

Habitat Assessment of Potential Wood Bison Relocation Sites in Alaska

Final Research Technical Report
1 July 2003–30 June 2006

Craig L. Gardner
Maria Berger
Mike E. Taras

Alaska Department of Fish and Game
Division of Wildlife Conservation
February 2007



Robert Stephenson

Federal Aid in Wildlife Restoration
Grants W-33-2, W-33-3, W-33-4
Project 9.10

STATE OF ALASKA
Sarah Palin, Governor

DEPARTMENT OF FISH AND GAME
Denby Lloyd, Commissioner

DIVISION OF WILDLIFE CONSERVATION
Matthew H. Robus, Director

Electronic copies of this and other Wildlife publications can be found on our website at www.wildlife.alaska.gov. For a hard copy of this report, please direct requests to:

Publications Specialist
ADF&G/Wildlife Conservation
P.O. Box 115526
Juneau, AK 99811-5526
(907) 465-4176
wildlife_publications@fishgame.state.ak.us

This is a progress report on continuing research. Information may be refined at a later date. Please reference as:

GARDNER, C. L., M. BERGER, AND M. E. TARAS. 2007. Habitat assessment of potential wood bison relocation sites in Alaska. Alaska Department of Fish and Game. Final Research Technical Report. Project 9.10. Juneau, Alaska, USA.

Cover Photo: Wood bison at the Alaska Wildlife Conservation Center near Portage Glacier, Alaska in fall 2004. Photo by Robert Stephenson.

The Alaska Department of Fish and Game (ADF&G) administers all programs and activities free from discrimination based on race, color, national origin, age, sex, religion, marital status, pregnancy, parenthood, or disability. The department administers all programs and activities in compliance with Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972.

If you believe you have been discriminated against in any program, activity, or facility please write:

- ◆ ADF&G ADA Coordinator, PO Box 115526, Juneau, AK 99811-5526. The department's ADA Coordinator can be reached via phone at the following numbers: (VOICE) 907-465-6077, (Statewide Telecommunication Device for the Deaf) 1-800-478-3648, (Juneau TDD) 907-465-3646, or (FAX) 907-465-6078.
- ◆ US Fish and Wildlife Service, 4040 N Fairfax Drive, Suite 300 Webb, Arlington, VA 22203, or;
- ◆ Office of Equal Opportunity, US Department of the Interior, Washington DC 20240

For information on alternative formats and questions on this publication, please contact the following:

- ◆ Publications Specialist, ADF&G/Division of Wildlife Conservation, PO Box 115526, Juneau, AK 99811-5526, or call 907-465-4176.

FINAL RESEARCH TECHNICAL REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 25526
Juneau, AK 99802-5526

STATE: Alaska **PROJECT:** 9.10
COOPERATOR: None
GRANTS: W-33-2, W-33-3, and W-33-4
TITLE: Habitat assessment of potential wood bison relocation sites in Alaska
AUTHORS: Craig L. Gardner, Maria Berger, and Mike E. Taras
PERIOD: 1 July 2003–30 June 2006

SUMMARY

There is state, national, and international interest in restoring wood bison (*Bison bison athabasca*) to Alaska to enhance Alaska's wildlife resources, provide subsistence, recreational and economic benefits, and assist the recovery and conservation of this subspecies. During 2003–2004 the Alaska Department of Fish and Game (ADF&G) conducted a study to identify and characterize potential wood bison habitat in Interior Alaska. The objective was to identify suitable bison habitat areas within Interior Alaska that could sustain ≥ 400 wood bison. Previous studies identified the Yukon Flats as having the highest quality wood bison habitat in Alaska. Five new areas were evaluated in this study; 2 of those, Minto Flats and the lower Innoko/Yukon, are recommended as possible sites for wood bison restoration. The recommendations were based on suitable forage abundance, seasonal access to forage, landownership patterns, potential impacts on resident wildlife, and proximity to existing plains bison (*B. bison bison*).

Key words: *Bison bison athabasca*, bison forage, habitat, Interior Alaska, relocation, restoration, wood bison.

CONTENTS

SUMMARY	i
BACKGROUND	1
STUDY AREA	3
METHODS	3
RESULTS AND DISCUSSION	4
NORTH FORK KUSKOKWIM RIVER	4
MINTO FLATS	6
LOWER INNOKO/YUKON RIVER	7
ANIAK RIVER.....	9
HOGATZA RIVER.....	9
MANAGEMENT RECOMMENDATIONS	10
ACKNOWLEDGMENTS	10
LITERATURE CITED	10

FIGURES

FIGURE 1. Location of potential wood bison ranges evaluated during this study. Areas in black represent current range of plains bison.	13
FIGURE 2. North Fork Kuskokwim study area (448 mi ² ; 1,161 km ²).	14
FIGURE 3. Habitat types and estimated percent coverage in the upper North Fork Kuskokwim River valley determined by aerial survey.	15
FIGURE 4. Minto Flats study area (810 km ² , 2,100 km ²)	16
FIGURE 5. Habitat types and estimated percent coverage in the Minto Flats determined by aerial survey.....	17
FIGURE 6. Lower Innoko/Yukon study area (1,348 mi ² , 3,491 km ²).	18
FIGURE 7. Aniak study area (280 mi ² , 725 km ²).	19
FIGURE 8. Hogatza River study area (811 mi ² , 2,100 km ²).....	20

TABLES

TABLE 1. Occurrence of wood bison forage and estimated percent cover in large (13) and small (21) meadows in the upper North Fork Kuskokwim River valley.	21
TABLE 2. Comparison of habitat potential for future wood bison restoration for the 7 areas evaluated in Interior Alaska prior to and during this study.	22
TABLE 3. Occurrence of wood bison forage and estimated percent cover in Minto Flats.	23
TABLE 4. Occurrence of wood bison forage and estimated percent cover in zone 1 (522 mi ² , 1,352 km ²) lower Innoko/Yukon River study area.	23
TABLE 5. Occurrence of wood bison forage and estimated percent cover in zone 2 (438 mi ² , 2,486 km ²) lower Innoko/Yukon River study area.	24
TABLE 6. Occurrence of wood bison forage and estimated percent cover in zone 3 (388 mi ² , 1,005 km ²) lower Innoko/Yukon River study area.	24
TABLE 7. Occurrence of wood bison forage and estimated percent cover in the lower Innoko/Yukon River study area (1,348 mi ² , 3,491 km ²).	24

BACKGROUND

Wood bison (*Bison bison athabascae*) were the last bison subspecies to naturally occupy Alaska (Skinner and Kaisen 1947; Harington 1977; van Zyll de Jong 1986; Guthrie 1990; Stephenson et al. 2001). Archaeological and paleontological evidence in combination with historic accounts from Alaska Native elders indicate that bison persisted in Alaska until 200–400 years ago, becoming extirpated probably due to a combination of unregulated hunting and habitat reduction (Guthrie 1990; Stephenson et al. 2001). There is widespread public and agency interest in restoring wood bison to Alaska to benefit recovery and conservation of the subspecies, enhance Alaska's wildlife resources, and provide subsistence, recreational and economic benefits.

Prior to restoring wood bison, certain biological and social criteria need to be met. There must be sufficient habitat with suitable forage to support a viable population and there must be a minimal chance that wood bison will conflict with people, existing plains bison (*B. bison bison*), or other wildlife. Potential range expansion must be carefully considered. Female–juvenile groups are relatively sedentary but range expansion occurs when population density approaches environmental limits. Major range expansion of the Mackenzie herd occurred at a density of 1.3–2.1 bison/mi² (0.5–0.8/km²) (Gates and Larter 1990).

Wood bison are bulk feeders that select for sedges and grasses (Reynolds et al. 1978). They use a variety of habitats throughout the year but show an affinity for wet and mesic sedge–grass meadows (Larter and Gates 1991; Berger et al. 1995). Bison do not occupy areas where sedge–grass meadows are absent (Gates and Larter 1990). Compared to other northern grazing ungulates, bison are less selective and can utilize available graminoid forage more fully. They use a variety of forage species, seasonally selecting for those that yield the greatest amount of protein (Larter and Gates 1991). The diet of the Slave River wood bison herd included 29 different plant species and 12 species contributed over 1 percent of the diet during at least one season (Reynolds et al. 1978). The most nutritious sedge throughout the year is slough sedge (*Carex atherodes*) and, where available, it is the most selected forage species (Reynolds et al. 1978; Larter and Gates 1990; Fortin et al. 2003).

Wet, boggy conditions and snow cover can affect bison movements and foraging behavior because bison exert a high weight load on track and have relatively short legs (Telfer and Kelsall 1979). Thus, during spring and summer, wood bison tend to prefer drier meadows. Because bison do not dig craters but use their head to push away snow to access forage, deep snow or a snowpack with hard layers may limit feeding sites. Snow depths up to 30 inches (76 cm) and 24 inches (61 cm) do not restrict foraging behavior of adult and calf bison, respectively (Van Camp 1975; Reynolds and Peden 1987). Bison can withstand deeper snow without affecting mortality or productivity if wind or icing do not increase snow density. Plains bison have been observed foraging in snow about 4 feet deep without hard or ice layers in Yellowstone National Park (Meagher 1973). Snow hardness was found to be the principal characteristic of snow cover influencing bison use of feeding sites. Bison select areas with soft snow for winter feeding habitat and avoid large open and windswept meadows (Reynolds and Peden 1987).

The ability of wood bison to utilize ranges that vary in forage quantity, quality and access is illustrated by comparing ranges and population trends of various free-ranging wood bison herds in Canada. Initial herd growth rates following release were comparable between the Mackenzie herd, which has an extensive meadow system and vast quantities of slough sedge (Larter and Gates 1990), and the Yukon herd, which resides in an area with few meadows and, apparently, little to no slough sedge (Fisher 2003). The Yukon wood bison herd's primary forage is water sedge (*Carex aquatilis*) which is common in both the Slave River lowlands and Mackenzie Sanctuary but is seldom used by bison on those ranges. Although water sedge is less digestible and is nutritionally inferior to slough sedge (Larter and Gates 1991), the Yukon herd is in excellent nutritional condition with annual population growth rates of about 20% (M. Oakley, Yukon Department of Environment, personal communication). It is thought that the Yukon herd can thrive on lower quality range because the area receives relatively low snowfall, allowing bison to obtain sufficient forage even though forage biomass is relatively low and some preferred forage species are not present (M. Oakley, personal communication).

In Alaska, 2 areas were previously evaluated as potential wood bison range. Berger et al. (1995) conducted a habitat inventory study on the Yukon Flats and concluded that bison forage was abundant, and that the combination of wet and dry meadows interspersed with spruce and mixed forest would provide excellent year-round habitat for wood bison. Slough sedge was common throughout the area. They estimated that the amount of forage and suitable habitat in 2 study areas on the Yukon Flats exceeded the amount found in any of the existing or potential bison ranges in Canada. They concluded that these areas could support at least 2,000 wood bison and that additional bison habitat existed adjacent to these areas. R. Stephenson (ADF&G, unpublished data) conducted a cursory habitat reconnaissance of the Minto Flats area during summers 1994 and 1996. Those surveys indicated there was a substantial amount of moderate quality forage on the eastern and western Minto Flats and limited amounts of summer and winter forage in the Black Bear Lake/Dune Lake area south of Minto Flats. R. Stephenson concluded additional information on winter and summer travel conditions for bison and a more thorough range assessment were needed for Minto Flats.

Canada's Wood Bison Recovery Team (Gates et al. 2001) recommended release sites should be large enough to: 1) offer forage supporting a minimum population of ≥ 400 bison, 2) provide separation from areas inhabited by plains bison, and 3) provide separation from conflicting land uses such as agriculture.

The Division of Wildlife Conservation, Alaska Department of Fish and Game, initiated this habitat evaluation study to identify and assess potential areas in Interior Alaska for wood bison restoration. This information will be used by a public planning team and in a Division of Wildlife Conservation Transplant Policy review of the proposal to restore wood bison to Alaska. Our objective was to identify suitable bison habitat areas within Interior Alaska that could sustain ≥ 400 wood bison. Measurable criteria were: magnitude of meadow habitats; accessibility of calving, summer, and winter habitats; relative abundance of preferred forage species; and potential conflicts between existing wildlife, land use practices, and plains bison.

STUDY AREA

We focused on areas in Interior Alaska within the known original range of wood bison (McDonald 1981; Gates et al. 1992; Stephenson et al. 2001), excluding areas that already support plains bison, occur within boroughs and national parks, or include large agricultural areas. We chose potential wood bison range sites based on the presence of a sufficient amount of sedge–grass meadows (>5% of the area) and size of the area (>600 mi² determined by aerial survey). We identified numerous potential sites for wood bison restoration in Interior and western Alaska and conducted range evaluations in 5 areas: North Fork Kuskokwim River, lower Innoko/Yukon River area from Shageluk to Paimiut Slough, Aniak River downstream from the Salmon Fork, Minto Flats, and the Hogatza River (Figure 1).

All 5 areas are flat, low elevation plains adjacent to major rivers. Vegetative types are similar and include mosaics of conifer–deciduous forests interspersed with riparian areas dominated by willow (*Salix* sp.), dwarf birch (*Betula* sp.), alder (*Alnus* sp.) and cottonwood (*Populus* sp.) and with various aged oxbow lakes and meadows supporting grasses and sedges (together known as “graminoids”). In the Kuskokwim and Hogatza River areas, wildfire has had a strong influence on plant communities.

METHODS

We consulted area biologists and other long-term residents of Interior Alaska and examined Landsat TM imagery (30-m pixel) produced by Ducks Unlimited to determine general distribution of sedge–grass meadow systems in the Interior. During 17–20 July 2003 we conducted an aerial reconnaissance from a PA-18 Super Cub in portions of Interior and western Alaska and mapped potential wood bison habitat.

Of the 5 areas chosen for further study, 2 (Minto Flats and North Fork Kuskokwim) did not have adequate aerial photography available to determine major vegetation types and amount of meadow habitats. In those 2 areas we estimated distribution of vegetation and meadow types from aerial surveys in a PA-18 (Super Cub). We first established parallel transects 0.8-km apart over each area, then divided the areas into zones. In each zone we randomly selected transects and established a sampling point every 0.8 km along the selected transects. We classified the vegetation type and meadow size at every third sampling point in the North Fork Kuskokwim study area and at every second point at Minto Flats.

To estimate abundance of wood bison forage species, we randomly selected and ground-sampled large (>200 acres) and small meadows. To ensure adequate sampling across the area, a comparable number of meadows were sampled from each zone. In the North Fork Kuskokwim River we sampled using methods originally described by Berger et al. (1995). In each selected meadow we walked from the edge to center, crossed all vegetative zones and recorded all wood bison forage species encountered. Physical characteristics of meadows were also recorded. The percent cover and the appropriate cover category for each bison forage species was estimated after surveying the entire transect line.

Berger et al.’s (1995) method adequately estimated abundance but was time-consuming, limiting the number of meadows that could be sampled. In the Minto Flats and Innoko/Yukon areas we altered meadow sampling protocols to increase the number of sampled meadows.

Instead of walking from the edge to the center, we randomly chose a single 10-m × 1-m transect in each meadow. In each transect we identified bison forage, estimated cover, and assessed meadow characteristics.

For both sampling methods we estimated sedge and grass cover using a logarithmic cover scale consisting of 4 categories: Category 4 had cover values >10 to 100%; category 3 cover values were >1 to 10%; category 2 was >0.1 to 1%; and category 1 was >0.01 to 0.1% (Berger et al. 1995). Percent cover was determined by translating the cover category recorded for each bison forage species into a percent value. The percent value used was the geometric midpoint of the cover category (i.e., the midpoint for category 4 was 31.6%; the number between the log of the upper and lower category boundaries). We estimated the amount of area covered by preferred forage species by multiplying percent cover by the sample area. We did not estimate forage production in any of the 5 areas.

We measured snow depths and ice layers to evaluate forage accessibility during the winter. We randomly chose 10–15 locations distributed among small and large meadows and spruce forests. At each location, we took 10–15 measurements within 50 yards (46 m) of the point and in the same habitat type and averaged the data for each habitat type. We compared the results to snow survey results collected by the National Resources Conservation Service in nearby areas.

We used chi-square contingency tables to test for differences in meadow occurrence and size and moisture regimes. Student *t*-test was used to test differences in snow depths between habitat types. All statistical analyses were performed using statistical software (Microsoft®Office Excel®, Version XP, 2002).

RESULTS AND DISCUSSION

NORTH FORK KUSKOKWIM RIVER

On 14 August we completed aerial surveys of zones 1–3 and about 80% of zone 4 (448 mi², 1,161 km²) (Figure 2). We classified vegetation at 300 sample points. The estimated percentage of meadow habitat was 21.3%, including 15.3% small meadows (<200 acres, 80 ha) and 6.0% large meadows (≥200 acres, 80 ha) (Figure 3). The number ($P = 0.021$) and size ($P = 0.012$) of meadows was higher in zones 3 and 4 compared to zones 1 and 2. Wildfires that occurred within the last 30 years covered 12% of the area.

On 18 August, M. Berger visited 34 (21 small and 13 large) meadows in zones 2 and 3. Graminoids dominated the meadow plant communities; horsetails (*Equisetum* spp.) were also common and were dominant in the wetter meadows (Table 1). The most common wood bison forage species available are beaked sedge (*Carex utriculata*) (14.8% coverage), reedgrasses (*Calamagrostis* spp.) (12.2%) and water sedge (4.1%). Beaked sedge was found to be important winter forage for the Slave River herd (Reynolds et al. 1978), reedgrasses are used extensively during summer and winter by the Slave River herd and during summer by the Mackenzie herd (Reynolds et al. 1978; Larter and Gates 1990), and the Yukon herd uses water sedge during the winter (Fisher 2003).

Meadow and bison forage characteristics were different in zones 2 and 3. In zone 2, meadows were drier and had a greater abundance of bison forage (53% coverage) compared to meadows in zone 3 (24.3% coverage). Meadows in zone 3 were very wet, indicating access by bison during spring and summer would be restricted. However, there were extensive spruce stringers in all zones that could be used for summer travel, and burns of various ages were distributed throughout all the zones. Shrubs and reedgrasses were common in these areas.

On 23 March 2004 we evaluated snow conditions by sampling 12 randomly selected sites. The overall average snow depth was 15.8 inches (40.1 cm) but there were differences between habitat types. There was significantly ($P < 0.001$) less snow on the large meadows compared to small meadows and spruce habitats due to wind. All 4 large meadows sampled had multiple 1–2 inches thick wind-packed layers distributed vertically throughout the snow profile that could restrict access to forage. The average snow depth was 19.0 inches (48.2 cm) in spruce habitats and 16.6 inches (42.2 cm) in small meadows. We did not find ice layers or hard packed snow in the small meadows (3) or spruce habitats sampled (5). In terms of access and forage abundance, zones 1 and 2 offered the best quality summer and winter habitat but quantity would be population limiting due to small total land area.

Land in the upper North Fork Kuskokwim is primarily under state management or is privately owned. The area is 70 miles (112 km) from the current Farewell plains bison herd's range. If wood bison are released in the North Fork Kuskokwim, geographical expansion of the population might be expected because the area of suitable habitat in potential release sites is small (<600 mi², 1,554 km²). Managing wood bison to maintain separation from plains bison could be difficult. However, significant conflicts between wood bison and other wildlife species in the North Fork Kuskokwim study area are unlikely (Gardner and DeGange 2003).

The upper North Fork Kuskokwim offers an abundance of meadow habitat that supports some of the sedges and grasses used by wood bison. The best habitat is in zones 1 and 2 but the area is limited in size (161 mi², 417 km²). In zones 3 and 4, meadow habitats are common but access to many of the larger meadows would be impaired by wet, boggy conditions during spring and summer, and wind-packed snow layers during winter. Sphagnum, marsh cinquefoil (*Potentilla* spp.), leatherleaf (*Chamaedaphne* spp.), and buckbean (*Menyanthes trifoliata*) were common in zones 3 and 4, indicating less productive sites. There are dry areas interspersed throughout the study area that were burned 2–30 years ago. Many of those areas support reedgrasses and shrubs that potentially could be used by bison during the summer, when much of the meadow habitat might be too wet.

Snow depth would not be limiting to wood bison foraging and travel (Van Camp 1975), but in zones 3 and 4 ice and hard snow layers were common in large meadows and could limit access to forage. In zones 1 and 2 hard layers were uncommon. Based on snow course data collected at Purkeypile Mine (50 miles, 80 km away), snow depth in 2004 was 90–95% of the 20-year average.

The North Fork Kuskokwim has low potential as a wood bison restoration site because of limited habitat and because of its proximity to both the Farewell plains bison herd and to Denali National Park (Table 2). If wood bison are released in this area, the release site should

be in either zone 1 or 2, but herd expansion away from the release site would probably occur and would result in management conflicts. We recommend that the North Fork Kuskokwim not be considered as a possible release site for wood bison.

MINTO FLATS

During June and July 2004, we conducted aerial surveys and estimated that Minto Flats includes about 810 mi² (2,100 km²) of suitable wood bison habitat (Figure 4). Graminoid meadows covered 25.9% (210.5 mi², 545.5 km²) of the area and were widely distributed (Figure 5).

To ensure equal sampling intensity across the study area, we subdivided the area into 3 zones: 1) the eastern portion of the study area, Zone 1, (343 mi², 889 km²) included 31.3% sedge–grass meadow; 2) the western portion, Zone 2, (360 mi², 934 km²), 29.1%; and 3) the northern portion, Zone 3 (108 mi², 281 km²), 12.2%. On 28 July 2004 we visited 54 randomly chosen meadows to estimate abundance of wood bison forage and evaluate accessibility during spring and summer. We sampled 23, 19, and 12 randomly selected meadows in zones 1, 2, and 3, respectively. Slough sedge was not found in any of the sampled areas but was found during an earlier reconnaissance trip at a site near Swanneck Slough by R. Stephenson (ADF&G, personal communication) and M. Berger (unpublished data) along the Tanana River south of the study area. At both sites slough sedge contributed <1% coverage. The most common wood bison forage species available on Minto Flats are beaked sedge (11% coverage), water sedge (8.9%), and reedgrasses (8.6%). Horsetails were also common (12.2%) (Table 3).

We categorized sampled meadows as wet or dry based on the presence of standing water and the suitability of the substrate to support bison travel and access to forage. The eastern portion of the study area (zone 1) was wetter than the western (zone 2) ($P = 0.11$) and northern portions (zone 3) ($P = 0.020$), and much of the area would be difficult for wood bison to access during spring and summer. Those assessments agree with previous assessments undertaken in 1994 by M. Berger when she concluded that wood bison probably would not use the eastern portion of Minto Flats during spring and early summer because of standing water or soft, wet soils.

On 16 March 2004 we evaluated snow conditions by sampling 15 randomly selected sites in spruce and small and large meadow habitats. The average snow depth was 15.9 inches (40.4 cm). Snow depths were greatest in spruce (17.5", 44.5 cm) and small meadow (17.8", 45.2 cm) habitats and were significantly greater ($P = 0.001$) than in large meadows (11.7", 29.7 cm). Hard-packed snow or ice layers were present in some of the large meadows but were not so extensive that they would limit wood bison foraging or travel. No ice or hard layers were found in spruce stands and only 2 of the 79 sample points in small meadows had crust layers. The 2004 snow levels for Minto Flats were probably within 75–95% of normal based on snowpack levels at surrounding snow course stations (Natural Resources Conservation Service 2004). The average snowfall on the western portion (14.7", 37.3 cm) was less than the east side (16.8", 42.7 cm) but the difference was not significant ($P = 0.20$).

Snow conditions at Minto Flats are commonly influenced by wind. Many of the large meadows and lakes from Big Minto Lake to Swanneck Slough and south to the Tanana River are often kept snow free, or nearly so, by wind, which exposes extensive areas of open meadows for foraging. Drifting does occur in sheltered areas but not to a degree that would impede travel by bison. The combination of wind and relatively low snowfall allows access to abundant forage in many areas.

The land on Minto Flats is primarily state and privately owned, which could reduce the complexity of management issues (Table 2). Most of the area is part of the Minto Flats State Game Refuge. The eastern edge of the Minto Flats study area is about 130 miles from the center of the Delta plains bison herd's range. The Delta herd's range has remained relatively consistent over the past 40 years and no long distance dispersals have been documented. Because the Delta herd is being maintained at ≤ 500 animals, significant dispersal and range expansion is not expected.

There could be possible conflicts with agriculture if wood bison are released on Minto Flats and allowed to expand their range to the vicinity of the Parks Highway. Maintaining the herd at < 500 animals should limit any density-caused range expansion into this agricultural area or towards the Delta plains bison herd's range.

The Minto Flats study area supports an extensive graminoid meadow system interspersed with spruce and mixed forest, but its potential to support wood bison is limited because of its relatively small size, wet conditions throughout the eastern portion, and the occurrence of some agriculture near the eastern edge of the flats. Bison forage species dominate the meadow ground cover. Bison access to the eastern side during summer would be limited but the western and northern regions offer good year-round habitat. The eastern portion would provide good winter habitat. Snow depths or drifts should not limit wood bison access to forage during winter. Land status and proximity to plains bison should not be factors preventing wood bison restoration to Minto Flats. Based on size of the area, presence of agriculture, and the available forage quality and quantity, Minto Flats should be considered as a potential release site for wood bison, but herd size should be limited to ≤ 500 bison and habitat use and movement patterns should be closely monitored as the herd grows before a herd size objective is determined (Table 2).

LOWER INNOKO/YUKON RIVER

The lower Innoko/Yukon River study area includes 1,348 mi² (3,491 km²) extending from just north of Shageluk south to Paimiut Slough (Figure 6). It includes an extensive sedge–grass meadow system covering 7.6% of the area. We estimated suitable forage species abundance and summer and winter forage accessibility by sampling 75 randomly selected meadows within 3 zones during 29–30 July 2004. We sampled 25 meadows in each zone.

Zone 1 (north portion) includes 522 mi² (1,352 km²) and contains 32 mi² (83 km²) of sedge–grass meadows (6.2%). Reedgrasses, water sedge, and beaked sedge were the most common forage species, covering 11.7%, 8.2%, and 6.7%, of the area respectively (Table 4). Other sedge and grass forage species were also present and covered an additional 11.6% of the area.

Zone 2 (central portion) is 438 mi² (1,134 km²) in size and contains 32 mi² (82 km²) of meadow habitat (7.3%). Similar to zone 1, reedgrasses, water sedge, and beaked sedge are the most common and dominant forage species (Table 5). However in zone 2 water sedge and reedgrasses were present in a greater percentage of the meadows and had higher coverage than in zone 1. In contrast, beaked sedge was less common in zone 2, and the coverage of the other forage species found in zone 1 (11.6%) was only 2.5% in zone 2.

Zone 3 (southern portion) includes 388 mi² (1,005 km²) and supports 39 mi² (101 km²) of sedge–grass meadow (10%). Reedgrasses, water sedge, and beaked sedge were again the most common graminoids, covering 17.8%, 21.8%, and 5.1% of the area respectively (Table 6). Zone 3 was quite similar to zone 2 in percent coverage of these 3 species and in the general absence of the other forage species found in zone 1. In general, it appears that water sedge and reedgrasses are more dominant in the central and southern portions of the study area, with a greater diversity of bison forage in the northern portion. Monotypic stands of at least 20 acres of water sedge and reedgrasses were not uncommon in zones 2 and 3.

Based on comments received from local residents and state and federal biologists, annual spring flooding of the lower Innoko/Yukon River is a concern. On 21 May and 5 June 2005, we monitored water conditions following snowmelt to evaluate spring and summer range accessibility. Snowfall that winter was 130–150% of normal and presumably spring flooding should have been worse than normal. The estimated amount of available range was 40% on 21 May and 25% on 5 June, and was located primarily on the western edge of the valley along the Yukon River. According to local residents water levels began to recede after 10 June.

On 3 March 2005, snow conditions were evaluated by sampling 8 randomly selected meadow sites. Average snow depth was 21.8 inches (55.4 cm). Snow depth in small meadows ranged from 30 to 36 inches (76.2–91.4 cm) with no ice or hard snow layers. Large meadows were influenced by wind; average snow depth was 13.0 inches (33.0 cm) and ice and hard snow layers were common throughout the snowpack. Windy conditions exposed substantial amounts of forage. Snow surveys conducted by the Natural Resource Conservation Service recorded area snow depths of 36–44 inches (91.4–111.8 cm) at stations not influenced by wind. The 20-year average for those snow courses is 28–36 inches (71.1–91.4 cm). Although average snowfall in the lower Innoko/Yukon River area is greater than in most wood bison ranges in Canada, access to forage should be adequate because forage rich, small to medium sized meadow systems with little wind influence and soft snow are common and well distributed throughout the area.

The lower Innoko/Yukon River study area includes a combination of private (53%) and Bureau of Land Management lands (47%) (Table 2). The area is bordered on both the north and south by national wildlife refuges. Prior to any restoration activities, landownership policies and mandates would have to be considered. The closest plains bison herd is more than 150 miles (240 km) away at Farewell. No exchange is expected because large areas of poor bison habit lie between potential wood bison release sites and the established range of plains bison.

The lower Innoko/Yukon River area is large and offers abundant suitable forage (Table 7). Based on forage availability, ≥ 400 wood bison could be supported in this area. The prime

concern is access during summer and winter. Spring flooding can be extensive but it appears that meadow habitat would be available along the western side of the study area even during the worst years, and burns of varying age in the hills adjacent to the Innoko River and along the Yukon River would provide additional forage. Reedgrasses are common in these areas. Average snow depths are at the upper limit recommended for bison. Snow conditions in the exposed portions of lower Innoko/Yukon River are commonly influenced by wind. Snow depths on the large meadows were lower ($\bar{x} = 19.2$ ", 48.7 cm) but hard layers were common throughout the snow profile. Windy conditions also commonly exposed forage along the meadow systems.

We recommend that the lower Innoko/Yukon River area be considered as a potential site for wood bison restoration (Table 2). Additional studies should be conducted to evaluate summer and winter access before a population objective >500 is considered.

ANIAK RIVER

The Aniak River study area (280 mi², 725 km²) was identified as a potential site based on conversations with local residents and biologists (Figure 7). On 30 July 2004, M. Taras (ADF&G) used a helicopter to survey the Swift Creek and Aniak River drainages above their confluence with the Kuskokwim River (Figure 2). The sedge–grass meadow system extends approximately one-half mile on either side of these drainages from the mouth of each drainage to about 15 miles upstream before transitioning to upland tundra. The area includes multiple large and small sedge meadows scattered throughout floodplain woodlands. The meadows were small compared to those in the Innoko area and their characteristics were different. Taras walked from the center to the edge of 6 different meadows and found that 5 contained extensive stands of beaked sedge and one had reedgrass. The tundra habitats contained few bison forage species.

Although this area offers adequate forage, it is too limited in size (<600 mi², 1554 km²) to support a herd of 400 wood bison. The area is separated from adequate range by large expanses of tundra habitats not suitable for bison. We recommend the Aniak River not be considered as a future release site for wood bison (Table 2).

HOGATZA RIVER

We initially surveyed the Hogatza River (Figure 8) using a Super Cub in July 2003, and it appeared to offer an extensive sedge–grass meadow system and areas with abundant reedgrasses. Using Landsat TM imagery (30-m pixel) produced by Ducks Unlimited we estimated those habitats covered about 21% of the area (811 mi², 2100 km²). We planned to identify presence and determine coverage of suitable bison forage in July 2005. In March 2005 we evaluated snow conditions in the Hogatza River valley. Average snow depth was 40 inches (101.6 cm) and in 25% of the areas sampled, hard layers were present within the snowpack. Snow depth was comparable to snow depths measured by Bureau of Land Management since 1996, indicating that deep snow conditions are common in this area and would restrict winter foraging.

We recommend that the Hogatza River valley no longer be considered as a potential area for wood bison restoration (Table 2).

MANAGEMENT RECOMMENDATIONS

Since 1995, 7 areas in Interior Alaska have been evaluated as potential release sites for wood bison (Berger et al. 1995; Stephenson unpublished data, this study) (Table 2). The Yukon Flats, Minto Flats, and lower Innoko/Yukon River could each support ≥ 400 wood bison. The Yukon Flats offers the best habitat and can support in excess of 2,000 bison (Berger et al. 1995). The Minto Flats offers abundant forage but habitat potential is limited due to the size of the area and summer access. The lower Innoko/Yukon River offers abundant habitat and could potentially support thousands of wood bison, but additional study is needed to determine the extent to which access to summer and winter forage would be limited by spring floods and winter snow. The available information indicates the area could support 400–500 bison at a minimum.

ACKNOWLEDGMENTS

Helicopter pilots R. Swisher and T. Cambier safely transported us to the field sites. R. O. Stephenson, L. A. McCarthy and M. E. McNay were reviewers and Xi Chen assisted with the statistical analyses.

LITERATURE CITED

- BERGER, M., R. O. STEPHENSON, P. KARZMARCZYK, AND C. C. GATES. 1995. Habitat inventory of the Yukon Flats as potential wood bison range. Alaska Department of Fish and Game, Fairbanks, Alaska, USA.
- FISHER, L. A. 2003. Late winter selection and the potential for competition between wood bison and woodland caribou in the Yukon. Thesis, University of Calgary, Calgary, Alberta, Canada.
- FORTIN, D., J. M. FRYXELL, AND L. O'BRODOVICH. 2003. Foraging ecology of bison at the landscape and plant community levels: the applicability of energy maximization principals. *Oecologia* 134:219–227.
- GARDNER, C. L., AND A. R. DEGANGE. 2003. A review of information on wood bison in Alaska and adjacent Canada, with particular reference to the Yukon Flats. Alaska Department of Fish and Game, Fairbanks, Alaska, USA.
- GATES, C. C., AND N. C. LARTER. 1990. Growth and dispersal of an erupting large herbivore population in northern Canada: the Mackenzie wood bison (*Bison bison athabasca*). *Arctic* 43:231–238.
- GATES, C. C., T. CHOWNS, AND H. W. REYNOLDS. 1992. Wood buffalo at the crossroads. Pages 139–165 in J. Foster, B. Harrison, and I. S. MacLaren, editors. Alberta: studies on the arts and sciences. Volume 3(1). Special Issue on the Buffalo. University of Alberta Press, Edmonton, Canada.

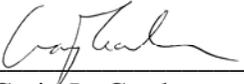
- GATES, C. C., R. O. STEPHENSON, H. W. REYNOLDS, C. G. VAN ZYLL DE JONG, H. SCHWANTJE, M. HOEFS, J. NISHI, N. COOL, J. CHISOLM, A. JAMES, AND B. KOONZ. 2001. National recovery plan for the wood bison (*Bison bison athabascae*). National Recovery Plan No. 21. Recovery of Nationally Endangered Wildlife (RENEW). Ottawa, Ontario, Canada.
- GUTHRIE, R. D. 1990. Frozen Fauna of the Mammoth Steppe: The Story of Blue Babe. The University of Chicago Press, Chicago, Illinois, USA.
- HARINGTON, C. R. 1977. Pleistocene mammals of the Yukon Territory. Dissertation, University of Alberta, Edmonton, Canada.
- LARTER, N. C., AND C. C. GATES. 1990. Home ranges of wood bison in an expanding population. *Journal of Mammalogy* 71:604–607.
- LARTER, N. C., AND C. C. GATES. 1991. Diet and habitat selection of wood bison in relation to seasonal changes in forage quantity and quality. *Canadian Journal of Zoology* 69:2677–2685.
- MCDONALD, J. N. 1981. North American bison, their classification and evolution. University of California Press, Berkeley.
- MEAGHER, M. 1973. The bison of Yellowstone National Park. NPS Scientific Monograph. No. 1. USGPO. Washington, D.C., USA.
- NATURAL RESOURCES CONSERVATION SERVICE. 2004. Alaska snow survey report. U.S. Department of Agriculture. <<http://www.ak.nrcs.usda.gov/snow>> Accessed 1 Feb 2007.
- REYNOLDS, H. W., R. M. HANSEN, AND D. G. PEDEN. 1978. Diets of the Slave River lowland bison herd, Northwest Territories, Canada. *Journal of Wildlife Management* 42:581–590.
- REYNOLDS, H. W., AND D. G. PEDEN. 1987. Vegetation, bison diets, and snow cover. Pages 39–44 *in* H. W. Reynolds and A. W. L. Hawley, editors. *Bison ecology in relation to agricultural development in the Slave River Lowlands, N.W.T.* (Occasional Paper No. 63; Catalogue No. CW69-1/93E.) Canadian Wildlife Service, Ottawa, Ontario, Canada.
- SKINNER, M. F., AND O. C. KAISEN. 1947. The fossil Bison of Alaska and preliminary revision of the genus. *Bulletin American Museum Natural History*. 89:123–256.
- STEPHENSON, R. O, S. C. GERLACH, R. D. GUTHRIE, C. R. HARINGTON, R. O. MILLS, AND G. HARE. 2001. Wood bison in late Holocene Alaska and adjacent Canada: paleontological, archaeological and historical records. *Wildlife and People in Northern North America. Essays in Honor of R. Dale Guthrie*. S. C. Gerlach and M. S. Murray, editors. British Archaeological Reports, International Series 944.

TELFER, E. S., AND J. P. KELSALL. 1979. Studies of morphological parameters affecting ungulate locomotion in snow. *Canadian Journal of Zoology* 57:2157–2159.

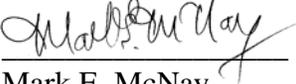
VAN CAMP, J. 1975. Snow conditions and the winter feeding behavior of *Bison bison* in Elk Island National Park. *Canadian Wildlife Service Report CWS-53-75*.

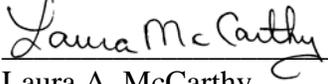
VAN ZYLL DE JONG, C. G. 1986. A systematic study of recent bison with particular consideration of the wood bison. *Canada National Museum of Natural Sciences Publications in Natural Sciences* 6.

XI. PREPARED BY:

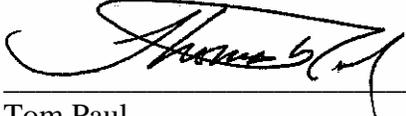

Craig L. Gardner
Wildlife Biologist III

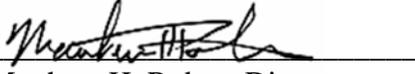
Submitted by:


Mark E. McNay
Research Coordinator


Laura A. McCarthy
Publications Technician II

APPROVED BY:


Tom Paul
Federal Aid Coordinator
Division of Wildlife Conservation


Matthew H. Robus, Director
Division of Wildlife Conservation

APPROVAL DATE: February 22, 2007

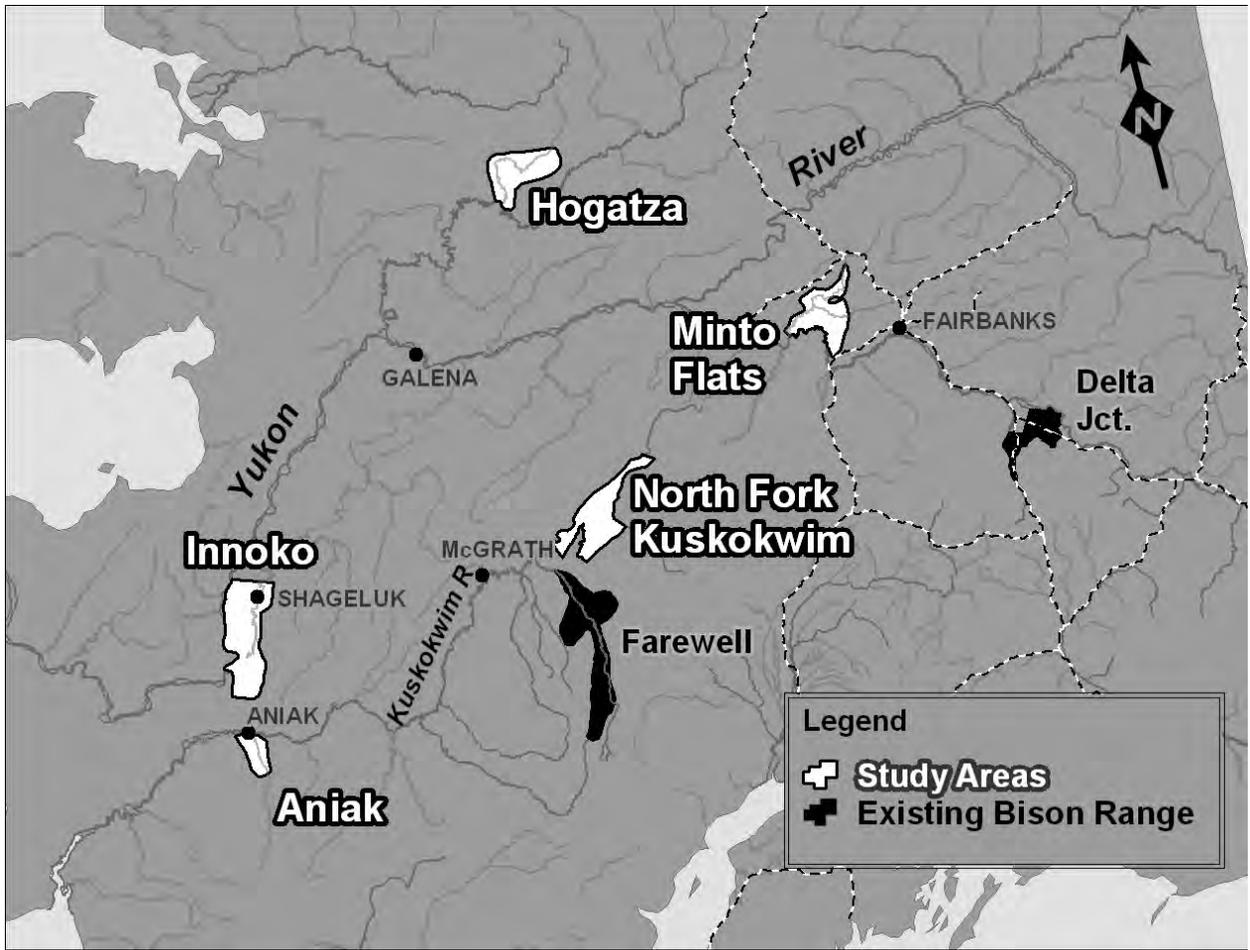


FIGURE 1. Location of potential wood bison ranges evaluated during this study. Areas in black represent current ranges of plains bison.

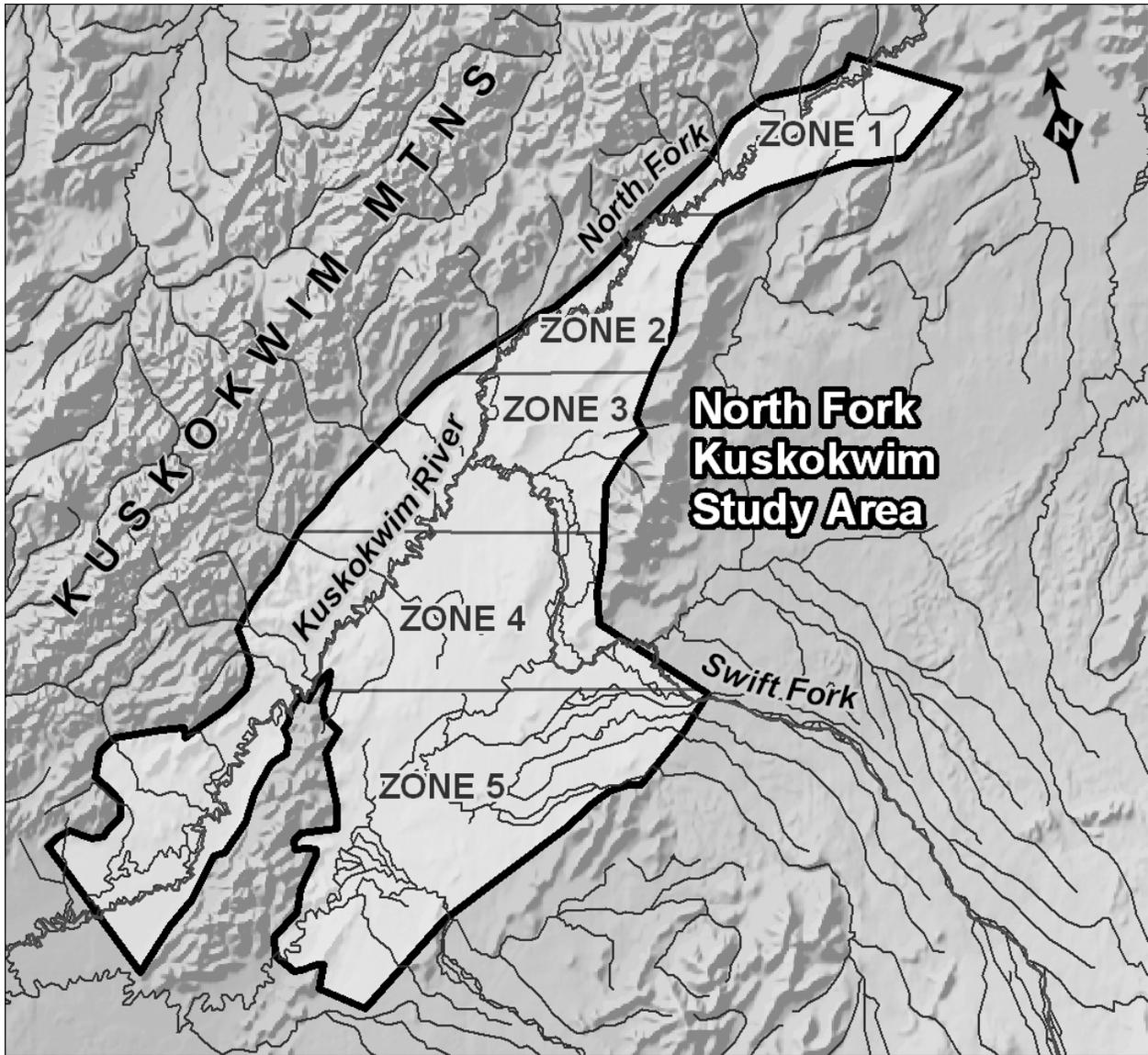


FIGURE 2. North Fork Kuskokwim study area (448 mi²; 1,161 km²).

Available Habitat (%)

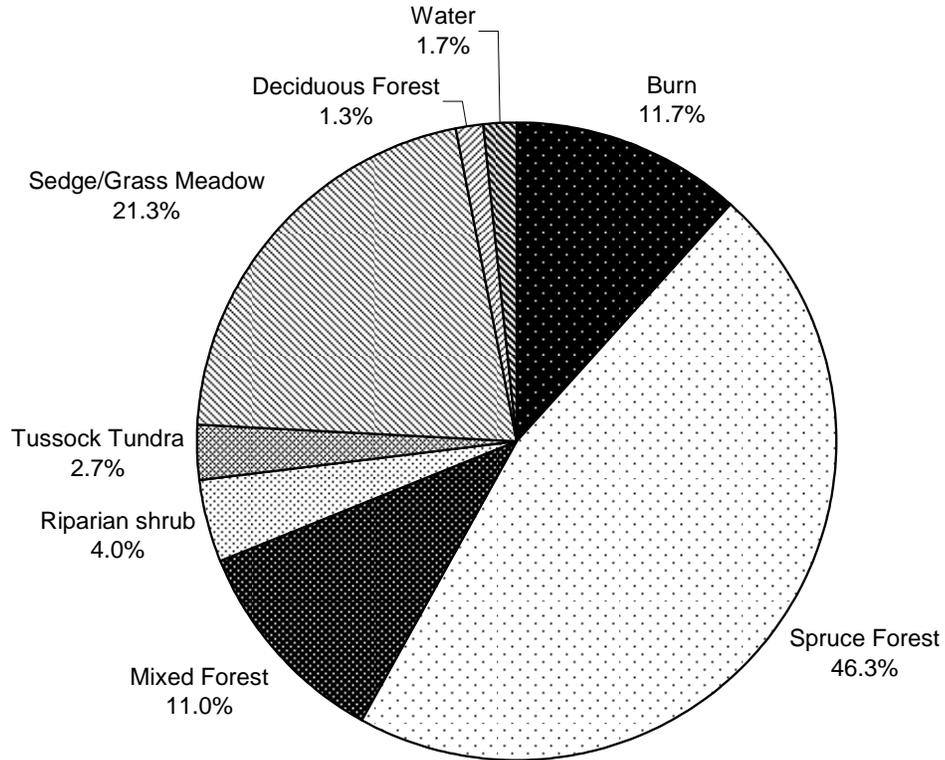


FIGURE 3. Habitat types and estimated percent coverage in the upper North Fork Kuskokwim River valley determined by aerial survey.

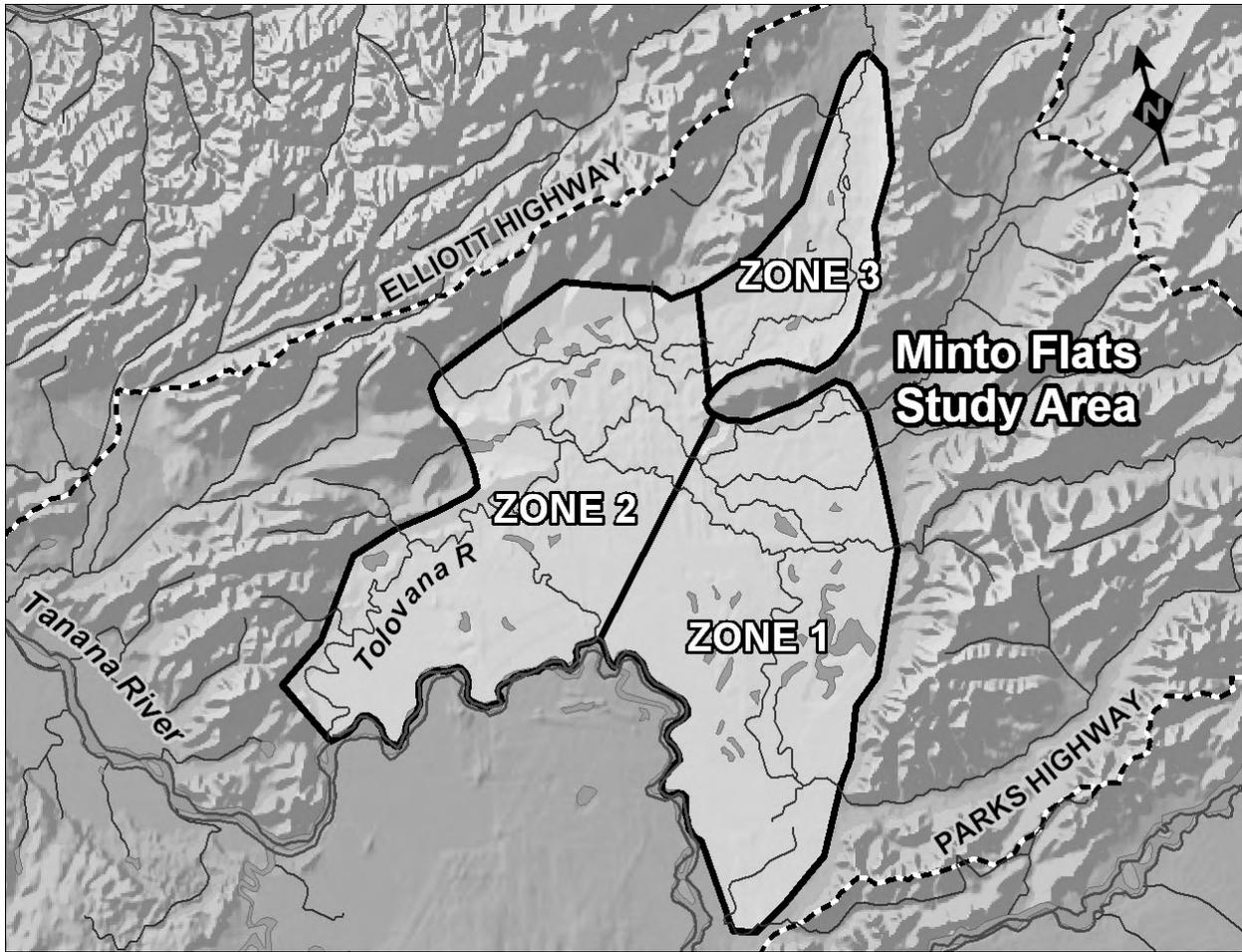


FIGURE 4. Minto Flats study area (810 km², 2,100 km²).

Available Habitat (%)

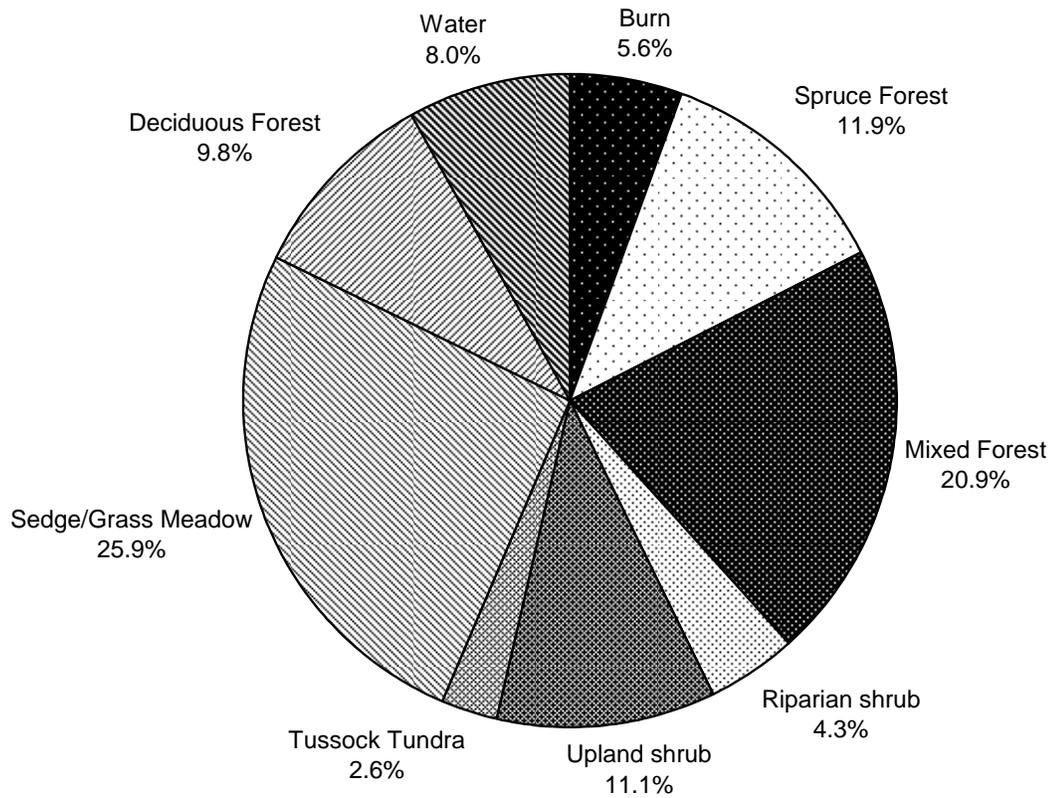


FIGURE 5. Habitat types and estimated percent coverage in the Minto Flats determined by aerial survey.

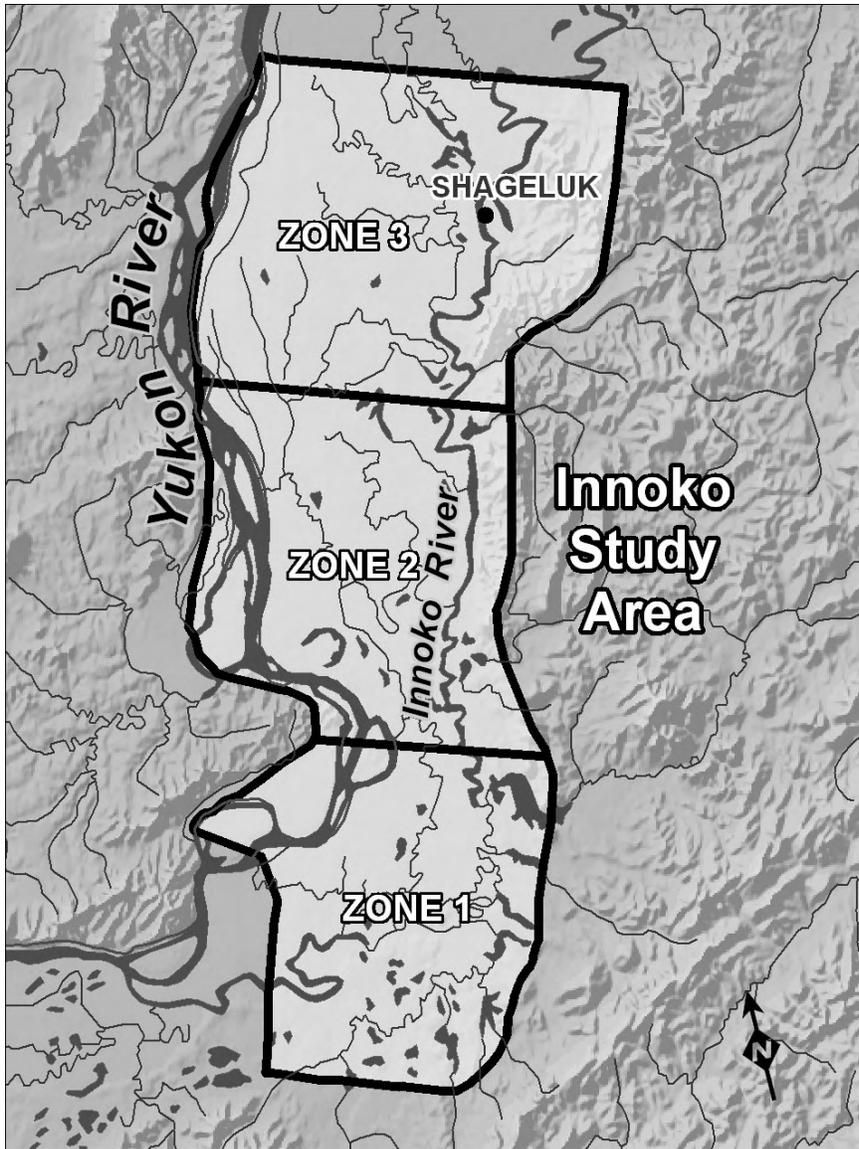


FIGURE 6. Lower Innoko/Yukon study area (1,348 mi², 3,491 km²).

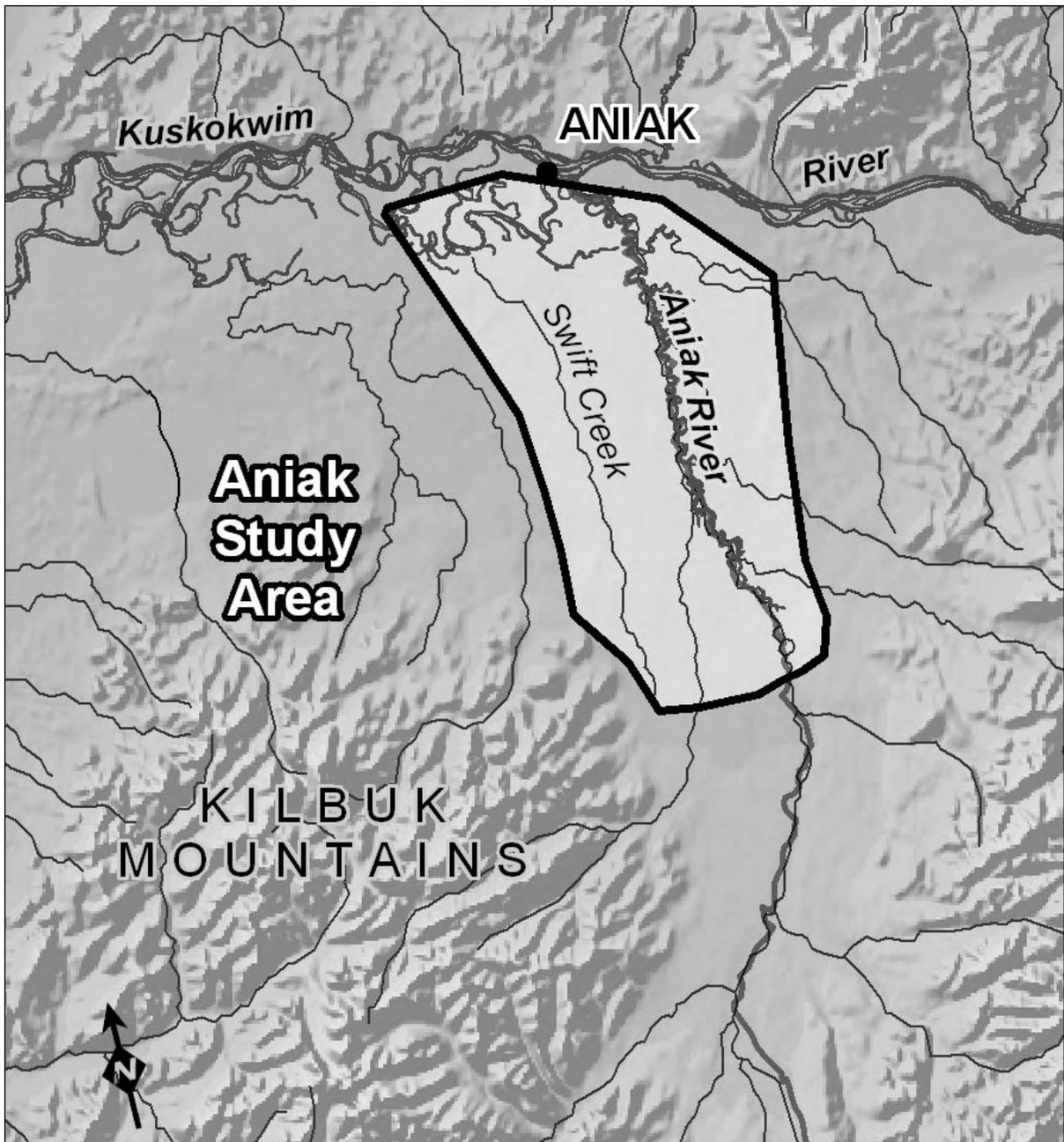


FIGURE 7. Aniak study area (280 mi², 725 km²).

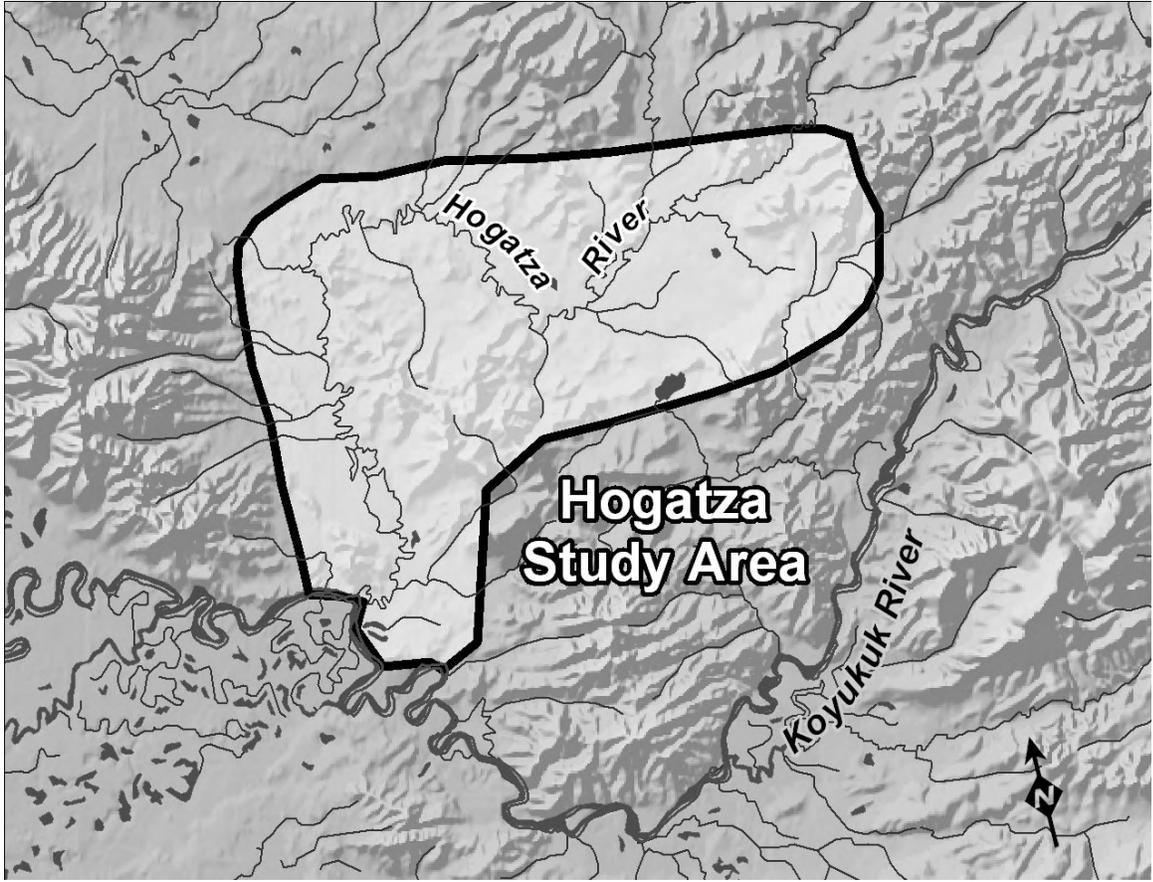


FIGURE 8. Hogatza River study area (811 mi², 2,100 km²).

TABLE 1. Occurrence of wood bison forage and estimated percent cover in large (13) and small (21) meadows in the upper North Fork Kuskokwim River valley.

Species	Percent occurrence			Percent coverage		Estimated area coverage (mi ²)
	All meadows	Large meadow	Small meadow	Large meadow	Small meadow	
<i>C. atherodes</i>	0.0	0.0	0.0	0.0	0.0	0.0 (0.0)
<i>C. aquatilis</i>	23.5	15.3	28.6	2.7	5.0	1.8 (4.1)
<i>C. utriculata</i>	70.6	76.9	66.7	9.0	18.4	6.4 (14.8)
<i>Calamagrostis</i> spp.	67.6	69.2	66.7	6.6	15.7	5.2 (12.2)
<i>Equisetum</i> spp.	58.8	76.9	47.6	22.1	8.3	5.9 (13.6)
<i>Juncus</i> spp.	5.9	7.7	4.8	0.2	0.1	0.04 (0.1)

^a Occurrence and coverage of water sedge is probably underestimated due to the lack of seed heads to aid recognition.

TABLE 2. Comparison of habitat potential for future wood bison restoration for the 7 areas evaluated in Interior Alaska prior to and during this study.

Area	Size (mi ²)	Density (bison/mi ²) ^a	Percent meadow habitat (mi ²)	Percent bison forage (mi ²)	Access concerns	Land status ^b	Distance from plains bison	Herd size recommendations
Yukon Flats	3,800	0.53	6.6–10.1 (250–385)	62.2% (156–239)	None	63% FWS 32% private 4% state	≥170 mi	2,000+ (Berger et al. 1995)
Minto	812	0.62	25.9 (210)	46.7% (98)	Wet/boggy conditions in 25% of range	84% state 14% private 2% BLM	≥130 mi	≤500 (this study)
Innoko	1,348	0.37	7.6 (103.1)	48.7% (50.2)	Spring flooding; deep snows	53% private 47% BLM 0% state	≥150 mi	≤500 (this study)
North Fork Kuskokwim	964		21.3 (205)	44.7% (91.6)	Wet/boggy conditions in >50% of range	61% state 30% private 9% BLM	≥70 mi	0 – Area does not provide adequate habitat due to available forage, access and proximity to plains bison (this study)
Aniak	280		Not determined	Not determined	None	35% FWS/BLM 34% state 31% private	≥150 mi	0 – Area does not provide adequate habitat due to available forage (this study)
Hogatza	811		21.0 (170)	Not determined	Excessive snow	93% BLM 6% private 1% state	≥220 mi	0 – Area does not provide adequate habitat due to excessive snow depths (this study)
Dune Lake	756		15 (113)	Not determined	None	88% state 11% BLM 1% private	≥110 mi	0 – Limited summer and winter forage (Stephenson, ADF&G, unpublished data)

^a Bison density within the study once the herd reaches recommended population objective.

^b FWS = U.S. Fish and Wildlife Service; BLM = Bureau of Land Management.

TABLE 3. Occurrence of wood bison forage and estimated percent cover in Minto Flats.

Species	Percent occurrence (51 sample units)	Percent cover	Estimated area coverage (mi ²)
<i>C. atherodes</i>	0.0	0.0	0.0
<i>C. aquatilis</i>	58.8	8.8	18.5
<i>C. utriculata</i>	56.9	11.0	23.2
<i>Calamagrostis</i> spp.	51.0	8.6	18.1
<i>Equisetum</i> spp.	56.9	12.2	25.7
<i>Glyceria striata</i>	3.9	0.01	0.03
<i>Juncus</i> spp.	2.0	0.06	0.12
<i>C. canescens</i>	15.7	2.1	4.4
<i>C. limosa</i>	15.7	2.6	5.5
<i>C. diandra</i>	7.8	1.3	2.7

TABLE 4. Occurrence of wood bison forage and estimated percent cover in zone 1 (522 mi², 1,352 km²) lower Innoko/Yukon River study area.

Species	Percent occurrence (25 sample units)	Percent cover	Estimated area coverage (mi ²)
<i>C. atherodes</i>	0	0.0	0.0
<i>C. aquatilis</i>	52	8.2	2.6
<i>C. utriculata</i>	40	6.7	2.1
<i>Calamagrostis</i> spp.	56	11.7	3.7
<i>Equisetum</i> spp.	64	10.8	3.4
<i>Juncus</i> spp.	8	1.4	0.4
<i>C. canescens</i>	4	1.3	0.4
<i>C. limosa</i>	16	3.8	1.2
<i>C. lasiocarpa</i>	16	5.1	1.6

TABLE 5. Occurrence of wood bison forage and estimated percent cover in zone 2 (438 mi², 2,486 km²) lower Innoko/Yukon River study area.

Species	Percent occurrence		Estimated area coverage (mi ²)
	(25 sample units)	Percent cover	
<i>C. atherodes</i>	0	0.0	0.0
<i>C. aquatilis</i>	76	22.9	7.3
<i>C. utriculata</i>	28	4.1	1.3
<i>Calamagrostis</i> spp.	68	18.0	5.7
<i>Equisetum</i> spp.	60	5.8	1.8
<i>Juncus</i> spp.	8	1.3	0.4
<i>C. canescens</i>	4	1.3	0.4

TABLE 6. Occurrence of wood bison forage and estimated percent cover in zone 3 (388 mi², 1,005 km²) lower Innoko/Yukon River study area.

Species	Percent occurrence		Estimated area coverage (mi ²)
	(25 sample units)	Percent cover	
<i>C. atherodes</i>	0	0.0	0.0
<i>C. aquatilis</i>	84	21.8	8.5
<i>C. utriculata</i>	16	5.1	2.0
<i>Calamagrostis</i> spp.	60	17.8	6.9
<i>Equisetum</i> spp.	32	1.8	0.7
<i>Juncus</i> spp.	4	0.1	0.04

TABLE 7. Occurrence of wood bison forage and estimated percent cover in the lower Innoko/Yukon River study area (1,348 mi², 3,491 km²).

Species	Percent occurrence		Estimated area coverage (mi ²)
	(75 sample units)	Percent cover	
<i>C. atherodes</i>	0.0	0.0	0.0
<i>C. aquatilis</i>	70.7	17.6	18.1
<i>C. utriculata</i>	28.0	5.3	5.5
<i>Calamagrostis</i> spp.	61.3	15.8	16.3
<i>Equisetum</i> spp.	52.0	6.1	6.3
<i>Juncus</i> spp.	6.7	0.9	1.0
<i>C. canescens</i>	2.7	0.8	0.9
<i>C. limosa</i>	5.3	1.3	1.3
<i>C. lasiocarpa</i>	5.3	1.7	1.8

The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition and archery equipment. The Federal Aid program allots funds back to states through a formula based on each state's geographic area and number of paid hunting license holders. Alaska receives a maximum 5% of revenues collected each year. The Alaska Department of Fish and Game uses federal aid funds to help restore, conserve and manage wild birds and mammals to benefit the public. These funds are also used to educate hunters to develop the skills, knowledge and attitudes for responsible hunting. Seventy-five percent of the funds for this report are from Federal Aid.



Robert Stephenson

Federal Aid in Wildlife Restoration
Grants W-33-2, W-33-3, W-33-4
Project 9.10