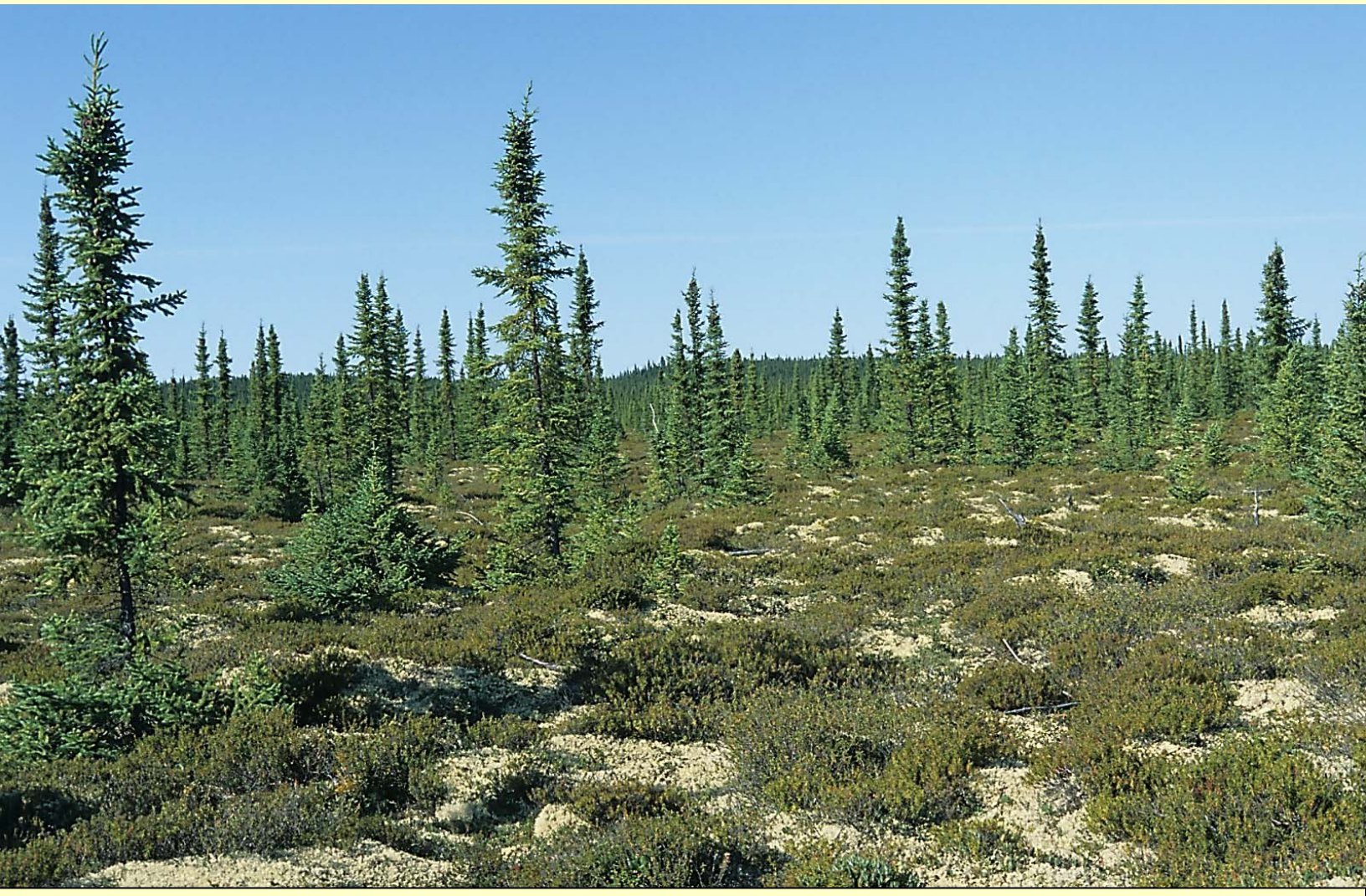
Small Patch Communities of Caribou Mountains Wildland Provincial Park

Lorna Allen, J. Derek Johnson and Ksenija Vujnovic



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Front page: Open Labradour tea / lichen community with scattered black spruce.
Photo by L. Allen

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Introduction

In July 2003 areas within Caribou Mountains Wildland Provincial Park (CMWPP) were surveyed to document small patch ecological communities. Small patch ecological communities add considerably to the diversity of a site, harbouring flora and potentially fauna dependent on these specialized habitats[1]. They are, however, often overlooked in vegetation studies because they are neither extensive nor common enough to be considered representative. The focus of this study was to look within the matrix of the representative ecological communities to find and document the small patch communities that may be significant in a provincial context.

Previous investigations of the vegetation of the Caribou Mountains (by Raup in the 1930s[2,3], Moss in the early 1950s[4,5] and Horton *et al.* in 1979[6]) are summarized in Lee *et al.*[7], along with results from their own field program in 1976 and 1979. Most of this early work was done on the south or east slopes of the Caribou Mountains, including the 1976 surveys. In 1979 they investigated the Horseshoe Lake area on the north side of the plateau. In 1992 approximately 50 kilometres in a more central area, along Rocky Island Creek, Margaret Lake and the Ponton River were explored by canoe[8]. The 2003 field program for the current study was centred in the southeast part of the Caribou Mountains, primarily in the Wentzel Lake area, but with a day spent at Pitchimi Lake, Horseshoe Lake and Rocky Island Lake, as well as an unnamed lake in the northern part of CMWPP.

The Study Area

The Caribou Mountains are a large plateau in north central Alberta (Figure 1) that rises up to 700 m above the surrounding lowlands. The plateau is generally rolling to gently rolling with large depressional areas. The sides of the plateau are for the most part gently sloping, although steeper slopes do occur on the northwest edge. The top itself is classified as occurring within the Boreal Subarctic Natural Subregion, while the slopes and some of the deeper valleys, including the Wentzel Lake valley, are classified as part of the Lower Boreal Highlands Natural Subregion. The total size of the Caribou Mountains, as defined by the subregions, is 14 222 sq. km CMWPP incorporates 5 908 sq. km, or about 41% of the Caribou Mountains proper, primarily in the Boreal Subarctic Natural Subregion, on the top of the plateau (Figure 1). Small areas at the southern edge of CMWPP are within the area classed as the Lower Boreal Highlands Natural Subregion. Wood Buffalo National Park also includes a portion of the Caribou Mountains.

Cretaceous shales and sandstones underlie the Caribou Mountains. Some of the higher hills are capped by Tertiary gravels. Extensive areas are covered by organic soils underlain by permafrost. The peatlands are ombrotrophic to weakly minerotrophic with a rich diversity of peat moss (*Sphagnum* spp.)[6]. Black spruce (*Picea mariana*) forests cover much of the area. While closed stands do occur, they are primarily open and often stunted. Deciduous woodlands dominated by aspen (*Populus tremuloides*) and Alaskan birch (*Betula neoalaskana*) are common only in the Wentzel Lake area, but occur sporadically elsewhere. Lodgepole pine (*Pinus contorta*) stands are abundant on dry ridges, often associated with black spruce[3].

There are several lakes on the plateau, with Margaret, Eva, Rocky Island, Pitchimi and Wentzel lakes being the largest in the Wildland Park. The majority of lakes in CMWPP are unnamed, but one visited during the 2003 survey was given the field name of "Roadrunner Lake". A second has previously been called Horseshoe Lake[7]. The major rivers and lakes in CMWPP are given in Figure 2.

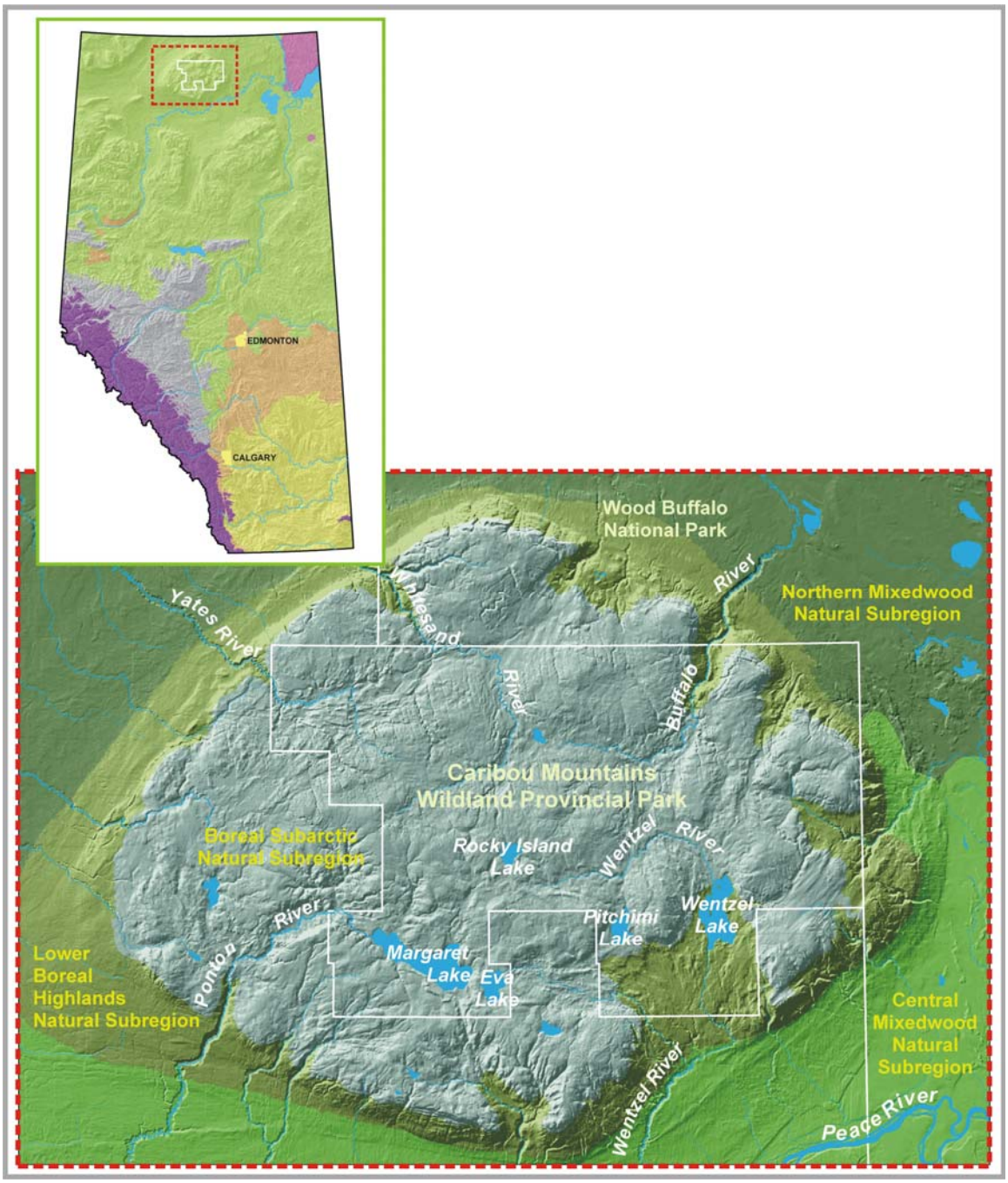

Figure 1. Caribou Mountains Wildland Provincial Park: Location and Natural Subregions.

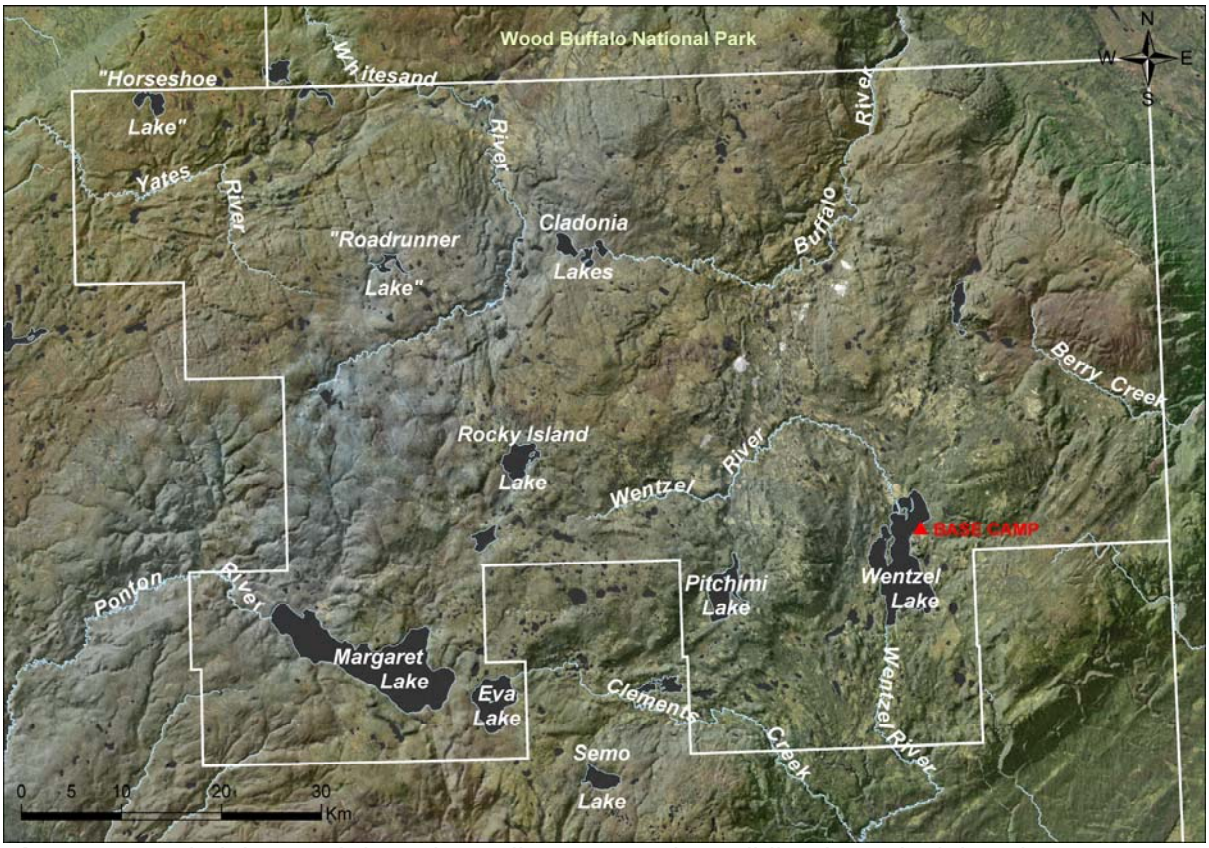

Figure 2. Main lakes and rivers in Caribou Mountains Wildland Provincial Park.

Methods

The focus of this work was to collect information on small patch communities in Caribou Mountains Wildland Provincial Park. Although the information presented here will supplement the information on representative vegetation, emphasis was placed on documenting communities that may be significant in a provincial context.

A literature review was done for sites with similarities to the Wildland Provincial Park, including sites in northern Alberta and the nearby Northwest Territories. Ecological communities or habitats that have been documented as unusual in any way were noted as community types of interest that potentially occur within CMWPP. Wherever possible these community types of interest were linked to habitats that could be picked out on aerial photographs. The types of interest and target habitats are listed in Appendix 1. Also included as types of interest are communities or habitats identified as unusual for the Caribou Mountains in previous studies. These include:

- The patterned fens by Horseshoe Lake (Figure 3) which are the only patterned fens identified in the Caribou Mountains and may have some unusual ecological communities associated with them.
- Deciduous stands which are generally rare in the Caribou Mountains, except in the Wentzel Lake area (Figure 4).
- A few-flowered spike-rush (*Eleocharis quinqueflora*) community type documented in the northwest corner of the Caribou Mountains and considered rare by Lee *et al*.[7]
- Ombrotrophic or weakly minerotrophic pools associated with thaw pockets embedded in the terrestrial landscape. Horton *et al.*[6] considered these unusual in that most pools in mires in Alberta are calcareous.
- Open woodlands of black spruce with a lichen understory that may be rare in the provincial context[9].

The Alberta Natural Heritage Information Centre Preliminary Plant Community Tracking List[10] (TL) is a compilation of ecological communities thought to be of restricted distribution in the province. Types known to occur in the Boreal Forest Natural Region were linked to a habitat, and are listed in Appendix 2.

In total, 41 unusual communities or sites were identified through the literature and tracking list review and linked to target habitats (Appendices 1 and 2). In all, 19 different habitats were recognized as having potential to include one or more of the 41 unusual communities or sites. Appendix 3 summarizes the 19 target habitats. Aerial photographs for the Wildland Provincial Park were then reviewed and all locations of target habitats were marked. Thirteen of the 19 target habitats were considered likely to occur in CMWPP, as noted in Appendix 3, although not all could be located on aerial photographs.

As many target areas as possible were visited during the field program (July 6 - 18, 2003). Sites were reached primarily by foot or by boat. Float plane was used to access three sites: the south shore of Pitchimi Lake, the southeast shore of Horseshoe Lake

and the north shore of the largest lake in township 119, Range 8 W5M (given the field name of Roadrunner Lake).

At least one location of each of the target areas chosen through the preliminary air-photo investigation was surveyed. In most cases, unusual communities were not encountered.

When an ecological community that might be unusual was encountered, a vegetation plot was subjectively placed in a homogeneous location. Site data and floristic composition were documented and the percent cover of each species visually estimated. General locations of detailed vegetation plots are marked on Figure 1. Plot sizes were chosen appropriate to the physiognomy of the vegetation. They are as follows:

- 20 X 20 m for cover values of tree species in forested stands
- 10 X10 m for shrublands and for understory estimates in forested stands
- 5 X 5 m for dwarf shrublands or grasslands

Specimens of difficult taxonomic groups or of unknown species were collected and identified in the camp or pressed for later identification. Scientific names for the most part follow Moss[11], but have been updated to be consistent with the taxonomy used by the Alberta Natural Heritage Information Centre. When taxonomy other than Moss is used, the name found in Moss is included in parenthesis in the discussion of the community type (CT). Common names generally follow Ealey[12], supplemented by Brodo *et al*.[13] for lichens. The methods outlined here are discussed in more detail in ANHIC 2002[14].

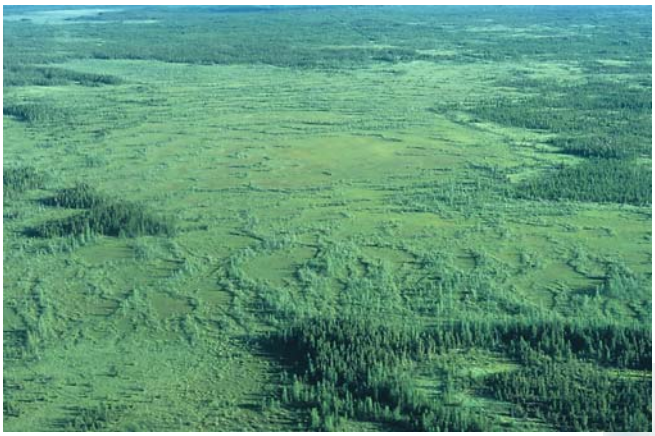

Figure 3. Aerial image of Horseshoe Lake patterned fens (Photo: L. Allen)

Figure 4. Deciduous stands around Wentzel Lake (Photo: L. Allen)

Results

Table 1 summarizes the targeted landscapes that the literature suggested may include some unusual community types and that the aerial photograph review suggested might be expected to occur in CMWPP. Of the 19 target habitats listed in Appendix 3, 13 had potential to occur in CMWPP. If a community type (CT) was located that was considered potentially significant, it is noted in the observations column and documented in further detail in the following section.

Table 1. Target Habitats

Target Habitats	Observations
Uplands	
Deciduous stands	Stands visited, no unusual types noted
Forest openings	No sites located on aerial photographs or noted during field study
Open spruce / lichen stands	Stands visited, CT documented (CT1)
Open pine stands	Stands visited, no unusual types noted
Riparian	
Deciduous stands	Sites visited, no unusual types noted
Shrublands	Sites visited, no unusual types noted
Wetlands	
Beaver ponds, ponds with open water	Sites visited, no unusual types documented. The extensive *Potamogeton praelongus* at Pitchimi and Horseshoe Lakes might be of interest, but could not be accessed in 2003 as no boat was available on those lakes.
Non-patterned fens	Sites visited, no unusual types noted
Tamarack fen	One small stand visited, no unusual types noted
Patterned fen	Southern edge visited, complex documented (CT2)
Protected bays in lakes	Sites visited, no unusual types noted
Sandy shoreline	Sites visited, no unusual types noted
Slow moving streams	Sites visited, no unusual types noted

Ecological Communities Documented

Most habitat types visited during the 2003 survey did not support ecological communities that were considered unusual. In these cases, ecological communities present were simply noted. A short description and discussion of these types is included in Appendix 4, and summarized as follows. Photographs for selected communities are provided in Appendix 5.

As reported in other studies, black spruce was found to be the dominant tree in both upland and wetland habitats in the Caribou Mountains. Feather mosses dominate in the understory of mature upland black spruce stands. More open stands have a strong lichen component. White spruce (*Picea glauca*) tends to be restricted to small stands on levees or other riparian areas underlain by mineral fluvial deposits and without permafrost. Till uplands do occur, primarily in sites within the Lower Boreal Highlands Natural Subregion, such as around Wentzel Lake. On these types of sites, stands of aspen or Alaskan birch are common, usually with a poorly developed understory. Lodgepole pine or mixed pine – black spruce stands on knolls and ridges were reported by both Moss[4] and Raup[3]. These were noted, particularly in the area around Rocky Island Lake, but not investigated. Localized lodgepole pine stands on the sandy substrate of beach ridges adjacent to some of the larger lakes were inspected, and tended to be open with a sparse to absent shrub layer and a dwarf shrub / herb understory dominated by bog cranberry (*Vaccinium vitis-idaea*), often with a significant lichen component dominated by green reindeer lichen (*Cladina mitis*).

The top of the plateau is dominated by peatlands. Raised bogs, usually with open, stunted black spruce communities on permafrost are extensive. Thermokarst collapse scars are common within the bogs. These are always wet, sometimes with open water in the middle, and commonly edged with a sheathed cotton grass / midway peat moss (*Eriophorum vaginatum* / *Sphagnum magellanicum*) community. Horton *et al*.[6] considered the thaw pockets an aquatic habitat and describe them as dominated by floating carpets of pendant branch peat moss (*Sphagnum jensenii*) and shore-growing peat moss (*Sphagnum riparium*), with low mounds of poor fen peat moss (*Sphagnum angustifolium*) in shallow locations and often edged by water sedge (*Carex aquatilis*). Slow-moving drainages, often with no visible water, wind through the peatlands. One in the Pitchimi Lake area was examined. Shore-growing peat moss dominates the wettest sites in the centre of the channel, with poor fen peat moss lining the slightly dryer edges. This grades into a linear community of leatherleaf (*Chamaedaphne calyculata*) hummocks and poor fen peat moss hollows, then back into the open bog community. Occasionally, pools of open water occupy the centre of the channel. These are edged by a floating mat dominated by mud sedge (*Carex limosa*), scheuchzeria (*Scheuchzeria palustris*), russet cotton grass (*Eriophorum chamissonis*) and poor fen peat moss.

Fens and lakes occur in non-permafrost areas. Fens tend to be shrublands, dominated by dwarf birch (*Betula pumila*) sometimes with bog willow (*Salix pedicellaris*) and often with a significant component of water sedge and peat mosses (*Sphagnum* spp.). Occasionally, tamarack (*Larix laricina*) is a significant component. Patterned fens occur in the Horseshoe Lake area and are detailed in Lee *et al*.[7]

Water sedge fens are common adjacent to streams or lakes, with mats of thin-leaved peat moss (*Sphagnum teres*), wide-tongued peat moss (*S. russowii*) and some *S. warnstorfii* along the edges[6]. Lakes in particular often had an abrupt bank of peat just

beyond the zone of ice push. The banks are 1 m or more high, often with mossy seepage areas at the edges. A narrow zone of flat-leaved willow / bluejoint (*Salix planifolia / Calamagrostis canadensis*) may be present along the top of the bank, usually leading back into a raised bog.

Aquatic communities were infrequently encountered. Lee *et al*.[7] reported various-leaved pondweed (*Potamogeton gramineus*) and yellow pond-lily (*Nuphar lutea*) to be the most common aquatic plants, however we found these species infrequently during our study. Our survey documented several locations of clasping-leaf pondweed (*Potamogeton richardsonii*) stands and white-stem pondweed (*P. praelongus*) areas were spotted from the air on Horseshoe and Pitchimi lakes, but not investigated.

Detailed Ecological Community Information

Ecological community types of potential significance are documented in more detail in the following sections. These are:

CT1. *Picea mariana* / *Cladina stellaris* woodland
Black spruce / star-tipped reindeer lichen woodland

CT2. Patterned fen complex

Detailed information for each is presented below, followed by a discussion, an evaluation of the community's significance, and brief recommendations. Several communities are discussed together as part of the patterned fen complex.

CT1. *Picea mariana / Cladina stellaris* woodland
Black spruce / Star-tipped reindeer lichen woodland

Location (Figure 5)

Caribou Mountains Wildland Provincial Park
UTM 11V 646189 Easting 6546901 Northing (NAD 83)

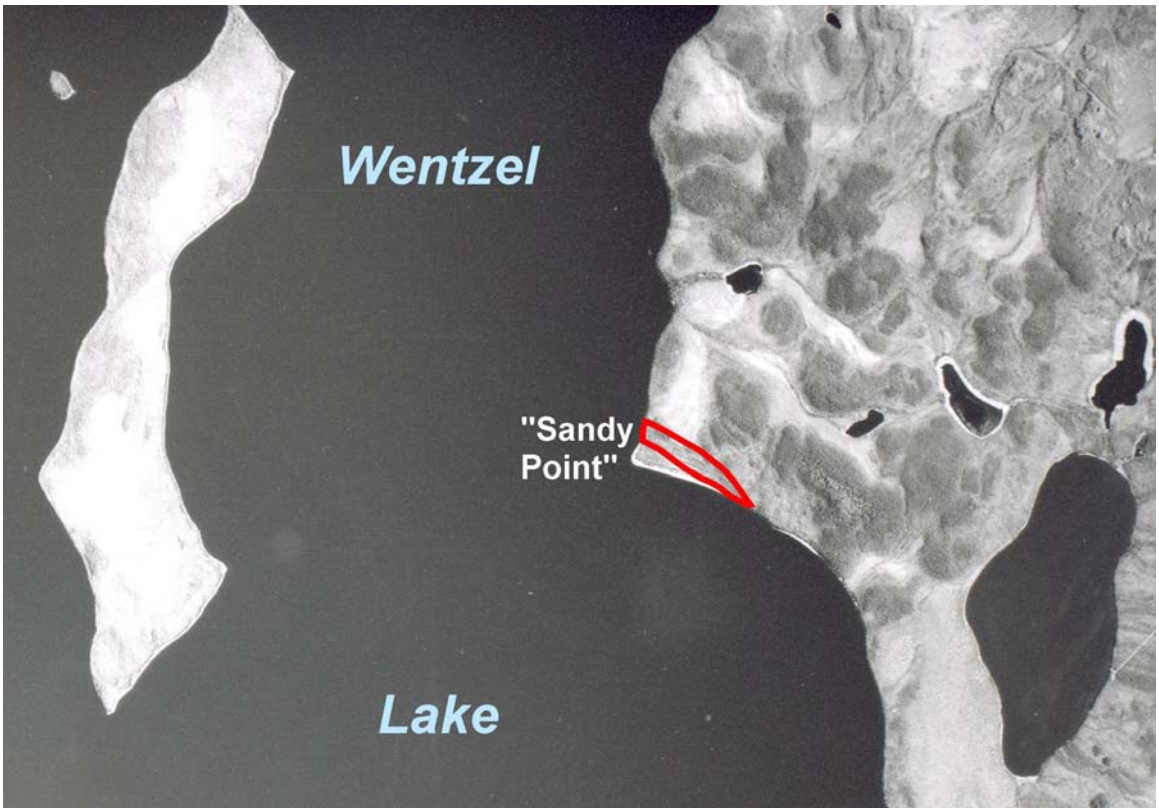

Figure 5. CT1 Occurrence Location

Site description

One stand on the east shore of Wentzel L. behind Sandy Point was studied. *Picea mariana* averaged about 8 m tall, with 20% cover. *Vaccinium vitis-idaea* was present, but with low (2%) cover. Although patches of *Ledum groenlandicum* were present, the understory was strongly dominated by lichens. *Cladina stellaris* was the dominant species, with *Cladina rangiferina* secondary. *Flavocetraria nivalis* also contributed significant cover. *Cladina mitis* was present, but not with significant cover.

Comments

This CT differs from many of the other *Picea mariana* CTs in the area by the lack of *Sphagnum* spp. and the total understory dominance by lichens. Few other species were present and none with significant cover.

Date: July 10, 2003

Species		**Cover (%)**
Scientific name	**Common name**	**Stand**
Trees		
Picea mariana	Black spruce	20
Shrubs		
Ledum groenlandicum	Common Labrador tea	5
Picea mariana	Black spruce	1
Herbs and Dwarf Shrubs		
Vaccinium vitis-idaea	Bog cranberry	2
Lichens		
Overall lichen cover		90
Cladina mitis	Green reindeer lichen	1
Cladina rangiferina	Gray reindeer lichen	10
Cladina stellaris	Star-tipped reindeer lichen	85
Flavocetraria nivalis	Crinkled snow lichen	2

Table 2. Plot data for CT1.

Discussion

Although similar to *Picea mariana / Ledum* spp./ *Cladina mitis*, this CT is restricted to well-drained sites not underlain by permafrost. *Cladina stellaris* becomes the dominant lichen only in older stands (beginning 80 to 120 years after fire)[15].

Significance

Open black spruce woodlands with an understory dominated by lichens are not uncommon in the Boreal Subarctic Subregion, and are relatively widespread in the Caribou Mountains on organic soils. This CT however represents an old growth type on mineral soil with a lichen understory that requires at least 80 years after fire to develop. Due to the extensive fires that are common in the region, this old growth type appears to be relatively uncommon, with only one site encountered during the 2003 survey.

Recommendation

The black spruce / lichen woodland should be recognized as a community of provincial significance and recommended for addition to the tracking list with a proposed rank of S2?. Further surveys are needed to document additional occurrences for this CT and to better characterize the type.

Figure 6. *Picea mariana* / *Cladina stellaris* woodland (Photo: L. Allen)

CT2. Patterned fen complex

Location (Figure 7)

Caribou Mountains Wildland Provincial Park
Patterned fen east of Horseshoe Lake in Twp 120 Rge 11 W5M

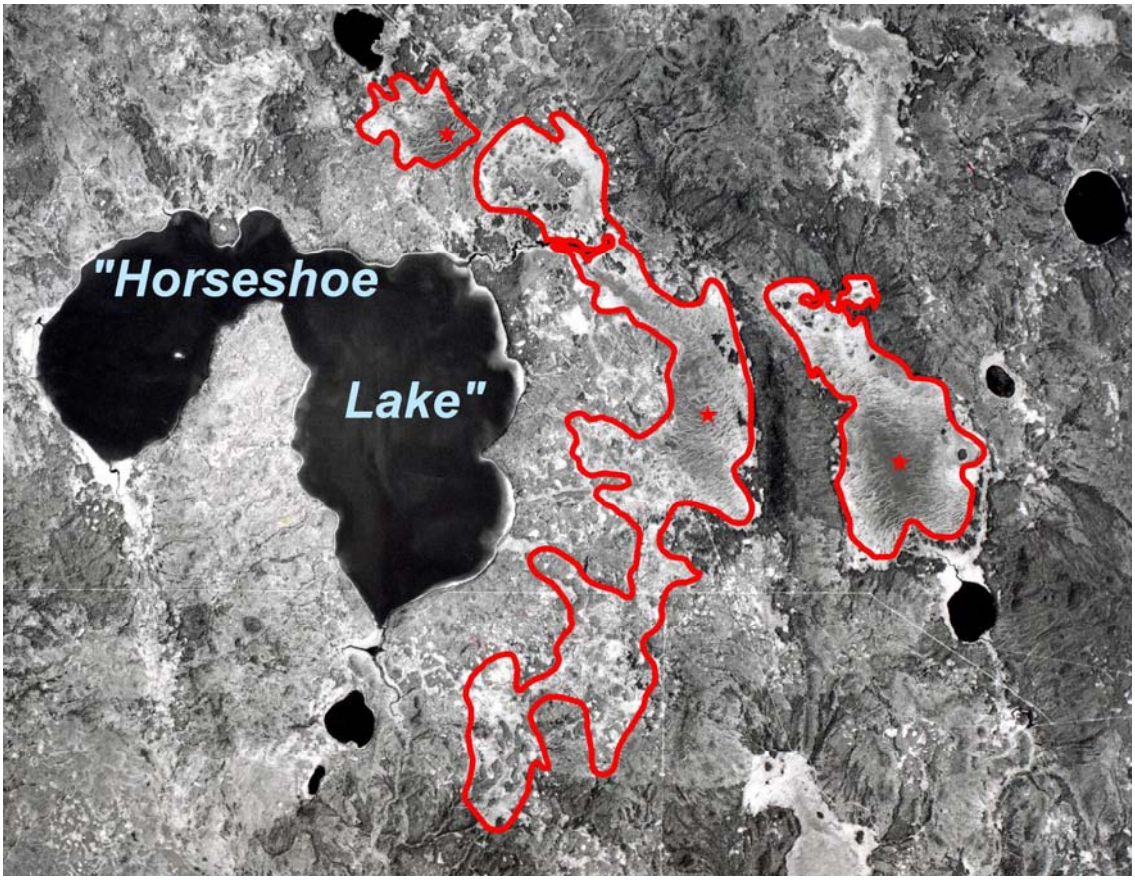

Figure 7. CT2 Occurrence Location (complex outlined in green)
(★ = Main areas of patterning in the fen complex)

Site description

One general location for patterned fens has been documented in CMWPP, in the area east of the lake given the unofficial name “Horseshoe Lake” by Lee *et al.*[7]. This is a wetland complex made up of a mosaic of plant communities that vary depending on water levels, depth to water table and presence of permafrost. The patterned fens themselves are made up of pools (flarks) and peat ridges (strings) with palsas occurring occasionally within the flarks[7]. In 2003, a half-day survey at the southern end of the more western fen area found that a number of permafrost thaw pockets are also part of the wetland complex.

Lee *et al.*[7] studied the patterned fen in detail and documented two flark CTs and two string CTs. The first type of flark they discuss is a *Menyanthes trifoliata* dominated community, with *Scorpidium scorpioides* as the dominant bryophyte, associated with *Limprichtia* (*Drepanocladus*) *revolvens* and *Meesia triquetra*. *Carex limosa* and *Juncus stygius* occur with high frequency. This is a rich patterned fen flark and was also noted in the 2003 survey.

Figure 8. *Carex limosa* flark with *Scorpidium scorpioides* (Photo: J.D. Johnson)

The second type of flark noted by Lee *et al.*[7] is dominated by *Carex limosa* with *Sphagnum jensenii* the dominant bryophyte and *S. lindbergii* present. A similar community was noted during the 2003 survey.

The *Betula glandulosa* string CT type of Lee *et al.*[7] is described as having a dense cover of *Betula* with *Larix laricina, Menyanthes trifoliata, Picea mariana,* and *Salix pedicellaris* also important. The dominant bryophytes are given as *Sphagnum angustifolium* and *S. warnstorfii.* This string type was also noted in the 2003 survey, although the *Betula* species was determined to be *B. pumila*.

A *Sphagnum angustifolium* string CT was the most prominent in the area surveyed in 2003 but was not documented in Lee *et al.*[7]. This is a lower string type of the rich patterned fen areas. *Sphagnum angustifolium* is the most prominent species, with only scattered *Larix laricina, Betula pumila, Salix pedicellaris*, and *S. planifolia*. The strings here were only about 15 cm above the water table. In areas more than 15 cm above the water table, approaching 25-30 cm, *Tomenthypnum nitens* replaces the *Sphagnum angustifolium.*

Figure 9. *Sphagnum angustifolium* strings alternating with *Menyanthes trifoliata* dominated flarks (Photo: J.D. Johnson)

A *Picea mariana* CT was noted in 2003 on very broad, highly elevated (at least 45 cm) strings. *Ledum groenlandicum, L. palustre, Rubus chamaemorus, Sphagnum capillifolium* and *S. fuscum* are dominant components. This fits with the second string CT documented by Lee *et al.*[7], a *Picea mariana / Rubus chamaemorus* CT on strings raised higher above the water table than the *Betula* strings.

Permafrost thaw pockets documented in the 2003 study are poor fens, dominated by *Sphagnum riparium* in the wettest areas, with *S. jensenii* and *S. lindbergii* in slightly drier positions and *S. angustifolium* in the transition area from the thaw pocket to treed tundra. *Sphagnum angustifolium* is most abundant where the transition from the thaw pocket to treed tundra is gradual. *Carex limosa, C. aquatilis* and *Juncus stygius* are the associated graminoids, with scattered shrubs of *Andromeda polifolia* on hummocks. Species diversity increases with decreasing wetness. There is often an abrupt transition between the thaw pocket and the treed areas. The steepest banks (sometimes up to a metre, but averaging 45-60 cm) face the direction of water flow. The permafrost beneath the treed areas acts as a barrier to water movement and the water stagnates (ombrotrophic) as opposed to the flow through system (minerotrophic) in the rich patterned fen. Higher rates of water movement mean a richer mineral environment, hence the rich fens in the areas without permafrost and poor fens in permafrost areas.

Figure 10. Permafrost thaw pocket (Photo: J.D. Johnson).

Lee *et al.*[7] also document the vegetation associated with the peat plateaus that are found within the patterned fen complex. No additional CTs were noted during the 2003 study.

Comments

A *Menyanthes trifoliata* dominated flark, with *Scorpidium scorpioides* as the dominant bryophyte, matches well with the typical flark of a northern ribbed fen[16]. Thaw pockets dominated by *Sphagnum riparium* are characteristic of collapse scars at the edge of collapsing peat plateaus[16].

Sphagnum-dominated strings also occur in the Swan Hills patterned fens[17]. There, in the drier fens, the flarks may also be dominated by *Sphagnum* species, but in the wetter fens, *Warnstorfia (Drepanocladus) exannulata* is the dominant flark species. The patterned fens in the Swan Hills, however, have a different hydrogeology and there is no permafrost. Precipitation is higher in the Swan Hills and the parent material is less minerotrophic. The strings in both are similar in that they are dominated by *Sphagnum angustifolium*, with some *Larix laricina* and *Betula pumila*. Willows (*Salix pedicellaris* and *S. planifolia)* are quite scarce. In the wetter patterned fens in the Swan Hills there is a zone of *Sphagnum jensenii* along the edge of the strings between *S. angustifolium* and *Warnstorfia exannulata,* which dominates the flarks.

At Horseshoe Lake, the flarks are dominated by *Carex limosa*, *Menyanthes trifoliata, Limprichtia revolvens*, *Scorpidium scorpioides*, and *Meesia triquetra*. *Warnstorfia exannulata* is present, but not dominant. In the area we visited, *Hamatocaulis (Drepanocladus) vernicosus* (rather than *Sphagnum warnstorfii* as described by Lee *et al*.[7]) filled in the zone between *Sphagnum angustifolium* and *Limprichtia revolvens*, with *Scorpidium scorpioides* in deeper water. The strings here were only about 15 cm above the water table. In areas more than 15 cm above the water table, approaching 25-30 cm, *Tomenthypnum nitens* replaces the *Sphagnum angustifolium*.

Discussion

Of the CTs noted within the patterned fen complex, two appear to be rare in Alberta; the *Sphagnum riparium - S. jensenii – S. angustifolium* permafrost thaw pockets and the *Sphagnum angustifolium* string CT.

The *Sphagnum riparium - S. jensenii – S. angustifolium* CT of permafrost thaw pockets appears to be an unusual CT, not documented elsewhere in Alberta. The vegetation in these thaw pockets is variable depending on wetness and trophic condition.

The *Sphagnum angustifolium* string CT is documented in Alberta only from the southern part of the Horseshoe Lake fen complex and the Swan Hills[17]. It appears that the fens in the Caribou Mountains are slightly more minerotrophic than those in the Swan Hills, and the make-up of the flarks supports this, in that the flarks in the former are dominated by *Limprichtia* and *Scorpidium*, whereas those in the latter are dominated by *Warnstorfia exannulata. Sphagnum angustifolium* however, has the widest amplitude of any of the peat mosses when it comes to tolerance of mineral salts. The water chemistry in the two areas may not be sufficiently different to preclude the development of *S. angustifolium* as the dominant species on the strings in either one. In terms of their vegetation composition, the strings in the two areas are very similar.

Significance

Patterned fens are relatively common in Alberta, occurring primarily in the Foothills and Boreal Natural Regions[18]. The patterned fens at Horseshoe Lake are unusual in the combination of *Sphagnum*-dominated strings with *Scorpidium scorpioides* dominated flarks. *Sphagnum*-dominated strings do occur in the Swan Hills patterned fens, but the flarks are often also *Sphagnum* dominated.

The juxtaposition of permafrost peatlands and an extreme rich patterned fen could be unique in Alberta. Adding to the significance of the fen complex is the number of rare species found here. This patterned fen complex is the only documented location for purple rattle (*Pedicularis sudetica*) in Alberta. The rare species[19] documented in the patterned fen complex include:

- marsh rush (*Juncus stygius*) and purple rattle in flarks
- bog bilberry (*Vaccinium uliginosum*) on strings and uplands throughout
- Hudson Bay sedge (*Carex heleonastes*) on strings
- small butterwort (*Pinguicula villosa*) on sphagnum mounds
- Lindberg's bog moss (*Sphagnum lindbergii*) in poor fen habitats

In addition, there are two ecological communities of significance, as follows:

- The *Sphagnum riparium - S. jensenii – S. angustifolium* CT has not been documented elsewhere in Alberta and is likely a rare ecological community in the provincial context.
- While *Sphagnum angustifolium* is a common constituent on the strings in many patterned fens, in Alberta, strings dominated by *S. angustifolium* have only been documented in the Caribou Mountains and the Swan Hills.

Recommendation

The *Sphagnum riparium - S. jensenii – S. angustifolium* permafrost thaw pocket CT and the *S. angustifolium* string CT should be recognized as ecological communities of provincial significance and recommended for addition to the ecological community tracking list with a proposed rank of S1S2 for the former and S1 for the latter.

The combination of permafrost peatlands in close proximity to an extreme rich patterned fen may be unique in Alberta and deserves special attention for preservation in any management planning. Rare ecological communities and rare plant species further emphasize the significance of the complex.

Discussion

The Caribou Mountains are predominantly covered by black spruce communities, with peatlands covering over 65% of the Boreal Subarctic landscape[18]. Given the simplicity of the regional vegetation, it is not surprising that few small patch communities of significance were noted. Deciduous woodlands are generally not extensive in the area and it is possible that some of the deciduous community types may be restricted in distribution, but more work is needed to define types and to determine their significance. Other groups that may include significant types are aquatic communities and herbaceous communities, but further work is needed to characterize and document these.

Although Horton *et al.*[6] considered ombrotrophic or weakly minerotrophic pools associated with thaw pockets unusual, thermokarst pools were found frequently in the Caribou Mountains and are common throughout the Upper Boreal Highlands, Boreal Subarctic and Northern Mixedwood subregions of Alberta. Lee *et al.*[7] documented a few-flowered spike-rush (*Eleocharis quinqueflora*) CT that they described as occurring rarely. They described it as dominated by *Eleocharis pauciflora* (synonym for *E. quinqueflora* in current taxonomy), with "lesser amounts of *Betula glandulosa, Sphagnum warnstorfii, Carex limosa* and *Andromeda polifolia.*" Similar types are reported for the Yukon Territory, Alaska[20] and British Columbia[21], where they are considered rare throughout their ranges. The few-flowered spike-rush CT was not relocated during the 2003 survey. This may in part be due to the rarity of the CT on the landscape in combination with the limited areas that were covered in the 2003 survey.

Recommendations

Three plant community types documented in this study are recommended for addition to the Alberta Natural Heritage Information Centre Preliminary Plant Community Tracking List and should be considered as significant features within CMWPP. These are:

CT1. *Picea mariana* / *Cladina stellaris* woodland
Black spruce / star-tipped reindeer lichen woodland

and two discussed in the CT2. patterned fen complex section, as follows:

CT2a. *Sphagnum riparium - S. jensenii – S. angustifolium* permafrost thaw pocket
shore-growing peat moss - pendant branch peat moss - poor fen peat moss permafrost thaw pocket

CT2b. *Sphagnum angustifolium* string
poor fen peat moss string

In addition, although not relocated during the 2003 survey, the few-flowered spike-rush minerotrophic fen CT documented by Lee *et al.*[7] should also be recommended for addition to the tracking list, and considered a significant feature within CMWPP.

Further work is recommended for several community types or groupings of communities noted during the course of this study. These are listed below, followed by the number of the corresponding type(s) as discussed in Appendix 4:

- Aquatic communities in Alberta generally need better documentation (types A1 through A3).

- Marsh communities for the Lower Boreal Highlands and Boreal Subarctic subregions are not well documented. Although some (CTs H1, H2, H3, H10, H11 and H15) are types that are widespread and well documented, further work is needed on others to both characterize them and to determine if they include any provincially significant CTs. This includes types H4, H5, H6 and H9.
- A hairy wild rye (*Leymus innovatus*) dominated CT (H13) was noted. Similar CTs are common in the Foothills and Rocky Mountain natural regions, but more work is needed to define types and evaluate their significance for the Boreal Natural Region.
- Successional community types are generally not well documented (types S3, S5, S11, W5) and it is therefore difficult to make recommendations regarding significance.
- More work is needed to characterize the shrublands found along the creeks and shorelines of lakes (types S4, S6, S8, S9, S10, S12, S14, S15 and S16), although most are likely widespread CTs.
- Limited time was spent at “Roadrunner” Lake. The extensive shrublands on the hills such as S13, should be looked at in detail, as some unusual CTs may occur there.
- One shrubland (S17) had an unusual lichen component. Further work on it, plus two other shrub CTs noted during this study (S2 and S7) is needed to characterize types and determine their significance.
- Birch stands are not well documented in the province and further work is needed to determine if there are some provincially significant CTs (types W1, W2, W3, W4 and mixed stands such as W10).
- Aspen woodlands are generally not extensive in the area, but more work is needed to define types and determine their significance (types W21 through W27).
- While many of the forest/woodland types noted are common and widespread (W7, W8, W9, W11, W12, W13, W15, W17, W19 and W20), types W6 and W18 may be regionally uncommon and require further study to determine their significance.
- W14 is common in the Caribou Mountains, but may be rare in the provincial context. More work in other locations within the Boreal Natural Region is required to determine this.

CMWPP is a large site and the 2003 study looked at only a small part of it. Limited time at Horseshoe and Roadrunner lakes prevented more detailed studies of some sites that are likely significant while many other potentially interesting locations were not accessed at all.

Conclusion

This study concentrated on documenting small patch communities of the Caribou Mountains Wildland Provincial Park. Three provincially significant plant communities were documented and other communities noted. Information gaps still remain on this aspect of the biodiversity of the wildland provincial park, and further work is recommended.

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Appendices

Appendix 1. Unusual communities or habitats that potentially occur in the Caribou Mountains from literature review

Community	Reason	Target Habitat
Aquatic communities	Not well documented, may be some restricted types[22]	Protected bays in lakes
		Slow moving steams
		Small ponds, other open water bodies
Birch and aspen stands	May be some restricted types[22]	Deciduous stands
Eleocharis pauciflora (few-flowered spike-rush) minerotrophic fen	Reported as a rare community of the Caribou Mountains[7]	Fens
Grasslands	Restricted in extent[3]	Forest openings
Grassy, south/southwest-facing slopes	Restricted habitat[23]	Open, south/southwest-facing slopes
Open pine stands	May be some restricted types	Open pine
Open black spruce / lichen	May be unusual in the provincial context[9]	Open black spruce / lichen
Rich fens	May be some restricted types[22]	Fens
Riparian shrublands	May be some restricted types[22]	Riparian* shrublands
Rocky shore	Minor habitat[24]	Rocky shore
Salt meadow	Restricted to a few sites[25]	Saline seepages
Sandy shore	Few vegetated sandy shores[24], may have communities of interest	Sandy shorelines
Thaw pockets	Unusual aquatic habitat embedded in a terrestrial ecosystem[6]	Small ponds

* Riparian is defined here as the terrestrial area where the vegetation is a product of the influence of high water tables associated with adjacent aquatic ecosystems.

Appendix 2. Communities on the Preliminary Plant Community Tracking List[10] that occur in the Boreal Forest Natural Region

Community		SRank	Target Habitat
Scientific name	**Common name**		
Upland Communities			
Amelanchier alnifolia / Arctostaphylos uva-ursi / Oryzopsis pungens	saskatoon / common bearberry / northern rice grass	S2S3	Forest openings
Picea glauca / Cetraria islandica	white spruce / lichen	S1	Open spruce stands, sandy knolls
Populus tremuloides / Rosa acicularis / Apocynum androsaemifolium	aspen / prickly rose / spreading dogbane	SU	Deciduous stands
Populus tremuloides / Rubus parviflorus / Aralia nudicaulis	aspen / thimbleberry / wild sarsaparilla	S2S3	Deciduous stands
Riparian Communities			
Picea glauca / Alnus tenuifolia – Betula neoalaskana / Equisetum pratense / Hylocomium splendens	white spruce / river alder - Alaska birch / meadow horsetail / stair-step moss	S3	Spruce stands, river terraces
Populus balsamifera / Alnus tenuifolia / Cornus stolonifera / Equisetum pratense	balsam poplar / river alder / red-osier dogwood / meadow horsetail	S3	Deciduous stands, river terraces
Populus balsamifera / Rhamnus alnifolia / Equisetum arvense	balsam poplar / alder-leaved buckthorn/common horsetail	S1	Riparian deciduous stands
Populus balsamifera / Viburnum opulus / Matteuccia struthiopteris	balsam poplar / high-bush cranberry / ostrich fern	S1S2	Deciduous stands, river terraces
Populus tremuloides / Salix bebbiana - Corylus cornuta / Calamagrostis canadensis – Matteuccia struthiopteris	aspen / Bebb's willow - beaked hazelnut / bluejoint - ostrich fern	S1	Riparian deciduous stands
Salix drummondiana / Scirpus microcarpus – Calamagrostis canadensis	Drummond's willow / small-fruited bulrush - bluejoint	S1	Riparian shrubland
Wetland communities			
Atriplex subspicata - Puccinellia nuttalliana - Triglochin palustris string fen	spearscale saltbrush - Nuttall's salt-meadow grass - slender arrow grass string fen	S1S3	Patterned fen
Betula neoalaskana / Ledum groenlandicum / Calamagrostis canadensis peatland	Alaska birch / common Labrador tea / bluejoint peatland	SU	Fen

Calamagrostis stricta - Triglochin maritima string fen	narrow reed grass - seaside arrowgrass string fen	S1S3	Patterned fen
Carex limosa - Menyanthes trifoliata - Cardamine pratensis	mud sedge - buck-bean - meadow bitter cress	S1S2	Fen
Carex limosa - Scheuchzeria palustris / Sphagnum teres - S. subsecundum	mud sedge - scheuchzeria / thin-leaved peat moss	S2?	Patterned fen
Carex pseudocyperus - Calla palustris	cypress-like sedge - water arum	S1S2	Beaver ponds, ponds with open water
Cymbella pusilla - Mastogloia smithii - Nitzschia palea	diatom ponds	S1S3	Ponds with open water
Elymus trachycaulus - Distichlis stricta	slender wheat grass - salt grass	S1	Saline seepage
Elymus trachycaulus - Hierochloe odorata	slender wheat grass - sweet grass	SU	Saline seepage
Elymus trachycaulus - Koeleria macrantha	slender wheat grass - June grass	SU	Saline seepage
Glyceria borealis - Sium suave - Sparganium angustifolium	northern manna grass - water parsnip - narrow leaved bur-reed	S1?	Slow moving streams
Isoetes echinospora	northern quillwort	S1	Sandy shorelines
Larix laricina / Carex prairea	tamarack / prairie sedge	S1	Larix fen
Puccinellia nuttalliana – Suaeda calceoliformis – Spergularia marina barren	Nuttall's salt-meadow grass - western sea-blite - salt-marsh sand spurry barren	S2	Saline seepage
Salicornia europaea	samphire	S2	Saline seepage
Salix athabascensis string shrubland	Athabasca willow string shrubland	SP	Patterned fen

Appendix 3. Target Habitats and the likelihood that they occur within Caribou Mountains Wildland Provincial Park

Target Habitats	Number of Associated Communities (from Appendices 1 and 2, above)	Likelihood Target Habitat is present in CMWPP (H = High; L = Low)
Upland Habitats		
Deciduous stands	3	H, documented around the plateau[7]
Forest openings	2	H, hard to spot on photos, but could occur
Open black spruce / lichen	1	H, documented in the Caribou Mtns[3]
Open, graminoid slopes	1	L, none noted in aerial photograph review
Open pine	1	H, documented in the Caribou Mtns[3]
Sand Dune Habitats		
Open spruce stands, sandy knolls	1	L, no dune formations
Riparian Habitats		
Deciduous stands, large river terraces	2	L, no large river terraces
Riparian deciduous stands	2	H, may develop on smaller riparian systems such as along streams
Riparian shrubland	2	H, may develop on smaller riparian systems such as along streams
Spruce stands, large river terraces	1	L, no large river terraces
Wetland Habitats		
Beaver ponds, ponds with open water	4	H, includes thaw pockets, documented in the Caribou Mountains[6].
Fens	4	H
Larix fen	1	H
Patterned fen	4	H, documented by Horseshoe Lake[7]
Protected bays in lakes	1	H
Rocky shore	1	L, requires extensive beaches to develop a distinctive CT.
Saline seepage	6	L, no saline seepages likely given geology and topography
Sandy shorelines	2	H, sandy shores occur on east end of some larger lakes
Slow moving streams	2	H

Appendix 4. Additional ecological communities noted in Caribou Mountains Wildland Provincial Park

No.	Community	Description and Location	Community Distribution and Significance*
Aquatic communities			
A1	*Nuphar lutea*	Patches of *Nuphar lutea* were noted occasionally in locations such as sheltered bays of lakes or in small ponds throughout the area. In most locations, the cover of *Nuphar* was patchy, and *Nuphar* roots appeared to be the main food source for beaver.	Numerous studies document *Nuphar lutea* CTs throughout Alberta's boreal[3,5,26]. Although not commonly encountered in the Caribous Mtns, this is likely a common and widespread CT.
A2	*Potamogeton praelongus*	Big patches of *P. praelongus* were obvious from the air at the south end of both Horseshoe and Pitchimi lakes. Two smaller patches near the mouth of the Wentzel River were entirely dominated by *P. praelongus*.	*P. praelongus* is rare in Alberta (ranked S2)[19], so a *P. praelongus* community would also be rare. The patches at Pitchimi and Horseshoe lakes are the best occurrences noted in the study area, but were difficult to access, so no information on structure or composition of this possible CT is available. Looman[26] recognizes a Potamogetum praelongi Association of boreal, low to medium eutrophic lakes in 4 m water or deeper.
A3	*Potamogeton richardsonii*	An aquatic community dominated by *P. richardsonii* was noted in about 0.5 to 0.7 m deep water in a protected bay on the north shore of Wentzel Lake.	A CT dominated by *P. richardsonii* was documented in La Butte Creek[27] and Colin-Cornwall Lakes[28]. Raup[3] noted a *P. richardsonii - P. gramineus* aquatic community in a slow moving creek in WBNP. Timoney[29] includes *P. richardsonii* as one of several pondweeds in his aquatic deepwater type from the Athabasca Delta. *P. richardsonii* is a widespread species in AB, and often dominant where it occurs. This CT is documented in Alaska[30], where it is considered common. Looman[26] recognizes a *Potamogeton richardsonii* CT at the sociation level. Likely a common submergent aquatic community, but not well documented in Alberta.

No.	Community	Description and Location	Community Distribution and Significance*
Bryophyte Communities			
B1	*Sphagnum riparium - S. angustifolium*	A "mat" that often forms at the edge of thermokarst pools and other ponds. Was also noted along sluggish drainages.	This type of bryophyte community is the characteristic edge of thermokarst pools. Sometimes termed "internal lawns", they are characteristically *Sphagnum* dominated. A CT dominated by *S. riparium* and *S. angustifolium* is indicative of newly-collapsed surfaces and wet conditions[31]. These occur in a zone from north-central to Alberta through to central Manitoba[32].
Herbaceous Communities			
H1	*Calamagrostis canadensis*	Forms patches or narrow bands beside some of the small lakes. Often adjacent to emergent *Carex aquatilis*.	Extensive *C. canadensis* meadows have been documented for the Peace-Athabasca Delta[3,29] associated with a variety of hydric to mesic site types[29]. This CT was also noted at Colin Lake[28] and is very similar to a type reported in Alaska[30]. This appears to be a widespread CT in North America, usually found as small patches in locations such as drying beaver meadows and moist forest openings[33].
H2	*Carex aquatilis*	An extensive *Carex aquatilis* meadow was found around one pond south of Wentzel Lake and around a pond near Rocky Island Lake. Tracks and droppings suggest this is an important area for bison. Smaller patches were found occasionally around other ponds and lakes visited.	Also noted at other northern Alberta wildland parks [22, 27, 28, 34] and documented in Alaska[26]. Noted in the Caribou Mtns as frequent at the edge of thaw pockets[6]. A well-recognized, widespread type in North America, defined by *Carex aquatilis* clearly dominant and *Carex utriculata* with low cover or absent[33].
H3	*Carex aquatilis – C. utriculata*	Small patches along creek edges at Wentzel and "Roadrunner" lakes; occasional along shores of ponds and lakes.	Common wetland type[21, 33], previously noted in the Caribou Mountains[7]. *Carex aquatilis* and *Carex utriculata* co-dominate the association, with both species present in equal or near-equal amounts[33].
H4	*Carex aquatilis - Calamagrostis canadensis / Sphagnum angustifolium*	Noted once around a small pond on Wentzel Lake.	Similar types have been reported in WBNP[3], but likely a transition zone between a wet H2 CT and the slightly dryer conditions that favour the H1 CT[28].

No.	Community	Description and Location	Community Distribution and Significance*
H5	*Carex aquatilis – Eriophorum chamissonis*	Openings in *Picea mariana* woodland in the Horseshoe Lake area. *Sphagnum jensenii* was the dominant moss in this CT.	A *Carex aquatilis – Eriophorum* spp. CT in recognized in Manitoba[33], but no additional details are available. In more southern areas, the *Sphagnum* associated with *E. chamissonis* is often *S. angustifolium* or *S. subsecundum* but in the Horseshoe L. area, there seems to be a *Sphagnum jensenii* variant of this CT.
H6	*Carex aquatilis - C. diandra - C. utriculata - C. curta*	A small wet meadow made up primarily of a mixture of sedge species around a small pond off the Wentzel River.	A similar mixed marsh was documented in CC[28]. More work is needed to document the diversity of community types that may be represented here before their significance can be evaluated.
H7	*Carex limosa*	Meltout pools and floating mats around ponds found in the Pitchimi L. areas as well as in openings in *Picea mariana* woodlands east of Horseshoe Lake. Wet pools were about 0.5 m lower than surrounding peatlands. Some pools had small mounds occupied by *Chamaedaphne calyculata*, or by *Andromeda polifolia.*	May represent areas of localized permafrost melt, as the pools tended to have an abrupt edge.
H8	*Carex limosa - Scheuchzeria palustris / Sphagnum angustifolium*	Floating mats dominated by *Carex limosa, Scheuchzeria palustris, Eriophorum chamissonis* and *Sphagnum angustifolium* at the edge of pools and lining open water occupying the centre of sluggish drainage channels. Noted in the Pitchimi L. area.	Very similar to a bog type documented in British Columiba[21] and considered uncommon there. Several CTs dominated by *C. limosa* and *S. palustris* have been documented in Alberta, and a number of them are on the plant community tracking list[10]. This may represent one of the more common types for Alberta.
H9	*Carex rostrata*	Forming a small patch in an area of emergent vegetation in a protected bay at the north end of Wentzel Lake.	Once considered rare in Alberta, *C. rostrata* has been noted as the dominant species in some northern Alberta wetlands, including in CCWPP[28]. A *C. rostrata* type is documented in Alaska[20,30,35]. There was also a *C. rostrata – E. fluviatile* ecotone noted, between *C. rostrata* and *E. fluviatile* dominated communities.
H10	*Carex utriculata*	*Carex utriculata* stands were noted edging a dugout in the Pitchimi L. area and along the northern edge of a protected bay at the north end of Wentzel Lake.	A well-recognized, widespread type defined by *Carex utriculata* clearly dominant and *Carex aquatilis* with low cover or absent[33].

No.	Community	Description and Location	Community Distribution and Significance*
H11	*Equisetum fluviatile*	Emergent CT at north end of Wentzel Lake, *E. fluviatile* with up to 50% cover is usually the only species present, but in places *Equisetum fluviatile* and *Carex utriculata* were co-dominant.	Widespread CT[33] that also occurs in Alaska[20, 30]. Associated with quiet waters and muddy substrate[3]. Found in WBNP[3], the Peace-Athabasca Delta[29] and other northern wildland parks in Alberta[22, 27,28,34] although not commonly encountered at CMWPP.
H12	*Eriophorum vaginatum / Sphagnum magellanicum*	Commonly found as the dominant community type in thermokarst collapse scars.	An *E. vaginatum* CT has been documented in Alaska[20], associated with a variety of habitats including pond edges and thermokarst ponds. This CT was found in relatively wet habitats for *E. vaginatum* in Alberta, but similar to those reported for Alaska; perhaps indicating near arctic conditions.
H13	*Leymus innovatus - Schizachne purpurascens*	Grassy area on a sandy terrace behind an ice-push ridge at the south end of Wentzel L. Dominated by *Leymus innovatus* (35% cover), *Schizachne purpurascens* (25%) and *Carex siccata* (10%). Open shrub layer of scattered *Betula pumila*, sometimes in patches of up to 10% cover.	*Leymus innovatus* CTs are common in the Foothills and Rocky Mountains Natural Regions[36, 37], but have not been previously described for the Boreal landscape. More work is needed to define types and assign status.
H14	Sparsely vegetated sandy shoreline	Sandy shorelines were found at both Wentzel and Pitchimi Lakes. A patchy, line of vegetation generally forms behind the zone of bare sand associated with wave action. Species include *Potentilla norvegica, Carex brunnescens, Juncus balticus*, *Calamagrostis canadensis*, *Barbarea orthoceras, Erysimum cheiranthoides, Alopecurus aequalis, Stellaria longipes,* and *Rorippa palustris.*	The sandy shoreline species of the Caribou Mountains did not seem to form any repeating ecological community.
H15	*Typha latifolia*	A small patch was noted only once, at the tip of a small pond south of Wentzel Lake.	*T. latifolia* tends to occur in dense, mono-specific stands. A widespread CT[21, 33], encountered infrequently in the study area. Northern Alberta may be near the limit of the northern range for this CT.

No.	Community	Description and Location	Community Distribution and Significance*
Shrub and Dwarf Shrub Communities			
S1	*Alnus tenuifolia*	Noted occasionally along the shore of Wentzel Lake. Usually found as a narrow line of young alder above the zone of ice push. One mature, fairly extensive stand was noted on the east shore of Wentzel Lake. Although some *Hylocomium splendens* clumps were present in the mature stand, these CTs generally have high leaf litter and few understory species.	Widespread CT[33], noted at other northern wildland parks in Alberta[27, 28, 34].
S2	*Arctostaphylos uva-ursi*	A community dominated by *Arctostaphylos uva-ursi* was noted at "Sandy Point" on the east shore of Wentzel L. It was found on low dunes, with *Geocaulon lividum*, but few other species and alternates with *Picea mariana* / lichen in the swales. An open shrubland (*Betula pumila* 3% cover, *Arctostaphylos* 30%) with 10% lichen cover and 25% unvegetated sand and humus was noted on a bench behind an ice-push sand ridge on the east shore of Wentzel Lake. Similar CTs were found elsewhere in CMWPP, usually without a *Betula pumila* component.	Various *Arctostaphylos uva-ursi* CTs have been documented throughout Alberta, but more work is needed to define types and assign status.
S3	*Betula glandulosa* / *Ledum groenlandicum*	Dominant species in a regenerating burn with scattered *Picea mariana* seedlings. On slopes beside inflow creek for "Roadrunner" Lake. In some spots, *Salix planifolia* rather than *Ledum* is co-dominant with *Betula glandulosa*. *Ledum groenlandicum* and *Chamaedaphne calyculata* co-dominant in other spots.	Successional community, regenerating after a burn. Likely a widespread type, but not well documented.
S4	*Betula glandulosa - Salix pedicellaris / Carex aquatilis*	Shrubland along a slow-moving drainage channel flowing into Horseshoe Lake.	A similar type was noted by Horton *et al*.[6], but with *Salix planifolia* the dominant willow. Likely a widespread type, although not well documented. Willow / dwarf birch fens are common in the NWT portion of WBNP[38].
S5	*Betula glandulosa – Larix laricina / Salix pedicellaris*	Shrubby fen at south end of Horseshoe Lake. *Betula* and *Larix* to 1m tall, *Salix pedicellaris* forming a second shrub layer at 0.5 m tall.	Successional type, presumably developing into a *Larix laricina* stand. Lee *et al.*[7] described a similar CT also from the Horseshoe L. area. Possibly a widespread type, but not well documented.

No.	Community	Description and Location	Community Distribution and Significance*
S6	*Betula pumila / Calamagrostis canadensis*	Found along the inflow creek for "Roadrunner" Lake.	Also found at CC[28]. Shrubby birch and willow communities along watercourses in the region usually have *Carex* as the dominant or co-dominant graminoid. More study is needed to determine the significance of *Calamagrostis* in these shrub wetlands.
S7	*Betula pumila / Empetrum nigrum - Vaccinium vitis-idaea*	A narrow CT along the crest of a north-facing ice push sand ridge, at the south end of Wentzel Lake. Similar CTs were noted on other sandy ice push ridges, although sometimes missing any significant *Betula pumila* cover.	Mats of *Empetrum nigrum* stabilizing sand were noted as a locally common CT in the Athabasca Plains Natural Subregion[22]. The linear CT noted here is similar, but information is insufficient to determine its significance.
S8	*Betula pumila / Rubus chamaemorus*	Found along the inflow creek for "Roadrunner" Lake. Hummocks of *Sphagnum fuscum*, areas with good cover of *Salix arbusculoides* and *S. planifolia*.	Some similarities to the shrubby poor fen[37] type of the Boreal Highlands. Likely a widespread type, although not well documented.
S9	*Chamaedaphne calyculata / Eriophorum vaginatum*	Occasionally found at the edges of some of the small ponds in CMWPP. A hummocky topography with *Eriophorum vaginatum* and *Sphagnum angustifolium* in the hollows and the hummocks dominated by *Chamaedaphne calyculata* and *S. fuscum* with scattered *Rubus chamaemorus.*	Wet shrublands dominated by *C. calyculata* are documented in Alaska[20] and common in the Kazan Upland[23], but are not adequately documented to sort out types. Also documented at CC[28], MGT[39] and FGW[22].
S10	*Chamaedaphne calyculata / Sphagnum angustifolium*	A linear community of *Chamaedaphne calyculata* hummocks and *S. angustifolium* hollows along the edge of channels that wind through an open bog community. Also found at the edge of pools, again grading into the bog. *Rubus chamaemorus* often prominent on the hummocks.	A small patch type of wet sites at the edge of wetlands that may be similar is described in Alaska[20]. *C. calyculata* shrublands are widespread, but not adequately documented to sort out types.
S11	*Ledum groenlandicum – Ledum palustre / Sphagnum* spp.	A hummocky shrubland dominated by *Ledum* spp.	This is the main successional CT noted on burned bogs. A very similar successional CT is documented in Alaska[40]. *Ledum groenlandicum* dominated shrublands are likely widespread, although not well documented.
S12	*Salix arbusculoides*	Stand of old, tall *Salix arbusculoides* with a sparse understory beside one of the small ponds along the Wentzel River. Another stand noted along a small creek on the east side of Wentzel Lake.	*Salix arbusculoides* shrublands are likely widespread, although not well documented.

No.	Community	Description and Location	Community Distribution and Significance*
S13	*Salix glauca – Betula pumila / Potentilla fruticosa - Vaccinium myrtilloides / Carex aquatilis / Aulacomnium palustre*	A shrubland with a 2 m tall shrub layer co-dominated by *Salix glauca* and *Betula pumila* , with a distinct low shrub layer on hummocks with low patches of *Carex aquatilis* between. An interesting and extensive shrubland on the slopes of the deep-cut valley that drains from the north into the west end of "Roadrunner" Lake.	This CMWPP shrubland seems to have affinities to mixed *Betula - Salix glauca* shrublands with *Potentilla fruticosa* that are documented for the Subalpine Natural Region, e.g. the type S10: *Salix glauca - Betula glandulosa - Potentilla fruticosa* of Banff and Jasper National Parks[36]. Further work is needed to determine the significance of these shrublands in CMWPP.
S14	*Salix planifolia*	Narrow strip along lakeshores, forming a definable line, but with no distinctive understory. Found along Pitchimi and Horseshoe Lakes. *Alnus tenuifolia* is occasionally mixed in with the *Salix planifolia*.	Also noted by Horton *et al*.[6] as tall shrubs overhanging narrow water channels. Likely a widespread type, but not well documented.
S15	*Salix planifolia / Carex aquatilis*	Linear community lining the channel of the inflow creek for "Roadrunner" Lake.	A similar type is documented for the Peace River area[41]. This is possibly a widespread boreal equivalent, but has not been well documented.
S16	*Salix planifolia / Calamagrostis canadensis*	Noted in numerous locations throughout the study area, usually beside ponds, sheltered bays of lakes and small creeks. Other species present may include *Rubus arcticus, Potentilla norvegica Betula pumila, Carex aquatilis* and *Orthilia secunda*. In some stands, *Calamagrostis canadensis* forms large hummocks, with *Carex aquatilis* dominant in the low areas between hummocks.	A similar community is documented on the Peace – Athabasca Delta[29] and another, with *Salix drummondiana* as a co-dominant is described for the Clear Hills[42]. This may be a widespread boreal equivalent, but has not been well documented.

No.	Community	Description and Location	Community Distribution and Significance*
S17	*Picea mariana - Betula glandulosa / Sphagnum fuscum*	An open shrubby CT of scattered 0.5 to 0.8 m *Picea mariana* and *Betula glandulosa* with *Sphagnum fuscum* hummocks on the south shore of Wentzel L., just east of the outlet. *Pinguicula villosa* was throughout this stand on the *Sphagnum* hummocks. Between the hummocks, patches of *Nephroma arcticum* were common. Other species noted include *Ledum palustre, Andromeda polifolia, Rubus chamaemorus, Empetrum nigrum, Vaccinium vitis-idaea*. Prominent lichens include *Cladina mitis, C. stellaris, C. rangiferina, Flavocetraria nivalis,* and *Cladonia amaurocraea.* About 10% cover of *Carex aquatilis,* restricted to a subtle infilling drainage channel. A *Larix laricina* stand occurred at the head of the channel.	Similar to a common boreal CT, treed poor fen[37], often with a prominent component of *Larix laricina*. Also found at MGT[39] and CC[28]. The lichen component seems unusual, but several CTs with *Nephroma arcticum* patches are documented in Alaska[20, 40]. Further work is needed to determine the significance of this CT.
Woodland / Forest Communities			
W1	*Betula neoalaskana / Hylocomium splendens*	Closed mature stand at the north end of Wentzel L. Understory dominated by leaf litter, with small mounds of *Hylocomium splendens.*	Birch dominated communities tend to be small in area and scattered in occurrence. They are not well studied, so more inventory is needed to define types and to determine their significance.
W2	*Betula neoalaskana / Ledum groenlandicum / Vaccinium vitis-idaea*	Open stand on the j-shaped island at the north end of Wentzel L. *Betula neoalaskana* (25% cover) *Ledum groenlandicum* (25% cover) and *Vaccinium vitis-idaea* (80% cover).	A similar type, but with a much lower cover of *Vaccinium vitis-idaea* (3%), and up to 30% cover of *Vaccinium myrtilloides* was documented at MGT[34].
W3	*Betula neoalaskana / Rosa acicularis / Equisetum sylvaticum*	A closed stand of Alaskan birch (30% cover) at the south end of a protected bay at the north end of Wentzel Lake. Well developed shrub layer dominated by *Rosa acicularis* and scattered *Picea mariana* in the understory. *Equisetum sylvaticum* dominates the herb layer, but *Cornus canadensis* and *Vaccinium vitis-idaea* prominent in patches. A nearby stand was similar, but lacked the prominent *Rosa acicularis* component.	A similar stand was noted at MR[34], but without a significant rose component. *Betula* CTs with an understory dominated by *Equisetum* spp. are found on rich sites throughout the Boreal in Alberta. The types documented however often are mixed birch – poplar CTs with *Equisetum arvense* and/or *E. pratense* the dominant understory species. More inventory is needed to define birch types and to determine their significance.

No.	Community	Description and Location	Community Distribution and Significance*
W4	*Betula neoalaskana – Picea glauca / Vaccinium vitis-idaea*	A stand on a point at the north end of Wentzel L. Sparse understory with high leaf-litter.	No similar mixedwood CTs were noted in the literature reviewed, although Lee *et al*.[7] did note a spruce - birch mixedwood, their stand had a much richer understory with species such as *Alnus crispa*.
W5	*Larix laricina / Picea mariana / Hylocomium splendens*	A dense pocket of *Larix* with a tall shrub layer of *Picea mariana* was noted in the Pitchimi L. area. It had a sparse understory, dominated by *Hylocomium*. Other prominent species noted include *Vaccinium vitis-idaea, Salix myrtillifolia* and *Cladina mitis.* A second stand south of Wentzel L. was similar, but also had a short shrub layer dominated by *Ledum palustre*.	*Larix laricina* dominated stands were not common in the Caribou Mountains and those noted were small patches, succeeding to *Picea mariana*. This is likely a common successional type, although not well documented in the literature.
W6	*Picea glauca / Betula pumila – Shepherdia canadensis / Cladina mitis*	A CT found on the E shore Wentzel L. It occurs on a bench behind a sandy ice push ridge as a transition between an open *Betula pumila* community and a *Populus tremuloides / Salix bebbiana / Equisetum sylvaticum* CT further back from the lake.	*Picea glauca* CTs with a strong *Shepherdia canadensis* component are common in the Foothills and Rocky Mountain natural regions, but less so in the Boreal. Willoughby *et al*.[43] found a similar open spruce forest, but lacking a *Betula pumila* or *Cladina mitis* component, on a sandy site with a high water table. They suggest such sites "may have a high pH and be somewhat nutrient poor as indicated by the abundance of buffaloberry." This may be a somewhat uncommon type in the Boreal Natural Region, due to the restricted habitat of sandy substrate and high water table.
W7	*Picea glauca / Leymus innovatus*	One small stand was looked at on a levee along the Wentzel R.	*Picea glauca* in the CM tended to be restricted to levees along rivers and creeks or other well-drained sites with better soils. A similar cordilleran association is recognized as a matrix type in CNVC[44] (424 *Picea glauca* (*Pinus contorta*) / *Shepherdia canadensis* / *Leymus innovatus* Forest). This may be a relatively common type that becomes increasingly restricted in distribution moving north as the peatlands become more extensive and the well-drained rich habitats less so.

No.	Community	Description and Location	Community Distribution and Significance*
W8	*Picea glauca / Equisetum pratense*	Mature stand on a levee along the Wentzel R.	*Picea glauca / Equisetum* riparian communities are widespread and well documented, although not common in the CM. This CT would fit in the CNVC[44] 418 *Picea glauca* / *Equisetum* (*arvense - pratense*) Forest type considered a small to medium patch forest found on river floodplains and upland seepage sites in Saskatchewan, Alberta, British Columbia and southern Yukon Territory.
W9	*Picea glauca / Hylocomium splendens*	A closed, mature forest with little understory other than a high feather moss cover, dominated by *Hylocomium splendens*, although *Pleurozium schreberi* is also prominent. Two stands were looked at, one on a levee along the Wentzel R, the other on a cobble ridge of an island in Wentzel L.	Although *Picea glauca* stands were not common in CM, *P. glauca* / feathermoss CTs are a widespread boreal type[33]. This CT would fit in the CNVC[44] 422 *Picea glauca (Pinus contorta) / Hylocomium splendens* Forest, a matrix late seral forest community found in British Columbia, Alberta, Saskatchewan and Yukon Territory.
W10	*Picea mariana – Betula neoalaskana / Ledum groenlandicum / Hylocomium splendens*	A small stand in a protected site behind an ice-push ridge on an island in Wentzel L.	Mixed *Picea mariana – Betula neoalaskana* stands were also noted at CC[28]. This CT likely occurs occasionally throughout Alberta's Boreal Natural Region, but is not well documented.
W11	*Picea mariana* / feathermoss	A closed, mature forest with *Pleurozium schreberi* the dominant feather moss in some stands, but often co-dominant with *Hylocomium splendens*. One stand on the SE shore of Wentzel L. also had *Picea glauca* and *Betula neoalaskana* in the canopy layer and a good cover of epiphytic lichens. As reported by Lee *et al*.[7], we also found *Vaccinium vitis-idaea, Equisetum sylvaticum* and *Cornus canadensis* to be associated with this CT.	This appears to be a CT found across northern Alberta on unburned sites[23, 24, 45] and into the NWT[45]. Also noted at MR[46] and FGW[22]. This CT fits well within the CNVC[44] type 429 *Picea (glauca - mariana) / Hylocomium splendens* Forest, a large patch or matrix forest community in Alberta and Saskatchewan, although not common in the CM.
W12	*Picea mariana* / feathermoss – *Cladina*	A patchy, open forest found at the S end of Wentzel L. Low, open *Picea mariana* with patches with high lichen cover. *Cladina mitis* dominates the forest openings and *Pleurozium schreberi* and *Hylocomium splendens* are found in the clumps of trees. *Vaccinium vitis-idaea* is patchy in the understory. A similar stand in the Horseshoe L. area had patches of *Equisetum sylvaticum*.	Lee *et al.*[7] describe this type for well-drained mineral soils, and consider it fairly widespread in the Caribou Mountains and similar to types documented in Alaska.

No.	Community	Description and Location	Community Distribution and Significance*
W13	*Picea mariana / Ledum* spp.	A closed to open woodland with a high cover of *Ledum* spp. and few other species in the understory. *Ledum groenlandicum* and *Ledum palustre* may be present separately or together. *Sphagnum fuscum* hummocks occasional. Noted on an island in Wentzel L.	A widespread CT. This CT fits within the CNVC[44] type 430 *Picea mariana / Ledum groenlandicum / Sphagnum* spp. Woodland, typic sub-association, a small or large patch woodland community of Alberta, Saskatchewan and British Columbia.
W14	*Picea mariana / Ledum* spp./ *Cladina mitis – Sphagnum fuscum*	An open woodland, with *Picea mariana* cover sometimes less than 5% and short trees (up to 6 m but averaging about 3 m). Hummocky micro topography with hummocks averaging about 0.5 m and *Sphagnum fuscum* dominant on hummocks. *Ledum groenlandicum* and *Ledum palustre* may be present separately or together, averaging 25% cover or greater. Found on the south shore of Wentzel L. and on some of the islands. Although generally vascular species poor, *Rubus chamaemorus* and *Vaccinium vitis-idaea* were usually present, and prominent in patches. *Eriophorum vaginatum* was present in some stands *Cladina mitis, Cladina rangiferina* and *Cladonia stellaris* were the dominant lichens, prominent on the tops of drier hummocks.	This is the classic Boreal Subarctic CT for Alberta, with hummocky topography, open to nearly absent tree cover and small trees (averaging about 3 m). Not widespread in Alberta, it is however a common type in the Boreal Subarctic Natural Subregion.
W15	*Picea mariana / Ledum groenlandicum / Rubus chamaemorus / Sphagnum fuscum*	A hummocky *Picea mariana* stand of small trees (average height 4 m) east of Horseshoe L. and several locations around Wentzel L. *Ledum groenlandicum* and *Rubus chamaemorus* were present in all stands, although often with low cover. *Ledum palustre* was present in some stands. *Sphagnum fuscum* is the dominant moss, with *Sphagnum capillifolium* a secondary species.	A widespread boreal bog type[37] that is very similar to the widespread boreal treed bog CT from Alberta and Saskatchewan[45,47]. This CT fits within the CNVC[44] type 430 *Picea mariana / Ledum groenlandicum / Sphagnum* spp. Woodland, *Rubus chamaemorus* sub-association, a small or large patch woodland community of Alberta, Saskatchewan and British Columbia.
W17	*Picea mariana / Salix planifolia / Carex aquatilis / Sphagnum angustifolium*	A closed stand of *Picea mariana* on the east shore of Wentzel L. The stand had a hummocky topography with scattered pools.	This CT is similar to treed poor fens common throughout the Boreal in Alberta[37].

No.	Community	Description and Location	Community Distribution and Significance*
W18	*Picea mariana / Vaccinium uliginosum / Sphagnum fuscum*	An open woodland on a peat plateau at the south end of Wentzel Lake. *Ledum* spp. were also prominent. *Vaccinium vitis-idaea*, *Arctostaphylos rubra* and *Rubus chamaemorus* as associated species, with abundant *Vaccinium oxycoccus* embedded in the *Sphagnum fuscum*.	Several *Picea mariana* CTs with *Vaccinium uliginosum* dominant in the shrub layer are documented in Alaska[20], including a closed *Picea mariana/Vaccinium uliginosum* plant association. This may be a restricted type in Alberta, but not well documented. A CT that likely becomes more common northward in areas where *V. uliginosum* is more common. Probably a relatively common CT to the north and west, although limited in extent in Alberta.
W19	*Pinus contorta / Betula pumila / Vaccinium vitis-idaea / Cladina mitis*	On sandy terrace east shore Wentzel L. A similar terrace CT was noted on the southeast corner of the lake, but with scattered *Picea glauca* in an open second canopy. Dwarf shrubs dominate the understory, primarily *Vaccinium vitis-idaea* with patchy lichens, mainly *Cladina mitis. Arctostaphylos uva-ursi* is the dominant dwarf shrub in spots.	The two *Pinus contorta* CTs noted at CM were both on sandy beach ridges and had very similar species composition. W19 and W20 were separated out here primarily on the prominence of *Betula pumila* and lichens in W19.
W20	*Pinus contorta / Vaccinium vitis-idaea*	Open stand of *Pinus contorta* with an open, shrub layer of 1.5 m tall *Rosa acicularis, Picea glauca*, *Shepherdia canadensis* and *Populus tremuloides*. *Leymus innovatus* is patchy, averaging about 3% cover. Dwarf shrubs dominate the understory, primarily *Vaccinium vitis-idaea* with patchy lichens, mainly *Cladina mitis*. *Arctostaphylos uva-ursi* is the dominant dwarf shrub in spots.	This CT is likely a common Boreal type as it fits well into the ecosites guide[37] CT SBa2.1 *Pinus contorta - Populus tremuloides / Arctostaphylos uva-ursi* both in site type and species present, although *Populus tremuloides* was only in the shrub layer, not in the canopy as described for the SBa2.1 type[37].
W21	*Populus tremuloides / Betula pumila / Arctostaphylos uva-ursi*	Airstrip clearing at the south end of Pitchimi Lake, now made up of regenerating aspen about 2.5 m tall.	*Populus tremuloides* stands were generally uncommon in the CM, although more common on the edges of the plateau than on the plateau itself. No similar types were noted in the literature, but further work is needed on northern *Populus tremuloides* stands to define types and determine significance.

No.	Community	Description and Location	Community Distribution and Significance*
W22	*Populus tremuloides / Leymus innovatus / Vaccinium vitis-idaea*	Found on a sandy terrace back from the east shore of Wentzel L. Shrub layer of *Picea glauca* and *Salix bebbiana* with a patchy low shrub layer of *Rosa acicularis*. Well developed herb/dwarf shrub layer with a diversity of species, including *Pyrola grandiflora*.	This CT has some affinities to the *Populus tremuloides* stands with *Rosa acicularis* and *Leymus innovatus* that are common and widespread in the foothills of Alberta. A similar aspen CT with significant cover of both *Leymus innovatus* and *Salix bebbiana* was described in the Clear Hills[42].
W23	*Populus tremuloides / Hylocomium splendens*	Mature, closed to fairly open stands (15 to 50% cover) were inventoried at Pitchimi and Wentzel Lakes. *Hylocomium* 25% cover, usually on small hummocks. Sparse understory with high leaf litter, but with patches of various species such as *Lycopodium annotinum, L. complanatum, Cornus canadensis, Arctostaphylos uva-ursi, Vaccinium vitis-idaea* and *Flavocetraria nivalis.* Occasional shrubby patches dominated by *Ledum groenlandicum* in some spots, *Rosa acicularis* in others. Often with *Picea mariana* in sub-canopy.	Aspen forests of the Caribou Mountains were uniformly low in species diversity and cover. Most of the stands looked at had *Picea mariana* in the understory. As the black spruce mature, the aspens seem to die out, moss cover goes up, leaf litter down and *Ledum* comes in as they seem to succeed to a *Picea mariana / Ledum / Hylocomium* stand. Although there may be some aspen CTs restricted to the subregion, further work is needed to define types and determine their significance.
W24	*Populus tremuloides – Picea glauca / f*eathermoss	Stand of mixed *Populus tremuloides – Picea glauca* with mixed feathermoss on a rough, colluviated terrain at the NE corner of Wentzel L.	Lee *et al*.[7] noted similar mixed stands at the edge of the plateau of the CM, but generally with a more diverse understory.
W25	*Populus tremuloides / Picea mariana / Linnaea borealis / Hylocomium splendens*	Mature *Populus tremuloides* 40% cover and up to 20 cm dbh on rolling moraine east of Wentzel L. *Picea mariana* forms a shrub layer approx. 1 m tall plus a few as 2nd canopy. High cover of leaf litter (50%), with patchy vegetation dominated by *Linnaea borealis* but *Vaccinium vitis-idaea*, *Empetrum nigrum, Equisetum sylvaticum, Ledum groenlandicum* or *Arctostaphylos rubra* also prominent in spots. *Hylocomium splendens* dominant moss.	This CT is likely a common Boreal type as it fits well into the ecosites guide[37] CT SBb3.3 *Populus tremuloides – Picea glauca - Picea mariana* – feathermoss.
W26	*Populus tremuloides / Salix bebbiana / Equisetum sylvaticum*	*Populus tremuloides* 50% cover with a tall shrub understory dominated by *Salix bebbiana* (10%). *Equisetum sylvaticum* is the dominant herb, and leaf litter cover is high. Found on a sandy terrace back from the east shore of Wentzel L.	W26 is on better drained sites than other *Populus tremuloides* CTs noted in the CM. Although there may be some aspen CTs restricted to the subregion, further work is needed to define types and determine their significance.

No.	Community	Description and Location	Community Distribution and Significance*
W27	*Populus tremuloides / Vaccinium vitis-idaea – Cornus canadensis / Pleurozium schreberi – Hylocomium splendens*	East-facing mature stand on moraine ridge, SW corner of Wentzel L. A closed, mixed stand dominated by *Populus tremuloides* (70% cover) with a significant component of *Betula neoalaskana* (5% cover) and scattered *Picea mariana* in an open 2nd canopy. There is a 1.5 m shrub layer dominated by *Picea mariana* (20% cover). The understory is patchy, with spots dominated by *Vaccinium vitis-idaea – Cornus canadensis / Pleurozium schreberi – Hylocomium splendens*. *Rosa acicularis* patches. *Vaccinium vitis-idaea* and *Linnaea borealis* become more prevalent upslope. In some spots, *Picea mariana* is denser and *Ledum groenlandicum* prominent. *Betula neoalaskana* cover is higher near the lakeshore, with *Viburnum edule* and *Leymus innovatus* in a narrow band.	This CT is a richer variant of W23. Although there may be some aspen CTs restricted to the subregion, further work is needed to define types and determine their significance.

* The following abbreviations are used in the comments:

CC = Colin-Cornwall Lakes Wildland Provincial Park
CM = Caribou Mountains
CNVC = Canadian National Vegetation Classification
CS = Canadian Shield Natural Region
CT = community
LaB = La Butte Creek Wildland Provincial Park
MR = Maybelle River Wildland Provincial Park
MGT = Marguerite River Wildland Provincial Park
NWT = Northwest Territories
RRD = Richardson River Dunes Wildland Provincial Park
WBNP = Wood Buffalo National Park

Appendix 5. Gallery of Communities (All photos by L. Allen)

A1. *Nuphar lutea*

B1. *Sphagnum riparium -S. angustifolium*

H7. *Carex limosa*

H9. *Carex rostrata – Equisetum fluviatile*

H11. *Equisetum fluviatile*

H12. *Eriophorum vaginatum / Sphagnum magellanicum*

H13. *Leymus innovatus – Schizachne purpurascens*

H14. Sparsely vegetated sandy shoreline

S2. *Arctostaphylos uva-ursi*

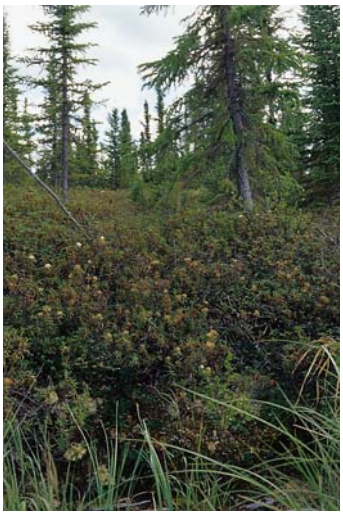
S9. *Chamaedaphne calyculata / Eriophorum vaginatum*

S11. *Ledum groenlandicum – Ledum palustre / Sphagnum* spp.

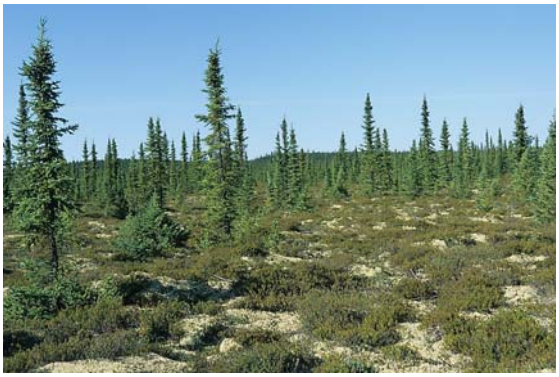
S15. *Salix planifolia / Carex aquatilis*

W3. *Betula neoalaskana / Rosa acicularis / Equisetum sylvaticum*

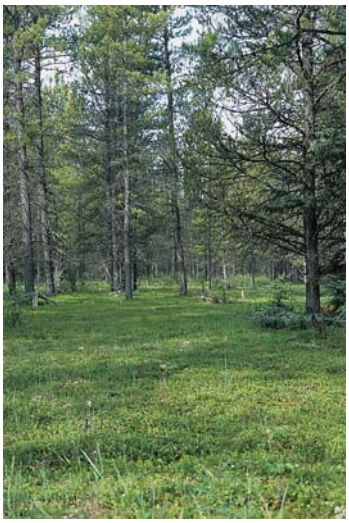
W5. *Larix laricina / Picea mariana / Hylocomium splendens* (in distance)



W13. *Picea mariana / Ledum* spp



W14. *Picea mariana / Ledum* spp./ *Cladina mitis – Sphagnum fuscum*



W20. *Pinus contorta / Vaccinium vitis-idaea*

W23. *Populus tremuloides / Hylocomium splendens*