Use of Summer and Winter Habitat by Alaska Sharp-Tailed Grouse (*Tympanuchus phasianellus caurus*) in Eastern Interior Alaska

by Richard L. Raymond

A thesis submitted in partial fulfillment of the
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In Environmental Science

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A thesis submitted to the Graduate Facility of Alaska Pacific University in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN ENVIRONMENTAL SCIENCE

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ABSTRACT

Summer and winter habitat use, home range, and movements of Alaskan sharp-tailed grouse in the Tanana Valley, Alaska were investigated from September 1998 to April 2000. Sixty-two sharp-tailed grouse (41 males and 21 females) were captured in the Delta Agriculture Project and fitted with radio transmitters, of which 18 sharptails provided home range information. The mean home range sizes were significantly greater in winter 15,818.80 $ha^2 \pm$ 8,378.96 ha^2 than summer 943.50 $ha^2 \pm$ 1,085.55 ha^2. Habitat analysis was conducted between two scales 25 meters and 100 meters. Between summer and winter, sharp-tailed grouse used 17 habitat types and habitat preference was determined from habitat use and availability. Summer habitat preference indicated that sharp-tailed grouse selected paper birch woodland deciduous habitat types more than expected and avoided aspen open deciduous and white spruce closed conifer habitats at the 25-meter scale. Aspen open deciduous and white spruce birch closed mixed habitats were avoided at the 100-meter scale. In winter, sharptails selected black spruce white spruce aspen closed mixed habitats and black spruce birch open deciduous habitat types at the 25-meter scale. Sharp-tailed grouse showed an apparent preference for black spruce white spruce aspen closed mixed habitats and an avoidance of white spruce open conifer, paper birch woodland deciduous, and black spruce tamarack open conifer habitat types more than expected at the 100-meter scale.

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INTRODUCTION

The sharp-tailed grouse or "sharptail" (*Tympanuchus phasianellus*) is a lekking species that occupies a wide range of habitats, primarily in brushy open areas associated with early to mid-succession ecosystems including boreal forests, mixed conifer and broadleaf forests, short grass prairie, sagebrush steppe, and oak savannas (Aldrich 1963). Sharp-tailed grouse were historically distributed over large portions of North America, ranging from northern New Mexico to Alaska, and east to western Quebec (Aldrich 1963, Johnsgard 1983). Although sharptails still range from the Great Lakes west to Alaska and south to Colorado, their present range has been reduced considerably and their numbers have declined greatly in the southern and eastern portions of their historical range.

Sharptails have adapted to areas where agriculture has created a mosaic of native vegetation and cultivated lands that provide habitats for food and cover. Most of our knowledge concerning sharp-tailed grouse ecology and life history comes from populations found in the contiguous United States and southern Canada. Little is known about species in Alaska and northern Canada where populations are considered stable (Johnsgard 1983).

Taxonomically, sharp-tailed grouse are members of the Order *Galliformes*, Superfamily *Phasianoidea*, Family *Phasianidae*, and Subfamily *Tetraoninae* (grouse and ptarmigan) (Johnsgard 1983). This group is separated from others in the pheasant family due to feathered legs (tarsus), nostrils, and pectinated toes which permit them to inhabit arctic and alpine regions. There are 16 species recognized worldwide, of which 7 are indigenous to Alaska (Johnsgard 1983, Weeden 1965).

The Alaskan sharp-tailed grouse (*T. p. caurus*) is one of 6 subspecies of sharp-tailed grouse found in the United States and Canada (Johnsgard 1983) and is the northern most ranging of all the subspecies. It occupies suitable habitats coinciding with the relatively open, but slow growing taiga regions of interior Alaska, southwestern Yukon Territory, northeastern British Columbia, and northern Alberta (Kessel 1981). In Alaska, their range includes the Yukon River valley, upper Kuskokwim, Tanana, and Copper River basins (Aldrich 1963, Johnsgard 1983, Sidle 1986). They are non-migratory, but exhibit local seasonal migration, attending a variety of habitat communities for cover, food, nesting, and brood rearing.

Knowledge pertaining to sharptail seasonal habitat requirements, habitat preference, and population ecology in Alaska has not been adequately recorded. Observations by hunters and biologists have contributed much of the current knowledge available concerning sharp-tailed grouse ecology. From these observations, anecdotal evidence suggest that habitat availability and quality influence grouse abundance.

The earliest known studies of sharp-tailed grouse in Alaska began in 1963. Weeden (1965) provided information on distribution, general habitat use, food habits, and hunter harvest. These early studies were limited to general observations because of the inability to capture, radio-mark, and follow individual sharptails. Recent innovations in capturing and radio marking have enabled the collection of detailed information on individual birds.

Sharp-tailed grouse are a popular game bird. They have contributed significantly to recreational hunting opportunities for Alaskans due to their wide distribution, cyclic abundance, and year-round availability (Weeden 1965), but few estimates exist pertaining to their historical abundance, range, and distribution. Buckley (1954) reported high numbers of sharp-tailed grouse in the 1920's and 1930's that may have been related to extensive wildfires that occurred in the Alaskan taiga after the turn of the century, which provided suitable habitats within the sharptails range (Weeden and Ellison 1968). Sharptail populations flourish when their habitats are disturbed and rejuvenated periodically by fire, land clearing, and river action (Weeden 1965). These conditions are present within the Tanana Valley region where frequent forest fires, land clearing, and geographic proximity to large drainage's have created habitats that can support high densities of sharptails. Conversion of boreal forests within portions of the Tanana Valley into agriculture lands in the early 1980's have resulted in improved habitat and consequentially higher densities of sharp-tailed grouse in recent years.

Population fluctuations may be attributed to several influencing factors such as hunting pressure, food availability, weather, predation, and disease. These oscillations greatly influence local concentrations from year to year. Synchronous wildlife cycles of nine to ten-year fluctuations have been noted to occur in microtines, small game, and galiformes (Kieth 1963). Angelstam et al. (1985) suspect that food quality, quantity, and predation is the likely driving force behind these fluctuations.

Most of Alaska's sharptail populations occur within the central-eastern interior portions of the state. Moderate to high densities of sharp-tailed grouse are found in the Shaw Creek-Delta Junction and Tanacross-Tok-Northway regions (Weeden and Ellison 1968). Many sharp-tailed grouse studies have focused on areas of declining grouse populations, with little research being undertaken in regions with stable populations (Roersma 1998). Several sharp-tailed grouse subspecies, especially the Columbian (*T. p. columbianus)* and prairie (*T. p. campestris*) subspecies have been drastically reduced or extirpated from portions of their native range due to habitat alterations caused by anthropocentric activities (Amman 1957, Johnsgard 1983, Cope 1992, Giesen 1997). Comparatively, the native range of the Alaskan sharptail has not been reduced by land use practices, but conversion of land for agriculture may have benefited sharptail populations in interior Alaska.

Recognizing the factors that affect population abundance could have important management applications. Management procedures could be identified and implemented for sustaining or increasing sharp-tailed grouse populations as related to summer and winter habitat needs. Wildlife managers could manage population trends and levels of abundance and identify the aspects contributing to population fluctuations, ultimately providing managers with a management tool for regulating harvest by assessing hunting pressure, land management practices, and other effects on local sharp-tailed grouse populations.

Information pertaining to the relationship between habitat quality and sharp-tailed grouse productivity is lacking in Alaska. In reaction to insufficient information concerning sharp-tailed grouse ecology, a study to understand sharp-tailed grouse summer and winter habitat in eastern interior Alaska was conducted under a grant from the Alaska Department of Fish and Game (ADF&G). The objectives of the study were to: 1) describe summer and winter home range sizes of sharp-tailed grouse in a study area within portions of the Tanana Valley, Alaska; 2) define summer and winter range habitat utilization, including selection and avoidance by individual birds; 3) make management recommendations based on the results of this study. This study was conducted from September 1998 to April 2000.

STUDY AREA

The 427,762 ha study area is located approximately 17 km east of the community of Delta Junction and encompasses the Delta Agriculture Project (DAP), Fort Greely Military Base, and other lands within the Tanana Valley. (See Figure 1.) The area is located at approximately 64°40' N Latitude and 145°90' W Longitude and lies within Game Management Unit (GMU) 20D. The Delta River and the Alaska Range border the area in the west; the Gerstle River in the east; the Granite Mountains in the south, and the Clearwater River, Tanana River, and Shaw Creek Flats in the north. The study area is approximately 74 km long from north to south and 92 km wide from east to west.

Two major roadways pass through the study area. The Richardson Highway follows the Delta River south from Fairbanks along the western boundary, and the Alaska Highway cuts through the center and continues east towards the Canadian border. Overall elevations range from 366-1,772 m. Topography is both rugged and rolling with steep ridges along the south and hills in the north separated by vast lowlands.

Geology and Soils

The majority of the region is comprised of crystalline bedrock overlaid by thick sediments including silt, sand, and gravel. The Delta-Clearwater and the Tanana River areas were glaciated during at least 3 epochs and are characterized by a low relief of kettle and kame topography (Schoephorster 1973). These past glacial events are evident with the presence of terminal moraines in the Delta and Gerstle River valleys along with wide flood plains and terraces formed by glacier fed rivers. Expansive outwash fans of the Gerstle and Delta Rivers

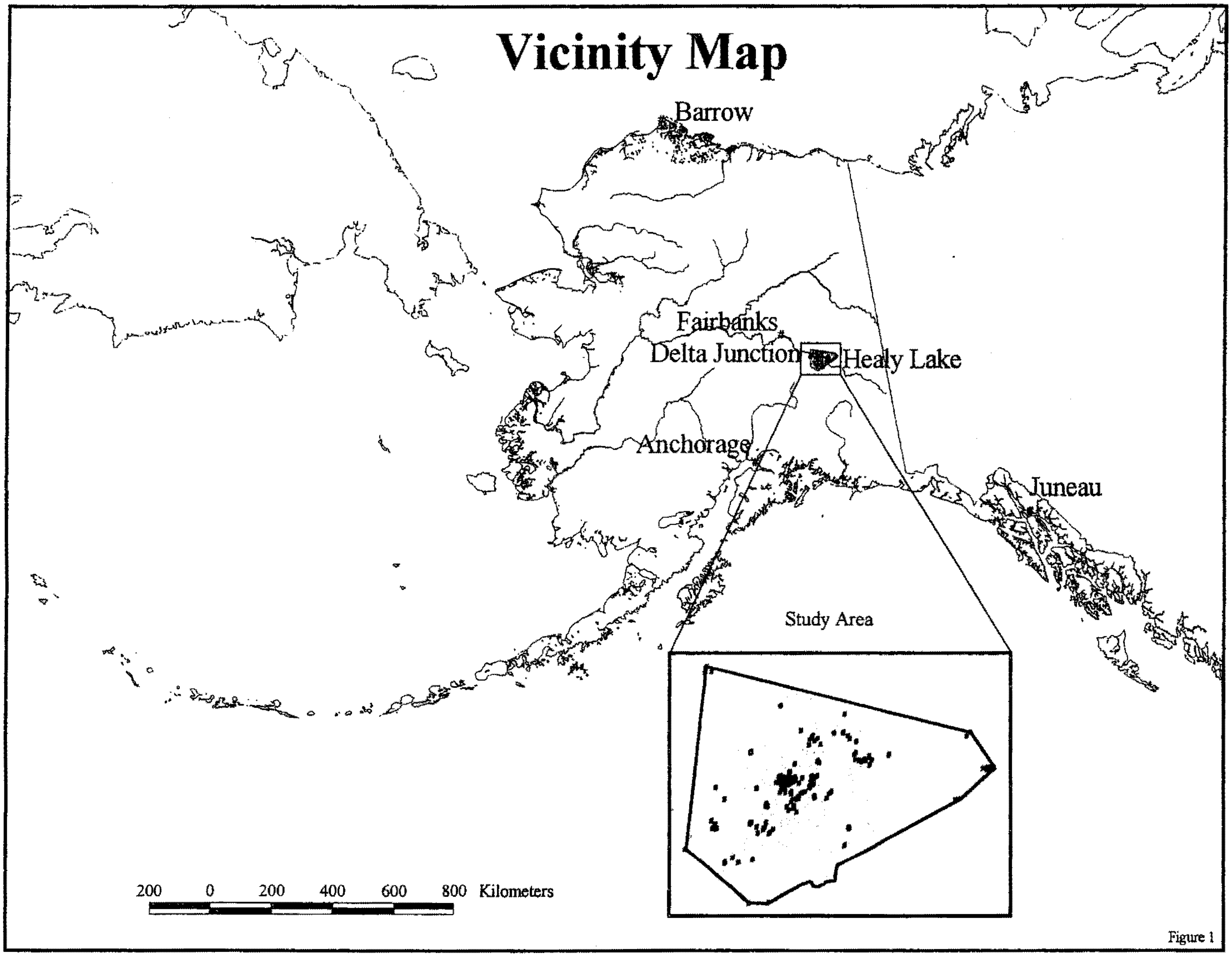

Figure 1. Map showing the study area location within the Tanana Valley, in eastern interior Alaska.

converge with the fans of smaller creeks that enter the area from the Alaska Mountain Range to form a continuous alluvial band at the base of the range.

Soil information was summarized from unpublished data provided by the Alaska Department of Natural Resources (ADNR). Soils are comprised predominately of silt loam, from 18 to 100 cm in depth and are overlaid by coarse sand and gravel outwash from the Alaska Range. Large patches of thin soils and exposed gravels comprise much of the soil characteristics, especially along the major drainages. The northern and western portion of the study area is underlain by discontinuous permafrost.

Vegetation

Most of the region is forested, although approximately 28,329 ha^2 of black spruce (*Picea mariana*) forest were cleared by the State of Alaska to facilitate agriculture. Extensive stands of aspen and balsam poplar (*Populus spp.*), birch (*Betula spp.*), and white spruce (*P. glauca*) are common in well-drained areas. Dense stands of black spruce, alder (*Alnus spp.*), and willow (*Salix spp.*) are generally common in poorly drained soils. Other vegetation such as moss, sedge, and low growing shrubs cover much of the muskeg and occur around riparian environments. Large portions of the study area include alpine areas of rolling hills and ridges close to climatic timberline, which contain patches of black spruce and deciduous trees. The trees are spaced with large openings. The openings a relatively uniform with floral mat characterized by low shrub, dwarf birch, lichens, mosses, forbs, sedges, and grasses that grow from beneath trees and on the floor.

Land Use

Large-scale farming never established itself as a major industry in the Delta Junction area, but small-scale farming took place in three general locations, including the 24,282 ha^2 DAP and the smaller Clearwater Area located north of Delta Junction, and Tanana Loop, located at the confluence of the Delta and Tanana Rivers.

The DAP is composed mostly of young deciduous aspen and willow, Conservation Reserve Program (CRP) grass, and crops. Agriculture farming consists primarily of grains such as barley (*Hordeum vulgare*), oats (*Avena sativa*), and grasses including brome (*Bromus ssp.*), bluegrass (*Poa spp.*), and fescue (*Festuca spp.*), which are primarily cultivated for hay.

The agriculture project consists of both privately and publicly owned land tracts that range from approximately 405 to 2,428 ha^2 in size. The tracts were created and subdivided and leased by the state during the anticipated agriculture boom in the early 1980's. The majority of the agricultural tracts contain uniform bands of intermittent windrows and burn piles of young aspen, willow, and shrubs within cleared fields of various widths. The average age of the deciduous stands in the agriculture project is indicative of the time of anthropogenic land clearing, which was initiated in the early 1980's (Glenn Franklin, ADNR, pers. comm.).

Livestock production has typically been on a small scale in the Tanana Valley. While most operations are small, the past few years have seen the development of game farms and domestication of several exotic and wild species including yak (*Bos grunniens*), reindeer (*Rangifer tarandus.*), bison (*Bison bison*), wild boar (*Sus scrofa*), and elk (*Cervis elaphus roossevelti*). In addition, one large confinement hog venture and several cattle herds greater than 100 head are operated commercially. Sheep, goats, chickens, and rabbits are raised mainly for domestic use.

The study area also includes lands owned by the United States Army at Fort Greely. The military installation is located along the southwestern boundary and is characterized by dense bottomland stands of white spruce, aspen, and balsam poplar (*Populus spp.*). Black spruce stands are found in higher elevations, north facing slopes, and in poorly drained areas. Mixed white spruce/hardwood forests are found along well-drained slopes and south facing slopes, with an understory of low shrubs, forbs, grass, ferns, and moss.

Climate

The climate is semi-arid, characterized by low precipitation, hot summers, and extremely cold winters that are typical of the Interior Basin of Alaska. Temperature extremes range from 35° C in summer to –52°C in winter, and precipitation ranges between 27.94 cm to 40.64 cm annually (Schoephorster 1973). Most of the annual precipitation occurs in June, July, and August, in the form of showers. The total annual snowfall is approximately 91.44 cm.

METHODS

Capture and Processing

Prior to fall 1998, few attempts were made to live capture sharp-tailed grouse in Alaska. Due to the lack of existing information concerning sharp-tailed grouse capture history, it is reasonable to assume that the first successful live capture of sharp-tailed grouse for scientific research may have been accomplished while conducting this study.

In an effort to follow individual birds to define summer and winter home ranges and habitat utilization, birds were captured and radio marked. Three trapping attempts were conducted in the DAP. Trapping of sharp-tailed grouse took place between 17-25 September 1998 and 7-22 May 1999, and 16-23 September 1999. Birds were located within the DAP and adjacent lands by searching for grouse using four-wheeled drive pickup trucks, all terrain vehicles (ATV's), and by foot. Adults and juveniles of both sexes were trapped in the fall while only adults were captured during the spring.

Individual birds were live captured using traps with one or two 15.24 m drift fence leads with attached one-way walk-in funnels (Toepfer et al. 1988). Drift fences made from 2.54 cm mesh chicken wire were 45.72 cm high. Traps were set where broods grouped in the fall and near dancing grounds where adult grouse congregated in the spring. Traps were placed perpendicularly and diagonally across windrows or placed within fields in a way that formed a box around a dancing arena with corners open to intercept walking grouse. Traps were checked twice daily.

Captured grouse were sexed, aged, and weighed. Sex was determined by crown and tail feather patterns (Henderson et al. 1967, Johnsgard 1983); female grouse have transverse barring patterns on the central tail feathers with alternating buff and dark brown crossbars on the crown. Solid dark crown feathers and white linear markings along the edges of the central tail feathers identified males (Johnsgard 1983). Weights were obtained using a 1 kg Pesola spring-loaded hanging hand scale, and age was determined to the extent possible by outer primary feather wear. Larger and heavier grouse showing primary feather wear in conjunction with full growth of the eighth primary were classified as an adult.

Radio-Telemetry

All captured grouse were radio-fitted with necklace style radio transmitters (Holohil Systems, model R1-2BM) and were identified using their radio transmitter frequencies. Radio-telemetry was used to identify individual movements of birds, seasonal dispersion, home range estimates, and summer and winter habitat use. Transmitters weighed between 13.9g and 16.0g, with a manufactured battery life of 24 months. Radio transmission distance was 2.5 km on the ground and 6 km in the air with a pulse width of 23 ms and a pulse rate of 42 ppm. Necklace-style transmitters were used because they mount easily and quickly, which resulted in less stress to the birds (Marks and Marks 1987). Marked grouse were located with Advanced Telemetry System (ATS), Telonics TR2 receivers and two-element "H" antennas. A 20 cm long antenna protruded from the rear of the transmitter neckband and lay along the mantle between the bird's scapulas, reducing wing interference.

Attempts were made to visually locate all radio-marked grouse. Locations were recorded with a Garmin 45 GPS recorder. Two hundred sixty nine GPS data point locations were collected for 57 sharp-tailed grouse during ground and aerial tracking over a 20-month period. On the ground, individual frequencies were followed in the direction of the strongest signal until the bird was sighted or transmitters were recovered from shed collars and from those found on mortality mode. Data on all bird observation and location points were plotted and overlaid on a Geographical Information Systems (GIS) grid vegetation coverage map (1 inch to mile) using ArcView GIS software and projected to Universal Transverse Mercator (UTM) 6.

Aerial Radio-Telemetry

Between late-April and early-October birds were located using conventional ground tracking methods. Due to the large size and remoteness of the study area, aerial surveys were conducted to locate birds during the winter season. Location data were collected one to two times per month using a PA-18 fixed wing aircraft to obtain general signal locations. A follow-up survey was conducted using a R-22 helicopter to radio track, visually locate, and document habitat at specific grouse use sites during the winter. Data were collected during daylight hours.

Home Range

Seasonal home range size was calculated and mapped using the minimum convex polygon method (White and Garrott 1990) and plotted on Delta Area vegetative coverage maps of the Tanana Valley using computerized GIS software. Home ranges for both seasons were obtained from 15 birds that were located at least 5 times and provided distribution points from time of capture until radio failure, radio loss, or mortality. Summer home range was obtained from 5 birds within the DAP. Winter home range was obtained from 10 birds and included all summer and winter location points. Home ranges were mapped, habitat types identified, and their areas calculated using GIS ArcInfo software.

Habitat Classification

Habitat types were classified for both the summer and winter range and analyzed at three scales. Scale one examined habitat composition at the microhabitat level during the summer season by physically measuring horizontal, vertical, ground cover, and stem density. Scales two and three involved using a vegetation coverage map of the Tanana Valley to analyze either macro summer and winter habitat composition at both bird observation and random points. Macro habitat (i.e. vegetation types) use versus availability was assessed in two ways: (1) using cover types at specific bird locations and comparing it to expected cover types within a 25 meter grid, and (2) extracting dominant habitat types within a 100 meter radius from bird location and random points.

Micro Habitat Measurements

The DAP is composed of cleared agriculture land dominated by aspen, closed tall willow shrubs, and fields. Habitat types were recorded each time a bird was located within the DAP. Availability of vegetative structure such as horizontal cover, vertical cover, shrub vegetation composition, and ground cover composition were measured around randomly chosen points and compared with actual grouse-use sites by using a "dimensionless-point target" (Collins and Becker 1997). Microhabitat vegetative structure was obtained using a 2 cm by 1.5 m conduit staff with two 9 cm cored plastic balls mounted quarter distance from the top and bottom of the staff. The staff and balls served as the dimensionless target. Once a bird was sighted and flushed the staff was imbedded in the ground at the flush location and a 30 m line transect was laid out with the 15 m mark centered at the flush point. The target was sighted from 10 systematically distributed points around the center staff from a predetermined sight radius of 6 m. Each flush sample was equal to one data point.

Random points were picked from a list of random locations, distances, and features such as agriculture tracts, access roads, and fields. Cardinal compass points and distances up to 30 m were randomly chosen to define the points. Trap locations were considered as grouse use locations and were included in the flush habitat sample. Grouse flush-sites were used as the focal point of non-random habitat measurements.

Vertical cover was determined by sighting through a densiometer mounted on top of a second 1.5 m staff to visually identify presence or absence of vegetation overhead. Groundcover measurements were obtained by documenting groundcover at 1 m point intervals along the 30 m transect. A habitat survey form was used to recorded the date, grouse frequency, age and type of succession, percent and type of ground cover, percent and type of horizontal cover, percent and type of vertical cover, height of vegetation, estimated age of vegetation, and stem density of vegetation at a height of 1 m (Appendix A). Within the DAP 59 randomly selected and 53 grouse-use sites were sampled from May through October 1999.

Four types of fields were recognized and classified within the agriculture project. The 4 field types included active hay fields, active barley fields, fallow hayfields, and fallow barley fields. Active hay fields were dominated by brome (*Bromus ssp.*) grass and were actively being utilized for barley production. Fallow hay fields were fields undergoing early old-field succession; brome grass was dominant, but early signs of succession was apparent with the invasion of fireweed and other species in low densities. Fallow barley fields were in more advanced stages of old field succession, presumably due to lack of perennial cultivation, leaving fields open to reestablishment of native species. Aspen and willow ≥ 2 m were the dominant plants along field edges. Bird observations indicated that the agriculture fields were important sharp-tailed grouse habitat use areas and were central to seasonal high grouse densities observed especially from May through September. These fields and associated windrows provide important cover and food for sharp-tailed grouse during their courtship, nesting and brood rearing activities.

Macro Habitat Measurements

Summer and winter vegetation types were classified and mapped using the established Alaska Department of Natural Resources (ADNR) vegetation typing system presented in list format for the Tanana Valley linked to computerized GIS ArcVeiw software (Appendix B). The maps, in the form of grid data, provided current information on vegetation, habitat availability, and spatial relationships between bird movement and habitat. The grid resolution was 25m X 25m representing a real life area of $625m^2$. Habitat utilization was evaluated based on the structural composition of vegetation communities, rather than plant species composition and were compared between summer and winter for analysis. Specific habitat types used by sharp-tailed grouse and random point comparisons were identified and processed using ArcInfo GIS software.

Habitat quality was assessed by comparing the amount of time a bird spent in a given habitat, represented by the proportion of observations in a habitat type. Habitat types were recorded at bird location points. The data collected provided location snapshots within a specific spacial and temporal period in a 25 m x 25 m grid cell, but did not provide information on potential utilization of other habitats outside of the grid cell location. A second method of assessing use of surrounding habitats included picking out the highest occurrences of habitat types (dominant rule) within a 100 m buffer radius from the bird location point. An equal number of random points and buffer distances were generated and compared to the observed values.

A total of 9 vegetation communities, 18 general vegetation types, and 49 vegetation type classifications were available to describe habitat utilization (Appendix B). Within the total study area 17 vegetative communities were available to sharp-tailed grouse and these communities were combined into logical habitat associations (habitat types) for both individual bird and random point comparisons. There were 22 habitat types available within the summer range and 28 habitat types available within the winter range. The text descriptions for the following 17 habitat types are described in Viereck et al. (1992) and were used for habitat utilization analysis:

Alder: These stands are dominated by alder (*Alnus spp.*) ≥1.5 meters tall, with a tall shrub cover of 75%. Other species include tall willows and occasionally aspen and spruce. Understory species are generally absent, but may include scattered growths of prickly rose (*Rosa acicularis*). The herb layer is composed of bluejoint grass (*Calamagrostis canedensis*), meadow horsetail (*Equisetum arvense*), monkshood (*Aconitum delphinifolium*), fireweed (*Epilobium spp.*), bluebell (*Mertensia paniculata*), and lady fern (*Athyrium filix-femina*).

Alder-Willow*:* Alders and willows codominate these communities. The average height is ≥ 1.5 meters with an average shrub cover ≥ 75%. Understory shrubs are scarce, but seedlings and saplings of tree species (especially spruce) are present on sites within the forest zone. The herb layer is often sparse, but commonly include bluejoint grass, meadow horsetail, lady fern, and fireweed.

Balsam Poplar*:* These stands are dominated by small aspen trees that provide 10 to 60 percent canopy cover > 12 centimeters d.b.h.(diameter at breast height) and ≥ 15 meters in height. Common low shrubs include buffaloberry (*Shepherdia canadensis*) and prickly rose 1 to 2 meters tall. Herb species include purple reed-grass (*Calamagrostis purpurascens*), northern bedstraw (*Galium boreale*), and pasqueflower (*Pulsitilla patens*). Patches of kinnikinnik berry (*Arctostaphylos uva-ursi*) often form the ground cover.

Aspen*:* These stands are dominated by Aspen and have a total tree cover ≥ 60 %. Other tree species are generally absent. Understory composition is variable, but scattered tall shrub layers consisting of *Salix spp.*, *Alnus spp.* and low shrub layer dominated by high bushcranberry (*Viburnum edule*), prickly rose, and buffaloberry are commonly present.

Birch-Aspen: The dominace in canopy in these communities is shared by paper birch and aspen and the total tree cover is > 60 %. American green alder (*Alnus crispa*) and several willow species form the tall shrub layer. Low shrub layer is composed of prickly rose and buffaloberry. The ground layer is dominated by kinnikinnik berry and horsetail grass.

Black and White Spruce-Aspen: These forests are co dominated by aspen and black spruce, aspen white spruce, or both. Tree canopy coverage is > 60%. Black spruce reach 6 to 7 cm d.b.h. (diameter at breast height) and 4 to 12 m in height. Aspen are smaller in these stands. In aspen-white spruce stands, aspen and white spruce reach > 25 cm d.b.h and > 18 m in height. Tall shrubs include American green alder, and willow. The low shrub layer is composed of prickly rose. Common dwarf shrubs include bog blueberry (*Vaccinium uliginosum*), mountain cranberry (*V. vitis-idaea*), kinnikinnik berry, twinflower (*Linnaea borealis*), Labrador tea (*Ledum groenlandicum*), and buffaloberry. Common herbs include fireweed, horsetail grass, dwarf dogwood (*Cornus canadensis*), reed grass (*Calamagrostis spp.*), bluebell (*Mertensia paniculata*), and wintergreens (*Pyrola spp.*). Common ground cover include feathermosses such as (*Hylocomium spp.*) and (*Polytrichum spp.*).

Black and White Spruce-Birch: These stands are composed of paper birch and black spruce, paper birch and white spruce, or both. White spruce-paper birch stands reach diameters ≥ 30 cm d.b.h. and heights ≥ 18 m. Stands can attain ≥ 140 years of age. A moderately dense tall shrub layer consisting of American green alder and willows are present. A low shrub layer consisting of prickly rose and highbush cranberry (*Viburnum edule*) is characteristic of these communities. Common herbs include bluejoint grass, dwarf dogwood, twinflower, and horsetails. Feather mosses occupy the forest floor. Black spruce-paper birch stands average > 9 cm d.b.h. and 2 to 17 meters tall and can reach ≥ 120 years of age. The tall shrub layer is composed of American green alder and willows. Low shrubs are represented by prickly rose, kinnikinnik berry, blueberry, and Labrador tea. The herb layer is composed of bluejoint grass and feather mosses, which dominate the ground layer.

Black Spruce: These communities are dominated by black spruce trees 4 to 7 cm d.b.h. and 3 to 9 m tall. A continuous cover of low shrubs 10-100 cm tall is characteristic of these communities. Low shrubs include bog blueberry, mountain cranberry, and Labrador tea. Tall shrubs include American green alder, bog birch, and willows. The herb layer includes reed grass, horsetail grass, cloudberry (*Rubus chamaemorus*), cotton grass (*Eriophorum spp.*), and sedges. The ground cover is dominated by feathermosses such as (*Pleurozium spp.*), (*Hylocomium spp.*), (*Sphagnum spp.*), and (*Polytrichum spp.*).

Black Spruce-Aspen: (See Black and White spruce-Aspen)

Black Spruce-Birch: (See Black and White spruce-Birch)

Black Spruce-Tamarack: These trees are small and stunted and exist on wet lowlands within a shallow layer above permafrost. The shrub layer is composed of bog birch and Labrador tea. The groundcover is composed of feathermosses and sphagnum mosses.

Black Spruce-White Spruce: These stands have tree cover > 60%. They are slow-growing trees and grow to ≤ 25 cm d.b.h and ≤ 25 m in height. The tall shrub layer is weakly developed, but American green alder and willows are commonly present. Other shrubs that grow < 1.5 m tall include prickly rose, high bushcranberry, Labrador tea, bog blueberry, kinnikinnik berry, currents (*Ribes spp.*), and crowberry (*Empetrum nigrum*). Common herbs include dwarf dogwood and twinflower. Feather mosses cover the ground layer.

Paper Birch: These communities are dominated by paper birch and have a tree cover of 25% to 60%. Scattered white spruce and black spruce may be present. Tall shrubs include alder and willows and dominate openings between the trees. Ericaceous (Heath Family) shrubs create a dwarf shrub layer beneath the taller shrubs. The ground layer is composed of continuous feathermosses.

Tamarack: (See Black Spruce-Tamarack)

White Spruce: These stands are dominated by white spruce with total tree cover ≤ 60%. Trees are variable in size, typically 30 cm d.b.h. and 16 m tall. A well-developed tall shrub layer consisting of bog birch is characteristic of these stands. Other tall shrubs include American green alder and willows. Low shrubs include buffaloberry and prickly rose. Common herbs include twinflower, horsetail, and reed grass. The ground cover beneath the shrubs consists of continuous feather mosses.

White Spruce-Birch: (See Black and White Spruce-Birch)

Willow: These stands include > 75% shrub cover taller than 1,5 m. Common dominant species include Feltleaf willow (*Salix alaxensis*), littletree willow (*S. arbusculoides*), diamondleaf willow (*S. planifolia*), and Richardson willow (*S. lanata*). Alders and aspen contribute to the overstory canopy. Low shrubs such as bush cinquefoil (*Potentilla fruticosa*), halberd willow (*S. hastata*), and barren-ground willow (*S. brachycarpa*) grow in openings. Mosses including *Polytrichum juniperinum* feathermoss, and *Drepanocladus uncinatus* are common in these communities.

Bird location points, that were located near habitat type boundaries, were placed in the habitat of the actual point even though the polygon overlapped the adjacent habitat type.

Habitat Preference and Avoidance

Habitat utilization relative to habitat availability is often used to assess "preference" or "avoidance" of habitats (Johnson 1980). Preference of a habitat is defined as habitat selection and use at proportions significantly greater than a habitats reletive area (White and Garrott 1990). Habitat avoidance occurs when animals spend proportionately less time in a habitat than the proportional availability of that habitat. Preference and avoidance were analyzed in three ways: 1) individual bird and random locations were measured within the DAP and compared to determine preference and avoidance patterns at the microhabitat scale. 2) individual bird and random locations were measured using location data within a 25 meter map grid at the macro habitat scale. 3) individual bird and random locations were measured using location data within a 100 meter radius around each location point. The occurrence of the dominant vegetation type was recorded as it appeared on a grid map. For example, when multiple vegetation types were encountered within the 100 m radius the vegetation type with the highest frequency of occurance was recorded.

Data Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS 9.0). Habitat use-availability analyses of habitat characteristics were conducted with chi-square goodness of fit tests (Neu et al. 1974). The Chi-square analysis identified whether flush habitat (observed) differed significantly from the randomly selected (expected) habitats. The vegetative measurements at flush points from May through October 1999 were combined by cover types for comparison with data collected at randomly selected points for the same period. Similarly, summer and winter habitat types were used for comparison with generated random points. The null hypothesis stated all habitat types were randomly distributed throughout the study area and sharp-tailed grouse used each habitat type in proportions equal to their availability. A two-tailed t-test was used to determine whether the mean of the winter home range area was significantly different from the mean of the summer home range area.

RESULTS

Combined Individual Bird and Capture Data

Sharp-tailed grouse succumb at a high rate to predators, hunters, and natural causes resulting in variations in the number of observations and location information among the birds. By April 2000, avian and ground predators killed 8 birds, hunters killed 5 birds, 1 was known to have died of starvation, 7 were lost after they shed their transmitters, 27 were classified as unknown, and 4 were active (Appendix C). Of the 62 grouse captured during the three capture periods, 18 birds provided ≥ 5 location points from September 1998 to April 2000.

Fall 1998

Twenty-nine birds were captured of which 15 were adults and 14 were juveniles (Appendix C). The mean weight of 21 male grouse (72%) was 758 ± 20 g and the mean weight of 8 females (28%) was 687 ± 55 g. The mean weight of 12 juveniles was 723 ± 50 g. Of the 29 birds captured and radio-tagged in the DAP, 4 provided at least 5 location data points from September 1998 to July 1999.

Spring 1999

Between 7 May to 22 May 1999, 13 males (81%) and 3 females (19%) were trapped on 5 dancing grounds (Appendix C). The mean weight for males was 733 ± 17 g and the mean weight for 3 females were 663 ± 79 g. Of the 16 birds captured in the DAP during spring of 1999, 9 provided at least 5 location data points from May 1999 through April 2000. All spring-captured birds with the exception of birds 31 and 33 were either missing or dead by January 2000.

Fall 1999

Seventeen birds were captured from September 16 to September 23, of which 7 were adults and 10 were juveniles. The mean weight of the 17 sharp-tailed grouse trapped in the DAP was 667 ± 45 grams. The mean weight of 7 males (41%) was 751 ± 48 grams and the mean weight of 10 females (59%) was 608 ± 36 grams. The mean juvenile weights were 612 ± 53 grams. By the end of September, 7 birds were missing from the study. Three birds were lost by October; 1 bird was lost by November; 1 was lost by January; 1 was lost by February; 1 was lost by March, and 3 provided continuous data through April 2000. Of the 17 birds captured and radio-tagged, 6 provided at least 5 location data points from September 1999 to April 2000.

Summer and Winter Range Boundaries

The total study area boundary was determined from extent of bird movement from point of capture, home range, and natural boundaries. Summer and winter range boundaries were selected from bird location points observed during the summer and winter season and calculated using the following equation: TA = A (1/10,000). TA equals the total area (m^2) of the landscape, divided by 10,000 (to convert to hectares). Approximately 44,243 ha^2 was classified as summer range and 383,519 ha^2 was classified as winter range. The winter range included all areas within the study area minus the summer range. Random points were generated for the total study area.

A validity check for randomness for sharp-tailed grouse location points showed they were not distributed randomly during summer ($z = 13.4662$, $r = 0.46013$, $n = 170$), but showed a tendency towards clustering. Winter location points were not randomly distributed ($z = 11.2509$, $r = 0.373076$, $n = 88$), but showed a tendency towards clustering. Generated random points for summer were distributed randomly ($z = 1.57807$, $r = 1.19443$, $n = 18$) and the random winter points were distributed randomly ($z = 0.297727$, $r = 0.990235$, $n = 254$).

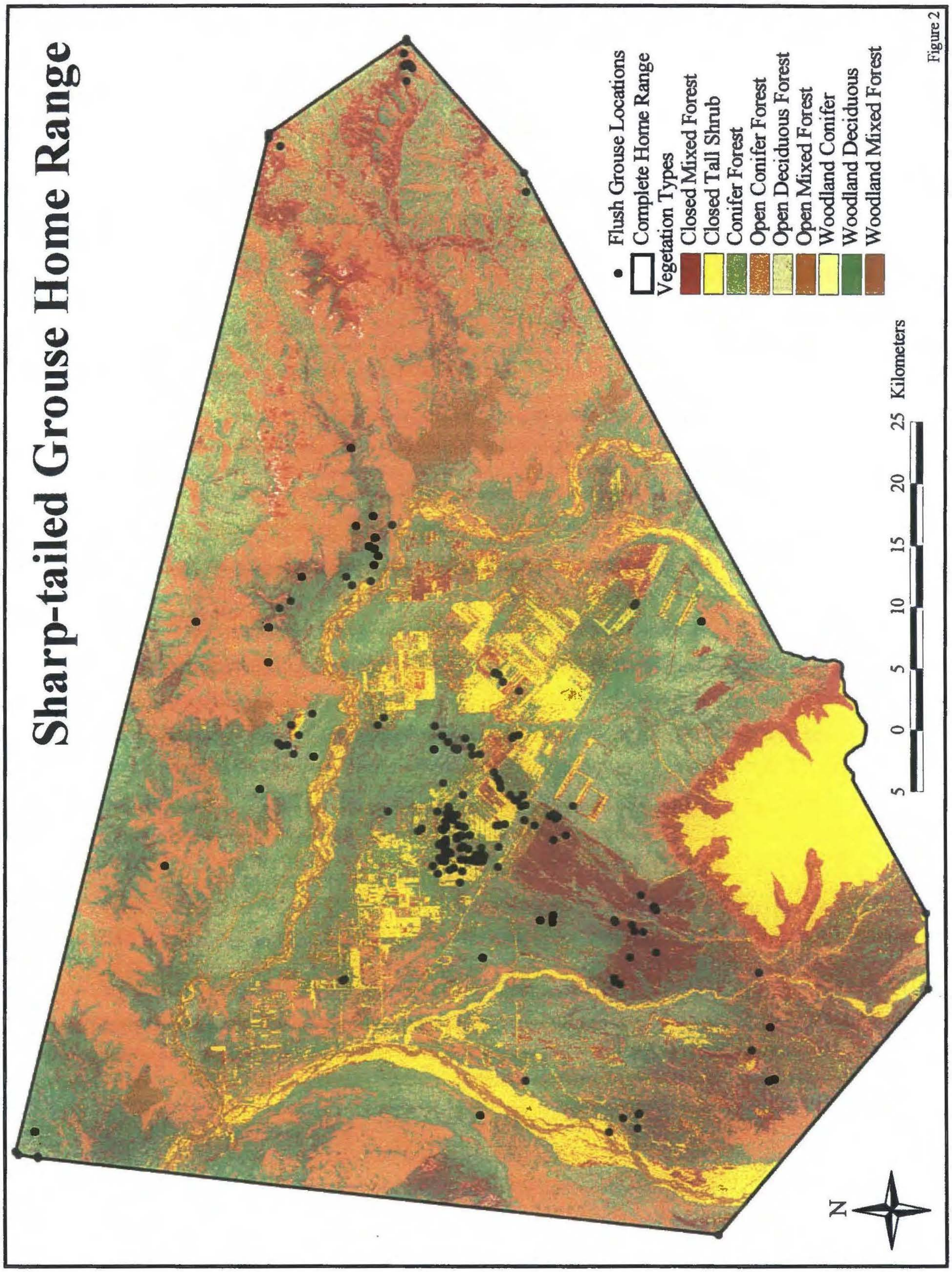

Figure 2. Map of the total study area showing general habitat types.

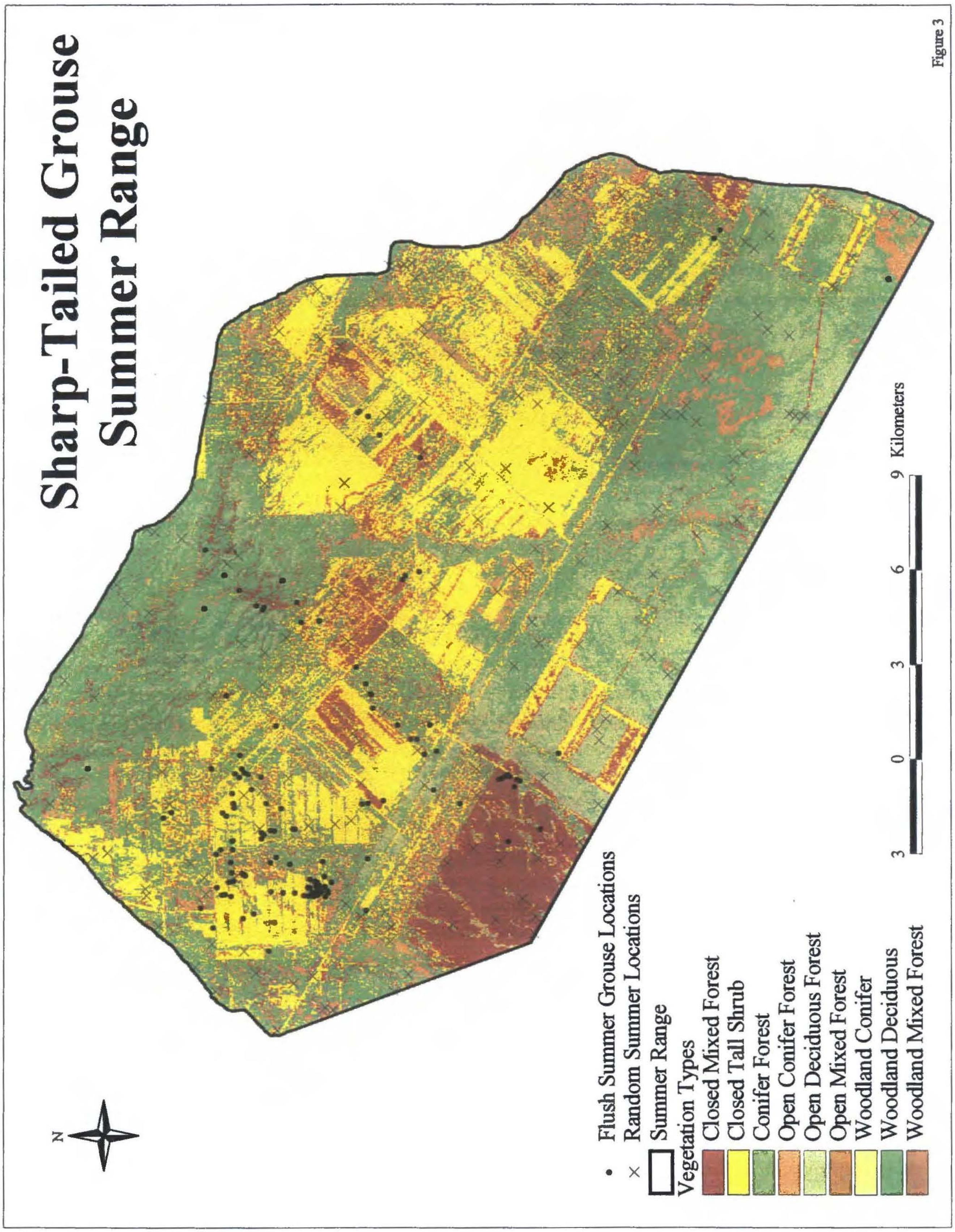

Figure 3. Distribution of sharp-tailed grouse location points and random points within the summer range.

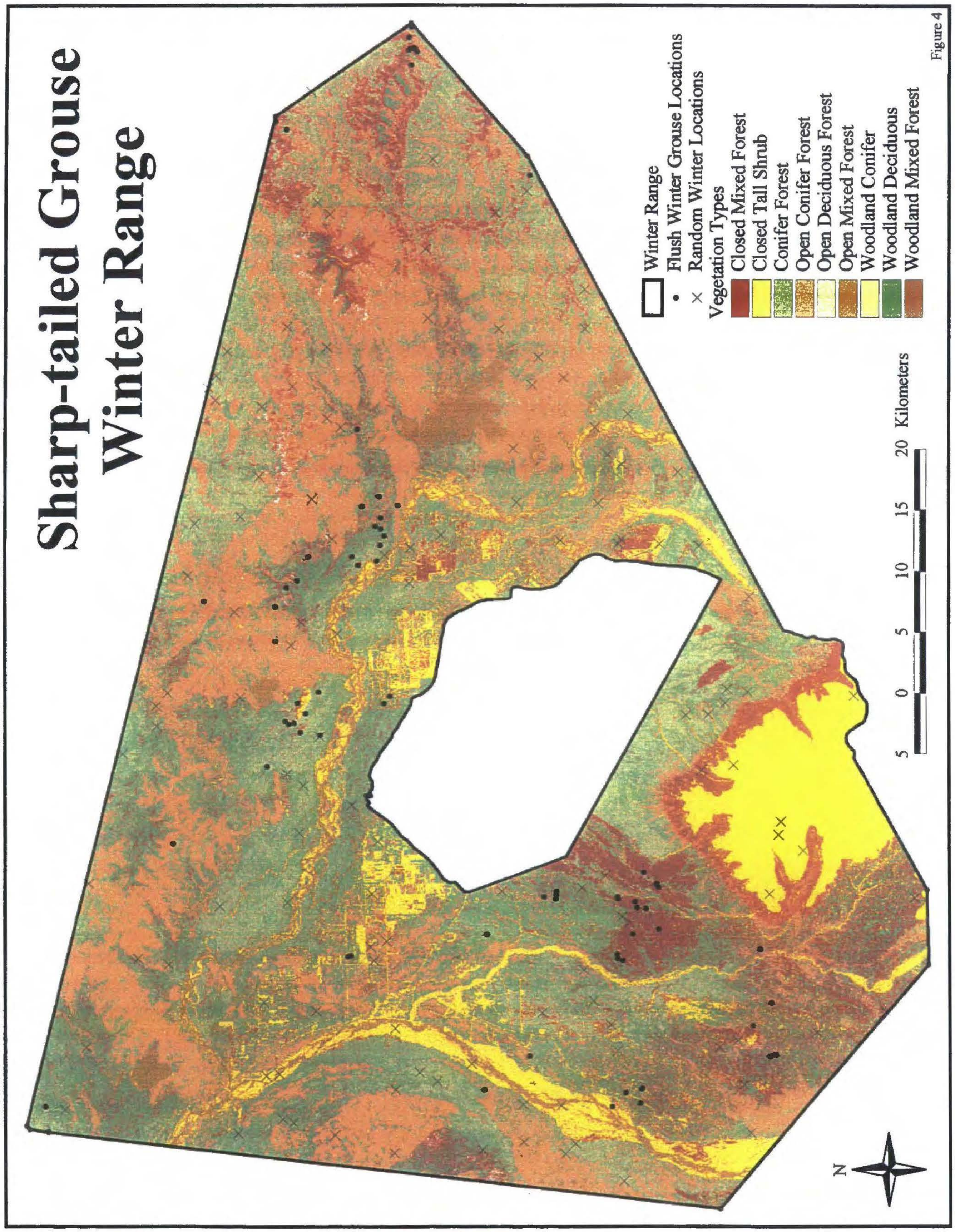

Figure 4. Distribution of sharp-tailed grouse location points and random points within the winter range.

Home Range

Home ranges were determined using data obtained from time of capture until mortality, transmitter loss, or radio failure. Summer and winter home range data were pooled for 15 birds (13 males and 5 females), which survived at least 4 weeks after trapping and were located ≥ 5 times, and their home ranges were calculated. Summer birds provided home range data strictly in the DAP. Summer home range size and habitat composition for 5 sharp-tailed grouse are shown in Table 1. Mean home range size for this group of birds was 1106 ± 1495 ha. There was a high degree of variability and low number of observations; therefore there was a high degree of uncertainty in summer home range sizes. The t-test analysis showed significant differences between the summer and winter home range size ($t\ (16\ df) = -4.9$, $p < 0.05$).

Table 1. Summer home range of 5 sharp-tailed grouse on the Delta Agriculture Project, September 1998 through October 1999.

Bird No.	Frequency No.	Sex	No. Observations	Observation Period	Home Range Area (ha)
37	153.178	Female	5	06/12/99 to 09/07/99	3,077
42	153.241	Male	5	05/20/99 to 09/05/99	258
43	153.360	Male	6	05/20/99 to 09/16/99	62
44	153.109	Male	5	08/01/99 to 09/17/99	838
45	153.329	Male	7	05/21/99 to 09/17/99	1,294
					Mean = 1,106
					SD = 1,204
					Median = 838

The mean winter home range of 15,818 (SD = 8,379) was significantly greater than the mean of the summer home range size of 1,106 (SD = 1,204). Winter home range sizes for 10 sharp-tailed grouse are presented in Table 2. The overall winter home ranges include those birds that survived through the summer season and dispersed into their winter range, therefore movement patterns of individual birds from summer to winter is depicted as one home range. Mean home range during the winter was 15,819 ± 5,994 ha. There was a high degree of variability in the home range size and few observations; therefore there was more uncertainty in the estimated winter home range sizes. Home range sizes for the summer season were relatively small, but increased substantially in winter. The largest home range size for summer was 3,077 ha, and the largest winter home range was 33,062 ha.

Table 2. Winter home range of 10 sharp-tailed grouse in the Tanana Valley, Alaska, study area, September 1998 to April 2000.

Bird No.	Frequency No.	Sex	No. Observations	Observation Period	Home Range Area (ha)
17	153.120	Female	10	09/25/98 to 5/18/99*	19,829
22	153.240	Male	5	10/21/98 to 4/22/99	16,914
30	153.289	Male	5	02/19/99 to 07/03/99*	8,343
31	153.168	Male	18	05/10/99 to 03/09/00	7,545
33	153.221	Male	19	05/11/99 to 04/05/00	11,961
50	153.552	Female	8	09/18/99 to 01/21/00	16,233
52	153.429	Female	17	09/18/99 to 03/09/00	17,269
53	153.631	Female	10	09/20/99 to 02/15/00	22,603
55	153.312	Male	18	09/22/99 to 04/05/00	4,429
57	153.302	Male	14	09/23/99 t0 04/05/00	33,062
					Mean = 15,819
					SD = 8,379
					Median = 16,574

* Survived into the summer season.

Micro Habitat Analysis

Individual habitat preference by sharp-tailed grouse within the DAP did not differ for vertical cover when use versus availability were compared (Table 3). Bird flush and random location points were pooled for vertical cover for microhabitat analysis. Sharp-tailed grouse did not select or avoid these cover types and utilized them according to their availability.

Table 3. Number of samples in which vegetation types were detected for verticle cover on the Delta Agriculture Project, May 1999 to October 2000.

Habitat Type	Presence of Habitat		Chi-square	(p. < .05)	Habitat Utilization
	Flush (N=53)	Random (N=50)			
Aspen (*Populus spp.*)	28	22	0.400	0.527	Neutral
Birch (*Betula spp.*)	3	0	2.770	0.096	Neutral
Spruce (*Picea spp.*)	0	3	2.770	0.096	Neutral
Willow (*Salix spp.*)	11	9	0.576	0.448	Neutral

Individual habitat preference by sharp-tailed grouse within the DAP did not differ for horizontal cover when use versus availability were compared (Table 4). Sharp-tailed grouse did not select or avoid these cover types and utilized them according to their availability. Sharptails used these vegetation types in proportion to their availability.

Table 4. Number of samples in which vegetation types were detected for horizontal cover on the Delta Agriculture Project, May 1999 to October 2000.

Habitat Type	Presence of Habitat		Chi-square	(p. = < .05)	Habitat Utilization
	Flush (N = 53)	Random (N = 59)			
Aspen (*Populus spp.*)	24	26	0.793	0.373	Neutral
Birch (*Betula spp.*)	2	1	0.242	0.623	Neutral
Spruce (*Picea spp.*)	3	4	0.289	0.591	Neutral
Willow (*Salix spp.*)	24	23	0.085	0.771	Neutral

Habitat preference by sharp-tailed grouse within the DAP differed for ground cover when use and availability were compared (Table 5). Sharp-tailed grouse location data showed that barley was avoided more than expected, but fireweed and prickly rose were preferred more than expected ($p < 0.05$, Chi-square). The remaining ground cover types were not selected or avoided, but were utilized according to their availability.

Table 5. Ground cover types found at flush and random locations on the Delta Agriculture Project, May 1999 through October 1999.

Habitat Type	Presence of Habitat Flush (N = 53)	Presence of Habitat Random (N = 59)	Chi-square	(p. = < .05)	Habitat Utilization
Aspen (*Populus spp.*)	13	7	2.885	0.089	Neutral
Spruce (*Picea spp.*)	7	4	1.227	0.268	Neutral
Willow (*Salix spp.*)	32	32	0.290	0.591	Neutral
Bare Soil	33	36	0.000	0.992	Neutral
Litter < 1.27 cm	51	53	0.819	0.366	Neutral
Debris > 1.27 cm	26	22	1.361	0.243	Neutral
Bryophytes	25	21	1.338	0.247	Neutral
Barley (*Hordeum spp.*)*	0	6	5.799	0.016	**Avoid**
Bluejoint Grass (*Calamagrostis spp.*)	11	12	0.000	0.997	Neutral
Herb Grasses	44	46	0.215	0.643	Neutral
Blueberry (*Vaccinium spp.*)	8	4	1.918	0.166	Neutral
Kinnikinnik Berry (*Arctostaphylos uva-ursi*)	32	26	2.605	0.107	Neutral
Dwarf Birch (*Betula nana*)	0	1	0.923	0.337	Neutral
Labrador Tea (*Ledum spp.*)	10	4	3.579	0.058	Neutral
Fireweed (*Epilobium spp.*)*	25	12	8.626	0.003	**Prefer**
Horsetail (*Equisetum spp.*)	3	0	3.367	0.067	Neutral
Lupine (*Lupinus spp.*)	6	6	0.026	0.871	Neutral
Yarrow (*Achillea spp.*)	1	0	1.102	0.294	Neutral
Foxtail Grass (*Alopecurus alpinus*)	1	0	1.102	0.294	Neutral
Prickly Rose (*Rosa acicularis*)*	12	4	5.532	0.019	**Prefer**
Fern (*Athyrium spp.*)	2	0	2.225	0.136	Neutral
Dwarf Dogwood (*Cornus canadensis*)	4	4	0.017	0.897	Neutral
Lichen	2	1	0.440	0.507	Neutral
Fleabane (*Erigeron spp.*)	1	0	1.102	0.294	Neutral
Snow	0	1	0.923	0.337	Neutral

* Significant avoidance or preference.

Habitat preference by sharp-tailed grouse within the DAP differed for stem density when use and availability were compared (Table 6). Sharp-tailed grouse location data and ground cover results (Table 5) showed that aspen and prickly rose were preferred more than expected ($p < 0.05$, Chi-square). All other vegetation types were used in proportion to their availability.

Table 6. Stem density measurements for sharp-tailed grouse flush sites compared to random locations within the Delta Agriculture Project from May to October 1999.

Habitat Type	Presence of Habitat Flush (N = 53)	Random (N = 59)	Chi-square	(p. < .05)	Habitat Utilization
Aspen*	47	41	6.105	0.013	**Prefer**
Birch	10	9	0.259	0.611	Neutral
Willow	45	48	0.250	0.617	Neutral
Prickly Rose*	12	3	5.186	0.023	**Prefer**
Labrador Tea	0	3	2.769	0.096	Neutral
Barley	1	0	1.123	0.289	Neutral
Fireweed	1	0	1.123	0.289	Neutral

* Significant avoidance or preference.

Habitat Availability

Availability of both summer and winter habitat is quantified as the area of each habitat type in the study area. Habitat selection analyses identified 22 habitat types in the summer range and 28 habitat types in the winter range, which were derived from an existing ADNR classification list. The availability of these habitat types in the study area is shown numerically in Table 7 and Table 8. The spatial distribution of habitat availability is displayed in Figure 4 and graphically in Figure 5.

Table 7. .Summer habitat types listed along with acronyms that were available to sharp-tailed grouse on the Delta Agriculture Project, September 1998 to April 2000.

Habitat Type	Summer Area (ha)	Percent of Area (ha)
Black Spruce Conifer-Forest (BSC)	33.06	0.07
White Spruce Conifer-Forest (WSC)	911.25	2.06
Tamarack Conifer-Forest (TC)	241.50	0.54
Black Spruce Open Confer-Forest (BSOC)	125.93	0.29
White Spruce Open Conifer-Forest (WSOC)	1128.37	2.55
Black Spruce Tamarack Open Conifer-Forest (BSTOC)	396.56	0.90
Tamarack Open Conifer-Forest (TOC)	5.56	0.01
White Spruce Woodland Conifer-Forest (WSWC)	11.00	0.03
Aspen Open Deciduous-Forest (BPOD)	1.37	0.00
Paper Birch Open Deciduous-Forest (PBOD)	62.75	0.14
Aspen Open Deciduous-Forest (AOD)	6397.00	14.46
Birch Aspen Open Deciduous-Forest (BAOD)	0.31	0.00
Aspen Woodland Deciduous-Forest (BPWD)	14742.31	33.32
Paper Birch Woodland Deciduous-Forest (PBWD)	1625.25	3.67
Black Spruce Aspen Closed Mixed-Forest (BSACM)	642.06	1.42
White Spruce Birch Closed Mixed-Forest (WSBCM)	667.93	1.51
Black Spruce White Spruce Birch Closed Mixed-Forest (BSWSBCM)	1363.68	3.08
Black White Spruce Aspen Closed Mixed-Forest (BSWSACM)	2864.25	6.47
Black Spruce Birch Open Mixed-Forest (BSBOM)	27.93	0.06
White Spruce Birch Open Mixed-Forest (WSBOM)	35.12	0.08
Black Spruce Birch Woodland Mixed-Forest (BSWM)	48.56	0.11
Willow Closed Tall Shrub-Shrubland (WCTS)	12899.87	29.16

Table 8. Winter habitat available to sharp-tailed grouse on the Tanana Valley study area, September 1998 through April 2000.

Habitat Type	Winter Area (ha)	Percent of Area (ha)
Black Spruce Conifer-Forest (BSC)	1628.00	0.42
White Spruce Conifer-Forest (WSC)	21811.94	5.69
Black Spruce-White Spruce Conifer-Forest (BSWSC)	3760.56	0.98
Black Spruce Tamarack Confer-Forest (BSTC)	128.25	0.03
Tamarack Conifer-Forest (TC)	4952.13	1.29
Black Spruce Open Conifer-Forest (BSOC)	3457.56	0.9
White Spruce Open Conifer-Forest (WSOC)	51740.56	13.49
Black Spruce-White Spruce Open Conifer-Forest (BSWSOC)	2.13	0.00
Black Spruce Tamarack Open Conifer-Forest (BSTOC)	37051.25	9.66
Tamarack Open Conifer-Forest (TOC)	362.81	0.10
Black Spruce Woodland Conifer-Forest (BSWC)	1626.60	0.47
White Spruce Woodland Conifer-Forest (WSWC)	94.38	0.03
Balsam Poplar Open Deciduous-Forest (BPOD)	159.81	0.04
Paper Birch Open Deciduous-Forest (PBOD)	469.19	0.12
Aspen Open Deciduous-Forest (AOD)	53553.75	13.96
Birch Aspen Open Deciduous-Forest (BAOD)	2162.44	0.56
Balsam Poplar Woodland Deciduous-Forest (BPWD)	81928.75	21.36
Paper Birch Woodland Deciduous-Forest (PBWD)	9562.75	2.49
Black Spruce Aspen Closed Mixed-Forest (BSACM)	13992.50	3.6
White Spruce Birch Closed Mixed-Forest (WSBCM)	7549.81	1.97
Black Spruce White Spruce Birch Closed Mixed-Forest (BSWSBCM)	14718.00	3.84
Black Spruce White Spruce Aspen Closed Mixed-Forest (BSWSACM)	8375.81	2.18
Black Spruce Birch Open Mixed-Forest (BSBOM)	5873.13	1.53
White Spruce Birch Open Mixed-Forest (WSBOM)	7116.94	1.86
Black Spruce Birch Woodland Mixed-Forest (BSBWM)	496.38	0.13
Willow Closed Tall Shrub-Shrubland (WCTS)	46337.31	12.08
Alder Closed Tall Shrub-Shrubland (ACTS)	28.88	0.01
Alder Willow Closed Tall Shrub-Shrubland (AWCTS)	4576.56	1.19

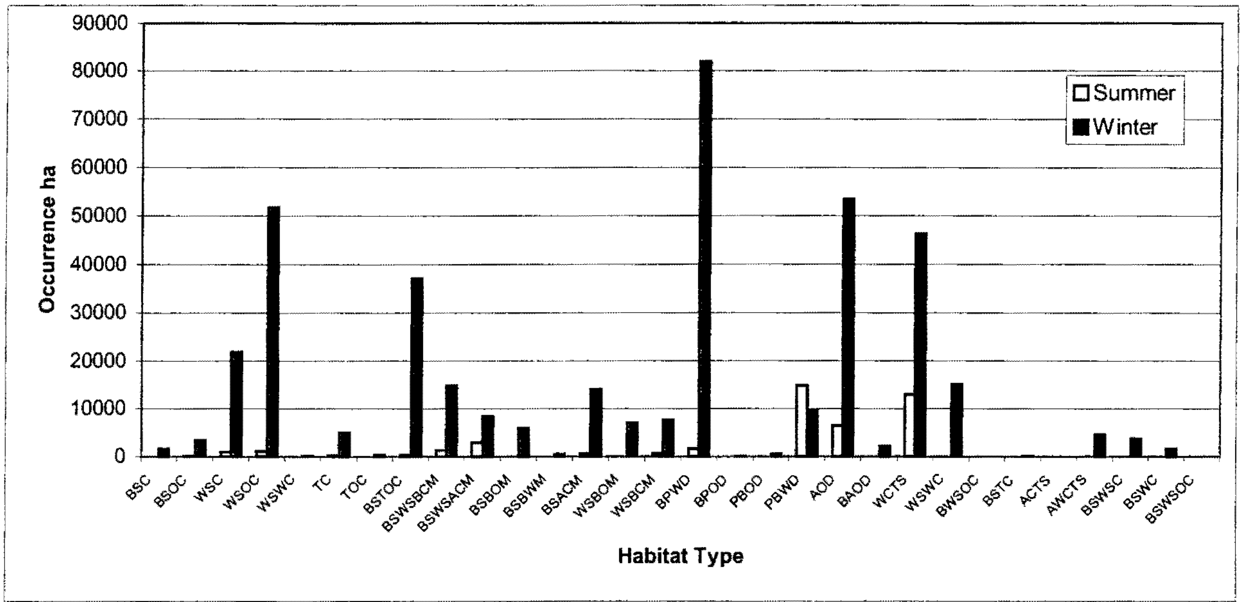

Figure 5. Summer and winter habitats available to sharp-tailed grouse on the Tanana Valley study area, September 1998 to April 2000 (see Tables 7 and 8 for description of habitat types).

Macro Habitat Analysis At The 25-Meter Scale

Habitat preference by sharp-tailed grouse within the summer range differed for habitat types when use and availability were compared at the 25-meter scale (Table 9). The high chi-square statistic and low significance values for PBWD, AOD, and WSCC (see Table 7 and Table 8 for acronym descriptions) indicate habitat selection for these cover types exists. Sharp-tailed grouse location data showed that use of AOD and WSCC were avoided more than expected, but use of PBWD was preferred more than expected. All other habitat types were neutral and were utilized in proportion to their availability (Figure 6).

Table 9. Summer habitat preference and avoidance at the 25 m scale by sharp-tailed grouse for 13 habitat types on the Tanana study area, Alaska, September 1998 to April 2000.

Habitat Type	Presence of Habitat Flush (N = 170)	Random (N = 170	Chi-square	(p. < .05)	Habitat Utilization
BPWD	54	57	0.120	0.729	Neutral
WCTS	64	48	3.409	0.065	Neutral
WSOC	3	3	0.000	1.000	Neutral
PBWD*	23	6	10.895	0.001	**Prefer**
AOD*	7	28	14.046	0.000	**Avoid**
WSBCM	1	1	0.000	1.000	Neutral
BWSBCM	4	5	0.114	0.735	Neutral
BSTOC	2	0	2.012	0.158	Neutral
BWSACM	11	13	0.179	0.672	Neutral
BSBCM	1	3	1.012	0.314	Neutral
BSBOM	0	1	1.003	0.317	Neutral
WSCC*	0	4	4.048	0.044	**Avoid**
TCC	0	1	1.003	0.317	Neutral

* Significant avoidance or preference.

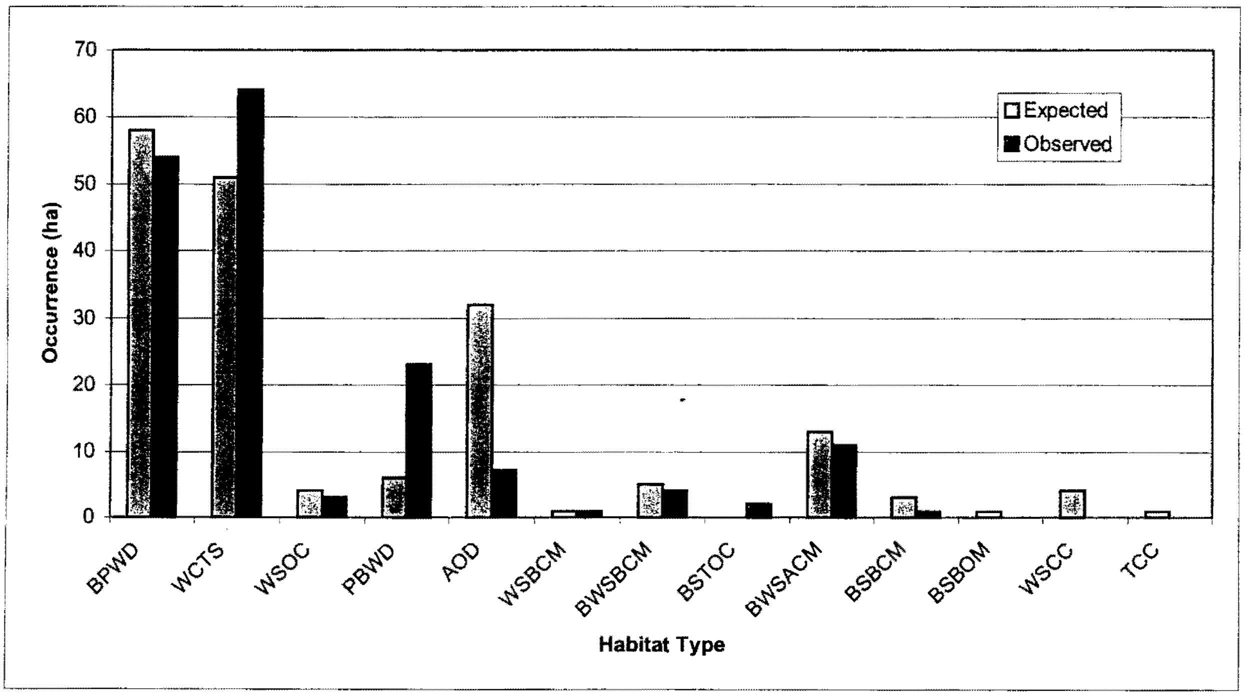

Figure 6. Habitat types present within the summer range at the 25 m scale, in the Tanana Valley study area, September 1998 to April 2000.

Habitat preference by sharp-tailed grouse within the winter range differed for habitat types (Table 10). Sharp-tailed grouse location data showed that use of BSBOM and BSWSACM was preferred more than expected ($p < 0.05$, Chi-square). All other habitat types were utilized in proportion to their availability (Figure 7).

Table 10. Winter habitat preference and avoidance at the 25 m scale by sharp-tailed grouse for 13 habitat types on the Tanana Valley study area, Alaska.

Habitat Type	Presence of Habitat Flush (N = 99)	Random (N = 99)	Chi-square	(p<.05)	Habitat Utilization
BPWD	22	28	0.963	0.326	Neutral
AOD	17	16	0.036	0.849	Neutral
BSTOC	5	12	3.153	0.076	Neutral
WSBOC	8	15	2.41	0.121	Neutral
BSBOD*	12	3	5.843	0.016	**Prefer**
BSBOM	1	0	1.005	0.316	Neutral
WCTS	9	9	0.000	1.000	Neutral
BSWSACM*	12	0	12.774	0.000	**Prefer**
WSCC	2	7	2.91	0.088	Neutral
BWSBCM	3	1	1.021	0.312	Neutral
WSBCM	2	3	0.205	0.651	Neutral
PBWD	4	2	0.688	0.407	Neutral
WSBOM	0	2	2.02	0.155	Neutral

* Significant avoidance or preference.

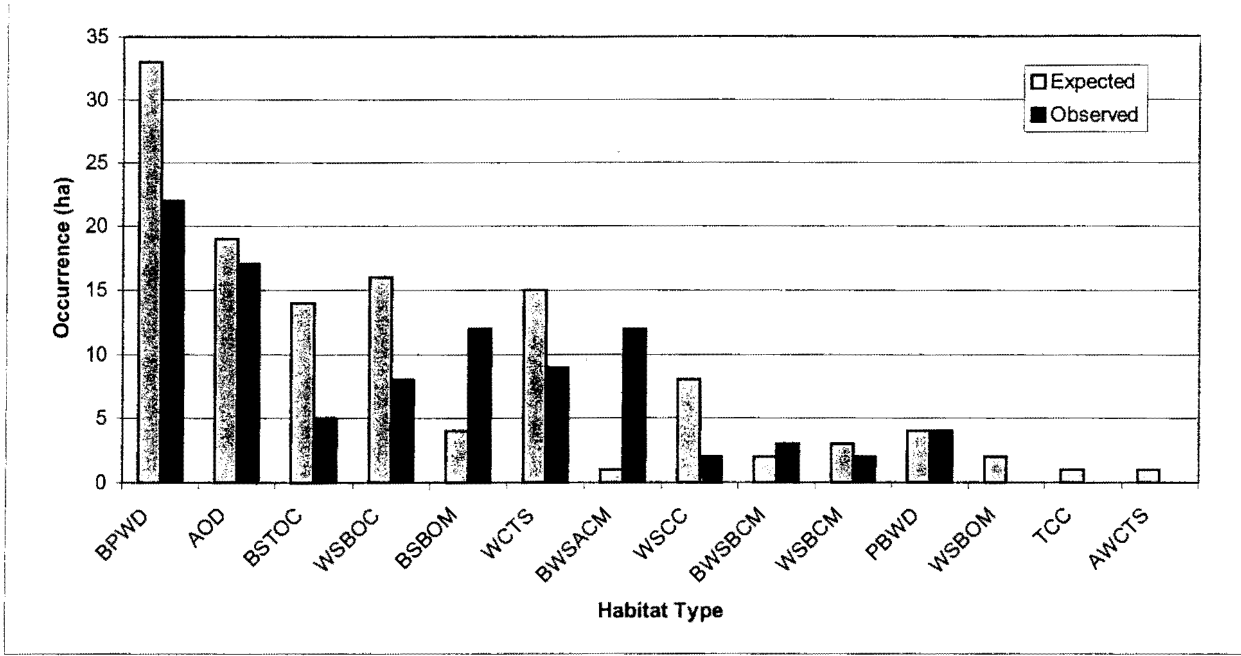

Figure 7. Habitat types present within the winter range at the 25 m scale, in the Tanana Valley study area, September 1998 to April 2000.

Macro Habitat Analysis At The 100-Meter Scale

Sharp-tailed grouse avoided AOD in their summer range, at the 100 m scale (Table 11). Habitat preference by sharp-tailed grouse within the summer range differed when use and availability were compared. The high chi-square statistic and low significance value for AOD indicates that selection for these habitat types exist, whereas all other habitat types within the summer range were utilized in proportion to their availability (Figure 8).

Table 11. Summer habitat preference and avoidance by sharp-tailed grouse for 11 habitat types at the 100-meter scale on the Tanana study area, Alaska, September 1998 to April 2000.

Habitat Type	Presence of Habitat		Chi-square	(p. < .05)	Habitat Utilization
	Flush (N = 170)	Random (N = 170)			
BPWD	60	67	0.616	0.433	Neutral
AOD*	8	21	6.371	0.012	**Avoid**
WCTS	69	54	2.866	0.090	Neutral
BSTOC	1	0	1.003	0.317	Neutral
WSOC	4	3	0.146	0.703	Neutral
PBWD	12	5	3.034	0.082	Neutral
BSWSACM	11	14	0.389	0.533	Neutral
WSCC	0	3	3.027	0.082	Neutral
BSBCM	3	0	3.027	0.082	Neutral
WSBOM	0	2	2.012	0.156	Neutral
BSWSBCM	2	1	0.336	0.562	Neutral

* Significant avoidance or preference.

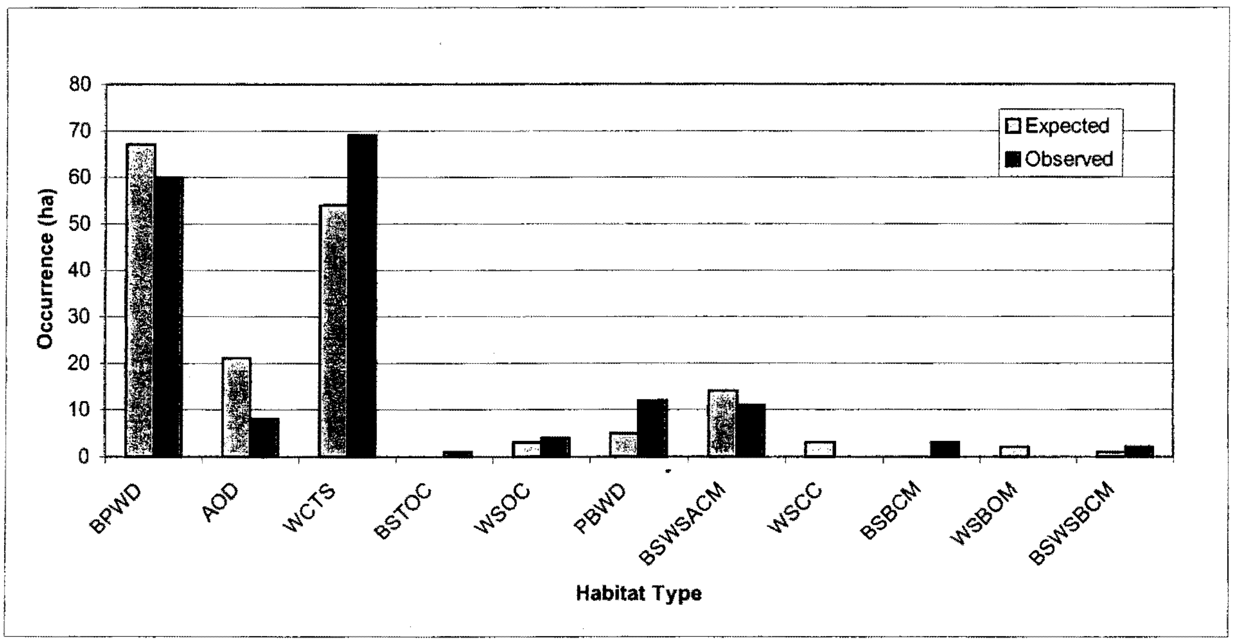

Figure 8. Habitat types present within the summer range at the 100 m scale, in the Tanana Valley study area, September 1998 to April 2000.

Habitat preference by sharp-tailed grouse within the winter range differed for habitat types when use and availability were compared (Table 12). Sharp-tailed grouse location data showed that use of BSTOC and WSOC was avoided more than expected, but BSWSACM was preferred more than expected. All other habitat types were utilized in proportion to their availability (Figure 9).

Table 12. Winter habitat preference and avoidance by sharp-tailed grouse for 12 habitat types at the 100-meter scale on the Tanana Valley study area, Alaska, September 1998 through April 2000.

Habitat Type	Presence of Habitat Flush (N = 99)	Random (N = 99)	Chi-square	(p < .05)	Habitat Utilization
BPWD	36	29	1.122	0.289	Neutral
AOD	9	14	1.230	0.267	Neutral
WCTS	18	11	1.980	0.159	Neutral
BSTOC*	3	12	5.843	0.016	**Avoid**
WSOC*	3	18	1.985	0.001	**Avoid**
PBWD	3	3	0.000	1.000	Neutral
BSWSACM*	16	1	14.478	0.001	**Prefer**
WSCC	2	4	0.688	0.407	Neutral
BSBCM	6	4	0.421	0.516	Neutral
BSOC	2	0	2.020	0.155	Neutral
WSBOM	0	1	1.005	0.316	Neutral
TCC	0	1	1.005	0.316	Neutral

* Significant avoidance or preference.

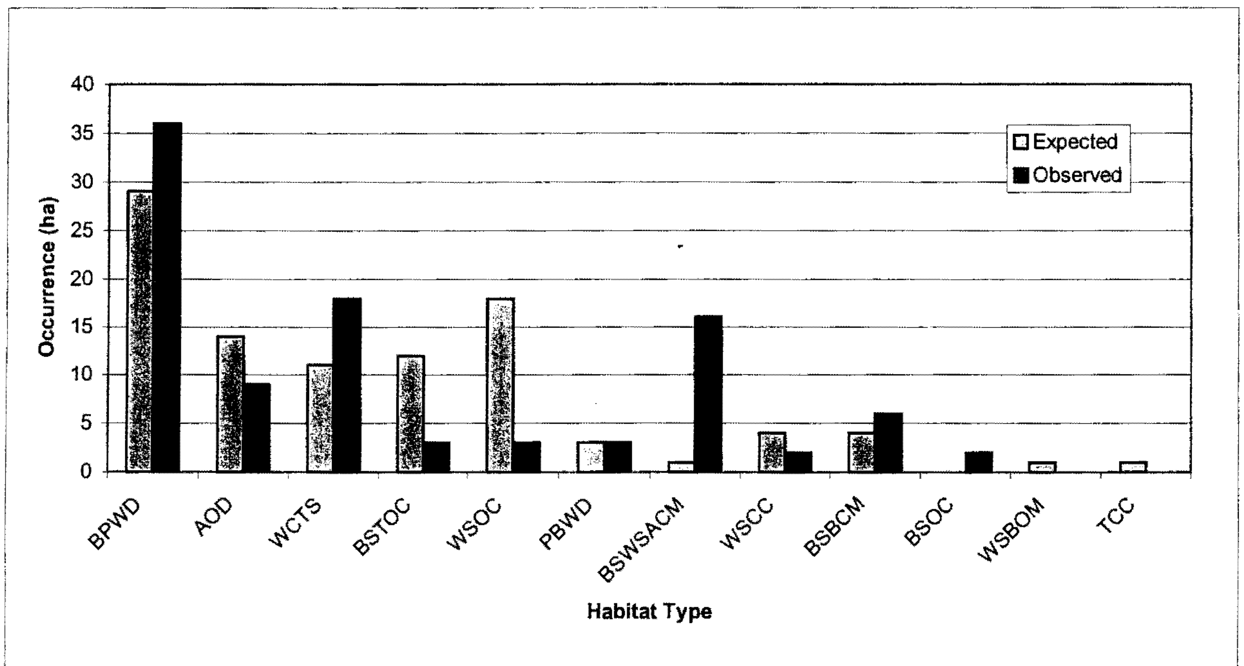

Figure 9. Habitat types present within the summer range at the 100 m scale, in the Tanana Valley study area, September 1998 through April 2000.

The use of habitats by sharptails differed between summer and winter range as well as between scales with respect to habitat types (Table 13). In summer, birds tended to prefer PBWD in the summer at the 25 m scale, but used it in proportion to its availability at the 100 m scale. In summer, birds completely avoided AOD at both scales, while WSCC was avoided the 25 m scale and used in proportion to its availability within the 100 m scale. In winter, BSWSACM habitats were preferred at both scales, but WSOC, PBWD, and BSTOC were avoided at the 100 m scale.

Table 83. Habitat use comparisons for sharp-tailed grouse between summer and winter range and at the 25- and 100-meter scale in the Tanana Valley study area, September 1998 through April 2000.

Habitat Type	25 m Summer	25 m Winter	100 m Summer	100 m Winter
BPWD	Neutral	Neutral	Neutral	Neutral
WCTS	Neutral	Neutral	Neutral	Neutral
WSOC	Neutral	a	Neutral	**Avoid**
PBWD	**Prefer**	Neutral	Neutral	Neutral
AOD	**Avoid**	Neutral	**Avoid**	Neutral
WSBCM	Neutral	Neutral	Neutral	a
BSWSBCM	Neutral	Neutral	Neutral	a
BSTOC	Neutral	Neutral	Neutral	**Avoid**
BSWSACM	Neutral	**Prefer**	Neutral	**Prefer**
BSBCM	Neutral	a	Neutral	Neutral
BSBOM	Neutral	Neutral	a	a
WSCC	**Avoid**	Neutral	Neutral	Neutral
TCC	Neutral	a	a	Neutral
WSBOC	Neutral	a	a	a
BSBOD	a	**Prefer**	a	a
BSOC	a	a	a	Neutral
WSBOM	a	Neutral	Neutral	Neutral

a = no habitat data

DISCUSSION

Summer Habitat

Grouse were found predominantly in the DAP during summer and exclusively outside of the DAP during winter. In interior Alaska, seasons are variable with long, cold winters and relatively short warm summers. Although there is a short transition thaw and freeze period between summer and winter it is not classified as a true spring or fall, but are referred to as breakup and freeze-up. Essentially there are only 2 seasons (summer and winter) and sharp-tailed grouse are found in habitats specifically associated with these 2 seasons.

Habitat quality appears to be a vital component in determining whether or not an area is suitable for Alaskan sharp-tailed grouse. Habitat selection is not well documented for Alaskan sharptails, but during summer and winter, birds utilize a variety of habitat types in interior Alaska. In summer (April to September), sharp-tailed grouse were distributed randomly relative to available habitat types except for paper birch open deciduous forests, open aspen deciduous forests, white spruce closed conifer, and white spruce birch closed mixed forests. They preferred paper birch deciduous habitats and avoided open aspen forests, white spruce closed, and closed mixed forests.

Sharp-tailed grouse prefer paper birch habitats (Table 13) due to the diversity in vegetatative species and structure and the presence of canopy cover > 50%, all of which contribute to providing escape cover from avian predators. Open paper birch habitats contain low shrub layers composed primarily of prickly rose, high bush cranberry, and dwarf shrubs such as low bush cranberry (Viereck et al. 1992). The herb layer is dominated by bluejoint and horsetail grasses. Low shrub, dwarf shrub berries and leaves may constitute important food items and grass and forbs may play a role in ground concealment as well as food in late summer. At the microhabitat scale, sharp-tailed grouse may use traditional areas between habitat types (i.e., habitat edges), especially when the area contains a variety of vegetative species including prickly rose and fireweed (Table 3). With respect to vegetation, many researchers have reported that grouse often select sites with more and taller herbaceous and woody cover (Giesen 1987, Marks and Marks 1987, Meints 1991), possibly because these sites provide food and escape cover. Rose hips may be an important food for grouse in late summer and because fireweed grows over a meter in height in dense patches in open areas, it may serve as low level cover when grouse forage for food in fields.

The food habits and nutritional requirements of sharp-tailed grouse are not well documented, but grasses, insects, and fruits of various shrub species may be important foods during late summer that are found in open paper birch deciduous habitats. Sidle (1986) examined 14 Alaskan sharptail crops in late summer and found 50% lowbush cranberry, 14.0% rose hips, 7.0 % birch leaves, and 7.0% birch catkins and buds contained within the crops. In South Dakota, Aldous (1943) listed the contents of 15 gizzards and 15 crops of Plains sharp-tailed grouse (*T. p. jamesi*) and found the most important food was the fruit of wild rose (*Rosa woodsii*). Parker (1970) concluded that 90% of the annual food supply of Columbian sharp-tailed grouse (*T. p. columbianus*) is comprised of forbs, grasses, fruits, buds and seeds, and the other 10% is comprised of insects. From 70 hunter-donated crops harvested from the DAP and examined in 1998, kinniknnik berry constituted 60%, grasshoppers (Orthoptera) 20%, lowbush cranberry 10%, blueberry 3%, barley 5%, and unidentified vegetation 2% of the estimated percent of volume of all the crop contents. In 1999, a high frequency of prickly rose fruit (rose hips), lowbush cranberry, and blueberries were found within 74 crops from grouse harvested in the DAP.

The study birds strongly avoided aspen, open, deciduous habitat types. These habitat types are dominated by large stands of quaking aspen (*Populus tremuloides*) and occur in dry sites on steep, south-facing slopes and along riverbanks in interior Alaska (Viereck et al. 1992). These observations agree with Moyles (1981) who recorded that sharp-tailed grouse use of display areas decreased as the percentage of aspen cover increased in the parklands of Alberta. Similiarly, in Manitoba, Caldwell (1976) noted that grouse ceased to use areas when there were low densities of grasses.

In summer, sharptails were usually observed within the DAP where the topography is relatively uniform and the vegetation is relatively homogenous within a mosaic of agriculture fields and windrows dominated by willow, forbs, grass, and shrubs. The preponderance of bird observations in the DAP suggests that the summer habitat type preferred by Alaskan sharp-tailed grouse is likely WCTS, which is characterized as shrubland containing 75% shrub cover (principally willow) taller than 1.5 m with a diversity of low shrubs, forbs, grasses, and mosses (Viereck et al. 1992). Although several rivers and hills border the DAP, sharptails were not observed in these areas. It is possible that in summer, sharptails avoided open aspen forest habitats because they tended to prefer tall shrubland habitats associated with agriculture fields that provided all the necessary resource components needed for survival and other activities such as cover, courtship, nesting, brood rearing, and food. However, during the summer months, vegetation types found within the DAP were used by grouse in proportion to its availability, indicating no selection was occurring for willow shrub habitat types (Table 9).

Mating areas (leks) are typically located on benches, knolls, or ridge tops that are slightly higher than surrounding topography (Sisson 1976) and possibly used by gouse for visibility for mate attraction and to detect predators. In Wisconsin, Grange (1948) found that Plains sharp-tailed grouse selected wild hay meadows, marshes, abandoned fields, cultivated fields, and upland grasslands for lek sites. Klott and Lindzey (1990) reported similar findings for Columbian sharp-tailed grouse, which chose lek sites with higher visibility over random locations more than expected (65% vs. 32%) and contained higher densities of shrub cover, forbs, tall shrubs, and grasses. Of the 5 lek sites found in the study area, all but one was located in abandoned fields similar to that described by Grange (1948). The lek sites were vegetated by short native grass and low shrubs located approximately 10-50 m from stands (windrows) of aspen and willow < 16 years old. The largest single lek was located on a knoll overlooking both abandoned and cultivated fields approximately 50 m from a young aspen/willow stand.

Although nesting behavior was not a focus of this study, 3 nests were located. Habitat selection for nests varied within the DAP. Nests were found on the ground in open fields composed of low shrub and grassess, along habitat edges, and on a debris pile at the edge of a field. Meints et al. (1992) suggested that Columbian sharp-tailed grouse need a minimum vegetative height of ≥ 25 cm for nesting. McArdle (1976) found that shrubs were important cover types throughout the nesting period. He reported that 77% of birds he found were in 20-40% shrub cover. Preferred nest sites were characterized by more cover, such as taller grasses, forbs, and shrubs (Kobriger 1980, Giesen 1987, Marks and Marks 1987, Meints 1991). Shrub density at nests ranged from 11,000 shrubs/ha in Idaho (Meints 1991) to 32,500 shrub/ha in Colorado (Giesen 1987).

In summer, sharp-tailed grouse avoided WSBSCM and WSCC habitat types. These finding are consistent with reports on sharp-tailed grouse throughout their range (Amman 1957, Moyles 1981, Johnsgard 1983, Swenson 1985, Gratson et al. 1990, Giesen 1997). There may be several possible reasons why sharptails avoid these habitat types, but the likely reason is that these areas contain less floral diversity and contain fewer food resources.

Winter Habitat

Sharp-tailed grouse habitat requirements are restricted in winter more than any other time of the year; therefore availability of winter habitat is probably a factor, which determines whether an area will support sharp-tailed grouse populations (Marks and Marks 1987). In winter (October to March), sharp-tailed grouse avoided BSWSACM, BSBOD, WSOC, PBWD, and BSTOC relative to available habitat types. They preferred BSWSACM and BSBOD, but avoided WSOC, PBWD, and BSTOC (Table 10, Figure 7, Table 12, Figure 9, and Table 13).

The onset of winter caused a substantial shift in habitat use by grouse. Sharp-tailed grouse completely vacated the summer range and moved into their winter range containing more woody, dense cover habitat types after the first snowfall and when leaves were shed from deciduous trees. Swenson (1985) observed a similar, apparently forced movement of birds from croplands to trees and shrubs in Montana after the first snowfall. Marks and Marks (1988) reported that grouse decreased their use of sagebrush-grass land and increased their use of mountain shrub and riparian cover types in winter. Woody habitats may be essential for survival in winter because they provide adequate sources of food and shelter from weather and predators above snow accumulations. No birds were observed in the DAP from approximately mid-October until early to mid-April.

Grouse preferred BSBOD habitat types, which can be classified as "muskeg" and habitats located at higher elevations up to approximately 650 m. Weeden (1965) characterized muskeg as areas with cold wet soils with tussock formations over wide areas that commonly contain low woody plants such as Labrador tea, lowbush cranberry, blueberry, and cloudberry, and low shrubs such as alder, dwarf birch, and willows, which are present in large quantities. Occasional islands of black spruce and birch occur throughout muskeg. In the aspen parklands of Alberta, Moyles (1981) noted that grouse preferred marsh vegetation in winter where sedges and willows provided cover and food. Marks and Marks (1986) and Meints (1991) observed Columbian sharp-tailed grouse closely associated with deciduous trees and riparian areas during winter. Although grouse in this study avoided WSOC and PBWD habitat types, in Wisconsin, Gratson et al. (1990) found that male sharptails used a greater percentage (deciduous woods and open coniferous woods) during the winter months than any other season.

In winter, closed aspen mixed spruce habitats were preferred at both the 25 m and 100 m scales. The closed aspen mixed forest stands commonly develop after fires (Viereck et al. 1992) and the sucessional stage of these stands may provide the necessary balance of cover and food requirements for maintenance in winter. Weeden and Ellison (1968) describe important Alaskan sharp-tailed grouse winter foods as buds and catkins of birch, aspen, and willow along with berries and fruits, which are commonly found in these stands. During winter in Colorado, Giesen and Connelly (1993) found a similar pattern of use of upland buds and berries of native shrubs including hawthorn, birch, aspen, chokecherry (*Prunus virginiana*), wild rose, willow, and snowberry (*Symphoricarpos occidentalis*) for winter sustenance. Swensen (1985) identified that silver buffaloberry (*Sherpherdia argentea*), skunkbush sumac (*Rhus triloata*), Russian olive (*Elaeaghus angustifolia*), and creeping juniper (*Juniperus horizontalis*) were the most important trees and shrubs for foraging grouse in Montana. Overall, it was hypothesized that the most important food for Alaskan sharp-tailed grouse in winter was dwarf birch because the greatest percentage of winter sharp-tailed grouse observations were directly related to the location of this species. These findings were supported with visual observation, tracks in the snow, and from large amount of plants that showed signs of browse.

Home Range Size and Sharp-tailed Grouse Movements

Home range was characterized in three ways. The overall range (population range) was determined from extent of bird movement between the two seasons. Seasonal range was based on location points during summer or winter. Unfortunately, no home range data for Alaskan sharp-tailed grouse is available to compare with the study birds.

The home range sizes of the Alaskan sharp-tailed grouse are larger than other sharptail subspecies and may not be typical within the extent of the sharp-tailed grouse range. Possible reasons may be related to the amount that Alaskan birds have to travel to find suitable habitat for food and cover from predators. These findings needs further study to establish their validity. However, these results were compared to Gratson (1983) who reported an annual home range size of 593 ± 50 ha for prairie sharp-tailed grouse in Wisconsin, with an average summer home range size of 82 ha. In Minnesota, Artmann (1970) found that spring and summer home range for female grouse ranged from 13 to 105 ha. In North Dakota, broods ranged 32 to 200 ha in summer (Christenson 1970, Marks and Marks 1986). Summer movements of study birds were generally limited to the DAP where a combination of agriculture fields, old fields, and willow shrub were used.

The onset of winter brought about a discernible shift into woody habitat types in all directions outside the DAP. Overall, the mean winter home range size was considerably larger than summer home range sizes. A possible explanation for the large mean winter home range size is the distribution of dwarf birch. Anecdotal observations suggest that dwarf birch buds are the primary food during winter and birds may disperse widely to areas where dwarf birch is found in high densities. These large winter home range sizes are not consistent with other studies and may be an anomaly, but may also be a characteristic specific to Alaskan sharp-tailed grouse. Other authors reported smaller winter home range sizes. In the Tobacco Valley in Montana, Cope (1992) observed an increase in the home range size during winter with a mean winter size of 638 ha. Also in Montana, Northrup (1991) reported a combined fall/winter home range size of 268 ha. While in Idaho, Ulliman (1995) reported median home range sizes of 59 to 187 ha during mild and typical winters respectively.

Little information is available documenting Alaskan sharp-tailed grouse movements between summer range and winter habitat. Grouse movements were large from summer to winter areas. During the winter, 7 birds traveled distances that were greater than 30 km. The largest movement was 65 km by bird 55, which spent the winter on a fire-scarred southeast-facing slope at an elevation of approximately 650 m. The habitat was composed of BSWSACM and BSBOD habitat types with large patches of low shrubs containing a high density of dwarf birch.

The overall movement of the study birds to winter habitats appears to be much larger when compared to the range of the species. From the literature it appears that long distance movements by sharp-tailed grouse are usually rare and that birds generally remain in the vicinity of their summer range. Though Amman (1957) reported that a banded adult male grouse moved 87 km from its capture site in Michigan, other authors report smaller movements. Marks and Marks (1986) reported that sharptails moved 4.5 km between breeding and winter habitats in western Idaho. Also in Idaho, Meints (1991) documented two hens moving as much as 20 km. In

Montana, Northup (1991) found that 95% of males remained within 3.1 km of their capture site, whereas females were relocated within 4.5 km during winter. Ulliman (1995) found that females moved a median distance of 3.3 to 3.4 km and males moved 0.6 km to 2.0 km depending upon the severity of the winter. The distribution and availability of winter food, such as buds and fruits of deciduous trees and shrubs "appears to explain" the extent of grouse movement between summer and winter ranges.

Management Implications

Relatively few problems have arisen concerning the status of sharp-tailed grouse populations in eastern interior Alaska, but local habitat removal and hunting are two potential problems that may affect sharptails in the future. In general, populations appear to be stable, unlike some subspecies in the contiguous United States and portions of Canada where populations are being threatened due to habitat changes. Habitat disturbance with the creation of large-scale farmland such as the Delta Agriculture Project has improved sharptail habitat, increasing rather than diminishing grouse numbers. The assemblage of fields and windrows found in the agriculture lands and its close proximity to wintering habitats seem to be a perfect blend supporting the sharptail's life cycle. Recently, however, there has been a move by a few Delta area farmers to actively cut down windrows, to increase farmland. These areas, in combination with fields in various stages of early succession, are optimal sharp-tailed grouse habitat. The long-term effect of the habitat loss could be detrimental to sharptail populations depending upon the scale and rate of the habitat removal.

Until now no formal investigations have been made into the life history of the sharp-tailed grouse in Alaska. Many more aspects of sharptails and their interaction with other animals and plants need to be studied, some of which may be of vital importance to resource managers.

In the future, however, humans may affect the welfare of the sharptail through population growth and industrialization causing changes in the availability of suitable habitat.

Hunting

Alaska game regulations for sharptails provides for liberal hunting seasons and harvest levels, allowing up to 15 grouse to be harvested with possession of 30 per day from August through November (Alaska Hunting Regulations 2000). The number of hunters and the affects they have on sharptail populations are largely unknown; there is little data to indicate what affects current seasons and bag limits have on sharp-tailed grouse populations. Unrestricted harvest of Columbian sharptails was a factor leading to the decline of the subspecies (Ulliman 1995) and over time, the effects of unrestricted seasons and harvest could be harmful to sharp-tailed grouse in Alaska. Begerud and Gratson (1988) found that hunted populations had higher losses, suggesting that hunting was additive to natural mortality. In Idaho, Marks and Marks (1987) state that sharp-tailed grouse are more vulnerable to hunting because males concentrate close to their leks during the fall hunting season However, where stable populations exist such as in Alaska, regulated hunting seasons and harvest will likely have little effect on long-term population viability.

Transplant

There has been interest by game bird societies and individuals to transplant sharp-tailed grouse into regions of Alaska where they currently do not exist. Transplanting game birds is not a new concept in Alaska; in fact it has been attempted 23 times with pheasants (*Phasianus spp.*), chukar (*Alectoris chukar*), spruce grouse (*Dendragapus canadensis*), blue grouse (*D. obscurus*), and ruffed grouse (*Bonasa umbellus*) from 1930 to 1996 (Burris and Knight 1973), of which all failed except possibly the relocation of ruffed grouse into southcentral regions from interior Alaska.

A capture and relocation of approximately 141 ruffed grouse was initiated by ADF&G in 1988 resulting in sustainable populations in GMU 14A, 14B, and 16A (Steen 1995). An additional 252 grouse were transplanted to the northern Kenai Peninsula, Alaska from 1997 to 1998. Prior to the relocation of these birds, ruffed grouse were not found in southcentral Alaska. Currently, ruffed grouse densities are increasing, as noted by harvest numbers and visual reports, suggesting that ruffed grouse are adapting to the areas they were transplanted. Because of the success in relocating ruffed grouse to new areas, a similar attempt could be feasible for sharp-tailed grouse providing that their habitat requirements and needs are met. Sharp-tailed grouse have been reintroduced successfully in Kansas by holding birds 3-9 weeks and releasing them onto artificial leks consisting of decoys, playback of lek recordings, and specially designed release boxes (Rodgers 1992). In Montana, Cope (1992) was able to transplant a small number of Columbian sharp-tailed grouse within the Tobacco Valley because the topography at the release site discouraged dispersal and habitat was of high quality. In Maine, however, sharptail transplants were unsuccessful due to a combination of bad release timing, poor habitat, too few birds, and adverse climate conditions (Applegate 1997).

This study has provided some insights into Alaskan sharp-tailed grouse requirements, but much more needs to be known. Before the relocation of sharp-tailed grouse from one geographic area to another can be attempted, a comprehensive policy on species relocation must be considered. The state of Alaska regulates its own transplant policies and the objectives of the transplant must fall within one or more of the following guidelines: 1) provide increased recreational hunting opportunities; 2) provide additional food supply; 3) provide economic gain;

4) reestablish a species; 5) preserve an endangered species, and 6) provide viewing opportunities (Burris and Knight 1973). A transplant could be successful if the following two requirements are met: 1) transplant sites provide sufficient and suitable habitats to support the transplanted species, and 2) prior studies show that the transplanted species will not be adversely affected and will not affect other species at the release site (Burris and Knight 1973).

Suggestions for Future Research

Research will be an important tool for effectively managing sharp-tailed grouse in Alaska. To manage Alaskan sharp-tailed grouse, managers should have a comprehensive knowledge of their seasonal habitat requirements and spatial and temporal patterns of resource selection. This information will be important in understanding how specific resources and habitat components affect the sharptails daily and seasonal movements and overall life history. Managers must also have a thorough knowledge of land use practices and their influence on the productivity and survival of sharp-tailed grouse.

Future experimental research may be necessary to identify impacts caused by habitat disturbance, habitat conversion, fragmentation, hunter harvest, and other land use practices such as prescribed burning, agriculture, and flood control as related to sharp-tailed grouse habitat use, dispersion, and productivity. Habitat restoration, population modeling, and population census may be important methods of research for identify these potential impacts. In order to fully understand the life history and ecology of the sharp-tailed grouse, studies should last longer, possibly as much five or more years.

The following are some suggestions for future research: sex ratio of breeding populations, estimated number of males to females attending leks, estimate of size of breeding population, nesting success, juvenile dispersal and survival, estimate of annual harvest and composition, and impact of climate on populations.

LITERATURE CITED

ADFG. 2000. Alaska hunting regulations. Alaska Dep. of Fish and Game, Juneau, Alaska.

ADNR. 1980. Delta land management plan. Division of Forest, Land and Water Management, North Central District.

Aldrich, J. W. 1963. Geographical orientation of American Tetraonidae. J. Wildl. Manage. 27: 529-545.

Aldous, S.E. 1943. Sharp-tailed grouse in the sand dune counry of north-central North Dakota. J. Wildl. Manage. 7:23-31.

Amman, G.A. 1957. The prairie grouse of Michigan. Mich. Dep. Cons., Tech. Bull. 220 pp.

Angelstam, P., E. Lindstrom, and P. Widen. 1985. Synchronous short-term population fluctuations of some birds and mammals in Fennoscandia-occurance and distribution. Holarctic Ecol. 8:285-98.

Applegate, R.D. 1997. Introduction of sharp-tailed grouse into Maine. Northeastern Naturalist. 4(2):105-110.

Artmann, J.W. 1970. Spring and summer ecology of the sharp-tailed grouse. Ph.D. diss., Univ. of Minnesota, St. Paul.

Buckley, J.L. 1954. Animal population fluctuations in Alaska. Trans. N. Am. Wildl. Conf. 19:338-354.

Burgerud,A.T., and M.W. Gratson. 1988. Survival and Breeding strategies of grouse. Pages 473-577 in A.T. Bergerud and M.W. Gratson, eds: Adaptive strategies and population ecology of northern grouse. Univ. Minnesota Press, Minneapolis.

Caldwell, P. J. 1976. Energetic and population considerations of sharp-tailed grouse in the aspen parkland of Canada. Ph.D. thesis, Kansas State Univ. 121 pp.

Christenson, C.D. 1970. Nesting and brood characteristics of sharp-tailed grouse (Pedioecetes phasianellus jamesi) in southwestern North Dakota. M.S. Thesis, Univ. of North Dakota, Grand Forks.

Collins, W.B. 1997. Measurement of horizontal cover.

Collins, W.B. and E.F. Becker 2001. Estimation of horizontal cover. J. Range Manage. 54:67-70.

Cope, M.G. 1992. Distribution, habitat selection and survival of transplanted Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) in the Tobacco Valley, Montana. M. S. thesis. Montana State Univ., Bozeman Montana. 60 pp.

Giesen, K.M. 1987. Population characteristics and habitat use by Columbian sharp-tailed grouse in northwest Colorado. Pages 251-279 in Fed. Aid Wildl. Final Rep. Proj. W 152-R. Colo. Div. Wildl., Denver.

Giesen, K.M. and J.W. Connelly. 1993. Guidelines for the management of Columbian sharp-tailed grouse habitats. Wildl. Soc. Bull. 21:325-333.

Giesen, K.M. 1997. Seasonal movements, home ranges, and habitat use by Columbian sharp-tailed grouse in Colorado. Colorado Division of Wildlife Special Report No. 72. 16 pp.

Grange, W. 1948. Wisconsin grouse problems. Wis. Cons. Dept., Madison. 318 pp.

Gratson, M.W. 1983. Habitat, mobility, and social patterns of sharp-tailed grouse in Wisconsin. M.S. Thesis, Univ. of Wisconsin, Stevens Point.

Gratson, M.W., J.E. Toepfer, and R.K. Anderson. 1990. Habitat use and selection by male sharp-tailed grouse (*Tympanuchus phasianellus campestris*). Can. Field-Nat.104:561-566.

Hamerstrom, F. N. and F. Hamerstrom. 1951. Mobility of the sharp-tailed grouse in relation to its ecology and distribution. Am. Midland Nat. 46: 174-226.

Hamerstrom, F.N. 1963. Sharptail brood habitat in Wisconsin's northern pine barrens. J. Wildl. Manage. 27: 793-802.

Henderson, F.R., and W.W. Jackson. 1967. History of selected dancing grounds in South Dakota. Proc. 7th Prairie grouse Tech. Council (Abstract).

Henderson, F. R., F. W. Brooks, R. E. Wood, and R. B. Dahlgren. 1967. Sexing of prairie grouse by crown feather patterns. J. Wildl. Manage. 31: 764-769.

Johnsgard, P. A. 1983. Grouse of the world. Nebraska Press, Lincoln. 413 p.

Johnson, D.H. 1980. The comparison of usage and availability measurements for evaluating resource preference. Ecology 61:65-71.

Kessel, B. 1981. Ecology and behavior of sharp-tailed grouse as related to potential impacts of the NorthwestAlaskan gas pipeline in interior Alaska. Univ. Alaska Museum, Fairbanks, Alaska. Unpubl. Rept. 48 pp.

Kieth, L. B. 1963. Wildlfe's ten-year cycle. University of Wisconsin Press, Madison. 201 pp.

Klott, J.H. and Lindzey. 1990. Brood habitats of sympatric sage grouse and sharp-tailed grouse leks in south central Wyoming. J. Wildl. Manage. 54:84-88.

Kobriger, G.D.1993. Regulation and hunting of sharp-tailed grouse: is it fit proper. Prairie grouse Tech. Council and West. States Sage and Columbian sharp-tailed grouse Tech. Comm., Colo. Div. Wildl., Fort Collins.

Marks, J.S. and V.S. Marks. 1987. Habitat selection by Columbian sharp-tailed grouse in west-central Idaho. U.S. Bur. Land Manage. Rep., Boise Dist., Idaho. 115 pp.

Marks, J.S. and V.S. Marks. 1988. Habitat selection by Columbian sharp-tailed grouse in west-central Idaho. J. Wildl. Manage. 52:743-746.

McArdle, B.A. 1976. The effect of habitat manipulation practices on sharp-tailed grouse utilization in southeastern Idaho. M.S. Thesis, Utah State Univ., Logan. 72 pp.

Meints, D.R. 1991. Seasonal movements, habitat use, and productivity of Columbian sharp-tailed grouse in southeastern Idaho. M.S. Thesis, Univ. Idaho, Moscow.

Meints, D.R., J.W. Connelly, K.P. Reese, A.R. Sands, and T.P Hemker. 1992. Habitat suitability index procedures for Columbian sharp-tailed grouse. Idaho For., Wildl. and Range Exp. Stn., Bull. 55, Moscow. 27 pp.

Moyles, D.L.J. 1981. Seasonal and daily use of plant communities by sharp-tailed grouse(*Pedioecetes phasianellus*) in the parklands of Alberta. Canadian Field-Naturalist 95(3):287-291.

Neu, C.W., C.R.Byers, and J.M.Peek. 1974. A technique for analysis of utilization-availability data. J. Wildl. Manage. 38:541-545.

Northrup,R.D. 1991. Sharp-tailed grouse habitat use during fall and winteron the Charles M. Russell National Wildlife Refuge, Montana. M.S. Thesis, Montana State Univ., Bozeman. 54 pp.

Parker, T.L. 1970. On the ecology of sharp-tailed grouse in southeastern Idaho. M.S. Thesis, Idaho State Univ., Pocatello.

Robel, R.J., F.R. Henderson, and W. Jackson. 1972. Some sharp-tailed grouse population statistics from South Dakota. J. Wildl. Manage. 36: 87-98.

Rodgers, R.D. 1992. A technique for establishing sharp-tailed grouse in unoccupied range. Wildl. Soc. Bull. 20:101:106.

Roersma, S.J. 1998. Nesting and brood rearing ecology of Plains Sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) in a mixed-grass/fescue Ecoregion of Southern Alberta. Natural Resources Institute. Univ. of Manitoba, Winnipeg. 21 pp.

Schoephorster, D.B. 1973. Soil survey of Salcha-Big Delta area, Alaska. U.S. Dep. Agr. Soil Cons. Ser. 51 pp.

Sidle, W.B. 1986. The sharp-tailed grouse in Alaska. USDA Forest Service. Unpubl. Rept. 14 pp.

Sisson, L. 1976. The sharp-tailed grouse in Nebraska. A research study. Nebr. Game Parks Comm. 88 pp.

Steen, N.C. 1996. Kenai Peninsula ruffed grouse transplant, 1995. Final Report. Alaska Dep. Fish and Game. Juneau. 8 pp.

Swenson,J.E. 1985. Seasonal habitat use by sharp-tailed grouse (*Tympnuchus phasianellus*) on mixed-grass prairie in Montana. Can. Field-Nat. 99:40-46.

Toepfer, J.E., J.A. Newell, and J. Monarch. 1988. A method for trapping prairie grouse hens on display grounds. Pages 21-23 in A. J. Bjugstad, Tech. Coord. Prairie chickens on the Sheyenne National Grasslands. U. S. Dep. Agric., For. Serv. Gen. Tech. Rep. RM-159.

Ulliman, M.J. 1995. Winter habitat ecology of Columbian sharp-tailed grouse in southeastern Idaho. M.S. Thesis, Univ. of Idaho, Moscow.

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick. 1992. The Alaskan vegetation classification. Gen. Tech. Rep. PNW-GTR-286. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 278 pp.

Weeden, R.B. and L.N. Ellison. 1968. Upland game birds of forest and tundra. Alaska Dep. of Fish and Game Wildl. Booklet Series: No. 3. 44 pp.

Weeden,R.B. 1965. Grouse and ptarmigan in Alaska. Alaska Dept. of Fish and Game, Fed. Aid in Wildl. Restor. Rep., Vol. V, Proj. W-6R-5, Work Plan I. Juneau, Alaska. 110 pp.

White,G.C. and R.A. Garrott. 1990. Analysis of wildlife radio-tracking data. Academic Press Inc., San Diego, California. 383 pp.

APPENDICES

Appendix A. Habitat survey form.

Date	Frequency					
Topography:	Slope	Aspect	Bench			
Vegetation Type (circle):		spruce	aspen/spruce	shrub	grass	other
	Ground Cover	**Shrub**	**Over story**		**Stem Density**	
Species/Kind	(0 - 2 in.)	(2 - 6 in.)	(> 6 ft.)		(1 x 30)	
bare ground						
litter (0 - 0.5) in.						
debris (> 0.5)						
aspen						
spruce						
birch						
willow						
rose						
moss						
barley						
bluejoint grass						
other grass						
blueberry						
lowbush cranberry						
crowberry						
kinnikinnik berry						
dwarf birch						
Other:						
Height:	**Horizontal Cover:**		**Age of Succession:**		**Comments**	
grass						
spruce						
aspen						
birch						
willow						
rose						
Other:						

Appendix B. Vegetation classification list.

Vegetation Type	General Vegetation	Community
1. Black Spruce 2. White Spruce 3. Black Spruce-White Spruce 4. Black Spruce-Tamarack 5.Tamarack	Closed Conifer Forest Open Conifer Forest Woodland Conifer	I. Conifer Forest
1. Balsam Poplar 2. Paper Birch 3. Aspen 4. Birch-Aspen	Closed Deciduous Forest Open Deciduous Forest Woodland Deciduous	II. Deciduous Forest
1. Black Spruce-Birch 2. White Spruce-Birch 3. Black and White Spruce-Birch 4. Black Spruce-Aspen 5. White Spruce-Aspen 6. Black and White Spruce-Aspen 7. Black Spruce-Birch-Tamarak 8. White Spruce-Birch-Aspen 9. White spruce-Balsam Polar	Closed Mixed Forest Open Mixed Forest Woodland Mixed Forest	III. Mixed Conifer Deciduous Forest
1. Willow 2. Alder 3. Alder-Willow 4. Mixed (Alder, Willow, Shrub Birch	Tall Shrub Open Tall Shrub	IV. Shrubland
1. Mixed (Dwarf Birch, Willow, Ericaceous) 1. Mixed (Dwarf Birch, Willow, Ericaceous) 2. Mixed (Dwarf Birch, Willow) in alpine 1. Mat Cushion, Dryas, Ericaceous, Willows, crowberry, cassiope, sedges (hill top) 1. Mat Cushion, Dryas, Ericaceous, Willows (hill top)	Closed Low Shrub Open Low Shrub Dwarf Shrub Closed Dwarf Shrub Open	V. Low Shrub
. Blue-joint Herb (hill top) 2. Midgrass-Herb-Sedge 1. Sedge-Grass-seasonally flooded . Herb-Sedge-Grass (tundra stringers) . Wet sedge-grass	Dry Moist Wet	VI. Herbacious
1. Water bodies greater than 20 acres 2. Water bodies greater than 20 acres with floating and Submerged vegetation 3. Emergent vegetation . Water bodies less than 20 acres . Water bodies less than 20 acres with floating and Submerged vegetation 6. Lower perennial streams and rivers 7. Upper perennial streams and rivers	Freshwater	VII. Aquatic
. Intermittent stream channels Para-riverine (sand and gravel bars) 3. Rock 4. Ice and snow		VIII. Barren-natural
Bare ground Urban-Suburban Agriculture 4. Gravel pits, mines, quarries 5. Roads Pipelines and Powerlins		IX. Cultural

Appendix C. Sharp-tailed grouse capture history and status, September 1998 to April 2000.

No.	Frequency	Capture Date	Sex	Age	Wt (gm)	Leg Band No.	Capture Location	Status
1	153.327	09/17/98	Male	Adult	825	552	Tract C-1	Shed Transmitter
2	153.228	09/18/98	Female	Adult	635	260	Tract C-1	Unknown
3	153.360	09/18/98	Male	Adult	750	277	Tract C-1	Shed Transmitter
4	153.106	09/18/98	Male	Adult	700	284	Tract C-1	Unknown
5	153.177	09/18/98	Male	Adult	775	264	Tract C-1	Hunt Mortality
6	153.346	09/18/98	Male	Juvenile	730	261	Tract C-1	Mortality
7	153.130	09/18/98	Male	Adult	720	266	Tract C-1	Unknown
8	153.200	09/18/98	Male	Juvenile	700	268	Tract C-1	Unknown
9	153.257	09/18/98	Male	Juvenile	770	263	Tract C-1	Unknown
10	153.301	09/18/98	Male	Juvenile	720	267	Tract C-1	Mortality
11	153.289	09/18/98	Male	Adult	785	262	Tract C-1	Mortality
12	153.137	09/18/98	Female	Adult	680	499	Tract H	Hunt Mortality
13	153.209	09/18/98	Male	Adult	765	498	Tract H	Mortality
14	153.167	09/18/98	Male	Juvenile	745	495	Tract H	Hunt Mortality
15	153.319	09/18/98	Male	Juvenile	735	496	Tract H	Unknown
16	153.309	09/20/98	Male	Juvenile	770	295	Tract B	Mortality
17	153.120	09/20/98	Female	Adult	625	270	Tract C-1	Unknown
18	153.151	09/21/98	Male	Juvenile	740	269	Tract C-1	Starvation Mortality
19	153.218	09/21/98	Female	Adult	685	271	Tract C-1	Unknown
20	153.250	09/21/98	Female	Juvenile	650	272	Tract C-1	Mortality
21	153.657	09/22/98	Female	Juvenile	645	273	Tract H	Unknown
22	153.240	09/22/98	Male	Adult	800	274	Tract B	Mortality
23	153.271	09/23/98	Male	Adult	765	275	Tract B	Unknown
24	153.506	09/25/98	Female	Adult	785	276	Tract L	Unknown
25	153.648	09/25/98	Female	Adult	790	297	Tract B	Mortality
26	153.536	09/25/98	Male	Juvenile	665	278	Tract B	Mortality
27	153.407	09/25/98	Male	Adult	845	279	Tract B	Unknown
28	153.686	09/25/98	Male	Adult	810	289	Tract B	Avian Predator Mortality
29	153.426	09/25/98	Male	Juvenile	805	280	Tract B	Unknown
30	153.289	05/09/99	Male	Adult	760	597	Tract B	Unknown
31	153.168	05/10/99	Male	Adult	770	520	Tract B	Avian Predator Mortality
32	153.152	05/11/99	Female	Adult	650	595	Tract E-1	Hunt Mortality
33	153.221	05/11/99	Male	Adult	750	565	1408 Rd	Active
34	153.192	05/12/99	Male	Adult	700	526	1408 Rd	Shed Transmitter
35	153.158	05/12/99	Male	Adult	740	516	1408 Rd	Unknown
36	153.212	05/12/99	Female	Adult	700	585	Tract C-1	Unknown
37	153.178	05/14/99	Female	Adult	640	587	Tract E-1	Shed Transmitter
38	153.201	05/14/99	Male	Adult	790	598	Tract B	Avian Predator Mortality
39	153.251	05/16/99	Male	Adult	730	558	Tract B	Avian Predator Mortality
40	153.139	05/16/99	Male	Adult	720	525	Tract B	Shed Transmitter
41	153.289	05/19/99	Male	Adult	720	281	Tract C-1	Unknown
42	153.241	05/20/99	Male	Adult	690	299	Tract B	Avian Predator Mortality
43	153.360	05/20/99	Male	Adult	740	298	Tract B	Unknown
44	153.109	05/20/99	Male	Adult	715	296	Tract B	Unknown
45	153.329	05/21/99	Male	Adult	715	293	Tract G	Hunt Mortality
46	153.671	09/16/99	Female	Juvenile	595	566	Track B	Unknown
47	153.367	09/16/99	Female	Juvenile	610	528	Track B	Unknown
48	153.492	09/16/99	Female	Adult	720	550	Track B	Unknown
49	153.639	09/16/99	Female	Juvenile	600	586	Track B	Unknown
50	153.552	09/18/99	Female	Adult	640	528	Track B	Mortality
51	153.690	09/18/99	Female	Juvenile	580	542	Track B	Unknown
52	153.429	09/18/99	Female	Juvenile	540	524	Track B	Active
53	153.631	09/20/99	Female	Juvenile	610	592	Track B	Shed Transmitter
54	153.400	09/22/99	Male	Adult	840	292	Track B	Mammal Predator Mortality
55	153.312	09/22/99	Male	Adult	790	294	Track B	Active
56	153.279	09/23/99	Male	Adult	755	590	Track H	Avian Predator Mortality
57	153.302	09/23/99	Male	Juvenile	710	599	Track H	Active
58	153.192	09/23/99	Male	Juvenile	685	288	Track G	Unknown
59	153.241	09/23/99	Female	Juvenile	635	290	Track G	Avian Predator Mortality
60	153.139	09/23/99	Male	Adult	755	291	Track G	Unknown
61	153.178	09/23/99	Male	Adult	725	286	Track G	Shed Transmitter
62	153.158	09/23/99	Female	Juvenile	555	285	Track B	Unknown