Ts'ude niline Tu'eyeta

Ecological Assessment of the

Ts'ude niline Tu'eyeta Candidate Protected Area

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Northwest Territories
Protected Areas Strategy

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Executive Summary

The K'asho Gotine Koe Dene Band, the federal and territorial governments and non-governmental organizations are partners in the Ts'ude niline Tu'eyeta candidate protected area initiative through the NWT Protected Areas Strategy (PAS). The Canadian Wildlife Service (CWS), working in cooperation with the Ts'ude niline Tu'eyeta Working Group is overseeing the ecological assessment of the Ts'ude niline Tu'eyeta candidate protected area as described in Step 5 of the PAS. This ecological assessment requires a detailed inventory of key ecological components of the Ts'ude niline Tu'eyeta candidate protected area. This information is required to determine species diversity and distribution to ensure that the candidate area captures the full range of successional stages, wildlife habitat, and sensitive/rare species. In this way, the candidate area's contribution to the conservation of these components and processes at a regional scale can be assessed. Such an understanding would also form a cornerstone of future management planning for the area.

The Ts'ude niline Tu'eyeta candidate protected area is drained by the Ramparts, Hume and Ontaratue Rivers. It features the Ramparts wetlands (approx. 4600 km^2), a low-lying, glacial lakebed consisting of floating bogs, and sedge wetlands interspersed with open black spruce forest and ericaceous shrublands. Part of the eastern boundary of the candidate area consists of 'the Ramparts', sheer limestone cliffs rising 100 m above the Mackenzie River. Much of the candidate area contains open boreal forest and a mosaic of large forest fires which occurred 10-30 years ago. The southern portion of the candidate area consists of the foothills and front range of the Mackenzie Mountains with peaks rising to 2000 m above sea level (asl) (Aylsworth *et al.*, 2000).

The Ts'ude niline Tu'eyeta ecological assessment was conducted 9-21 June 2005 and the 6-18 June 2006. Seventy-seven sites were sampled during this study. At each site the vegetation was described and forest bird point counts and wildlife transects were conducted. We also recorded all incidental wildlife and wildlife sign observed while moving about each sample site and during flights to and from the sampling sites.

A survey of the literature indicated one species of amphibian, 24 species of fish, 174 species of bird, and 43 species of mammal occurring within the Ts'ude niline Tu'eyeta candidate protected area. In this study, one species of amphibian, 67 species of bird and 13 species of mammal were recorded. For birds, a wide range of waterfowl, waterbirds and raptors were observed as well as forest birds. Two avian 'species at risk'- Peregrine Falcon and Short-eared Owls were also observed. The forest bird community was characterized based on habitat using quantitative data

from point counts. Two mammalian 'species at risk' - boreal woodland caribou and wolverine tracks - were observed. In March 2006, late winter distribution of boreal woodland caribou and moose was documented through aerial surveys conducted by the Department of Environment and Natural Resources.

The ecological significance of the Ts'ude niline Tu'eyeta candidate protected area includes a number of factors:

1. It supports several 'species at risk', as listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, 2006). These species are both resident in the area on a year-round basis or occur there as migrants. Boreal woodland caribou (COSEWIC listed 'threatened') occur in Ts'ude niline Tu'eyeta at all times of the year and evidence of calving was observed. Wolverine ('special concern') are also year-round residents. The Peregrine Falcon ('threatened') and the Short-eared Owl ('special concern') nest within Ts'ude niline Tu'eyeta.
2. Ramparts River Wetlands is a wetland the Canadian Wildlife Service considers as a "key migratory bird terrestrial habitat site" in the NWT. The 4660 km² key site is an important nesting area for scaup and scoter as well as a key migration staging area for birds migrating further north. Ramparts River Wetlands (Tuyetah) supports over 1% of the national populations of a number of migratory bird populations including scaup, scoter, and Pacific loons.
3. The Ts'ude niline Tu'eyeta candidate area provides the water sources for three important drainages in the Sahtu region – the Hume, Ramparts and Ontaratue Rivers, and very small portion of the Arctic Red River and the Mountain Rivers.
4. The Ts'ude niline Tu'eyeta candidate area falls within the Taiga Plains and Taiga Cordillera ecozones. The Taiga Plains portion of Ts'ude niline Tu'eyeta contains the Fort MacPherson Plain (19.7%), Peel River Plateau (16.8%), and the Mackenzie River Plain (8.2%) ecoregions. The Taiga Cordillera ecozone is represented in the southern portion of the candidate area by the Mackenzie Mountains ecoregion (3.2%).
5. Core representative area analysis indicated that Ts'ude niline Tu'eyeta contains several highly representative or unique areas which likely cannot be found elsewhere in any of the ecoregions within it. Ts'ude niline Tu'eyeta is also effective in capturing the range of biodiversity within 100 km around it.

Acknowledgements

Many people contributed to the success of this project.

- J. Wilson, Protected Areas Strategy – GNWT Department of Environment and Natural Resources (GNWT ENR), assisted with the planning and execution of this project.
- Field monitors, L. Caesar and B. Cotchilly of Fort Good Hope contributed their knowledge of the area and provided valuable assistance in the field. We appreciated their hard work and contribution of traditional knowledge of the area.
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- R. Popko and B. Tracz of GNWT ENR conducted aerial surveys in March 2006, documenting late-winter distribution of ungulates.
- Ducks Unlimited provided Earth Cover Classification for the candidate protected area.
- B. Tracz of GNWT ENR kindly provided additional ungulate survey and satellite collaring data.
- E. Gah (GNWT ENR) and A. Korpach (Ducks Unlimited) provided assistance with the ecological representation of the candidate area.
- K. St. Laurent did the transcription of point count recordings.
- C. Savignac of Dendroica Consulting contributed to the statistical analysis of the data.
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1.0 INTRODUCTION

The Ts'ude niline Tu'eyeta candidate protected area is 15,119 km^2 of land located within the Sahtu Dene and Metis Comprehensive Land Claim (DIAND, 1993) area within the Sahtu region of the Northwest Territories (NWT) (Figure 1). It is located west of the community of Fort Good Hope and the Mackenzie River between 65º 03´ N and 66º 40´N and 128º 42´ and 132º 00´ W, centred at 65° 58´ N, 130° 16´ W.

The Canadian Wildlife Service (CWS), working in cooperation with the Ts'ude niline Tu'eyeta Working Group, is overseeing the ecological assessment of the Ts'ude niline Tu'eyeta candidate protected area as described in Step 5 of the Northwest Territories Protected Areas Strategy (NWT PAS1999). An ecological assessment of Ts'ude niline Tu'eyeta requires a detailed assessment of the candidate protected area's key ecological components. This information is required to determine species diversity and distribution to ensure that the candidate area captures the full range of successional stages, wildlife habitat, self-sustaining land and water systems, and sensitive/rare species. In this way, the candidate area's contribution to the conservation of these components and processes at a regional scale can be assessed. This information will also form the cornerstone of future management planning for the area.

The Ts'ude niline Tu'eyeta ecological assessment was conducted 9-21 June 2005 and the 6-18 June 2006. Seventy-seven sites were sampled during this study (**Figure 2**). At each site the vegetation was described and forest bird point counts and wildlife transects were conducted. We also recorded all incidental wildlife and wildlife sign observed while moving about each sample site and during flights to and from the sampling sites.

1.1 Objectives

The purpose of the ecological assessment, as set out in the NWT Protected Areas Strategy (NWT PAS 1999), is to assess the ecological value of candidate protected areas and to evaluate their ability to meet the criteria set out in the Strategy. The ecological assessment guidelines (NWT PAS 2002) outline the following objectives:

- Provide an effective, timely and cost-efficient evaluation of the species diversity and habitat potential of the candidate protected areas.
- Improve the state of knowledge of ecological processes for these areas.
- Provide a coordinated and consistent process for government agencies, communities and other stakeholders to plan and implement ecological assessment activities for candidate protected areas.

- Provide information for the consideration of social and economic implications of the ecological values, to be used along with the social and economic implications of the other evaluation study results for candidate protected areas.

The objective of this study was to provide an assessment of the flora and fauna of the Ts'ude niline Tu'eyeta candidate protected area based on as broad a sampling program as possible within the temporal and financial limits of the study. This was accomplished through direct observation of the plants and animals, bird surveys, aerial reconnaissance, a scientific literature search, and interviewing stakeholders and researchers who have lived and worked in the area. Specific aspects of the assessment included:

- Vegetation classification and description
- Vegetation sampling sites
- Forest bird point count surveys
- Habitat use by wildlife through direct observation of individuals as well as indirect evidence such as nests, dens, tracks and other natural history sign
- Species lists of plant, bird and mammal species observed, augmented by a hypothetical species list based on the relevant literature.

This report is intended, in part, to augment and refine the biotic information described in the Yamoga Land Corporation's proposal to the Canadian Wildlife Service (Yamoga Land Corporation, 2006), that also described the abiotic and cultural features of Ts'ude niline Tu'eyeta.

2.0 Study area

The Ts'ude niline Tu'eyeta candidate protected area features the Ramparts wetlands (approx. 4600 km²) a low-lying, glacial lakebed consisting of floating bogs, sedge wetlands interspersed with open black spruce forest and ericaceous shrublands. Part of the eastern boundary of the candidate area consists of 'the Ramparts', sheer limestone cliffs rising 100 m above the Mackenzie River. Much of the candidate area contains open boreal forest and a mosaic of large forest fires which occurred 10-30 years ago. The southern portion of the candidate area consists of the foothills and the front range of the Mackenzie Mountains with peaks rising to 2000 m above sea level (asl) (Figure 3) (Aylsworth *et al.*, 2000). Ts'ude niline Tu'eyeta lies within two ecozones – the Taiga Plain and the Taiga Cordillera ecozones. The majority of the candidate

Figure 1: Ts'ude niline Tu'eyeta candidate protected area within the Northwest Territories.

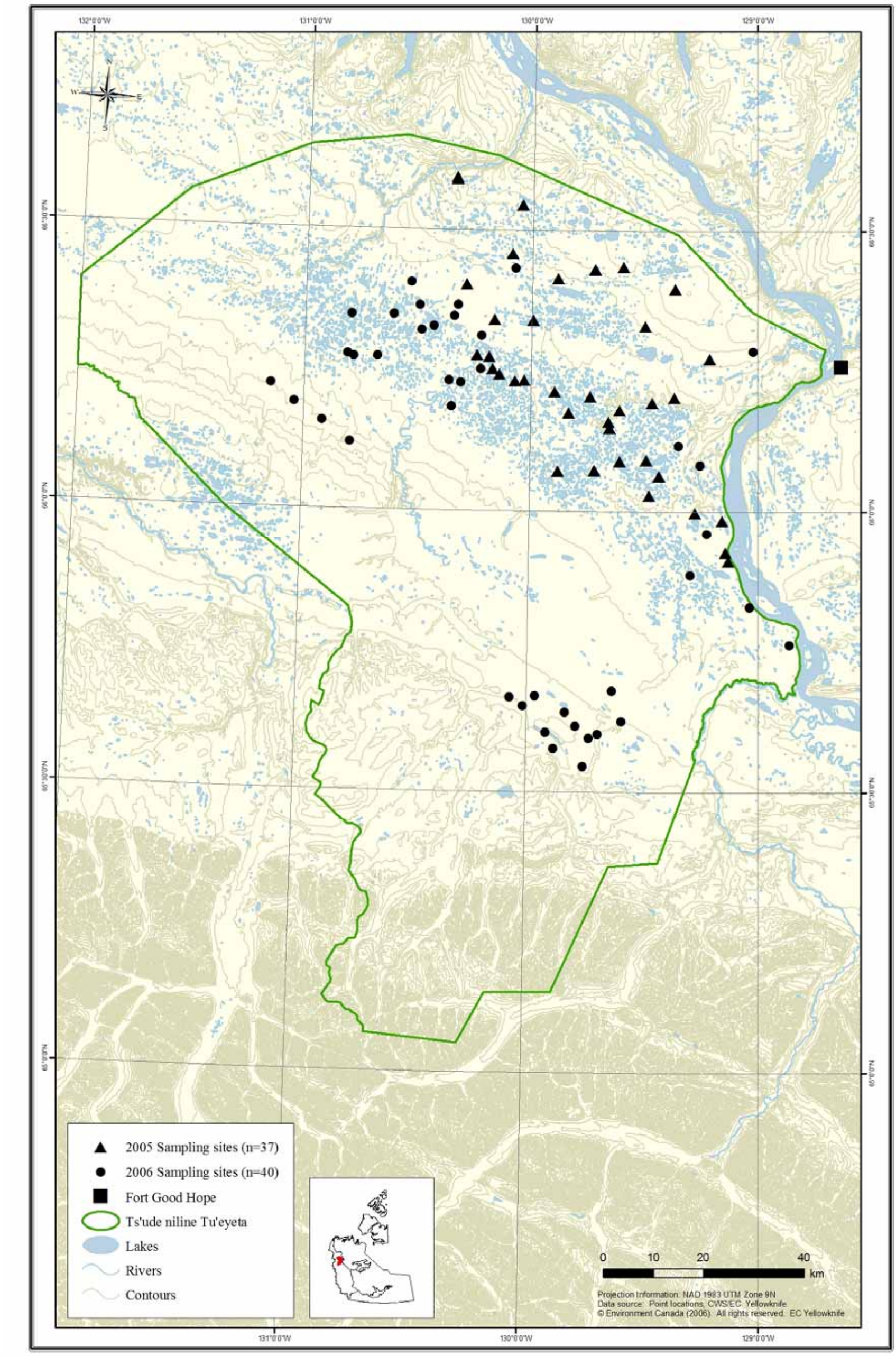

Figure 2: Ecological assessment sampling sites within Ts'ude niline Tu'eyeta candidate protected area, 2005 and 2006.

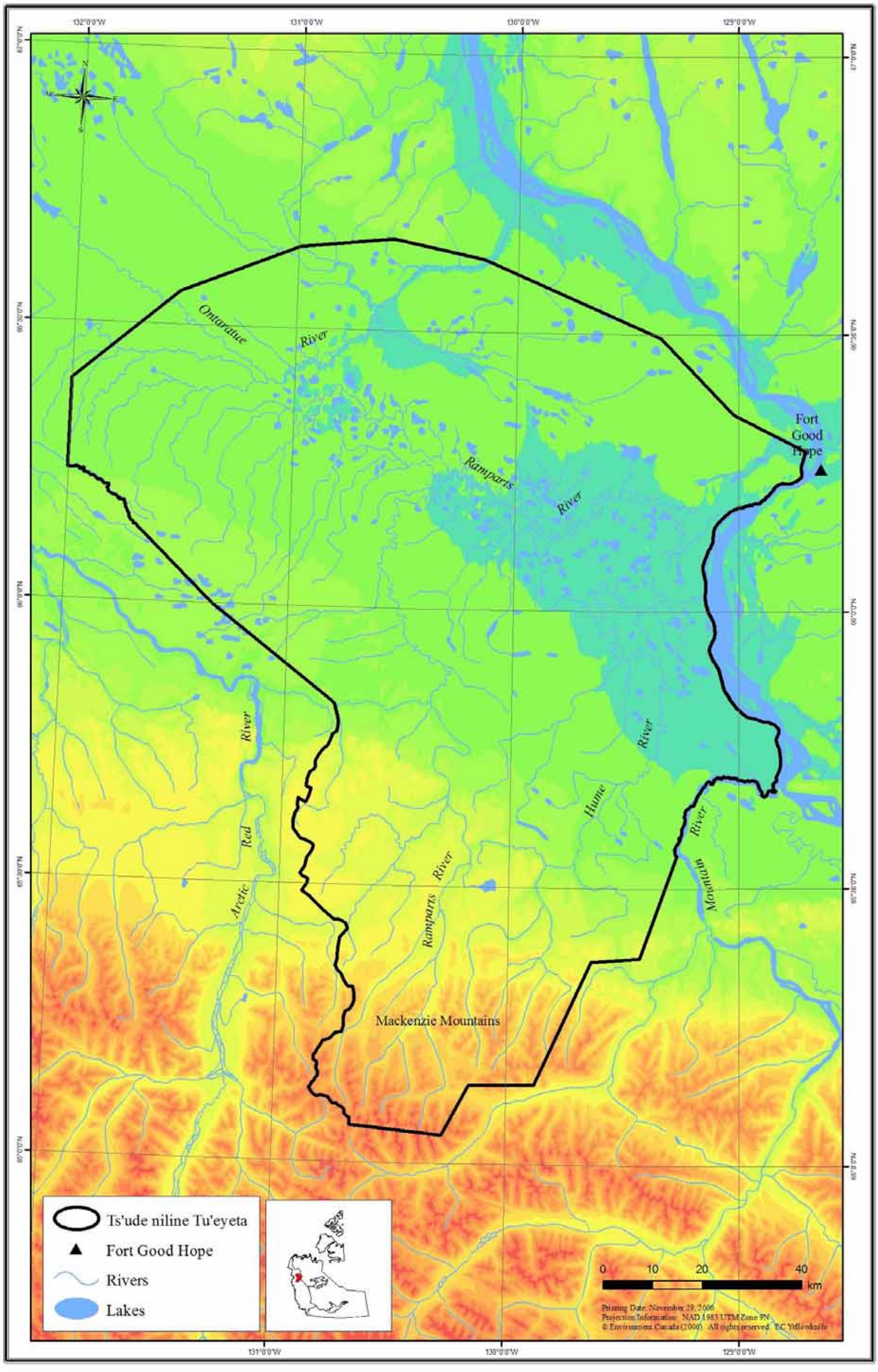

Figure 3: Topographic detail of the Ts'ude niline Tu'eyeta candidate protected area.

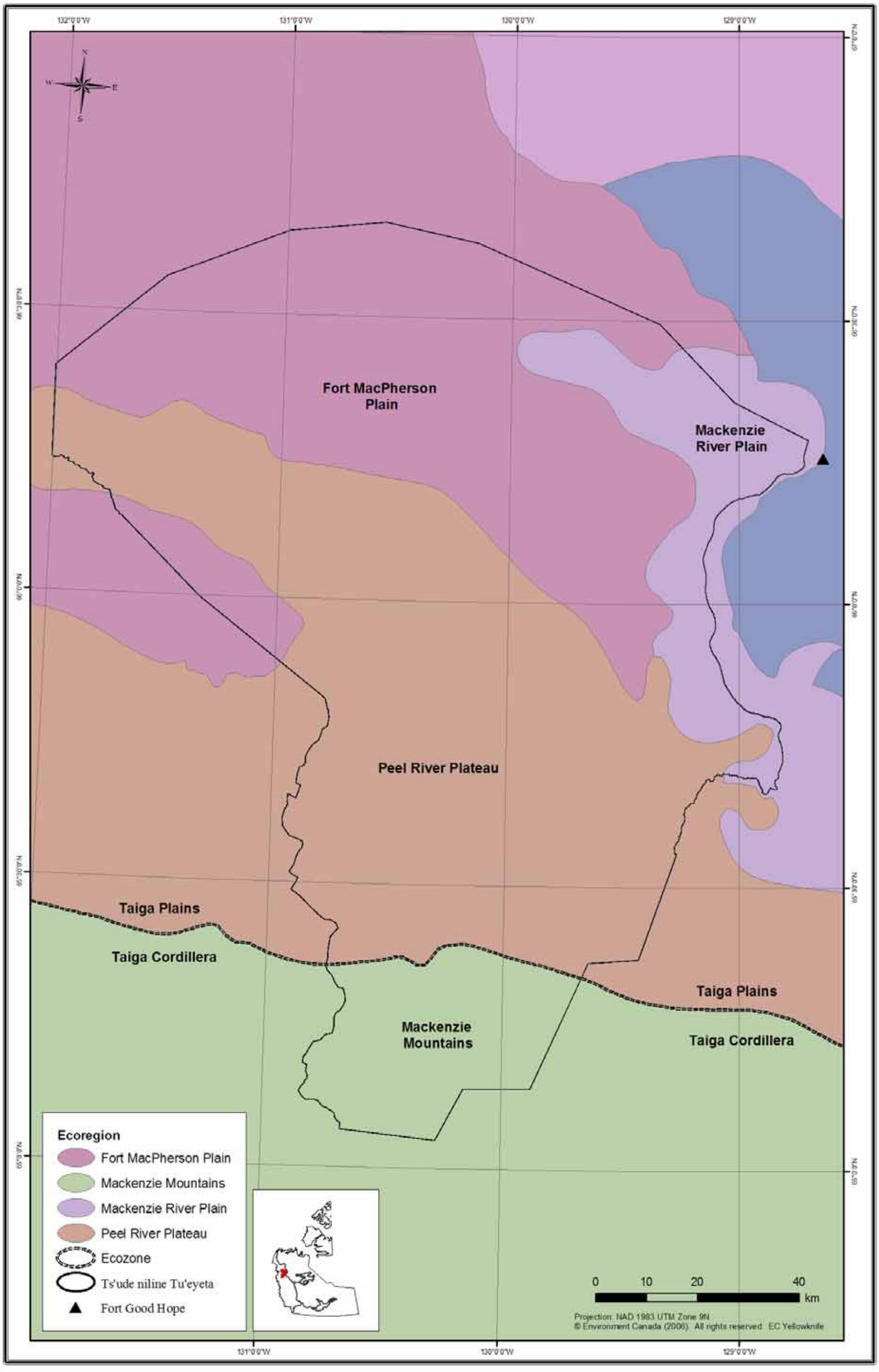

Figure 4: Ecoregions within Ts'ude niline Tu'eyeta candidate protected area.

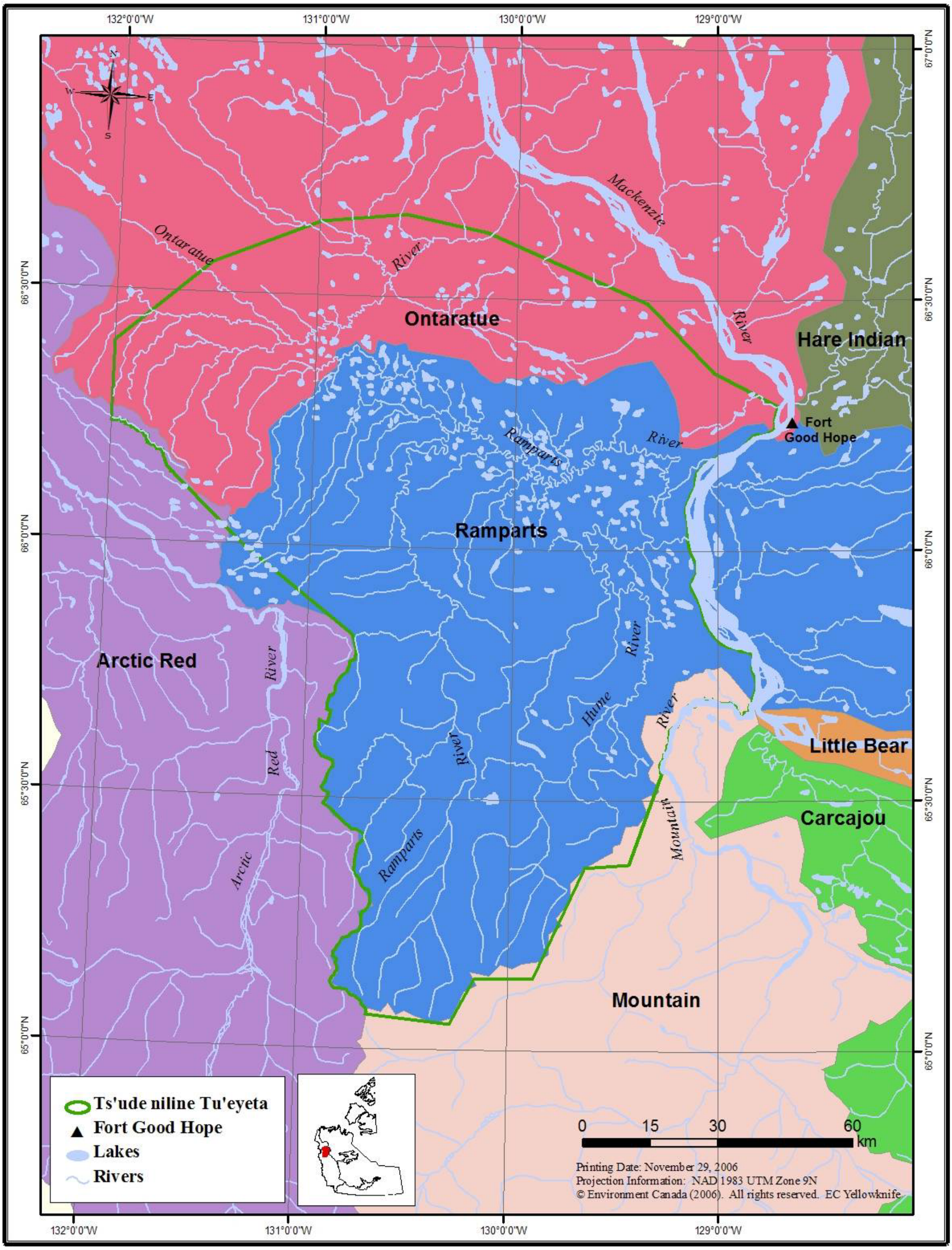

Figure 5: Watersheds within the Ts'ude niline Tu'eyeta candidate protected area.

protected area is within the Taiga Plains ecozone and includes the Peel River Plateau, Fort MacPherson Plain and the Mackenzie River Plain ecoregions (Figure 4, Appendix G). The southern portion of Ts'ude niline Tu'eyeta is within the Taiga Cordillera ecozone covering the Mackenzie Mountain ecoregion. Vegetation within the Taiga Plains ecozone is primarily open, slow-growing conifer (black spruce), with dwarf birch, Labrador tea and willow in the shrub layer and bearberry, mosses, and sedge within the understory (Ecological Stratification Working Group, 1996). Alluvial flats along the rivers support white spruce and balsam poplar. The portion of Ts'ude niline Tu'eyeta within the Taiga Cordillera ecozone is found at higher elevations and is mainly alpine tundra, consisting of dwarf shrub, lichens, saxifrages, and mountain avens. Lower elevations are taiga or open woodlands with spruce and shrubs (Ecological Stratification Working Group, 1996).

Weather

The weather in this region is marked by short, cool summers and long, cold winters. The mean annual temperature is -6.4°C (Table 1). The mean summer temperatures range from 9.0 to 11.5°C and the mean winter temperatures range from -19.5 to -24.5°C. Mean annual precipitation varies between 200 mm in the east to 600 mm in the west. The area is classified as having a high subarctic ecoclimate (Ecological Stratification Working Group, 1996). Climate varies somewhat between the four ecoregions that comprise Ts'ude niline Tu'eyeta.

Table 1: Climatic data for the four ecoregions in Ts'ude niline Tu'eyeta. (Ecological Stratification Working Group, 1996)

Ecoregion	Mean Annual Temperature	Mean Summer Temperature	Mean Winter Temperature	Mean Annual Precipitation
Peel River Plateau	-6.0° C	10.0° C	-22.5° C	200-275 mm
Fort McPherson Plain	-8.0° C	9.5° C	-25.0° C	250-350 mm
Mackenzie River Plain	-6.5° C	11.5° C	-24.5° C	300-400 mm
Mackenzie Mountains	-5.0° C	9.0° C	-19.5° C	400-600 mm

Geology

Ts'ude niline Tu'eyeta lies mainly within the Interior Platform geological province of Canada, with a small southern portion lying within the Cordillera geological province (Yamoga Land Corporation, 2006). The area is made of gently dipping sedimentary rocks and lies between the Precambrian Canadian Shield to the east and the Mackenzie Mountains to the west. (Yamoga Land Corporation, 2006). Much of the Mackenzie Valley has a thin and discontinuous to thick

and continuous cover of glacial ground moraine (till), and therefore there is very little bedrock exposed within Ts'ude niline Tu'eyeta. The underlying bedrock is composed mainly of lower Cretaceous aged sedimentary rock and can be found along a few outcrops along the lower Ramparts River (Cook and Aitken, 1975). Middle Devonian outcrops occur along the Mackenzie River, downstream from Spruce Island, and form the cliffs of the Ramparts, which are resistant limestone of Ramparts Formation.

The southern portion of Ts'ude niline Tu'eyeta is within the Mackenzie Mountains ecoregion of the Taiga Cordillera ecozone. This ecozone represents the northernmost portion of the Rocky Mountain system and within the candidate area includes the front ranges of the Mackenzie Mountains. The area has steep, mountainous topography with ridges and narrow valleys, along with foothills and basins. The bedrock in this ecoregion is mainly sedimentary with some igneous bodies with evidence of localized alpine and valley glaciation (Ecological Stratification Working Group, 1996). The region is dominated by alluviam, fluvioglacial deposits, and morainal veneers and blankets. Higher elevations typically have rock outcrops. Turbic Cryosols with some Dystric Brunisols and Regosols occur on sloping colluvium (Ecological Stratification Working Group, 1996).

The retreat of the Late Wisconsin Laurentide Ice Sheet and associated drainage channels integrated to form the Mackenzie River. The Ramparts, Hume and Ontaratue Rivers are the main drainages of Ts'ude niline Tu'eyeta. These arose from the drainage of Glacial Lake Ontaratue and subsequent Lake Mackenzie into the Mackenzie River along channels formed adjacent to the retreating ice sheet (Figure 5). Glacial lake sediments extend along the Mackenzie River between the mouth of the Mountain River and Fort Good Hope (The Ramparts) and are up to 30 m thick (Duk-Rodkin and Lemmen, 2000).

The Mackenzie Valley is entirely within the permafrost region of northwest Canada and most moisture in the ground occurs as ground ice, meaning that the temperature of the ground is continuously below 0°C over significant proportions of the area (Heginbotton, 2000). Ts'ude niline Tu'eyeta has both extensive discontinuous permafrost (permafrost occurs beneath 65-90% of the land area) and intermediate discontinuous permafrost (permafrost occurs beneath 35-65% of the land area) (Heginbotton, 2000). Ice content is moderate (5-15%) throughout much to Ts'ude niline. The central wetlands portion has high ground ice content (>15%), while the areas along the Ramparts, Hume, and Mountain Rivers have low ice content (0-5%) (Heginbotton, 2000).

2.1 Existing Biological Information

Plant Communities

Although there has been considerable botanical work completed across the NWT, including collection sites adjacent to Ts'ude niline Tu'eyeta, few of the early investigators travelled through Ts'ude niline Tu'eyeta. A search of the Canadian Museum of Nature ((J. Doubt, pers. commun., 2007). revealed 159 plant collection records in the vicinity of Ts'ude niline Tu'eyeta dating back to 1856 by McTavish, McConnell (1888), Taylor (1892), Porsild and Thorbjorn (1928), Porsild (1947), Lindsay (1951), Dabbs (1971), Marsh (1972), Reid (1972), Friesen (1975), Bird and Hinkes (1977), Bird and Thomson (1978). Most of these records and collections were along the Mackenzie River, the Ramparts, Mountain, Hume, Sans Sault Rapids, and Hare Indian River.

Ducks Unlimited produced the Middle Mackenzie Earth Cover Classification as part of its' Western Boreal Forest Program (Ducks Unlimited Inc., 2006). This classification covers 5.2 million hectares of the Taiga Plains ecozone in the Middle Mackenzie, including areas within Ts'ude niline Tu'eyeta. Vegetation classification produced by Natural Resources Canada is available for the entire Ts'ude niline Tu'eyeta through the Earth Observation for Sustainable Development of Forests (EOSD) satellite imagery (Natural Resources Canada, 2006). The Sahtu Vegetation Classification Project was conducted by the GNWT to provide baseline quantitative and descriptive data on vegetation within the Sahtu Settlement Area (Zimmer *et al.*, 2000).

Fire history for the Ts'ude niline Tu'eyeta candidate area has been mapped from 1967-2005 by Forestry Management Division of the GNWT Department of Environment and Natural Resources (ENR, 2006).

Northern Land Use Information Series

The Northern Land Use Information Series (NLUIS) was the first, and remains the only, broad wildlife (fish, birds, and mammals) habitat classification in the Mackenzie Valley (Department of Environment, 1975). It documented the study area as having high wildlife diversity and importance owing to its importance for beaver, muskrat, moose in the complex of lakes and low lying, poorly drained areas around the Hume and Ramparts rivers. The floodplains along the Ramparts and Hume Rivers, with their riparian vegetation provide suitable winter range habitat for moose. The exposed rocky cliffs at "the Ramparts" and areas west of Fort Good Hope are identified as critical wildlife areas due to their important nesting sites for raptors. The candidate area also provides important spring and fall staging habitat for migrating swans, geese and ducks. The southern portion of the candidate area within the northern slopes of the Mackenzie

Mountains is choice habitat for Dall's sheep and grizzly bear, while the lower elevations provide winter range for woodland caribou (Department of Environment, 1975, (106 G, H, I, J)).

Fish

Several baseline fisheries studies were conducted during the Mackenzie Valley pipeline review in the 1970s (Shotton, 1971; Hatfield *et al.*, 1972; Dryden *et al.*, 1973; Shotton, 1973; Stein *et al.*, 1973; Jessop *et al.*, 1974). The Department of Fisheries and Oceans conducted experimental fisheries at special harvesting areas in the area but these concentrated on the Upper Ramparts section of the Mackenzie River and the lakes and rivers east of the Mackenzie (Stewart *et al.*, 1997; Stewart *et al.*, 2003). Stewart (1996) reviewed the status and harvest of fish stocks in the Sahtu, which included the Ramparts, Hume and Ontaratue rivers within the candidate area.

Birds

The Canadian Wildlife Service recognizes the Ramparts River Wetlands as a key migratory bird terrestrial habitat site (Alexander *et al.*, 1991; Latour *et al.*, 2006). A key habitat site supports at least 1% of a Canadian population of at least one species. It is an important annual nesting and staging area for several species. Salter (1974) identified the Ramparts wetlands as one of the top three Mackenzie Valley wetlands in terms of numbers of waterfowl observed. Ducks Unlimited Canada (1997) conducted surveys in 1997 and 1998 in the Ramparts wetlands and reported Greater and Lesser Scaup and Surf and White-winged scoter as the most abundant species, which represented 1% of the Canadian population. Salter and Ducks Unlimited Canada (1997) also observed high densities of Pacific Loons in the wetlands and these numbers are thought to represent >1% of the Canadian population (Latour *et al.*, 2006).

In the 1970s, Salter and Davis (1974) conducted surveys as part of the Arctic Gas Biological Report Series and twenty-three point counts were conducted within Ts'ude niline Tu'eyeta and the 200 km buffer. Of the two sites within Ts'ude niline Tu'eyeta, 283 observations representing 44 species were made.

Canadian Wildlife Service coordinates the NWT/NU Bird Checklist and maintains a database of observations reported by the checklist survey (Canadian Wildlife Service, 2006). Records for Ts'ude niline Tu'eyeta are available for the Ramparts, Mountain and Hume rivers as well as inland sites. Raptor nests and sightings in the NWT are documented in the NWT- NU Raptor Database (GNWT, 2007) and contain numerous sighting for "the Ramparts" along the Mackenzie River and areas west of the river.

Mammals

The GNWT Department of Environment and Natural Resources (ENR) has conducted mammal population census studies within the Sahtu and Ts'ude niline Tu'eyeta since the 1970s. The work includes beaver surveys (Wooley, 1974; Poole and Croft, 1990; Popko and Veitch, 1998; Popko *et al.*, 2002), moose surveys (Prescott et al., 1973; Walton-Rankin, 1977; Brackett et al., 1985; Treseder and Graf, 1985; Jinkfors et al., 1987; Latour, 1992a; MacLean, 1994) and sheep (Latour, 1992b). Satellite collaring and habitat classification work on boreal woodland caribou is currently underway within the Gwichin and Sahtu region (Nagy *et al.*, 2003; Nagy *et al.*, 2005b; Nagy *et al.*, 2006).

3.0 Methodology

3.1 Literature Review

We conducted a literature search to identify all biological information relevant to Ts'ude niline Tu'eyeta. Government libraries and databases were searched with the keywords "Ramparts River," "Hume River," "Ontaratue River," "Fort Good Hope" including: Environment Canada, GNWT ENR, Department of Fisheries and Oceans, Arctic Science and Technology Information System (ASTIS), and the Canada Institute for Science and Technical Information (CISTI). In addition the following journals were searched: Auk, Bird-Banding, Condor, Ecological Applications, Ecological Monographs, Ecology, Journal of Field Ornithology, Journal of Vegetation Science, Journal of Wildlife Management, Ornithological Monographs, Studies in Avian Biology, Wildlife Monographs, Wildlife Society Bulletin and Wilson Bulletin, Arctic and Canadian Field Naturalist. Interviews were conducted with individuals from a number of government and non-government agencies who have worked in, or nearby, Ts'ude niline Tu'eyeta.

Based on the literature review, we compiled a list of plant and animal species found or hypothetically found within Ts'ude niline Tu'eyeta and an arbitrarily set 200 km buffer (Figure 6**).** Mammal species lists were generated using Banfield (1977) and Burt and Grossenheider (1980). Bird species lists were generated using Sibley(Sibley, 2003) and the NWT/NU Bird Checklist (Canadian Wildlife Service, 2006). We summarized past research providing additional biotic and abiotic information for the candidate protected area.

Figure 6: Ts'ude niline Tu'eyeta candidate protected area and 200 km buffer.

3.2 Ecological Representivity

Each of the NWT's ecoregions has a unique combination of flora, fauna, and landscapes. A goal of the NWT PAS is to protect representative samples of all ecoregions within the NWT – this is called ecological representation (NWT Protected Areas Strategy (PAS) Advisory Committee, 1999). Core representative areas within an ecoregion contain the maximum diversity of flora, fauna, and landscapes that is possible within that ecoregion.

The NWT PAS completed an analysis using MARXAN software to identify core representative areas within NWT ecoregions, including the three ecoregions that lie partially within Ts'ude niline Tu'eyeta (NWT PAS Ecological Working Group, 2006). This analysis incorporated the full range of biological and physical diversity within the NWT's ecoregions by using three broad features: vegetation types, landscape units, and physiographic units. The assumption is that these three broad features account for almost the entire biotic and abiotic factors that determine an ecoregion's biodiversity (e.g., flora and fauna). Vegetation types consist of distinct associations of plant species such as spruce forest, deciduous forest, mixed forest, the tall shrub community, and wetlands. Landscape units consist of areas with similar types of rock, soil and terrain. Physiographic units consist of areas with similar elevation, climate, slope, aspect, and landforms.

The goal of the analysis was to ensure that approximately 30% of each of the broad features within each ecoregion was represented. The types/units within each feature were represented on the basis of their total area (size) within each ecoregion. Proportional representation targets range from 10% and 25% for most type/unit components, and 100% for rare types/unit components (NWT Protected Area Strategy Ecological Working Group (EWG), 2006).

Open and closed scenarios were used to describe the ecological representation of Ts'ude niline Tu'eyeta. In the open scenario, core representative areas based on these broad features and their components, are determined and mapped for each ecoregion within the NWT. The boundary of Ts'ude niline Tu'eyeta is then overlain on this map of representative areas to assess its importance to ecoregion representivity.

In the closed scenario, the Ts'ude niline Tu'eyeta candidate area is "locked in." Ts'ude niline Tu'eyeta is considered a core representative area and areas outside of Ts'ude niline Tu'eyeta will only be selected if they contain conservation features that cannot be found within Ts'ude niline Tu'eyeta. In other words, the spatial influence of Ts'ude niline Tu'eyeta in capturing the ecoregion representivity around it can be assessed.

3.3 Field Sampling

Sampling Site Selection

In 2005, we selected sampling sites using the NWT Land Cover Classification (GNWT RWED, 2002), based on Landsat 5 Thematic Mapper (TM) imagery. Using ArcMap 9.1 (ESRI, 2005), we selected areas in homogeneous habitat types that were more than 100 ha in size. Sampling sites were at least 100 m from a habitat edge. Sites were chosen according to the proportion of habitat present in the study area, although smaller patches of homogeneous habitat were also used for logistical reasons (AMEC Earth and Environmental, 2005). For example, if white spruce communities covered 75% of the area, approximately 75% of the sampling sites were within that habitat type, where possible. Sites were selected at least 20 m away from any disturbance and at least 20 m away from the edge of other vegetation types to reduce edge effect. In cases where site contours had to be altered to accommodate the natural site dimensions, efforts were taken to maintain plot size at 400 m² (AMEC Earth and Environmental, 2005).

In 2006, we used the Duck Unlimited Inc. Middle Mackenzie Earth Cover Project (MMECP) classification (DUC, 2006) for site selection. This newly available classification is based on Landsat 5 TM satellite scenes acquired during the summers of 1998 and 1999 and covered the Taiga Plains ecozone. This classification was not available for the southern portion of Ts'ude niline Tu'eyeta, which falls within the Taiga Cordillera ecozone. The 2005 sampling locations were subsequently re-cast over this newer imagery in order to standardize between the years.

In 2005 and 2006, sampling sites were accessed daily using a Hughes 500 helicopter. The four-person crew worked in pairs - two people did the point counts and wildlife transects and two people completed the vegetation plots. The survey intensity was limited by time, aircraft range, weather and the general vastness of the region (Figure 7). No fieldwork was conducted in the southern mountain portion of the study area because of logistical limitations.

Vegetation Description

Prior to field sampling, we generated a species list of plants based on taxonomic guides such as *Vascular Plants of Continental Northwest Territories* (Porsild and Cody, 1980) (Appendix B). We included plant species within Ts'ude niline Tu'eyeta and an arbitrarily set 200 km buffer (Figure 6**).** Species observed during field work within Ts'ude niline Tu'eyeta are highlighted in bold (Appendix B). We also developed a list of rare plants whose ranges overlap the Ts'ude niline Tu'eyeta boundary and the surrounding 200 km buffer based on *Rare Vascular Plants in the Northwest Territories* (McJannet *et al.*, 1995).

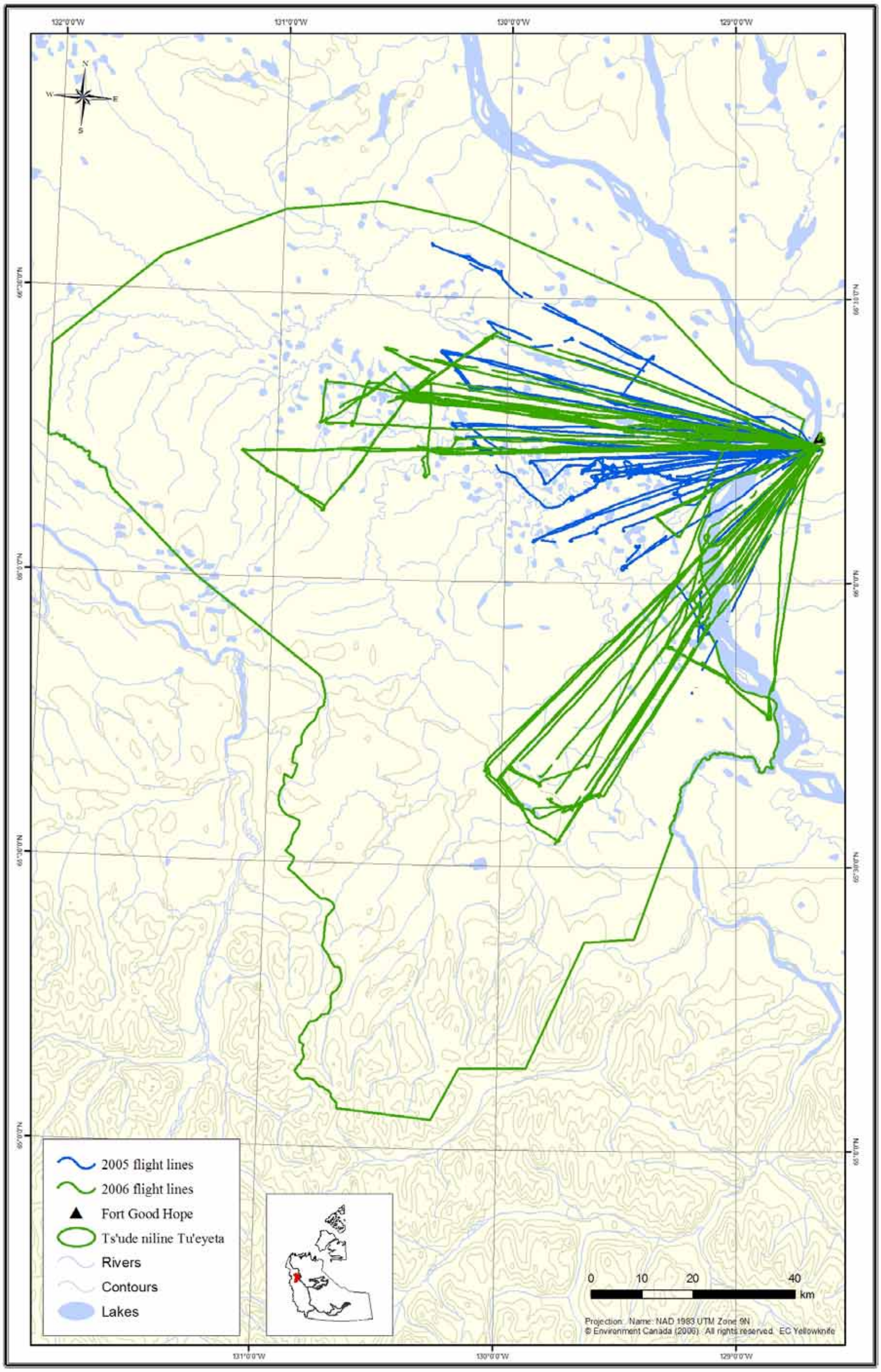

Figure 7: Flight lines within Ts'ude niline Tu'eyeta candidate protected areas, 2005 and 2006.

The methodology for surveying vegetation in the Ts'ude niline Tu'eyeta was previously developed for the NWT PAS by AMEC Earth & Environmental (2005). In 2005 and 2006, vegetation characteristics were collected in 20 m x 20 m (400 m²) plots at 77 sites (Figure 2) distributed throughout the study area. Trees within each plot were counted by standing at one point and listing all species observed in each layer. New species were also noted by walking in a spiral pattern within each plot. Percent cover of each tree species as well as height class(1=trees ≥ 25 m; 2= trees ≥ 20 m < 25 m; 3= trees ≥ 10 m < 20 m; 4= trees ≥ 2 m < 10 m) and diameter-at breast-height (dbh) were recorded. The percent cover of each tree species in the plot was determined by estimating the percentage of the ground surface covered when the crowns are projected vertically following the methodology in AMEC Earth & Environmental (2005). All shrubs (including all woody evergreen and woody deciduous plants) within the study plots, were identified and placed in one of two height classes (low shrubs ≤1.5 m tall; tall shrubs <1.5 m tall and ≤ 5 m tall). Shrub percent cover was assessed using the methodology described by AMEC Earth & Environmental (2005). The percent cover was also estimated for plants (i.e. grasses, sedges, rushes and forbs, bryophytes and lichens), litter, bare ground, moss, and standing water. All percent cover was estimated using a comparison chart for visual estimation of foliage cover (See Appendix A for detailed field data collection forms). Other variables measured within each plot include moisture regime class (1-8: 1= xeric, 8= hydric), and structural stage class (1-7: 1= sparse bryoid, 7= old forest) based on the methodology found in AMEC Earth & Environmental (2005). Coarse woody debris (CWD) abundance was assessed in each plot along a transect crossing diagonally from one corner to the other. Each piece of fallen CWD (logs) and standing snags intersecting transects were counted. Decay classes (1 to 5) were assigned to each piece using the classification scheme in AMEC Earth & Environmental (2005). Volume CWD (m^3/ha) was calculated using the formula $V = (\pi^2/8l) \sum (nidi^2)$ from Van Wagner (1968), where v is the volume per unit area, l is the total transect length, and n is the number of pieces of diameter d (m). For this study, n = 1 since individual pieces were enumerated and l = 28.28 m (diagonal distance between 2 corners of a 400 m² plot). Volume per ha was then calculated as volume per unit area (m) × 10 000 m² ha-1 (m^3ha-1). We used the following classes to assess CWD diameter: 1:< 2 cm; 2: 3-8; and 3: ≥ 8 cm. CWD was divided into three height classes: 1: ground; 2: < 30 cm, and 3: ≥ 30 cm. Twenty- five variables were derived from field vegetation data for inclusion in univariate and multivariate statistical analyses (Table 2).

Table 2: Vegetation variables derived from field vegetation data collected in Ts'ude niline Tu'eyeta.

Variable	Description
%TreeC	% tree cover
%ShrubC	% shrub cover
%HerbC	% plant cover
%MosLicC	% moss cover
%LitterC	% litter cover
%BareGrC	% bare ground cover
%WaterC	% water cover
%covconT	% total conifer trees cover (for class 1-4 only), class 5 is less than 2 m)
%covdecT	% total deciduous tree cover (class 1-4)
Dbhcon	Mean dbh of conifer trees (cm)
Dbhdec	Mean dbh of deciduous trees (cm)
Dbhtree	Mean tree dbh (cm)
HtconT	Mean height of conifer trees (m)
HtdecT	Mean height deciduous trees (m)
Httree	Mean tree height (m)
NoconT	No. of conifer tree per ha
NodecT	No. of deciduous tree per ha
TotalnoT	Total no. of trees per ha
Nosnag	No. of snags per unit area (m)
Snagdiam	Median snag diameter (1-3, 1:< 2cm, 2: 2-8 cm, 3: > 8 cm)
Snagrot	Median snag decay class (1-5, 5 being most rotten)
Snaght	Median snag height (1-3, 1: ground, 2:< 30 cm, 3: > 30 cm)
CWDvol	Coarse woody debris volume (m^3/ha)
StrStage	Structural stage (classes 1-7)
MoistReg	Moisture regime (1-8; 1=xeric – 8=hydric)

3.4 Vegetation classification

A two-way-indicator species analysis using the TWINSPAN program (TWINSPAN version 2.3, Hill and Šmilauer, 2005) was used to determine how the 25 vegetation variables (Table 2) grouped into distinct habitat types. A second technique, detrended correspondence analysis (DCA) was used to verify the TWINSPAN analysis (Appendix J).

Comparison with the Middle Mackenzie Earth Cover Project Classification (MMECP)

To determine if vegetation data collected in the field corresponded to assigned MMECP classification, we compared the distribution of sites obtained in the DCA (Appendix J) for field vegetation variables with site distribution obtained from a DCA performed on variables derived from the MMECP classification. The MMECP DCA was produced using four vegetation variables: the coverage (%) of conifer trees, deciduous trees, shrubs, and lichen derived from the decision tree provided by Ducks Unlimited Inc. (2006). Because the decision tree produces a range of percent cover (e.g. ≥ 75 % needleleaf, < 75 % needleleaf) for each category, we used

median values for all four variables. For example, if the percent canopy cover of a conifer tree estimated at one site was 50 %, we followed the decision tree until we found a category that fit the value measured in the field (in this case, the respective category of percent canopy cover for conifer assigned to the site would be 87.5 %).

In order to determine whether field vegetation data correspond to assigned vegetation classes from the MMECP classification, we compared the correlation between the two DCA matrices using a Mantel test from PC-Ord (McCune and Mefford, 1999) (Appendix J). Although this test does not permit a fine comparison among vegetation classes, it does give a general idea of the similarity between field vegetation data and assigned vegetation classes from the MMECP classification.

3.5 Forest Birds

Forest songbirds were surveyed during 8 – 21 June, 2005 and 6 – 18 June, 2006 using the point count technique (Ralph *et al.*, 1995). At each site, three point counts were spaced 300 m apart in a triangular manner following the methodology prescribed by AMEC Earth & Environmental (2005) (Figure 8). When possible, point-count stations were positioned at least 100 m from a habitat edge to reduce edge effects. Point counts were also located in areas of homogeneous vegetation types that were preselected to be representative of the major vegetation classes in the area. At each point count, vegetation type was visually confirmed within an area of 20 m around the station.

Songbirds were recorded at point count stations using the methodology described in Hobson *et al.* (2002) and in Rempel *et al.* (2005). This technique uses the Earthsong E-3A Field Recorder (Figure 9). System and a pair of directional microphones (CZM Bio-acoustic Microphone) set to record birds in a radius of approximately 150 m (C. Machtans, pers. comm. 2006). At each point count/recording station, trained field technicians waited for one-minute in silence and then recorded sounds for a period of 10 minutes. Bird songs and calls were recorded and stored in MP3 format for later identification by a skilled interpreter. Double counting was minimized by setting the distance between point counts at 300 m. The survey was conducted from one half hour before dawn to approximately six hours after sunrise, depending on weather and temperature conditions. Recording was postponed during periods of high winds or heavy rains when birds are not vocal and calls cannot be distinguished. Site and point count number, date and start time were noted at each point count and all point counts were localized using a handheld global positioning system (GPS) unit (Universal Transverse Mercator [UTM] coordinates, NAD 83).

Outside of recording periods, incidental bird species were also recorded along wildlife transects between each of the point count stations (AMEC Earth and Environmental, 2005). All point

counts were localized using a handheld global positioning system (GPS) unit (Universal Transverse Mercator [UTM] coordinates, NAD 83).

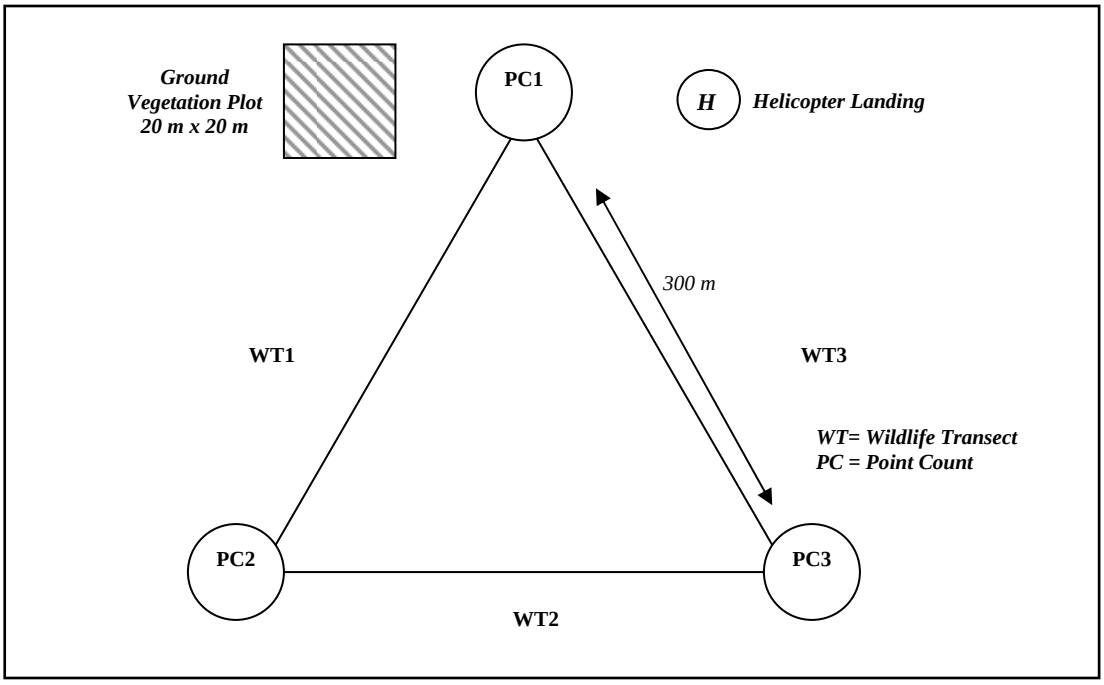

Figure 8: Sampling design used in Ts'ude niline Tu'eyeta.

Figure 9: Field configuration of the E3A Bioacoustic Monitor recording unit using a stereo configuration with two 180° CZM microphones.

The recordings were subsequently downloaded to a computer system for later analysis. The point count recordings were transcribed after the field season by an expert in bird song identification into Microsoft Access (Microsoft Corporation, 2005).

Description of bird communities

Prior to performing any multivariate analysis, point counts from each site were pooled to reduce the effect of pseudoreplication. Summed counts for each species were used in all analysis. We included in the analysis all individual birds regardless of their behaviour (i.e. singing or calling). We omitted rare species (≤ 3 detections) from the analysis, as well as bird species that are known to be inadequately surveyed by point count technique. A complete list of all species detected in the study area is provided in Table 17.

We used TWINSPAN analysis (Hill and Šmilauer, 2005) to classify sites according to bird species composition and abundance. We did not use the TWINSPAN analysis performed on field vegetation because our goal was to classify sites in a biologically meaningful way based on their bird species.

We used direct gradient analysis, Canonical Correspondence Analysis (CCA) to statistically test the significance of each explanatory variable in determining bird abundance (ter Braak and Šmilauer, 2002) (see Appendix J for details). This technique allows non-linear, unimodal relationships between bird species abundance and habitat variables to be investigated. The axes are scaled such that the correlation of each environmental variable with an axis can be read directly by drawing a perpendicular line from the axis of interest to the head of the arrow. Therefore, longer arrows are more correlated with the data than shorter arrows. Horizontal and vertical arrows are highly correlated with only one axis, while more diagonal arrows are correlated with both axes. In the ordination space, the position of each bird species relative to each vegetation variables is indicative of its response to that variable. Moreover, the proximity of species to others in the ordination space means that they responded to similar vegetation variables. For data handling, we used SPSS 8.0 for Windows (SPSS Inc., 1997); for data analysis we used TWINSPAN (Hill and Šmilauer, 2005) and CANOCO 4.5 for Windows (ter Braak and Šmilauer, 2002).

3.6 Wildlife Sign and Incidental Observations

Wildlife sign (e.g. scat, tracks, browsing) was recorded along the 300 m route between the bird point count locations (Figure 8). Observers walked side by side, 5 m apart if possible, and recorded all wildlife and wildlife sign encountered within 1 m of the transect centerline. All incidental wildlife and wildlife sign encountered during helicopter ferry flights, sampling sites,

and at point count sites and vegetation sampling plots was also recorded and included in the wildlife species lists.

3.7 Late Winter Distribution of Ungulates

The Department of Environment and Natural Resources (Norman Wells) surveyed late winter distribution of boreal woodland caribou in Ts'ude niline Tu'eyeta on 28, 30 - 31 March 2006 (Popko, 2006). A total of 2500 km of transect lines with 10 km spacing were flown in a Fairchild Courier airplane on skis. Transects were flown 500 feet above-ground-level at 100 mph air speed. A total of 23.4 hours, including daily ferrying from Norman Wells to Fort Good Hope and the study area, were flown.

3.8 Presentation of Data

As much as possible, we presented the data in this assessment through the use of maps. Since this report will be read and used by a wide audience, most importantly Fort Good Hope and other Sahtu communities, we felt that maps were the most effective way to show what was observed and where within Ts'ude niline Tu'eyeta. Observations were quantified as much as possible directly onto the maps. Numbers in parentheses directly after species indicate either the total number of individuals seen at that location (e.g. Northern Hawk Owl (2) or the total number of observations of sign recorded at that location (e.g. ungulates – individuals, tracks, and pellets piles). In this way, a picture emerges of the abundance and distribution of wildlife in the areas sampled. In some areas where the number of observations was dense, a summary list is provided on the map.

4.0 Results and Discussion

4.1 Ecological Representation

Ts'ude niline Tu'eyeta falls within the Taiga Plains and Taiga Cordillera ecozones. Ecozones are further divided into ecoregions and the candidate protected area includes four of the 42 ecoregions within the NWT, listed in descending order of representation within Ts'ude niline Tu'eyeta: Peel River Plateau, Fort MacPherson Plain, Mackenzie River Plain, and the Mackenzie Mountain ecoregion (Table 3; Figure 4).

Table 3: Ecoregion representation within Ts'ude niline Tu'eyeta

No.	Ecoregion	Size of ecoregion (km^2)	Area within Ts'ude niline Tu'eyeta (km^2)	% of Ts'ude niline Tu'eyeta	% of ecoregion protected
Taiga Plains Ecozone					
51	Peel River Plateau	41192.3	6936.3	45.8%	16.8%
53	Fort MacPherson Plain	27765.9	5473.6	36.1%	19.7%
56	Mackenzie River Plain	16479.5	1358.7	9.0%	8.2%
Taiga Cordillera Ecozone					
170	Mackenzie Mountains	44059.9	1390.2	9.2%	3.2%

An 'open scenario' analysis of the ecological representivity within Ts'ude niline Tu'eyeta identified highly representative or unique areas (dark green - Figure 10) which cannot be found elsewhere within any of the ecoregions comprising Ts'ude niline Tu'eyeta. Other areas (light green - Figure 10) contain more common features and can probably be found elsewhere in the region. The core representative area boundaries indicate how much of both irreplaceable and common features are required to fully meet the representation goals.

The 'closed scenario' analysis shows how ecologically-representative Ts'ude niline Tu'eyeta is, compared to the area around it (Figure 11). The fewer areas that the model needs to select outside of Ts'ude niline Tu'eyeta, the more representative it is. All existing and proposed protected areas together contribute to meeting representation goals, so decisions made about one protected area may affect decisions on another one nearby. For example, if a proposed protected area just south of Ts'ude niline Tu'eyeta is reduced in size, or removed, it will no longer contribute to ecological representation. The southern portion of Ts'ude niline Tu'eyeta alone then might not be enough to meet the representation goals for the mountain ecoregion that it lies in. Compared to the open scenario, fewer areas to the north and west of Ts'ude niline Tu'eyeta are required to meet representation goals. This indicates that Ts'ude niline Tu'eyeta is likely doing a good job of representing the conservation features in that region (i.e., within 100 km). A region to the east of Ts'ude niline Tu'eyeta (south of Fort Good Hope) appears as a core representative area in both the open and closed scenarios. If boundary modification is desired, this area would be the most practical to include as part of the Ts'ude niline Tu'eyeta protected area.

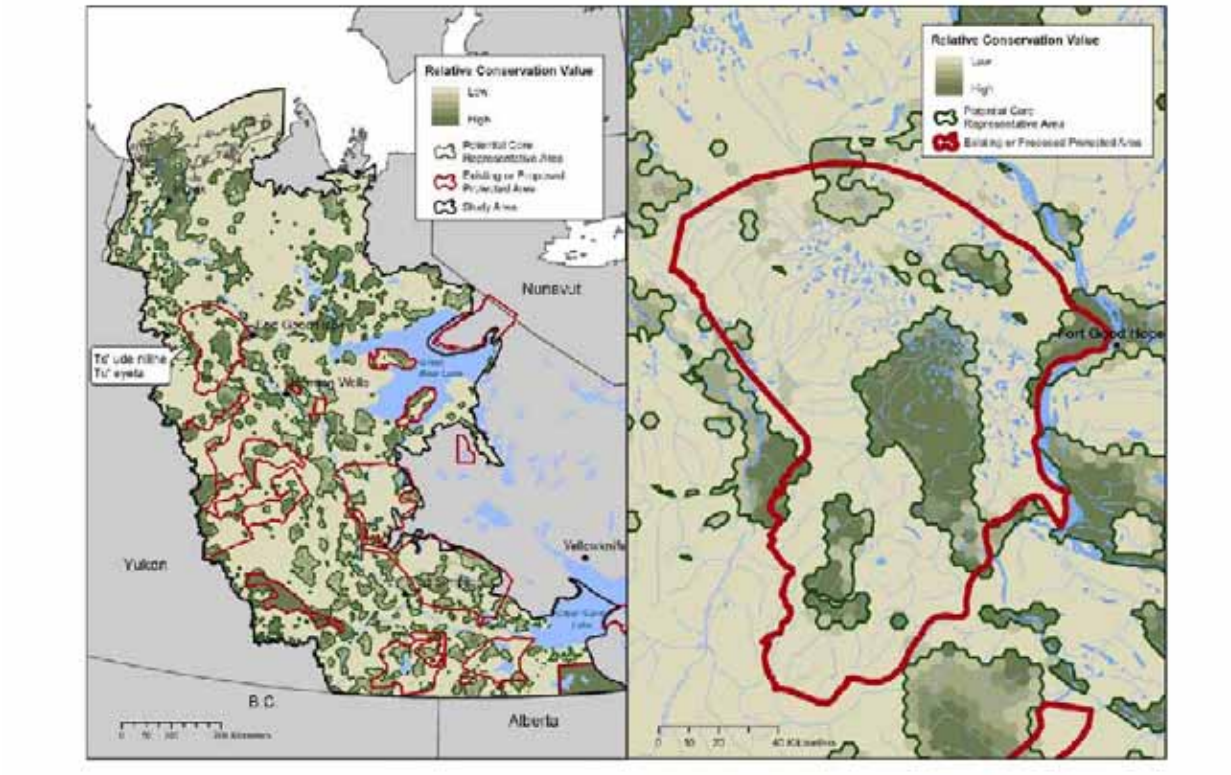

Figure 10: Ecological representation of Ts'ude niline Tu'eyeta: Open Scenario. Left: Results for the Mackenzie Valley and Mackenzie Mountain ecoregions. Right: results for Ts'ude niline Tu'eyeta (NWT PAS EWG, 2006)

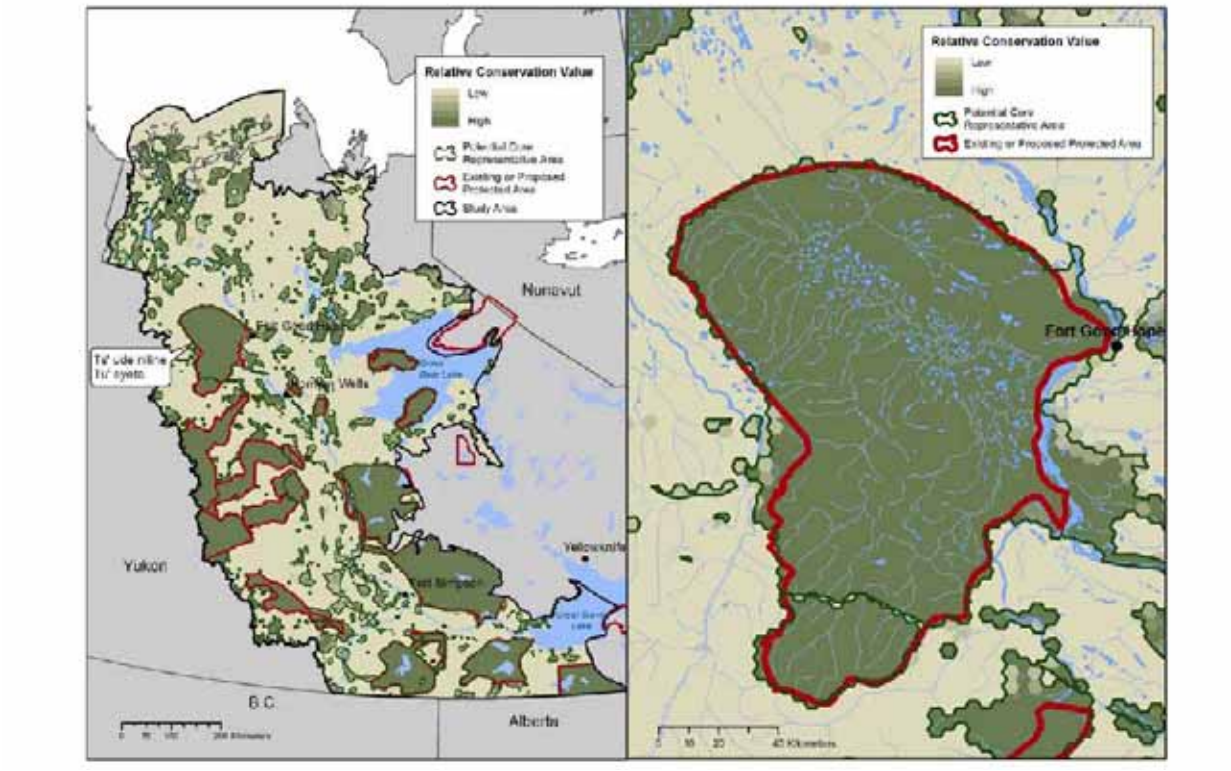

Figure 11: Ecological representation of Ts'ude niline Tu'eyeta: Closed Scenario.

4.2 Watersheds

Ts'ude niline Tu'eyeta is located within the Mackenzie-Great Bear sub-basin of the Mackenzie River Basin (Mackenzie River Basin Board, 2004). Ts'ude niline Tu'eyeta includes portions of four watersheds (Table 4, Figure 5) – Central Mackenzie – Ramparts (69.3%), Lower Mackenzie – Ontaratue (16.7%), Mountain River (2.0%), and the Arctic Red River (0.4%).

Table 4: Watersheds within Ts'ude niline Tu'eyeta

Watershed name	Watershed Area (km^2)	Watershed area within Ts'ude niline Tu'eyeta (km^2)	% of Ts'ude niline Tu'eyeta	% within Ts'ude niline Tu'eyeta
Central Mackenzie - Ramparts	15184.9	10520.8	69.6%	69.3%
Lower Mackenzie - Ontaratue	25240.9	4202.9	27.8%	16.7%
Mountain	15086.0	308.5	2.0%	2.0%
Arctic Red	21772.0	87.5	0.6%	0.4%
Total		15119.8	100%	

4.3 Vegetation

General Vegetation Description

Ts'ude niline Tu'eyeta candidate protected area falls within the Taiga Plains (91%) and Taiga Cordillera (9%) ecozones, each with its own characteristic vegetation. The Taiga Plains ecozone, classified as a high subarctic ecoclimate, supports open, slow-growing conifer forests, mainly black spruce, with a well-developed shrub layer, and bearberry, mosses, and sedges as key species within the understory. White spruce and balsam popular grow along alluvial flats of the large rivers (Ecological Stratification Working Group, 1996). The Peel Plateau and Fort McPherson Plain ecoregions are mainly open and stunted black spruce and tamarack, with small quantities of white spruce. Ground cover consists of dwarf birch, willow, shrubs, cottongrass, lichen, and moss. Wet areas support sedge, cottongrass and sphagnum moss. Also common is low shrub tundra vegetation with dwarf birch and willow. Wetlands cover about 25% of both ecoregions and are characterized by peat plateau bogs and fens. The Mackenzie River Plain ecoregion is mainly medium to tall, closed stands of black spruce and jack pine. The understory consists of feathermoss, bog cranberry, blueberry, Labrador tea, and lichens (Ecological Stratification Working Group, 1996). Poorly drained sites are low, closed and open stands of black spruce, ericaceious shrubs and sphagnum moss in poorly drained, peat depressions. Wetlands cover approximately 25 - 50 % of the ecoregion, and are characterized by peat plateau bogs and fens. The Taiga Cordillera ecozone contains thee Mackenzie Mountains ecoregion. At upper elevations the vegetation is mainly alpine tundra while the lower elevations are subalpine

open woodland (Ecological Stratification Working Group, 1996). Alpine vegetation is mainly lichens, mountain avens, dwarf ericaceuous shrubs, sedge and cottongrass. The subalpine vegetation includes discontinuous open stands of stunted white spruce within willow, dwarf birch and Labrador tea.

The Middle Mackenzie Earth Cover Project (MMECP) (Ducks Unlimited Inc., 2006) delineated 24 different vegetation classifications within Ts'ude niline Tu'eyeta (Table 5, Figure 13, Appendix D). The top five vegetation classes made up 73.1% of the land cover within Ts'ude niline Tu'eyeta: Open-Needleleaf Other, Woodland Needleleaf Lichen, Low Shrub Other, Woodland Needleleaf Other and Closed Needleleaf (Table 5, Figure 12). The remaining 19 classes ranged in cover from 4.6% to only trace amounts. From the top five classes, "needleleaf" vegetation made up 63.1%, followed by "low shrub" (10.9%)

Table 5: Earth cover classification within Ts'ude niline Tu'eyeta (MMECP)[1]

Earth cover classification	Area (km^2)	% cover within Ts'ude niline Tu'eyeta
Open Needleleaf - Other	3806	31.9
Woodland Needleleaf - Lichen	1355	11.3
Low Shrub - Other	1307	10.9
Woodland Needleleaf - Other	1288	10.8
Closed Needleleaf	980	8.2
Clear Water	547	4.6
Closed Mixed Needleleaf/Deciduous	513	4.3
Tall Shrub	370	3.1
Open Needleleaf - Lichen	262	2.2
Wet Herbaceous	246	2.1
Recent Burn	213	1.8
Closed Deciduous	212	1.8
Low Shrub - Lichen	192	1.6
Open Mixed Needleleaf/Deciduous	174	1.5
Aquatic Bed	160	1.3
Moss	133	1.1
Turbid Water	74	0.6
Emergent Vegetation	44	0.4
Open Deciduous	43	0.4
Rock/Gravel	25	0.2
Sparse Vegetation	2	0.0
Mesic/Dry Herbaceaous	0	0.0
Non-Vegetated Soil	0	0.0
Dwarf Shrub - Lichen	0	0.0
Total	11950	100%

[1] Based on Middle Mackenzie Project Earth Cover Classification (mmack_earthcover_final) (Ducks Unlimited Inc., 2006) This image only covers 79% of Ts'ude niline Tu'eyeta . Areas with no data included in the calculations.

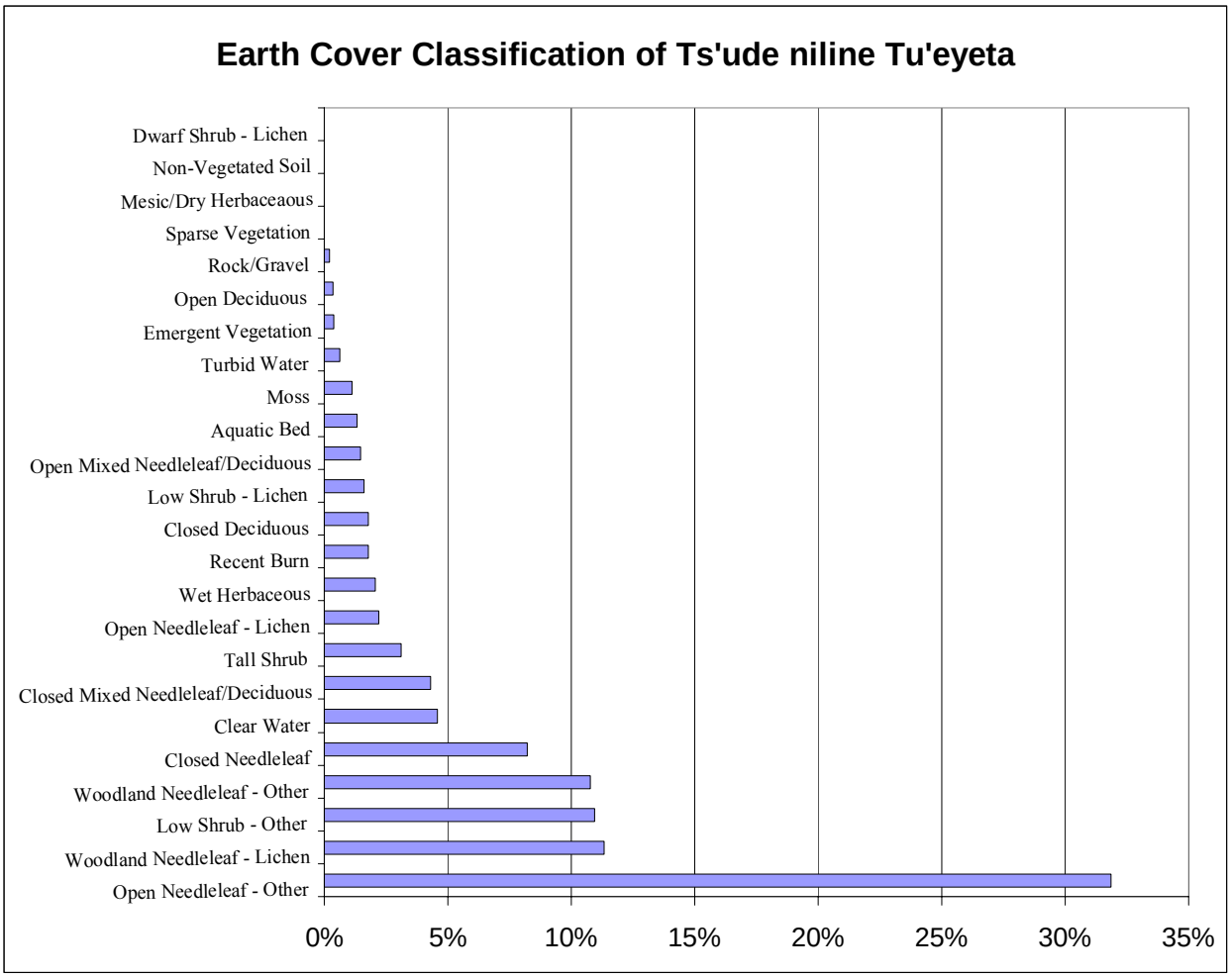

Figure 12: Plant communities based on DU Earth Cover Classification Satellite Imagery with Ts'ude niline Tu'eyeta (mmack-earthcover-final).(Ducks Unlimited Inc., 2006)

A total of 77 site assessments were conducted during the 2005 and 2006 field season (Figure 2) in 14 of the 24 vegetation classes (Table 6). Common names of plant species are used in the descriptions; for species without common names, scientific names were used. Plant species nomenclature follows Porsild and Cody (1980). A full listing of plant species observed in each community type is provided in Appendix B.

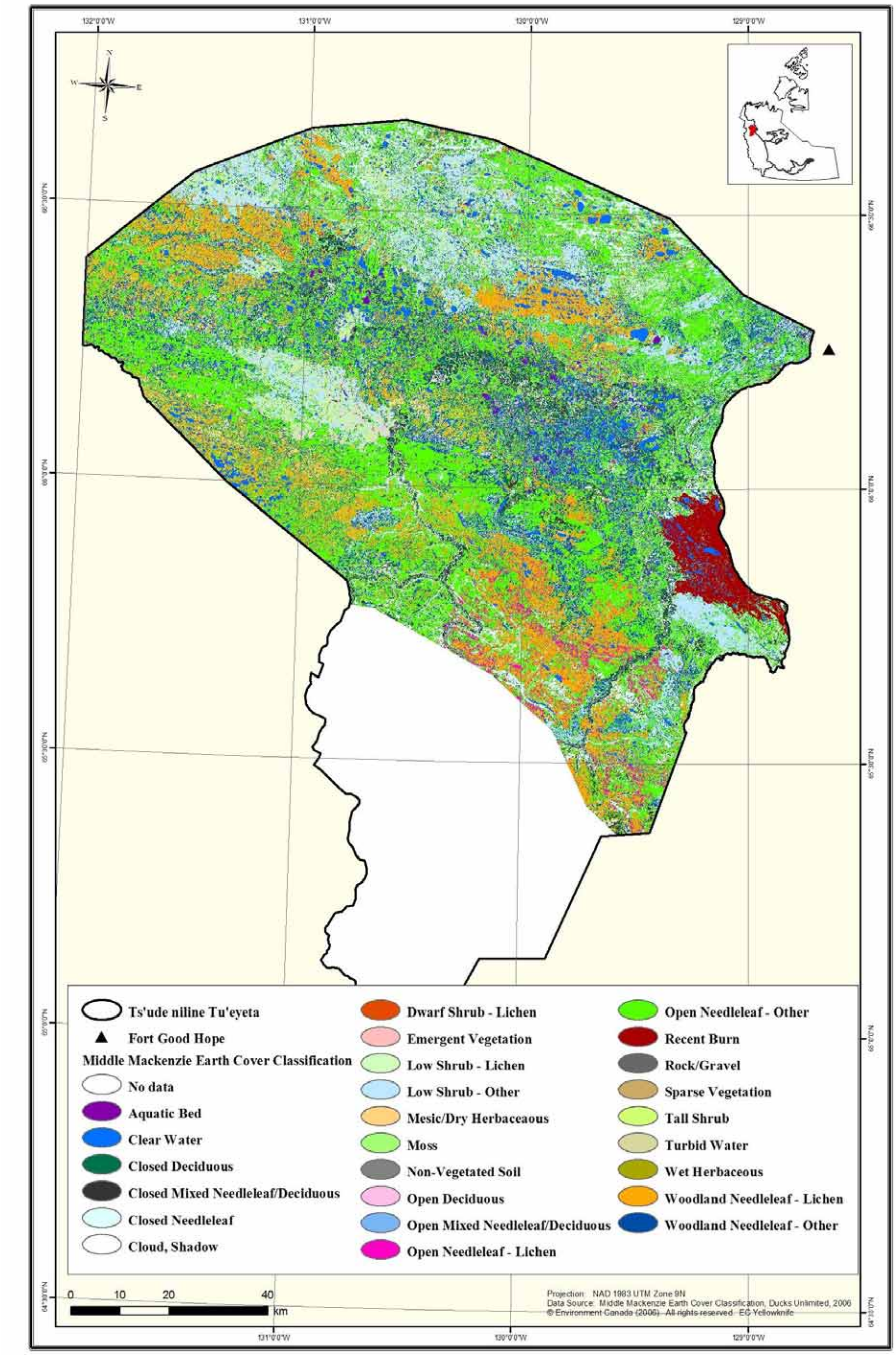

Figure 13: Earth cover classification within Ts'ude niline Tu'eyeta candidate protected area.

Table 6: Number and percentage of vegetation plots by vegetation class and % of cover.

Vegetation Classification	Number of vegetation plots (2005-2006)	% of sites	% of cover within Ts'ude niline Tu'eyeta
Open Needleleaf - Other	19	24.7%	31.85%
Low Shrub - Other	14	18.2%	10.94%
Closed Deciduous	7	9.1%	1.78%
Recent Burn	7	9.1%	1.78%
Woodland Needleleaf - Lichen	7	9.1%	11.34%
Closed Needleleaf	6	7.8%	8.20%
Closed Mixed Needleleaf/Deciduous	4	5.2%	4.29%
Open Needleleaf - Lichen	3	3.9%	2.20%
Tall Shrub	3	3.9%	3.10%
Woodland Needleleaf - Other	3	3.9%	10.78%
Clear Water	1	1.3%	4.58%
Low Shrub - Lichen	1	1.3%	1.61%
Open Deciduous	1	1.3%	0.36%
Open Mixed Needleleaf/Deciduous	1	1.3%	1.46%
Total	77	100.0%	94.26%

There are eight different phytogeographical provinces within the Northwest Territories (Porsild and Cody, 1980; McJannet *et al.*, 1995). Ts'ude niline Tu'eyeta and the 200 km radius lies within three of these provinces (Figure 14):

- Region 1: Mackenzie Mountains Province
- Region 5: Northern Boreal Province- region of treed vegetation extending from the lower Mackenzie River diagonally southeastward to the southern border of the territory
- Region 6: Southern Boreal Province – region circumscribed by the upper Mackenzie River and the Liard and Slave rivers.

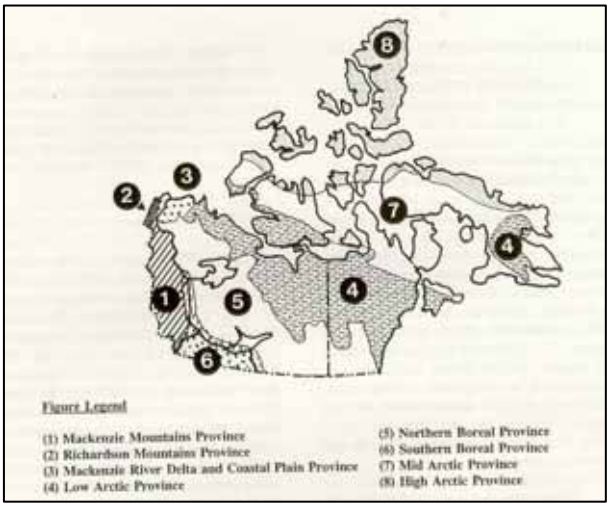

Figure 14: The phytogeographical provinces in the Northwest Territories (after Porsild & Cody 1980 and McJannet, et al 1993)

A plant list was developed using Porsild and Cody (1980) and 675 different plant species were identified, representing 68 families. The most common 10 families make up 63% of all species in Ts'ude niline Tu'eyeta (423/675) (Table 7).

Of the 675 species hypothetically within Ts'ude niline Tu'eyeta, the NWT General Status Rank (Government of the Northwest Territories, 2006) identifies 74% secure, 12.8% sensitive, and 4.3% which may be at risk (Table 8).

Table 7: Vascular plant species within Ts'ude niline Tu'eyeta and 200km buffer based on Porsild and Cody (1980)

Family	Number of species	%
Asteraceae	80	11.9
Cyperaceae	75	11.1
Brassicaceae	50	7.4
Poaceae	47	7.0
Rosaceae	37	5.5
Salicaceae	32	4.7
Ranunculaceae	29	4.3
Saxifragaceae	25	3.7
Caryophyllaceae	25	3.7
Fabaceae	23	3.4
Scrophulariaceae	21	3.1
Juncaceae	18	2.7
Ericaceae	16	2.4
Orchidaceae	13	1.9
Potamogetonaceae	11	1.6
Liliaceae	10	1.5
Polygonaceae	9	1.3
Onagraceae	9	1.3
Dryopteridaceae	9	1.3
Primulaceae	8	1.2
Equisetaceae	8	1.2
Gentianaceae	8	1.2
Betulaceae	6	0.9
Pyrolaceae	6	0.9
Apiaceae	6	0.9
Sparganiaceae	5	0.7
Grossulariaceae	5	0.7
Violaceae	4	0.6
Campanulaceae	4	0.6
Polemoniaceae	4	0.6
Boraginaceae	4	0.6
Lamiaceae	4	0.6
Pinaceae	4	0.6
Chenopodiaceae	4	0.6
Fumariaceae	3	0.4
Pteridaceae	3	0.4
Plantaginaceae	3	0.4
Lentibulariaceae	3	0.4
Papaveraceae	3	0.4
Haloragaceae	3	0.4
Valerianaceae	2	0.3
Ophioglossaceae	2	0.3
Cornaceae	2	0.3
Rubiaceae	2	0.3
Lycopodiaceae	2	0.3
Cupressaceae	2	0.3
Droseraceae	2	0.3
Portulacaceae	2	0.3
Elaeagnaceae	2	0.3
Juncaginaceae	2	0.3
Isoetaceae	1	0.1
Lemnaceae	1	0.1
Plumbaginaceae	1	0.1
Menyanthaceae	1	0.1
Myricaceae	1	0.1
Iridaceae	1	0.1
Crassulaceae	1	0.1
Linaceae	1	0.1
Nymphaeaceae	1	0.1
Callitrichaceae	1	0.1
Santalaceae	1	0.1
Caprifoliaceae	1	0.1
Orobanchaceae	1	0.1
Selaginellaceae	1	0.1
Hippuridaceae	1	0.1
Thelypteridaceae	1	0.1
Typhaceae	1	0.1
Empetraceae	1	0.1
Total	675	100.0

Table 8: Breakdown of NWT General Status Rank of species found within Ts'ude niline Tu'eyeta

NWT General Status Rank	Number of Species	%
Secure	489	72.4
Sensitive	87	12.8
Not Assessed	55	8.1
May Be At Risk	29	4.3
Undetermined	8	1.2
Presence Expected	6	0.8
Exotic/Alien	1	0.1
Grand Total	675	

Rare Plants

There are potentially 37 rare plants within Ts'ude niline Tu'eyeta and the 200 km based on *Vascular Plants of Restricted Range in the Continental Northwest Territories* (Cody, 1979) and *Rare Vascular Plants in the Northwest Territories* (McJannet *et al.*, 1995). A species is considered "rare" if it exists in low numbers or in a very restricted area within a region. The occurrence of rare plants may reflect biological characteristics such as restricted habitat requirements or evolutionary factors such as refugia or centres of evolution (Argus and McNeill, 1975 cited in McJannet el al. 1995). These rare plants often have genetic characteristics worth preserving because of their contribution to global diversity.

Ts'ude niline Tu'eyeta and the 200 km around it lies within three of the eight NWT phytogeographical provinces (Figure 14) (Porsild and Cody, 1980; McJannet *et al.*, 1995): the Southern Boreal Province, the Mackenzie Mountains Province, and the Northern Boreal Province. Approximately one-third of the rare taxa in the Northwest Territories are boreal and 31%, 20%, and 15% of them occur in these provinces respectively (McJannet *et al.*, 1995). Ts'ude niline Tu'eyeta would contribute to the conservation of these 37 rare taxa within the NWT.

Table 9: Rare plants within Ts'ude niline Tu'eyeta and 200 km radius

Family	Scientific Name	Phyto-geography	Status Rare in…	Habitat
Asteraceae	*Agoseris aurantiaca*	Montane	QB	Meadow, hot springs, and disturbed areas
Apiaceae	*Angelica lucida*	Montain	YK	Shrubby alpine tundra
Asteraceae	*Antennaria friesiana alaskana*	Arctic Alpine	YK, Canada and Canadian Arctic	Alpine ridges and snowbeds
Asteraceae	*Artemisia alaskana*	Arctic-alpine	BC	Cliffs and scree slopes
Asteraceae	*Aster yukonensis*	Montane	YK, Canada.	Subalpine stoney, silty, and saline places. Few widely separated populations
Poaceae	*Calamagrostis holmii*	Arctic	Canadian Arctic	
Brassicaceae	*Cardamine microphylla*	Arctic-alpine		
Cuperaceae	*Carex eleusinoides*	Montane	YK, Canada`	Wet gravelly river banks and meadows
Asteraceae	*Cirsium drummondii*	Prairie	ON and BC	Dry meadows and disturbed areas
Portulacaceae	*Claytonia megarhiza*	Montane	BC	Alpine tundra and scree and talus slopes
Adiantaceae	*Cryptogramma stelleri*	Cosmopolitan	YK, NS, BC and Canadian Arctic	Moist shale slopes
Brassicaceae	*Draba albertina*	Montane		Moist alpine and subalpine slopes
Brassicaceae	*Draba incerta*	Montane	Canadian Arctic	Alpine tundra and rocky slopes
Brassicaceae	*Draba ogilviensis*	Montane	YK, Canada	Lake shores and alpine meadows
Onagraceae	*Epilobium hornemannii hornemannii*	Montane		Wet alpine tundra. New to the NWT flora since (Porsild and Cody, 1980)
Gentianaceae	*Gentiana affinis*	Prairie	BC	Gravelly and silty river bars
Isoetaceae	*Isoetes lacustris*	Aquatic	PEI and SK	Shallow, sandy lake margins
Scrophulariaceae	*Limosella aquatica*	Aquatic	YK, NL, BC and Canadian Arctic	Wet, muddy or sandy pond margins
Boraginaceae	*Mertensis paniculata alaskana*	Boreal		Open woods and river banks
Caryophyllaceae	*Minuartia macrcarpa*	Arctic-alpine	Canadian Arctic	Alpine tundra
Lamiaceae	*Monarda fistulosa menthifolia*	Boreal	BC	River banks. New to NWT flora since Porsild & Cody 1980.
Nymphaeaceae	*Nuphar lutea polysepala*	Aquatic	Canadian Arctic	Lakes and slow moving streams
Fabaceae	*Oxytropis scammaniana*	Montane	BC	Alpine shale and limestone slopes
Papaveraceae	*Papaver mcconnellii*	Montane	YK, Canada	Alpine shale slopes
Scrophulariaceae	*Penstemon gormanii*	Montane	BC	Dry mountain slopes
Poaceae	*Poa abbreviate jordalii*	Montane	Canada	Dry calcareous slopes and tundra. Widely separated populations.
Poaceae	*Poa porsildii*	Montane	YK and Canada	Turfy alpine slopes and meadows. Endemic.
Potamogetonaceae	*Potamoegeton foliosus foliosus*	Aquatic	YK, PEI, NL	Shallow still waters
Ranunculaceae	*Rannunculus turneri*	Arctic-alpine	YK, Canada, Canadian Arctic	Subalpine meadows.
Brassicaceae	*Rorippa barbareifolia*	Boreal	YK, Canada	Disturbed sites. Possible introduction.
Cyperaceae	*Scirpus rollandii*	Boreal	YK, QB, SK, BC and Canada	Marly lake shores and hot springs.
Cyperaceae	*Scirpus rufus neogaeus*	Boreal	PEI, NS, ON, MB, SK, AB, and Canadian Arctic	Wet river banks and saline meadows. Disjunct.

Family	Scientific Name	Phyto-geography	Status Rare in…	Habitat
Asteraceae	*Senecio ogotorukensis*	Arctic-alpine	BC	Eroding alpine slopes
Brassicaceae	*Smelowskia calycina media*	Arctic-alpine	Canada and Canadian Arctic	Stoney slopes and lakeshores
Sparganiaceae	*Sparganium eurycarpum*	Aquatic	NF	Shallow ponds and sloughs
Ranunculaceae	*Thalictrum sparsiflorum richardsonii*	Borea	ON	River banks
Violaceae	*Viola selkerkii*	Boreal	Canadian Arctic, YK, NF, MB, AB,	Moist thickets, woods, fens, and alpine tundra

Vegetation Classification

The TWINSPAN analysis separated 51 largely forested sites characterized by high values of mean tree height (hTdecT), number of deciduous trees (NodecT), mean dbh of deciduous trees (dbhdec), and coverage (in %) by deciduous trees (%covdec; Figure 15). The 25 remaining sites were sparsely treed or treeless such of those with high values of moss-lichen stands (%moslicC; Figure 15).

Univariate comparisons of 21 quantitative variables between the four habitat types indicate that only five variables were significantly different among habitat types (Table 11). The volume of CWD was significantly higher in Tall Shrub and Closed Deciduous groups and significantly lower in Low Shrub and Conifer ($F = 5.11$, $df = 3$, $P = 0.003$). The number of conifer trees per ha was significantly lower in Low Shrub habitat types but did not differ between the other habitat types ($F = 5.8$, $df = 3$, $P \leq 0.001$). The total number of trees per ha differed significantly among Low Shrub, Conifer and Tall Shrub habitat types ($F = 7.1$, $df = 3$, ≤ 0.001). Mean dbh of conifer trees was significantly in Tall Shrub compared to all other habitat types ($F = 3.6$, $df = 3$, $P = 0.02$). Finally, the number of snags per unit area was significantly higher in Tall Shrub compared to Low Shrub and Conifer ($F = 4.0$, $df = 3$, $P = 0.01$).

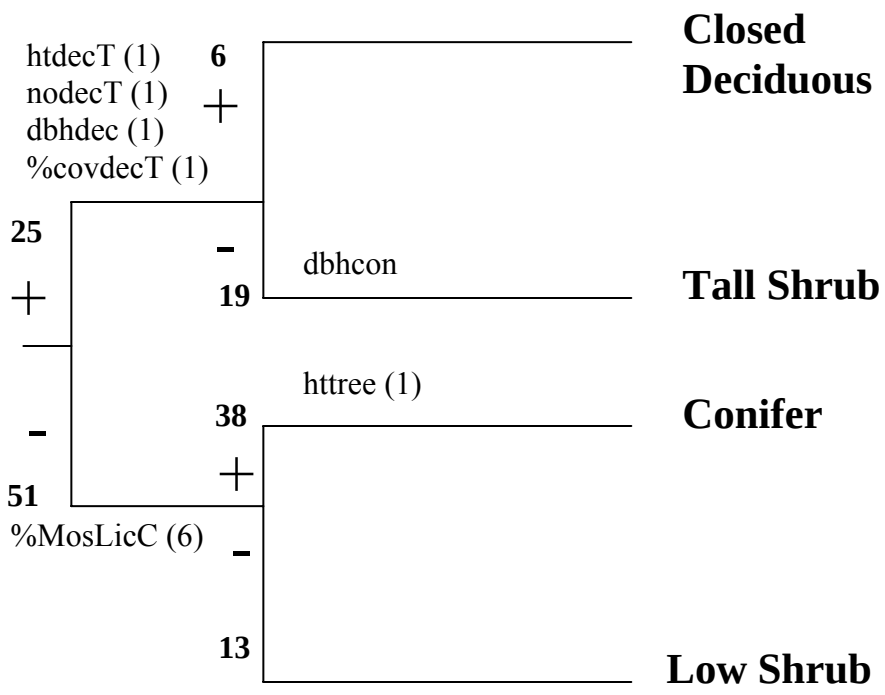

Figure 15: TWINSPAN classification of vegetation variables measured at 76 sites in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT.

The vegetation variables listed are indicators for each TWINSPAN division level. Categorized end groups were labelled according to TWINSPAN site classification for each level of division (see Table 10).

Table 10: List of sites classified by their TWINSPAN groups/ habitat types. Field description was based on visually estimating dominant vegetation.

Group 1: Low Shrub		Group 2: Conifer				Group 3: Tall Shrub		Group 4: Closed deciduous	
Site	Field description	Site	Field description	Site	Field description	Site	Field description	Site	Field description
44	open black spruce-moss	1	black spruce-lichen	39	unburned patch of spruce/birch	15	lichen dominant	50	black spruce-lichen
45	–	2	black spruce	42	black spruce bog	18	black spruce bog	53	open spruce-lichen
47	black spruce-lichen	3	black spruce-lichen	49	old burn regent/ birch and tall shrubs	19	birch stand (deciduous)	54	closed poplar
55	birch forest	4	black spruce-lichen	52	black spruce-moss	20	mixed - birch spruce	66	burn
56	low shrub – burn	5	spruce lichen	60	closed spruce forest	25	riparian spruce (white and black)	67	riparian closed poplar forest
57	low shrub – recent burn	7	black spruce-lichen	64	low shrub	26	Riparian spruce	72	black spruce forest
58	low shrub	8	black spruce-lichen	69	low shrub burn	27	birch stand regeneration/birch/alder/willo		
61	tall spruce forest	9	black spruce-lichen-moss	70	black spruce-lichen	28	w regeneration - burn tall		
62	low shrub burn	11	Tall shrub - burn	71	low shrub poplar and tall	29	shrubs		
63	recently burned	12	burn tall shrub lichen	73	shrub black spruce-	34	fire regeneration regeneration /black		
65	recent burn	13	dominant/black spruce lichen	74	lichen spruce lichen	35	spruce/birch		
68	riparian poplar forest	14	dominant with sphagnum mixed - black	75	swamp regen/birch/spru	36	mixed forest - tall shrub black spruce/lichen area in		
76	open spruce lichen	16	spruce lichen and birch black spruce	30	ce black spruce-	37	30-40 yrs old burn		
		17	bog black spruce birch, open	31	lichen	38	old burn - mixed forest		
		21	mixed forest white	32	burn tall shrub	40	black spruce snags		
		22	spruce/alder black spruce	33	burn tall shrub	41	mixed forest		
		23	riparian forest black spruce	46	recent burn Burn- black	43	black spruce-sphagnum		
		24	riparian forest	48	spruce bog	59	low shrub - burn regeneration		

Table 11: Summary statistics (Mean±SD) of vegetation variables collected in each habitat type in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT.

The median values are presented in brackets for each category. Habitat types were determined by TWINSPAN classification based on vegetation data. Significant variables for ANOVA are shown in bold. Multiple comparisons (Tukey test) between groups for significant variables are represented by letters where significantly different values have different letters.

Variable	Low Shrub (13)		Conifer (38)		Tall Shrub (19)		Closed Deciduous (6)	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
% total conifer trees cover	2.8	6.4	8.5	10.9	6.0	6.6	2.7	3.3
% total deciduous tree cover	5.5	13.3	3.6	13.2	6.0	12.1	18.3	28.6
% tree cover	10.3	13.2	12.7	14.2	15.7	15.6	22.2	25.8
% shrub cover	30.2	11.9	28.7	20.7	35.4	26.6	25.5	14.7
% moss cover	37.5	28.6	26.2	23.6	27.8	30.1	20.3	30.7
% plant cover	5.8	9.3	3.7	5.3	7.6	10.2	3.0	3.8
% bare ground cover	4.6	11.4	4.4	10.3	0.3	1.2	0.8	2.0
% litter cover	14.0	21.5	8.9	17.2	23.3	32.0	30.8	45.4
% water cover	1.1	1.7	0.9	1.3	0.5	1.2	0.3	0.5
Coarse woody debris volume (m^3/ha)	**1121.5**	**1565.0[a]**	**993.3**	**1197.1[a]**	**4158.6**	**5380.3[b]**	**2295.4**	**2240.9[ab]**
No. of conifer trees per ha	**11.5**	**16.5[a]**	**50.7**	**36.1[b]**	**56.9**	**33.0[b]**	**33.3**	**37.6[ab]**
No. of deciduous trees per ha	9.6	16.3	8.8	14.7	23.6	23.4	12.5	20.9
Total no. of trees per ha	**21.2**	**28.6[a]**	**59.5**	**36.5[b]**	**80.6**	**40.7[c]**	**45.8**	**29.2[ab]**
Mean dbh of conifer trees (cm)	**2.6**	**4.0[a]**	**4.6**	**4.0[a]**	**7.3**	**4.5[b]**	**3.2**	**4.0[a]**
Mean dbh of deciduous trees (cm)	2.6	5.6	1.9	3.5	5.0	5.8	4.0	6.4
Mean dbh of trees (cm)	4.6	6.0	5.3	4.1	7.3	4.2	7.2	5.1
Mean height of conifer trees (m)	2.6	3.8	3.3	2.4	4.8	4.3	2.0	2.3
Mean height of deciduous trees (m)	4.1	8.4	1.7	3.3	4.9	5.3	2.1	3.6
Mean tree height (m)	5.9	8.2	4.1	2.9	5.2	3.9	4.1	2.9
No. of snags per unit area	**0.1**	**0.1[a]**	**0.1**	**0.1[a]**	**0.3**	**0.4[b]**	**0.1**	**0.2[ab]**
Median snag diameter class	6		6		10		10	
Median snag height class	5		5		6		6	
Median snag decay class	2		1		1		1	
Structural stage class	5		5		4		4	
Moisture regime class	5		5		4		5	

This analysis revealed a relatively low diversity of habitat types in Ts'ude niline Tu'eyeta. Generally, the forested landscape varied from treeless stands such as Low Shrub-Lichen and Tall Shrub stands that originated from recent and old forest fires, to coniferous forested areas such as open and closed black spruce stands. Three of the four habitat types obtained from the

TWINSPAN were well clustered in the DCA, meaning that these habitat types have distinct plant communities. Sites classified as Low Shrub were not well clustered in the ordination space, meaning that there was a lot of variability in vegetation structure among them.

The most abundant habitat type visited was Conifer (38 sites), which included vegetation classes such as Open Needleleaf and Woodland Needleleaf (i.e. black spruce–lichen and black spruce bog) (Table 10). This forest types is usually characterized by 25 - 39 % tree cover dominated by coniferous species such as black spruce (Ducks Unlimited Inc. 2006). This habitat type had among the highest density of conifer trees of all four groups. Tree species were dominated principally by black spruce, white spruce and tamarack. Dominant shrub species included Labrador tea, dwarf birch and mountain cranberry. Lichens such as *Cladina* and *Cladonia* spp. and sphagnum mosses dominated the ground cover.

The second most abundant habitat type within Ts'ude niline Tu'eyeta was Tall Shrub (19 sites) (Table 10). Tree cover was low to absent in this type (i.e. ≤ 10 % of the cover) and shrub species (usually ≥ 1.3 m tall) dominate the shrub layer with more than 25-100 % of the cover (Ducks Unlimited Inc. 2006). Dominant shrub species include green alder, Labrador tea, and mountain cranberry. Tall shrub sites also tend to have a greater volume of CWD than the other habitat types. Volume of CWD was highest in this habitat type principally due to the occurrence of forest fire. Relative to its proportion in the Middle Mackenzie where it represents up to 25 percent of the area (Ducks Unlimited Inc. 2006), tall shrub habitat correspond to a relatively rare habitat type in the TPCA with only 4.7 percent.

The third most abundant habitat type was Low Shrub (13 sites) dominated mainly by recent burns, low shrub-lichen, and low-shrub-other (Table 10). In this habitat type, low shrubs usually make up 25-100 % of the cover and include a wide variety of shrub species such as Labrador tea and dwarf birch (Ducks Unlimited Inc. 2006). Sites classified as Shrub were also characterized by the lowest tree density of all habitat types. The proportion of low shrub habitat types (including Shrub-Other, Low Shrub-Lichen and Recent burn) within the study area represented 17 % which was similar to the value of 13% found for the Middle Mackenzie (Ducks Unlimited Inc., 2006). However, it was lower than in the Norman Wells area, where recent forest fires dominate the landscape (Cooper *et al.* 2004).

The least abundant habitat type was Closed Deciduous stands (7.8% of sites) (Table 10). This forest type was found mainly along riparian areas such as river floodplain and in patches on plateaus (Ducks Unlimited Inc., 2006) and was composed principally of poplar and birch stands. In terms of forest structure, this habitat type was characterized by higher and larger snags than in other habitat types which are important habitat components for various species of cavity-nesting birds in the boreal forest (Savignac, 1998; Savignac and Machtans, 2006). This habitat type,

although relatively rare in Ts'ude niline Tu'eyeta, was found at a much higher proportion than in the Middle Mackenzie region, where it represents only 1 % of the area (Ducks Unlimited Inc. 2006). Presence of several rivers and associated riparian zones within Ts'ude niline Tu'eyeta are likely the cause of the high percent of deciduous stands in this area.

Comparison of Vegetation Classification with Middle Mackenzie Earth Cover Project Classification

The ordination graph of the DCA on vegetation variables derived from the Middle Mackenzie Earth Cover Project classification (MMECP) shown in Figure 16, indicates a gradient from open forested areas, on the left of the horizontal axis, to treeless sites on the right. From the top to the bottom, the gradient of the vertical axis is from closed forest stand (such as riparian spruce stands) to open canopy stands. Tall Shrub and Lichen/Open Spruce-Lichen sites are tightly clustered on the right of the ordination, while sites from Low Shrub and Open/closed spruce are clustered on the left (Figure 16). There was a positive and significant association between the matrix formed by 25 field vegetation (DCA analysis: Figure 3, Appendix J) and the matrix formed by the four derived MMECP vegetation variables (Figure 16); Standardized Mantel statistic r= 0.12, P= 0,004). This indicates that the vegetation variables collected at each site during 2005 and 2006 correlate fairly well with the assigned vegetation classes derived from the MMECP classification (see Appendix J for details). However, in order to better determine the agreement between the vegetation variables measured in this study compared to the MMECP, a larger sample size of sampling sites was required using a methodology more appropriate for such a comparison. Future ecological assessments related to other candidate protected areas should use the MMCEP given a similar amount of time and resources available for the work.

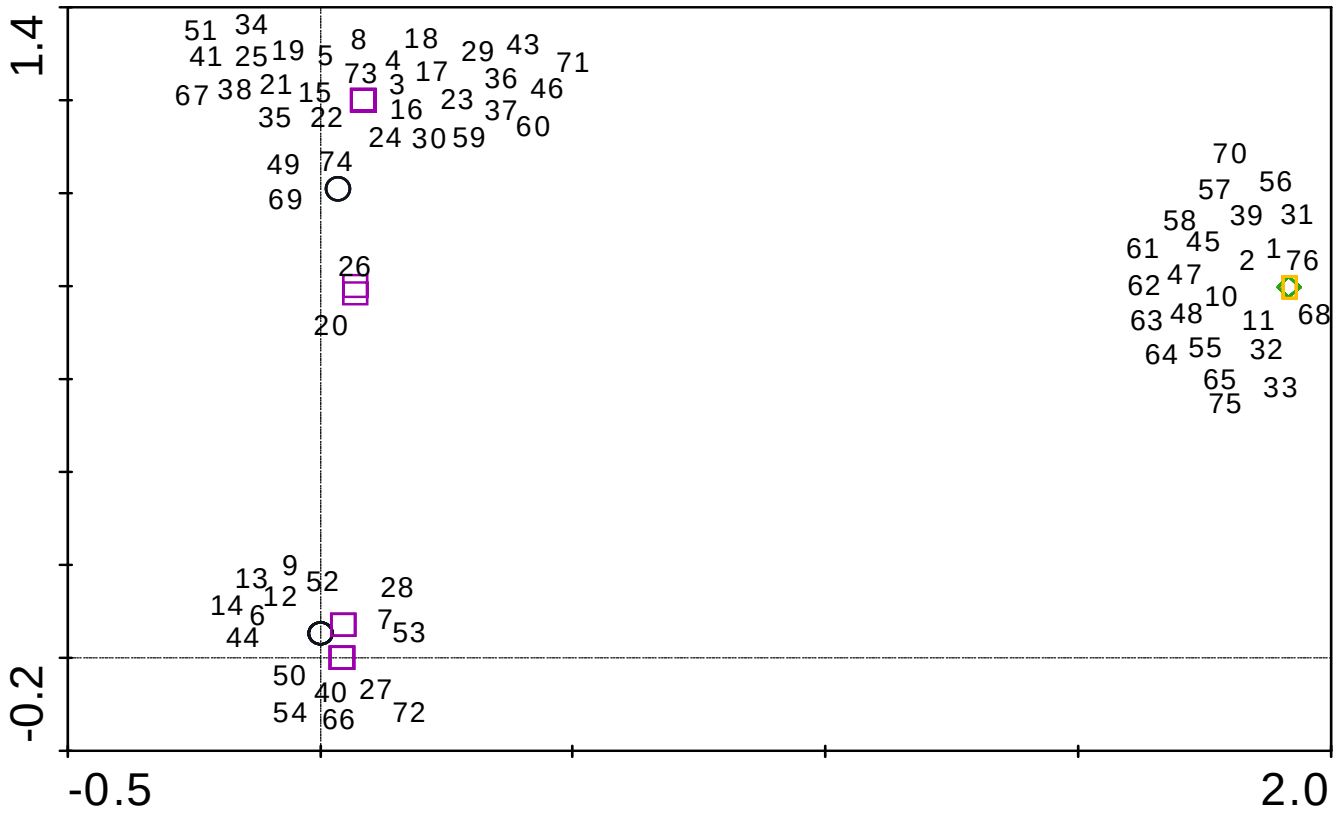

Figure 16: DCA on vegetation variables derived from the MMECP classification for each site surveyed in the Ts'ude niline Tu'eyeta Candidate Protected Area. TWINSPAN groups are: Low Shrub = black circles, Open/Closed Spruce = purple squares; Tall Shrub = green diamond; Lichen/ Open Spruce-Lichen = yellow rectangle.

Fire History

Approximately 5,912 km² (39%) of Ts'ude niline Tu'eyeta has been burned between 1967 and 2003 (ENR, 2006). Some areas have experienced burns in multiple years. The total amount of burned area in Ts'ude niline Tu'eyeta is 6141 km² (Table 12; Figure 17). The largest burn in the candidate area occurred in 1969 when 2100 km² was burned. The most recent burn in 1999 (Hume River) covered 1609 km².

Table 12: Fire history (area km^2) within Ts'ude niline Tu'eyeta, 1967 and 2003.

Year	Total Area Burned (km^2)
1967	12.7
1969	2099.7
1971	115.4
1973	77.8
1974	36.5
1976	5.0
1977	60.9
1979	21.0
1980	30.3
1982	7.1
1983	5.1
1985	0.8
1986	383.2
1987	151.3
1988	185.5
1989	32.9
1992	0.3
1993	789.9
1994	75.0
1998	434.2
1999	1609.4
2003	7.7
Total	6141.7 km^2

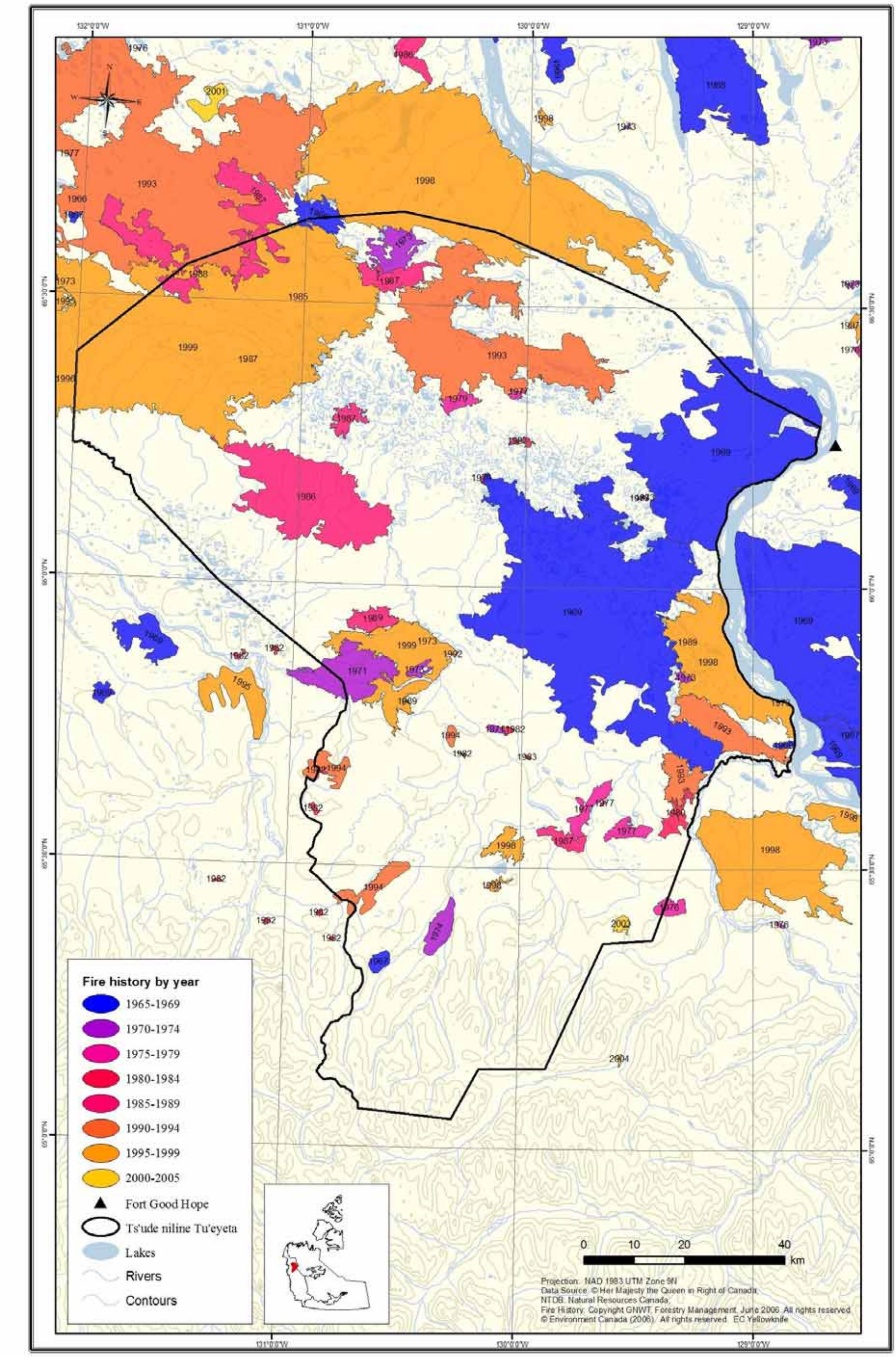

Figure 17: Areas burned between 1967 and 2003 within Ts'ude niline Tu'eyeta.

4.4 Wildlife (Fish, Amphibians, Birds, and Mammals)

Fish

Baseline fish studies were conducted in the Ramparts, Hume and Ontaratue rivers in 1971-1973 as part of the Mackenzie Valley pipeline review (Shotton, 1971; Hatfield *et al.*, 1972; Dryden *et al.*, 1973; Shotton, 1973; Stein *et al.*, 1973; Jessop *et al.*, 1974; Department of Environment, 1975 in Stewart, 1996). These studies and examination of range maps (Scott and Crossman, 1973) identified 26 different species of fish within Ts'ude niline Tu'eyeta (Table 13).

The headwater lakes of the Hume River provide important nursery habitat for Arctic grayling and lake chub. Many small lakes between the Ramparts and Hume rivers have been fished for subsistence, and residents of Fort Good Hope also fish year-round for subsistence in the Hume River. Whitefish, inconnu, and burbot are the main species harvested (Stewart, 1996). The Ramparts is fished for subsistence by residents of Fort Good Hope throughout the summer and fall. The peak fishing period is between mid- August and late September. Major fish species encountered at the Ramparts are Arctic cisco, burbot, inconnu, and whitefish species (Stewart, 1996).

Amphibians

Two wood frogs (Rana sylvatica) were observed in Ts'ude niline Tu'eyeta (Figure 18). Wood frogs are considered common and widely distributed throughout the forested regions of the NWT and are one of four species of amphibians known to occur in the NWT (Fournier, 1997). The wood frog is freeze-tolerant and hibernates within the frost zone. Boreal chorus frogs (Pseudacris maculata) may also occur in Ts'ude niline Tu'eyeta, although beyond their existing range (M. Fournier, pers.comm).

Table 13: Fish species recorded within Ts'ude niline Tu'eyeta during past studies (Scott and Crossman, 1973)

Common Name	Scientific Name	Hume[1]	Ramparts[2]	Ontaratue[3]
Lake trout	*Salvelinus namaykush*			
Lake whitefish	*Coregonus clupeaformis*		*X*	
Lake cisco	*Coregonus artedii*			
Least cisco	*Coregonus sardinella*			
Broad Whitefish	*Coregonus nasus*	*X*	*X*	
Round whitefish	*Prosopium cylindraceum*	*X*		
Mountain whitefish	*Prosopium williamsoni*			
Inconnu	*Stenodus leucichthys*		*X*	*X*
Arctic grayling	*Thymallus arcticus*	*X*	*X*	*X*
Northern pike	*Esox lucius*	*X*	*X*	*X*
Walleye	*Stizostedion vitreum*		*X*	*X*
Burbot	*Lota lota*	*X*	*X*	
Longnose sucker	*Catostomus catostomus*	*X*	*X*	*X*
White sucker	*Catostomus commersoni*	*X*	*X*	*X*
Lake chub	*Couesius plumbeus*	*X*	*X*	*X*
Flathead chub	*Platygobio gracilis*	*X*	*X*	
Emerald shiner	*Notropis atherinoides*			
Spottail shiner	*Notropis hudsonius*			
Finescale dace	*Chrosomus neogaeus*			
Northern redbelly dace	*Chrosomus eos*			
Longnose dace	*Rhynichthys cataractae*			
Slimy sculpin	*Cottus cognatus*	*X*	*X*	*X*
Spoonhead sculpin	*Notropis hudsonius*		*X*	
Trout perch	*Percopsis omiscomaycus*	*X*	*X*	*X*
Brook stickleback	*Culea inconstans*			
Ninespine stickleback	*Pungitius pungitius*			

Species reported in particular rivers drainage:

[1]Hume: (Shotton, 1971; Hatfield *et al.*, 1972; Dryden *et al.*, 1973; Shotton, 1973; Stein *et al.*, 1973; Jessop *et al.*, 1974)

[2] Ramparts: (Shotton, 1971; Hatfield *et al.*, 1972; Dryden *et al.*, 1973; Shotton, 1973; Stein *et al.*, 1973; Jessop *et al.*, 1974)

[3]Ontaratue: (Hatfield *et al.*, 1972)

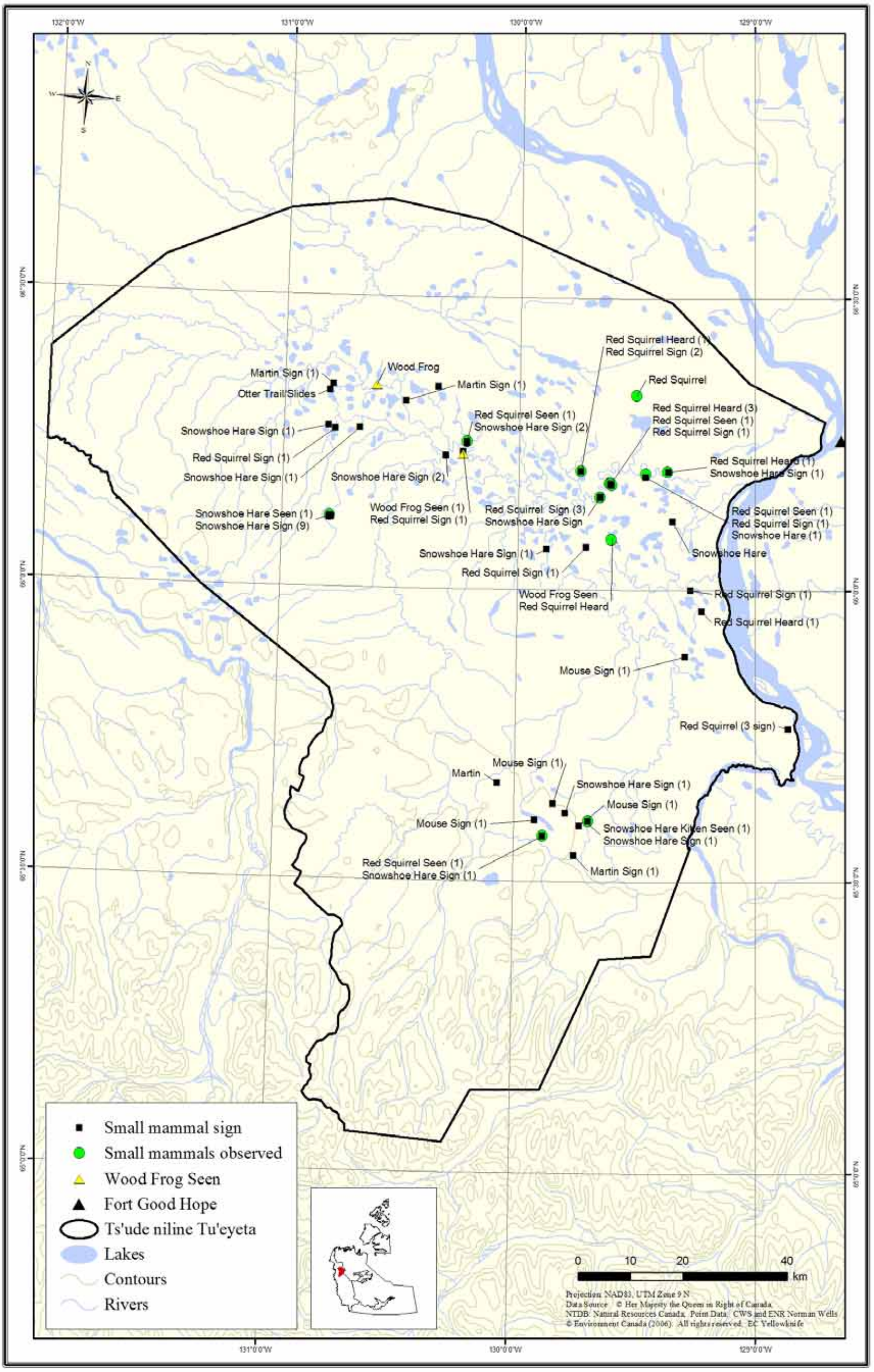

Figure 18: Amphibians and small and medium size mammals observed within the Ts'ude niline Tu'eyeta candidate protected area, June 2005 and 2006 and March 2006.

Birds

A total of 175 bird species were confirmed or have ranges overlapping the Ts'ude niline Tu'eyeta study area (i.e., within 200 km), either as breeders or during migration, including 31 waterfowl, 11 waterbirds, 22 shorebirds, 18 raptors, and 93 passerines (Table 14, Appendix F).

Table 14: Number of bird species within Ts'ude niline Tu'eyeta.

Group	Number of Species	Order	Family	Number of Species	Representative Species
Waterfowl	31	Anseriformes	Anatidae	26	Swans, geese, ducks
		Gaviiformes	Gaviidae	3	Loons
		Podicipediforme	Podicipedidae	2	Grebes
Waterbirds	11	Gruiformes	Gruidae	1	Sandhill Crane
			Rallidae	2	Coot, Sora
		Charadriiformes	Laridae	8	Jaeger, gull, tern
Shorebirds	22	Charadriiformes	Charadriidae	4	Plover, Killdeer
			Scolopacidae	18	Yellowlegs, sandpiper, Dowitcher, Snipe
Raptors	18	Falconiformes	Accipitridae	9	Osprey, eagle, hawk
			Falconidae	4	Falcon, Merlin, Kestrel
		Strigiformes	Strigidae	5	Owls
Passerines	93	Passeriformes	Alaudidae	1	Horned Lark
			Bombycillidae	1	Waxwing
			Cinclidae	1	Dipper
			Corvidae	3	Jay, Magpie, Raven
			Emberizidae	17	Sparrows
			Fringillidae	8	Finch, Crossbill, Grosbeak, Redpoll
			Hirundinidae	4	Swallow
			Icteridae	3	Blackbird, Cowbird
			Laniidae	1	Northern Shrike
			Motacillidae	2	Wagtail, Pipet
			Paridae	2	Chickadee
			Parulidae	14	Warblers
			Regulidae	1	Kinglet
			Sittidae	1	Nuthatch
			Thraupidae	1	Tanager
			Turdidadae	8	Thrush
			Tyrannidae	8	Flycatchers, Kingbird, Phoebe
			Vireonidae	2	Vireo
		Caprimulgiforme	Caprimulgidae	1	Nighthawk
		Coraciiformes	Alcedinidae	1	Kingfisher
		Galliformes	Phasianidae	7	Grouse, Ptarmigan
		Piciformes	Picidae	6	Woodpecker, sapsucker, flicker
Total	175			175	

Forest Birds

Seventy-seven sites were visited and three forest bird point counts were conducted at each site (Figure 2, Figure 8, Table 15) for a total of 2356 birds, including 67 different species (Appendix F). Twenty-one different families were recorded during the point counts (Table 16). The top three families were Emberizidae (sparrows), Parulidae (warblers), and Turdidadea (thrushes), and represented 75% of the species recorded. A total of 44 songbird species, 14 species of waterbirds, four species of woodpecker, one species of ptarmigan, and one species of owl were recorded (Table 17),. The six most common species detected during the songbird survey comprised 39% of the all species detected: Swainson's Thrush, White-crowned Sparrow, Fox Sparrow, Lincoln Sparrow, Chipping Sparrow, and Yellow-rumped Warbler.

Species with less than three detections that were omitted from the analysis were the American Redstart, Common Yellowthroat, Magnolia Warbler, Bohemian Waxwing, Downy Woodpecker, Hairy Woodpecker, Varied Thrush, Western Tanager, Western-Wood Peewee, Yellow-bellied Sapsucker, Le Conte Sparrow and Purple Finch. Waterfowl (4 species), grebes (1 species), ptarmigan (1 species), owls (1 species), rails (1 species), shorebirds (5 species), gulls (1 species), Sandhill Cranes, and the Common raven were also omitted because they are inadequately sampled by the point count technique. A total of 47 species remained for analysis.

Table 15: Forest bird point count summary

Year	Number of sampling sites	Number of point count	Number of bird observations/recordings
2005	37	107	1069
2006	40	120	1286
Total	77	227	2356

Table 16: Bird families recorded, in descending order of abundance, during point counts, 2005 and 2006.

Family	Number recorded	Percent
Emberizidae	785	33.32
Parulidae	604	25.64
Turdidadae	370	15.70
Scolopacidae	127	5.39
Tyrannidae	120	5.09
Fringillidae	84	3.57
Regulidae	60	2.55
(blank)	39	1.66
Gaviidae	38	1.61
Gruidae	30	1.27
Anatidae	28	1.19
Corvidae	20	0.85

Family	Number recorded	Percent
Vireonidae	13	0.55
Laridae	11	0.47
Picidae	10	0.42
Icteridae	7	0.30
Phasianidae	4	0.17
Bombycillidae	2	0.08
Strigidae	1	0.04
Thraupidae	1	0.04
Rallidae	1	0.04
Podicipedidae	1	0.04
Total	2356	100.00

Table 17: Bird species recorded during forest bird point counts, 2005 and 2006.

Family	Scientific Name	Common Name	Number Recorded
Gaviidae	*Gavia immer*	Common Loon	38
Podicipedidae	*Podiceps grisegena*	Red-necked Grebe	1
Anatidae	*Branta canadensis*	Canada Goose	16
Anatidae	*Anas americana*	American Wigeon	8
Anatidae	*Anas platyrhynchos*	Mallard	2
Anatidae	*Aythya collaris*	Ring-necked Duck	2
Phasianidae	*Lagopus lagopus*	Willow Ptarmigan	4
Rallidae	*Porzana carolina*	Sora	1
Gruidae	*Grus canadensis*	Sandhill Crane	30
Scolopacidae	*Tringa melanoleuca*	Greater Yellowlegs	1
Scolopacidae	*Tringa flavipes*	Lesser Yellowlegs	23
Scolopacidae	*Tringa solitaria*	Solitary Sandpiper	3
Scolopacidae	*Actitis macularia*	Spotted Sandpiper	1
Scolopacidae	*Gallinago gallinago*	Common Snipe	59
Scolopacidae	*Tringa species*	Unidentified Yellowlegs	40
(blank)	*(blank)*	Unidentified Shorebird	3
Laridae	*Larus canus*	Mew Gull	4
Laridae	*Larus species*	Unidentified Gull	7
Strigidae	*Surnia ulula*	Northern Hawk Owl	1
Picidae	*Sphyrapicus varius*	Yellow-bellied Sapsucker	2
Picidae	*Picoides pubescens*	Downy Woodpecker	2
Picidae	*Picoides villosus*	Hairy Woodpecker	1
Picidae	*Colaptes auratus*	Northern Flicker	5
Tyrannidae	*Contopus borealis*	Olive-sided Flycatcher	9
Tyrannidae	*Contopus sordidulus*	Western Wood-Pewee	2
Tyrannidae	*Empidonax flaviventris*	Yellow-bellied Flycatcher	4
Tyrannidae	*Empidonax alnorum*	Alder Flycatcher	99
Tyrannidae	*Empidonax minimus*	Least Flycatcher	6
Vireonidae	*Vireo gilvus*	Warbling Vireo	7
Vireonidae	*Vireo olivaceus*	Red-eyed Vireo	6
Corvidae	*Perisoreus canadensis*	Gray Jay	12
Corvidae	*Corvus corax*	Common Raven	8
Regulidae	*Regulus calendula*	Ruby-crowned Kinglet	60
Turdidadae	*Catharus minimus*	Gray-cheeked Thrush	44
Turdidadae	*Catharus ustulatus*	Swainson's Thrush	193
Turdidadae	*Catharus guttatus*	Hermit Thrush	31
Turdidadae	*Turdus migratorius*	American Robin	100
Turdidadae	*Ixoreus naevius*	Varied Thrush	2
Bombycillidae	*Bombycilla garrulus*	Bohemian Waxwing	2
Parulidae	*Vermivora peregrina*	Tennessee Warbler	41
Parulidae	*Vermivora celata*	Orange-crowned Warbler	101
Parulidae	*Dendroica petechia*	Yellow Warbler	103
Parulidae	*Dendroica magnolia*	Magnolia Warbler	2
Parulidae	*Dendroica coronata*	Yellow-rumped Warbler	114
Parulidae	*Dendroica palmarum*	Palm Warbler	47
Parulidae	*Dendroica striata*	Blackpoll Warbler	90

Family	Scientific Name	Common Name	Number Recorded
Parulidae	*Setophaga ruticilla*	American Redstart	3
Parulidae	*Seiurus noveboracensis*	Northern Waterthrush	92
Parulidae	*Geothlypis trichas*	Common Yellowthroat	1
Parulidae	*Wilsonia pusilla*	Wilson's Warbler	6
Thraupidae	*Piranga ludoviciana*	Western Tanager	1
Emberizidae	*Spizella arborea*	American Tree Sparrow	21
Emberizidae	*Spizella passerina*	Chipping Sparrow	114
Emberizidae	*Passerculus sandwichensis*	Savannah Sparrow	61
Emberizidae	*Ammodramus leconteii*	Le Conte's Sparrow	1
Emberizidae	*Passerella iliaca*	Fox Sparrow	171
Emberizidae	*Melospiza lincolnii*	Lincoln's Sparrow	135
Emberizidae	*Melospiza georgiana*	Swamp Sparrow	4
Emberizidae	*Zonotrichia albicollis*	White-throated Sparrow	21
Emberizidae	*Zonotrichia leucophrys*	White-crowned Sparrow	191
Emberizidae	*Junco hyemalis*	Dark-eyed Junco	66
Icteridae	*Agelaius phoeniceus*	Red-winged Blackbird	7
Fringillidae	*Carpodacus purpureus*	Purple Finch	1
Fringillidae	*Loxia leucoptera*	White-winged Crossbill	21
Fringillidae	*Carduelis flammea*	Common Redpoll	60
Fringillidae	*Carduelis pinus*	Pine Siskin	2
(blank)	*(blank)*	other species observed	36
Total			2356

The TWINSPAN analysis separated 51 sites with a large component of open black spruce and low and tall shrubs from the remaining stands: these were characterized by high numbers of ground species such as White-crowned Sparrow, Blackpoll Warbler and Lincoln Sparrow (rank 1:Figure 19). The remaining 25 sites were principally black spruce bog and riparian deciduous and mixed stands, and were characterized mainly by large number of Tennessee Warblers (rank 1, Figure 19).

TWINSPAN identified four end-groups which are shown on the right of Figure 19. The first group (28 sites) was composed of vegetation classes characterized by Black Spruce-Lichen sites as suggested by the indicator species, the Ruby-crowned Kinglet. The second group (23 sites) was composed of Shrub sites such as low and tall shrub stands often associated with recent and old burns. Indicator species for these sites were the Hermit Thrush, American Robin, Savannah Sparrow, Alder Flycatcher and, Orange-crowned Warbler (Figure 19). Group 3 (15 sites) was composed of Deciduous stands, such as closed poplar stands. Yellow Warbler, Northern Waterthrush, Tennessee Warbler and Swainson's Thrush were characteristic inhabitants. The 10 sites in group 4 were associated with Black Spruce Bog, as demonstrated by two indicator species; the Lincoln and Savannah Sparrows (Figure 19).

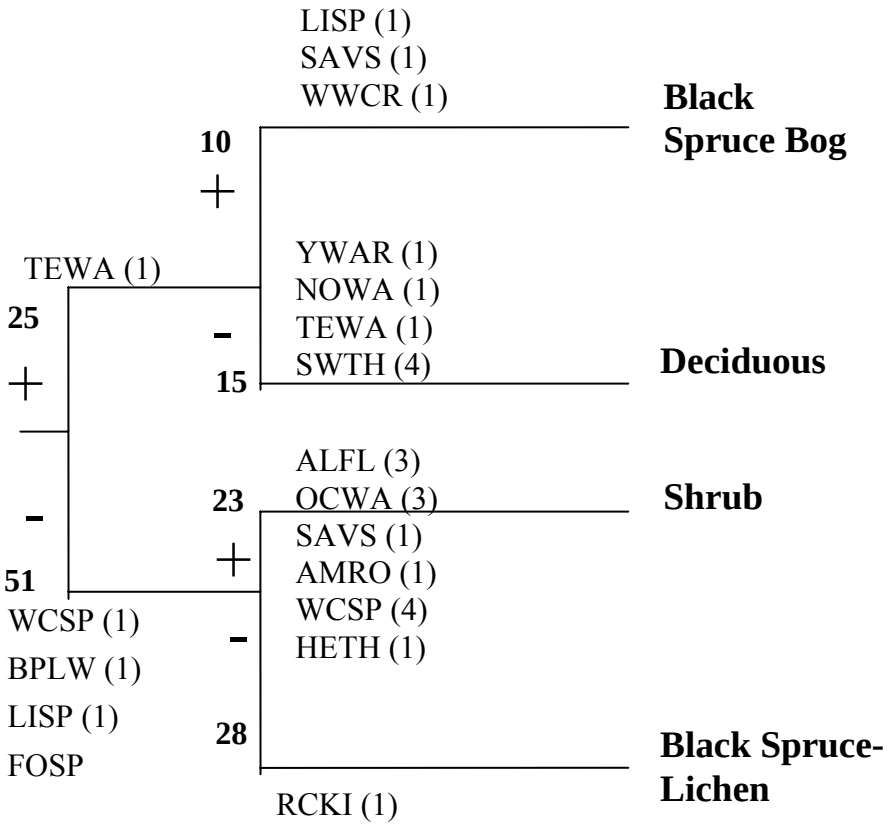

Figure 19: TWINSPAN classification of sites based on bird species abundance (summer bird count) in the Ts'ude'hliline-Tuyetah Candidate Protected Area. Indicator species (rank) are provided for each TWINSPAN division level. Species codes are provided in Appendix 1 in Appendix J. Categorized end groups were labeled according to TWINSPAN site classification for each level of division (see Table 7, Appendix J).

When the total number of individuals per species was considered, Deciduous and Black Spruce Bog had the highest bird species richness while Black Spruce-Lichen and Shrub had the lowest (Figure 20). Generally bird species richness estimated for Ts'ude niline Tu'eyeta was lower than Norman Wells, located at similar latitude (less than 150 km to the southeast). In Ts'ude niline Tu'eyeta, a total of 64 species were detected, whereas 76 species were detected in the Norman Wells area (Cooper *et al.*, 2004). This lower species richness is not surprising considering the relatively simple habitat structure and the low habitat heterogeneity found in Ts'ude niline Tu'eyeta. Species richness is usually higher at lower latitudes, where more diversified forests exist (Machtans and Latour, 2003).

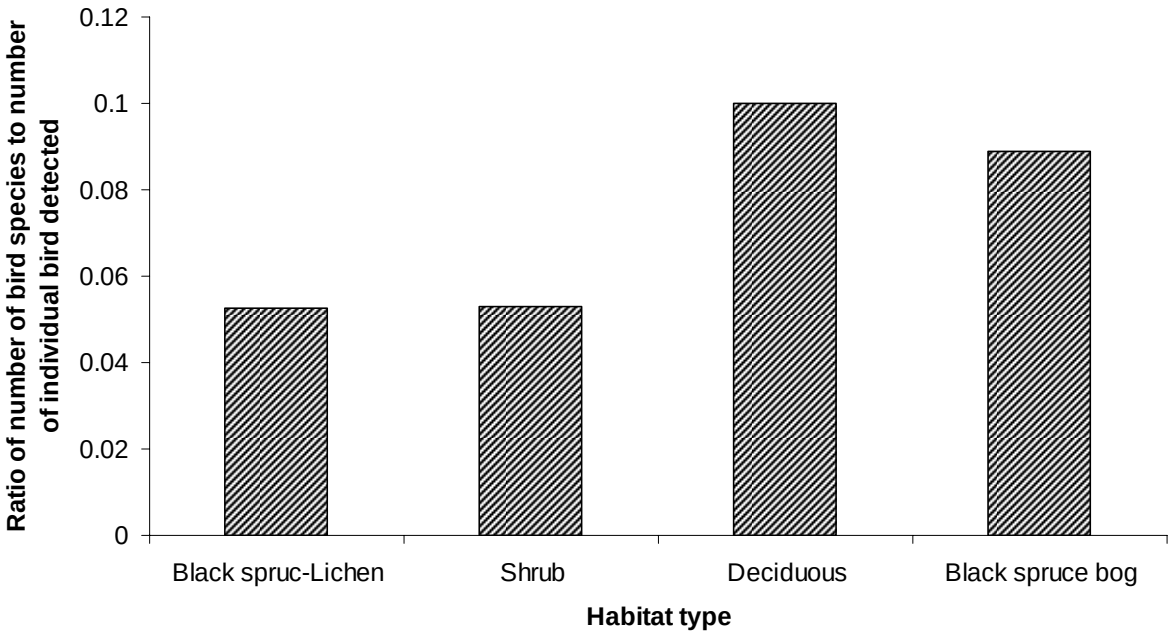

Figure 20: Bird species richness in each of the four habitat types surveyed in the Ts'ude niline Tu'eyeta Candidate Protected Area. Habitat types are based on TWINSPAN categorization. Bird Communities in Relation to Vegetation Variables

Comparison of species relative abundance indicates that species composition was characterized by a few very abundant species such as the Fox Sparrow and Swainson's thrush (Table 18). Each habitat type hosts distinct bird communities. Black Spruce-Lichen habitat type was characterized mainly by ground and tree species such as Fox Sparrow, Swainson's thrush and White-crowned Sparrow. The Purple Finch, Varied Thrush and Pine Siskin occurred only in Black Spruce-Lichen (Table 18). Ground and shrub dwelling birds constituted the bird community of the Shrub habitat type (Table 18); including three ground nesting species, the White-crowned, Lincoln, and Fox Sparrows. Le Conte's Sparrow was the only species found specifically in shrub habitat. The Deciduous habitat type was characterized by mixed and deciduous bird species such as Swainson's Thrush, Chipping Sparrow and Yellow-rumped Warbler (Table 18). Species specific to this habitat include the Western Tanager, Common Yellowthroat, and Hairy Woodpecker. Ground nesting species such as Chipping, Savannah, and Lincoln Sparrows characterized the songbird community of Black Spruce Bog (Table 18). These species, along with Bohemian Waxwing and American Tree Sparrow, reached their highest abundance in this habitat. In contrast with other habitat types, no species specifically occurred in Black Spruce Bog that did not occur elsewhere.

Ten species of forest bird observed in the Ts'ude niline Tu'eyeta study area were outside their recognized breeding range (Sibley 2001); these were Hermit Thrush, Yellow-bellied Flycatcher, Least Flycatcher, Magnolia Warbler, Purple Finch, Western Wood-Peewee, Yellow-bellied Sapsucker, Cape May Warbler, LeConte's Sparrow, and Western Tanager. Another 7 species were on the extreme northern edge of their recognized breeding range; these were Olive-sided Flycatcher, Warbling Vireo, American Redstart, Common Yellowthroat, Downy Woodpecker, Hairy Woodpecker, and Red-eyed Vireo.

Table 18: Mean relative abundance of bird species in four habitat types in the Ts'ude niline Tu'eyeta Candidate Protected Area, NWT. Data are summarized from 150-m radius point counts grouped by TWINSPAN analysis (classification of sites by their summed bird counts).

Species	Species code	Black spruce-lichen (n=28)	Shrub (n=23)	Deciduous (n=15)	Black spruce bog (n=10)
Fox Sparrow	FOSP	11.50	7.07	6.52	5.11
Swainson's Thrush	SWTH	10.15	7.07	12.50	6.81
White-crowned Sparrow	WCSP	9.89	12.41	4.35	5.96
Blackpoll Warbler	BPLW	6.93	4.04	1.90	1.70
Yellow-rumped Warbler	YRWA	6.05	3.75	7.07	5.53
Yellow Warbler	YWAR	5.92	5.34	2.99	2.13
Lincoln's Sparrow	LISP	5.18	9.52	3.53	7.23
Northern Waterthrush	NOWA	4.37	3.75	7.07	2.55
Ruby-crowned Kinglet	RCKI	4.17	2.60	2.99	1.28
Orange-crowned Warbler	OCWA	4.03	5.05	4.35	6.81
Common Redpoll	CORE	3.77	2.89	2.17	1.70
Chipping Sparrow	CHSP	3.70	3.90	8.97	9.79
Alder Flycatcher	ALFL	3.70	6.93	2.17	5.96
American Robin	AMRO	3.56	4.91	4.62	7.23
Dark-eyed Junco	DEJU	3.36	1.59	3.53	6.38
Gray-cheeked Thrush	GCTH	3.30	1.88	1.36	0.00
Palm Warbler	PAWA	2.15	1.15	2.45	5.11
Savannah Sparrow	SAVS	1.34	4.04	0.54	8.51
Tennessee Warbler	TEWA	1.08	1.15	5.16	2.13
White-winged Crossbill	WWCR	0.94	1.01	0.27	2.13
American Tree Sparrow	ATSP	0.81	2.02	0.00	0.43
Hermit Thrush	HETH	0.81	1.59	2.45	1.70
Olive-sided Flycatcher	OSFL	0.40	0.29	1.09	0.00
Warbling Vireo	WAVI	0.40	0.43	0.27	0.00
Yellow-bellied Flycatcher	YBFL	0.40	0.00	0.27	0.00
Pine Siskin	PISI	0.27	0.00	0.00	0.00
Varied Thrush	VATH	0.27	0.00	0.00	0.00
Bohemian Waxwing	BOWA	0.20	0.00	0.00	0.43
Gray Jay	GRJA	0.13	0.43	1.09	0.85
Least Flycatcher	LEFL	0.13	0.72	0.00	0.00
Magnolia Warbler	MAGW	0.13	0.00	0.27	0.00
Northern Flicker	NOFL	0.13	0.58	0.00	0.00
Purple Finch	PUFI	0.13	0.00	0.00	0.00
Swamp Sparrow	SWSP	0.13	0.43	0.00	0.00
Wilson's Warbler	WIWA	0.13	0.14	0.54	0.85
White-throated Sparrow	WTSP	0.13	1.59	2.17	0.43
Western Wood-Pewee	WWPE	0.13	0.14	0.27	0.00

Yellow-bellied Sapsucker	YBSA	0.13	0.00	0.27	0.00
American Redstart	AMRE	0.00	0.29	0.27	0.00
Cape May Warbler	CMWA	0.00	0.14	0.82	0.00
Common Yellowthroat	COYE	0.00	0.00	0.27	0.00
Downy Woodpecker	DOWO	0.00	0.29	0.00	0.00
Hairy Woodpecker	HAWO	0.00	0.00	0.27	0.00
Le Conte's Sparrow	LESP	0.00	0.14	0.00	0.00
Red-eyed Vireo	REVI	0.00	0.29	1.09	0.00
Red-winged Blackbird	RWBL	0.00	0.43	0.00	1.28
Western Tanager	WETA	0.00	0.00	0.27	0.00

Waterfowl and Waterbirds

Thirty-one species of waterfowl and 11 species of waterbirds were confirmed or have ranges that overlap Ts'ude niline Tu'eyeta and the surrounding 200 km (Table 14, Appendix F). During June field work, 484 observations were recorded during wildlife transects and incidental wildlife (Table 19, Figure 21, Figure 22). Ducks accounted for 66% of the species observed and were mainly observed during helicopter ferry flights. The majority of these were from the 2005 field season. In June 2006, there was a marked decrease in the number of ducks observed. Canada Geese were the second most prevalent species observed, followed by loons and swans. Twelve swans were observed in June 2006 in the Ramparts wetlands. Ts'ude niline Tu'eyeta overlaps the range of Tundra Swans but unfortunately we did not get a visual to confirm whether the swans seen were Tundra or Trumpeter swans. The following species were recorded during point counts within the study area: Canada Goose, Mallard, American Wigeon, Ring-necked Duck, Common Loon, and Red-necked Grebe.

Salter (1974) and Kay (DUC, 1997) observed relatively high densities of Pacific Loons in the wetlands adjacent to the Ramparts River (3,692 loons), as well as in the wetlands to the northwest and north (D. Kay, pers. comm.). This number is thought to represent more than 1% of the Canadian population of this species.

Table 19: Waterfowl observed during wildlife transects and incidental wildlife, June 2005 and 2006.

Species	Number observed
Duck spp.	172
Canada Goose	95
Scoter	58
Scaup	54
Pacific Loon	44
Mallard	22
Swan spp.	12
Surf Scoter	10
Common Loon	8
Gull spp.	3
White-winged Scoter	2
Common Goldeneye	2
Bufflehead	1
Loon spp.	1
Total	484

Eleven species of waterbirds and 22 species of shorebirds were confirmed or have ranges that overlap Ts'ude niline Tu'eyeta and the 200 km boundary (Table 14, Figure 22, Appendix F). For this report, waterbirds include shorebirds, cranes, gulls, jaegers and terns.

Ducks Unlimited surveys in 1997 and 1998 documented spring staging and late breeding populations for waterfowl the Ramparts River study area (Figure 23). These data area presented as density maps for scoter (Figure 24, Figure 25), scaup (Figure 26; Figure 27), all ducks (, Figure 29), and Pacific Loons (Figure 30, Figure 31). (Ducks Unlimited Canada, 1997). Densities and estimated numbers reported are conservative and portray the minimum number of birds on the landscape. The distribution of staging scaup and scoter species differed (Figure 24, Figure 26), although an area in the west-central part of Ts'ude niline Tu'eyeta showed high densities of both. For scaup and scoter species, 6.4% and 4.1% of the study area respectively had greater than 25 birds/km² during spring staging (Table 20). The late breeding densities of both scaup and scoter species were more evenly distributed across the DU study area (Figure 25, Figure 27,) and were lower than the densities during the staging period (Table 20). When all duck species are considered together during spring staging, 49.3% of the area had greater than 25 birds/km², including 9.3% with 50-100 birds/km² and 3.0% with 100-385 birds/km². In contrast, the percentage dropped to 27.4% of the area having greater than 25 birds/km² during the late breeding season (Table 19). The wetlands within Ts'ude niline Tu'eyeta are important spring staging area for waterfowl with reduced densities during the breeding period. Pacific Loons, on the other hand, were similarly distributed during both the staging and late breeding periods (Table 20).

Table 20: % of study area at various waterfowl densities during spring staging and late breeding surveys (based on density maps).

Species	Survey	% of study area at different densities				
Scoter	Density (birds/km²)	0-10	10-25	25-50	50-100	100-155
	Spring Staging	87	8.8	2.7	1.0	0.4
	Late Breeding	95.2	0.4	0.0	0.0	0.0
Scaup	Density (birds/km²)	0-10	10-25	25-50	50-100	100-155
	Spring Staging	47.4	46.2	5.5	0.9	0.0
	Late Breeding	95.9	4.1	0.04	0.0	0.0
All ducks	Density (birds/km²)	0-10	10-25	25-50	50-100	100-385
	Spring Staging	9.5	41.2	37.0	9.3	3.0
	Late Breeding	0.0	72.6	26.0	1.4	0.0
Pacific Loon	Density (birds/km²)	0-1	1-3	3-5	5-7	7-9
	Spring Staging	34.0	53.4	11.9	0.6	0.1
	Late Breeding	52.0	44.6	3.4	0.0	0.0

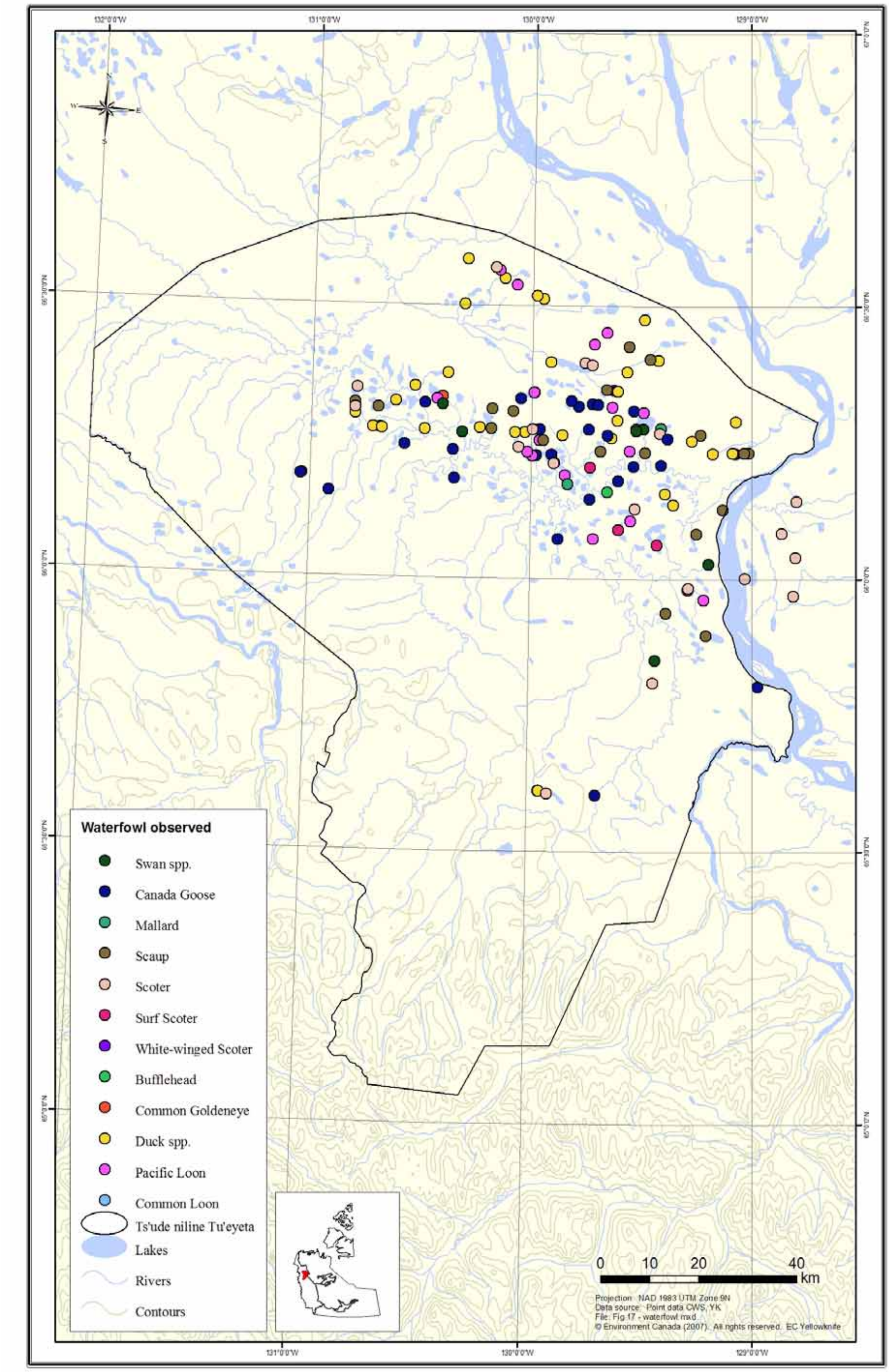

Figure 21: Waterfowl observed within Ts'ude niline Tu'eyeta candidate protected area, June 2005 and 2006.

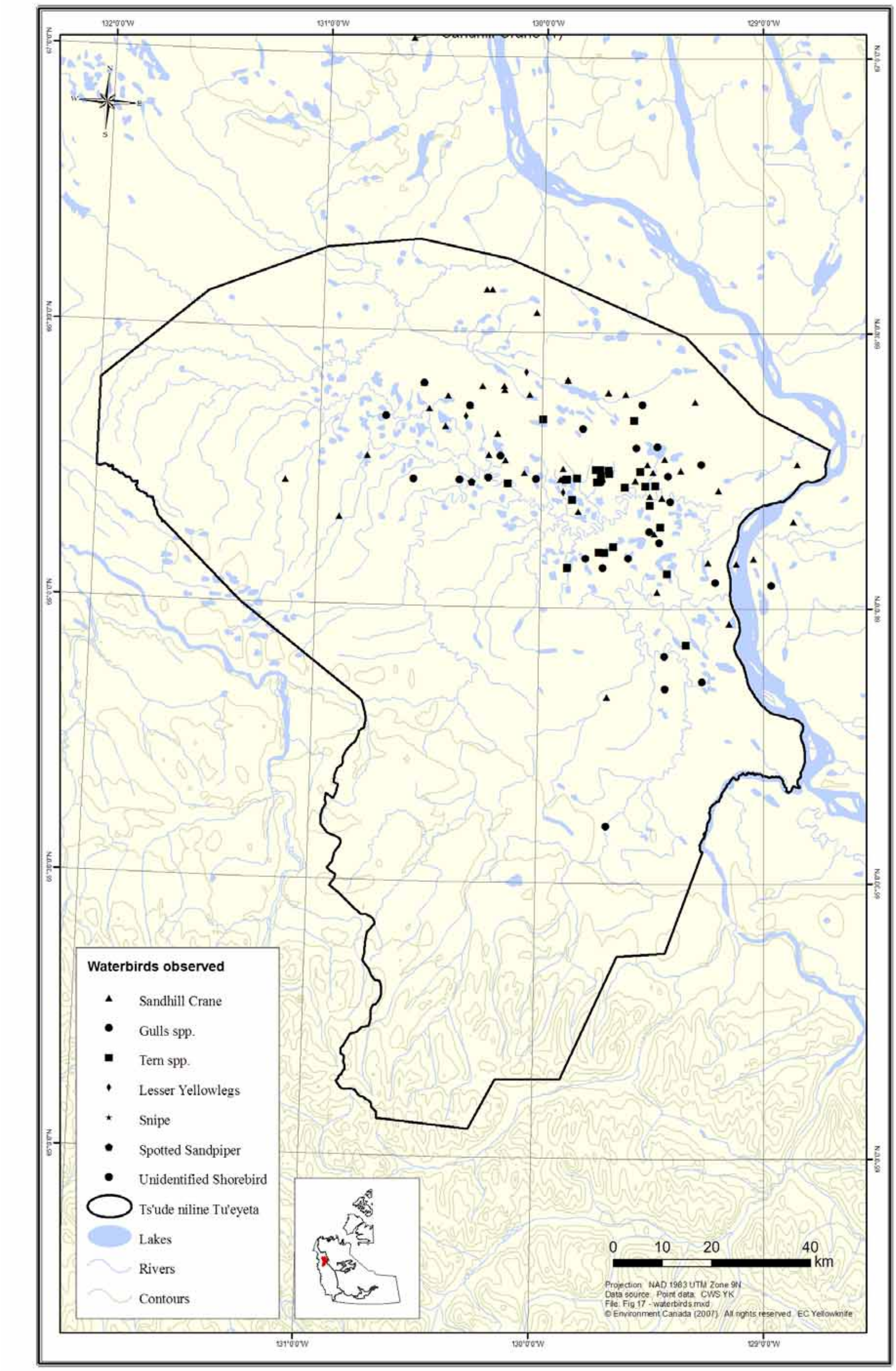

Figure 22: Waterbirds observed within Ts'ude niline Tu'eyeta candidate protected area, June 2005 and 2006

Figure 32 and Figure **33** indicate the proportions of the estimated total numbers of waterfowl and waterbirds within the DU study area. Scaup are the most abundant species in both the spring staging and the late breeding surveys, followed by scoter species, ring-necked ducks, American wigeon and mallards. Pacific loon numbers remained fairly steady from the spring staging to the late breeding season, whereas most duck numbers dropped noticeably (e.g. Scaup: spring staging= 11,000; late breeding: =3500). These data indicate 1% of the estimated Canadian populations of both scaup and scoters (Latour *et al.*, 2006), were nesting in that area. The wetlands immediately north and northwest of the DU study area contain lower densities of scaup and scoters (Latour *et al.*, 2006), and their extensive nature would account for considerably more in Ts'ude niline Tu'eyeta. Ts'ude niline Tu'eyeta, therefore, provides staging habitat for additional, and likely large, numbers of scaup and scoters migrating to areas farther north. Salter (1974) recorded approximately five times the number of scaup and scoters on the wetlands during the early June migration period compared to July. Continental populations of scaup and scoter species have been in long term decline (Afton and Anderson, 2001) and the use of Ts'ude niline Tu'eyeta during spring staging and breeding represents a significant portion of the population.

US Fish and Wildlife Service waterfowl breeding population and habitat surveys conducted between 1976 and 2003 and summarized in Fournier and Hines (2005) indicate the following waterfowl densities within Ts'ude niline Tu'eyeta: scaup (2 to >8 birds/km²); scoter (1 to 4 birds/km²), Mallard (0.2-0.5 birds/km²), American Wigeon (<1 bird/km²), Greenwing Teal (<0.2 to 0.5 birds/km²). Densities of less than 0.2 birds/km² were found for the following species: Blue-winged Teal, Northern Shoveler, Northern Pintail, Ring-necked Ducks, Buffleheads, Canvasbacks, Long-tailed Ducks, Goldeneyes, mergansers, Canada Geese, and swans. Geographic changes in population densities were recorded between 1976-1980 and 1999-2003 and most species within Ts'ude niline Tu'eyeta have remained stable, except for scaup species, which have experienced significant declines of -17 to -2.1 birds/km² and -2 to -1.1 birds/km² (Fournier and Hines, 2005).

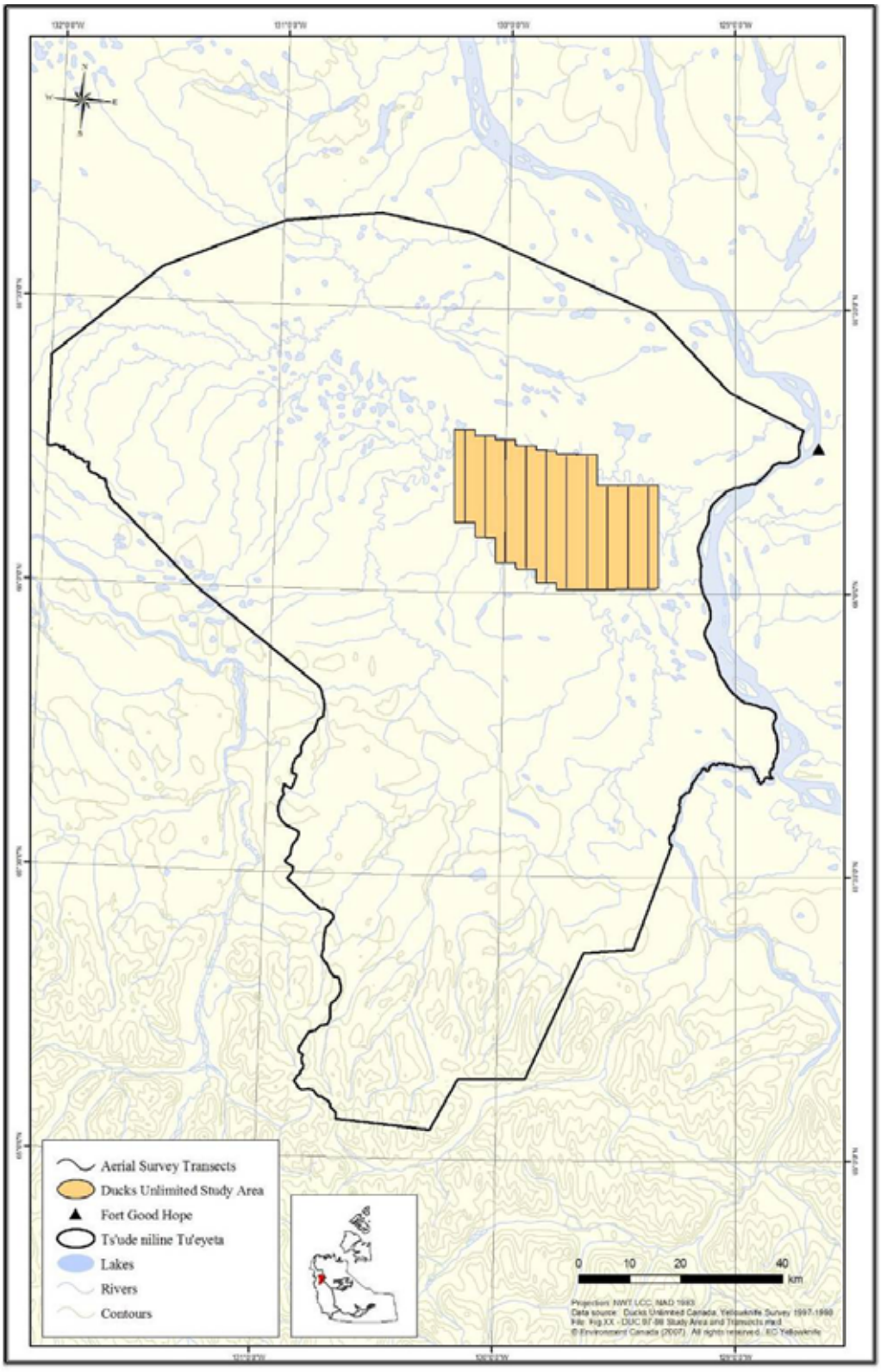

Figure 23: 1997-1998 Ducks Unlimited Canada waterfowl study area within Ts'ude niline Tu'eyeta candidate protected area.

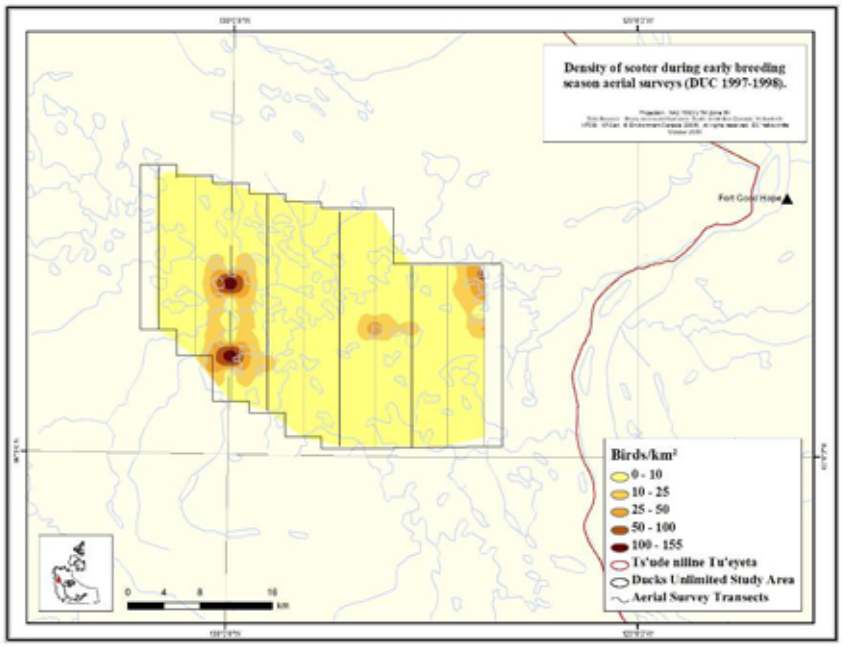

Figure 24: Estimated density of scoter during spring staging aerial surveys by Ducks Unlimited Canada (averaged 1997-1998 data).

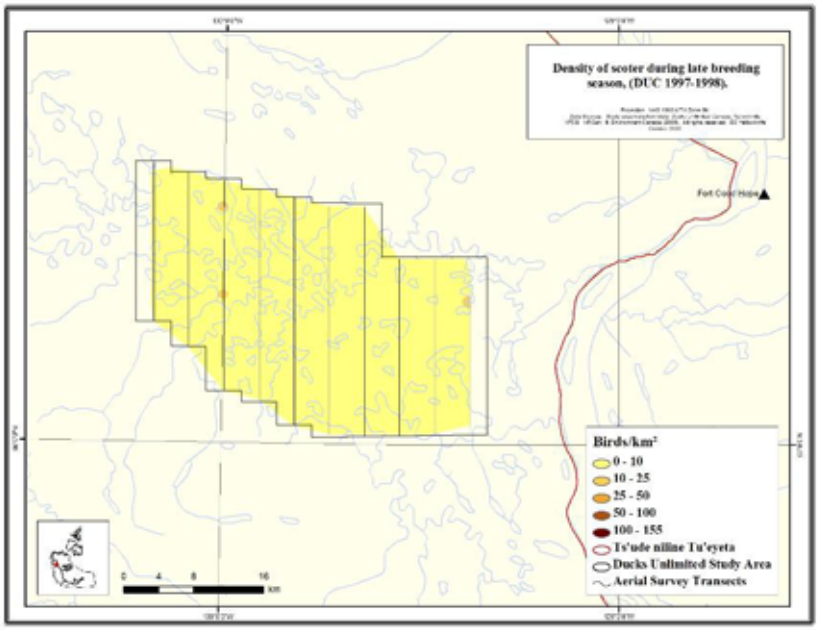

Figure 25: Estimated density of scoter during late breeding season aerial surveys by Ducks Unlimited Canada, (averaged 1997-1998 data).

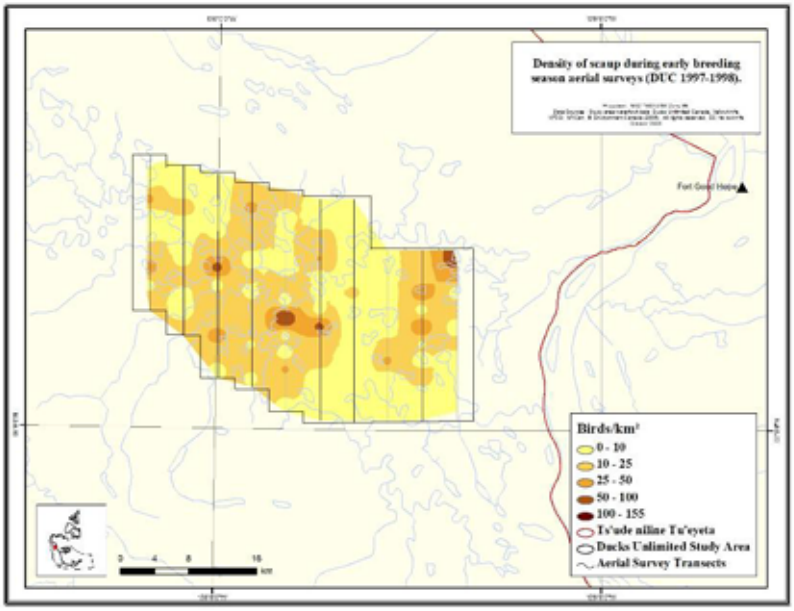

Figure 26: Estimated density of scaup during spring staging aerial surveys by Ducks Unlimited Canada, (averaged 1997-1998 data).

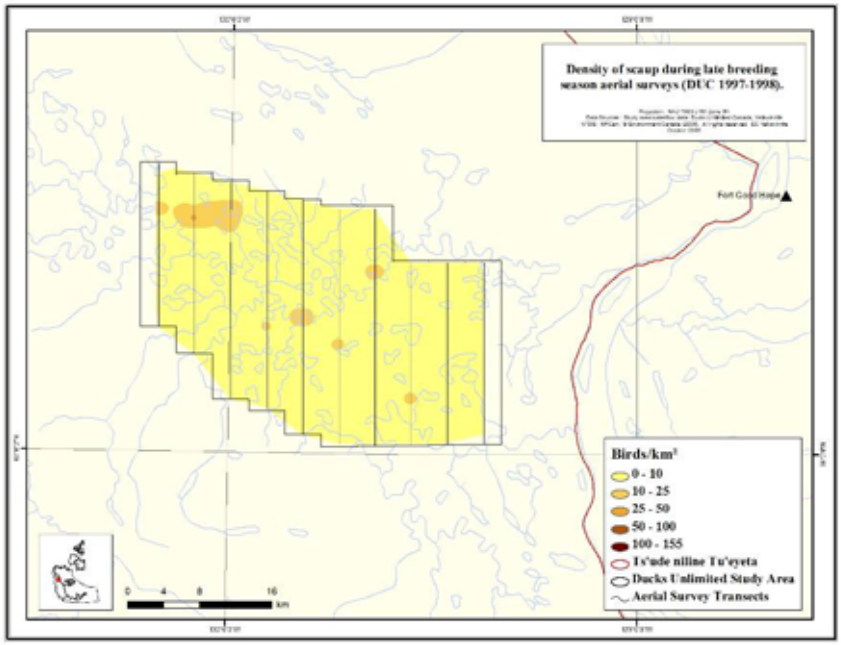

Figure 27: Estimated density of scaup during late breeding season aerial surveys by Ducks Unlimited Canada, 1(averaged 1997-1998 data).

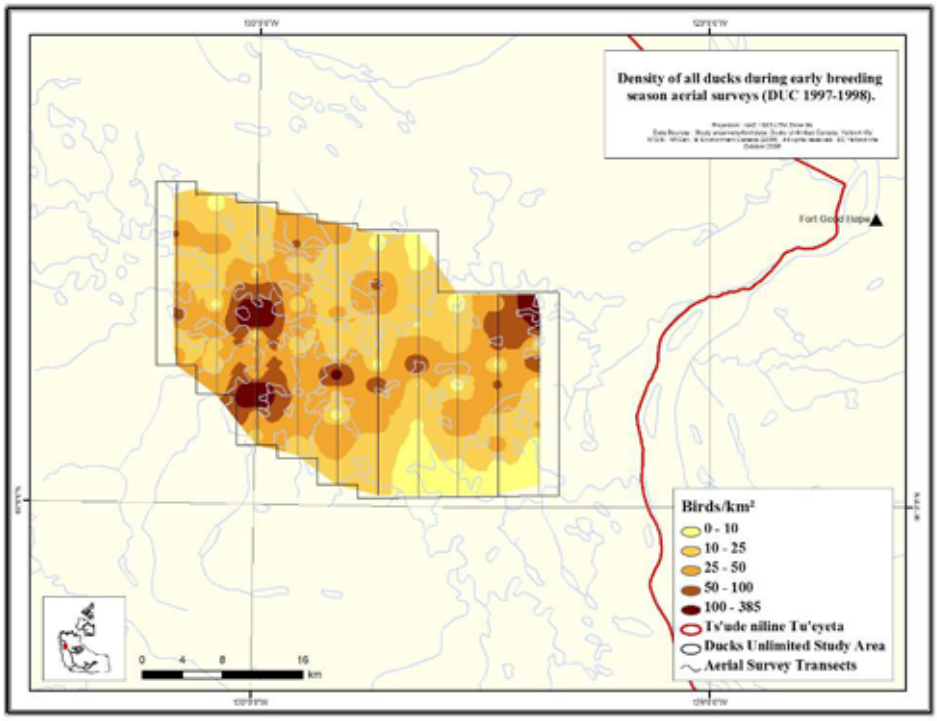

Figure 28: Estimated density of all ducks during spring staging aerial surveys by Ducks Unlimited Canada, (averaged 1997-1998 data).

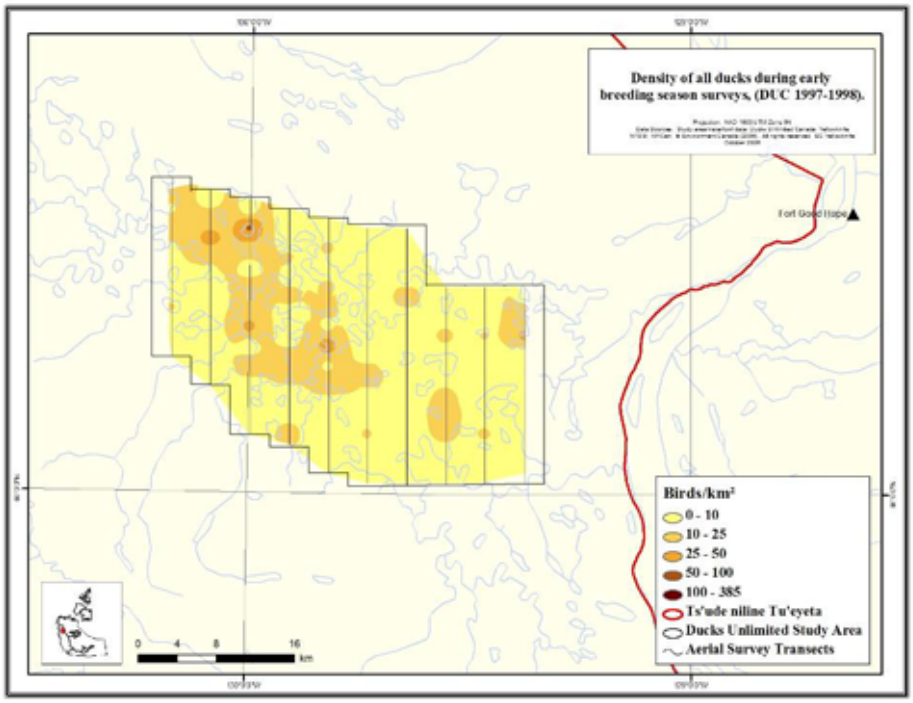

Figure 29: Estimated density of all ducks during late breeding season aerial surveys by Ducks Unlimited Canada, (averaged 1997-1998 data).

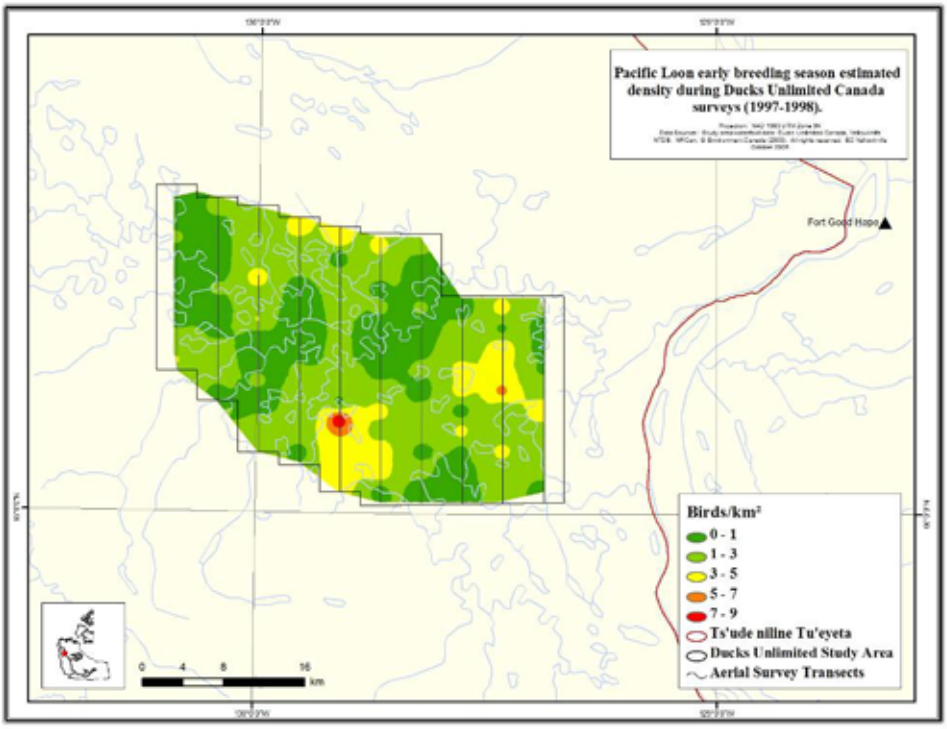

Figure 30: Estimated density of Pacific loon during spring staging during Ducks Unlimited surveys, (averaged 1997-1998 data).

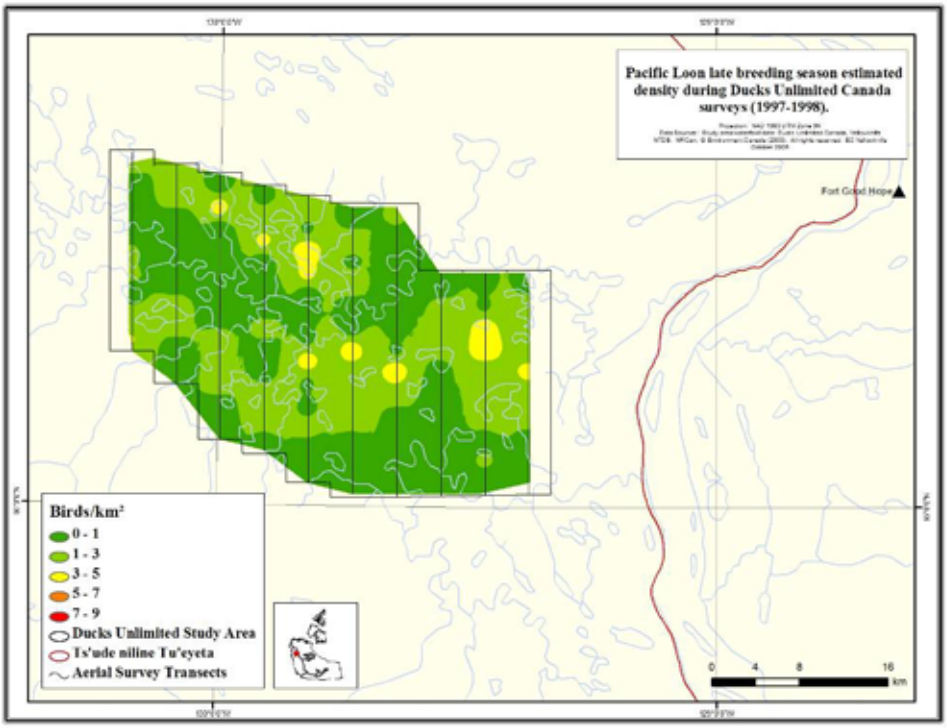

Figure 31: Estimated density of Pacific loons during late breeding season aerial surveys by Ducks Unlimited Canada, (averaged 1997-1998 data).

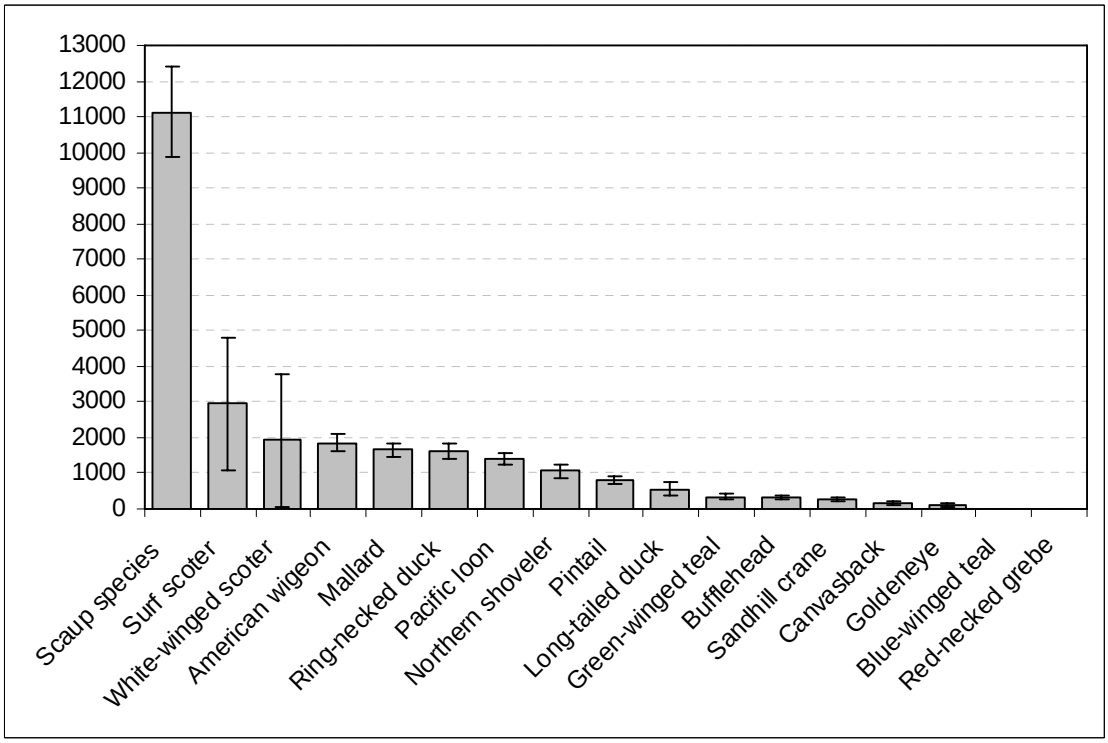

Figure 32: Estimated numbers (+/- standard error) of waterbird species in the Ramparts River wetlands study area during the spring staging: Averaged 1997-1998 data.

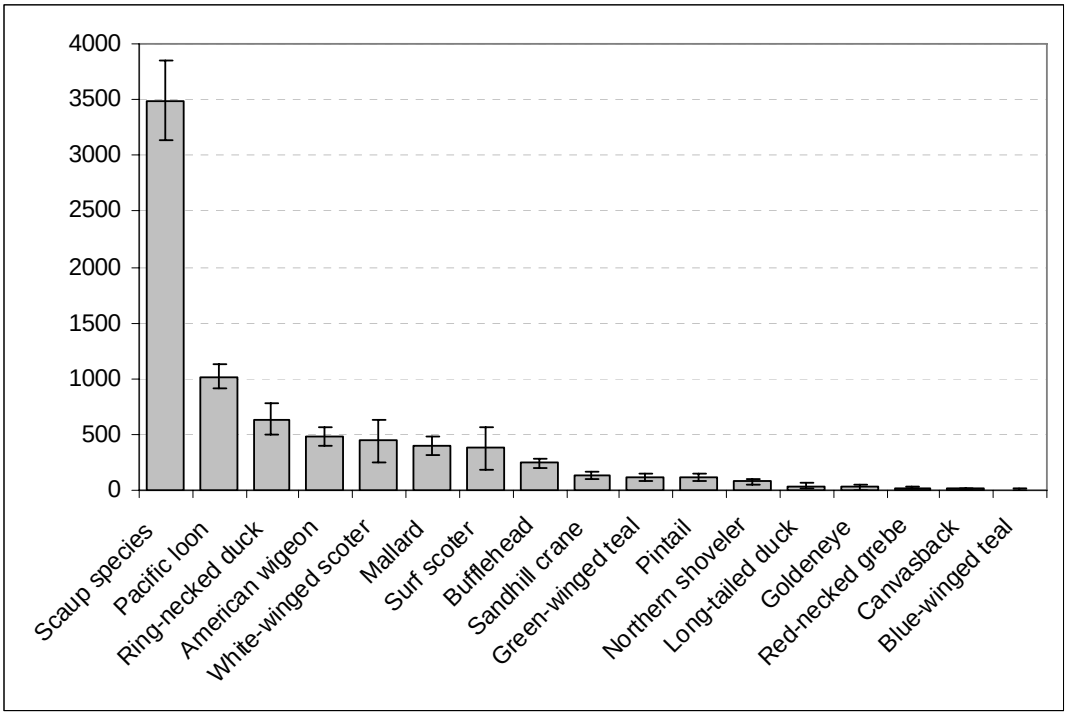

Figure 33: Estimated numbers (+/- standard error) of waterbird species in the Ramparts River wetlands study area during the late breeding season: Averaged 1997-1998 data.

Raptors

Eighteen species of raptors (Osprey, eagles, hawks, and owls) occur or hypothetically occur within Ts'ude niline Tu'eyeta and nine of these species were observed. Forty raptor observations were made during June 2005 and 2006 and March 2006 (Table 21, Figure 34).

Northern Harriers were the most abundant species observed and are considered to be breeding in Ts'ude niline Tu'eyeta (Table 21, Figure 34). Short-eared Owls, listed as 'special concern' by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, 2006), were the second most abundant species observed. Short-eared Owls' preference for open habitats (Holt and Leasure, 1993) and it's availability within Ts'ude niline Tu'eyeta . Two other owl species were observed, a Great Grey Owl and Northern Hawk Owl. A pair of Northern Hawk Owls were observed on a nest.

Five Peregrine Falcons (*anatum* subspecies), listed as 'threatened' (COSEWIC, 2006), were observed in Ts'ude niline Tu'eyeta. One pair was observed at an 'open needleleaf-lichen' site in the north-central part of Ts'ude niline Tu'eyeta in June 2005 (Figure 34**).** They remained at this site during the entire time the survey team was there (2 hrs), perching in trees and flying locally in the vicinity of a small lake. They were 45 km from the closest known Peregrine Falcon nesting area at the Ramparts cliffs along the Mackenzie River (GNWT, 2007). . Peregrine Falcons were also observed in this study along the Ramparts River cliffs and at Fossil Lake.

The exposed rocky cliffs at "the Ramparts" and the Fossil Lake area west of Fort Good Hope are identified as critical wildlife areas due to their important nesting sites for raptors and especially Peregrine Falcons (NLUIS, Department of Environment, 1975). The Department of Environment and Natural Resources maintains a NWT/NU Raptor Database, which includes historical raptor sightings and sightings from their raptor surveys (GNWT, 2007). A search of the database revealed 599 raptor observations along the Mackenzie River (Figure 35) in the vicinity of Ts'ude niline Tu'eyeta between 1966 and 2006 .Of these 56% were Peregrine Falcons, 37% were unknown species, followed by Bald Eagles (4.3%), Golden Eagles (2.3%), Merlin (0.2%) and Rough-legged Hawk (0.2%) (GNWT, 2007).

The Mackenzie Valley Peregrine Falcon survey conducted by GNWT ENR has been done every five years since 1970 along the Mackenzie River from Saline River from Tulita to Inuvik (Bromley and Matthews, 1988; Murphy, 1990; Matthews *et al.*, 2006). The 2005 survey visited 155 sites, including 20 new sites and revealed very high occupancy (73%) for Peregrine Falcon territorial pairs. The productivity (average number of young per productive site) was 2.4.

Table 21: Raptors observed within the Ts'ude niline Tu'eyeta candidate protected area, June 2005 and 2006.

Family	Scientific Name	Common Name	Number observed
Accipitridae	*Haliaeetus leucocephalus*	Bald Eagle	2
Accipitridae	*Aquila chrysaetos*	Golden Eagle	1
Accipitridae	*Circus cyaneus*	Northern Harrier	14
Accipitridae	*Buteo jamaicensis*	Red-tailed Hawk	2
Falconidae	*Falco columbarius*	Merlin	1
Falconidae	*Falco peregrinus*	Peregrine Falcon	5
Strigidae	*Strix nebulosa*	Great Gray Owl	1
Strigidae	*Surnia ulula*	Northern Hawk Owl	2
Strigidae	*Asio flammeus*	Short-eared Owl	8
		Unidentified Raptor	3
		Unknown Hawk	1
Total			40

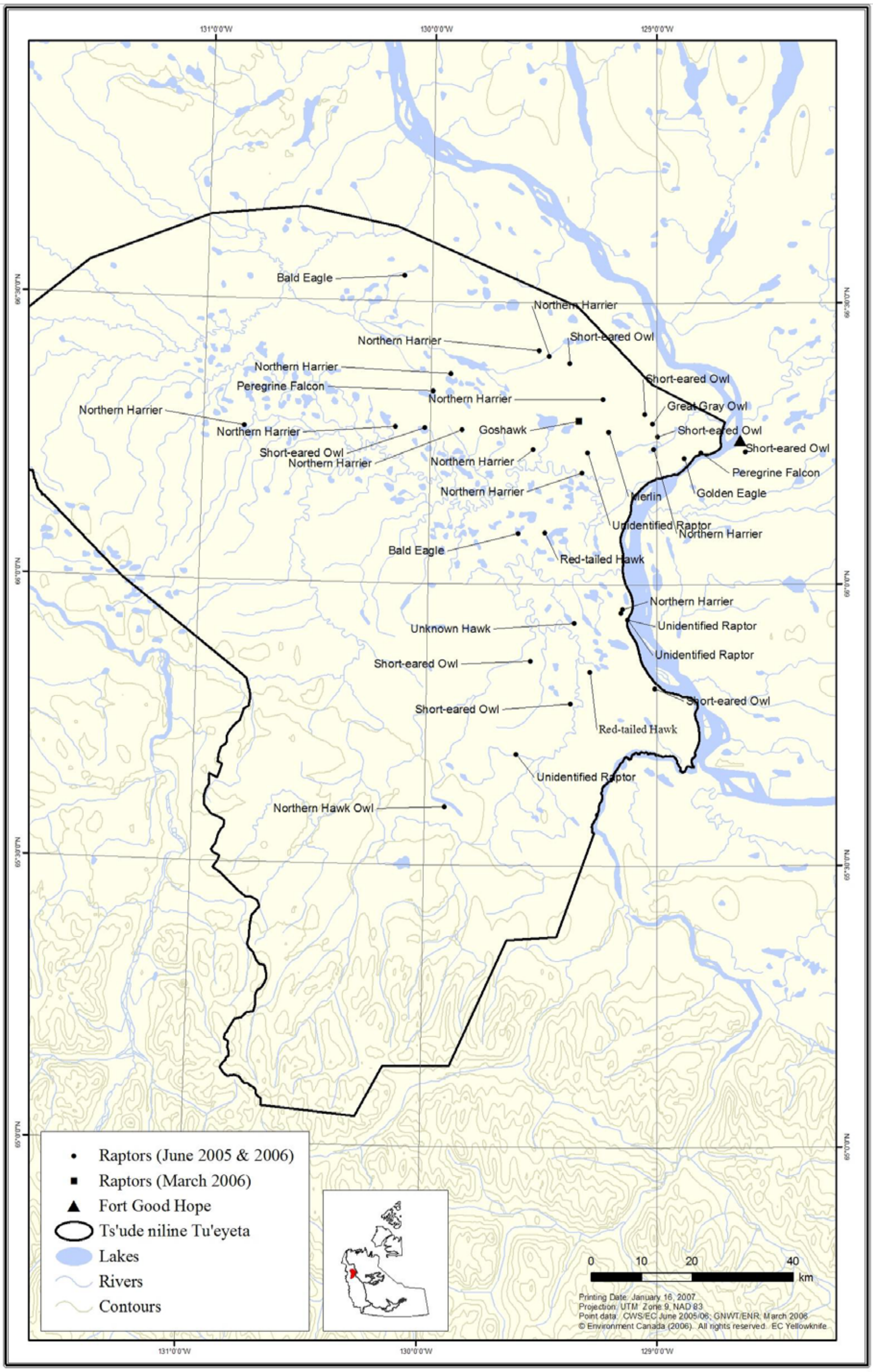

Figure 34: Raptors observed within the Ts'ude niline Tu'eyeta candidate protected area, June 2005 and 2006 and March 2006.

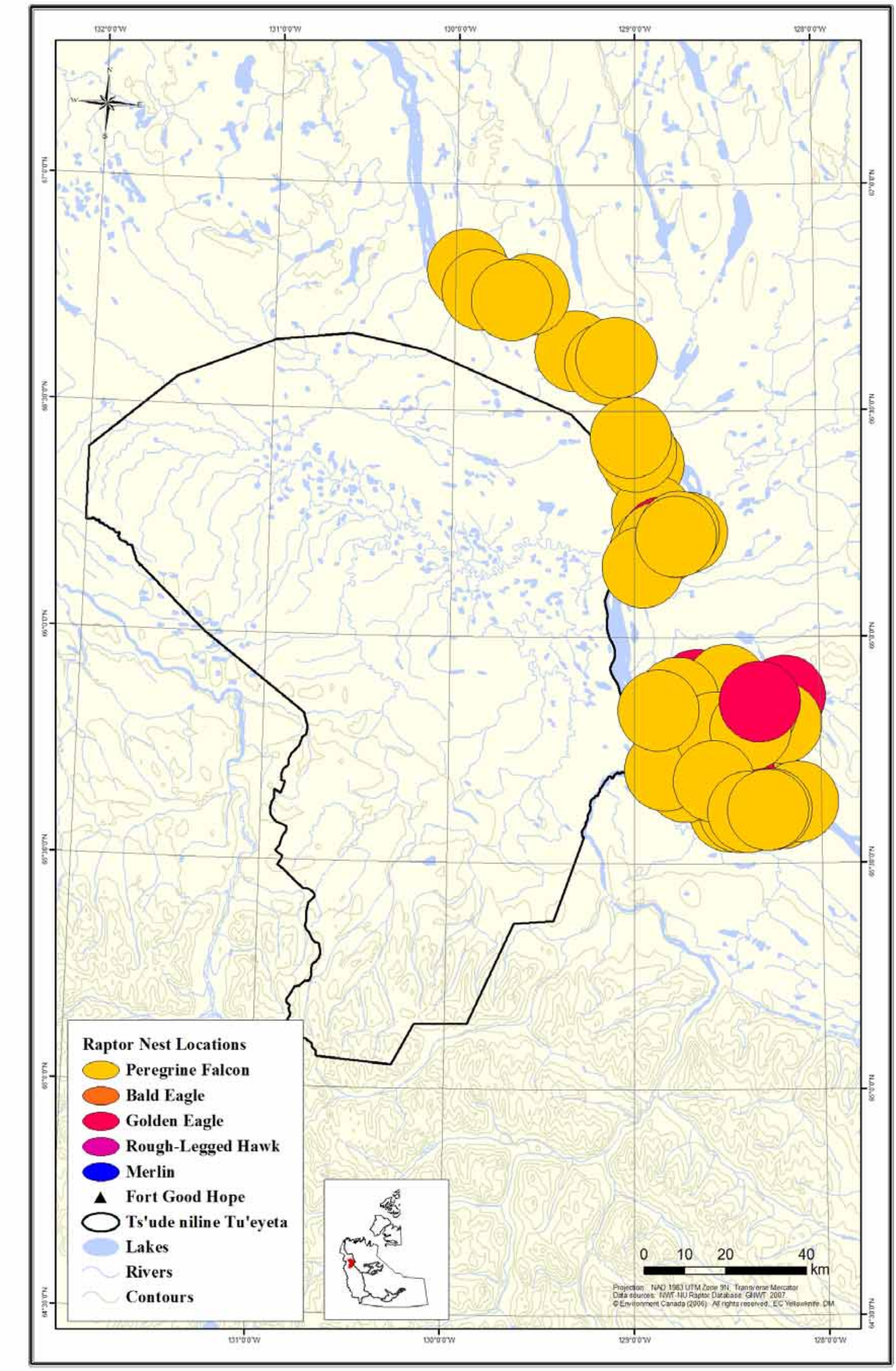

Figure 35: Raptors documented in the the Ts'ude niline Tu'eyeta area based on the NWT/NU Raptor Database (GNWT, 2007)

Mammals

Forty-three mammal species are confirmed or hypothetically occur within Ts'ude niline Tu'eyeta (*i.e.* within 200 km of the study area) (Appendix F). A total of 13 different mammals (Table 22) were recorded during field studies in June 2005, 2006 and March 2006, including actual sightings or sign.

Table 22: Mammal species observed in Ts'ude niline Tu'eyeta, June 2005 and 2006 and March 2006. Species in bold were observed during June 2005 and 2006 and March 2006.

Scientific Name	Common Name	NWT Status	COSEWIC Status	SARA Status
Microtus pennsylvanicus	Meadow Vole	Secure		
Microtus miurus	Singing Vole			
Microtus oeconomus	Tundra Vole			
Microtus xanthognathus	Yellow-cheeked Vole			
Microtus longicaudus	Long-tailed Vole			
Neotoma cinerea	Bushy-tailed Woodrat			
Sorex cinereus	Masked Shrew	Secure		
Sorex monticolus	Dusky Shrew	Secure		
Sorex arcticus	Arctic Shrew	Secure		
Sorex hoyi	Pigmy Shrew	Secure		
Ochotona princeps	American Pika			
Lepus americanus	**Snowshoe Hare**	**Secure**		
Marmota caligata	Hoary Marmot			
Spermophilus parryii	Arctic Ground Squirrel			
Tamiasciurus hudsonicus	**Red Squirrel**	**Secure**		
Glaucomys sabrinus	Northern Flying Squirrel	Sensitive		
Castor canadensis	**Canadian Beaver**	**Secure**		
Peromyscus maniculatus	Deer Mouse	Secure		
Clethrionomys rutilus	Northern Red-backed Vole	Secure		
Lemmus sibiricus	Brown Lemming	Secure		
Synaptomys borealis borealis	Northern Bog Lemming	Secure		
Phenacomys intermedius (mackenzii)	Heather Vole	Secure		
Ondatra zibethicus	Muskrat	Secure		
Erethizon dorsatum	Porcupine	Secure		
Canis latrans	Coyote	Undetermined		
Canis lupus	**Gray Wolf**	**Secure**		
Vulpes vulpes	**Red Fox**	**Secure**		
Alopex lagopus	Arctic Fox			
Ursus americanus	**Black Bear**	**Secure**	**Not at risk - 1999**	
Ursus arctos	Grizzly Bear			
Martes americana	**American Marten**	**Secure**		
Mustela erminea	Ermine (Stoat)	Secure		
Mustela nivalis	Least Weasel	Secure		
Mustela vison	Mink	Secure		
Gulo gulo	**Wolverine**	**Secure**	**Western population – Special concern - 2003**	**None**
Lontra canadensis	**River Otter**	**Sensitive**		
Lynx lynx canadensis	**Lynx**	**Secure**	**Not at risk - 2001**	

Scientific Name	Common Name	NWT Status	COSEWIC Status	SARA Status
Alces alces	**Moose**	**Secure**		
Rangifer tarandus caribou	**Woodland Caribou (boreal population)**	**Sensitive**	**Threatened - 2002**	**Threatened - Schedule 1**
Rangifer tarandus granti	**Woodland Caribou (mountain population)**	**Sensitive**	**Threatened - 2002**	**Threatened - Schedule 1**
Ovibox moschatus	Muskox			
Ovis dalli dalli	**Dall's Sheep**			
Ovis dalli stonei	Stone's Sheep			

Small and Medium Sized Mammals

Small mammals (i.e., shrews, voles, mice, lemmings, bats, hares, squirrels) and medium sized mammals (i.e. beaver, fox, martin) known to occur, or hypothetically occurring, in the study area are listed in Appendix F. Species observed during June fieldwork are indicated in Table 23, Figure 18.

Table 23: Small and medium-sized mammals and mammal sign observed in Ts'ude niline Tu'eyeta, June 2005 and 2006 and March 2006.

Species	Scientific Name	Observed	Sign
Beaver	*Castor canadensis*		
Heard	*Castor canadensis*		3
Seen	*Castor canadensis*	9	
Dam	*Castor canadensis*		11
Lodge	*Castor canadensis*		178
Tracks	*Castor canadensis*		1
Trails	*Castor canadensis*		1
Trees	*Castor canadensis*		4
Fox sp.	*Vulpes vulpes*	1	3
Martin	*Martes americana*		4
Red Squirrel	*Tamiasciurus hudsonicus*	12	14
Snowshoe Hare	*Lepus americanus*	2	23

Beaver lodges were the most prevalent mammal sign observed in Ts'ude niline Tu'eyeta (Table 23; Figure 36). Research over the years has documented the importance of the Ramparts River area for beaver within the NWT. Aerial survey conducted in 1972 in the Ontaratue and Ramparts areas found a density of 0.26 beaver colonies per mile (Wooley, 1974). From these surveys, Wooley described the large basins drained by the Ontaratue, Ramparts and Hume rivers as the best beaver habitat north of Fort Simpson, with its many streams and shallow lakes (Wooley, 1974). Popko and Veitch (1998) reported high densities of active beaver lodges in the Ramparts (85 lodges/100 km²) and moderate densities (32 lodges/100 km²) of inactive beaver lodges. Since 1989 the average density of active lodges in the Sahtu survey blocks (Poole and Croft, 1990) reported a mean active beaver lodge density of 26 lodges/100 km².

Large Mammals

Evidence of six species of large mammals was observed within Ts'ude niline Tu'eyeta during the fieldwork in June and March (Table 22).

Black bears occupy much of the NWT and were the most common large mammal encountered within Ts'ude niline Tu'eyeta. During fieldwork in 2005 and 2006, 28 black bears were observed, including 4 cubs (Table 24, Figure 37). Numerous black bear sign was observed during wildlife transects and at sampling sites. During late winter ungulate distribution surveys in March 2006, lynx, wolverine, wolf, fox, otter and Dall's Sheep were encountered (Popko, 2006).

Table 24: Large mammals (excluding caribou and moose) observed during June 2005 and 2006 and March 2006.

Species	Scientific Name	Seen	Sign
Lynx	*Lynx lynx canadensis*		3
Otter	*Lontra canadensis*		1
Dall's Sheep	*Ovis dalli dalli*		1
Wolf	*Canis lupus*	14	9
Wolverine	*Gulo gulo*		4
Black Bear	*Ursus americanus*	28	20

Boreal Woodland Caribou

A total of 12 boreal woodland caribou, including three calves, were recorded during helicopter ferrying flights in June 2005 and 2006 (Table 25, Figure 38). Caribou were observed in four earth cover classes: low shrub (n = 7), woodland needleleaf – other (n=3), woodland needleleaf – lichen (n = 1), and open needleleaf –other (n = 1). These vegetation classes are also the four most prevalent classes, covering 65% of Ts'ude niline Tu'eyeta. Thirty-five boreal woodland caribou sign, mainly tracks and scat, were observed within Ts'ude niline Tu'eyeta. Seventy-five percent (n=9 of 12) of the caribou observed in June were in burn areas dating from 1969 to 1993 (Figure 40).

Table 25: Woodland caribou and caribou sign observed within Ts'ude niline Tu'eyeta candidate protected areas, June 2005 and 2006.

Species	Type of Observation	Age Class	Number observed
Caribou	Observed	Bull	1
		Calf	3
		Cow	1
		Unk	7
Total Observed			12
Total Sign			35

A late winter survey conducted by the Department of Environment and Natural Resources (Norman Wells) recorded 85 boreal woodland caribou and caribou cratering activity within Ts'ude niline Tu'eyeta (Popko, 2006). These were found mainly within mature spruce vegetation in the northeastern portion of Ts'ude niline Tu'eyeta and outside the boundary along the Mackenzie River (). Thirteen small scattered groups were recorded, ranging from two to 12 animals. All groups, with the exception of one, were located in unburned areas.

Five boreal woodland caribou initially satellite collared in Ts'ude niline Tu'eyeta (Tracz 2007) and tracked from May 2005 to March 2007 (Figure 41) spent all their time entirely within Ts'ude niline Tu'eyeta or immediately adjacent to it. Two boreal woodland caribou collared northwest of Ts'ude niline Tu'eyeta (Nagy 2006) moved into the area in May 2005 and remained there until at least December 2006 (Figure 42). A generalized presentation of the seasonal distribution of all satellite collared boreal woodland caribou in Ts'ude niline Tu'eyeta indicates that in summer (1 June – 31 August) (Figure 43) caribou were distributed widely across a range of habitat types including the large burned areas in the northern portion of the area. During late winter (1 February – 15 April) (Figure 44), the caribou appeared to be more restricted in their distribution with less occurrence in burned areas. In spring (15 April – 31 May) (Figure 45) and fall to mid winter (1 September – 31 January) collared caribou were distributed widely across Ts'ude niline Tu'eyeta. Two of the satellite collared boreal woodland (Tracz 2007) caribou spent at least part of the winter of 2007/07 within a concentration of mountain woodland caribou along the Arctic Red River (and Figure 41).

Nagy *et al.* (2003; 2005a) for a study area centred 100 km northwest of Ts'ude niline Tu'eyeta reported that boreal woodland caribou use of burn areas varied based on season with burns being used less than expected during the December to May (winter/spring) and more than expected from June to November (summer/fall). Caribou appear to be selecting mature open black spruce and woodland needleleaf forests during the winter/spring season for greater food availability (lichens), and greater security and thermal cover (Nagy *et al.*, 2005a). Open habitats used in the summer/fall period may provide access to high quality forage, help avoid predators, provide relief from insect, or may be more desirable during the rut. Two caribou from this study captured in early 2005 moved steadily south and entered Ts'ude niline Tu'eyeta in early 2006, remaining there until at least April 2007 (Figure 42). These individuals can be considered resident within Ts'ude niline Tu'eyeta (J. Nagy, pers. comm.)

Nagy *et al.* (2003; 2005a) found a minimum boreal woodland caribou density of 1.1 to 1.5 caribou per 100 km². Based on satellite collar data on females, the estimated median home range for females was 2080 km², ranging from 481 to 10,326 km² (Nagy *et al.*, 2005a). Calving sites

were dispersed and were found primarily within black spruce forest (closed and open), bog/fen complexes, and in open burns. .

Northern Mountain Woodland Caribou

The late winter ungulate survey by Popko (2006) observed a concentration of 1000 mountain woodland caribou in groups of 5 – 200 individuals along the Arctic Red River, 10 km from the southwest boundary of Ts'ude niline Tu'eyeta. Extensive caribou cratering over almost the entire foothill region within Ts'ude niline Tu'eyeta indicated long-term winter occupation by mountain caribou. The foothills and front range of the Mackenzie Mountains in the southern portion of Ts'ude niline Tu'eyeta are know to be important wintering habitat for northern mountain woodland caribou (NLUIS, Department of Environment, 1975).

Moose

Moose and moose sign were observed frequently during fieldwork in June 2005 and 2006. A total of 30 moose were observed, including nine calves (Table 26). A considerable portion of these observations were made in the Hume and Ramparts River areas (Figure 38).

Table 26: Moose and moose sign observed within Ts'ude niline Tu'eyeta candidate protected area, June 2005 and 2006.

Species	Type of Observation	Age Class	Number observed
Moose	Observed	Bull	4
		Calf	9
		Cow	10
		Unk	7
	Total observed		30
	Total sign		171

Eighty percent of the moose were observed in open habitats: recent burns (n = 10) and tall shrub (n = 7) and open needleleaf-other (n = 7). The remaining 20% were observed in closed needleleaf (n = 2), closed deciduous, closed mixed needleleaf deciduous, low shrub-other, and clear water. Ninety percent (n=26) of the moose were within burn areas, based on GNWT Forest Fire History (ENR, 2006).

During the March aerial survey, a total of 113 moose were seen both in and out of Ts'ude niline Tu'eyeta, and 97 moose trails were intersected along the transect lines (Figure 46) (Popko, 2006). Moose were generally associated with secondary growth in recent burns or riparian willow flats along the Ramparts, Hume, Ontaratue, and Mackenzie Rivers. Two dead moose

were observed with wolves and red foxes nearby. A total of 46 moose were recorded within Ts'ude niline Tu'eyeta. The majority (n = 22) were lone moose, followed by pairs (n = 9) and two groups of three moose. Fifty-five percent (n = 18) of the moose were observed in low shrub-other and open needleleaf-other. Seventy-three per cent (n = 34) of the moose were observed in burn areas, ranging from recent burns (1999) to older burns (1969).

Brackett *et al.* (1985) reported 184 moose in 475 km of flight or 0.39 moose/km² along the Hume and Ramparts River. Maclean (1994) resurveyed the area in 1992 and estimated a population of 362 ± 71 (90% C.I.) moose. The coefficient of variation for the estimate was 12%. There were 53 calves/100 cows (females > 2 year old), 54 yearlings/100 cows, and 94 bulls (males > 2 year old)/ 100 cows). The twinning rate was 31% (5/16), and the mean group size was 2.08 + 1.11. The density was 0.17 moose/ km², which is the highest reported density for moose in the NWT. This estimate was higher than the previous survey conducted in 1984.

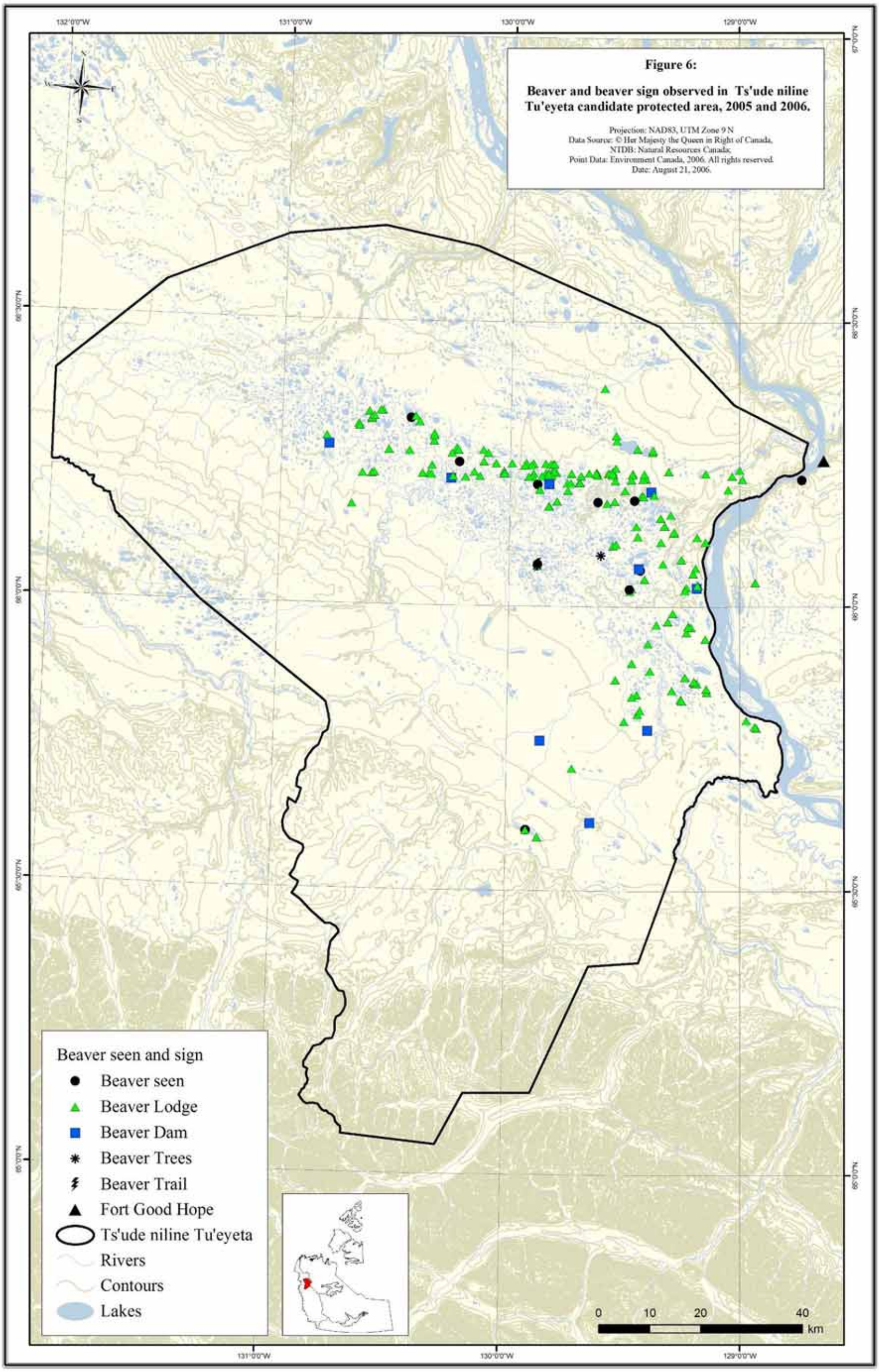

Figure 36: Beaver and beaver sign observed within the Ts'ude niline Tu'eyeta candidate protected area, June 2005 and 2006.

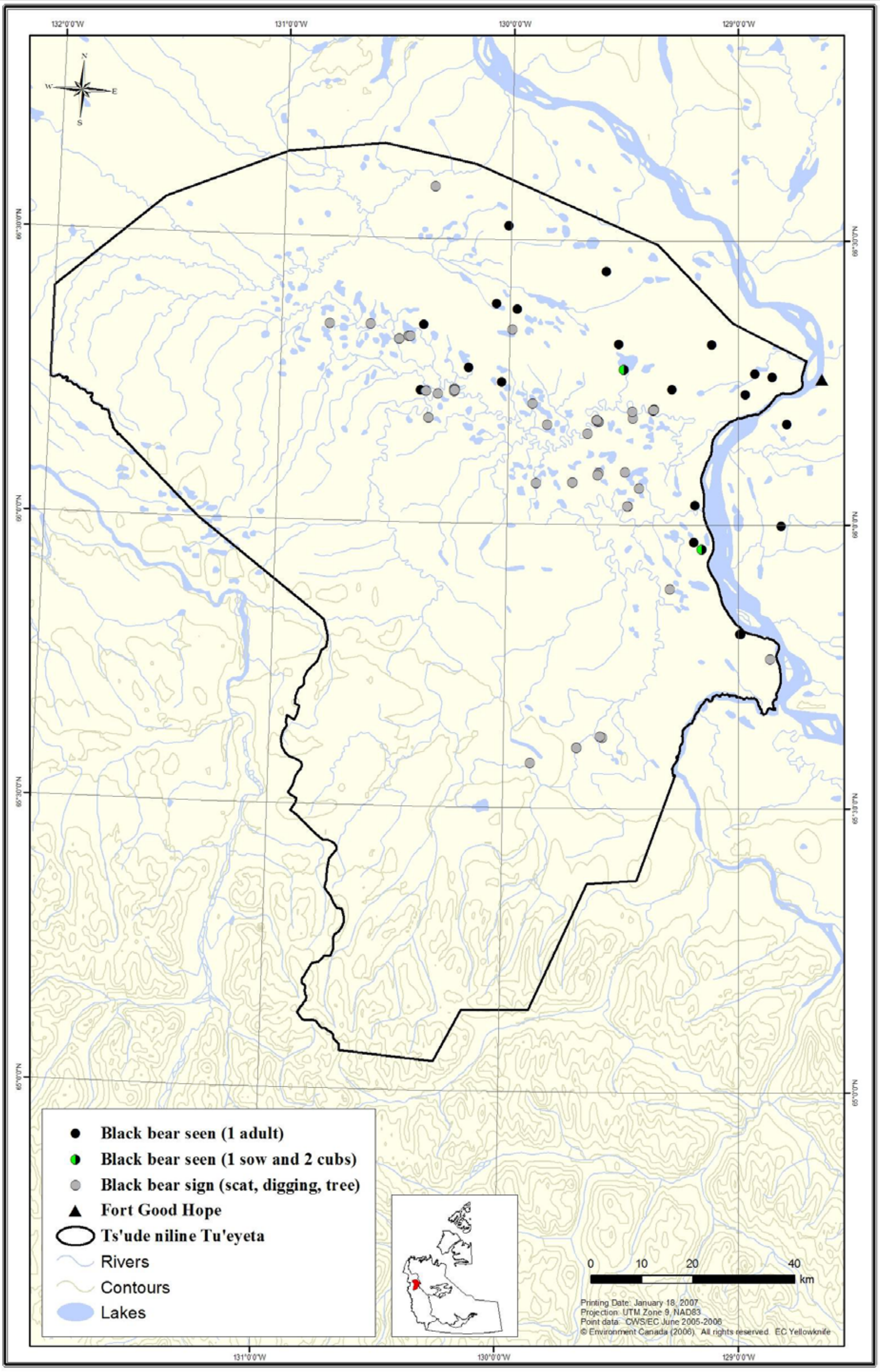

Figure 37: Black bear and black bear sign observed within the Ts'ude niline Tu'eyeta candidate protected area, June 2005 and 2006.

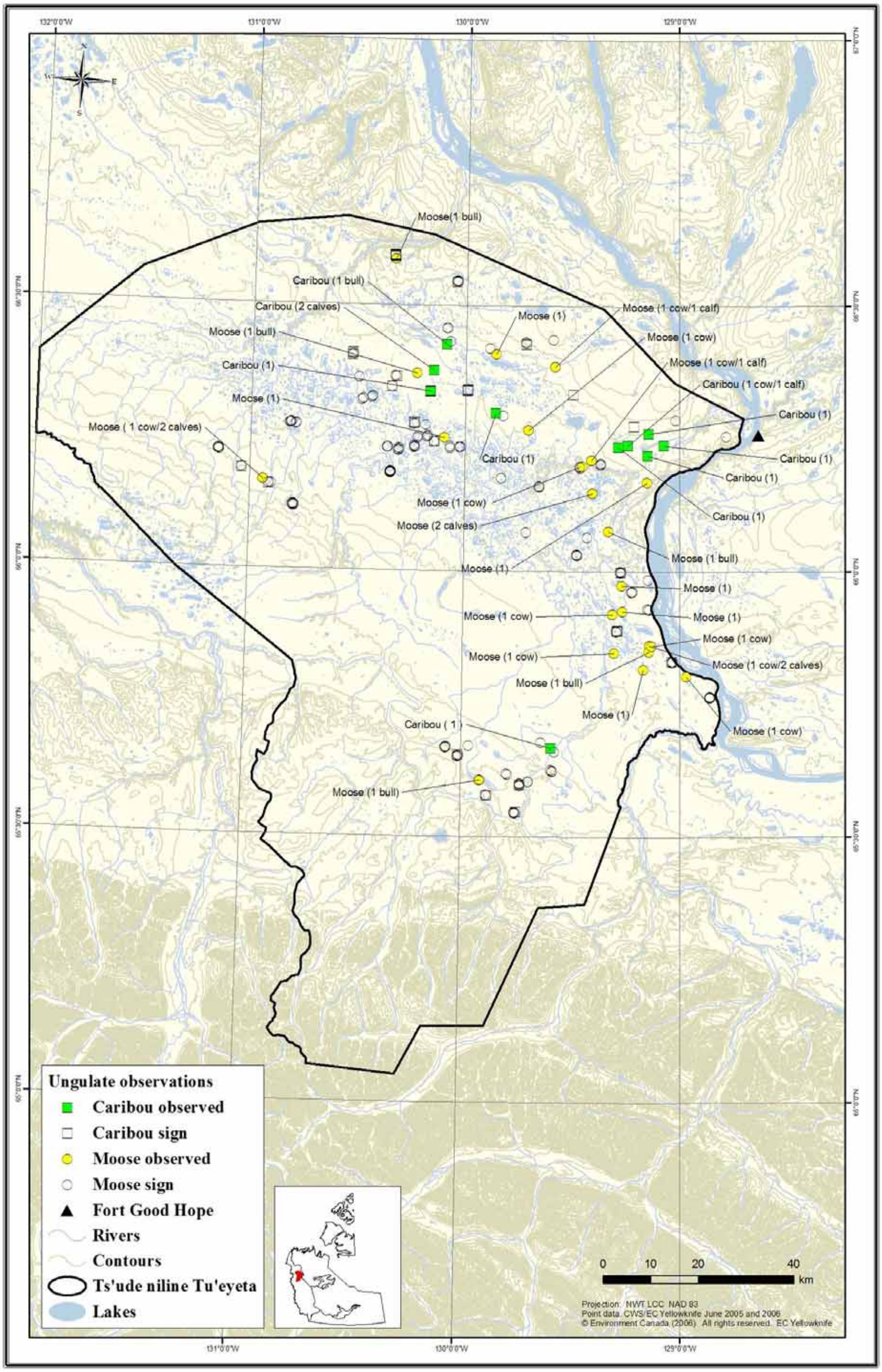

Figure 38: Ungulate (woodland caribou and moose) and ungulate sign observed within the Ts'ude niline Tu'eyeta candidate protected area, June 2005 and 2006.

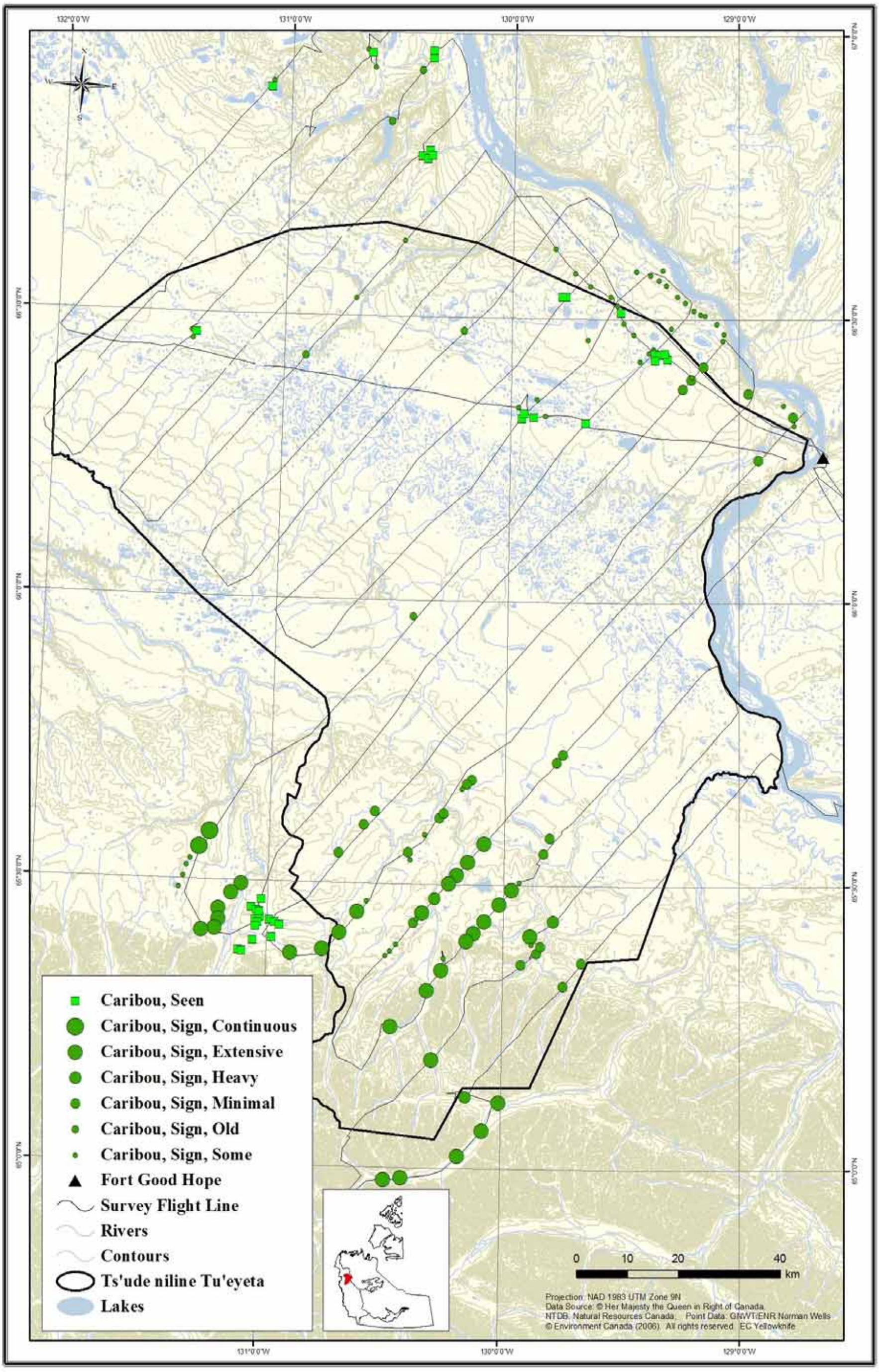

Figure 39: Caribou and caribou sign observed within and around Ts'ude niline Tu'eyeta candidate protected area, March 2006.

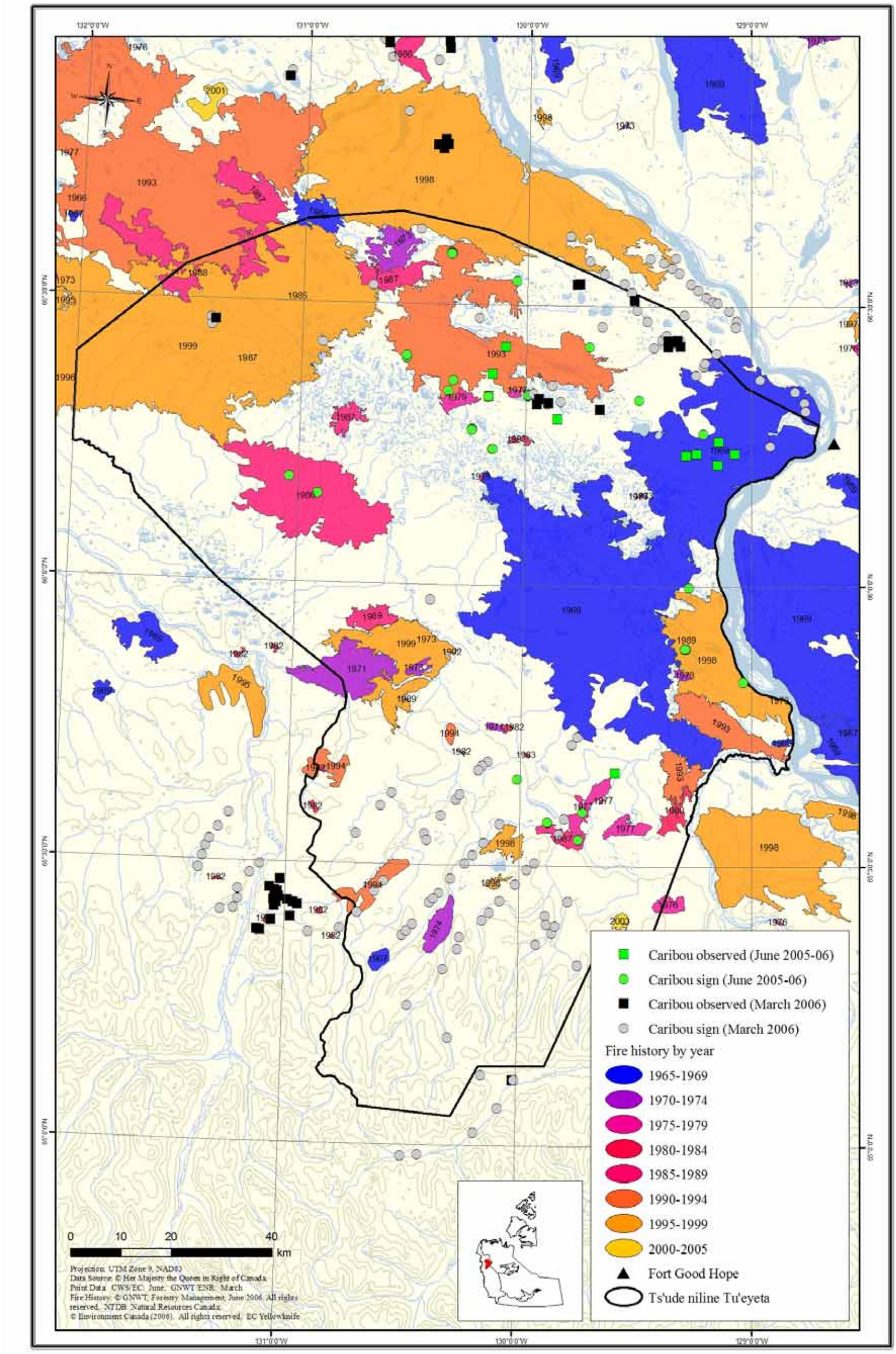

Figure 40: Caribou observed in relation to fire history within and around the Ts'ude niline Tu'eyeta candidate protected area.

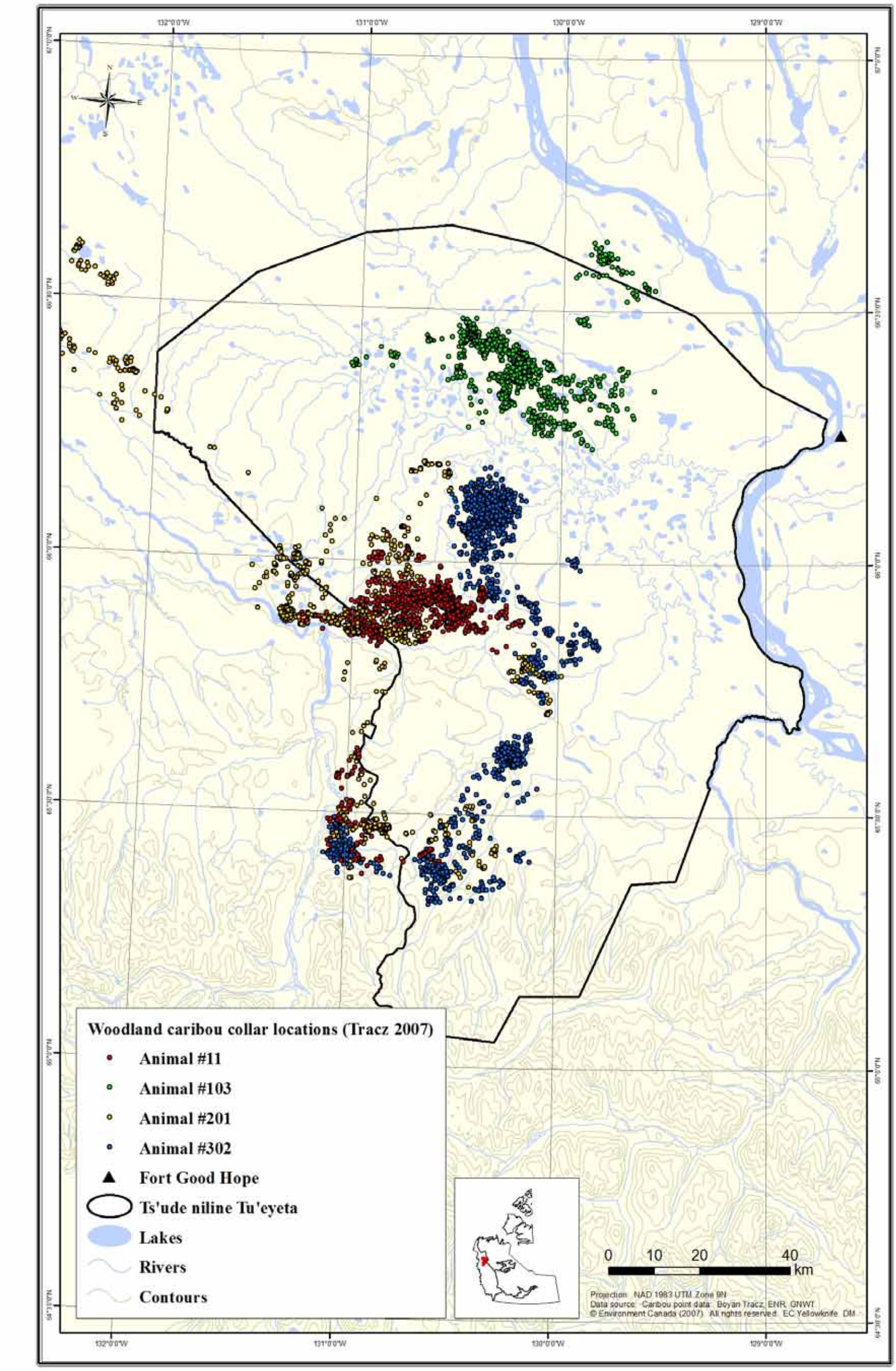

Figure 41: Woodland caribou collar locations within Ts'ude niline Tu'eyeta between May 2005 and 2007 (Tracz 2007)

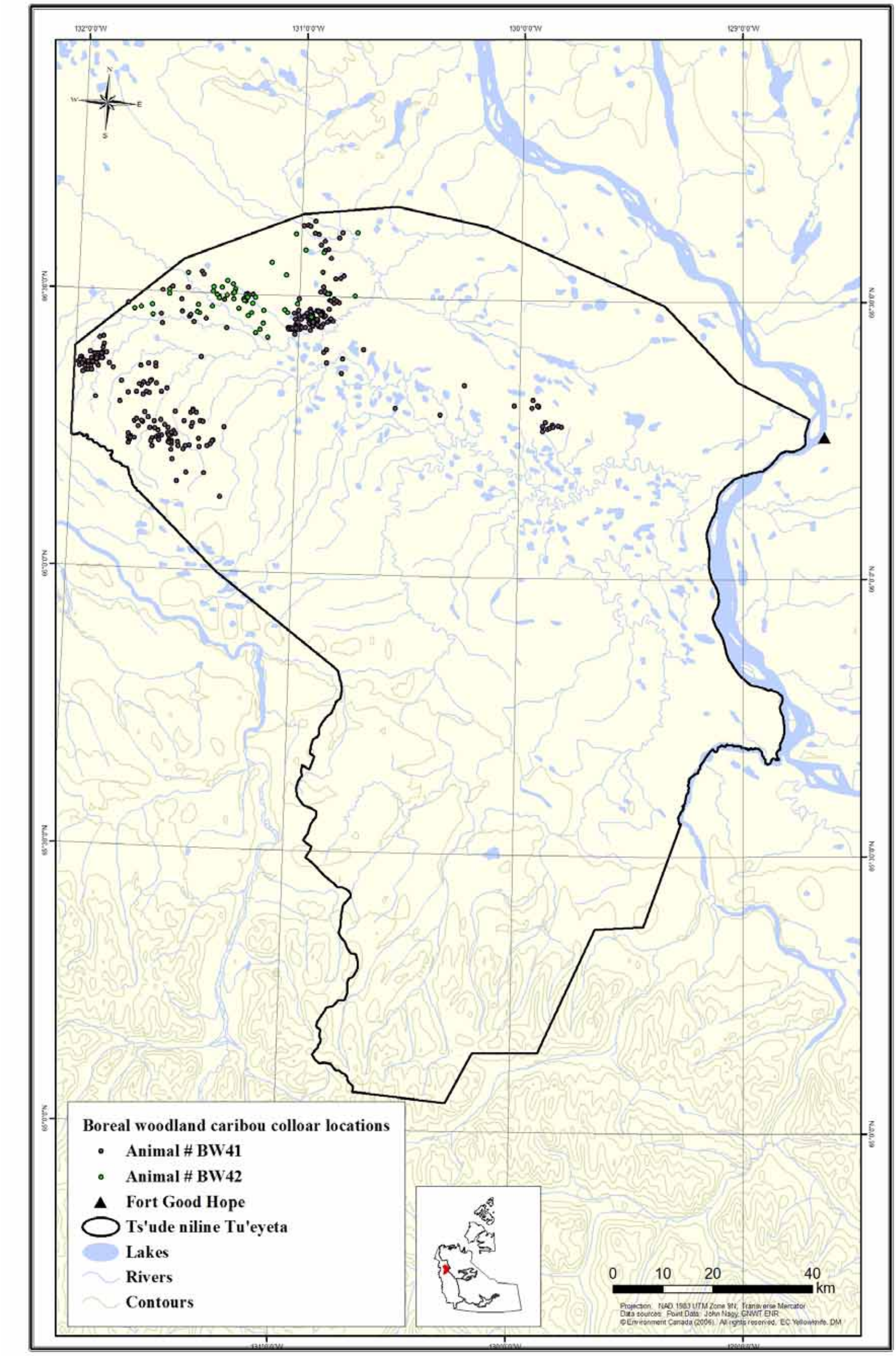

Figure 42: Woodland caribou collar locations within Ts'ude niline Tu'eyeta between May 2005-Dec 2006 (Nagy 2006)

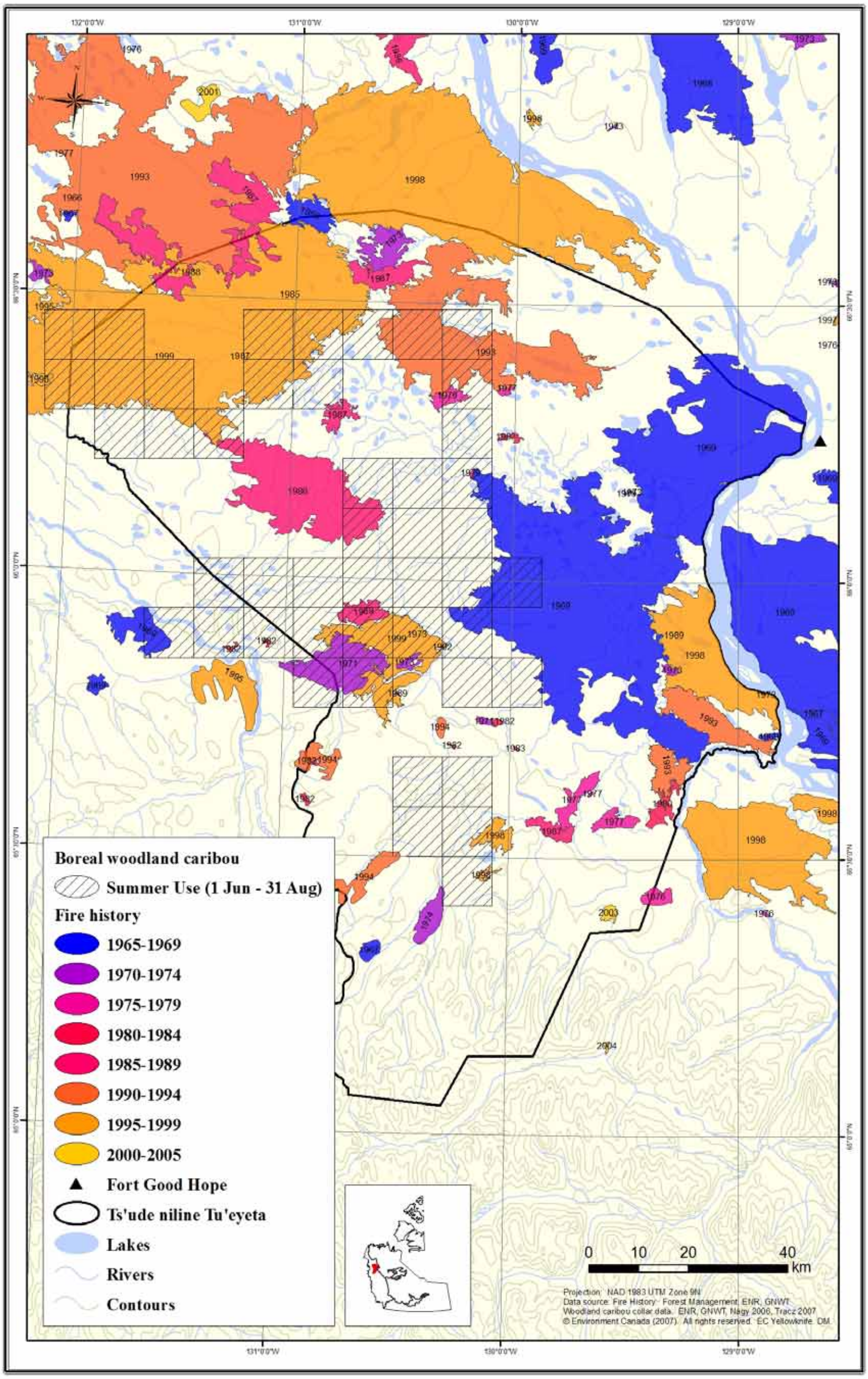

Figure 43: Summer (1 Jun - 31 Aug) use of Ts'ude niline Tu'eyeta by collared boreal woodland caribou in relation to fire.

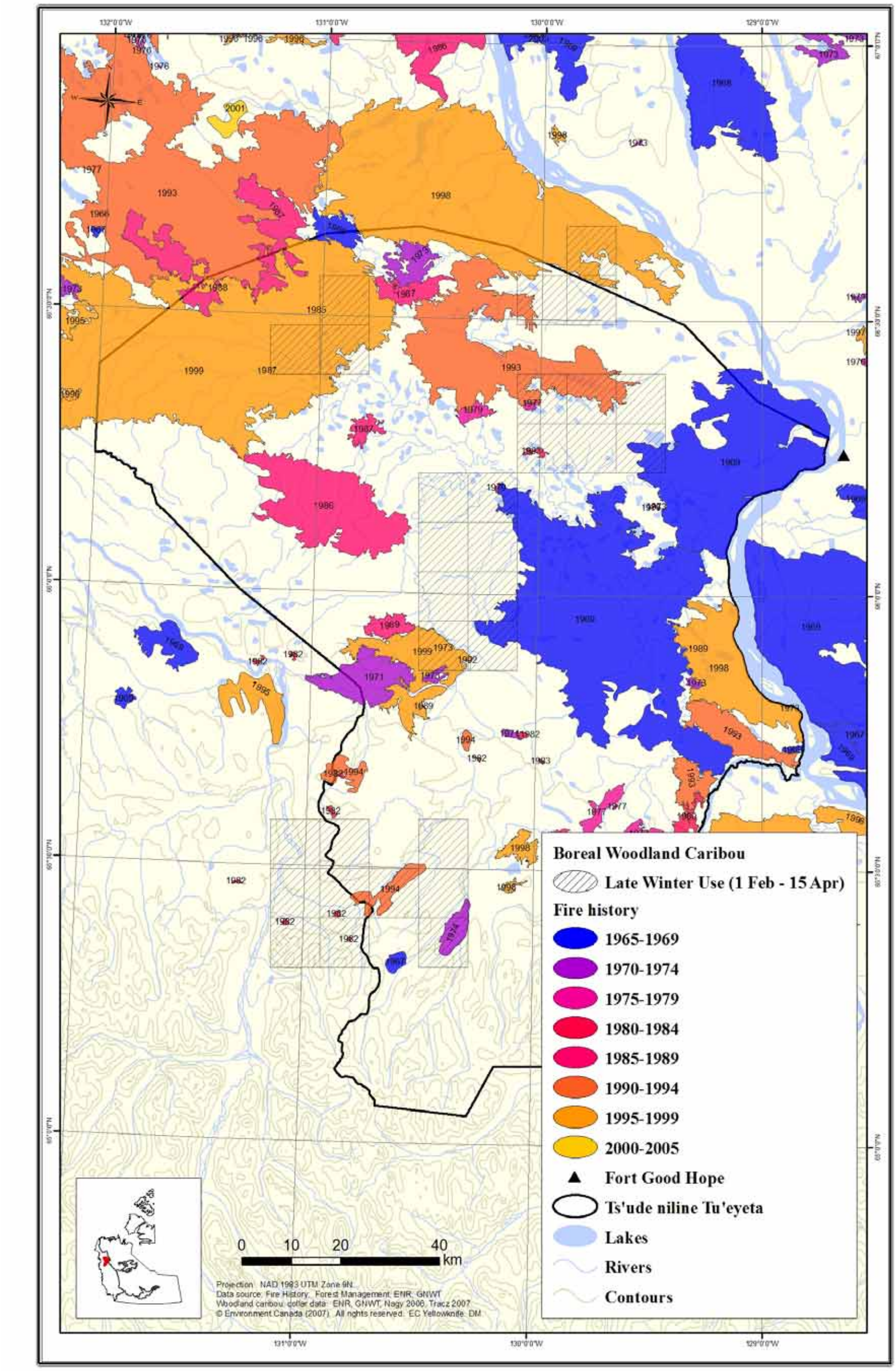

Figure 44: Late Winter (1 Feb – 15 Apr) use of Ts'ude niline Tu'eyeta by collared boreal woodland caribou in relation to fire.

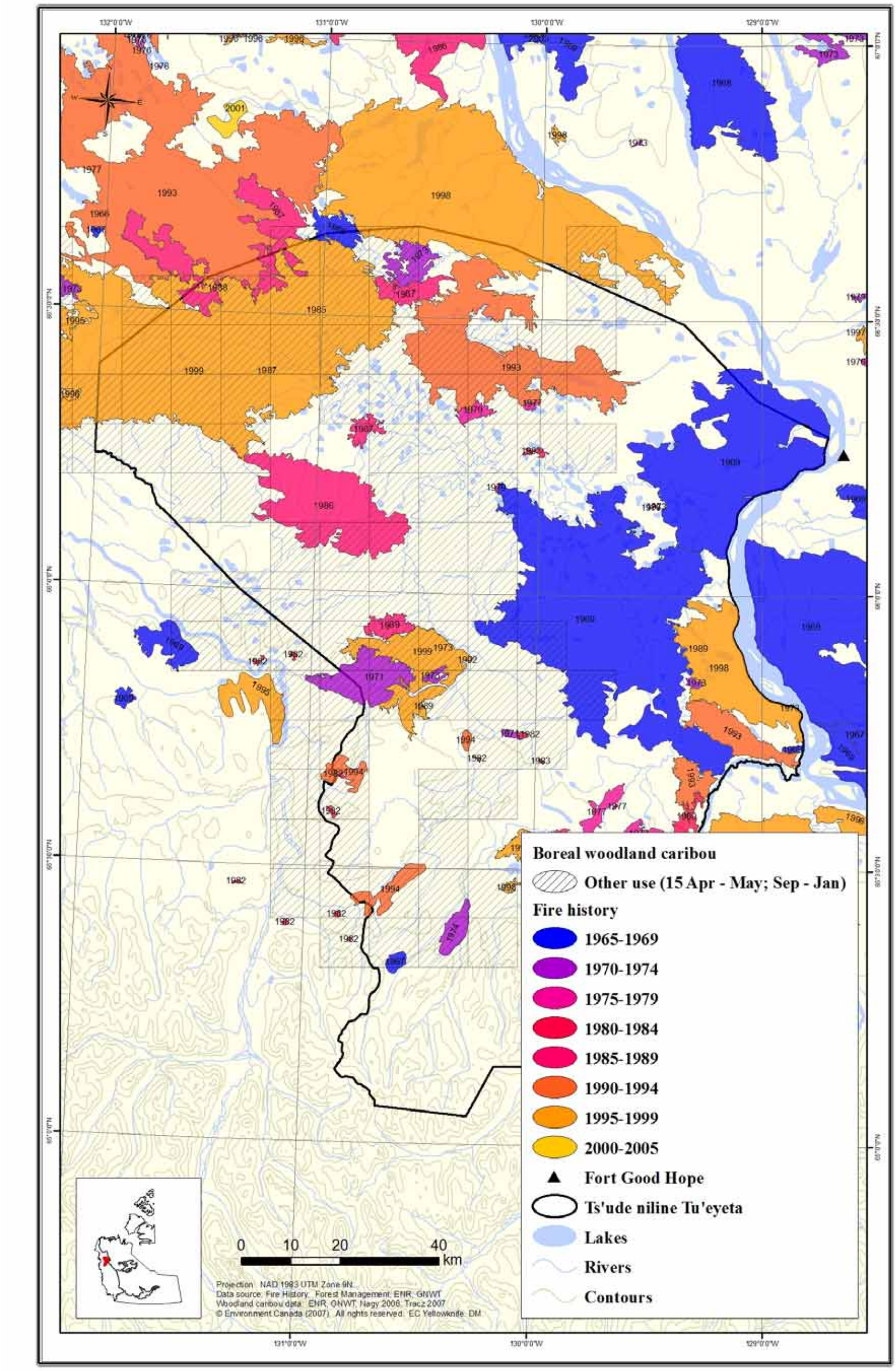

Figure 45: Woodland caribou use of Ts'ude niline Tu'eyeta during other seasons (15 Apr - 31 May; Sep - Jan) based on collared caribou locations.

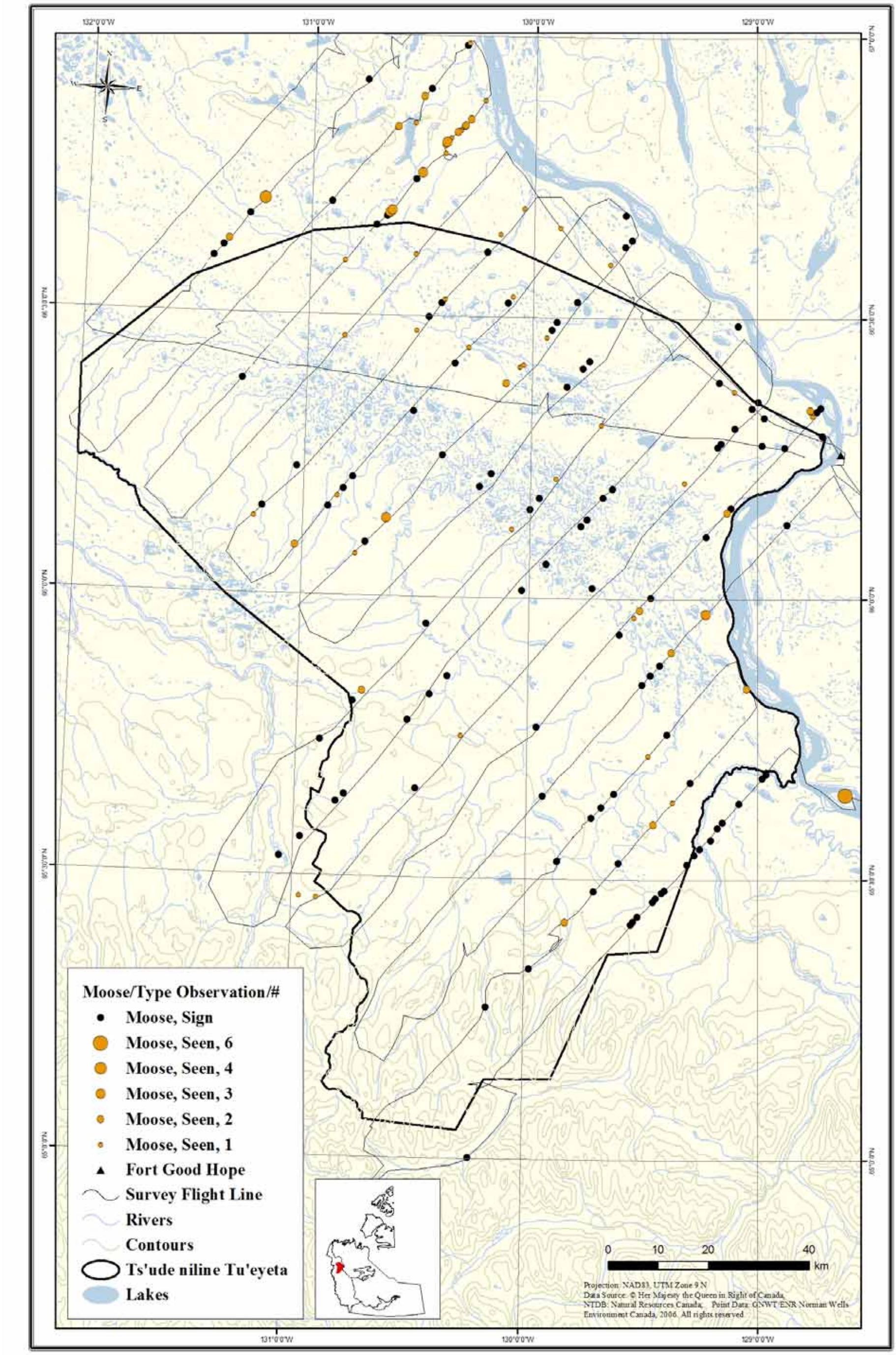

Figure 46: Moose and moose sign observed within and around Ts'ude niline Tu'eyeta candidate protected area, March 2006.

5.0 Ecological Significance of the Ts'ude niline Tu'eyeta Candidate Protected Area

5.1 Species at Risk

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is an independent, expert committee which assesses the level of risk to wildlife species. Assessments are based on the best available science, aboriginal traditional knowledge, and community knowledge. Seven species (Table 27) whose ranges overlap Ts'ude niline Tu'eyeta are designated under the following species at risk categories:

- Special Concern species may become threatened or endangered because of their biological characteristics and identified threats.
- Threatened species are likely to become endangered if nothing is done to reverse the factors leading to extirpation or extinction (e.g. Peregrine Falcon *anatum sp*).

Four of these species are also listed under the Species at Risk Act (SARA) Schedule 1 and 3, and the others are pending. Species listed under SARA Schedule 1 benefit from the protections afforded by SARA. Under SARA, critical habitat for 'threatened' species such as boreal woodland caribou and peregrine falcons must be protected by territorial/provincial or federal governments (Government of Canada, 2006). Ts'ude niline Tu'eyeta has several species designated as species at risk and its permanent, legislated protection would meet the requirement for protection of these species and their habitat, particularly in advance of large scale development in the Mackenzie Valley.

Table 27: Species at Risk within Ts'ude niline Tu'eyeta (COSEWIC and SARA)

Species	COSEWIC Status	SARA Schedule
Peregrine Falcon (*anatum sp*.)	Threatened	1
Woodland Caribou (Boreal Population)	Threatened	1
Woodland Caribou (Northern Mountain Population)	Special Concern	1
Short-eared Owl	Special Concern	3
Grizzly Bear	Special Concern	Pending
Wolverine	Special Concern	Pending
Rusty Blackbird	Special Concern	Pending

Two populations of woodland caribou are found within Ts'ude niline Tu'eyeta – the Boreal population and the Northern Mountain population, listed as 'threatened' and 'special concern' respectively by COSEWIC and on SARA Schedule 1. The Boreal population is found within the boreal forest between the Mackenzie Mountains and the Canadian Shield (GNWT ENR, 2005),

including the Ts'ude niline Tu'eyeta candidate protected area. The NWT Boreal woodland caribou population was estimated to be between 4000 and 6400 in 2001 (GNWT ENR, 2005). The number within the candidate area is unknown.

The range of the Northern Mountain population of woodland caribou includes much of the Mackenzie Mountains in the NWT, Yukon, and extends into northern British Columbia. The Northern Mountain population was estimated to be up to 48,000 in 2001, but the NWT portion of this population is unknown (GNWT ENR, 2005). Under the national Recovery Strategy, the GNWT Department of Environment and Natural Resources is developing an action plan for the conservation of woodland caribou.

The Peregrine Falcon (*anatum* subspecies) breeding range overlaps Ts'ude niline Tu'eyeta and they are designated as 'threatened' by COSEWIC (2006). They are listed on Schedule 1 under the SARA (Government of Canada, 2006). The *anatum* subspecies is found within the treeline in the NWT, with large numbers along the Mackenzie River (GNWT ENR, 2005). Within Ts'ude niline Tu'eyeta, the exposed cliffs of 'the Ramparts' along the Mackenzie River and was west of Fort Good Hope are important breeding areas for peregrines and other raptors.

Grizzly Bears, listed as "special concern" by COSEWIC and pending addition to SARA Schedule 1 (EC, 2006b), are found throughout the NWT, with the highest concentrations in the Mackenzie Mountains. The southern portion of the candidate area within the Mackenzie Mountains is considered important habitat for grizzly bears.

Wolverine are designated as 'special concern' (COSEWIC, 2006) and are pending listing under SARA. The northern boreal forest and tundra support an unknown number of wolverine in the NWT. The NWT population is thought to be stable but sparsely distributed, numbering in the thousands (GNWT ENR, 2005).

Short-eared Owls are listed as 'special concern' (COSEWIC, 2006) and are on Schedule 3 of SARA. The Rusty Blackbird was recently designated as "special concern" by COSEWIC in April 2006 and their addition to SARA Schedule 1 is pending. The reason for designation is severe decline in the species, which breed throughout the boreal forest in Canada, within the last 40 years (COSEWIC, 2006). Although this species was not observed within Ts'ude niline Tu'eyeta, we believe that this species is likely to occur in the study area due to its relatively high abundance of its preferred habitat, namely shrubby muskegs and black spruce bog (COSEWIC, 2006) and because it has been observed in many areas along the Mackenzie Valley (Cooper *et al.*, 2004). Two possible reasons for the absence of this species in the study area were the difficulty in surveying this species using conventional bird survey techniques, such as point

count (COSEWIC, 2006), and the possibility of having confused this species with the Red-winged Blackbird, during recording because of similarities in their calls.

Seven bird species that are at risk either in the Northwest Territories or in adjacent provinces (British Columbia and Alberta) were detected in Ts'ude niline Tu'eyeta. Five of those are considered at risk uniquely in the Northwest Territories (Table 28). For example, the Western tanager and the Cape May warbler are judged to be 'Secure' in the Northwest Territories but are designated as sensitive and imperilled in Alberta and British Columbia respectively (Table 28). Most of these species are currently experiencing long term population decline or are of high responsibility because they have most of the global population in the Northwest Territories and are sensitive to change in their habitat

Table 28 : Bird species found in the Ts'ude'hliline-Tuyetah Candidate Protected Area that are considered at risk in the Northwest Territories, British Columbia, Alberta or in Canada.

Species	Northwest Territories[a]	British Columbia[b]	Alberta[c]	Canada[d]
Lesser Yellowlegs	Sensitive	Secure	Secure	Undetermined
White-throated Sparrow	Sensitive	Secure	Secure	Undetermined
American Tree Sparrow	Sensitive	Secure	Secure	Undetermined
Western Tanager	Secure	Secure	Sensitive	Undetermined
Blackpoll Warbler	Sensitive	Secure	Secure	Undetermined
Cape May Warbler	Secure	Imperilled	Sensitive	Undetermined
Rusty Blackbird[e]	May be at Risk	Vulnerable-apparently Secure	Sensitive	Special Concern

[a]NWT species 2006-2010, http://www .nwtwildlife.com
[b]NatureServe 2006, http://www.natureserve.org
[c]Alberta Ministry of Sustainable Resource Development, http://www.srd.gov.ab.ca/fw/wildspecies/search.htm
[d]COSEWIC, http://www.cosewic.gc.ca/fra/sct5/index_f.cfm
[e]Species not detected within the TCPA but known to occur as a confimed breeder in the Sahtu Settlement Area (Auld and Kershaw 2005).

According to the North American Landbird Conservation Plan (Rich *et al.*, 2004), thirteen species found in Ts'ude niline Tu'eyeta are of continental importance in the Northern Forest Avifaunal Biome (Table 29Table 29: Bird species found in Ts'ude' niline Tu'eyeta Candidate Protected Area considered to be of continental importance in the Northern Forest Avifaunal Biome (Rich *et al.*, 2004). Two species are on the Watch List; the Rusty Blackbird and the Olive-sided Flycatcher (Table 29). On a scale of 20, Watch List species have the highest vulnerability scoring (combined score of ≥ 14) and are the species that should be highly considered for conservation across their entire range (Rich *et al.*, 2004). Eleven species are considered Stewardship Species because of the high proportion of their global population or range within the Northern Forest Avifaunal Biome (Table 29).

Table 29: Bird species found in Ts'ude' niline Tu'eyeta Candidate Protected Area considered to be of continental importance in the Northern Forest Avifaunal Biome (Rich *et al.*, 2004).

Watch list species[a]	Stewardship species[b]
Rusty Blackbird[c]	Palm Warbler
Olive-sided Flycatcher	Cape May Warbler
	Tennessee Warbler
	White-throated Sparrow
	Alder Flycatcher
	Swamp Sparrow
	Yellow-bellied Sapsucker
	Gray jay
	Lincoln's Sparrow
	Bohemian Waxwing
	White-winged Crossbill

[a]Watch list species= species with highest vulnerability scoring (combined score of ≥ 14 on a 20 scale, Rich *et al.* 2004).
[b]Stewardship species= species with high proportion of their global population or range within the Northern Forest Avifaunal Biome.
[c]Species not detected within the TCPA but known to be breeding in the Sahtu Settlement Area (Auld and Kershaw 2005).

5.2 Key Migratory Bird Terrestrial Habitat: Ramparts River Wetlands

The Ramparts River wetlands are recognized as a regionally important wetland. It is classified as a 'key migratory bird habitat site' by the Canadian Wildlife Service (Latour *et al.*, 2006). There are 23 such sites in the NWT that meet the criteria of >1% of the national population of at least one species of bird using the site at some point during the year. Surveys have recorded 20 000 Greater and Lesser scaup and 6000 Surf and White-winged scoters in these wetlands during the nesting period. Accounting for missed birds, these surveys indicate that 1% of the estimated Canadian populations of both scaup and scoters were nesting in that area. The Ramparts River wetlands also provide staging habitat for additional numbers of scaup and scoters migrating to areas farther north. Relatively high densities of Pacific Loons (3692 loons) have also been observed in the wetlands. This number is thought to represent >1% of the Canadian population of this species.

5.3 Watershed Protection

The Ts'ude niline Tu'eyeta candidate protected area provides the source waters for the Ramparts and Hume Rivers and a significant portion of the Ontaratue River drainage.

5.4 Representivity

Ts'ude niline Tu'eyeta falls within the Taiga Plains and Taiga Cordillera ecozones. Ecozones are further divided into ecoregions and the candidate protected area includes four of the 42 ecoregions within the NWT, listed in descending order of representation within Ts'ude niline Tu'eyeta: Peel River Plateau, Fort MacPherson Plain, Mackenzie River Plain, and the Mackenzie Mountain ecoregion. Core representative area analysis indicated that Ts'ude niline Tu'eyeta contains several highly representative or unique areas likely cannot be found elsewhere. The analysis also indicates that Ts'ude niline Tu'eyeta is effective at capturing the range of biodiversity within 100 km around it.

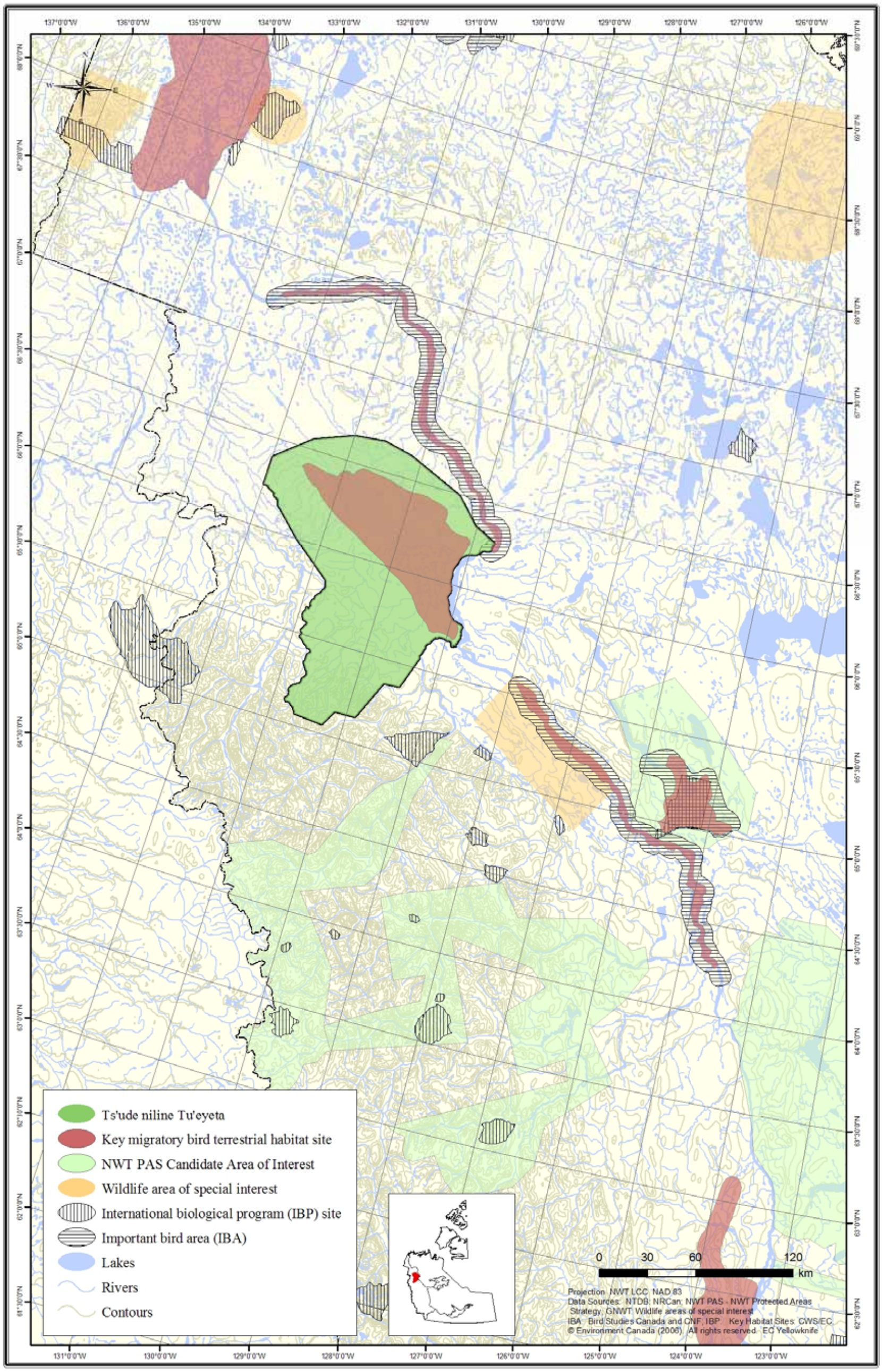

Figure 47: Protected areas and areas of special interest for wildlife within and around the Ts'ude niline Tu'eyeta candidate protected area.

6.0 Literature Cited

Literature Cited

Afton, A. D. and Anderson, M. G., 2001: Declining Scaup populations: A retrospective analysis of long-term population and harvest survey data. *Journal of Wildlife Management,* 65 (4): 781-796.

Alexander, S. A., Ferguson, R. S., and McCormick, K. J., 1991: *Key migratory bird terrestrial habitat sites in the Northwest Territories*. Yellowknife, NT: Canadian Wildlife Service, Western and Northern Region, Northern Operations, 184 pp pp.

AMEC Earth and Environmental, 2005: *Guidelines for Ecological Inventory Methods for Candidate Protected Areas in the Northwest Territories*. Calgary, AB: AMEC Earth and Environmental, 43 pp.

Argus, G. W. and McNeill, J., 1975: The conservation of evolutionary centres in Canada. *In* Maini, J. S. and Carlyle, J. (eds.), *Conservation in Canada - A conspectus*. Ottawa, ON: Environment Canada.

Aylsworth, J. M., Burgess, M. M., Descrochers, D. T., Duk-Rodkin, A., Robertson, T., and Traynor, J. A., 2000: Surficial geology, subsurface materials, and thaw sensitivity of sediments. *In* Dyke, L. D. and Brooks, G. R. (eds.), *The Physical Environment of the Mackenzie Valley, Northwest Territories: a Base Line for the Assessment of Environmental Change, Bulletin 547*: Geological Survey of Canada, 41-48.

Banfield, A. W. F., 1977: *The mammals of Canada*. Toronto, ON: University of Toronto Press, 438 pp.

Brackett, D., Spencer, W., Baird, G., Snowshoe, J. A., Krutko, E., Males, L., and Latour, P., 1985: Moose surveys in Mackenzie River Delta, Valley and Tributaries, 1980, *GNWT File Report 48*. Yellowknife, NT: GNWT Wildlife Service.

Bromley, R. G. and Matthews, S. B., 1988: Status of the Peregrine Falcon in the Mackenzie river Valley, Northwest Territories, 1969-1985. *In* Cade, T. J., Enderson, J. H., Thelander, C. G., and White, C. M. (eds.), *Peregrine falcon populations: their management and recovery*. Boise, ID: The Peregrine Fund Inc., 59-64.

Burt, W. H. and Grossenheider, R. P., 1980: *Peterson Field Guide to Mammals*. Boston, Massachusetts: Houghton Mifflin Company, 289 pp.

Canadian Wildlife Service, 2006: *Northwest Territories/Nunavut Bird Checklist: Database accessed Dec. 2006*. Yellowknife, NT: Environment Canada.

Cody, W. J., 1979: *Vascular plans of restricted range in the continental Northwest Territories, Canada*. Ottawa, ON: National Museum of Natural Sciences, National Museum of Canada, 57 pp.

Cook, D. G. and Aitken, J. D., 1975: *Ontaratue (106-J), Travaillant Lake (106-O), and Canot Lake (106-P) map-areas. District of Mackenzie, Northwest Territories*: Geological Survey of Canada.

Cooper, J. M., Wheatley, M., Chytyk, P. A., Deans, A., Holschuh, C., and Beauchesne, S. M., 2004: *Potential impacts on birds in the Mackenzie Valley from pipeline clearings for the Mackenzie Gas Project. Technical report series Number 442.* . Yellowknife.: Canadian Wildlife Service, Prairie and Northern Region.

COSEWIC, 2006: *Canadian Species at Risk, August 2006*: Committee on the Status of Endangered Wildlife in Canada, 74 pp.

Department of Environment, 1975: *Northern Land Use Information Map Series*. Ottawa, ON: Environment Canada.

Department of Indian Affairs and Northern Development (DIAND), 1993: *Sahtu Dene and Metis Comprehsive Land Claim Agreement (Volume 1 and 2)*. Ottawa, ON: Government of Canada.

Doubt, J., 2007: *Botanical collections and records within the vicinity of Ts'ude niline Tu'eyeta. Data provided by Jennifer Doubt, Chief Collection Manager, Botany Section, Canadian Museum of Nature (Jan. 2007).* Ottawa, ON: Canadian Museum of Nature.

Dryden, R. L., Sutherland, B. G., and Stein, J. N., 1973: *An evaluation of the fish resources of the Mackenzie River Valley as related to pipeline development. Volume 2.*: Environmental-Social Committee Northern Pipelines, Task Force on Northern Oil Development Report 73-2, 176 pp.

Ducks Unlimited Canada, 1997: Distribution, Abundance and Nesting Success of Waterfowl at the Ramparts-Hume Wetland Complex, Sahtu Region, Northwest Territories. 1997 Progress Report. Yellowknife, NT: Ducks Unlimited Canada.

Ducks Unlimited Inc., 2006: *Middle Mackenzie Project Earth Cover Classification User's Guide*: Ducks Unlimited, Inc., Rancho Cordova, California. Prepared for: Ducks Unlimited Canada; Gwich'in Renewable Resource Board; Sahtu Renewable Resources Board; Government of the Northwest Territories (Department of Resources, Wildlife and Economic Development); Department of Indian Affairs and Northern Development (DIAND); North American Wetlands Management Plan; The Pew Charitable Trusts; Canadian Boreal Initiative; U.S. Forest Service, 73 pp.

Duk-Rodkin, A. and Lemmen, D. S., 2000: Glacial history of the Mackenzie region. *In* Dyke, L. D. and Brooks, G. R. (eds.), *The Physical Environment of the Mackenzie Valley, Northwest Territories: a Base Line for the Assessment of Environmental Change, Bulletin 547*: Geological Survey of Canada, 11-20.

Ecological Stratification Working Group, 1996: *A national ecological framework for Canada*. Ottawa-Hull, ON: Agriculture and Agra-Food Canada, Research Branch, Centre or Land and Biological Resources Research, Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, 125 pp.

ENR, G., 2006: *NWT Fire History 1967-2006* Fort Smith: GNWT RWED.

Environment Canada, 2006a: Ecological Framework - Terrestrial Ecozone and Ecoregions of Canada. URL http://www.ec.gc.ca/soer-ree/English/Framework/Nardesc/Region.cfm?region=51

Environment Canada, 2006b: Species at Risk Act Public Registry. URL www.sararegistry.gc.ca/species.

ESRI, 2005: ArcMap 9.1. Redlands, CA: ESRI.

Fournier, B. J. and Hines, J. E., 2005: *Geographic distribution and changes in population densities of waterfowl in the Northwest Territories, Canada, 1976-2003. Techncial Report Series No. 433*. Canadian Wildlife Service, Yellowknife, NT.

Fournier, M. A., 1997: Amphibians in the Northwest Territories. *In* Green, D. M. (ed.), *Amphibians in Decline: Canadian Studies of a Global Problem*. Saint Louis, Missouri Society for the Study of Amphibians and Reptiles, 100-106.

GNWT Environment and Natural Resources, 2005: *NWT Species at Risk Fact Sheets: Woodland Caribou (Boreal); Grizzly Bear; Wolverine; Woodland Caribou (Northern Mountain); Peregrine Falcon anatum; Short-eared Owl*. Yellowknife, NT: GNWT ENR.

GNWT RWED, F. M. D., 2002: Northwest Territories Land Cover Classification (Version 1:2002) Fort Smith, NT, NWT Land Cover Classification.

Government of Canada, 2006: Species at Risk Act Public Registry. URL www.sararegistry.gc.ca/species.

Government of the Northwest Territories, 2005: NWT Species Monitoring - Infobase. URL www.nwtwildlife.rwed.gov.nt.ca/monitor

Government of the Northwest Territories, 2006: *NWT Species 2006-2010: General Status Ranks of Wild Species in the Northwest Territories*. Yellowknife, NT: GNWT Department of Resources, Wildlife and Economic Development, 50 pp.

Government of the Northwest Territories (GNWT), 2007: *NWT - NU Raptor Database. Provided by NT Coordinator Dr. S. Carriiere, Wildlife Biologist. Data agreement, ENR*. Yellowknife, NT.

Hatfield, C. T., Stein, J. N., Falk, M. R., and Jessop, C. S., 1972: *Fish resources of the Mackenzie River Valley, Interim Report 1, Volumes 1 and 2*. Winnipeg, MB: Canada Department of the Environment, Fisheries Service, Volume 1: 249 p.; Volume 242: 289 p. pp.

Heginbotton, J. A., 2000: Permafrost distribution and ground ice in surficial materials. *In* Dyke, L. D. and Brooks, G. R. (eds.), *The Physical Environment of the Mackenzie Valley, Northwest Territories: a Base Line for the Assessment of Environmental Change, Bulletin 547*: Geological Survey of Canada, 31-39.

Hill, M. O. and Šmilauer, P., 2005: TWINSPAN for Windows version 2.3: Centre for Ecology and Hydrology, University of South Bohemia, Huntingdon & České Budějovice.

Hobson, K. A., Rempel, R. S., Greenwood, H., Turnbull, B., and Wilgenburg, S. L. V., 2002: Acoustic surveys of birds using electronic recordings: new potential from an omnidirectional microphone system. *Wildlife Society Bulletin,* 30: 709-720.

Holt, D. W. and Leasure, S. M., 1993: Short-eared Owl (Asio flammeus). *In* Poole, A. and Gill, F. (eds.), *The Birds of North America*. Washington, D.C: The American Ornithologists' Union.

Jessop, C. S., Chang-Kue, K. T. J., Lilley, J. W., and Percy, R. J., 1974: *A further evaluation of the fish resources of the Mackenzie River Valley as related to pipeline development*, 94 pp.

Jinkfors, K., Bullion, R., and Case, R., 1987: Abundance and population composition of moose along the Mackenzie River, November 1984, *GNWT Department of Renewable Resources File Report 70*. Yellowknife, NT.

Latour, P. B., 1992a: Moose distribution along the Lower Mountain and Hume Rivers during oil drilling, winter 1989/1990, *GNWT Manuascript Report No. 43*. Norman Wells, NT: GNWT ENR Library, 18.

Latour, P. B., 1992b: A survey of Dall's Sheep in Zone E/1-1, Northern Mackenzie Mountains, *GNWT Manuscript Report No. 44*. Norman Wells, NT: GNWT Department of Renewable Resources.

Latour, P. B., Leger, J., Hines, J. E., Mallory, M. L., Mulders, D. L., Gilchrist, H. G., and Dickson, D. L., 2006: *Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut*. Yellowknife: Canadian Wildlife Service, 160 pp.

Machtans, C. S. and Latour, P. B., 2003: Boreal forest songbird communities of the Liard Valley, Northwest Territories, Canada. *Condor,* 105: 27-44.

Mackenzie River Basin Board, 2004: *Mackenzie River Basin State of the Aquatic Ecoystem Report 2003*. Fort Smith, NT: Mackenzie River Basin Board, 213 pp.

MacLean, N., 1994: Population size and composition of moose in the Fort Good Hope area, NWT, November 1992, *GNWT Manuscript Report 78*. Norman Wells, NT: GNWT Department of Renewable Resources.

Matthews, S., Carrière, S., Hodson, K., and Doyle, F., 2006: *2005 Mackenzie Valley, NWT - Peregrine Falcon Survey*. Yellowknife, NT: Government of the Northwest Territories, Department of Environment and Natural Resources.

McCune, B. and Mefford, M. J., 1999: Multivariate analysis of ecological data. Gleneden Beach, Oregon, US: MJM Software.

McJannet, C. L., Argus, G. W., and Cody, W. J., 1995: *Rare Vascular Plants in the Northwest Territories*. Ottawa, ON: Canadian Museum of Nature, 104 pp.

Microsoft Corporation, 2005: Microsoft Access, part of Microsoft Office Professional Edition 2003: Microsoft Corporation.

Murphy, J. E., 1990: The 1985-86 Canadian Peregrine Falcon, Falco peregrinus, survey. *Canadian Field Naturalist,* 104: 182-192.

Nagy, J., Auriat, D., Ellsworth, I., Wright, W., and Slack, T., 2003: *Ecology of Boreal Woodland Caribou in the Lower Mackenzie Valley, NT: Work completed in the Inuvik Region 1 April 2002 to 31 March 2003*. Government of the Northwest Territories, Department of Environment and Natural Resources, Inuvik, NT.

Nagy, J., Auriat, D., Wright, W., Slack, T., Ellsworth, I., and Kienzler, M., 2005a: *Ecology of Boreal Woodland Caribou in the Lower Mackenzie Valley, NT: Work completed in the Inuvik Region April 2003 to November 2004*. Government of the Northwest Territories, Department of Environment and Natural Resources, Inuvik, NT.

Nagy, J., Auriat, D., Wright, W., Slack, T., Ellsworth, I., and Kienzler, M., 2005b: *Ecology of Boreal Woodland Caribou in the Lower Mackenzie Valley, NT: Work completed in the Inuvik Region April 2003 to November 2004*. Government of the Northwest Territories, Department of Environment and Natural Resources, Inuvik, NT.

Nagy, J., Derocher, A. E., Nielson, S. E., Wright, W., and Heikkila, J. M., 2006: *Modelling Seasonal Habitats of Boreal Woodland Caribou at the Northern Limits of their Range: A Preliminary Assessment of the Lower Mackenzie River Valley, Northwest Territories, Canada*. Government of the NWT, Department of Environment and Natural Resources, Inuvik, NT.

Natural Resources Canada, 2006: *Earth Observation for Sustainable Development of Forests (EOSD) [shapefile]*: Government of Canada.

NWT Protected Area Strategy Ecological Working Group (EWG), 2006: *Interim Technical Report on Ecological Representation Analysis for the Mackenzie Valley (Draft November 2006)*. Yellowknife, NT: NWT Protected Areas Strategy Committee, 59 pp.

NWT Protected Areas Strategy (NWT PAS) Ecological Working Group, 2006: *Ecological Representation in the the Northwest Territories: Ts'ude niline Tu'eyeta Candidate Protected Area*. Yellowknife, NT: NWT Protected Areas Strategy, 7 pp.

NWT Protected Areas Strategy (PAS) Advisory Committee, 1999: *NWT Protected Areas Strategy, A Balanced Approache to Establishing Protected Areas in the Northwest Territories*. Yellowknife, NT: NWT Protected Areas Strategy, 101 pp.

NWT Protected Areas Strategy (PAS) Advisory Committee, 2002: *NWT Protected Areas Strategy: Ecological Assessment Guidelines*. Yellowknife, NT, 7 pp.

Poole, K. G. and Croft, B., 1990: Beaver survey in the western NWT, September-October 1989. Yellowknife, NT: GNWT Wildlife and Fisheries Division.

Popko, R. and Veitch, A. M., 1998: An aerial survey for beavers in the Sahtu Settlement Area, October 1997, *GNWT Manuscript Report 108*. Norman Wells, NT.

Popko, R., 2006: Aerial Wildlife Survey in the Proposed Ramparts Wetlands Protected Area, 28-31 March 2006. Norman Wells, NT: GNWT, Department of Environment and Natural Resources, 1-4.

Popko, R. A., Veitch, A. M., and Promislow, M. C., 2002: *An Aerial Survey for Beaver Lodges in the Sahtu Settlement Area*. GNWT Department of Resources, Wildlife and Economic Development, Norman Wells, NT.

Porsild, A. E. and Cody, W. J., 1980: *Vascular Plants of Continental Northwest Territories, Canada*. Ottawa, Ontario: National Museum of Natural Sciences. National Museums of Canada, 667 pp.

Prescott, W. H., Erickson, G. L., Walton, L. E., and Smith, D. G., 1973: *Atlas of moose habitat maps: part of a wildlife habitat inventory of the Mackenzie Valley and northern Yukon.* : Canadian Wildlife Service.

Ralph, C. J., Sauer, J. R., and Droege, S., 1995: *Monitoring bird populations by point counts. General Technical Report PSW. GRT-149*. Albany, CA: Pacific Southwest Research Station, Forest Service, US. Department of Agriculture, 187 pp.

Rempel, R. S., Hobson, K. A., Holborn, G., Wilgenburg, S. L. V., and Elliott, J., 2005: Bioacoustic monitoring of forest songbirds: interpreter variability and effects of configuration and digital processing methods in the laboratory. *Journal of Field Ornithology,* 76 (1): 1-11.

Rich, T. D., Beardmore, C. J., Berlanga, H., Blancher, P. J., Bradstreet, M. S. W., Butcher, G. S., Demarest, D. W., Dunn, E. H., Hunter, W. C., Iñigo-Elias, E. E., Kennedy, J. A., Martell, A. M., Panjabi, A. O., Pashley, D. N., Rosenberg, K. V., Rustay, C. M., Wendt, J. S., and Will, T. C., 2004: *Partners in Flight North American Landbird Conservation Plan*. Ithaca, NY: Cornell Lab of Ornithology.

Salter, R., 1974: Autumn migration of birds through the central and upper Mackenzie Valley region, 1972, *Arctic Gas Biological Report Series 13(2).* Calgary, AB: Canadian Arctic Gas Study, 1-83.

Salter, R. and Davis, R. A., 1974: Surveys of terrestrial bird populations in Alaska, Yukon Territory, Northwest Territories and northern Alberta, May, June, July, 1972. *In* Gunn, W. W. H. and Livingston, J. A. (eds.), *Bird distribution and populations ascertained through ground survey techniques, 1972*: Prepared by L.G.L. Limited, Environmental Research Associates, February 1974.

Savignac, C., 1998: *Songbird diversity and cavity-nesting bird habitat in the Prophet Territory of Northeastern British Colimbia, 1998. Prophet River Wildlife Inventory Report No. 8. Submitted to Fish and Wildlife Branch, British Columbia Ministry of Environment, Lands and Parks, Peace subregion, Fort St. John, B.C.*

Savignac, C. and Machtans, C. S., 2006: Habitat requirements of the Yellow-bellied Sapsucker, Sphyrapicus varius, in boreal mixedwood forests of northwestern Canada. *Canadian Journal of Zoology-Revue Canadienne De Zoologie,* 84: 1230-1239.

Savignac, C., 2007: *Ts'ude niline Tu'eyeta Vegetation and Songbird Survey Report 2007. Prepared for the Canadian Wildlife Service, Yellowknife, NT.* Quebec: 42.

Scott, W. B. and Crossman, E. J., 1973: *Freshwater Fishes of Canada, Bulletin 184*. Toronto, ON: Royal Ontario Museum, Fisheries Research Board of Canada.

Shotton, R. T., 1971: *Towards an environmental impact assessment of a gas pipeline from Prudhoe Bay, Alaska, to Alberta. Appendix II. fish. Unpublished report prepared by Inter-disciplinary Systems Ltd, Interim Report 1*. Winnipeg, MB: Environment Protection Board.

Shotton, R. T., 1973: Towards an environmental impact assessment of the portion of the Mackenzie gas pipeline from Alaska to Alberta. Appendix II. fish base data, *Unpublished report prepared by Interdisciplinary Systems Ltd. for the Environment Protection Board. Interim Rep*. Winnipeg, MB: Environmental Protection Board, 199

Sibley, D. A., 2003: *The Sibley field guide to birds of western North America*. New York, NY: Alfred A. Knopf, National Audubon Society, 545 pp.

SPSS Inc., 1997: SPSS/PC+. Version 8.0.0 Computer program. Chicago, IL: SPSS Inc.

Stein, J. N., Jessop, C. S., Porter, T. R., and Chang-Kue, K. T. J., 1973: *Fish resources of the Mackenzie River Valley* Environmental-Social Committee, Northern Pipelines, Task Force on Northern Oil Development, 260 pp.

Stewart, D. B., 1996: A review of the status and harvests of fish stocks in the Sahtu Dene and Metis Settlement area, including Great Bear Lake, *Canadian manuscript report of fisheries and aquatic sciences; 2337*. Winnipeg, MB: Canada. Dept. of Fisheries and Oceans. Central and Arctic Region.

Stewart, D. B., Low, G., Taptuna, W. E. F., and Day, A. C., 1997: Biological data from experimental fisheries at Special Harvesting areas in the Sahtu Dene and Metis Settlement areas, NWT. Volume 1, The Upper Ramparts and Little Chicago areas of the Mackenzie River, *Canadian data report of fisheries and aquatic sciences; 1020*. Winnipeg, MB: Department of Fisheries and Oceans, 67.

Stewart, D. B., Taptuna, W. E. F., Lockhart, W. L., and Low, G., 2003: Biological Data from Experimental Fisheries at Special Harvesting Areas in the Sahtu Dene and Metis Settlement Area, NT: Volume 2. Lakes Near the Communities of Colville Lake, Fort Good Hope, Norman Wells, and Tulita. *Canadian Data Report of Fisheries and Aquatic Sciences 1126*: viii + 101.

ter Braak, C. J. F. and Šmilauer, P., 2002: *CANOCO reference manual and CanDraw for Windows User's Guide. Software for canonical community ordination (version 4.5)*. Ithaca, NY: Microcomputer Power, 500 pp.

Treseder, L. and Graf, R., 1985: *Moose in the Northwest Territories - A discussion paper*. GNWT Wildlife Service, Yellowknife, NT.

Walmsley, M., Utzig, G., Vold, T., and van Barneudd, J., 1980: *Describing Ecosystems in the Field* Victoria, BC: BC Ministry of Environment, Resource Analysis Branch.

Walton-Rankin, L., 1977: *An inventory of moose habitat of the Mackenzie Valley and Northern Yukon*: Canadian Wildlife Service, 39 pp.

Wooley, D. R., 1974: Beaver (Castor canadensis) studies in the Mackenzie Valley, 1972. *In* Ruttun, R. A. and Wooley, D. R. (eds.), *Studies of Furbearers Associated with Proposed Pipeline Routes in the Yukon and Northwest Territories*: Arctic Gas Biological Report Series, 52.

Yamoga Land Corporation, 2006: *Ts'ude niline Tu'eyeta (Ramparts River and Wetlands) Candidate Protected Area: A Proposal to the Canadian Wildlife Service by the Yamoga Land Corporation, Fort Good Hope*. Fort Good Hope, NT: Yamoga Land Corporation.

Zimmer, A., Robinson, L., Veitch, A. M., Trembath, R., and Whiteman, N., 2000: Sahtu Settlement Area Vegetation Classification Project Progress Report 1999, *GNWT Manuscript Report 124*. Norman Wells, NT.

Appendix A: Ecological Assessment Field Forms and Class Descriptions

Ts'ude niline Tu'eyeta CPA June 2006

Site #:

Bird Point Count Survey Form

Site #		Date		Helicopter Wypt:	
Habitat Type		Observers		GPS ID	

1

Waypoint		Start Time		Wildlife Transect		Wildlife Transect 1	
Easting		Recording #					
Northing		Temp					
Habitat		Sky					
Photo #		Wind					
		Noise					

2

Waypoint		Start Time		Wildlife Transect		Wildlife Transect 2	
Easting		Recording #					
Northing		Temp					
Habitat		Sky					
Photo #		Wind					
		Noise					

3

Waypoint		Start Time		Wildlife Transect		Wildlife Transect 3	
Easting		Recording #					
Northing		Temp					
Habitat		Sky					
Photo #		Wind					
		Noise					

Sky:

0 Clear or a few clouds
1 Partly cloudy or variable sky
2 Cloudy or overcast
3 Fog or smoke
4 Snow
5 Rain

Wind:

0	<1 mph	smoke rises vertically
1	1-3 mph	wind direction shown by smoke drift
2	4-7 mph -	wind felt on face, leaves rustle
3	8-12 mph	leaves and small twigs in constant motion
4	13-18 mph	raises dust and small branches are moved
5	19-24 mph	small trees in leaf begin to sway
6	25-31 mph	large branches in motion
7	32-38 mph	whole trees in motion

Noise:

1. Quiet
2. Some noise, but not distracting (dogs or coyotes barking/howling)
3. Significant noise that may have reduced detectability (flowing creek)
4. Constant noise (heavy traffic, compressor/generator, roaring creek)

	PC 1: Wpt# _____	**PC 2: Wpt#** _____	**PC 3: Wpt#** _____
	Easting_____	_____=_____**E**	_____=_____**E**
	Northing_____	_____=_____**N**	_____=_____**N**

Site #:

Site #:

Vegetation Ground Inspection Form

Site No		Slope		*Wpt Target #*		Moisture Regime	
Date		Aspect		*GPS ID*		Nutrient Regime	
Vegetation Type		Observers		*Wypt: UTM 9, NAD1983*		Permafrost (cm)	
Structural Stage				*Easting*		Photo No	
Pretyped as				*Northing*			

% Cover by Layer

Tree		Litter	
Shrub		Bare Ground	
Herb		Water	
Moss/Lichen			

Tree Core

	Species	*Height (m)*	*Diameter (cm)*
1			
2			
3			
4			

Coarse Woody Debris

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Decay Class																								
Diameter Class																								
Height (cm)																								
Layers																								

% Cover by Layer

Trees (A)	%	DBH (cm)	Height (m)	A1	A2	A3	B1	B2	Vascular Plant Layer (C)	%	Moss/Lichen/ Seedling (D)	%

Shrub(B)	%	B1	B2			Additional Species	%

Site #:

Page ____ of _______

Incidental Wildlife Observation Form

Date:		Observers:		GPS ID	

ID	Species	Wypt # Easting/Northing	Sex	Age/ Stage	No.	Type of Observation Seen/Sign/Heard	Activity	Comments	Photo #
						Seen/Sign/Heard			
						Seen/Sign/Heard			
						Seen/Sign/Heard			
						Seen/Sign/Heard			
						Seen/Sign/Heard			
						Seen/Sign/Heard			
						Seen/Sign/Heard			
						Seen/Sign/Heard			
						Seen/Sign/Heard			
						Seen/Sign/Heard			
						Seen/Sign/Heard			
						Seen/Sign/Heard			
						Seen/Sign/Heard			

Estimate % Foliage Cover

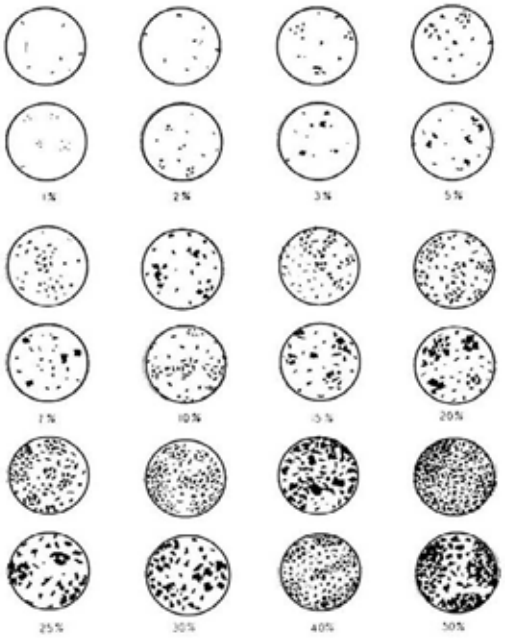

FIGURE 3.2. Comparison charts for visual estimation of foliage cover.

*some exceptions for very low growing stands

Course Woody Debris

TABLE 5.13 Decay classes for coarse woody debris

	Class 1	Class 2	Class 3	Class 4	Class 5
Portion on Ground	Elevated on support points	Elevated but sagging slightly	Sagging near ground, or broken	All of log on ground, sinking	All of log on ground, partly sunken
Twigs < 3 cm (if originally present)	Present	Absent	Absent	Absent	Absent
Bark	Intact	Intact or partly missing	Trace	Absent	Absent
Shape	Round	Round	Round	Round to oval	Oval
Texture	Intact, hard	Intact, hard to partly decaying	Hard, large pieces, partly decaying	Small, blocky pieces	Many small pieces, soft portions
Invading Roots	None	None	In sapwood	In heartwood	In heartwood

Diameter Class		Height Class	
Diameter	**Class**	**Height**	**Class**
< 2 cm	1	Ground	1
2 – 8 cm	2	< 30 cm	2
> 8 cm	3	> 30 cm	3

Soil moisture regime classes	
Very xeric	Water removed extremely rapidly in relation to supply; soil is moist for a negligible time after precipitation
Xeric	Water removed very rapidly in relation to supply; soil is moist for brief periods following precipitation
Subxeric	Water removed rapidly in relation to supply; soil is moist for short periods following precipitation
Submesic	Water removed readily in relation to supply; water available for moderately short periods following precipitation
Mesic	Water removed somewhat slowly in relation to supply; soil may remain moist for a significant, but sometimes short period of the year. Available soil moisture reflects climatic inputs
Subhygric	Water removed slowly enough to keep soil wet for a significant part of growing season; some temporary seepage and possibly mottling below 20 cm
Hygric	Water removed slowly enough to keep soil wet for most of growing season; permanent seepage and mottling; gleyed colours common
Subhydric	Water removed slowly; enough to keep water table at or near surface for most; of year; gleyed mineral or organic soils; permanent seepage < 30 cm below surface
Hydric	Water removed so slowly: that water table is at or above soil surface all year; gleyed mineral or organic soils

Structural Stage

1 (SB) Sparse/bryoid
- 1a (SP) Sparse
- 1b (BR) Bryoid

2 (H) Herb Early successional
- 2a (FO) Forb-dominated
- 2b (GR) Graminoid-dom
- 2c (AQ) Aquatic
- 2d (DS) Dwarf shrub-dominated

3 (SH) Shrub/Herb Early Succ
- 3a (LS) Low shrub
- 3b (TS) Tall shrub

4 (PS) Pole/Sapling Trees > 10 m tall

5 (YF) Young Forest

6 (MF) Mature Forest Trees

7 (OF) Old Forest Old

C = coniferous B = broadleaf M = mixed

Stand structure
- s = single-storied Closed forest
- t = two-storied Closed forest
- m = multistoried Closed forest
- i = irregular Forest
- h = shelterwood Forest

Ecological Moisture Regime Classes (after Walmsley *et al.*, 1980)

MOISTURE REGIME	DESCRIPTION	PRIMARY WATER SOURCE	SLOPE POSITION
0 Very Xeric	Water removed extremely rapidly in relation to supply; soil is moist for a negligible time after precipitation	Precipitation	Ridge crests shedding
1 Xeric	Water removed very rapidly in relation to supply; soil is moist for brief periods following precipitation	Precipitation	Ridge crests shedding
2 Subxeric	Water removed rapidly in relation to supply; soil is moist for short periods following precipitation	Precipitation	Ridge crests shedding or Upper slopes shedding
3 Submesic	Water removed readily in relation to supply; water available for moderately short periods following precipitation	Precipitation	Upper slopes shedding
4 Mesic	Water removed somewhat slowly in relation to supply; soil may remain moist for a significant, but sometimes short period or the year; available soil moisture reflects climatic inputs	Precipitation in moderately to fine-textured soils & limited seepage in coarse textured soils	Mid-slope normal rolling to flat
5 Subhygric	Water removed slowly enough to keep the soil wet for a significant part of the growing season; some temporary seepage and possibly mottling below 20 cm	Precipitation and seepage	Mid-slope normal rolling to flat or Lower slopes receiving
6 Hygric	Water removed slowly enough to keep the soil wet for most of the growing season; permanent seepage and mottling present; possibly weak gleying	Seepage	Lower slopes receiving
7 Subhydric	Water removed slowly enough to keep the water table at or near the surface for most of the year; gleyed mineral or organic soils; permanent seepage less than 30 cm below the surface	Seepage or Permanent water table	Lower slopes receiving or Depressions receiving
8 Hydric	Water removed so slowly that the water table is at or above the soil surface all year; gleyed mineral or organic soils	Permanent water table	Depressions receiving

Appendix B: Plant species known to occur or hypothetically occur in and within 200 km of the Ts'ude niline Tu'eyeta candidate protected area

Plant species known to occur or hypothetically occur in and within 200 km of the Ts'ude niline Tu'eyeta candidate protected area

This plant species list was generated from range maps in Vascular Plants of Continental Northwest Territories (Porsild and Cody, 1980) and in Rare Plants of Northwest Territories (McJannet *et al.*, 1995). Species in **bold** were documented in Ts'ude niline Tu'eyeta during this study.

Family	Scientific Name	Common Name	NWT GS Rank
Apiaceae	*Angelica lucida (Coelopleurum gmelinii)*	Seaside Angelica	May Be At Risk
	Cicuta bulbifera	Bulbous Water-Hemlock	Secure
	Cicuta virosa (Cicuta mackenzieana)	Mackenzie's Water-hemlock	Secure
	Cnidium cnidiifolium (Conioselinum cnidiifolium)	Jakutsk Snow-parsley	Secure
	Heracleum maximum (Heracleum lanatum)	Cow parsnip	Secure
	Sium suave	Water Parsnip	Secure
Asteraceae	*Achillea millefolium (Includes Achillea lanulosa & Achillea nigrescens)*	Common Yarrow	Secure
	Achillea nigrescens ssp nigrescens	Yarrow spp	Not Assessed
	Achillea sibirica	Siberian Yarrow	Secure
	Antennaria alborosea (see Antennaria rosea)	Everlasting spp	Not Assessed
	Antennaria alpina (syn A. canescens, A. compacta, A. crymophila, A. pallida, A. pedunculata, A. stolonifera, A. subcanescens, A. ungavensis)	Alpine Pussytoes	Secure
	Antennaria crymophila (see Antennaria alpina)	Everlasting spp	Not Assessed
	Antennaria densifolia	Dense-Leaved Pussytoes	Secure
	Antennaria elegans (see Antennaria rosea)	Everlasting spp	Not Assessed
	Antennaria friesiana (incl neoalaskana ssp neoalaskana, A. ekmaniana, Antennaria alaskana)	Fries' Pussytoes	Secure
	Antennaria incarnata (see Antennaria rosea)	Everlasting spp	Not Assessed
	Antennaria isolepis ssp pulvinata (see Antennaria rosea)	Everlasting spp	Not Assessed
	Antennaria microphylla (Antennaria nitida)	Small-leaf Cat's-foot	Secure
	Antennaria monocephala (incl. angustata & philonipha & pygmaea)	Single-Head Pussytoes	Secure
	Antennaria monocephala (includes Antennaria angustata; A. philonipha; A. pygmaea)	Pygmy Pussytoes	Not Assessed
	Antennaria philonipha (see Antennaria monocephala)	Pussytoes spp	Not Assessed
	Antennaria pulcherrima	Handsome Pussytoes	Secure
	Antennaria rosea (incl alborosea & elegans & incamata & isolepis & oxyphylla & subviscosa)	Rosy Pussytoes	Secure
	Antennaria stolonifera (see Antennaria alpina)	Everlasting spp	Not Assessed
	Arnica angustifolia (Arnica alpina var. tomentosa)	Narrowleaf Arnica	Secure
	Arnica chamissonis	Leafy Arnica	Secure
	Artemisia alaskana	Alaska Sagebrush	May Be At Risk
	Artemisia arctica	Arctic Sagebrush	Secure
	Artemisia campestris (incl Artemisia borealis, A. canadensis) ssp borealis	Field Sagebrush	Secure
	Artemisia canadensis	Wormwood spp	Not Assessed
	Artemisia frigida	Prairie Sagebrush	Secure
	Artemisia tilesii	Tilesius Sagebrush	Secure
	Aster alpinus	Alpin Aster	Secure
	Aster junciformis (See Symphyotrichum boreale)	Aster spp	Not Assessed

Family	Scientific Name	Common Name	NWT GS Rank
	Crepis elegans	Elegant Hawksbeard	Undetermined
	Crepis nana	Dwarf Alpine Hawksbeard	Secure
	Erigeron acris (including E. jucundus=E. acris ssp. debilis)	Bitter Fleabane	Secure
	Erigeron caespitosus	Tufted Fleabane	Presence Expected
	Erigeron compositus	Dwarf Mountain Fleabane	Secure
	Erigeron elatus	Angular Fleabane	Secure
	Erigeron grandiflorus	Large- Flower Fleabane	Secure
	Erigeron humilis	Low Fleabane	Secure
	Erigeron hyssopifolius	Hyssop-leaved Fleabane	Secure
	Erigeron lonchophyllus (Trimorpha lonchophyllla)	Short-Ray Fleabane	Secure
	Erigeron pallens	Pale Fleabane	Sensitive
	Erigeron purpuratus	Purple Fleabane	Sensitive
	Erigeron uniflorus (E. uniflorus ssp. eriocephalus; E. eriocephalus)	One-flower Fleabane	Secure
	Eurybia sibirica (Aster sibiricus)	Siberian Aster	Secure
	Euthamia graminifolia (Solidago graminifolia)	Grass-leaved Goldenrod	Sensitive
	Hieracium gracile	Alpine Hawkweed	Sensitive
	Hieracium triste	Woolly Hawkweed	Sensitive
	Hieracium umbellatum (H. scabriusculum)	Umbellate Hawkweed	Secure
	Lactuca tatarica (pulchella)	Tartarian Lettuce	Secure
	Leucanthemum integrifolium (Chrysanthemum integrifolium)	Entire-leaf Daisy	Secure
	Packera cymbalaria (Senecio cymbalaria)	Dwarf Arctic Groundsel	Secure
	Packera hyperborealis (Senecio hyperborealis)	Boreal Groundsel	Secure
	Packera indecora (Senecio indecorus)	Rayless Mountain Groundsel	Secure
	Packera paucifora (Senecio pauciflorus)	Alpine Goundsel (Few-Flower Ragwort)	Sensitive
	Packera paupercula (Senecio pauperculus)	Balsam Groundsel	Secure
	Packera streptanthifolia (Senecio streptanthifolius)	Rocky Mountain Groundsel (Cleftleaf Ragwort)	Secure
	Petasites arcticus (=P. frigidus var. palmatus; See P. frigidus)	Sweet Coltsfoot spp	Not Assessed
	Petasites frigidus (arcticus & hyperboreus & palmatus & sagittatus & vitifolius)	Arctic Sweet Coltsfoot	Secure
	Petasites hyperboreus (= P. frigidus var. frigidus; See P. frigidus)	Sweet Coltsfoot spp	Not Assessed
	Petasites sagittatus (=P. frigidus var. sagittatus; See P. frigidus)	Arrow-Leaved Sweet-Coltsfoot	Not Assessed
	Petasites vitifolius (= P.frigidus var.xvitifolius; See P. frigidus)	Sweet Coltsfoot spp	Not Assessed
	Saussurea angustifolia	Narrow-Leaf Saw-Wort	Secure
	Senecio congestus	Marsh Ragwort	Secure
	Senecio lugens	Black-Tip Ragwort	Secure
	Senecio sheldonensis	Mount Sheldon Ragwort	May Be At Risk
	Senecio triangularis	Arrow-leaf Ragwort	Secure
	Solidago canadensis (S. lepida subspp)	Canada Goldenrod	Secure
	Solidago multiradiata	Alpine Goldenrod	Secure
	Solidago simplex (var. nana = Solidago decumbens)	Sticky Goldenrod	Secure
	Symphyotrichum ericoides (Aster pansus) var pansus	White Heath Aster	Secure
	Symphyotrichum spathulatum (Aster spathulatus)	Western Mountain Aster	Sensitive
	Symphyotrichum yukonense (Aster yukonensis)	Yukon Aster	May Be At Risk
	Taraxacum alaskanum (See Taraxacum phymatocarpum)	Dandelion spp	Not Assessed

Family	Scientific Name	Common Name	NWT GS Rank
	Taraxacum lyratum (T. sibiricum; T. scopulorum)	Alpine Dandelion	Sensitive
	Taraxacum mackenziense (See T. phymatocarpum)	Dandelion spp	Not Assessed
	Taraxacum officinale (including T. maurolepium; T. lapponicum; T. lacerum; T. pellianum; T. pseudonorvegicum; T. integratum; T. dumentorum; T. hyperboreum)	Common Dandelion	Secure
	Taraxacum pellianum (See T. officinale) ssp ceratophorum	Dandelion spp	Not Assessed
	Taraxacum phymatocarpum (phymatocarpon & hyparcticum & alaskanum & pumilum)	Northern Dandelion	Not Assessed
	Tephroseris (Senecio) yukonensis	Yukon Groundsel	Secure
	Tephroseris atropurpurea (Senecio atropurpureus; S. frigidus)	Dark Purple Groundsel	Secure
	Tephroseris kjellmanii (Senecio kjellmanii)	Kjellman's groundsel	Sensitive
	Tephroseris lindstroemii (Senecio lindstroemii)	Twice-hairy Groundsel	Sensitive
Betulaceae	***Alnus crispa, ssp crispa (see Alnus viridis)***	**Green Alder**	**Not Assessed**
	Alnus incana (sp.tenuifolia)	**Speckled Alder (mountain alder, gray alder, hoary alder)**	**Secure**
	Betula nana (Betula glandulosa)	Arctic Dwarf Birch (Dwarf Birch)	Secure
	Betula neoalaskana (Betula papyrifera ssp neoalaskana)	**Alaska Paper Birch**	**Secure**
	Betula occidentalis (Betula fontinalis)	Water Birch	Secure
	Betula papyrifera (Betula papyrifera var. commutata)	Paper birch (white birch)	Secure
Boraginaceae	*Lappula occidentalis (Lappula redowskii)*	Western Stickseed	Sensitive
	Mertensia paniculata (Incl var. alaskana)	Bluebell	Secure
	Mertensia paniculata (see Mertensis paniculata)	Northern Bluebell	Not Assessed
	Myosotis asiatica (Myosotis alpestris var asiatica)	Asian Forget-me-not	Secure
Brassicaceae	*Arabis drummondii*	Drummond Rock Cress	Sensitive
	Arabis hirsuta	Western Hairy Rock Cress	Secure
	Arabis holboellii	Holboell Rock Cress	Secure
	Arabis lyrata (Arabis lyrata ssp lyrata;Arabis kamchatica; Arabis lyrata var. kamchatica)	Lyre-Leaf Rock Cress	Secure
	Arabis x divaricarpa	Rock Cress	Secure
	Barbarea orthoceras	American Winter Cress	Secure
	Braya glabella (incl Braya purpurascens, Braya glabella ssp.purpurascens, Braya henryae)	Smooth Rockcress	Secure
	Braya henryae (see Braya glabella)	Mustard family	Not Assessed
	Braya humilis (incl Braya richardsonii)	Alpine Northern Rockcress	Secure
	Braya purpurascens (see B. glabella)	Purple Braya	Not Assessed
	Braya richardsonii (see B.humilis)	Mustard family	Not Assessed
	Cardamine bellidifolia	Alpine Bittercress	Secure
	Cardamine digitata	Richardson's Bittercress	Secure
	Cardamine microphylla	Small-leaved Bittercress	May Be At Risk
	Cardamine oligosperma (Cardamine oligosperma var. kamtschatica, Cardamine umbellata)	Few-seeded Bittercress	Sensitive
	Cardamine pensylvanica	Pennsylvania Bittercress	Sensitive
	Cardamine pratensis	Cuckooflower Bittercress	Secure
	Cardamine purpurea	Purple Bittercress	Presence Expected
	Descurainia incana (Descuriania incisa, Descurainia richardsonii)	Green Tansy Mustard	Secure
	Descurainia sophioides	Northern Tansy Mustard	Secure
	Draba albertina	Slender Whitlow-grass	May Be At Risk

Family	Scientific Name	Common Name	NWT GS Rank
	Draba alpina (Draba micropetala, Draba pilosa)	Alpine Whitlow-grass	Secure
	Draba borealis	Boreal Whitlow-grass	Sensitive
	Draba breweri (Draba breweri var. cana, Draba cana, Draba lanceolata)	Brewer's Whitlow-grass	Secure
	Draba cinerea	Gray-Leaf Whitlow-Grass	Secure
	Draba corymbosa (Draba macrocarpa, Draba bellii)	Flat-top Whitlow-Grass	Secure
	Draba fladnizensis	White Arctic Whitlow-Grass	Sensitive
	Draba glabella (Draba daurica, Draba hirta)	Rock Whitlow-Grass	Secure
	Draba incerta	Yellowstone Whitlow-Grass	May Be At Risk
	Draba juvenilis (Draba longipes)	Long-stalk Whitlow-grass	Secure
	Draba lactea	Milky Whitlow-Grass	Secure
	Draba lonchocarpa (Draba lonchocarpa var. lonchocarpa, Draba nivalis ssp. lonchocarpa)	Lance-pod Whitlow-Grass	Sensitive
	Draba macounii	Macoun's Whitlow-Grass	Sensitive
	Draba nemorosa (D. nemorosa var. leiocarpa)	Wood Whitlow-Grass	Sensitive
	Draba nivalis	Yellow Arctic Whitlow-grass	Secure
	Draba ogilviensis	Ogilvie Range Whitlow-Grass	May Be At Risk
	Draba oligosperma	Few-seeded Whitlow-grass	Sensitive
	Draba palanderiana (Draba caesia auctt)	Palander's Whitlow-Grass	Sensitive
	Draba porsildii	Porsild's Whitlow-Grass	May Be At Risk
	Draba praealta	Tall Whitlow-Grass	Secure
	Erysimum cheiranthoides	Worm-seed Wallflower	Secure
	Erysimum inconspicuum (Erysimum coarctatum)	Shy Wallflower	Secure
	Erysimum pallasii	Pallas Wallflower	Secure
	Eutrema edwardsii	Edward Mock Wallflower	Secure
	Lepidium bourgeauanum (See L. ramosissimum)	Bourgeau's Peper-Grass	Not Assessed
	Lesquerella arctica	Arctic Bladderpod	Secure
	Parrya nudicaulis	Naked Stemmed Wallflower	Secure
	Rorippa palustris (Rorippa islandica)	Bog Yellowcress	Secure
	Smelowskia borealis	Boreal Smelowskia	Sensitive
	Smelowskia calycina (incl. var. media)	Alpine Smelowskia	Sensitive
Callitrichaceae	*Callitriche palustris (Callitriche verna)*	March Water-starwort	Secure
Campanulaceae	*Campanula aurita*	Yukon Bellflower	Secure
	Campanula lasiocarpa	Alaska Bellflower	Secure
	Campanula rotundifolia	American Harebell	Secure
	Campanula uniflora	Arctic Harebell	Secure
Caprifoliaceae	*Viburnum edule*	Squashberry	Secure
Caryophyllaceae	*Arenaria humifusa*	Creeping Sandwort	Secure
	Cerastium arvense	Field Mouse-ear chickweed	Secure
	Cerastium beeringianum	Bering Sea Chickweed	Secure
	Minuartia arctica (Arenaria arctica)	Arctic Stitchwort	Secure
	Minuartia biflora (Arenaria sajanensis)	Moutain Stitchwort	Secure
	Minuartia dawsonensis (Arenaria dawsonensis)	Rock Stitchwort	Secure
	Minuartia macrocarpa (Arenaria macrocarpa)	Long-Pod Stitchwort	May Be At Risk
	Minuartia obtusiloba (Arenaria obtusiloba)	Alpine Stitchwort	Sensitive
	Minuartia rossii (Arenaria rossii)	Ross' Stitchwort	Secure
	Minuartia rubella (Arenaria rubella, Arenaria verna)	Boreal Stitchwort	Secure
	Minuartia stricta (Arenaria stricta, Arenaria uliginosa)	Bog Stitchwort	Sensitive
	Moehringia lateriflora (Arenaria laterifolia)	Blunt-leaved Sandwort	Secure
	Sagina nivalis (Sagina intermedia)	Snow Pearlwort	Secure

Family	Scientific Name	Common Name	NWT GS Rank
	Sagina nodosa	Knotted Pearlwort	Sensitive
	Sagina saginoides (Sagina linnaei)	Alpine Pearlwort	Sensitive
	Silene acaulis	Moss Campion	Secure
	Silene involucrata (syn Melandrium affine, M. furcatum, Lychnis brachycalyx, L. gillettii, Silene tayloriae (as S. involucrata ssp tenella)	Arctic Campion	Secure
	Silene taimyrensis (Silene ostenfeldii, Melandrium ostenfeldii & Melandrium taimyrense)	Taimyr Campion	Secure
	Silene tayloriae (Melandrium tayloriae) also see Silene involucrata	Peel River Campion	Secure
	Silene uralensis (Melandrium apetalum)	Nodding Campion	Secure
	Stellaria borealis (may incl. Stellaria calycantha)	Boreal Stitchwort (Northern Stitchwort)	Secure
	Stellaria crassifolia	Fleshy Stitchwort	Secure
	Stellaria longifolia (Stellaria atrata)	Longleaf Stitchwort	Secure
	Stellaria longipes (S. laeta, S. monantha, S. stricta, S. subvestita, S. edwardsii, S. ciliatosepala, S. crassipes)	Long-stalked Stitchwort	Secure
	Wilhelmsia physodes	Arctic-Flower Merkia	Secure
Chenopodiaceae	*Chenopodium berlandieri*	Berlandier's Goosefoot	Secure
	Chenopodium capitatum	Strawberry-blite (Strawberry Goosefoot)	Secure
	Chenopodium glaucum	Oakleaf Goosefoot	Not Assessed
	Corispermum hookeri (Corispermum hyssopifolium)	Hooker's Bugseed	Sensitive
Cornaceae	*Cornus canadensis*	Dwarf Dogwood	Secure
	Cornus sericea (Cornus stolonifera)	Red Osier Dogwood	Secure
Crassulaceae	*Rhodiola integrifolium*	Entire-leaved Stonecrop	Sensitive
Cupressaceae	*Juniperus communis*	Common Juniper (ground juniper)	Secure
	Juniperus horizontalis	Creeping Juniper	Secure
Cyperaceae	*Blysmopsis rufus (Blysmus rufus; Scirpus rufus)*	Red Clubrush	May Be At Risk
	Carex aquatilis	Water Sedge	Secure
	Carex atherodes	Wheat Sedge	Secure
	Carex atratiformis (Carex raymondis)	Scabrous Black Sedge	Secure
	Carex atrofusca	Dark-brown Sedge	Secure
	Carex atrosquama	Lesser Black-scaled Sedge	Sensitive
	Carex aurea	Golden Fruit Sedge	Secure
	Carex bicolor	Two-colour Sedge	Secure
	Carex bigelowii (Carex consimilis, Carex lugens, Carex cyclocarpa, Carex yukonensis, Carex anguillata)	Bigelow's Sedge	Secure
	Carex bonanzensis	Yukon Sedge	Secure
	Carex brunnescens	Brownish Sedge	Secure
	Carex buxbaumii	Buxbaum's Sedge	Secure
	Carex canescens	Silvery Sedge	Secure
	Carex capillaris	Hair-like Sedge	Secure
	Carex capitata	Capitate Sedge	Secure
	Carex chordorrhiza	Creeping Sedge	Secure
	Carex concinna	Low Northern Sedge	Secure
	Carex deflexa	Northern Sedge	Secure
	Carex diandra	Lesser Panicled Sedge	Secure
	Carex disperma	Softleaf Sedge	Secure
	Carex eburnea	Bristle-leaved Sedge	Secure
	Carex eleusinoides	Goosegrass Sedge	May Be At Risk
	Carex fuliginosa (Carex misandra; Carirex fuliginosa ssp.	Short-Leaf Sedge	Secure

Family	Scientific Name	Common Name	NWT GS Rank
	misandra)		
	Carex garberi	Garber's Elk Sedge	Secure
	Carex glacialis	Glacier Sedge	Secure
	Carex gynocrates	Northern Bog Sedge	Secure
	Carex lachenalii (Carex bipartita)	Arctic Hare-Foot Sedge	Secure
	Carex lapponica (Carex canescens ssp. Subloliacea)	Lapland Sedge	Secure
	Carex lasiocarpa	Slender Sedge	Sensitive
	Carex laxa	Weak Sedge	May Be At Risk
	Carex leptalea	Bristly-Stalk Sedge	Secure
	Carex limosa	Mud Sedge	Secure
	Carex lugens (see Carex bigelowii)	A Sedge	Not Assessed
	Carex mackenziei (Carex norvegica)	Mackenzie Sedge	May Be At Risk
	Carex macloviana (incl. Carex soperi)	Falkland Island Sedge	Undetermined
	Carex magellanica (Carex paupercula)	Boreal Bog Sedge (Magellan's Carex)	Secure
	Carex media (Carex norvegica)	Norvegian Carex	Secure
	Carex membranacea	Fragile-Seed Sedge	Secure
	Carex microchaeta	Alpine Tundra Sedge	Secure
	Carex microglochin	False Unicinia Sedge	Secure
	Carex micropoda (Carex pyrenaica)	Pryenean Sedge	Sensitive
	Carex nardina	Nard Sedge	Secure
	Carex obtusata	Blunt Sedge	Secure
	Carex petricosa (Carex franklinii)	Rock Dwelling Sedge	Secure
	Carex physocarpa (see Carex saxatilis)	A Sedge	Not Assessed
	Carex podocarpa	Short-Stalk Sedge	Secure
	Carex praticola	Northern Meadow Sedge	Sensitive
	Carex rariflora	Loose-Flowered Sedge	Secure
	Carex rossii	Ross' Sedge	Secure
	Carex rotundata	Pumpkin-fruited Sedge	Secure
	Carex rupestris	Rock Sedge	Secure
	Carex sartwellii	Sarwell's Sedge	Sensitive
	Carex saxatilis (Carex physocarpa)	Russet Sedge	Secure
	Carex scirpoidea	Bulrush Sedge	Secure
	Carex supina	Weak Arctic Sedge	Secure
	Carex tenuiflora	Sparse- Flowered Sedge	Secure
	Carex vaginata	Sheathed Sedge	Secure
	Eleocharis acicularis	Least Spike Rush	Secure
	Eleocharis palustris	Common Spike Rush	Secure
	Eleocharis quinqueflora (Eleocharis pauciflora)	Few-flowered Spike Rush	Secure
	Eleocharis uniglumis (Eleocharis macrostachya)	One-Glume Spike-Rush	Sensitive
	Eriophorum angustifolium (incl. Eriophorum triste)	Narrow-leaved Cotton-grass	Secure
	Eriophorum brachyantherum (Eriophorum opacum)	Short-Antler Cotton-grass	Secure
	Eriophorum callitrix	Sheathed Cotton-grass	Secure
	Eriophorum chamissonis (Eriophorum russeolum var. albindum)	Chamisso's Cotton-grass	Secure
	Eriophorum scheuchzeri	Schechzeri White Cotton-grass	Secure
	Eriophorum triste (See Eriophorum angustifolium)	Cotton Grass spp	Not Assessed
	Eriophorum vaginatum	Tussock Cotton-grass	Secure
	Eriophorum viridicarinatum	Tassel Cotton-grass	Secure
	Kobresia myosuroides (Kobresia bellardi)	Pacific Kobresia	Secure

Family	Scientific Name	Common Name	NWT GS Rank
	Kobresia sibirica (Kobresia hyperborea)	Siberian Bog Sedge	Secure
	Kobresia simpliciuscula	Simple Kobresia	Secure
	Schoenoplectus tabernaemontani (Scirpus validus)	Soft-Stem Bulrush	Undetermined
	Trichophorum caespitosum (Scirpus caespitosus)	Tufted Bulrush	Secure
	Trichophorum pumilum (Scirpus pumilus, Scirpus rollandii)	Rolland's Bulrush	May Be At Risk
Droseraceae	*Drosera anglica*	English Sundew	Secure
	Drosera rotundifolia	**Round-leaved Sundew**	**Secure**
Dryopteridaceae	*Athyrium filix-femina*	Subarctic Lady-fern	Sensitive
	Cystopteris fragilis	Fragile Fern	Secure
	Cystopteris montana	Mountain Bladder fern	Sensitive
	Dryopteris expansa (D. dilatata)	Northern Wood-fern	May Be At Risk
	Dryopteris fragrans	Fragrant Cliff Wood-Fern	Secure
	Gymnocarpium disjunctum (Gymnocarpium dryopteris ssp disjunctum; Dryopteris disjuncta)	Western Oak Fern	Secure
	Gymnocarpium jessoense (Dryopteris robertiana)	Nahanni Oak Fern	Secure
	Woodsia glabella	Smooth Cliff Fern (Smooth Woodsia)	Secure
	Woodsia ilvensis	Rusty Cliff Fern (Rusty Woodsia)	Secure
Elaeagnaceae	*Elaeagnus commutata*	American Silverberry	Secure
	Shepherdia canadensis	Canada Buffalo-Berry	Secure
Empetraceae	*Empetrum nigrum*	Black Crowberry	Secure
Equisetaceae	*Equisetum arvense*	Field Horsetail	Secure
	Equisetum fluviatile	Water Horsetail	Secure
	Equisetum hyemale var. affine	Tall Scouring Rush	Secure
	Equisetum palustre	Marsh Horsetail	Secure
	Equisetum pratense	Meadow Horsetail	Secure
	Equisetum scirpoides	**Dwarf Scouring Rush**	**Secure**
	Equisetum sylvaticum	Woodland Horsetail	Secure
	Equisetum variegatum	Variegated Horsetail	Secure
Ericaceae	*Andromeda polifolia*	Bog Rosemary	Secure
	Arctostaphylos alpina	Alpine Bearberry	Secure
	Arctostaphylos rubra	Red Bearberry	Secure
	Arctostaphylos uva-ursi	Common Bearberry (Kannikannik)	Secure
	Cassiope tetragona	Arctic White Heather	Secure
	Chamaedaphne calyculata	Leatherleaf	Secure
	Kalmia polifolia	Bog Laurel	Secure
	Ledum groenlandicum	Common Labrador Tea	Secure
	Ledum palustre ssp decumbens (Ledum decumbens)	Narrow-leaved Labrador Tea	Secure
	Loiseleuria procumbens	Alpine Azalea	Secure
	Phyllodoce empetriformis	Pink Mountain Heather	Sensitive
	Phyllodoce glanduliflora	Yellow Moutnain Heather	Sensitive
	Rhododendron lapponicum	Lapland Rosebay	Secure
	Vaccinium oxycoccos (Oxycoccus microcarpus, Oxycoccus quadripetalus)	**Small Cranberry**	**Secure**
	Vaccinium uliginosum	Alpine Bilberry	Secure
	Vaccinium vitis-idaea	Mountain Cranberry (Lingonberry)	Secure
Fabaceae	*Astragalus agrestis*	Meadow Milk-vetch	Sensitive
	Astragalus alpinus	Alpine Milk-vetch	Secure
	Astragalus americanus	American Milk-vetch	Secure

Family	Scientific Name	Common Name	NWT GS Rank
	Astragalus australis (A.aboriginorum, A. richardsonii, A. linearis)	Indian Milk-vetch	Secure
	Astragalus laxmannii (Astragalus adsurgens, A.adsurgens var. robustior, A. laxmannii var. robustior, A. striatus)	Rattle Milk-vetch	Sensitive
	Astragalus tenellus	Loose-Flowered Milk-vetch	Secure
	Astragalus umbellatus (Astragalus frigidus)	Tundra Milk-vetch	Secure
	Hedysarum alpinum	Alpine Sweet-Vetch	Secure
	Hedysarum boreale (H. boreale ssp. mackenziei, Hedysarum mackenziei)	Boreal Sweet- vetch	Secure
	Lupinus arcticus	**Arctic Lupine**	**Secure**
	Oxytropis borealis (incl. O. borealis var. hudsonica, O. glutinosa, O. viscida, O. sheldonensis, O. leucantha)	Boreal Locoweed	Secure
	Oxytropis campestris (O. campestris var. varians, and var. roaldii, O. hyperborea, O. jordalii, O. sericea var. spicata)	Field Locoweed	Secure
	Oxytropis deflexa (O. deflexa var. foliolosa, var. parviflora, var. sericea)	Pendent-pod Locoweed	Secure
	Oxytropis jordalii (See Oxytropis campestris)	Jordal's Locoweed	Not Assessed
	Oxytropis maydelliana	Maydell Locoweed	Secure
	Oxytropis nigrescens (O. nigrescens var. uniflora, O. arctobia, O. nigrescens ssp. pygmaea, O. nigrescens ssp. bryophylla)	Blackish Locoweed	Secure
	Oxytropis nigrescens (See other O. nigrescens with all pertinent synonyms)	Blackish Locoweed	Not Assessed
	Oxytropis scammaniana	Scamman's Locoweed	May Be At Risk
	Oxytropis sheldonensis (See Oxytropis borealis)	Oxytrope spp	Not Assessed
	Oxytropis splendens	Showy Locoweed	Secure
	Oxytropis varians (See Oxytropis campestris)	Oxytrope spp	Not Assessed
	Oxytropis viscida (See Oxytropis borealis)	Sticky Locoweed	Not Assessed
	Vicia americana	American Purple Vetch	Secure
Fumariaceae	*Corydalis aurea*	Golden Corydalis	Secure
	Corydalis pauciflora	Few-Flowered Corydalis	Sensitive
	Corydalis sempervirens	Pale Corydalis	Secure
Gentianaceae	*Gentiana affinis*	Prairie Gentian	Sensitive
	Gentiana arctophila (See Gentianella propinqua)	Gentian spp	Not Assessed
	Gentiana glauca	Pale Gentian	Secure
	Gentiana prostrata	Pygmy Gentian	Sensitive
	Gentianella amarella (Gentiana acuta)	Northern Gentian	Secure
	Gentianella propinqua (syn Gentiana propinqua & Gentiana arctophila)	Four-parted Gentian	Secure
	Gentianopsis detonsa ssp. Raupii (see Gentianopsis detonsa)	Sheared Gentian	Not Assessed
	Lomatogonium rotatum	Marsh Felwort	Secure
Grossulariaceae	*Ribes glandulosum*	Skunk Currant	Secure
	Ribes hudsonianum	Northern Black Currant	Secure
	Ribes lacustre	Bristly Black Current	Secure
	Ribes oxyacanthoides	Canada Gooseberry	Secure
	Ribes triste	Swamp Red Currant	Secure
Haloragaceae	*Myriophyllum alterniflorum*	Alternate-Flower Water Milfoil	May Be At Risk
	Myriophyllum sibiricum (Myriophyllum exalbescens)	Spilked Water Milfoil	Secure
	Myriophyllum verticillatum	Whorled Water-Milfoil	Secure
Hippuridaceae	*Hippuris vulgaris*	Common Mare's Tail spp	Secure
Iridaceae	*Sisyrinchium montanum*	Strict Blue-eyed Iris	Secure

Family	Scientific Name	Common Name	NWT GS Rank
Isoetaceae	*Isoetes echinospora (Isoetes tenella, Isoetes muricata)*	Spiny-spored Quillwort	Undetermined
Juncaceae	*Juncus alpinoarticulatus (Juncus alpinus ssp. nodulosus)*	Northern Green (Bog) Rush	Secure
	Juncus arcticus (Juncus arcticus ssp. alaskanus; Juncus balticus var. alaskanus)	Arctic Rush	Secure
	Juncus balticus (see Juncus arcticus)	Baltic Rush	Not Assessed
	Juncus biglumis	Two-Flowered Rush	Secure
	Juncus bufonius	Toad Rush	Secure
	Juncus castaneus	Chestnut Rush	Secure
	Juncus drummondii	Drummond Rush	Secure
	Juncus filiformis	Thread Rush	Secure
	Juncus mertensianus	Merten's Rush	Presence Expected
	Juncus nodosus	Knotted Rush	Secure
	Juncus triglumis (ssp. albescens; Juncus albescens)	Northern White Rush	Secure
	Luzula arctica (Luzula nivalis; Luzula tundricola)	Arctic Woodrush	Secure
	Luzula arcuata	Curved Wood Rush	Secure
	Luzula confusa	Northern Wood Rush	Secure
	Luzula groenlandica	Greenland Wood Rush	Secure
	Luzula parviflora	Small-Flowered Wood Rush	Secure
	Luzula spicata	Spiked Wood Rush	Secure
	Luzula wahlenbergii	Wahlenber's Wood Rush	Secure
Juncaginaceae	*Triglochin maritima*	Seaside Arrowgrass	Secure
	Triglochin palustris (Triglochin palustre)	Marsh Arrowgrass	Secure
Lamiaceae	*Dracocephalum parviflorum (Moldavica parviflora)*	American Dragonhead	Secure
	Mentha arvensis	Corn Mint	Secure
	Scutellaria galericulata	Hooded Skullcap	Secure
	Stachys pilosa (includes Stachys palustris?)	Hairy Hedge Nettle	Secure
Lemnaceae	*Lemna trisulca*	Star Duckweed	Secure
Lentibulariaceae	*Pinguicula villosa*	Hairy Butterwort	Secure
	Pinguicula vulgaris	Common Butterwort	Secure
	Utricularia macrorhiza (Utricularia vulgaris)	Bladderwort spp	Secure
Liliaceae	*Allium schoenoprasum*	Wild Chives	Secure
	Lloydia serotina	Common Alpine Lilly	Secure
	Maianthemum stellatum (Smilacina stellata)	Starry False Soloman's Seal	Secure
	Maianthemum trifolium (Smilacina trifolia)	**Three-leaf False Soloman's Seal**	**Secure**
	Streptopus amplexifolius	Clasping Twisted Stalk	Sensitive
	Tofieldia coccinea	Northern False Asphodel	Secure
	Tofieldia pusilla (Tofieldia palustris)	Scotch False Asphodel	Secure
	Triantha glutinosa (Tofieldia glutinosa,Tofieldia occidentalis)	Sticky False Asphodel	Secure
	Veratrum viride (Veratrum eschscholtzii)	False Hellebore	Sensitive
	Zigadenus elegans	Mountain Death Camas	Secure
Linaceae	*Linum lewisii*	Lewis Blue Flax	Secure
Lycopodiaceae	*Huperzia selago (Lycopodium selago)*	Fir Clubmoss	Secure
	Lycopodium dendroideum (Lycopodium obscurum)	Tree Clubmoss	Sensitive
Menyanthaceae	*Menyanthes trifoliata*	Bog Buckbean	Secure
Myricaceae	*Myrica gale*	Sweet Gale	Secure
Nymphaeaceae	*Nuphar polysepala (Nuphar lutea ssp polysepala)*	Rocky Mountain Pond lily	May Be At Risk
Onagraceae	***Chamerion angustifolium (Epilobium angustifolium)***	**Fireweed**	**Secure**
	Chamerion latifolium (Epilobium latifolium)	River Beauty	Secure

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	Epilobium anagallidifolium	Alpine Willow Herb	Sensitive
	Epilobium arcticum	Arctic Willowherb	Sensitive
	Epilobium ciliatum (Epilobium glandulosum)	Hairy Willow Herb	Secure
	Epilobium davuricum	Dauria Willow Herb	Sensitive
	Epilobium glandulosum (See Epilobium ciliatum)	Willow Herb spp	Not Assessed
	Epilobium lactiflorum	White-Flower Willow Herb	May Be At Risk
	Epilobium palustre	Marsh Willow Herb	Secure
Ophioglossaceae	*Botrychium lanceolatum*	Triangle Moonwort	Presence Expected
	Botrychium lunaria	Common Moonwort (Grape-fern)	Secure
Orchidaceae	*Amerorchis rotundifolia (Orchis rotundifolia)*	Small Round-leaved Orchis	Secure
	Calypso bulbosa	Caypso	Secure
	Coeloglossum viride (Habenaria viridis var. bracteata)	Long-bract Orchid	Undetermined
	Corallorhiza trifida	Early Coral Root	Secure
	Cypridedium guttatum	Spotted Lady's-slipper	Secure
	Cypridedium parviflorum (Cypridedium calceolus)	Yellow Lady's-slipper	Secure
	Cypripedium passerinum	Sparrow's-egg Lady's-slipper	Secure
	Goodyera repens	Lesser Rattlesnake Plantain	Secure
	Listera borealis	Northern Twayblade	Secure
	Listera cordata	Heart-leaved Twayblade	Sensitive
	Platanthera aquilonis (Habenaria hyperborea, Platanthera hyperborea)	Tall Northern Green Orchid	Secure
	Platanthera obtusata (Habenaria obtusata)	Blunt-leaved Bog Orchid	Secure
	Spiranthes romanzoffiana	Hooded Ladies' -tresses	Secure
Orobanchaceae	*Boschniakia rossica*	Northern Groundcone	Undetermined
Papaveraceae	*Papaver lapponicum (Papaver hultenii)*	Lapland Poppy	Secure
	Papaver macounii (Papaver keelei)	Macoun's Poppy	Secure
	Papaver radicatum (incl. Papaver polare, Papaver dahlianum, P. nudicaule var radicatum, P. cornwallisensis)	Arctic Poppy	Secure
Pinaceae	***Larix laricina***	**American Larch (Tamarack)**	**Secure**
	Picea glauca	**White Spruce**	**Secure**
	Picea mariana	**Black Spruce**	**Secure**
	Pinus banksiana (Pinus divaricata)	Jack Pine	Secure
Plantaginaceae	*Plantago canescens (Plantago septata)*	Hairy Plantain	Secure
	Plantago eriopoda	Saline Plantain	Secure
	Plantago major	Nipple-seed Plantain	Exotic/Alien
Plumbaginaceae	*Armeria maritima*	Western Thrift	Secure
Poaceae	*Agrostis mertensii (Agrostis borealis)*	Northern Bentgrass	Secure
	Agrostis scabra	Rough Bentgrass	Secure
	Alopecurus aequalis	Short-Awn Meadow-foxtail	Secure
	Alopecurus alpinus	Alpine Meadow-foxtail	Secure
	Arctagrostis arundinacea (See Arctagrostis latifolia ssp. arundinacea)	Broad-Leaf Arctic-Bent	Not Assessed
	Arctagrostis latifolia	Broad-Leaf Arctic-Bent	Secure
	Arctophila fulva	Pendant- Grass	Secure
	Beckmannia syzigachne	American Sloughgrass	Secure
	Bromus ciliatus	Fringed Brome	Secure
	Bromus pumpellianus (Bromus inermis var. pumpellianus)	Pumpelly Brome	Secure
	Calamagrostis canadensis	Blue-jointed Reed Grass	Secure
	Calamagrostis lapponica	Lapland Reedgrass	Secure

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	Calamagrostis neglecta (see Calamagrostis stricta)	Reed Bentgrass spp	Not Assessed
	Calamagrostis purpurascens	Purple Reed Grass	Secure
	Calamagrostis stricta (Calamagrostis inexpansa, Calamagrostis neglecta and Calamagrostis chordorrhiza)	Slim-Stem Reed Grass	Secure
	Danthonia intermedia (see Danthonia spicata)	Timber Wild Oat Grass	Not Assessed
	Deschampsia brevifolia (Deschampsia cespitosa ssp. brevifolia)	Short-Leaf Hair Grass	Secure
	Deschampsia cespitosa (Deschampsia caespitosa)	Tufted Hairgrass	Secure
	Elymus alaskanus [ssp. latiglumis] (Agropyron violaceum; Agropyron boreale)	Alaska Wild Rye	Secure
	Elymus macrourus (Elymus sericeum; Agropyron sericeum)	Thick-Spike Wild Rye	Secure
	Elymus trachycaulus (Agropyron trachycaulum)	Slender Wild Rye	Secure
	Festuca altaica	Rough Fescue	Secure
	Festuca baffinensis	Baffin Fescue	Secure
	Festuca brachyphylla	Short-Leaved Fescue	Secure
	Festuca richardsonii (incl. Festuca rubra ssp. richardsonii)	Richardson's Fescue	Secure
	Festuca saximontana	Rocky Mountain Fescue	Secure
	Glyceria grandis	American Manna Grass	Secure
	Glyceria pulchella	Mackenzie Valley Manna Grass	Secure
	Hierochloe alpina	Alpine Sweet Grass	Secure
	Hierochloe odorata	Vanilla Sweet Grass	Secure
	Hordeum jubatum	Fox-Tail Barley	Secure
	Leymus innovatus (Elymus innovatus)	Downy Lyme Grass	Secure
	Muhlenbergia richardsonis	Matted Muhly	Sensitive
	Phleum alpinum (Phleum commutatum)	Mountain Timothy	Sensitive
	Poa abbreviata [incl. ssp. jordalii]	Northern Bluegrass	Secure
	Poa alpigena (see Poa pratensis)	Kentucky Blue Grass	Not Assessed
	Poa alpina	Alpine Bluegrass	Secure
	Poa arctica (includes Poa brintnellii; Poa lanata; Poa williamsii)	Arctic Bluegrass	Secure
	Poa glauca	White Blue Grass	Secure
	Poa palustris	Fowl Bluegrass	Secure
	Poa paucispicula (Poa leptocoma ssp. paucispicula)	Alaska Blue Grass	Secure
	Poa pratensis (incl. Poa alpigena; P. pratensis ssp. pratensis and ssp. colpodea)	Kentucky Bluegrass	Secure
	Puccinellia borealis (see Puccinellia arctica)	Goose Grass (Arctic Alkali Grass)	Not Assessed
	Puccinellia vahliana (Colpodium vahlianum)	Vahl's Alkali Grass	Secure
	Schizachne purpurascens	False Melic Grass	Secure
	Trisetum spicatum	Narrow False Oat	Secure
	Vahlodea atropurpurea (Deschampsia atropurpurea)	Arctic-Hair Grass (Mountain Hairgrass)	Sensitive
Polemoniaceae	*Phlox richardsonii (incl. spp alaskensis, syn P. alaskensis (P. richardsonii ssp alaskensis), P. sibirica ssp alaskensis)*	Richarson's Phlox	Sensitive
	Polemonium acutiflorum	Jacob's Ladder spp	Secure
	Polemonium boreale	Northern Jacob's Ladder	Secure
	Polemonium pulcherrimum	Showy Jacob's Ladder	Sensitive
Polygonaceae	*Aconogonum alaskanum (Polygonum alpinum, Polygonum alaskanum)*	Alaska wild-rhubarb (Alpine Smartweed)	Sensitive
	Bistorta plumosa (Polygonum bistorta ssp plumosum)	Meadow Bistort	Secure
	Bistorta vivipara (Persicaria vivipara, Polygonum viviparum)	Alpine Knotweed	Secure

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	Oxyria digyna	Mountain Sorrel (scurvey grass)	Secure
	Persicaria amphibia (Polygonum amphibium)	Water Smartweed	Secure
	Polygonum humifusum ssp caurianum (Polygonum caurianum)	Alaska Knotweed	Sensitive
	Rumex arcticus (Rumex arctica)	Arctic Dock	Secure
	Rumex occidentalis (Rumex aquaticus)	Western Dock	Secure
	Rumex triangulivalvis (Rumex salicifolius)	Triangular-valved Dock	Secure
Portulacaceae	*Claytonia megarhiza*	Alpine Spring Beauty	May Be At Risk
	Claytonia tuberosa	Tuberous Spring Beauty	Sensitive
Potamogetonaceae	*Potamogeton alpinus*	Northern Pondweed	Secure
	Potamogeton foliosus	Leafy Pondweed	Sensitive
	Potamogeton friesii	Fries Pondweed	Secure
	Potamogeton gramineus	Grassy Pondweed	Secure
	Potamogeton pusillus (Potamogeton pusillus ssp. tenuissimus)	Slender Pondweed	Secure
	Potamogeton richardsonii	Richardson's pondweed	Secure
	Potamogeton strictifolius	Straightleaf Pondweed	Secure
	Potamogeton subsibiricus (Potamogeton porsildiorum)	Yenisei River Pondweed	Sensitive
	Potamogeton zosteriformis	Flatstem Pondweed	Undetermined
	Stuckenia filiformis (Potamogeton filiformis)	Slender Pondweed	Secure
	Stuckenia vaginata (Potamogeton vaginatus)	Sheathed Pondweed	Secure
Primulaceae	*Androsace chamaejasme*	Sweet-Flower Rock-Jasmine	Secure
	Androsace septentrionalis	Pygmy-Flower Rock-Jasmine	Secure
	Dodecatheon frigidum	Northern Shooting-Star	Secure
	Primula egaliksensis	Greenland Primrose	Secure
	Primula incana	Jones Primrose	Secure
	Primula mistassinica	Bird's Eye Primrose	Secure
	Primula stricta	Stiff Primrose	Secure
	Trientalis europaea	Arctic Star Flower	Sensitive
Pteridaceae	*Cryptogramma acrostichoides (crispa)*	American Parsley-fern (American Rock-brake)	Secure
	Cryptogramma sitchensis (crispa)	Alaska Parsley Fern	May Be At Risk
	Cryptogramma stelleri	Slender Rock-brake	May Be At Risk
Pyrolaceae	*Moneses uniflora*	One-flowered Wintergreen	Secure
	Orthilia secunda (Pyrola secunda)	One-sided Wintergreen	Secure
	Pyrola asarifolia	Pink Pyrola	Secure
	Pyrola chlorantha (Pyrola virens)	**Greenish-flowered Pyrola**	**Secure**
	Pyrola grandiflora	**Arctic Pyrola**	**Secure**
	Pyrola minor	Lesser Pyrola	Secure
Ranunculaceae	*Aconitum delphiniifolium*	Larkspur-Leaf Monkshood spp	Secure
	Actaea rubra	Red Baneberry	Secure
	Anemone drummondii	Drummond's Anemone	Sensitive
	Anemone multifida	Hudson Bay Anemone	Secure
	Anemone narcissiflora	Narcissus Thimbleweed	Secure
	Anemone parviflora	Small-Flower Anemone	Secure
	Anemone patens (Pulsatilla patens ssp. Multifida, P. ludoviciana, Anemone patens ssp. multifida)	Prairie Crocus	Secure
	Anemone richardsonii	Yellow Anemone	Secure
	Aquilegia brevistyla	Small-Flower Columbine	Secure

Family	Scientific Name	Common Name	NWT GS Rank
	Caltha palustris	Marsh marigold	Secure
	Delphinium glaucum	Pale Larkspur	Secure
	Ranunculus abortivus	Kidney Leaved Buttercup	Sensitive
	Ranunculus aquatilis (R a. var eradicatus, Ranunculus trichophyllus; R longirostris)	White Water buttercup	Secure
	Ranunculus cymbalaria	Northern Seaside Crowfoot	Secure
	Ranunculus eschscholtzii	Eschscholtz Buttercup	Secure
	Ranunculus flammula (Ranunculus filiformis, Ranunculus reptans)	Lesser Spearwort	Secure
	Ranunculus gelidus (Ranunculus karelinii)	Arctic Buttercup	Sensitive
	Ranunculus gmelinii (incl. Ranunculus purshii)	Small Yellow Water-Buttercup	Secure
	Ranunculus hyperboreus	Arctic Buttercup	Secure
	Ranunculus lapponicus	Lapland Buttercup	Secure
	Ranunculus macounii	Macoun Buttercup	Secure
	Ranunculus nivalis	Snowy Buttercup	Secure
	Ranunculus purshii (see Ranunculus gmelinii)	Buttercup / Crowfoot spp	Not Assessed
	Ranunculus pygmaeus	Dwarf Buttercup	Secure
	Ranunculus sceleratus (R. sceleratus var. multifidus, R. sceleratus ssp. multifidus)	Cursed Crowfoot	Secure
	Ranunculus sulphureus	Sulphur Buttercup	Secure
	Thalictrum alpinum	Alpine Meadow Rue	Secure
	Thalictrum sparsiflorum (Thalictrum sparsiflorum var. richardsonii)	Few Flower Meadow Rue	May Be At Risk
	Thalictrum venulosum	Veined Meadow Rue	Secure
Rosaceae	*Argentina anserina (Potentilla anserina)*	Silverweed	Secure
	Comarum palustre (Potentilla palustris)	Marsh Cinqefoil	Secure
	Dasiphora fruticosa (Potentilla fruticosa)	Shrubby Cinquefoil	Secure
	Dryas crenulata (Dryas integrifolia ssp.crenulata) (see Dryas integrifolia)	**Mountain Avens spp**	**Not Assessed**
	Dryas drummondii	Yellow Mountain Avens	Secure
	Dryas hookeriana (see Dryas octopetala)	Mountain Avens spp	Not Assessed
	Dryas integrifolia (incl Dryas chamissonis, Dryas sylvatica, Dryas crenulata)	Entire-Leaved Mountain Avens	Secure
	Dryas octopetala (incl. Dryas punctata)	Eight-Petal Mountain Avens	Secure
	Dryas punctata (See Dryas octopetala)	Mountain Avens spp	Not Assessed
	Dryas sylvatica (see Dryas integrifolia)	Mountain Avens spp	Not Assessed
	Fragaria virginiana	Virginia Strawberry	Secure
	Geum aleppicum	Yellow Avens	Secure
	Geum glaciale	Glacier Avens	Sensitive
	Geum macrophyllum	Large-Leaved Avens	Secure
	Geum rossii	Ross Avens	Secure
	Luetkea pectinata	Segmented Luetkea	May Be At Risk
	Potentilla biflora	Two Flower Cinqefoil	Secure
	Potentilla bimundorum (Potentilla multifida)	Divided Cinqefoil	Secure
	Potentilla diversifolia	Mountain Meadow Cinqefoil	Sensitive
	Potentilla elegans	Elegant Cinqefoil	Secure
	Potentilla nana (Potentilla hyparctica)	Arctic Cinqefoil	Secure
	Potentilla nivea	Snow Cinqefoil	Secure
	Potentilla norvegica	Norwegian Cinqefoil spp	Secure
	Potentilla rubricaulis	Rocky Mountain Cinqefoil	Secure
	Potentilla uniflora (Potentilla ledebouriana)	One-Flower Cinqefoil	Secure

Family	Scientific Name	Common Name	NWT GS Rank
	Prunus pensylvanica	Pin Cherry	Secure
	Rosa acicularis	Prickly Rose	Secure
	Rubus acaulis (see Rubus arcticus)	**Raspberry spp**	**Not Assessed**
	Rubus alaskensis	Raspberry spp	Not Assessed
	Rubus arcticus (incl. Rubus acaulis and Rubus stellatus)	Raspberry spp	Secure
	Rubus chamaemorus	**Cloudberry**	**Secure**
	Rubus idaeus (Rubus idaeus ssp. strigosus)	Wild Raspberry	Secure
	Rubus stellatus (See Rubus arcticus)	Raspberry spp	Not Assessed
	Sanguisorba canadensis (Sanguisorba sitchensis)	Canada Burnet	Presence Expected
	Sibbaldia procumbens	Arizona Cinquefoil	Sensitive
	Sorbus scopulina	Cascade Mountain-Ash	Sensitive
	Spiraea stevenii (Spiraea beauverdiana)	Steven Spiraea	Secure
Rubiaceae	*Galium boreale*	Northern Bedstraw	Secure
	Galium trifidum (includes Galium brandegei & Galium tinctorium)	Small Bedstraw	Secure
Salicaceae	***Populus balsamifera***	**Balsam Poplar**	**Secure**
	Populus tremuloides	Quaking Aspen	Secure
	Salix alaxensis (Salix longistylis)	Alaska Willow	Secure
	Salix arbusculoides	Littletree Willow	Secure
	Salix arctica (Salix anglorum, Salix crassijulis, Salix hudsonensis)	Arctic Willow	Secure
	Salix arctophila	Northern Willow	Secure
	Salix athabascensis	Athabasca Willow	Secure
	Salix barclayi	Barclay Willow	Secure
	Salix barrattiana	Barratt Willow	Secure
	Salix bebbiana (S. rostrata)	Bebb Willow (long-beaked willow)	Secure
	Salix brachycarpa	Short-fruit Willow	Secure
	Salix candida	Hoary Willow	Secure
	Salix commutata	Undergreen Willow	Sensitive
	Salix exigua (Salix interior)	Sandbar Willow	Secure
	Salix glauca (cordiflora ssp callicarpea & glauca ssp stenolepsis?)	Gray willow	Secure
	Salix gracilis (see Salix petiolaris)	Willow spp	Not Assessed
	Salix longistylis (see Salix alaxensis)	Willow spp	Not Assessed
	Salix lucida (Salix lasiandra)	Shining Willow	Secure
	Salix lutea	Yellow Willow	Secure
	Salix myrtillifolia	Myrtle-Leaf Willow	Secure
	Salix niphoclada	Barren-ground Willow	Secure
	Salix pedicellaris	Bog Willow	Secure
	Salix petiolaris (Salix gracilis)	Meadow Willow (slender willow)	Sensitive
	Salix planifolia (incl Salix tyrrellii)	Diamond-leaved Willow	Secure
	Salix polaris	Snow-Bed Willow	Secure
	Salix prolixa (Salix mackenzieana, S. eriocephala mackenzieana, S. rigida mackenzieana]	Mackenzie Willow	Secure
	Salix pulchra	Tea-leaved Willow	Secure
	Salix reticulata	Net-veined Willow	Secure
	Salix richardsonii (Salix lanata ssp. richardsonii)	Lanatz Willow	Secure
	Salix rotundifolia (Salix dogeana) ssp dodgeana and ssp rotundifolia	Round-leaved Willow	Secure

Family	Scientific Name	Common Name	NWT GS Rank
	Salix scouleriana	Scouler Willow (mountain willow, fire willow)	Secure
	Salix serissima	Autumn Willow	Secure
Santalaceae	***Geocaulon lividum***	**Northern Comandra spp**	**Secure**
Saxifragaceae	*Chrysosplenium tetrandrum*	Northern Golden-Carpet	Secure
	Chrysosplenium wrightii	Wright Golden- Saxifrage	Sensitive
	Leptarrhena pyrolifolia	Leather-leaved Saxifrage	May Be At Risk
	Mitella nuda	Naked Bishop's Cap	Secure
	Parnassia fimbriata	Fringed Grass-of- Parnassus	Sensitive
	Parnassia kotzebuei	Kotzebue's Grass-Of - Parnassus	Secure
	Parnassia montanensis (see Parnassia palustris)	Grass-of-Parnassus spp	Not Assessed
	Parnassia palustris (incl. P. palustris var. montanensis)	Marsh Grass-of-Parnassus	Secure
	Saxifraga adscendens	Asending Saxifrage	Sensitive
	Saxifraga aizoides	Yellow Mountain Saxifrage	Secure
	Saxifraga caespitosa	Tufted Saxifrage	Secure
	Saxifraga cernua	Nodding Saxifrage	Secure
	Saxifraga flagellaris	Spider Saxifrage	Secure
	Saxifraga hieraciifolia	Stiff Stem Saxifrage	Secure
	Saxifraga hirculus	Yellow Marsh Saxifrage	Secure
	Saxifraga lyallii	Red Stemmed Saxifrage	Sensitive
	Saxifraga nelsoniana (Saxifraga punctata)	Heart-leaved Saxifrage	Secure
	Saxifraga nivalis	Snow Saxifrage	Secure
	Saxifraga oppositifolia	Purple Mountain Saxifrage	Secure
	Saxifraga razshivinii (Saxifraga davurica)	Razshivin's Saxifrage	Secure
	Saxifraga reflexa	Yukon Saxifrage	Secure
	Saxifraga rivularis	Alpine Brook Saxifrage	Secure
	Saxifraga serpyllifolia	Thyme-Leaf Saxifrage	Sensitive
	Saxifraga sibirica (Saxifraga radiata)	Siberian Saxifrage	Secure
	Saxifraga tricuspidata	Prickly Saxifrage	Secure
Scrophulariaceae	*Castilleja caudata*	Indian Paintbrush / Painted Cup spp	Secure
	Castilleja elegans	Indian Paintbrush / Painted Cup spp	Secure
	Castilleja hyperborea	Northern Indian-Paintbrush	Sensitive
	Castilleja raupii	Ruap Indian-Paintbrush	Secure
	Castilleja yukonis	Yukon Indian-Paintbrush	May Be At Risk
	Euphrasia subarctica	Arctic Eyebright	Sensitive
	Lagotis minor (Lagotis stelleri)	Figwort family	Sensitive
	Limosella aquatica	Northern Mudwort	May Be At Risk
	Pedicularis capitata	Capitate Lousewort	Secure
	Pedicularis flammea	Red-Tip Lousewort	Sensitive
	Pedicularis labradorica	**Labrador Lousewort**	**Secure**
	Pedicularis lanata	Woolly Lousewort	Secure
	Pedicularis langsdorfii (Pedicularis arctica)	Langsdorf's Lousewort (Arctic Lousewort)	Secure
	Pedicularis lapponica	Lapland Lousewort	Secure
	Pedicularis sudetica	Sudetan Lousewort	Secure
	Penstemon gormanii	Gorman's Beard Tongue	May Be At Risk
	Penstemon procerus	Beard Tongue spp	Presence Expected
	Rhinanthus minor (ssp. borealis, Rhinanthus borealis)	Yellow Rattle spp	Secure

Family	Scientific Name	Common Name	NWT GS Rank
	Veronica americana	American Speedwell	Sensitive
	Veronica scutellata	Marsh Speedwell	Sensitive
	Veronica wormskjoldii (Veronica alpina)	Alpine Speedwell	Secure
Selaginellaceae	*Selaginella selaginoides*	Northern Spikemoss	Secure
Sparganiaceae	*Sparganium angustifolium*	Narrow-leaf Bur-reed	Secure
	Sparganium eurycarpum	Giant Bur-reed	Undetermined
	Sparganium hyperboreum	Northern Bur-reed	Secure
	Sparganium multipedunculatum (See Sparganium angustifolium)	Bur-reed spp	Not Assessed
	Sparganium natans (Sparganium minimum)	Small bur-reed	Secure
Thelypteridaceae	*Phegopteris connectilis (Dryopteris phegopteris, Thelypteris phegopteris)*	Northern Beech Fern	Sensitive
Typhaceae	*Typha latifolia*	Broad -leaf Cattail	Secure
Valerianaceae	*Valeriana capitata*	Clustered Valerian	Secure
	Valeriana sitchensis	Sitka Valerian	Sensitive
Violaceae	*Viola epipsila*	Northern Marsh Violet	Sensitive
	Viola macloskeyi (Viola pallens)	Smooth white violet	Sensitive
	Viola nephrophylla	Northern Bog Violet	Sensitive
	Viola renifolia	Kidney-Leaf White Violet	Secure

Appendix C: Site Photographs

Photograph 1: This dense "white spruce forest" community was located along the Ramparts River.

Photograph 2: A typical "woodland needleleaf/other" community, dominated by black spruce.

Photograph 3: Woodland Needleleaf/Lichen community.

Photograph 4: Wetland area

Photograph 5: A “closed deciduous” community comprised mainly of white birch and balsam poplar; common along the Ramparts River floodplains and in other small patches.

Photograph 6: A regenerating burn dominated by low shrubs. This was common as many areas within Ts’ude niline Tu’eyeta have experienced fire.

Photograph 7: Lawrence Caesar measures the diameter at breast height (dbh) of trees within a vegetation plot.

Photograh 8: Lawrence Caesar takes a tree core sample within a vegetation plot.

Photograph 9: Paul Latour and Lawerence Caesar determine percent coverage of vegetation within a vegetation plot.

Photograh 10: 2007 field crew (Left to Right): Donna Mulders, Lawrence Caesar, James Kitchen (pilot), Barthy Cotchilly Joanna Wilson, Paul Latour (missing).

Appendix D: Ducks Unlimited Canada Middle Mackenzie Earth Cover Class Descriptions (DU, 2006)

Appendix D. Middle Mackenzie Earth Cover Class Descriptions (Ducks Unlimited Inc., 2006)

1.0 Forest

Needleleaf and Deciduous Trees-
The needleleaf species generally found were black spruce (*Picea mariana*), white spruce (*Picea glauca)* and tamarack (*Larix laricina*). White spruce tended to occur on warmer sites with better drainage, and deeper soils while black spruce and tamarack dominated poorly drained sites with poorer soils.

The deciduous tree species commonly found were white birch (*Betula papyfera*) and balsam poplar (*P. balsamifera*). Aspen (*P. tremuloides*) was observed in a few small patches. Deciduous stands were found in river floodplains, on slopes bordering the rivers, and in small patches within the plateau. Mixed deciduous/coniferous stands were present in the same areas as pure deciduous stands and in the interface between deciduous and needleleaf stands.

1.11 Closed Needleleaf
At least 40% of the cover was trees, and ≥75% of the trees were needleleaf. Common distribution throughout image. (NOTE: Tamarack was also observed in the project area, but was most often secondary to spruce. Since only 5 Closed Mixed Needleleaf sites were visited in the field, this class was combined with the Closed Spruce class and mapped as a general Closed Needleleaf class.)

1.211 Open Needleleaf / Lichen

25-39% of the cover was trees, ≥75% of the trees were needleleaf, and ≥20% of the understory was lichen. Common throughout the study area. Open Spruce Lichen and Open Mixed Needleleaf Lichen were combined and mapped as this general Open Needleleaf Lichen class.

1.213 Open Needleleaf Other

25-39% of the cover was trees, and ≥75% of the trees were needleleaf. Common throughout study area. This class is a combination of the Open Spruce/Moss and Open Spruce/Other. Moss was present to some degree in most of the open spruce sites and the two subclasses could not reliably be spectrally discriminated. Open Mixed Needleleaf Other and Open Mixed Needleleaf Moss were also mapped as part of the Open Needleleaf Other class.

1.31 Woodland Needleleaf / Lichen

10-24% of the cover was trees, and ≥75% of the trees were needleleaf with a height greater than 1 meter, and >20% lichen. Common through the project area in patches. Spruce was the dominant tree species.

1.33 Woodland Needleleaf Other

10-24% of the cover was trees, and ≥75% of the trees were needleleaf with a height greater than 1 meter. Common throughout the project area. Spruce was the dominant woodland needleleaf species. Regenerating burns with a component of spruce often fell within this class. This class is a combination of the Woodland Needleleaf/Moss and Woodland Needleleaf/Other subclasses. Moss was present to some degree in most of the woodland needleleaf sites and the two subclasses could not reliably be spectrally discriminated.

1.4 Closed Deciduous

At least 40% of the cover was trees, and ≥75% of the trees were deciduous. Common in the river floodplains, on the slopes bordering rivers, and in patches on the plateau. This class is a rollup of the single-species deciduous subclasses. White birch and balsam poplar were the most common deciduous species. A few small stands of Aspen were observed.

1.6 Closed Mixed Needleleaf/Deciduous

At least 40% of the cover was trees, but neither needleleaf nor deciduous trees made up ≥75% of the tree cover. This class was distributed throughout image, generally at the interface between deciduous and needleleaf stands.

2.0 Shrub

The shrub classes were dominated by willow species (*Salix spp.*), bog birch (*Betula glandulosa*), alder (*Alnus crispa*), and *Ledum* species. However, the proportions of shrub species and their relative heights varied widely, which created difficulties in determining whether a site was made up of tall or low shrub. As a result, the height of the shrub species making up the largest proportion of the site dictated whether the site was called a low or tall shrub. The shrub heights were averaged within a genus, as in the case of a site with both tall and low willow shrubs. Tall shrubs generally had a major willow component that was mixed with bog birch and/or alder. It was found most often in drainages and in regenerating burn areas. The most common low shrubs were bog birch, Labrador tea, and willow.

2.1 Tall Shrub

Shrubs made up 25-100% of the cover, ≥25% of the site is shrub ≥1.3 meters in height or shrubs ≥1.3 meters in height are the most common in the site. Common in drainages and regenerating burn areas. Includes both Closed Tall Shrub and Open Tall Shrub subclasses.

2.21 Low Shrub / Tussock Tundra

Shrubs made up 25-100% of the cover, ≥25% of the site is shrub 0.25 – 1.3 meters in height or shrubs 0.25-1.3 meters in height are the most common shrubs in the site, and ≥35% tussock graminoids. Observed only along a tributary to the Iroquois River in the Path 60 image.

2.22 Low Shrub / Lichen
Shrubs made up 25-100% of the cover, ≥ 25% of the site is shrub 0.25 – 1.3 meters in height or shrubs 0.25 – 1.3 meters in height are the most common shrubs in the site, and ≥20% lichen. Found in the peat plateau bogs.

2.23 – 2.26 Low Shrub / Other
Shrubs made up 25-100% of the cover, ≥25% of the site is shrub 0.25 – 1.3 meters in height or shrubs 0.25-1.3 meters in height are the most common shrubs in the site. Common throughout the project area. This class is a combination of the following subclasses: Low Shrub Willow/Alder, Low Shrub Herbaceous, Low Shrub Moss, and Low Shrub Other.

2.31 Dwarf Shrub / Lichen
Shrubs made up 25-100% of the cover, ≥25% of the site is shrub <0.25 meters in height or shrubs <0.25 meters in height are the most common shrubs in the site, and ≥20% lichen. This class is generally made up of dwarf ericaceous shrubs and Dryas species, but often includes a variety of forbs and graminoids, and some rock. It is nearly always found at higher elevations on hilltops, mountain slopes, and plateaus.

3.0 Herbaceous

The classes in this category included bryoids, forbs, and graminoids. Bryoids and forbs were present as a component of most of the other classes.

3.12 Moss

Composed of ≥40% herbaceous species, ≤25% water, and where ≥50% of the herbaceous cover was moss species. This class was found in small patches throughout the project area, generally encroaching into shallow lakes or filling the whole lake.

3.2 Wet Herbaceous

Composed of ≥40% herbaceous species, ≥5 and ≤25% water or ≥20% wet sedge, and where ≥50% of the herbaceous cover was graminoid. Common throughout the project area around edges of lakes and in herbaceous fens running through the peatlands of the project area.

4.0 Aquatic Vegetation

The aquatic vegetation was divided into Aquatic Bed and Emergent classes. The Aquatic Bed class was dominated by plants with leaves that float on the water surface, with the most common species being pond lilies (*Nuphar spp.*). The Emergent Vegetation class was composed of species that were present in standing, more permanent water, including freshwater herbs such as horsetails (*Equisetum* spp.) and buckbean (*Menyanthes trifoliata).*

4.1 Aquatic Bed

Aquatic vegetation made up ≥20% of the cover, and ≥20% of the vegetation was composed of plants that grow principally on or near the surface of the water. Plants may be attached to the substrate or float freely in the water. Pond lilies (*Nuphar spp*.)were the most common aquatic species.

4.2 Emergent Vegetation

Aquatic vegetation made up ≥20% of the cover, and ≥20% of the vegetation was composed of erect, rooted herbaceous hydrophytes. Most common emergent plants were horsetails (*Equistum spp*.) and buckbean (*Menyanthes trifoliata*).

5.0 Water

Includes both clear and turbid water found in lakes, streams, rivers, and wetlands.

5.1 Snow

Composed of ≥50% snow cover.

5.3 Clear Water

Composed of ≥80% clear water.

5.4 Turbid Water

Composed of ≥80% turbid water.

6.0 Barren

This class included sparsely vegetated sites, riparian gravel bars, and rock/gravel faces in the mountains above the treeline.

6.1 Sparse Vegetation

At least 50% of the area was barren, but vegetation made up ≥20% of the cover. This class was generally found on steep slopes or in recently burned areas in the early stages of regeneration. The plant species were generally herbs, graminoids and bryoids.

6.3 Non-vegetated Soil

At least 50% of the area was barren, ≥50% of the cover was composed of mud, silt or sand, and vegetation made up less than 20% of the cover. This type was observed in slump areas of the foothills and on steep slopes bordering rivers.

6.2 Rock/Gravel

At least 50% of the area was barren, ≥50% of the cover was composed of rock and/or gravel, and vegetation made up less than 20% of the cover. This class was found on steep slopes at the upper elevations of the mountains and on gravel bars along the rivers.

6.3 Non-vegetated Soil
At least 50% of the area was barren, ≥50% of the cover was composed of mud, silt or sand, and vegetation made up less than 20% of the cover. This type was observed in slump areas of the foothills and on steep slopes bordering rivers.

6.4 Recent Burn
Includes areas that have been relatively recently burned such that vegetation is either limited or the vegetation signature is masked by the burn litter, making classification of the area difficult.

7.0 Urban
At least 50% of the area was urban.

9.1 Cloud/Haze
At least 50% of the cover was cloud, cloud shadow, or haze.

9.2 Terrain Shadow

Includes areas darkened by terrain shadows.

10.0 Other

Sites that did not fall into any other category were assigned to Other. For example, sites containing 25%-80% water, <25% shrub and <20% aquatic vegetation were classed as Other. Sites classed as Other may have also included extensive areas of vegetative litter, such as downed wood. This class was not mapped. The Other field sites were treated as the class that they most closely resembled.

Appendix E: Vertebrate species known to occur or hypothetically occur in and within 200 km of the Ts'ude niline Tu'eyeta Candidate Protected Area

Vertebrate species known to occur or hypothetically occur in and within 200 km of the Ts'ude niline Tu'eyeta candidate protected area[1]

[1] Species highlighted in bold have been documented in the Ts'ude niline Tu'eyeta during fieldwork in 2005 and 2006 and March 2006.

Family	Latin Name	Common Name	Species range		Species recorded/observed		NWT Status	COSEWIC	SARA
			In Ts'ude niline Tu'eyeta	In 200 km buffer	Point Count	Incidental Wildlife & Wildlife Transect			
Gaviidae	Red-throated Loon	*Gavia stellata*	X	X			Secure		
Gaviidae	Pacific Loon	*Gavia pacifica*	X	X		X	Secure		
Gaviidae	Common Loon	*Gavia immer*	X	X	X		Secure	Not At Risk - 1997	
Podicipedidae	Horned Grebe	*Podiceps auritus*	X	X			Secure		
Podicipedidae	Red-necked Grebe	*Podiceps grisegena*	X	X	X		Secure		
Anatidae	Greater White-fronted Goose	*Anser albifrons*	X	X			Secure		
Anatidae	Snow Goose	*Chen caerulescens*	X	X			Secure		
Anatidae	Canada Goose	*Branta canadensis*	X	X	X	X	Secure		
Anatidae	Tundra Swan	*Cygnus columbianus*	X	X			Secure		
Anatidae	Gadwall	*Anas strepera*	X	X			Undetermined		
Anatidae	American Wigeon	*Anas americana*	X	X	X		Secure		
Anatidae	Mallard	*Anas platyrhynchos*	X	X	X	X	Secure		
Anatidae	Blue-winged Teal	*Anas discors*		X			Secure		
Anatidae	Northern Shoveler	*Anas clypeata*	X	X			Secure		
Anatidae	Northern Pintail	*Anas acuta*	X	X			Sensitive		
Anatidae	Green-winged Teal	*Anas crecca*	X	X			Secure		
Anatidae	Canvasback	*Aythya valisineria*	X	X			Secure		
Anatidae	Ring-necked Duck	*Aythya collaris*	X	X	X		Secure		
Anatidae	Greater Scaup	*Aythya marila*	X	X			Secure		
Anatidae	Lesser Scaup	*Aythya affinis*	X	X	X		Sensitive		
Anatidae	Harlequin Duck	*Histrionicus histrionicus*		X			May be at risk		
Anatidae	Surf Scoter	*Melanitta perspicillata*	X	X			Sensitive		

Appendix E: Vertebrate species within Ts'ude niline Tu'eyeta

Family	Latin Name	Common Name	Species range		Species recorded/observed		NWT Status	COSEWIC	SARA
			In Ts'ude niline Tu'eyeta	In 200 km buffer	Point Count	Incidental Wildlife & Wildlife Transect			
Anatidae	White-winged Scoter	*Melanitta fusca*	X	X			Sensitive		
Anatidae	Black Scoter	*Melanitta nigra*		X			Sensitive		
Anatidae	Long-tailed Duck	*Clangula hyemalis*	X	X			Sensitive		
Anatidae	Bufflehead	*Bucephala albeola*	X	X			Secure		
Anatidae	Common Goldeneye	*Bucephala clangula*	X	X		X	Secure		
Anatidae	Barrow's Goldeneye	*Bucephala islandica*	X	X			Secure		
Anatidae	Common Merganser	*Mergus merganser*	X	X			Secure		
Anatidae	Red-breasted Merganser	*Mergus serrator*	X	X			Secure		
Anatidae	Ruddy Duck	*Oxyura jamaicensis*	X	X			Secure		
Accipitridae	Osprey	*Pandion haliaetus*	X	X			Secure		
Accipitridae	Bald Eagle	*Haliaeetus leucocephalus*	X	X			Secure	Not at risk – 1984	
Accipitridae	Golden Eagle	*Aquila chrysaetos*	X	X					
Accipitridae	Northern Harrier	*Circus cyaneus*	X	X	X	X	Secure	Not at risk – 1993	
Accipitridae	Sharp-shinned Hawk	*Accipiter striatus*	X	X			Secure	Not at risk – 1997	
Accipitridae	Northern Goshawk	*Accipiter gentilis*	X	X			Secure	Not at risk – 1995	
Accipitridae	Swainson's Hawk	*Buteo swainsoni*	X	X			Undetermined		
Accipitridae	Red-tailed Hawk	*Buteo jamaicensis*	X	X		X	Secure	Not at risk – 1995	
Accipitridae	Rough-legged Hawk	*Buteo lagopus*	X	X			Secure	Not at risk - 1995	
Falconidae	American Kestrel	*Falco sparverius*	X	X			Secure		
Falconidae	Merlin	*Falco columbarius*	X	X			Secure	Not at risk – 1985	
Falconidae	Gyrfalcon	*Falco rusticolus*	X	X			Secure	Not at risk – 1987	
Falconidae	Peregrine Falcon	*Falco peregrinus*	X	X	X		Sensitive	Threatened – 2000	
Phasianidae	Ruffed Grouse	*Bonasa umbellus*	X	X	X		Secure		
Phasianidae	Spruce Grouse	*Dendragapus canadensis*	X	X		X	Secure		

Appendix E: Vertebrate species within Ts'ude niline Tu'eyeta

Family	Latin Name	Common Name	Species range		Species recorded/observed		NWT Status	COSEWIC	SARA
			In Ts'ude niline Tu'eyeta	In 200 km buffer	Point Count	Incidental Wildlife & Wildlife Transect			
Phasianidae	Willow Ptarmigan	*Lagopus lagopus*	X	X	X		Secure		
Phasianidae	Rock Ptarmigan	*Lagopus mutus*	X	X			Secure		
Phasianidae	White-tailed Ptarmigan	*Lagopus leucurus*	X	X			Undetermined		
Phasianidae	Blue Grouse	*Dendragapus obscurus*		X			Undetermined		
Phasianidae	Sharp-tailed Grouse	*Tympanuchus phasianellus*	X	X		X	Secure		
Rallidae	Sora	*Porzana carolina*	X	X	X		Secure		
Rallidae	American Coot	*Fulica americana*		X			Secure	Not at risk – 1991	
Gruidae	Sandhill Crane	*Grus canadensis*	X	X	X	X	Secure		
Charadriidae	Black-bellied Plover	*Pluvialis squatarola*		X			Sensitive		
Charadriidae	American Golden Plover	*Pluvialis dominica*	X	X			Sensitive		
Charadriidae	Semipalmated Plover	*Charadrius semipalmatus*	X	X			Secure		
Charadriidae	Killdeer	*Charadrius vociferus*	X	X			Secure		
Scolopacidae	Greater Yellowlegs	*Tringa melanoleuca*		X			Undetermined		
Scolopacidae	Lesser Yellowlegs	*Tringa flavipes*	X	X	X	X	Sensitive		
Scolopacidae	Solitary Sandpiper	*Tringa solitaria*	X	X	X		Undetermined		
Scolopacidae	Wandering Tattler	*Heteroscelus incanus*	X	X			Undetermined		
Scolopacidae	Spotted Sandpiper	*Actitis macularia*	X	X	X	X	Secure		
Scolopacidae	Upland Sandpiper	*Bartramia longicauda*	X	X			Undetermined		
Scolopacidae	Eskimo Curlew	*Numenius borealis*		X			At risk	Endangered 1978, 2000	
Scolopacidae	Whimbrel	*Numenius phaeopus*		X			Sensitive		
Scolopacidae	Surfbird	*Aphriza virgata*		X			Vagrant/ Accidental		
Scolopacidae	Semipalmated Sandpiper	*Calidris pusilla*		X			Sensitive		
Scolopacidae	Least Sandpiper	*Calidris minutilla*	X	X			Sensitive		
Scolopacidae	White-rumped Sandpiper	*Calidris fuscicollis*		X			Secure		
Scolopacidae	Baird's Sandpiper	*Calidris bairdii*		X			Secure		
Scolopacidae	Pectoral Sandpiper	*Calidris melanotos*		X			Secure		
Scolopacidae	Stilt Sandpiper	*Calidris himantopus*		X			Undetermined		
Scolopacidae	Long-billed Dowitcher	*Limnodromus scolopaceus*		X			Sensitive		

Appendix E: Vertebrate species within Ts'ude niline Tu'eyeta

Family	Latin Name	Common Name	Species range		Species recorded/observed		NWT Status	COSEWIC	SARA
			In Ts'ude niline Tu'eyeta	In 200 km buffer	Point Count	Incidental Wildlife & Wildlife Transect			
Scolopacidae	Common Snipe	*Gallinago gallinago*	X	X	X	X			
Scolopacidae	Red-necked Phalarope	*Phalaropus lobatus*	X	X			Sensitive		
Laridae	Parasitic Jaeger	*Stercorarius parasiticus*		X			Undetermined		
Laridae	Long-tailed Jaeger	*Stercorarius longicaudus*		X			Undetermined		
Laridae	Bonaparte's Gull	*Larus philadelphia*	X	X			Secure		
Laridae	Mew Gull	*Larus canus*	X	X			Secure		
Laridae	Herring Gull	*Larus argentatus*	X	X			Secure		
Laridae	Arctic Tern	*Sterna paradisaea*	X	X		X	Secure		
Laridae	Black Tern	*Chlidonias niger*		X			Sensitive		
Strigidae	Great Horned Owl	*Bubo virginianus*	X	X			Secure		
Strigidae	Northern Hawk Owl	*Surnia ulula*	X	X	X	X	Secure	Not at risk – 1992	
Strigidae	Great Gray Owl	*Strix nebulosa*	X	X			Secure	Not at risk – 1996	
Strigidae	Short-eared Owl	*Asio flammeus*	X	X		X	Sensitive	Special concern - 1994	
Strigidae	Boreal Owl	*Aegolius funereus*	X	X			Secure	Not at risk – 1995	
Caprimulgidae	Common Nighthawk	*Chordeiles minor*		X			Secure	Draft COSEWIC – expected 2007	
Alcedinidae	Belted Kingfisher	*Ceryle alcyon*	X	X			Secure		
Picidae	Yellow-bellied Sapsucker	*Sphyrapicus varius*	X	X			Secure		
Picidae	Downy Woodpecker	*Picoides pubescens*		X	X		Secure		
Picidae	Hairy Woodpecker	*Picoides villosus*	X	X	X		Secure		
Picidae	Three-toed Woodpecker	*Picoides tridactylus*	X	X			Secure		
Picidae	Black-backed Woodpecker	*Picoides arcticus*		X			Secure		
Picidae	Northern Flicker	*Colaptes auratus*	X	X	X		Secure		
Tyrannidae	Olive-sided Flycatcher	*Contopus borealis*	X	X	X		Sensitive	Draft assessment	

Appendix E: Vertebrate species within Ts'ude niline Tu'eyeta

Family	Latin Name	Common Name	Species range		Species recorded/observed		NWT Status	COSEWIC	SARA
			In Ts'ude niline Tu'eyeta	In 200 km buffer	Point Count	Incidental Wildlife & Wildlife Transect			
Tyrannidae	Western Wood-Pewee	*Contopus sordidulus*		X	X		Secure		
Tyrannidae	Yellow-bellied Flycatcher	*Empidonax flaviventris*		X	X		Secure		
Tyrannidae	Alder Flycatcher	*Empidonax alnorum*	X	X	X		Secure		
Tyrannidae	Least Flycatcher	*Empidonax minimus*	X	X	X		Secure		
Tyrannidae	Eastern Phoebe	*Sayornis phoebe*		X			Secure		
Tyrannidae	Say's Phoebe	*Sayornis saya*	X	X			Undetermined		
Tyrannidae	Eastern Kingbird	*Tyrannus tyrannus*		X		X	Secure		
Laniidae	Northern Shrike	*Lanius excubitor*	X	X			Secure		
Vireonidae	Warbling Vireo	*Vireo gilvus*	X	X	X		Secure		
Vireonidae	Red-eyed Vireo	*Vireo olivaceus*	X	X	X		Secure		
Corvidae	Gray Jay	*Perisoreus canadensis*	X	X	X		Secure		
Corvidae	Black-billed Magpie	*Pica pica*		X			Secure		
Corvidae	Common Raven	*Corvus corax*	X	X	X	X	Secure		
Alaudidae	Horned Lark	*Eremophila alpestris*	X	X			Secure		
Hirundinidae	Tree Swallow	*Tachycineta bicolor*	X	X			Secure		
Hirundinidae	Bank Swallow	*Riparia riparia*	X	X			Secure		
Hirundinidae	Cliff Swallow	*Hirundo pyrrhonota*	X	X			Secure		
Hirundinidae	Barn Swallow	*Hirundo rustica*	X	X			Sensitive		
Paridae	Boreal Chickadee	*Parus hudsonicus*	X	X			Sensitive		
Paridae	Gray-headed Chickadee	*Parus cinctus*		X			May be at risk		
Sittidae	White-breasted Nuthatch	*Sitta carolinensis*	X				Secure		
Cinclidae	American Dipper	*Cinclus mexicanus*	X	X			Undetermined		
Regulidae	Ruby-crowned Kinglet	*Regulus calendula*		X	X		Secure		
Turdidadae	Northern Wheatear	*Oenanthe oenanthe*	X	X			Undetermined		
Turdidadae	Mountain Bluebird	*Sialia currucoides*	X	X			Undetermined		
Turdidadae	Townsend's Solitaire	*Myadestes townsendi*	X	X			Secure		
Turdidadae	Gray-cheeked Thrush	*Catharus minimus*	X	X	X		Secure		
Turdidadae	Swainson's Thrush	*Catharus ustulatus*	X	X	X	X	Secure		
Turdidadae	Hermit Thrush	*Catharus guttatus*	X	X	X		Secure		

Family	Latin Name	Common Name	Species range		Species recorded/observed		NWT Status	COSEWIC	SARA
			In Ts'ude niline Tu'eyeta	In 200 km buffer	Point Count	Incidental Wildlife & Wildlife Transect			
Turdidadae	American Robin	*Turdus migratorius*	X	X	X	X	Secure		
Turdidadae	Varied Thrush	*Ixoreus naevius*	X	X	X		Undetermined		
Motacillidae	Yellow Wagtail	*Motacilla flava*		X			Presence Expected		
Bombycillidae	Bohemian Waxwing	*Bombycilla garrulus*	X	X	X		Secure		
Parulidae	Orange-crowned Warbler	*Vermivora celata*	X	X	X		Secure		
Parulidae	Yellow Warbler	*Dendroica petechia*			X		Secure		
Parulidae	Magnolia Warbler	*Dendroica magnolia*	X	X	X		Secure		
Parulidae	Bay-Breasted Warbler	*Dendroica castanea*			X		Secure		
Parulidae	Yellow-rumped Warbler	*Dendroica coronata*	X	X	X		Secure		
Parulidae	Townsend's Warbler	*Dendroica townsendi*		X			Undetermined		
Parulidae	Palm Warbler	*Dendroica palmarum*	X	X	X		Secure		
Parulidae	Blackpoll Warbler	*Dendroica striata*	X	X	X	X	Sensitive		
Parulidae	Tennessee Warbler	*Vermivora peregrina*	X	X	X	X	Secure		
Parulidae	Black-and-white Warbler	*Mniotilta varia*	X	X	X		Secure		
Parulidae	American Redstart	*Setophaga ruticilla*		X	X		Secure		
Parulidae	Northern Waterthrush	*Seiurus noveboracensis*	X	X	X		Secure		
Parulidae	Common Yellowthroat	*Geothlypis trichas*		X	X		Secure		
Parulidae	Wilson's Warbler	*Wilsonia pusilla*	X	X	X		Secure		
Thraupidae	Western Tanager	*Piranga ludoviciana*		X	X		Secure		
Emberizidae	American Tree Sparrow	*Spizella arborea*	X	X	X	X	Sensitive		
Emberizidae	Chipping Sparrow	*Spizella passerina*	X	X	X		Secure		
Emberizidae	Clay-colored Sparrow	*Spizella pallida*		X		X	Undetermined		
Emberizidae	Savannah Sparrow	*Passerculus sandwichensis*	X	X	X		Secure		
Emberizidae	Le Conte's Sparrow	*Ammodramus leconteii*			X		Secure		
Emberizidae	Fox Sparrow	*Passerella iliaca*	X	X	X		Secure		
Emberizidae	Song Sparrow	*Melospiza melodia*		X			Undetermined		
Emberizidae	Lincoln's Sparrow	*Melospiza lincolnii*	X	X	X		Secure		
Emberizidae	Swamp Sparrow	*Melospiza georgiana*	X	X	X		Secure		
Emberizidae	White-throated Sparrow	*Zonotrichia albicollis*	X	X	X		Sensitive		

Appendix E: Vertebrate species within Ts'ude niline Tu'eyeta

Family	Latin Name	Common Name	Species range		Species recorded/observed		NWT Status	COSEWIC	SARA
			In Ts'ude niline Tu'eyeta	In 200 km buffer	Point Count	Incidental Wildlife & Wildlife Transect			
Emberizidae	Harris' Sparrow	*Zonotrichia querula*	X	X			Sensitive		
Emberizidae	White-crowned Sparrow	*Zonotrichia leucophrys*	X	X	X		Secure		
Emberizidae	Golden-crowned Sparrow	*Zonotrichia atricapilla*		X			Secure		
Emberizidae	Dark-eyed Junco	*Junco hyemalis*	X	X	X	X	Secure		
Motacillidae	American Pipit	*Anthus rubescens*	X	X			Sensitive		
Emberizidae	Lapland Longspur	*Calcarius lapponicus*	X	X			Secure		
Emberizidae	Smith's Longspur	*Calcarius pictus*	X	X			Undetermined		
Emberizidae	Snow Bunting	*Plectrophenax nivalis*	X	X			Secure		
Icteridae	Red-winged Blackbird	*Agelaius phoeniceus*	X	X	X		Secure		
Icteridae	Rusty Blackbird	*Euphagus carolinus*	X	X			May be at risk	Special concern – 2006	
Icteridae	Brown-headed Cowbird	*Molothrus ater*	X	X			Secure		
Fringillidae	Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	X	X			Undetermined		
Fringillidae	Pine Grosbeak	*Pinicola enucleator*	X	X			Secure		
Fringillidae	Purple Finch	*Carpodacus purpureus*			X		Secure		
Fringillidae	Red Crossbill	*Loxia curvirostra*		X			Secure		
Fringillidae	White-winged Crossbill	*Loxia leucoptera*	X	X	X		Secure		
Fringillidae	Common Redpoll	*Carduelis flammea*	X	X	X		Secure		
Fringillidae	Hoary Redpoll	*Carduelis hornemanni*	X	X			Undetermined		
Fringillidae	Pine Siskin	*Carduelis pinus*		X	X		Secure		

Scientific Name	Common Name	NWT Status (GNWT, 2005))	COSEWIC (COSEWIC, 2006)	SARA (EC, 2006b)
Amphibians				
Rana sylvatica	**Wood Frog**	**Secure**		
Fish				
Salvelinus namaykush	Lake Trout	Secure		
Coregonus clupeaformis	Lake Whitefish	Secure		
Coregonus artedii	Lake Cisco	Secure		
Coregonus sardinella	Least Cisco	Secure		
Prosopium cylindraceum	Round Whitefish	Secure		
Prosopium williamsoni	Mountain Whitefish			
Stenodus leucichthys	Inconnu	Sensitive		
Thymallus arcticus	Arctic Grayling	Sensitive		
Esox lucius	Northern Pike	Secure		
Stizostedion vitreum	Walleye	Sensitive		
Lota lota	Burbot	Secure		
Catostomus catostomus	Longnose Sucker	Secure		
Catostomus commersoni	White Sucker	Secure		
Couesius plumbeus	Lake Chub	Undetermined		
Platygobio gracilis	Flathead Chub	Undetermined		
Notropis atherinoides	Emerald Shiner	Undetermined		
Notropis hudsonius	Spottail Shiner	Undetermined		
Chrosomus neogaeus	Finescale Dace	Undetermined		
Chrosomus eos	Northern Redbelly Dace	Undetermined		
Rhynichthys cataractae	Longnose Dace	Secure		
Cottus cognatus	Slimy Sculpin	Undetermined		
Percopsis omiscomaycus	Trout Perch	Undetermined		
Culea inconstans	Brook Stickleback	Sensitive		
Pungitius pungitius	Ninespine Stickleback	Secure		
Mammals				
Microtus pennsylvanicus	Meadow Vole	Secure		
Microtus miurus	Singing Vole	Undetermined		
Microtus oeconomus	Tundra Vole	Secure		
Microtus xanthognathus	Yellow-cheeked Vole			
Microtus longicaudus	Long-tailed Vole	Undetermined		
Neotoma cinerea	Bushy-tailed woodrat	Undetermined		
Sorex cinereus	Masked Shrew	Secure		
Sorex monticolus	Dusky Shrew	Secure		
Sorex arcticus	Arctic Shrew	Secure		
Sorex hoyi	Pigmy Shrew	Secure		
Ochotona princeps	American Pika			
Lepus americanus	**Snowshoe Hare**	**Secure**		
Marmota caligata	Hoary Marmot	Undetermined		
Spermophilus parryii	Arctic Ground Squirrel	Secure		
Tamiasciurus hudsonicus	**Red Squirrel**	**Secure**		
Glaucomys sabrinus	Northern Flying Squirrel	Secure		

Scientific Name	Common Name	NWT Status (GNWT, 2005))	COSEWIC (COSEWIC, 2006)	SARA (EC, 2006b)
Castor canadensis	**Canadian Beaver**	**Secure**		
Peromyscus maniculatus	Deer Mouse	Secure		
Clethrionomys rutilus	Northern Red-backed Vole	Secure		
Lemmus sibiricus	Brown Lemming	Secure		
Synaptomys borealis borealis	Northern Bog Lemming	Secure		
Phenacomys intermedius (mackenzii)	Heather Vole	Secure		
Ondatra zibethicus	Muskrat	Secure		
Erethizon dorsatum	Porcupine	Secure		
Canis latrans	Coyote	Secure		
Canis lupus	**Gray Wolf**	**Secure**	Canis lupus occidentalis = not at risk - 1999	
Vulpes vulpes	**Red Fox**	**Secure**		
Alopex lagopus	Arctic Fox	Secure		
Ursus americanus	**Black Bear**	**Secure**	**Not at risk - 1999**	
Ursus arctos	Grizzly Bear	Sensitive	Special concern - 2002	
Martes americana	**American marten**	**Secure**		
Mustela erminea	Ermine (Stoat)	Secure		
Mustela nivalis	Least Weasel	Secure		
Mustela vison	Mink	Secure		
Gulo gulo	**Wolverine**	**Secure**	**Western population – Special concern - 2003**	**None**
Lontra canadensis	**River Otter**	**Sensitive**		
Lynx lynx canadensis	**Lynx**	**Secure**	**Not at risk 1989, 2001**	
Alces alces	**Moose**	**Secure**		
Rangifer tarandus caribou	**Woodland Caribou (boreal population)**	**Sensitive**	**Threatened - 2002**	**Threatened - Schedule 1**
Rangifer tarandus granti	**Woodland Caribou (mountain population)**	**Secure**	**Threatened - 2002**	**Threatened - Schedule 1**
Ovibox moschatus	Muskox	Secure		
Ovis dalli dalli	Dall's Sheep	Secure		
Ovis dalli stonei???	Stone's Sheep			

Appendix F: Descriptions of Terrestrial Ecozones and Ecoregions within Ts'ude niline Tu'eyeta (Environment Canada, 2006a)

Taiga Plains Ecozone

The Taiga Plains are located mainly in the southwesterly corner of the Northwest Territories, northeastern British Columbia, and northern Alberta. Taiga, a Russian word, refers to the northern edge of the boreal coniferous forest, that land of little sticks which spans from the subarctic of Labrador to Alaska and beyond, from Siberia to Scandinavia. The ecozone is dominated by Canada's largest river, the mighty Mackenzie, and its tributaries. It is bordered in the west by cordilleran mountain ranges, to the east by two huge lakes - the Great Slave and Great Bear, to the north by extensive Mackenzie Delta, and to the south by the closed forests of the Boreal Plains ecozone.

Climate The climate is marked by short, cool summers and long, cold winters. Cold arctic air influences the area for most of the year. The mean annual temperature ranges between -10°C in the Mackenzie Delta region to -1°C in Alberta and British Columbia. From north to south, the mean summer temperature ranges from 6.5°C to 14°C. The mean winter temperature ranges from -26°C in the north to -15°C in the south of the ecozone. Snow and freshwater ice persist for six to eight months of the year. The mean annual precipitation is low, ranging 200-500 mm.

Vegetation The ecozone is characterised by an open, generally slow growing, conifer dominated forests of predominantly black spruce. The shrub component is often well developed and includes dwarf birch, Labrador tea, and willow. Bearberry, mosses, and sedges are dominant understory species. Upland and foothill areas and southerly locales tend to be better drained, are warmer, and support mixedwood forests characterized by white and black spruce, lodgepole pine, tamarack, white birch, trembling aspen, and balsam poplar. Along the nutrient-rich alluvial flats of the larger rivers white spruce and balsam poplar grow to sizes comparable to the largest in the boreal forests to the south.

Landforms and Soils This ecozone is the northern extension of the flat Interior Plains which dominate the Prairie and Boreal Plains ecozones to the south. The subdued relief of broad lowlands and plateaus are incised by major rivers, the largest of which can show elevational differences of several hundred metres. Underlain by horizontal sedimentary rock - limestone, shale and sandstone - the nearly level to gently rolling plain is covered with organic deposits and, to a lesser degree, with undulating to hummocky morainal and lacustrine deposits. Alluvial deposits are common along the major river systems, including braided networks of abandoned channels. Low-lying wetlands cover 25-50% of the zone. A large portion of the area is underlain by permafrost, and this acts to perch the surface water table and promote a regional overland seepage system. When combined with low-angle slopes, it creates a landscape that is seasonally waterlogged over large areas. Patterned ground features are common. The region's widespread permafrost and poor drainage create favourable conditions for Cryosolic, Gleysolic, and Organic soils.

Wildlife Characteristic mammals include moose, woodland caribou, wood bison, wolf, black bear, marten, lynx, and arctic ground squirrel. Barren-ground caribou overwinter in the northwest corner of the ecozone. Common bird species include the common redpoll, gray jay, common raven, red-throated loon, northern shrike, sharp-tailed grouse, and fox sparrow. Fish-eating raptors include the bald eagle, peregrine falcon, and osprey. The Mackenzie Valley forms one of North America's most travelled migratory corridors for waterfowl (ducks, geese, and swans) breeding along the Arctic coast.

Human Activities The population of 21 400 is approximately 60% aboriginal. The major communities include Fort Nelson, Inuvik, Hay River, Fort Smith, and Fort Simpson. Hunting, trapping, and fishing are the primary subsistence activities in the local economy. Mining, oil and gas extraction, and some forestry and tourism are the main activities in the ecozone.

51. PEEL RIVER PLATEAU

This ecoregion spans the Yukon and Northwest Territories border between the Peel and Arctic Red rivers along the foothills of the Mackenzie and Richardson mountains. The ecoregion is marked by long, very cold winters and short cool summers. The mean annual temperature is approximately -6°C. The mean annual summer temperature is 10°C and the mean winter temperature is -22.5°C. Mean annual precipitation ranges 200-275 mm. The ecoregion is classified as having a high subarctic ecoclimate. The predominant vegetation consists of open, very stunted stands of black spruce and tamarack with secondary quantities of white spruce, and a ground cover of dwarf birch, willow, ericaceous shrubs, cottongrass, lichen, and moss. Poorly drained sites usually support tussocks of sedge, cottongrass, and sphagnum moss. Low shrub tundra, consisting of dwarf birch and willow, is also common. The surface of this ecoregion is characterized by truncated and upturned edges of Palaeozoic and Mesozoic strata, forming terraces, and rounded plateaus. Some portions of the ecoregion in the southwest are unglaciated, but most of its surface is covered by thin, discontinuous, hummocky to dissected glacial drift and organic deposits. Wetlands are present on over 25% of the ecoregion, characterized by peat plateau bogs, and ribbed and horizontal fens. Permafrost is continuous, and characterized by sparse ice wedges and massive ground ice bodies, with high to medium ice content in the northern part of the ecoregion above Mountain River, and extensive discontinuous permafrost with medium to low ice content below the river. Turbic and Organic Cryosols with some Eutric Brunisols and Static Cryosols are the dominant soils in the ecoregion. Characteristic wildlife includes caribou, moose, grizzly and black bear, wolf, red fox, snowshoe hare, and beaver. Common birds include raven, osprey, spruce grouse, and waterfowl. Land use activities include trapping, hunting, and fishing, with some recreation and tourism. There are no permanent communities in this ecoregion.

53. FORT MCPHERSON PLAIN

This ecoregion spans the Yukon and Northwest Territories' borders and extends from Fort McPherson to the Mackenzie and Ramparts rivers. The climate is marked by short cool summers and long very cold winters. The mean annual temperature is approximately -8°C. The mean summer temperature is 9.5°C and the mean winter temperature is -25°C. Mean annual precipitation ranges between 250 mm in the eastern portion of the ecoregion to 350 mm in the west. The ecoregion is classified as having a high subarctic ecoclimate. The predominant vegetation consists of open, very stunted stands of black spruce and tamarack with secondary quantities of white spruce, and a ground cover of dwarf birch, willow, ericaceous shrubs, cottongrass, lichen, and moss. Poorly drained sites usually support tussocks of sedge, cottongrass, and sphagnum moss. Low shrub tundra, consisting of dwarf birch and willow, is also common. This ecoregion is underlain by Cretaceous shale, and incorporates a broad, shallow basin in its southwestern section at about 120 m asl. Some parts of the ecoregion have numerous lakes, and others are without. In the northeast, isolated hills rise to about 460 m asl, where it consists of Palaeozoic carbonate rocks. Both the Arctic Red and the Ontaratue rivers follow

follow deeply incised valleys through this ecoregion to the Mackenzie River. Permafrost is continuous with medium to high ice content, and is characterized by sparse ice wedges. Turbic and Organic Cryosols with some Static Cryosols developed on level to undulating morainal and organic deposits are the dominant soils. Unfrozen Dystric and Eutric Brunisolic soils also occur. Wetlands cover over 25% of the area in the north of the ecoregion, over 50% of the area in the south. Characteristic wildlife includes caribou, moose, black bear, wolf, red fox, snowshoe hare, beaver, spruce grouse, raven, osprey, and waterfowl. Land use activities are limited to trapping, hunting, fishing, recreation, and tourism. Major communities include Fort McPherson and Arctic Red River. The population of the ecoregion is approximately 900.

56. MACKENZIE RIVER PLAIN

This ecoregion extends from north of Fort Good Hope on the west side of the Mackenzie River to Wrigley. It is a narrow northern extension of the boreal forest along the east side of the Mackenzie River. The ecoregion is marked by cool summers and very cold winters. The mean annual temperature is approximately -6.5°C. The mean summer temperature is 11.5°C and the mean winter temperature is -24.5°C. The mean annual precipitation ranges 300-400 mm. The ecoregion is classified as having a subhumid high boreal ecoclimate. The ecoregion is a broad, rolling, drift-covered plain lying between Mackenzie and Franklin mountains, into which the Mackenzie River is entrenched for part of its course. Native vegetation consists predominantly of medium to tall, closed stands of black spruce and jack pine with an understory of feathermoss, bog cranberry, blueberry, Labrador tea, and lichens. White spruce, balsam fir, and trembling aspen occur in the warmer, more moist sites in the southern section of the region. Drier sites have more open stands of black spruce and jack pine. Low, closed and open stands of black spruce, ericaceous shrubs, and sphagnum mosses dominate poorly drained, peat-filled depressions. Wetlands cover 25-50% of the ecoregion, and are characteristically peat plateau bogs, and ribbed and horizontal fens. Permafrost is extensive and discontinuous with medium ice content, and is characterized by sparse ice wedges. Dominant soils in the ecoregion are Organic and Turbic Cryosols and Eutric and Dystric Brunisols with some Regosols that have developed on terraced to rolling morainal, alluvial, lacustrine, and organic deposits. Characteristic wildlife includes moose, black bear, beaver, fox, wolf, hare, raven, grouse, and waterfowl. Limited forestry, oil production near Norman Wells, hunting, and trapping are the principal land use activities. The main communities include Norman Wells and Fort Norman. The population of the ecoregion is approximately 1200.

Taiga Cordillera Ecozone

This ecozone is located along the northernmost extent of the Rocky Mountain system and covers most of the northern half of the Yukon and southwest corner of the Northwest Territories. In this ecozone are found Canada's largest waterfalls, deepest canyons and wildest rivers.

Climate Annual precipitation ranges from less than 300 mm in the north to over 700 mm in the southeast (Selwyn Mountains). Mean annual temperatures range from -10°C in the north to -4.5°C in the south. Mean summer temperatures range from 6.5°C to 10°C and are modified by vertical zonation and aspect. Summers are warm to cool with extended periods of daylight. Mean winter temperatures range from -25°C in the north to -19.5°C in the south. Winters are long and

cold with very short daylight hours. Weather patterns from the Arctic and Alaskan coasts have a marked influence on this ecozone.

Vegetation Natural vegetation ranges from arctic tundra (dwarf or low shrubs, mosses and lichens, and cottongrass) in the north, to alpine tundra (dwarf shrubs, lichens, saxifrages, and mountain avens) in higher elevations, and taiga or open woodland in the south (white spruce and white birch), mixed with medium to low shrubs (dwarf birches and willows), mosses, and lichens.

Landforms and Soils Steep, mountainous topography, consisting of repetitive, sharply etched ridges and narrow valleys, predominates with foothills and basins also present. The bedrock is largely sedimentary in origin with minor igneous bodies. Much of the area is mantled with colluvial debris with frequent bedrock exposures and minor glacial deposits. The northwest portion of this ecozone consists of unglaciated terrain. Brunisols, Regosols, and Cryosols tend to be the predominant soils. Most wetlands, which in some ecoregions are extensive, are underlain by permafrost. Abundant permafrost features, such as peat hummocks, palsas, and peat plateaus, are common in peatlands. The unglaciated portions of this ecozone commonly exhibit periglacial features such as cryoplanation terraces and summits and various forms of sorted and unsorted patterned ground. Continuous permafrost underlies most of the ecozone with the exception of the western half of the Mackenzie and Selwyn Mountains ecoregions.

Wildlife Wildlife in the area is diverse. Characteristic mammals include Dall's sheep, woodland and barren-ground caribou, moose, mountain goat, black and grizzly bear, wolf, lynx, arctic ground squirrel, American pika, hoary marmot, and a large concentration of wolverine. Important birds include gyrfalcon, willow and rock ptarmigan, and waterfowl. Most of the area remains a wilderness. The Yukon's Old Crow Flats is a large wetland complex which has received international recognition for its value to swans, Canada Geese, and other waterfowl species that nest or stage here each year in the tens of thousands.

Human Activities Present activities include hunting, trapping, ecotourism, and outdoor recreation, as well as exploration for minerals. During the 1960s and 1970s much exploration for hydrocarbons was undertaken in the major basins of the ecozone. The ecozone is sparsely populated and home to the Vuntut Gwitchin people. Total population is roughly 300 of which over 80% reside in the remote settlement of Old Crow, the Yukon's most northern settlement.

170. MACKENZIE MOUNTAINS

This extremely rugged, heterogeneous mountainous ecoregion spans the Yukon-Northwest Territories border from Alaska to the Mackenzie Valley. It includes the Ogilvie and Wernecke mountains in its westernmost section, the Backbone Ranges in its interior, and the Canyon Ranges to the east. The eastern ranges of the Mackenzie Mountains that lie in the rain shadow of the higher Selwyn Mountains to the west are also included. The ecoregion shows evidence of localized alpine and valley glaciation. The mean annual temperature for the area is approximately -5°C with a summer mean of 9°C and a winter mean of -19.5°C. Mean annual precipitation is highly variable with the highest amounts, greater than 600 mm, occurring in the southwest portion of the ecoregion. Moving west towards Alaska and the southern Ogilvies, precipitation drops to approximately 400 mm. Higher precipitation occurs at higher elevations. The region is characterized by alpine tundra at upper elevations and subalpine open woodland vegetation at lower elevations. Alpine vegetation consists of lichens, mountain avens,

intermediate to dwarf ericaceous shrubs, sedge, and cottongrass in wetter sites. Barren talus slopes are common. Subalpine vegetation consists of discontinuous open stands of stunted white spruce and occasional alpine fir in a matrix of willow, dwarf birch, and Labrador tea. The Ogilvie Mountains, composed of Palaeozoic and Proterozoic sedimentary strata intruded by granitic stocks, reach 2134 m asl in elevation. The Wernecke Mountains are formed of phyllite and nearly horizontal carbonate rocks carved by glaciation. They are divided into several ranges by broad northwesterly-trending valleys. Permafrost is continuous and of low ice content in most of the Yukon portion of the ecoregion. Permafrost is extensive but discontinuous with variable ice content in the Northwest Territories portion of the ecoregion. Alluvium, fluvioglacial deposits, and morainal veneers and blankets are dominant in the region. Rock outcrops are common at higher elevation. Turbic Cryosols with some Dystric Brunisols and Regosols occur on steeply sloping colluvium. Characteristic wildlife includes caribou, grizzly and black bear, Dall's sheep, moose, beaver, fox, wolf, hare, raven, rock and willow ptarmigan, golden eagle, gyrfalcon, and waterfowl. These ranges support various forms of hunting and trapping, and contain considerable mineral potential, but for the most part the ecoregion is an isolated wilderness with little permanent human occupation.

Appendix G: Ducks Unlimited Canada Waterfowl Surveys in Ts'ude niline Tu'eyta

Distribution, Abundance and Nesting Success of Waterfowl at the Ramparts-Hume wetland complex, Sahtu Region, Northwest Territories

1997 Progress Report

Ducks Unlimited Canada. PO Box 1438, Yellowknife, NT. X1A 2P1

Introduction

The Continental Conservation Plan (Anonymous 1994) was designed to guide the conservation programs of Ducks Unlimited through the year 2000. This document identified the Western Boreal Forest as a limiting and threatened habitat region and thus a priority area for research. It also recognised that information on the reproductive success of wigeon (*Anas americana*) and scaup (*Aythya* spp.) breeding in northern areas is a major research need.

The Taiga Plains eco-zone of the Northwest Territories is perhaps the least understood component of the Western Boreal Forest. It comprises 500 000 km^2 of boreal/sub-arctic transitional habitat along the Mackenzie Valley (Wiken 1986). Much of this region is closed forest and therefore non-contributing to waterfowl. Compared to the adjacent Taiga Shield , however, it is relatively fertile and contains highly productive wetland ecosystems, typically occurring as post-glacial-lakebeds. Relatively secure from the intensive land use and cyclical droughts of the prairie potholes region, these systems provide critical breeding, moulting and staging habitat for significant numbers of continental waterfowl (Anonymous 1985).

Despite the importance of this region to continental waterfowl populations, significant wetland ecosystems are poorly documented. Quantitative data on the distribution and abundance of waterfowl using these areas is either lacking or of little value and the ecology of waterfowl breeding here is poorly understood. Informed management decisions with respect to waterfowl population or habitat issues are therefore not possible here.

One such wetland ecosystem, the Ramparts-Hume complex in the Sahtu region, has traditionally been considered the most important wetland habitat for waterfowl in the Mackenzie Valley (Davis 1974: 64). Residents of Fort Good Hope have long recognized its significance and seasonally frequent this area for subsistence purposes. Despite this, it lacks official recognition as a key migratory bird habitat site (Alexander *et al.* 1991) due to a lack of information.

The Sahtu land claim agreement created a resource management system which is governed by conservation principles and which promotes the long term economic, social and cultural interests

of claim participants. With the settlement of this claim, hydro-carbon exploration activities have increased dramatically. Local managers require baseline information on areas important for subsistence purposes in order to make informed decisions regarding land-use.

This co-operative study involves claim beneficiaries in a meaningful way in wildlife management, by providing information and technical expertise for the implementation of conservation practises in this area. This study will be a valuable addition to our knowledge base by providing accurate information on the distribution and abundance of waterfowl in an important wetland ecosystem in the Taiga Plains of the Northwest Territories. This will quantify the importance of the Ramparts-Hume complex to migratory birds and therefore serve to protect it from adverse land-use.

Program Objectives

1. Determine the distribution and abundance of waterfowl species breeding in this area by combining traditional ecological knowledge with systematic aerial and ground-based surveys.
2. Determine nesting effort and factors limiting reproductive success in this area.
3. Provide the necessary skills and information for local wildlife managers to successfully manage this ecosystem.

Study Area

The Ramparts-Hume Complex (ca. 66^{o}N, 129^{o}W) is a 4000 km^2 wetland ecosystem lying on a broad plain in the Mackenzie Valley. The lower Hume and Ramparts rivers drain the remnants of a large post-glacial lake bed. Low relief and the presence of permafrost create poor drainage here, with wetlands and open water comprising more than seventy-five percent of the area (National Wetlands Working Group 1988). The environment in this area is highly dynamic, resulting in a large diversity of wetland types. Numerous thermo-karst and oxbow lakes occur here. Bog-fen sequences, with irregular shorelines and dense emergent vegetation, are the dominant wetland type (Wakelyn 1990).

This area lies in the low sub-arctic eco-climatic zone (Eco-regions Working Group 1989) and contains a variety of plant communities ranging from closed boreal forest to open sub-arctic tundra. Typical vegetation on uplands consists of open stands of Black Spruce (*Picea glauca*) and Tamarack (*Larix laricina*) with under-stories of Labrador Tea (*Ledum groenlandicum*),

mosses, and lichens. Fire history is quite evident, with large monotypic stands of Trembling Aspen, (*Populus tremuloides*) interspersed throughout the conifer forest.

In wetlands, the most common emergent plants are sedges (*Carex spp.*), horsetail (*Equisetum spp.*), Buck-bean (*Menyanthes trifoliata*) and mare's tail (*Hippuris spp.*). Submergent communities are dominated by Yellow Pond Lily (*Nuphar variegatum*), pondweeds (*Potomageton spp.*), Bur-reed (*Sparganium hyperboreum*) and Water-Milfoil (*Myriophyllum exalbescens*).

1997 Field Season

Traditional Knowledge

Meetings were held in Fort Good Hope in mid-March to secure community support for a co-operative 3 year program. After endorsement, a local field worker (Jim Pierrot) was hired to assist in conducting interviews. Interviews were held with interested hunters in mid-April. Information was acquired on the timing of spring migration and the locations of key breeding, moulting and brood-rearing areas. Information on traditional harvesting practices as well as logistical details was also collected. This information was compiled on base maps and was used to refine the logistics associated with aerial and ground surveys.

Aerial Surveys

The local Hunters and Trappers Association was contracted to cache fuel at the study area to optimise helicopter use. Standardised helicopter transect surveys (Kay and Barrett 1997) were used to determine the distribution and abundance of waterfowl breeding in the study area. Timing of both breeding pair and brood surveys was based on information from traditional knowledge interviews and from known chronology in similar areas. Breeding pair surveys were conducted in late May to correspond to dabbling duck breeding chronology. A similar survey was conducted in mid-June to correspond with diving ducks. Brood surveys were conducted in July and August for dabbling and diving ducks respectively.

A Bell 206 helicopter was flown along straight transects at 45 m above ground level and 80 km/hr maximum ground speed. Transects were systematically spaced at 4-km intervals, resulting in 10% coverage of the study area. Transects were divided into 2-km segments to more accurately

delineate waterfowl concentrations. All waterbirds within transect boundaries were recorded as to species, sex and social status. Broods were classified according to species and duckling age class (Gollop and Marshall 1954). This survey technique is a modification of the standard operation procedures used for fixed-wing surveys of waterfowl by the USFWS. It has been extensively tested throughout similar habitats and visibility correction factors have been calculated (Kay and Barrett 1997, Kay *et. al* 1997).

Our first breeding pair survey was conducted on 28 May 1997. A total of 10.2 hrs were flown, resulting in 10% coverage of the study area. Spring chronology was retarded, with most large wetlands still ice-covered, and water levels more reminiscent of spring flood conditions. Based on social structure of breeding dabblers, survey timing was optimal. The attached table summarises densities of breeding waterfowl for the 1997 field season.

Brood surveys confirmed the widespread failure of scaup to successfully nest in 1997. Production of dabbling ducks, particularly wigeon, was good, however, with an abundance of Class 2 broods present.

Ground Surveys

With the assistance of the Fort Good Hope Hunters and Trappers Association, Lawrence T'selie and Roger Boniface were hired to assist with nest searches. Intensive canoe surveys and nest searches, directed primarily at scaup, were conducted in mid-June to correspond with the latter half of peak incubation. Although good data was collected on habitat diversity, ten days of intensive searching produced no nests. Lesser Scaup pairs and trios were well spaced throughout sedge nesting areas, but few were able to initiate nesting. The protracted spring and high water levels (the highest seen in the area in over 30 years; Lawrence T'selie , pers. comm.), resulted in widespread failure of this species to nest. This illustrates the potential dynamics of waterfowl populations in such high latitude wetland complexes, confirming the need for multiple year surveys.

Large flocks of moulting male widgeon and family groups of Canada Geese (likely B. c. parvipes) were distributed along the Ramparts River. The deep silt of inside bends provided extensive flats of horsetail, optimal grazing habitat for these birds. The importance of this habitat type to waterfowl populations has not been documented.

Both Lawrence and Roger proved worthy field assistants. Their knowledge of the study area was invaluable to the relative success of the ground survey portion in 1997. Several large,

fen-lake complexes were reconnoitred for future nesting studies. Recommendations for 1998 include the rental of Lawrence Tselie's cabin on the Ramparts River. This site is in close proximity to several of these complexes and will make a good base camp from which to conduct studies on scaup nesting effort.

Literature Cited

Alexander, S.A., R.S. Ferguson and K.J. McCormick. 1991. Key migratory terrestrial bird habitat sites in the Northwest Territories (2nd Edition). Canadian Wildlife Service, Occasional Paper No.71. Canadian Wildlife Service, Ottawa, 85pp

Anonymous. 1985. Flyways: Pioneering waterfowl management in North America. A.S. Hawkins, R.C. Hanson, H.K. Nelson and H.M. Reeves Eds. United States Dept. of Interior. 517pp.

Anonymous. 1994. Continental Conservation Plan - An analysis of North American waterfowl populations and a plan to guide the conservation programs of Ducks Unlimited through the year 2000. Ducks Unlimited Inc., 379pp.

Davis, R.A. 1974. Aerial survey of bird populations along the route of the proposed gas pipeline in the Mackenzie District, NWT, summer 1971. Arctic Gas Biological Report Series 11(1): 1-156.

Gollop, J.B., and W.H. Marshall. 1954. A guide for aging duck broods in the field. Mississippi Flyway Council, Technical Section Report. 14 pp.

Kay, D.G. and G.M. Barrett. 1996. Distribution, abundance and nesting success of waterfowl at Brackett Lake, Northwest Territories. Technical Report. Ducks Unlimited Canada. Yellowknife.

Kay, D.G., J.E. Hines and G.M. Barrett. 1996. Visibility correction factors for helicopter transect surveys of waterfowl in boreal forest. Technical Report. Ducks Unlimited Canada. Yellowknife.

National Wetlands Working Group. 1988. Wetlands of Canada. Ecological Land Classification Series, No.24. Sustainable Development Branch, Environment Canada, Ottawa, Ontario and Polyscience Publications Inc., Montreal, Quebec, 452pp.

Wakelyn, L.A. 1990. Wetland inventory and mapping in the Northwest Territories using digital landsat data. Department of Renewable Resources, Government NWT, file report #96.

Wiken, E. 1986. Terrestrial Ecozones of Canada. Ecological Classification Series, No. 19. Lands Directorate, Environment Canada, Ottawa, Ontario, 26 pp.

Appendix H: Ramparts River Wetlands (Tuyetah)

Key Migratory Bird Terrestrial Habitat Site No. 13

NT Site 13 – Ramparts River Wetlands (Tuyetah)

Location: 66°15'N, 130°00'W

Size: 4660 km²

Description: The Ramparts River wetlands are located along the lower Ramparts and upper Ontaratue rivers. The eastern edge of this key site lies 35 km west of Fort Good Hope. The wetlands are a low-lying postglacial lakebed consisting of open black spruce bog, ericaceous shrublands, floating bogs, and sedge wetlands surrounding many of the innumerable ponds and small lakes. Stands of old-growth, riparian white spruce occur along the Ramparts River.

Biological value: Thousands of nesting and staging waterfowl are known to use the Ramparts River wetlands annually. Salter (1974) found that for the Mackenzie Valley, these wetlands were in the top three in terms of the numbers of waterfowl observed. Greater and Lesser scaup and Surf and White-winged scoters were the most abundant species. Surveys in the late 1990s (D. Kay, unpubl. data) reported 20000 Greater and Lesser scaup and 6000 Surf and White-winged scoters in wetlands adjacent to the Ramparts River during the nesting period. Accounting for missed birds, these surveys indicate that 1% of the estimated Canadian populations of both scaup and scoters were nesting in that area. In addition, the wetlands immediately north and northwest contained lower densities of scaup and scoters, but their extensive nature would account for considerably more of them in the entire key site area. The Ramparts River wetlands also provide staging habitat for additional, and likely large, numbers of scaup and scoters migrating to areas farther north. Salter (1974) recorded approximately five times the number of scaup and scoters on the wetlands during the early June migration period compared with July.

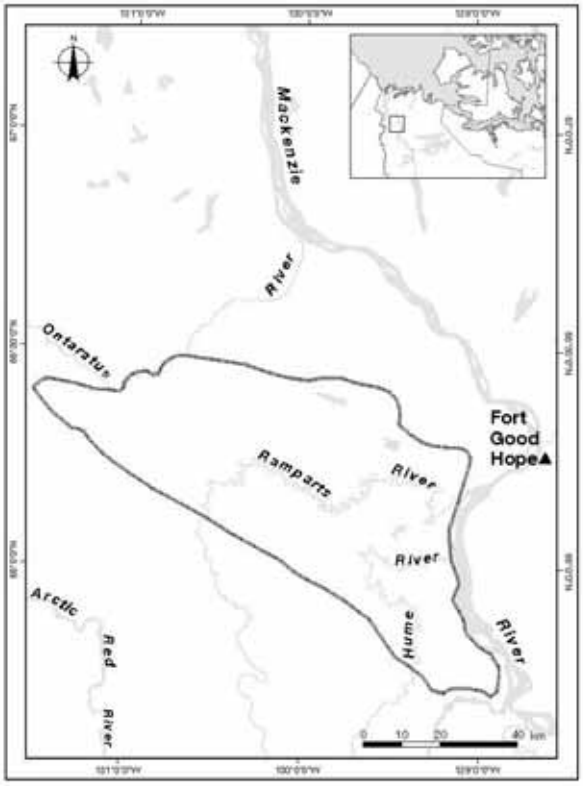
Salter (1974) and D. Kay (unpubl. data) also observed relatively high densities of Pacific Loons (3692 loons) in the wetlands adjacent to the Ramparts River as well as in the wetlands to the northwest and north (D. Kay, pers. commun.). This number is thought to represent >1% of the Canadian population of this species.

The Ramparts River wetlands also provide locally important habitat for a range of mammals, such as moose and furbearers.

Sensitivities: Waterfowl and other migratory birds are sensitive to disturbance during the nesting, brood-rearing, moulting, and migration periods. Low-lying habitats are susceptible to terrain disturbance through the disruption of natural drainage patterns and the melting of permafrost.

Potential conflicts: The area has moderate to high oil and gas potential. Extensive seismic exploration has occurred within the key site as well as surrounding areas, and several wells have been drilled. Large oil and gas leases occur immediately northwest of the key site.

Status: None. The community of Fort Good Hope is currently exploring the possibility of creating a legislated protected area that would include all, or a large portion, of this key site. This key site was identified in the draft Sahtu Land Use Plan as a "Conservation Area" (Sahtu Land Use Planning Board 2003) and by the Sahtu Heritage Places and Sites Joint Working Group as an area that should be legally protected (Joint Working Group 2000).



Appendix I: Ts'ude niline Tu'eyeta Vegetation and Songbird Survey Report 2007 (Savignac, 2007)

Executive summary

As part of the ecological assessment of the Ts'ude'hliline-Tuyetah Conservation Protected Area (TPCA), vegetation and songbird surveys were conducted by the Canadian Wildlife Service in 2005 and 2006. Dendroica Environnement et Faune has been retained to analyse field data and prepare a report for inclusion in final ecological assessment documents. The goals of this report are to: 1) identify plant communities present in the TCPA based on vegetation characteristics collected within the study area; 2) assess the accuracy of the Middle Mackenzie Earth Cover Project (MMECP) classification based on vegetation characteristics collected in the field; and 3) identify terrestrial songbird communities based on habitat types and determine bird-habitat relationships within the TPCA.

Covering approximately 15,000 km^2, the Ts'ude'hliline-Tuyetah Candidate Protected Area is located on the west bank of the Mackenzie River, across from the small community of Fort Good Hope, NWT. The topography is relatively flat to rolling throughout most of the study area, except in the south, where foothills of the Mackenzie mountain range are present. The vegetation of the TCPA is typical of the Taiga Plains and is composed of vast wetland complexes and peatlands that provide important breeding and staging habitat for both waterbirds and landbirds. Forest fire is the main natural disturbance occurring throughout the TCPA.

AMEC Earth & Environmental (2006) developed the methodology used to survey vegetation and songbirds. Characteristics of vascular plants, shrubs, trees, coarse woody debris (CWD), snags and other environmental variables were collected in 20 m x 20 m (400 m^2) plots at 77 sites throughout the TPCA. A total of twenty-five variables were derived from field data for inclusion in univariate and multivariate statistical analyses. We used two-way-indicator-species TWINSPAN analysis to identify and classify sites according to field vegetation variables and bird abundance. We also used Detrended Correspondence Analysis (DCA), an indirect ordination technique, to define sites based on their ecological similarity/dissimilarity in a multidimensional ordination space. We used a Mantel test with 5000 randomized runs to assess the correlation between vegetation data and assigned vegetation classes from MMECP classification.

Forest songbirds were surveyed once at each site in June of 2005 and 2006 using the point count technique. At each site, three point counts were spaced 300 m apart in a triangular manner, and songbirds were recorded for 10 minutes in a radius of approximately 150 m using the Earthsong E-3A Field Recorder System and a pair of directional microphones (CZM Bio-acoustic Microphone). We used the TWINSPAN analysis to identify and classify sites according to bird abundance. We used DCA to define sites based on their

ecological similarity/dissimilarity in bird species composition and abundance. We used Canonical Correspondence Analysis (CCA) to statistically test the significance of each explanatory vegetation variable in determining bird abundance (ter Braak and Smilauer 2002).

According the TWINSPAN analysis, vegetation in the TPCA could be grouped into four distinct groups or habitat types: Low Shrub, Conifer, Tall Shrub and Closed Deciduous. Conifer was the most prevalent habitat type and was characterized by the highest density of conifer trees such as black spruce, white spruce and tamarack. Low percent tree cover, high percent shrub cover and a large amount of CWD define the Tall Shrub habitat, which was found in 25 percent of survey sites. In contrast, Low Shrub habitat was dominated by vegetation classes such low shrub-lichen, and low-shrub-other, and was characterized by the lowest tree density of all habitat types. As in the case of Tall Shrub habitat, sites classified as Shrub often originated from recent forest fire. The least abundant forest type found in the TPCA was Closed Deciduous habitat; composed principally of poplar and birch stands found along riparian areas.

The DCA for vegetation communities in the TPCA organized the sites into discrete groups that agreed well with the TWINSPAN classification. The most important vegetation gradients defined by the DCA were from coniferous to deciduous stands. The DCA graph suggested that percent cover of deciduous trees, dbh of deciduous trees, and number of deciduous trees were all highly associated with sites classified as Deciduous. In contrast, coniferous communities were defined most by a high percent cover of coniferous trees, high number of coniferous trees, and a higher average height of coniferous trees. Variables related to high bare ground cover, high percent cover of shrub, and those related to high number of snags were more strongly associated with sites classified as Low Shrub.

There was a positive and significant association between the matrix formed by the field vegetation variables and the matrix formed by the MMECP derived variables (Standardized Mantel statistic r= 0.12, P= 0,004), suggesting that MMECP classification was generally similar to the vegetation data collected in the field. This result agrees with another study that found a concordance of $>$ 70 % between the MMECP vegetation classes and on-the-ground vegetation.

Altogether, 2356 individual birds of 64 species were detected in 228 point counts conducted at 76 sites in the TPCA. Bird communities were characterized by a few very abundant species found in most habitat types. Generally, species richness differed among habitat types. It was lower in Black Spruce–Lichen and Shrub habitat types, and higher in both Deciduous and Black Spruce Bog. Higher species richness in Deciduous and Black Spruce Bog can be explained by a higher vegetation structure and higher moisture regime respectively. Compared to another study conducted in Norman Wells (at a similar latitude), the bird

community found in the TPCA had 15 % less bird species. This pattern reflects the premise that species richness generally decreases as latitude increases.

Based on bird species abundance, TWINSPAN classified sites into four distinct communities. The bird community found in Black Spruce-Lichen habitat was characterized by ground and shrub species such as Fox Sparrow, and Swainson's thrush. The Shrub habitat type supported ground dwelling birds such as White-crowned Sparrow, and Le Conte's Sparrow was the only species found exclusively in this habitat. The third community, Deciduous, was defined by deciduous forest bird species. Species limited to this habitat include the Western Tanager and Hairy Woodpecker. The fourth bird community, Black Spruce Bog, was characterized mainly by ground nesting species such as Chipping Sparrow and Lincoln Sparrow. According to the DCA ordination, while the Deciduous community was dissociated from all others, the three other bird communities largely overlapped in both bird species abundance and composition.

The CCA revealed that 10 of the 25 variables contributed significantly to variation in bird species composition and abundance. The three most important vegetation variables were the number of conifer trees, the percent cover of herbs, and the percent cover of shrubs. The CCA showed a distinct gradient of structural complexity in the canopy from treed to treeless sites, and from sites with a high moisture regime to sites with a low moisture regime. Examples of strong relationships between bird species and vegetation variables included Swainson 's Thrush that had higher abundances with increasing moss-lichen percent cover. In contrast, Alder Flycatcher increased in abundance as the amount of bare ground increased. Some examples of generalist species that had intermediate correlation with the vegetation variables are Lincoln Sparrow, Fox Sparrow, and Blackpoll Warbler.

Seven species that are at risk either in the Northwest Territories or in adjacent provinces were detected in the TCPA during the bird survey. According to the North American Landbird Conservation Plan, another thirteen species found in the TCPA are of continental importance in the Northern Forest Avifaunal Biome including two species that are on the Watch List: the Rusty Blackbird and the Olive-sided Flycatcher. The Rusty Blackbird breeds in forested wetlands of the boreal forest, while the Olive-sided Flycatcher occupies mainly recent burns and riparian areas. These habitats occurred in relatively large amounts in the TPCA.

Potential loss of various habitats will likely occur along the Mackenzie River during the proposed Mackenzie Pipeline Project. Most of the habitat types found to be affected by this project are also dominating the TCPA. Conservation of representative landscape and songbird communities within the TCPA is therefore essential to mitigate potential negative impacts of the Mackenzie Pipeline Project.

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Acknowledgments

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Introduction

The Mackenzie Valley of the Northwest Territories contains one the world's last great free-running river systems that are still in a natural state (NWT Protected Areas Strategy Secretariat 2003). The Mackenzie is the longest River in Canada and has both the largest Delta and the second largest wetland in the country (NWT Protected Areas Strategy Secretariat 2003) and it is knows as a major North American migratory corridor for sub-arctic and arctic waterfowl, shorebirds, and songbirds.

The pace of industrial development along the Mackenzie Valley is increasing, principally in regards to the proposed Mackenzie Valley Pipeline Project; one of the largest energy development projects in Canada (NWT Protected Areas Strategy Secretariat 2003). Conserving and developing lands that have ecological and cultural significance in a sustainable manner is becoming ever more challenging (NWT Protected Areas Strategy Secretariat 2003). The Northwest Territories Protected Areas Strategy has been formed to provide an effective community-based tool for advancing culturally and ecologically significant areas to long-term protected status. One of the goals of the conservation plan proposed by this strategy is the planning of new protected regions in the Mackenzie Valley by mapping ecologically representative areas (NWT Protected Areas Strategy Secretariat 2003).

So far, an ecological assessment has been completed for the Edéhzhie Candidate Protected Area (EBA Engineering Consultants Ltd. and CWS 2006) and another one is currently underway for the Ts'ude'hliline-Tuyetah Candidate Protected Area (TCPA). Ts'ude'hliline -Tuyetah was identified in the Sahtu Land Use Plan as a conservation zone and by the Sahtu Heritage Places and Sites Joint Working Group as an area that should be legally protected. The Canadian Wildlife Service has offered to protect Ts'ude'hliline-Tuyetah as a National Wildlife Area because of its' significant wetland complexes that are essential for breeding waterbirds in this area. As part of the ecological assessment of the TCPA, vegetation and songbird surveys were done by the Canadian Wildlife Service in 2005 and 2006. Dendroica Environnement et Faune has been retained to analyse field data and prepare a report for inclusion in final ecological assessment documents.

Goals of this report are to: 1) identify plant communities present in the TCPA based on vegetation characteristics collected at 77 sites within the study area; 2) based on vegetation characteristics collected in the field, assess the accuracy of the Middle Mackenzie Earth Cover Project which is based on Landsat imagery obtained in 1998-1999 (MMECP; Ducks Unlimited Inc. 2006), and 3) identify terrestrial songbird communities based on habitat types found within the study area.

Study area

The Ts'ude'hliline-Tuyetah Candidate Protected Area encompasses approximately 15,000 km^2 and is located on the west bank of the Mackenzie River across from the small community of Fort Good Hope (Figure 1). This area lies within the continuous permafrost zone, and covers portions of four ecoregions or subregions of the Taiga Plains ecozone: Great bear Lake Plain, Fort MacPherson Plain, Peel River Plateau, and Norman Range (Ducks Unlimited Inc. 2006). The topography is relatively flat to rolling throughout most of the study area, except in the southern portion where foothills of the Mackenzie mountain range are present. The Ramparts River watershed which lies in the centre of the Ts'ude'hliline-Tuyetah Candidate Protected Area is considered to be a critical wetland for migratory birds. It provides excellent nesting, brood rearing and staging habitat for ducks, geese and loons, as well as forest songbirds (Northwest Territories Protected Areas Strategy 2003).

The vegetation of the TCPA is typical of the Taiga Plains where open and closed spruce stands dominated by black spruce along with white birch and tamarack, and ericaceous shrubs lichen, is found throughout the landscape (Auld and Kershaw 2006). The major natural disturbance frequently occurring within the TPCA is forest fires (Auld and Kershaw 2006; Ducks Unlimited Inc. 2006).

Methodology

Vegetation survey

Methodology to survey vegetation in the TPCA was previously developed by AMEC Earth & Environmental (2005). In 2005 and 2006, vegetation characteristics were collected in 20 m x 20 m (400 m^2) plots at 77 sites distributed throughout the study area. Sites were chosen according to the proportion of habitat present in the TCPA following the NWT Land Cover Classification and according to the MMECP Classification (Ducks Unlimited Inc. 2006). Sites were selected in homogenous habitat types of more than 100 ha in size, although smaller patches of homogeneous habitat were also used for logistical reasons (AMEC Earth & Environmental 2005). Sites were selected at least 20 m away from any disturbance and at least 20 m away from the edge of other vegetation types to reduce edge effect. In cases where site contours had to be altered to accommodate the natural site dimensions, efforts were taken to maintain plot size at 400 m^2 (AMEC Earth & Environmental 2005).

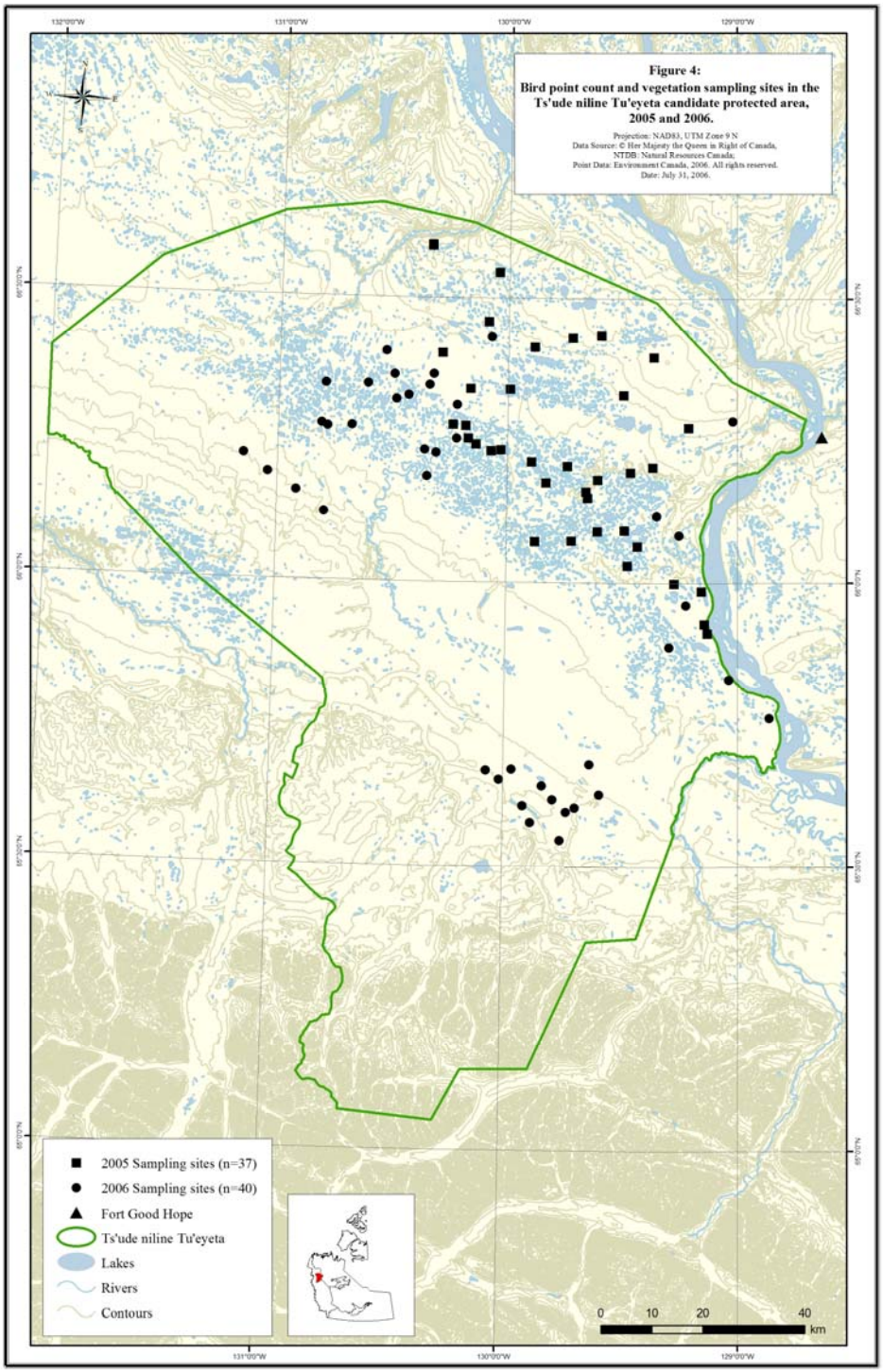

Figure 1: Location of the Ts'ude'hliline – Tuyetah candidate Protected Area, NWT and distribution of 2005 and 2006 vegetation and bird survey sites.

Within each plot, tree species were counted by standing at one point and listing all species observed in each layer. New species were also noted by walking in a spiral pattern within each plot. Percent cover of each tree species as well as height class(1=trees $\geq$ 25 m; 2= trees $\geq$ 20 m $<$ 25 m; 3= trees $\geq$ 10 m $<$ 20 m; 4= trees $\geq$ 2 m $<$ 10 m) and diameter-at breast-height (dbh) were recorded. The percent cover of each tree species in the plot was determined by estimating the percentage of the ground surface covered when the crowns are projected vertically following the methodology in AMEC Earth & Environmental (2005).

All shrubs (including all woody evergreen and woody deciduous plants) within the study plots, were identified and placed in one of two height classes (low shrubs $\leq$1.5 m tall; tall shrubs $<$1.5 m tall and $\leq$ 5 m tall). Shrub percent cover was assessed using the methodology described by AMEC Earth & Environmental (2005).

The percent cover was also estimated for plants (i.e. grasses, sedges, rushes and forbs, bryophytes and lichens), litter, bare ground, moss, and standing water. All percent cover was estimated using a comparison chart for visual estimation of foliage cover. Other variables measured within each plot include moisture regime class (1-8: 1= xeric, 8= hydric), and structural stage class (1-7: 1= sparse bryoid, 7= old forest) based on the methodology found in AMEC Earth & Environmental (2005).

In each plot, coarse woody debris (CWD) abundance was assessed along a transect crossing diagonally from one corner to the other. Each piece of fallen CWD (logs) and standing snags intersecting transects were counted. Decay classes (1 to 5) were assigned to each piece using the classification scheme in AMEC Earth & Environmental (2005). Volume CWD (m3/ha) was calculated using the formula $V = (\pi^2/8l) \sum (n_i d_i^2)$ from Van Wagner (1968), where v is the volume per unit area, l is the total transect length, and n is the number of pieces of diameter d (m). For this study, n = 1 since individual pieces were enumerated and l = 28.28 m (diagonal distance between 2 corners of a 400 m^2 plot). Volume per ha was then calculated as volume per unit area (m) $\times$ 10 000 m2 ha^{-1} ($m^3 ha^{-1}$). We used the following classes to assess CWD diameter: 1:$<$ 2 cm; 2: 3-8; and 3: $\geq$ 8 cm. CWD was divided into three height classes: 1: ground; 2: $<$ 30 cm, and 3: $\geq$ 30 cm.

Twenty- five variables were derived from field vegetation data for inclusion in univariate and multivariate statistical analyses (Table 1).

Table 1: Vegetation variables derived from field vegetation data collected in the Ts'ude'hliline–Tuyetah Candidate Protected area, NWT.

Variable	Description
%TreeC	% tree cover
%ShrubC	% shrub cover
%HerbC	% plant cover
%MosLicC	% moss cover
%LitterC	% litter cover
%BareGrC	% bare ground cover
%WaterC	% water cover
%covconT	% total conifer trees cover (for class 1-4 only), class 5 is less than 2 m)
%covdecT	% total deciduous tree cover (class 1-4)
Dbhcon	Mean dbh of conifer trees (cm)
Dbhdec	Mean dbh of deciduous trees (cm)
Dbhtree	Mean tree dbh (cm)
HtconT	Mean height of conifer trees (m)
HtdecT	Mean height deciduous trees (m)
Httree	Mean tree height (m)
NoconT	No. of conifer tree per ha
NodecT	No. of deciduous tree per ha
TotalnoT	Total no. of trees per ha
Nosnag	No. of snags per unit area (m)
Snagdiam	Median snag diameter (1-3, 1:< 2cm, 2: 2-8 cm, 3: > 8 cm)
Snagrot	Median snag decay class (1-5, 5 being most rotten)
Snaght	Median snag height (1-3, 1: ground, 2:< 30 cm, 3: > 30 cm)
CWDvol	Coarse woody debris volume (m^3/ha)
StrStage	Structural stage (classes 1-7)
MoistReg	Moisture regime (1-8; 1=xeric – 8=hydric)

Songbird survey

Forest songbirds were surveyed once in June of 2005 and 2006 using the point count technique (Ralph et al. 1995). At each site, three point counts were spaced 300 m apart in a triangular manner following the methodology prescribed by AMEC Earth & Environmental (2005). When possible, point-count stations were positioned at least 100 m from a habitat edge to reduce edge effects. Point counts were also located in areas of homogeneous vegetation types that were preselected to be representative of the major vegetation classes in the area. At each point count, vegetation type was visually confirmed within an area of 20 m around the station .

Songbirds were recorded at point count stations using the methodology described in Hobson et al. (2002) and in Rempel et al. (2005). This technique uses the Earthsong E-3A Filed Recorder System and a pair of directional

microphones (CZM Bio-acoustic Microphone) set to record birds in a radius of approximalty 150 m (C. Machtans, pers. comm. 2006). At each point count/recording station, one trained field technician waited for one-minute in silence and then recorded sounds for a period of 10 minutes. Bird songs and calls were recorded on CD and stored in MP3 format for later identification by a skilled interpreter. Double counting was minimized by setting the distance between point counts at 300 m. The survey was conducted from one half hour before dawn to approximately four hours after sunrise, depending on weather and temperature conditions. Recording was postponed during periods of high winds or heavy rains when birds are not vocal and calls cannot be distinguished. Site and point count number, date and start time were noted at each point count and all point counts were localized using a handheld global positioning system (GPS) unit (Universal Transverse Mercator [UTM] coordinates, NAD 83).

Outside of recording periods, incidental bird species were also recorded along wildlife transects in between each of the point count stations (AMEC Earth & Environmental 2005). All point counts were localized using a handheld global positioning system (GPS) unit (Universal Transverse Mercator [UTM] coordinates, NAD 83).

Statistical analysis

Description of vegetation communities

We used two-way-indicator-species TWINSPAN analysis (TWINSPAN version 2.3. for Windows; Hill and Šmilauer 2005) to identify and classify sites according to field vegetation variables. We used level 2 division, and cut-levels of 0, 1, 2, 4, 8, 16, 32 and 64.

We used Detrended Correspondence Analysis (DCA), an indirect ordination technique described in ter Braak and Šmilauer (2002), to define sites based on their ecological similarity/dissimilarity from a complex of vegetation variables. The interpretation of DCA is graphical, where sites with similar vegetation community types are clustered closer together in ordination space. To help interpret the DCA, sites were symbolized with their respective TWINSPAN groups. We used all 25 variables in the DCA, but square-root transformed them to reduce skewedness.

Comparison of field vegetation classification with the MMECP classification

To determine if vegetation data collected in the field corresponded to assigned MMECP classification, we compared the distribution of sites obtained in the DCA for field vegetation variables with site distribution obtained from a DCA performed on variables derived from the MMECP classification. The MMECP DCA was produced using four vegetation variables: the coverage (%) of conifer trees, deciduous trees, shrubs, and lichen derived from the decision tree provided by Ducks Unlimited Inc. (2006). Because the decision tree produces a range of percent cover (e.g. $\geq$ 75 % needleleaf, $<$ 75 % needleleaf) for each category, we used median values for all four variables. For example, if the percent canopy cover of a conifer tree estimated at one site was 50 %, we followed the decision tree until we found a category that fit the value measured in the field (in this case, the respective category of percent canopy cover for conifer assigned to the site would be 87.5 %).

In order to determine whether field vegetation data correspond to assigned vegetation classes from the MMECP classification, we compared the correlation between the two DCA matrices using a Mantel test from PC-Ord (McCune and Mefford 1999). We used the Bray Curtis distance with 5000 randomized runs. Positive association between the two data matrices was determined by comparing the observed Z value with the averaged Z value obtained from the randomized runs. If the observed Z value was greater than the averaged Z value then the association between the two matrices was positive or that matrices were similar. A significant association was determined at α = 0.05. Although this test does not permit a fine comparison among vegetation classes, it does give a general idea of the similarity between field vegetation data and assigned vegetation classes from the MMECP classification.

Description of bird communities

Prior to perform any multivariate analysis, point counts from each site were pooled to reduce the effect of pseudoreplication. Summed counts for each species were used in all analysis. We included in the analysis all individual birds regardless of their behavior (i.e. singing or calling). We omitted rare species ($\leq$ 3 detections) from the analysis, as well as bird species that are known to be inadequately surveyed by point count technique. A complete list of all species detected in the study area is provided in Appendix 2.

We used TWINSPAN analysis (Hill and Šmilauer 2005) to classify sites according to bird species composition and abundance. We did not use the TWINSPAN analysis performed on field vegetation because our goal was to classify sites in a biologically meaningful way based on their bird species. We used all TWINSPAN defaults, except for the selection of cut levels which were set at 0,1,2,4, and 8.

We used the DCA to define sites based on bird species composition and abundance. We used DCA in order to interpret sites based on our knowledge of species habitat association. We used a prior classification of sites (i.e. 4 groups) from the previous TWINSPAN analysis to group sites in the ordination to help in the interpretation.

We used direct gradient analysis, Canonical Correspondence Analysis (CCA) which simultaneously employs ordination and multiple regression to statistically test the significance of each explanatory variable in determining bird abundance (ter Braak and Smilauer 2002). This technique allows non-linear, unimodal relationships between bird species abundance and habitat variables to be investigated. The axes are scaled such that the correlation of each environmental variable with an axis can be read directly by drawing a perpendicular line from the axis of interest to the head of the arrow. Therefore, longer arrows are more correlated with the data than shorter arrows. Horizontal and vertical arrows are highly correlated with only one axis, while more diagonal arrows are correlated with both axes. In the ordination space, the position of each bird species relative to each vegetation variables is indicative of its response to that variable. Moreover, the proximity of species to others in the ordination space means that they responded to similar vegetation variables. We used stepwise forward selection and selected significant variables ($P < 0.1$) to rank each variable in terms of its contribution to variation in bird species abundance. Variables were tested using Monte Carlo Permutation with 999 permutations. Vegetation variables were not transformed because they represented different values that may have needed different transformations.

For data handling, we used SPSS 8.0 for Windows (SPSS Inc. 1997); for data analysis we used TWINSPAN (Hill and Šmilauer 2005) and CANOCO 4.5 for Windows (ter Braak and Smilauer 2002).

Results

A total of 14 vegetation classes were observed in the 77 sites within the TCPA in 2005 and 2006 (Table 2). We included 76 sites in the analyses because site # 10 had several missing data. The majority (i.e. $>$ 70 %) of vegetation plots were represented by five vegetation classes: Open Needleleaf-Other, Low

Shrub-Other, Closed Deciduous, Recent burn, and Woodland Needleleaf- Lichen (Table 2). When compared with the percent of the study area that is covered by each classes, Open Needleleaf-Other was surveyed less than its total proportion in the study area while Low Shrub-other, Closed Deciduous, Recent burn and in Woodland Needleleaf- Lichen were surveyed more often than their proportion (Table 2).

Table 2: Proportion of sites surveyed per vegetation class within the Ts'ude'hliline–Tuyetah Candidate Protected Area (based on the MMECP classification, Ducks Unlimited Inc. 2006).

Vegetation class	# sites surveyed	% of sites	% cover within Study area
Open Needleleaf - Other	19	24.7	31.9
Low Shrub - Other	14	18.2	10.9
Closed Deciduous	7	9.1	1.9
Recent Burn	7	9.1	1.8
Woodland Needleleaf - Lichen	7	9.1	11.3
Closed Needleleaf	6	7.8	8.2
Closed Mixed Needleleaf/Deciduous	4	5.2	4.3
Open Needleleaf - Lichen	3	3.9	2.2
Tall Shrub	3	3.9	3.1
Woodland Needleleaf - Other	3	3.9	10.8
Clear Water	1	1.3	4.6
Low Shrub - Lichen	1	1.3	1.6
Open Deciduous	1	1.3	0.4
Open Mixed Needleleaf/Deciduous	1	1.3	1.5
Grand Total	77	100	94.3

Identification of vegetation communities

The TWINSPAN division separated 51 sites with a large component of forested areas that were characterized by high values of mean tree height (hTdecT), number of deciduous trees (NodecT), mean dbh of deciduous trees (dbhdec), and coverage (in %) by deciduous trees (%covdec; Figure 2). The 25 remaining sites were characterized by treeless sites such of those with high values of moss-lichen stands (%moslicC; Figure 2). TWINSPAN analysis separated the field vegetation variables into four end groups or habitat types (Figure 2, Table 3) Group 1 (13 sites) was composed of vegetation classes characterized by recent burns (Table 3) and was categorized as 'Low shrub' habitat (Figure 2). Group 2 (38 sites) was composed of pure coniferous stands such as Black Spruce –Lichen, Black spruce bog and riparian White spruce-Black spruce stands (Table 3) and was called 'Conifer'. Group 3 (19 sites) was

rather composed of tall shrub stands dominated by black spruce and white birch such as old burns in regeneration (Table 3) and was named 'Tall shrub'. Group 4 (6 sites) was composed of closed poplar and open spruce stands (Table 3) and was labelled 'Closed Deciduous' (Figure 2, Table 3).

Univariate comparisons of 21 quantitative variables between the four habitat types indicate that only five variables were significantly different among habitat types, these are shown in Table 4. The volume of CWD was significantly higher in Tall Shrub and Closed Deciduous groups and significantly lower in Low Shrub and Conifer ($F = 5.11$, $df = 3$, $P = 0.003$). The number of conifer trees per ha was significantly lower in Low Shrub habitat types but did not differ between the other habitat types ($F = 5.8$, $df = 3$, $P \leq 0.001$). The total number of trees per ha differed significantly among Low Shrub, Conifer and Tall Shrub habitat types ($F = 7.1$, $df = 3$, ≤ 0.001). Mean dbh of conifer trees was significantly in Tall Shrub compared to all other habitat types ($F = 3.6$, $df = 3$, $P = 0.02$). Finally, the number of snags per unit area was significantly higher in Tall Shrub compared to Low Shrub and Conifer ($F = 4.0$, $df = 3$, $P = 0.01$).

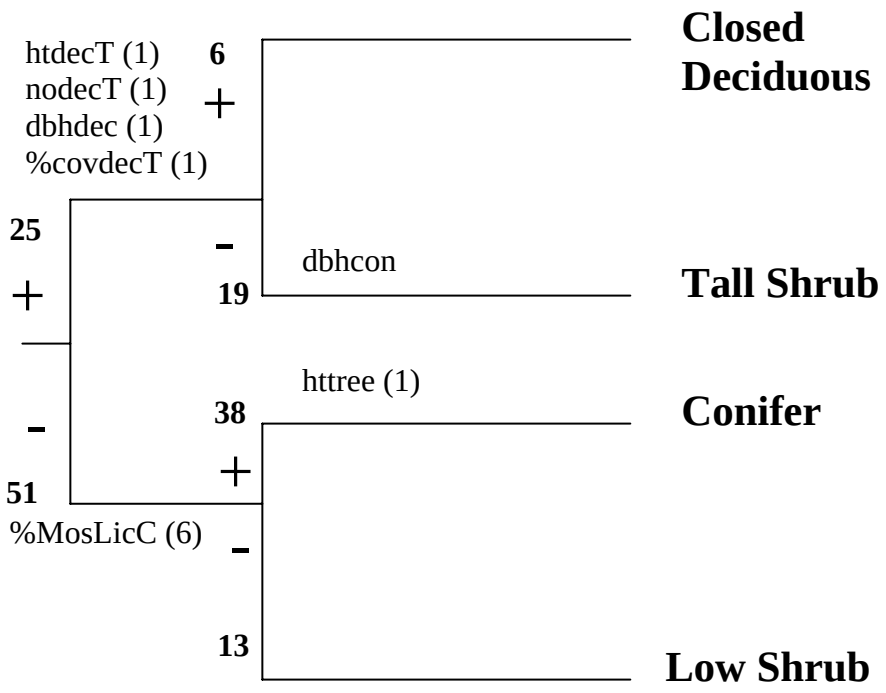

Figure 2: TWINSPAN classification of vegetation variables measured at 76 sites in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT. The vegetation variables listed are indicators for each TWINSPAN division level. Categorized end groups were labeled according to TWINSPAN site classification for each level of division (see Table 3).

Table 3: List of sites classified by their TWINSPAN groups/ habitat types. Field description was based on visually estimating dominant vegetation.

Group 1: Low Shrub		Group 2: Conifer				Group 3: Tall Shrub		Group 4: Closed deciduous	
Site	Field description	Site	Field description	Site	Field description	Site	Field description	Site	Field description
44	open black spruce-moss	1	black spruce-lichen	39	unburned patch of spruce/birch	15	lichen dominant	50	black spruce-lichen
45	–	2	black spruce	42	black spruce bog	18	black spruce bog	53	open spruce-lichen
47	black spruce-lichen	3	black spruce-lichen	49	old burn regent/ birch and tall shrubs	19	birch stand (deciduous)	54	closed poplar
55	birch forest	4	black spruce-lichen	52	black spruce-moss	20	mixed - birch spruce	66	burn
56	low shrub - burn	5	spruce lichen	60	closed spruce forest	25	riparian spruce (white and black)	67	riparian closed poplar forest
57	low shrub – recent burn	7	black spruce-lichen	64	low shrub	26	Riparian spruce	72	black spruce forest
58	low shrub	8	black spruce-lichen	69	low shrub burn	27	birch stand regeneration/birch/alder/willo		
61	tall spruce forest	9	black spruce-lichen-moss	70	black spruce-lichen	28	w regeneration - burn tall		
62	low shrub burn	11	Tall shrub - burn	71	low shrub poplar and tall	29	shrubs		
63	recently burned	12	burn tall shrub lichen	73	shrub	34	fire regeneration		
65	recent burn	13	dominant/black spruce lichen	74	black spruce-lichen	35	regeneration /black spruce/birch		
68	riparian poplar forest	14	dominant with sphagnum mixed - black	75	spruce lichen swamp	36	mixed forest - tall shrub		
76	open spruce lichen	16	spruce lichen and birch	30	regen/birch/spru ce	37	black spruce/lichen area in 30-40 yrs old burn		
		17	black spruce bog	31	black spruce-lichen	38	old burn - mixed forest		
		21	black spruce birch, open mixed forest	32	burn tall shrub	40	black spruce snags		
		22	white spruce/alder	33	burn tall shrub	41	mixed forest		
		23	black spruce riparian forest	46	recent burn	43	black spruce-sphagnum		
		24	black spruce riparian forest	48	Burn- black spruce bog	59	low shrub - burn regeneration		

Table 4: Summary statistics (Mean±SD) of vegetation variables collected in each habitat type in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT. The median values are presented in brackets for each category. Habitat types were determined by TWINSPAN classification based on vegetation data. Significant variables for ANOVA are shown in bold. Multiple comparisons (Tukey test) between groups for significant variables are represented by letters where significantly different values have different letters.

Variable	Low Shrub (13)		Black Spruce-Lichen (38)		Tall Shrub (19)		Closed Deciduous (6)	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
% total conifer trees cover	2.8	6.4	8.5	10.9	6.0	6.6	2.7	3.3
% total deciduous tree cover	5.5	13.3	3.6	13.2	6.0	12.1	18.3	28.6
% tree cover	10.3	13.2	12.7	14.2	15.7	15.6	22.2	25.8
% shrub cover	30.2	11.9	28.7	20.7	35.4	26.6	25.5	14.7
% moss cover	37.5	28.6	26.2	23.6	27.8	30.1	20.3	30.7
% plant cover	5.8	9.3	3.7	5.3	7.6	10.2	3.0	3.8
% bare ground cover	4.6	11.4	4.4	10.3	0.3	1.2	0.8	2.0
% litter cover	14.0	21.5	8.9	17.2	23.3	32.0	30.8	45.4
% water cover	1.1	1.7	0.9	1.3	0.5	1.2	0.3	0.5
Coarse woody debris volume (m^3/ha)	1121.5	1565.0[a]	993.3	1197.1[a]	4158.6	5380.3[b]	2295.4	2240.9[ab]
No. of conifer trees per ha	11.5	16.5[a]	50.7	36.1[b]	56.9	33.0[b]	33.3	37.6[ab]
No. of deciduous trees per ha	9.6	16.3	8.8	14.7	23.6	23.4	12.5	20.9
Total no. of trees per ha	21.2	28.6[a]	59.5	36.5[b]	80.6	40.7[c]	45.8	29.2[ab]
Mean dbh of conifer trees (cm)	2.6	4.0[a]	4.6	4.0[a]	7.3	4.5[b]	3.2	4.0[a]
Mean dbh of deciduous trees (cm)	2.6	5.6	1.9	3.5	5.0	5.8	4.0	6.4
Mean dbh of trees (cm)	4.6	6.0	5.3	4.1	7.3	4.2	7.2	5.1
Mean height of conifer trees (m)	2.6	3.8	3.3	2.4	4.8	4.3	2.0	2.3
Mean height of deciduous trees (m)	4.1	8.4	1.7	3.3	4.9	5.3	2.1	3.6
Mean tree height (m)	5.9	8.2	4.1	2.9	5.2	3.9	4.1	2.9
No. of snags per unit area	0.1	0.1[a]	0.1	0.1[a]	0.3	0.4[b]	0.1	0.2[ab]
Median snag diameter class	6		6		10		10	
Median snag height class	5		5		6		6	
Median snag decay class	2		1		1		1	
Structural stage class	5		5		4		4	
Moisture regime class	5		5		4		5	

The DCA for vegetation communities organized the sites into discrete groups that agreed well with the TWINSPAN classification (Figure 3). The DCA graph shows a clear vegetation gradient from coniferous stands (on the left) to deciduous stands (on the right; Figure 3). Sites from the Tall Shrub habitat type were clustered at the centre of the horizontal axis between Coniferous and Closed Deciduous meaning that those sites share both a coniferous and a deciduous component. The slope of the second axis was generally weak but represents a gradient from treeless areas (i.e. recent burns) to treed areas (Figure 3). Low shrub sites did not show any obvious cluster in the ordination and are distributed at the top, while the three other groups, which have higher tree densities, are closer to the bottom of the vertical axis and represent treed areas.

Distribution of sites in relation to vegetation variables in the ordination space, first suggests an association between vegetation variables related to deciduous forest (Figure 3). The percent cover of deciduous trees, dbh of deciduous trees and number of deciduous trees were associated with sites classified as Deciduous by TWINSPAN (Figure 3). In comparison, sites categorized as Conifer were defined most by a high percent cover of coniferous trees, high number of coniferous trees, and a higher average height of coniferous trees. Variables related to high bare ground cover, high percent cover of shrub and those related to high number of snags were on the other hand more strongly associated with sites classified as Low Shrub (Figure 3).

Variation defined by the DCA for vegetation communities was relatively low and ranged between 28.5 and 61.1 % (Table 5). The gradient length of the first axis (1.7 SD) did not indicate a very strong unimodal response within this restricted subset of data. A value of ≥ 4 would, for example, indicate sites with strong habitat association (ter Braak and Smilauer 1998).

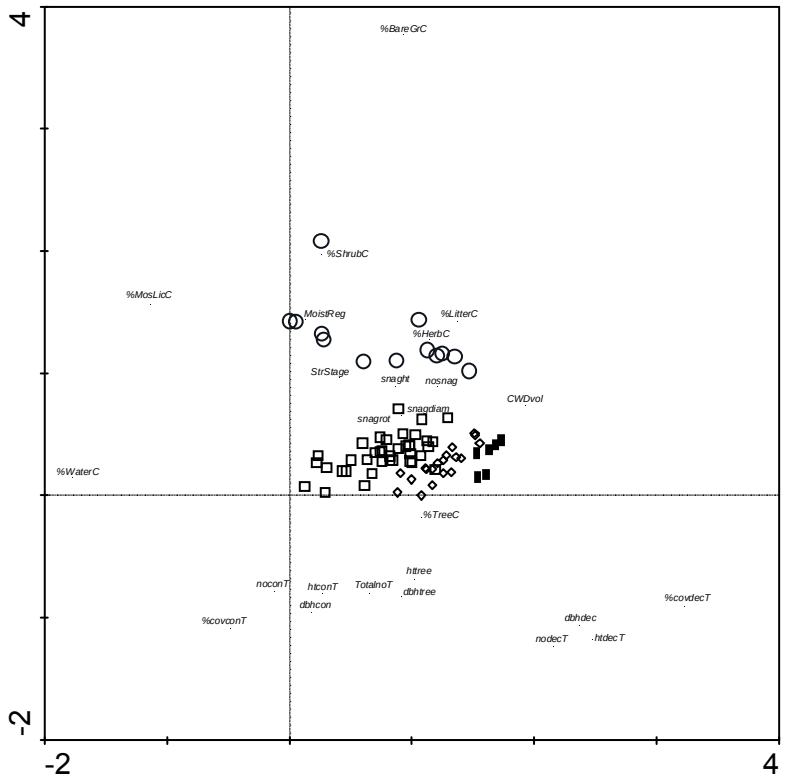

Figure 3: DCA ordination of 76 sites based on vegetation data in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT. TWINSPAN site groups are shown in different symbols. Low Shrub = circles; Black Spruce-Lichen = squares; Tall Shrub = diamonds; Closed Deciduous = black filled rectangles.

Table 5: DCA statistics for vegetation communities in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT.

DCA Statistic	Axis 1	Axis 2	Axis 3	Axis 4
Eigenvalue	0.150	0.097	0.051	0.026
Gradient Length (SD)	1.73	2.09	1.54	1.10
Cumulative % variation explained	28.5	46.9	56.7	61.1

Comparison of field vegetation classification with MMECP classification

The ordination graph of the DCA on vegetation variables derived from the MMECP classification shown in Figure 4, indicates a gradient from open forested areas, on the left of the horizontal axis, to treeless sites on the right. From the top to the bottom, the gradient of the vertical axis is from closed forest stand (such as riparian spruce stands) to open canopy stands. Tall Shrub and Lichen/Open Spruce-Lichen sites are tightly clustered on the right of the ordination, while sites from Low Shrub and Open/closed spruce are clustered on the left (Figure 4).

The variation in the DCA for vegetation communities derived from the MMECP classification is relatively high and varies between 52.2 and 85.6 % (Table 6). The gradient length of the first axis is 1.92 SD indicating a relatively low unimodal response within this restricted subset of data (ter Braak and Smilauer 1998).

There was a positive and significant association between the matrix form by 25 field vegetation (Figure 3) and the matrix form by the four derived MMECP vegetation variables (Figure 4; Standardized Mantel statistic r= 0.12, P= 0,004).

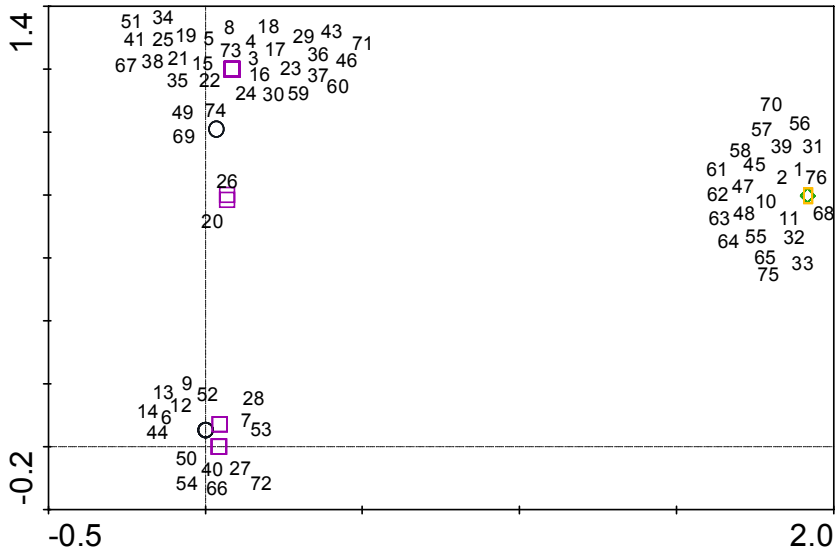

Figure 4: DCA on vegetation variables derived from the MMECP classification for each site surveyed in the Ts'ude'hliline-Tuyetah Candidate Protected Area,NWT. TWINSPAN groups are: Low Shrub = black circles, Open/Closed Spruce = purple squares; Tall Shrub = green diamond; Lichen/ Open Spruce-Lichen = yellow rectangle.

Table 6: Ordination statistics for vegetation communities in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT.

DCA Statistic	Axis 1	Axis 2	Axis 3
Eigenvalue	0.56	0.32	0.05
Gradient Length (SD)	1.92	1.20	1.08
Cumulative % variation explained	52.2	80.9	85.6

Identification of bird communities

Altogether, 2356 individual birds were detected in 228 point counts conducted at 76 sites in 2005 and 2006. A total of 64 species were detected inside and outside of the survey period. This include 44 songbird species, 14 species of waterbirds, four species of woodpecker, one species of ptarmigan, and one species of owl. The six most common species detected during the songbird survey comprised 39 % of the all species detected: Swainson's Thrush (*Catharus ustulatus*), White-crowned Sparrow (*Zonotrichia leucophrys*), Fox Sparrow (*Passerella iliaca*), Lincoln Sparrow (*Melospiza lincolnii*), Chipping Sparrow (*Spizella passerine),* and Yellow-rumped Warbler (*Dendroica coronata*).

Species with less than three detections that were omitted from the analysis were the American Redstart, Common Yellowthroat, Magnolia Warbler, Bohemian Waxwing, Downy Woodpecker, Hairy Woodpecker, Varied Thrush, Western Tanager, Western-Wood Peewee, Yellow-bellied Sapsucker, Le Conte Sparrow and Purple Finch. Waterfowl (4 species), grebes (1 species), ptarmigan (1 species), owls (1 species), rails (1 species), shorebirds (5 species), gulls (1 species), Sandhill Cranes, and the Common raven were also omitted because they are inadequately sampled by the point count technique. A total of 47 species remained for analysis.

Classification of sites based on bird composition and abundance

The TWINSPAN division separated 51 sites with a large component of open black spruce and low and tall shrubs from the remaining stands: these were characterized by high numbers of ground species such as White-crowned Sparrow, Blackpoll Warbler and Lincoln Sparrow (rank 1: Figure 5). The remaining 25 sites were principally black spruce bog and riparian deciduous and mixed stands, and were characterized mainly by large number of Tennessee Warblers (rank 1, Figure 5).

TWINSPAN identified four end-groups which are shown on the right of Figure 5. The first group (28 sites) was composed of vegetation classes characterized by Black Spruce-Lichen sites (Table 7) as suggested by the indicator species, the Ruby-crowned Kinglet. The second group (23 sites) was composed of Shrub sites such as low and tall shrub stands often associated with recent and old burns (Table 7). Indicator species for these sites were the Hermit Thrush, American Robin, Savannah Sparrow, Alder Flycatcher and, Orange-crowned Warbler (Figure 5). Group 3 (15 sites) was composed of Deciduous stands, such as closed poplar stands (Table 7). Yellow Warbler, Northern Waterthrush, Tennessee Warbler and Swainson's Thrush were characteristic inhabitants. The 10 sites in group 4 were associated with Black Spruce Bog, as demonstrated by two indicator species; the Lincoln and Savannah Sparrows (Figure 5).

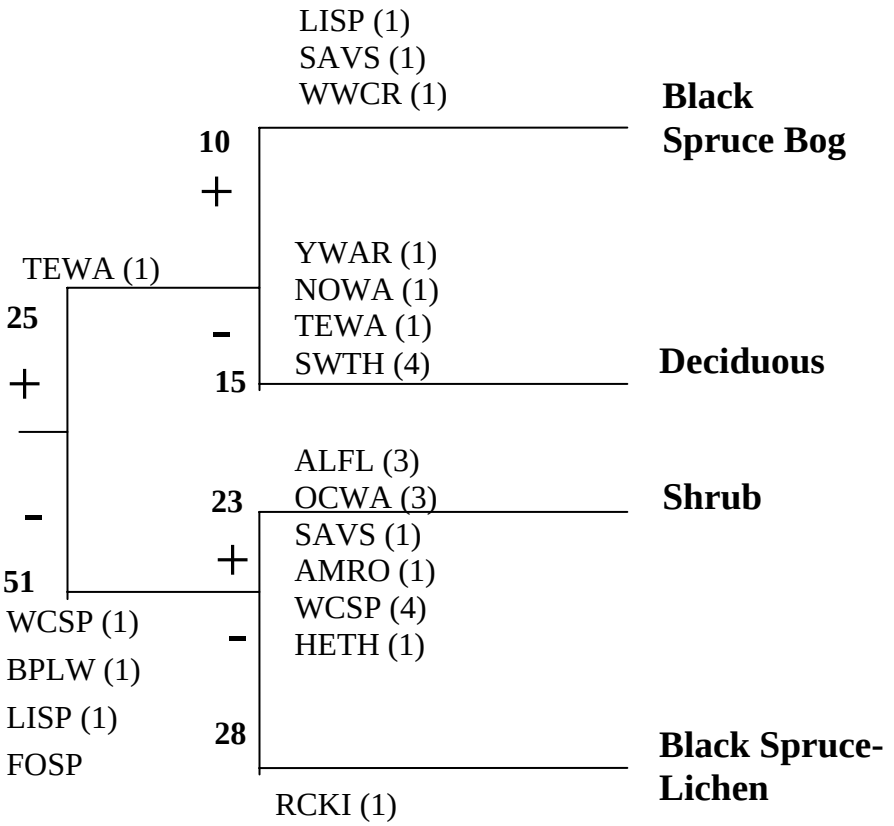

Figure 5: TWINSPAN classification of sites based on bird species abundance (summed bird count) in the Ts'ude'hliline-Tuyetah Candidate Protected Area. Indicator species (rank) are provided for each TWINSPAN division level. Species codes are provided in Appendix 1. Categorized end groups were labeled according to TWINSPAN site classification for each level of division (see Table 7).

Table 7: List of sites classified by their TWINSPAN groups/ habitat types. Field description was based on visual estimation of dominant vegetation.

Black spruce-lichen	Site	Shrub	Site	Deciduous	Site	Black spruce bog	Site
Low shrub-burn	6	Low shrub-burn	33	Deciduous-birch	54	Black spruce bog	17
Black spruce	2	Low shrub-burn	76	low shrub	63	Deciduous-birch	18
Black spruce-lichen	4	Low shrub-burn	55	Closed Poplar	67	Riparian black spruce	22
Black spruce	3	Low shrub-burn	56	Poplar-tall shrub	72	Black spruce bog	16
Black spruce	5	Low shrub-burn	58	Closed Poplar	53	Open mixed	20
Black spruce-lichen	7	Low shrub-burn	68	Closed Poplar	66	black spruce-lichen-moss	9
Old burn-mixed forest	37	Deciduous tall shrub burn	11	Riparian spruce	24	Lichen-Moss dominant	13
Black spruce/old burn	39	Low shrub/ black spruce bog	47	Riparian spruce	25	Lichen Dominant	14
Black spruce	46	Low shrub	57	Deciduous-birch	26	Black spruce- lichen	69
Black spruce	8	Recent burn	45	Riparian birch forest	50	Black spruce bog	41
Black spruce-sphagnum	42	Deciduous tall shrub	48	white spruce/alder	21		
Black spruce-lichen	52	low shrub burn	61	tall shrub-burn	28		
Closed spruce	59	tall shrub – burn	10	Mixed regeneration	29		
Black spruce	71	Burn	65	Black spruce-lichen	27		
Black spruce-lichen/bog	74	Mixed- black spruce/birch	15				
Low shrub	70	Mixed- black spruce/birch	19				
Black spruce	73	recent burn	64				
Black spruce	30	Regeneration mixed	34				
Black spruce-sphagnum	43	Mixed forest	35				
Black spruce lichen	49	Low shrub-burn	31				
Open spruce lichen	75	Low shrub-burn	32				
Black spruce-lichen	1	Mixed	40				
Lichen dominant	12	Low shrub-burn	62				
Riparian black spruce	23						
Tall spruce	60						
Mixed spruce/birch	38						
Not classified	44						
Black spruce-sphagnum	51						

When the total number of individuals per species was considered, Deciduous and Black Spruce Bog had the highest bird species richness while Black Spruce-Lichen and Shrub had the lowest (Figure 6).

Comparison of species relative abundance indicates that species composition was characterized by a few very abundant species such as the Fox Sparrow and Swainson's thrush (Table 8). Each habitat type hosts distinct bird communities. Black Spruce-Lichen habitat type was characterized mainly by ground and tree species such as Fox Sparrow, Swainson's thrush and White-crowned Sparrow. The Purple Finch, Varied Thrush and Pine Siskin occurred only in Black Spruce-Lichen (Table 8).

Ground and shrub dwelling birds constituted the bird community of the Shrub habitat type (Table 8); including three ground nesting species, the White-crowned, Lincoln, and Fox Sparrows. Le Conte's Sparrow was the only species found specifically in shrub habitat.

The Deciduous habitat type was characterized by mixed and deciduous bird species such as Swainson's Thrush, Chipping Sparrow and Yellow-rumped Warbler (Table 8). Species specific to this habitat include the Western Tanager, Common Yellowthroat, and Hairy Woodpecker.

Ground nesting species such as Chipping, Savannah, and Lincoln Sparrows characterized the songbird community of Black Spruce Bog (Table 8). These species, along with Bohemian Waxwing and American Tree Sparrow, reached their highest abundance in this habitat. In contrast with other habitat types, no species specifically occurred in Black Spruce Bog that did not occur elsewhere.

Table 8: Mean relative abundance of bird species in four habitat types in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT. Data are summarized from 150-m radius point counts grouped by TWINSPAN analysis (classification of sites by their summed bird counts).

Species	Species code	Black spruce-lichen (n=28)	Shrub (n=23)	Deciduous (n=15)	Black spruce bog (n=10)
Fox Sparrow	FOSP	11.50	7.07	6.52	5.11
Swainson's Thrush	SWTH	10.15	7.07	12.50	6.81
White-crowned Sparrow	WCSP	9.89	12.41	4.35	5.96
Blackpoll Warbler	BPLW	6.93	4.04	1.90	1.70
Yellow-rumped Warbler	YRWA	6.05	3.75	7.07	5.53
Yellow Warbler	YWAR	5.92	5.34	2.99	2.13
Lincoln's Sparrow	LISP	5.18	9.52	3.53	7.23
Northern Waterthrush	NOWA	4.37	3.75	7.07	2.55
Ruby-crowned Kinglet	RCKI	4.17	2.60	2.99	1.28
Orange-crowned Warbler	OCWA	4.03	5.05	4.35	6.81
Common Redpoll	CORE	3.77	2.89	2.17	1.70
Chipping Sparrow	CHSP	3.70	3.90	8.97	9.79
Alder Flycatcher	ALFL	3.70	6.93	2.17	5.96
American Robin	AMRO	3.56	4.91	4.62	7.23
Dark-eyed Junco	DEJU	3.36	1.59	3.53	6.38
Gray-cheeked Thrush	GCTH	3.30	1.88	1.36	0.00
Palm Warbler	PAWA	2.15	1.15	2.45	5.11
Savannah Sparrow	SAVS	1.34	4.04	0.54	8.51
Tennessee Warbler	TEWA	1.08	1.15	5.16	2.13
White-winged Crossbill	WWCR	0.94	1.01	0.27	2.13
American Tree Sparrow	ATSP	0.81	2.02	0.00	0.43
Hermit Thrush	HETH	0.81	1.59	2.45	1.70
Olive-sided Flycatcher	OSFL	0.40	0.29	1.09	0.00
Warbling Vireo	WAVI	0.40	0.43	0.27	0.00
Yellow-bellied Flycatcher	YBFL	0.40	0.00	0.27	0.00
Pine Siskin	PISI	0.27	0.00	0.00	0.00
Varied Thrush	VATH	0.27	0.00	0.00	0.00
Bohemian Waxwing	BOWA	0.20	0.00	0.00	0.43
Gray Jay	GRJA	0.13	0.43	1.09	0.85
Least Flycatcher	LEFL	0.13	0.72	0.00	0.00
Magnolia Warbler	MAGW	0.13	0.00	0.27	0.00
Northern Flicker	NOFL	0.13	0.58	0.00	0.00
Purple Finch	PUFI	0.13	0.00	0.00	0.00
Swamp Sparrow	SWSP	0.13	0.43	0.00	0.00
Wilson's Warbler	WIWA	0.13	0.14	0.54	0.85
White-throated Sparrow	WTSP	0.13	1.59	2.17	0.43
Western Wood-Pewee	WWPE	0.13	0.14	0.27	0.00
Yellow-bellied Sapsucker	YBSA	0.13	0.00	0.27	0.00
American Redstart	AMRE	0.00	0.29	0.27	0.00
Cape May Warbler	CMWA	0.00	0.14	0.82	0.00
Common Yellowthroat	COYE	0.00	0.00	0.27	0.00
Downy Woodpecker	DOWO	0.00	0.29	0.00	0.00
Hairy Woodpecker	HAWO	0.00	0.00	0.27	0.00
Le Conte's Sparrow	LESP	0.00	0.14	0.00	0.00
Red-eyed Vireo	REVI	0.00	0.29	1.09	0.00
Red-winged Blackbird	RWBL	0.00	0.43	0.00	1.28
Western Tanager	WETA	0.00	0.00	0.27	0.00

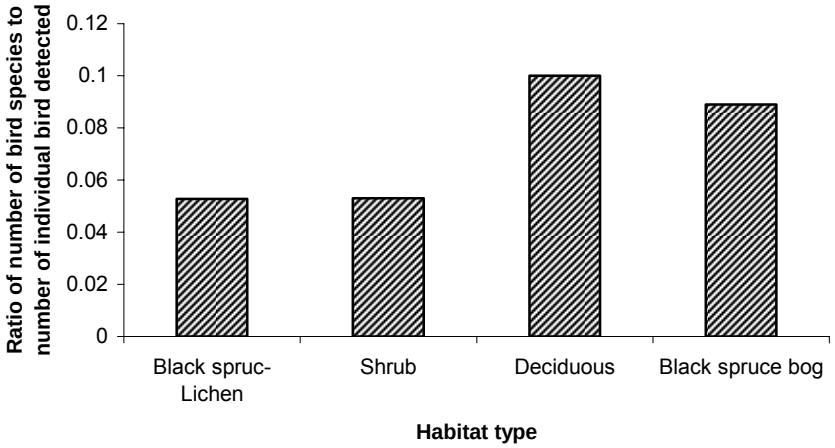

Figure 6: Bird species richness in each of the four habitat types surveyed in the Ts'ude'hliline-Tuyetah Candidate Protected Area. Habitat types are based on TWINSPAN categorization.

In the DCA ordination space, songbird species appear to cluster in a way that is similar to the cluster arrangement of sites. The DCA graph shows a clear community gradient from open burned areas, through black spruce, to closed canopy deciduous and mixed stands (Figure 7). Sites belonging to Black Spruce Bog and Deciduous were obviously dissociated between themselves and between the two other habitat types (Black Spruce-Lichen and Shrub) corresponding to contrasting bird communities. However, sites in the groups Black Spruce –Lichen and Shrub were overlapping greatly (Figure 7), meaning that bird communities were similar in these habitat types.

In particular, black spruce bird communities were defined most by the following species: Ruby-crowned Kinglet, Fox Sparrow, Blackpoll Warbler and White-crowned Sparrow. Shrub communities were best defined by the American Robin, Savannah Sparrow, Hermit Thrush, Alder Flycatcher and Orange-crowned Warbler. Swainson's Thrush, White-throated Sparrow, Tennessee Warbler, Warbling Vireo and Red-eyed Vireo defined Deciduous communities; and Black spruce bog communities were defined most by Lincoln's , Savannah, and Chipping Sparrows (Figure 7).

The variation explained by the DCA is not high (Table 9). The gradient length for the four axes varied between 1.6 to 2.7 (in unit of standard deviations of species turnover), and did not indicate a very strong unimodal response.

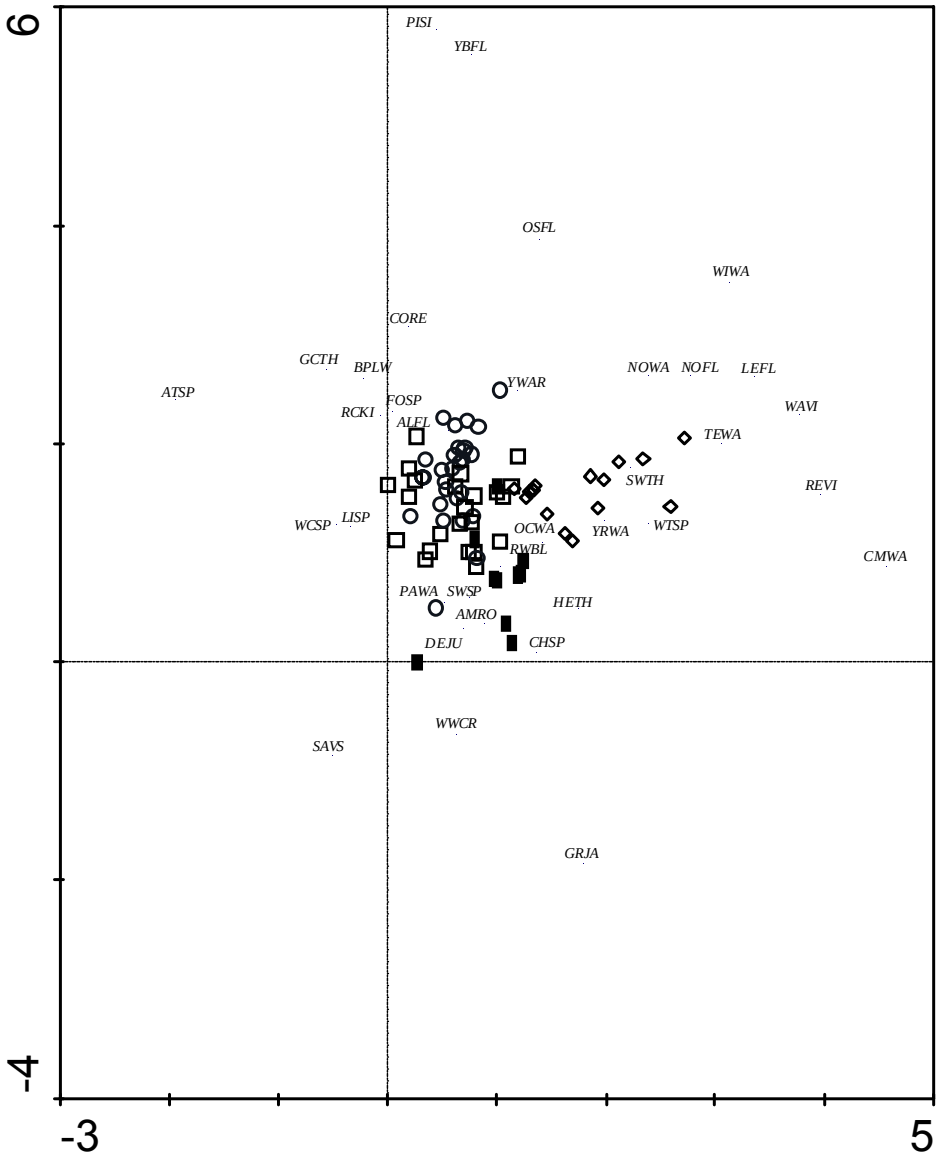

Figure 7: Detrended Correspondence Analysis graph of 76 sites based on summed bird counts (square-root transformed) in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT. TWINSPAN site groups are shown in different symbols. Group 1 (Black Spruce–Lichen) = circles; Group 2 (Shrub) = squares; Group 3 (Deciduous) = diamonds; Group 4 (Black Spruce Bog) = black filled rectangles. Species codes are provided in Appendix 1.

Table 9: Ordination statistics for the CCA and the DCA on bird communities in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT.

		Axis			
		1	2	3	4
Canonical Correspondance Analysis[a]	Eigenvalues	0.118	0.090	0.076	0.059
	R	0.890	0.814	0.786	0.692
	Cumulative species-vegetation relation (%)	7.3	12.8	17.4	21.0
Detrended Correspondence Analysis	Eigenvalues	0.275	0.161	0.115	0.074
	Gradient Length	2.714	2.497	1.704	1.612
	cumulative species variance explained	14.4	22.8	28.8	32.6

[a]CCA performed without outlier sites (i.e. TWINSPAN Group 3- Deciduous) and including only significant vegetation variables

Association between bird species and vegetation variables

Two Canonical Correspondence Analyses were conducted to assess the relationship between bird species and vegetation variables. The first one included the totality of sites (not shown here). The first axis of this CCA corresponded to a gradient between a low percent in deciduous tree cover to a high percent of deciduous tree cover. Bird species that responded positively to an increase of the percent of deciduous tree cover were Red-eyed Vireo and Warbling Vireo. The second axis represented a gradient in the structural stage of coniferous forest (i.e. from low percent of coniferous tree cover to high values of percent of coniferous cover and structural stage classes). Sites clustered on the right of the ordination were primarily those with an important deciduous component. This largely contrasted with all other sites, which were mainly clustered in the centre. This was likely due to the fact that the Deciduous habitat type (Group 3) categorized by TWINSPAN contained only a few deciduous sites

(i.e. riparian poplar stands), and these were very different from the rest of the sites (for example sites characterized either by recent burns or black spruce stands). This effectively 'pulled' the entire ordination towards deciduous sites in the same way outliers would.

To better assess the effect of a vegetation gradient on bird species, a second CCA was performed on all sites except the ones from group 3 which we believed were acting as outliers and were affecting the whole ordination. The second CCA (Figure 8) revealed that 10 of the 25 variables contributed significantly to variation in bird species composition and abundance (Table 10). The three most important vegetation variables were the number of conifer trees, the percent cover of herbs, and the percent cover of shrubs.

The first axis of the CCA was negatively correlated with increasing structural stage class and number of conifer trees, and moderately correlated with increasing moss-lichen cover (Figure 8). It was highly positively correlated with increasing percent of bare ground cover, and moderately correlated with increasing shrub cover. The CCA therefore showed a distinct gradient of structural complexity in the canopy from treed sites (e.g. Black Spruce-lichen) to treeless sites (e.g. low shrub burns) on the horizontal axis. Using the biplot interpretation rule, Swainson 's Thrush and the Ruby-crowned Kinglet had higher abundances with increasing moss-lichen coverage and a strong response relative to other bird species (Figure 8). Conversely, the Alder Flycatcher, Orange-crowned Warbler, and Yellow Warbler increased in abundance as the percent cover of bare ground increased.

The second axis of the CCA was highly negatively correlated with an increase in moisture regime, and an increase in herb cover, but was moderately correlated with an increase in the number of snags (Figure 8). Our interpretation of this axis gradient is related to an increase of moisture regime from the bottom (i.e. mainly Black Spruce bogs) to the top (i.e. upland spruce stands) of the vertical axis (Figure 8). Songbird species that responded to this gradient included the Grey-checked Thrush and Savannah Sparrow in wetter sites and Red-winged Blackbird, Olive-sided Flycatcher, Pine Siskins, Wilson Warbler, Tennessee warbler and Least Flycatcher in drier sites (Figure 8).

Species located close to the centre of the ordination corresponded to generalist species that have intermediate correlation with the vegetation variables. Examples of such species include the Lincoln Sparrow, Fox Sparrow, Blackpoll Warbler, American Robin and Common Redpoll (Figure 8).

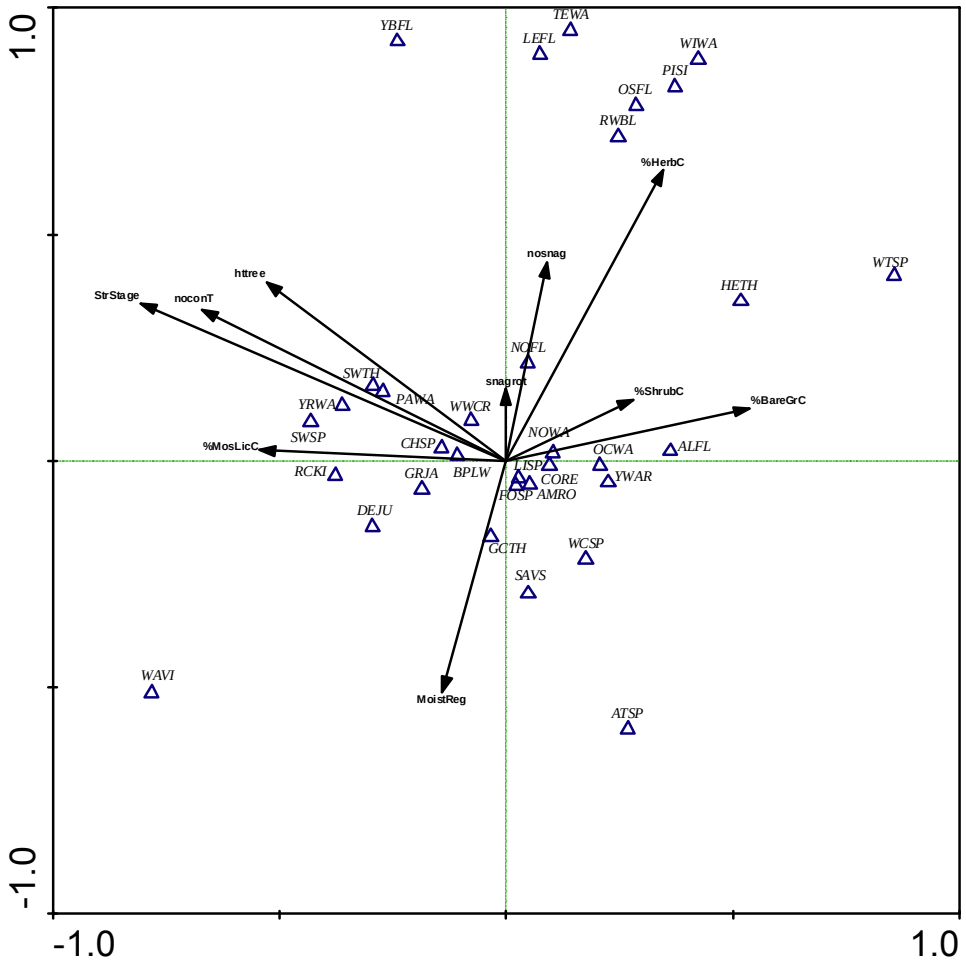

Figure 8: Canonical Correspondence Analysis of bird-habitat relationships in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT. Only significant ($P \leq 0.05$) explanatory variables are shown. The two gradients are from treed to treeless sites on the horizontal axis, and from high moisture regime sites to those with a low moisture regime on the vertical axis. The proximity of a species to any arrow, and its perpendicular distance along the arrow, are measures of the relative influence of explanatory variables. Sites from Group 3 (Deciduous) were omitted for the analysis. Bird species codes are provided in Appendix 1.

Table 10. Importance of explanatory variables in CCA models for birds in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT. Significant variables from a stepwise forward selection are shown in bold characters. TWINSPAN group 3 was excluded from the analysis.

Vegetation variable	SR [a]	TVE [b]	P
% Tree Cover (%TreeC)	18	0.02	0.526
% Shrub Cover (%ShrubC)	4	0.05	**0.017**
% Herb cover (%HerbC)	2	0.07	**0.001**
% Moss/Lichen (%MosLicC)	7	0.04	**0.074**
% Litter Cover (%LitterC)	24	0.01	0.877
% Bare ground (%BareGrC)	5	0.03	**0.07**
% Water (%WaterC)	14	0.02	0.408
% Total cover coniferous trees (%covconT)	11	0.03	0.127
% Total cover deciduous trees (%covdecT)	12	0.03	0.07
Mean dbh conifer (dbhcon)	22	0.01	0.86
Mean dbh deciduous (dbhdec)	19	0.02	0.743
Mean dbh tree (dbhtree)	13	0.03	0.32
Mean ht conifer (htconT)	21	0.02	0.596
Mean dbh deciduous (htdecT)	20	0.02	0.82
Mean tree ht (httree)	10	0.04	**0.044**
No conifer tree /ha (NoConT)	3	0.05	**0.006**
No deciduous tree /ha (NodecT)	23	0.02	0.869
Total no trees /ha (TotalnoT)			
Structural stage (StrStage)	1	0.1	**0.001**
Moisture Regime (MoistReg)	6	0.04	**0.044**
No snags (nosnag)	8	0.03	**0.083**
Median snag diameter (snagdiam)	17	0.02	0.452
Median CWD decay class (Snagrot)	9	0.04	**0.046**
Median snag height (snaght)	16	0.02	0.617
Downed woody material (CWDvol)	15	0.02	0.56

[a] SR = Selection rank from forward selection model in CCA.
[b] TVE = Total variance explained by explanatory variables in model.

Discussion

Description of vegetation communities within the TCPA

Our analysis of vegetation classification for the TCPA revealed a relatively low diversity of habitat types in the TPCA. Generally, the forested landscape varied from treeless stands such as Low Shrub-Lichen and Tall Shrub stands that originated from recent and old forest fires, to coniferous forested areas such as open and closed black spruce stands. Three of the four habitat types obtained from the TWINSPAN were well clustered in the DCA, meaning that these habitat types have distinct plant communities. Sites classified as Low Shrub were not

well clustered in the ordination space, meaning that there was a lot of variability in vegetation structure among them.

According to TWINSPAN, the most prevalent forest type (found at 38 sites) in the study area was Conifer, which included vegetation classes such as Open Needleleaf and Woodland Needleleaf (i.e. black spruce–lichen and black spruce bog). This forest types is usually characterized by 25 - 39 % tree cover dominated by coniferous species such as black spruce (Ducks Unlimited Inc. 2006). This habitat type had among the highest density of conifer trees of all four groups. Tree species were dominated principally by black spruce, white spruce and tamarack. Dominant shrub species included Labrador tea, dwarf birch and mountain cranberry. Lichens such as *Cladina* and *Cladonia* spp. and sphagnum mosses dominated the ground cover.

The second most abundant habitat type within the study area was characterized by Tall Shrub habitat types (25 % of survey sites). Tree cover was low to absent in this group (i.e. ≤ 10 % of the cover) and shrub species (usually ≥ 1,3 m tall) dominate the shrub layer with more than 25-100 % of the cover (Ducks Unlimited Inc. 2006). Dominant shrub species include green alder, Labrador tea, and mountain cranberry. Tall shrub sites also tend to have a greater volume of CWD than the other habitat types. Volume of CWD was highest in this habitat type principally due to the occurrence of forest fire. Relative to its proportion in the Middle Mackenzie where it represents up to 25 percent of the area (Ducks Unlimited Inc. 2006), tall shrub habitat correspond to a relatively rare habitat type in the TPCA with only 4.7 percent.

Seventeen percent of survey sites (i.e. 13 sites) were characterized by Low Shrub stands. This habitat type was dominated mainly by recent burns, low shrub-lichen, and low-shrub-other. In this habitat type, low shrubs usually make up 25-100 % of the cover and include a wide variety of shrub species such as Labrador tea and dwarf birch (Ducks Unlimited Inc. 2006). Sites classified as Shrub were also characterized by the lowest tree density of all habitat types. The proportion of low shrub habitat types (including Shrub-Other, Low Shrub-Lichen and Recent burn) within the study area represented 17 % which was similar to the value of 13% found for the Middle Mackenzie (Ducks Unlimited Inc. 2006). However, it was lower than in the Norman Wells area, where recent forest fires dominate the landscape (Cooper et al. 2004).

The least abundant forest type found in the study area was represented by closed deciduous stands (7.8% of sites). This forest type was found mainly along riparian areas such as river floodplain and in patches on plateaus (Ducks Unlimited Inc. 2006) and was composed principally of poplar and birch stands. In terms of forest structure, this habitat type was characterized by higher and larger snags than in other habitat types which are important habitat components for various species of cavity-nesting birds in the boreal forest (Savignac 1998; Savignac and Machtans 2006). This habitat type, although relatively rare in the

TCPA, was found at a much higher proportion than in the Middle Mackenzie region, where it represents only 1 % of the area (Ducks Unlimited Inc. 2006). Presence of several rivers and associated riparian zones within the TPCA are likely the cause of the high percent of deciduous stands in this area.

Comparison of field vegetation classification with MMECP classification

According to our analysis, vegetation variables collected at each site during 2005 and 2006 correlate fairly well with the assigned vegetation classes derived from the MMECP classification. This result generally agrees with those of Ducks Unlimited Inc. (2006) for the TCPA. These authors use accuracy assessment tests and error matrices to assess whether field vegetation data correspond to assigned vegetation classes from the MMECP categorization (see Ducks Unlimited Inc. (2006) for more details about the methodology used). For example, accuracy assessment on Paths 60 of the landsat imagery, which account for about 40 % of the TCPA suggests an overall accuracy of 64% (71% if fuzzy logic is used; Ducks Unlimited Inc. 2006). For Path 58 (ca. 20 % of the study area on the eastern section) the accuracy is similar with 70 % (82% if fuzzy logic is used).

Although our results indicated that there is a general correspondence between field vegetation data and assigned vegetation classes from the MMECP classification, accuracy assessment remain a more valid test (Ducks Unlimited Inc. 2006). Several factors prevented us from performing an accuracy assessment on data colleted in the TCPA. Firstly, a minimum number of sites per vegetation class (generally 15) has to be attained in order to provide adequate testing, and any classes that have a very low number of sites should not be attempted (R. Spell, pers. comm. 2007). In this study, for example, only one vegetation class had more than 15 sites. An example of adequate sampling is given by the accuracy assessment conducted by Ducks Unlimited Inc. (2006) for two other areas adjacent to the TCPA for which there were more than 250 sites (R. Spell pers. comm. 2007). A second factor that may have prevented us from using accuracy assessment testing is the fact that data collected during this survey were not collected specifically to perform an accuracy assessment of the MMECP classification (R. Spell pers. comm. 2007). Finally, contrasting actual field vegetation data with the MMECP classification would have likely been biased due to recent changes in large sections of the TCPA (mainly by recent forest fires) since landsat imagery were taken in 1998 and 1999.

Description of bird communities within the TCPA

Species richness

Generally bird species richness estimated for the TCPA was lower than Norman Wells, located at similar latitude (less than 150 km to the southeast). In the TCPA, a total of 64 species were detected, whereas 76 species were detected in the Norman Wells area (Cooper et al. 2004). This lower species richness is not surprising considering the relatively simple habitat structure and the low habitat heterogeneity found in the TCPA. Species richness is usually higher at lower latitudes, where more diversified forests exist (Machtans and Latour 2003).

Generally, species richness across the TCPA differed among habitat types. It was lower in Black Spruce –Lichen and Shrub habitat types, and higher in both Deciduous and Black Spruce Bog. A possible reason for this is the greater vegetation heterogeneity found in these two habitat types. Mature mixed and deciduous stands elsewhere, for example, with well developed shrub and canopy layers, usually have higher species richness (Machtans and Latour 2003). The higher species richness found in bogs is more surprising considering that this habitat has often low species richness relative to other habitat types (Savignac 1998; Machtans and Latour 2003). One possible explanation for this higher species richness is that Black Spruce Bog was among the most heterogeneous habitat found in the TCPA with a relatively well developed plant and shrub layer as well as an open tree layer.

Community structure and species composition

Bird communities in the TCPA were characterized by a few very abundant species found in most habitat types (e.g. Swainson's Thrush, Fox Sparrow and White-crowned Sparrow). The six most common species detected in the TCPA comprised nearly 40 % of all birds detected. Most of these common species were either low shrub or ground nesters. Canopy nesting species such as Red-eyed Vireo were less common in the TCPA and were found mainly in the closed canopy stands along riparian zones, or in mature and unburned stands in upland areas. This pattern of heavy weighting of the community to a few species is also documented in other studies that have been conducted in the Northwest Territories (Machtans and Latour 2003; Cooper et al. 2004).

Although the bird composition for the whole TCPA area was generally similar with to that of Norman Wells area (Table 11; Cooper et al. 2004), it differed in many ways. For example, in the black spruce habitat type, although

species composition is defined by coniferous specialist species, important differences exist in the composition of the five most common species (Table 11). Our study shows that the Fox Sparrow, Swainson 's thrush and White-crowned Sparrow were the most common species in the TCPA, while they were not represented in the top five species in the Norman Wells area. Instead, the Chipping Sparrow, Palm Warbler and Dark-eyed Junco were the most common species (Table 11). Only the Yellow-rumped Warbler, a generalist species of the boreal forest, occurred in the top five of both study areas (Table 11). Although we believe that most of the difference observed between the two areas is caused by differences in habitat structure, it may also be caused, in part, by a difference in the method used to classify sites into habitat classes; NWT land cover classification was used in the Norman wells area instead of TWINSPAN.

Table 11: Comparison between the five most common bird species in the Ts'ude'hliline-Tuyetah Candidate Protected Area and those in the Norman Wells study area (from Cooper et al. 2004). The total number of species for each habitat type are in brackets. Species codes are provided in Appendix 1.

Species rank	Black Spruce-Open		Shrub		Deciduous	
	TCPA (38)	Norman Wells (15)	TCPA (37)	Norman Wells (20)	TCPA (36)	Norman Wells (9)
1	fosp	chsp	**wcsp**	lisp	**swth**	ocwa
2	swth	pawa	lisp	**wcsp**	chsp	**swth**
3	wcsp	deju	fosp	chsp	nowa	**yrwa**
4	bplw	swth	swth	ccsp	**yrwa**	wavi
5	**yrwa**	**yrwa**	**alfl**	**alfl**	fosp	baww

In the Shrub habitat type, bird communities in both study areas seem to be defined by ground nesting and foraging species such as sparrows (Table 13). White-crowned sparrow and Lincoln's Sparrow were the most common species in both study areas. Moreover, Alder Flycatcher, a species that colonizes recent burns is also common to both areas. Species composition in the TCPA differed from the one in Norman Wells by exhibiting a greater abundance of Fox Sparrow and Swainson's Thrush, two species that seems to be overall more abundant in the TCPA than in the Norman Wells area (Table 13).

In the Deciduous habitat type, species that are common to both study areas include the Swainson's Thrush and the Yellow-rumped Warbler. While the Orange-crowned Warbler, warbling vireo and Black-and-white Warbler were relatively rare in the TCPA, they were the most common Deciduous dwelling species occurring in the Norman Wells area (Table 11). Differences in species

composition between the two areas could have been caused, in part, by the low sample size in the Norman Wells study as well as by differences in methodology used in the two studies (Cooper et al. 2004).

Bird-habitat relationships

Our results indicate that the abundance of several bird species nesting in the TCPA was highly correlated with vegetation variables. Vegetation gradients which bird species responded to were described as treed to treeless sites (i.e. low shrub- burn) and from wet spruce bogs to drier upland stands. The abundance of certain bird species was strongly correlated with habitat variables found in specific habitat types. For example, Swainson's Thrush, Palm Warbler and Yellow-rumped Warbler were mostly associated with a higher tree height, more numerous coniferous trees, and a more complex structure stage. The abundance of the Alder Flycatcher was correlated with more bare ground, and these birds were more abundant in low Shrub stands. On the other hand, the Northern Flicker and Olive-sided Flycatcher were strongly associated with the high number of snags found in recent burns. Other species such as the Fox Sparrow, American Robin and Blackpoll Warbler did not show high correlation with vegetation variables, and occurred in most habitat types found in the TCPA.

Species at risk

Seven species that are at risk either in the Northwest Territories or in adjacent provinces (British Columbia and Alberta) were detected in the TCPA during the breeding bird survey. Five of those are considered at risk uniquely in the Northwest Territories (Appendix 3). For example, the Western tanager and the Cape May warbler are judged to be 'Secure' in the Northwest Territories but are designated as sensitive and imperilled in Alberta and British Columbia respectively (Appendix 3). Most of these species are currently experiencing long term population decline or are of high responsibility because they have most of the global population in the Northwest Territories and are sensitive to change in their habitat

According to the North American Landbird Conservation Plan (Rich et al. 2004), thirteen species found in the TCPA are of continental importance in the Northern Forest Avifaunal Biome (Appendix 4). Two species are on the Watch List; the Rusty Blackbird and the Olive-sided Flycatcher (Appendix 4). On a scale of 20, watch list species have the highest vulnerability scoring (combined score of $\geq$ 14) and are the species that should be highly considered for conservation across their entire range (Rich et al. 2004). Eleven species are considered Stewardship Species because of the high proportion of their global population or range within the Northern Forest Avifaunal Biome (Appendix 4).

The Rusty Blackbird is considered of Special Concern in Canada by the COSEWIC due to its long term and continuous decline since 1968 (COSEPAC 2006). It is also on the Watch List of the North American Landbird Conservation Plan (Rich et al. 2004). Although this species was not observed within the TCPA, we believe that this species is likely to occur in the study area due to its relatively high abundance of its preferred habitat: shrubby muskegs and black spruce bog COSEPAC 2006) and because it occurred in many areas along the Mackenzie Valley (Cooper et al. 2004). Two possible reasons for the absence of this species in the study area were the difficulty in surveying this species using conventional bird survey techniques, such as point count (COSEPAC 2006), and the possibility of having confused this species with the Red-winged Blackbird, during recording surveys due to similarities in their calls.

The Olive-sided Flycatcher is another species placed on the Watch List by the North American Landbird Conservation Plan (Rich et al. 2004). Bird Breeding Surveys indicate widespread declines (4.1 % decline/ year) in Canada (Downes et al. 2003). This species occurred on eight occasions in three of the four habitat types in the TCPA. It occurred more frequently in forest stands were water is present, such as riparian areas. This habitat association seems to agree with what is known about the species habitat use ecology (Altman and Sallabanks 2000). Within the boreal forest, this species is most often associated with forest openings, forest edges near natural openings (e.g., meadows, rivers), or human-made openings (e.g., harvest cutblocks). It appears to be dependent on availability of snags or residual live trees for foraging and singing perches in semi-open forest stands as well as early successional forest (Altman and Sallabanks 2000). Olive-sided Flycatchers are strongly associated with the presence of burns; where hunting perches and prey density are high (Hutto 1995; Altman and Sallabanks 2000). Considering that burns are a major component of the TCPA, and that forest fire regularly occurs in this area, the TCPA could provide long term suitable habitat for this species.

Conclusion

Compared to landscape found in southern latitude, TCPA includes a relatively low diversity of habitat types (i.e. four distinct vegetation communities). Habitat structure in the TCPA follows two main vegetation gradients: the first one from coniferous stands to deciduous stands and the second one from treeless areas to treed areas. These habitat types found within the TCPA are representative of the Middle Mackenzie region.

The comparison of field vegetation data and the MMECP classification using multivariate analysis failed to provide conclusive results. However, a review of the work conducted by Ducks Unlimited Inc (2006) using accuracy assessment in the TCPA revealed that landsat imagery corresponded relatively well to vegetation classes present on the ground. We therefore suggest that MMECP

classification be used for future habitat assessment in other candidate protected areas in the NWT. A note of caution is in order, however. If one chooses to use field vegetation to assess the accuracy of the MMECP classification in the future, field technicians must be properly trained to collect vegetation data for specific use in accuracy assessment matrices. Moreover, a sufficient number of sites should be sampled and should be surveyed according to methodology described in Ducks Unlimited Inc. (2006). Finally, future accuracy assessment should be performed using up-to-date landsat imagery in order to take into consideration recent changes in vegetation in the field.

Our results show that the TCPA has diverse songbird communities which can be organized into four distinct groups: Black Spruce–Lichen, Shrub, Deciduous, and Black Spruce Bog. Bird species responded principally to vegetation gradients from treed sites to treeless sites and from sites with a high moisture regime to sites with a low moisture regime.

Potential loss of various habitats will likely occur along the Mackenzie River during the proposed Mackenzie Pipeline Project (Cooper et al. 2004). It is estimated that stands of black spruce and mixed forest, as well as low shrubland stands dependent on fire for regeneration, will be most affected by this project (Cooper et al. 2004). Most of these habitat types dominate the TCPA. Conservation of representative landscape and songbird communities within the TCPA is therefore essential to mitigate potential negative impacts of the Mackenzie Pipeline Project on vegetation and bird communities in the Middle Mackenzie region.

Literature cited

Altman, B., and R. Sallabanks. 2000. Olive-sided Flycatcher (*Contopus cooperi*). *In* The Birds of North America, No. 502 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

AMEC Earth & Environmental. 2005. Guidelines for ecological inventory methods for candidate protected areas in the Northwest Territories. Draft report prepared for Environment Canada. 29 pp.

Auld and Kershaw. 2005. The Sahtu Atlas: Maps and stories from the Sahtu Settlement area in Canada's Northwest Territories. Friesens, Yellowknife, NWT.

Canadian Wildlife Service. 2006. Ts'ude'hliline-Tuyetah Candidate Protected Area: Ecological Inventory Methodology. Unpublished report. Canadian Wildlife Service, Prairie and Northern Region, Yellowknife.

Cooper, J.M., M. Wheatley, P.A. Chytyk, A. Deans, C. Holschuh, and S. M. Beauchesne. 2004. Potential impacts on birds in the Mackenzie Valley from pipeline clearings for the Mackenzie Gas Project. Technical report series Number 442. Canadian Wildlife Service, Prairie and Northern Region, Yellowknife.

COSEWIC 2006. COSEWIC assessment and status report on the Rusty Blackbird (*Euphagus carolinus*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 28 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Downes, C.M., B.T. Collins and M. Damus. 2003. Canadian Bird Trends Web site Version 2.1. Migratory Birds Conservation Division, Canadian Wildlife Service, Hull, Québec.

Ducks Unlimited, Inc. November 2002. *Lower Mackenzie River Delta, NWT, Earth Cover Classification User's Guide*. 67 pp. Ducks Unlimited, Inc., Rancho Cordova, California. Prepared for: Ducks Unlimited Canada, Edmonton, Alberta; Gwich'in Renewable Resource Board, Inuvik, NWT; Government of the Northwest Territories – Department of Resources, Wildlife and Economic Development, Inuvik, NWT; Inuvialuit Game Council, Inuvik, NWT; and the Wildlife Management Advisory Council, Inuvik, NWT. Source: Ducks Unlimited tel: (780) 489-8110.

EBA Engineering Consultants Ltd. and CWS. 2006. Ecological Assessment of the Edéhzhie Candidate Protected Area. In collaboration with Ducks Unlimited Canada and Environment and Natural Resources, Government of the Northwest Territories. 85 pp.

Godfrey, W. E. 1986. The birds of Canada. Rev. ed. Natl. Mus. Nat. Sci., Ottawa.

Hill, M.O. and P. Šmilauer. 2005. TWINSPAN for Windows version 2.3. Centre for Ecology and Hydrology, University of South Bohemia, Huntingdon & České Budějovice.

Hobson, K.A., R.S. Rempel, H. Greenwood, B. Turnbull, and S.L. Van Wilgenburg. 2002. Acoustic surveys of birds using electronic recording: New potential from an omni-directional microphone system. Wildl. Soc. Bull. 30: 709-720.

Hutto, R. L. 1995a. Composition of bird communities following stand-replacement fires in northern Rocky Mountain forests. Conserv. Biol. 9: 1041–1058.

Machtans, C.S. and P.B. Latour. 2003. Boreal forest songbird communities of the Liard Valley, Northwest Territories, Canada. Condor, 105: 27-44.

Machtans, C. Personal communication. 2006. Forest songbird biologist. Canadian Wildlife Service, Prairies and northern region, Yellowknife.

McCune, B. and M.J. Mefford. 1999. Multivariate analysis of ecological data. MJM software, Gleneden Beach, Oregon, USA.

Mulders, D. Personal communication. 2006. Wildlife Technician. Canadian Wildlife Service, Prairies and northern region, Yellowknife.

NWT Protected Areas Strategy Secretariat. 2003. Northwest Territories Protected Areas Strategy: Mackenzie Valley five-year action plan (2004-2009), Conservation Planning for pipeline development. 34 pp.

Ralph, C.J., J.R. Sauer, and S. Droege. 1995. Monitoring bird populations by point counts. General Technical Report PSW. GRT-149. Albany, CA. Pacific Southwest Research Station, Forest Service, US. Department of Agriculture. 187pp.

Rempel, R.S., K. A. Hobson, G. Holborn, S.L. Van Wilgenburg, and J. Elliott. 2005. Bioacoustic monitoring of forest songbirds: interpreter variability and effects of configuration and digital processing methods in the laboratory. J. Field ornithol. 76: 1-11.

Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Iñigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, and T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY. Partners in Flight website. http://www.partnersinflight.org/cont_plan/ (Version: March 2005).

Savignac, C. 1998. Songbird diversity and cavity-nesting bird habitat in the Prophet Territory of Northeastern British Colimbia, 1998. Prophet River Wildlife Inventory Report No. 8. Submitted to Fish and Wildlife Branch, British Columbia Ministry of Environment, Lands and Parks, Peace subregion, Fort St. John, B.C.

Savignac, C. and C.S. Machtans. 2006. Habitat requirements of the Yellow-bellied Sapsucker, *Sphyrapicus varius*, in boreal mixedwood forests of northwestern Canada. Can. J. Zool. 84: 1230-1239.

Spell, R. 2007. Senior Remote Sensing Analyst.Ducks Unlimited, Inc. Rancho Cordova, CA. Personal communication to Carl Savignac via email.

SPSS Inc. 1997. SPSS/PC+. Version 8.0.0 Computer program).SPSS Inc. Chicago.

ter Braak, C.J.F. and P. Smilauer. 2002. CANOCO reference manual and CanoDraw for Windows User's guide to Canoco for windows. Software for community Community Ordination (Version 4.5). Microcomputer Power (Ithaca, NY, USA), 500 pp.

Van Wagner, C.E. 1968. The line intersect method for forest fuel sampling. Forest Science 14: 20-26.

Appendix 1: Species code, common name and scientific name of bird species detected during the 2005-2006 bird surveys of Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT.

Species code	Common name	Scientific name	Species code	Common name	Scientific name
ALFL	Alder Flycatcher	*Empidonax alnorum*	OSFL	Olive-sided Flycatcher	*Contopus borealis*
AMRE	American Redstart	*Setophaga ruticilla*	PAWA	Palm Warbler	*Dendroica palmarum*
AMRO	American Robin	*Turdus migratorius*	PISI	Pine Siskin	*Carduelis pinus*
AMWI	American Wigeon	*Anas americana*	PUFI	Purple Finch	*Carpodacus purpureus*
ATSP	American Tree Sparrow	*Spizella arborea*	RCKI	Ruby-crowned Kinglet	*Regulus calendula*
BOWA	Bohemian Waxwing	*Bombycilla garrulus*	REVI	Red-eyed Vireo	*Vireo olivaceus*
BPLW	Blackpoll Warbler	*Dendroica striata*	RNDU	Ring-necked Duck	*Aythya collaris*
CAGO	Canada Goose	*Branta canadensis*	RNGR	Red-necked Grebe	*Podiceps grisegena*
CHSP	Chipping Sparrow	*Spizella passerina*	RUGR	Ruffed Grouse	*Bonasa umbellus*
CMWA	Cape May Warbler	*Dendroica tigrina*	RWBL	Red-winged Blackbird	*Agelaius phoeniceus*
COLO	Common Loon	*Gavia immer*	SACR	Sandhill Crane	*Grus canadensis*
CORA	Common Raven	*Corvus corax*	SAVS	Savannah Sparrow	*Passerculus sandwichensis*
CORE	Common Redpoll	*Carduelis flammea*	SORA	Sora	*Porzana carolina*
COSN	Common Snipe	*Gallinago gallinago*	SOSA	Solitary Sandpiper	*Tringa solitaria*
COYE	Common Yellowthroat	*Geothlypis trichas*	SPSA	Spotted Sandpiper	*Actitis macularia*
DEJU	Dark-eyed Junco	*Junco hyemalis*	SWSP	Swamp Sparrow	*Melospiza georgiana*
DOWO	Downy Woodpecker	*Picoides pubescens*	SWTH	Swainson's Thrush	*Catharus ustulatus*
FOSP	Fox Sparrow	*Passerella iliaca*	TEWA	Tennessee Warbler	*Vermivora peregrina*
GCTH	Gray-cheeked Thrush	*Catharus minimus*	UNGU	Unidentified Gull	*Larus species*
GRJA	Gray Jay	*Perisoreus canadensis*	VATH	Varied Thrush	*Ixoreus naevius*
GRYE	Greater Yellowlegs	*Tringa melanoleuca*	WAVI	Warbling Vireo	*Vireo gilvus*
HAWO	Hairy Woodpecker	*Picoides villosus*	WCSP	White-crowned Sparrow	*Zonotrichia leucophrys*
HETH	Hermit Thrush	*Catharus guttatus*	WETA	Western Tanager	*Piranga ludoviciana*
LEFL	Least Flycatcher	*Empidonax minimus*	WIPT	Willow Ptarmigan	*Lagopus lagopus*
LESP	Le Conte's Sparrow	*Ammodramus leconteii*	WIWA	Wilson's Warbler	*Wilsonia pusilla*
LEYE	Lesser Yellowlegs	*Tringa flavipes*	WTSP	White-throated Sparrow	*Zonotrichia albicollis*
LISP	Lincoln's Sparrow	*Melospiza lincolnii*	WWCR	White-winged Crossbill	*Loxia leucoptera*
MAGW	Magnolia Warbler	*Dendroica magnolia*	WWPE	Western Wood-Pewee	*Contopus sordidulus*
MALL	Mallard	*Anas platyrhynchos*	YBFL	Yellow-bellied Flycatcher	*Empidonax flaviventris*
MEGU	Mew Gull	*Larus canus*	YBSA	Yellow-bellied Sapsucker	*Sphyrapicus varius*
NHOW	Northern Hawk Owl	*Surnia ulula*	YRWA	Yellow-rumped Warbler	*Dendroica coronata*
NOFL	Northern Flicker	*Colaptes auratus*	YWAR	Yellow Warbler	*Dendroica petechia*
NOWA	Northern Waterthrush	*Seiurus noveboracensis*			
OCWA	Orange-crowned Warbler	*Vermivora celata*			

Appendix 2: List of plant and tree species observed during the vegetation survey in the Ts'ude'hliline-Tuyetah Candidate Protected Area, NWT.

Common name	Latin Name	Common name	Latin Name
American larch	*Larix laricina*	Speckled alder	*Alnus rugosa*
		Three-leaf False Solomon's Seal	*Smilacina trifolia*
Arctic Wintergreen	*Pyrola grandiflora*	Twinflower	*Linnaea borealis*
Arctic Lupine	*Lupinus arcticus*	Viola spp.	*Viola spp.*
Balsam poplar	*Populus balsamifera*	White spruce	*Picea glauca*
Aster spp.	*Aster spp.*		
Black spruce	*Picea mariana*		
Carex spp.	*Carex spp.*		
Cloudberry	*Rubus chamaemorus*		
Common Wintergreen	*Chimaphila umbellata*		
Cotton Grass spp.	*Eriophorum angustifolium (incl. Eriophorum triste)*		
Cranberry spp.	*Oxycoccos quadripetalus*		
Dock spp.	*Rumex spp.*		
Dwarf Red Raspberry	*Rubus pubescens var. pubescens*		
Dwarf scouring rush	*Equisetum scirpoides*		
Equisetum spp.	*Equisetum spp.*		
Fireweed	*Epilobium angustifolium*		
Grass spp. (Poa family)	*Arctagrostis spp.*		
Green alder	*Alnus crispa*		
Greenish- Flowered Wintergreen	*Pyrola chlorantha*		
Labrador Lousewort	*Pedcularis labradorica*		
Mountain Avens	*Dryas spp.*		
Northern Comandra	*Geocaulon lividum*		
Paper birch	*Betula papyrifera*		
Rose spp.	*Rubus spp.*		
Round-leaved Sundew	*Drosera rotundifolia*		
Scouring Rush	*Equisetum hyemale var. affine*		
Sedge	*Carex holostoma*		
Small-flowered Anemone	*Anemone parviflora*		
Small-flowered Columbine	*Aquilegia brevistyla*		
Small Northern Bog Orchid	*Habenaria obtusata*		

Appendix 3: Bid species found in the Ts'ude'hliline-Tuyetah Candidate Protected Area that are considered at risk in the Northwest Territories, British Columbia, Alberta or in Canada.

Species	Northwest Territories[a]	British Columbia[b]	Alberta[c]	Canada[d]
Lesser Yellowlegs	Sensitive	Secure	Secure	Undetermined
White-throated Sparrow	Sensitive	Secure	Secure	Undetermined
American Tree Sparrow	Sensitive	Secure	Secure	Undetermined
Western Tanager	Secure	Secure	Sensitive	Undetermined
Blackpoll Warbler	Sensitive	Secure	Secure	Undetermined
Cape May Warbler	Secure	Imperilled	Sensitive	Undetermined
Rusty Blackbird[e]	May be at Risk	Vulnerable-apparently Secure	Sensitive	Special Concern

[a]NWT species 2006-2010, http://www .nwtwildlife.com
[b]NatureServe 2006, http://www.natureserve.org
[c]Alberta Ministry of Sustainable Resource Development, http://www.srd.gov.ab.ca/fw/wildspecies/search.htm
[d]COSEWIC, http://www.cosewic.gc.ca/fra/sct5/index_f.cfm
[e]Species not detected within the TCPA but known to occur as a confimed breeder in the Sahtu Settlement Area (Auld and Kershaw 2005).

Appendix 4: Bird species found in Ts'ude'hliline-Tuyetah Candidate Protected Area considered to be of continental importance in the Northern Forest Avifaunal Biome (from Rich et al. 2004).

Watch list species[a]	Stewardship species[b]
Rusty Blackbird[c]	Palm Warbler
Olive-sided Flycatcher	Cape May Warbler
	Tennessee Warbler
	White-throated Sparrow
	Alder Flycatcher
	Swamp Sparrow
	Yellow-bellied Sapsucker
	Gray jay
	Lincoln's Sparrow
	Bohemian Waxwing
	White-winged Crossbill

[a]Watch list species= species with highest vulnerability scoring (combined score of ≥ 14 on a 20 scale, Rich et al. 2004).
[b]Stewardship species= species with high proportion of their global population or range within the Northern Forest Avifaunal Biome.
[c]Species not detected within the TCPA but known to be breeding in the Sahtu Settlement Area (Auld and Kershaw 2005).