gravel Pit, and Pipeline Access #1 and #2) in the Gulkana Village planning region showing surface ownership and aerial imagery.

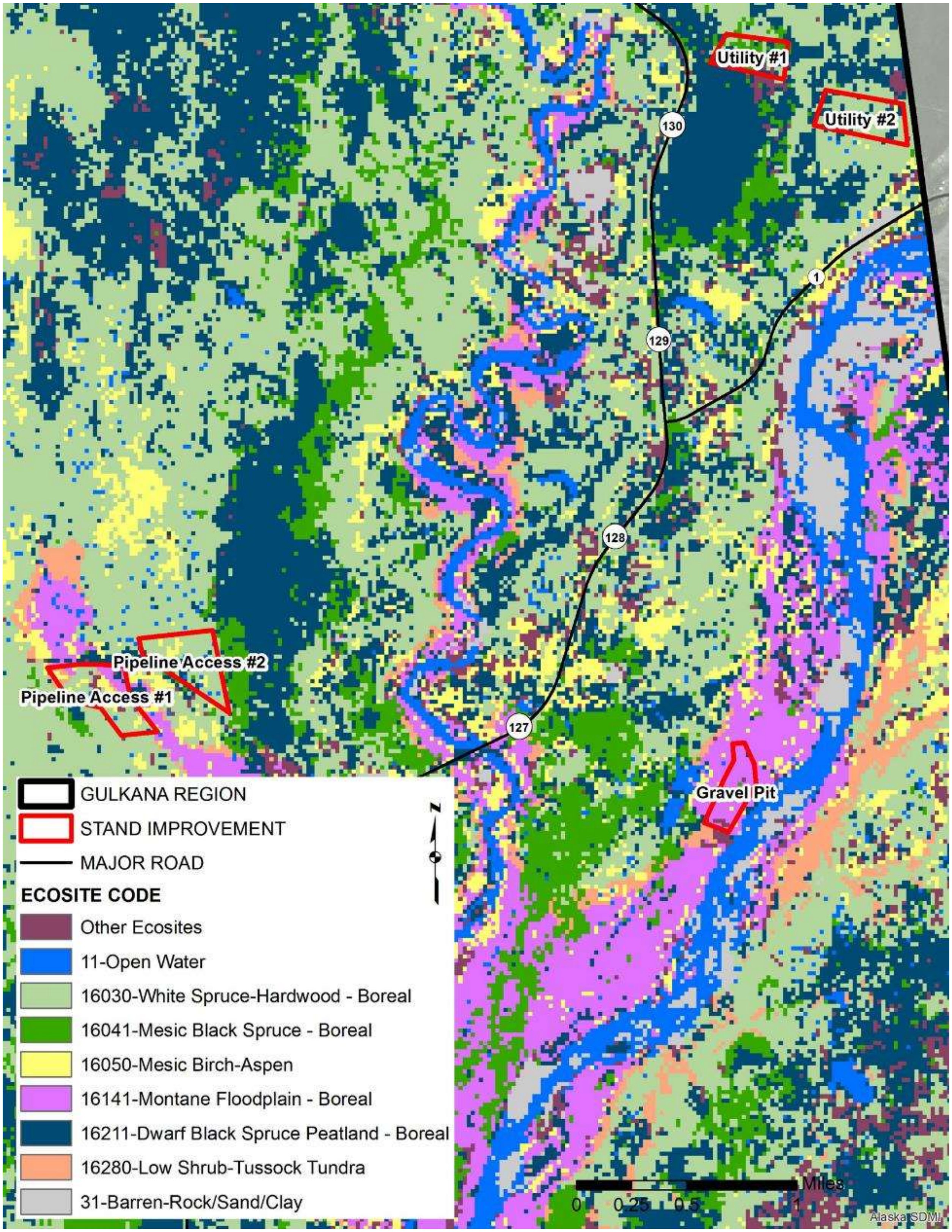


Figure 171. Map of proposed treatment areas (Utility #1 and #2, Gravel Pit, and Pipeline Access #1 and #2) in the Gulkana Village planning region showing ecological sites.

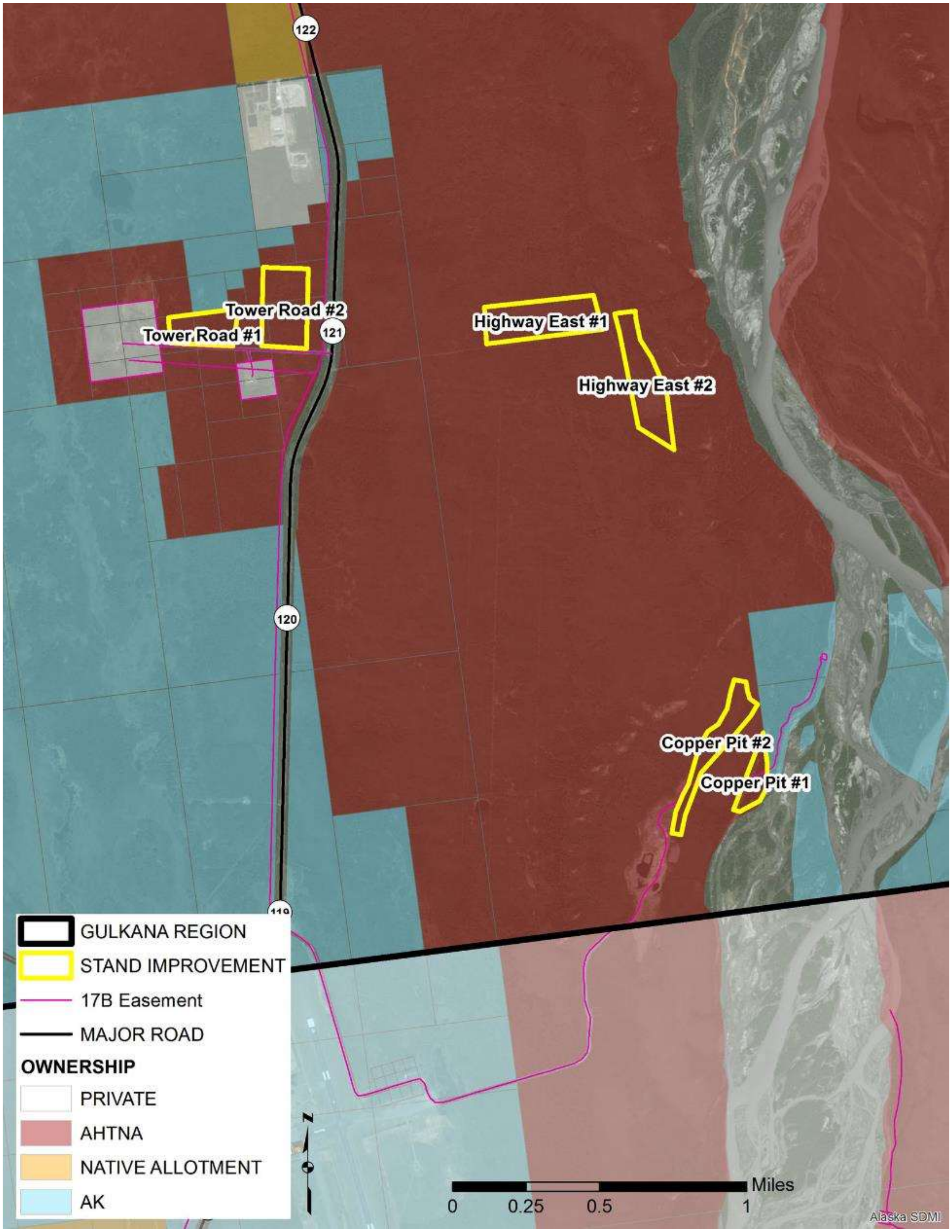


Figure 172. Map of proposed habitat improvement areas (Tower Road #1 and #2, Copper Pit #1 and #2, and Highway East #1 an #2) in the Gulkana Village planning region showing surface ownership and aerial imagery.

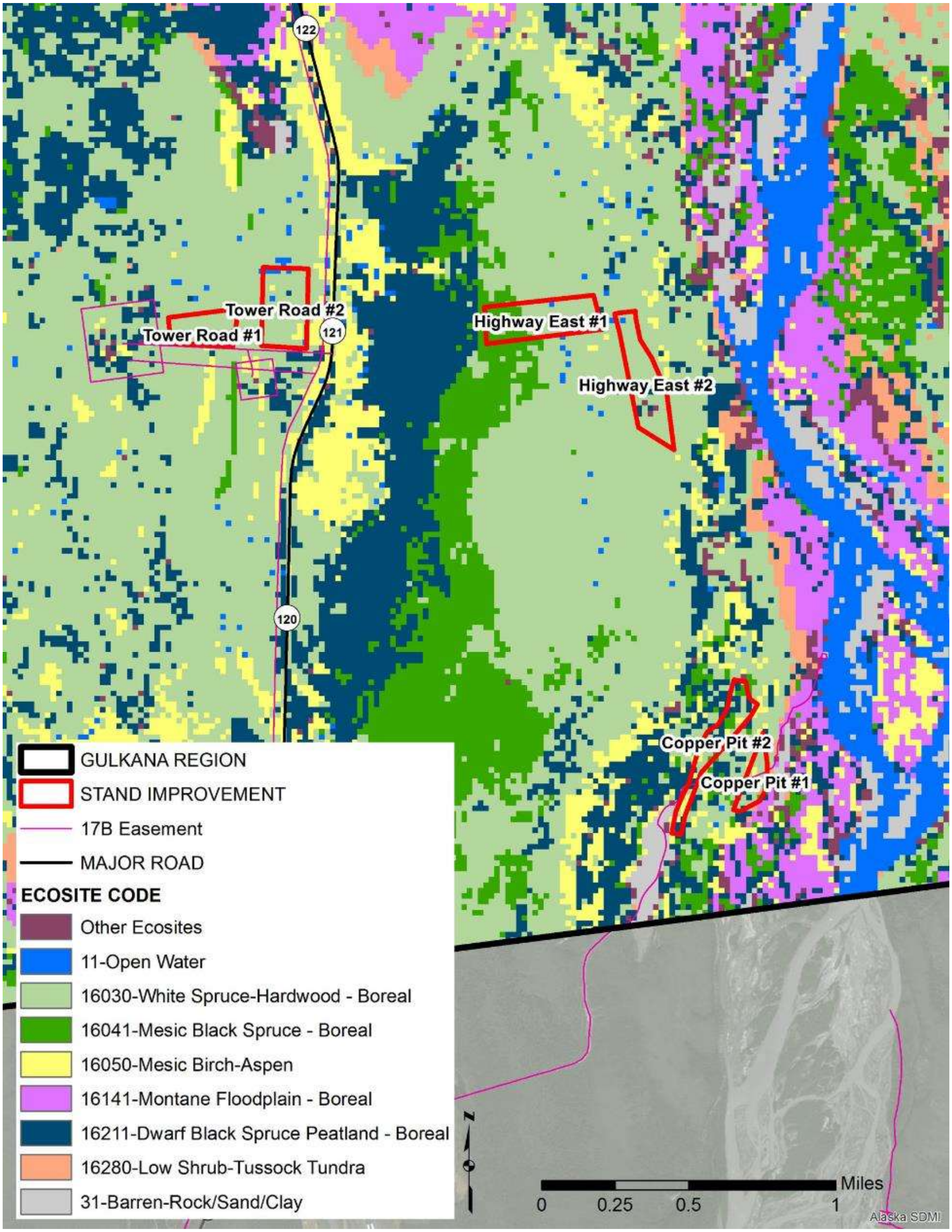


Figure 173. Map of proposed habitat improvement areas (Tower Road #1 and #2, Copper Pit #1 and #2, and Highway East #1 an #2) in the Gulkana Village planning region showing ecological sites.

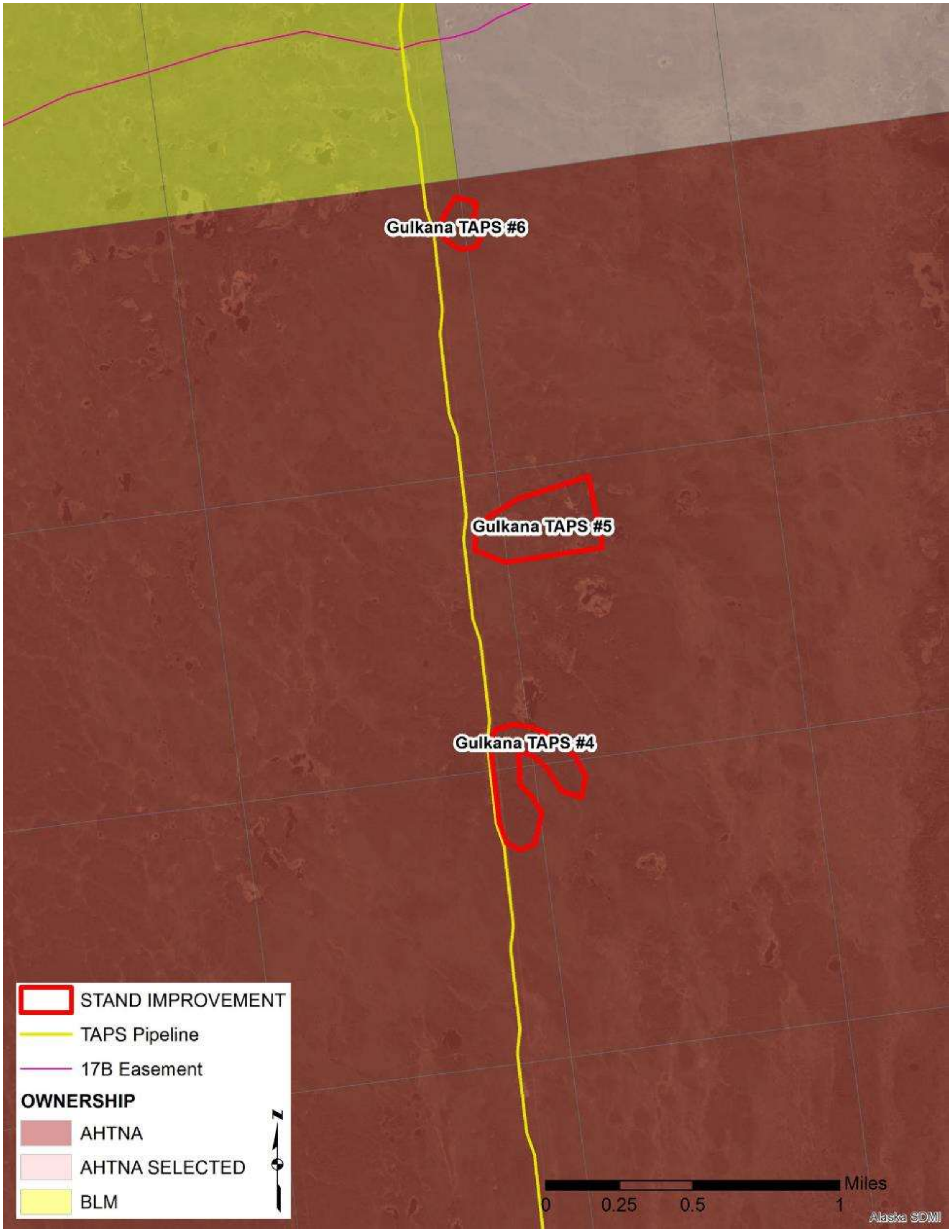


Figure 174. Map of proposed habitat improvement areas (Gulkana TAPS #4, #5, and #6) in the Gulkana Village planning region showing surface ownership and aerial imagery.

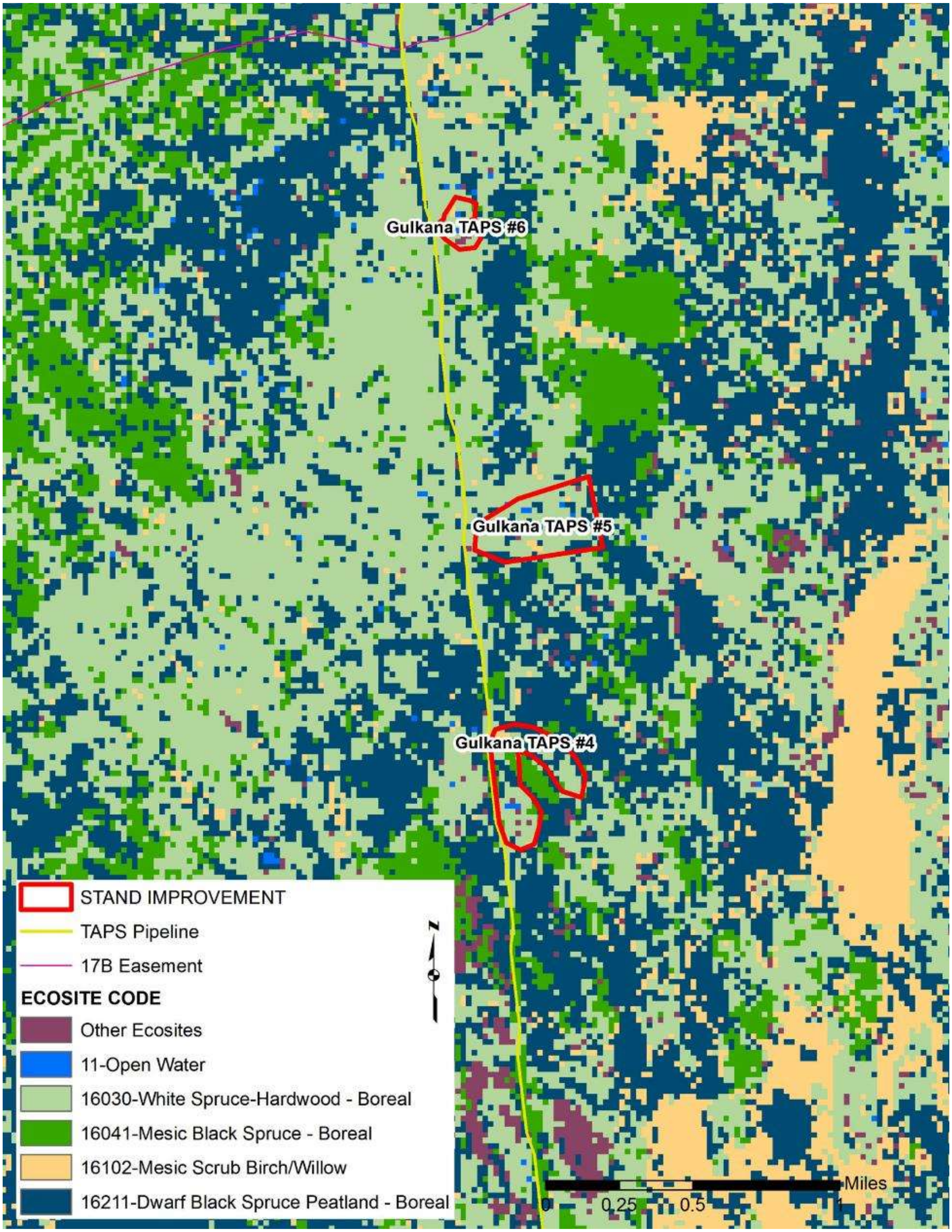


Figure 175. Map of proposed habitat improvement areas (Gulkana TAPS #4, #5, and #6) in the Gulkana Village planning region showing ecological sites.

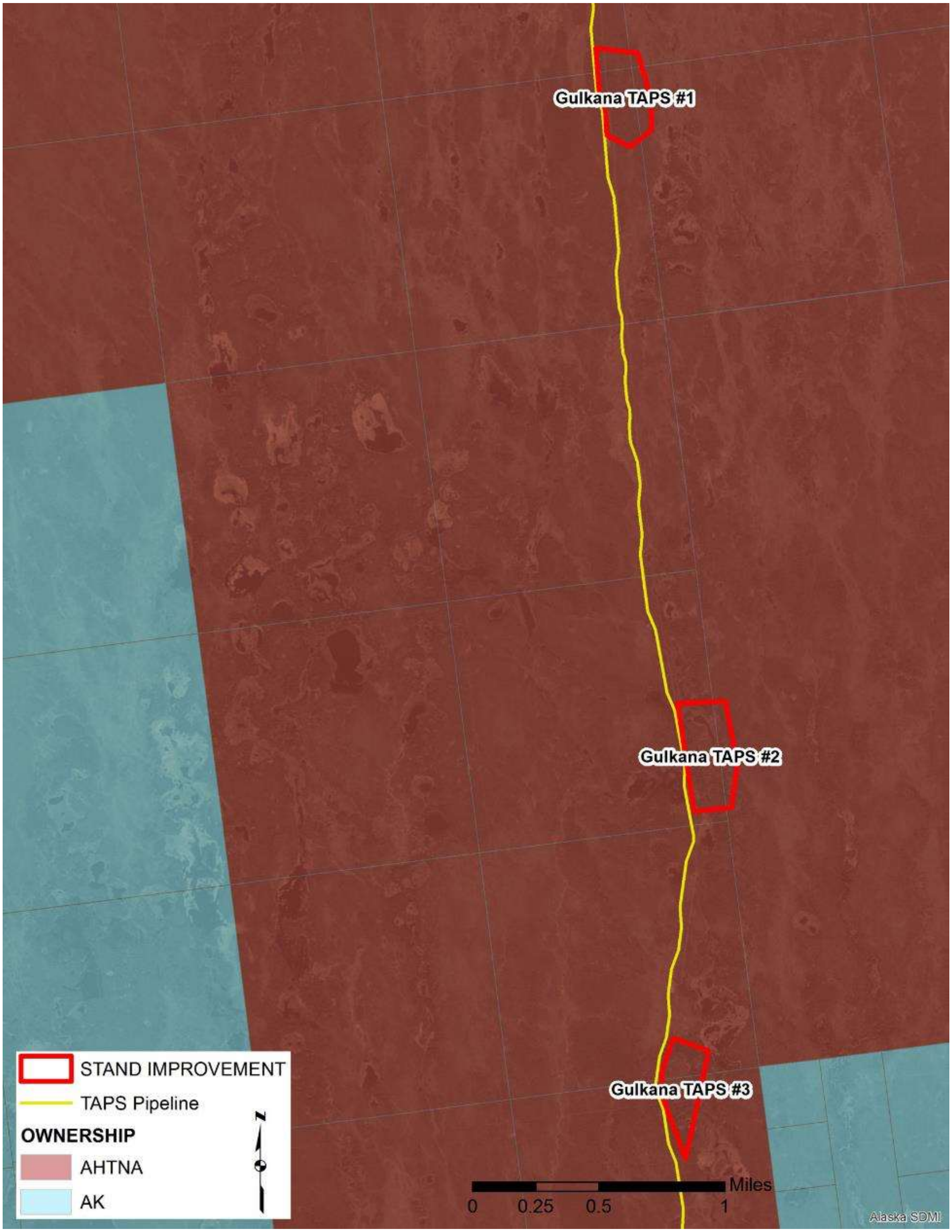


Figure 176. Map of proposed habitat improvement areas (Gulkana TAPS #1, #1, and #3) in the Gulkana Village planning region showing surface ownership and aerial imagery.

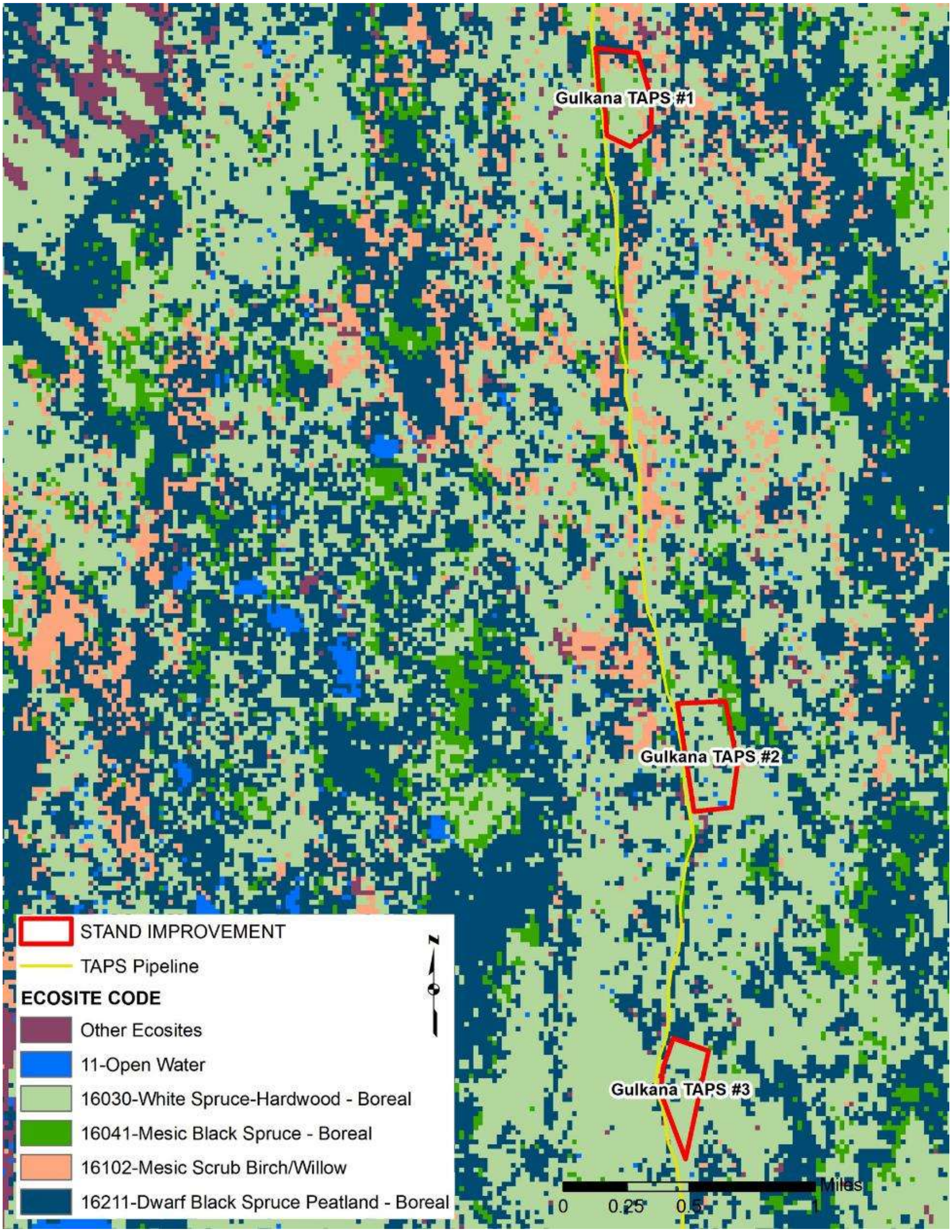


Figure 177. Map of proposed habitat improvement areas (Gulkana TAPS #1, #2, and #3) in the Gulkana Village planning region showing ecological sites.

Table 25. Vegetation treatment sites in the Kluti-Kaah Village planning region and their primary ecosystem type, treatment goal, size (acres), and total biomass (tons).

Treatment Site Name	Ecosystem Code	Primary Treatment Goal	Acres	Biomass (tons)
Beaver Dam	16030_C	Moose Browse	23.1	857.2
Copper Pit #1	16030_C	Moose Browse	8.8	299.3
Copper Pit #2	16030_C	Moose Browse	19.5	454.2
Gulkana Gravel Pit	16141_A	Biomass/Browse	30.3	78.9
Gulkana TAPS #1	16030_C	Moose Browse	39.9	1645.6
Gulkana TAPS #2	16030_C	Moose Browse	51.1	1922.6
Gulkana TAPS #3	16030_C	Moose Browse	32.6	1258.2
Gulkana TAPS #4	16030_C	Moose Browse	45.2	1372.1
Gulkana TAPS #5	16030_C	Moose Browse	53.4	1467.0
Gulkana TAPS #6	16030_C	Moose Browse	10.9	396.0
Highway East #1	16030_C		30.3	1355.7
Highway East #2	16030_C		26.6	1034.3
Pipeline Access #1	16030_C	Biomass/Browse	50.1	1562.1
Pipeline Access #2	16030_C	Biomass/Browse	48.7	1751.3
Tower Road #1	16030_C	Biomass/Browse	26.5	1044.0
Tower Road #2	16030_C	Biomass/Browse	15.5	625.9

Kluti-Kaah Village Management Plan

The Kluti-Kaah Village planning region encompasses an area of 390,361 acres. Figure 178 displays the overall planning area along with associated infrastructure. Ownership of this and the surrounding area is shown in Figure 179. As Figure 179 displays, land ownership patterns are varied in this area with Ahtna, Inc. owning 59.4% (231,824 acres) of the land.

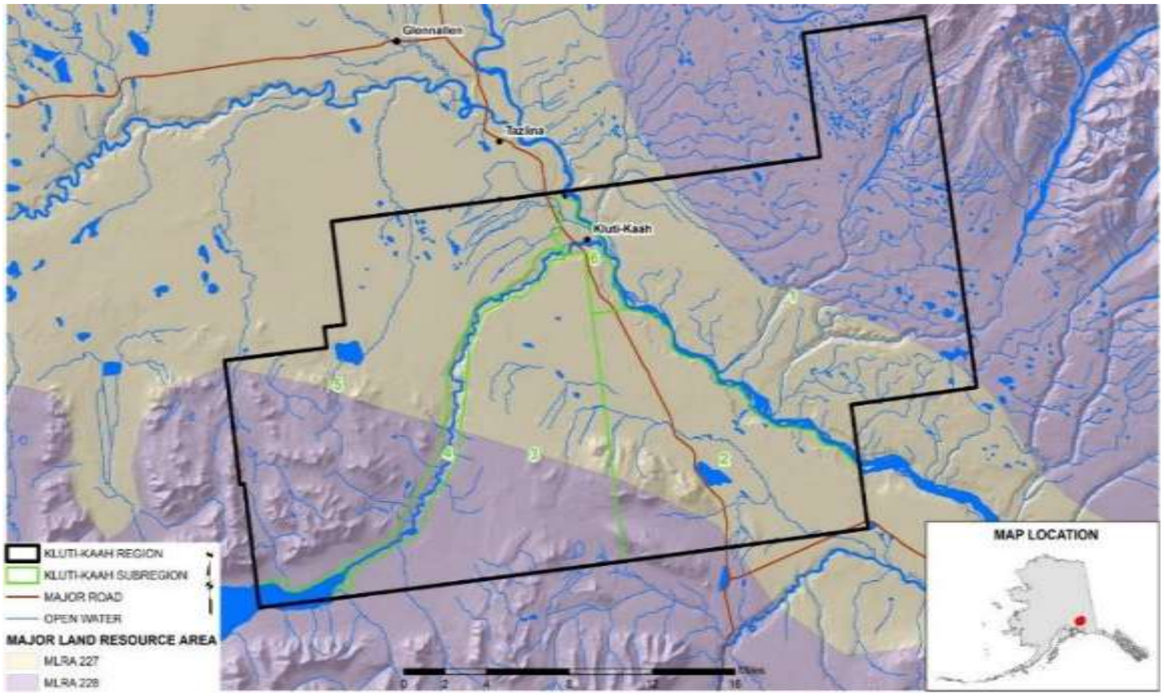


Figure 178. Overview of the Kluti-Kaah Village planning region.

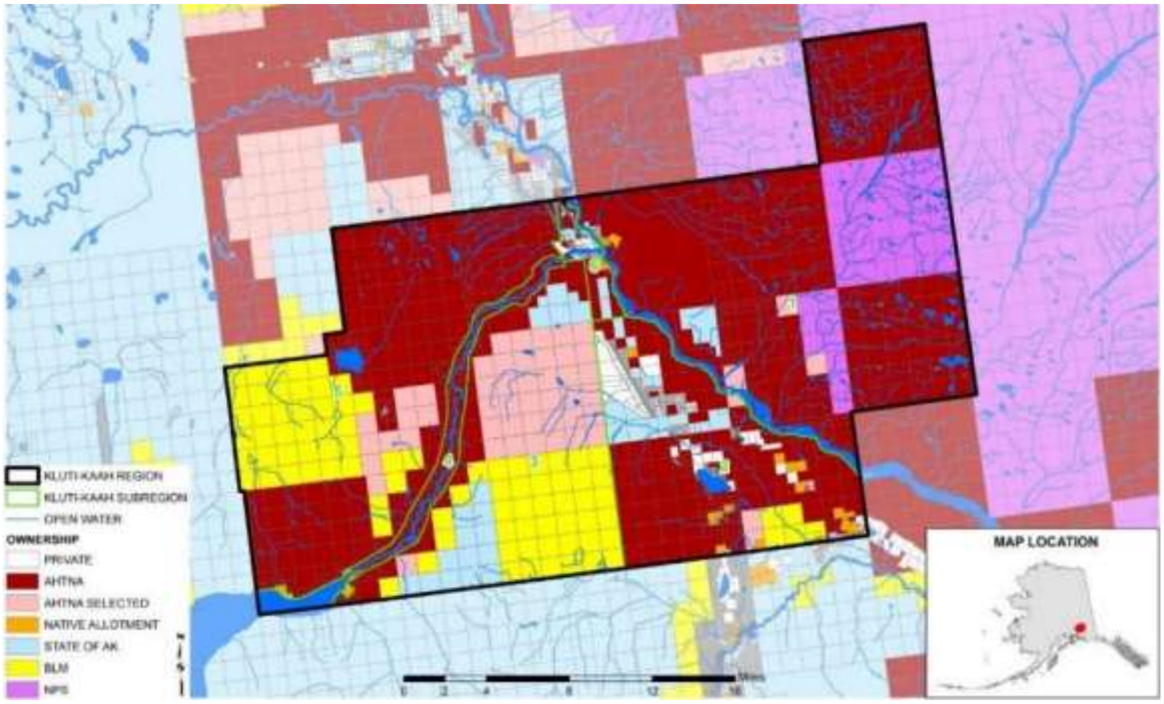


Figure 179. Land ownership patterns in the Kluti-Kaah Village planning region.

Planning Area Description

A description of the general geology, climate, soils, permafrost, and vegetation is found in Chapter 1 of this report. Figures showing these features specific to the Kluti-Kaah Village planning region are displayed below. Soil texture in the Kluti-Kaah area is shown in Figure 180 and Figure 181 displays soil drainages. Permafrost in the Kluti-Kaah area is shown in Figure 182.

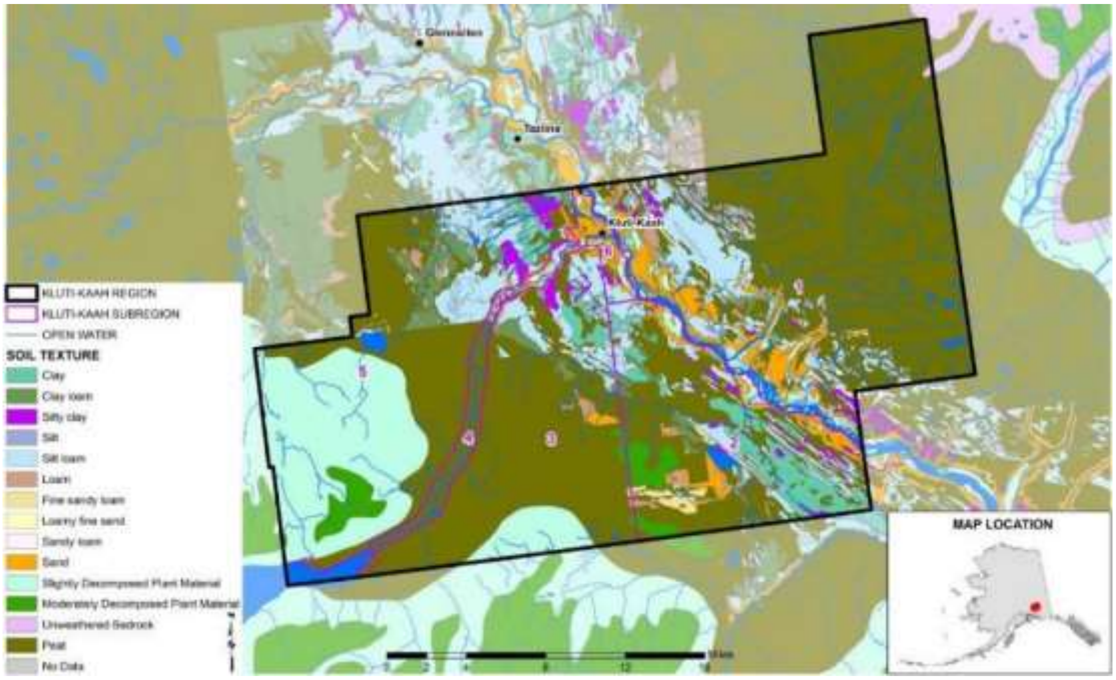


Figure 180. Soil texture in the Kluti-Kaah Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

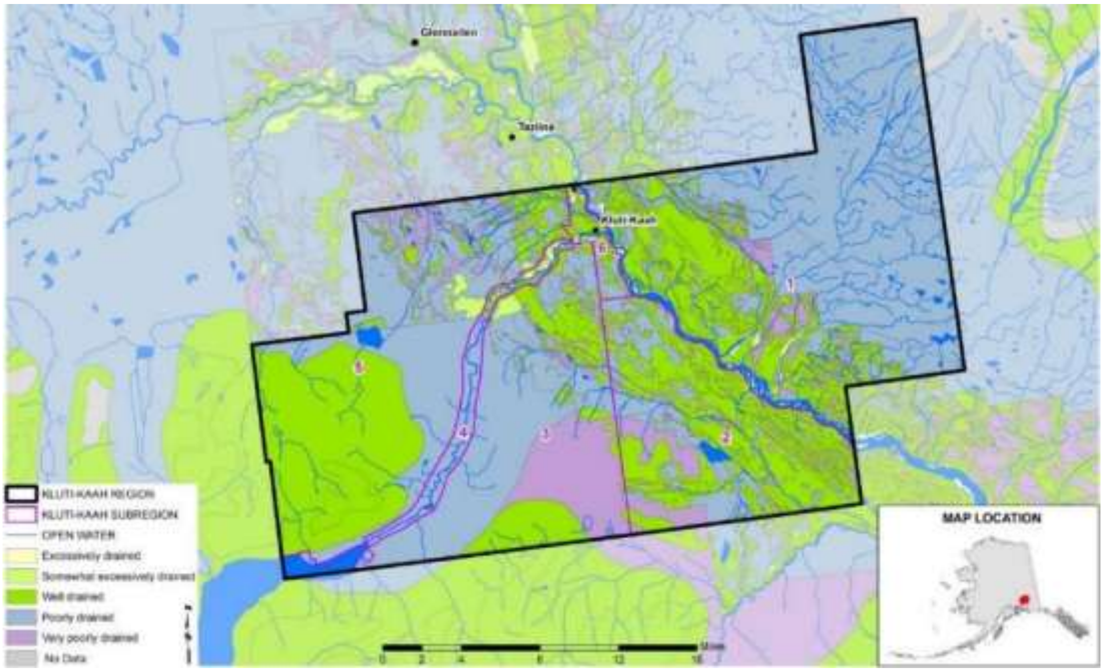


Figure 181. Soil drainage in the Kluti-Kaah Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

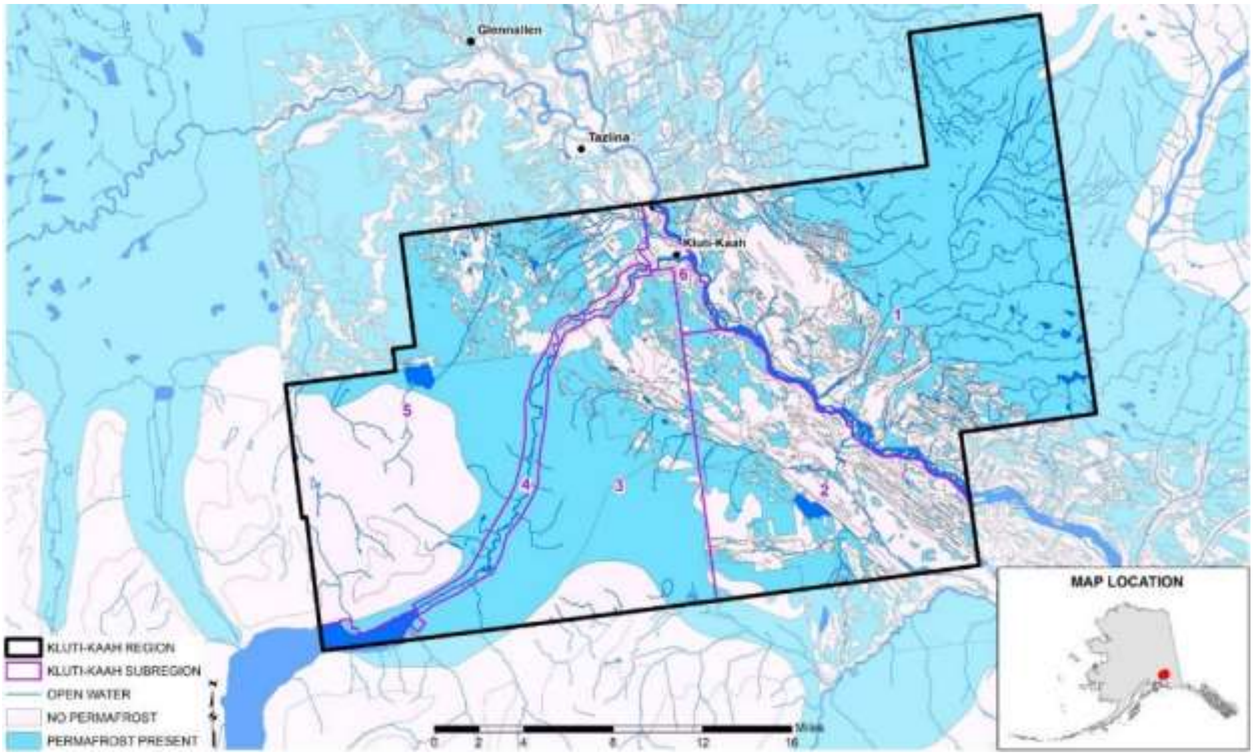


Figure 182. Permafrost in the Kluti-Kaah Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

Fire is the primary disturbance factor influencing the vegetation ecology in the Copper River Basin. Figure 183 shows the fire history of the Kluti-Kaah area along with current fire protection zones. Although the level of fire occurring in this southcentral Alaska landscape is substantially less than that occurring in more interior areas of Alaska north of the Alaska Range, fire is still a significant disturbance when it occurs. When fire does occur it serves to set back succession. It can also burn off the organic material at the ground surface, including peat that can occur on many sites. This can influence the thermal layer protecting the underlying permafrost on some sites, causing the permafrost to melt (thermokarst) and changing the site conditions through this process. Riparian areas are also influenced by flooding and ice events. These serve to set back succession of vegetation in riparian areas, and can even shift site conditions, particularly in the case of significant flooding events.

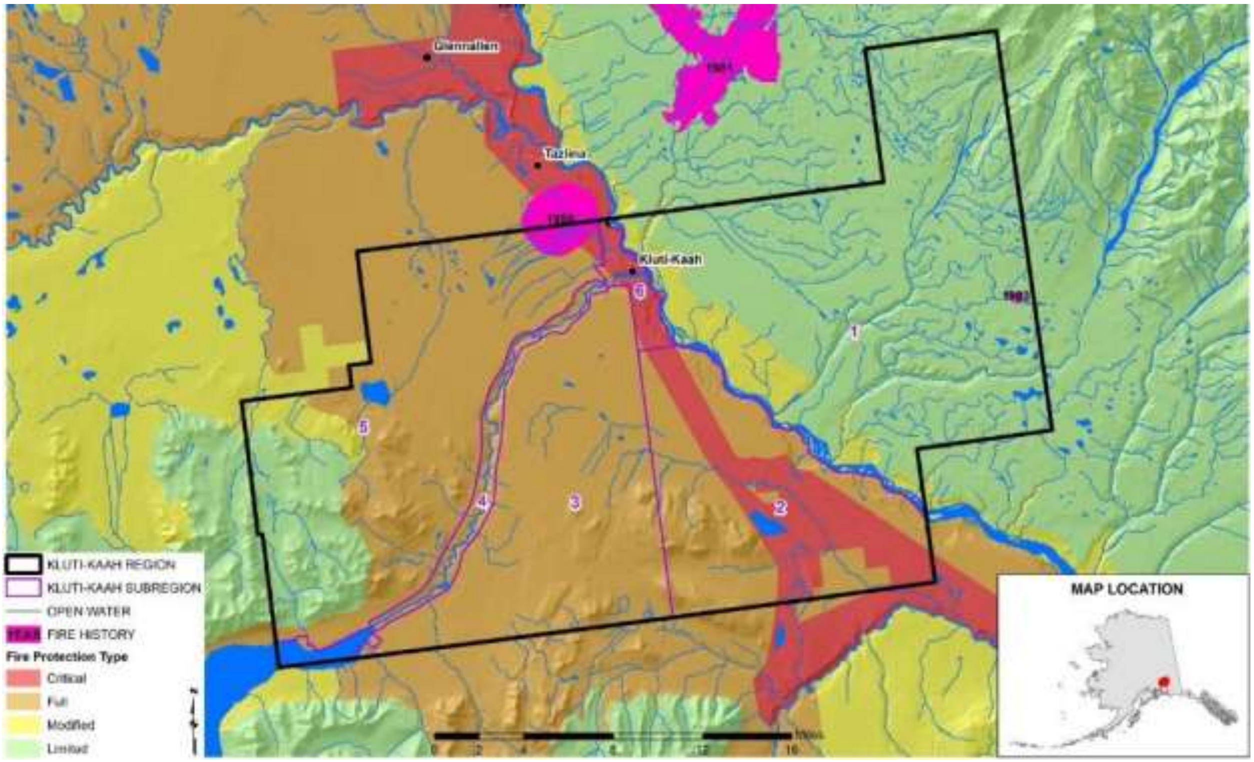


Figure 183. Current fire protection classes and fire history since 1940 in the Kluti-Kaah Village planning region. Data from Alaska Interagency Coordination Center.

Landscape Assessment Results

Ecosystem Diversity

The ecological sites present within the Kluti-Kaah Village planning region are displayed in Figure 184. Table 26 displays the acres for each ecological site and disturbance class. Figure 185 is a map of ecosystem diversity (represented by ecological site and disturbance class) in the Kluti-Kaah Village planning region.

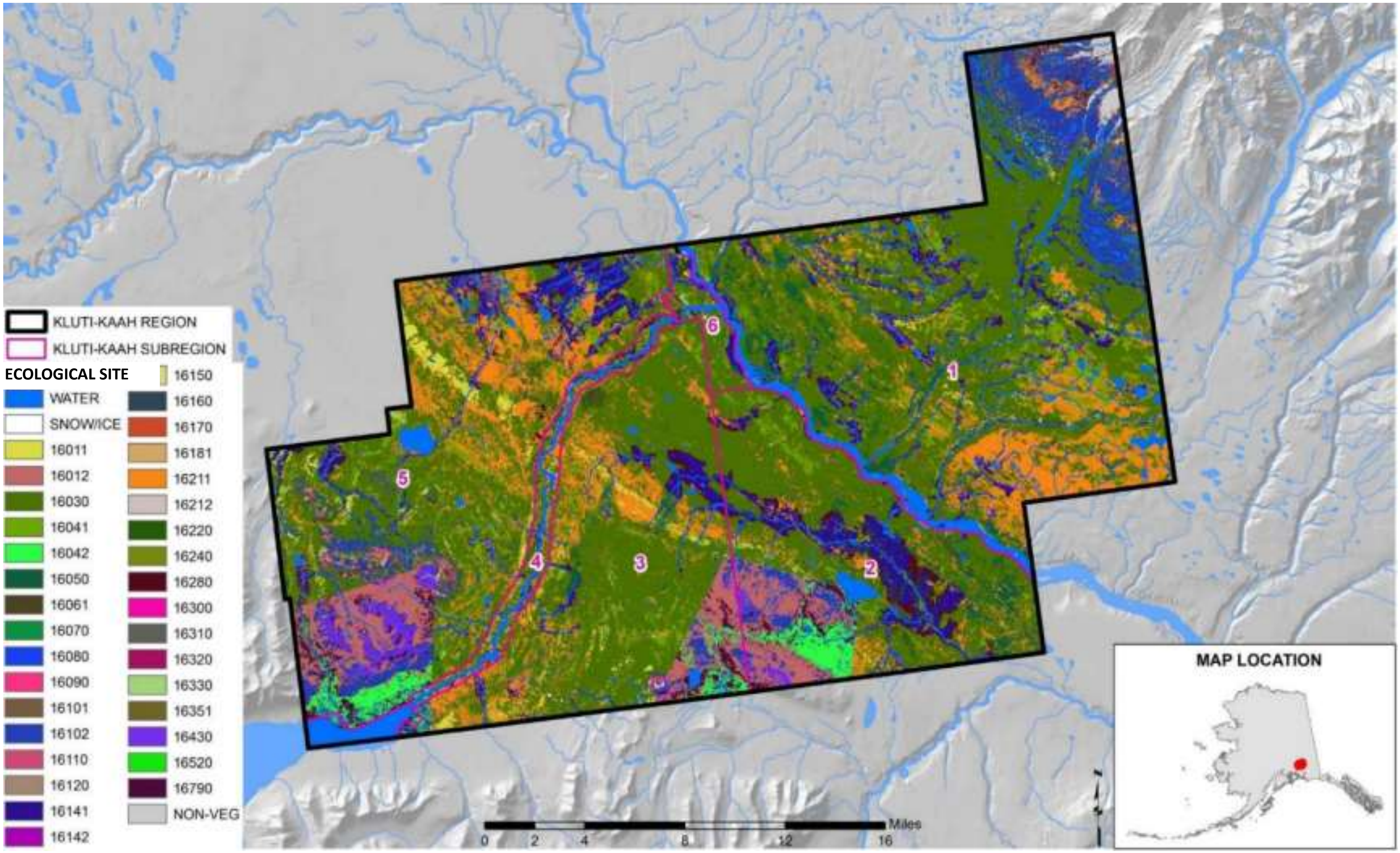


Figure 184. Ecological sites mapped in the Kluti-Kaah Village planning region. See Appendix A for ecological site code definitions.

Table 26. Ecosystems mapped in the Kluti-Kaah Village planning region and their associated acres. The ecological site vegetation label is provided as reference.

Ecosystem Code	Ecological Site Label	Acres	Ecosystem Code	Ecolgocal Site Label	Acres
11	Open Water	9212.0	16142_A	Montane Floodplain-Subboreal	2.0
12	Perrennial Ice-Snow	146.3	16142_B	Montane Floodplain-Subboreal	0.4
16011_A	Treeline White Spruce-Boreal	737.7	16142_C	Montane Floodplain-Subboreal	0.4
16011_B	Treeline White Spruce-Boreal	6929.2	16142_D	Montane Floodplain-Subboreal	1.8
16011_C	Treeline White Spruce-Boreal	2.0	16150_A	Large River Floodplain	190.6
16012_A	Treeline White Spruce-SubBoreal	2510.4	16150_B	Large River Floodplain	30.2
16012_B	Treeline White Spruce-SubBoreal	12957.2	16150_C	Large River Floodplain	49.8
16012_C	Treeline White Spruce-SubBoreal	3.6	16150_D	Large River Floodplain	2.9
16030_A	White Spruce-Hardwood-Boreal	2304.7	16150_E	Large River Floodplain	1.1
16030_B	White Spruce-Hardwood-Boreal	18647.2	16160_A	Riparian Stringer	2.0
16030_C	White Spruce-Hardwood-Boreal	151152.8	16160_B	Riparian Stringer	11.1
16030_E	White Spruce-Hardwood-Boreal	257.1	16170_A	Shrub and Herbaceous Floodplain	153.0
16041_A	Mesic Black Spruce-Boreal	808.2	16170_B	Shrub and Herbaceous Floodplain	8.9
16041_B	Mesic Black Spruce-Boreal	3209.2	16170_C	Shrub and Herbaceous Floodplain	1.6
16041_C	Mesic Black Spruce-Boreal	1922.6	16170_D	Shrub and Herbaceous Floodplain	1.6
16041_D	Mesic Black Spruce-Boreal	15856.1	16170_E	Shrub and Herbaceous Floodplain	44.3
16041_E	Mesic Black Spruce-Boreal	5.1	16181_A	Herbaceous Fen	47.6
16042_A	Mesic Black Spruce-SubBoreal	992.8	16181_B	Herbaceous Fen	10.7
16042_B	Mesic Black Spruce-SubBoreal	5678.9	16181_C	Herbaceous Fen	5.8
16042_C	Mesic Black Spruce-SubBoreal	295.1	16181_D	Herbaceous Fen	76.3
16042_D	Mesic Black Spruce-SubBoreal	1.6	16211_A	Dwarf Black Spruce Peatland-Boreal	1503.4
16050_A	Mesic Birch-Aspen	11065.3	16211_B	Dwarf Black Spruce Peatland-Boreal	2887.8
16050_B	Mesic Birch-Aspen	2841.3	16211_C	Dwarf Black Spruce Peatland-Boreal	4110.3
16050_D	Mesic Birch-Aspen	4.2	16211_D	Dwarf Black Spruce Peatland-Boreal	46672.3
16050_E	Mesic Birch-Aspen	8.9	16212_A	Dwarf Black Spruce Peatland-Subboreal	1.8
16061_A	Dry Aspen-Steppe Bluff	39.1	16212_B	Dwarf Black Spruce Peatland-Subboreal	3.8
16061_B	Dry Aspen-Steppe Bluff	482.8	16212_C	Dwarf Black Spruce Peatland-Subboreal	14.5
16061_C	Dry Aspen-Steppe Bluff	580.2	16220_A	Black Spruce Wet-Mesic Slope	177.2
16061_D	Dry Aspen-Steppe Bluff	1305.7	16220_B	Black Spruce Wet-Mesic Slope	191.3
16070_A	Subalpine Balsam Poplar-Aspen	10.9	16220_C	Black Spruce Wet-Mesic Slope	80.3
16070_B	Subalpine Balsam Poplar-Aspen	39.1	16220_D	Black Spruce Wet-Mesic Slope	962.7
16080_A	Avalanche Slope Shrubland	47.1	16240_A	Deciduous Shrub Swamp	574.4
16080_B	Avalanche Slope Shrubland	66.5	16240_B	Deciduous Shrub Swamp	8.0
16090_A	Mesic Subalpine Alder	283.6	16280_A	Low Shrub-Tussock Tundra	7553.0
16090_B	Mesic Subalpine Alder	325.1	16280_B	Low Shrub-Tussock Tundra	1316.8
16102_A	Mesic Scrub Birch-Willow	5820.5	16280_C	Low Shrub-Tussock Tundra	278.4
16102_B	Mesic Scrub Birch-Willow	19204.9	16290_A	Tussock Tundra	0.4
16110_A	Mesic Bluejoint Meadow	17.6	16300_A	Wet Black Spruce-Tussock	35.4
16120_A	Dry Grassland	10.5	16300_B	Wet Black Spruce-Tussock	24.0
16141_A	Montane Floodplain-Boreal	3118.9	16300_C	Wet Black Spruce-Tussock	81.6
16141_B	Montane Floodplain-Boreal	3788.7	16310_A	Alpine Dwarf-Shrub Summit	72.9
16141_C	Montane Floodplain-Boreal	1591.7	16310_B	Alpine Dwarf-Shrub Summit	0.9
16141_D	Montane Floodplain-Boreal	19285.0	16320_A	Alpine Talus and Bedrock	1458.2
16141_E	Montane Floodplain-Boreal	1432.4	16320_B	Alpine Talus and Bedrock	22.0

Table 26, continued. Ecosystems mapped in the Kluti-Kaah Village planning region and their associated acres. The ecological site vegetation label is provided as reference.

Ecosystem Code	Ecological Site Label	Acres
16330_A	Alpine Mesic Herbaceous Meadow	326.9
16351_A	Alpine Ericaceous Dwarf-Shrubland	2264.0
16351_B	Alpine Ericaceous Dwarf-Shrubland	70.9
16372_B	Alpine Floodplain	0.7
16430_A	Alpine Dwarf Shrubland	3121.3
16430_B	Alpine Dwarf Shrubland	98.3
16481_A	Mountain Hemlock	0.7
16500_A	Periglacial Woodland-Shrubland	0.7
16500_B	Periglacial Woodland-Shrubland	0.2
16520_A	Subalpine Alder-Salmonberry	3.1
Ecosystem Code	Ecolgocal Site Label	Acres
16520_B	Subalpine Alder-Salmonberry	4.0
16550_A	Montane Floodplain	1.3
16590_A	Mountain Hemlock Peatland	0.4
16620_A	Emergent Marsh	0.7
16790_A	White Spruce-Hardwood-SubBoreal	939.8
16790_B	White Spruce-Hardwood-SubBoreal	4760.1
16790_C	White Spruce-Hardwood-SubBoreal	143.0
16790_D	White Spruce-Hardwood-SubBoreal	8.2
31	Barren-Rock-Sand-Clay	4797.1

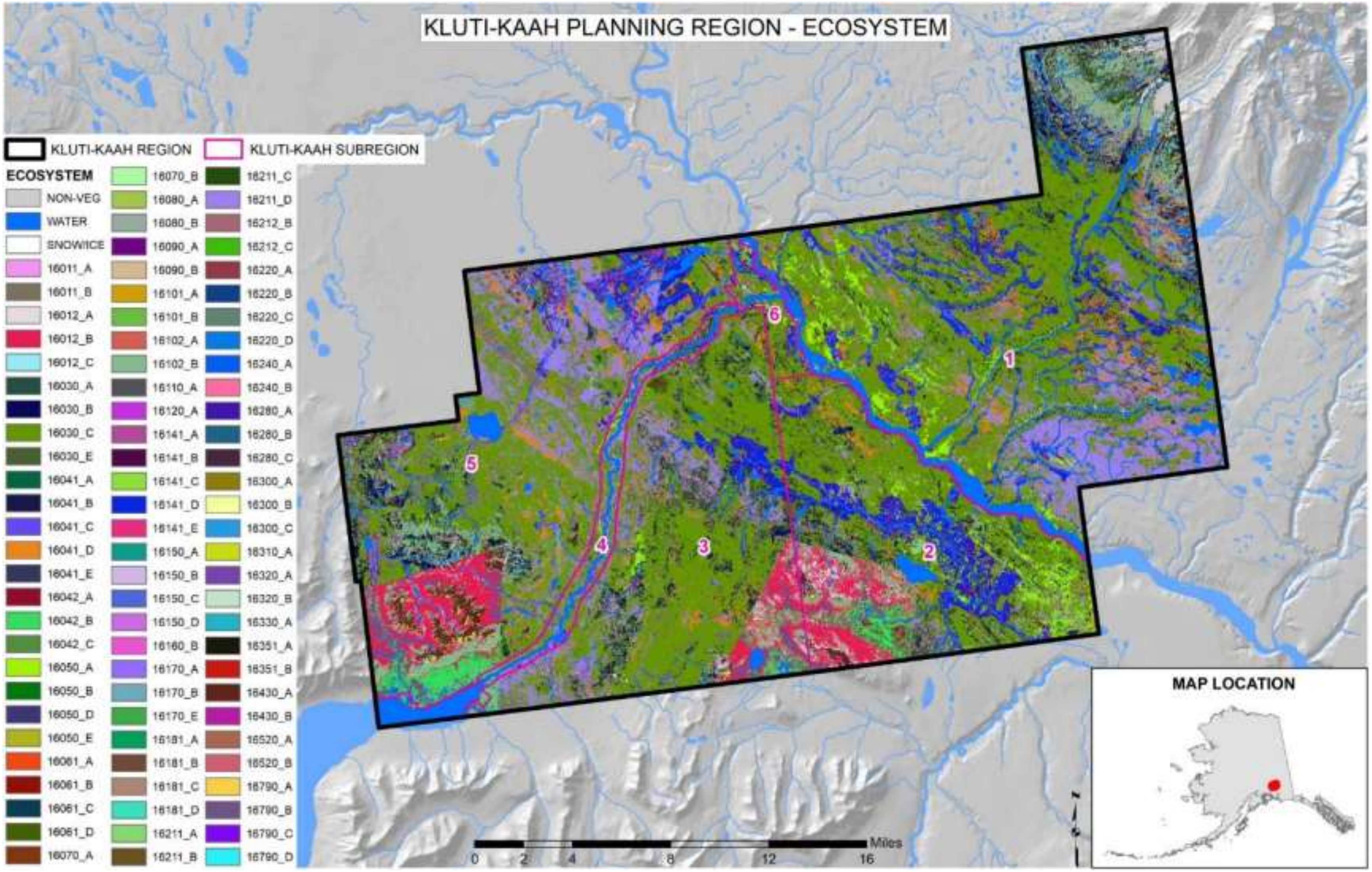


Figure 185. Ecosystem diversity in the Kluti-Kaah Village planning region. See Appendix A for ecosystem code definitions..

Berry Production Areas

Figure 186 shows the areas identified with the highest potential for berry production. It may be desirable to avoid disturbances to these areas, but verifying the actual presence of good berry production is recommended on a site by site basis.

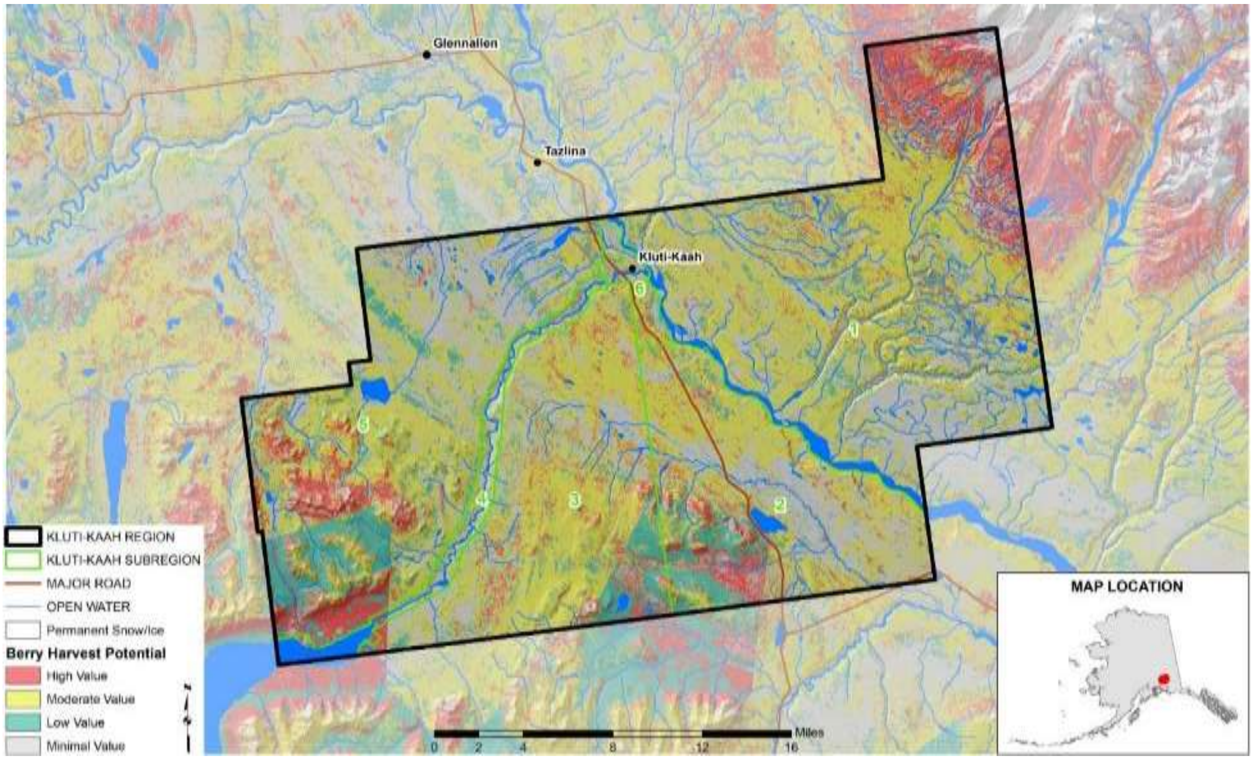


Figure 186. Potential berry production values in the Kluti-Kaah Village planning region.

Moose and Caribou Habitat Quality Assessment - Model Results

Moose

Ecosystem-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 187 to 189. Landscape-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 190 to 192. A complete description of the moose habitat quality models can be found in Appendix B.

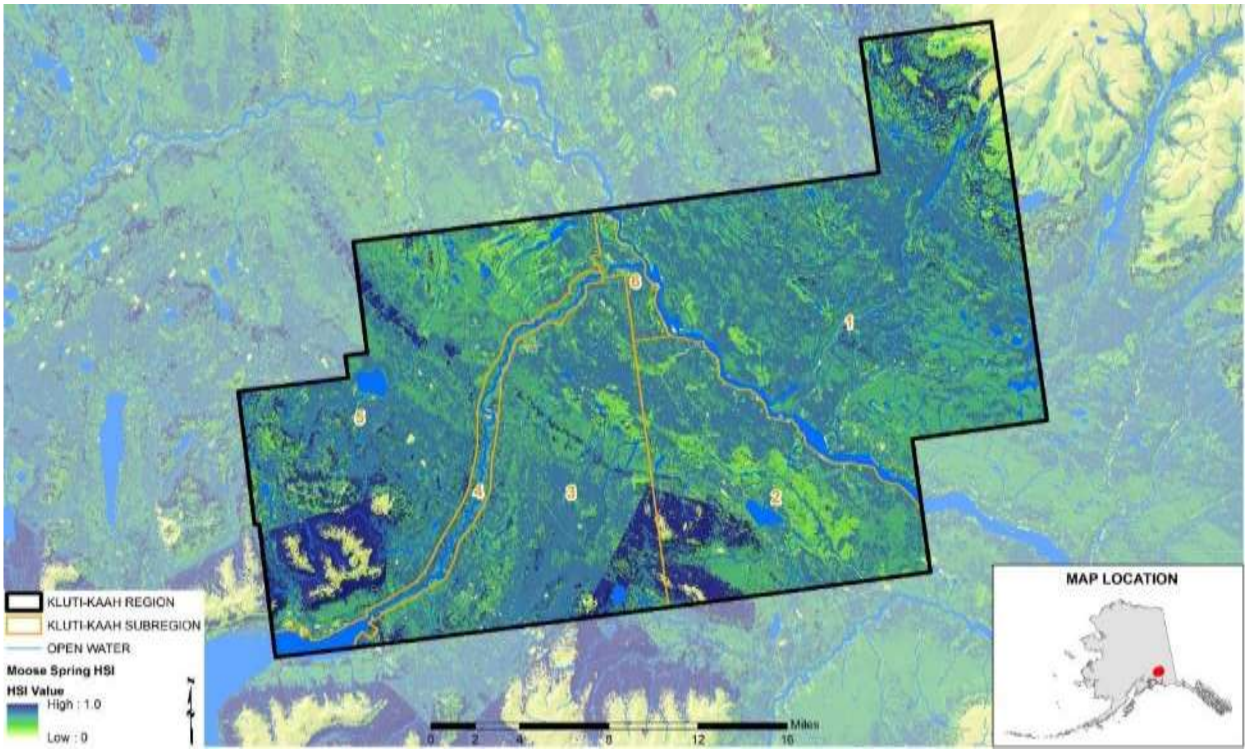


Figure 187. Results of the ecosystem-scale model outputs for moose spring habitat quality.

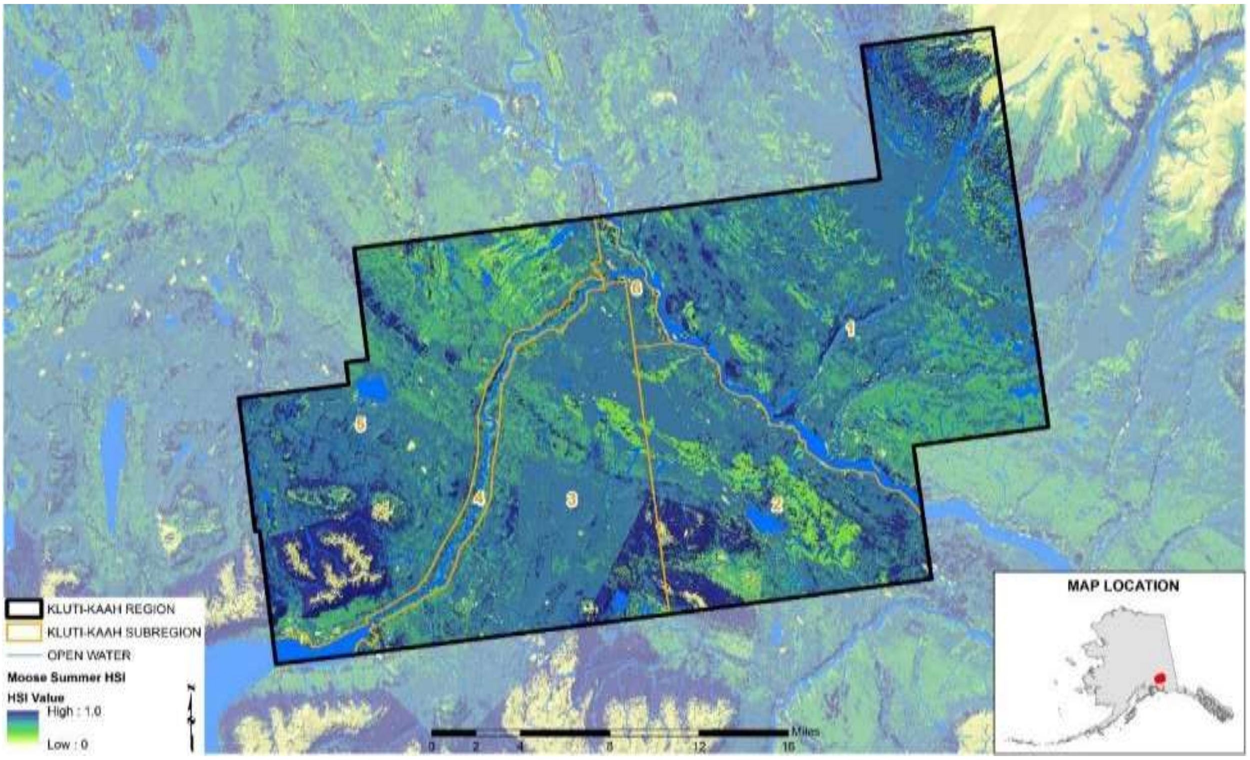


Figure 188. Results of the ecosystem-scale model outputs for moose summer habitat quality.

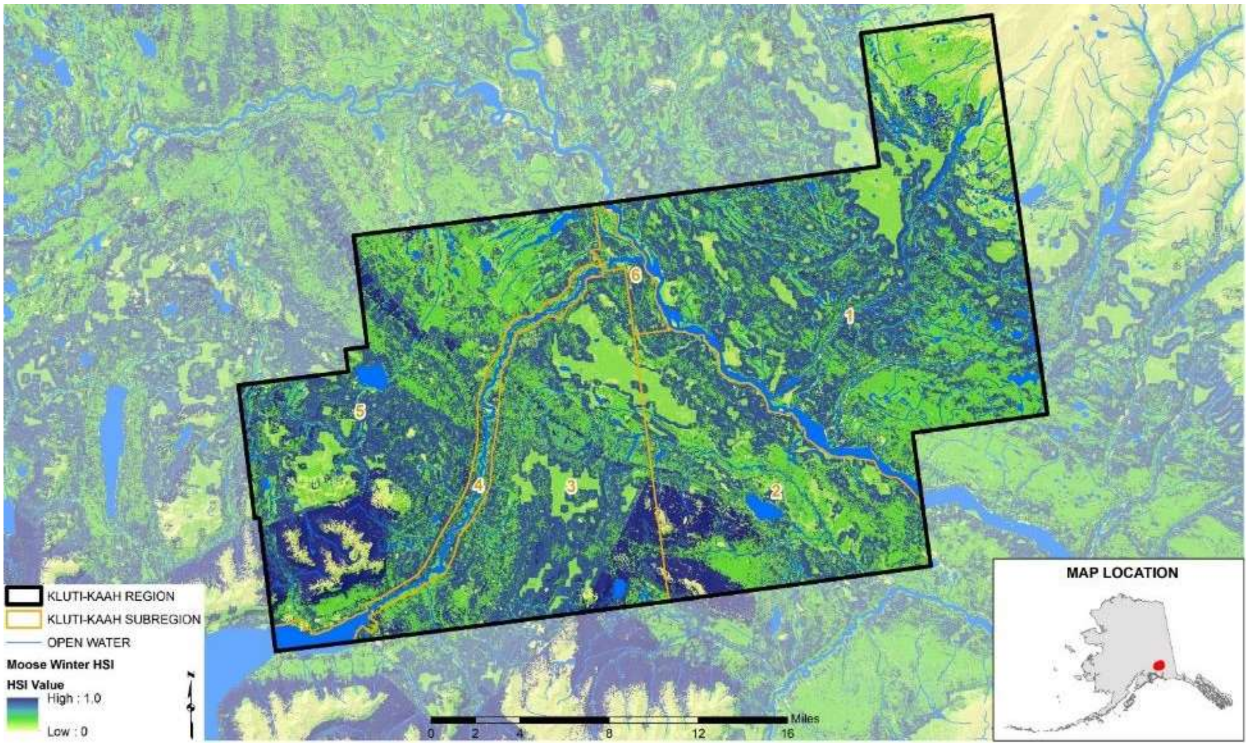


Figure 189. Results of the ecosystem-scale model outputs for moose winter habitat quality.

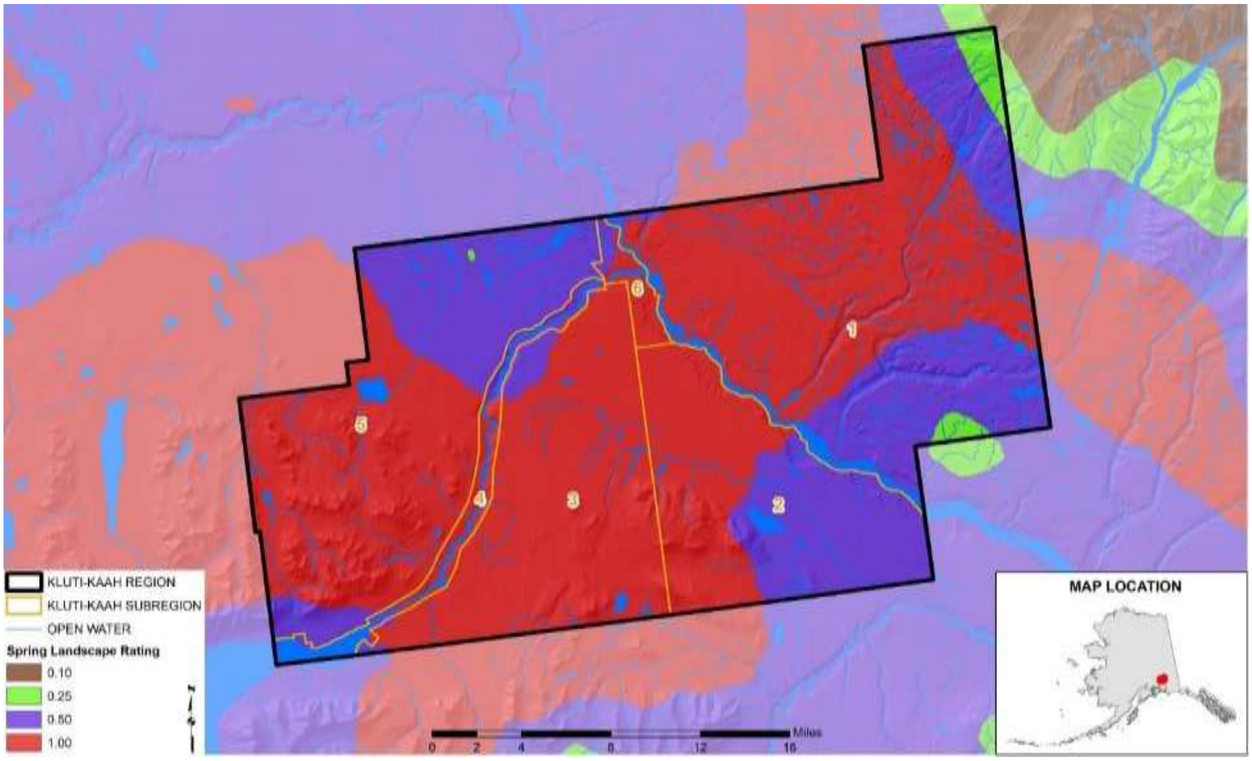


Figure 190. Results of the landscape-scale model outputs for moose spring habitat quality.

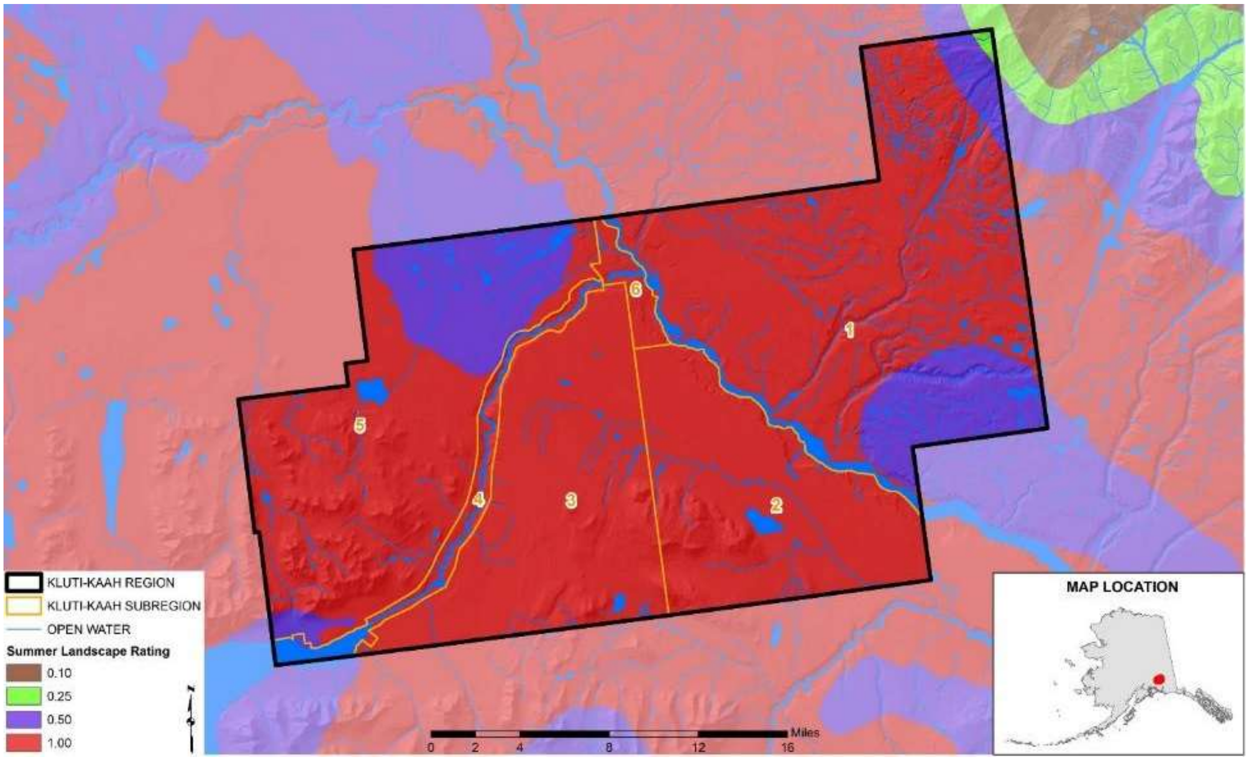


Figure 191. Results of the landscape-scale model outputs for moose summer habitat quality.

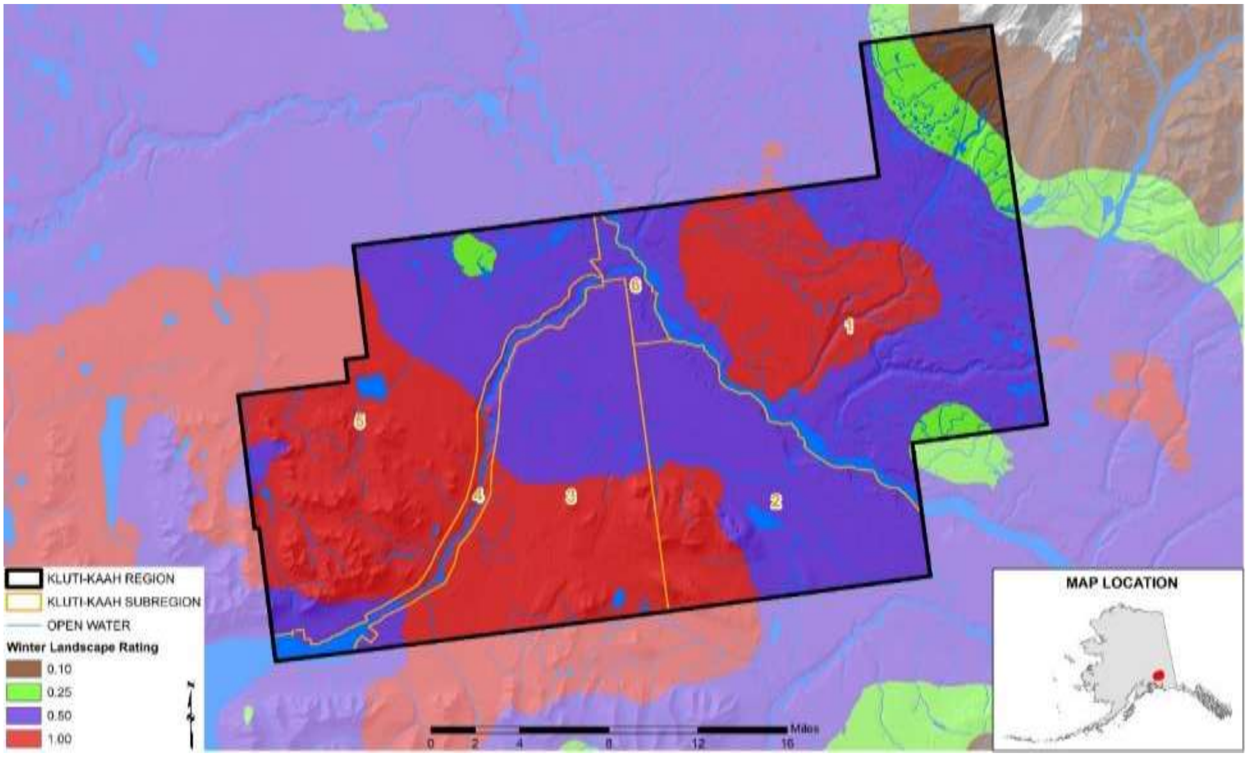


Figure 192. Results of the landscape-scale model outputs for moose winter habitat quality.

Caribou

Ecosystem-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 193 and 194. Landscape-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 195 and 196. A complete description of the caribou habitat quality models can be found in Appendix C.

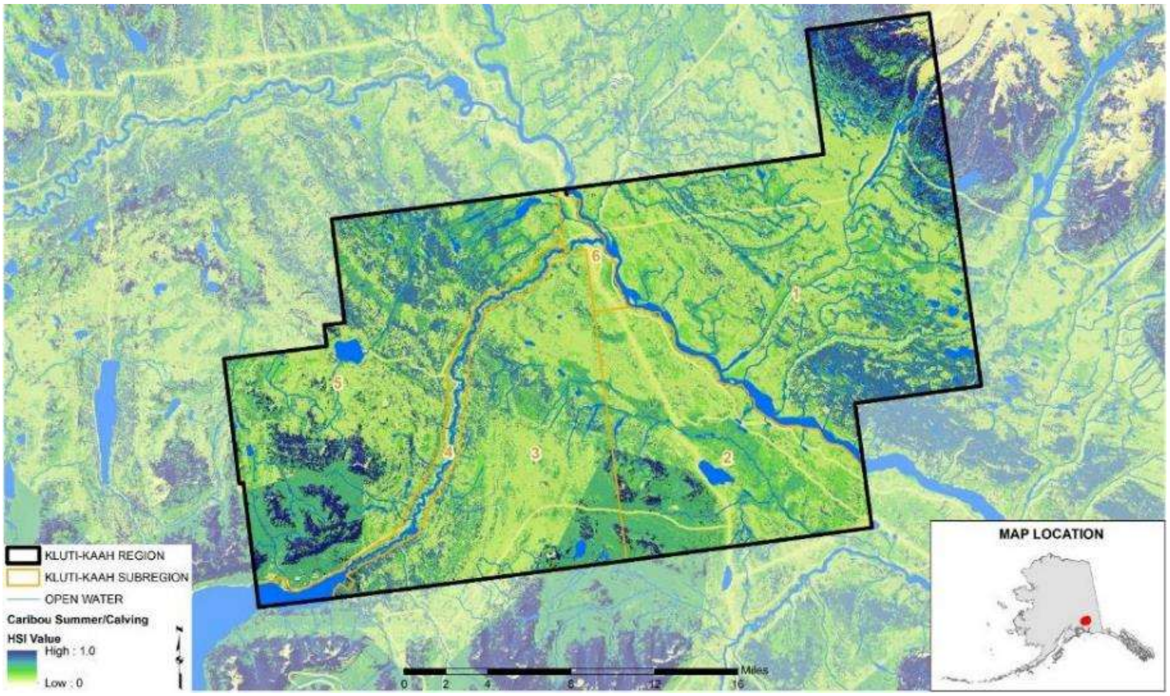


Figure 193. Results of the ecosystem-scale model outputs for caribou summer/calving habitat quality.

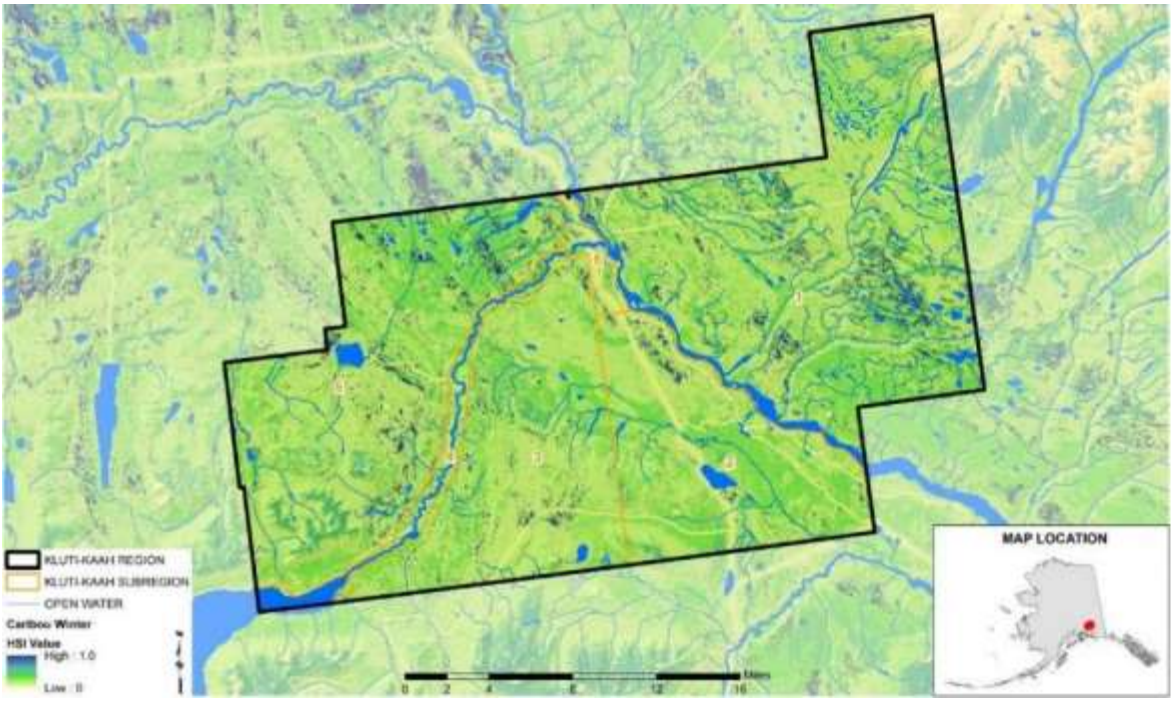


Figure 194. Results of the ecosystem-scale model outputs for caribou winter habitat quality.

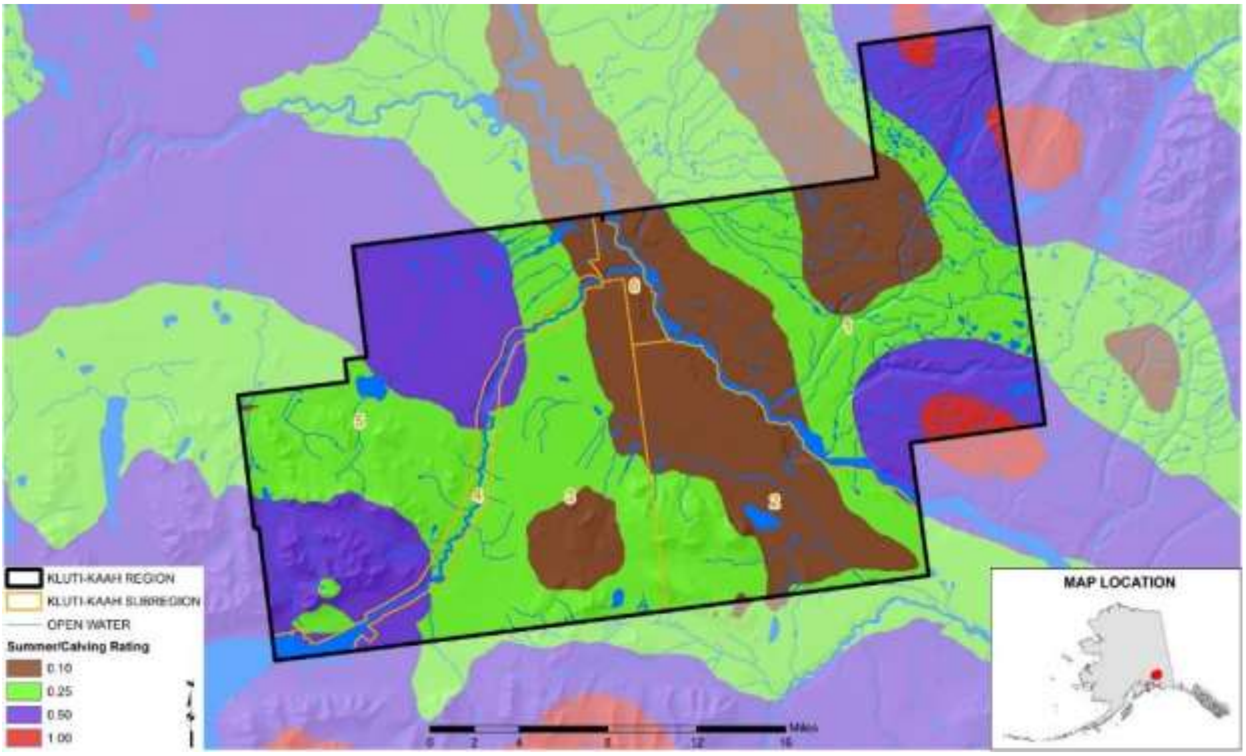


Figure 195. Results of the landscape-scale model outputs for caribou summer/calving habitat quality.

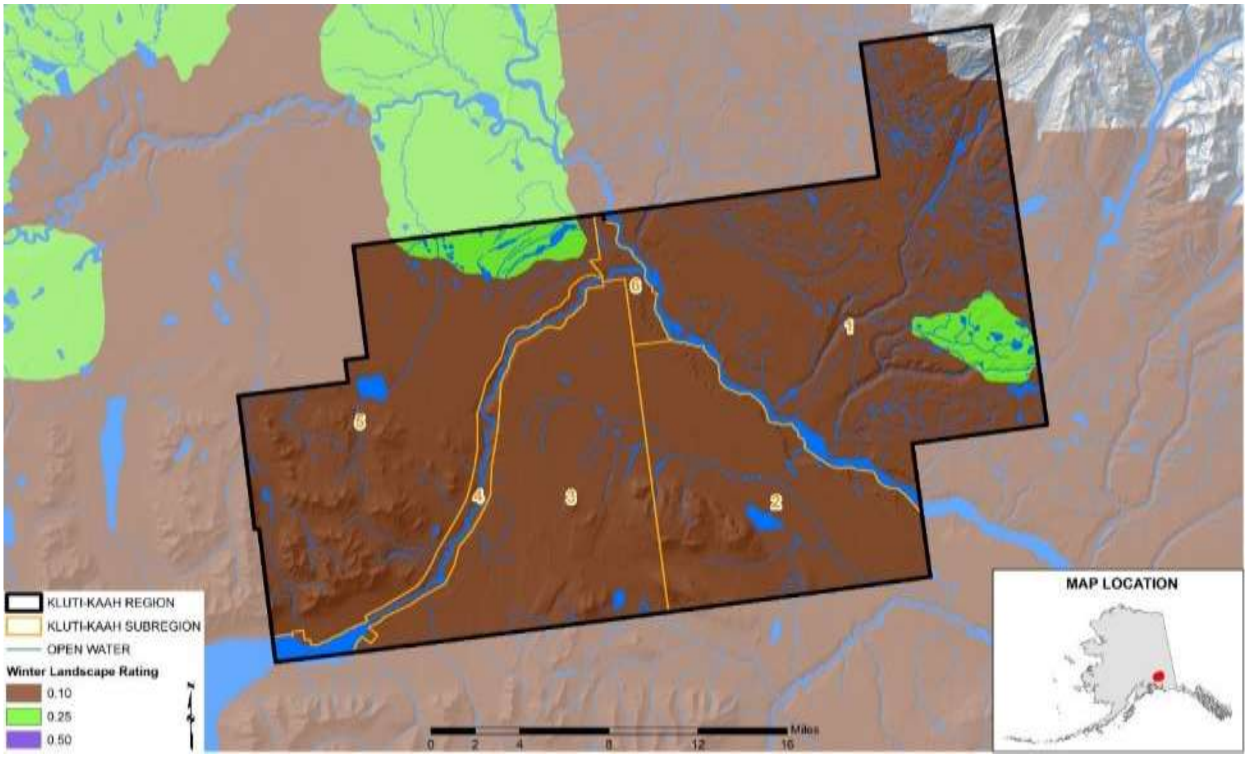


Figure 196. Results of the landscape-scale model outputs for caribou winter habitat quality.

Kluti-Kaah Site Improvement Areas

Potential treatment sites identified in the Kluti-Kaah area are displayed in figure 197. Based on all of the stated criteria, a number of sites were located for designated treatments. Figures 198-200 depict the locations of these areas. Appendix C provides a description of each of these sites. Sites ranging from approximately 35-52 acres in size were identified and are listed in Table 27. This table gives the site size and the treatment goal of primarily timber stand improvement and biomass production or moose browse enhancement. The table also displays an estimate of the total biomass of all standing above ground biomass. This estimate is not tonnage of usable biomass for energy but the total of all stems regardless of size. However, stands on the higher end of the total amount will typically have larger trees and are a candidate for biomass energy production.

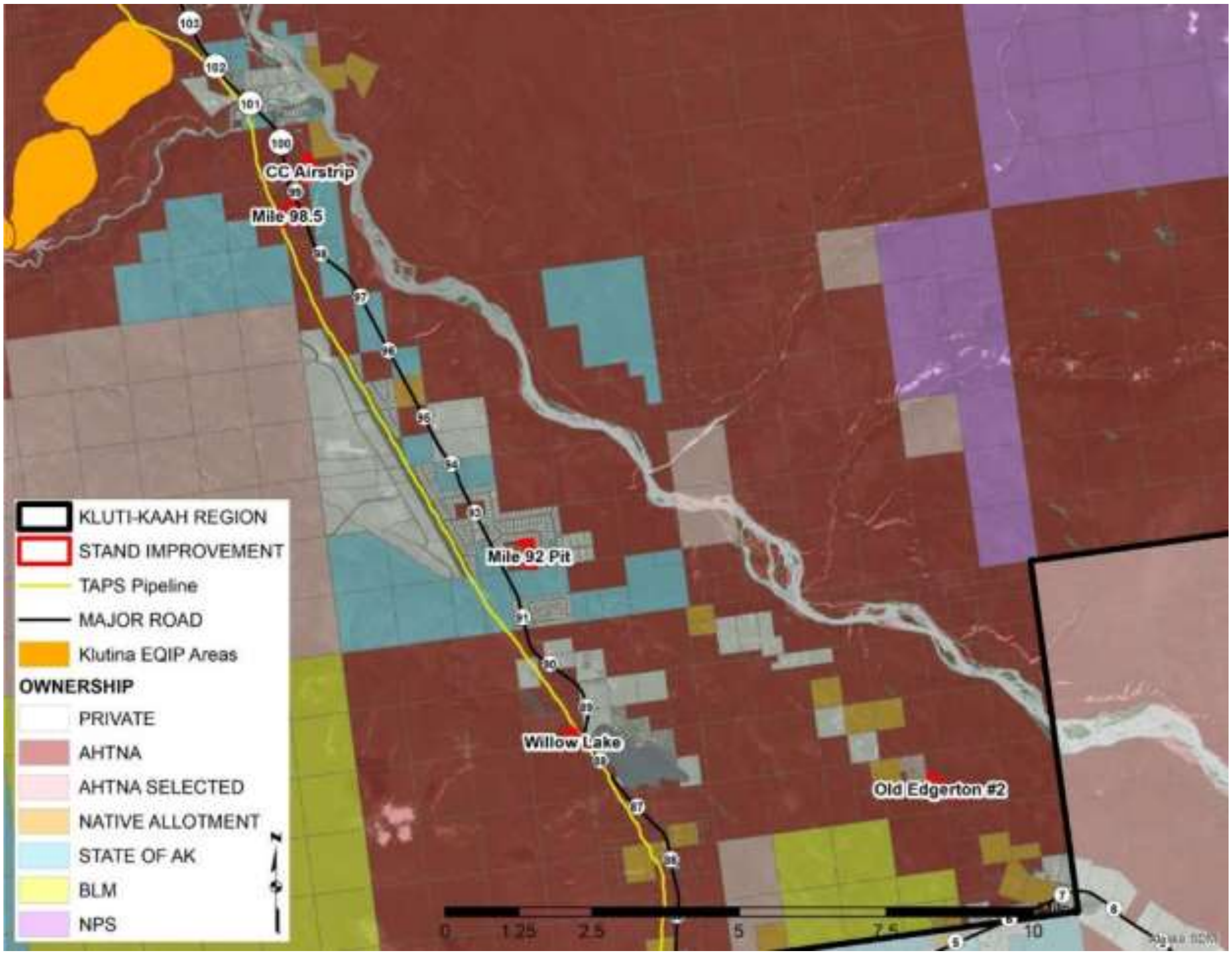


Figure 197. Overview of recommended treatment sites in the Kluti-Kaah Village planning region.

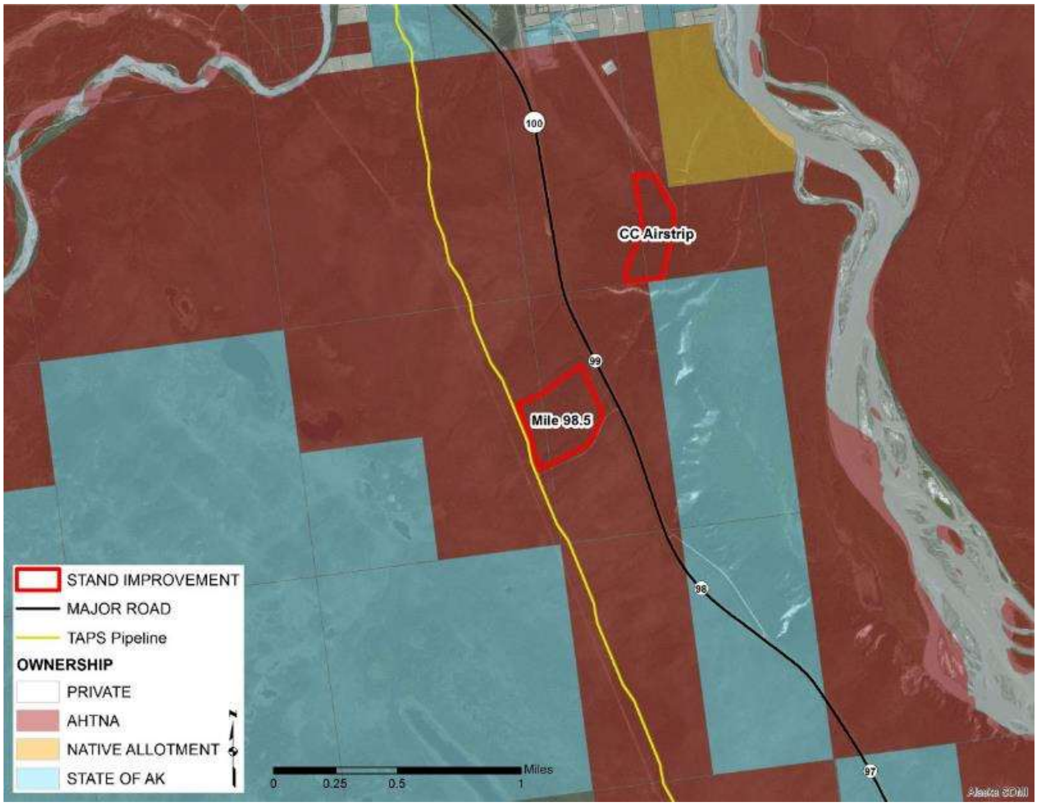


Figure 198. Map of proposed treatment areas (CC Airstrip and Mile 98.5) in the Kluti-Kaah Village planning region showing surface ownership and aerial imagery.

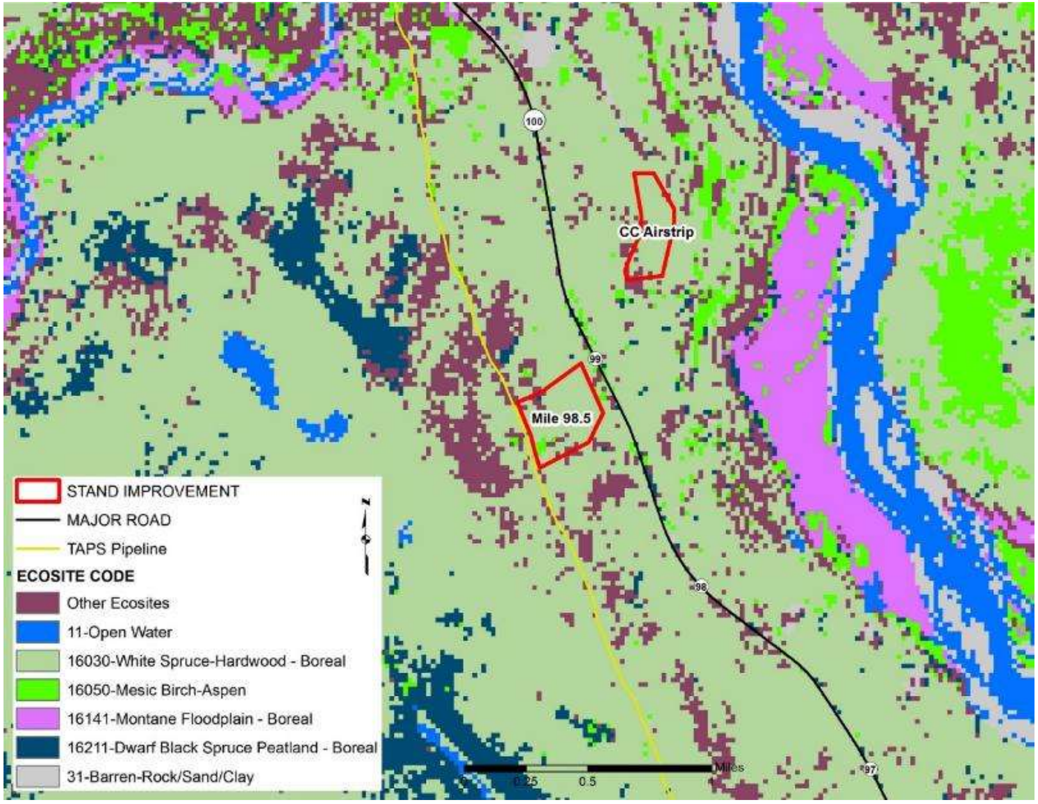


Figure 199. Map of proposed treatment areas (CC Airstrip and Mile 98.5) in the Kluti-Kaah Village planning region showing ecological sites.

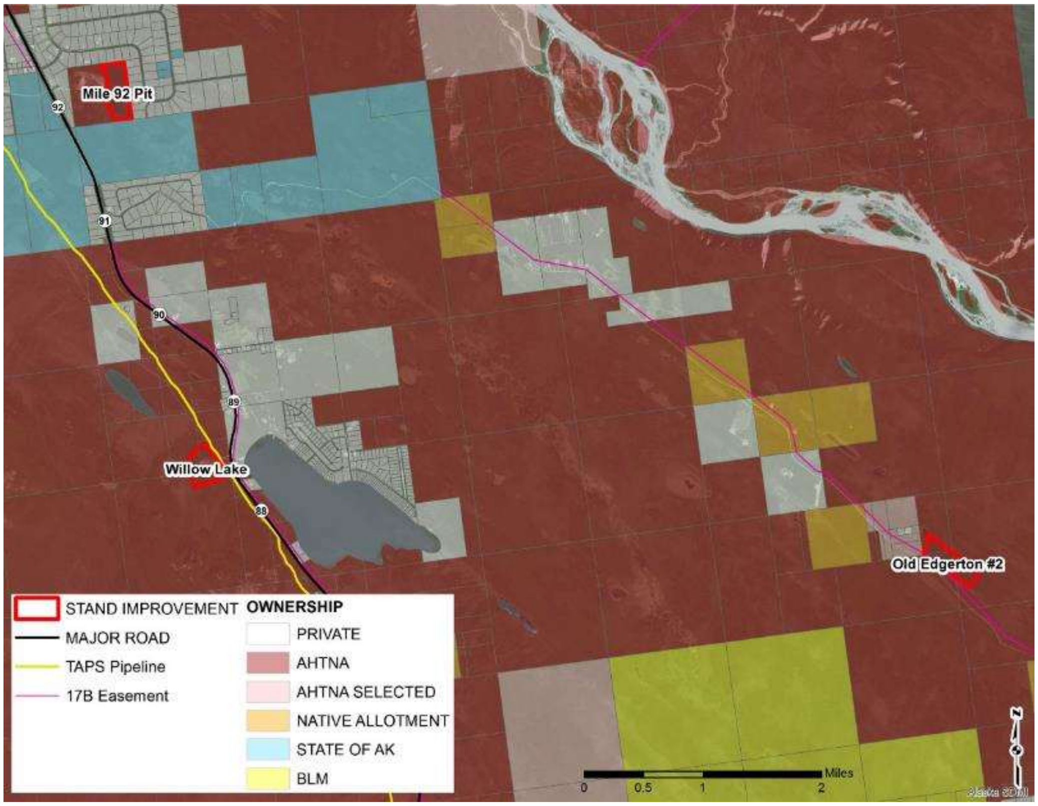


Figure 200. Map of proposed habitat improvement areas (Mile 92 Pit, Willow Lake, and Old Edgerton #2) in the Kluti-Kaah Village planning region showing surface ownership and aerial imagery.

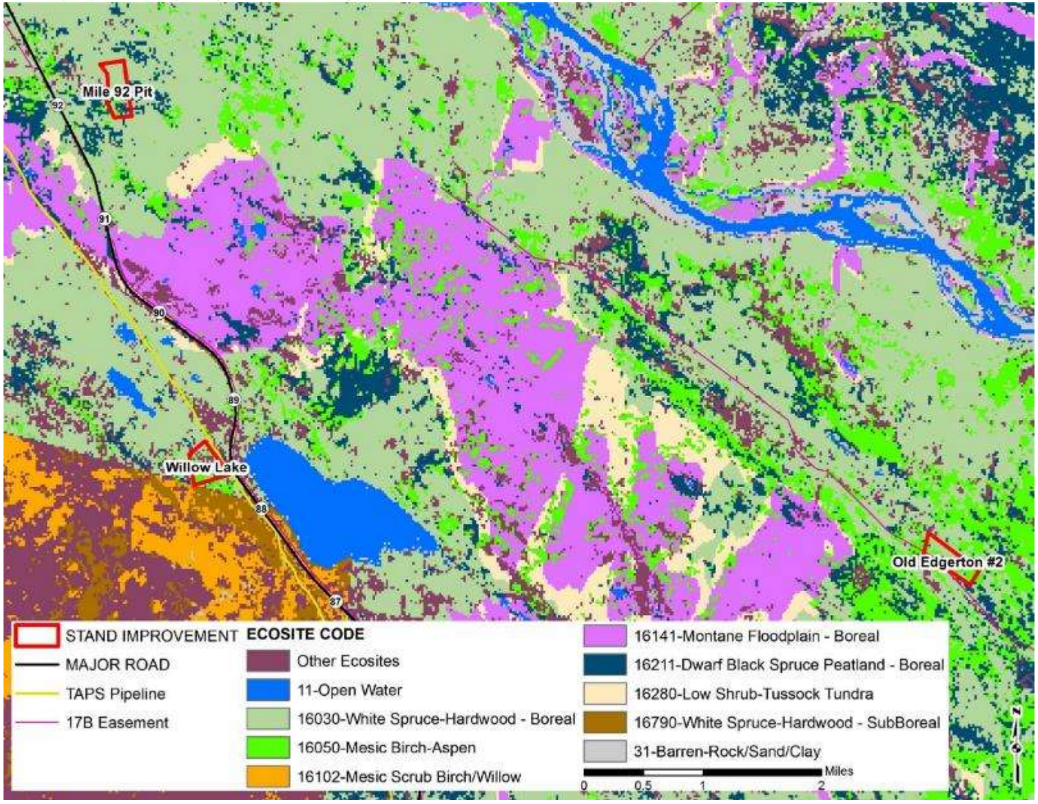


Figure 201. Map of proposed habitat improvement areas (Mile 92 Pit, Willow Lake, and Old Edgerton #2) in the Kluti-Kaah Village planning region showing ecological sites.

Table 27. Treatment site with treatment goal, site size, total tons of biomass and the ecological site code and disturbance class for each site in the Kluti-Kaah Village planning region.

Treatment Site Name	Ecosystem Code	Primary Treatment Goal	Acres	Biomass (tons)
CC Airstrip	16030_C	Biomass/Browse	34.8	1668.0
Mile 92 Pit	16030_C	Biomass/Timber/Browse	51.2	1976.0
Mile 98.5	16030_C	Moose Browse	52.4	2426.6
Old Edgerton #2	16030_C	Moose Browse	49.9	1227.9
Willow Lake	16030_C	Moose Browse	44.9	784.3

Mentasta Village Management Plan

The Mentasta area includes an area of 641,274 acres. Figure 202 displays the overall planning area along with associated infrastructure. Ownership of this and the surrounding area is shown in Figure 203. As Figure 203 displays, land ownership patterns are varied in this area with Ahtna owning 42.0% (269,100 acres) of the land.

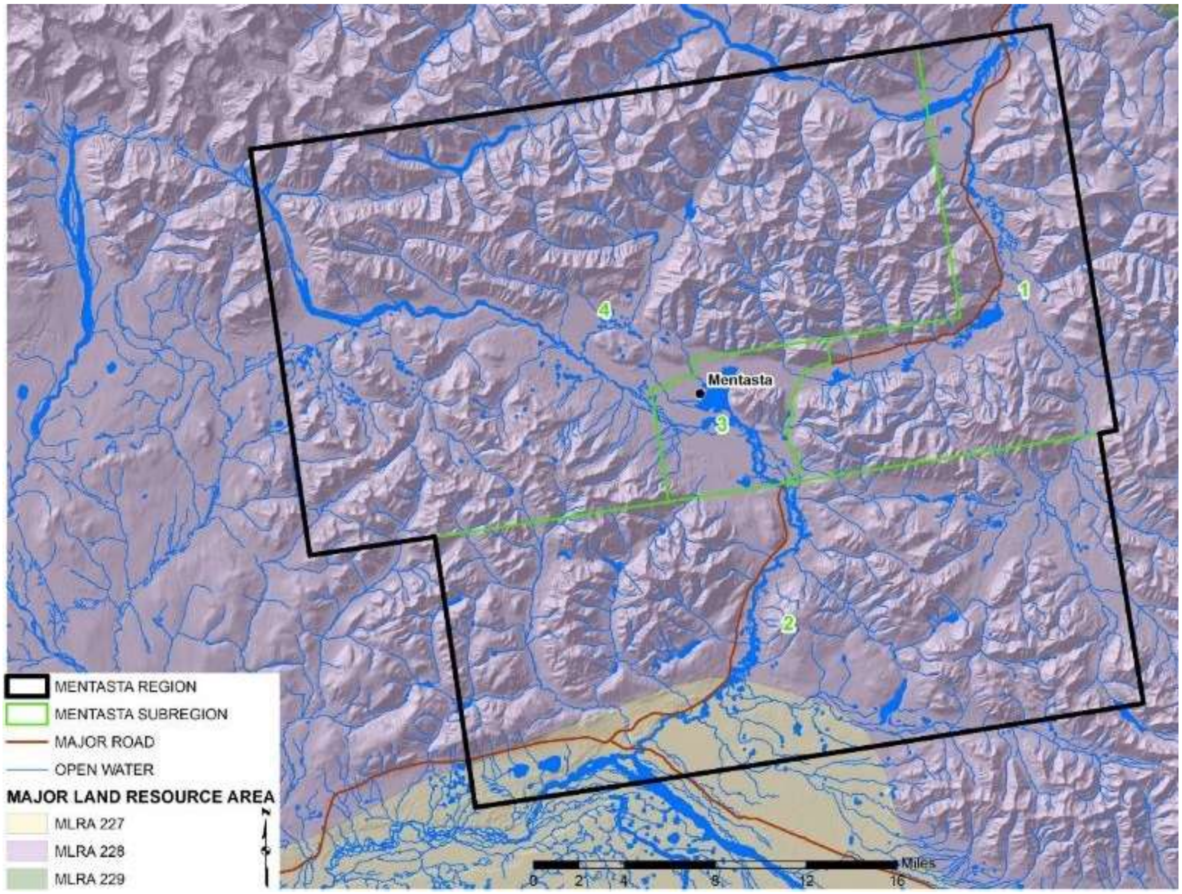


Figure 202. Overview of the Mentasta Village planning region.

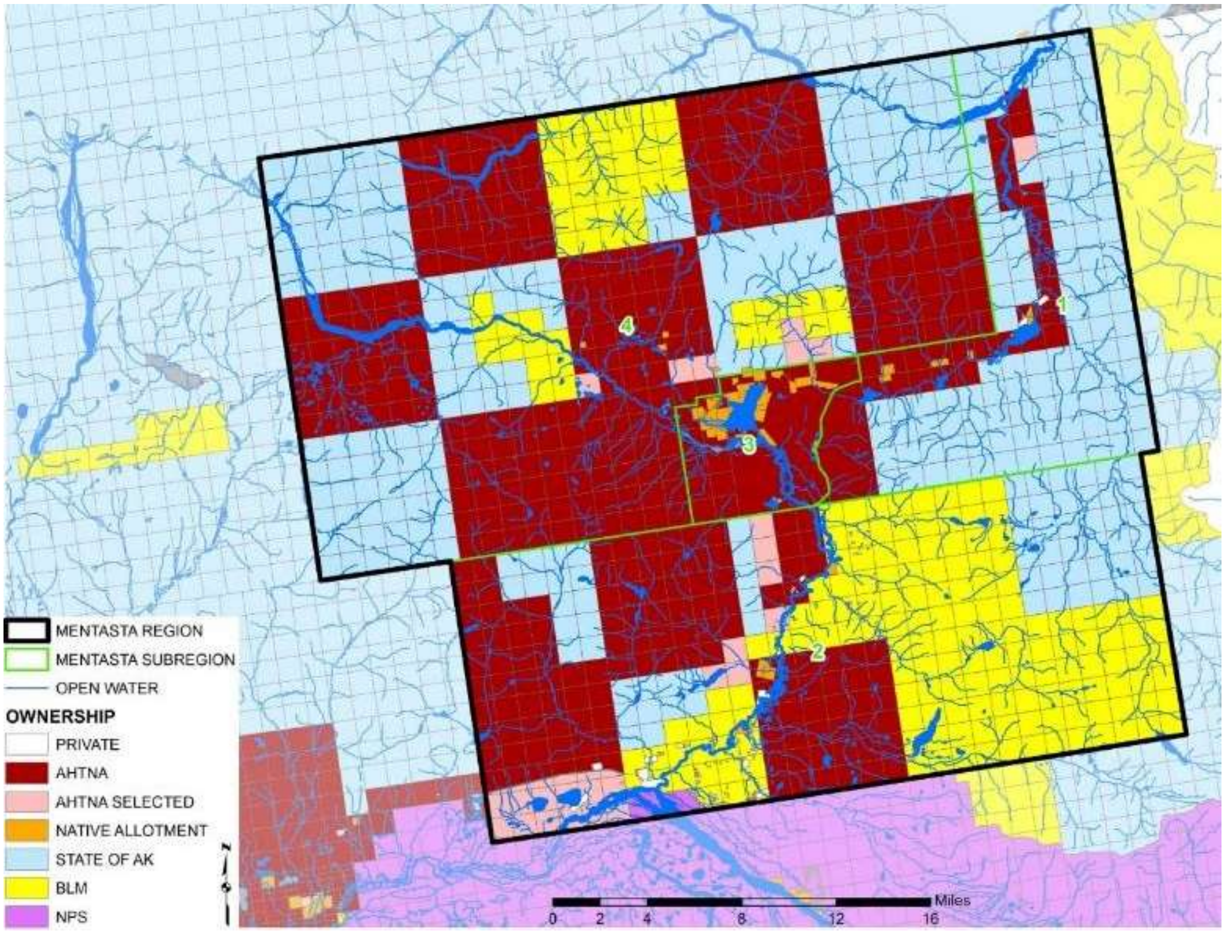


Figure 203. Land ownership patterns in the Mentasta Village planning region.

Planning Area Description

The Mentasta area falls within the Alaska Range and has a sub-arctic continental climate characterized by long cold winters and short warm summers. The average minimum temperature in January is -11.7 °F (-24.3 °C); daily low temperatures of -50 °F (-46 °C) or less occur frequently during the winter and may last for two or more weeks. The average maximum temperature in July is 68.5 °F (20.3 °C) and on occasion exceed 85 °F (30 °C). Although the daily minimum temperature in summer averages in the forties, freezing temperatures have been recorded in every month resulting in a varied growing season length each year. Mean annual precipitation is 15.4 inches (39.1 cm) with 45% being received as rain during the growing season (June-August). Average annual snowfall is 55.4 inches (140.7 cm). Continuous sunlight and twilight occur from early June through mid-July. Day length at the winter solstice is less than 5 hours long.

There is not detailed soil information for the Mentasta Planning Area. Large scale soil data are available for Alaska through STATSGO program. These data give information on certain soil characteristics. Figure 204 shows general soil textures and Figure 205 shows soil drainage for the Mentasta area.

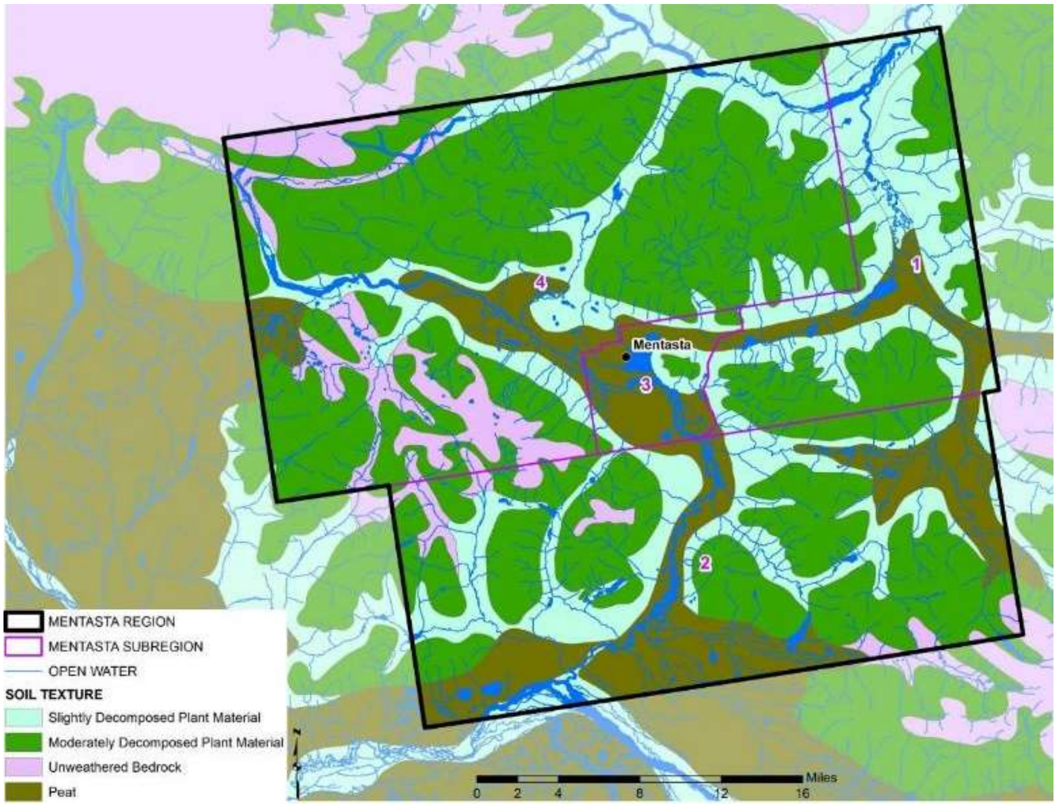


Figure 204. Soil texture in the Mentasta Village planning region. Data from NRCS STATSGO database for Alaska.

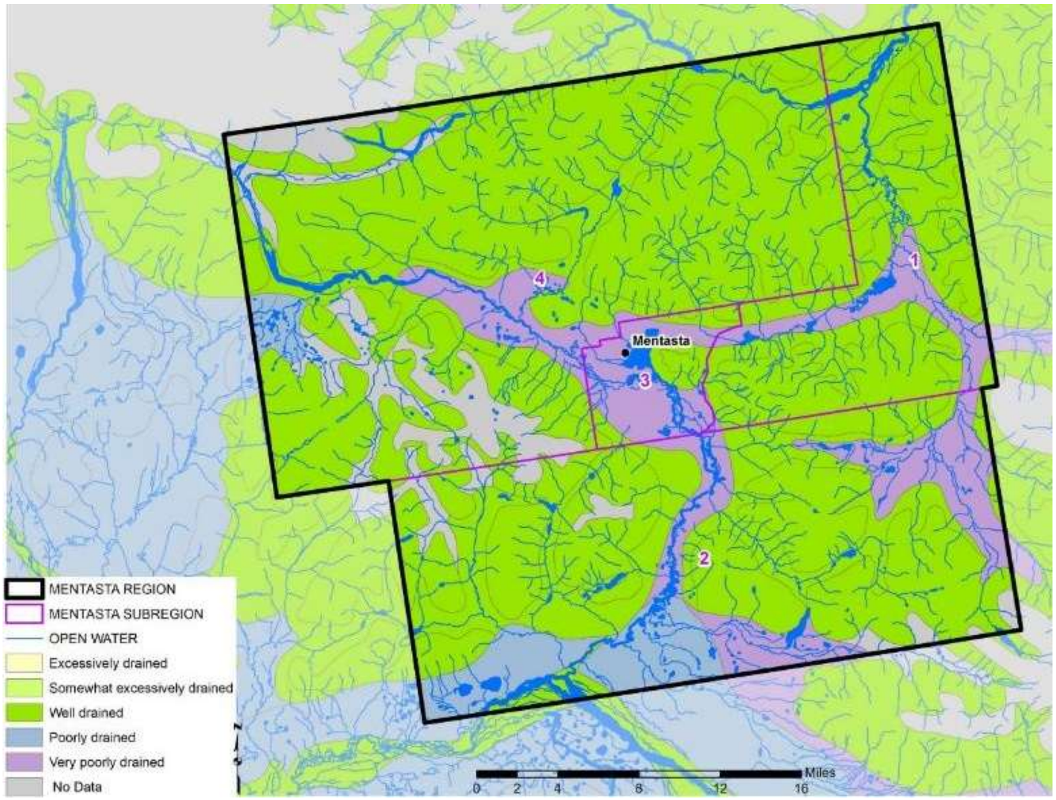


Figure 205. Soil drainage in the Mentasta Village planning region. Data from NRCS STATSGO database for Alaska.

Figure 206 displays the occurrence of permafrost in the Mentasta project area as interpreted from the soil survey information.

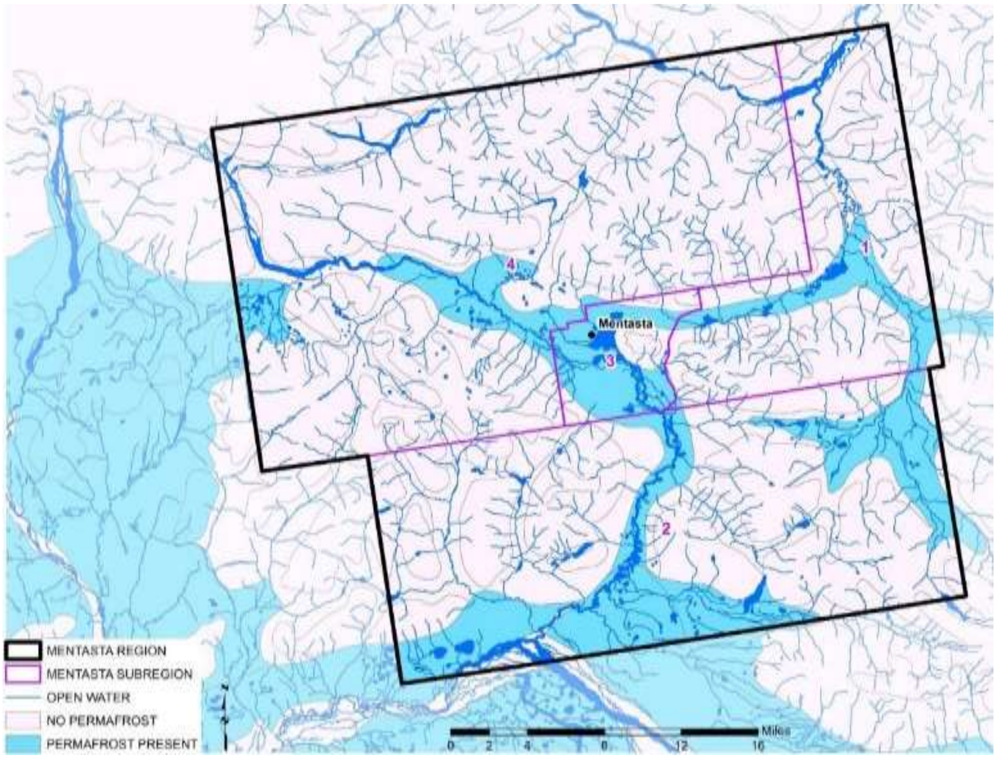


Figure 206. Permafrost in the Mentasta Village planning region. Data from NRCS STATSGO database for Alaska.

The Denali National Park Area Soil Survey provided a general description of the vegetation occurring higher elevation areas of central Alaska. While the region specifically described in the report is located approximately 200 miles (320 km) west of the Mentasta Village planning region it is relevant due to climatic, elevational, and biotic conditions. It stated: "General patterns of vegetation in the study area are the result of two major influences: the elevation gradient of the Alaska Range, and the different climactic regions north and south of the range. Much of the Denali Park is above tree line, and almost one-sixth is non-vegetated ice and rocky mountain slopes. In the vegetated zone, harsh conditions at high elevations limit plant communities to dwarf shrubs and herbaceous meadows in nivation hollows. Medium or tall shrubs are found lower down the slopes and these grade into forests or woodlands on well-drained substrates at lower elevations. Poor drainage at all elevations, because of glacial drift or permafrost, limits productivity. In lowlands, wet woodlands, shrubs, and herbaceous communities are found in a mosaic of fens, bogs, marshes and muskegs. Mountain vegetation of the Alaska Mountains Section is dominated by white mountain avens (*Dryas octopetala*) - dwarf ericaceous shrubs, which grade into medium-sized shrubs dominated by shrub birch and ericaceous shrubs such as blueberry (*Vaccinium uliginosum*), Labrador tea (*Ledum palustre* ssp. *decumbens* and *L. groenlandicum*) and crowberry (*Empetrum hermaphroditum*). On cooler, more northerly aspects these shrubs sometimes have high percentages of sedge and other herbaceous vegetation. Warmer low slopes, especially in the Kantishna Hills and Park headquarters areas, support white spruce/mixed scrub woodlands."

Fire is a major disturbance factor influencing the vegetation ecology in the project area. Figure 207 shows the fire history of the Mentasta area along with current fire protection zones. With Mentasta falling in the Alaska Range on the transition between the Copper River Basin and the true Interior the rate of fire return is higher than areas further south in the Basin. Six large fires have occurred since 1940 in the project area, even though the most recent was in 1969. Although the level of fire occurring is substantially less than that occurring in more interior areas of Alaska north of the Alaska Range, fire is still a significant disturbance when it occurs. When fire does occur it serves to set back succession. It can also burn off the organic material at the ground surface, including peat that can occur on many sites. This can influence the thermal layer protecting the underlying permafrost on some sites, causing the permafrost to melt (thermokarst) and changing the site conditions through this process. Riparian areas are also influenced by flooding and ice events. These serve to set back succession of vegetation in riparian areas, and can even shift site conditions, particularly in the case of significant flooding events.

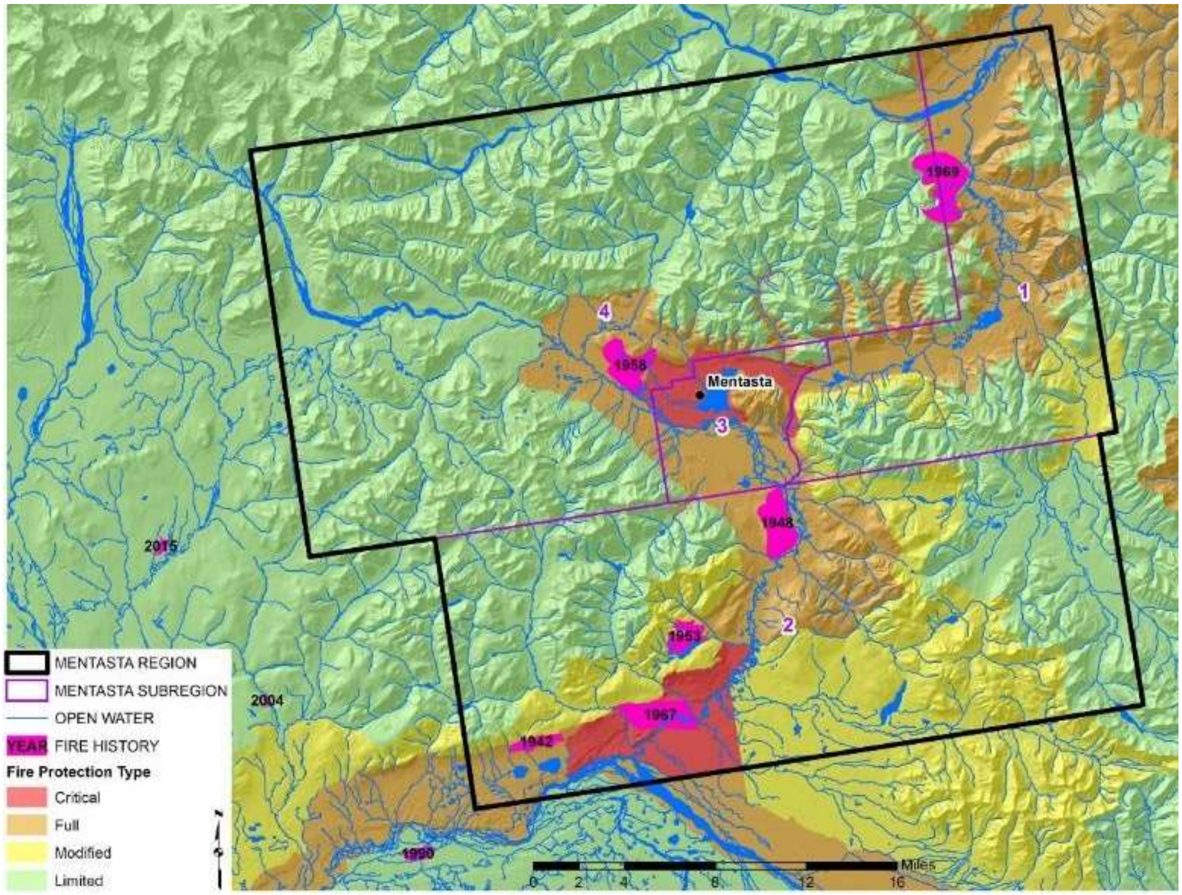


Figure 207. Current fire protection classes and fire history since 1940 in the Mentasta Village planning region. Data from Alaska Interagency Coordination Center.

Landscape Assessment Results

Ecosystem Diversity

The ecological sites present within the Mentasta Village planning region are displayed in Figure 208. Table 28 displays the acres for each ecosystem (i.e., ecological site and disturbance class). Figure 209 is a map of ecosystem diversity in the Mentasta Village planning region.

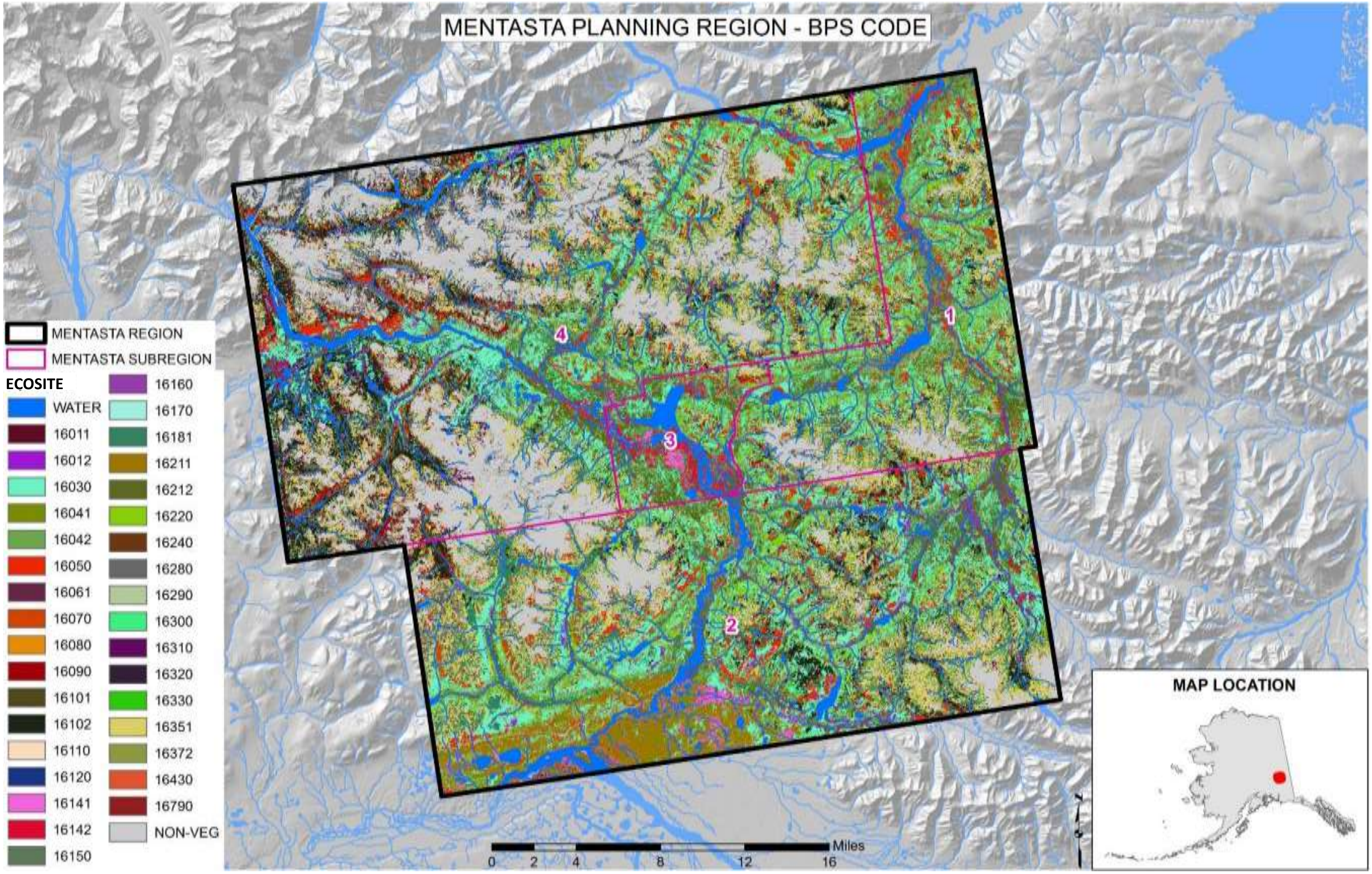


Figure 208. Ecological site (codes) in the Mentasta Village planning region. Data from LANDFIRE.

Table 28. Ecosystems mapped in the Mentasta Village planning region and their associated acres. The ecological site vegetation label is provided as reference.

Ecosystem Code	Ecological Site Label	Acres
11	Open Water	8237.7
12	Perrennial Ice-Snow	15249.2
16011_A	Treeline White Spruce-Boreal	145.9
16011_B	Treeline White Spruce-Boreal	129.7
16011_C	Treeline White Spruce-Boreal	0.4
16012_A	Treeline White Spruce-SubBoreal	3531.0
16012_B	Treeline White Spruce-SubBoreal	3527.4
16012_C	Treeline White Spruce-SubBoreal	18.9
16030_A	White Spruce-Hardwood-Boreal	1797.0
16030_B	White Spruce-Hardwood-Boreal	40888.0
16030_C	White Spruce-Hardwood-Boreal	54815.5
16030_E	White Spruce-Hardwood-Boreal	332.9
16041_A	Mesic Black Spruce-Boreal	222.0
16041_B	Mesic Black Spruce-Boreal	1272.3
16041_C	Mesic Black Spruce-Boreal	1054.6
16041_D	Mesic Black Spruce-Boreal	4058.0
16041_E	Mesic Black Spruce-Boreal	24.2
16042_A	Mesic Black Spruce-SubBoreal	10569.8
16042_B	Mesic Black Spruce-SubBoreal	20690.1
16042_C	Mesic Black Spruce-SubBoreal	8081.2
16042_D	Mesic Black Spruce-SubBoreal	271.5
16042_E	Mesic Black Spruce-SubBoreal	3.8
16050_A	Mesic Birch-Aspen	17742.5
16050_B	Mesic Birch-Aspen	15857.9
16050_D	Mesic Birch-Aspen	78.1
16050_E	Mesic Birch-Aspen	123.7
16061_A	Dry Aspen-Steppe Bluff	18.0
16061_B	Dry Aspen-Steppe Bluff	71.8
16061_C	Dry Aspen-Steppe Bluff	98.3
16061_D	Dry Aspen-Steppe Bluff	83.8
16070_A	Subalpine Balsam Poplar-Aspen	6483.5
16070_B	Subalpine Balsam Poplar-Aspen	7821.6
16080_A	Avalanche Slope Shrubland	1213.8
16080_B	Avalanche Slope Shrubland	661.4
16090_A	Mesic Subalpine Alder	725.2
16090_B	Mesic Subalpine Alder	3397.3
16102_A	Mesic Scrub Birch-Willow	6219.3
16102_B	Mesic Scrub Birch-Willow	45055.7
16110_A	Mesic Bluejoint Meadow	42.9
16120_A	Dry Grassland	2.2
16141_A	Montane Floodplain-Boreal	1879.2
16141_B	Montane Floodplain-Boreal	2207.9
16141_C	Montane Floodplain-Boreal	891.8
16141_D	Montane Floodplain-Boreal	3007.0
16141_E	Montane Floodplain-Boreal	575.6
16142_A	Montane Floodplain-Subboreal	7370.6
16142_B	Montane Floodplain-Subboreal	3049.9
16142_C	Montane Floodplain-Subboreal	2120.1
16142_D	Montane Floodplain-Subboreal	2060.5
16142_E	Montane Floodplain-Subboreal	335.1
16150_A	Large River Floodplain	290.7
16150_B	Large River Floodplain	158.6
16150_C	Large River Floodplain	136.1
16150_D	Large River Floodplain	1.3
16160_A	Riparian Stringer	64.0
16160_B	Riparian Stringer	350.7
16160_C	Riparian Stringer	8.9
16170_A	Shrub and Herbaceous Floodplain	171.9
16170_B	Shrub and Herbaceous Floodplain	28.7
16170_C	Shrub and Herbaceous Floodplain	2.7
16170_D	Shrub and Herbaceous Floodplain	8.9
16170_E	Shrub and Herbaceous Floodplain	105.9
16181_A	Herbaceous Fen	12295.3
16181_B	Herbaceous Fen	4218.6
16181_C	Herbaceous Fen	709.2
16181_D	Herbaceous Fen	20233.3
16211_A	Dwarf Black Spruce Peatland-Boreal	1470.3
16211_B	Dwarf Black Spruce Peatland-Boreal	1313.9
16211_C	Dwarf Black Spruce Peatland-Boreal	3840.3
16211_D	Dwarf Black Spruce Peatland-Boreal	15809.6
16212_A	Dwarf Black Spruce Peatland-Subboreal	3769.8
16212_B	Dwarf Black Spruce Peatland-Subboreal	10410.8
16212_C	Dwarf Black Spruce Peatland-Subboreal	28649.6
16220_A	Black Spruce Wet-Mesic Slope	6231.7
16220_B	Black Spruce Wet-Mesic Slope	10907.8
16220_C	Black Spruce Wet-Mesic Slope	140.6
16220_D	Black Spruce Wet-Mesic Slope	9207.6
16240_A	Deciduous Shrub Swamp	2163.9
16240_B	Deciduous Shrub Swamp	142.1
16280_A	Low Shrub-Tussock Tundra	4343.6
16280_B	Low Shrub-Tussock Tundra	3150.4
16280_C	Low Shrub-Tussock Tundra	808.2
16290_A	Tussock Tundra	321.1
16290_B	Tussock Tundra	156.8
16300_A	Wet Black Spruce-Tussock	1526.1
16300_B	Wet Black Spruce-Tussock	1791.6
16300_C	Wet Black Spruce-Tussock	4424.3
16310_A	Alpine Dwarf-Shrub Summit	3668.9

Table 28, continued. Ecosystems mapped in the Mentasta Village planning region and their associated acres. The ecological site vegetation label is provided as reference.

Ecosystem Code	Ecological Site Label	Acres	Ecosystem Code	Ecolgocal Site Label	Acres
16310_B	Alpine Dwarf-Shrub Summit	29.8	16372_B	Alpine Floodplain	0.4
16320_A	Alpine Talus and Bedrock	8027.1	16430_A	Alpine Dwarf Shrubland	17.8
16320_B	Alpine Talus and Bedrock	129.9	16450_A	Alpine Mesic Herbaceous Meadow	0.7
16330_A	Alpine Mesic Herbaceous Meadow	283.3	16790_A	White Spruce-Hardwood-SubBoreal	11.3
16330_B	Alpine Mesic Herbaceous Meadow	53.2	16790_B	White Spruce-Hardwood-SubBoreal	3.8
16351_A	Alpine Ericaceous Dwarf-Shrubland	72099.4	16790_C	White Spruce-Hardwood-SubBoreal	2.2
16351_B	Alpine Ericaceous Dwarf-Shrubland	4605.8	31	Barren-Rock-Sand-Clay	99118.1
16372_A	Alpine Floodplain	1.8			

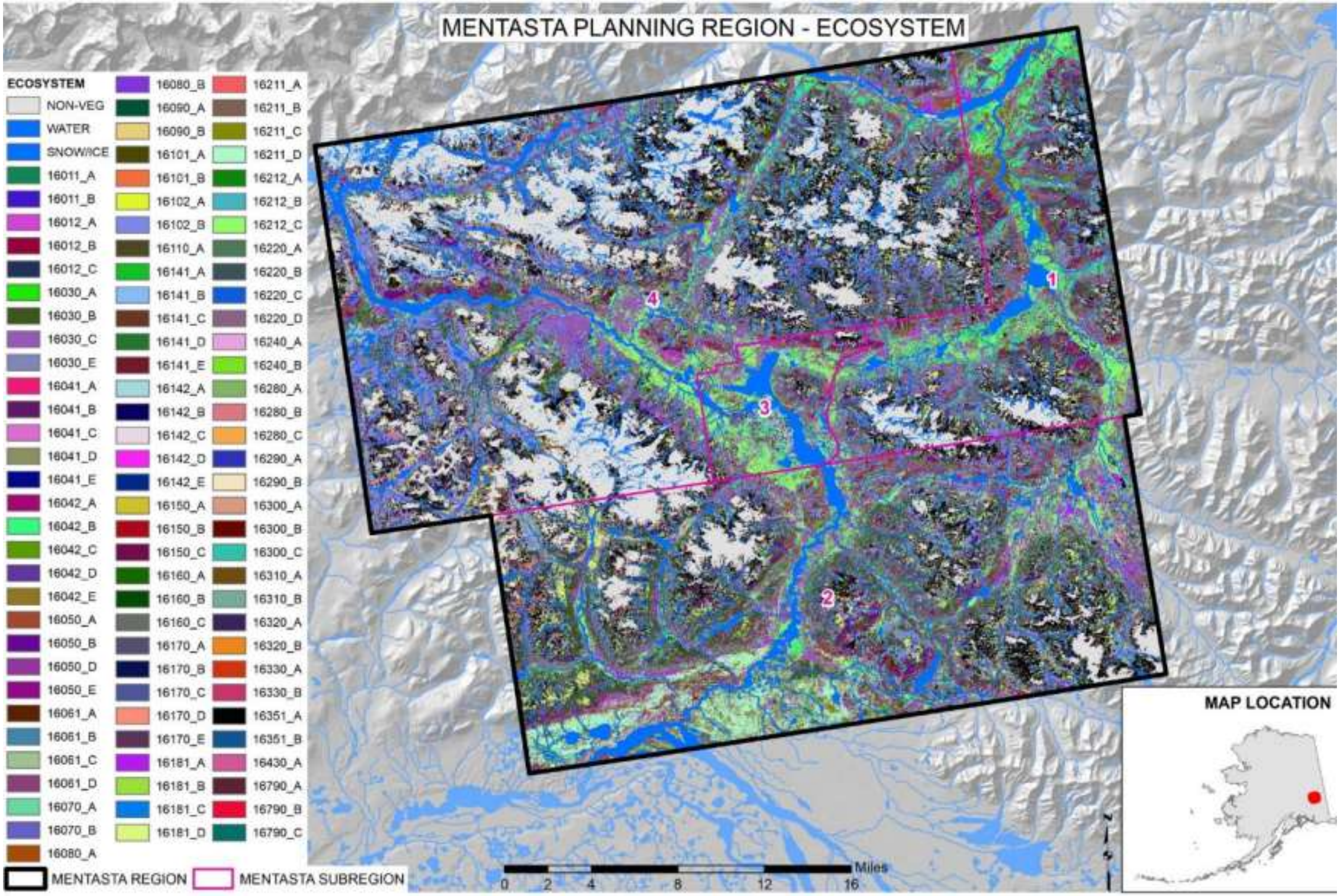


Figure 209. Ecosystem diversity for the Mentasta Village planning region. See Appendix A for ecosystem definitions.

Berry Production Areas

Figure 210 shows the areas identified with the highest potential for berry production. It may be desirable to avoid disturbances to these areas, but verifying the actual presence of good berry production is recommended on a site by site basis.

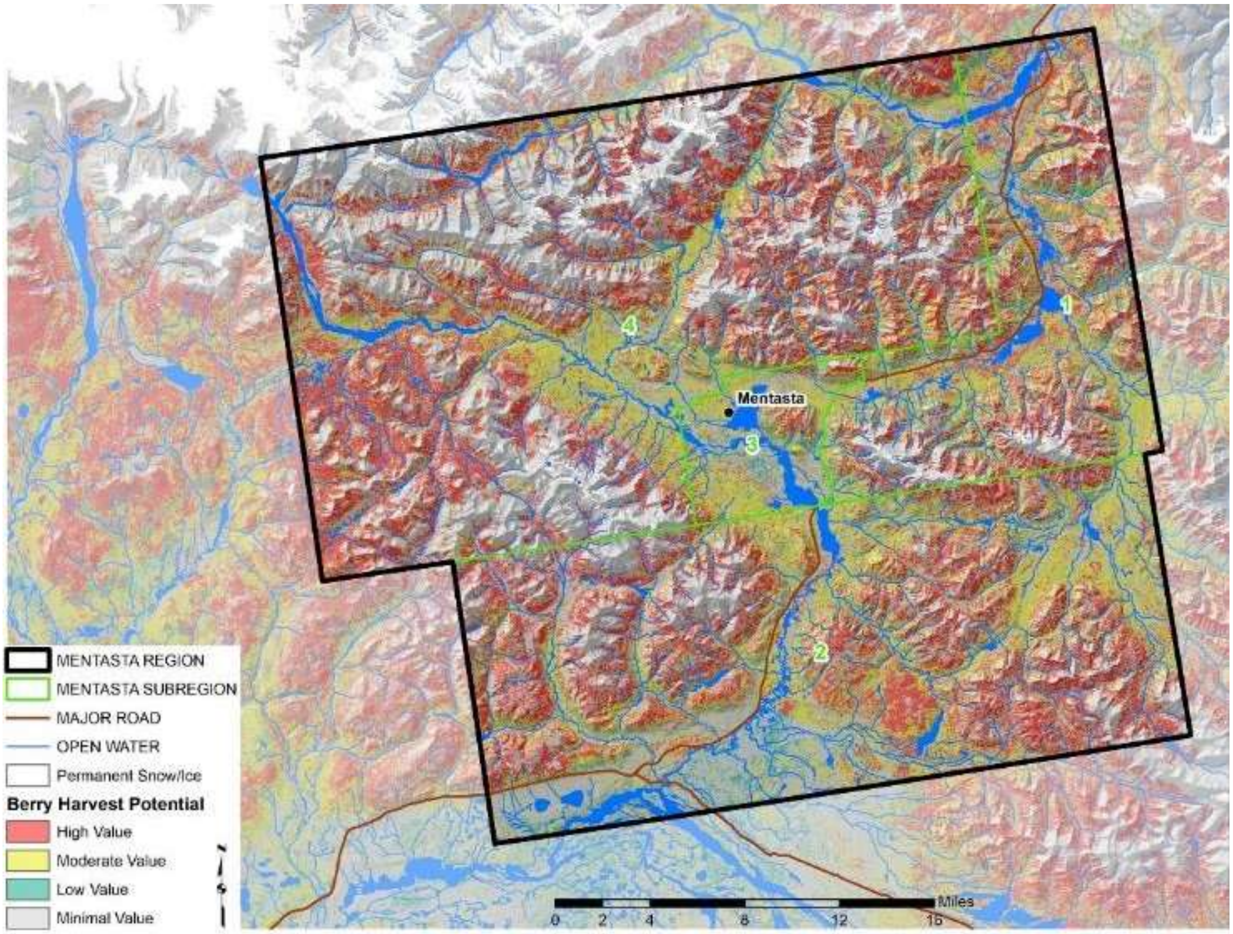


Figure 210. Potential berry production values in the Mentasta Village planning region.

Moose and Caribou Habitat Quality Assessment - Model Results

Moose

Ecosystem-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 187 to 189. Landscape-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 190 to 192. A complete description of the moose habitat quality models can be found in Appendix B.

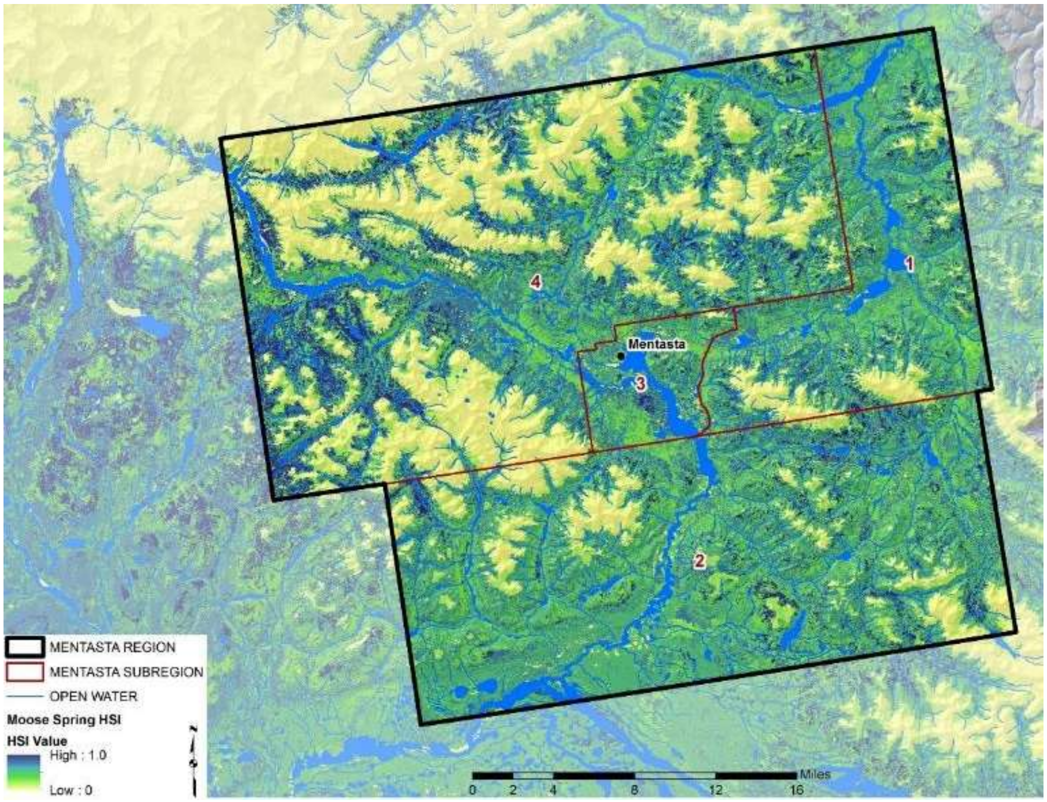


Figure 211. Results of the ecosystem-scale model outputs for moose spring habitat quality.

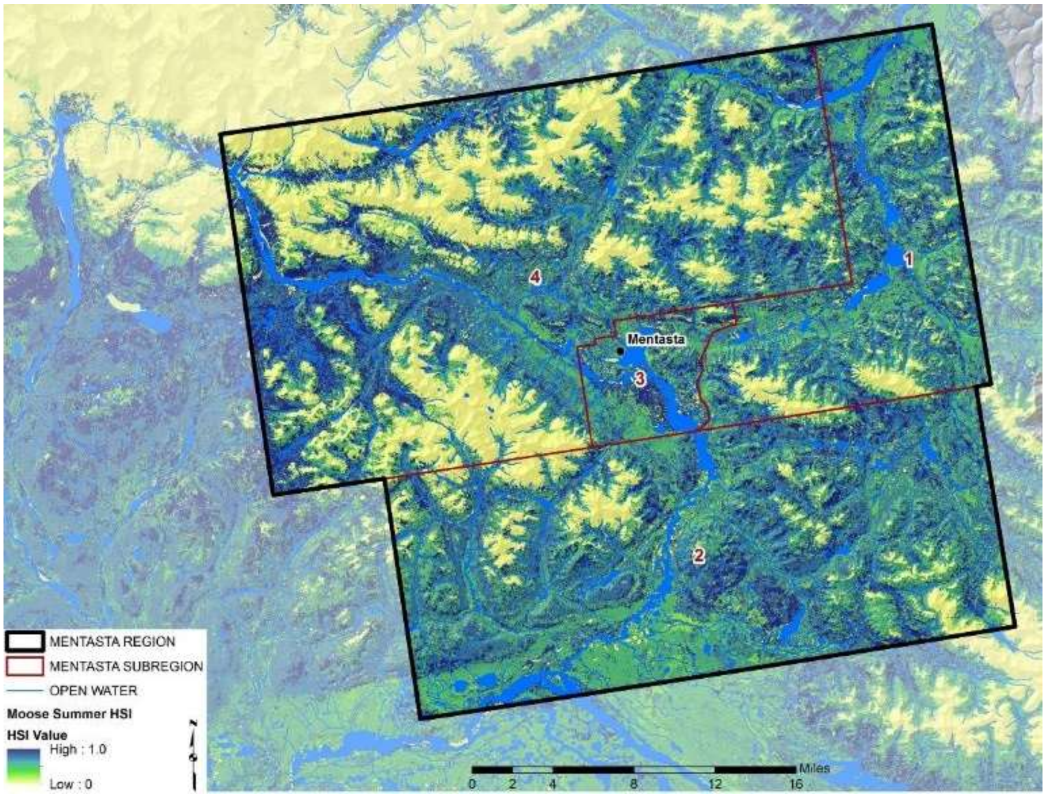


Figure 212. Results of the ecosystem-scale model outputs for moose summer habitat quality.

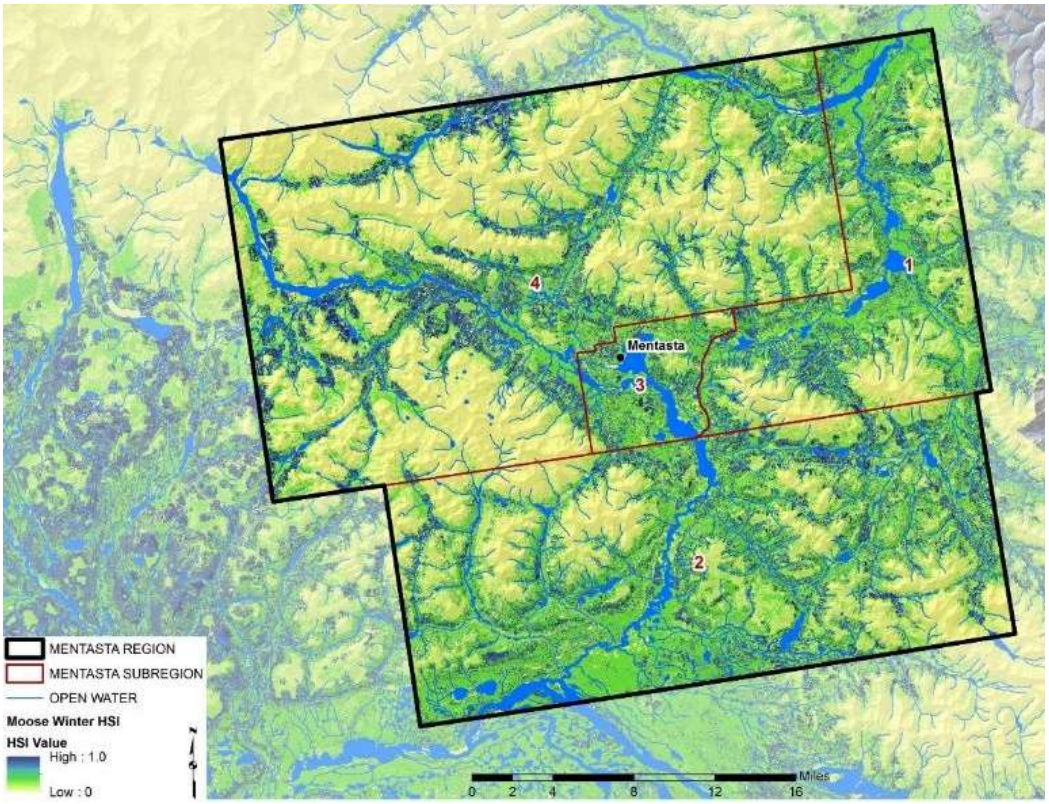


Figure 213. Results of the ecosystem-scale model outputs for moose winter habitat quality.

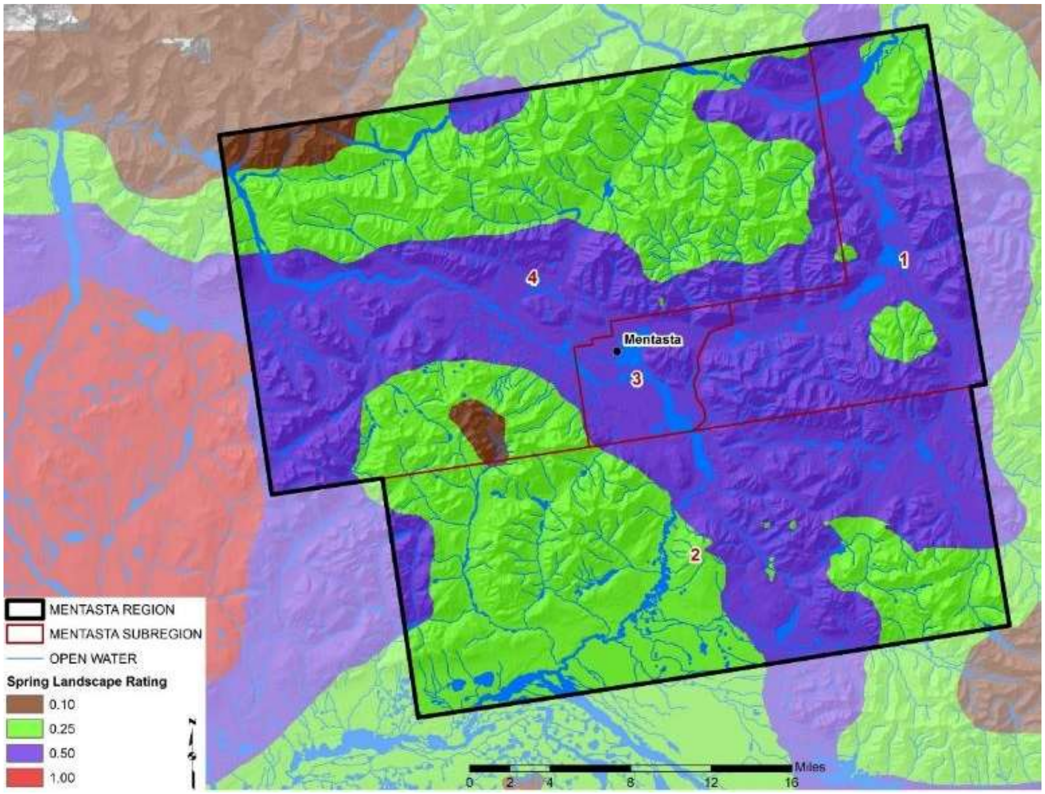


Figure 214. Results of the landscape-scale model outputs for moose spring habitat quality.

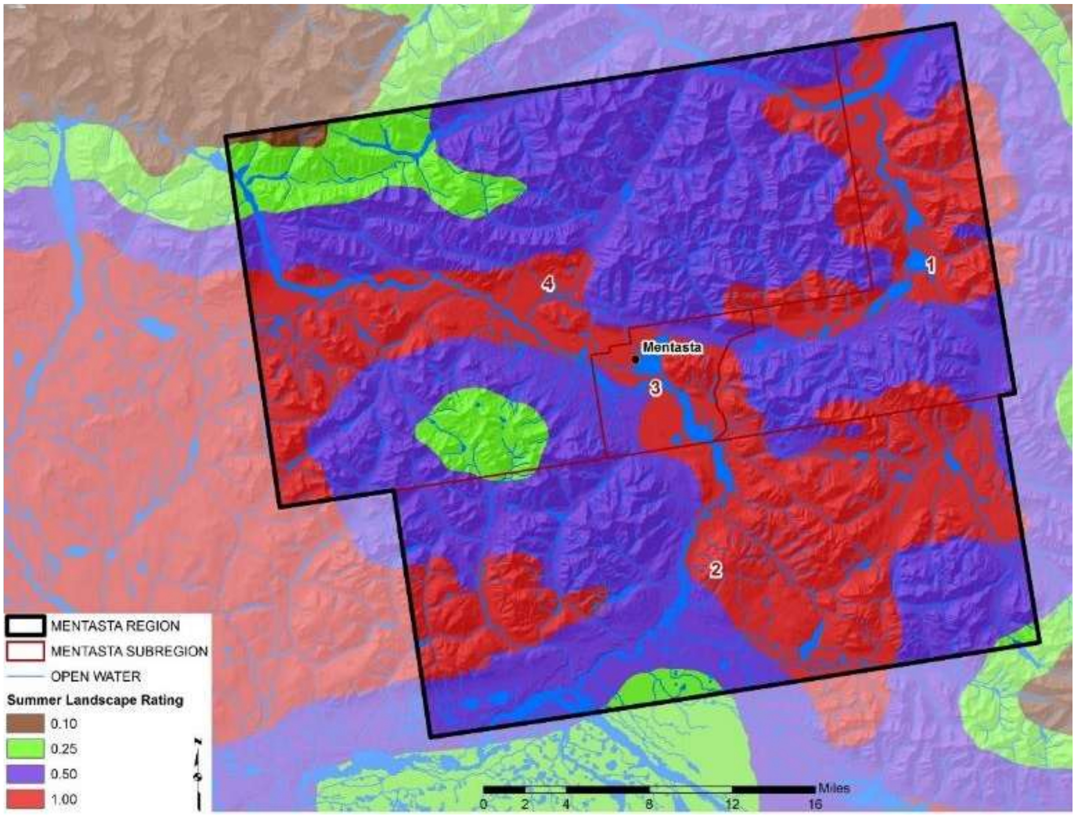


Figure 215. Results of the landscape-scale model outputs for moose summer habitat quality.

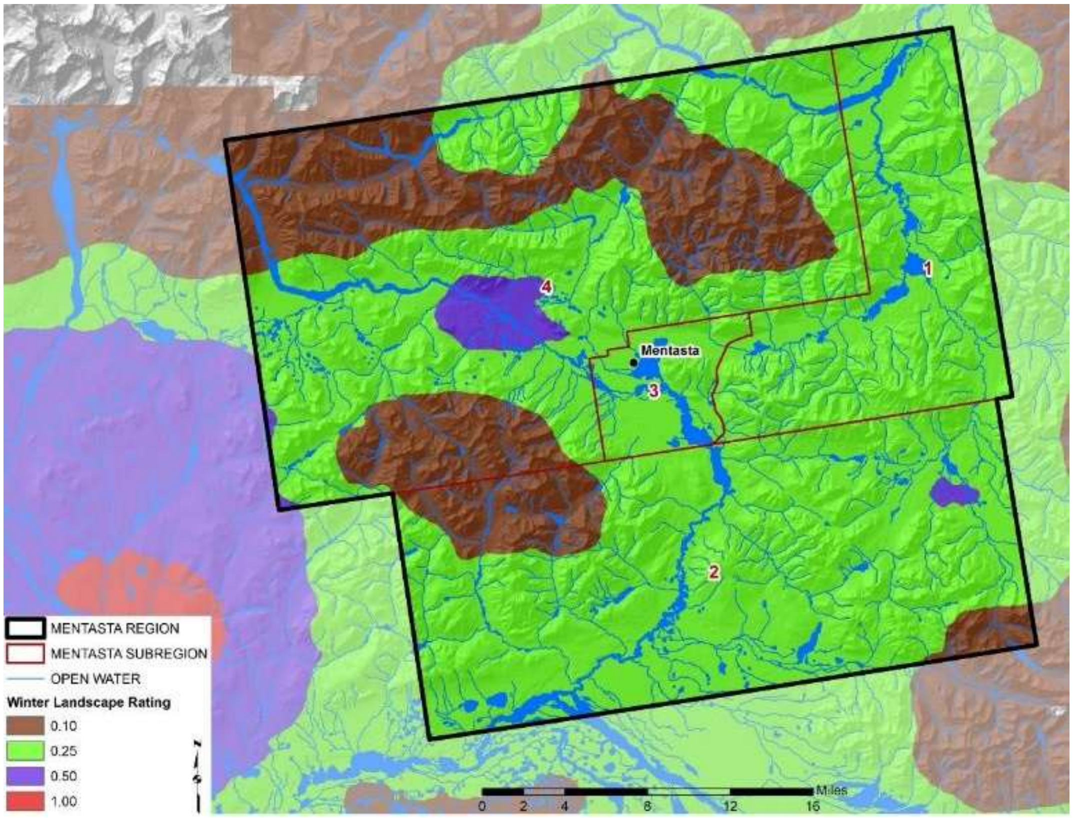


Figure 216. Results of the landscape-scale model outputs for moose winter habitat quality.

Caribou

Ecosystem-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 217 and 218. Landscape-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 219 and 220. A complete description of the caribou habitat quality models can be found in Appendix C.

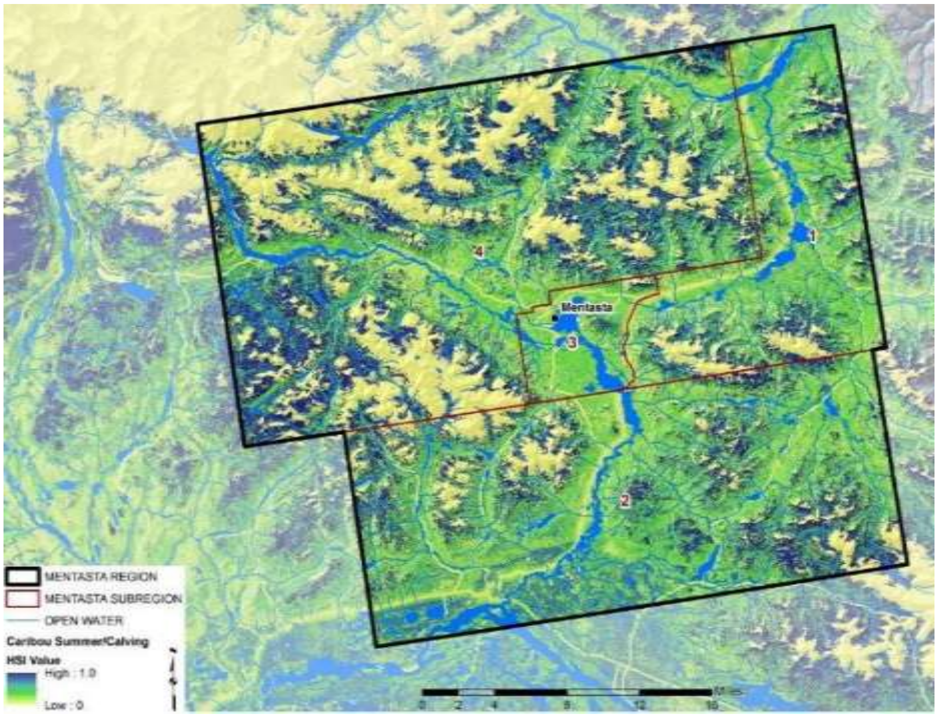


Figure 217. Results of the ecosystem-scale model outputs for caribou summer/calving habitat quality.

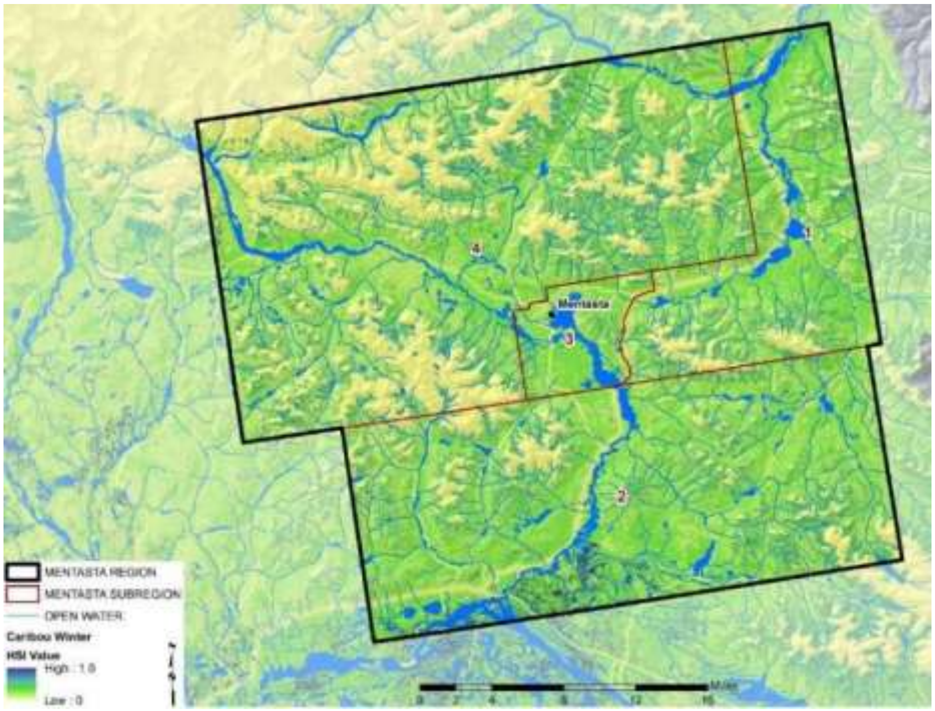


Figure 218. Results of the ecosystem-scale model outputs for caribou winter habitat quality.

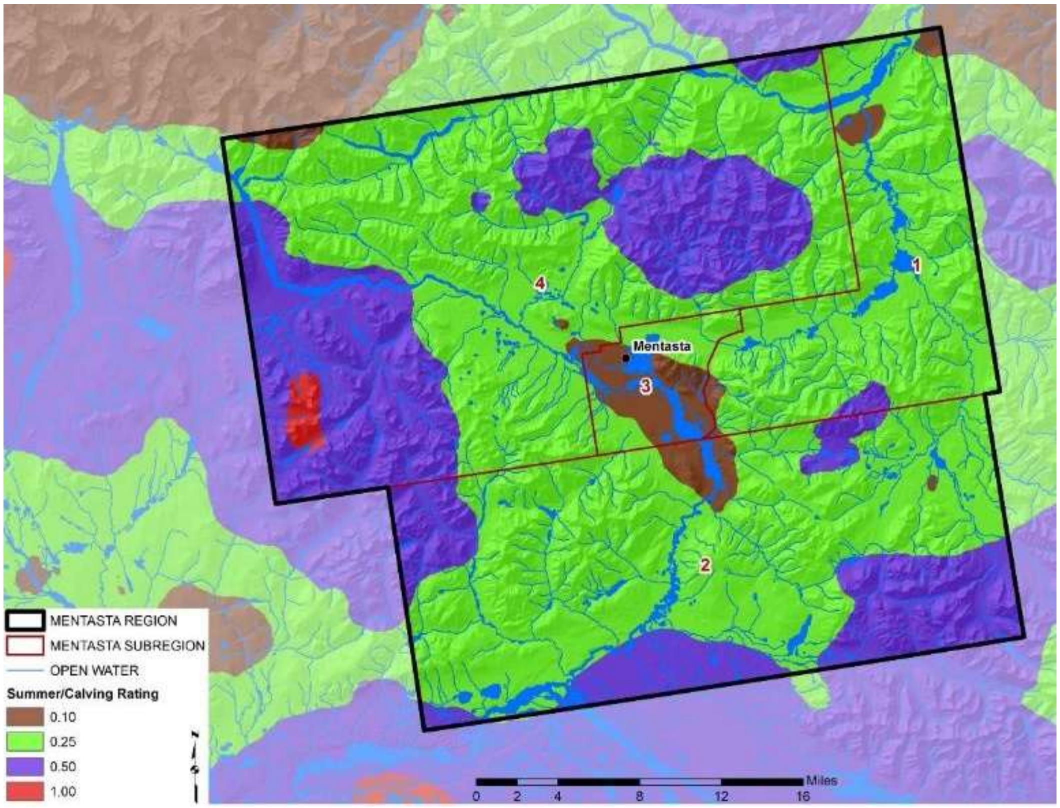


Figure 219. Results of the landscape-scale model outputs for caribou summer/calving habitat quality.

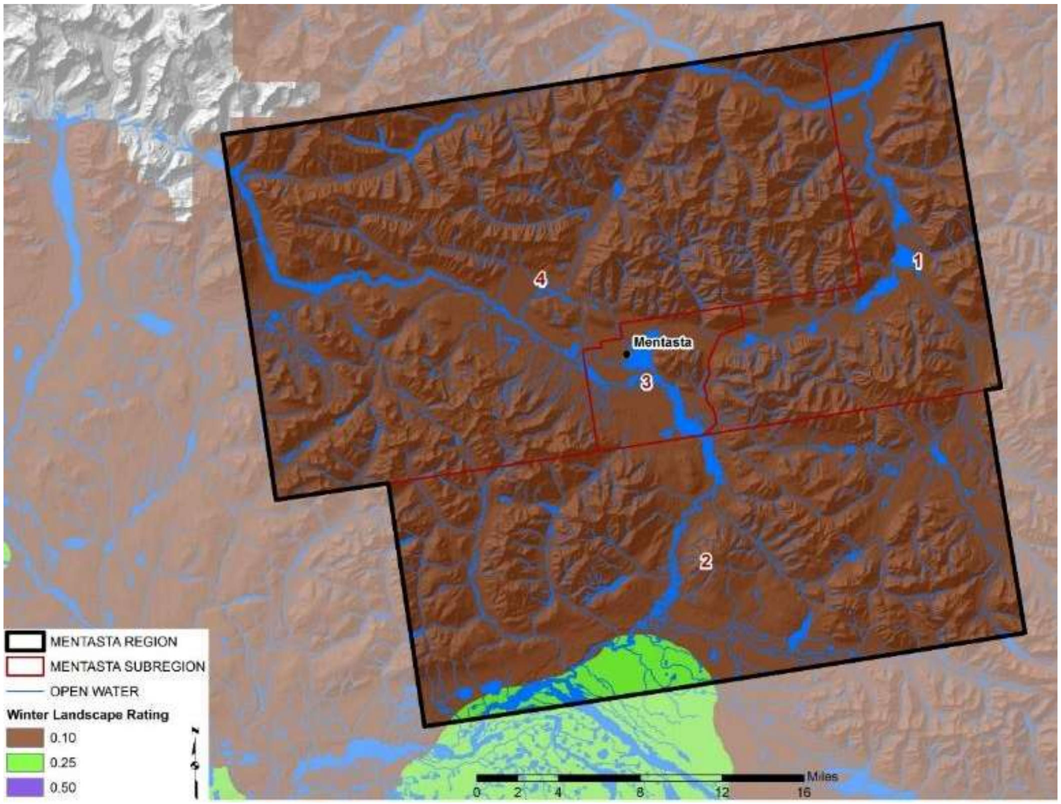


Figure 220. Results of the landscape-scale model outputs for caribou winter habitat quality.

Mentasta Site Improvement Areas

Potential treatment sites identified in the Mentasta area are displayed in figure 221. Based on all of the stated criteria, a number of sites were located for designated treatments. Figures 222-230 depict the locations of these areas. Appendix C provides a description of each of these sites. Sites ranging from approximately 13-51 acres in size were identified and are listed in Table 29. This table gives the site size and the treatment goal of primarily timber stand improvement and biomass production or moose browse enhancement. The table also displays an estimate of the total biomass of all standing above ground biomass. This estimate is not tonnage of usable biomass for energy but the total of all stems regardless of size. However, stands on the higher end of the total amount will typically have larger trees and are a candidate for biomass energy production.

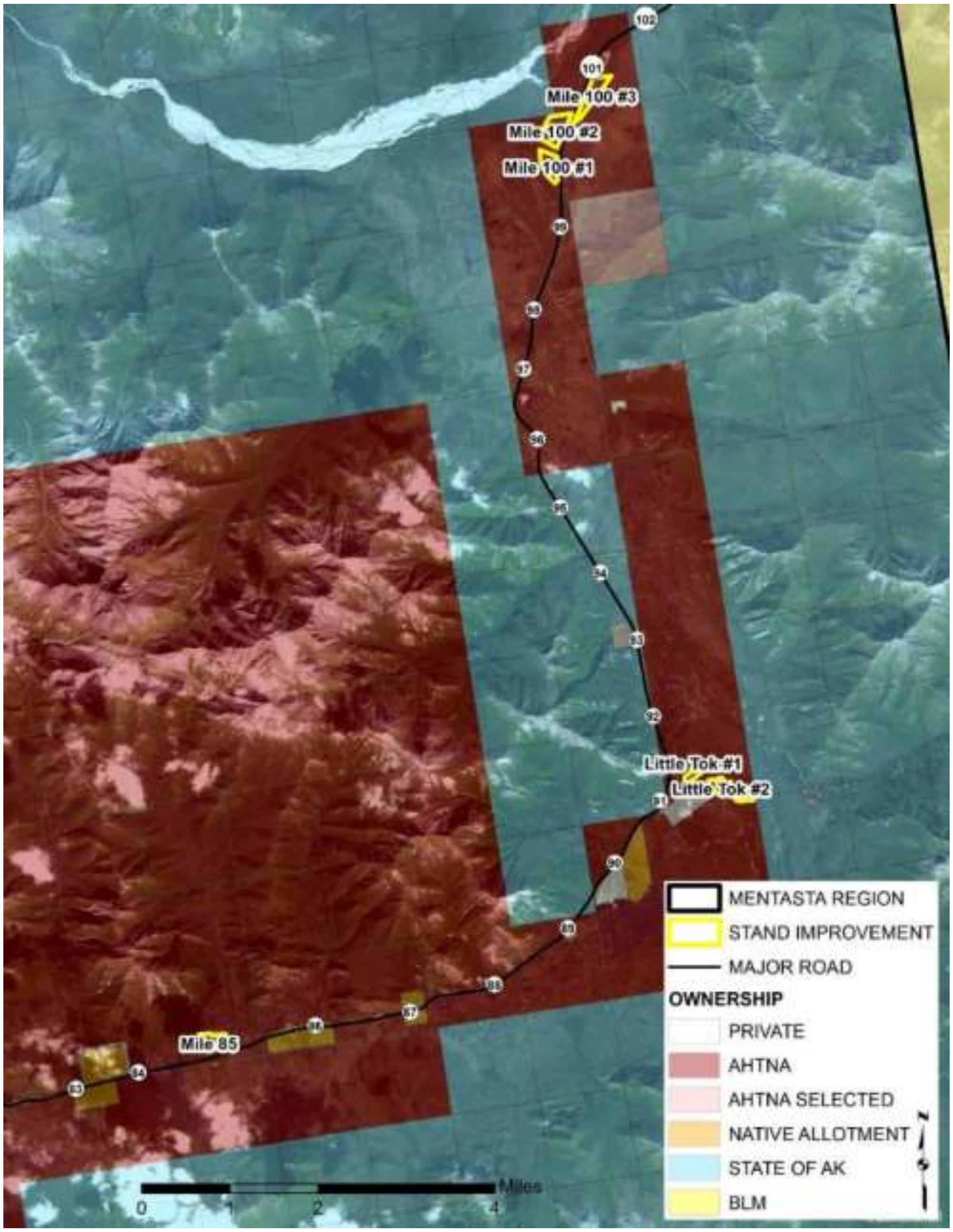


Figure 221. Recommended treatment sites in the northern half of the Mentasta Village planning region.

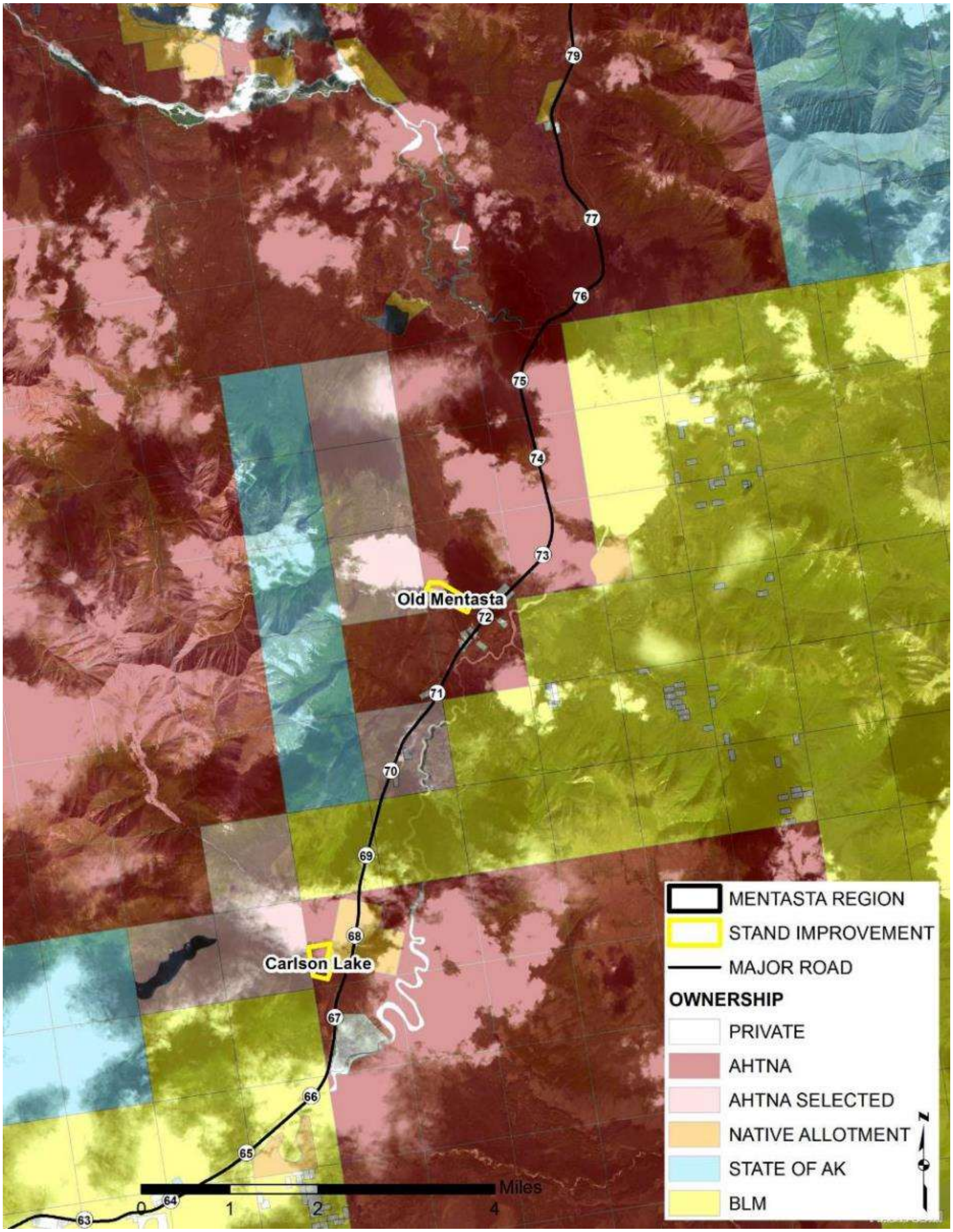


Figure 222. Recommended treatment sites in the southern half of the Mentasta Villange planning area.

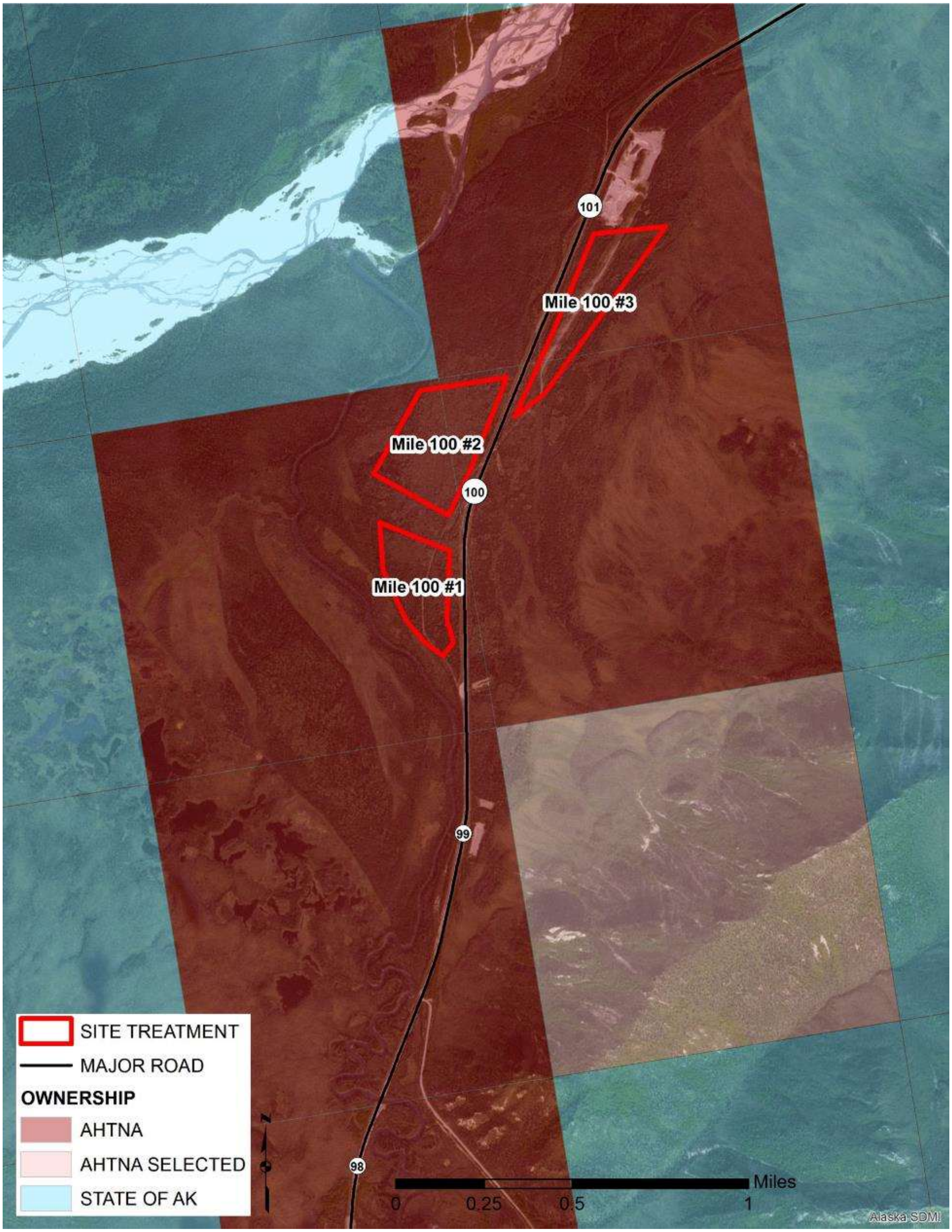


Figure 223. Map of proposed treatment areas (Mile 100 #1, #2, and #3) in the Mentasta Village planning region showing surface ownership and aerial imagery.

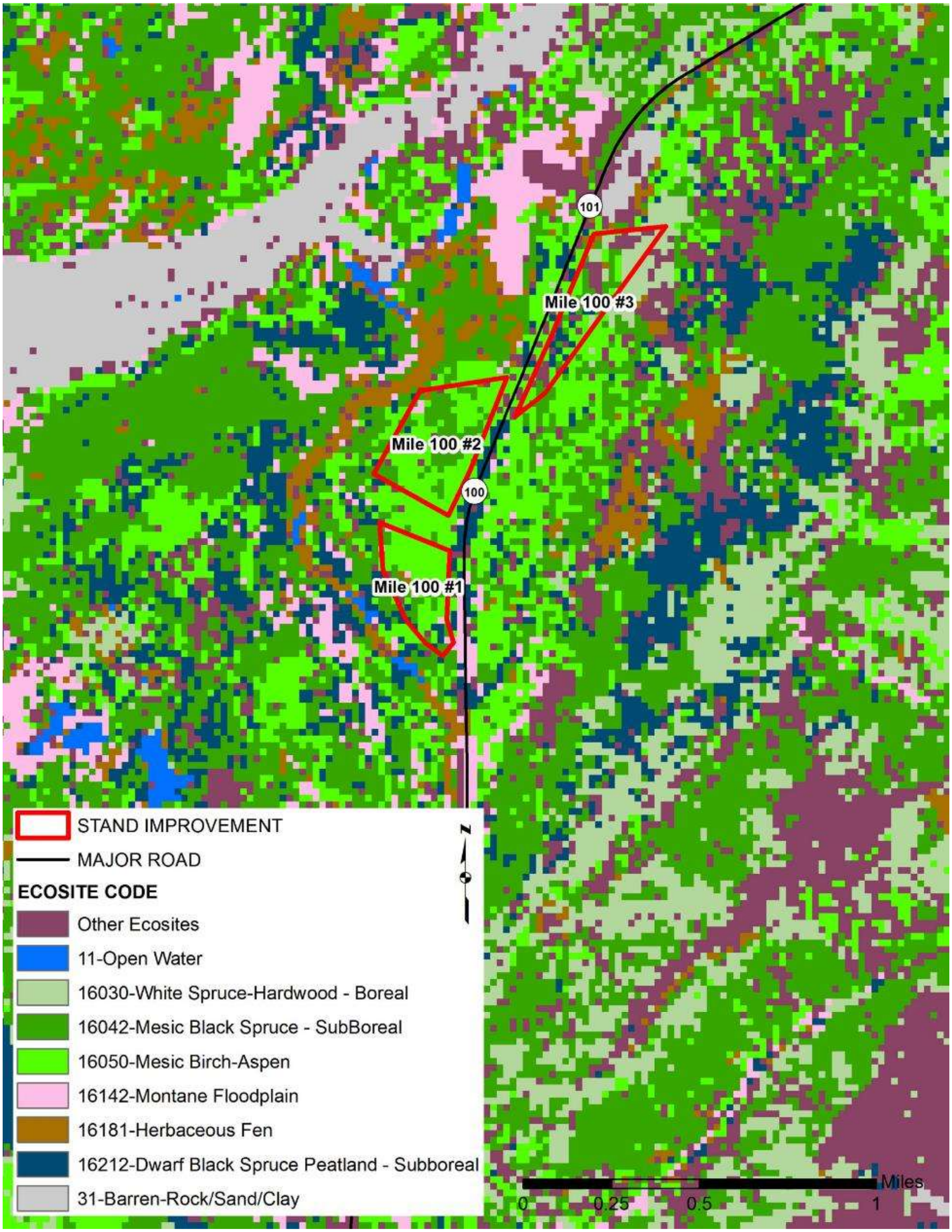


Figure 224. Map of proposed treatment areas (Mile 100 #1, #2, and #3) in the Mentasta Village planning region showing ecological sites.

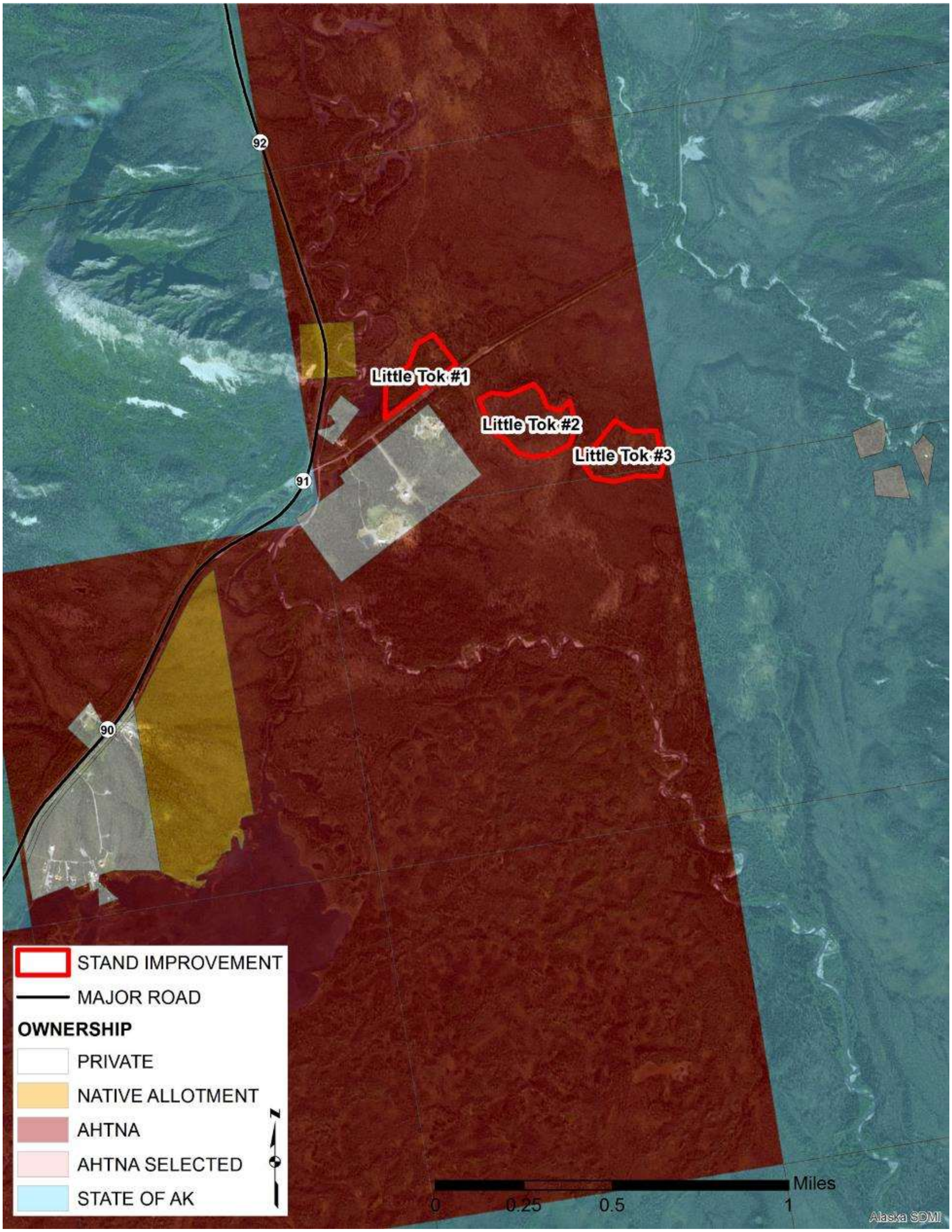


Figure 225. Map of proposed habitat improvement areas (Little Tok #1, #2, and #3) in the Mentasta Village planning region showing surface ownership and aerial imagery.

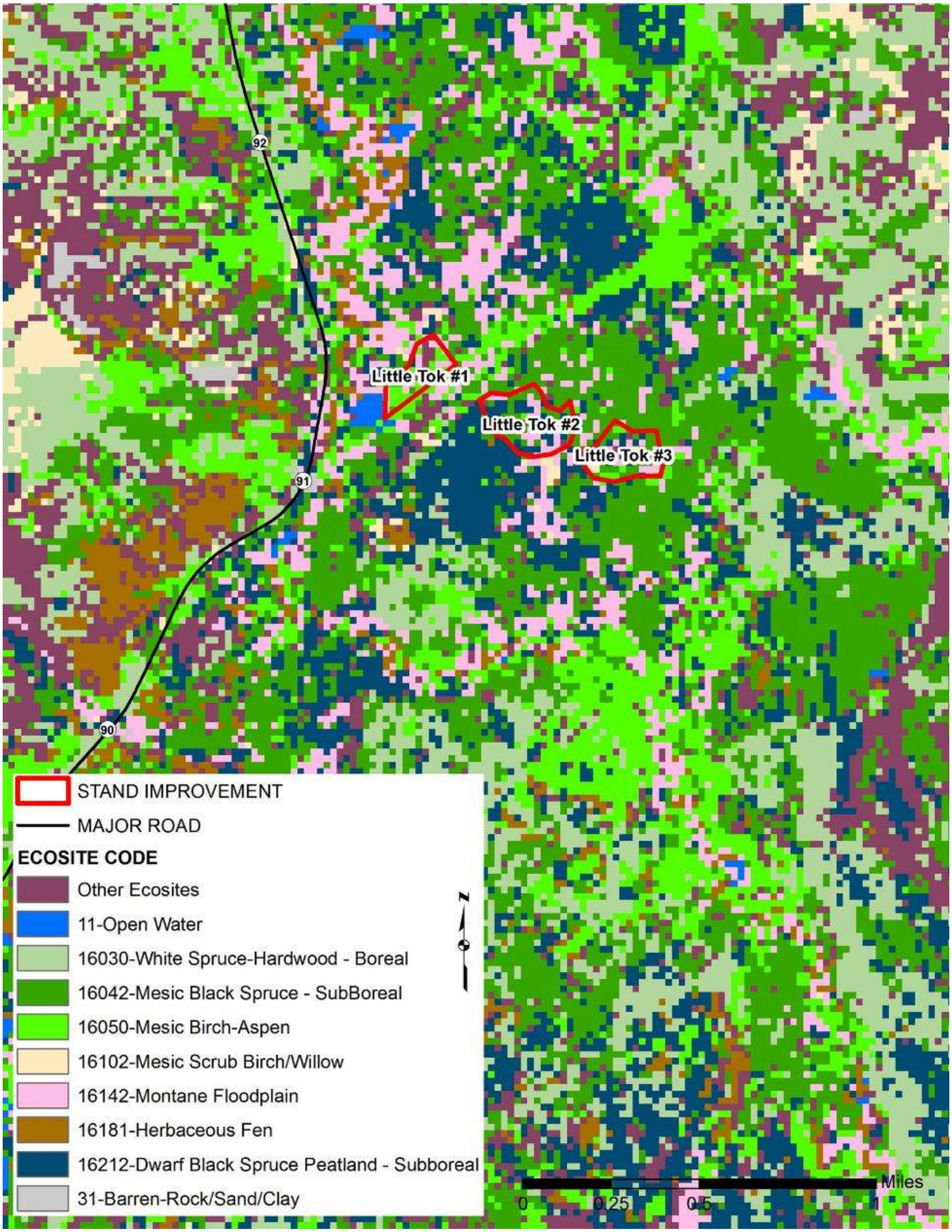


Figure 226. Map of proposed habitat improvement areas (Little Tok #1, #2, and #3) in the Mentasta Village planning region showing ecological sites.

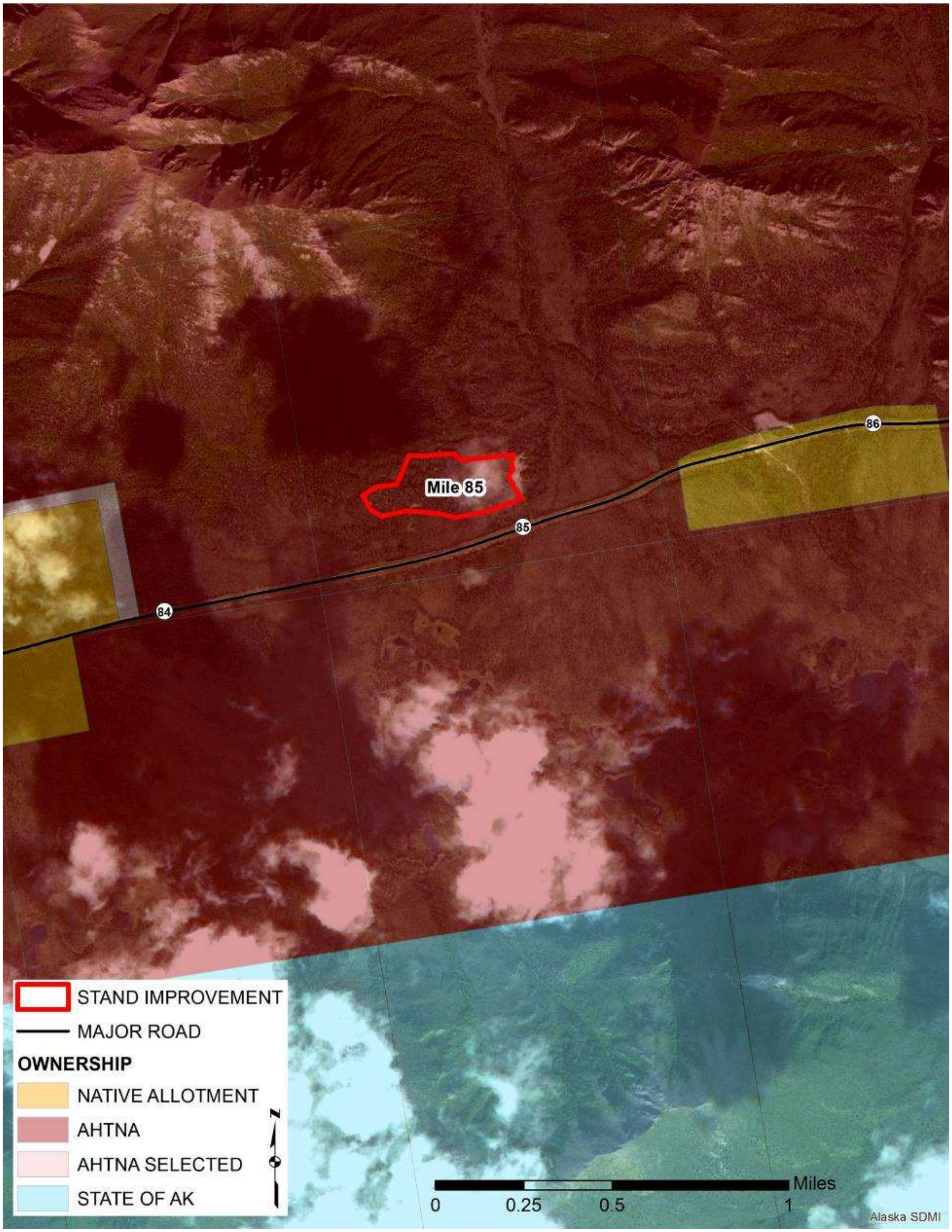


Figure 227. Map of proposed habitat improvement areas (Mile 85) in the Mentasta Village planning region showing surface ownership and aerial imagery.

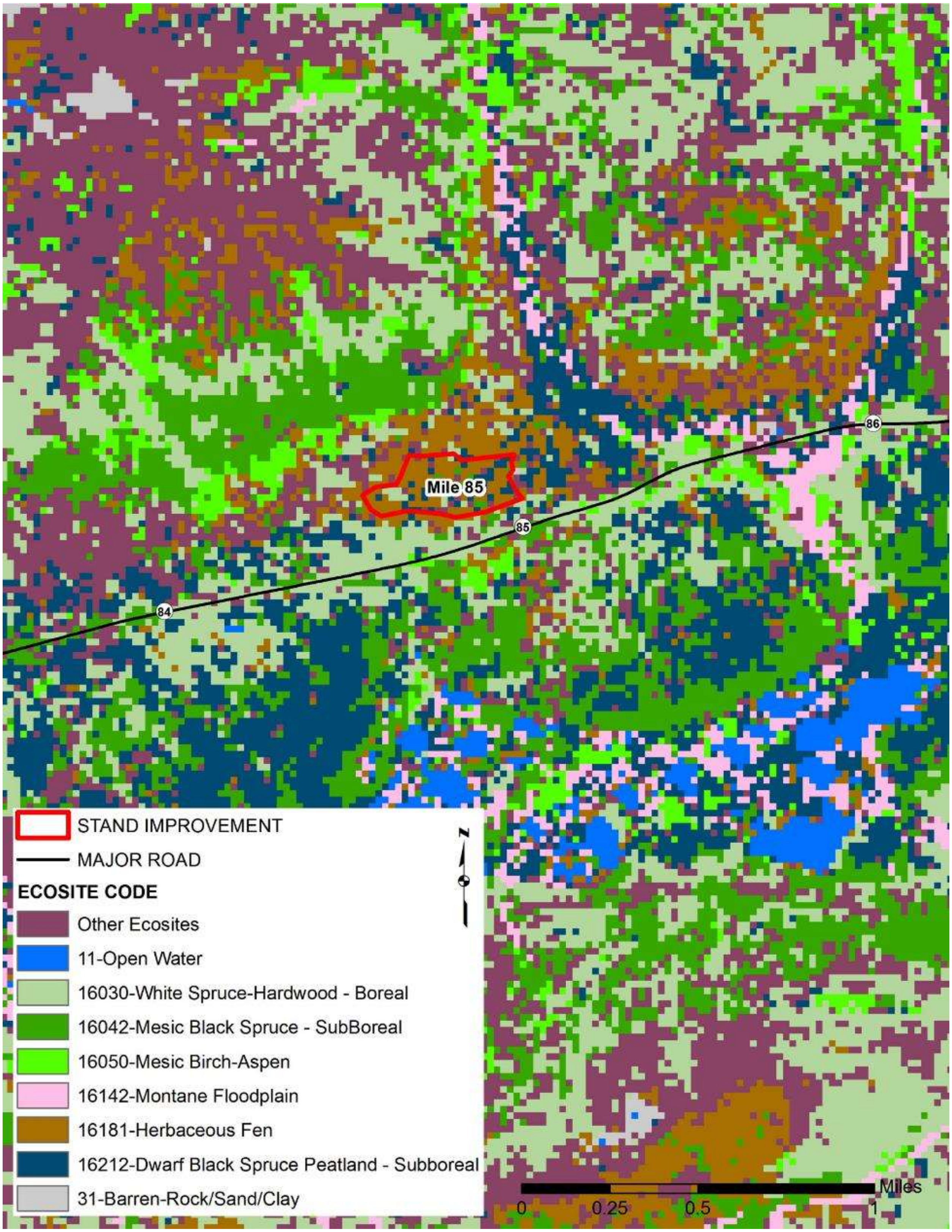


Figure 228. Map of proposed habitat improvement areas (Mile 85) in the Mentasta Village planning region showing ecological sites.

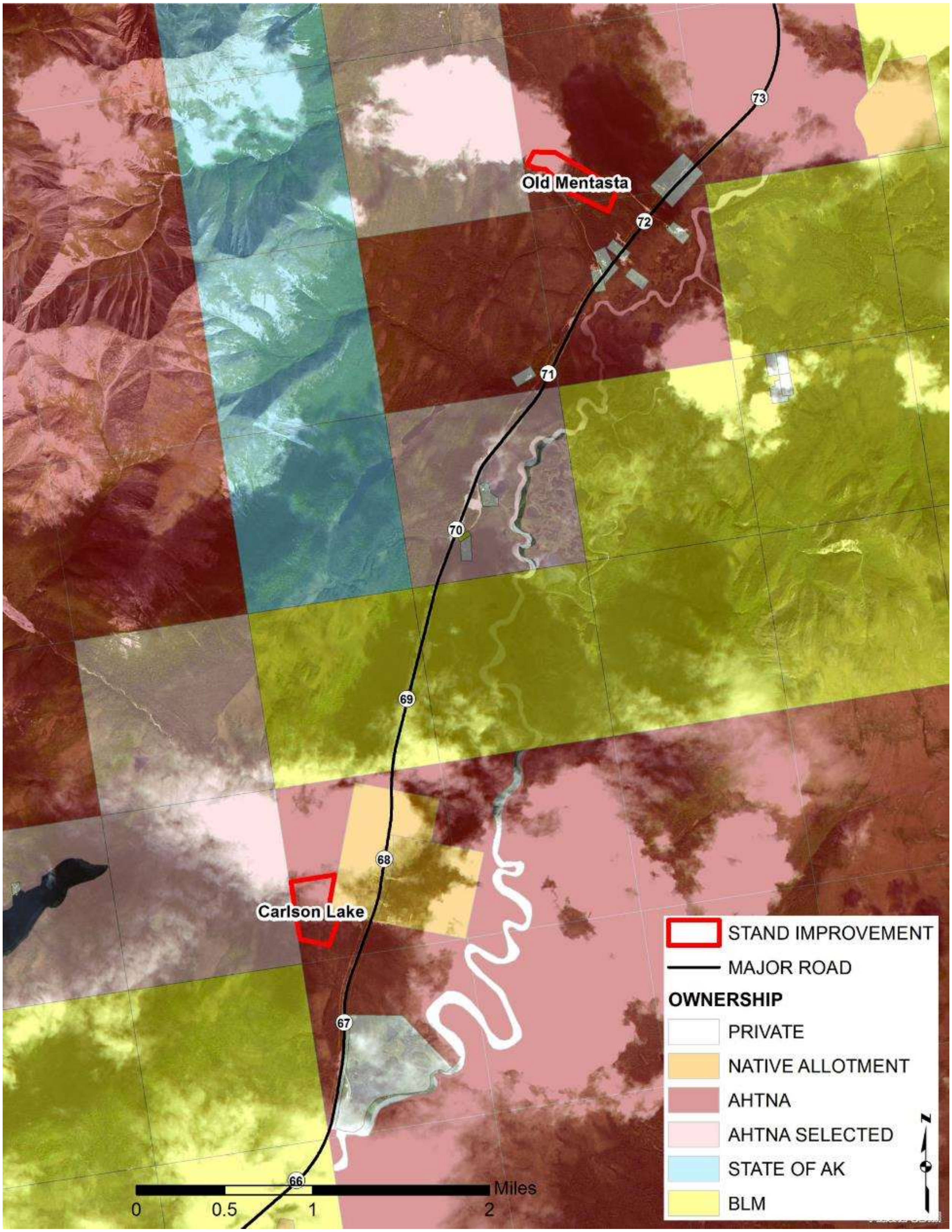


Figure 229. Map of proposed habitat improvement areas (Old Mentasta and Carlson Lake) in the Mentasta Village planning region showing surface ownership and aerial imagery.

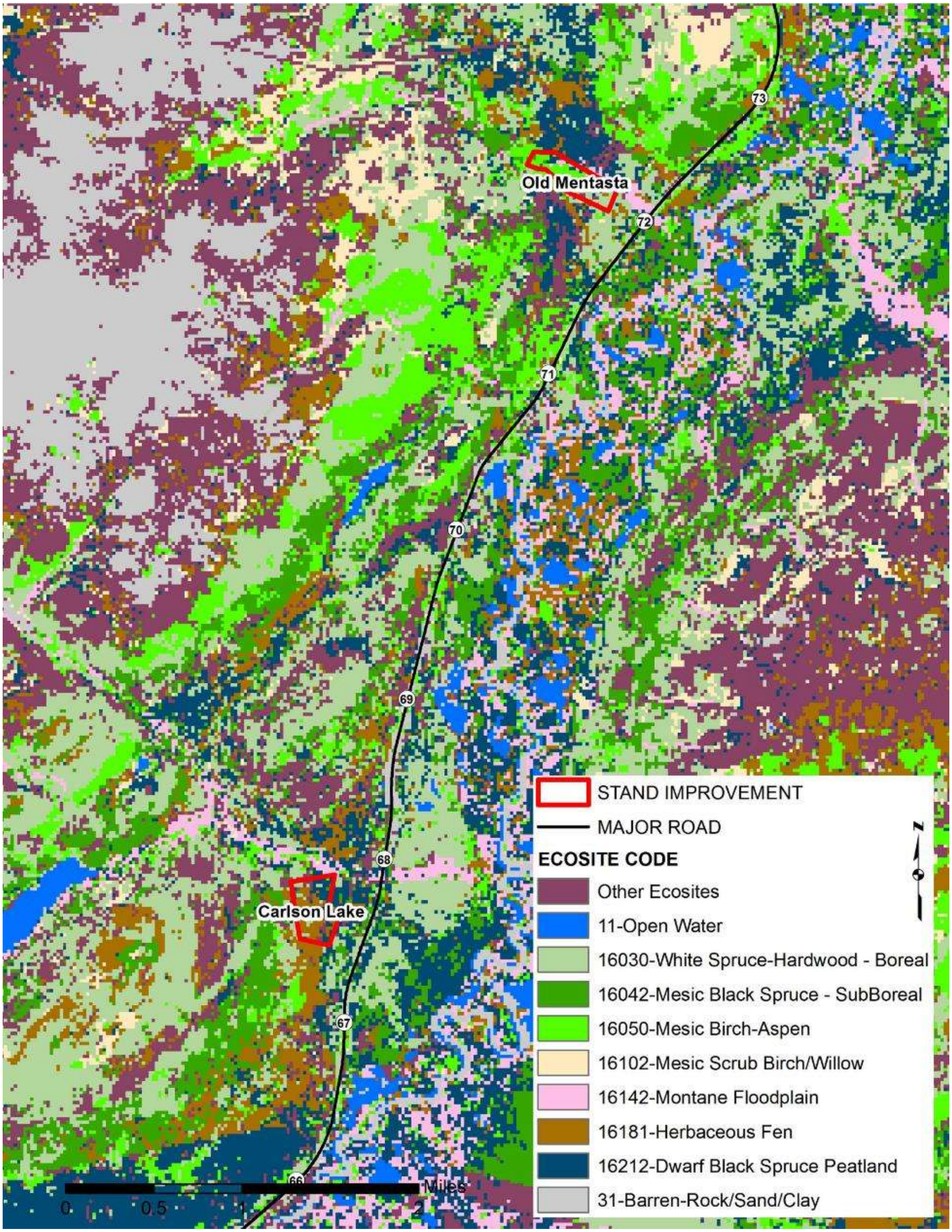


Figure 230. Map of proposed habitat improvement areas (Old Mentasta and Carlson Lake) in the Mentasta Village planning region showing ecological sites.

Table 29. Vegetation treatment sites in the Mentasta Village planning region and their primary ecosystem type, treatment goal, size (acres), and total biomass (tons).

Treatment Site Name	Ecosystem Code	Primary Treatment Goal	Acres	Biomass (tons)
Carlson Lake	16181_A	Timber/Browse	48.8	634.5
Little Tok #1	16050_A	Moose Browse	12.8	116.1
Little Tok #2	16212_C	Timber Management	23.1	535.3
Little Tok #3	16042_B	Timber Management	17.6	397.7
Mile 100 #1	16042_B	Timber Management	30.3	459.3
Mile 100 #2	16042_B	Moose Browse	50.8	990.0
Mile 100 #3	16030_C	Moose Browse	37.2	847.9
Mile 85	16181_A		36.6	311.8
Old Mentasta	16030_C	Timber Improvement	44.5	733.2

Tazlina Village Management Plan

The Tazlina Village planning region encompasses an area of 250,843 acres. Figure 231 displays the overall planning area along with associated infrastructure. Ownership of this and the surrounding area is shown in Figure 232. As Figure 232 displays, land ownership patterns are varied in this area with Ahtna, Inc. owning 48.3% (121,213 acres) of the land.

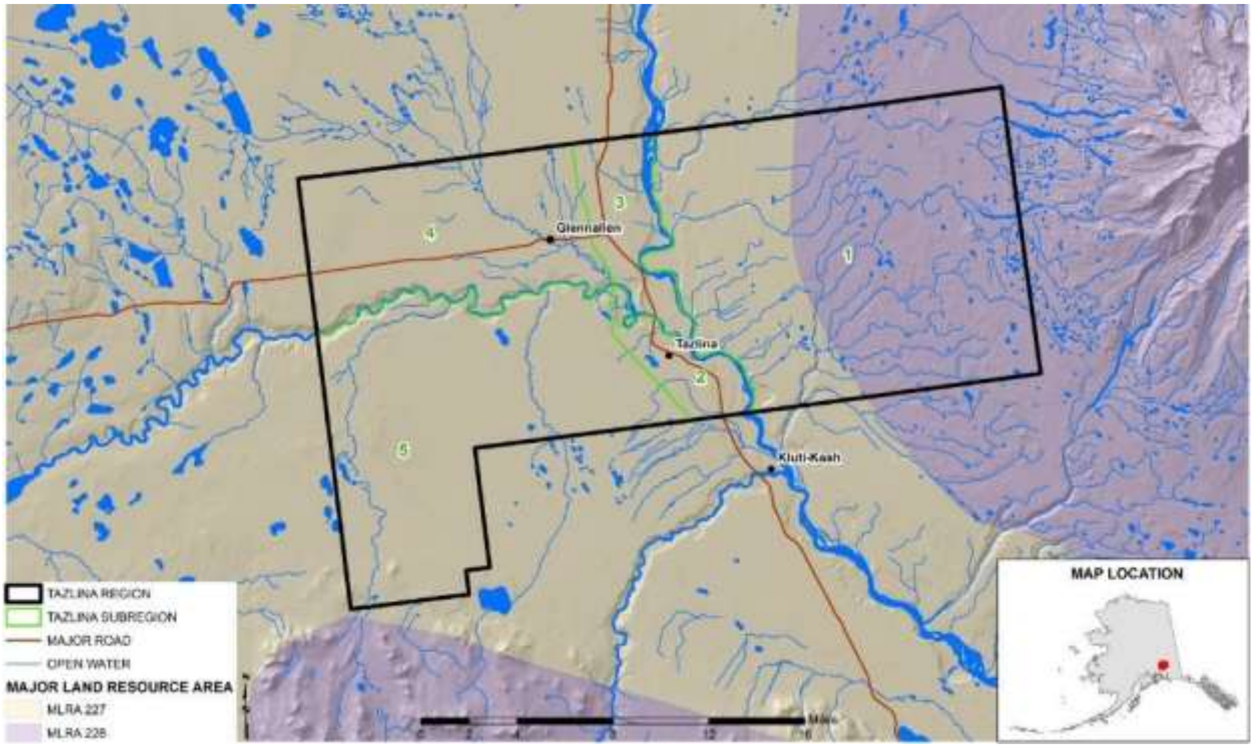


Figure 231. Overview of the Tazlina Village planning region.

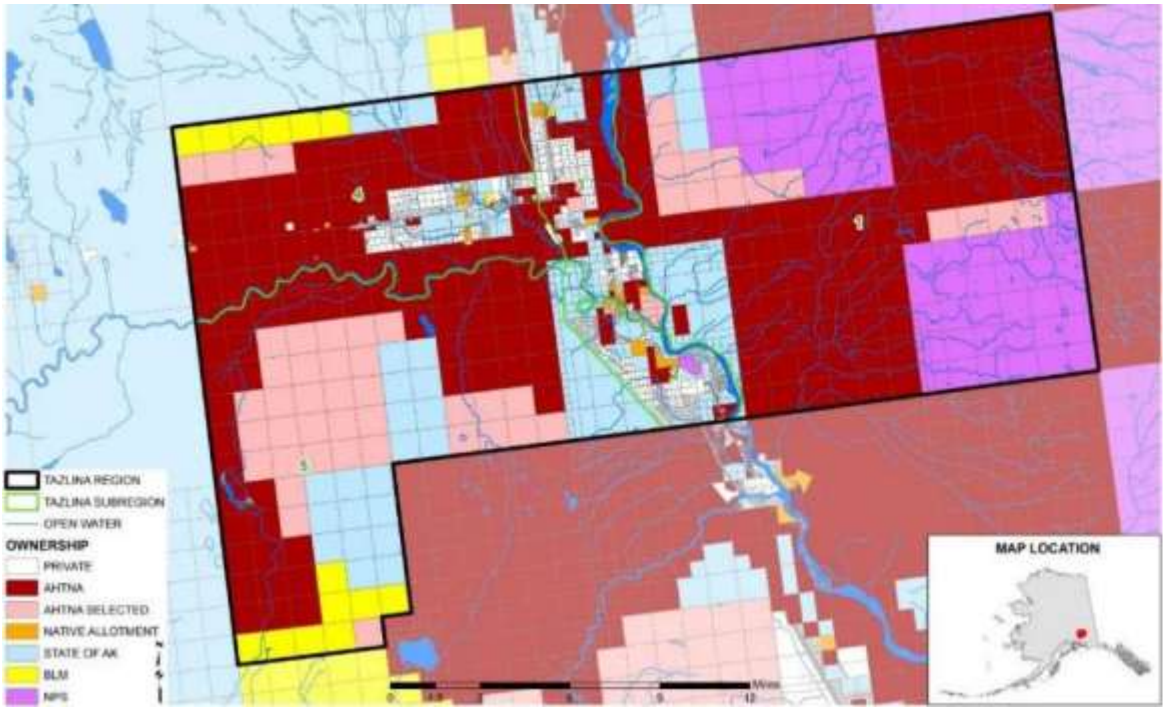


Figure 232. Land ownership patterns in the Tazlina Village planning region.

Planning Area Description

A description of the general geology, climate, soils, permafrost, and vegetation is found in Chapter 1 of this report. Figures showing these features specific to the Tazlina Village planning region are displayed below. Soil texture in the Tazlina area is shown in Figure 233 and Figure 234 displays soil drainages. Permafrost in the Tazlina area is shown in Figure 235.

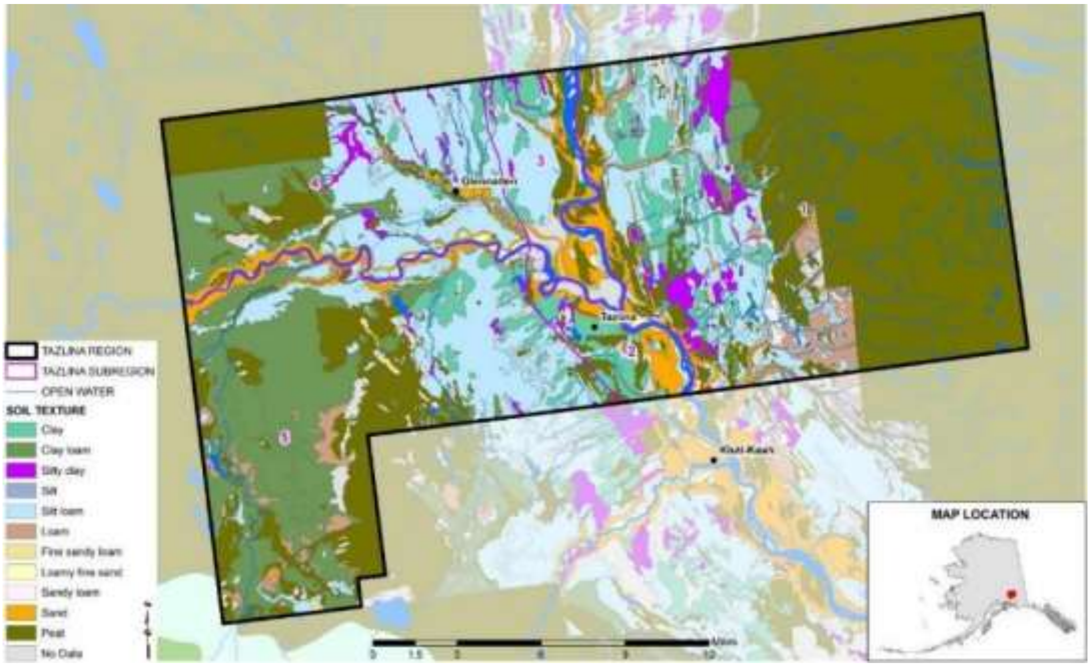


Figure 233. Soil texture in the Tazlina Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

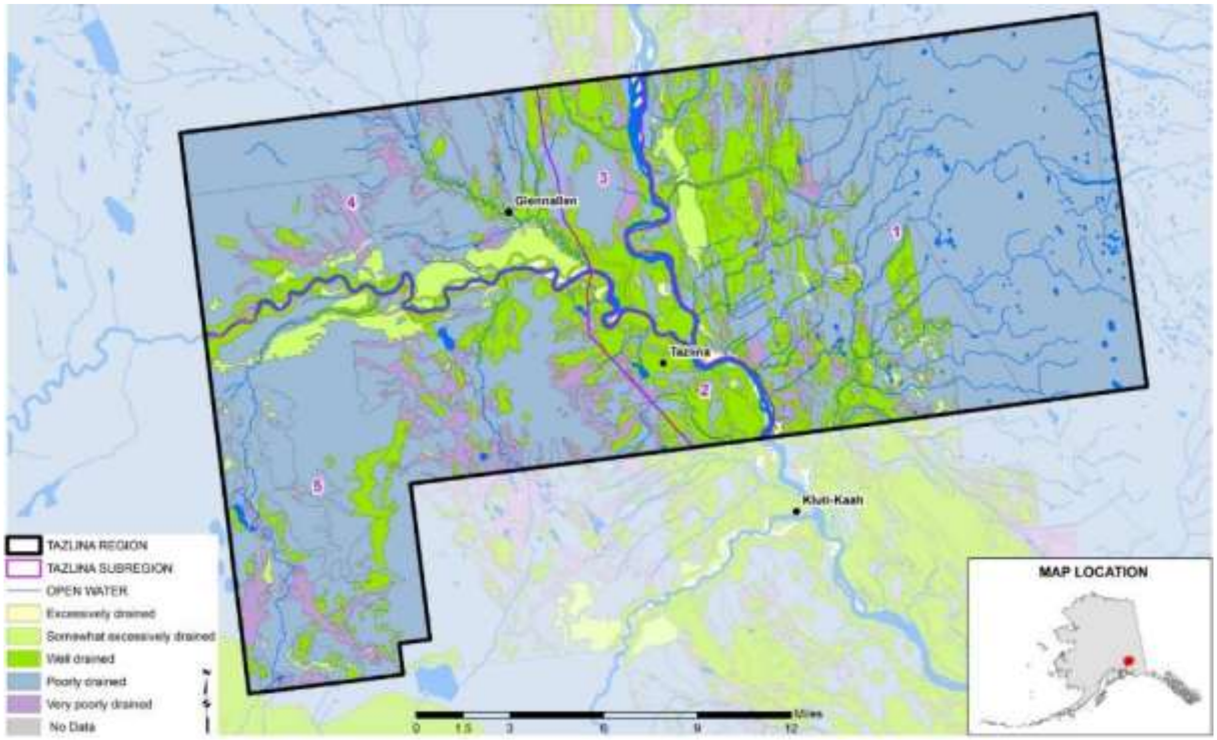


Figure 234. Soil drainage in the Tazlina Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

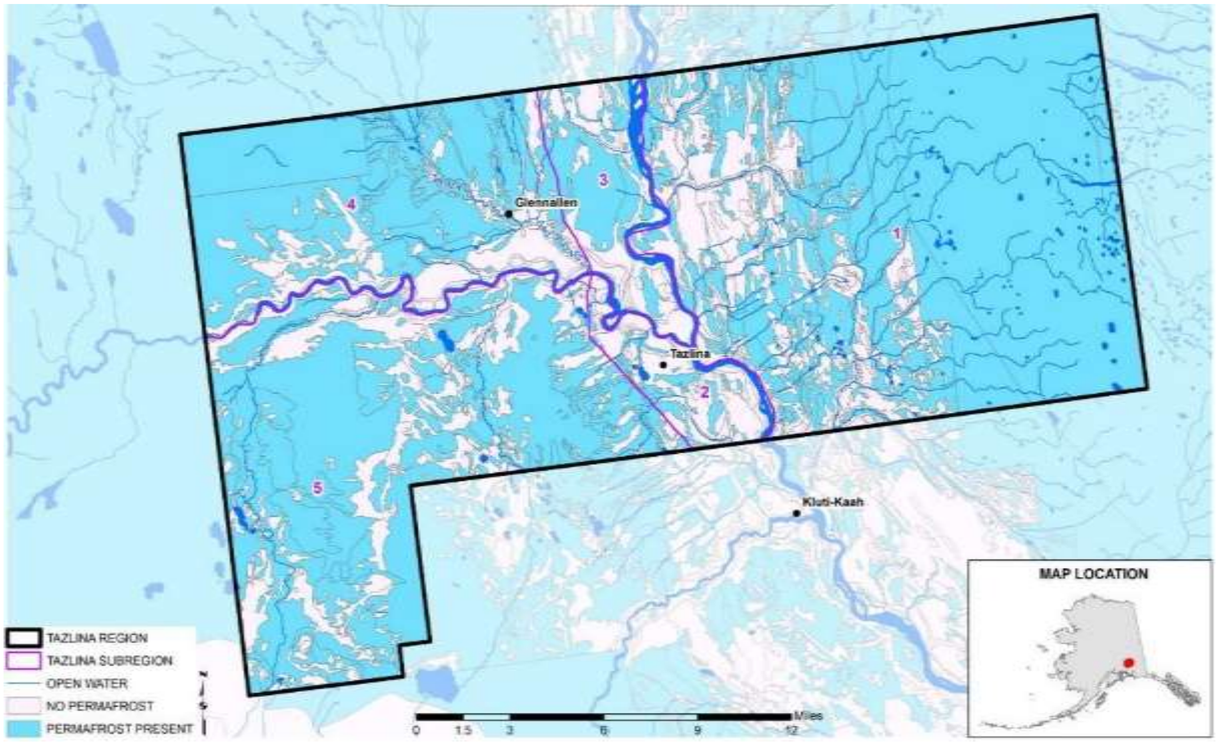


Figure 235. Permafrost in the Tazlina Village planning region. Data from NRCS SURRGO database for Soil Map Unit AK612 and NRCS STATSGO database for Alaska.

Fire is the primary disturbance factor influencing the vegetation ecology in the Copper River Basin. Figure 236 shows the fire history of the Tazlina area along with current fire protection zones. Although the level of fire occurring in this southcentral Alaska landscape is substantially less than that occurring in more interior areas of Alaska north of the Alaska Range, fire is still a significant disturbance when it occurs. When fire does occur it serves to set back succession. It can also burn off the organic material at the ground surface, including peat that can occur on many sites. This can influence the thermal layer protecting the underlying permafrost on some sites, causing the permafrost to melt (thermokarst) and changing the site conditions through this process. Riparian areas are also influenced by flooding and ice events. These serve to set back succession of vegetation in riparian areas, and can even shift site conditions, particularly in the case of significant flooding events.

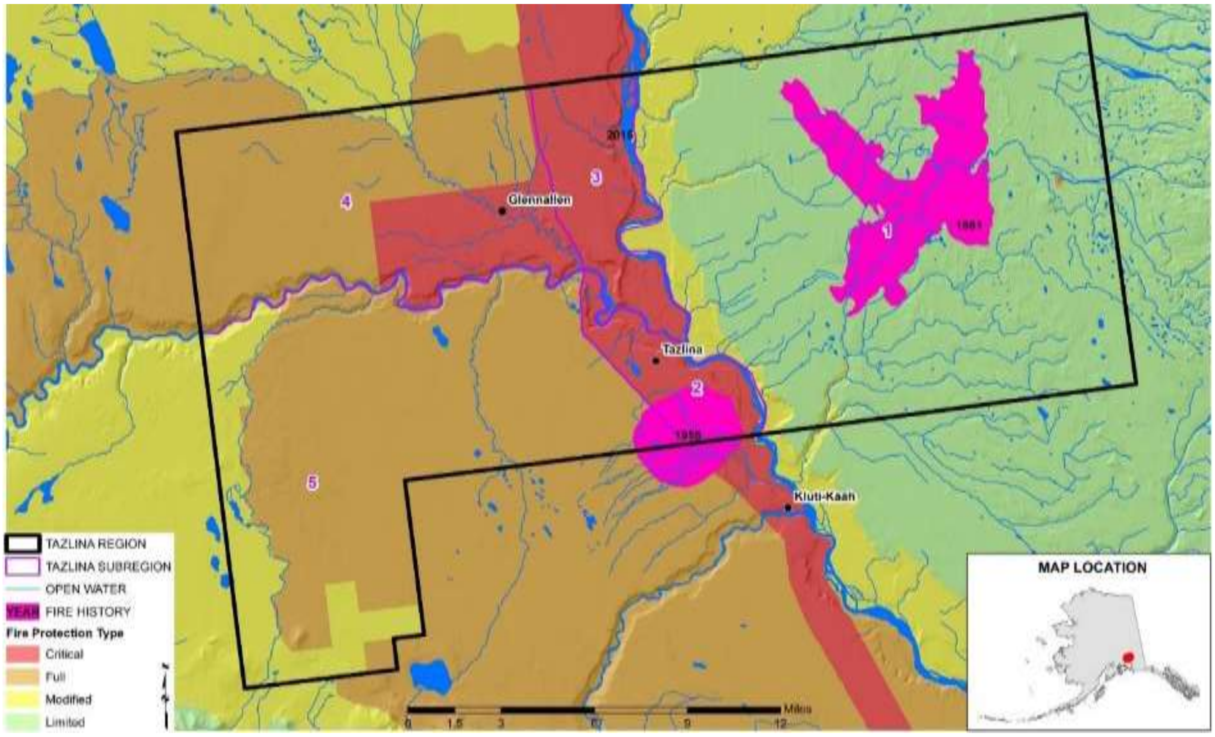


Figure 236. Current fire protection classes and fire history since 1940 in the Tazlina Village planning region. Data from Alaska Interagency Coordination Center.

Landscape Assessment Results

Ecosystem Diversity

The ecological sites present within the Tazlina Village planning region are displayed in Figure 237. Table 30 displays the acres for each ecosystem (i.e., ecological site and disturbance class. Figure 238 is a map of the overall ecosystem diversity in the Tazlina Village planning region.

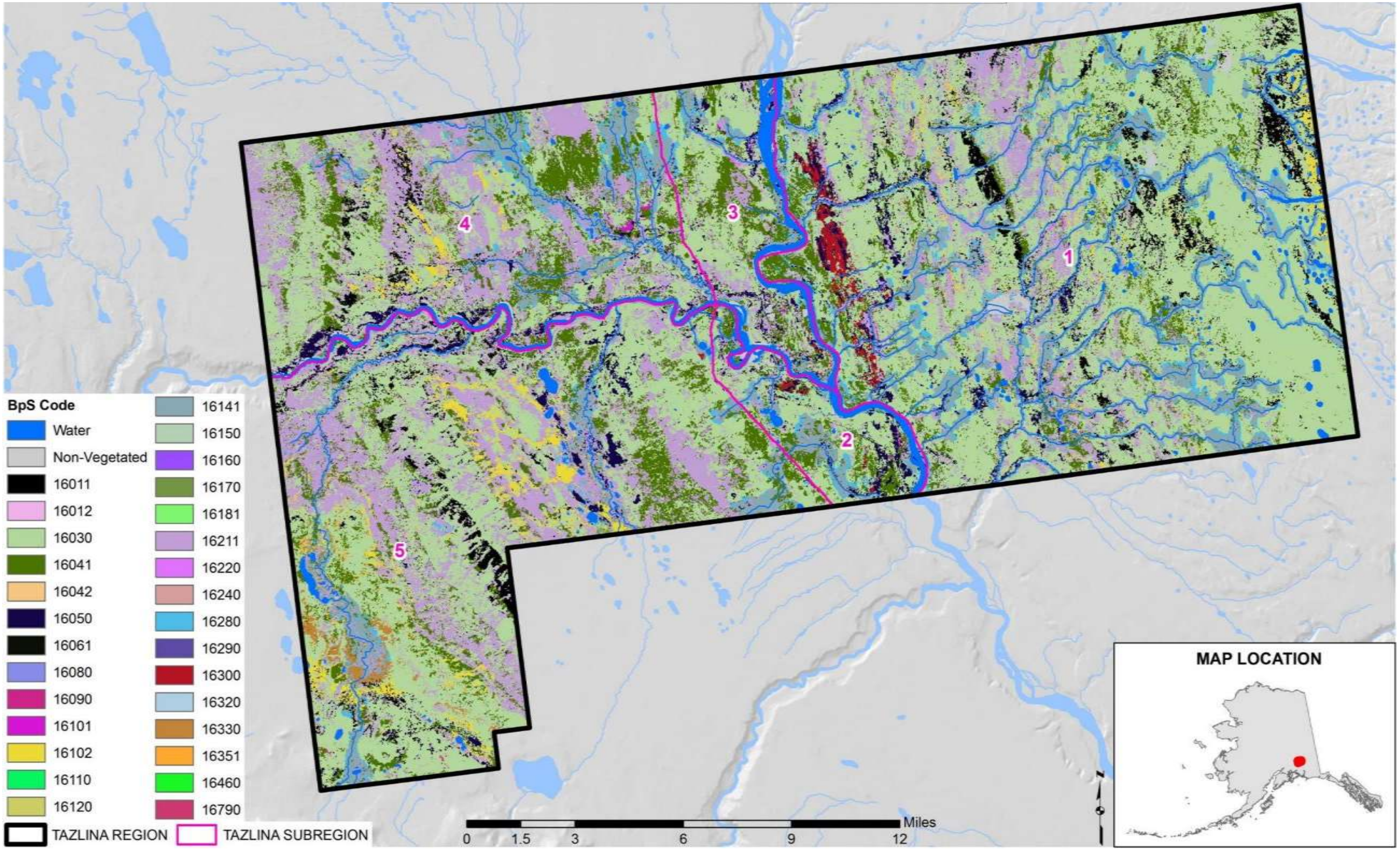


Figure 237. Ecological sites (codes) in the Tazlina Village planning region. Data from LANDFIRE.

Table 30. Acres by ecological site code and disturbance class (A – E) in the Tazlina Village planning region. The ecological site vegetation label is provided as well.

Ecosystem Code	Ecological Site Label	Acres	Ecosystem Code	Ecolgocal Site Label	Acres
11	Open Water	4230.8	16150_B	Large River Floodplain	28.5
12	Perrennial Ice/Snow	22.5	16150_C	Large River Floodplain	57.2
16011_A	Treeline White Spruce – Boreal	1576.1	16150_D	Large River Floodplain	2.0
16011_B	Treeline White Spruce – Boreal	4757.0	16150_E	Large River Floodplain	0.7
16012_A	Treeline White Spruce – SubBoreal	15.4	16160_A	Riparian Stringer	1.8
16012_B	Treeline White Spruce – SubBoreal	30.9	16160_B	Riparian Stringer	6.0
16030_A	White Spruce-Hardwood – Boreal	3360.4	16170_A	Shrub and Herbaceous Floodplain	175.0
16030_B	White Spruce-Hardwood – Boreal	14292.9	16170_B	Shrub and Herbaceous Floodplain	9.1
16030_C	White Spruce-Hardwood – Boreal	93422.8	16170_C	Shrub and Herbaceous Floodplain	1.8
16030_E	White Spruce-Hardwood – Boreal	236.4	16170_D	Shrub and Herbaceous Floodplain	1.8
16041_A	Mesic Black Spruce – Boreal	1136.9	16170_E	Shrub and Herbaceous Floodplain	52.0
16041_B	Mesic Black Spruce – Boreal	2603.4	16181_A	Herbaceous Fen	51.2
16041_C	Mesic Black Spruce – Boreal	1820.8	16181_B	Herbaceous Fen	4.5
16041_D	Mesic Black Spruce – Boreal	21569.9	16181_C	Herbaceous Fen	0.9
16041_E	Mesic Black Spruce – Boreal	12.9	16181_D	Herbaceous Fen	13.8
16042_A	Mesic Black Spruce – SubBoreal	8.0	16211_A	Dwarf Black Spruce Peatland – Boreal	2374.1
16042_B	Mesic Black Spruce – SubBoreal	37.6	16211_B	Dwarf Black Spruce Peatland – Boreal	2930.7
16042_C	Mesic Black Spruce – SubBoreal	6.2	16211_C	Dwarf Black Spruce Peatland – Boreal	3109.3
16042_D	Mesic Black Spruce – SubBoreal	0.2	16211_D	Dwarf Black Spruce Peatland – Boreal	41100.2
16050_A	Mesic Birch-Aspen	5859.4	16212_A	Dwarf Black Spruce Peatland – Subboreal	3.6
16050_B	Mesic Birch-Aspen	1140.4	16212_B	Dwarf Black Spruce Peatland – Subboreal	5.8
16050_D	Mesic Birch-Aspen	11.1	16212_C	Dwarf Black Spruce Peatland – Subboreal	14.5
16050_E	Mesic Birch-Aspen	18.9	16220_A	Black Spruce Wet-Mesic Slope	81.4
16061_A	Dry Aspen-Steppe Bluff	86.1	16220_B	Black Spruce Wet-Mesic Slope	50.9
16061_B	Dry Aspen-Steppe Bluff	353.6	16220_C	Black Spruce Wet-Mesic Slope	221.5
16061_C	Dry Aspen-Steppe Bluff	296.2	16240_A	Deciduous Shrub Swamp	62.5
16061_D	Dry Aspen-Steppe Bluff	1623.5	16280_A	Low Shrub-Tussock Tundra	6032.5
16080_A	Avalanche Slope Shrubland	0.4	16280_B	Low Shrub-Tussock Tundra	793.5
16080_B	Avalanche Slope Shrubland	2.0	16280_C	Low Shrub-Tussock Tundra	149.9
16090_A	Mesic Subalpine Alder	30.5	16290_A	Tussock Tundra	0.2
16090_B	Mesic Subalpine Alder	6.9	16290_B	Tussock Tundra	0.2
16102_A	Mesic Scrub Birch/Willow	2483.7	16300_A	Wet Black Spruce-Tussock	767.0
16102_B	Mesic Scrub Birch/Willow	3422.4	16300_B	Wet Black Spruce-Tussock	127.2
16110_A	Mesic Bluejoint Meadow	13.3	16300_C	Wet Black Spruce-Tussock	359.4
16120_A	Dry Grassland	3.1	16320_A	Alpine Talus and Bedrock	706.8
16141_A	Montane Floodplain – Boreal	21082.6	16320_B	Alpine Talus and Bedrock	8.9
16141_B	Montane Floodplain – Boreal	1434.2	16330_A	Alpine Mesic Herbaceous Meadow	919.2
16141_C	Montane Floodplain – Boreal	650.1	16351_A	Alpine Ericaceous Dwarf-Shrubland	166.8
16141_D	Montane Floodplain – Boreal	58.9	16481_C	Mountain Hemlock	0.2
16141_E	Montane Floodplain – Boreal	32.9	16790_A	White Spruce-Hardwood – SubBoreal	26.0
16142_A	Montane Floodplain – Subboreal	3.6	16790_B	White Spruce-Hardwood – SubBoreal	43.1
16142_B	Montane Floodplain – Subboreal	2.0	16790_C	White Spruce-Hardwood – SubBoreal	24.7
16142_C	Montane Floodplain – Subboreal	0.7	16790_D	White Spruce-Hardwood – SubBoreal	0.9
16150_A	Large River Floodplain	192.6	31	Non-Vegetated	2326.7

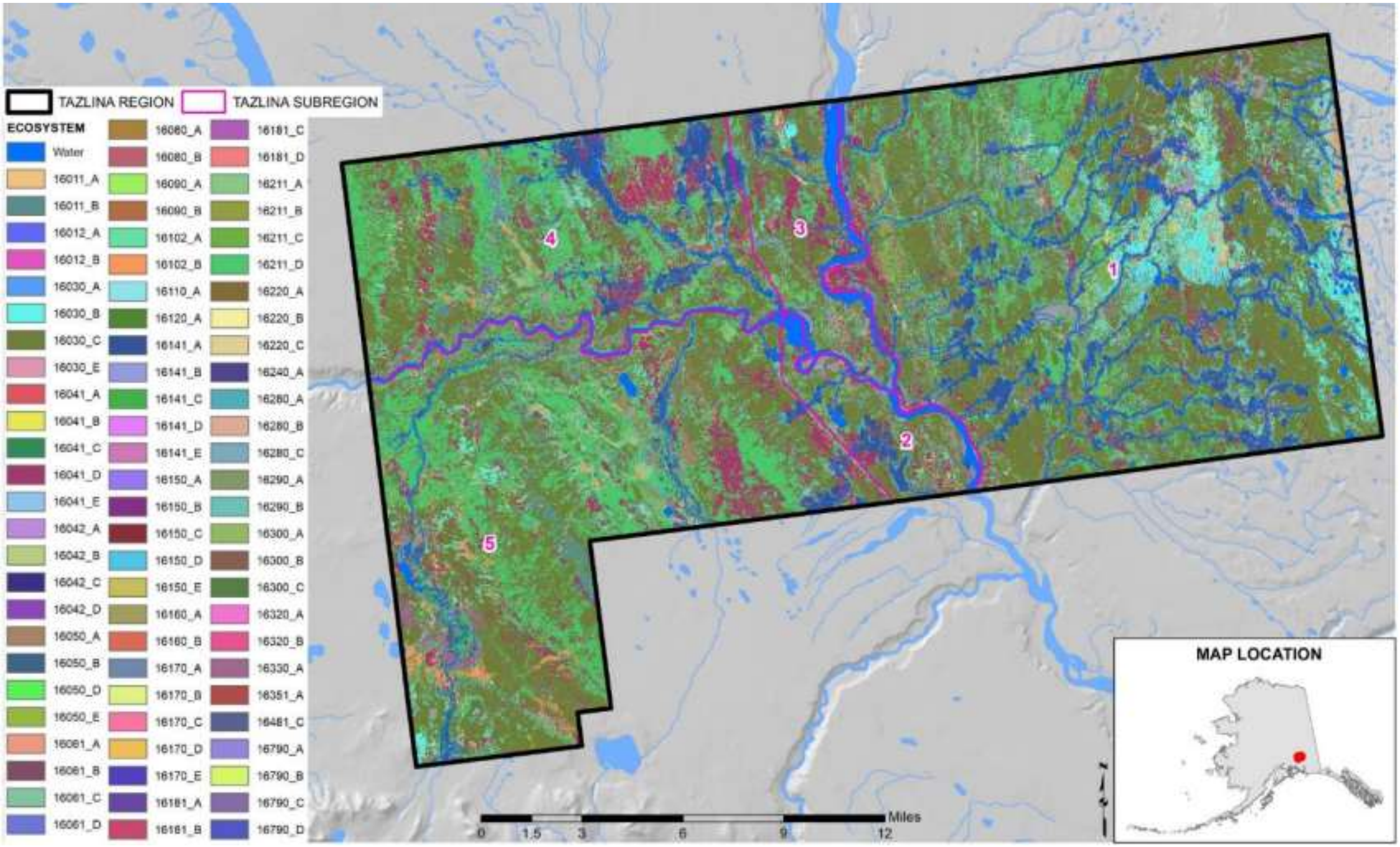


Figure 238. Ecosystem diversity of the Tazlina Village planning region. See Appendix A for ecosystem code definitions

Berry Production Areas

Figure 239 shows the areas identified with the highest potential for berry production. It may be desirable to avoid disturbances to these areas, but verifying the actual presence of good berry production is recommended on a site by site basis.

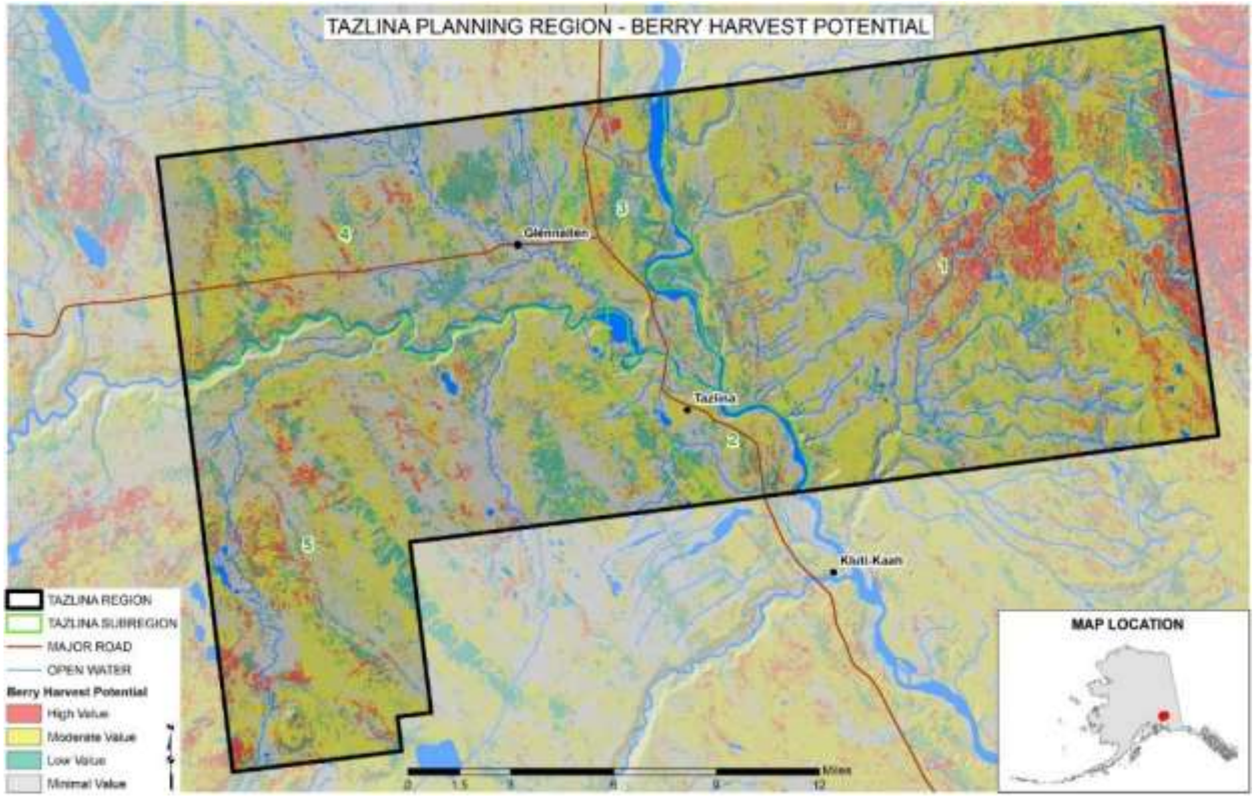


Figure 239. Potential berry production values in the Tazlina Village planning region.

Moose and Caribou Habitat Quality Assessment - Model Results

Moose

Ecosystem-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 240 to 242. Landscape-scale model outputs for moose habitat quality by seasonal habitat use are presented in Figures 243 to 245. A complete description of the moose habitat quality models can be found in Appendix B.

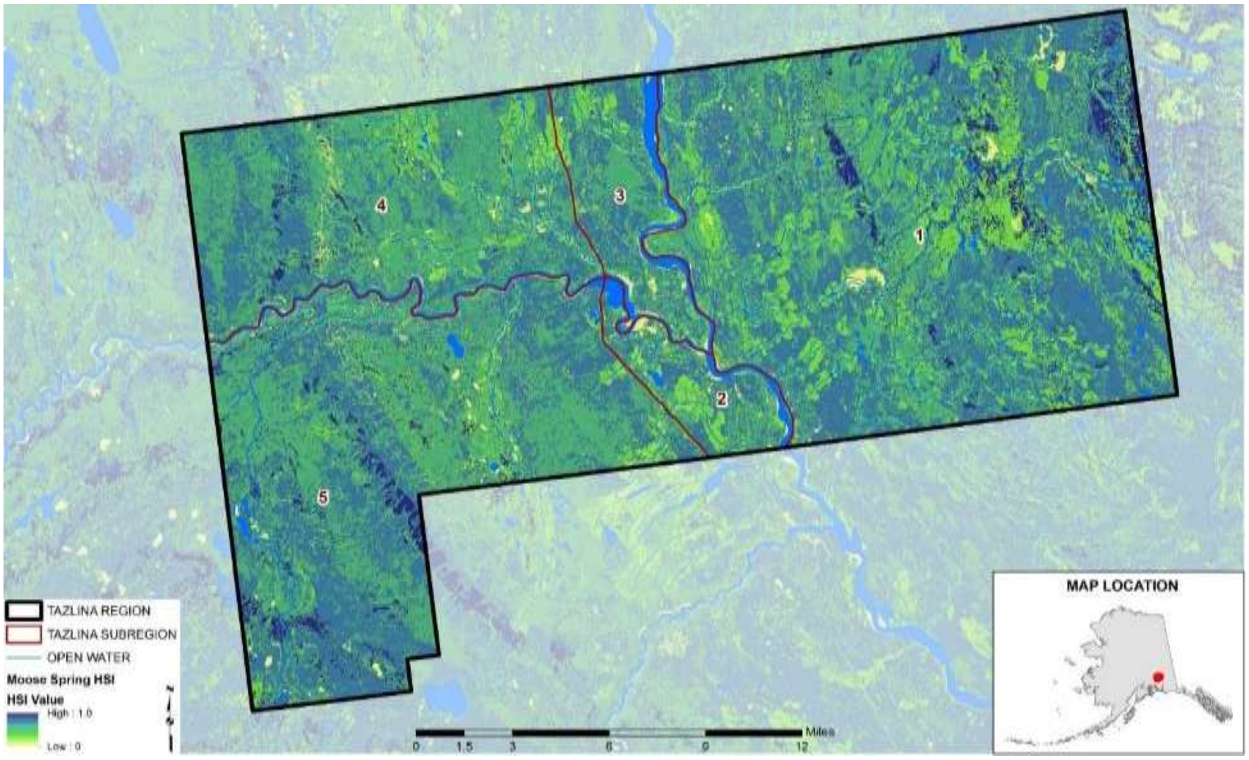


Figure 240. Results of the ecosystem-scale model outputs for moose spring habitat quality.

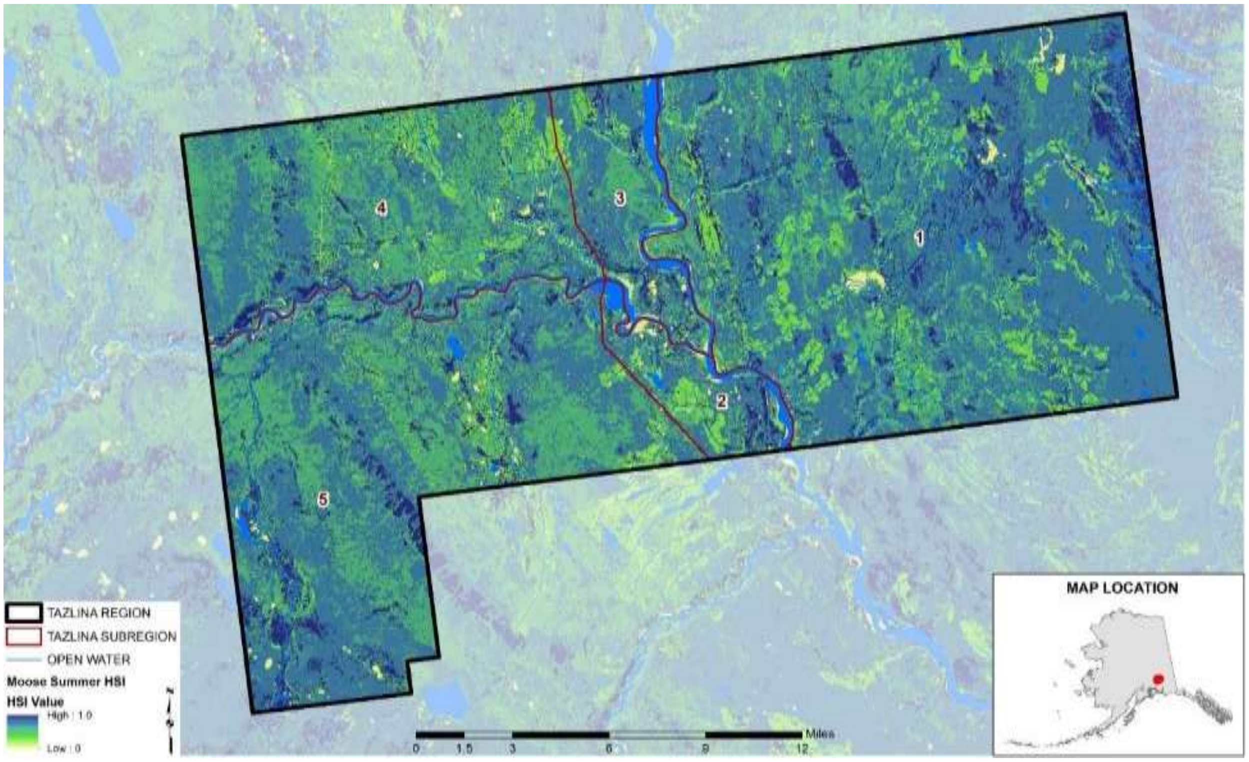


Figure 241. Results of the ecosystem-scale model outputs for moose summer habitat quality.

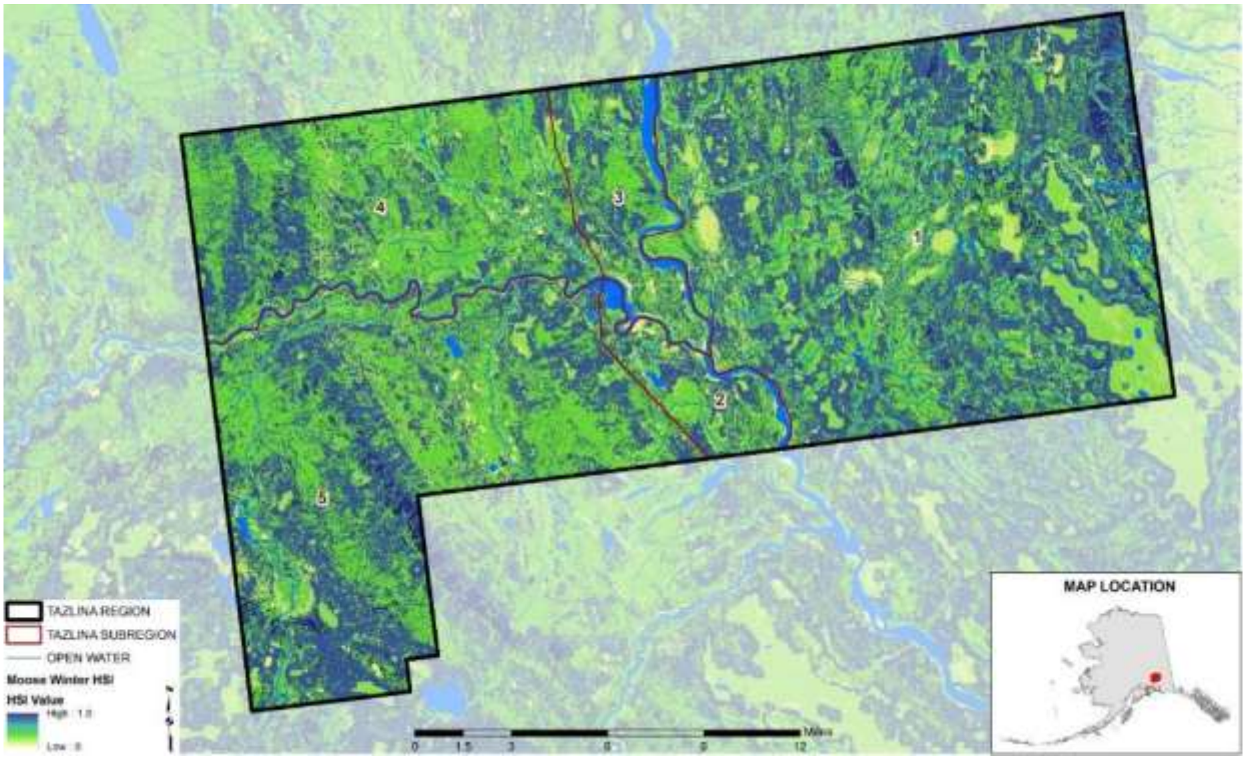


Figure 242. Results of the ecosystem-scale model outputs for moose winter habitat quality.

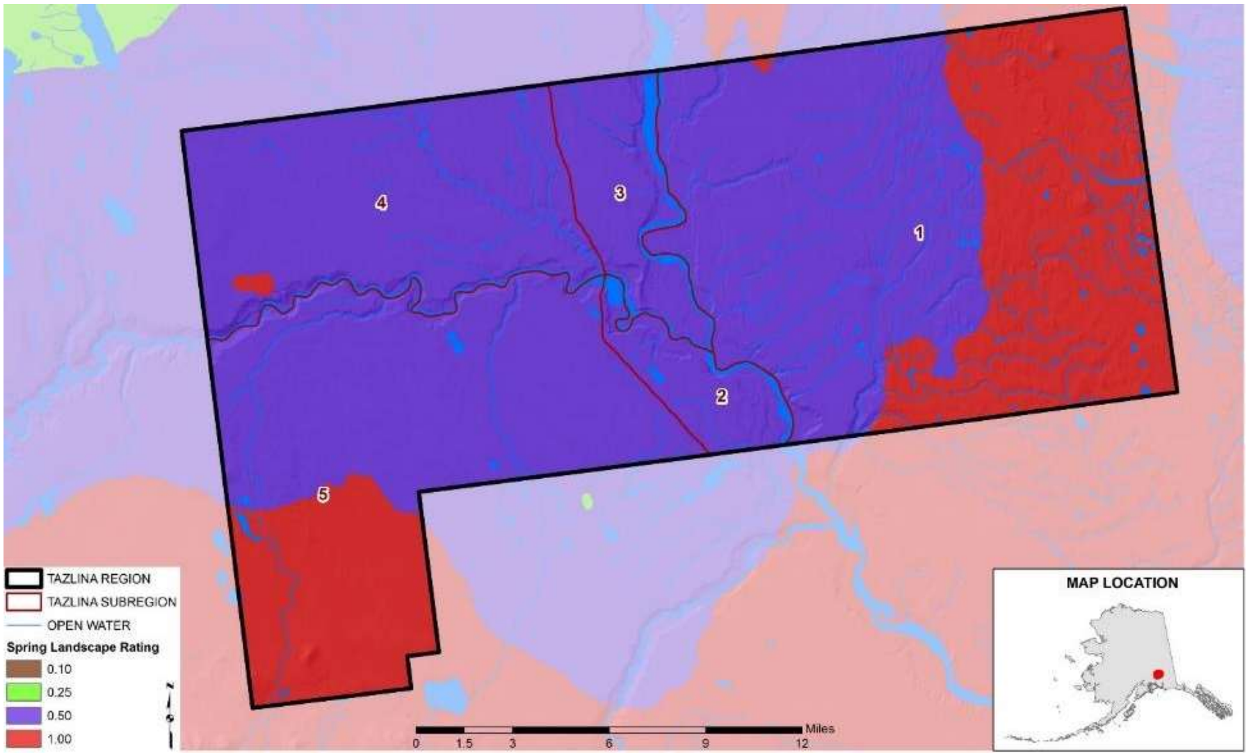


Figure 243. Results of the landscape-scale model outputs for moose spring habitat quality.

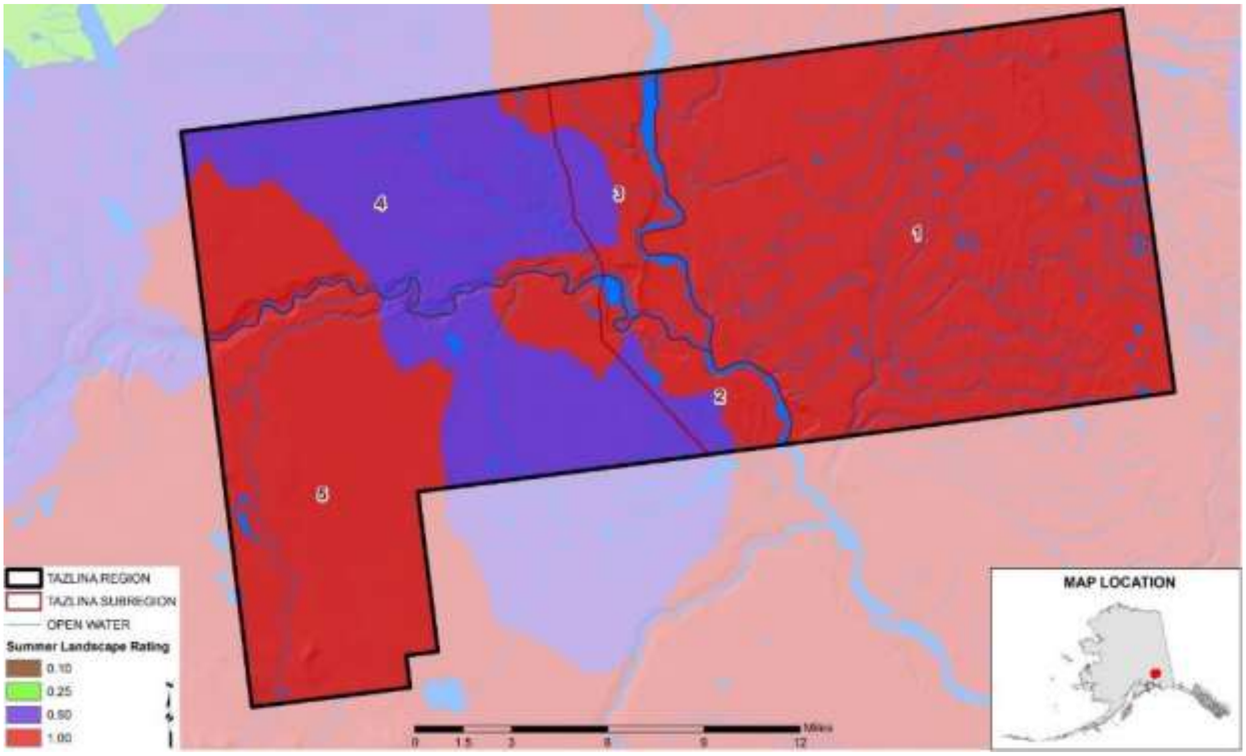


Figure 244. Results of the landscape-scale model outputs for moose spring habitat quality.

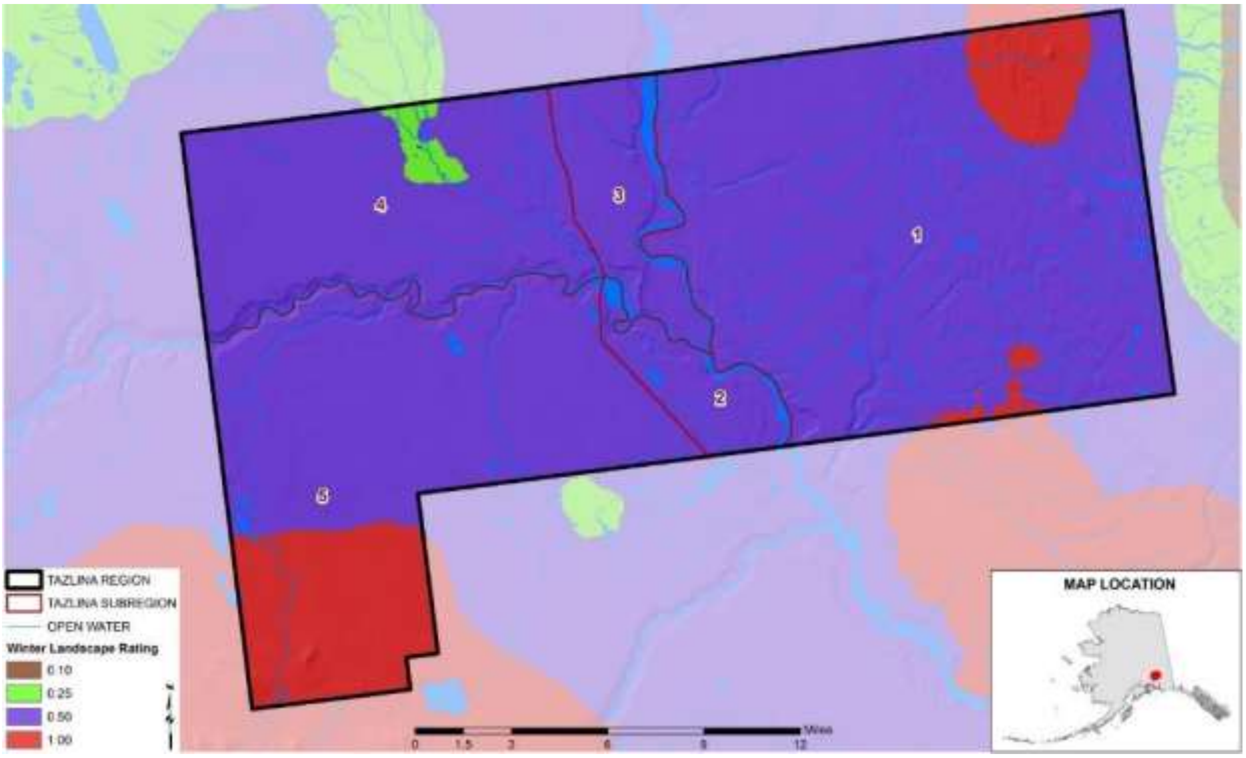


Figure 245. Results of the landscape-scale model outputs for moose winter habitat quality.

Caribou

Ecosystem-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 246 and 247. Landscape-scale model outputs for caribou habitat quality by seasonal habitat use are presented in Figures 248 and 249. A complete description of the caribou habitat quality models can be found in Appendix C.

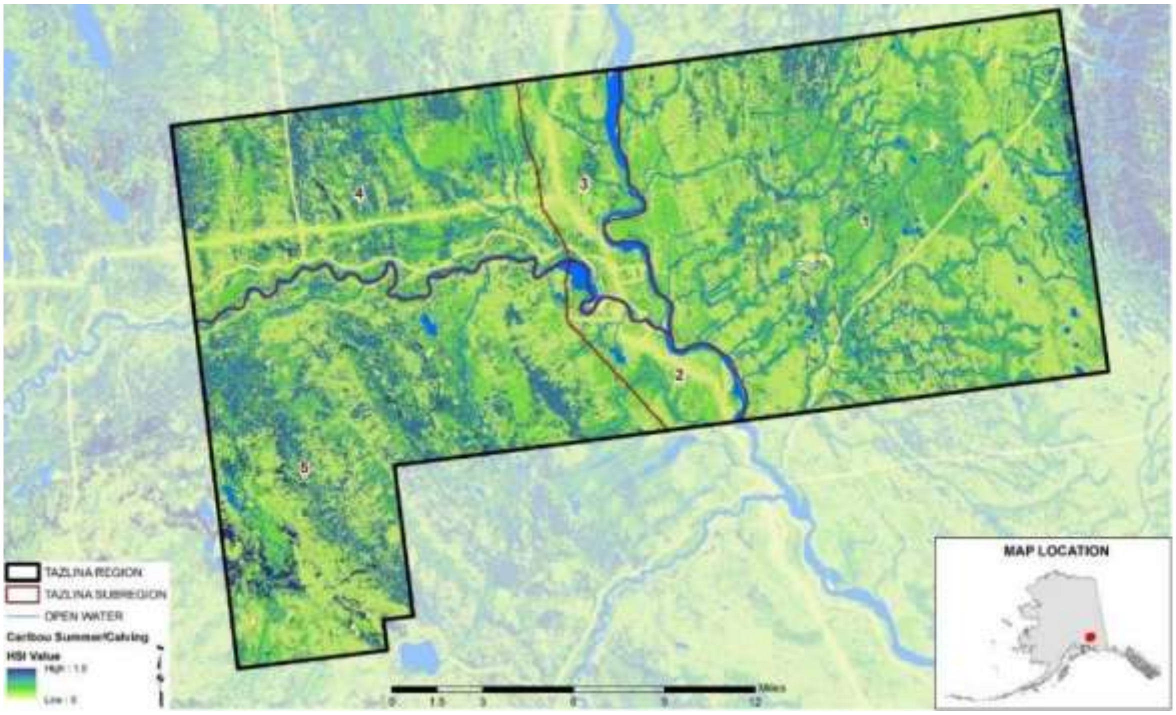


Figure 246. Results of the ecosystem-scale model outputs for caribou summer/calving habitat quality.

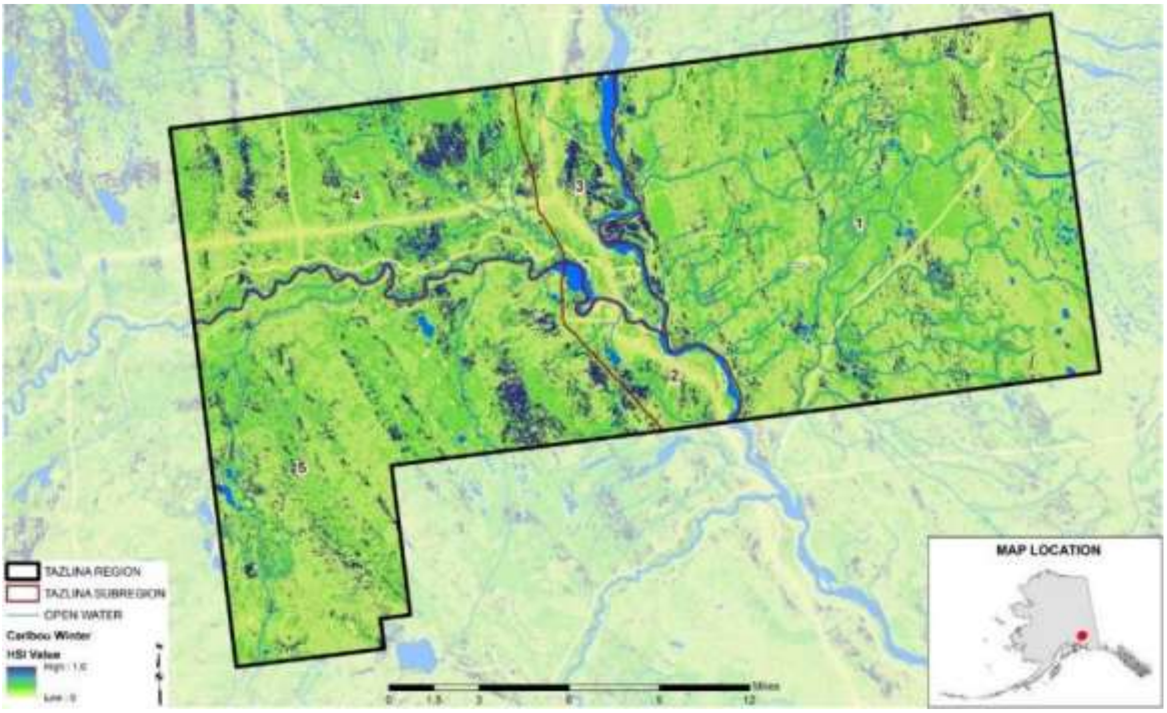


Figure 247. Results of the ecosystem-scale model outputs for caribou winter habitat quality.

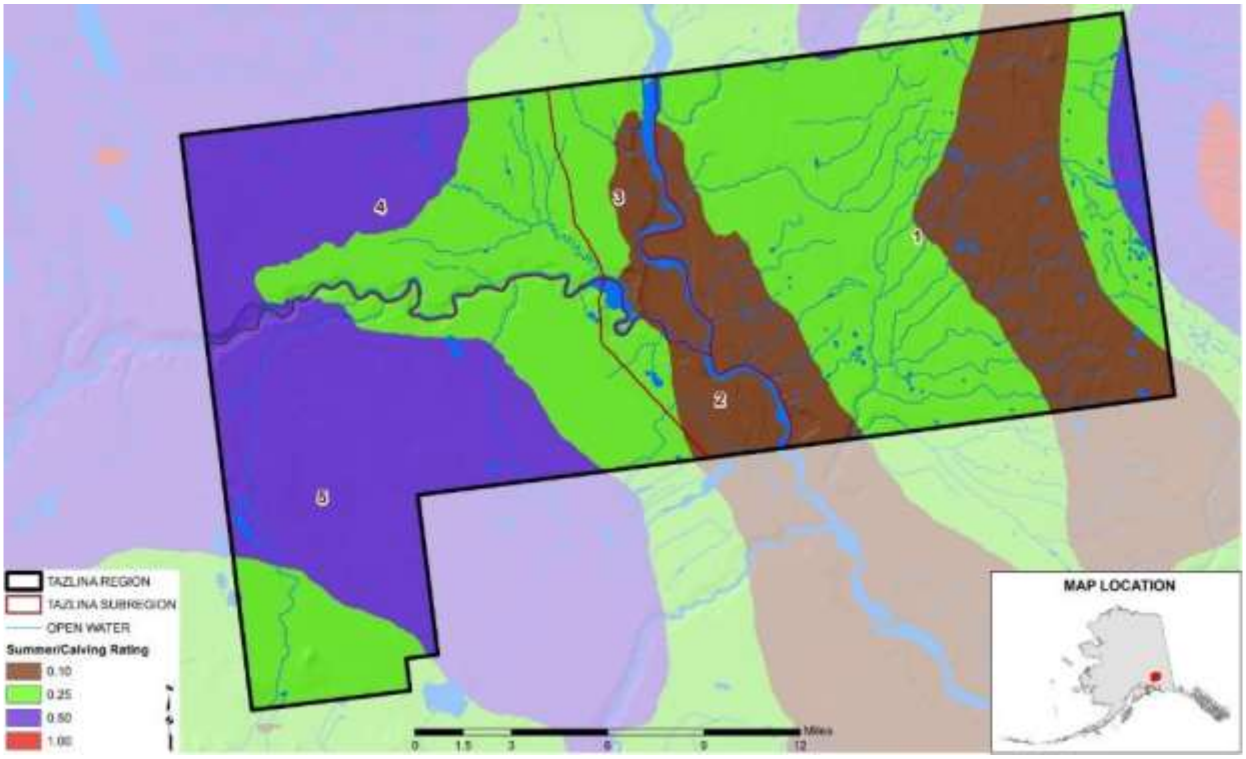


Figure 248. Results of the landscape-scale model outputs for caribou summer/calving habitat quality.

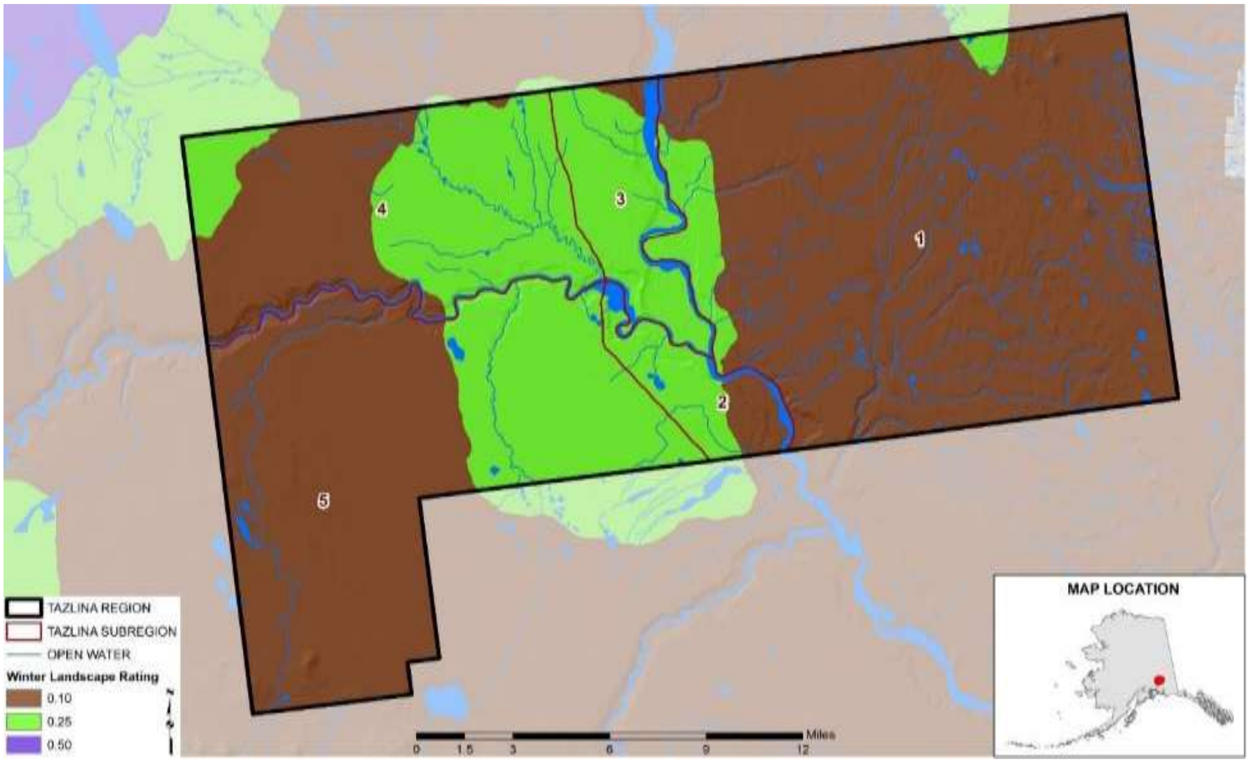


Figure 249. Results of the landscape-scale model outputs for caribou winter habitat quality.

Tazlina Site Improvement Areas

Site selection for improvement areas in the Tazlina project area identified a number of sites for designated treatments. Figure 250 provides an overview of the treatment site locations and figures 251-258 depict the locations and conditions of some of these areas. Appendix C provides a description of each of these sites.

Treatments for moose habitat improvement could use a number of possible mechanical treatments designed to stimulate growth of preferred moose browse species such as willow, or potentially prescribed fire. Treatments for fuel mitigation would use similar methods, but are designed to reduce the amounts of flammable material in the primary lines of defense and provide a location where defensive actions can be taken to counter an approaching fire (Figure 259). Specific treatments need to be determined for each selected site. Site characteristics are listed in Table 31.

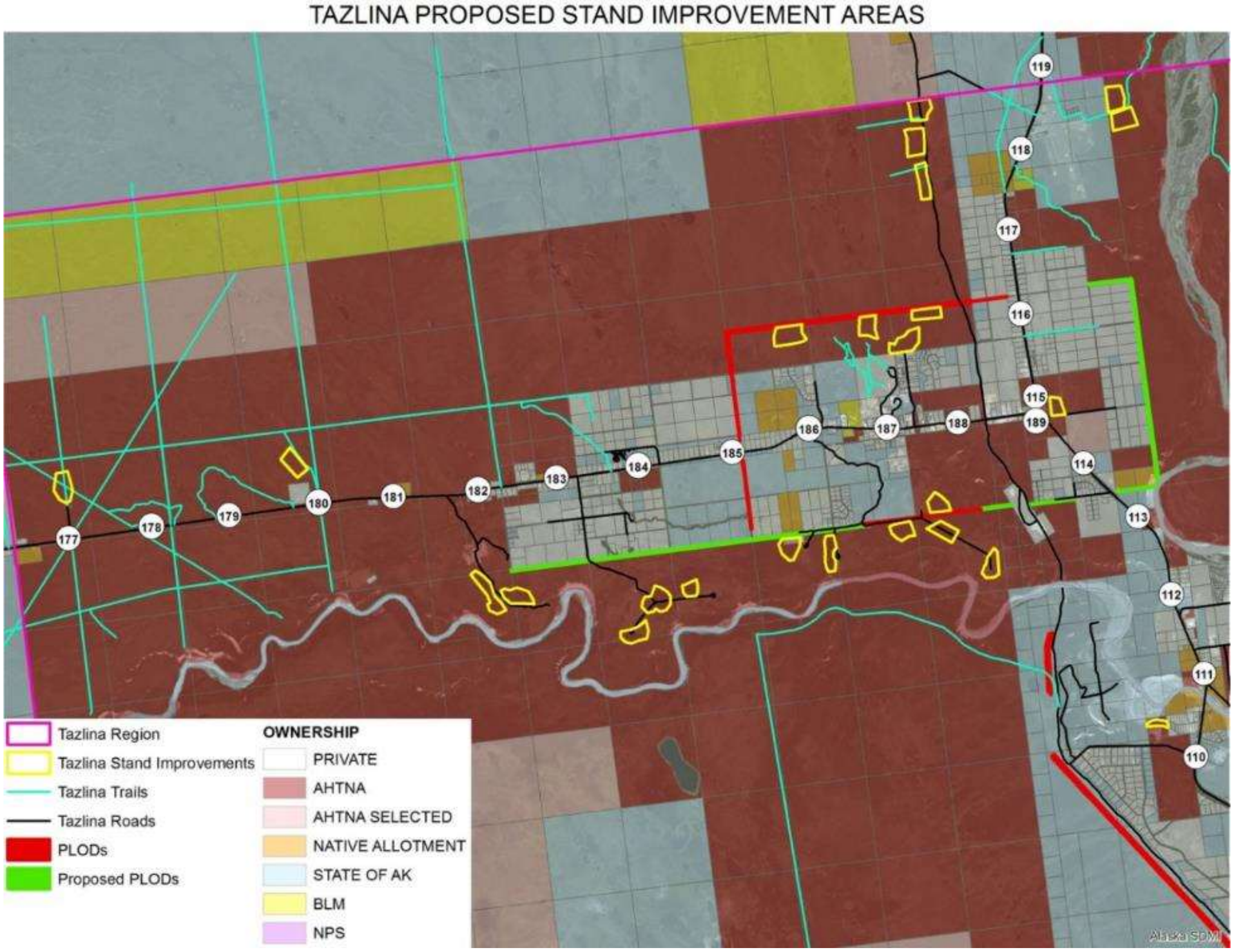


Figure 250. Overview of recommended treatment sites in the Tazlina Village planning region.

Figure 251. Example a proposed improvement area to be mechanically treated to open up the canopy and stimulate production of willow or other browse species. This is ecosystem type 16030-C.

Figure 252. Example of a proposed improvement area that could be mechanically treated to stimulate aspen production and thereby increase browse production. This is ecosystem type 16030-C.

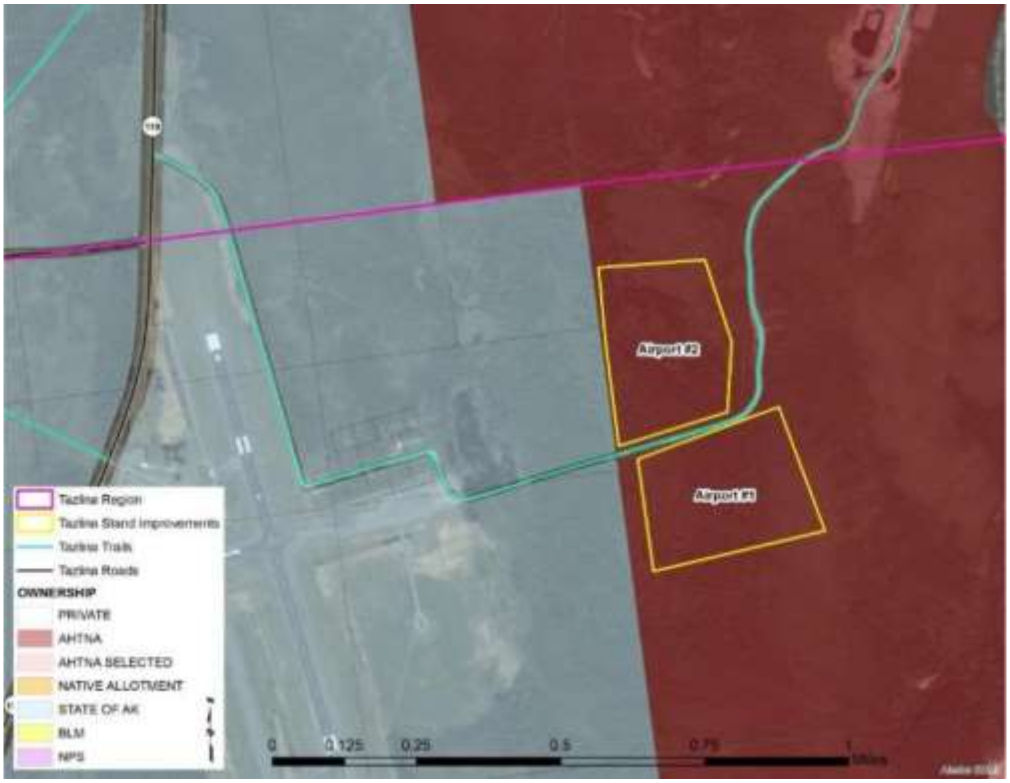


Figure 253. Map of proposed habitat improvement areas (Airport 1 and 2) in the Tazlina Village planning region showing surface ownership and aerial imagery.

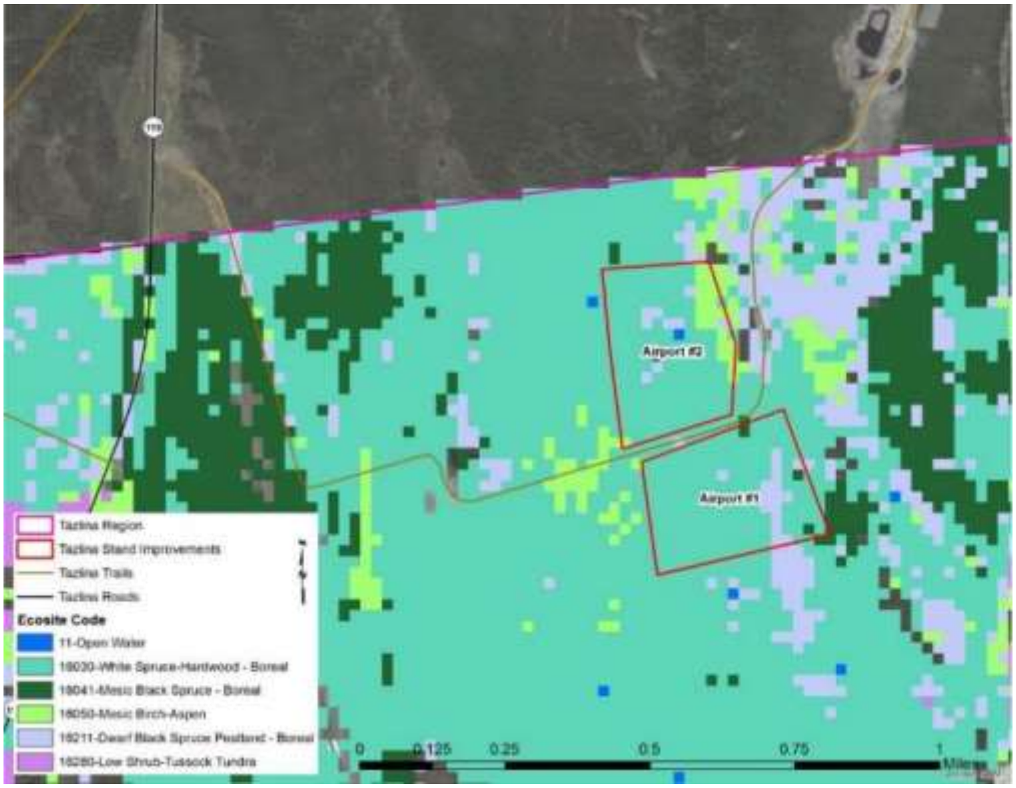


Figure 254. Map of proposed habitat improvement areas (Airport 1 and 2) in the Tazlina Village planning region showing ecological sites.

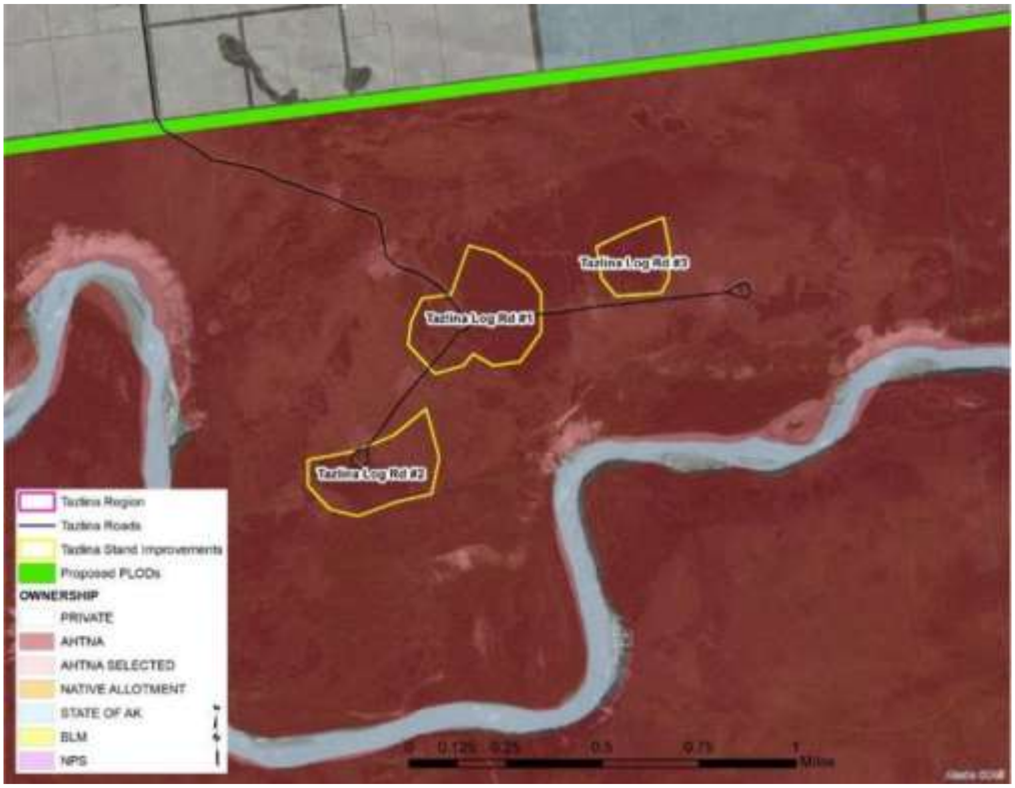


Figure 255. Map of proposed habitat improvement areas (Tazlina Log Road 1, 2, and 3) in the Tazlina Village planning region showing surface ownership and aerial imagery.

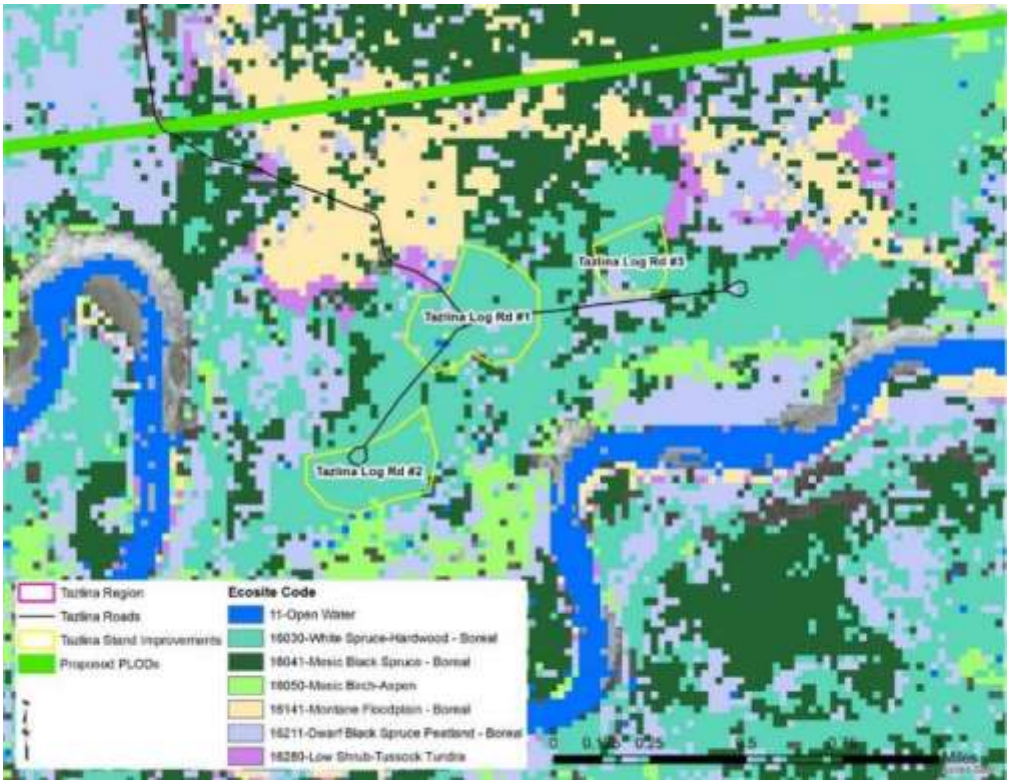


Figure 256. Map of proposed habitat improvement areas (Tazlina Log Road 1, 2, and 3) in the Tazlina Village planning region showing ecological sites.

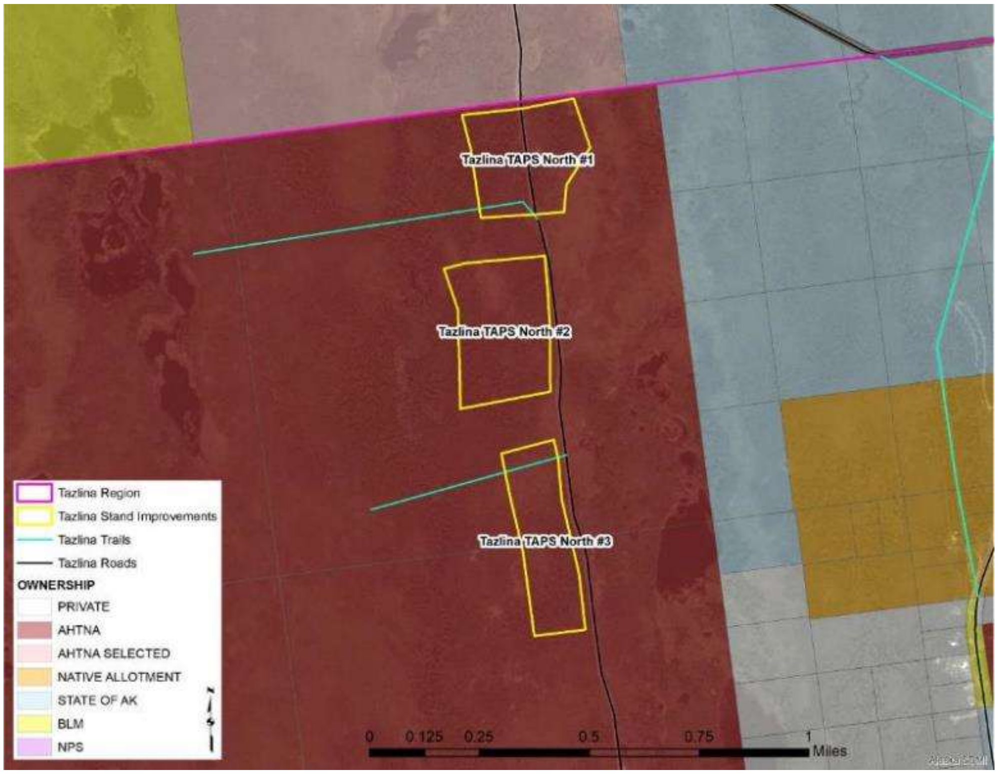


Figure 257. Map of proposed habitat improvement areas (TAPS North 1, 2, and 3) in the Tazlina Village planning region showing surface ownership and aerial imagery.

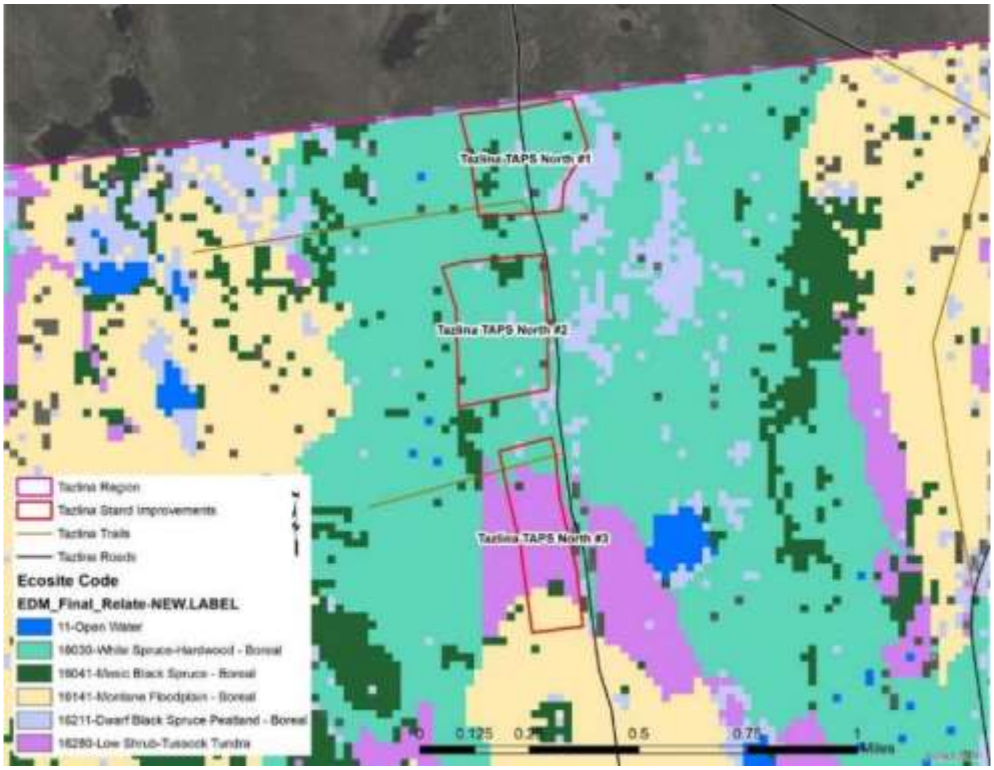


Figure 258. Map of proposed habitat improvement areas (TAPS North 1, 2, and 3) in the Tazlina Village planning region showing ecological sites.

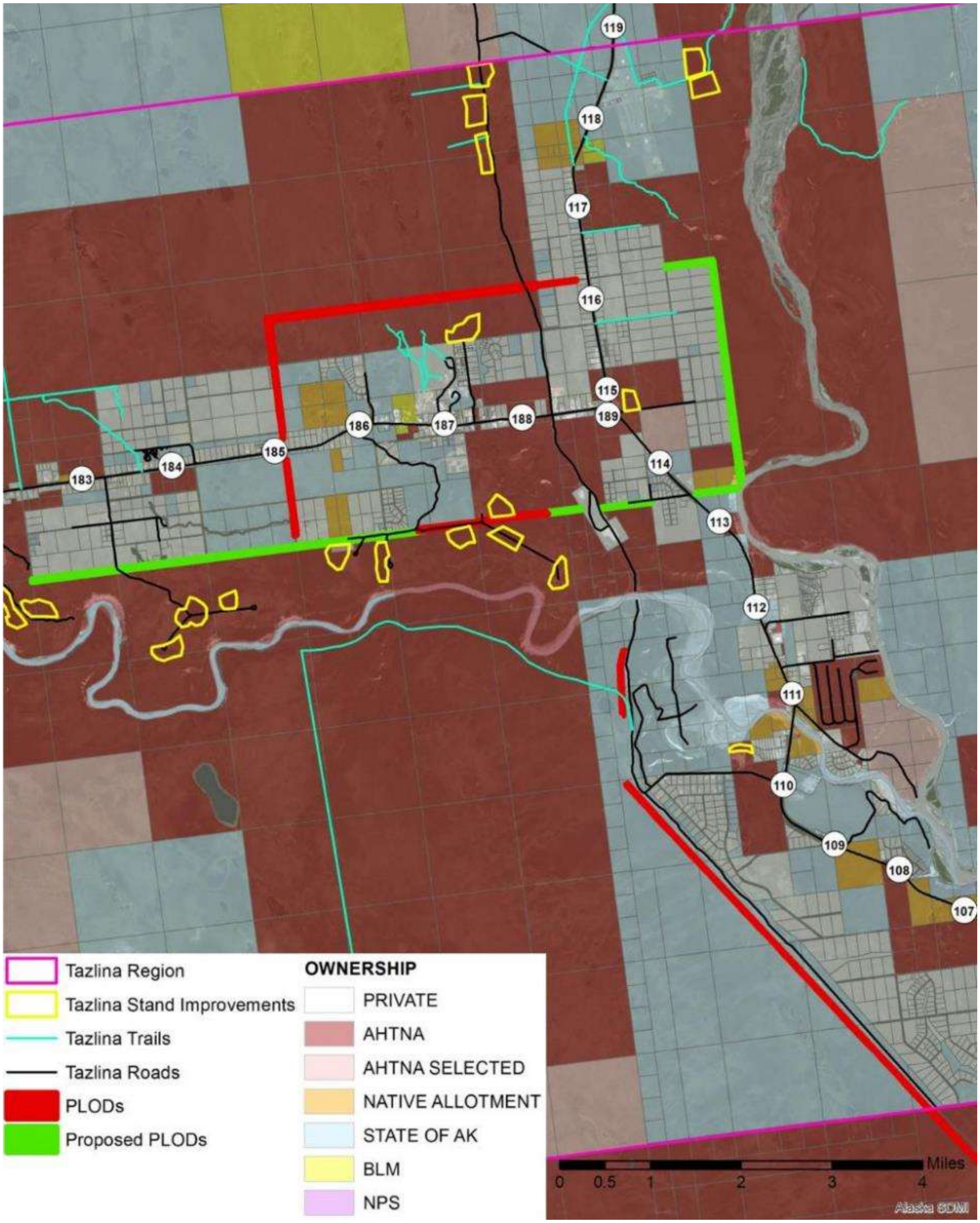


Figure 259. Map of existing and proposed primary line of defense (PLOD) in the Tazlina Village planning region for wildfire defense.

Table 31. Vegetation treatment sites in the Tazlina Village planning region and their primary ecosystem type, treatment goal, size (acres), and total biomass (tons). See Appendix A

Treatment Site Name	Ecosystem Code	Primary Treatment Goal	Acres	Biomass (tons)
Ahtna Office #1	16030_C	Moose Browse	20.0	642.8
Airport #1	16030_C	Moose Browse	38.3	1296.3
Airport #2	16030_C	Moose Browse	37.5	1250.0
Fishers Pit #1	16030_C	Moose Browse	43.6	1361.3
Fishers Pit #2	16030_C	Moose/Timber	35.3	1048.1
North Fireline #1	16141_A	Moose Browse	26.4	316.1
North Fireline #2	16211_D	Moose Browse	30.8	805.9
North Fireline #3	16211_D	Moose Browse	48.6	650.7
Taz West Trails #5	16030_C	Moose Browse	34.7	1254.3
Taz West Trails #6	16211_D	Moose Browse	40.6	1007.1
Tazlina Fireline #1	16030_C	Moose/Timber	31.6	826.3
Tazlina Fireline #2	16211_D	Timber Improvement	31.0	476.4
Tazlina Fireline #3	16030_C	Moose Browse	30.3	1112.4
Tazlina Fireline #4	16030_C	Moose/Timber	28.8	767.3
Tazlina Fireline #5	16030_C	Moose/Timber	29.8	942.1
Tazlina Fireline #6	16211_D	Moose/Timber	33.0	1017.4
Tazlina Log Rd #1	16030_C	Timber Improvement	47.9	1758.6
Tazlina Log Rd #2	16030_C	Moose Browse	34.4	1366.6
Tazlina Log Rd #3	16030_C	Timber Improvement	18.2	647.0
Tazlina Pit	16030_C	Moose Browse	9.9	175.8
Tazlina TAPS North #1	16030_C	Moose Browse	37.3	1282.1
Tazlina TAPS North #2	16030_C	Moose Browse	43.1	1503.6
Tazlina TAPS North #3	16280_A	Moose Browse	32.4	205.0
Terrace Drive	16030_C	Timber Improvement	43.0	1582.4

Landscape-level Planning

In addition to planning site treatments around each of the 8 villages, potential broader scale planning objectives were considered. The site treatments in each village had the objectives of improving moose browse production, harvesting biomass, improving stand conditions, or creating a primary line of defense from fire. All of these are envisioned to use mechanical treatments. Improvement of moose habitat from these treatments is unlikely to have any significant influence on moose populations other than to shift their distributions slightly to take advantage of areas with higher browse availability and increase opportunities for subsistence hunting by the villages. Limited amounts of biomass will be produced from these treatments, but can help to provide the villages with wood for fuel. The primary lines of defense will be a factor in community wildfire protection planning. However, when viewed from a broader landscape perspective (Figure 267), it is apparent that the scale of these treatments will not have significant effects on such things as improvement of moose habitat.

At the broader landscape level, other objectives are considered. If increases in overall moose numbers are desired through habitat improvements, larger areas must be treated than those conducted at the village planning level. Mechanical treatments can play a role by providing fuel breaks or fire

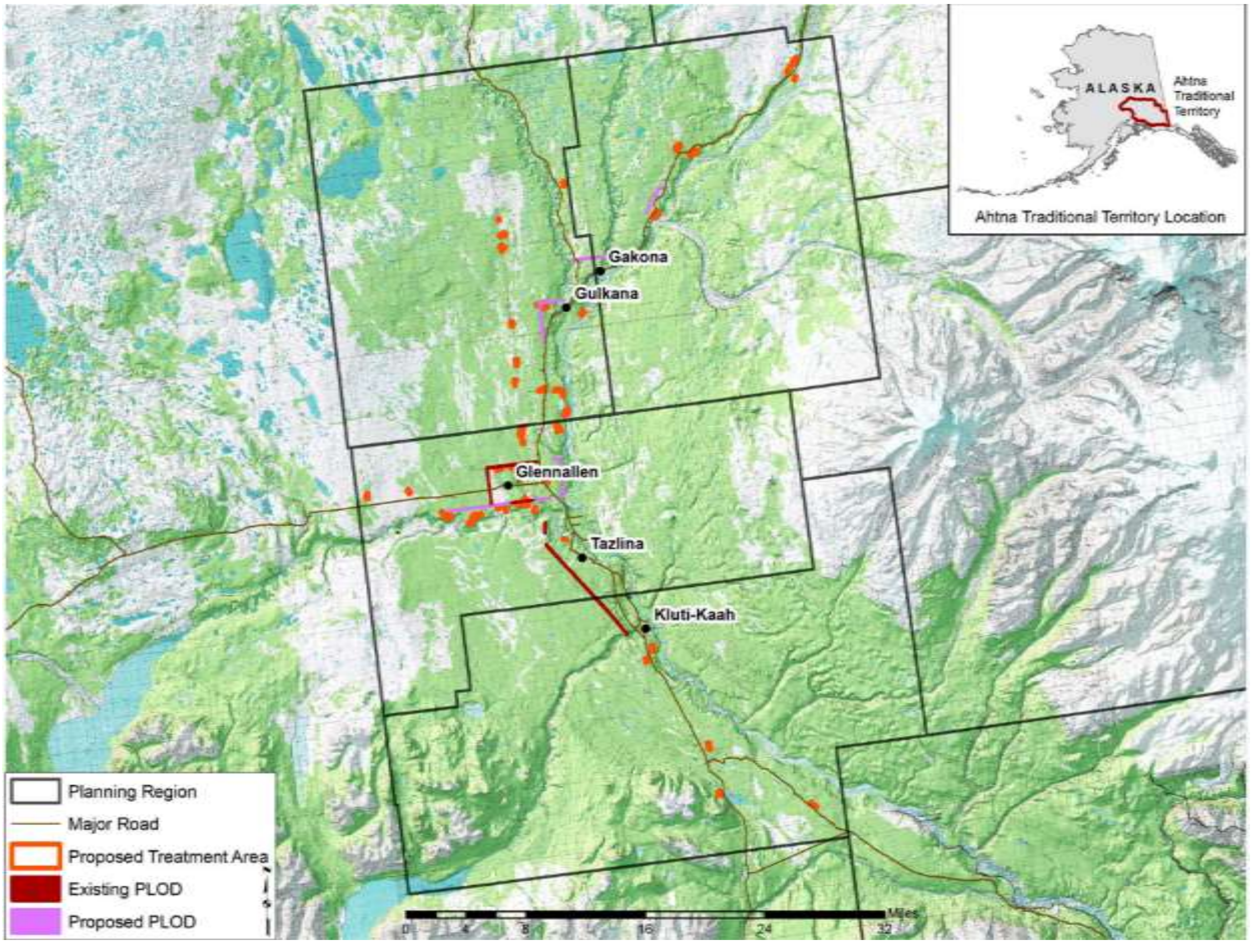


Figure 267. Proposed village treatments for the Gakona, Gulkana, Tazlina, and Kluti-Kaah village planning areas.

management lines, but are not thought to be practical for large scale treatments. Large scale treatments will rely on either effects from wildfire managed through various fire response actions, or from use of prescribed fire. Existing fire protection designations (Figure 268) should be reviewed and adjusted if appropriate for desired future management actions.

Carbon sequestration was added as an additional landscape level objective for the project in 2016. Ahtna, Inc. has entered into a carbon sequestration agreement to provide carbon offsets for the California carbon market. This means that amounts of carbon on designated lands owned by Ahtna must be managed to maintain or increase amounts of carbon into the future. Areas included in the carbon agreement are displayed in Figure 269. Immediate objectives for these lands recommend that full wildfire suppression is desired. However, this status will change after 2 years allowing for new management to occur.

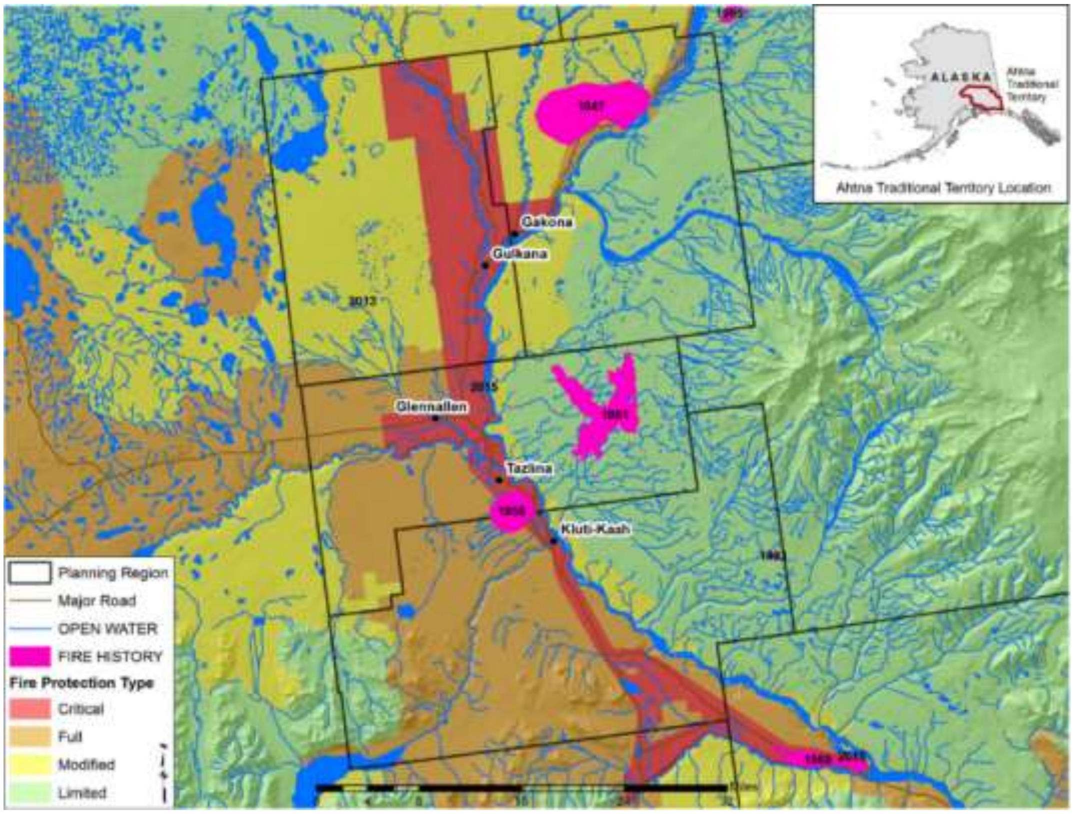


Figure 268. Current fire protection status and past fire locations in the primary Ahtna land ownership portion of the Ahtna Traditional Use Territory.

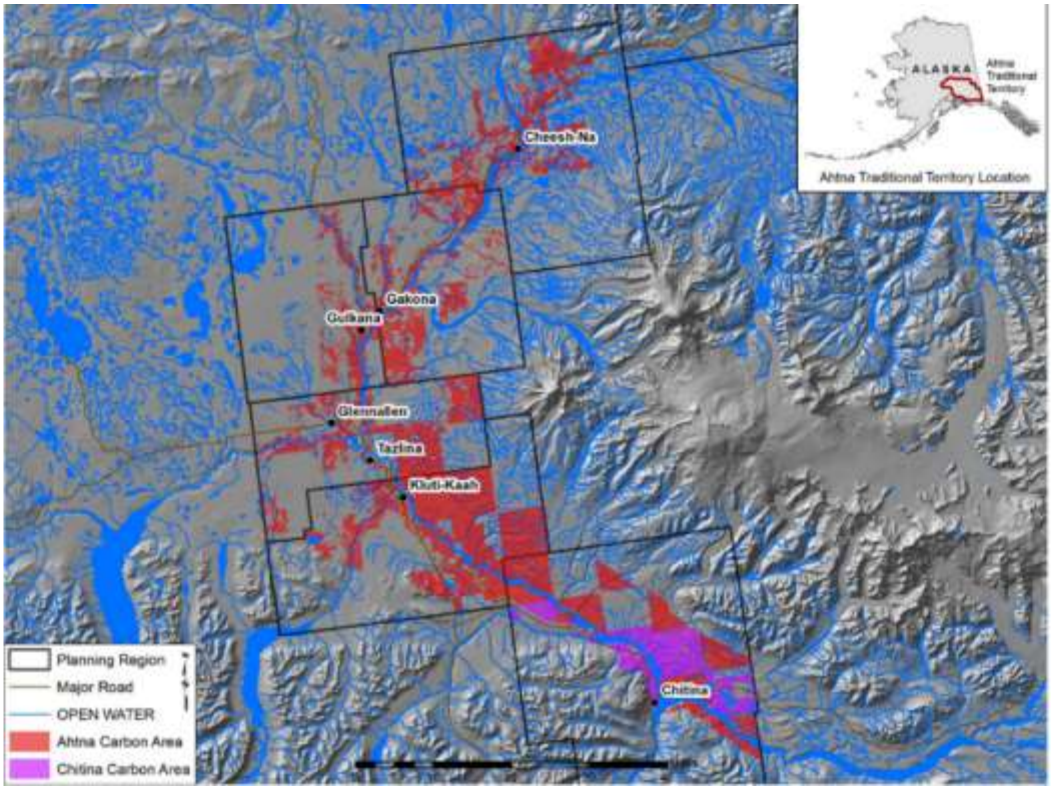


Figure 269. Current carbon sequestration areas on Ahtna and Chitina lands.

Recommendations for Local and Landscape-level Planning

One of the primary objectives of this project was to recommend ways to increase subsistence supply of moose for native villages while maintaining caribou habitat. Moose occur at relatively low densities, so efforts to increase overall population sizes requires improvements to large areas. The habitat treatments recommended for the villages will improve small patches of habitat. These can help a few moose by providing improved foraging opportunities, but will have very limited effects on overall population sizes. The primary function of these treatments is to increase harvest opportunities on existing moose populations by concentrating moose in accessible locations on Ahtna lands. To increase moose populations over larger areas will require much larger scales of treatments. This largely precludes mechanical treatments such as timber harvests or roller chopping from being effective tools except when used in conjunction with other disturbances. Primary recommended tools are selective let burn areas for wildfires and prescribed burning. Use of these tools must integrate with protection of human infrastructure, carbon sequestration goals, maintenance of caribou habitat, agreement from adjacent landowners, and economic viability.

Carbon sequestration can be compatible with moose habitat improvement and biomass harvests when properly coordinated. Some lands contain decadent stands of spruce that hold carbon in the biomass present on these sites, but are losing this carbon through tree mortality over time. Additional carbon can be sequestered by disturbing some types of sites and encouraging tree species with higher productivity and sequestration rates. In particular, those ecological sites that support productive white or black spruce or aspen hardwood sites but that are currently in late seral, decadent stands can be improved through either mechanical treatments or fire. This can not only result in greater long term carbon sequestration, but can improve moose habitat and in some locations be sources of biomass. Figure 270 displays some areas that may have this potential, that are mapped as ecological site and current successional conditions that may benefit from future treatments to set back succession. If these can be targeted for a combination of mechanical treatments that can produce fuel breaks or defensive lines for fire, areas can then be designated to allow wildfires to burn or for application of prescribed burning. The fire protection zones assigned to such areas should be reviewed to determine if adjustments to these zones are needed to integrate with the potential treatment zones. Figure 271 provides a closer look at potential sites near the village of Kluti-Kaah. Figure 272 shows potential areas to increase the quality of moose habitat. Figures 273-275 focus on one potential area as an example and also shows other resource values that may be impacted by management activities in those areas.

It is beyond the scope of this project to propose and evaluate specific landscape level treatment zones. However, the GIS data and maps developed through this project provide starting points for identifying potential treatment areas as shown in Figures 270-275. Such areas should be checked for their other resource values, such as high quality berry production areas or caribou habitat (Figure 275), and then considered for further treatments.   All proposed treatment zones should receive ground verification before assuming the mapped existing conditions are accurate.

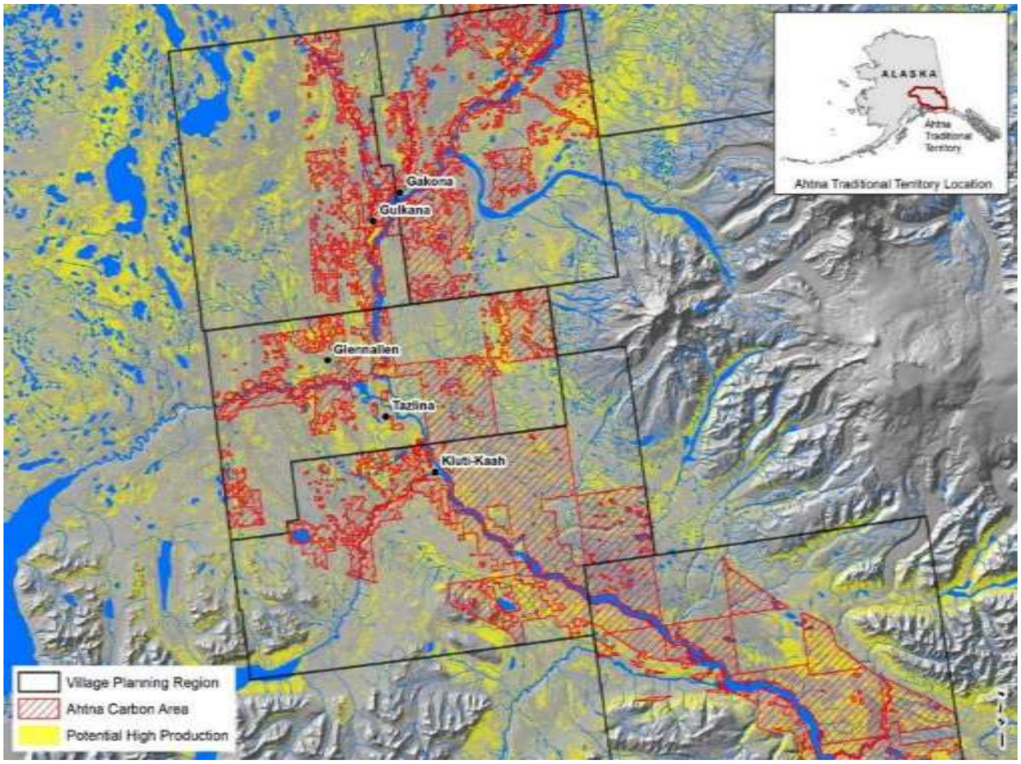


Figure 270. Potential areas for improving moose winter habitat and increasing carbon sequestration. Potential high production means a stand is currently in a late successional state, but could be returned to high production through management activities.

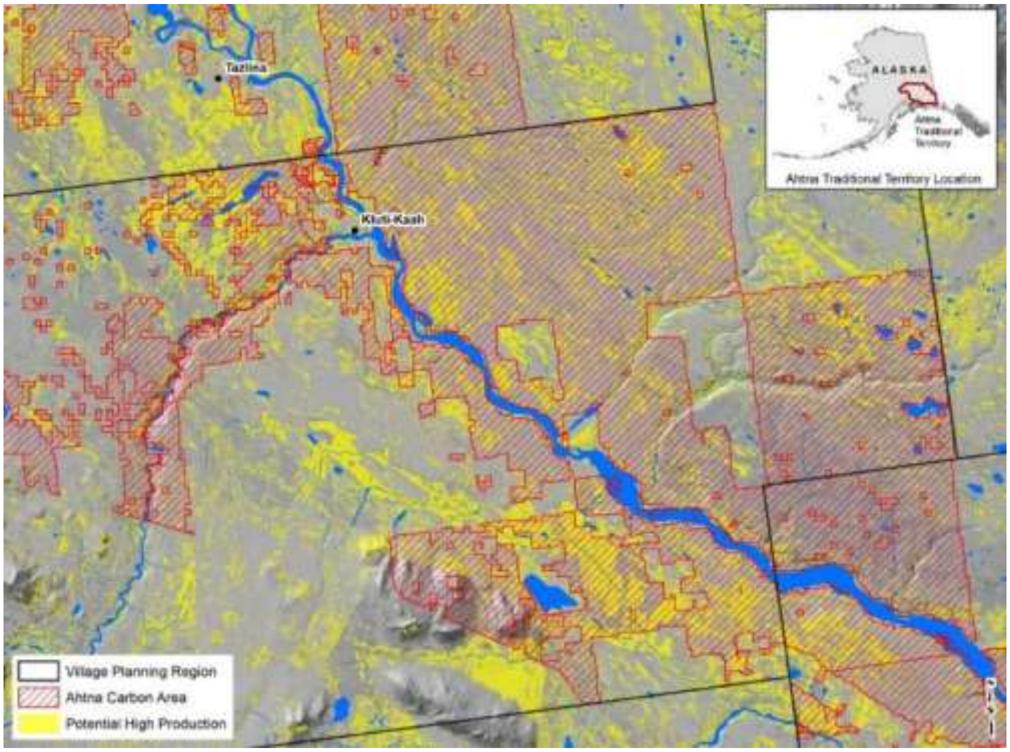


Figure 271. Potential areas for improving moose winter habitat and increasing carbon sequestration. Potential high production means a stand is currently in a late successional state, but could be returned to high production through management activities. This figure provides a closer view of the region south of Kluti-Kaah.

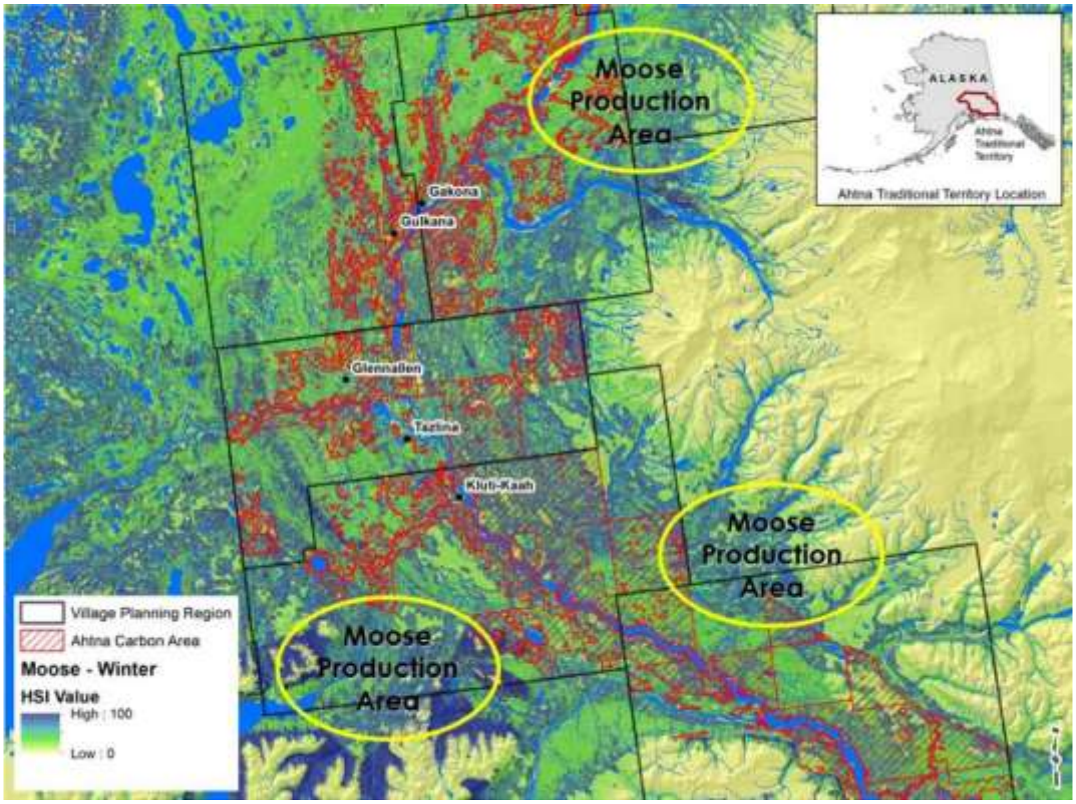


Figure 272. Potential areas for improving moose winter habitat along with carbon sequestration boundary.

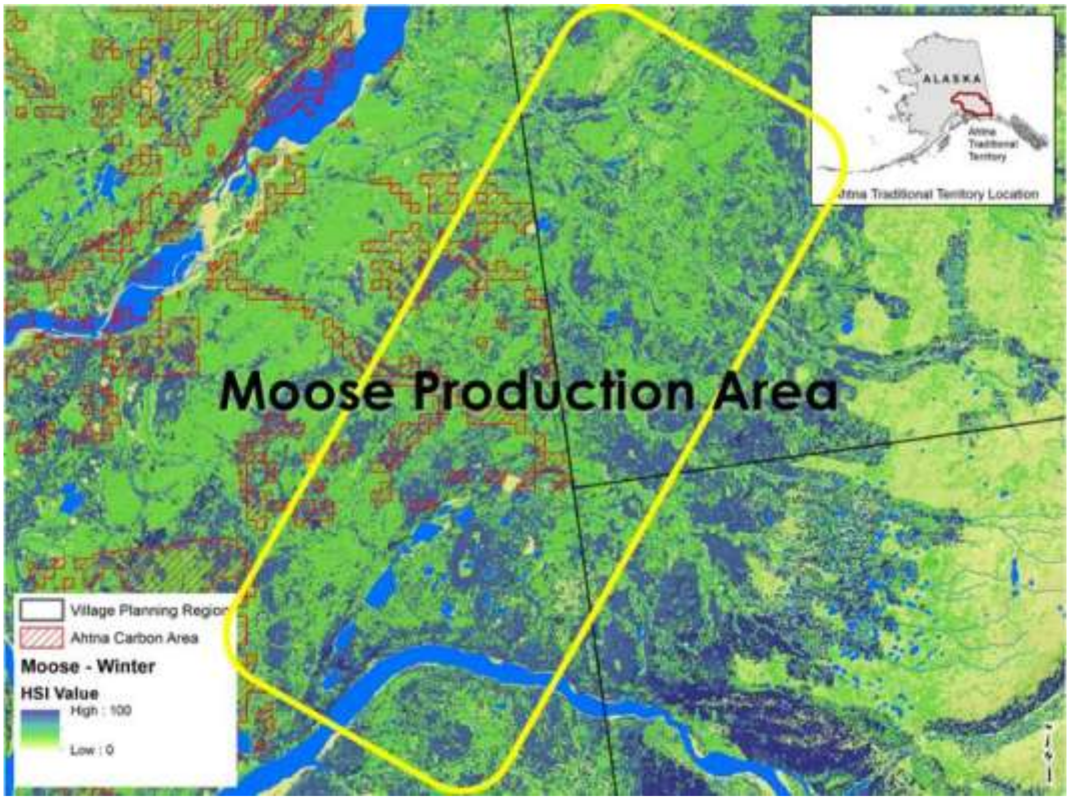


Figure 273. Zoomed in view of northerly example moose production area showing moose winter habitat quality and carbon sequestration stands.

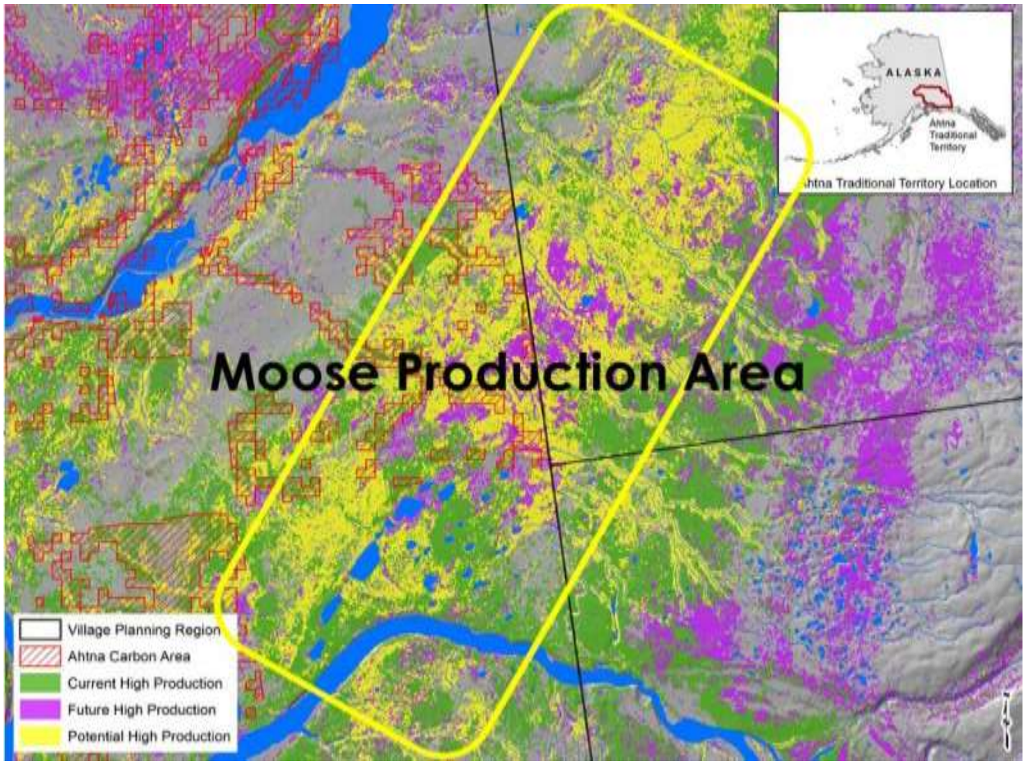


Figure 274. Zoomed in view of northerly example moose production area showing stand productivity. Future high production means the stand will increase in productivity as it ages. Potential high production means the stand could be returned to high production through management activities.

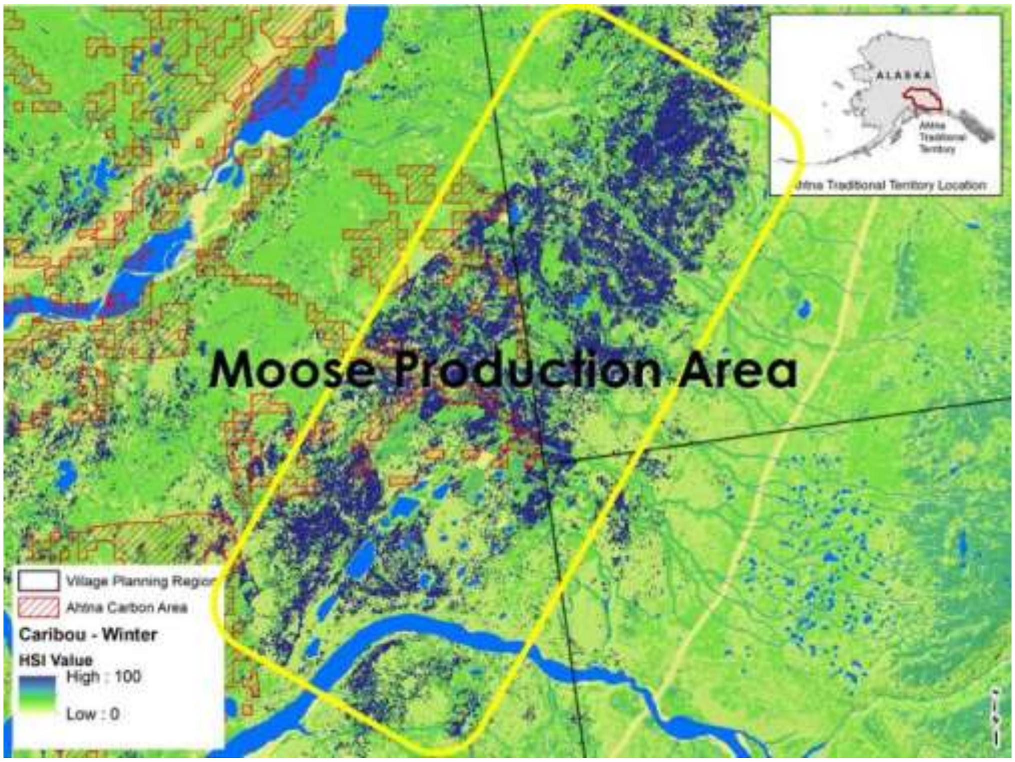


Figure 275. Zoomed in view of northerly example moose production area showing caribou winter habitat quality and carbon sequestration stands.

Climate Change Considerations

Alaska is experiencing significant impacts from climate change with more extreme changes being noted than many other parts of the United States. Future planning for natural resource management should consider the potential effects of these changes. While projections of future climate conditions have considerable variance around their estimates, the modelled outputs represent the best science-based assessments of likely conditions. We used SNAP (Scenarios Network for Alaska and Arctic Planning) as the primary source for climate change information (https://www.snap.uaf.edu/tools-and-data/all-analysis-tools). We examined climate projections for 3 locations that span the Ahtna Traditional Use Territory; Cantwell, Glennallen, and Chitina). Figures 260-265 display the projected changes in climate (monthly temperature and precipitation means) that are predicted to occur under a continued high worldwide production of greenhouse gases (8.5 scenario). While these levels may not be achieved if aggressive response actions are adopted by human society, to date such actions have not been initiated.

Climate projections reveal Southcentral Alaska is expected to experience an increase in annual temperatures. This will be especially true in the summer months. Increases in winter temperatures are also expected as indicated by the trends in future temperatures, but the ranges in these estimated projections include potential overlap with historical temperatures. Precipitation shows trends for increases, but these are relatively small and ranges overlap with existing levels. Even if precipitation levels increase, increases in temperatures will result in greater evapotranspiration, especially in the summer, likely producing a drying effect across the landscape.

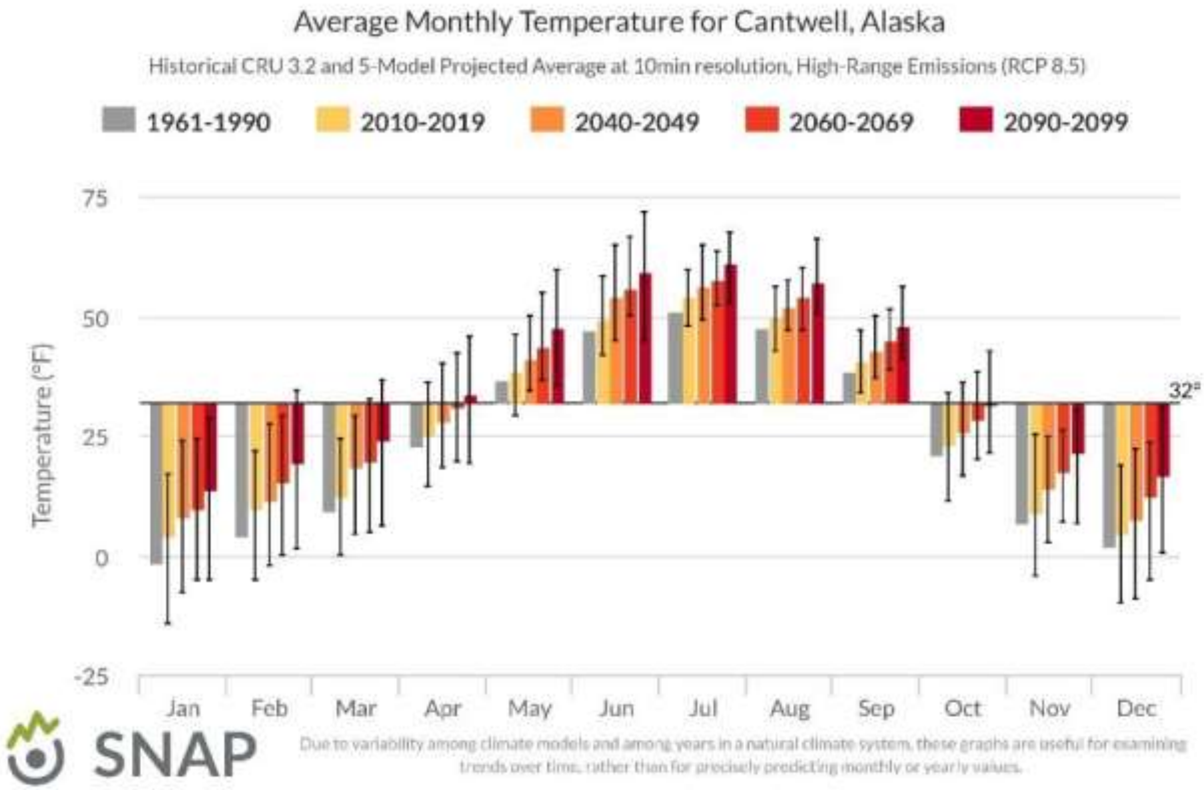


Figure 260. Average monthly temperature projections for Cantwell, Alaska, 2010-2099 (SNAP).

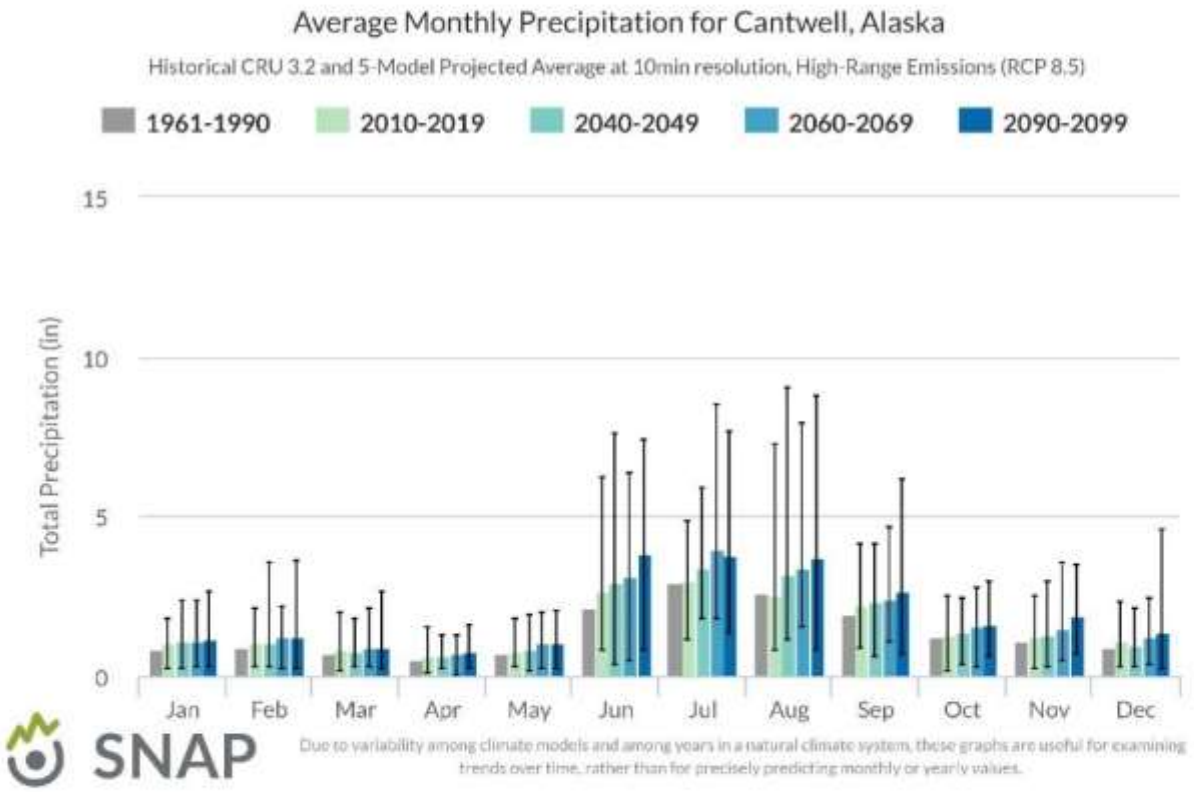


Figure 261. Average monthly precipitation projections for Cantwell, Alaska, 2010-2099 (SNAP).

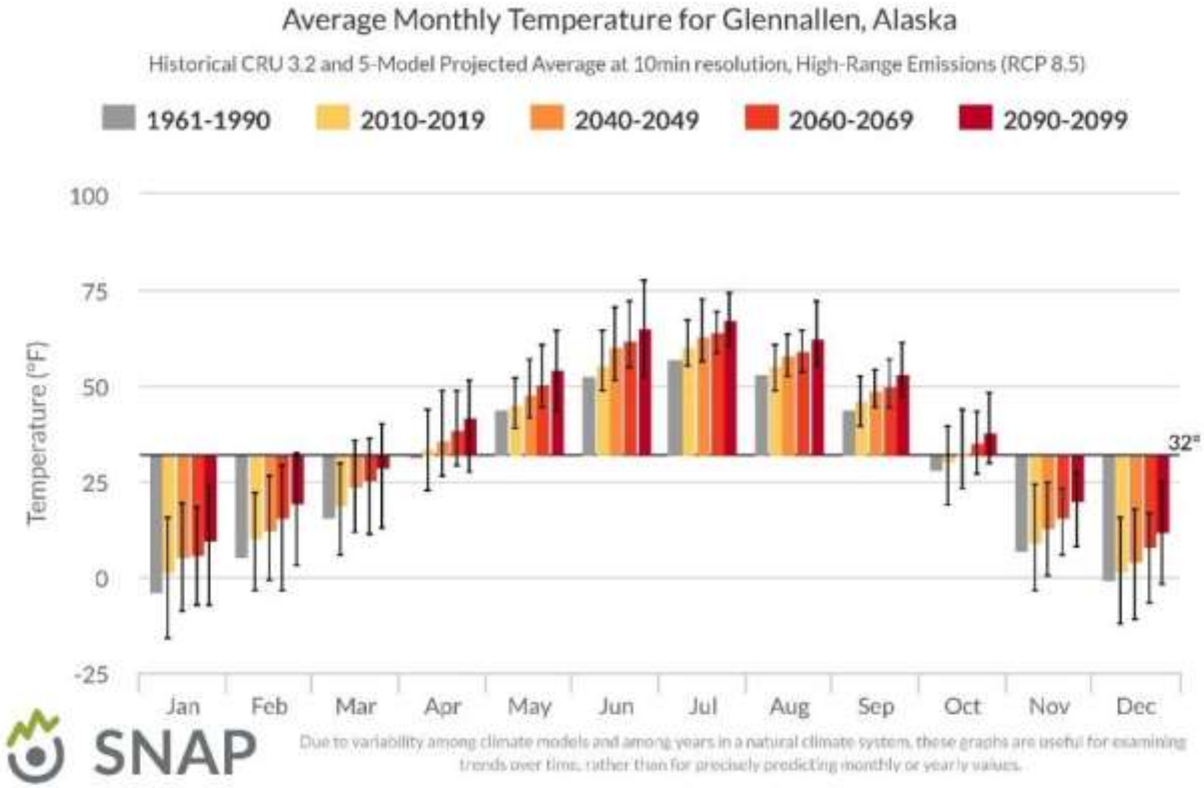


Figure 262. Average monthly temperature projections for Glennallen, Alaska, 2010-2099 (SNAP).

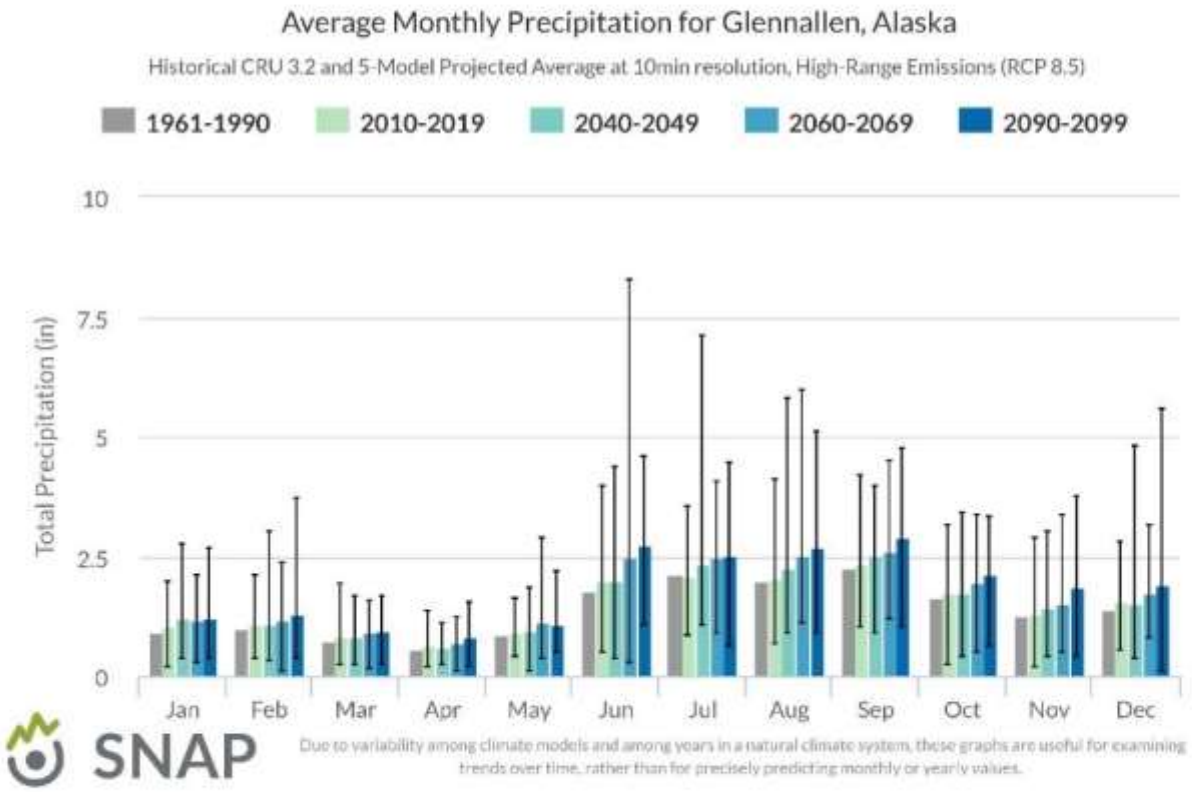


Figure 263. Average monthly precipitation projections for Glennallen, Alaska, 2010-2099 (SNAP).

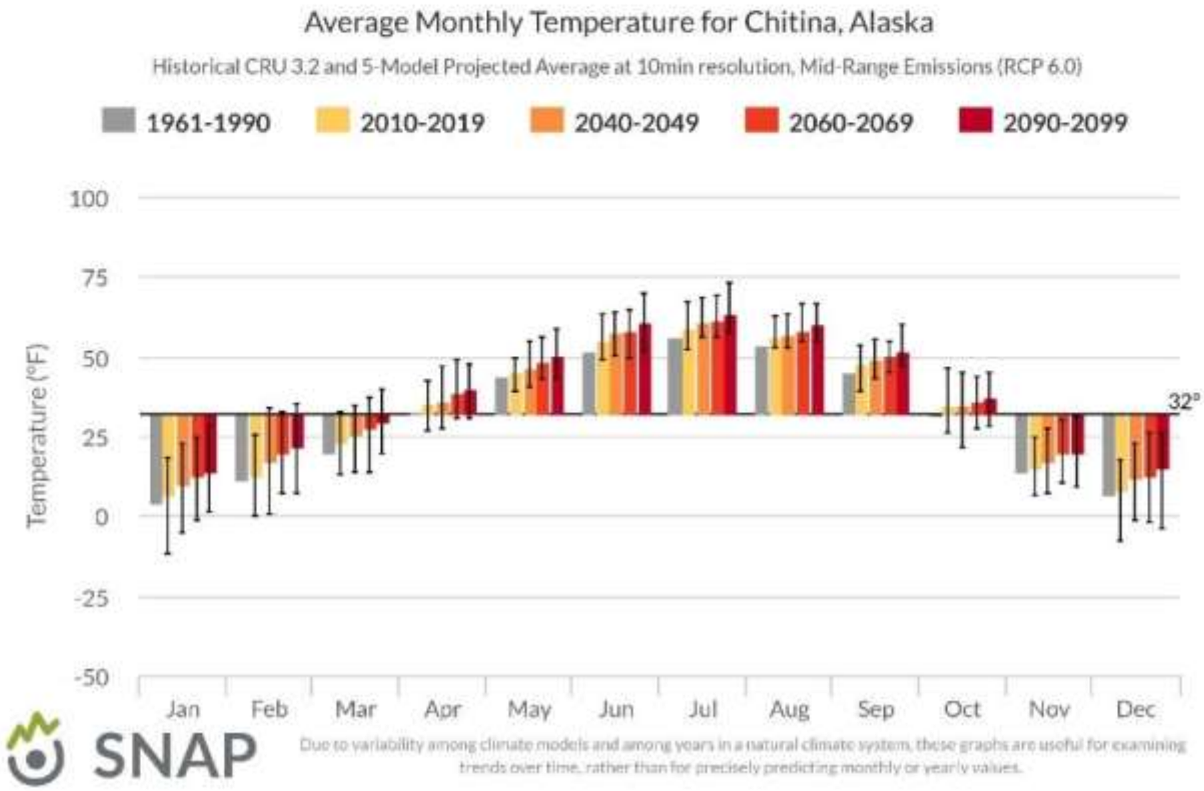


Figure 264. Average monthly temperature projections for Chitina, Alaska, 2010-2099 (SNAP).

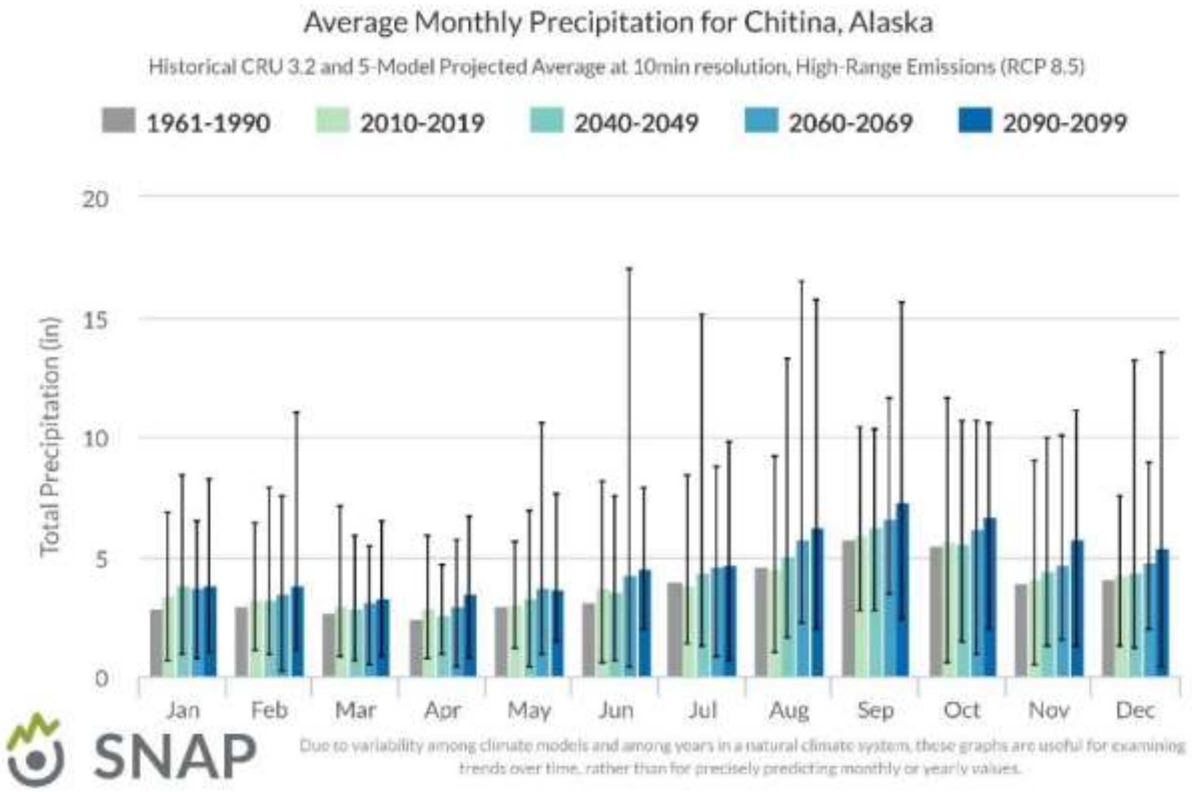


Figure 265. Average monthly precipitation projections for Chitina, Alaska, 2010-2099 (SNAP).

Ecosystem Diversity Trends

Short-term

The interior boreal forest of the Copper River Basin has been shaped by disturbance in the form of fire and influenced by the presence of discontinuous permafrost. In the short term these effects will likely remain as the primary forces shaping ecosystems and influencing succession. The presence of permafrost dictates possible vegetation types starting with open water or emergent wetlands and culminating in dwarf black spruce or tall shrubs. Over short time frames these sites are likely to remain static. Increased summer temperatures and/or increased disturbance in the form of fire could convert sites as the depth to permafrost increases or the permafrost melts entirely. Upland sites are likely to see short term changes due to increased prevalence of insects and disease and increased fire return intervals.

Long-term

The driving force behind long term ecosystem diversity trends is climate change. While this continues to be a developing field of study, current research indicates that over time both summer and winter mean temperatures will rise. Warmer summer temperatures could result in increased fire frequency in forested sites, shrub encroachment in alpine sites, increased flood frequency in riparian sites, and melting of permafrost. Warmer winter temperatures could result in more frequent rain and/or icing events, increased avalanche frequency, increased pests that are normally controlled by cold winter temperatures, and longer growing seasons which would result in increased fine fuel loads and longer fire seasons. Warmer temperatures could also result in decreased surface area of glaciers which may provide new habitat for forest and shrub ecosystems. Thermokarst is expected to increase significantly, changing many sites with the removal of permafrost and associated inundation and successional processes described previously.

An additional consideration with rising mean summer temperatures coupled with increasing summer precipitation is the likely increase in number and severity of thunderstorms in the project area. Associated with these storms is a likely increase in the number of lightning strikes. Analysis of the number of lightning strikes that have occurred in the Ahtna Traditional Use Territory between 1986 and 2014 (Figure 266) showed a trend of a slight increase in strikes, but these data are too preliminary to make any solid future predictions. Both lightning strike frequency and the moisture level of fine fuels determine the number of wildfire starts resulting from thunderstorm activity. Future climate conditions may result in wildfire conditions that are currently more common north of the Alaska Range, or at least an increase from past amounts of wildfire in this region.

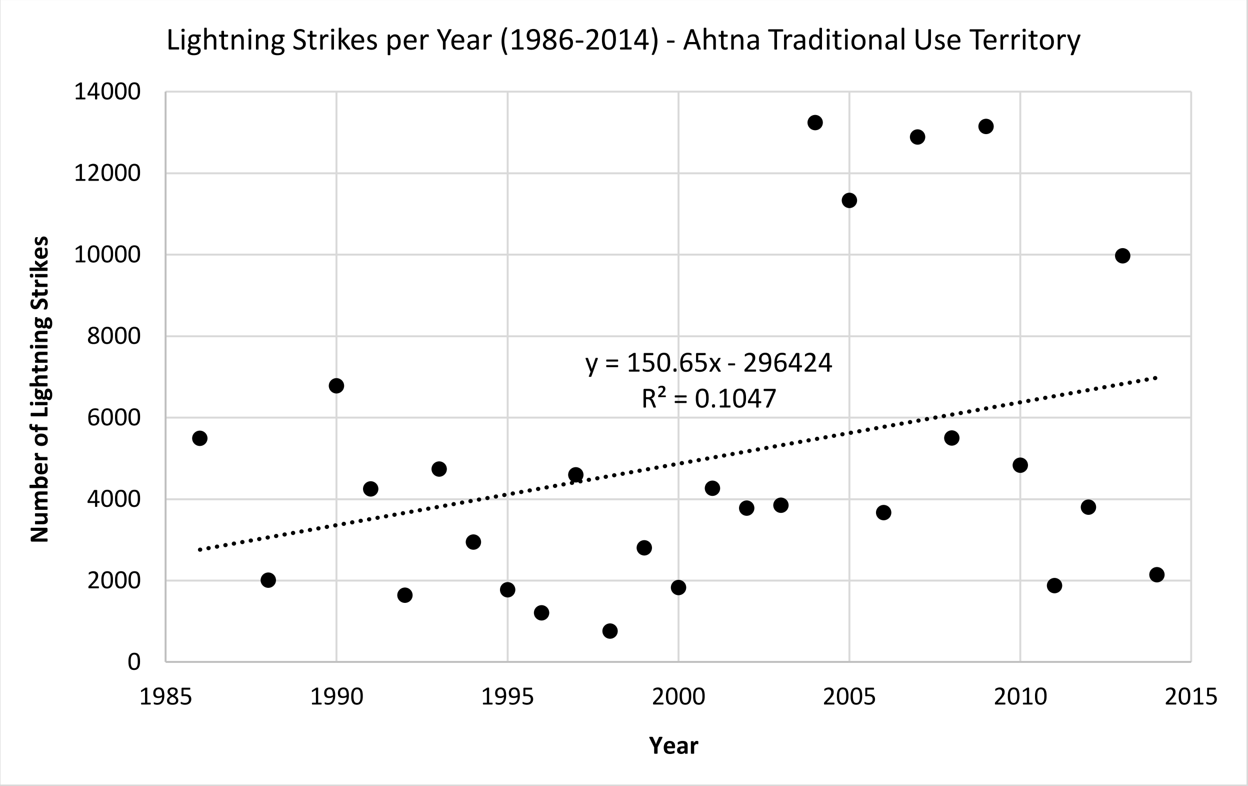


Figure 266. Number of lightning strikes in the Ahtna Traditional Use Territory between 1986 and 2014.

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Appendix A. Supporting Tables and Definitions

Table A-1. Ecological site names, codes, disturbance class (from LANDFIRE) and ecosystem code definitions. The number of acres of each ecosystem represented in each of the four MLRAs occurring in the Ahtna Traditional Use Territory are also summarized.

ECOLOGICAL SITE NAME	ECOLOGICAL SITE CODE	DISTURBANCE CLASS	ECOSYSTEM CODE	Major Land Resource Area (MLRA)(Acres)			
				222	223	227	228
W. NA Boreal Treeline White Spruce Woodland - Boreal	16011	A	16011_A	414	797	9841	24546
W. NA Boreal Treeline White Spruce Woodland - Boreal	16011	B	16011_B	501	6241	95324	62171
W. NA Boreal Treeline White Spruce Woodland - Boreal	16011	C	16011_C	2	5	40	88
W. NA Boreal Treeline White Spruce Woodland - Alaska Sub-boreal	16012	A	16012_A	5902	11002	2263	91786
W. NA Boreal Treeline White Spruce Woodland - Alaska Sub-boreal	16012	B	16012_B	32056	26043	7630	209533
W. NA Boreal Treeline White Spruce Woodland - Alaska Sub-boreal	16012	C	16012_C	54	63	6	312
W. NA Boreal White Spruce-Hardwood Forest	16030	A	16030_A	17	10398	11774	61246
W. NA Boreal White Spruce-Hardwood Forest	16030	B	16030_B	83	142867	119576	754257
W. NA Boreal White Spruce-Hardwood Forest	16030	C	16030_C	219	104502	802025	1334315
W. NA Boreal White Spruce-Hardwood Forest	16030	D	16030_D	0	0	0	0
W. NA Boreal White Spruce-Hardwood Forest	16030	E	16030_E	1	469	1245	3873
W. NA Boreal Mesic Black Spruce Forest - Boreal	16041	A	16041_A	454	81	5333	5778
W. NA Boreal Mesic Black Spruce Forest - Boreal	16041	B	16041_B	2029	536	29979	39930
W. NA Boreal Mesic Black Spruce Forest - Boreal	16041	C	16041_C	385	421	20600	29515
W. NA Boreal Mesic Black Spruce Forest - Boreal	16041	D	16041_D	224	308	299276	144318
W. NA Boreal Mesic Black Spruce Forest - Boreal	16041	E	16041_E	1	3	184	130
W. NA Boreal Mesic Black Spruce Forest - Alaska Sub-boreal	16042	A	16042_A	11218	10177	549	82373
W. NA Boreal Mesic Black Spruce Forest - Alaska Sub-boreal	16042	B	16042_B	71615	19467	3669	138619
W. NA Boreal Mesic Black Spruce Forest - Alaska Sub-boreal	16042	C	16042_C	24314	9773	671	37378
W. NA Boreal Mesic Black Spruce Forest - Alaska Sub-boreal	16042	D	16042_D	67	114	3	787
W. NA Boreal Mesic Black Spruce Forest - Alaska Sub-boreal	16042	E	16042_E	5	13	0	20
W. NA Boreal Mesic Birch-Aspen Forest	16050	A	16050_A	435	10342	54790	109044
W. NA Boreal Mesic Birch-Aspen Forest	16050	B	16050_B	306	16703	12050	132872
W. NA Boreal Mesic Birch-Aspen Forest	16050	C	16050_C	0	0	0	0

Table A-1, continued. Ecological site names, codes, disturbance class (from LANDFIRE) and ecosystem code definitions. The number of acres of each ecosystem represented in each of the four MLRAs occurring in the Ahtna Traditional Use Territory are also summarized.

ECOLOGICAL SITE NAME	ECOLOGICAL SITE CODE	DISTURBANCE CLASS	ECOSYSTEM CODE	Major Land Resource Area (MLRA)(Acres)			
				222	223	227	228
W. NA Boreal Mesic Birch-Aspen Forest	16050	D	16050_D	0	45	185	501
W. NA Boreal Mesic Birch-Aspen Forest	16050	E	16050_E	2	46	177	789
W. NA Boreal Dry Aspen-Steppe Bluff - Lower Elevations	16061	A	16061_A	2	240	305	616
W. NA Boreal Dry Aspen-Steppe Bluff - Lower Elevations	16061	B	16061_B	7	1649	1887	3581
W. NA Boreal Dry Aspen-Steppe Bluff - Lower Elevations	16061	C	16061_C	7	188	1673	860
W. NA Boreal Dry Aspen-Steppe Bluff - Lower Elevations	16061	D	16061_D	11	465	6301	1547
W. NA Boreal Subalpine Balsam Poplar-Aspen Woodland	16070	A	16070_A	1	29	0	21014
W. NA Boreal Subalpine Balsam Poplar-Aspen Woodland	16070	B	16070_B	0	59	4	18453
Alaska Sub-boreal Avalanche Slope Shrubland	16080	A	16080_A	0	1605	243	19131
Alaska Sub-boreal Avalanche Slope Shrubland	16080	B	16080_B	0	1797	290	17055
Alaska Sub-Boreal Mesic Subalpine Alder Shrubland	16090	A	16090_A	1	48832	1044	39427
Alaska Sub-Boreal Mesic Subalpine Alder Shrubland	16090	B	16090_B	0	77722	855	163186
W. NA Boreal Mesic Scrub Birch-Willow Shrubland - Boreal	16101	A	16101_A	1409	332	443	10216
W. NA Boreal Mesic Scrub Birch-Willow Shrubland - Boreal	16101	B	16101_B	594	2978	278	1629
W. NA Boreal Mesic Scrub Birch-Willow Shrubland - Alaska Sub-boreal	16102	A	16102_A	15200	23585	16267	281411
W. NA Boreal Mesic Scrub Birch-Willow Shrubland - Alaska Sub-boreal	16102	B	16102_B	91080	193151	71765	2019544
W. NA Sub-boreal Mesic Bluejoint Meadow	16110	A	16110_A	0	19996	1776	4592
W. NA Boreal Dry Grassland	16120	A	16120_A	0	14999	18	4537
W. NA Boreal Montane Floodplain Forest and Shrubland - Boreal	16141	A	16141_A	6	2722	152077	74889
W. NA Boreal Montane Floodplain Forest and Shrubland - Boreal	16141	B	16141_B	2	1370	19954	48034
W. NA Boreal Montane Floodplain Forest and Shrubland - Boreal	16141	C	16141_C	2	406	13136	18300
W. NA Boreal Montane Floodplain Forest and Shrubland - Boreal	16141	D	16141_D	15	6	60280	95238
W. NA Boreal Montane Floodplain Forest and Shrubland - Boreal	16141	E	16141_E	0	1	6097	5711
W. NA Boreal Montane Floodplain Forest and Shrubland - Alaska Sub-bor	16142	A	16142_A	1	16021	2399	113310
W. NA Boreal Montane Floodplain Forest and Shrubland - Alaska Sub-bor	16142	B	16142_B	1	9211	306	34184
W. NA Boreal Montane Floodplain Forest and Shrubland - Alaska Sub-bor	16142	C	16142_C	0	9821	48	12572

Table A-1, continued. Ecological site names, codes, disturbance class (from LANDFIRE) and ecosystem code definitions. The number of acres of each ecosystem represented in each of the four MLRAs occurring in the Ahtna Traditional Use Territory are also summarized.

ECOLOGICAL SITE NAME	ECOLOGICAL SITE CODE	DISTURBANCE CLASS	ECOSYSTEM CODE	Major Land Resource Area (MLRA)(Acres)			
				222	223	227	228
W. NA Boreal Montane Floodplain Forest and Shrubland - Alaska Sub-bor	16142	D	16142_D	0	252	24	5476
W. NA Boreal Montane Floodplain Forest and Shrubland - Alaska Sub-bor	16142	E	16142_E	0	38	3	705
W. NA Boreal Lowland Large River Floodplain Forest and Shrubland	16150	A	16150_A	18	456	1988	15991
W. NA Boreal Lowland Large River Floodplain Forest and Shrubland	16150	B	16150_B	4	110	550	3832
W. NA Boreal Lowland Large River Floodplain Forest and Shrubland	16150	C	16150_C	8	161	685	2216
W. NA Boreal Lowland Large River Floodplain Forest and Shrubland	16150	D	16150_D	2	2	21	62
W. NA Boreal Lowland Large River Floodplain Forest and Shrubland	16150	E	16150_E	0	1	4	12
W. NA Boreal Riparian Stringer Forest and Shrubland	16160	A	16160_A	0	7	500	624
W. NA Boreal Riparian Stringer Forest and Shrubland	16160	B	16160_B	0	110	1710	2291
W. NA Boreal Riparian Stringer Forest and Shrubland	16160	C	16160_C	0	2	44	35
W. NA Boreal Shrub and Herbaceous Floodplain Wetland	16170	A	16170_A	0	983	5976	1472
W. NA Boreal Shrub and Herbaceous Floodplain Wetland	16170	B	16170_B	0	770	563	273
W. NA Boreal Shrub and Herbaceous Floodplain Wetland	16170	C	16170_C	0	0	81	94
W. NA Boreal Shrub and Herbaceous Floodplain Wetland	16170	D	16170_D	0	242	92	147
W. NA Boreal Shrub and Herbaceous Floodplain Wetland	16170	E	16170_E	0	146	1506	1148
W. NA Boreal Herbaceous Fen - Alaska Sub-Boreal Complex	16181	A	16181_A	0	22088	835	57484
W. NA Boreal Herbaceous Fen - Alaska Sub-Boreal Complex	16181	B	16181_B	0	43010	74	41498
W. NA Boreal Herbaceous Fen - Alaska Sub-Boreal Complex	16181	C	16181_C	0	3	5	1700
W. NA Boreal Herbaceous Fen - Alaska Sub-Boreal Complex	16181	D	16181_D	0	20199	110	124347
W. NA Boreal Black Spruce Dwarf-tree Peatland - Boreal Complex	16211	A	16211_A	28	900	16917	23486
W. NA Boreal Black Spruce Dwarf-tree Peatland - Boreal Complex	16211	B	16211_B	26	1748	23662	56741
W. NA Boreal Black Spruce Dwarf-tree Peatland - Boreal Complex	16211	C	16211_C	29	1782	43705	123633
W. NA Boreal Black Spruce Dwarf-tree Peatland - Boreal Complex	16211	D	16211_D	58	2020	577092	303926
W. NA Boreal Black Spruce Dwarf-tree Peatland - Alaska Sub-boreal	16212	A	16212_A	0	4630	17	15904
W. NA Boreal Black Spruce Dwarf-tree Peatland - Alaska Sub-boreal	16212	B	16212_B	0	25631	243	77188
W. NA Boreal Black Spruce Dwarf-tree Peatland - Alaska Sub-boreal	16212	C	16212_C	0	16012	1425	78304

Table A-1, continued. Ecological site names, codes, disturbance class (from LANDFIRE) and ecosystem code definitions. The number of acres of each ecosystem represented in each of the four MLRAs occurring in the Ahtna Traditional Use Territory are also summarized.

ECOLOGICAL SITE NAME	ECOLOGICAL SITE CODE	DISTURBANCE CLASS	ECOSYSTEM CODE	Major Land Resource Area (MLRA)(Acres)			
				222	223	227	228
W. NA Boreal Black Spruce Wet-Mesic Slope Woodland	16220	A	16220_A	2	882	1305	18985
W. NA Boreal Black Spruce Wet-Mesic Slope Woodland	16220	B	16220_B	1	1822	1104	30461
W. NA Boreal Black Spruce Wet-Mesic Slope Woodland	16220	C	16220_C	0	422	618	2492
W. NA Boreal Black Spruce Wet-Mesic Slope Woodland	16220	D	16220_D	2	447	4957	29816
W. NA Boreal Deciduous Shrub Swamp	16240	A	16240_A	1	17516	4184	115182
W. NA Boreal Low Shrub-Tussock Tundra	16280	A	16280_A	8	13220	62976	109990
W. NA Boreal Low Shrub-Tussock Tundra	16280	B	16280_B	2	60200	6733	195948
W. NA Boreal Low Shrub-Tussock Tundra	16280	C	16280_C	1	10221	2595	46146
W. NA Boreal Tussock Tundra	16290	A	16290_A	0	1016	6918	7145
W. NA Boreal Tussock Tundra	16290	B	16290_B	0	3511	930	20610
W. NA Boreal Wet Black Spruce-Tussock Woodland	16300	A	16300_A	0	304	1384	4714
W. NA Boreal Wet Black Spruce-Tussock Woodland	16300	B	16300_B	0	1319	2223	9615
W. NA Boreal Wet Black Spruce-Tussock Woodland	16300	C	16300_C	0	118	14673	13895
W. NA Boreal Alpine Dwarf-Shrub Summit	16310	A	16310_A	43	104944	27	138952
W. NA Boreal Alpine Talus and Bedrock	16320	A	16320_A	81580	134931	4149	446883
W. NA Boreal Alpine Mesic Herbaceous Meadow	16330	A	16330_A	0	3420	4280	10547
W. NA Boreal Alpine Ericaceous Dwarf-Shrubland - Complex	16351	A	16351_A	2	311810	7021	901087
W. NA Boreal Alpine Floodplain - Higher Elevations	16372	A	16372_A	0	1393	11	664
W. NA Boreal Alpine Floodplain - Higher Elevations	16372	B	16372_B	0	2964	4	1170
Alaskan Pacific Maritime Sitka Spruce Forest	16440	A	16440_A	1525	0	0	0
Alaska Sub-boreal and Maritime Alpine Mesic Herbaceous Meadow	16450	A	16450_A	0	13932	0	3611
Alaskan Pacific Maritime W. Hemlock Forest	16460	A	16460_A	4727	26	28	28
Alaskan Pacific Maritime W. Hemlock Forest	16460	B	16460_B	1589	11	8	11
Alaskan Pacific Maritime W. Hemlock Forest	16460	C	16460_C	982	1	2	1
Alaskan Pacific Maritime W. Hemlock Forest	16460	D	16460_D	100	0	0	0
Alaskan Pacific Maritime Mountain Hemlock Forest - Northern	16481	A	16481_A	2361	2361	0	22

Table A-1, continued. Ecological site names, codes, disturbance class (from LANDFIRE) and ecosystem code definitions. The number of acres of each ecosystem represented in each of the four MLRAs occurring in the Ahtna Traditional Use Territory are also summarized.

ECOLOGICAL SITE NAME	ECOLOGICAL SITE CODE	DISTURBANCE CLASS	ECOSYSTEM CODE	Major Land Resource Area (MLRA)(Acres)			
				222	223	227	228
Alaskan Pacific Maritime Mountain Hemlock Forest - Northern	16481	B	16481_B	1547	99	0	12
Alaskan Pacific Maritime Mountain Hemlock Forest - Northern	16481	C	16481_C	41	5	0	0
Alaskan Pacific Maritime Periglacial Woodland and Shrubland	16500	A	16500_A	1674	0	0	1
Alaskan Pacific Maritime Periglacial Woodland and Shrubland	16500	B	16500_B	749	0	0	0
Alaskan Pacific Maritime Periglacial Woodland and Shrubland	16500	C	16500_C	0	0	0	0
Alaskan Pacific Maritime Periglacial Woodland and Shrubland	16500	D	16500_D	0	0	0	0
Alaskan Pacific Maritime Subalpine Alder-Salmonberry Shrubland	16520	A	16520_A	43241	15	1	7170
Alaskan Pacific Maritime Subalpine Alder-Salmonberry Shrubland	16520	B	16520_B	161539	2	6	20292
Alaskan Pacific Maritime Floodplain Forest and Shrubland	16550	A	16550_A	1383	0	0	639
Alaskan Pacific Maritime Floodplain Forest and Shrubland	16550	B	16550_B	1628	0	0	255
Alaskan Pacific Maritime Floodplain Forest and Shrubland	16550	C	16550_C	37	0	0	3
Alaskan Pacific Maritime Floodplain Forest and Shrubland	16550	D	16550_D	1	0	0	0
Alaskan Pacific Maritime Floodplain Forest and Shrubland	16550	E	16550_E	1	0	0	0
Alaskan Pacific Maritime Mountain Hemlock Peatland	16590	A	16590_A	2846	0	0	413
Temperate Pacific Freshwater Emergent Marsh	16620	A	16620_A	1730	0	0	30
Alaska Sub-boreal White Spruce-Hardwood Forest	16790	A	16790_A	61887	36696	1968	78455
Alaska Sub-boreal White Spruce-Hardwood Forest	16790	B	16790_B	66334	40175	3920	82331
Alaska Sub-boreal White Spruce-Hardwood Forest	16790	C	16790_C	5064	8287	277	5218
Alaska Sub-boreal White Spruce-Hardwood Forest	16790	D	16790_D	173	297	19	784
Alaska Sub-boreal White Spruce-Hardwood Forest	16790	E	16790_E	28	40	0	47
Alaskan Pacific Maritime Avalanche Slope Shrubland	16800	A	16800_A	433	3	0	42
Alaskan Pacific Maritime Avalanche Slope Shrubland	16800	B	16800_B	1452	5	0	592

Table A-2. Plant code definitions and growth forms used in the ecosystem diversity framework. Source: plants.gov -November 2017

PLANTS Code	Scientific Name	Common Name	Growth Form
ACCI	*Acer circinatum*	vine maple	Shrub
ACDE2	*Aconitum delphiniifolium*	larkspurleaf monkshood	Forb
ACHIL	*Achillea*	yarrow	Forb
ACMI2	*Achillea millefolium*	common yarrow	Forb
ALIN2	*Alnus incana*	gray alder	Shrub
ALINT	*Alnus incana ssp. tenuifolia*	thinleaf alder	Shrub
ALRU2	*Alnus rubra*	red alder	Tree
ALVI5	*Alnus viridis*	green alder	Shrub
ALVIF	*Alnus viridis ssp. fruticosa*	Siberian alder	Shrub
ALVIS	*Alnus viridis ssp. sinuata*	Sitka alder	Shrub
AMAL2	*Amelanchier alnifolia*	Saskatoon serviceberry	Shrub
ANLU	*Angelica lucida*	seacoast angelica	Forb
ANNA	*Anemone narcissiflora*	narcissus anemone	Forb
ANPO	*Andromeda polifolia*	bog rosemary	Shrub
ARAL2	*Arctostaphylos alpina*	alpine bearberry	Shrub
ARAL5	*Artemisia alaskana*	Alaska wormwood	Shrub
ARAR9	*Artemisia arctica*	boreal sagebrush	Forb
ARCTA	*Arctagrostis*	polargrass	Grass
ARCTO3	*Arctostaphylos*	manzanita	Shrub
ARFR4	*Artemisia frigida*	prairie sagewort	Shrub
ARRU	*Arctostaphylos rubra*	red fruit bearberry	Shrub
ARUV	*Arctostaphylos uva-ursi*	kinnikinnick	Shrub
ATFI	*Athyrium filix-femina*	common ladyfern	Forb
BEGL	*Betula glandulosa*	resin birch	Shrub
BENA	*Betula nana*	dwarf birch	Shrub
BENE4	*Betula neoalaskana*	resin birch	Tree
BEPA	*Betula papyrifera*	paper birch	Tree
BRINP	*Bromus inermis ssp. pumpellianus*	Pumpelly's brome	Grass
CAAQ	*Carex aquatilis*	water sedge	Grass
CABI5	*Carex bigelowii*	Bigelow's sedge	Grass
CACA4	*Calamagrostis canadensis*	bluejoint	Grass
CACH5	*Carex chordorrhiza*	creeping sedge	Grass
CALA11	*Carex lasiocarpa*	woollyfruit sedge	Grass
CALI	*Carex livida*	livid sedge	Grass
CALI7	*Carex limosa*	mud sedge	Grass
CAMA11	*Carex macrochaeta*	longawn sedge	Grass
CAME4	*Carex membranacea*	fragile sedge	Grass
CAME7	*Cassiope mertensiana*	western moss heather	Shrub
CAMI6	*Carex microglochin*	fewseeded bog sedge	Grass
CAPA	*Calla palustris*	water arum	Forb
CAPA19	*Carex pauciflora*	fewflower sedge	Grass

Table A-2, continued. Plant code definitions and growth forms used in the ecosystem diversity framework. Source: plants.gov -November 2017

PLANTS Code	**Scientific Name**	**Common Name**	**Growth Form**
CAPA5	*Caltha palustris*	yellow marsh marigold	Forb
CAPL6	*Carex pluriflora*	manyflower sedge	Grass
CAPU	*Calamagrostis purpurascens*	purple reedgrass	Grass
CARA5	*Carex rariflora*	looseflower alpine sedge	Grass
CARO7	*Carex rotundata*	round sedge	Grass
CAST10	*Carex stylosa*	variegated sedge	Grass
CATE11	*Cassiope tetragona*	white arctic mountain heather	Shrub
CAUN4	*Castilleja unalaschcensis*	Alaska Indian paintbrush	Forb
CHAMA5	*Chamaedaphne*	leatherleaf	Shrub
CHAN9	*Chamerion angustifolium*	fireweed	Forb
CHCA2	*Chamaedaphne calyculata*	leatherleaf	Shrub
CHLA13	*Chamerion latifolium*	dwarf fireweed	Forb
CIVI5	*Cicuta virosa*	Mackenzie's water hemlock	Forb
CLADI3	*Cladina*	reindeer lichen	Lichen
CLADO3	*Cladonia*	cup lichen	Lichen
COCA13	*Cornus canadensis*	bunchberry dogwood	Forb
COPA28	*Comarum palustre*	purple marshlocks	Forb
COSE16	*Cornus sericea*	redosier dogwood	Shrub
CREL	*Crepis elegans*	elegant hawksbeard	Forb
CRNA	*Crepis nana*	dwarf alpine hawksbeard	Forb
DAFRF	*Dasiphora fruticosa ssp. floribunda*	shrubby cinquefoil	Shrub
DASIP	*Dasiphora*	shrubby cinquefoil	Shrub
DILA	*Diapensia lapponica*	pincushion plant	Shrub
DRDR	*Dryas drummondii*	Drummond's mountain-avens	Shrub
DREX2	*Dryopteris expansa*	spreading woodfern	Forb
DROC	*Dryas octopetala*	eightpetal mountain-avens	Shrub
DRYAS	*Dryas*	mountain-avens	Shrub
ELCO	*Elaeagnus commutata*	silverberry	Shrub
ELTR7	*Elymus trachycaulus*	slender wheatgrass	Grass
EMNI	*Empetrum nigrum*	black crowberry	Shrub
EQAR	*Equisetum arvense*	field horsetail	Forb
EQFL	*Equisetum fluviatile*	water horsetail	Forb
EQSC	*Equisetum scirpoides*	dwarf scouringrush	Forb
EQUIS	*Equisetum*	horsetail	Forb
EQVA	*Equisetum variegatum*	variegated scouringrush	Forb
ERAC2	*Erigeron acris*	bitter fleabane	Forb
ERAN6	*Eriophorum angustifolium*	tall cottongrass	Grass
ERVA4	*Eriophorum vaginatum*	tussock cottongrass	Grass
FEAL	*Festuca altaica*	Altai fescue	Grass
FERU2	*Festuca rubra*	red fescue	Grass
FRCA5	*Fritillaria camschatcensis*	Kamchatka fritillary	Forb

Table A-2, continued. Plant code definitions and growth forms used in the ecosystem diversity framework. Source: plants.gov -November 2017

PLANTS Code	Scientific Name	Common Name	Growth Form
GATR2	*Galium trifidum*	threepetal bedstraw	Forb
GEER2	*Geranium erianthum*	woolly geranium	Forb
GELI2	*Geocaulon lividum*	false toadflax	Forb
GYDR	*Gymnocarpium dryopteris*	western oakfern	Forb
HAST3	*Harrimanella stelleriana*	Alaska bellheather	Shrub
HEDYS	*Hedysarum*	sweetvetch	Forb
HEMA80	*Heracleum maximum*	common cowparsnip	Forb
HYLOC2	*Hylocomium*	Hylocomium feather moss	Moss
HYSP70	*Hylocomium splendens*	splendid feather moss	Moss
JUCO6	*Juniperus communis*	common juniper	Shrub
JUHO2	*Juniperus horizontalis*	creeping juniper	Shrub
LARIX	*Larix*	larch	Tree
LEDUM	*Ledum*	Labrador tea	Shrub
LEGR	*Ledum groenlandicum*	bog Labrador tea	Shrub
LEIN6	*Leymus innovatus*	downy ryegrass	Grass
LEMO8	*Leymus mollis*	American dunegrass	Grass
LEPA11	*Ledum palustre*	marsh Labrador tea	Shrub
LIBO3	*Linnaea borealis*	twinflower	Shrub
LOPR	*Loiseleuria procumbens*	alpine azalea	Shrub
LUCO5	*Luzula confusa*	northern woodrush	Grass
LUNO	*Lupinus nootkatensis*	Nootka lupine	Forb
LUPE	*Luetkea pectinata*	partridgefoot	Shrub
LUPIN	*Lupinus*	lupine	Forb
MENYA	*Menyanthes*	buckbean	Forb
MEPA	*Mertensia paniculata*	tall bluebells	Forb
MYGA	*Myrica gale*	sweetgale	Shrub
PELTI2	*Peltigera*	felt lichen	Lichen
PHAL4	*Phyllodoce aleutica*	Aleutian mountainheath	Shrub
PHGL6	*Phyllodoce glanduliflora*	yellow mountainheath	Shrub
PIGL	*Picea glauca*	white spruce	Tree
PILU	*Picea lutzii*	hybrid spruce	Tree
PIMA	*Picea mariana*	black spruce	Tree
PISI	*Picea sitchensis*	Sitka spruce	Tree
PLSC70	*Pleurozium schreberi*	Schreber's big red stem moss	Moss
POAC	*Polemonium acutiflorum*	tall Jacob's-ladder	Forb
POBA2	*Populus balsamifera*	balsam poplar	Tree
POBAT	*Populus balsamifera ssp. trichocarpa*	black cottonwood	Tree
POTR5	*Populus tremuloides*	quaking aspen	Tree
PSSP6	*Pseudoroegneria spicata*	bluebunch wheatgrass	Grass
PYROL	*Pyrola*	wintergreen	Forb
RHLA2	*Rhododendron lapponicum*	Lapland rosebay	Shrub

Table A-2, continued. Plant code definitions and growth forms used in the ecosystem diversity framework. Source: plants.gov -November 2017

PLANTS Code	Scientific Name	Common Name	Growth Form
RITR	*Ribes triste*	red currant	Shrub
ROAC	*Rosa acicularis*	prickly rose	Shrub
RUAR6	*Rumex arcticus*	arctic dock	Forb
RUCH	*Rubus chamaemorus*	cloudberry	Forb
RUSP	*Rubus spectabilis*	salmonberry	Shrub
SAAL	*Salix alaxensis*	feltleaf willow	Shrub
SAAR27	*Salix arctica*	arctic willow	Shrub
SAAR3	*Salix arbusculoides*	littletree willow	Shrub
SABA3	*Salix barclayi*	Barclay's willow	Shrub
SABA4	*Salix barrattiana*	Barratt's willow	Shrub
SABE2	*Salix bebbiana*	Bebb willow	Shrub
SACA14	*Sanguisorba canadensis*	Canadian burnet	Forb
SACA4	*Salix candida*	sageleaf willow	Shrub
SAFU	*Salix fuscescens*	Alaska bog willow	Shrub
SAIN3	*Salix interior*	sandbar willow	Shrub
SALIX	*Salix*	willow	Shrub
SALUL	*Salix lucida ssp. lasiandra*	Pacific willow	Shrub
SANI10	*Salix niphoclada*	barrenground willow	Shrub
SAPH	*Salix phlebophylla*	skeletonleaf willow	Shrub
SAPO	*Salix polaris*	polar willow	Shrub
SAPS	*Salix pseudomonticola*	false mountain willow	Shrub
SAPS8	*Salix pseudomyrsinites*	firmleaf willow	Shrub
SAPU15	*Salix pulchra*	tealeaf willow	Shrub
SARA2	*Sambucus racemosa*	red elderberry	Shrub
SARE2	*Salix reticulata*	netleaf willow	Shrub
SARI4	*Salix richardsonii*	Richardson's willow	Shrub
SARO2	*Salix rotundifolia*	least willow	Shrub
SASC	*Salix scouleriana*	Scouler's willow	Shrub
SASE4	*Salix setchell*	Setchell's willow	Shrub
SHCA	*Shepherdia canadensis*	russet buffaloberry	Shrub
SPHAG2	*Sphagnum*	sphagnum	Moss
SPST3	*Spiraea stevenii*	beauverd spirea	Shrub
STERE2	*Stereocaulon*	snow lichen	Lichen
TSHE	*Tsuga heterophylla*	western hemlock	Tree
TSME	*Tsuga mertensiana*	mountain hemlock	Tree
UTRIC	*Utricularia*	bladderwort	Forb
VAOV	*Vaccinium ovalifolium*	oval-leaf blueberry	Shrub
VAOX	*Vaccinium oxycoccos*	small cranberry	Shrub
VASI	*Valeriana sitchensis*	Sitka valerian	Forb
VAUL	*Vaccinium uliginosum*	bog blueberry	Shrub
VAVI	*Vaccinium vitis-idaea*	lingonberry	Shrub
VEVI	*Veratrum viride*	green false hellebore	Forb
VIED	*Viburnum edule*	squashberry	Shrub

Appendix B. Moose Habitat Quality Model – Methods and Results

Introduction

The Ahtna Intertribal Resource Commission (CRITR) has initiated a landscape scale project funded through the Conservation Innovation Grant program of the Natural Resources Conservation Service. The purpose of the project is to develop innovative tools and to increase the technical capacity for planning by CRITR. The specific objectives include:

- Conduct an ecologically based resource assessment of Ahtna lands; develop ecological site classification, and develop site-specific vegetation treatments;
- Develop moose and caribou habitat models to support habitat management of these species;
- Develop an innovative 10-year management plan for Ahtna’s 1.7 million acres to increase moose for food and biomass for energy while maintaining or improving caribou habitat; and
- Train local technicians to conduct habitat treatments and monitor results.

A moose habitat model will be an important tool to help identify sites with the best potential for improving moose habitat and to incorporate management of these sites into an overall plan that considers a landscape context.

Literature Review – Distribution, Habitat Requirements, and Habitat Changes

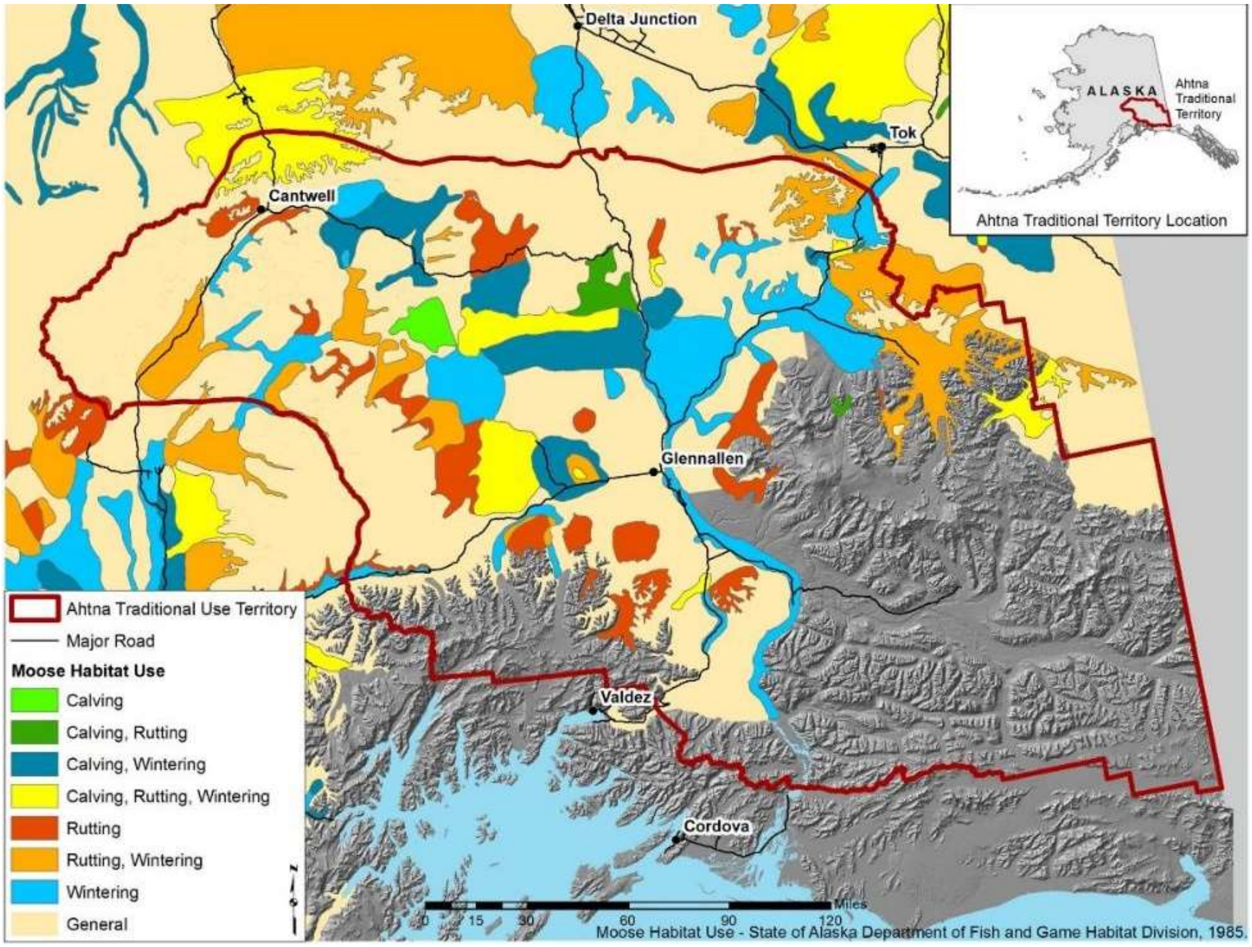
Distribution in the Project Area

Alaskan moose (*Alces alces gigas*) are the largest in size of 4 subspecies of moose in North America. Moose distribution in southcentral Alaska, as determined by Alaska Department of Fish and Game, is shown in Figure A-1.

Habitat Requirements

Moose habitat requirements vary throughout the year with greatest consideration given to winter, spring, and summer habitat. All three seasons are influenced by the availability of preferred foods as well as avoidance of predation risk and disturbance from human activities, and selection of thermal cover in both winter and summer.

Moose select areas providing them with a mix of food and cover (Maier et al. 2005). Moose rely heavily on willows throughout the year (MacCracken et al. 1997). Other foods include sweetgale (*Myrica gale*), Sitka alder (*Alnus sinuata*), and emergent aquatic plants like marsh fivefinger (*Potentilla palustris*), horsetails (*Equisetum* spp.) and buckbean (*Menyanthes trifoliate*) (MacCracken et al. 1997). Habitat selection by moose has been shown to be influenced by the scale of analysis. For example, a study in Norway showed that at large scales, moose selected areas that contained higher percentages of preferred habitat types, while at the scale of the home range, smaller home ranges contained higher percentages of the preferred habitat types than larger home ranges (Herfindal et al. 2009). However, they found at the home range scale that the preference for preferred habitat types was not found because the home ranges were selected in areas containing these preferred types.



Moose Habitat Use - State of Alaska Department of Fish and Game Habitat Division, 1985.

Figure A-1. Existing moose distribution in southcentral Alaska (from Alaska Department of Fish and Game).

Winter Habitat

Collins and Helm (1997) studied moose winter habitat selection in a floodplain in southcentral Alaska and found that moose selected areas that provided high amounts of browse with feltleaf willow (*Salix alaxensis*) the preferred food. Highbush cranberry (*Viburnum edule*) and rose (*Rosa acicularis*) were also present on selected sites, but were not available as browse when snow depths exceeded 110 cm. They noted that flood action in the floodplain was the primary disturbance that maintained preferred early succession conditions. They recommended that moose habitat management focus on upland areas where fire or other disturbances were needed to produce increased amounts of early successional habitat. LeResche and Davis (1973) reported moose using burned areas for up to 50 years with greatest use occurring 20-25 years post burn. Maier et al. (2005) found that moose utilized areas 11-30 year post burn, and had higher densities in areas with mixed vegetation conditions, and avoided areas of mixed terrain or lacking vegetation. Puttock et al. (1996) found that moose selected stands that were 1-20 years of age as well as stands with <30% canopy cover in Ontario. Moose in southeast Alaska used riparian shrub and high volume coniferous forests during thick snow, and were found to use clearcuts <30 years old more heavily than unlogged forest (Doerr 1983).

Maier et al. (2005) looked at moose distributions in early winter, and found that moose selected areas that had a diversity of vegetation conditions but did not select areas that were variable in terrain. They particularly selected areas that had burned 11-30 years previously.

Moose have been found to respond to snow depths. Nietfeld et al. (1985) reported that moose avoided areas where snow depths exceeded 65-75 cm. Eastman (1977) reported that moose increased use of mature conifer stands when snow depths approached 80 cm. Schwab and Pitt (1991) reported that conifer stands should have >70% cover to provide optimal snow reductions and thermal cover in the winter. Poole and Stuart-Smith (2006) reported that moose occurred at lower elevations in their study area in British Columbia as the winter progressed which they attributed to moose selecting areas with lower snow depths. They also found that moose selected areas with more gentle terrain and that offered solar radiation. Dussault et al. (2005b) studied moose in Quebec and found that in winter moose avoided areas with the lowest snow depths, a response they attributed to avoiding wolves. In their study, moose selected areas that provided shelter from snow in close proximity to foraging areas. In a related analysis, Dussault et al. (2005a) found that moose home ranges were smaller in winter where good food resources occurred, but they did not observe this in summer. Moose movements were less in areas with good supply of food in both winter and summer (Dussault et al. 2005a). Leclerc et al. (2012b) also studied moose in Quebec and found that moose selected harvested areas in winter where forage was available, but needed a mix of cover and foraging areas.

Spring/Calving Habitat

Chekchak et al. (1998) identified moose calving sites in Quebec. They found that moose selected sites on tops of hills with gentle slopes. Bowyer et al. (1999) similarly looked at calving sites of moose in Alaska. They found that moose selected sites higher on hills with dry southerly exposures as preferred calving locations where females had some visibility so that predators could be observed and avoided, but that also supported some willow, thus balancing risk of predation with food availability.

Several studies found that females with calves selected areas in the spring/early summer that contained forest cover to provide predator avoidance (Miquelle et al. 1992, White and Berger 2001, Oehlers et al. 2011). In contrast, both of these studies found that males selected areas that maximized forage production at this time of the year without needing forest cover, as predation was apparently not a driver of habitat selection at this time of the year for this segment of the population.

Summer Habitat

Forage, escape cover, and thermal cover are habitat needs of moose in summer. Moose diets have been noted to expand in the summer with the availability of additional foods such as aquatic plants (MacCracken et al. 1993). Areas providing both forage and cover were selected by moose in Norway, with moose using areas containing more preferred forage and cover types having smaller home ranges (Bjorneraas et al. 2012).

Demarchi and Bunnel (1995) found that moose selected thermal cover during times of heat stress in British Columbia. They found that moose selected areas with greater forest cover when conditions of heat stress during certain times of the day existed in open areas. Dussault et al. (2004) reported that moose selected thermal cover in summer when air temperatures got high, and switched their activity patterns to occur more at night than during the day. McCann et al. (2013) monitored captive moose responses to summer temperatures and found that moose became stressed at around 17º C in calm conditions, but this increased to 24º C when wind provided some cooling. They noted that moose selected shady areas during hot weather when the sun was out, indicating that solar radiation is also a factor in heat stress. Melin et al. (2014) reported that there was a strong selection by moose for thermal cover containing higher and denser canopies when day time temperatures exceeded 20º C.

Similarly, van Beest et al. (2012) found that moose selected closed canopy conifer cover when temperatures got higher in summer, reducing use of more open areas and thus reducing their ability to find forage. However, Lowe et al. (2010) did not find habitat selection by moose to avoid higher temperatures in a study in southern Ontario.

Anthropogenic Disturbance and Habitat Changes

Eldegard et al. (2012) found that moose in Norway appeared to balance their selection for high levels of browse with proximity to roads, noting that moose preferred sites with high amounts of browse as well as sites farther from roads. They also found that moose moved closer to smaller roads with lower amounts of traffic than larger roads with more traffic. Beyer et al. (2013) investigated moose occurrence and movements in relation to roads in Ontario. They found that moose occurred in areas with roads at a landscape scale, as roads were linked with timber harvests that produced early successional habitat favored by moose, but that moose avoided roads based on analysis at a finer scale. Leclerc et al. (2012a) found that moose abundance decreased with road density. Dussault et al. (2007) found that moose movement rates increased when crossing roads and that the area around roads was perceived as low quality habitat by moose.

Laurian et al. (2012) examined moose locations in relation to roads in Quebec and found that moose searched for areas containing high amounts of forage while avoiding highways and roads, but that this avoidance was only for 100-250m. In a related article (Laurian et al. 2008) that tracked nearly 200,000 moose movement segments, only 328 crossed highways and 1,172 crossed forests roads which were 16 and 10 times less than by chance. They did note that while moose generally avoided highways, some moose did use areas along highways for foraging which they attributed to selection for sodium-rich foods. In fact, browsing rates along highways were equal to those more distant from highways even though use by moose as measured by time or occurrence was substantially less.

Harris et al. (2014) evaluated the effects of winter recreation on moose, focusing on snowmobile use. They found that snowmobile use affects moose when it is unpredictable, spans large areas, is long in duration, has a large spatial footprint, involves non-motorized use, and when animals are displaced into poor quality habitat. Shanley and Pyare (2011) evaluated moose distributions in summer and fall in relation to OHV use and found that even relatively low levels of OHV use (<0.25 km travel/km^2/day) elicited a response with males affected up to 1000m away from a trail and females affected even more than 1000m away.

Mortality Factors

The relationship of moose population sizes as influenced by habitat qualities and mortality factors, in particular predation by wolves and bears and human harvest, has been and continues to be evaluated. Ballard et al. (1991) studied moose in southcentral Alaska from 1976-1986 found high pregnancy rates (81%) and twinning rates (38%) in this population, but only a 39% rate of calf survival through 5 months with 83% of loss caused by predation of which 96% occurred during the first 6 weeks of life and 73% of this loss attributed to brown bears. McCracken et al. (1997) found calf production on the Copper River Delta to average 1 calf/cow, but fall cow/calf ratios averaged 30 calves/100 cows. Mortality of calves was due to cold spring weather and predation by brown bears.

Existing Habitat Models

Moose habitat requirements have shown many similarities across the range of the species. However, Mabille et al. (2012) cautioned that functional habitat selection by moose can vary locally depending on the types of conditions occurring at the location, so extrapolations about habitat selection or use from other areas must be treated cautiously. Similarly, McLoughlin et al. (2011) found differences in seasonal habitat selection (in response to hunting) and road avoidance between two nearby study areas that had substantially different management programs, while Osko et al. (2004) found different selection of habitat by two groupings of moose based on availability of habitat classes. Further, sex and reproductive status have been shown to influence seasonal habitat selection by moose (Miquelle et al. 1992). They found that females with calves selected areas in early summer that provided forest cover, apparently as a predator avoidance for calves, while males selected areas specifically for high forage production in Denali National Park. Some additional sexual separation was noted in the Denali study at other times of the year, but it was not as noticeable as during early summer. A study conducted in Tongass National Forest (Oehlers et al. 2011) found similar differences in habitat selection by males and females with calves during the spring. Thus, a generic habitat model for moose should generally characterize habitat for the species, but some differences in habitat selection may be missed or masked, especially when considering spring (calving) habitat requirements. Dettki et al. (2003) modeled moose habitat quality related to vegetation and compared this to an empirically driven model that computed a number of environmental variables and found substantial differences, stressing the importance of incorporating environmental variables (e.g., elevation) into models.

Various habitat models have been developed for moose, but need to be carefully evaluated for their application to moose in southcentral Alaska. A habitat suitability model was developed for moose in Quebec (Dussault et al. 2006). They included two variables in the model, food and an interspersion measurement, and evaluated the model at different scales. The model that integrated the two variables worked well for wintering males at a scale of 500 ha, but not for females. Females responded to the food variable, but not the interspersion variable. Female habitat use was found to correspond better to forage at home range scales measured in 100 ha polygons than compared to the 500 ha scale.

A habitat suitability model for moose in the Lake Superior area was developed by Allen et al. (1987). This model incorporated measures of summer and winter browse, wetland areas for summer food, and winter cover as variables. It evaluated winter based on the provision of food as modified by proximity to cover (within 100 m of cover). This model was then put into a GIS framework using remotely sensed mapping (Hepinstall et al. 1996). This application suggested that a 50% overlap in a moving window analysis was sufficient to capture landscape variation.

Several models have been developed as part of impact evaluations for oil and gas or other developments in Canada. These models have generally used vegetation classifications and associated rankings of moose habitat that have very limited application to a landscape-scale for southcentral Alaska.

An Ecosystem- and Landscape-scale Habitat Quality Assessment for Southcentral Alaska

Ecosystem-scale

The existing moose habitat use presented in Figure C-2 was mapped for each ecosystem which was then assigned a habitat quality value for winter, spring, and summer habitat use. This value was then further modified based on an overlay of anthropogenic disturbances. Table B-2 lists the habitat quality value (HSI) for each ecosystem. See Appendix A for definitions of each ecosystem code.

Table B-2. Moose habitat quality values (HSI) for each ecosystem by winter, spring, and summer habitat use in the Ahtna Traditional Use Territory. See Appendix A for definitions of ecosystem codes.

ECOSYSTEM	FORAGE			COVER			ECOSYSTEM	FORAGE			COVER		
	Winter	Spring	Summer	Winter	Spring	Summer		Winter	Spring	Summer	Winter	Spring	Summer
11	0	0	0	0	0	0	16150_B	1	1	1	0.25	0.5	0.75
12	0	0	0	0	0	0	16150_C	0.5	0.5	0.75	0.5	0.75	1
16011_A	1	1	1	0.1	0.25	0.25	16150_D	0.25	0.25	0.25	0.5	0.5	0.5
16011_B	1	1	1	0.5	0.75	0.75	16150_E	0.1	0.1	0.1	1	0.75	1
16012_A	1	1	1	0.1	0.25	0.25	16160_A	1	1	1	0.1	0.5	0.75
16012_B	1	1	1	0.5	0.75	0.75	16160_B	0.75	0.75	0.75	0.5	0.75	0.75
16030_A	0.25	0.25	0.75	0.1	0.25	0.25	16170_A	0.1	0.5	1	0.1	0.25	1
16030_B	0.25	0.25	0.75	0.1	0.25	0.25	16170_B	0.1	0.5	1	0.1	0.25	0.75
16030_C	0.75	0.75	0.75	0.25	0.5	0.5	16170_C	0.25	0.5	0.75	0.1	0.25	0.25
16030_E	0.1	0.1	0.1	1	0.5	0.75	16170_D	0.5	0.75	0.75	0.1	0.25	0.25
16041_A	0.75	0.75	1	0.1	0.25	0.25	16170_E	0.1	0.25	0.25	0.1	0.1	0.1
16041_B	0.75	0.75	1	0.1	0.25	0.25	16181_A	0.1	0.5	1	0.1	0.25	0.75
16041_C	0.75	0.75	0.75	0.25	0.5	0.5	16181_B	0.1	0.5	1	0.1	0.25	0.5
16041_D	0.25	0.5	0.5	0.75	0.75	0.75	16181_C	0.25	0.5	0.75	0.1	0.25	0.25
16041_E	0.25	0.5	0.5	0.75	0.5	0.75	16181_D	0.5	0.75	0.75	0.1	0.25	0.25
16042_A	0.25	0.5	0.1	0.1	0.1	0.1	16211_A	0.1	0.75	1	0.1	0.5	0.75
16042_B	0.25	0.5	0.5	0.5	0.5	0.5	16211_B	0.1	0.5	0.75	0.1	0.5	0.75
16042_C	0.75	0.75	0.75	0.25	0.5	0.75	16211_C	0.5	0.5	0.5	0.1	0.1	0.25
16042_D	0.25	0.5	0.5	0.5	0.75	1	16211_D	0.25	0.5	0.5	0.5	0.5	0.5
16050_A	0.25	0.5	1	0.1	0.25	0.25	16212_A	0.1	0.5	0.75	0.1	0.5	0.75
16050_B	0.25	0.5	1	0.1	0.25	0.25	16212_B	0.1	0.5	0.75	0.1	0.5	0.75
16050_D	0.75	0.75	0.75	0.25	0.5	0.75	16212_C	0.25	0.25	0.5	0.1	0.1	0.25
16050_E	0.5	0.5	0.5	0.25	0.75	1	16220_A	0.25	0.5	0.5	0.25	0.5	0.5
16061_A	0.75	0.75	1	0.1	0.25	0.25	16220_B	0.25	0.5	0.5	0.25	0.5	0.5
16061_B	0.75	0.75	1	0.1	0.25	0.25	16220_C	0.1	0.1	0.1	1	0.5	1
16061_C	0.25	0.25	0.5	0.25	0.5	0.75	16240_A	0.75	0.75	0.75	0.1	0.5	1
16061_D	0.1	0.1	0.25	0.5	0.75	0.75	16280_A	0.1	0.25	0.25	0.1	0.1	0.1
16080_A	0.1	0.25	0.25	0.1	0.1	0.1	16280_B	0.75	0.75	0.75	0.25	0.5	0.75
16080_B	0.5	0.5	0.5	0.1	0.25	0.75	16280_C	0.5	0.5	0.5	0.1	0.25	0.5
16090_A	0.1	0.25	0.25	0.1	0.1	0.1	16290_A	0.1	0.1	0.1	0.1	0.1	0.1
16090_B	0.5	0.5	0.5	0.1	0.5	0.75	16290_B	0.1	0.25	0.25	0.1	0.1	0.1
16102_A	0.1	0.25	0.25	0.1	0.1	0.1	16300_A	0.1	0.25	0.25	0.1	0.1	0.1
16102_B	1	1	1	0.1	0.25	0.75	16300_B	0.1	0.25	0.25	0.1	0.1	0.1
16110_A	0.1	0.25	0.25	0.1	0.1	0.1	16300_C	0.1	0.25	0.25	0.25	0.25	0.25
16120_A	0.1	0.25	0.25	0.1	0.1	0.1	16320_A	0	0	0	0	0	0
16141_A	0.25	0.75	1	0.1	0.1	0.1	16320_B	0	0	0	0	0	0
16141_B	1	1	1	0.25	0.5	0.75	16330_A	0.1	0.5	0.5	0.1	0.1	0.1
16141_C	0.5	0.5	0.75	0.5	0.75	1	16351_A	0.1	0.5	0.5	0.1	0.1	0.1
16141_D	0.25	0.25	0.25	0.5	0.5	0.5	16481_C	0.1	0.1	0.1	1	1	1
16141_E	0.1	0.1	0.1	1	0.75	1	16790_A	0.25	0.25	1	0.1	0.1	0.1
16142_A	0.25	0.75	1	0.1	0.1	0.1	16790_B	0.75	0.75	0.75	0.25	0.5	0.75
16142_B	1	1	1	0.25	0.5	0.75	16790_C	0.5	0.5	0.5	0.1	0.25	0.5
16142_C	0.5	0.5	0.75	0.5	0.75	1	16790_D	0.25	0.5	0.5	0.5	0.75	1
16150_A	0.25	0.75	1	0.1	0.1	0.1	31	0	0	0	0	0	0

The following describe some of the assumptions and initial values used in the model.

Winter Habitat Use

Ecosystems were used to rate forage quality and thermal cover quality of each ecosystem defined pixel. Ratings for each ecosystem type were assigned as 0.1, 0.25, 0.5, 0.75, or 1.0, with poorest quality habitat ranked as 0.1 and highest quality ranged at 1.0. Similarly, thermal cover values were assigned, but a minimum size of 2 acres was set for an ecosystem type to qualify as thermal/escape cover.

Spring Habitat Use

Ecosystems were used to rate each category for spring foods and escape cover. Forage values were rated as 0.1, 0.25, 0.5, 0.75, or 1.0, with poorest quality habitat ranked as 0.1 and highest quality ranged at 1.0. As with winter thermal cover, a minimum size of 2 acres was set for an ecosystem type to qualify as thermal/escape cover.

Summer Habitat Use

Ecosystems were rated for summer habitat use in terms of providing desired foraging or thermal/escape cover. As with winter and spring, each pixel or stand was assigned a rating based on its ecological site and structure category as 0.1, 0.25, 0.5, 0.75, or 1, with poor quality habitat ranked as 0.1. Similar to winter and spring, thermal cover needed to be at least 2 acres in size to be considered functional.

Interspersion Evaluation

Foraging is influenced by proximity to thermal or escape cover. This may vary by season. For example, summer thermal cover may only need to be within 500m, while winter thermal escape cover is preferred within 100m and use may be minimal beyond 300m away. The following interspersion values were used as modifiers such that they reduced the rated value of foraging areas by moose.

Winter foraging: Forage quality based on the forage value assigned to the Ecosystem discussed above was further modified based on its interspersion with thermal cover. Forage within 300m of thermal cover that was rated at least 0.5 in value remained at its assigned forage quality rating. Beyond 300m, the forage quality rating was multiplied by 0.25 to reduce its value. Alternatively, forage qualities could be further refined based on distance from thermal cover: within 100m of thermal/escape cover rated as the full forage value, 100-200m rated as 0.75 times the forage value, 200-300m away rated as 0.5 times the forage value, and >300m rated as 0.25 times the forage value. These banded modifiers have not been incorporated into the current model.

Spring forage quality values were reduced in the same manner as winter forage values based on distance from escape cover. Forage quality ratings within 300m of escape cover that was rated as 0.5 or greater in value received its full foraging value, while areas >300m from escape cover were reduced in value as 0.25 times the forage value.

Summer foraging: Summer forage quality values that were located within 500m of thermal cover at least 0.5 in value received full value. Areas >500m away from thermal cover were reduced in value by a multiplier of 0.25 times the forage value.

Summer thermal cover may also be provided by wetlands/ponds. These have not currently been mapped or included in the model.

Additional Considerations

Habitat quality is clearly a driver of moose population status and dynamics, as high quality habitat is necessary for populations to have high levels of recruitment and survival. However, given the relatively low productivity of moose populations even in high quality habitat, mortality factors can play a significant role as well. Severe winters can impact populations (Ballard et al. 1991). Wolves have been identified as a major predator of moose (Ballard et al. 1991). Bears, both brown and black have also been found to be significant predators on calves (Ballard et al. 1991). Balancing habitat quality, predator populations, human impacts on habitat, and human harvest of moose is a challenging management issue. Boertje et al. (2010) reviewed information on moose population dynamics in relation to predator control programs. They found that predator control can be an effective tool to increase available human harvest of moose, but stressed that nutrient-based management and consideration of other factors is essential to make both politically and biologically correct decisions. Similarly, Crete and Courtois (1997) noted that limiting factors to moose populations need to be assessed prior to making management decisions relative to mortality factors.

Landscape-scale

At a landscape scale, moose habitat will be considered to be important within mapped moose range (Figure B-1). Within existing moose range, moose habitat quality will be rated according to the procedures outlined below. A moving window analysis is used to evaluate the quality of an area of approximately 10,000 ha (24,000 ac) surrounding each pixel as indicated in Table A-1.

Table B-1. Landscape scale rating of habitat quality based on aggregate quality of winter, spring and summer moose habitat within a 10,000 ha area.

Percentage of 10,000 ha area with HSI > 0.75	**Area weighted HSI value For winter, spring and summer habitat**
>50%	1.0
25-50%	0.5
10-25%	0.25
<10%	0.1

Model Results

Ecosystem-scale

Figures B-2 to B-4 display ecosystem-scale model outputs of moose habitat quality for the three habitat use seasons of winter, spring, and summer, within the Ahtna Traditional Use Territory.

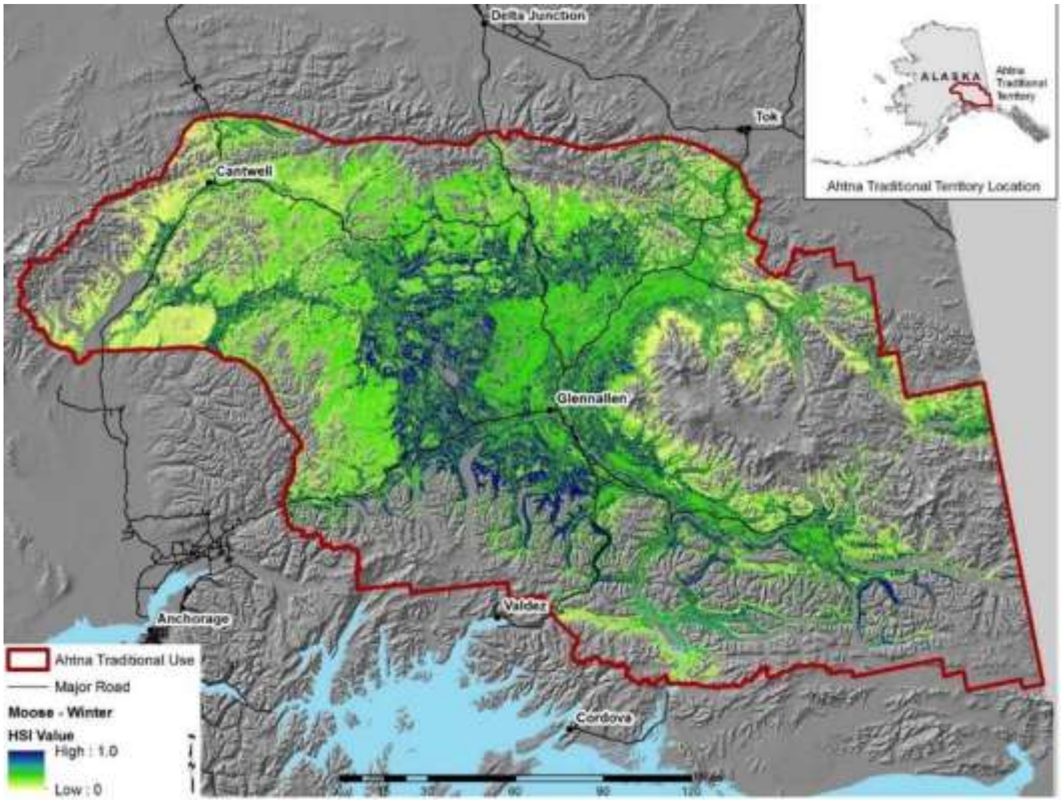


Figure B-2. Results of the ecosystem-scale model outputs for moose winter habitat quality.

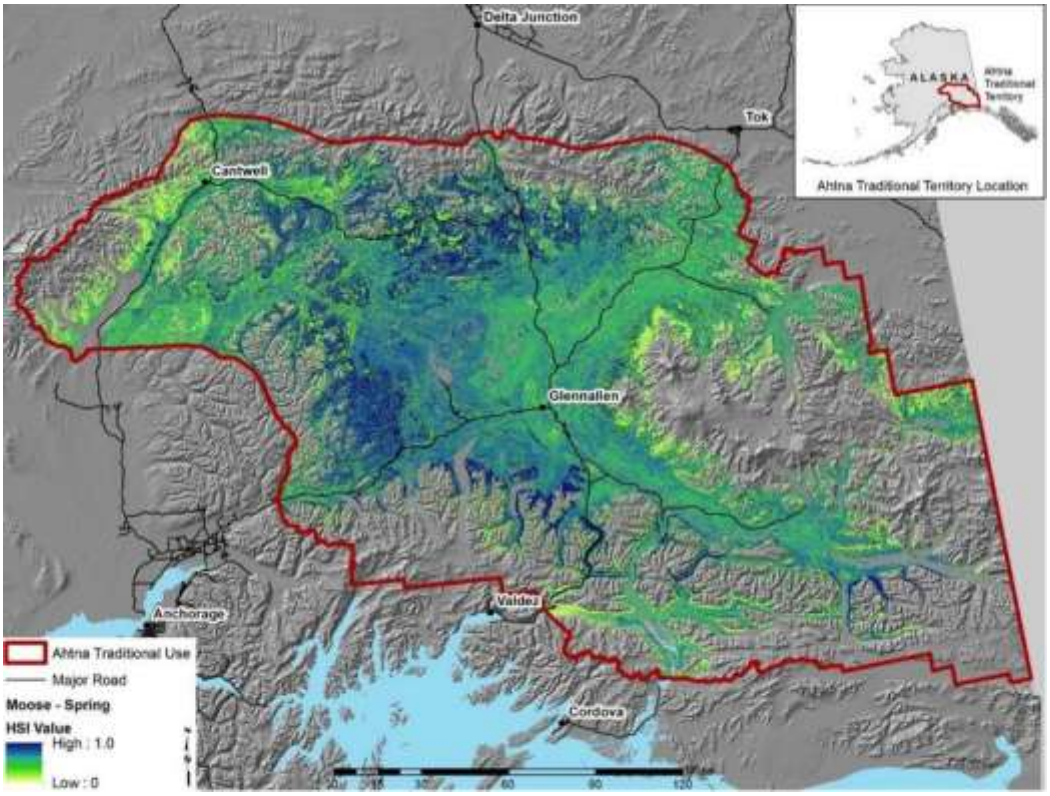


Figure B-3. Results of the ecosystem-scale model outputs for moose spring habitat quality.

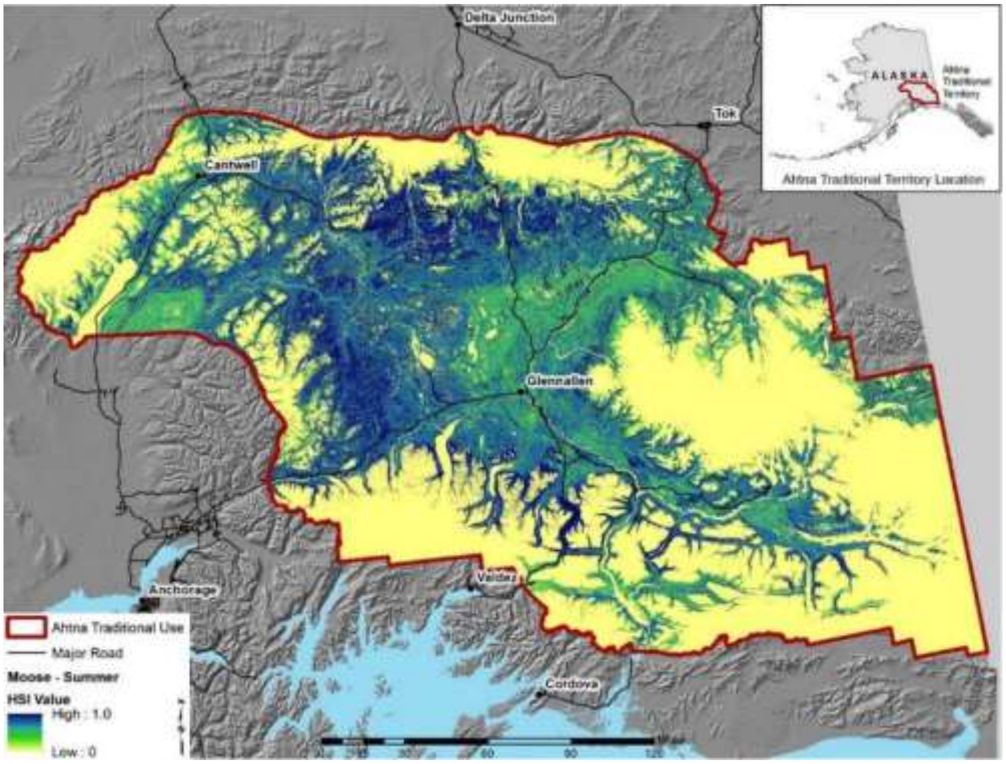


Figure B-4. Results of the ecosystem-scale model outputs for moose summer habitat quality.

Landscape-scale

Figures B-5 to B-7 display model outputs of the landscape-scale moose habitat quality assessment for the three habitat use seasons of winter, spring, and summer, within the Ahtna Traditional Use Territory.

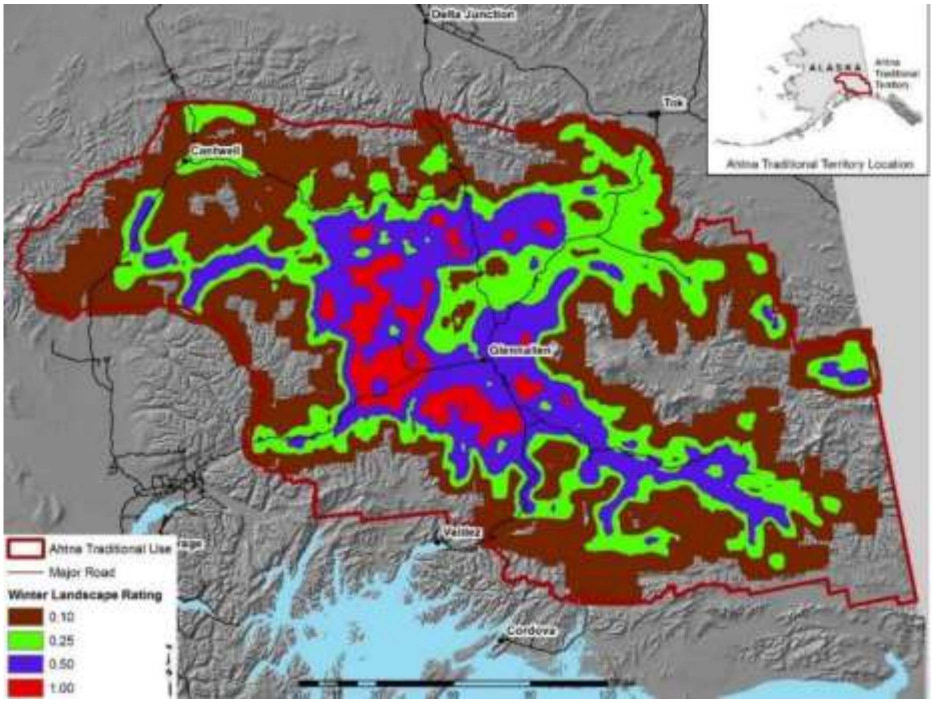


Figure B-5. Results of the landscape-scale model outputs for moose winter habitat quality.

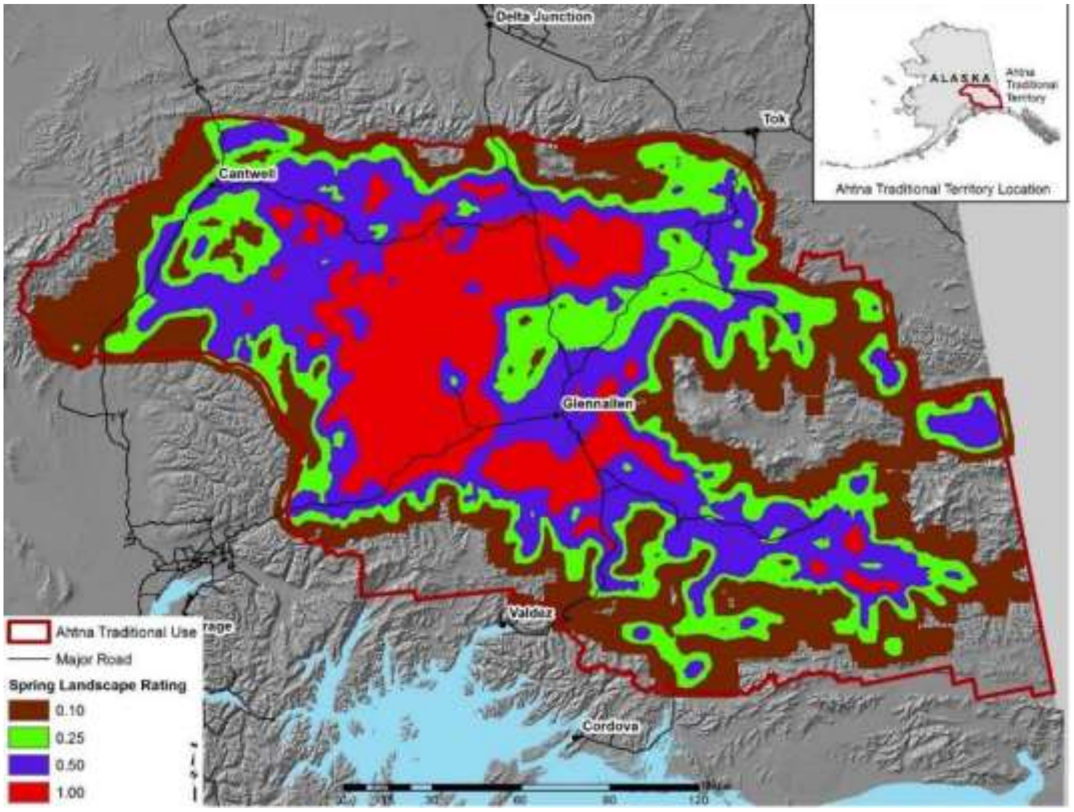


Figure B-6. Results of the landscape-scale model outputs for moose spring habitat quality.

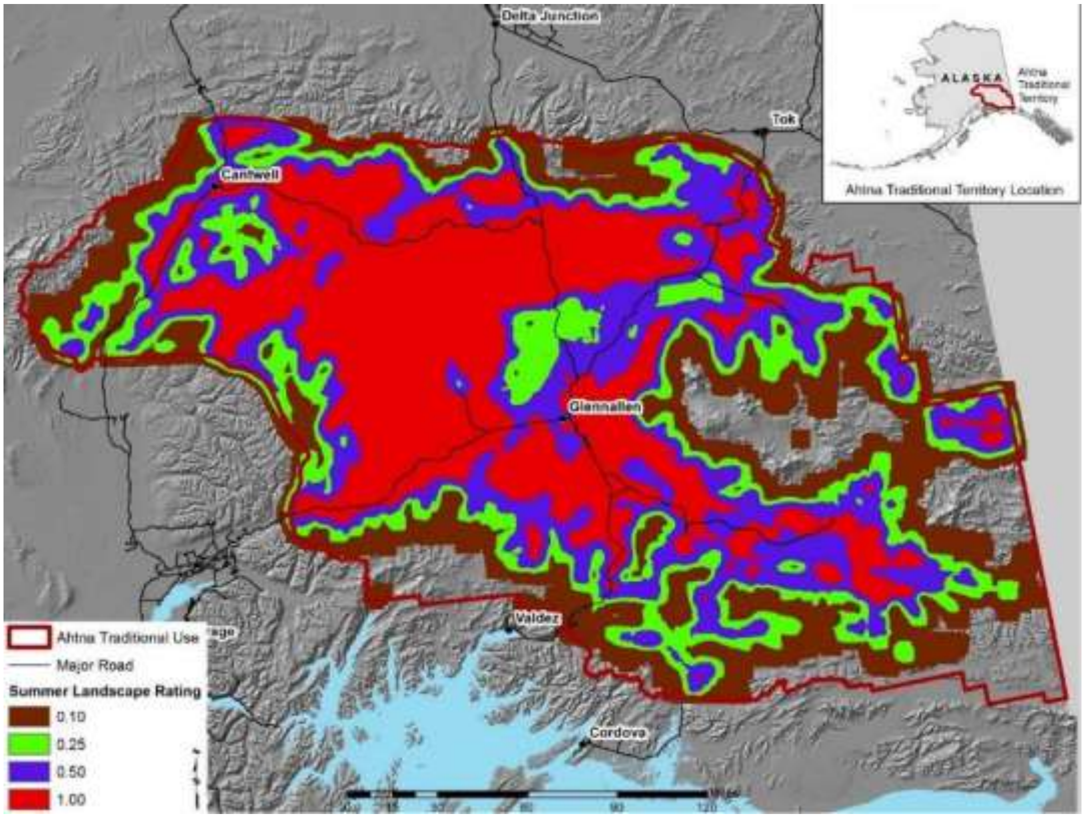


Figure B-7. Results of the landscape-scale model outputs for moose summer habitat quality..

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Appendix C. Caribou Habitat Quality Model – Methods and Results

Introduction

The Ahtna Intertribal Resource Commission (CRITR) has initiated a landscape-scale project funded through the Conservation Innovation Grant program of the Natural Resources Conservation Service. The purpose of the project is to develop innovative ecologically-based tools to support sustainable resource management and to increase the technical capacity for planning by CRITR. The specific objectives include:

- Conduct an ecologically based resource assessment of Ahtna lands; develop ecological site classification, and develop site-specific vegetation treatments;
- Develop moose and caribou habitat models to support habitat management of these species;
- Develop an innovative 10-year management plan for Ahtna's 1.7 million acres to increase moose for food and biomass for energy while maintaining or improving caribou habitat; and
- Train local technicians to conduct habitat treatments and monitor results.

A caribou habitat quality model is an important tool to help identify sites with the best potential for maintaining caribou habitat and to incorporate management of these sites into an overall plan that considers a landscape context.

Literature Review – Distribution and Habitat Requirements

Caribou in Alaska

Caribou (*Rangifer tarandus*) in Alaska are all considered to be of the Grants subspecies (*R.t. granti*). Weckworth et al. (2012) examined mitochondrial DNA and found that this subspecies was not different from the barren-ground caribou (*R.t. groenlandicus*) in the Yukon and Northwest Territories, although these subspecies are still generally considered separate. Weckworth et al. (2012) also reported greater similarities in the northern woodland ecotype of the woodland caribou (*R.t. caribou*) along with Grants and barren-ground caribou when compared to other subspecies of caribou which they attributed to the location of refugia for these subspecies during the ice ages, with the Grants, barren-ground, and northern woodland caribou being of Beringian origin while the other subspecies and ecotypes relied on refugia south of the glacial ice. These differences could result in habitat and behavioral differences between these groupings, although all caribou and reindeer are considered the same species. Genetic analysis of Grants caribou in Alaska (Mager et al. 2014) indicated that while individual herds on the Alaska Peninsula showed considerable genetic variation among discrete herds, caribou on the Mainland did not show the same level of herd distinction. Caribou subspecies and ecotypes in Canada are largely distinguished by differences in their environments and in their habitat use. In Alaska, genetic analyses (Mager et al. 2014) do not support differentiation among the different mainland herds even though considerable differences exist in the types of habitat conditions used across the range of the species.

Caribou habitat requirements vary throughout the year with greatest consideration given to winter habitat, calving habitat, and summer habitat. Winter and summer habitats are influenced by the availability of preferred foods as well as avoidance of predation risk and disturbance from human activities. Calving habitat, as discussed below, appears to be most sensitive to predator avoidance, but also requires food availability.

Caribou habitat selection has been identified to have hierarchical considerations meaning that landscape characteristics can determine if caribou will use a particular zone or region, while daily use of sites within the zone will be based on specific stand characteristics (Bradshaw et al. 1995, Stuart-Smith et al. 1997, Anderson 1999, Boan et al. 2014). Both landscape and daily use scales need to be considered in assessing caribou habitat requirements.

Distribution in the Project Area

Caribou herds occurring in southcentral Alaska discussed by Hemming (1971), Alaska Department of Fish and Game (ADFG) (2011) and Collins et al. (2011) included the Chisana, Mentasta, and Nelchina herds. Population estimates by ADFG (2011) for expected herd sizes in 2011 were 700 for the Chisana herd, 350 for the Mentasta herd, and 46,500 for the Nelchina herd. The U.S. National Park Service (Putera 2015) estimated the Chisana herd size to be 701 in 2013 with a 90% confidence interval of 639-763. They reported 16 calves/100 cows and 49 bulls for 100 cows from their 2013 survey.

Chisana Herd

The Chisana herd was described by Hemming (1971) as originating from the Fortymile Herd and were reported to use the Nutzotin Mountains along tributaries of the Chisana and White rivers. He also reported that no migratory movements occurred, and that calving was reported to occur from the benchlands along Sheep Creek on Mt. Sulzer to the rolling hills north of Ptarmigan Lake. This herd currently occupies the upper Chisana and White River drainages in Wrangell St. Elias National Park and areas of neighboring Yukon, Canada (Bentzen 2011). Alaska considers this part of the Grants subspecies of caribou while Canada considers it part of the woodland subspecies of caribou which has been supported by genetic analysis (Zittlau et al. 2000). This herd has been noted to have habitat selection for calving similar to mountain caribou in that individual cows select higher elevations to disperse their densities (Bentzen 2011). ADFG (2011) identified low calf recruitment as a management concern for the Chisana Herd. They reported that winter range condition appeared to be poor based on a low percentage of lichens and higher amounts of moss in the winter diet in this area, however no recommendations on how to improve winter habitat quality were included in their report.

Mentasta Herd

The Mentasta herd was reported by Hemming (1971) as having originated from the Fortymile Herd and occurring from the Mentata Mountains south to the western slopes of the Wrangell Mountains. He also reported that winter habitat was alpine areas and sparsely covered spruce flats from the Wrangell Mountains north to the Gerstle River, and that calving occurred on the slopes of Mount Sanford and on the Macomb Plateau east of the Johnson River. This herd is included on the map of caribou herds in Alaska (ADFG 2011), but overlaps with the Nelchina herd. It is not individually described in the ADFG caribou management report.

Nelchina Herd

The range of the Nelchina herd, occurring in the Nelchina Basin, was extensively described by Hemming (1971). However, Collins et al. (2011) reported changes to this range starting in the 1990's as a result of heavy foraging on lichens in the original range (Figure C-1). Collins et al. (2011:369) provided an excellent description of these dynamics:

> "The Nelchina Caribou (Rangifer tarandus) Herd (NCH) declined from a peak population of 70,000 in the mid-1960s to approximately 10,000 in the early 1970s (Siniff and Skoog 1964, Bos 1975, Lieb et al. 1988). From 1977 to 1995, the herd rebounded, reaching about 45,000 caribou and surpassing the Alaska Department of Fish and Game management objective of 30,000.

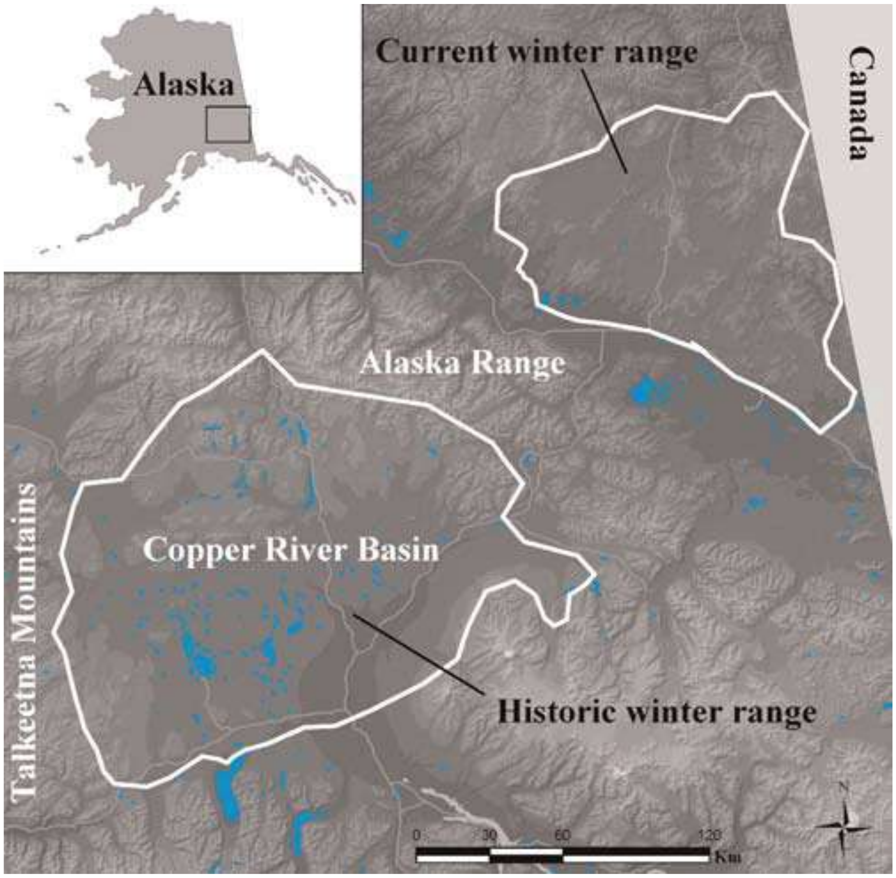


Figure C-1. Blue polygons indicate the current habitat use by the Nelchina Caribou Herd compared to its previous range. Figure taken from Collins et al. (2011).

During this time, forage lichens only partially recovered from previous overgrazing, raising concerns about negative impacts by caribou on lichen standing crops within the herd's winter range (Lieb 1994). Since the mid-1990s, increased harvests have been used to reduce caribou herd size to the management objective, and numbers have fluctuated between about 30,000 and 35,000 during this time. In the early 1990s as the NCH reached high numbers and lichens were overgrazed, the herd began a dramatic shift from its historic wintering range in the Copper River Basin and southern Alaska Range to its current winter range in the Tanana Hills and western Yukon Territory (Valkenburg et al. 2002). This was the first shift in approximately 100 yr for which records are available, and it required additional migration of 100 km. Prior to arrival of the NCH, the current winter range had not been grazed since collapse of the Fortymile Caribou Herd approximately 40 yr earlier."

This herd has varied considerably in population size from 7,000-70,000 animals over the past 70 years but is now managed with a population goal of between 35-40,000 and an annual harvest of 3-6,000 animals (Schwanke 2011). Calving habitat occurs in the eastern Talkeetna Mountains from the Little Nelchina River to the Fog Lakes (Schwanke 2011) with habitat use of this area continuing into the summer. Winter habitat use occurs from Cantwell east through game management units 13A, 13B, 11, 12 and 20E with apparent use of lichens associated with older burns along the Taylor Highway (Schwanke 2011). Despite a large burn in 2004 in subunit 20E which is avoided, 60-95% of the herd still winters in this subunit. Overlap with wintering caribou from the Fortymile herd in this area could lead to over-utilization of lichen and range deterioration.

Habitat monitoring of areas used by the Nelchina herd (Lieb 1994 as reported in Schwanke 2011) found that at times when herd sizes were larger, amounts of lichens in key winter and calving areas declined. It appeared that heavy use of the East Talkeetna Mountain area in the 1970's heavily impacted lichen amounts so that the area has not been used as a calving or wintering area ever since. Poor range conditions were noted as a contributing factor to the low weight gains of calves in this herd. Following herd reductions through hunting programs initiated in the 1990's, calf weight gains, though still quite variable, have been increasing. However, because of the high elevation of the range of this herd, cool, late springs shorten the summer growing season, reducing food availability in some years, resulting in considerable variation in calf weight gains.

Habitat Requirements

General and Year-round Habitat

Critical habitat needs of woodland caribou were discussed by Racey and Arsenault (2007). They identified critical habitat as high quality winter and summer range, calving areas, other known high use areas, and the connectivity among these areas. They recommended strategies to maintain these high quality areas with minimal disturbance including fire and anthropogenic activities.

Rettie and Messier (2000) reported that caribou in Saskatchewan used seasonal ranges that included peatlands and black spruce dominated stands relative to recently disturbed stands and early seral stage forests. In all populations, caribou preferred peatlands and black spruce forests to all other habitat types at the daily area scale.

Jones et al. (2007) identified the variability in habitat requirements of "ecotypes" of woodland caribou in British Columbia with different herds selecting for different vegetation types to meet their habitat requirements. This study emphasizes the importance of considering the local habitat selection of caribou in specific management areas, as the species differs considerably across its range in what it selects as habitat to meet its various food, reproduction, cover, and other needs. For example, Apps and McLellan (2006) analyzed distributions of subpopulations of mountain caribou in southcentral British Columbia and found that this subspecies required blocks of old forests of cedar and hemlock occurring on wet sites that were away from roads and other human developments, revealing a different habitat selection than other subspecies of caribou even within British Columbia.

Wittmer et al. (2005) reported that various caribou subpopulations are declining as a consequence of increased predation. Recovery of these subpopulations will require a multi-species perspective to address the issues of predator densities in relation to other prey species. Ferguson et al. (1988) studied a herd of woodland caribou that persisted on an island in Ontario and concluded that this small population were not extirpated as were those on the nearby mainland because of the lack of predation by wolves, as food resources were greater on the mainland than on the island, but wolves were not regularly present on the island.

O'Brien et al. (2006) stated "Although predation on calves and adults is the proximate limiting population factor, it is the reduction in the availability of lichen-rich mature conifer stands and increased access by predators and hunters that have led to a decline in woodland caribou populations across Canada (e.g., James and Stuart-Smith, 2000, Smith et al., 2000 and Dyer et al., 2001)." They recommended strategies that maintain older conifer forests providing high-quality patches that are connectivity within a framework that can facilitate movement and foraging away from predators and human activity, citing supporting evidence from Rettie and Messier (2000), Smith et al. (2000), and

James et al. (2004). O'Brien et al. (2006) examined locations and movements of caribou in Manitoba and reported that of 721 late winter location points, "42.4% were located within high-quality patches, 90.8% were located within 500 m and 99.3% were located within 1000 m from high-quality patches." They compared this to random points with had 21.6% located within high-quality patches, 60.9% within 500 m and 81.8% within 1000 m of high-quality patches. They noted that the caribou herds they studied concentrated in areas which they defined as being >5-10,000 ha in size which contained large clusters of high quality habitat.

Wittmer et al. (2007) found that timber harvesting that increased the occurrence of early seral forests in landscapes occupied by woodland caribou in British Columbia altered the predator–prey system by maintaining alternative prey that increased numbers of predators. Survival probabilities for adult females were best explained by the amount of early seral stands within an overall range of a subpopulation. Female survival was higher at the home range scale when higher proportions of old forest and lower amounts of mid-aged forest were present.

Joly et al. (2003) reported that caribou in the Nelchina herd in southcentral Alaska selected areas that had not burned in the past 50 years, but Schwanke (2011) noted that burned areas did provide grasses and forbs that are preferred summer food, so a mosaic of burned and unburned areas may be desirable. Robinson et al. (2012) reported that burned areas decreased quality of caribou habitat while also increasing densities of wolves that then reduced the amount of "safe zones" for caribou. They suggested that management should strive to maintain these safe zones for caribou. Briand et al. (2009) studied woodland caribou in eastern Canada and reported that they avoided areas in summer that had a well-developed shrub layer that would be higher quality habitat for moose.

Summer foods of caribou were reported to not be well documented, but were thought to include sedges, cotton-grass, fungi, grasses, ericaceous shrubs (e.g., Labrador tea, blueberry, bearberry), twinflower, mosses and woody browse such as willows, birch and aspen (Cenovus FCCL Ltd. Narrows Lake Project 2010). Thompson et al. (2015) determined diets of caribou in Ontario and reported that caribou heavily used lichens in the winter, and continued to make use of these foods in the summer as well. The breadth of diet doubled in summer, but lichens still contributed over 60% of food eaten. Three genera of green plants were the predominant additional foods eaten in summer but were not species associated with early successional areas.

Calving Habitat

Calf predation during the neonatal period was reported to occur from wolves (Gasaway et al. 1983, Bergerud and Elliot 1986, Bergerud and Page 1987, Seip 1992), bears (Ballard 1994, Adams et al. 1995, Young and McCabe 1997, Mahoney and Virgl 2003, Pinard et al. 2012, Dussault et al. 2012), golden eagles (Dale et al. 1994, Adams et al. 1995, Schwanke 2011), bald eagles (Schwanke 2011), and wolverine (Gustine et al. 2006). Risk of predation appears to strongly influence selection of calving areas (Bergerud et al. 1984, Bergerud 1996, Barten et al. 2001) as well as the general presence of caribou (Boan et al. 2014). Pinard et al. (2012) found that caribou in their study area in Quebec appeared to select calving areas that minimized densities of wolves, their primary predator. However, in this study area bear populations have been increasing and caribou did not appear to select calving areas that minimized bear densities resulted in nearly 60% calf predation by bears.

Bergerud (2007) reported that the persistence of mountain and boreal woodland caribou depended upon low predation risk in calving areas and suggested that for these subspecies, directly reducing predation by wolves and coyotes may be needed given the expansion of these predators and their primary prey (moose and deer) due to human activities including climate change. Concern over increasing numbers of predators was also noted by Latham et al. (2013) who identified expanding deer and coyote populations as a concern for woodland caribou in Alberta where increases in deer could support increased numbers of predators including coyotes.

Latham et al. (2011a) agreed with concerns over wolf predation on caribou but also noted that bears are an additional predator that could influence calf survival. While they found that bears generally avoided the bogs and fens selected by woodland caribou in Alberta where they conducted their study, they noted that some bears did select these areas and could be effective predators on calves. Latham et al. (2011b) examined relationships of wolves, moose, deer and woodland caribou in southern Alberta. They found that deer populations have increased dramatically and appear to be supporting an increase in wolf populations. They reported that wolf predation on caribou had also increased and contributed to caribou populations going from being stable to being in decline.

Gustine et al. (2006) reported that woodland caribou selected calving areas that had lower amounts of herbaceous vegetation and more shrub cover than random locations in British Columbia. However, Barten et al. (2001) reported that female caribou with calves avoided shrub areas and selected lichen tundra areas more than female caribou without calves in Wrangell St. Elias National Park in Alaska.

Leclerc et al. (2012) studied woodland caribou calving areas in Quebec. They found that calving areas were located away from roads and cutover areas at three different scales, the annual home range, calving home range, and forest stand. They noted that at the forest stand scale calving areas were located away from cutovers and roads and in areas with a lower basal area of black spruce or balsam fir.

Winter Habitat

Barrier and Johnson (2012) investigated winter foraging sites of barren-ground caribou in the Northwest Territories. They found that caribou selected sites with higher amounts of lichen present. Higher amounts of rock or higher basal area of conifer trees reduced selection of sites for foraging. They suggested that future increases in incidences and severity of fires could reduce available habitat for caribou. Briand et al. (2009) found that woodland caribou in eastern Canada selected wintering areas that had higher amounts of terrestrial lichens or ericaceous shrub cover in older stands, and avoided areas that had a well-developed shrub layer that would be higher quality habitat for moose. Joly et al. (2010) found that caribou in Northwest Alaska selected areas with higher amounts of lichen in winter, and avoided burned areas that were less than 58 years old.

The Cenovus FCCL Ltd. Narrows Lake Project (2010) developed a caribou habitat model for Alberta and provided a review of caribou habitat requirements. They reported that winter habitat selection by woodland caribou is strongly associated with peatland habitats citing studies conducted by Anderson (1999), Bradshaw et al. (1995), Edmonds and Bloomfield (1984), Stuart-Smith et al. (1997), and Schneider et al. (2000). Upland-dominated landscapes were reported to be generally used less by woodland caribou (Bradshaw et al. 1995, Schneider et al. 2000). Schneider et al. (2000) reported that the majority of upland habitat use by caribou was in patches occurring within large peatland complexes. Schneider et al. (2000) also reported that caribou use of pure upland habitat decreased exponentially with distance from peatlands.

The most important winter foods of caribou in boreal are terrestrial lichens (Edmonds and Bloomfield 1984, Manitoba Model Forest 1995) including *Cladina* species, such as *C. mitis*, *C. uncialus and C. rangiferina; Centraria islandica* and *Stereocaulon* spp. (Manitoba Model Forest 1995). Bradshaw et al.

(1995) reported that *Cladina* were the most common food species found in snow craters dug by woodland caribou in northeastern Alberta.

Collins et al. (2011) studied winter habitat selection of the Nelchina Herd. They found that this herd seldom occurred above 1500m in elevation in winter. As discussed previously, they found that this herd had shifted the location of its winter range, and attributed this to over-utilization of lichen in the original range and the improved status of lichen in the new winter range. They reported the lichens present in the new range to be *Cladonia amaurocraea*, *Cladina rangiferina, Flavocetraria cucullata*, that were used by caribou along with lowbush cranberry (*Vaccinium vitis-idaea*). Collins et al. (2011:370) described this wintering area as: "Black spruce (*Picea mariana*) forest was the dominant cover type. Aspen (*Populus tremuloides*), birch (*Betula papyrifera*), and white spruce (*Picea glauca*) were also present as small stands interspersed within the black spruce forest. At elevations >1,100 m, forest gave way to shrubs (Alder [*Alnus* spp.], birch [*Betula* spp.]) and alpine communities. Muskegs and tussock tundra were common in poorly drained, low-lying areas." They also reported that preferred species of lichen were *Cladina arbuscula–mitis, C. rangiferina,* and *C. stellaris,* with *Flavocetraria cucullata, Cetraria islandica*, *Cladonia uncialis*, and *Stereocaulon* spp. being secondary species. *Peltigera apthosa* and *Peltigera* spp. were lichens reported to not be used as forage. Collins et al. (2011:375) found that: "After fires, forage lichens seldom recovered sufficiently to attract grazing until after 60 yr, and as a group, primary forage lichen species did not reach maximum productivity until after 180 yr." Overgrazing of lichens could significantly reduce lichen abundance, but recovery could occur as quickly as 20 years if the grazing was removed.

Boan et al. (2014) reported that presence of wintering woodland caribou in Ontario was negatively influenced by higher probability of wolves, which in turn were influenced by the presence of moose and logging roads. They also found a negative relationship between occurrence of moose habitat in close proximity to caribou and an indirect negative influence of the quality of moose forage habitat and caribou habitat.

Anthropogenic Disturbance and Habitat Changes

Vors et al. (2007) estimated effects of anthropogenic disturbances on caribou extirpation in areas of Ontario and reported that "forest cutovers were the best predictor of caribou occupancy, with a tolerance threshold of 13 km to nearest cutover and a time lag of 2 decades between disturbance by cutting and caribou extirpation."

James and Stuart-Smith (2000) examined woodland caribou and wolf locations and predation sites in relation to linear corridors (roads, trails, seismic lines, and pipelines). They reported that caribou locations were farther from linear corridors than random locations, while wolf locations were closer. They also reported that wolf predation sites on caribou were closer to linear corridors than live locations of caribou, and caribou killed by wolves were killed closer to linear corridors than their live locations prior to being predated. They concluded that adding linear corridors in caribou range will increase caribou risks to predation.

James et al. (2004) studied woodland caribou in Alberta. They reported "selection of fen/bog complexes by caribou and selection of well-drained habitats by moose and wolves resulted in spatial separation. This spatial separation in turn reduced wolf predation pressure on caribou but did not provide a total refuge from wolves. Any management activities that increase the density of moose and wolves or increase access of wolves into fen/bog complexes will likely reduce the refuge effect provided by large fen/bog complexes." This study supported the contention that increasing moose populations in an area will result in increased predation on caribou, but also noted that any increase in accessibility or numbers of wolves in caribou range can contribute to increased mortality and population risks. Similarly, Adam et al. (2004) found that moose and wolves utilized well-drained areas in Alberta while caribou stayed in bogs/fens where numbers of wolves were lower. They cautioned that any activities that increased moose or wolf access into the wetter areas could increase predation on caribou. Both of these studies supported the contention that increasing moose populations in an area will result in increased predation on caribou, but also noted that any increase in accessibility or numbers of wolves in caribou range can contribute to increased mortality and population risks.

Johnson and Russell (2014) studied the distribution of the Porcupine caribou herd in winter in relation to human disturbances over a 27-year time frame. They reported caribou avoided human disturbances, particularly settlements followed by main roads. They also noted gradual changes over time in avoidance patterns.

Smith et al. (2000) conducted a long-term study of woodland caribou in Alberta and noted the effects of timber harvesting on this population. They reported “Caribou avoided using recently fragmented areas by an average of 1.2 km. If fragmentation of the winter range continues through timber harvesting and other industrial activities, the 'spacing out' antipredator strategy used by caribou may be compromised. Based on these findings, timber-harvesting strategies are recommended that (i) ensure an adequate area of usable habitat to support the current population, (ii) minimize the amount of fragmented area, and (iii) in the short term avoid presently defined core use areas.” Courtois et al. (2007) reported that forest management strategies should be oriented toward the protection of large interconnected blocks of forest to favor caribou spacing away from humans and predators in order to keep direct and indirect sources of caribou mortality at low levels. Leclerc et al. (2012) made recommendations for caribou in Quebec including amalgamating all forestry activities within intensive management zones in order to spatially isolate large patches of suitable calving habitat from anthropogenic disturbances.

Home ranges of caribou vary seasonal and depending upon the migratory status of a herd. Johnson et al. (2003) reported home ranges up to 182 km^2. O’Brien et al. (2006) in examining caribou habitat use found that caribou responded to overall habitat quality in areas of >5-10,000 ha in size. Courtois et al. (2007) recommended maintaining blocks of caribou habitat of 100-250 km^2 (10,000- 25,000 ha) with minimal amounts of disturbance (burns, logging, or mechanical treatments less than 20-30 years old) for persistence of woodland caribou in Quebec. Lesmerises et al. (2013) also examined effects of patch sizes on use of caribou in managed landscapes in Quebec. They determined that use increased sharply as patch sizes increased up to 100 km^2 (10,000 ha), with further increases up to 500 km^2 (50,000 ha) but leveled off after that. These studies indicate that with large enough patch sizes of high quality habitat, caribou can disperse to low densities and through this reduce overall risks of predation (Bergerud and Page 1987) where primary predators (wolves) select other areas where prey densities (moose and deer) may be higher. This strategy breaks down then high quality habitat becomes fragmented due to habitat changes caused by human activities including logging and other mechanical treatments, fires that alter historical patterns of disturbance, and anthropogenic infrastructure that disrupt caribou habitat use or that allow greater access into high quality habitat by predators. In particular, as habitat changes and climate change combine effects in some landscapes, new predators such as coyotes and bears have been reported to increase in densities putting new pressures on caribou herds through increased predation, primarily on calves. Fortin et al. (2013) studied caribou distributions in Quebec in relation to anthropogenic created edges and found that caribou, in avoiding human disturbances, tended to be pushed into concentrations about 4.5 km from edges where they then become more vulnerable to predation by wolves or other predators. This finding provides further explanation of the increases in predation around anthropogenic edges found by James and Stuart-Smith (2000) discussed previously.

Dyer et al. (2002) examined the effects of roads and seismic lines on movements of woodland caribou in Alberta. They did not find any effects from seismic lines, but reported that roads with moderate traffic were 6 times less likely to be crossed than habitat without a road present. Shindler et al. (2007) examined the effects of a logging road through winter habitat of caribou in Manitoba. They reported that even with the road closed to all but logging traffic, that high quality habitat within 1 km of the road received less use by caribou than in areas farther from the road. Similarly, Leblond et al. (2011) reported that caribou were influenced by the presence of roads within 1.25 km in Quebec.

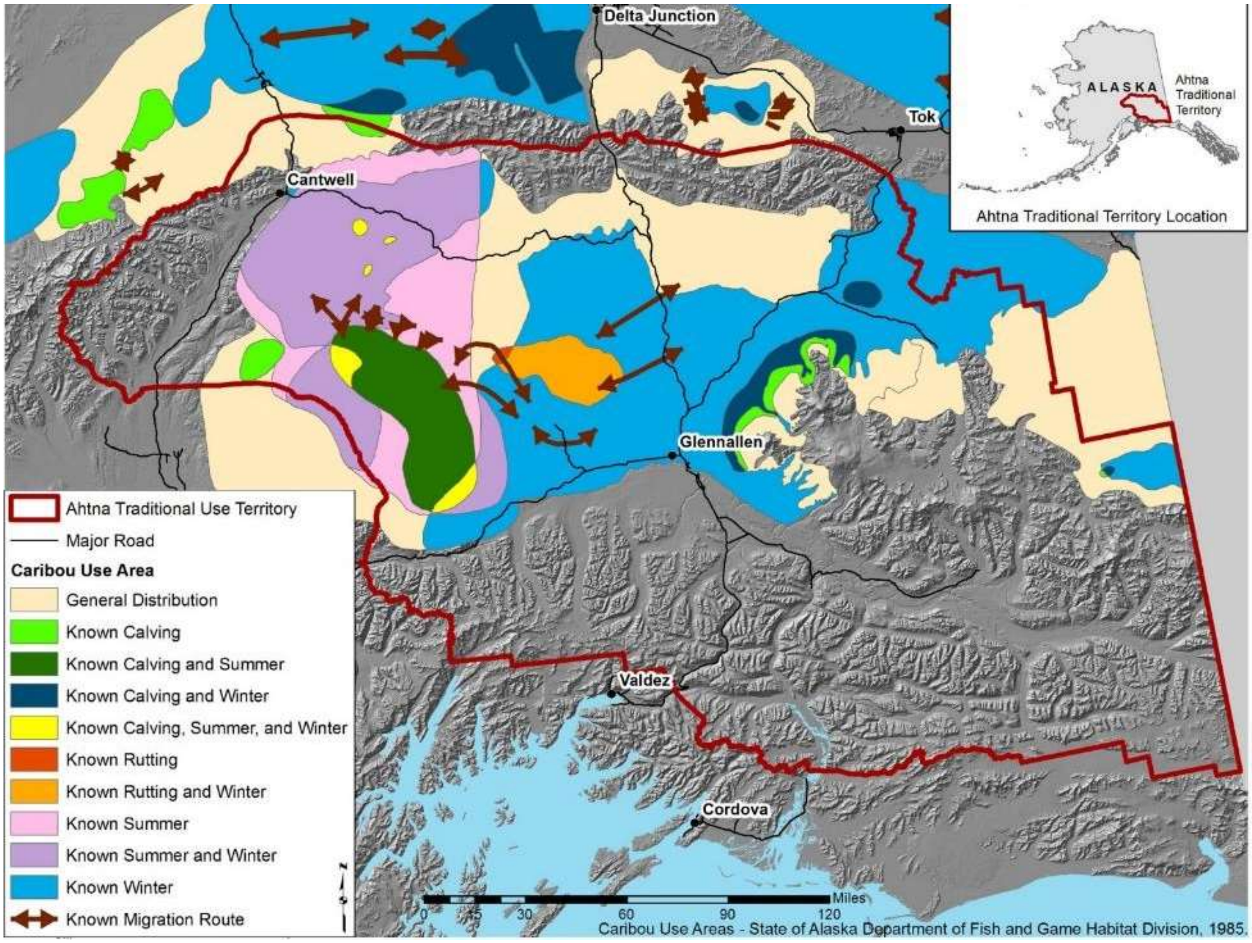
Woodland caribou have been reported to be sensitive to various human activities including activities that allow human access to wilderness areas, especially on All-Terrain Vehicles (ATVs) and snowmobiles (Cenovus FCCL Ltd. Narrows Lake Project 2010, Manitoba Model Forest 1995). Apps and McLellan (2006) found that persistence of subpopulations of mountain caribou was best explained by the presence of preferred habitat types as well as remoteness from human activities including low road densities and minimal motorized access.

Beauchesne et al. (2013) found that caribou in Quebec expanded their home ranges as the amount of disturbances in their habitat increased, up to a point where further increase in disturbances caused home range contraction. They reported “density of major roads and the proportion of clearcuts had an important impact on space use throughout the whole year, but the impact of roads was particularly important during calving, summer and rut, while the impact of clearcuts prevailed in spring, early and late winter.” They also found that a more convoluted shape of cutblocks amplified the effect of clearcuts on caribou space use.

An Ecosystem- and Landscape-Scale Habitat Quality Assessment for Southcentral Alaska

Ecosystem-scale

The existing caribou habitat use presented in Figure C-2 was mapped for each ecosystem which was then assigned a habitat quality value for both winter and calving/summer habitat. This value was then further modified based on an overlay of anthropogenic disturbances. Table C-1 lists the habitat quality value for each ecosystem. See Appendix A for definitions of each ecosystem code.



Caribou Use Areas - State of Alaska Department of Fish and Game Habitat Division, 1985.

Figure C-2. Caribou distribution, habitat use, and migration routes in the Ahtna southcentral Alaska project area (from Alaska Department of Fish and Game).

Table C-1. Caribou habitat quality values for each ecosystem by winter and summer/calving habitat use in the Ahtna Traditional Use Territory. See Appendix A for definitions of ecosystem codes.

ECOSYSTEM	WINTER	SUMMER/ CALVING
16030_A	0.25	0.25
16030_B	0.25	0.25
16030_C	0.10	0.10
16030_D	0.10	0.25
16030_E	1.00	0.50
16790_A	0.25	0.25
16790_B	0.10	0.25
16790_C	0.10	0.25
16790_D	0.50	0.75
16790_E	0.75	0.50
16041_A	0.25	0.25
16041_B	0.25	0.25
16041_C	0.10	0.10
16041_D	1.00	0.25
16041_E	1.00	0.50
16042_A	0.25	0.25
16042_B	0.25	0.25
16042_C	0.10	0.10
16042_D	1.00	0.75
16042_E	1.00	0.50
16011_A	0.25	0.25
16011_B	0.10	0.25
16011_C	1.00	1.00
16012_A	0.25	0.25
16012_B	0.10	0.25
16012_C	1.00	1.00
16050_A	0.25	0.25
16050_B	0.25	0.25
16050_C	0.10	0.10
16050_D	0.10	0.10
16050_E	0.10	0.25
16070_A	0.25	0.25
16070_B	0.10	0.10
16061_A	0.25	0.25
16061_B	0.25	0.25
16061_C	0.10	0.10
16061_D	0.10	0.10
16212_C	0.25	0.25
16220_A	0.25	0.25
16220_B	0.25	0.10
16220_C	1.00	0.50
16300_A	0.25	0.25
16300_B	0.25	0.25
16300_C	0.25	0.50
16102_A	0.25	0.25
16102_B	0.10	0.50
16280_A	0.25	0.25
16280_B	0.10	0.25
16280_C	0.10	0.50
16351_A	0.50	0.50
16310_A	0.50	0.25
16290_A	0.25	0.10
16290_B	0.10	0.25
16330_A	0.50	0.25
16110_A	0.25	0.25
16120_A	0.25	0.25
16080_A	0.25	0.25
16080_B	0.10	0.25
16090_A	0.25	0.25
16090_B	0.10	0.10
16520_A	0.25	0.25
16520_B	0.10	0.10
16430_A	0.50	0.25
16170_A	0.10	0.10
16170_B	0.25	0.25
16170_C	0.25	0.25
16170_D	0.10	0.25
16170_E	0.10	0.10
16181_A	0.25	0.25
16181_B	0.25	0.25
16181_C	0.25	0.25
16181_D	0.10	0.25
16372_A	0.25	0.25
16372_B	0.10	0.25

Table C-1, continued. Caribou habitat quality values for each ecosystem by winter and summer/calving habitat use in the Ahtna Traditional Use Territory. See Appendix A for definitions of ecosystem codes.

ECOSYSTEM	WINTER	SUMMER/ CALVING
16141_A	0.25	0.25
16141_B	0.25	0.25
16141_C	0.10	0.25
16141_D	0.25	0.50
16141_E	0.25	0.50
16142_A	0.25	0.25
16142_B	0.25	0.25
16142_C	0.10	0.25
16142_D	0.25	0.50
16142_E	0.25	0.50
16150_A	0.25	0.25
16150_B	0.25	0.25
16150_C	0.50	0.25
16150_D	1.00	0.75
16150_E	1.00	0.75
16160_A	0.25	0.25
16160_B	0.10	0.25
16160_C	0.25	0.50
16211_A	0.50	0.25
16211_B	0.50	0.25
16211_C	0.50	0.25
16211_D	0.25	0.75
16212_A	0.25	0.25
16212_B	0.25	0.25
16372_C	0.25	0.25
16240_A	0.10	0.25
16481_A	0.25	0.25
16481_B	0.10	0.10
16481_C	0.10	0.10
16460_A	0.25	0.25
16460_B	0.10	0.10
16460_C	0.10	0.10
16460_D	0.10	0.10
16440_A	0.10	0.10
16500_A	0.25	0.25
16500_B	0.25	0.25
16500_C	0.10	0.10
16500_D	0.10	0.10
16550_A	0.25	0.25
16550_B	0.25	0.25
16550_C	0.10	0.10
16550_D	0.10	0.10
16550_E	0.10	0.10
16590_A	0.10	0.10
16450_A	0.25	0.25
16800_A	0.50	0.25
16800_B	0.10	0.25
16620_A	0.25	0.25

Winter Habitat Use

Quality of each pixel or stand based on lichen (*Cladina arbuscula–mitis, C. rangiferina, C. stellaris, Flavocetraria cucullata, Cetraria islandica*, *Cladonia uncialis*, and *Stereocaulon* spp.) production categorized by ecosystem. Rated as 0.1, 0.25, 0.50, 0.75, or 1, with poor quality habitat ranked as 0.1.

a. Questions or assumptions:
   i. Should a variable be added for elevation, with winter habitat occurring below 1500m?
   ii. Peatlands with moss from either burns or over-utilization of lichens are low quality while peatlands with lichens are high quality. These may not be capable of being mapped with remotely sensed information, so that a potential habitat quality may need a site visit to adjust.
   iii. Should there be a variable that provides for snow depth adjustments- based on climate/physical settings or terrain features?
   iv. At low elevations are mature conifer stands used as thermal cover?

v. At high elevations, burns will provide good summer/calving habitat, but will reduce winter habitat- so a mosaic of the two is desirable with greater needs for winter habitat than summer habitat. At lower elevations, burns will improve moose habitat and increase wolf densities, so do not provide for quality summer habitat- large blocks of unburned areas needed for winter and/or summer habitat at lower elevation ecological sites.

Caribou Summer/Calving Habitat Use

Summer habitat requirements mirror those for calving habitat, but occur over a longer temporal period. As a result, the ecosystem ratings for both calving and summer habitat are the same and the two categories were combined into a single category for modeling purposes. Ecosystem ratings were highest in areas with mature conifers at low elevations, as well as lichen tundra areas at higher elevations and large fens/bogs. Areas of lower value with poor quality are ranked at 0.1. Categories will be rated as: 0.1, 0.25, 0.50, 0.75, or 1, with high quality for landscape analyses considered 75 or higher.

Disturbance Evaluation

Human disturbances will be mapped across the range of caribou. Each human disturbance will be buffered by an assigned width of effect. This width will be divided into 4 bands with the closest band receiving a reduction of 90%, the second band a reduction of 75%, the third band a reduction of 50%, and the 4th band a reduction of 25%. Disturbance effect distances are listed in Table 4.

Vistnes and Nelleman (2008) reported that 87% of studies looking at caribou responses to disturbance from the 1980's found that human features reduced caribou use by 50-95% within 5 km. Leblond et al. (2014) identified effects of mines, paved roads, and forest roads on caribou in Alberta. They presented the following relationships:

Distance to paved road = -3E-06x2 + 0.0343x + 8.2524
Distance to forest road = 2E-09x3 - 2E-05x2 + 0.0632x + 21.886
Distance to mine = -2E-06x2 + 0.0279x + 5.9313

These equate to effects out to 2500 m on a curvilinear relationship for forest roads and out to 5000 m for paved roads.

Losier et al. (2015) reported higher mortality of caribou cows when then in home ranges that contained 6-20 year old clearcuts, and identified a threshold of >7km that reduced these effects in Quebec. They identified an increasing percentage of clearcuts as a key contributor through indirect habitat loss associated with increases in moose and wolf densities.

These findings help to identify effect distances for impacts to caribou habitat shown in Table C-2. It appears that 5km is an appropriate maximum effect distance. A linear response is assumed, although a curvilinear response which increases closer to the disturbance may also be occurring. However, without better data to support such a relationship, the relationship used in this model designates impacts in bands of distance with higher impacts assigned closer to the anthropogenic disturbance.

Table C-2. Winter and Calving disturbance distances (linear decrease with proximity to disturbance) for caribou.

Disturbance Type	Effective Distance
Major road	500 m
Forest or minor road or motorized trail	100 m
Development- towns, etc.	500 m

Landscape-scale

At a landscape scale, caribou habitat will be considered to be important within mapped caribou range (Figure C-2). Within existing caribou range, caribou habitat quality will be rated according to the procedures outlined below. A moving window analysis will be used to evaluate the quality of an area of approximately 10,000 ha (24,000 ac) surrounding each pixel as indicated in Table C-3.

Table C-3. Landscape scale rating of habitat quality based on aggregate quality of winter, calving, and summer habitat within a 10,000 ha area.

Percentage of 10,000 ha area with HSI > 0.75	Area weighted HSI value For winter, calving habitat and summer habitat
>50%	1.0
25-50%	0.5
10-25%	0.25
<10%	0.1

Additional Habitat Considerations

The Chisana herd is non-migratory, so connectivity between seasonal ranges may not be an issue. The Nelchina herd has seasonal movements. Should an analysis of potential movement barriers that can occur between seasonal ranges be added?

Model Results

Ecosystem-scale

Figures C-3 to C-4 display ecosystem-scale model outputs of caribou habitat quality for the two habitat use seasons of winter and summer/calving seasons, within the Ahtna Traditional Use Territory.

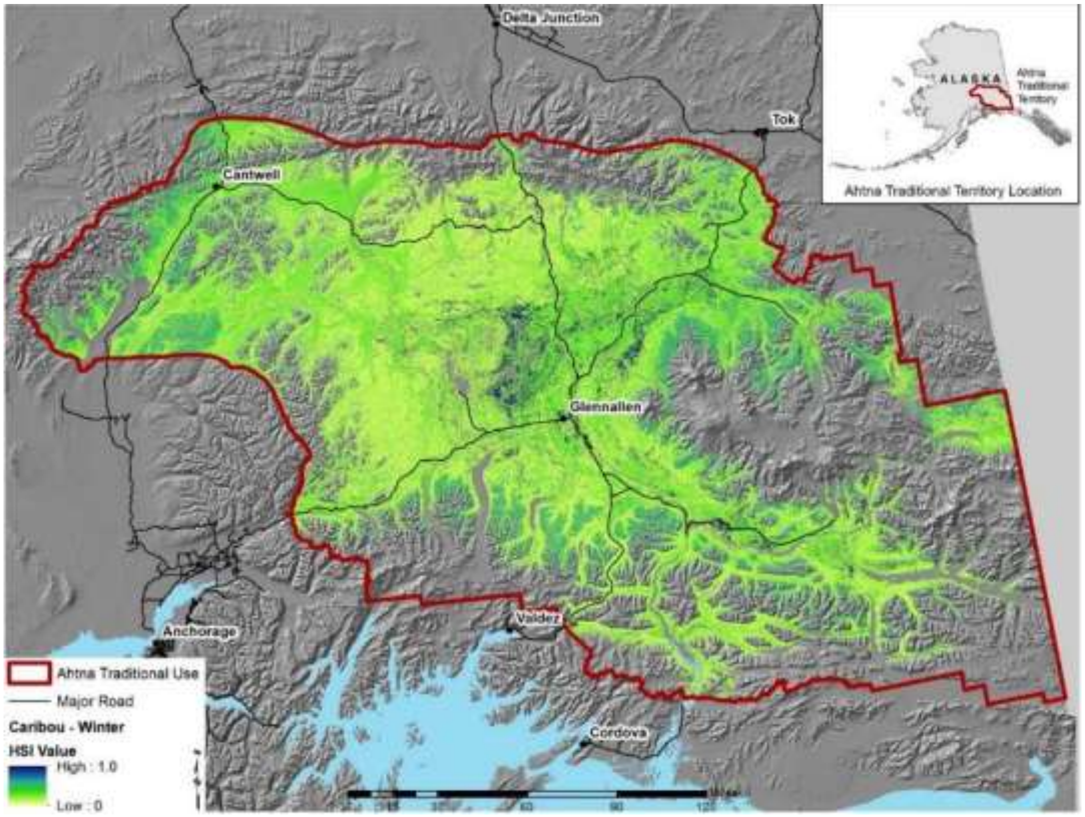


Figure C-3. Results of the ecosystem-scale model outputs for caribou winter habitat quality.

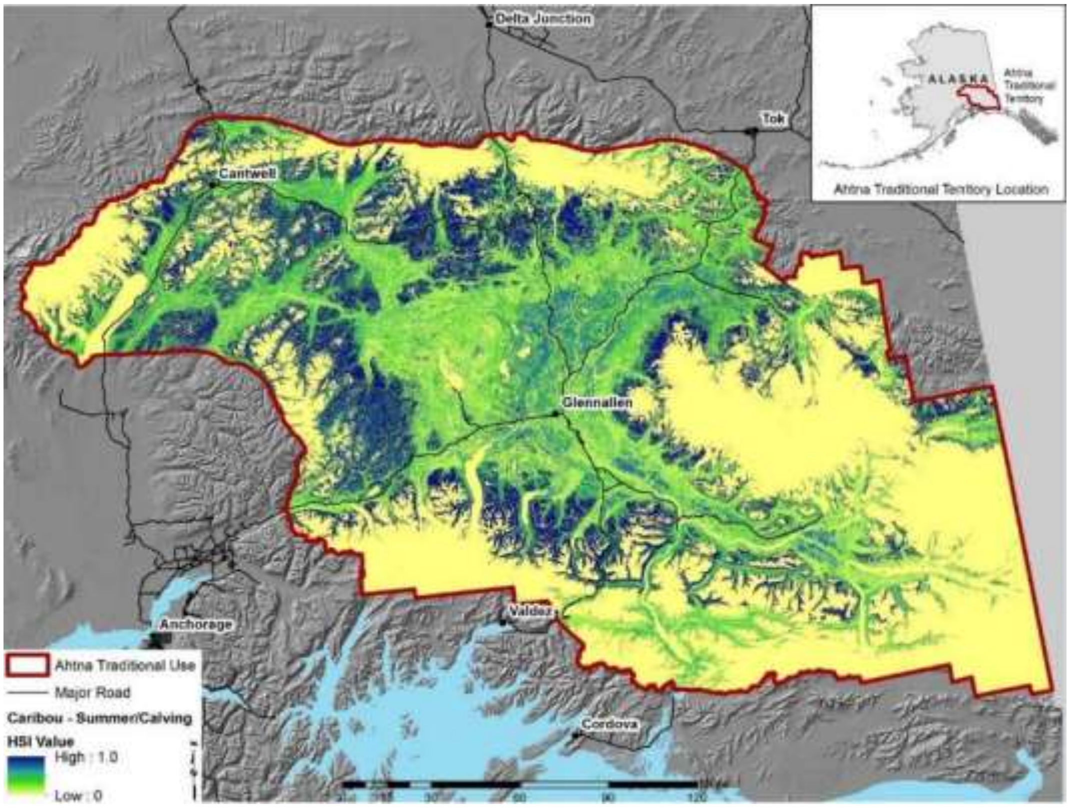


Figure C-4. Results of the ecosystem-scale model outputs for caribou summer/calving habitat quality.

Landscape-level

Figures C-5 and C-6 display landscape-scale model outputs of caribou habitat quality for the two habitat use seasons of winter and summer/calving seasons, within the Ahtna Traditional Use Territory.

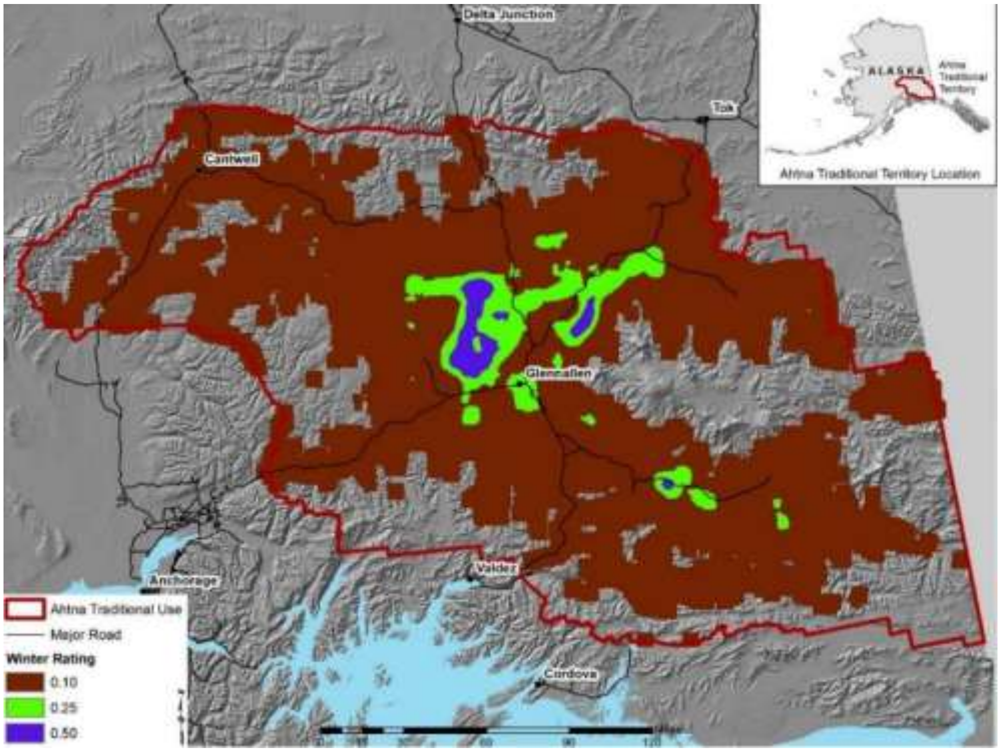


Figure C-5. Results of the landscape-scale model outputs for caribou winter habitat quality.

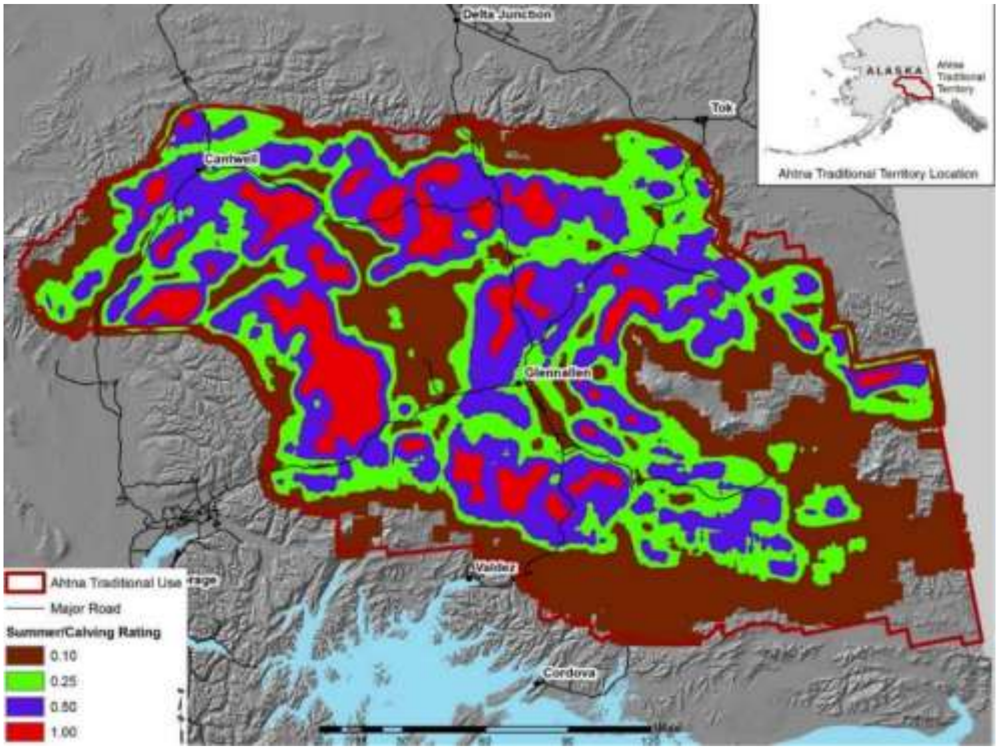


Figure C-6. Results of the landscape-scale model outputs for caribou summer/calving habitat quality.

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Appendix D. Proposed Improvement Area Descriptions

Cantwell Site Improvements

Carlos Creek: This treatment stand encompasses an old gravel pit that has regenerating willow and poplar which have escaped browsing and are now too tall to be effectively browsed by moose. Cutting and or roller chopping would allow moose to utilize the available browse. The site is also well drained and removing some of the overstory would allow for additional seedling establishment of preferred hardwood species.

Intertie #1 & #2: Good sites along old power line right of way near the Nenana River that has been suggested by the Village Council. There is a white spruce overstory with willow and some cottonwood and poplar in the understory. Wet site which would likely require winter treatment. Primarily a moose browse improvement site but does have the potential to harvest some white spruce.

Jack Canyon: This site is located in the flood plain of Jack Creek. It is heavily covered with large willows that are overgrown and mostly too large to provide moose browse. It is located in important winter range and receives heavy moose use. Access to this parcel is across a Native Allotment which would require permission from the owner.

Slime Creek: Site is located on old gravel pit between Parks Highway and Nenana River. The site has scattered white spruce and poplar with heavy cover of willow and alder. Crushing the willow will allow for the regeneration of moose browse.

Transfer Site: Site is located on old gravel pit between Parks Highway and Nenana River. The site has an overstory of poplar with heavy cover of willow and alder. Crushing the willow and cutting the poplar will allow for the regeneration of moose browse.

Chistochina Site Improvements

Airstrip: Appears to be an old gravel pit that is now used as a community shooting range and dumping area. Appears to receive heavy moose use, particularly in the winter. More heavily disturbed areas have good amounts of willow regeneration and the surrounding stand consists of aspen and poplar. Roller chopping could provide firewood for local community and improve moose browse.

Aspen #1 & #2: White spruce overstory in these stands with scattered popular and occasional willow. Extensive stands of buffaloberry (*Sheperdia canadensis*) in the understory. Stand has good potential for precommerical thinning of spruce and poplar.

Aspen #3, #4, & #5: Increased amounts of willow, aspen, and poplar compared to stands #1 and #2. These sites were previously treated 10+ years ago and regrowth has reached a point where it is escaping moose browsing pressure. Roller chopping would return these stands to productive condition for moose browse.

Mile 26: Stand overstory primarily consists of mature aspen and poplar with scattered white spruce. Stand would be improved for moose browse by overstory removal. Also possible to generate pulp from aspen and poplar.

Roadside: This site has mature white spruce and poplar near the highway and transitions to black spruce and sphagnum moss as the aspect changes. Scattered willow through the stand and present in both timber types. This site has the potential for both timber and moose browse improvements.

Gakona Site Improvements

North Trail #1, #2, & #3: This stand is mostly a timber improvement site with good numbers of white spruce. Moose browse could be enhanced by crushing willows along an existing roadway.

Old Pit #1 & #2: Heavy beetle kill among white spruce, especially in #1. Timber improvement treatment needed to remove beetle kill spruce in #1 and thin white spruce in #2.

Radio Tower #1 & #2: Good willow growth, particularly on #1. Would benefit from crushing to promote regrowth and improve moose browse. These sites are located in potential caribou habitat which should be a factor when considering treatments.

Sanford Trail #1, #2, & #3: These sites all have good stands of white spruce and would benefit from timber improvement. The stands are merchantable and would continue to be productive for years if managed properly.

Swimming Hole: Site is located around an active gravel pit. It contains got amounts of willow and poplar with some alder. Site would benefit from crushing to bring browse back to a level that would allow moose to utilize it.

Mentasta Site Improvements

Carlson Lake: This site is located along a 17B easement. Overstory of white spruce with scattered shrubs. There is long term potential to manage the white spruce and possibly improve the amount of willow over time.

Little Tok #1: This is an excellent site with large amounts of willow that would benefit from being crushed in order to improve the quality of moose browse. This site is adjacent to a shareholder moose camp which further increases its value for treatment.

Little Tok #2 & #3: White spruce stand that has been previously harvested. These stands would benefit from continued timber management with periodic entry to thin spruce and then eventually harvest the overstory.

Mile 100 #1: Site has heavy cover of young white spruce. It would benefit from a precommercial thin and continued management to insure good timber production. There are some willow and aspen in the understory as well.

Mile 100 #2 & #3: These stands are primarily aspen and willow with some young white spruce in the understory. They would benefit from crushing of the willow and aspen to improve moose browse quality. In addition there is a shareholder moose camp near #3.

Mile 85: Unable to access stand, but appears to be a good candidate for a moose browse improvement. Located around an old gravel pit.

Old Mentasta: Excellent site for timber improvement. Very good white spruce stand with mature trees in overstory. Located along 17B easement. Contact adjacent landowners before beginning work.

Gulkana Site Improvements

Beaver Dam: Excellent site that is set back from the highway about 400 meters. It consists of islands of aspen and white spruce among black spruce wetlands. There is heavy willow use by moose. It would benefit from treatments to enhance browse quality.

Gulkana Gravel Pit: Very good site for treatments behind the town site of Gulkana. Great access for shareholders to the Copper riverbottom. High willow density in places with occasional dense stands of white spruce and scattered poplar. Excellent place to enhance moose browse and provide biomass for Gulkana.

Copper Pit #1 & #2: Good sites behind locked gate located along active gravel pit in Copper River floodplain. Site would benefit greatly from overstory removal of white spruce and crushing of hardwoods to provide biomass and increase the quality of moose browse.

Gulkana TAPS #1, #2, & #3: Good sites with mix of white spruce and aspen. Also have willow and poplar in the understory. Treatment would benefit moose browse and TAPS provides access to stand. Hauling distance might be a little far to take advantage of biomass.

Gulkana TAPS #4, #5, & #6: Good sites with mix of white spruce and aspen. Also has willow and poplar in the understory. Treatment would benefit moose browse and TAPS provides access to stand. Hauling distance might be a little far to take advantage of biomass.

Highway East #1 & #2: Access to these stands is controlled by Ray Ewan (but they are located on Ahtna Land). We were not able to survey the stands but they have a high potential to be good treatment sites.

Pipeline Access #1 & #2: These are both ideal stands for both browse treatments and biomass production. They are close to Gulkana which reduces trucking times and also allows shareholder access. In addition, they are located behind a locked gate which reduces trespass. Consist mostly of hardwoods with white spruce in understory and some mature white spruce. Willow scattered throughout.

Tower Road #1 & #2: These are both ideal stands for both browse treatments and biomass production. They are close to Glennallen which reduces trucking times and also allows shareholder access. In addition, they are located behind a locked gate which reduces trespass. There is a possible access issue due to the road leading to FAA equipment. The stand is a mix of white spruce, aspen, and poplar. Willow scattered throughout.

Chitina Site Improvements

Mile 3 #1 & #2: Decent sites for moose browse improvement. Site currently consists of tall willows and alders with young white spruce in understory. Crushing would revive browse and improve quality and accessibility.

Kluti-Kaah Site Improvements

CC Airstrip: Good stand for browse enhancement and biomass production. Access is good along the Copper Center airstrip. Stand consists of mature white spruce and aspen with a willow understory.

Mile 92 Pit: Nice site located behind a gravel pit. Access is restricted due to a locked gate which makes it ideal for discouraging trespass. Site consists of mixed white spruce and aspen overstory with willow understory. Good site for biomass production, timber harvest, and browse enhancement.

Mile 98.5: Nice site located along a pipeline access road and the TAPS. Access is restricted due to a locked gate which makes it ideal for discouraging trespass. Site consists of young white spruce with some aspen and a lot of willow in the understory. Great site for browse enhancement with some biomass.

Old Edgerton #2: Really nice site that is heavy to aspen. There are some white spruce and poplar in the overstory as well. Scattered willow in the understory. Good stand for browse enhancement and some timber harvest possible.

Willow Lake: Excellent site on the other side of TAPS from the highway. Provides locked access, but there is a passage under TAPS to allow equipment to access site. Old gravel pit with good density of felt-leaf willow along with poplar, aspen, and young spruce. Perfect location for browse enhancement.

Tazlina Site Improvements

Ahtna Office #1: Access ends at the beginning of this unit. The site is almost too wet, but would be fine for winter treatments. There is 20-30% cover of spruce with a lot of willow in the understory. Recommend harvesting spruce and knocking down willows to improve moose browse.

Airport #1 & #2: Good mix of species with very mature aspen, medium sized white spruce, some balsam poplar and a variety of willow species. Excellent access with good road. Recommend harvesting overstory and treating willows to improve moose browse.

Fisher's Pit #1 & #2: Mix of harvested and unharvested timber. Pockets of 100% white spruce with pockets of aspen and white spruce understory. Extremely variable stand. Recommend harvesting mature spruce and aspen, thinning younger spruce, and treating willows to improve moose browse.

North Fireline #1, #2, & #3: These were recommended as good sites for moose browse treatments by Sarah Daszkiewicz.

Taz West Trails #5: This may be a good site. Due to the soft ground it is only suitable for a winter treatment. There is a mix of stunted black spruce and taller black spruce with mixed willow in the understory. Recommend crushing or cutting spruce and encouraging willow regeneration/regrowth for improving moose browse.

Taz West Trails #6: Good access off well pad road. Mix of spruce with a few hardwoods. There is also some beetle killed spruce. Variety of willow species in the understory. Recommend harvesting overstory and treating willows to improve moose browse.

Tazlina Fireline #1, #4, #5, & #6: These stands are all adjacent to areas that have been previously harvested. Portions of them may have been harvested as well. They consist of medium white spruce and mature aspen. They all have willow present in the understory. Suitable treatments would include harvesting the aspen and some spruce and then treating the willow to improve moose browse.

Tazlina Fireline #2: This stand consists of dense medium white spruce. It would benefit from a timber improvement treatment to thin the spruce and allow the remaining trees to increase growth rates.

Tazlina Fireline #3: This stand has been harvested and seen significant regrowth of aspen, spruce, and willow. It would benefit from roller chopping to improve the moose browse.

Tazlina Logging Road #1: Stand consists of aspen and white spruce. A precommercial thinning would be an excellent treatment to improve the production of this stand. It would also increase the quality of moose browse.

Tazlina Logging Road #2: This is a closed stand and is overstocked with spruce. Thinning would allow the remaining spruce to increase production. It is an excellent candidate for a timber stand improvement.

Tazlina Logging Road #3: Previously harvested stand in places with a lot of aspen regeneration. More white spruce could be removed and the aspen could be treated to increase moose browse.

Tazlina Pit: Treatment area surrounds a gravel pit with gated access road. Excellent location to treat the willows surrounding the gravel pit and provide a harvest location for shareholders.

Tazlina TAPS North #1: Beetle killed white spruce in overstory that should be removed. A lot of willow in the understory that could be treated to improve moose browse. Some poplar and aspen. Along pipeline so there could be access difficulties.

Tazlina TAPS North #2 & #3: White spruce overstory with some poplar and aspen. Decent amount of willow in the understory that could be treated to improve moose browse. Along pipeline so there could be access difficulties.

Terrace Drive: This would make an excellent demonstration area for a timber stand improvement due to proximity to town. It is mostly mature spruce with 40% canopy cover. Potentially thin now, then return and harvest in approximately 35 years.