TAIGA CORDILLERA ECOZONE

This ecozone covers the subarctic regions of the Western Cordillera. It 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 some of 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 Selwyn Mountains. Mean annual temperatures range from –10°C in the north to –4.5°C in the south. Average summer temperatures range from 6.5 to 10°C, modified by elevation and aspect. Summers are warm to cool with extended periods of daylight. Average winter temperatures range from –25°C in the north to –20°C in the south. Winters are long and cold with very short daylight hours, particularly in the northern portions of the ecozone. Weather systems moving inland from the Arctic coast have a marked influence on the climate of this ecozone.

Hydrology: The underlying permafrost, which is continuous north of the Ogilvie and Wernecke mountains, largely controls streamflow characteristics. Runoff is large relative to precipitation compared with more southern ecozones because of the underlying permafrost and low rates of evapotranspiration. Peak flows, which generally occur in June, are likewise greater relative to areas with less permafrost due to shorter pathways through the watershed, as a result of limited infiltration rates. Summer rain events can produce

J. Meikle, Yukon Government

East of the Snake River in the Wernecke Mountains (within the Mackenzie Mountains Ecoregion) is this glaciated U-shaped valley north of Mount McDonald, with walls 1,500 m high.

secondary peaks and sometimes annual peaks on smaller streams, especially in mountainous areas. Minimum flows generally occur in March and tend to be lower than the Pacific Maritime and Boreal Cordillera ecozones to the south, because of the effect of lower winter temperatures on groundwater flow. Small streams within this ecoregion frequently experience zero flows while some intermediate-sized streams may occasionally experience zero winter flows.

Vegetation: Vegetation cover ranges from tussock tundra composed of dwarf or low shrubs, mosses and lichens, and cottongrass at higher elevations in the northernmost portions of the ecozone, to taiga or open woodlands in the southern portions of the ecozone composed of white spruce and paper birch mixed with dwarf birch and willows, mosses, and lichens. Alpine tundra, composed of shrubs, lichens, saxifrages, and mountain avens, occur at higher elevations throughout the ecozone.

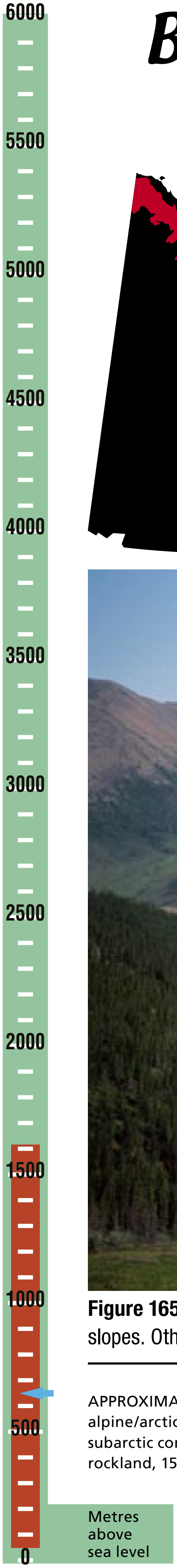
Landforms and soils: Mountainous topography, often consisting of semi-parallel ridges with deep intervening valleys, dominates the landscape of the ecozone. Foothills and intermontane basins are also present and common in the northern Yukon. Much of the surface is mantled with colluvium with frequent bedrock exposures and minor glacial deposits. The northwestern portion of this ecozone consists of unglaciated terrain. Cryosols, Brunisols and Regosols tend to be the predominant soils. Wetlands are extensive in some ecoregions. Permafrost features, such as earth hummocks, palsas, and peat plateaus, are common. The unglaciated portions of this ecozone commonly exhibit periglacial features, such as cryoplanation terraces and summits, and various forms of sorted and non-sorted patterned ground. Continuous permafrost underlies most of the ecozone.

Wildlife: Wildlife in the area is diverse. Characteristic mammals include Dall sheep, woodland and barren-ground caribou, moose, mountain goat, black and grizzly bear, wolf, lynx, Arctic ground squirrel, American pika, hoary marmot, and a concentration of wolverine. Important birds include Gyrfalcon, Willow and Rock Ptarmigans, and waterfowl. The Yukon's Old Crow Flats is a large wetland complex that has received international recognition for its value for the tens of thousands of swans, geese, and other waterfowl that nest or stage in this large intermontane basin each year.

J. Meikle, Yukon Government

Vegetation patterns repeat, controlled by permafrost, fire and low relief, near Shaefer Creek, Eagle Plains, with view northwest toward the David Lord Range.

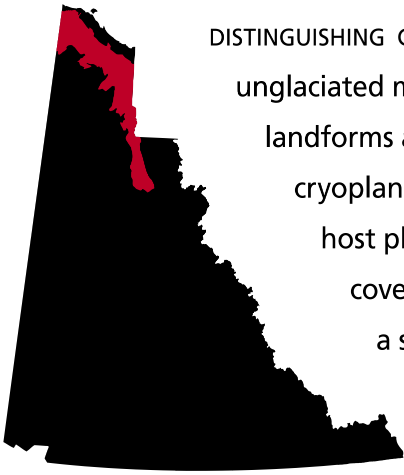
Human activities: Present activities include subsistence hunting, trapping and fishing; ecotourism; and outdoor recreation. During the 1960s and 1970s much exploration for hydrocarbons was undertaken in the major basins of the ecozone and pressure continues to explore these resources. In the Yukon, the ecozone is sparsely populated and home to the Vuntut Gwitch'in. The total population is roughly 350, most of whom reside in Old Crow, the Yukon's most northerly settlement.



British-Richardson Mountains

Taiga Cordillera Ecozone

ECOREGION 165



DISTINGUISHING CHARACTERISTICS: The ecoregion contains the largest extent of unglaciated mountain ranges in Canada. Some excellent examples of periglacial landforms are found within the ecoregion, including solifluction lobes and cryoplanation summits and terraces. The northernmost Richardson Mountains host phosphate minerals, including lazulite, the Yukon gemstone. Vegetation cover, strongly influenced by aspect and elevation (Fig. 165-1), produces a surprising diversity of ecosystems and habitats. This mountainous ecoregion contains the Yukon portion of calving habitat along with important migration routes of the Porcupine caribou herd.

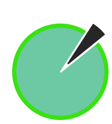
J. Hawkings, Canadian Wildlife Service

Figure 165-1. View looking eastward in the Richardson Mountains showing spruce forest growing on lower elevation, south-facing slopes. Other slope aspects and elevations above 600 m asl support only shrub and/or tundra vegetation.

APPROXIMATE LAND COVER
alpine/arctic tundra, 65%
subarctic coniferous forest, 20%
rockland, 15%

TOTAL AREA OF ECOREGION IN CANADA
26,690km^2

TOTAL AREA OF ECOREGION IN THE YUKON
22,900 km^2



ECOREGION AREA AS A PROPORTION OF THE YUKON
5%

ELEVATIONAL RANGE
40–1,610 m asl
mean elevation 640 m asl

CORRELATION TO OTHER ECOLOGICAL REGIONS: Mountainous portion of **Northern Mountains and Coastal Plain Ecoregion** (Oswald and Senyk, 1977) • Equivalent to **Northern Mountain Ecoregion** (Wiken et al., 1981) • Yukon portion of **Brooks Range Tundra Region** (CEC, 1997) • Yukon portion of **Brooks/British Range Tundra Ecoregion** (Ricketts et al., 1999). Contiguous with the **Brooks Range Ecoregion of Alaska** (Nowacki *et al.*, 2001)

PHYSIOGRAPHY

The British, Barn and Richardson mountains and intervening valleys compose the British–Richardson Mountains Ecoregion (Rampton, 1982) (Fig. 2). They have been sometimes known collectively as the Arctic Mountains or Ranges (Bostock, 1948; Hughes, 1987b). The British Mountains comprise the eastern extension of the Alaskan Brooks Range, including the Buckland Hills and the northern foothills of the British Mountains (Rampton, 1982). The British and Barn mountains run parallel to the north coast of the Yukon. The Richardson Mountains trend north–south from east of the Barn Mountains south to the Peel River.

The mountains have remained largely unglaciated except for minor alpine glaciation in the British Mountains and the eastern flank of the Richardson Mountains (Fig. 165-2). The ecoregion is characterized by steep, V-shaped valleys in the higher ranges and gently sloping pediments where the valleys are broader.

The relief in the mountains ranges from 450 to 900 m. The highest elevations are associated with the western British Mountains and the southern Richardson Mountains where there are unnamed peaks over 1,600 m asl. In the northern Richardson and Barn mountains, the topography is more subdued.

The British, Barn and Richardson mountains are cut by large rivers flowing north to the Beaufort Sea. From the west, the most significant are the Malcolm, Firth, Babbage, Blow and Big Fish rivers. The southern slopes of the mountain ranges are drained by small tributaries to the Porcupine River. Most of the Richardson Mountains also drain to the Porcupine via the Bell and tributaries of the Eagle River. The south and east slopes of the Richardsons are part of the Peel watershed.

J. Meikle, Yukon Government

Figure 165-2. A view of the Richardson Mountains showing Laurentide glacial drift in valley bottoms and unglaciated upper slopes and ridgetops. Note the contrast between light coloured, lichen-dominated colluvial slopes and valley-bottom drift surfaces that are vegetated by darker coloured sedge tussock/moss communities.

BEDROCK GEOLOGY

This ecoregion contains well-exposed sedimentary rocks of Proterozoic to Cretaceous age and small Devonian granite intrusions, and spans three separate geological structures. The British and Barn mountains, an eastern continuation of the Alaskan Brooks Range, are part of the Arctic–Alaska Terrane, consisting of continental margin sediments (Wheeler and McFeely, 1991). The topographically subdued region east of the mountains is the Blow Trough, a mid-Cretaceous extension basin. The south-trending Richardson Mountains resulted from Paleozoic deep-water clastic sediments being uplifted by outward-verging thrust faults located at an interpreted westward-dipping crustal ramp (Lane, 1996) in latest Cretaceous or early Tertiary time.

Bedrock geology of the entire ecoregion is shown on regional maps by Norris (1981a,b,f,g) and described by various authors in his report (Norris [editor], 1997). Many regional aspects of the stratigraphy and structure have been studied in detail.

The British and Barn mountains comprise folded and faulted structural blocks, uplifted in early Tertiary time, separated by a structural depression along the Babbage River. The Romanzov Uplift, traversed by the Firth River, exposes a thick structural succession consisting of the following units: Proterozoic mixed carbonate and fine clastic rocks; latest Proterozoic to Cambrian sandstone — the Neruokpuk Formation, 600–1000 m thick; Cambrian and Ordovician volcanic and volcanic-clastic rocks with limestone and argillite — the Whale Mountain succession; and Ordovician to Devonian black argillite and siltstone — equivalent to Road River Formation. Most of the succession is directly correlated with the Proterozoic to mid-Paleozoic Selwyn Basin of the central Yukon (Lane and Cecile, 1989; Lane, 1991). Mount Sedgewick in the British Mountains is cored by a biotite quartz monzonite pluton (370 Ma; Mortensen and Bell, 1991). The Barn Range is a tectonic uplift of a structurally thickened succession of dark grey to black, red, and green shale, ridge-forming grey quartzite and siltstone, and light grey limestone (Cecile, 1988; Cecile and Lane, 1991) equivalent to the upper Hyland group and overlying Road River Formation. Two hornblende–biotite granites, Mount Fitton and Hoidahl Dome, have prominent orange-weathering pyrite haloes. The flanks of these two uplifts constitute the Endicott and Lisburne groups of Carboniferous age overlain by Kingak Formation from the Jurassic–Cretaceous. Blow River Trough contains 4 to 10 km of Albian flysch, in part the Rapid Creek Formation (Young, 1975).

The Richardson Mountains are divided by a structural and topographic depression at the head of the Vittrekwa River at the continental divide on the Dempster Highway with different structural styles to north and south. To the north, ridges formed by differential erosion of more resistant units are short and offset by faults. The White Mountains are an uplifted block of light-grey Paleozoic limestone, which produces extremely rugged topography, surrounded by dark brown clastic sediments of Ordovician to Devonian age. In contrast, the southern Richardson Mountains are a breached anticlinorium with sandstone and limestone of the Slats Creek and Illtyd formations, being Lower and Middle Cambrian respectively (Fritz, 1996) in the hinges, flanked by more resistant chert and limestone of the Road River Formation of Ordovician to Middle Devonian age. Throughout the Richardson Mountains are long, curved and near-vertical faults of the Richardson Fault Array. The southern Richardson Mountains remain seismically active (Forsyth *et al.*, 1996).

In general the oldest succession of mixed carbonate and clastic rocks underlies subdued topography and produces calcareous soil with common caliche surfaces (L. Lane, pers. comm., 1997). The blocky talus below thick limestone units, as well as from Precambrian sandstone units, provides denning sites for foxes, wolf and bear. Slopes underlain by the sandstone, as well as Cambro–Ordovician volcanic and volcaniclastic rocks are characteristically unstable and lightly vegetated with blocky talus cones. Cambro–Ordovician argillite and chert underlies subdued topography with fine, granular talus that is well vegetated and suitable habitat for burrowers. Steeply dipping chert layers locally produce jagged, razor-like ridge crests. The Carboniferous dark shale of the Kayak Formation and sandstone locally harbour evaporite minerals, used as salt licks by caribou, while the tilted limestone strata erode into rugged topography.

A variety of mineral types are known, although much of the northern part of the ecoregion was withdrawn from claim staking in 1978, limiting further investigations. The Blow River, Rapid Creek and Big Fish River area contain new phosphate minerals (Robinson *et al.*, 1992), including lazulite, the Yukon gemstone. This area also contains very large phosphatic iron manganese reserves. The Barn Mountains hold uranium in conglomerate of Carboniferous and Cretaceous Age as well as in skarns with molybdenum, tungsten and copper near the Fitton and Sedgewick granitic intrusions. Minor gold occurs at Mount Sedgewick and at Whale Mountain. The erosion of Devonian granite in nearby Alaska has produced the placer deposit in Sheep Creek, near the Firth River. A magnetite iron formation occurs locally in the Cambrian to Devonian units of the Romanzov Uplift near the Alaska–Yukon border (Lane *et al.*, 1995). Seams of anthracite are common in the Mississippian Kayak and Cretaceous Kamik formations throughout the ecoregion. The Richardson Mountains contain several galena and sphalerite occurrences, typically in breccia zones within the Illtyd (Pilon showing) and Road River (Vittrekwa showing) limestones. Magnetite, minor chalcopyrite and brannerite occur in a diatreme breccia within Proterozoic lime siltstone. Large gypsum lenses in the Richardson Fault Array straddle the Yukon–Northwest Territories border.

A spectacular exposure of Road River sedimentary rocks occurs at Canyon Creek, and quartzite of the Jurassic Bug Creek Group provides impressive cryoplanation terraces in the northern Richardson Mountains (Fig. 27 *in* Norris [editor], 1997).

SURFICIAL GEOLOGY AND GEOMORPHOLOGY

This high relief, largely unglaciated terrain has been affected mostly by mass wasting and weathering. Rock outcrops are common, being mostly composed of friable sedimentary rocks such as sandstone, limestone and shale. At high elevations, tors, pinnacles and dyke-like ridges stand out at or near summits. The summits, as well as the uppermost slopes of mountains, are usually blanketed by unvegetated rock fragments either as felsenmeer or colluvium veneer, interspersed with frost-shattered crags.

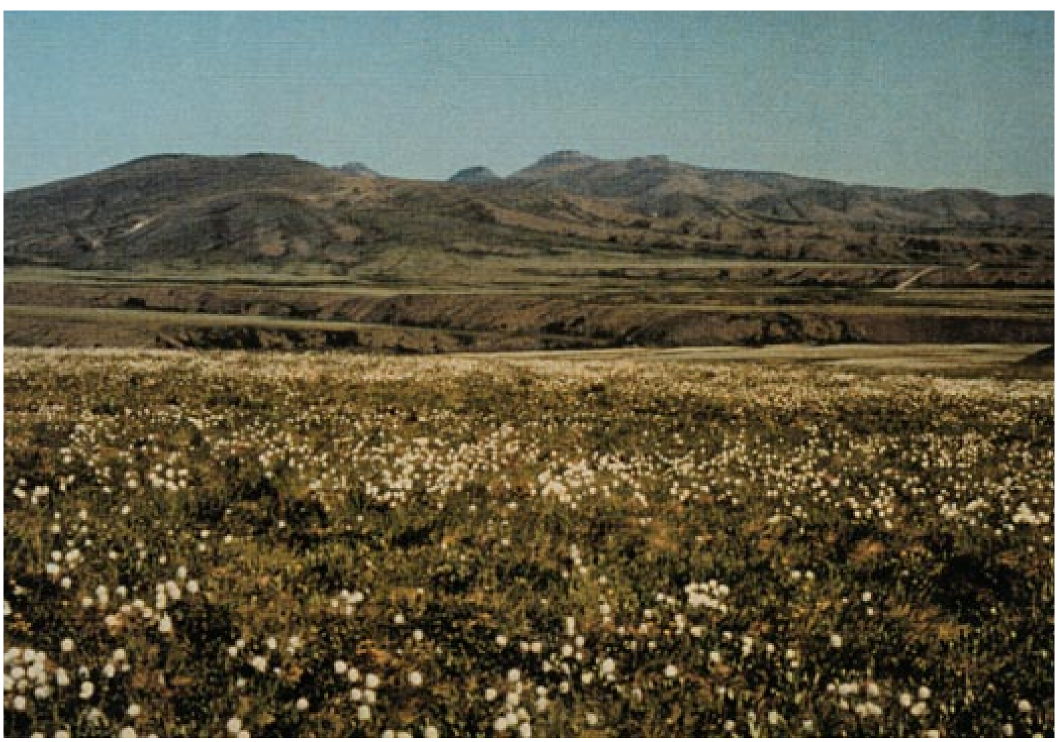
Middle and low elevations are covered by residual or weathered rock, or soliflucted and colluvial materials, which form fans or long, gentle pediment slopes. Pediments are extensively developed in this mountainous ecoregion, with three levels identified in the Richardson Mountains and at least six in the British Mountains (L. Lane, pers. comm., 1997) (Fig. 165-3). Stone circles and other patterned grounds are occasionally present.

Most small streams have coarse gravel beds. The streams are often entrenched in pediment surfaces. Upper slopes have developed intricate, feather-like drainage patterns. Thin loess deposits are common throughout the ecoregion.

Modern processes relate dominantly to colluvium deposits, including a variety of materials transported by solifluction and sheetwash (Fig. 165-4). Periglacial features include cryoplanation terraces found all along the northern Cordillera, with the highest concentration along the southern slopes of the British Mountains north of the Old Crow Basin (Lauriol and Godbout, 1988; Lauriol, 1990).

GLACIAL HISTORY

Localized alpine glaciers affected the highest mountains during Pleistocene glacial periods of undetermined ages. There are two restricted areas where local glaciers developed: at the headwater of Malcolm River in the British Mountains (Duk-Rodkin, in press) and east of Bell River in an unnamed peak in the Richardson Mountains (Duk-Rodkin and Hughes, 1992a). Cirque scars are found in both these areas, but no glacial deposits have been recognized in the valleys of the Richardson Mountains. Malcolm Valley has glacial features that could relate to three glacial periods, including the Late Wisconsinan. The identification of these three glacial periods is based on the degree of preservation of glacial features on these valleys.



A. Duk-Rodkin, Geological Survey of Canada

Figure 165-3. Pediment terraces on the eastern slope of the Richardson Mountains have been partly glaciated by the Laurentide ice sheet. The tundra vegetation in the foreground is dominated by cotton grass *(Eriophorum vaginatum)*.

Figure 165-4. The mottled texture of this slope results from solifluction, the sliding of the active layer over the underlying permafrost. The solifluction lobes, like rolls, are several metres across and up to 2 m high. They are composed of a mix of mineral soil, organic matter and rock fragments.

During its maximum extent, the Laurentide Ice Sheet extended up to 970 m asl in the southern Richardson Mountains, descending to 880 m asl in McDougall Pass. This Late Wisconsinan limit 30,000 years ago (Hughes *et al.*, 1981; Schweger and Matthews, 1991) is the only glacial limit represented in this ecoregion. Though the ice sheet crossed the continental divide in this ecoregion only at McDougall Pass, meltwater drained to the western side of the mountains at several sites, including the headwaters of the Road and Vittrekwa rivers. This resulted in several changes to pre-existing drainages, most importantly the westward diversion of the Porcupine River (Duk-Rodkin and Hughes, 1994) that caused the inundation of the Bell–Old Crow–Bluefish basins. The outlet of this proglacial lake cut a canyon to the west, establishing the Porcupine River as a tributary to the Yukon River. Today, the former thalweg of the paleo-Porcupine River in McDougall Pass is buried under 150 m of glacial drift. Terraces related to the preglacial drainage are found along both sides of the valley in McDougall Pass, some of which have been partially glaciated by the Laurentide Ice Sheet (Duk-Rodkin and Hughes, 1992a, 1994). The paleo-Porcupine River was one of the many drainage systems that were changed by the Laurentide Ice Sheet.

Pediment development has been ongoing since at least the late Miocene (McNeil *et al.*, 1993; Duk-Rodkin and Hughes, 1994). Lower pediment surfaces grade into alluvial fans towards the interior basins. Pediment surfaces commonly have a veneer of colluvium derived from local bedrock. Extensive pediment areas are found along the eastern and western slopes of Richardson Mountains (Duk-Rodkin and Hughes, 1992a,b). However, pediments along the eastern side of the mountains were covered by the Laurentide Ice Sheet (Fig. 165-3). On the deep glacial drift in McDougall Pass, the dominant surface units are morainal blankets, hummocky moraine and lacustrine deposits.

CLIMATE

Mountains in this ecoregion are oriented southeastward through the northern Yukon and then southward to the Peel River valley. Although not massive, with elevations from 500 to 1,600 m asl, these mountains are rugged and have significant climatic effects. The higher elevations have less extreme temperatures, but greater precipitation and wind velocity, than in surrounding terrain. Winds are stronger over higher elevations, but particularly significant is the funneling effect of the valleys. There are frequent occurrences of strong to gale-force winds that can develop through depressions when masses of cold Arctic air either spill into or out of the Yukon's interior during the winter. Due to the latitude, the sun remains above the horizon from early June to mid-July, and below the horizon from early December to early January.

Mean annual temperatures are near –7.5°C. Mean January temperatures are –20 to –25°C, but near –5°C temperatures are not uncommon. Equally frequent are temperatures near –40°C, particularly in the lower valley floors. Spring or summer conditions are generally delayed until early June. Mean temperatures are near 10°C in July, but again with variations from near freezing to 25°C.

Precipitation is relatively moderate ranging from 250 to 400 mm annually with the heaviest precipitation from June through August over the Richardson Mountains. Precipitation remains moderate through to December, primarily as snow from September onwards.

Winds are believed to be moderate, but during the winter can often be strong to gale force. The prime directions are west and east, but these can be strongly influenced by local topography. Active systems moving over the Beaufort Sea can result in strong outflows of cold Arctic air spilling through depressions such as the Blow and Babbage rivers. These winds can result in extensive snow redistribution.

Little long-term weather data are available from within the mountains but inferences can be made from such stations as Old Crow, Eagle Plains, Fort McPherson, Shingle Point and Komakuk Beach. Interesting data are becoming available from an automatic weather station at Rock Creek, near Wright Pass north of Eagle Plains. The wind data may be indicative of conditions in other passes.

HYDROLOGY

The northern watersheds of the ecoregion fall largely within the Arctic Hydrologic Region, while the southern Richardson Mountains watersheds extend down into the Northern Hydrologic Region. The area of waterbodies is relatively small; there are few large lakes within the ecoregion and wetland coverage is limited in this unglaciated landscape.

Because of the elongated nature of the ecoregion, hydrologic response is somewhat variable. The majority of the ecoregion is located north of 68°N and exhibits a relatively uniform response. The Richardson "panhandle," which extends to below 66°N, extends into a region of higher precipitation. There are two representative hydrometric stations within the Yukon portion of the ecoregion: Firth and Babbage rivers, though the Eagle River is on the periphery and is somewhat representative of the southern portion of the ecoregion. In addition, three hydrometric stations are adjacent to the ecoregion in Alaska: Kaparuk and Sagavanirktok rivers and the Sagavanirktok River tributary. Annual streamflow is generally characterized by a gradual increase in discharge in the spring, rising to a peak in May or June due to snowmelt inputs. Peak flows tend to be consistently earlier within the southern portion, and later with a more variable timing in the north. This ecoregion has among the highest peak flows and lowest winter low flows in the Yukon. Many of the first- and second-order headwater streams are steep and relatively short; therefore, streamflow response tends to be rapid and flashy. On these smaller streams, approximately 40% of the annual maximum flows are due to intense summer rainstorm events. Some small steep streams are susceptible to mud flows triggered by these summer rainstorms. Mean annual runoff is moderate ranging from 150 to 280 mm, with an ecosystem average of 208 mm. Mean seasonal and summer flows are likewise moderate with values of 15.8 X 10^{-3} and 11.4 X 10^{-3} $m^3/s/km^2$, respectively. The mean annual flood is relatively high with a value of 128 X 10^{-3} $m^3/s/km^2$, while the mean maximum summer flow is more moderate with a value of 35 X 10^{-3} $m^3/s/km^2$. Minimum streamflow generally occurs during January or February in the southern portion of the ecoregion and earlier in the northern portion. The mean annual minimum flow ranges from zero in the northern portion to 0.04 X 10^{-3} $m^3/s/km^2$ in the southern portion. Mean summer minimum flow within the ecoregion is 1.9 X 10^{-3} $m^3/s/km^2$. Most streams experience zero winter flow.

PERMAFROST

Permafrost is continuous in the British–Richardson Mountains Ecoregion of the northern Yukon (Harris, 1986) (Fig. 21). Most of the ecoregion was not glaciated during the Quaternary period, so there are terrain features produced by over 2 million years of frost action. The ecoregion is accessible along the Dempster Highway, from which aprons of frost-shattered debris, extensive networks of patterned ground, and numerous solifluction lobes are visible on the mountainsides (Fig. 165-4). The land grading down from the Barn Mountains towards the Yukon Coastal Plain Ecoregion forms extensive pediments of gentle gradient (French and Harry, 1992). Similarly, high elevations within the Richardson Mountains have well-developed sequences of up to 15 cryoplanation terraces (Lauriol, 1990) — flat surfaces separated by short, steep rock walls, which have formed after long-term frost weathering of host material (Rampton, 1982).

The near-surface permafrost layers are often ice-rich, even in bedrock (EBA, 1985). Ice-rich ground has been detected at depths over 5 m by ground-probing radar along the Dempster Highway near the Yukon–Northwest Territories border (EBA, 1987a). Many features characteristic of continuous permafrost, such as ice wedges, may be found beneath the regolith, but soil movement down slope may mask their surface expression. Thaw slumps are occasionally seen in riverbanks where recent erosion has exposed ground ice.

Several of the rivers and creeks draining the ecoregion are fed by perennial springs, and extensive ice develops in the channel beds each winter. The largest aufeis, in the Firth River, is visible on satellite images taken well into summer (Lauriol *et al.*, 1991). This ice may be several metres thick and extend over 25 km^2.

There are no published determinations of permafrost thickness in this ecoregion, but data from neighbouring areas suggest depths of 200 to 300 m (Burgess *et al.*, 1982). The active layer is usually less than 0.5 m deep on pediments and lower slopes, but Rampton (1982) reports a thickness of 2.5 m at favourable well-drained upland sites.

SOILS

Soils in this ecoregion have formed under the influence of a subarctic climate, strong local relief and varied geologic parent materials. They are formed on mountainside colluvium slope deposits or on the large pediment surfaces of broad valleys. The near-surface permafrost is nearly continuous, except for localized occurrences of unfrozen ground along alluvial systems, glacio-fluvial terraces and some well-drained south-facing slope deposits. The soil–landscape relationships in this ecoregion have been described by Wiken *et al.* (1981) and more recently by Welch and Smith (1990) and are summarized in Figure 165-5. Well-developed periglacial landforms exist, including cryoplanation terraces and cryopediment slopes (French and Harry, 1992). Soils have formed in nonglacial parent materials except for those on the eastern flank of the Richardson Mountains, which were subjected to Laurentide glaciations during the Pleistocene.

All gently sloping surfaces tend to have soil development strongly influenced by cryoturbation. These Cryosols are often silty or clay-textured, saturated for most of the growing season, and classified as Gleysolic Turbic Cryosols. These soils tend to be acidic, particularly in association with shale bedrock; are high in organic matter and silt, and have active layers of less than 50 cm (see site 9, Tarnocai *et al.*, 1993). On pediment surfaces, these soils are associated with tussock tundra vegetation. Shallow soils over bedrock on upland surfaces above treeline exhibit a variety of patterned ground formations, mostly sorted and non-sorted nets and stripes, tend to be less saturated, and are classified as Orthic Turbic Cryosols. On mountain slopes below treeline where there is no near-surface permafrost, soils are most often classified as Eutric Brunisols, or occasionally as Melanic Brunisols if they have thick surface A horizons. Soils are classified as Orthic Turbic Cryosols wherever permafrost occurs on steep slopes (Fig. 165-6). Alluvial sands and gravels tend to lack strong cryoturbation features or a near-surface permafrost table, and are classified as Orthic or Humic Regosols. On older, more stable alluvial surfaces where permafrost is established, soils are typically classified as Regosolic Static Cryosols. On well-drained fluvial terraces, near-surface permafrost may be lacking and soils are classified as Orthic Eutric Brunisols.

One of the unique soil features of the ecoregion is the humus-rich, rendzina-like soil of the limestone areas of the British Mountains (Welch and Smith, 1990; Smith *et al.*, 1990,). Others are the cryoplanation terraces and summits of the Richardson Mountains with their associated patterned ground formations, unique soil fauna populations (Tynen *et al.*, 1991), and solifluction lobes (see site 7 in Tarnocai *et al.*, 1993).

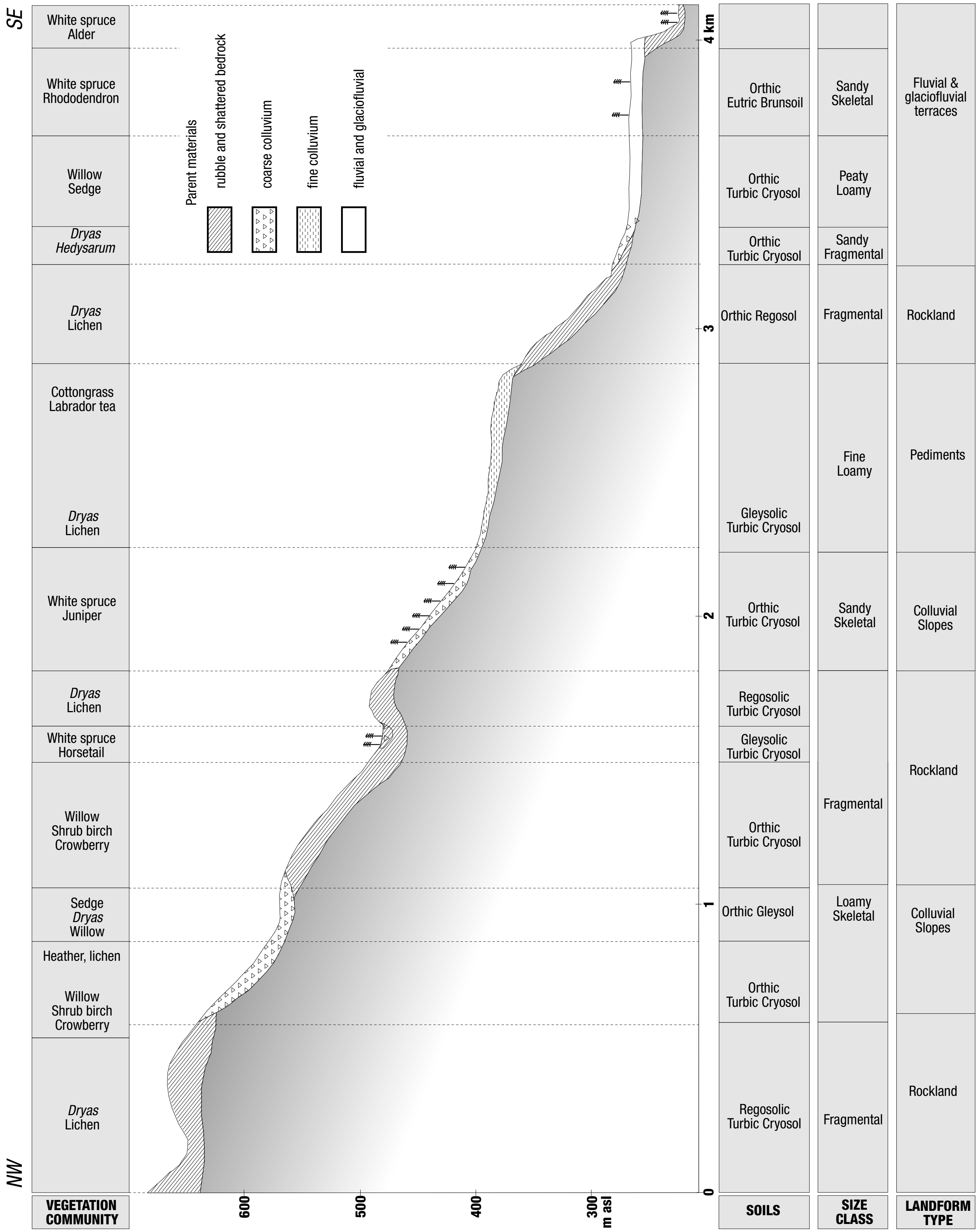


Figure 165-5. Cross-section of soil and vegetation relationships in the Firth River valley in the British Mountains portion of the ecoregion.

VEGETATION

The vegetation of the British–Richardson Mountains Ecoregion is dominated by shrub tundra. Treeline ranges from around 600 m asl in the south to 300 m asl in the north (Zoltai and Pettapiece, 1973; Ritchie, 1984; Loewen and Staniforth, 1997b). Ridge crests support dwarf willow or dryas–lichen tundra, often with sparse vegetation cover. Upper and middle slopes are covered by dry to moist, low shrub and heath tundra, while on lower slopes sedge tussock communities predominate. Shrub thickets are typical along creeks and drainage channels. Trees are limited to river valleys such as the Firth, Big Fish, Bell, and lower slopes with favourable aspects (Fig. 165-1).

On mountain and ridge crests, ranging from 330 to 1,600 m asl, the vegetation is dependent on the parent material. Because most of the area was not glaciated, the soil and vegetation communities reflect the underlying bedrock. Shrub willow (*Salix phlebophylla)* is the dominant cover on shale and sandstone. A sparse cover of *S. phlebophylla*, arctic bearberry, dryas, locoweed, and shrub birch often occurs on only 10 to 20% of the ground surface (Ritchie, 1984; Loewen and Staniforth, 1997b). On calcareous parent material (more extensive to the west in the British Mountains), a floristically rich, although very sparse, dryas–sedge alpine community with numerous forbs, including moss campion, northern sweet-vetch and anemone, and ground shrubs is more typical (Ritchie, 1984).

Slopes contain a mix of shrub and heath tundra. On moister snow accumulation sites and solifluction slopes, willow and ericaceous shrubs including mountain heather, blueberry, lingonberry, mosses and forbs are common. Slopes are often unstable in permafrost areas and many are characterized by scattered flows or slides. These create numerous microsites and intricate complexes of dry to moist vegetation communities. The scarps usually have dry, low shrubs, while the depressions below are wet, colonized first by moss, and then quite rapidly by shrubs. Earth hummocks also create diverse microsites. In the numerous drainages that transect the slopes, tall to medium willow grows with some shrub birch and alder, commonly with an understory of stepmoss, horsetail, forbs and grass (Kennedy, 1990).

On the gentle pediment surfaces of lower slopes, sedge tussock communities predominate. Cottongrass (*Eriophorum vaginatum)* is the major tussock-forming species associated with sedge (*Carex lugens)*, shrub birch, Labrador tea, blueberry, lingonberry and mosses dominated by *Aulacomnium*, *Tomenthypnum* and *Hylocomium*.

Major river valleys provide lower elevation sheltered environments and deeper active layers, which can support open stands of white spruce on inactive

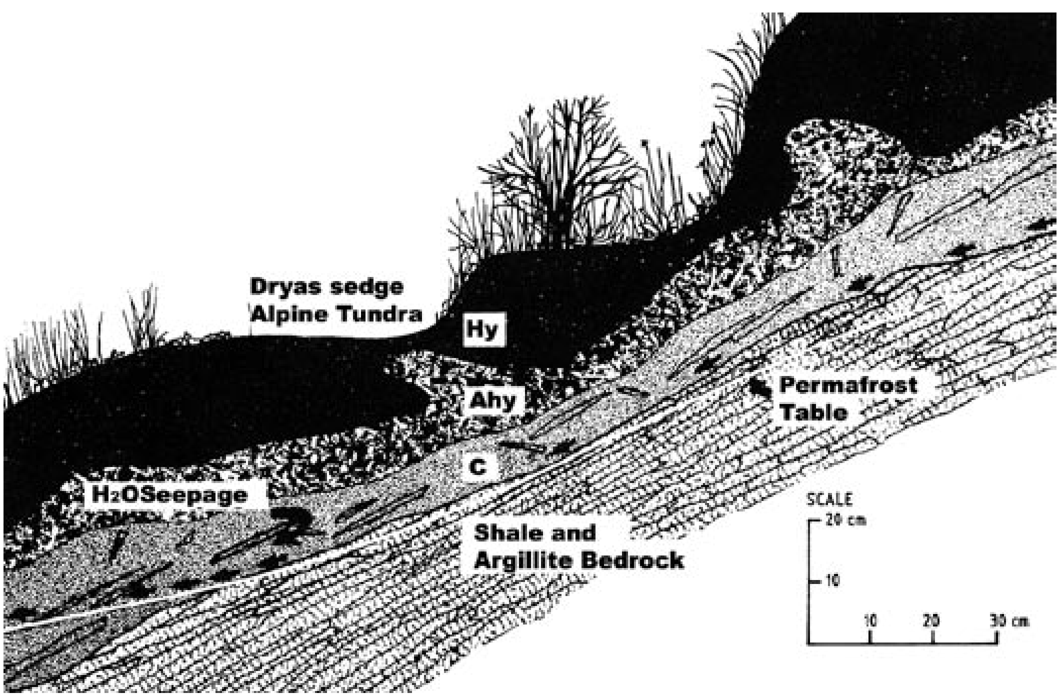


Figure 165-6. Cross-section of typical soil formation on steep slopes, Richardson Mountains. Soils typically have dark-coloured, humus-rich surface horizons (Hy and Ahy). These horizons are mixed with rock fragments as a result of solifluction and cryoturbation. These overlie a mineral horizon (C) of weathered bedrock (from Smith *et al.*, 1990).

river terraces and on well-drained slopes above the streams (Kennedy, 1990). Tamarack is found at treeline in the Richardson Mountains with white spruce on moist calcareous substrate. Balsam poplar is found along recent floodplains and is probably successional to white spruce if left undisturbed. Willow, and sometimes alder, thickets are associated with permafrost-free Regosolic soils on recent floodplains. Horsetails and annual herbs are found on the most frequently flooded sites beside the rivers (Welch and Smith 1990).

WILDLIFE

Mammals

This mountainous region is the primary Canadian calving area of the Porcupine barren-ground caribou herd (Fancy *et al.*, 1994). Caribou use the mountain ridges to maximize wind exposure and gain relief from biting insects in summer. The ecoregion is also used for spring and fall migrations and winter range by the herd. Dall sheep reach their northern limit of distribution in the British Mountains near the Alaska border and in the Richardson Mountains near the Northwest Territories border (Barichello *et al.*, 1989a). Most moose are seasonal residents of riparian habitats, migrating below treeline on the south slope of the mountains in winter (Smits, 1991).

Grizzly bears reach their highest density north of the Mackenzie Mountains here. Wolverines are abundant and heavily dependent on caribou, which they opportunistically cache for future use. River otters are present along fish-bearing streams. Singing Vole colonies and Varying Lemming are common. A list of mammal species known or expected to occur in this ecoregion is given in Table 4.

Birds

The Surfbird is a significant breeder in these rocky slopes and ridges, as its Canadian distribution is limited to these mountains and the Ogilvie Mountains (Frisch, 1987). The mostly barren uplands are utilized in summer by nesting Baird's Sandpipers, Hoary Redpolls, Horned Larks, Northern Wheatears and Gray-crowned Rosy Finch (Frisch, 1975, 1987; Godfrey, 1986).

Sedge tussock tundra provides habitat for many species such as Rock Ptarmigan, American Golden-Plover, Whimbrel, Long-tailed Jaeger and American Pipit (Frisch, 1975, 1987; Weerstra, 1997). Shrubby tundra at these and lower elevations is inhabited by Willow Ptarmigan, Northern Shrike, American Tree, Savannah and White-crowned Sparrows, Smith's Longspur and Common Redpoll (Godfrey, 1986; Frisch, 1987; Weerstra, 1997). Upland Sandpipers breed in sparsely treed, subalpine bogs (Frisch, 1987).

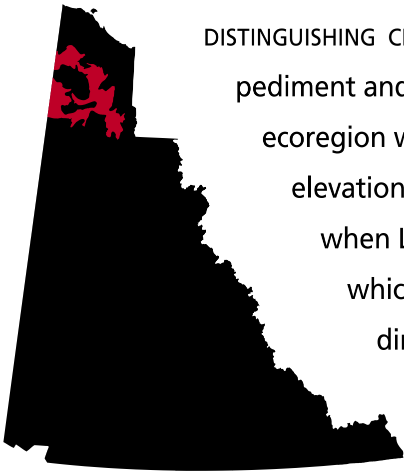
Scattered forests provide breeding habitat for Gray Jay, Townsend's Solitaire, Gray-cheeked Thrush, American Robin, Yellow-rumped Warbler and Fox Sparrow (Frisch, 1987; Weerstra, 1997). The rare Gray-headed Chickadee is occasionally found in this sparsely treed habitat, while the omnipresent Common Raven occurs throughout (Frisch, 1987; Sinclair *et al.* [editors], 2003).

Cliffs, banks, and canyon walls of the Firth River provide breeding sites for Rough-legged Hawk, Golden Eagle, Peregrine Falcon, Gyrfalcon and Say's Phoebe (Theberge *et al.* [editors], 1979; CWS, Birds of the Yukon Database). Harlequin Ducks occur in summer on swift flowing streams and smaller rivers (Frisch, 1987). Wandering Tattlers nest along gravel bars of mountain streams (Godfrey, 1986). Dense willow and alder along many of these watercourses provide habitat for breeding Yellow and Wilson's Warblers (Frisch, 1987). Tundra ponds provide breeding habitat for Red-throated Loon, Tundra Swan, Northern Pintail, Long-tailed Duck and Red-necked Phalarope (Frisch, 1987). Ferns and shallow water ponds provide breeding habitat for Northern Harrier, Least Sandpiper and Common Snipe (Frisch, 1987).

Old Crow Basin

Taiga Cordillera Ecozone

ECOREGION 166



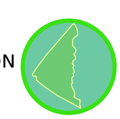
DISTINGUISHING CHARACTERISTICS: This ecoregion is a large physiographic basin with pediment and upland topography surrounding the Old Crow Flats Ecoregion. The ecoregion was left unglaciated during the Pleistocene, but much of the lower elevations were submerged under Glacial Lake Old Crow. The glacial lake formed when Laurentide ice blocked the former drainage outlet of the ecoregion, which was eastward to the Mackenzie Delta. This ultimately changed the direction of flow of the Porcupine River westward into Alaska and on to the Bering Sea via the Yukon River. The ecoregion contains spring and fall migration routes of the Porcupine caribou herd.

J. Meikle, Yukon Government

Figure 166-1. Confluence of the Bell and Eagle rivers. View eastward into the foothills of the Richardson Mountains, showing the extensive lowlands with thick accumulation of peat. Alluvial sites along the rivers are colonized by willow and white spruce. The ecoregion is underlain by continuous permafrost.

APPROXIMATE LAND COVER
subarctic coniferous forest, 60%
alpine/arctic tundra, 30%
lakes and wetlands, 10%

TOTAL AREA OF ECOREGION IN CANADA
14,590 km^2



TOTAL AREA OF ECOREGION IN THE YUKON
14,590 km^2

ECOREGION AREA AS A PROPORTION OF THE YUKON
3%

Metres above sea level

ELEVATIONAL RANGE
300–1,080 m asl
mean elevation 450 m asl

CORRELATION TO OTHER ECOLOGICAL REGIONS: Equivalent to **Old Crow Basin** (excluding Old Crow Flats) and **Berry Creek Ecoregions** (Oswald and Senyk, 1977) • Equivalent to **Old Crow Basin Ecoregion** excluding Old Crow Flats (Wiken et al., 1981) • Portion of **Alaskan Boreal Interior Region** (CEC, 1997) • Portion of the **Interior Alaska/Yukon Lowland Ecoregion** (Ricketts et al., 1999)

PHYSIOGRAPHY

The Old Crow Basin Ecoregion incorporates the Old Crow Pediplain, Old Crow Range and Bell River section of the Eagle Lowland physiographic units of Matthews (1986). The ecoregion is part of the Porcupine Plain and Plateau (Bostock, 1948). It includes the Old Crow Mountains, part of the Porcupine Plain, and the higher parts of the Old Crow, Bell and Bluefish basins (Hughes, 1987b).

The terrain is a uniform, gently sloped surface extending from the mountains down to the Old Crow Flats and the Porcupine River and its tributaries (Fig. 166-1). It is surrounded by the Keele Range and Dave Lord Range to the south, the Richardsons to the east and the British Mountains to the north.

Most of the ecoregion lies between 300 and 600 m asl. Only the Old Crow Range and a few other hills in the north rise higher. The highest point is in the Old Crow Range, just over 1,000 m asl.

BEDROCK GEOLOGY

Thick Tertiary and Quaternary lacustrine and fluvial sediments up to 1,200 m thick underlie all of the Old Crow Basin except a single exposure of Carboniferous shale near the mouth of Timber Creek (Morrell and Dietrich, 1993). The surrounding elevated areas are structural uplifts or resistant granite; some rivers have incised to bedrock. Large areas of outcrop are shown on regional geological maps by Norris (1981b,c,d) and the general distribution of rocks beneath the covering sediments by Wheeler and McFeely (1991).

Beneath the Old Crow Basin and the northern Old Crow Flats are a succession of transgressive passive margin deposits of the Endicott Group and stable shelf carbonate of the Lisburne Group (Norris [editors], 1997). Undated granite intrudes the Yukon–Alaska border northwest of the Old Crow Basin as Mount Ammerman. South of the Old Crow Basin and north of the Porcupine River are unnamed varicoloured clastic and carbonate rocks. These areas are cored by granitic intrusions of Middle Devonian age. The southeast lobe of the Old Crow Flats Ecoregion extends across the Aklavik Arch, where the rock succession contains unconformities between Carboniferous, Permian, Jurassic and Cretaceous rocks, indicating numerous periods of uplift. It includes part of the Bell Basin, beneath which is the structural intersection of northeast- and east-trending folds and thrusts with the north-trending Richardson Mountains (Lane, 1996). Here, river canyons expose dark clastic sedimentary rocks of the Permian Jungle Creek and Takhandit formations, the Jurassic-to-Cretaceous Parsons Group and the upper Cretaceous Eagle Plains Group.

Few mineral occurrences are known here. In the Old Crow Range, lead and zinc of Sunaghun showing (Yukon MINFILE, 2001) and tungsten of the Scheelite occurrence are found in the granitic rocks. Uranium, lead and zinc are found in the Dave Lord stock (Carswell occurrence). Copper and uranium in Carboniferous rocks were investigated near the Driftwood River. Hydrocarbon potential has been tested near Whitefish Lake in the Bell Basin (Lane, 1996) and shale-like lignite is exposed nine kilometres east of Old Crow village.

The caves on the Blue Fish River, which are of much archeological importance (Cinq-Mars, 1990), are part of a widespread paleokarst developed in the Devonian Ogilvie Formation.

SURFICIAL GEOLOGY AND GEOMORPHOLOGY

This ecoregion is formed mainly of gently sloping pediment surfaces that surround the Old Crow Flats. Colluvium covers approximately four-fifths of the ecoregion (Fig. 166-2). It derives from millions of years of weathering throughout the Late Tertiary and Quaternary in the surrounding mountains. Plateau and low relief uplands are characterized by broad valleys and at least two levels of pediments.

Surficial deposits are weathered rock or fine-textured colluvium up to a few metres thick on slopes (Hughes, 1969b). This colluvium tends to be silty and clayey on pediment surfaces. On steep slopes it is gravelly to blocky overlying carbonate bedrock, platy when overlying argillite, and blocky overlying limestone and quartzite. The pediment width ranges from 5 to 10 km along the northern side of the ecoregion, where they border calcareous rocks. Pediments are developed on shale, siltstone and sandstone in the east of the ecoregion, on granite in the west, and on carbonates in the north and southwest. The depressions and seepage lines are often covered by thicker organic material. Where there is no well-defined drainage channel, a feathered drainage pattern is enhanced

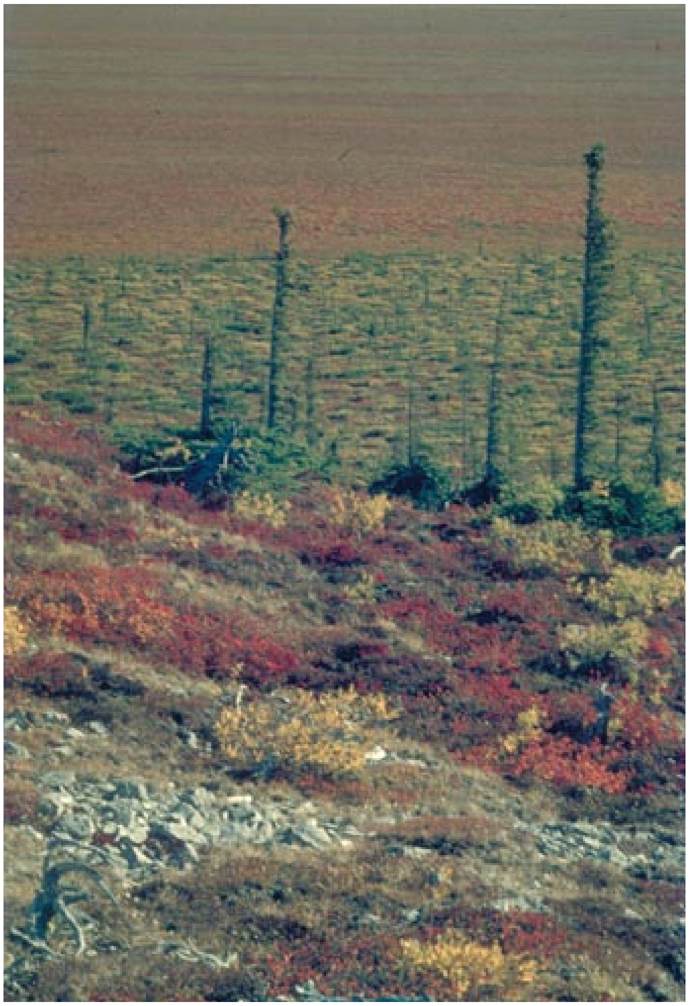


Figure 166-2. Between the Old Crow Flats and the British Mountains is the Old Crow Pediplain, which includes some of the limited outcropping in the ecoregion. This area is characterized by extensive gently sloping pediment surfaces, formed by millions of years of weathering.

by vegetation growth. Well-defined meandering channels are less common (Wiken *et al.*, 1981).

Glaciolacustrine deposits and alluvial deposits cover the remainder of the ecoregion (Hughes *et al.*, 1973).

GLACIAL HISTORY

This ecoregion is located within the unglaciated terrain of the northern Yukon. However, the eastern part of this ecoregion in the lower Bell River area contains glaciolacustrine sediments over 30 m thick. These sediments record the eastern part of Glacial Lake Old Crow, which formed when the Late Wisconsinan Laurentide Ice Sheet blocked drainage of the Porcupine and Rock rivers to the east and the Peel River to the south. This diverted the Mackenzie region drainage across the continental divide about 30,000 years ago (Lemmen *et al.*, 1994; Duk-Rodkin and Hughes, 1995; see Old Crow Flats Ecoregion). In the Bell Basin, faint shoreline traces indicate that the glacial lake was more extensive than the lacustrine sediment distribution in the basin.

These sediments reveal a complex history related to the drainage dynamics in the paleo-Porcupine River Valley, now occupied by the upper Bell River and its continuation on the eastern side of the Richardson Mountains as the Rat River (Duk-Rodkin and Hughes, 1994). The ice sheet blocked eastward drainage of the paleo-Porcupine River, forming temporary glacial lakes (Fig. 166-3). Catastrophic flooding is recorded in both Rock and Rat rivers (Catto, 1986; Schweger and Matthews, 1991). At McDougall Pass, the paleo-Porcupine River thalweg is buried under 150 m of Laurentide glacial drift. The sediments in Bell Basin record inundation of the basin by a glacial lake, deposition of several glaciolacustrine units, drainage of the lake, and subsequent development of terraces and modern floodplains that inset the glaciolacustrine sediments (Hughes *et al.*, 1973).

CLIMATE

Although the climates of the Old Crow Basin and Old Crow Flats ecoregions are very similar, some areas of higher elevation in the Old Crow Basin may have slightly higher precipitation, and temperatures may be slightly more moderate.

At this latitude north of the Arctic Circle, the sun is continuously above the horizon for approximately two weeks in the summer. During the winter, the area is dominated by an arctic high-pressure system. Infrequently, a strong low-pressure system moving over the Beaufort Sea can result in brief, windy, mild spells. During the short summer, the area is under a weak low-pressure system with relatively mild and moist air. Spring and summer are delayed by almost a month compared to the southern Yukon.

Mean annual temperatures are among the lowest in the Yukon, approximately –8 to –10°C with a strong seasonal variation. The average January temperature is –30 to –35°C; the average July temperature ranges from 12 to 15°C. Extreme winter minimums are –55 to –60°C, but above freezing temperatures have briefly occurred. Extreme

J. Meikle, Yukon Government

Figure 166-3. In response to being diverted by Laurentide Ice from its course through McDougall Pass and into the Mackenzie River, the Porcupine River flows westward into the Yukon River. It is pictured here at the Ramparts where downcutting continues.

summer maximums are 33 to 35°C, but frosts can occur at any time of the year. Winters are prolonged and generally extend from October to mid-May. The North Ogilvie Mountains to the south are enough of a barrier to retard southerly winds eroding the cold air from the lower elevations. The transition from winter to summer conditions is rapid. The prolonged low angle of the sun above the horizon during winter reduces the daily cycle of temperatures during this period.

Precipitation is relatively light, amounting only to 200 to 300 mm annually. The wettest period is June through August with monthly amounts of 30 to 45 mm. This summer precipitation falls as rain, primarily showers or thunderstorms. There have been some summer months with precipitation amounts of 100 to 150 mm. The driest period is January to April, averaging 10 to 15 mm of snow monthly.

Wind data are limited, although some data are available from the village of Old Crow. Winds are generally light at less than 15 km/hr, particularly during the winter months. Periods of moderate winds, 15 to 30 km/hr, occur less than a quarter of the time, coming primarily from the northeast and less frequently from the southwest. Winds greater than 40 km/hr are common.

Representative climate information is available from Old Crow.

HYDROLOGY

The Old Crow Basin Ecoregion is situated within the Northern Hydrologic Region. The ecoregion is narrow and irregular in shape, completely enveloping the Old Crow Flats Ecoregion. Flanked by the North Ogilvie Mountains to the south, the Richardson Mountains in the east, and the British Mountains in the north, the ecoregion drains the Old Crow Flats Ecoregion and surrounding slopes. The Porcupine River flows into Alaska where it is joined by the Coleen River, a major tributary. Flow within the ecoregion is divided by headwater tributary flows to the Old Crow River while lower reach tributaries flow directly into the Porcupine River (Fig. 166-3). The lower reaches of the north-flowing Eagle River and the southwest-flowing Bell River are the largest tributary streams of the Porcupine River. Intermediate streams include the Rock and Bluefish rivers and Lord Creek. South-flowing streams from the British–Richardson Mountains Ecoregion include the Driftwood River and Johnson, Timber and Thomas creeks. There are no lakes on the pediment surfaces surrounding the Old Crow Flats Ecoregion, however, numerous smaller, lowland and oxbow lakes are associated with the Porcupine, Bell and Eagle rivers, as well as some upland, headwater lakes. The largest waterbody is Whitefish Lake, in the southern portion of the ecoregion. The most significant wetland is the Whitefish complex, an area more similar to the Old Crow Flats than to the rest of the ecoregion.

There are no representative hydrometric stations records for the ecoregion; therefore, a regional analysis was carried out to estimate the characteristic streamflow characteristics. The ecoregion is sufficiently similar in physiography, vegetation, surficial geology and climate, to the adjacent Eagle Plains Ecoregion that streamflow characteristics may be transferred directly. The exception lies with winter low-flow characteristics, which are estimated to be approximately 50% of those in the Eagle Plains Ecoregion due to the increasing importance of permafrost with increasing latitude. Because of the very similar topography, it is estimated that annual and seasonal runoff characteristics and peak flows will be similar. As with the Eagle Plain Ecoregion, runoff is moderately low because of the relatively low relief. Within most ecosystem streams, annual streamflow is estimated to have an increase in discharge in April due to snowmelt, then rise to a peak in May. Summer rain events can produce secondary peaks, and sometimes the annual peak runoff. This is thought to be especially true of smaller streams, which more frequently experience peak rainfall events. Mean annual runoff is estimated to be moderately low with a value of 200 mm, while mean seasonal and summer flows are likewise estimated to be moderately low with values of 12 X 10^{-3} and 10 X 10^{-3} $m^3/s/km^2$ respectively. The mean annual flood and mean maximum summer flow are estimated to be moderately high and low with values of 93 X 10^{-3} and 31 X 10^{-3} $m^3/s/km^2$, respectively. The minimum annual and summer flows are estimated to be relatively low, with values of 0.34 X 10^{-3} and 2 X 10^{-3} $m^3/s/km^2$, respectively. Minimum streamflow generally occurs during March or earlier with the relative magnitude among the lowest of all Yukon ecoregions, due to the increasing role of winter temperatures and permafrost on streamflow. Most small and intermediate streams frequently experiences zero winter stream flow.

PERMAFROST

The Old Crow Basin Ecoregion lies in the continuous permafrost zone. Lower elevations in the Old Crow Basin were covered by a glacial lake during the late Wisconsinan period. Permafrost was likely eradicated from beneath the lake at that time. The base of permafrost was encountered at 63 m depth in two holes drilled to provide a water supply for the community of Old Crow (EBA, 1982a); all holes drilled for construction in the community have encountered frozen ground within two metres of the surface. Annual mean near-surface ground temperatures are about –4°C (Stanley Associates, 1979). The active layer depth in the peatlands of the basin is usually greater than 40 cm and occasionally greater than 60 cm (Ovenden and Brassard, 1989).

Shallow lakes within the ecoregion are warm in summer and sufficiently deep to prevent freezing of lake-bottom sediments in winter. As a result, a talik persists beneath the lakes, many of which are sufficiently wide for the talik to penetrate though permafrost, theoretically. The lakes are oddly rectangular and oriented northeast–southwest or northwest–southeast. Their surface expression is likely unassociated with permafrost conditions, but may be a product of wind-generated currents (Mackay, 1956).

The low-lying terrain and pediment surfaces have a hummocky microtopography typical of moist taiga regions and near-surface permafrost is usually ice-rich. Ice-wedge polygons occur throughout the region, but they have not developed into the extensive networks characteristic of the Yukon Coastal Plain Ecoregion. There are well-developed, active ice wedges along the Porcupine River, growing syngenetically with floodplain deposits (Lauriol *et al.*, 1995).

Sedimentary sequences exposed in bluffs cut by the Porcupine River have been used to trace environmental conditions back to the late Tertiary (Pearce *et al.*, 1982). Ice-wedge casts in the sediments provide early evidence of permafrost in the Yukon (Burn, 1994).

SOILS

Soils in this ecoregion have formed under the influences of a strongly continental subarctic climate and unglaciated, broad, gently sloping basin topography. There have been few regional studies of the soils of the Old Crow Basin other than the ecological survey of Wiken *et al.* (1981) and a number of site-specific investigations associated with Quaternary research in the ecoregion (Morison and Smith, 1987).

Most of the landscape is composed of unglaciated pediment surfaces emanating from the surrounding ranges of the Richardson, Keele, Old Crow, Barn and British mountains. These colluvial surfaces are mantled with 1 to 2 m of fine-textured deposits supporting open black spruce forest or shrubby, tussock tundra vegetation. These soils are all characterized by shallow (<1 m) active layers and intensive frost churning and are classified as Gleysolic Turbic Cryosols, if they remain saturated through most of the growing season, or as Orthic Turbic Cryosol, if imperfectly drained. Upland areas support more forest growth and soils tend to be better drained. Paleosols composed of residual weathering products occur where older bedrock surfaces have escaped erosion (Tarnocai, 1987c). While most of the ecoregion is underlain by continuous permafrost, some permafrost-free soils, usually Eutric Brunisols, are found on well-drained, south-facing slopes in the uplands.

There are extensive wetlands near the Eagle and Bell river systems (Fig. 166-1). Here, peat accumulations may be over 2 m thick under fen and polygonal peat plateau vegetation. These wetland soils are classified as Fibric or Mesic Organic Cryosols (i.e. perennially frozen, semi-decomposed sedge and moss peat). Where the peat is less than 40 cm thick adjacent to the wetlands proper, the soils are classed as Gleysolic Turbic Cryosols.

VEGETATION

Open spruce–lichen–heath vegetation communities dominate the pediments of the Old Crow Basin. Pediment surfaces with slopes less than 5% are typically dominated by sedge and cottongrass tussocks. A sparse shrub layer of willow, shrub birch and ericaceous shrubs, and rarely black spruce, accompany the tussocks with sphagnum or other mosses between the tussocks. The stunted trees average about 4 m in height. Treeline is reached at 600 m asl (Zoltai and Pettapiece, 1973). Higher elevations of the Old Crow Range and other mountains rimming the ecoregion support scrub heath tundra (Hettinger *et al.*, 1973).

On imperfectly drained soils, open black and white spruce–lichen–heath communities are associated with earth hummocks and Orthic Turbic Cryosol soils. The understory vegetation is mainly shrub birch, ericaceous shrubs, mosses, and lichens dominated by *Cetraria*, *Cladina* and *Cladonia*. Paper birch and alder may be found on steep, east-facing slopes. Many seral stages are represented due to fire disturbance.

Lowland sites of the Bell and Whitefish basin areas are similar to those of the Old Crow Flats Ecoregion. Black spruce–lichen–heath communities dominate the frozen organic soils of the peat plateaus. Floating mats of sedges and mosses are also common. A succession of vegetation communities occurs on riparian sites (Fig. 166-4). Flood-tolerant species such as willow and alder colonize the floodplain, being taken over by white spruce and paper birch on more stable sites (Loewen and Staniforth, 1997a).

The scrub heath tundra, found on colluvial and residual slopes at higher elevations, consists of dwarf and low shrub birch and willows underlain by moss and lichen. On exposed ridges and slopes, the vegetation highlights non-sorted circles, nets and stripes. Where the underlying rocks are more resistant, rocks and boulders cover much of the surface.


C.D. Eckert, Yukon Government

Figure 166-4. Lowest elevations on this ecoregion are underlain by glaciolacustrine sediments from Glacial Lake Old Crow. The Whitefish wetland complex shown here is located in the eastern portion of the former glacial lake basin.

WILDLIFE

Mammals

The Old Crow Basin and Old Crow Flats possess the most abundant wildlife populations of the Taiga Cordillera, with many species reaching densities typical of the Boreal Cordillera of the southern Yukon. However, the diversity of rodents and ungulates is comparatively low. Grizzly bear, moose, wolverine, lynx, and marten are abundant. The Porcupine barren-ground caribou herd migrates through in spring and fall. Muskrat are abundant in the Whitefish Lake Wetlands at the confluence of the Eagle, Bell and Porcupine rivers. There is no information on populations of small rodents. A list of mammal species known or expected to occur in this ecoregion is given in Table 4.

Birds

The Porcupine and Old Crow drainages are significant nesting areas for Peregrine Falcon (Hayes and Mossop, 1978). Extensive fens and bogs associated with meandering rivers in the basin and tundra ponds on the plateaus are used by Northern Harrier, Least Sandpiper, Common Snipe, and Short-eared Owl in summer (CWS, Birds of the Yukon Database). Shrubby areas of willow, birch and alder along these watercourses provide nesting habitat for Yellow Warbler, Northern Waterthrush, and Wilson's Warbler (CWS, Birds of the Yukon Database). The Whitefish Lake complex at the confluence of the Bell, Eagle, and Porcupine rivers is an important wetland area for breeding and moulting geese and ducks (Dennington, 1985). While there is little documented information, it is known that this area supports breeding and moulting Greater White-fronted and Canada Geese, diving ducks, and possibly Tundra Swan (Dennington, 1985; Hawkings, 1994). Wetlands support waterbirds such as Red-throated and Pacific Loons, Horned and Red-necked Grebes, American Widgeon, Mallard, Northern Pintail, Green-winged Teal, scaup, goldeneye, Red-necked Phalarope, and Mew Gull (Dennington, 1985; CWS, Birds of the Yukon Database).

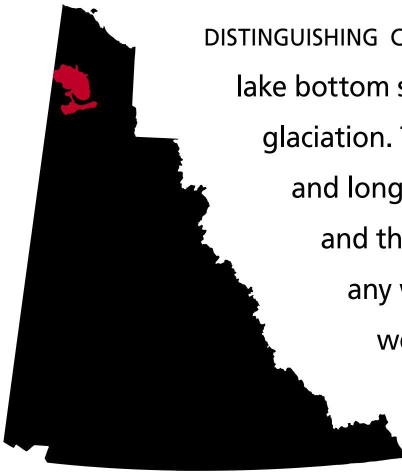
Spruce forests provide breeding habitat for Sharp-shinned Hawk, Red-tailed Hawk, Merlin, Northern Hawk Owl, Great Gray Owl, Gray-cheeked Thrush, and Yellow-rumped and Blackpoll Warblers (CWS, Birds of the Yukon Database). Year-round residents include Gray Jay, Common Raven, and Spruce Grouse at their northern limit (Rand, 1946; CWS, Birds of the Yukon Database).

Upland areas of tussock tundra support Arctic breeders such as Rough-legged Hawk and Long-tailed Jaeger. As well, American Kestrel, Rock Ptarmigan, American Golden-Plover, Whimbrel, Least Sandpiper, Savannah Sparrow, and Smith's Longspur may also breed in this habitat (CWS, Birds of the Yukon Database). Gyrfalcons breed on rocky ledges in these alpine areas and small numbers of Golden Eagle may also breed here (CWS, Birds of the Yukon Database). Birds such as Willow Ptarmigan, American Robin, American Tree Sparrow, White-crowned Sparrow, and Common Redpoll occur in shrubby tundra areas associated with subalpine forests (CWS, Birds of the Yukon Database). Scattered barren ridges and rocky slopes likely host small numbers of breeding Baird's Sandpiper, Horned Lark, and Gray-crowned Rosy Finch (Godfrey, 1986).

Old Crow Flats

Taiga Cordillera Ecozone

ECOREGION 167



DISTINGUISHING CHARACTERISTICS: The extent of this eroregion is defined by the area of lake bottom sediments deposited by a glacial lake that formed at the end of the last glaciation. The climate of the ecoregion is strongly continental with warm summers and long, cold winters. The difference between the mean July temperature and the mean January temperature at Old Crow village is the greatest of any weather station in the Yukon. The ecoregion is composed of lakes and wetlands occupying a large topographic basin that forms an extremely important wildlife habitat. The ecoregion supports the most abundant waterfowl population within the Taiga Cordillera Ecozone in Canada.

J. Hawkings, Canadian Wildlife Service

Figure 167-1. The level landscape of the Old Crow Flats Ecoregion is covered by small lakes, wetlands and meandering streams. The outline of lakes changes over time through a cycle of erosion and permafrost decay, potential lake drainage, revegetation and re-establishment of permafrost.

APPROXIMATE LAND COVER
subarctic coniferous forest, 55%
lakes and wetlands, 35%
tussock tundra, 10%

TOTAL AREA OF ECOREGION IN CANADA
5,970 km^2

TOTAL AREA OF ECOREGION IN THE YUKON
5,970 km^2

ECOREGION AREA AS A PROPORTION OF THE YUKON
1%

Metres above sea level

ELEVATIONAL RANGE
325–610 m asl
mean elevation 327 m asl

CORRELATION TO OTHER ECOLOGICAL REGIONS: Equivalent to Old Crow Flats portion of **Old Crow Basin Ecoregion** (Oswald and Senyk, 1977) • Equivalent to Old Crow Flats portion of **Old Crow Basin Ecoregion** (Wiken et al., 1981) • Portion of **Alaskan Boreal Interior Region** (CEC, 1997) • Portion of the **Interior Alaska/Yukon Lowland Ecoregion** (Ricketts et al., 1999) • Portion of **Yukon Old Crow Basin** (Nowacki *et al.*, 2001)

PHYSIOGRAPHY

The Old Crow Flats Ecoregion includes two parts joined along the Old Crow River: the Old Crow Flats or Basin, and the lowlands along the Porcupine River, from the mouth of the Driftwood River to the Bluefish River. This second part is a portion of the Old Crow Pediplain (Matthews, 1986), the Bluefish Basin (Hughes, 1987b), or the Porcupine Plain (Bostock, 1948).

This is a lowland area in which most of the elevation is less than 600 m asl. The basins, the result of downwarping or downfaulting, are sites of deposition. Local relief is about a few metres. Lakes are numerous, covering about 35% of the land surface. Many lakes are rectangular (Fig. 167-2) and oriented northwest–southeast, perpendicular to the prevailing wind.

The Old Crow River and its tributaries flow southward through the Old Crow Flats to the Porcupine River, which heads west into Alaska.

BEDROCK GEOLOGY

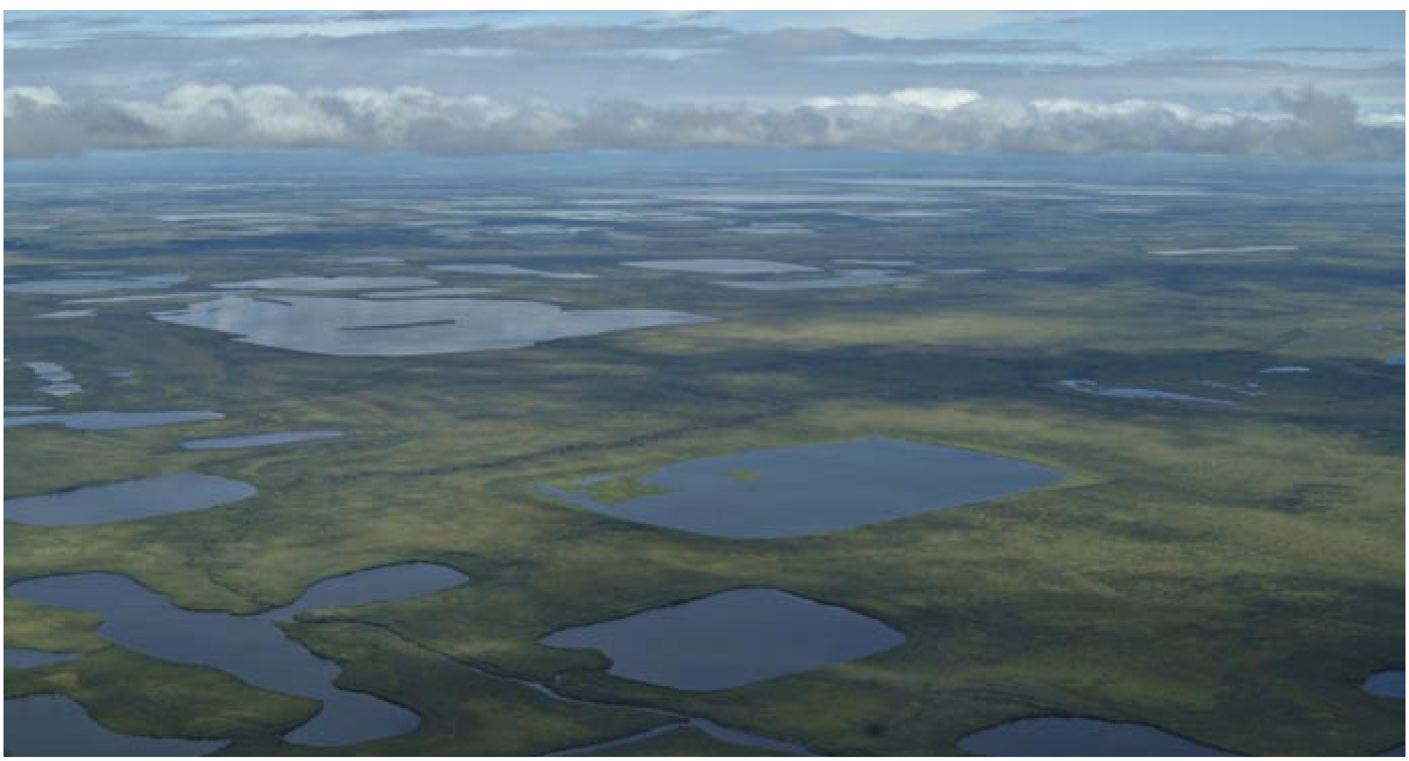
Thick Tertiary and Quaternary glaciolacustrine and fluvial sediments up to 1,200 m thick underlie all of the Old Crow Flats Ecoregion except a single exposure of Carboniferous shale near the mouth of Timber Creek (Morrell and Dietrich, 1993). The surrounding Flats contain several elevated areas that are structural uplifts or resistant granite; some rivers have incised to bedrock. Large areas of outcrops are shown on regional geological maps (Norris, 1981b,c).

Few mineral occurrences are present. The potential for oil and gas has been tested near Whitefish Lake in the Bell Basin (Lane, 1996) and shale-like lignite is exposed nine kilometres east of Old Crow Village.

SURFICIAL GEOLOGY AND GEOMORPHOLOGY

Most of the surface deposits in this ecoregion are composed of nearly flat, thick glaciolacustrine sediments overlain by frozen peats, often several metres thick. The entire area appears as a maze of small, shallow angular lakes, ponds and wetlands crossed by the Old Crow River and Johnson Creek with their broad meanders and oxbow lakes.

Ice-wedge polygons and oriented rectangular thermokarst lakes, as well as active layer detachment slides, retrogressive thaw flow slides, debris flows and rotational slumping, are all



J. Meikle, Yukon Government

Figure 167-2. Rectangular lake in the Old Crow Flats. Rectangular lakes are typically oriented with the prevailing wind. Vegetation debris blown across the surface tends to accumulate uniformly at the ends of long reaches.

indicative of ice-rich permafrost present in the fine-grained sediments.

The remainder of the area is covered by alluvium deposited by the Old Crow River or one of its tributaries. The alluvium tends to lack near-surface permafrost.

GLACIAL HISTORY

This ecoregion is located on flat terrain comprising the Old Crow and Bluefish Basin physiographic units. These basins were part of an extensive proglacial lake during the Late Wisconsinan; Glacial Lake Old Crow formed when the Laurentide Ice Sheet stood along the eastern slopes of the Richardson Mountains and Bonnet Plume Depression, blocking drainage of the Porcupine and Peel rivers. It thereby diverted all drainage from the Mackenzie Mountains region across the continental divide, causing inundation of the Bell–Bluefish–Old Crow Basins about 30 ka ago (Lemmen *et al.*, 1994; Duk-Rodkin and Hughes, 1995). This vast lake discharged westward through the present-day Ramparts of the Porcupine River. By the time McDougall Pass was free of ice, the outlet at The Ramparts had incised below the elevation of the pass, and the present westward drainage for the Porcupine River was established. Glacial Lake Old Crow shorelines are traceable discontinuously around the basins, reaching 366 m asl (Hughes *et al.*, 1973; Matthews *et al.*, 1987). Repeated catastrophic flooding related to fluctuations of the Laurentide Ice Sheet are recorded in the Porcupine River sediments west of The Ramparts into Alaska (Thorson, 1989), as well as in McDougall Pass (Catto, 1986) and Rock River (Schweger and Matthews, 1991). Over 70 m of unconsolidated sediments lie below the village of Old Crow, recording lacustrine, glaciolacustrine, delta, and fluvial sedimentation (Hughes, 1969b; Matthews *et al.*, 1987). The lacustrine sediments likely are related to tectonic activity on the Old Crow Basin and late Tertiary uplift of the Richardson Mountains which affected the Porcupine River in pre-glacial time (Duk-Rodkin and Hughes, 1994).

CLIMATE

The climate of the Old Crow Flats Ecoregion is very similar to that of the Old Crow Basin Ecoregion. However, some areas with higher elevation in the Old Crow Basin may have slightly higher precipitation, and temperatures may be slightly more moderate. When relatively calm and very cold air masses persist, the Old Crow Flats may experience colder temperatures than the surrounding upland areas.

During the winter, the area is dominated by an Arctic high-pressure system. Infrequently, a strong low-pressure system moving through the Beaufort Sea can result in short, windy, mild spells. During the short summer, the area is under a weak low-pressure system with relatively mild moist air. Spring and summer are delayed by almost a month compared with the southern Yukon.

Mean annual temperatures are among the lowest in the Yukon, approximately –8 to –10°C with a strong seasonal variation. Mean January temperatures are –30 to –35°C; the mean July temperature ranges from 12 to 15°C. Extreme winter minimums are –55 to –60°C, but above freezing temperatures have briefly occurred. Extreme summer maximums are 33 to 35°C, but frosts can occur at any time of the year. Winters are prolonged, and generally extend from October to mid-May. The North Ogilvie Mountains to the south are enough of a barrier to retard southerly winds eroding the cold air from the lower elevations. The transition from winter to summer conditions is rapid. The prolonged low angle of the sun above the horizon during winter also reduces the daily cycle of temperatures during those periods.

Precipitation is relatively light, amounting only to 200 to 300 mm annually. The wettest period is June through August, with monthly amounts of 30 to 45 mm. This summer precipitation is in the form of rain, primarily showers or thunderstorms. There have been some summer months with precipitation amounts of 100 to 150 mm. The driest period is January to April, averaging 10 to 15 mm of snow monthly.

Wind data are limited, although some data are available from the Old Crow village site. Winds are generally light at less than 15 km/hr, particularly during the winter. Periods of moderate winds of 15 to 30 km/hr occur less than one quarter of the time, primarily from the northeast, and less frequently from the southwest. Winds greater than 40 km/hr are common.

Representative climate information is available from Old Crow.

HYDROLOGY

The Old Crow Flats Ecoregion is level, encompassing the middle and lower reaches of the Old Crow River basin, an area known as the Old Crow Flats. The Old Crow River flows southward into the Porcupine River, of which a 120 km long, low-lying reach is included within the ecosystem. In addition to the Porcupine and Old Crow rivers, intermediate streams include the very lowest reaches of the Bluefish and Driftwood rivers, north- and south-flowing, respectively. Smaller streams include Johnson and Schaeffer creeks, and the lower reaches of Timber, Thomas, and Black Fox creeks. The coverage by waterbodies and wetlands is the highest of all Yukon ecoregions, estimated at about one third of the total area. The ecoregion contains hundreds of interconnected lakes, including many that are large and unnamed.

There is only one representative historical hydrometric station record for the ecoregion: Old Crow River. Though it is a relatively large watershed, the nature and consistency of the ecoregion's topography allows for the transfer of its hydrologic characteristics throughout the ecosystem. The hydrologic characteristics are completely dominated by the waterbody and wetland storage features of the ecosystem, such that these characteristics can be scaled down to smaller basins with little loss in accuracy. Because of the extremely low relief, runoff and peak flow events are likewise low. Annual streamflow is estimated to have an increase in discharge in April due to snowmelt, rising to a peak in May or June. Because of the significant storage throughout the ecosystem, summer rain events do not produce significant secondary peaks as in most other ecoregions.

Mean annual runoff, the lowest of all ecoregions, is 98 mm, while mean seasonal and summer flows are likewise relatively low with values of 7.1 X 10^{-3} and 3.5 X 10^{-3} $m^3/s/km^2$ respectively. The mean annual flood and mean maximum summer flow are moderate to low with values of 56 X 10^{-3} and 12 X 10^{-3} $m^3/s/km^2$, respectively. The minimum annual and summer flows are both near the lowest of all ecoregions with values of 0.03 X 10^{-3} and 0.3 X 10^{-3} $m^3/s/km^2$, respectively. Minimum streamflow generally occurs during March or earlier with the relative magnitude among the lowest of all Yukon ecoregions, due to the increasing role of winter temperatures and permafrost on streamflow. Unlike other ecoregions at this high latitude, winter flows are higher due to storage contributions. All streams, other than the Porcupine River, occasionally experience zero winter flows.

PERMAFROST

The Old Crow Flats Ecoregion lies in the continuous permafrost zone. Old Crow Flats were covered by Glacial Lake Old Crow during the Late Wisconsinan. Permafrost was likely eradicated from beneath the lake at that time. The base of permafrost was encountered at 63 m depth in two holes drilled to provide a water supply for the community of Old Crow (EBA, 1982a). All holes drilled for construction in the community have encountered frozen ground within 2 m of the surface. Annual mean near-surface ground temperatures are about –4°C (Stanley Associates, 1979), and the active layer depth in the peatlands of the basin is usually more than 40 cm and occasionally greater than 60 cm (Ovenden and Brassard, 1989).

Shallow lakes within the ecoregion are warm in summer, and sufficiently deep to prevent freezing of lake-bottom sediments in winter. As a result, a talik persists beneath the lakes, many of which are sufficiently wide for the talik to penetrate through permafrost, theoretically. The lakes are oddly rectangular and oriented northeast–southwest or northwest–southeast (Fig. 167-2). Their surface expression is likely unassociated with permafrost conditions, but may be a product of wind-generated currents (Mackay, 1956).

The low-lying terrain and pediment surfaces have a hummocky microtopography typical of moist taiga regions and near-surface permafrost is usually ice-rich. Ice-wedge polygons occur throughout the region, but they have not developed into the extensive networks characteristic of the Yukon Coastal Plain Ecoregion. There are well-developed, active ice wedges along the Porcupine River, growing syngenetically with floodplain deposits (Lauriol *et al.*, 1995).

Sedimentary sequences exposed in bluffs cut by the Porcupine River have been used to trace environmental conditions back to the late Tertiary (Pearce *et al.*, 1982). Ice-wedge casts in the sediments provide early evidence of permafrost in the Yukon (Burn, 1994).

SOILS

The soils in this ecoregion have formed within the extensive wetlands of the Old Crow Flats. Soil parent materials found throughout the ecoregion include lacustrine silts and clays, alluvial deposits, accumulated peat and thermokarst sediments, and slumps. The fine-textured soil parent materials of the Old Crow Flats are usually ice-rich and have experienced cryoturbation during their formation. As all of the ecoregion existed as a lake basin during the Late Pleistocene, the soil parent materials are younger here than in the surrounding pediments and mountain ranges. Soils are often high in incorporated organic matter resulting from the formation and cycling of organic debris in earth hummocks that underlie the open, black spruce forest. Wetlands have considerable peat accumulations in some locations. Wetland forms include peat plateau bogs and ribbed fens (Fig. 167-3). These soils are mostly classified as Mesic Organic Cryosols. The only portions of the landscape without near-surface permafrost are the active alluvial landforms associated with the major rivers of the ecoregion, the Old Crow and Porcupine, and recently drained lake basins. These soils are classified as Regosols, or as Regosolic Static Cryosols if permafrost has re-established in these materials.

As with other lowland regions of the Low Arctic and Subarctic, there exists a cycle of lake formation through thermokarst, lake drainage by stream capture, and wetland establishment with peat accumulation leading ultimately to a subsequent round of thermokarst and lake formation (Fig. 167-4). There are distinctive soil and vegetation features associated with each stage within the "thaw-lake" cycle (MacKay, 1997; Eisner and Peterson, 1998). As ground ice is exposed through erosion, tremendous melting occurs, often with considerable disruption to the surrounding landscape. This process of thermokarst can generate fresh surfaces on which soil development begins. Recently disrupted materials will not have evidence of active cryoturbation for some years. These soils

J. Hawkings, Canadian Wildlife Service

Figure 167-3. The Old Crow Flats Ecoregion is characterized by extensive sedge fens surrounding irregular lakes with emergent vegetation, including horsetail, bur-reed, yellow pond lily and buckbean. Slightly higher elevation peat plateaus support open stands of stunted black spruce in the distance.

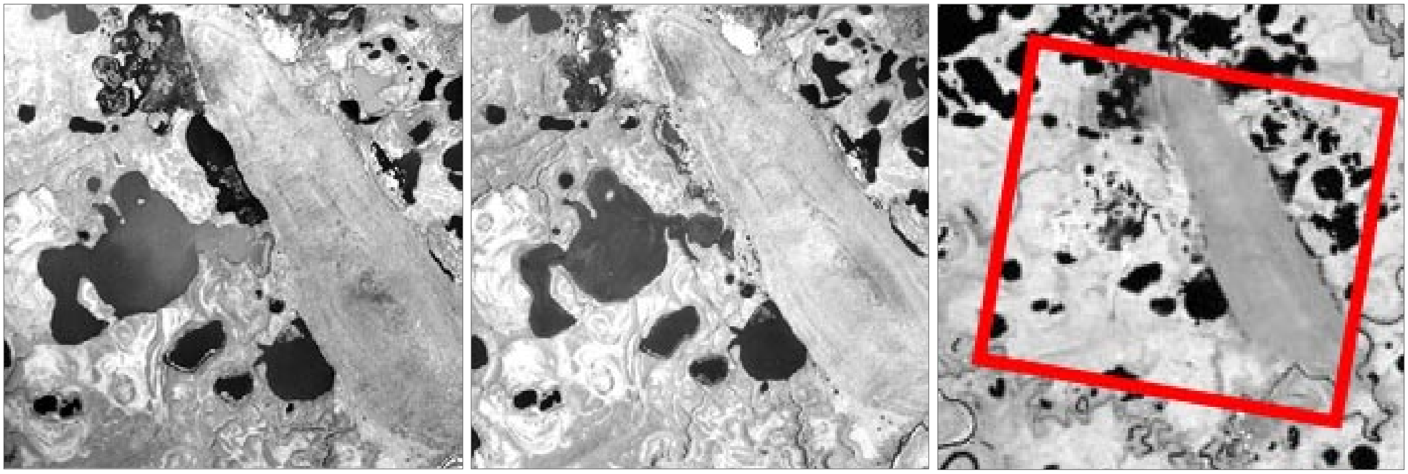


Figure 167-4. The highly dynamic nature of shallow thaw lakes adjacent to Timber Hill in the Old Crow Flats Ecoregion is illustrated in this series of aerial photographs (1951, 1972) and a satellite image (1999 Landsat 7 ETM, band 4). Drainage of the lakes is related to change in the drainage pattern controlled by local degradation and aggradation of near-surface permafrost (adapted from Labreque *et al.*, 2001). The red box on the right-hand photo corresponds to the area of the 1951 and 1972 photos.

may be classified as Static Cryosols if permafrost has re-established.

VEGETATION

The vegetation of the Old Crow Flats Ecoregion reflects the distribution pattern of cyclical formation and draining of lakes and wetlands, and intervening sparsely treed uplands. The vegetation ranges from shallow-water emergent wetland types to graminoid meadows, sphagnum blankets, shrub thickets, and sparsely treed heath and tussock tundra. The Porcupine and Old Crow rivers and their tributaries have cut deep channels dissecting the wetland surface.

There is a complex "thaw-lake" cycle of thermokarst lakes forming and growing larger by thermokarst erosion of the banks, and then draining as outlets are eroded. Because of this ongoing cycle, there is a complex pattern of vegetation found at all stages of the process (National Wetlands Working Group, 1988). Much of the Flats are underlain by thick peat. Shallow-water wetlands supports dense communities of bur-reed and yellow pond lily (Fig. 167-3). Shore marshes and fens on the lake margins consist of *Carex aquatilis*, *Arctophila fulva*, horsetail, and buckbean. Moist parts of drained lakebeds support sedges, grasses and water-tolerant forbs (Fig. 167-5), succeeded by tall willows. Gradually, as the permafrost table re-establishes within the rooting zone, the willows die from lack of moisture. *Arctophila fulva*, or *Calamagrostis* grasslands with scattered willow and alder, dominate other drained lakebeds. Low-centre polygons, an early stage of lowland polygon development (National Wetland Working Group, 1988), are also found in old drained basins. The vegetation of the low-centre polygons consists of sphagnum mats with sedges and some dwarf shrubs (Ovenden and Brassard, 1989; J. Hawkings unpubl. data)

Much of the "upland" area is also wetland. Polygonal peat plateau bogs are dominated by lichen heath (Ovenden and Brassard, 1989; Eamer *et al.*, 1996). Sparse, scraggly black spruce, and low shrubs are underlain by sphagnum moss in moister parts, and by reindeer lichen on drier parts of peat plateaus (Murray, 1997).

On the drier mineral "upland" soils between the lakes, cottongrass tussock and open spruce/shrub/lichen communities are typical. On the best-drained sites, sparse black and white spruce, shrub birch, Labrador tea, blueberry and other ericaceous shrubs and lichen predominate. On imperfectly drained soils, extensive areas of sedge tussocks with sparse white and black spruce and Labrador tea are found (Zoltai and Pettapiece, 1973; Eamer *et al.*, 1996; J. Hawkings, unpubl. data).

Where rivers have cut up to 20 m below the surface of the flats, white spruce with some black spruce, paper birch and aspen occupy favourable warm

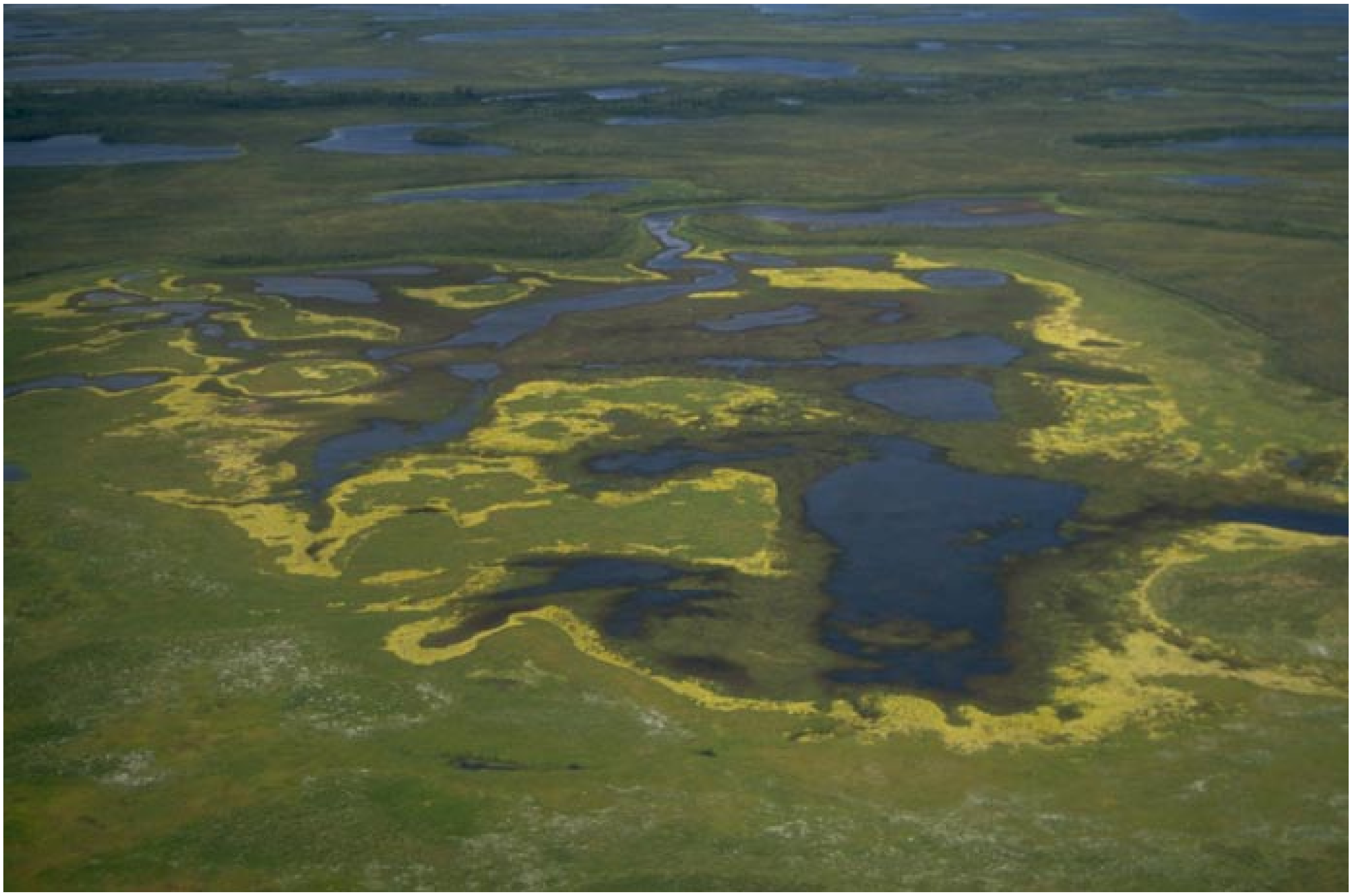

J. Hawkings, Canadian Wildlife Service

Figure 167-5. A recently drained lake in Old Crow Flats Ecoregion supports lush growth of colonizing sedges, grasses and yellow Mastadon flower *(Senecio congestus)*.

slopes with deeper active layers. The deciduous trees usually follow some disturbance, such as fire. Alder, shrub birch and soapberry, with ground shrubs and herbs, dominate the understory. Balsam poplar is found on the active floodplains.

WILDLIFE

Mammals

The Old Crow Flats possess some of the most abundant wildlife populations of the Taiga Cordillera, with many species reaching densities typical of the Boreal Cordillera of the southern Yukon. However, the diversity of rodents and ungulates is low by comparison.

This is both a unique and highly productive ecoregion of the Yukon. The vast wetlands are home to moose, grizzly bear, muskrat and mink. Moose are present only during summer, migrating to the head of drainages in the British Mountains in the fall. The most abundant muskrat populations in the Yukon, numbering in the hundreds of thousands, are near the northern edge of their range and experience slow growth and low productivity (Simpson *et al.*, 1989). The Flats are on the annual spring and fall migration routes of the Porcupine Caribou, which numbers about 150,000 individuals. The mammals of this ecoregion have received little attention other than opportunistic observation during caribou and waterfowl studies. Mammal species known or expected to occur in this ecoregion are listed in Table 4.

Birds

The interconnected lakes and marshes dominating this landscape are the single most important waterfowl area in the Yukon, providing over 500,000 waterbirds with breeding, moulting, and staging habitat (Yukon Waterfowl Technical Committee, 1995). More than 100 bird species have been recorded on the Flats, including at least 21 species of waterfowl (Hawkings, 1996).

According to aerial surveys conducted each June by the U.S. Fish and Wildlife Service, breeding populations over the past 30 years have included 20,000-100,000 American Widgeon, 10,000 to 100,000 Northern Pintail, 5,000 to 40,000 Canvasback, 50,000 to 100,000 scaup, 20,000 to 80,000 White to winged and Surf Scoters, and 10,000 to 30,000 Long-tailed Duck (Hawkings, 1996). The Old Crow Flats also support three species of loons, Tundra Swan, White-fronted Goose, and a variety of other waterbirds. Banding studies have shown these birds to be associated with all four North American flyways. Waterfowl are more concentrated here than at other locations in the north. For example, densities of ducks on the Flats are usually about 80 ducks/km^2, two to three times higher than in any of the 11 primary waterfowl breeding grounds surveyed annually in Alaska by the U.S. Fish and Wildlife Service. Some of these birds breed and moult on the Flats, while others, such as Barrow's Goldeneye, do not breed there, but come in midsummer from further south to undergo their annual moult (Hawkings, 1996).

Other waterbirds occurring in these wetlands include Lesser Yellowlegs, Solitary, Spotted, and Least Sandpipers, Common Snipe, Red-necked Phalarope, and Herring, Mew, and Bonaparte's Gulls (CWS, Birds of the Yukon Database). Common songbirds associated with wetlands include Yellow Warbler, Northern Waterthrush, and Rusty Blackbird (Canadian Wildlife Service, unpubl.).

Peregrine Falcon are known to nest along cliffs and cutbanks of the Porcupine and Old Crow drainage (Hayes and Mossop, 1978) and Golden Eagle and Gyrfalcon nest on cliffs and rock ledges in tundra areas. Other raptors include Osprey, Bald Eagle, and Northern Harrier (Sinclair *et al.* [editors], 2003).

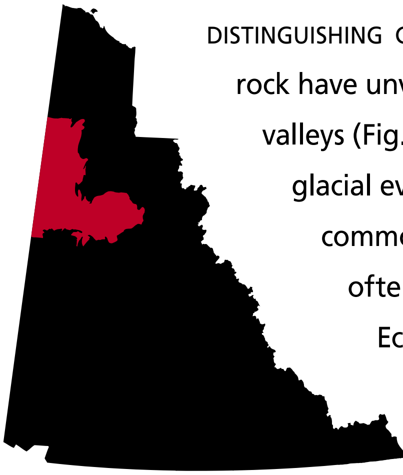
Species common in shrub tundra include Willow Ptarmigan, American Robin, American Tree, Savannah, Fox, and White-crowned Sparrows, and Common Redpoll (CWS, Birds of the Yukon Database). Gray-headed Chickadee, a rare resident of these subarctic forests, has been observed on a few occasions and likely breeds in shrubby riparian habitats (Murie, 1928; Eckert, 1994; Sinclair *et al.* [editors], 2003).

Subarctic forests provide breeding habitat for Merlin, Three-toed Woodpecker, Gray-cheeked and Varied Thrushes, Blackpoll Warbler, and Dark-eyed Junco (Sinclair *et al.* [editors] 2003). Year-round residents of these subarctic forests probably include Gray Jay and Common Raven (Godfrey, 1986).

North Ogilvie Mountains

Taiga Cordillera Ecozone

ECOREGION 168



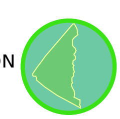
DISTINGUISHING CHARACTERISTICS: Mountains of modest relief formed of sedimentary rock have unvegetated summits and rubble covered slopes, separated by broad valleys (Fig. 168-1). This ecoregion was largely ice-free during the most recent glacial event, but has evidence of older glaciations. Periglacial landforms are common. The coldest daily minimum winter temperatures in the Yukon are often recorded in valleys of this ecoregion. The North Ogilvie Mountains Ecoregion provides wintering grounds for the Porcupine caribou herd and is home to perhaps the only mammal species restricted to the Yukon — the Ogilvie Mountain lemming.

M. Hoefs

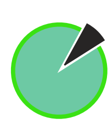
Figure 168-1. The Northern Ogilvie Ranges are characterized by strata of light grey limestone and dolostone with unvegetated summits and cliff bands. Chemical weathering produces humus-rich calcareous soils. Alpine tundra is composed of heath and sedge tussock cummunities as seen in the foreground.

APPROXIMATE LAND COVER
subarctic coniferous forest, 50%
arctic/alpine tundra, 25%
rocklands, 20%
lakes and wetlands, 5%

TOTAL AREA OF ECOREGION IN CANADA
39,260 km^2



TOTAL AREA OF ECOREGION IN THE YUKON
39,260 km^2



ECOREGION AREA AS A PROPORTION OF THE YUKON
8%

Metres above sea level

ELEVATIONAL RANGE
280–1,860 m asl
mean elevation 870 m asl

CORRELATION TO OTHER ECOLOGICAL REGIONS: Equivalent to **North Ogilvie Mountains Ecoregion** (Oswald and Senyk, 1977) • Portion of **Taiga Cordillera Region** (CEC, 1997) • Portion of the **Ogilvie/ Mackenzie Alpine Tundra Ecoregion** (Ricketts et al., 1999) • Contiguous with the **North Ogilvies Ecoregion of Alaska** (Nowacki *et al.*, 2001)

PHYSIOGRAPHY

The North Ogilvie Mountains Ecoregion includes the North Ogilvie physiographic region, the Keele Range, part of the Dave Lord Range and the Central Ogilvies. Matthews (1986) lumped the Central Ogilvies with the South Ogilvies. Bostock (1948) and Hughes (1987b) divided the Ogilvie Mountains into the higher South Ogilvies and the remainder, the North and Central Ogilvies and the Taiga Valley, which conforms more closely to the ecoregion boundary. Hughes (1987b) and Bostock (1948) have mapped the Keele Range and the Dave Lord Range, sometimes included in the Keele Range, as part of the Porcupine Plateau. The Taiga Ranges form the eastern part of the North Ogilvie Mountains; they are separated from the South Ogilvies and Wernecke's by the Taiga Valley. The Nahoni Range is also part of the North Ogilvies.

Ranges in the Northern Ogilvie Mountains are less rugged and lower in elevation than the South Ogilvies. With a few exceptions the terrain consists of flat-topped hills and eroded remnants of a former plain (Oswald and Senyk, 1977). Castellations, like battlements along ridge tops, surrounded by long scree slopes are characteristic of the long period of erosion in unglaciated areas. The mountains in the south are higher and the valleys are cut deeper, giving relief greater than 1,200 m. There are two summits over 1,850 m asl in the southern Taiga Ranges. In the north the mountains range from 1,000 to 1,400 m asl and the valleys are less deeply entrenched, resulting in less than 800 m of local relief.

The North Ogilvie Mountains Ecoregion is the source of numerous rivers but large lakes are few. Only along the Blackstone River and around the junction of Rae Creek and the West Hart with the Hart River, are lakes common (Hughes, 1969). The Bluefish and Useful lakes are in the Keele Range.

BEDROCK GEOLOGY

This ecoregion encompasses the Keele Range and the Taiga–Nahoni Fold Belt, which extends through the Nahoni Range and the North Ogilvie Mountains. The ecoregion is almost entirely underlain by sedimentary formations; no granitic rocks are known. Regional geology is depicted on bedrock maps by Norris (1981c,e; 1982a,b,c) and Thompson (1995). Lower Paleozoic stratigraphic units are described by Morrow (1999). Less complete descriptions of the Proterozoic inliers are found in Green (1972) and Norris (editor, 1997), while a detailed description of the Upper Paleozoic and Mesozoic formations in the adjacent area is given by Dixon (1992). A classic description along the Yukon–Alaska border is in Cairnes (1914).

The Taiga–Nahoni Fold Belt (Norris [editor], 1997) is underlain by a thick succession of craton-derived sediment and carbonate shelf deposits of Proterozoic through Middle Devonian age, referred to as the Yukon Stable Block. The oldest units exposed in the cores of anticlines are metasandstone, siltstone and argillite, probably the Quartet Group of the Wernecke Supergroup and overlying Windermere equivalent rocks.

The Lower Paleozoic succession is about 2,500 m thick. At the base are two Cambrian units: white limestone of the Illtyd and orange-weathering sandstone of the Slats Creek Formation. Unconformably overlying these are two distinctively different units representing sediments of the Mackenzie Platform and the Richardson Trough. The former underlies ridges and cliffs. It is the Bouvette Formation (Morrow, 1999; formerly referred to as the Cdb unit) and up to 900 m thick. It consists of a lower section of yellowish-grey finely layered dolostone with pockets of mud-chip breccia and siltstone, a middle unit of light-grey, vuggy, crystalline dolostone and an upper part with very thick beds of light-grey dolostone (Fig. 168-2). The latter is the Road River Formation of black shale, chert and siltstone. It typically underlies valleys and smooth shaley slopes.

The Devonian Ogilvie Formation of dark-grey limestone and Imperial and Canol formations of black, sulphide-rich shale are overlain by Carboniferous shale and limestone of the Ford Lake Formation, brown Carboniferous dolostone of the Hart River Formation, Permian Takhandit Formation limestone, and the Triassic Shublik Formation. These units are exposed in synclines of north-trending folds that change to broad, east-trending warps southeast of the Ogilvie River. The Shublik Formation consists of black limestone, mudstone, siltstone and sandstone, with notable shell and conglomerate beds (p. 253-265 *in* Norris [editor], 1997). The Jurassic Kingak siltstone with softer shale and harder sandstone intervals, overlain by Early Cretaceous Kamik sandstone and quartzite, is preserved in the northwestern Ogilvie Mountains and Keele Range.

M. Hoefs

Figure 168-2. Tor formed in light-grey dolostone bedrock in the North Ogilvie Mountains Ecoregion. Note the unvegetated colluvial slope immediately below the tor and the black spruce-dominated taiga forest in the valley bottom. Raptors including Golden Eagle, Peregrine Falcon, and Gyrfalcon nest in these rocky outcrops.

The oldest exposed rock is calcareous shale, quartzite, red and green siltstone, and thin-bedded dolostone of the Tindir Group, which resembles other successions of the Late Proterozoic-to-Cambrian Windermere Supergroup. The overlying Bouvette Formation dolostone and Carboniferous Ettrain limestone and Permian Jungle Creek Formation are exposed in the north on flanks of the Dave Lord Uplift. Porcupine Terrane was thrust eastward in middle Tertiary time and the boundary is the Yukon Fault (Fig. 3.17 *in* Norris [editor], 1997).

The ecoregion contains at least six classes of mineral deposits. Barite veins and lenses occur in Lower Paleozoic dolostone. Galena and sphalerite in quartz breccia and veins are locally present in the Jones Ridge, Ogilvie and Takhandit formations as well as in the Endicott Group of Porcupine Terrane. Oolitic magnetite and banded iron formation are found in the Permian Jungle Creek Formation. Copper, with cobalt and arsenide mineralization is common where mafic dykes intrude Proterozoic dolostone. The Rusty Springs prospect consists of silver, copper and zinc mineralization in limonitic chert. Coal seams are present in the Cretaceous Kamik Formation in the Kandik Basin.

Naturally acidic streams drain iron-sulphide-bearing siliceous shale units such as the Canol Formation. A tributary of Engineer Creek, at km 180 on the Dempster Highway, and nearby Red Creek, have iron-hydroxide bottoms and low pH in which aqueous zinc is particularly high. Downstream, the ferric hydroxides precipitate along the creek; chemical reactions, including neutralization, serve to capture zinc, cadmium, lead and copper so that the aqueous concentration of most metals is nearly normal in Engineer Creek (Kwong and Whitley, 1992).

Dall sheep use the exposed saline beds of the Ogilvie Formation near Sapper Hill as salt licks. Exposures of the black Canol Formation and Ford Lake shale are locally and seasonally coated with an evaporite crust containing calcium and iron sulphide, though mostly gypsum, and are commonly used as mineral licks by wildlife.

SURFICIAL GEOLOGY AND GEOMORPHOLOGY

Bedrock surfaces occupy at least 20% of this ecoregion. Many summits have tors, characteristic of unglaciated areas (Fig. 168-2). These structures are angular, frost-shattered rock outcrops. Tors develop in easily shattered rocks like shales, sandstones and dolomite. Here they are found both at the peaks and on the side of middle-to-high elevation unglaciated slopes.

Surface deposits include colluvium, which covers approximately one-third of the land surface of the ecoregion. Pediment slopes formed by erosion characterize the intermontane basin that are common within the ecoregion. The slopes extend from broad valleys over considerable distance to the foothills of subdued mountains.

The southern and western portions of the ecoregion have extensive deposits of colluvial and scree materials on slopes and castellations on the crests of the more rugged, mountainous ridges. Rock fragments of many scree and colluvial slopes are uniform in size from toe to crest. The depth of the material is variable but generally shallow. Gentler slopes are frequently overlain with loess and/or silty colluvium and capped with organic material. Erosion scarps in sedimentary rock form striking features at many locations.

Glacial deposits cover approximately 35% of the ecoregion and include till and glaciofluvial outwash.

Earth hummocks and tussock fields often cover valley bottoms. Beaded streams, large peat plateaus, and palsas are also common. Aufeis is a common feature throughout. Slopes are frequently striated with parallel downslope drainage patterns or runnels (Oswald and Senyk, 1977).

Modern processes are largely associated with landslide activities, rock slides and debris flows. Periglacial processes include soil creep, solifluction, and active layer detachment slides. Cryoplanation terraces are common in the Keele Range (Lauriol and Godbout, 1988).

GLACIAL HISTORY

This ecoregion includes both glaciated and unglaciated terrain. During pre-Reid glaciations, a discontinuous ice-free corridor existed between extensive alpine glaciers that formed in the mountain ranges of this ecoregion. Well-developed pediment landforms now characterize these unglaciated areas. Extensive pediments characterize these unglaciated areas.

Pre-Reid features include very subdued and highly colluvial moraine, drainage diversions, and outwash plains or terraces. Glaciers were more extensive on the east flanks of the North Ogilvie Mountains than to the west. Piedmont glaciers occupied Ogilvie Valley east and south of Mount Klotz and coalesced with piedmont glaciers from the northern slopes of South Ogilvie Mountains. The meltwater drainage from these piedmont glaciers is traceable around and across Mount Skookum Jim. Glaciers also extended to Miner River from the Mount Bragg area. Outwash plains and terraces extend along Ogilvie River and its southern tributaries.

As in other parts of the northern Cordillera, features associated to the last two glaciations are much better defined. During the Reid glaciation, glaciers formed on the piedmont slopes along the eastern North Ogilvie Mountains and valley glaciers along the western side. During this glaciation, part of the northwest headwaters of the Ogilvie River was diverted northward into Miner River. McConnell Glaciation was restricted to individual valley glaciers in the Mount Klotz and Mount Bragg area.

CLIMATE

Weather systems from the Gulf of Alaska drop most of their moisture before they reach the slopes of this ecoregion, but some moisture reaches this area in systems moving eastward through Alaska. The result is moderate precipitation, coming predominantly as rain in the summer. Because of its northern latitude, temperatures are fairly low, but are not as extreme as in the lowlands of the Old Crow Basin and Flats to the north.

Mean annual temperatures are from –7 to –10°C, but there is considerable variation due to season and elevation. Winters are prolonged, lasting generally from October to May. Mean January temperatures in the lower valleys are near –30°C, with extremes to –50 to –60°C. Infrequently, mild spells associated with strong southerly winds can result in above freezing temperatures. At higher elevations, January means are some 10 degrees higher at near –20°C, with milder, windy weather more common. Summers are brief with mean July temperatures ranging from 12°C in the valley floors to 6°C over the higher terrain. Extremes can reach 30°C but periods of cool weather with frost can occur anytime.

Precipitation is moderate, ranging from 300 to 450 mm, with the heaviest precipitation over the higher terrain of the southern portion of this region. The period from February through May is dry with average monthly precipitation amounts of only 10 to 20 mm. June through August is the wettest period with monthly rain amounts of 40 to 60 mm, mostly in the form of showers or thunderstorms. Monthly rainfall values of over 100 mm have occurred. Snow is the main form of precipitation from September to May, with the heaviest amounts in the fall.

No wind data are available in this region. Depending on orientation, winds are expected to be moderate to light in most of the valleys of the ecoregion.

The only climate station in this ecoregion is Ogilvie River. Reference data from Eagle Plains and Klondike can be used to indicate conditions at intermediate elevations.

HYDROLOGY

The ecoregion drains the Ogilvie Mountains flowing westward into the Yukon and Porcupine rivers within Alaska, northeastward into the Peel River basin, and northward into the Porcupine River basin. There are no large rivers within the ecoregion, though there are numerous, major intermediate streams including the Ogilvie, Blackstone, Hart, Whitestone, Miner, Fishing Branch, and Bluefish rivers. Smaller streams draining into Alaska include the Tatonduk, Nation, Kandik, and Black rivers, and Orange Creek. Though the ecoregion has considerable relief, there are no glaciers within its boundaries. There are few major lakes or wetland areas within the ecoregion. Wetland coverage is limited largely to locations in the upper reaches of the Ogilvie and Blackstone River valleys, the site of a terminal moraine of the Reid glaciation (Hughes, 1968). These are examples of karst-related flow in some systems such as the Fishing Branch River.

There are only two representative hydrometric stations within the ecoregion: Ogilvie and Blackstone rivers, though with some adjustment, stations within the Mackenzie Mountains Ecoregion can be used to represent hydrologic response. Annual streamflow is generally characterized by a gradual increase in discharge in the spring, rising to a peak in May or June due to snowmelt inputs. This ecoregion has among the highest peak flows and lowest winter low flows in the Yukon. Many of the first- and second-order headwater streams are steep and relatively short; therefore, streamflow response tends to be rapid and flashy. On these smaller streams, approximately 40% of the annual maximum flows are due to intense summer rainstorm events. Some small, steep streams are susceptible to mud flows triggered by these summer rainstorms.

Along the Dempster Highway, the headwaters of Engineer Creek are prone to flash floods following summer thunderstorms because the unvegetated dolostone talus on surrounding mountainsides has little capacity to hold moisture.

Mean annual runoff is moderately high with little variation, ranging from 178 to 445 mm, with an ecoregion average of 324 mm. Mean seasonal and summer flows are both moderately high with values of 22 X 10^{-3} and 17 X 10^{-3} $m^3/s/km^2$, respectively. The mean annual and mean summer floods are both moderate with values of 92 X 10^{-3} and 46 X 10^{-3} $m^3/s/km^2$, respectively. Minimum streamflow generally occurs during March or April in the southern portion of the ecoregion, and earlier in the northern portion. The mean annual and summer minimum flows are moderate and high, with values of 0.90 X 10^{-3} and 7.5 X 10^{-3} $m^3/s/km^2$, respectively. Because of the increasing permafrost coverage associated with the increasing latitude, most smaller streams experience zero winter flows relatively frequently.

PERMAFROST

The North Ogilvie Mountains Ecoregion has continuous permafrost. The ecoregion was largely unglaciated, so much of the terrain has been exposed to at least 2 million years of periglacial conditions. The mountains exhibit the landform patterns of a frost-weathered landscape with talus accumulations at the base of most slopes. The upper surfaces of many mountains are barren and frost-shattered. Permafrost thickness have not been measured directly in the ecoregion, but depths of 300 to 700 m have been inferred from geophysical records, with the deepest permafrost inferred south of Eagle Plains Ecoregion. In the carbonate rocks of northern karst landscapes, cold air drainage in caves and other solution cavities likely increases the depth of permafrost (Lauriol and Clarke, 1993).

Paleomagnetic evidence from stalagmites in caves south of Old Crow indicates that permafrost formed in the early Quaternary and has been present ever since (Lauriol *et al.*, 1997). These features stopped growing once groundwater circulation ceased following permafrost aggradation. Cryoplanation terraces are well developed on Tsiittoh Choh Mountain in the Keele Range, where their development is assisted by the solubility of the host limestone (Lauriol, 1990).

The Dempster Highway traverses southern portions of the ecoregion, where permafrost is sometimes absent close to watercourses. Where gravel is perennially frozen, the active layer may be up to 1 m thick. The ground is usually icy beneath peat or other organic accumulations (Klohn Leonoff, 1986). Michel (1983) describes massive ice up to 18 m deep at one site near the highway, as well as ice over 20 cm thick at the surface of permafrost. Occasional pingo development has been observed in the Blackstone River valley (Fig. 168-3).

There is considerable mineralized groundwater flow in the southern portions of the ecoregion, with persistent development of icings (aufeis) in river channels each winter (Harris *et al.*, 1983b).

SOILS

Soils have formed in this ecoregion under the influence of moderate relief topography, a strong continental climate, and continuous permafrost.

Limestone dominates the numerous, small, rounded, mountain ranges including the Nahoni, Keele and Hart ranges. The upper slopes of the ranges tend to be covered by coarse angular rubble with little vegetation cover or soil formation. Well-drained middle slopes tend to have unique rendzina-like soils on which mixed open forests of aspen and white spruce grow (Fig. 168-4). These soils are characterized by thick accumulations of humus-rich surface horizons produced as a result of the weathering of carbon from limestone, a long unglaciated history of soil development, and cold temperatures that inhibit decomposing microbial activity (Schreier and Lavkulich, 1985).

Lower slopes are characterized by abundant soil moisture and extensive permafrost. The predominant soil formations are Orthic and Gleysolic Turbic Cryosols. Pediments cover most valley bottoms other than some glaciofluvial and alluvial landforms associated with major streams and rivers. Along the Ogilvie and Blackstone rivers, gravelly soils may be without near-surface permafrost and are classified as Eutric Brunisols. Some valleys in the upper Blackstone and headwaters of Engineer Creek contain mid-Pleistocene moraine deposits. Soils tend to be well developed with deep sola and evidence of Luvisol formation, presumably from times of temperate paleoclimate (site 17 *in* Tarnocai *et al.*, 1993).

There are a few small basin formations between the main ranges in the ecoregion, such as the upper Ogilvie and Hart rivers, in which wetlands can

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Figure 168-3. An open system pingo exposed and eroded by the Blackstone River reveals ice-rich, deformed alluvial sediments. The dark void at the base of the sediment layer resulted from river erosion of pingo ice. The exposed face of the pingo collapsed three weeks after the photo was taken (June 1999).

Figure 168-4. This limestone ridge near the confluence of the Wind and Peel rivers illustrates the influence of aspect on vegetation and soil development. The south-facing slope (left of the ridge) supports an open forest of White Spruce *(Picea glauca)* growing on Brunisolic soils with an active layer greater than one metre thick. The north-facing slope supports tundra vegetation atop Cryosolic soil and near-surface permafrost.

be found. These contain many small thermokarst lakes and ponds. These wetlands are composed of sedge and sphagnum peat. For the most part, these wetland soils are underlain by permafrost and thus classified as Organic Cryosols.

VEGETATION

The vegetation of the North Ogilvie Mountains is distinguished by the high incidence of calcareous sedimentary bedrock, which is host to numerous calcium-loving plants. Many of these are considered rare glacial relicts (Kennedy and Smith, 1999).

Alpine tundra vegetation dominates the subdued mountain topography of the North Ogilvies. Sedge tussock communities mantle the unglaciated pediments, while most valleys contain open spruce taiga communities. Treeline is reached around 900 m asl (Oswald and Senyk, 1977).

Many ridge crests and scree slopes are sparsely vegetated. On ridges and slopes with calcareous substrates at higher elevations, *Dryas* communities are common. These are diverse communities with numerous sedges and forbs, typically including *Dryas integrifolia*, *Saxifraga tricuspidata*, and *Parrya nudicaulis*. Many species are endemic to calcareous soils in unglaciated parts of North America. Rare species include *Eritrichium aretioides* (Stanek *et al.*, 1981; Brooke and Kojima, 1985). Where the bedrock is more acid, willow–ground shrub–lichen communities predominate, associated with patterned ground (Stanek, 1980).

Low shrub tundra is common on low elevation ridges and mid-slopes. Shrub birch, low willows, blueberry and lichens dominate this community. On gentler pediment slopes with near-surface permafrost, shrub–tussock tundra is most common.

Below treeline, sparse spruce–shrub tundra communities mantle the slopes. Well-developed shrub layers include willow, shrub birch, and Labrador tea. Better-drained southerly aspects support white spruce–shrub–forb types that include rhododendron, shrubby cinquefoil, and rose. On more gentle slopes, black spruce–shrub–sedge tussock communities are more common.

White spruce–feathermoss forests occupy some alluvial terraces as well as some protected, well-drained, permafrost-free sites. These fluvial sites are the most productive in the ecoregion, with trees reaching 30 m. Sparse shrubs, including willow, alder, rose, and Labrador tea, shade feathermosses, ground shrubs, diverse forbs and horsetail of the understory. Younger fluvial deposits often support dense stands of balsam poplar, and, in areas of frequent flooding, dense willow thickets (Stanek *et al.*, 1981; MacHutcheon, 1997; Kennedy and Smith, 1999).

WILDLIFE

Mammals

Grizzly bear, wolverine, Dall sheep, the Ogilvie Mountains lemming, and collared pika epitomize this mountain wilderness. The Ogilvie Mountains lemming may be the only mammal species restricted to the Yukon; it is found in only one other ecoregion, the adjacent Mackenzie Mountains Ecoregion.

A small population of stone sheep is found in the western Ogilvie Mountains (Barichello *et al.*, 1989a). Ranges of the Hart River woodland caribou and Porcupine herds overlap in the Peel River watershed. The population of the Hart River herd was estimated to be 1,200 in 1978, and the Porcupine herd numbered about 123,000 (in 2000). The Fishing Branch River is a chum salmon spawning ground, which attracts grizzly bear, mink, river otter and wolverine.

Most mammal species have received little attention and ranges can only be estimated. Species known or expected to occur in this ecoregion are listed in Table 4.

Birds

Large rivers offer breeding habitat for Canada Goose, Red-breasted and Common Mergansers, and Mew Gull. Harlequin Ducks breed on smaller, swift flowing mountain streams (Frisch, 1987). Red-throated Loon and Long-tailed Duck breed on tundra ponds and lakes (Williams, 1925; Frisch, 1987). Wetland breeders include Horned Grebe, American Widgeon, Mallard, Northern Shoveler, Northern Pintail, Green-winged Teal, Greater and Lesser Scaup, Bufflehead, Barrow's Goldeneye, Bald Eagle, Northern Harrier, Lesser Yellowlegs, Least Sandpiper, and Common Snipe (McKelvey, 1977; Frisch, 1987). Common songbirds inhabiting marshy areas include Yellow Warbler, Savannah Sparrow, and Rusty Blackbird (Frisch, 1987).

Breeding bird species that occur in white spruce forests include Northern Flicker, Say's Phoebe, Ruby-crowned Kinglet, American Robin, Yellow-rumped Warbler, Fox Sparrow, and Dark-eyed Junco (Williams, 1925; Frisch, 1987). Year-round residents include Gray Jay, Common Raven, and Boreal Chickadee (Williams, 1925; Frisch, 1987). Bogs and willow thickets along streams at treeline are productive habitats for Upland Sandpiper and Orange-crowned and Wilson's Warblers, while Northern Shrike and Townsend's Solitaire reside in the adjacent subalpine forests (Frisch, 1975, 1987).

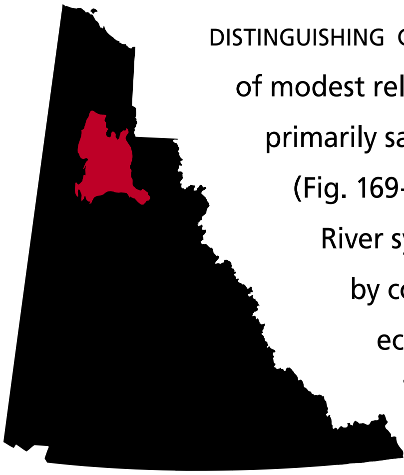
Broad expanses of willow, alder, and low shrub birch in upland areas provide breeding habitat for Willow Ptarmigan, American Tree Sparrow, White-crowned Sparrow, and Common Redpoll (Brown, 1979; Frisch, 1987).

Raptors that nest on cliffs and rocky outcrops include Golden Eagle, Peregrine Falcon, and Gyrfalcon (Frisch, 1987; CWS, Birds of the Yukon Database). Nesting gyrfalcons hunt along rocky slopes and dry ridges for prey species such as Rock Ptarmigan (Frisch, 1987; Sinclair *et al.* [editors], 2003). Horned Lark and Northern Wheatear reside in upland barren areas along with small colonies of Surfbirds, whose Canadian breeding distribution is centred in these mountains (Frisch, 1987). Alpine meadows are inhabited in summer by American Golden-Plover, Baird's Sandpiper, Long-tailed Jaeger, Short-eared Owl, American Pipit, and Smith's Longspur (Frisch, 1987).

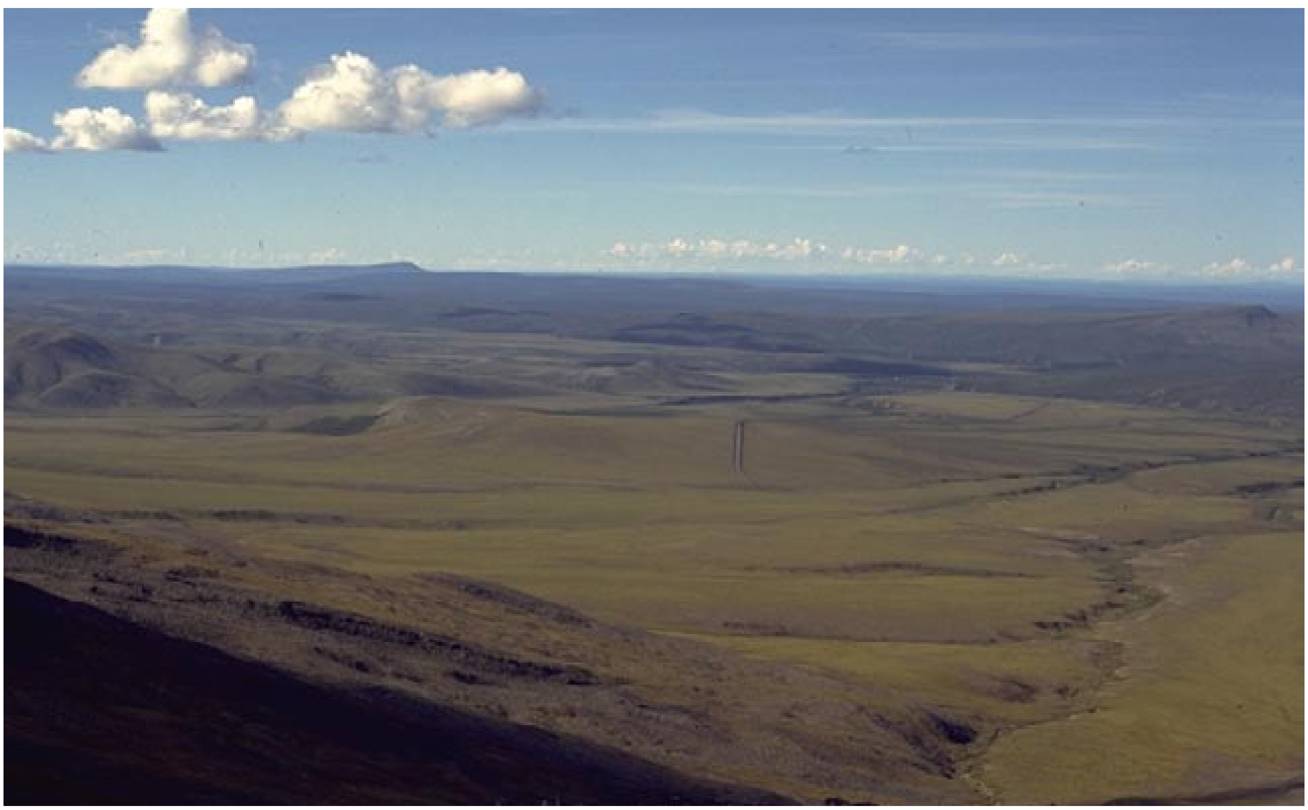
Eagle Plains

Taiga Cordillera Ecozone

ECOREGION 169



DISTINGUISHING CHARACTERISTICS: Eagle Plains Ecoregion is an intermontane basin of modest relief underlain by Devonian through Cretaceous sedimentary rocks, primarily sandstone and shale. Extensive pediments shape lower slopes (Fig. 169-1). The ecoregion drains into both the Yukon and Mackenzie River systems. Much of the area escaped glaciation, but is now underlain by continuous permafrost and periglacial features are common. This ecoregion has one of the lowest levels of mammalian diversity in the Taiga Cordillera Ecozone because habitat diversity for many species is limited.

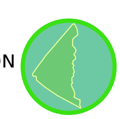


J. Meikle, Yukon Government

Figure 169-1. The Eagle Plains landscape. The Eagle River valley was created from the outflow of Glacial Lake Hughes. Alluvial soils in the Eagle River valley support small stands of balsam poplar *(Populus balsamifera)* and white spruce *(Picea glauca)* forests. Mount Joyal, seen as the small peak in the horizon, is one of the higher points (925 m asl) within the ecoregion and supports alpine habitat and well-developed cryoplanation terraces.

APPROXIMATE LAND COVER
subarctic coniferous forest, 90%
mixed forest, 5%
arctic/alpine undra, 5%

TOTAL AREA OF ECOREGION IN CANADA
20,400 km^2



TOTAL AREA OF ECOREGION IN THE YUKON
20,400 km^2

ECOREGION AREA AS A PROPORTION OF THE YUKON
4%

ELEVATIONAL RANGE
250–1,110 m asl
mean elevation 560 m asl

CORRELATION TO OTHER ECOLOGICAL REGIONS: Equivalent **Eagle Plain Ecoregion** (Oswald and Senyk, 1977) • Portion of **Taiga Cordillera Region** (CEC, 1997) • Portion of **Interior Alaska/Yukon Lowland Taiga Ecoregion** (Ricketts et al., 1999)

PHYSIOGRAPHY

The Eagle Plains Ecoregion occupies the Eagle Lowland of Matthews (1986), or part of the Porcupine Plateau and Porcupine Plain as defined by Bostock (1948) and Hughes (1987).

The Eagle Plains lie between the Richardson Mountains to the east and the North Ogilvies to the west. Most of the rolling low-relief terrain lies between 300 and 600 m asl (Oswald and Senyk, 1977), although a few high points are over 1000 m asl. Both the Porcupine and Peel rivers have cut down to less than 300 m asl.

Most of the ecoregion drains north via the Whitestone, Porcupine and Eagle rivers and their tributaries to the Yukon River watershed. The southeast corner drains east via the Ogilvie, Peel and Wind rivers to the Mackenzie; however, this is probably fairly recent. The Hart, Blackstone, and Ogilvie rivers drained north to the Porcupine, but have recently been captured by the Peel River by rapid downcutting (Bostock, 1948). The walls of Aberdeen Canyon on the Peel River are about 50 m high (Fig. 169-2).

Very few lakes are found in the ecoregion except on the floodplains of the Whitestone, Porcupine and Eagle rivers. Most of these are either oxbow lakes in old meander channels or thermokarst lakes. Moose, Davis and Palmer lakes, and a few others between the Peel and Wind rivers in the glaciated part of the ecoregion, are the exception.

BEDROCK GEOLOGY

This ecoregion encompasses Devonian through Cretaceous sedimentary rocks representing an intermontane basin sandwiched between the uplifted Richardson, North Ogilvie and Dave Lord Mountain ranges. The rare outcrops are confined to downcutting streams draining into the Eagle and Rock rivers and excavations along the Dempster Highway. Over the rest of the subdued topography of the ecoregion, unvegetated areas consist of loose chips of the underlying shale and sandstone units.

The distribution of rock units at the surface is shown by Norris (1981c,e,f; 1982a,b) and the units are chronologically described by Norris (editors, 1997) and Dixon (1992). Lower- to middle

J. Meikle, Yukon Government

Figure 169-2. The Aberdeen Canyon on the Peel River is cut into thickly bedded limestone overlying calcareous shale of the Hart River Formation (Carboniferous age). The gentle scarp visible in the middle distance (arrow) is the eroded face of silty deposits of Glacial Lake Hughes.

Cretaceous Eagle Plains Group, consisting of light-coloured sandstone and siltstone separated by darker shale intervals, underlies two-thirds of the ecoregion. In the central and western parts of the ecoregion, the zebra-striped patterns of these light- and dark-coloured strata outline the gently folded nature of the terrain. Beneath this unit is an erosional unconformity that systematically truncates older rock units. The gentle, southern, regional dip of the older units results in a distribution of broad bands across the southeastern and eastern third of the ecoregion. In northeast succession from the vicinity of Eagle Plains Lodge, these include the Beiderman Argillite (Lower Cretaceous), the Jungle Creek Formation (Permian), the Ettrain Formation (Upper Carboniferous), the Hart River Formation and Ford Lake Shale (Lower Carboniferous), and the Imperial Formation (Upper Devonian). Prominently exposed along the Dempster Highway are beige limestone of Hart River Formation at about km 340, conglomerate and conglomerate-rich sandstone with black shale and coal horizons of the Upper Devonian to Lower Carboniferous Tuttle Formation at km 359. Exposures of brown siltstone, sandstone and shale with nodules of the Imperial Formation exist between the Arctic Circle and the Rock River. An undivided and unnamed Paleozoic carbonate (CDb unit, now Bouvette Formation) is exposed in several thrust-cored anticlines near the Peel River.

Gentle, moderately plunging folds have north-trending axes in the western part of the ecoregion, and bend to easterly trends in the southern area. These folds and minor contraction faults developed during the Late Cretaceous Laramide Orogeny. A second, more intense regional deformation in Early Tertiary time resulted in block faulting, such as Deception Fault near the eastern edge of the ecoregion, along the geological boundary of the Richardson anticlinorium. The entire block upon which the Eagle Plains lie was displaced eastward during Early Tertiary time (Lane, 1996).

The Eagle Plains have proven hydrocarbon reserves, but no known coal or metallic mineral deposits. Three of the 11 wells drilled before an exploration moratorium in 1968 intersected porous Carboniferous and Permian sandstone in the Chance and Dagleish anticlines in the southern and southeastern part of the ecoregion. Approximate reserves in this area are $2.8 \times 10^9 m^3$ of gas and $3.1 \times 10^6 m^3$ of oil (T. Bird, *in* Hamblin, 1990).

SURFICIAL GEOLOGY

Colluvial deposits cover most of the ecoregion; the remaining areas are covered by mostly alluvial sediments along river systems with a few glaciofluvial and glaciolacustrine deposits associated with meltwater generated by glacial activity outside the ecoregion. The tectonic origin of this region has resulted in thick accumulations of colluvial deposits on ridge crests and slopes (Thomas and Rampton, 1982c). Pediment surfaces commonly have a veneer of fine colluvium generated from local upslope bedrock.

The ecoregion lies within the zone of discontinuous permafrost where permafrost is up to 200 m thick, with taliks present in major rivers (Thomas and Rampton, 1982c). Ice-wedge polygons occur in poorly drained, fine-grained soils. Modern processes include thermokarst subsidence and soil creep, cryoturbation, solifluction, and active layer detachment slides on shale.

GLACIAL HISTORY

This ecoregion is comprised dominantly of unglaciated terrain, with the exception of parts of the Nahoni Range where there is scattered evidence of a past local glaciation of undetermined age. However, glaciers outside this ecoregion have influenced the major rivers, with up to three levels of glacially controlled terraces present (Thomas and Rampton, 1982c).

Major meltwater outlets exited the eastern slopes of the North Ogilvie Mountains, near Mount Klotz and Mount Bragg, and the northern slopes of the South Ogilvie Mountains, via Ogilvie, Miner, Whitestone, Blackstone and Hart rivers, during all glacial periods known in the area. At the Late Wisconsinan maximum (ca. 30 ka; Hughes *et al*., 1981; Schweger and Matthews, 1991), the Laurentide Ice Sheet blocked drainage of the Peel River and its southern tributaries forming Glacial Lake Hughes, and diverting the drainage northward through the Eagle River discharge channel (Duk-Rodkin and Hughes, 1995). Glacial Lake Hughes received all the water exiting the Mackenzie and Wernecke mountains and the Ogilvie, Blackstone and Hart river basins. The Eagle and Porcupine rivers were the two major contributors to the inundation of the Old Crow, Bluefish and Bell basins.

Pediment surfaces are widespread along major rivers and streams, such as the Whitestone and Ogilvie rivers and the western slopes of Richardson Mountains (Fig. 169-3). Three levels of pediments are identified in the Richardson Mountains, with ongoing development since at least the late Miocene (McNeil *et al.*, 1993; Duk-Rodkin and Hughes, 1994).

CLIMATE

Winter conditions are prolonged, usually extending from October to early May. This is due in part to the northerly latitude and the warmer south winds that infrequently erode cold air from the valleys north of the Ogilvie Mountains. This ecoregion lies near the Arctic Circle, therefore the periods of continuous sun above or below the horizon are relatively brief.

Mean annual temperatures are near –7.5°C, but there is strong seasonal variation; during the winter, there is an elevation variation though local relief is not great. Average January temperatures range from –31°C on the lower valley floors to near –25°C over the higher terrain. This is believed to be the result of relatively light winds during the winter and the settling of the coldest air in the valley bottoms. Mean July temperatures are not as dependent on elevation and are near 13°C. Extreme temperatures range from –60 to 30°C; again the extreme minimums are more common in the valley floors. Frost can occur at any time of the year.

Precipitation is moderate with annual amounts near 400 mm. Most precipitation falls as rain during the summer months, primarily in showers and thunderstorms. Mean June through August amounts are 50 to 80 mm per month. The lightest precipitation is from September through April as snow. Little to no wind data are available in this ecoregion. It is believed that winds are generally light from November to March although prolonged periods of moderate easterly winds can occur, due to predominant cells of high pressure over the northern Yukon. Frequently, strong southwesterly winds can occur as the high-pressure cells move over the central Yukon. During the summer, winds will be moderate to light and most frequently from the west or east.

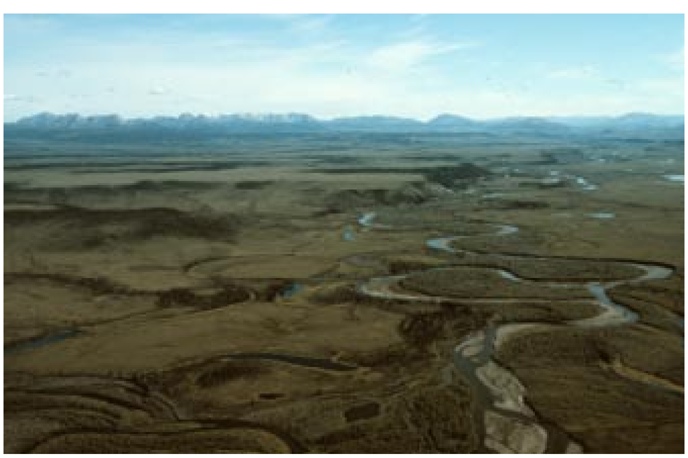

A. Duk-Rodkin, Geological Survey of Canada

Figure 169-3. Pediment surfaces extend from the Richardson Mountains to the Eagle River valley, as shown above. The pediments began forming during the Late Miocene, about 5 million years ago.

Representative stations for climatic data are Eagle Plains, Parkin (closed) and, to a lesser degree, Old Crow.

HYDROLOGY

The majority of the flow out from the Eagle Plains Ecoregion is to the Porcupine River, which flows northward through the northern portion. The north-flowing Eagle River, a tributary of the Porcupine, is another large stream within the ecoregion. Intermediate Porcupine River tributary streams include the north-flowing Whitestone River and the south-flowing Johnson Creek. The ecoregion also contains the lower portion of the Rock River, which flows into the Bell River, a tributary of the Porcupine. Coverage by waterbodies is less than 1% of the ecoregion. There are no large- or intermediate-sized lakes. While there are a few upland lakes in the headwater regions of the ecoregion, the majority of waterbodies consist of lowland, oxbow lakes associated with the Porcupine and Eagle rivers. There are a few large wetlands within the Porcupine and Eagle River lowlands.

There are three historical representative hydrometric stations: Whitestone, Eagle and Porcupine rivers. Annual streamflow is characterized by an increase in discharge in April due to snowmelt leading to a peak flow in May within most ecosystem streams. Summer rain events will produce secondary peaks, and sometimes the annual peak, throughout the summer. This is especially true of smaller streams, which more frequently experience peak rainfall events. Mean annual runoff is moderately low, ranging from 173 to 233 mm with an ecosystem average of 201 mm, while mean seasonal and summer flows are likewise moderately low with values of 12×10^{-3} and 10×10^{-3} $m^3/s/km^2$, respectively (Table 2). The mean annual flood and mean maximum summer flow are moderately high and low with values of 93 X 10^{-3} and 31 X 10^{-3} $m^3/s/km^2$, respectively. The minimum annual and summer flows are relatively low with values of 3 X 10^{-3} and 20 $m^3/s/km^2$ respectively. Minimum streamflow generally occurs during March or earlier with the relative magnitude lower than most other ecoregions due to the increasing role of winter temperatures and permafrost on streamflow. Many small streams experience zero winter flows relatively frequently.

PERMAFROST

Eagle Plains Ecoregion is underlain by continuous permafrost. Ground temperature measurements at the North Cath drill site, near the border with the North Ogilvie Mountains Ecoregion, indicate permafrost thickness of 89 m (Fig. 22), but various geophysical records suggest the base of ice-bearing permafrost may be considerably deeper. Mean near-surface ground temperatures at the Eagle River bridge are –3°C (Johnston, 1980; –2.8°C in 1991–1992, Tarnocai *et al.*, 1993). Rapid permafrost aggradation has been recorded in freshly exposed sediments of Eagle River (Crampton, 1979). The active layer thickness is generally less than 1 m (Tarnocai *et al.*, 1993).

Ground ice was encountered at all sites in the ecoregion examined for granular material in association with Dempster Highway maintenance and construction (EBA, 1990a). Extensive ground-ice accumulations were delineated in near-surface horizons during drilling for the potential Dempster Highway pipeline (Michel, 1983). Examination of the isotopic characteristics of near-surface icy sediments recovered from near Eagle River indicates that the ice formed during the Wisconsinan period, when Eagle River was part of the drainage route for

S. Smith, Agriculture and Agri-Food Canada

Figure 169-4. Cross-section of a well-developed earth hummock under black spruce forest near Eagle Plains Lodge. The permafrost table undulates in a mirror image beneath the surface of the hummocks. The active layer is up to 90 cm thick under the hummock and only 30 cm thick in the mossy inter-hummock depressions (tape measure on the left). This is a good example of an Orthic Eutric Turbic Cryosol with highly cryoturbated soil horizons, typical of the soils of subarctic Canada.

M. Hoefs

Figure 169-5. Extensive black spruce–paper birch woodlands exist on well-drained uplands throughout the ecoregion.

meltwater from the Laurentide Ice Sheet to the Old Crow Basin (Michel, 1983). Ice wedges and near-surface segregated ice are the prevalent forms of ground ice.

SOILS

Soils form under a cold continental climate on the broad, gently sloping, unglaciated surfaces that characterize this ecoregion. General soil and landscape relations have been described for the ecoregion by Tarnocai *et al.* (1993).

Near-surface permafrost is extensive, and absent only from active alluvial locations and some south-facing upper slopes. On these well-drained landscape positions under open black and white spruce stands, soils are classified as Dystric Brunisols (site 3 *in* Smith *et al.*, 1990). When associated with sandstone bedrock of the Eagle Plains Group, these soils may have pH as low as 4.0 and contain large amounts of iron oxides, a reflection of long periods of weathering. In other upland sites, often at elevations just above treeline, Turbic Cryosols produce patterned ground formations including well-developed sorted and non sorted nets and stripes (site 11 *in* Tarnocai *et al.*, 1993). Turbic Cryosols associated with earth hummocks are most commonly found under open stands of black spruce, birch and larch. Active layers vary from 20 cm in the inter-hummock area to over 90 cm immediately below the hummock forms. A cross-section of a typical earth hummock near Eagle Plains Lodge is shown in Figure 169-4. Annual mean soil temperature at 50 cm depth within the earth hummocks is about –3°C (Smith *et al.*, 1998). Forest fires disrupt the thermal regime of most middle and upper slope positions, causing a lowering of the permafrost table and releasing stored frozen water. In some cases, thaw slumps are triggered, as can be seen around km 300 on the Dempster Highway.

VEGETATION

Much of the Eagle Plains Ecoregion is characterized by black spruce woodlands associated with earth hummocks. Black spruce–tussock tundra dominates the lower slopes (Zoltai and Pettapiece, 1973). At the highest elevations, over about 800 m, shrub tundra with non-sorted nets and circles occurs on plateau summits. Tussock tundra lies on level and gently sloping surfaces (Fig. 169-5).

The black and white spruce woodlands common on uplands of the Eagle Plains are typically rich in shrubs, such as Labrador tea, shrub birch, willows, alder, blueberry, rose, lowbush cranberry and spirea, over a moss and lichen groundcover. White spruce with a lichen understory is more common on better-drained sites (Russell *et al.*, 1992; Murray, 1997).

On fine-textured soils of gentle gradients and lower slopes, the black spruce–shrub tundra contains Labrador tea, shrub birch, crowberry, lingonberry and spirea (Fig. 169-6). Cottongrass tussocks dominate the groundcover, though bog cranberry, cloudberry, lichen and moss are significant. Tamarack is often a component of the canopy.

Forest fires are a significant component of the landscape ecology. Paper birch typically is the first tree species to colonize burns, although on warm, well-drained sites aspen and balsam poplar may be found (Zoltai and Pettapiece, 1973). Extensive black spruce–paper birch woodlands (Fig. 169-5) indicate the extent of old burns (Terrain Resources Ltd. 1996). Fires increase the depth of the active layer and may trigger numerous slope failures.

Willow, alder and balsam poplar colonize active alluvial deposits along the major rivers.

The shrub tundra found above 800 m is often associated with patterned ground, such as raised-centre mudboils. Shrub birch, willow and prostrate shrubs dominate the vegetation. Cottongrass tussocks are also found at higher elevations in areas of impeded drainage in the Embankment Hills.

WILDLIFE

Mammals

This ecoregion has one of the lowest levels of mammalian diversity in the Taiga Cordillera, because it does not provide suitable habitats for many of the rodent and ungulate species found elsewhere. However, many species of voles find suitable habitat here and predators such as marten, ermine and red fox are common. Barren-ground caribou of the Porcupine herd use this area primarily in the fall and winter. The herd numbered about 123,000 in 2001. Large predators such as wolf, wolverine and grizzly and black bear (Fig. 169-6) are found in low densities. Information on mammal species other than caribou is poor. Species known or expected to occur in this ecoregion are listed in Table 4.

Birds

There is key nesting habitat for Peregrine Falcon along the Porcupine and Eagle rivers (Hayes and Mossop, 1978; Peepre and Associates, 1993). Wetlands are inhabited by small numbers of Pacific and Red-throated Loons, Tundra Swan, Greater White-fronted Goose, Canada Goose, American Widgeon, Green-winged Teal, Bufflehead, Lesser Yellowlegs, Solitary Sandpiper, and Common Snipe (McKelvey, 1977; Frisch, 1987).

Common Merganser, Spotted Sandpiper, Herring and Mew Gulls, a few Bald Eagle, Belted Kingfisher, and a few Bank and Cliff Swallow colonies exist along rivers (Frisch, 1987). Swift mountain

J. Meikle, Yukon Government

Figure 169-6. Black bear (brown phase) with cub grazing in shrub tundra vegetation.

streams support breeding Harlequin Duck and American Dipper (Frisch, 1987). Riparian thickets provide breeding habitat for Willow Ptarmigan, Alder Flycatcher, Yellow Warbler, Wilson's Warbler, American Tree Sparrow, and Lincoln's Sparrow (Frisch, 1987).

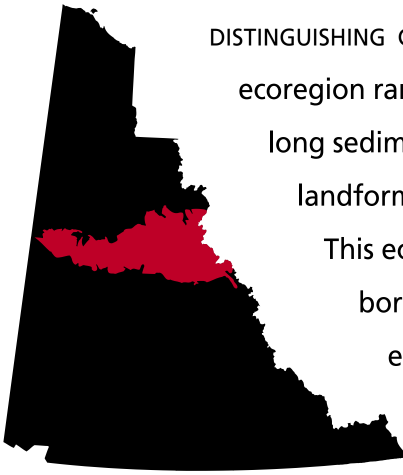
Upland forests provide breeding habitat for resident Northern Goshawk, Spruce Grouse, Northern Hawk Owl, Three-toed Woodpecker, Gray Jay, Common Raven, Boreal Chickadee, Pine Grosbeak, White-winged Crossbill, and Common Redpoll (Frisch, 1987). In winter, birds from higher altitudes or latitudes, including Gyrfalcon and Willow Ptarmigan, join these year-round residents (Frisch, 1987). Swainson's, Gray-cheeked, and Varied Thrushes, Bohemian Waxwing, Yellow-rumped and Blackpoll Warblers, and Dark-eyed Junco migrate north each spring to breed in these forests (Frisch, 1987). American Kestrel, Say's Phoebe, American Robin, Orange-crowned Warbler, and Chipping, Fox, and White-crowned Sparrows breed in the many forest openings and shrub habitats (Frisch, 1987). Swainson's Hawk, which is extremely rare elsewhere in the Yukon, regularly occurs in summer and is usually seen soaring over stunted spruce forest, leading to speculation that they may nest in the area.

Alpine tundra supports low numbers of Golden Eagle and Rock Ptarmigan and is probably used in summer by small numbers of Horned Lark, American Pipit, and Gray-crowned Rosy Finch (Frisch, 1987). Upland Sandpiper and Townsend's Solitaire breed in the subalpine zone (Frisch, 1987).

Mackenzie Mountains

Taiga Cordillera Ecozone

ECOREGION 170



DISTINGUISHING CHARACTERISTICS: The sedimentary rocks that underlie much of the ecoregion range in age from Early Proterozoic to Middle Jurassic, a 1.6 billion year long sedimentary record exposed in few other places in Canada. Spectacular landforms are associated with multiple glaciations and periglacial weathering. This ecoregion encompasses a significant ecological transition from the boreal in the south to the taiga in the north. The Yukon portion of the ecoregion is home to some of the largest woodland caribou herds in the territory.

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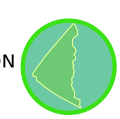
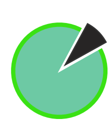
Figure 170-1. Broad U-shaped valleys and bare mountain ridges characterize the Wernecke Mountains in the Mackenzie Mountains Ecoregion. This southward view in the upper Snake River drainage shows braided streams with small aufeis remaining in midsummer (right side of photo) and small lakes contained within a glaciofluvial complex from the most recent McConnell glaciation. Half of the area of this ecoregion lies above treeline, which at this latitude is about 1200 m asl.

APPROXIMATE LAND COVER
subarctic coniferous forest, 50%
rocklands, 30%
arctic/alpine tundra, 20%

TOTAL AREA OF ECOREGION IN CANADA
86,460 km^2



TOTAL AREA OF ECOREGION IN THE YUKON
42,900 km^2



ECOREGION AREA AS A PROPORTION OF THE YUKON
9%

Metres above sea level

ELEVATIONAL RANGE
400–2,750 m asl
mean elevation 1,290 m asl

CORRELATION TO OTHER ECOLOGICAL REGIONS: Equivalent **Eagle Plain Ecoregion** (Oswald and Senyk, 1977) • Portion of **Taiga Cordillera Region** (CEC, 1997) • Portion of **Ogilvie/Mackenzie Alpine Tundra Ecoregion** (Ricketts et al., 1999)

PHYSIOGRAPHY

This ecoregion includes the South Ogilvie and Wernecke (Fig. 170-1) mountains, a broad band of mountains conventionally thought of as separating northern Yukon from central Yukon. It also encompasses much of the Mackenzie Mountains proper; the Bonnet Plume Range and the Knorr Range in northeastern Yukon, and the northern portions of the Backbone and Canyon ranges (Matthews, 1986) of the Northwest Territories. Within the South Ogilvie Mountains of the Yukon, the Tombstone and Cloudy ranges are spectacular ranges in the westernmost portion of this ecoregion.

The relief is generally between 750 and 1,500 m. Only a few peaks exceed 2,100 m elevation, although the highest, Mount McDonald in the Bonnet Plume Range, is more than 2,740 m asl. The floodplain of the Bonnet Plume River as it exits the ecoregion is the lowest elevation in the ecoregion at less than 600 m asl.

These mountains form part of the Mackenzie–Yukon hydrologic divide. They drain southward into the Yukon River and the Bering Sea, and north to the Mackenzie and Beaufort Sea. To the south are the headwaters of the Stewart, Nadaleen, McQuesten and Klondike rivers; to the north, they begin the Ogilvie, Blackstone, Hart, Wind, Bonnet Plume and Snake rivers. Lakes are few and small in the ecoregion.

BEDROCK GEOLOGY

The entire ecoregion lies within the Cordilleran Foreland Fold and Thrust Belt (Gabrielse and Yorath [editors], 1991). The rock units and structures largely define the landscape. Resistant carbonate protrudes as steep and rugged ridges, clearly revealing mountain-scale folds, while recessive siltstone, shale and major faults underlie intervening valleys. This is particularly evident in the southern Ogilvie and Wernecke mountains where older rocks are exposed in an erosional window. Second, distinctive peaks in the Tombstone and Antimony ranges are cored by syenite to quartz diorite intrusions. The intrusive rocks are frost-fractured along vertical joints, resulting in sheer cirque walls and blocky talus (Fig. 170-2). Bedrock of the ecoregion has been mapped (Green, 1972; Blusson, 1974; Norris, 1982c,d; Thompson, 1995) and is described in Gabrielse and Yorath (editors, 1991; chapters 5–9), which includes coloured illustrations (Plates 3–10, 13–15 and 29 *in* Gabrielse and Yorath [editors], 1991) of the spectacular geology exposed in the ecoregion.

The sedimentary rocks range from Early Proterozoic to Middle Jurassic, a 1.6 billion year sedimentary record exposed in only a few other places in Canada. Sandstone, siltstone, and a prominently weathered orange-brown, thinly bedded dolomite, older than 1,750 Ma, constitute the Wernecke Supergroup (Delaney, 1981). Succeeding units, including dark-coloured shale, thick- and thin-bedded dolomite and sandstone comprise the overlying Fifteenmile (Thompson, 1995) and Pinguicula (Thorkelson and Wallace, 1995) groups in the western half of the ecoregion, and Mackenzie Mountain Supergroup east of the Snake River. From 750 to about 600 Ma, maroon shale, sandstone and conglomerate reflect widespread rifting (Mustard and Roots, 1997) and glaciation (Eisbacher, 1981).

All these older rocks are unconformably overlain in the northern part of the ecoregion by thick-bedded, grey and white Paleozoic carbonate in the west and sandstone in the east. This renewed continental shelf setting is called the Mackenzie Platform. The southern third of the ecoregion is part of the Selwyn Basin. Between them is the Dawson Fault, a reactivated boundary. Selwyn Basin is defined by a deep-water succession of grit and shale (the Hyland Group, part of Windermere Supergroup) overlain by black shale and chert, the Road River Group, with mafic volcanic lenses, minor limestone and siltstone units of Cambrian and Ordovician age. North of Dawson and around the Tombstone Mountains is a thrust panel of quartzite, black argillite and limestone of Upper Paleozoic through Jurassic age. Sub-circular 90 and 94 Ma granitic stocks intruded both folded sedimentary rocks and thrust faults.

The distribution of metallic minerals varies greatly within this broad ecoregion. Entire ranges of sedimentary strata are almost devoid of mineralization, but some structures and rock units have many known occurrences and, therefore, high potential for ore deposits. The Bonnet Plume Range contains uraniferous mineral brannerite; abundant iron as hematite; and traces of copper, barium, cobalt and gold in irregularly shaped breccia bodies (Archer and Schmidt, 1978). A very large hematite iron deposit lies in the headwaters of the Snake River. Significant lead- and zinc-rich veins occur in the south end of the Bonnet Plume Range, as well as in the southern Wernecke and Ogilvie

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Figure 170-2. Steep walls result from exfoliation of syenite in the Tombstone Range. Vertical joints in the rock allow water to penetrate and freeze, incrementally levering out large slabs from the bedrock core. Talus blocks are then reduced in size by physical and chemical weathering, and with time become vegetated by moss and lichen.

mountains. Numerous copper–zinc–lead showings are known in the western Wernecke Mountains near the Hart River volcanogenic massive sulphide deposit. A similar deposit, in Upper Paleozoic quartzite, indicates a prospective horizon for more of these deposits along the southern edge of the ecoregion (Turner and Abbott, 1990). The Tombstone and adjacent stocks contain large, low-grade concentrations of uranium (Bremner, 1994) and adjacent skarn hosts copper–gold (Marn 116B#056) as well as possible porphyry-style gold, copper or molybdenum occurrences. Areas underlain by Devonian to Carboniferous black shale of Imperial Formation or Earn Group have high background barium, zinc, lead and arsenic concentrations, and host local barite and nickel–platinum stratiform deposits. Coal seams are abundant in the Bonnet Plume drainage and near the Monster River, at the northeastern and northwestern edges of the ecoregion.

SURFICIAL GEOLOGY AND GEOMORPHOLOGY

Colluvial deposits cover approximately 70% of the area, while glacial deposits, primarily within glaciated valleys, cover about 25%. The remaining 5% includes organic, alluvial and lacustrine deposits.

Modern processes include landslides, rotational slumps, rock fall, and debris flows. Landslides have occurred around Tombstone Mountain and the headwaters of the Wind and Bonnet Plume rivers. Retrogressive thaw–flow slides are developed mainly in lacustrine deposits within discontinuous permafrost. Periglacial features such as pingos, cryoplanation terraces, solifluction lobes, stone polygons, and rock glaciers are present.

The very long exposure of surfaces to weathering, frost shattering and soil creep has resulted in well-developed colluvial blankets on most surfaces at middle to high elevation and thick alluvial fans and aprons in valley bottoms. These deposits can also be subjected to slope- and permafrost-related processes and disturbed surfaces are usually susceptible to retrogressive thaw slides, or detachment slides common on soliflucted surfaces. Several large rockslides in the 30 to 50 X 10 m^3 class are indicative of possible rapid and severe mass movements, sometimes affecting the drainage of rivers, as was the case in the past with the Bonnet Plume River. A few slides were mapped (Thomas and Rampton, 1982a) in the Ogilvie Mountains between 64°15'N and 64°25'N. Another large slide was mapped on the west side of Lake Creek (Vernon and Hughes, 1966). The sedimentary rocks in the area are prone to such catastrophic slumps when the bedding plane is subparallel and steeper than the slope surface (Ricker, 1974).

Solifluction and soil creep are present on many of the hillside and valley walls and are often an indication of permafrost presence. Colluvial fans and talus cones are considered to be unstable and, in many cases, ice-rich. Valley bottoms are occupied by fluvial and morainal sediments and are often overlain by peat deposits of variable thickness, with evidence of patterned ground or cryoturbation. Palsa bogs have been mapped throughout the ecoregion and ice wedges are common in fine-grained sediments. Following disturbance, some of the melting ice wedges can leave depressions up to 3 m wide and 2 m deep.

Rock glaciers and debris-covered glaciers, as well as ice-cored or ice-rich talus cones, are abundant in the Yukon portions of the ecoregion. Active rock glaciers show unvegetated steep fronts (Fig. 170–3) and are usually located at elevations above 1,820 m. Inactive rock glaciers are mostly vegetated, have a rounder front profile, and usually begin at elevations as low as 1,000 m asl. Rock glaciers occupy northeast- to northwest-facing cirques, and occasionally more southerly aspects, particularly in the Wernecke Mountains. Debris-covered glaciers can be as thick as 60 m and head in cirques with steep, north-facing headwalls.

Braided rivers have unstable channels and are subject to seasonal flooding after ice thaw and rain storms. Expansive river icing (aufeis) takes place on most streams. In addition, alluvial and colluvial fans are usually susceptible to erosion and channel migrations.

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Figure 170–3. A rock glacier in the Bonnet Plume Range, cored by ice at its snout and fed by repeated rockfall at its head.

GLACIAL HISTORY

A record of several pre-Reid glaciations starting in the late Pliocene is preserved in the South Ogilvie Mountains portion of the ecoregion. These glaciations are recorded in the Tintina Trench and along the northern slopes of the South Ogilvie Mountains (Duk-Rodkin, 1996). Evidence of the youngest two glaciations, the Reid (ca. 200 ka) and the McConnell (ca. 23 ka), is found in most mountain valleys (Duk-Rodkin, 1996; Kennedy and Smith, 1999). The extent of glaciers during older glaciations was greater than during subsequent ones, a pattern observed throughout the northern Cordillera. Morphologic evidence of glaciation is widespread and is mainly related to the last two glacial periods (Vernon and Hughes, 1966; Duk-Rodkin, 1996).

The Wernecke Mountains portion of the ecoregion was largely covered by the Cordilleran Ice Sheet. The western margin of this ice sheet formed valley glaciers that merged with local glaciers from the South Ogilvie Mountains. Cordilleran valley glaciers also extended westward to the Hart River area and towards the Tintina Trench during pre-Reid glaciations. During the Reid Glaciation, main and local valley glaciers coalesced in the central part of this ecoregion. Local ice caps may also have been present. During the McConnell Glaciation, glaciers occupied only about 50% of cirques thought to have been active during the Reid Glaciation (Vernon and Hughes, 1966). Cordilleran glaciers during the McConnell Glaciation did not reach the central part of this ecoregion. Pre-Reid moraines are absent or subdued and highly colluviated. Reid-age features are also subdued compared to the well-preserved features of the McConnell Glaciation.

In the northern part of the region, the Snake and Bonnet Plume river valleys were affected by the Late Wisconsinan Laurentide Ice Sheet (ca. 30 ka; Hughes *et al.*, 1981; Schweger and Matthews, 1991). At its maximum extent, the ice sheet blocked the drainage of all streams in the Mackenzie and Wernecke mountains, creating a meltwater channel system that crossed divide areas of the Canyon Ranges, exited through a meltwater channel connecting the Arctic Red, Snake, and Bonnet Plume rivers and the Bonnet Plume Depression, and drained into Glacial Lake Hughes (Duk-Rodkin and Hughes, 1995).

CLIMATE

The mountains of the ecoregion act as a second major barrier to air masses moving off the Gulf of Alaska inland. The barrier generates a wet belt, particularly along the southern slopes. These mountains are also formidable enough to stop shallow layers of cold arctic air from reaching the central and southern Yukon.

Mean annual temperatures are near –6°C. There is a seasonal variability, but locally it is not as marked as in many other Yukon ecoregions due to the consistently high elevations here. Mean January temperatures are near –25°C and in July near 8°C. Extreme temperatures from near –50 to 30°C have occurred in the valley floors but probably only range from –35 to 15°C over the highest terrain. In part due to the higher elevations, thawing temperatures can occur in all the winter months and frosts at anytime during the summer.

Precipitation is relatively heavy, particularly over the eastern portions of this ecoregion. Typical annual amounts range from 450 to 600 mm, higher in some years. The heaviest precipitation occurs in July and August with monthly amounts of 50 to 70 mm. Even during the summer, this precipitation can occasionally be in the form of snow, particularly over the higher terrain. The least amount of precipitation is from December to May with monthly amounts of 20 to 30 mm.

Little wind data are available in this ecoregion. The prime storm tracks trend well south or north of this area, so prolonged periods of light winds are expected. However, periods of strong winds may occur due to the higher elevations and funneling effects within the extensive mountain peaks and ranges.

The only climate station that exists in this ecoregion is Klondike. Some inferences could be made using historical data from Ogilvie, Elsa and Tungsten.

HYDROLOGY

The Mackenzie Mountains Ecoregion straddles the divide between the Yukon and Peel river drainage basins. The ecoregion drains the Ogilvie and Wernecke mountains in the central Yukon, as well as the Backbone Ranges of the western Northwest Territories. Major streams include the Hart, Wind, Bonnet Plume, Snake and upper Stewart rivers in the Yukon, as well as the Arctic Red, Mountain and Twitya rivers in the Northwest Territories. Smaller streams include the Beaver, McQuesten, North Klondike, Chandindu and Fifteenmile rivers. The ecoregion is very rugged with considerable relief, and as such, the streamflow characteristics typify that of a high-energy mountain system. A few of the higher mountain peaks contain cirque glaciers. There are no major lakes, though there are numerous intermediate and small upland lakes including Bonnet Plume, Ortell, Fairchild, Pinguicula and Kathleen lakes. Wetland coverage is primarily limited to the upper reaches of the major river valleys (Fig. 170-4).

There are four representative hydrometric stations within the ecoregion: Bonnet Plume and North Klondike within the Yukon portion of the ecoregion, and the Twitya and Mountain rivers within the

Northwest Territories portion of the ecoregion. Annual streamflow is generally characterized by a gradual increase in discharge in the spring, rising to a peak in June or July due to snowmelt inputs. The exception lies within small headwater basins immediately downstream of the glaciated area. In these basins, peak flows occur in July or August due to high elevation snowfield and glacier melt. Many of the headwater streams are steep and relatively short; therefore, streamflow response tends to be rapid and flashy. On these smaller streams, approximately 40% of the annual maximum flows are due to intense summer rainstorm events. Some small steep streams are susceptible to mud flows triggered by these summer rainstorms. Mean annual runoff is moderately high with values ranging from 350 to 445 mm, with an ecosystem average of 377 mm. Mean seasonal and summer flows are likewise moderately high with values of 25 X 10^{-3} and 20 X 10^{-3} $m^3/s/km^2$, respectively. The mean annual flood and mean maximum summer flow are moderate with values of 92 X 10^{-3} and 52 X 10^{-3} $m^3/s/km^2$, respectively. Minimum streamflow generally occurs during March or April in the southern portion of the ecoregion, and earlier in the northern portion. The mean annual minimum and mean summer minimum flows are moderately high and high with values of 1.3 X 10^{-3} and 8.3 X 10^{-3} $m^3/s/km^2$, respectively.

PERMAFROST

The Mackenzie Mountains Ecoregion straddles the southern boundary of the continuous permafrost zone. Permafrost is found throughout the ecoregion because of its elevation, with near-surface ground temperatures usually above –4°C (Harris *et al.*, 1983b). At Keno Hill, just south of the ecoregion, Wernecke (1932) reported 135 m of permafrost. Placer miners working in the upper reaches of creeks in the Mayo District, also near the southern border of the ecoregion, regularly encounter frozen ground and ground ice in surficial deposits. Similar conditions could be expected within this ecoregion.

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Figure 170-4. A valley-bottom, headwater fen wetland in the upper Bonnet Plume River in the Wernecke Mountains portion of the ecoregion. These headwater fens are the most common form of wetland in the ecoregion.

The Dempster Highway crosses the western portion of the ecoregion. Inspection of geotechnical records from drilling associated with highway maintenance and construction indicates an increase in permafrost occurrence with distance north of Tintina Trench. During a detailed investigation at km 60 to 78, permafrost was encountered in 56% of 165 holes (Department of Highways and Public Works Canada, 1974). Brown (1967) reported permafrost continuous above alpine treeline along the road, with ice wedge networks developed in plateau areas. Ice-rich ground is mainly encountered in moraine and colluvial deposits on hillsides, but when these overlie gravel, the coarse material may be cemented by a matrix of ice (EBA, 1990b). Moist valley-bottom sediments contain ground ice (EBA, 1990b) and thermokarst lakes. There are relatively few pingos in the ecoregion, because surficial materials are predominantly fine-grained. There are a few palsas in some of the valleys.

Occasionally, high, north-facing cirques host debris-covered glaciers, presumably relict from Neoglacial periods (Vernon and Hughes, 1966; Hughes, 1983a). Rock glaciers are also found in the northern portion of the ecoregion, but these occur over a wider range of elevations (Vernon and Hughes, 1966). Above treeline, the ground exhibits features common to periglacial terrain: solifluction lobes on slopes, and a range of patterned ground features at flatter sites. Cryoplanation terraces are evident above glacial limits (e.g. Hughes, 1983b). Extensive bedrock outcrops are frost-weathered throughout the ecoregion, with talus accumulations at their bases.

There is considerable seasonal groundwater flow through the active layer in this terrain, with regular growth of frost blisters in valley floors (Pollard and French, 1984), and persistent development of ice in river channels each winter (Harris *et al.*, 1983b).

SOILS

Strong relief and a continental climate characterize this mountainous ecoregion. Valley bottoms experience very cold winter temperatures and permafrost-affected soils are predominant in the ecoregion. There has been little detailed soils work done in the Yukon portion of the ecoregion except for the area around the Tombstone Range in the South Ogilvie Mountains (sites 17–23 *in* Tarnocai *et al.*, 1993; Kennedy and Smith, 1999).

Soils have formed primarily from colluvial parent materials derived from a variety of lithologies of sedimentary and metamorphic origin. Bedrock outcrops and felsenmeer are common along ridges and summits. Alpine tundra environments exhibit patterned ground formations associated with Turbic Cryosols; in the more level topography of mountain passes, ice-wedge formations underlie most of the soil surface. Upper slope colluvium is coarse and often without near-surface permafrost. Eutric and Dystric Brunisols form depending on the reaction of the parent geologic materials; where materials are more unstable, Regosols are most common. Lower- and mid-slope positions vary in texture and in temperature regime. Warmer aspects often support Brunisols and associated spruce forest. Cooler aspects and moister sites tend to have Cryosol development under open stands of black spruce.

Most of the ecoregion has been subject to localized valley glaciation so that moraine and glaciofluvial materials are found on most valley bottoms. Eutric Brunisols are formed on gravelly glaciofluvial deposits; however, most finer-textured materials have Turbic Cryosol formation. This is particularly true in the higher elevations and mountain passes (Kennedy and Smith, 1999). There are no extensive wetlands in this ecoregion, although localized depressions on valley floors contain ribbed fens and occasional peat plateau bogs. All are underlain, at least in part, by permafrost, and the soils are both Gleysolic Turbic Cryosols and Organic Cryosols.

VEGETATION

The vegetation of the Mackenzie Mountains Ecoregion is primarily alpine tundra interfingered with valleys of taiga forest. The steep mountains separated by narrow valleys have lichen-ground shrub alpine tundra on summits and slopes, sparsely vegetated scree slopes, and shrub-dominated subalpine valleys or treed valleys at lower elevations (Fig. 170-5). Treeline is around 1,200 m asl, though slightly lower in the South Ogilvie Mountains in the west of the ecoregion (Oswald and Senyk, 1977). Lodgepole pine and subalpine fir are largely absent from the ecoregion. No systematic regional vegetation surveys exist for this ecoregion except in the proposed Tombstone Park area in the western corner (Kennedy and Smith, 1999).

Shrub- and herb-rich white spruce communities are found on low-elevation alluvial sites and similar, though often less diverse, communities are found along the sides of valleys. Shrubs include Labrador tea, willow, rose, soapberry and alpine blueberry; horsetail, lupine, and bear root characterize the herb layer. Typically, white spruce may be found on the sides of the valleys while shrub birch communities dominate coarser valley deposits. Stands of black and white spruce or mixed stands of spruce, aspen, paper birch and balsam poplar are found at low elevations (LGL, 1981; Stanek *et al.*, 1981; Kennedy, 1992; MacHutcheon, 1997).

Balsam poplar, willow and alder colonize recent floodplain deposits that are permafrost free. These communities typically have an understory of diverse forbs. Tall willow–sedge swamps establish along creek drainages and lake margins with a groundcover dominated by sedges and moss, with other graminoids and sparse but diverse forbs (Kennedy and Smith, 1999). Seepage sites on mountain slopes host a diverse forb community (Fig. 170-6). Poorly drained, gently sloping lower slopes, with near surface permafrost and Gleysolic Turbic Cryosol soil formation, are dominated by low shrub tussock tundra. Sedge tussocks with Labrador tea, shrub birch and other ground shrubs constitute this community. Tall willow swamps indicate drainages with deeper active layers.

Shrub birch–willow communities dominate middle elevations. These communities are found both on mountain slopes and on river terraces in subalpine valleys (Russell et al., 1992; MacHutcheon, 1997; Kennedy and Smith, 1999). On drier sites with Brunisolic soils, Dryas and ground shrubs such as net-veined willow, lowbush cranberry, Labrador tea and lichen underlie the shrub birch. Juniper and kinnikinnick grow on the driest sites. Scattered white spruce may be present at lower elevations. On moister sites, willow predominates with Dryas, moss, lichen, and commonly bearberry, lowbush cranberry, alpine blueberry, cloudberry, and sometimes horsetail.

At the highest elevations (>1,500 m), exposed sites and steep, unstable slopes may be bare rock or rock and rubble. Rock lichens such as *Umbilicaria* spp. colonize the rubble talus while very sparse forbs,

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Figure 170-5. Scattered stands of boreal forest are present in valley bottoms along the southern fringes of the ecoregion. South-facing slopes support closed forest (white spruce where well drained, black spruce elsewhere). Stand structure and age are controlled by fire history. View northward toward the Nadaleen Range, from the lower Nadaleen River valley.

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Figure 170-6. Above treeline (1,200 m elevation) in the upper Stewart River valley, are verdant slopes of monkshood *(Aconitum delphinifolium,* blue), goldenrod *(Solidago multiradiata)*, wild sweet pea *(Hedysarum boreale,* pink) and other wildflowers. These well-drained slopes are free of near-surface permafrost and receive long summer sun. An important factor is abundant seepage from melting snow at higher elevations. Runoff from the dolomite, argillite and siltstone ranges tends to be alkaline and enhances the diversity of plant communities.

graminoids and bryophytes establish in sheltered pockets (Kennedy and Smith, 1999). Lichen, *Dryas* spp., dwarf willow and ericaceous shrubs dominate more gentle slopes usually associated with patterned ground and Turbic Cryosol soils (Jingfors and McKenna, 1991). White mountain heather communities are common on mesic to moist sites with northerly aspects and where snow persists late in the season. Periglacial features such as solifluction lobes and patterned ground are outlined by vegetation patterns. Steep slopes are often very sparsely vegetated.

WILDLIFE

Mammals

Grizzly bear and wolverine, indicators of ecosystem health, are abundant here, though wolves are not. Woodland caribou of the Bonnet Plume and Hart River herds range in the north and the Redstone herd ranges in the southeastern part of the ecoregion. The Bonnet Plume herd, numbering about 5,000, and the Redstone herd, numbering 5,000 to 10,000, are among the largest woodland caribou herds in the Yukon. Dall sheep are found in the northern and eastern sections of the ecoregion and Stone sheep are more common to the south and west (Barichello *et al.*, 1989a).

Collared pika, singing vole, and Ogilvie Mountains lemming are characteristic small mammals. The Ogilvie Mountains lemming may be the only mammal species restricted to the Yukon, and occurs in only one other ecoregion (North Ogilvie Mountains Ecoregion). The deer mouse, least chipmunk, and hoary marmot reach their northern range limits here. Most mammal species have received little attention and ranges can only be estimated. Species known or expected to occur in this ecoregion are listed in Table 4.

Birds

Few documented bird records exist for this remote ecoregion. Overall, waterbird populations are low; there are few wetlands. Swift-flowing mountain streams are inhabited in summer by Harlequin Duck and Wandering Tattler, and possibly year-round by American Dipper (Osgood, 1909; Frisch, 1987). Small numbers of Trumpeter Swans breed in the upper reaches of the Stewart River (McKelvey and Hawkings, 1990). Mew Gull and Belted Kingfisher breed on some lower elevation lakes and rivers while Solitary and Spotted Sandpipers occur along the shores and marshes of these scattered wetlands. Riparian thickets of willow, alder, and birch support breeding songbirds such as Alder Flycatcher, Orange-crowned Warbler, Yellow Warbler, Northern Waterthrush, Savannah Sparrow, and Lincoln's Sparrow (Frisch, 1987).

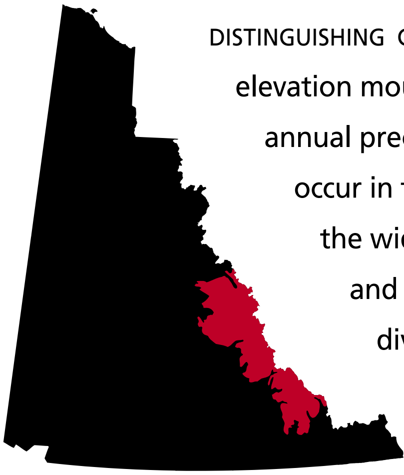
Spruce forests provide breeding habitat for Merlin, Northern Flicker, Swainson's Thrush, Yellow-rumped Warbler, Blackpoll Warbler, and Dark-eyed Junco (Osgood, 1909; Frisch, 1975). Peregrine Falcon nests on bluffs overlooking the forested valleys (Osgood, 1909; Canadian Wildlife Service, unpubl.). Year-round residents include Northern Goshawk, Northern Hawk Owl, Three-toed Woodpecker, Gray Jay, Common Raven, and Boreal Chickadee (Frisch, 1987).

At higher elevations, Townsend's Solitaire nest in open subalpine forests, while Upland Sandpipers favour tundra just above treeline (Frisch, 1987). Near treeline, shrub birch and willow provide breeding habitat for Willow Ptarmigan; Northern Shrike; Wilson's Warbler; and American Tree, White-crowned, and Golden-crowned Sparrows (Frisch, 1987; Sinclair, 1996). Exposed, rocky slopes support small numbers of White-tailed Ptarmigan, Northern Wheatear, Gray-crowned Rosy Finch (Sinclair, 1995), and possibly Horned Lark (Osgood, 1909; Frisch, 1975; Sinclair, 1996). Golden Eagle and Gyrfalcon nest on cliffs and ledges, while Snow Bunting is known to breed on north-facing cirques with areas of permanent snow (Osgood, 1909; Frisch, 1975). Surfbird, a species whose Canadian breeding range is restricted to the mountains of the northern Yukon, inhabits heath-covered slopes (Frisch, 1987). Alpine tundra provides breeding habitat for Rock Ptarmigan, Short-eared Owl, and American Pipit (Frisch, 1975; Canadian Wildlife Service, unpubl.).

Selwyn Mountains

Taiga Cordillera Ecozone

ECOREGION 171



DISTINGUISHING CHARACTERISTICS: This ecoregion is characterized by rugged, high-elevation mountain ranges, many supporting alpine glaciers. Some of the highest annual precipitation values in the Yukon, outside of the Pacific Maritime Ecozone, occur in this ecoregion. The heavy snow blanket insulates many valleys from the widespread establishment of permafrost. Subalpine shrub–birch–willow and alpine vegetation predominate. These areas support the highest diversity of mammals in the Taiga Cordilleran Ecozone, including the northern limit of the range for flying squirrel, little brown bat, jumping mouse, wood rat, mule deer and mountain goat.

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Figure 171-1. The Selwyn Mountains Ecoregion forms the last major cordilleran barrier to eastward-moving weather systems and produces a "wet belt" in eastern Yukon. The ice sheets on Keele Peak are the most extensive outside of Kluane National Park.

APPROXIMATE LAND COVER
boreal/subalpine coniferous forest, 65%
rocklands, 15%
alpine tundra, 20%

TOTAL AREA OF ECOREGION IN CANADA
71,890 km^2

TOTAL AREA OF ECOREGION IN THE YUKON
35,578 km^2

ECOREGION AREA AS A PROPORTION OF THE YUKON
7%

Metres above sea level

ELEVATIONAL RANGE
745–2,970 m asl
mean elevation 1,380 m asl

CORRELATION TO OTHER ECOLOGICAL REGIONS: Equivalent to **Itsi Range and Logan Mountains Ecoregions** (Oswald and Senyk, 1977) • Portion of **Taiga Cordillera Region** (CEC, 1997) • Portion **Ogilvie/Mackenzie Alpine Tundra Ecoregion** (Ricketts et al., 1999)

PHYSIOGRAPHY

The Selwyn Mountains Ecoregion incorporates the Hess and Logan mountains, which form the Yukon–Northwest Territories border between 61°N and 64°N. About half of the ecoregion extends into the Northwest Territories.

The Hess and Logan mountains are the rugged, high-elevation physiographic units (Matthews, 1986) in this ecoregion. They consist of mountains and ridges separated by broad valleys. Between the Hess and Logan mountains is a less rugged area with broader valleys, the headwaters of the Pelly River. The Tasin, Rogue and Itsi ranges make up the Hess Mountains. Most of the massifs are cored by more resistant intrusive rocks. Keele Peak (Fig. 171-1), the Itsi Range and peaks in the Logan and Rogue ranges support alpine glaciers.

Keele Peak is 2,970 m asl and the highest point in the ecoregion. Numerous other mountains are over 2,200 m asl and much of the area lies above 1,500 m asl. Local relief ranges from 900 to 1,500 m.

The Hess Mountains drain mainly west to the Stewart and Macmillan rivers and southwest via the Ross River. The Logan Mountains drain west via the Pelly River and south through tributaries of the Frances, Hyland and Coal rivers to the Liard River. Lakes are found occasionally throughout the ecoregion but are more common in the broader valleys between the Hess and Logan mountains. Pelly Lakes are the largest waterbodies in the ecoregion.

BEDROCK GEOLOGY

The geology of the Yukon part of this ecoregion differs markedly from that portion in the adjacent Northwest Territories. It is characterized by dark-weathering Paleozoic clastic sedimentary rocks of the Selwyn Basin tectonic assemblage, rather than the colourful Proterozoic and Paleozoic carbonate strata of the Mackenzie Platform in the Northwest Territories. Regional geological maps exist for most of the Yukon portion of the ecoregion (Gabrielse *et al.*, 1973; Gordey and Irwin, 1987; Gordey and Anderson, 1993; Cecile, 2000), although some are in preliminary form (Blusson, 1966; Roots *et al.*, 1995).

The Selwyn Basin was a deep-water depositional environment with periodic clastic influx and reducing conditions. The oldest rocks are a thick, widely exposed sequence of coarse sandstone, conglomerate and maroon shale of the Hyland Group (this and all subsequently mentioned units are described in Gordey and Anderson, 1993). These Late Proterozoic to Cambrian sediments are overlain in adjacent areas by the dull grey-brown shale Gull Lake Formation, and by thin-bedded limestone of the Rabbitkettle Formation, both of Cambrian age. The Road River Group is the most widespread unit, commonly underlying subdued topography. It includes black and silvery weathering shale and grey chert, which northward is increasingly green or blue.

In Late Devonian time, the Selwyn Basin was inundated by chert–quartz sandstone and chert pebble conglomerate of the Earn Group, eroded from the units further west (Abbott *et al.*, 1986). Atop these dark-coloured rocks, thin remnants of turbidic sandstone and shale of the Tsichu, Mount Christie and Jones Lake formations are locally preserved. Numerous sub-circular plutons of hornblende and biotite granite of the Selwyn Plutonic Suite (92–106 Ma) form extremely rugged massifs, such as Horn Peak, Keele Peak, Itsi Range and Mount Billings. The plutons are encircled by a 0.5 to 2 km wide zone of contact metamorphosed, high-standing and commonly rusty-weathering sedimentary rocks, though surrounding areas have typically low relief.

In Late Jurassic and Early Cretaceous time, the sedimentary strata were intensely deformed into tight folds, separated by thrust faults. Seemingly enormous thicknesses of similar strata are really thin beds imbricated by layer-parallel thrust faults. Furthermore, horizontal thrust faults, rarely apparent without regional structural analysis (e.g. Gordey, 1981), underlie most of the ecoregion. Two regional-scale, dextral faults, the Hess and Macmillan (Abbott and Turner, 1990), extend northwest from the headwaters of their namesake rivers. Large unexplained earthquakes occasionally shake the region (Wetmiller *et al.*, 1989) and may trigger the rockslides in jointed, well-bedded, carbonate rocks perched above the glacially deepened valleys (Eisbacher, 1977, 1978).

Most known mineralization consists of shale-hosted zinc, lead and tungsten in altered carbonate rock near granite plutons; thus, certain sedimentary horizons and plutons have potential for ore deposits. Near Macmillan Pass, zinc, lead and barite deposits are spatially related to syndepositional faults (Abbott and Turner, 1990) in the Earn Group, which also contains barite deposits and geochemical anomalies. Road River shales contain large stratiform zinc–lead deposits at Howards Pass, 40 km southeast of Macmillan Pass. Mactung, 5 km northeast of Macmillan Pass, and Cantung, 105 km north of Watson Lake, are significant scheelite deposits in the ecoregion. Sub-economic zinc–lead–silver (copper–tungsten) skarn showings are abundant around the granite north of Mount Billings, east of Tillei Lake. Other deposit types include the Plata–Inca argentiferous galena in quartz veins cutting black shale about 15 km northeast of the mouth of Rogue River, and gold, bismuthenite and gem-quality sphalerite collected from sheeted quartz veins within the Emerald Lake pluton.

SURFICIAL GEOLOGY AND GLACIAL HISTORY

The Selwyn Mountains Ecoregion was a centre of ice accumulation and intense glacial erosion during the McConnell glaciation of the Yukon (Bostock, 1966). Alpine landforms such as horns and arêtes are common in this area. Significant accumulations of glacial sediments are present only in the bottoms of major valleys where moraine and glaciofluvial deposits can be found. Upper slopes and side valleys are blanketed with Holocene colluvium deposits of various thickness and particle size.

Ice crossed the continental divide from west of the Nahanni Valley to feed the Selwyn Lobe of the Cordilleran Ice Sheet (Jackson, 1987). The Selwyn Mountains also shed ice south into the Liard Basin (Dyke, 1990a) and fed eastward flowing glaciers which merged with the Laurentide Ice Sheet in the Mackenzie Valley (Jackson and Mackay, 1991; Jackson *et al.*, 1991; Jackson, 1994). The major expansion of glaciers in this region occurred less than 26,000 years ago (Jackson and Harington, 1991; Jackson *et al.*, 1991). Deglaciation occurred from the top down, with upland areas being the first to emerge while valleys remained under stagnant valley glaciers (Jackson, 1987, 1994). During the postglacial period, streams incised into the glaciated terrain left flights of stream terraces and built alluvial fans. Intense mechanical weathering and mass wasting created mantles of colluvium on mountain slopes. Cirque glaciers and rock glaciers advanced during the Little Ice Age of the past few centuries; rock glaciers remain active in many areas (Jackson and MacDonald, 1980; Jackson, 1987; Dyke, 1990b). Alpine glaciers of significant size remain today on Keele Peak, Horn Peak, the Itsi Range and numerous peaks east of Tillei Lake in the Logan Mountains.

CLIMATE

This ecoregion is located on the western slopes of the continental divide between the Yukon and Northwest Territories. Elevations rise from near 1,000 m asl along this ecoregion's eastern boundary to an average of 1,700 m asl along the divide. Seasonal variations and the effect of elevation result in a complex climate. Useful but limited climatic data are available from Sheldon Lake (Twin Creeks), Yukon and Tsichu River and Tungsten, Northwest Territories.

Mean annual temperatures are believed to range from –5 to –8°C. Mean temperatures are expected to be near –20°C in January, and 5 to 10°C in July. Summer temperatures are lower in summer at the higher elevations. Temperature extremes in January in the valley floors can range from –55 to 3°C, but over the higher terrain temperatures would probably range from –30 to –5°C. In July, extremes would range from –5 to 30°C in the valley floor and from –5 to 15°C over higher terrain. Frost can be expected at any time of the year.

Precipitation is moderate and locally heavy with annual amounts of 600 to 700 mm. These are the highest values for precipitation in the Yukon outside of the coastal ranges (Fig. 171-1). The winter months have mean amounts of 30 to 50 mm with the least amounts from February to April. The wettest months are July and August with rainfall amounts of 60 to 90 mm. Even during the warmer months the precipitation may fall as wet snow or snow pellets.

There is little wind data, but winds are believed to be light to moderate. Due to funnelling effects in the mountain ranges, it is expected that periods of strong winds should be expected at any time of year.

HYDROLOGY

The ecoregion straddles the Northwest Territories border from the Hyland River in the south to the Lansing River in the north. It drains the Selwyn Mountains to the west and south through the upper Hyland (Fig. 171-2) into the Liard River basin; the Pelly, Ross, Macmillan, Hess, Rogue and Lansing rivers into the Yukon River basin within the Yukon, and the South Nahanni, Keele and Mountain rivers to the south and east within the Northwest Territories. Streamflow characteristics typify that of a high-energy mountain system. Several of the highest mountain peaks contain alpine glaciers. There are no major lakes, though there are numerous medium-sized and small lakes including Pelly, Fortin, Itsi, Fuller, Keele and Arrow lakes. Wetland coverage is limited but distributed throughout the major river valleys.

There are 12 representative hydrometric stations for the ecoregion: Hyland, South Macmillan, Hess and Pelly rivers, and King and Boulder creeks within the Yukon portion of the ecoregion. Other representative stations within the Northwest Territories portion of the ecoregion include Flat, Tsichu, and Silverberry rivers and Mac and Lened creeks. Though several glaciers are present, their respective areas are relatively small; therefore, hydrologic response within the ecoregion does not generally exhibit characteristics typical of a glaciated system. The exception lies within first- and second-order basins immediately downstream of the glaciated area. Annual streamflow within these exceptional areas is characterized by a gradual increase in discharge in the spring, rising to a peak in July or August due to high elevation snowfield and glacier melt. In non-glaciated systems, peak flows occur in June as a result of snowmelt inputs.

This ecoregion has among the highest peak flows in the Yukon. Many of the first- and second-order headwater streams are steep and relatively short; therefore, streamflow response tends to be rapid and flashy. On these smaller streams, approximately 40% of the annual maximum flows are due to intense summer rainstorm events. Some small, steep streams are susceptible to mud flows triggered by these summer rainstorms. Mean annual runoff is generally high, though variable, ranging from 290 mm in lower elevation basins to 705 mm in higher elevation basins with an ecosystem average of 536 mm. Mean seasonal and summer


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Figure 171-2. Mixed stands of white spruce, subalpine fir and black spruce occur along the upper Hyland River in the southeastern portion of the ecoregion. The alpine vegetation, as seen here in the Billings Range (background), is a much more common vegetation condition over most of the ecoregion.

flows are likewise high, with values of 37 X 10^{-3} and 30 X 10^{-3} $m^3/s/km^2$, respectively. The mean annual flood and mean maximum summer flows are moderately high with values of 127 X 10^{-3} and 76 X 10^{-3} $m^3/s/km^2$, respectively. Minimum streamflow generally occurs during March or April in the southern portion of the ecoregion, and earlier in the northern portion. The mean annual minimum and mean summer minimum flows are likewise high, with values of 1.3 X 10^{-3} and 8.8 X 10^{-3} $m^3/s/km^2$, respectively.

PERMAFROST

The Selwyn Mountains Ecoregion is in the widespread discontinuous permafrost zone. Harris (1986) suggested that permafrost is continuous above 1,300 m asl in the north of the ecoregion, and above 1,450 m asl in the south. In valleys, permafrost is often absent or discontinuous due to snow accumulation in winter. In Macmillan Pass, at 1,106 m asl, permafrost occurs in the valley bottom as isolated palsas (Kershaw and Gill, 1979; Harris and Nyrose, 1992) and is not extensive. The active layer in these peat mounds is less than 60 cm thick and overlies up to 5 m of permafrost (Kershaw and Gill, 1979). Mean near-surface ground temperatures in the valley at Macmillan and Howards passes are above 0°C (Burgess *et al.*, 1982).

At higher elevations, there are plenty of features that indicate the presence of permafrost. Hundreds of rock glaciers were noted by Dyke (1990a) in the southern portion of the ecoregion (Fig. 171-3), as well as debris-covered glaciers and small cirque glaciers. The terrain was glaciated; a veneer of drift that has developed solifluction lobes covers most mountainsides. The active layer in this drift is often over 1 m deep, due to its coarse nature (Dyke, 1990a). Ground ice is prevalent in glaciolacustrine sediments and ubiquitous in organic soils, which form blanket bogs in some valleys (Jackson, 1987).

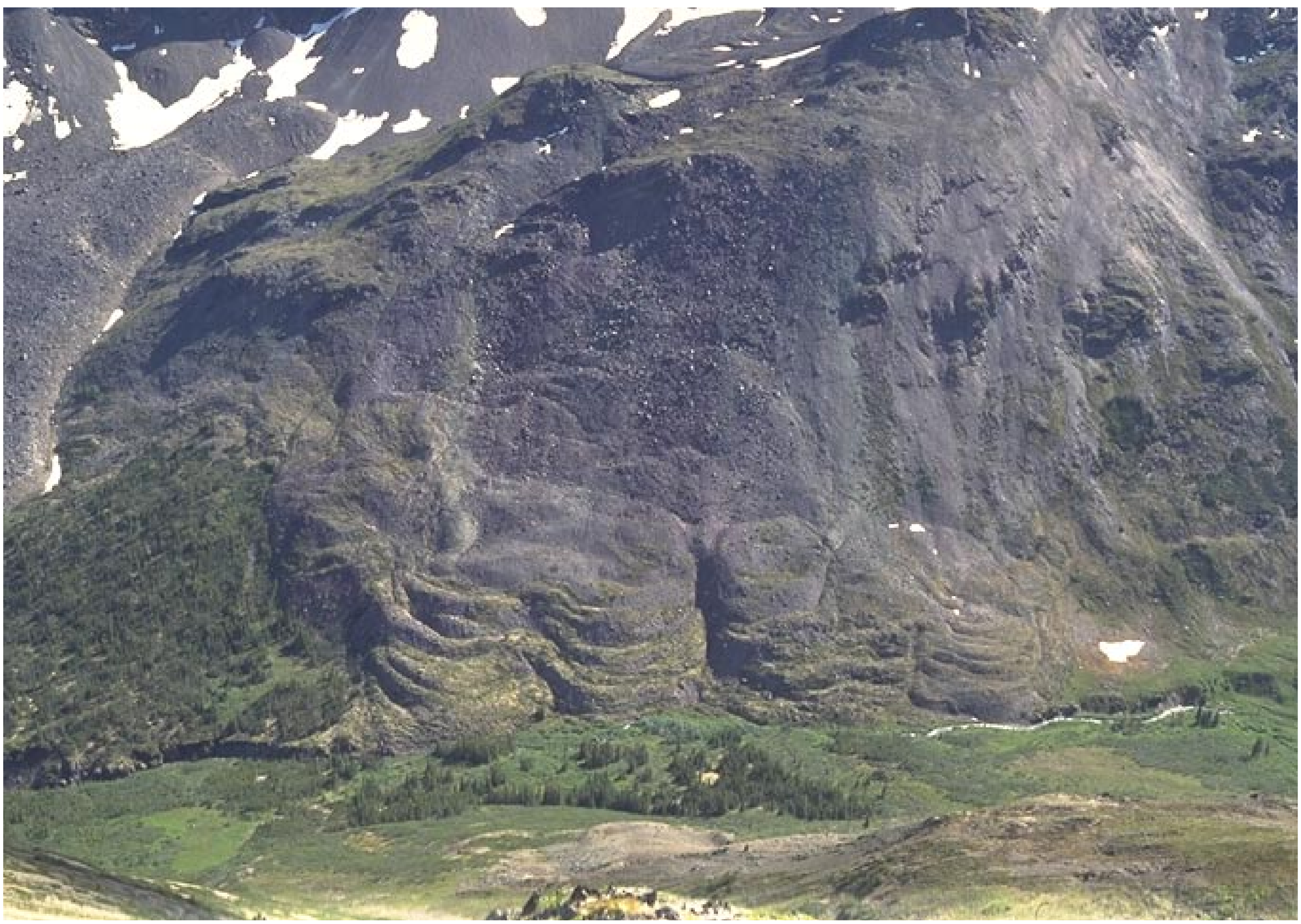

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Figure 171-3. Series of rock glaciers formed in coarse talus in the Lansing Range. The rock glaciers are visible as lobes of rock debris along the lower slope that "flow" as a result of an ice core.

SOILS

Soils in this rugged, high-elevation ecoregion have formed under the influence of a relatively moist, continental climate on a variety of geologic parent materials. Detailed soil studies have been conducted in the northern part of the ecoregion in the Macmillan Pass area (Department of Renewable Resources, 1981) and in the southern portions of the ecoregion in the upper Hyland River watershed (Zoladeski and Cowell, 1996).

Mountain summits and ridges are characterized by bedrock outcrops and shallow soil over bedrock. Coarse colluvium associated with felsenmeer or active alpine glaciers supports Regosol formation. Alpine environments present a mosaic of soils, such that a complex of Turbic Cryosols and Eutric Brunisols co-exist depending on moisture regime and the extent and location of permafrost. North-facing slopes and seepage areas tend to be underlain by permafrost, particularly in the northern portion of the ecoregion where Regosolic Turbic Cryosols and Orthic Turbic Cryosols are found on slopes under open-canopy black spruce forests. Warmer slopes tend to be without permafrost and support Eutric and Dystric Brunisols, depending on the mineralogy of parent materials. Occasional Orthic Humo–Ferric Podzols occur on well-drained parent materials at subalpine elevations (Department of Renewable Resources, 1981).

A variety of glacial materials are found on lower slopes and valley bottoms. Moraine most often supports Eutric Brunisol formation. Strong leaching in gravelly glaciofluvial materials leads to the development of Dystric Brunisols and, in some localities, Orthic Humo–Ferric Podzols. This is the only ecoregion in the Yukon where podzolic soils are significant.

There are some extensive wetlands in major valley systems. Sedge-dominated wetlands, or fens, are often without permafrost; their associated soils are Typic Mesosols. Where sphagnum peat accumulates, peat plateau bogs underlain by near-surface permafrost support Organic Cryosol formation.

VEGETATION

The vegetation of the Selwyn Mountains is mainly alpine and subalpine. Valleys and middle to lower slopes are forested (Fig. 171-2).

Alpine ridges and peaks are sparsely vegetated. The vegetation composition of alpine areas varies greatly within short distances due to microtopography, microclimate and changes in bedrock lithology. The more nutrient-rich limestones and carbonate-rich shales host different plant assemblages, including more forbs (dryas, anemone and gentian) than the more acidic bedrock types.

Lichen–grass communities with lots of exposed soil and rock dominate the most extreme sites at high elevations. Dwarf shrub communities are common on slopes and ridges between 1,200 and 1,800 m asl, occupying slightly moister sites than the lichen-dominated communities. White mountain heather, crowberry and alpine blueberry, grass, sagewort, gentian, feathermoss, *Cetraria* and reindeer lichens are the typical plants found in these areas. Rock lichen colonizes scree slopes.

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Figure 171-4. Near treeline, the vegetation consists of open stands of subalpine fir trees intermingled with krummholz surrounded by heath–forb meadows. This ecoregion contains many mineralized showings in the exposed rock of alpine areas.

Shrub birch–willow communities dominate much of the subalpine including many colluvial slopes, coarser deposits of subalpine valleys, and gentle moraine slopes in the northern part of the ecoregion along the Northwest Territories border (Department of Renewable Resources, 1981). Shrub birch has an understory of alpine blueberry, crowberry, feathermoss and lichens, with willow on moister sites.

Subalpine fir is also common in the subalpine found between about 1,200 and 1,600 m asl. Sparse trees and krummholz growth forms predominate with increasing elevation. On dry southerly exposures, sparse patches of fir krummholz form the treeline (Fig. 171-4). Denser stands of fir and fir krummholz are found on north-facing slopes.

Black spruce predominates at lower elevations through much of the ecoregion. In the valleys, patches of white and black spruce, subalpine fir, and mixed stands are interspersed with shrubland and wetlands. White spruce–feathermoss stands are restricted to river floodplains associated with Regosolic and Gleysolic soils (Zoladeski and Cowell, 1996).

Black spruce is found on lower slopes or level areas with near-surface permafrost and Cryosols in organic and moraine parent materials. On these poorly drained sites, black spruce is associated with shrub birch, willow, Labrador tea, sphagnum, feathermosses and lichen. On slightly better drained mounds and moraine slopes, lichen and shrub birch dominate the understory.

Lodgepole pine is restricted to old burns in the lower part of the Hyland River Valley and possibly other lowland areas on the margins of the ecoregion.

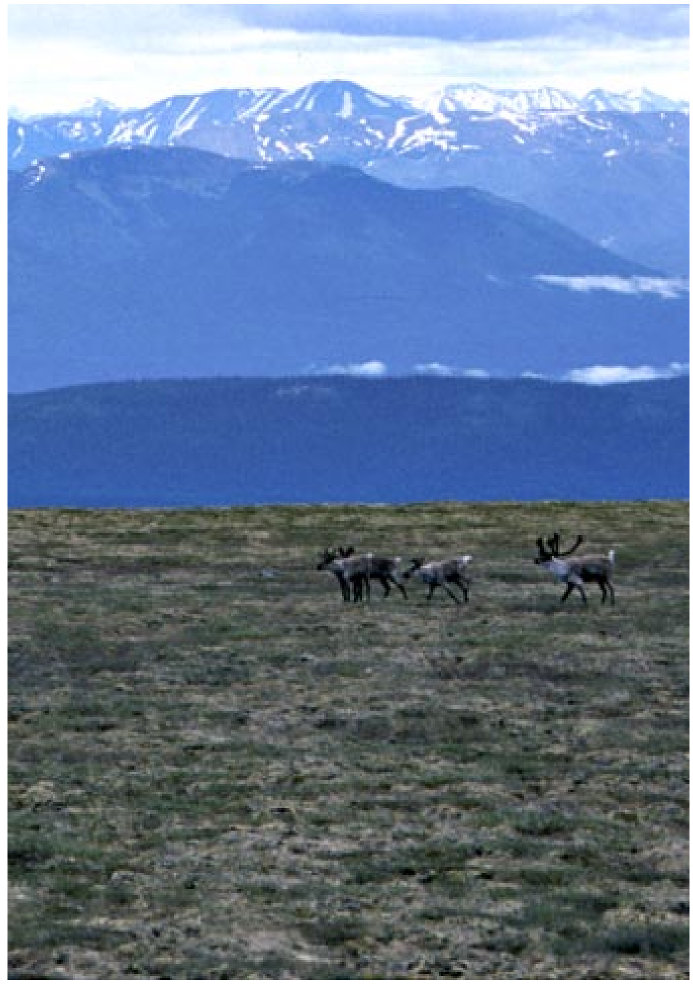

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Figure 171-5. The Selwyn Mountains Ecoregion is used by large woodland caribou herds for calving and summer habitat. The Yukon portion of this ecoregion receives heavy snowloads, forcing the Finlayson and Tay (above) caribou to migrate to winter range in the Yukon Plateau North Ecoregion.

WILDLIFE

Mammals

The Selwyn Mountains possess the highest diversity of mammals in the Taiga Cordillera of the Yukon. Woodland caribou are present as two herds largely confined to the Yukon; the Tay River herd was estimated at 3,800 in 1996 and the Finlayson herd was estimated at 4,100 in 1999 (Fig. 171-5). Also, a number of woodland herds range across the Yukon–Northwest Territories border. Of these, the best studied is the Nahanni herd estimated at about 900 in 2001. Other caribou are known to live in the alpine blocks of the upper Hyland and Coal watersheds in the Yukon. These caribou and the Nahanni herd all appear to use a large wintering area within Nahanni National Park and south of the park. Their range use is known only from movements of a few satellite radio-collared caribou.

The highest densities of mountain goats in the Yukon, outside of Kluane National Park, occur in the Logan Mountains, within this ecoregion. They reach their northern limit of distribution in Yukon's Itsi Range (Barichello and Carey, 1988). Dall sheep are found in the eastern sections and Stone sheep in the western sections of the ecoregion.

Other species at their northern limit here include the Northern Flying Squirrel, Meadow Jumping Mouse, Little Brown Myotis, Bushy-tailed Wood Rat and Mule Deer. Grizzly bears, wolves and wolverine are relatively common. Mammal species known or expected to occur in this ecoregion are listed in Table 4.

Birds

Common waterbirds breeding on low elevation rivers, lakes, and wetlands include Pacific and Common Loons, Horned Grebe, Trumpeter Swan, Canada Goose, American Widgeon, Mallard, Northern Pintail, Surf Scoter, Long-tailed Duck, and Common Merganser. Typical shorebirds and gulls include Lesser Yellowlegs, Solitary Sandpiper, Least Sandpiper, Common Snipe, Bonaparte's and Mew Gulls, and Arctic Tern (Dennington *et al.*, 1983; Theberge *et al.*, 1986; McKelvey and Hawkings, 1990). Alder Flycatcher, Tree and Cliff Swallows, Yellow Warbler, Northern Waterthrush, Lincoln's Sparrow, and Rusty Blackbird are among the many songbirds that breed in association with these wetland areas (Theberge *et al.*, 1986).

Low elevation forests support a variety of breeding songbirds including Olive-sided and Yellow-bellied Flycatchers; Ruby-crowned Kinglet; Gray-cheeked and Swainson's Thrushes; Yellow-rumped, Blackpoll, and Tennessee Warblers at its northern limit; Chipping Sparrow; Dark-eyed Junco; and Pine Grosbeak (Theberge *et al.*, 1986). These forests are probably inhabited year round by species such as Gray Jay, Common Raven, and Black-capped and Boreal Chickadees (Godfrey, 1986).

Dwarf birch and shrub willow in the subalpine provide breeding habitat for Willow Ptarmigan and a number of migrant songbirds such as Wilson's Warbler, and American Tree, Savannah, White-crowned, and Golden-crowned Sparrows (Rand, 1946; Godfrey, 1986; Theberge *et al.*, 1986). Blue Grouse, Northern Shrike, and Townsend's Solitaire inhabit open subalpine forests (Rand, 1946; Theberge *et al.*, 1986). Scattered lakes and ponds in these subalpine areas support nesting Red-throated Loons (Theberge *et al.*, 1986).

Despite the apparent abundance of suitable nesting habitat for Golden Eagle and Gyrfalcon, only very low densities of Golden Eagles and a few Gyrfalcons have been reported (Theberge *et al.*, 1986). These areas of rock outcrops, boulder fields and talus slopes do support Rock Ptarmigan and, rarely, White-tailed Ptarmigan. Other breeding species in these high alpine areas are Wandering Tattler, Short-eared Owl, Horned Lark, American Pipit, and Gray-crowned Rosy Finch (Theberge *et al.*, 1986). Snow Buntings breed in areas of permanent snow, usually on north-facing slopes of these mountains (Theberge *et al.*, 1986).