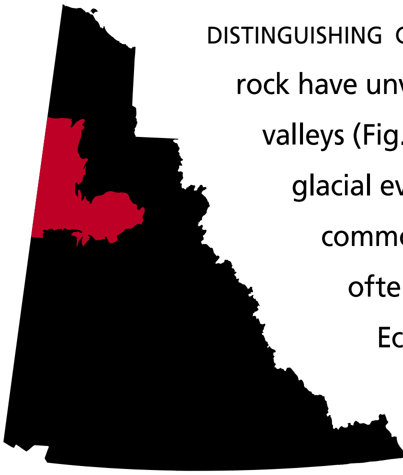
North Ogilvie Mountains

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.

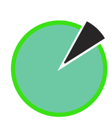
M. Hoefs

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 Wernecks 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.

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

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).