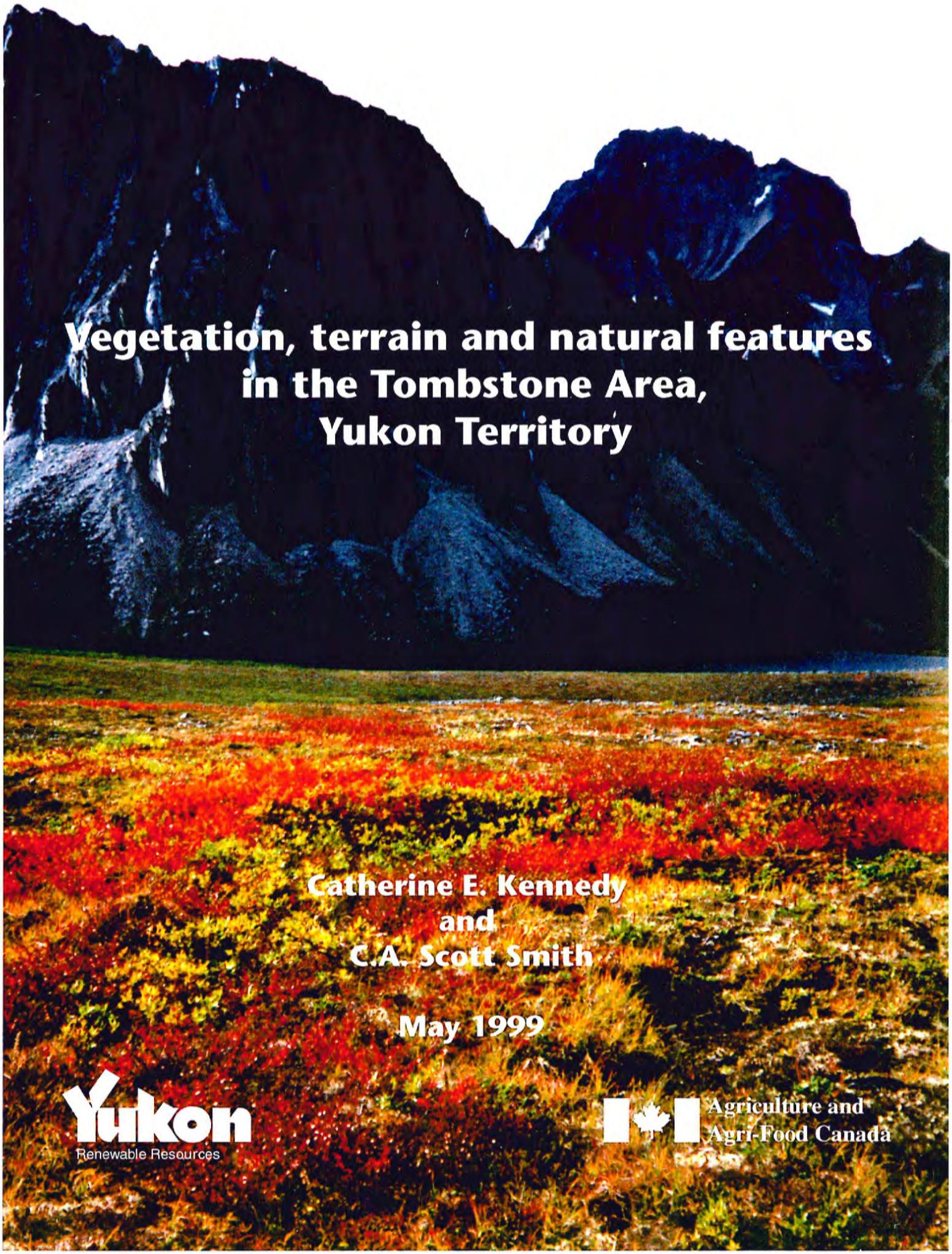

Vegetation, terrain and natural features in the Tombstone Area, Yukon Territory

Catherine E. Kennedy
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C.A. Scott Smith

May 1999

Yukon
Renewable Resources

Agriculture and
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Catherine E. Kennedy, Vegetation Specialist, Habitat Management, Fish and Wildlife Branch, Department of Renewable Resources, Government of Yukon, Whitehorse, Yukon Y1A 2C6

C.A. Scott Smith, Soil Scientist, Pacific Agri-Food Research Centre, Agriculture and Agrifood Canada, Summerland, B.C. V0H 1Z0

To obtain copies of this report, contact:

Protected Areas Secretariat
Department of Renewable Resources
Government of the Yukon
Box 2703
Whitehorse, Yukon Y1A 2C6

ISBN 1-55018-913-1

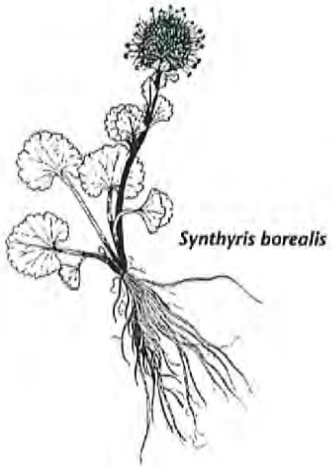
May, 1999

Cover photograph: Headwaters of Tombstone River, near Mount Monolith (C.E. Kennedy, Government of the Yukon)

This report to be cited as:

Kennedy, C.E. and C.A.S. Scott, 1999. Vegetation, terrain and natural features in the Tombstone area, Yukon Territory. Department of Renewable Resources, Government of the Yukon and Agriculture and Agri-Food Canada, Whitehorse, 47 pp.

SUMMARY


Synthyris borealis

The Tombstone and surrounding ranges of the Mackenzie Mountains Ecoregion encompass an outstanding diversity of landform and vegetation features. This unique area exhibits features that are representative not only of the boreal biome of central Yukon but also the sub-arctic and arctic biomes of northern Yukon.

The rock spires of the Tombstone Range, a striking landmark visible from the Dempster Highway, is the best known natural feature of the inventory area. Although these spires are not the highest peaks in the region, they present spectacular vertical relief, with pillars of black syenite reaching 2,200 metres elevation, and would logically form the core of any protected area.

Less well known, but equally impressive, are the diversity and abundance of glacial and periglacial landforms in the mountain ranges and valleys that make up the Tombstone Inventory Area. Periglacial features such as pingos and ice wedge polygons, typically associated with arctic landscapes on the Yukon's north slope, can be observed along the floors of major valleys. Other features associated with permanently frozen ground include solifluction lobes, cryoplanation terraces, sorted patterned ground and active thermokarst.

The inventory area also exhibits a complete array of glacial features (such as tarns, cirques, arêtes, terraces and moraines) in a concentration seldom seen elsewhere in the territory. Active and inactive rock glaciers are numerous. Multiple glaciations have scoured the region during the Pleistocene epoch (the past two million years) in such a way that surface features from at least two glacial periods are evident today in the area. However, many of the uplands remained unglaciated during this time and display landforms (pediments, tors, cryoplanation terraces) typical of unglaciated terrain.

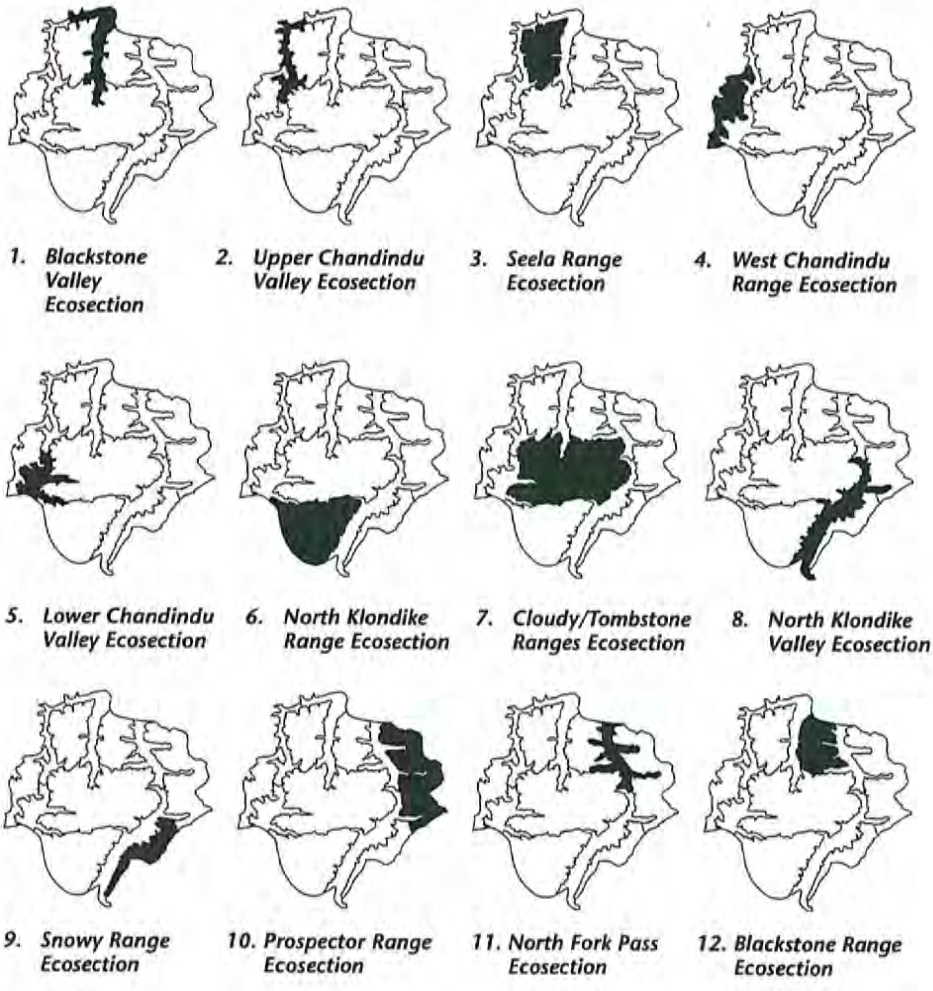
The Tombstone area hosts a diverse and unusual flora which has attracted botanists from all over the world. The area is reknown for its endemic species, as well as occurrences of circumpolar, Amphi-Beringian and North American species. Many of these species are considered rare, due to their very limited range in the region, a sparse or disjunct distribution over a wide area, or because they occur at the very limits of a range that extends far beyond the Yukon.

Like the flora itself, the vegetation communities are extremely diverse. The communities reflect a major influence and convergence of colder climates from the

north and warmer climates from the south, compounded in complexity by microclimates associated with altitudinal effects in steeply mountainous terrain.

The major valleys extending southward in the inventory area support boreal forests of black and white spruce, aspen and paper birch. Much of the remaining area is a vast tundra landscape, where tree growth is limited by permafrost and cold air drainage. Extensive shrublands of willow, shrub birch and ericaceous species predominate over mountain slopes and broad, open north-trending valleys. Sedge tussock communities, often in association with ice wedge polygons along drainages, are reminiscent of arctic environments. The alpine flora at higher elevations adds to the community diversity.

The Tombstone Inventory Area comprises 2500 square kilometres, or less than two percent of the Mackenzie Mountains Ecoregion. To facilitate field sampling and comparison of representative characteristics and natural features, the area was subdivided into 12 ecosections. These smaller ecological units share similar topography, elevation range, geomorphology, soils and vegetation. Each ecosection, shown below, is named after the major physiographic feature within its boundaries.



1. Blackstone Valley Ecosection
2. Upper Chandindu Valley Ecosection
3. Seela Range Ecosection
4. West Chandindu Range Ecosection
5. Lower Chandindu Valley Ecosection
6. North Klondike Range Ecosection
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Vegetation, terrain and natural features in the Tombstone area, Yukon Territory

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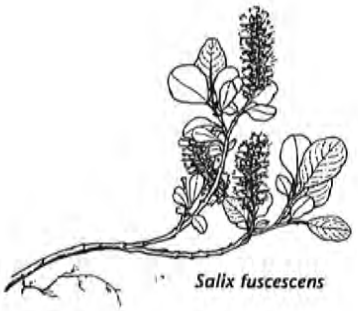
Salix fuscescens

over

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Photo 12. Vegetation Community 2:*Picea glauca/Betula-Salix* Blackstone Valley Ecosection, Site 6, Elev.1,227 m.a.s.1. Note the tors on the unglaciated summits of hills in the background.

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Photo 29. Vegetation Community 19:*Salix reticulata/Dryas* Seela Range Ecosection, Site 9, Elev.1,402 m.a.s.l.

Photo 31. Vegetation Community 21: *Cassiope /Carex* West Chandindu Range Ecosection , Site 14, Elev.1,463 m.a.s.l. Note the active erosion on the slopes, producing coarse colluvium.

ECOSECTIONS

The inventory area covers approximately 2,500 square kilometres, comprising less than two percent of the total area of the McKenzie Mountains Ecoregion. Prior to field sampling, the area was subdivided into smaller, local ecological units of similar topography, elevation range, geomorphology and vegetation cover, referred to as ecosections. This organization facilitated sampling stratification and comparison of representative characteristics and natural features throughout the inventory area.

A total of 12 ecosections were delineated in the inventory area. These are shown on Map 3 and are named after the major physiographic features within their boundaries. In the following text, each of the ecosections is described briefly in terms of its physiography, geology, soils and vegetation. The natural features associated with each of the ecosections are summarized in Table 2 (page 21).

Twenty-five vegetation communities occurring in the inventory area and their associated terrain descriptions are summarized in Table 5 (page 25). Appendix B contains photographs of each of the vegetation communities.

1. Blackstone Valley Ecosection

Physiography

Broad U-shaped valleys, up to two kilometres wide, contain the headwaters of the Blackstone River and East Seela Creek. The valleys lie between 1,100 and 1,300 metres above sea level between the Seela Range and the Blackstone Range and cover the Seela Pass area. The rivers flow northward toward the Peel River. The valley is covered by mixed glacial sediments, alluvium and coalescing fluvial fans of tributary streams.

Surficial geology

The valley is covered by unconsolidated Quaternary sediments derived from the bedrock materials of the surrounding mountain ranges. McConnell-aged glaciers occupied the valley of the Blackstone River to almost the edge of the inventory area and produced its characteristic U-shape. Morainal materials cover the valley floor along with alluvial materials along the active floodplain of the river. A prominent McConnell terminal moraine exists on the valley floor where the valley opens out on the plateau west of the White Hat Hills along the northern edge of the inventory area (Map 5). A unique partially collapsed pingo (Photo 1) occurs in the Blackstone Valley just west of this moraine.

Photo 1. ***Partially collapsed open system pingo on the floor of the Blackstone Valley Ecosection. Small pingos are found scattered throughout central and northern Yukon. Their number, origin and distribution have been reported by Hughes (1969).***

Soils

Most soil parent materials, except recent alluvium associated with the Blackstone River, are underlain by permafrost. Tundra soils are often hummocky and show signs of intense frost churning (Turbic Cryosols). Much of the landscape is underlain by ice wedge polygons. Soils are medium- to fine-textured. Soils (Regosols) formed from alluvium are common along the Blackstone River and vary from silt to gravel. Slopes in this valley bottom ecosection are gentle, usually less than ten percent.

Vegetation

The broad valley bottom of Seela Pass and the headwaters of the Blackstone River present a vast treeless landscape where the vegetation resembles the arctic tundra of the far northern Yukon. Sites of medium to fine texture soils, with drainage severely restricted by permafrost, are colonized by *Eriophorum* tussocks, in association with *Betula glandulosa*, *Salix* spp. and ericaceous shrubs (Comm. 14, 18); sparse *Picea mariana* may invade on slightly better drained sites on adjacent side slopes rising gently above the valley floor (Comm. 13). Riparian sites along drainages are delineated by *Salix* spp., *Carex* spp. and mosses (Comm. 10). Well-drained sites are colonized by *Betula glandulosa*, *Salix* spp. and ericaceous groundshrubs (Comm 12).

2. Upper Chandindu Valley Ecosection

Physiography

This glaciated valley bottom ecosection covers the headwater channel of the Chandindu River. The valley is narrow and somewhat incised. Lower slopes of the valley are covered by unconsolidated glacial sediments and fans, the valley bottom by the recent alluvium of the Chandindu River. The elevation varies from 1,200 metres near the Seela Pass down to 1,000 metres at the southern end of the ecosection.

Surficial geology

The Chandindu valley was glaciated during the Reid glaciation but escaped any glacial action associated with the most recent McConnell glaciation. Reid-aged moraine dominates the side slopes of the valley along with more recent colluvial fans and talus. The floor of the valley is covered by alluvium and moraine.

Soils

Most of the ecosection is underlain by near-surface permafrost except the soils (Regosols) associated with recent alluvium, which support forest and willow growth. On gentle slopes, soils are underlain by ice-rich permafrost and are strongly affected by frost churning (Turbic Cryosols). On steep south-facing slopes, the soils (Eutric Brunisols) are without permafrost and exhibit the properties of forest soils of the boreal region to the south.

Vegetation

Much of the ecosection vegetation has a component of *Eriophorum* tussocks due to the underlying permafrost; long gentle slopes of pediments are typically colonized by *Betula glandulosa*, *Ledum groenlandicum*, *Eriophorum* tussocks and sparse *Picea mariana* (Comm. 13). Mixed coniferous forests of *Picea mariana* and *P. glauca* occur on slightly elevated sites on the valley floor with improved drainage (Comm. 4). Riparian communities comprised of early successional species (*Salix* spp., *Alnus* sp., *Populus balsamifera*, Comm. 9) occur on active alluvial channels, often adjacent to mature stands of *Picea glauca/ Hylocomium* (Comm. 1) along the Chandindu River. The lower slopes of steep tributary valleys support mixed tree canopies of coniferous and deciduous species (Comm. 7 and 8). In the north toward Seela Pass, well-drained knobs and terraces above the Chandindu River support the diverse *Rhododendron* and lichen vegetation community (Comm. 16).

3. Seela Range Ecosection

Physiography

This ecosection encompasses a rugged mountain range with peaks up to 2,000 metres and narrow glaciated valleys with basal elevations of 1,200 metres. Two major tributaries to the upper Blackstone River emanate from this range; Junior Creek and Bompass Creek both possess cirque basins at their headwaters.

Surficial geology

The bedrock geology is variable, being composed primarily of quartzite in the southern portion of the ecosection, volcanic rock in the vicinity of Junior Creek and a thin band of argillite and dolomite in the most northernly section adjacent to Seela Pass. Each bedrock type produces a characteristic colluvial material, erosional pattern of tors, solifluction features and gullies (Photo 2). The ecosection was not glaciated during the McConnell Glaciation and only scattered evidence of older Reid glacial deposits remain in some of the narrow valley bottoms within the Seela Range (Map 5).

Soils

Soil characteristics vary on most of the mountain sides, depending on the underlying geology. In general, the soils are rubbly colluvium and are without near-surface permafrost. The soils (Dystric Brunisols) derived from quartzite tend to be brown in colour and have slightly acidic reaction. The soils (Eutric Brunisols) formed on argillite and dolomite tend to be of neutral reaction and higher in organic matter. On lower slopes and valley bottoms, permafrost is evident and is associated with thick surface humus layer accumulations, solifluction and frost churning (Turbic Cryosol).

Photo 2. ***The irregular surface mounds in the foreground and on the slopes are solifluction lobes, formed as a result of mass movement of slope debris above the permanently frozen subsoil (permafrost table). The angular, physically weathered rock outcrops along the ridge are called tors. These features persist only in unglaciated terrain. Note the lack of abrasion and rounding that glaciation would impart on such outcrops.***

Vegetation

Much of this mountainous ecosection lies above treeline; communities of groundshrubs, forbs, lichens, *Gramineae* spp., *Carex* spp., mosses and lichens predominate (Comm. 19, 20, 21, 22, 23). An *Eriophor um* tussock community occurs on north-facing slopes at high elevation (Comm. 24). Extensive rock fields on peaks and summits are covered by crustose lichens, scant graminoids and *Draba* (Comm. 25). Further plant collecting in the dolomite rock formation in the northwestern portion of this ecosection may yield endemic species similar to those recorded in the dolomite rock north of Seela Pass. Lower slopes in the ecosection are vegetated with shrublands of variable diversity (Comm. 12), dominated by *Betula glandulosa, Salix* spp. and *Vaccinium uliginosum.*

4. West Chandindu Range Ecosection

Physiography

This ecosection is characterized by a spectacular range of rugged peaks ranging up to 2,000 metres. Multiple level cirques and tarns exist at the headwaters of numerous tributaries of the Chandindu River north of Deadman's Gulch. Rock glaciers are also occasionally present. The ecosection becomes more plateau-like in its southern portions with broad flat-topped summits.

Surficial geology

The ecosection is predominantly underlain by quartzite and quartz pebble conglomerate. The rock weathers to highly angular ridges and peaks. Very coarse rubbly colluvium is common on lower slopes. There are occasional outcrops of volcanic rock in the southern portion of the ecosection, which stand out prominently on the landscape. Localized McConnell-aged valley glaciers emanated from numerous cirque basins in the ecosection and extended out over the adjacent lower elevation Lower Chandindu valley.

Soils

Soils are derived from the weathering of quartzite bedrock to produce coarse-textured soils (Dystric Brunisols) of acidic reaction. The soils tend to be brown in colour, low in organic matter and without near-surface permafrost. Upper slopes are without any soil development, comprised mainly of rock outcrops and rubble. Some sorted pattern ground features exist in cirque basins, plateaus and mountain passes and are associated with frost-churned soils underlain by permafrost (Turbic Cryosols).

Vegetation

Non-treed vegetation communities characterize this high elevation ecosection. Low shrubs (e.g. *Salix* spp., *Betula glandulosa, Cassiope tetragona, Vaccinium uliginosum, Empetrum nigrum, Vaccinium vitis-idaea*) with a lichen understory form an extensive cover on the mountain slopes (Comm. 17, 19, 20, 22, 23, 25). Cirque basins and north aspects host communities dominated by *Cassiope tetragona* and *Carex* spp. (Comm. 21), associated with late snow melt and seepage. Open stands of *Picea glauca* with a shrub understory (Comm. 2) colonize the tributary valleys, which dissect the ridges and plateaus.

5. Lower Chandindu Valley Ecosection

Physiography

This ecosection is a broad, irregular valley system with numerous tributary valleys which extend to the lowest elevations (approximately 600 metres) in the inventory area. The ecosection is made up of many large, low-angle alluvial fans, some prominent bedrock outcrops (such as Lone Mountain) and an active alluvial system with associated terraces of the Chandindu River (Photo 3). The physiography is varied enough to produce a wide variety of landscape conditions. The valley was glaciated extensively during the Reid Glaciation. The southern end of the ecosection opens out into generally south-facing slopes leading into the Tintina Trench.

Surficial geology

Most of the ecosection is covered by morainal deposits associated with the Reid Glaciation and mixed colluvium. The colluvium is derived from landslides associated with tectonic activity in the Tintina Trench and is composed of a complex of glacial and non-glacial materials. Large terminal moraines extend into the Chandindu River valley from the Tombstone River valley and Fireweed Creek to the east and from two small drainages in the Chandindu Range to the west. These mark the limit of the McConnell Glaciation from the surrounding ranges into this ecosection (Map 5).

Photo 3. ***The Lower Chandindu Valley Ecosection is characterized by braided channels of coarse-textured gravel and sand. These alluvial deposits are generally not underlain by permafrost. Gentle lower slopes tend to be underlain by soils affected by near-surface permafrost (Turbic Cryosols).***

Soils

The gentle lower slopes and fan tend to be underlain by soils affected by near-surface permafrost (Turbic Cryosols). The alluvial deposits of the Chandindu River and its larger tributaries are usually coarse-textured gravel or sand and are not underlain by permafrost (Regosolic soils). Well-drained soils without the influence of permafrost (Brunisols) are confined to steeper south and westerly facing slopes formed of colluvium. Soil drainage controls the amount and type of surface vegetation and associated decomposing organic matter, which in turn insulate the ground against summer thawing.

Vegetation

Mixed coniferous/deciduous boreal forests including *Betula papyrifera*, *Picea glauca* and *P. mariana* (Comm. 8) and *P. glauca/Betula glandulosa* (Comm. 2) predominate on sites without permafrost; stands are dense and diverse. *Populus tremuloides* (Comm. 7) colonizes steep south-facing slopes of tributary valleys. On the broad, gently sloping fans and pediments characterized by seepage and restricted drainage due to permafrost, *Eriophorum* tussock communities with scattered *Picea mariana* (Comm. 13) are typical. On lower slopes of the Little Twelve Mile and Tombstone Rivers, sparse stands of *Picea mariana/ Sphagnum* (Comm. 5) are common. Active alluvial channels support early successional communities of *Salix* spp., *Alnus incana* and *Populus balsamifera* (Comm. 9); mature and robust stands of *Picea glauca/Hylocomium* (Comm. 1) occur along the Chandindu River and its major confluences.

6. North Klondike Range Ecosection

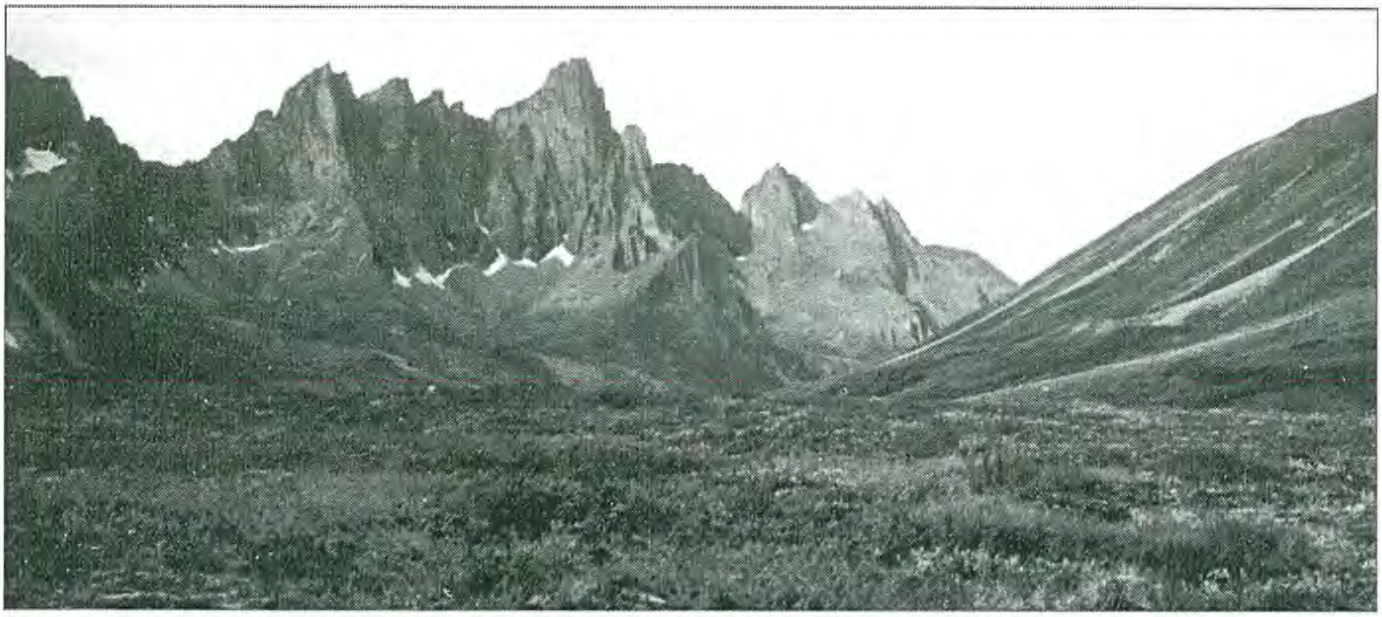
Physiography

The ecosection is composed of mountains of modest elevation, which form the north boundary of the Tintina Trench. Summits are rounded to level and range up to 2,000 metres but most are from 1,600 to 1,800 metres above sea level. Mount Jeckell, Yin Yang Mountain and Dipslope Mountain are the major summits. The ecosection is drained by tributaries of the North Klondike River.

Surficial geology

The rock types of this range are younger than the Palaeozoic quartzites and dolomites of the ecosections to the west and north. Significant variation in rock type exists. Mesozoic quartzites are common and are intermixed with brightly coloured intrusive rocks (gabbro and diorite) which give the landscape a character that is unique within the inventory area. The ridges and summits are covered by coarse colluvium. Valley floors between ranges are typically mantled by moraine that was deposited by alpine and small valley glaciers of McConnell age that did not extend into the major valley systems (North Klondike and Chandindu rivers) of the region. The location of the ecosection adjacent to the Tintina Trench affords distant views of the landscapes of the Yukon Plateau North Ecoregion to the south.

Photo 4. ***Tombstone Mountain (2,200 metres above sea level) is the most well-known landmark of the inventory area. Spires of syenite bedrock up to 350 metres in veritical relief are an outstanding natural feature of this ecosection. Tombstone Mountain is visible from the Dempster Highway.***



Soils

The upper slopes associated with the plateau-like summits are characterised by well drained soils formed over coarse rubbly parent materials. Permafrost is below a depth of one metre and the soils weather to a dark brown colour and an acidic reaction (Dystric Brunisols). Steeper slopes and summits are covered by rubble and have little soil development (Regosols). Permafrost is ubiquitous at higher elevations. Some alpine valleys show evidence of peat accumulation (Organic Cryosols) and patterned ground (Turbic Cryosols).

Vegetation

Extensive shrublands cover the rubbly slopes and plateaus at mid-elevations throughout the ecoregion, predominated by *Salix* spp., *Betula glandulosa, Vaccinium uliginosum, Arctostaphylos rubra* and lichens (Comm. 12). Mountain valleys with poorer drainage are typically colonized by *Betula glandulosa, Cassiope tetragona,* other ericaceous ground shrubs and lichens (Comm. 17); the associated drainages are often densely colonized by *Salix* spp. and *Carex* spp. (Comm. 10). Exposed sites at the highest elevations typically host communities of *Carex* and *Salix phlebophylla* (Comm. 23) and lichens, mosses and scant herbs on talus fields (Comm. 25). High productivity sites exist in select valleys intruding from the east, supporting robust stands of white *Picea glauca/ Hylocomium* (Comm. 1).

7. Cloudy/Tombstone Ranges Ecosection

Physiography

The ecosection encompasses two of the most rugged mountain ranges in the ecoregion. Spires of syenite bedrock up to 350 metres in vertical relief are an outstanding natural feature of the ecosection and

Photo 5. ***The broad valley floor of the North Klondike Valley Ecosection typically hosts stands of*** **Picea mariana/Sphagnum** ***(Black spruce/Sphagnum, Comm. 5) underlain by Turbic Cryosolic soils visible at lower left,*** **Picea glauca/Cladina** ***(White spruce/ lichen, Comm. 6) with the light ground cover visible at centre right, and*** **Alnus crispa-Populas balsamifera/Epilobium** ***(Alder-Balsam Poplar/fireweed, Comm. 3) visible on the dry bars and riparian zone along the North Klondike River, upper right. These two communities are without near-surface permafrost and are associated with Brunisol and Regosolic soils respectively.***

characterize the Tombstone Mountain area. Cirque basins and multiple tarns are common. Mountain summits are extremely steep with near vertical walls and knife-edge ridges and crests. While the summit elevations of the highest mountains in the Cloudy and Tombstone Ranges are modest (Tombstone Mountain is approximately 2,200 metres above sea level), it is the vertical relief that is so spectacular (Photo 4). Classic horns, arêtes and rock glaciers are all present on this landscape. Multiple Pleistocene glaciations are responsible for the U-shaped valleys, the numerous cirque basins and associated alpine glacial features.

Surficial geology

The formation responsible for the general form of the ranges is a Cretaceous hornblende/biotite syenite intrusion. The formation weathers to spectacular vertical relief. Also present are surrounding formations of quartzite and schist. Black shales occur along the eastern margin of the ecosection. Physical weathering is the dominant weathering process and leads to the development of a coarse blocky colluvium that mantles most steep slopes. A major valley system runs through the middle of the ecosection. This system is comprised of the uppermost reaches of the North Klondike River flowing in a northwesterly direction, and the headwaters of the Tombstone River, which flows in a southwesterly direction. Both valleys are mantled with moraine of McConnell age, from alpine glaciers that extended 10 to 15 kilometres down these valleys, as well as the upper reaches of the Blackstone River flowing to the north. There are no glaciers remaining in the ecosection today although a number of rock glaciers do exist.

Soils

Most slopes are composed of rubbly colluvium except areas of shale where finer materials support moist soils with greater vegetation cover. Most colluvial soils do not have permafrost within one meter of the surface (Dystric Brunisols). On valley bottoms, the soils are formed on glacial till parent materials. These soils (Turbic Cryosols) are gravelly, moderately well drained, often show signs of patterned ground formation and have a permafrost table one to two metres below the ground surface.

Vegetation

Climate and substrate are severe limitations to vegetation development in this rugged ecosection. Steep slopes of talus appear unvegetated, but are colonized by lichens, scant mosses and herbs (Comm. 25). Less exposed slopes support diverse low shrubs (*Arctostaphylos alpina, Empetrum nigrum, Cassiope tetragona, Salix* spp., *Betula glandulosa, Vaccinium vitis-idaea* and *Vaccinium uliginosum*) (Comm. 17, 19, 20, 21, 22). The groundcover of mosses and lichens frequently includes small circles of bare ground; these frost boils remain free of vegetation as long as freezing and thawing continues. Drainages in the valley bottoms are colonized by open or dense stands of *Salix* spp., *Carex* spp. and mosses (Comm. 10).

8. North Klondike Valley Ecosection

Physiography

This broad glaciated valley forms the headwaters of the North Klondike River. The valley floor is dominated by the floodplain of the river and is bounded by the gentle, irregular lower slopes of the mountain ranges to the east and west. Elevation range of the ecosection is from 800 to 1,200 metres above sea level. Major tributaries include Grizzly Creek, Wolf Creek, Robert Service Creek and Chisholm Creek. Each occupies a major side valley to the North Klondike River (Map 2).

Surficial geology

The northerly portion of the ecosection is composed of a mixture of morainal materials attributable to the McConnell Glaciation and alluvium deposited along the active floodplain of the North Klondike River. A series of terminal moraines emanate from tributary valleys, marking the limit of this most recent glaciation (Map 5). Within the main valley of the North Klondike River south of Grizzly Creek, much of the ecosection is covered by morainal deposits attributable to the Reid Glaciation. Occasional rock outcrops occur in the valley bottom. These are either quartzite or shale depending on location. The rocks to the east of the valley are predominantly Palaeozoic quartzite and associated rocks. West of the ecosection, the rocks are much younger. Quartzite, shale and schist of Mesozoic age are common in this area and produce a coarse colluvium on most steep slopes.

Soils

Most of the valley bottom soils are formed on glacial drift, are moist and underlain by permafrost at about one metre below the surface (Turbic Cryosols). Wetlands are common on the valley floor. Soils composed of accumulations of frozen peat result (Organic Cryosols). Side slopes have soils with variable moisture and temperature regime depending on position and aspect. The floodplains of the North Klondike River are characterized by mineral soils without near-surface permafrost, that tend to be low in organic matter and have slightly acidic to acidic reaction (Dystric Brunisols and Regosols) (Photo 5).

Vegetation

This ecosection is extensively treed and exhibits the greatest diversity of boreal forest communities in the

inventory area. Mixed coniferous/deciduous stands of *Populus tremuloides, Populus balsamifera, Picea glauca, Betula papyrifera* and *Salix* spp. (Comm. 8) colonize most of the valley sides, with pockets of pure *Populus tremuloides* (Comm. 7) on steep, south-facing slopes. Level sites on the valley floor, underlain by permafrost, are colonized by stands of *Picea mariana* and *P. glauca* (Comm. 4). Gently sloping seepage sites are colonized by *Picea mariana/ Sphagnum* (Comm. 5). Morainal deposits on the valley floor are well drained and support open stands of mature *Picea glauca* with a well-developed lichen groundcover (Comm. 3) (Photo 5). A tundra-like landscape occurs to a limited extent on poorly drained north-facing terraces, colonized by *Ledum groenlandicum, Betula glandulosa, Carex* spp., and *Eriophorum*. Successional riparian vegetation (*Alnus incana, Salix* spp., *Populus balsamifera*)(Comm. 9) colonizes active alluvial sites; mature *Picea glauca/ Hylocomium* (Comm. 1) establishes on stable alluvial sites near the Klondike River. Well-drained sites extending up the valley sides to treeline are characterized by an open canopy of *Picea glauca*, with an understory of *Betula glandulosa* and *Salix* spp. (Comm. 2).

9. Snowy Range Ecosection

Physiography

The ecosection is composed of mountains of modest relief and elevation. The basal elevations of valley systems within the ecosection are at 1,200 metres above sea level. The highest ridges are approximately 2,000 metres above sea level. Mount Labbe, Mount Chisholm and Mt. Robert Service are the largest peaks. All have cirque development and/or rock glaciers on their north-facing aspects. The general character of the landscape is rounded except for the highest cirque headwalls.

Surficial geology

Most of the ecosection is underlain by quartzite. The western border of the ecosection is underlain by schist. Most slopes are covered by colluvium of local bedrock origin. There are a number of large landslide deposits on the upper slopes of Mt. Chisholm. Valley bottoms and lower slopes are mantled with a complex mixture of morainal deposits attributed to both the Reid and McConnell Glaciations; higher elevations supported cirque glaciers during the McConnell Glaciation.

Photo 6. ***Typical rounded lobate forms of a well developed rock glacier. Below the surface cover of angular rock fragments is an ice core. Flowage of the internal ice produces the lobate forms visible in the foreground of this photo. A second smaller rock glacier is visible spreading onto the valley floor in the distance.***

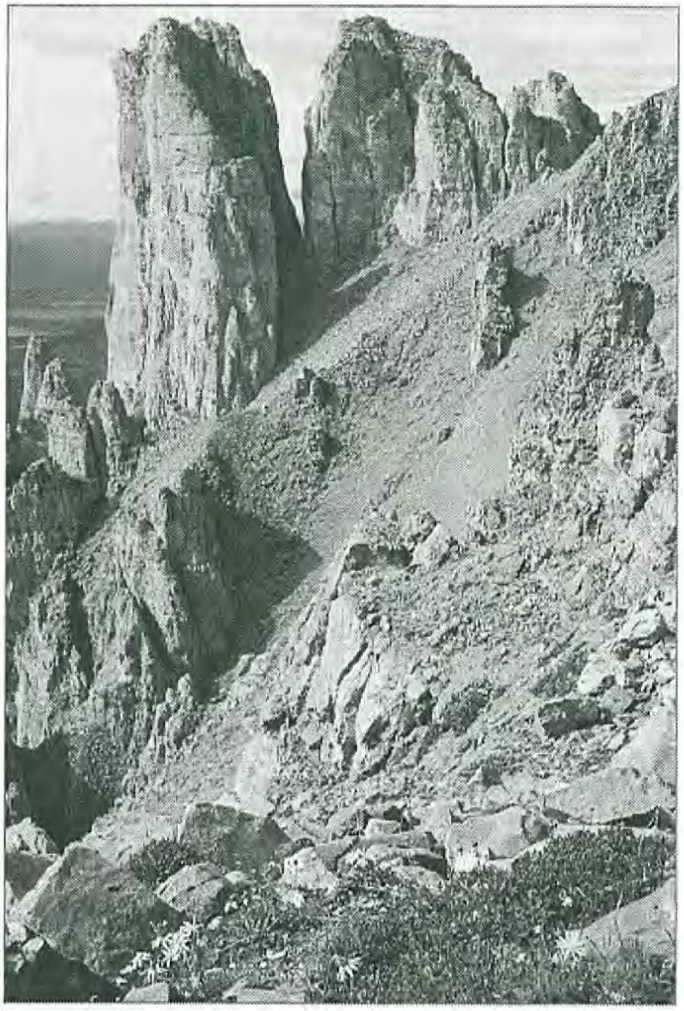
Soils

Steep slopes are composed of coarse colluvium of slightly acidic reaction (Regosols and Dystric Brunisols). Lower slopes are blanketed by soils (Turbic Cryosols) with thick organic deposits that are poorly to imperfectly drained and are underlain by near-surface permafrost. Highest summits are without soil formation, being simply rock outcrops.

Vegetation

Rocky, high elevation sites in this ecosection generally appear unvegetated; however, these rock outcrops and talus slopes on summits and exposed ridges are covered with lichens and scant mosses and herbs (Comm. 25). Shrublands colonize most mountain slopes, with *Betula glandulosa* and *Salix* spp. the predominant species (Comm. 12). Exposed ridges and knobs are colonized by groundshrubs, *Dryas*, graminoids and forbs (Comm. 19, 23). Sites with late snowmelt host communities of *Cassiope tetragona* (Comm. 20, 21).

Photo 7. ***Tors on Sheep Mountain, Prospector Range Ecosection. Ridgetop and ridgecrest crags like these are easily visible from the Dempster Highway. These rocky peaks are associated with physical weathering of rock and subsequent removal by periglacial processes but not by glaciers.***



10. Prospector Range Ecosection

Physiography

The ecosection is characterized by mountain ranges of modest elevation and relief intersected by very broad valleys with level floors up to two kilometres wide. Mt. Chester Henderson is the highest peak at 2,100 metres above sea level. Valley floors are at 1,200 to 1,250 metres above sea level. Some north-facing summits of the major massives in the ecoregion show evidence of multiple cirque glaciation.

Surficial geology

The ecosection is crossed by numerous bedrock formations of varied character. The southern portion of the ecoregion is underlain by Mesozoic quartzites and schists. However, further to the north, Palaeozoic volcanic and quartzite formations predominate. The volcanic rock has a characteristic pattern of erosional remnant outcrops (tors) and common solifluction lobes. Cirques within the quartzite rock often show large accumulations of coarse rubble. In some cases, rock glaciers are present (Photo 6). Valleys were glaciated to a limited extent during the McConnell Glaciation, leaving numerous lateral and terminal moraines inset into older Reid-aged deposits. The patterns of multiple glaciations are a predominant feature of the ecosection along West Hart River and Yakamaw Creek.

Soils

Soils formed on glacial drift in valley bottoms are all underlain by near-surface permafrost (Turbic Cryosols). On slopes, the geologic parent materials control the nature of the soils such that they may be coarse and somewhat acidic in reaction (Dystric Brunisols) or fine-textured and neutral in reaction, with permafrost often present (Turbic Cryosol, Static Cryosol). Periglacial processes are important in soil formation and rock weathering along ridge tops in the ecosection (Photo 7).

Vegetation

This ecosection is almost entirely untreed. At its lowest elevation, the ecosection extends down into tributary valleys, where a community of scattered *Picea glauca* with an understory of *Betula glandulosa* and *Salix* spp. (Comm. 2) establishes. The remaining landscape is vegetated by low and dwarf shrub, graminoids, mosses and lichens. Talus slopes are common, vegetated by crustose lichens and scant mosses and herbs (Comm. 25).

In this alpine environment, vegetation communities can change frequently over short distances, depending on moisture, exposure, soil development and insolation. Moister sites support communities of *Cassiope tetragona* (Comm. 20, 21) and *Carex* spp. and *Salix phlebophylla* (Comm. 23); communities of *Betula glandulosa, Salix* spp., *Dryas, Vaccinium vitis-idaea, Arctostaphylos rubra, Vaccinium uliginosum*, graminoids, forbs, mosses and lichens develop on well-drained colluvial sites (Comm. 17, 19, 22, 23).

11. North Fork Pass Ecosection

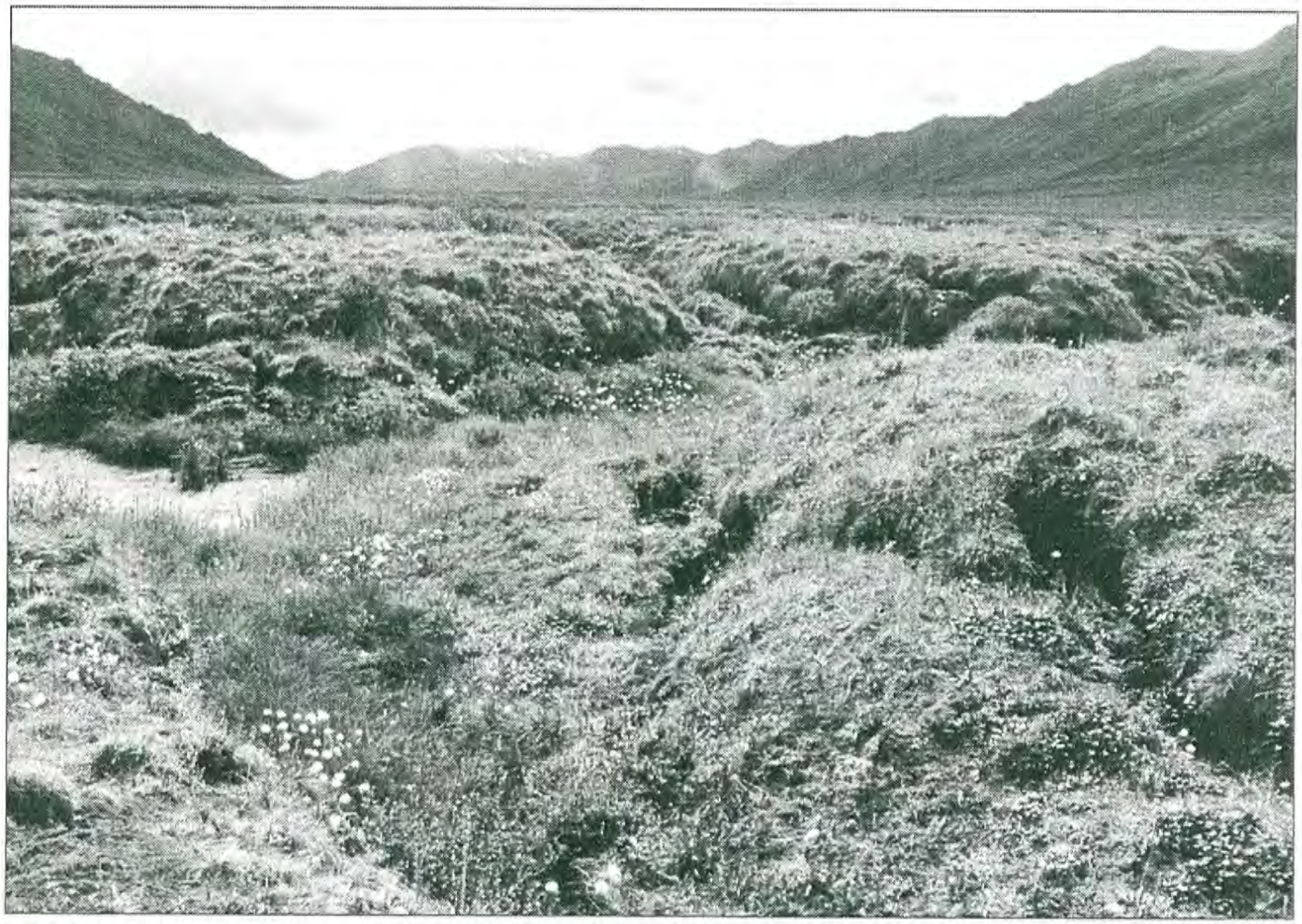
Physiography

The ecosection covers the valley systems of the headwaters of the East Blackstone River. This northward-flowing river marks the point where the Dempster Highway first enters the Arctic watershed. The valley floor lies 1,100 to 1,250 metres above sea level. Physiographically, it is similar to the Blackstone Valley Ecosection. The main valley and its tributaries are wide (up to two kilometres), with a broad U shape. The expanse of tundra vegetation through this ecosection is an important natural feature of the inventory area.

Surficial geology

This valley section cuts through a series of Palaeozoic rock types including argillite, quartzite and volcanic breccia and agglomerate. The underlying bedrock is exposed on the upper slopes of the valley walls. At least two ages of glacial drift are present along the valley floor, as well as recent alluvial and side-slope colluvial deposits. The glacial materials are of a mixed lithology. The upper reaches of the tributary valleys were glaciated during the McConnell Glaciation, while the main valley of the East Blackstone was last glaciated during the Reid Glaciation. There are large aufeis features in the river floodplain.

Photo 8. ***Ditch-like troughs up to a metre deep have formed on this previously level tundra landscape as the result of the melting of ground ice (ice wedges). The resultant irregular topography is referred to as thermokarst terrain. The melting was triggered by highway construction in 1984 that disrupted the delicate thermal balance in the soil.***



Hummocky sections of the valley floors mark former limits of Pleistocene glaciers. The hammerhead-shaped McConnell terminal moraine emanating from the headwaters of the East Blackstone River in the Cloudy Range west of the Dempster Highway is a predominant natural feature of the ecosection (Map 5). Permafrost is continuous throughout the valley bottom and many of the valley sediments are rich in ground ice. This ground ice, in the form of ice wedges, has been exposed along a number of locations adjacent to the Dempster Highway. Some of the ice wedges are melting to create pronounced thermokarst landform features (Photo 8).

Soils

The soils of the valley bottoms are all underlain by ice-rich permafrost. Sedge tussocks and shrub vegetation cover an extensive network of ice wedge polygons (Photo 9). Ice mounds, palsas and thermokarst features are present. The soils all have permafrost within one metre of the surface and are strongly frost churned (Turbic Cryosols). The soils are slightly acidic and surfaces are rich in organic matter. Alluvial fans are common and composed of gravel. Older surfaces tend to be covered by an eolian veneer of silt-sized particles. Only soils on steep (exceeding 30 percent) south-facing slopes are free of permafrost (Brunisols).

Vegetation

This ecosection is generally untreed, due to cold air drainage, cold soil temperatures and soil drainage restricted by permafrost. Extensive areas of *Eriophorum* tussocks and *Sphagnum* hummocks occur on broad valley bottoms, giving the ecosection a visual appearance similar to the Yukon's north slope. Both high- and low-centre polygons occur, the former being most common. Polygon centres are typically colonized by sedge tussocks, ericaceous shrubs (*Ledum groenlandicum, Vaccinium uliginosum), Sphagnum*, mosses and lichens (Comm. 13, 14); alternatively, the centres are colonized by low-shrubs dominated by *Ledum groenlandicum* and *Betula glandulosa*, with a groundcover of *Sphagnum* and *Rubus chamaemorus* (Comm. 18). The ice wedge channels between both types of polygons are colonized by *Salix, Carex* and mosses (Comm. 10).

Sites with better drainage support medium- to tall-shrub communities of *Betula glandulosa/Cladina* (Comm. 15), *Betula glandulosa-Salix* with scattered *Picea glauca* on higher slopes (Comm. 2) and *Salix/Festuca* (Comm. 11). Well-drained morainal landforms (such as glaciofluvial outwash) support a low-shrub community dominated by *Betula glandulosa, Vaccinium vitis-idaea* and *Empetrum nigrum*.

12. Blackstone Range Ecosection

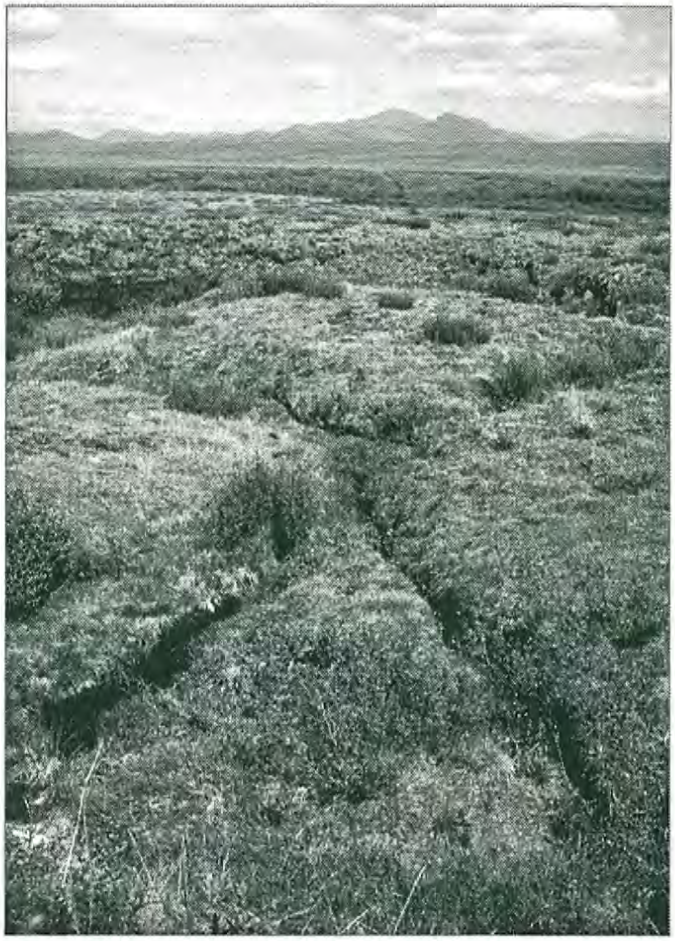
Physiography

The Blackstone Range is a rugged range of mountain peaks and headwater valleys draining into the East Blackstone and the Blackstone Rivers. The tallest peaks are up to 2,000 metres above sea level. There are numerous cirque basins in the northern portion of the ecosection. The volcanic rocks which border Foxy Creek and Austin Pass are associated with spectacular solifluction lobes and tors.

Surficial geology

The Blackstone Range Ecosection is composed of the same bedrock types as the Prospector Range. Quartzite is most common in the southern portion of the ecosection, volcanic rocks dominate the central portion of the ecosection, and argillites and shales are most common

Photo 9. ***Polygonal troughs visible in the foreground are the expression of underlying ice wedge polygons that commonly underlie most of the tundra on the valley floor of the North Fork Pass Ecosection. Melting of the ice wedge polygons produces thermokarst terrain, as illustrated in Photo 8.***



along the northern edge of the range. Other than Foxy Creek, where moraine of McConnell age is present, most valleys are covered by deposits attributable to the Reid Glaciation. The northern limit of the ecosection is marked by a prominent Reid glacial limit.

Soils

The highest peaks are composed of rock rubble except for the argillite formations in which fine-textured colluvial deposits produce dark-coloured, silty soils at higher elevation (Turbic Cryosols). Soils on steep slopes tend to be well drained and without permafrost. Lower slopes and small valleys tend to have soils that are of higher moisture regime. Thicker, peaty, surface cover insulates the ground and promotes permafrost development (Turbic and Organic Cryosols). Coarse colluvium is the most common parent material in the ecosection. The soils associated with this parent material are well drained and of acidic reaction (Dystric and Eutric Brunisols).

Vegetation

Trees are uncommon due to climatic limitations of altitude. At treeline, *Betula glandulosa-Salix* communities dominate, with scattered *Picea glauca* occurring as low trees (Comm. 2). At higher elevations, a low-shrub community of prostrate willows and *Dryas* predominates (Comm. 19). Extensive rocky peaks, knobs, outcrops and talus slopes are colonized by crustose lichens, scattered herbs, graminoids and lichens.

NATURAL FEATURES


Aconitum delphinifolium

The natural features observed in the inventory area by ecosection are listed in Table 2. The features listed are primarily geomorphological features associated with the environment of the southern Ogilvie Mountains. They are grouped by glacial, periglacial or geological origin. Definitions of the terminology used to describe these features follows those given in Permafrost Subcommittee, 1988. Definitions for the natural features listed in Table 2 are presented in Table 3.

Locations of outstanding natural features are an important consideration in the planning of park boundaries. Three broad groups of ecosections tend to share similar natural features. The Blackstone Valley and North Fork Pass Ecosections are broad valleys trending northward that are covered by tundra vegetation and underlain by widespread discontinuous permafrost. They are dominated by permafrost and periglacial features. The Upper Chandindu, Lower Chandindu and North Klondike Valleys are all forested valleys trending southward that have features associated with landforms, (colluvial and alluvial fans, and moraines). The mountainous ecosections (i.e. Seela Range, West Chandindu Range, North Klondike Range, Cloudy/ Tombstone Range, Snowy Range, Prospector Range, and Blackstone Range) show tremendous glacial features (cirques, tarns, rock glaciers) and to a lesser extent, periglacial features such as solifluction and sorted patterned ground.

Table 2. ***Summary table of occurrence of natural features in the Tombstone Inventory Area, listed by ecosection, and grouped into periglacial, glacial, and other features. ✓ indicates occurrence of a feature and ● indicates the predominant feature observed in each ecosection during the field reconnaissance.***

	Blackstone Valley	Upper Chandindu Valley	Seela Range	West Chandindu Range	Lower Chandindu Valley	North Klondike Range	Cloudy/ Tombstone Ranges	North Klondike Valley	Snowy Range	Prospector Range	North Fork Pass	Blackstone Range
PERIGLACIAL FEATURES												
Pingos	●										✓	
Thermokarst features	✓	✓			✓	✓		✓			✓	
Ice wedge polygons	✓	●			✓	✓		✓			✓	
Solifluction			●	✓		✓	✓		✓	✓		●
Cryoplanation terraces						●						
Sorted patterns			✓	✓		✓	✓		✓	✓		✓
Nonsorted patterns	✓	✓			✓			✓			✓	
Pediments			✓			✓						
GLACIAL FEATURES												
Tors			✓	✓		✓	✓		✓	●		✓
Rock glaciers				✓			✓		●	✓		✓
Moraines	✓	✓	✓	✓	✓	✓	✓	●	✓	✓	●	✓
Cirques (old)			✓	✓		✓	✓		✓	✓		✓
Cirques (young)			✓	●		✓	✓		✓	✓		✓
Tarns			✓	✓		✓	✓		✓	✓		✓
OTHER FEATURES												
Rock spires				✓			●		✓			
Colluvial fans		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Alluvial fans	✓	✓			●			✓			✓	
Aufeis	✓	✓						✓			✓	

ASSESSMENT OF GEOGRAPHIC DISTRIBUTION OF NATURAL FEATURES

Periglacial features are landform features that are attributable to intense freeze-thaw action associated with permafrost environments. Open system pingos (Hughes 1969) are found occasionally in north and central Yukon. The pingos of the Blackstone Valley Ecosection are unique, due to their location and their size. Ice wedge polygons are very common in permafrost environments; these are well expressed in the Upper Chandindu and also the North Fork Pass Ecosections. Solifluction lobes, a feature of slope mass movement over a permafrost table, are very well expressed in the Seela and Blackstone Range Ecosections. Cryoplanation terraces and summits are particularly prominent in the North Klondike Range Ecosection.

There are many features that are attributable to glacial formation, movement and deposition. The inventory area is unique in that both Reid and McConnell Glaciations are evident in many of the valley ecosections and are particularly well expressed in the North Fork Pass Ecosection. Multiple terminal moraines and tarns are evidence of the numerous glaciations known to have occurred throughout the Pleistocene. The existence of multi-aged cirque basins within one mountain range is unique to this inventory area in the Yukon. This situation is well exhibited in the West Chandindu Range Ecosection. Rock glaciers are found in a number of mountain range ecosections but one large rock glacier is present in the Snowy Range Ecosection.

The rock spires of the Cloudy/Tombstone Ranges Ecosection, the large alluvial fans of the Lower Chandindu Valley Ecosection and the prominent aufeis features of the North Fork Pass Ecosection are exceptional natural features of the inventory area.

The entire inventory area is comprised of a wide range of periglacial, glacial and related features of note. There are few other areas of the Yukon that provide such a varied and diverse set of natural features in such concentration as in this inventory area. Boundary selection will impact the type and diversity of natural features protected. No one ecosection contains all of the features of the inventory area. Protecting the widest range of natural features would necessitate including both the mountain range and valley types of ecosections. Similarly, no one mountain range ecosection contains all of the features of mountain ranges.

The Cloudy/Tombstone Ranges Ecosection is the most unique and spectacular in the inventory area and would logically form the core of any protected area. The surrounding ecosections provide the diversity of landscapes to best exemplify the ecology of the western portion of the Mackenzie Mountains Ecoregion.

Photo 10. ***The bowl-like depressions, referred to as cirques, are formed by alpine glaciers which previously occupied the depressions. The small lake in the foreground is called a tarn.***

Table 3. Definitions of natural features described in the Tombstone Inventory Area.

ALLUVIAL FAN
Cone-shaped accumulation of alluvium.

ALLUVIUM
A general term for clay, silt, sand, gravel or similar unconsolidated material deposited during recent geological time by running water on a fan, stream bed, floodplain(s) or delta.

AUFEIS
Ice formed during winter by freezing of groundwater or river water thick enough to persist through the summer to form a perennial feature; sheets of ice formed by the freezing of overflow water. Synonym of icing.

CIRQUE
Semicircular basin in an alpine landscape resulting from mountain glaciation; progressive expansion of neighboring cirques results in the reduction of the unglaciated slopes between them to sharp, knife-edged ridges or arêtes.

COLLUVIAL FAN
Cone-shaped accumulation of colluvium.

COLLUVIUM
A heterogeneous mixture of materials which has reached its present position due to direct, gravity-induced movement; coarse colluvium is associated with steep slopes, rock slabs and large fragmented pieces of bedrock; fine colluvium is associated with gentle slopes on or adjacent to the valley floor.

CRYOPLANATION TERRACE
A level to nearly level bench near or on mountain summits in periglacial areas and usually covered by block fields and backed by a rocky bluff.

FAN
A sloping accumulation of detritus forming a section of a low cone, commonly where there is a notable decrease in gradient of streams and debris chutes as they reach the feet of mountain and hill slopes.

MORAINE
(1) An accumulation of glacial materials, primarily till, deposited directly by glacial ice and having a variey of relief forms, including: ground moraines (till sheets); terminal, lateral and interlobate moraines (elongated mounds or ridges marking the edge of an ice sheet); (2) Any unsorted, unstratified glacial deposit; debris deposited directly by a glacier without appreciable water sorting; may contain boulders, gravel, and, and clay mixed together.

PEDIMENT
A broad, smooth, gently sloping bedrock erosion surface or plain, developed mainly by running water, at the base of a mountain front. Pediment formation takes long periods of time and are thus characteristic of unglaciated areas.

PINGO
An Inuit term for a perennial, conical-shaped, ice-cored mound of earth formed in a periglacial environment; may measure as much as 65 metres high and 1,000 metres in diameter. Most commonly found on the arctic coastal plain, but open-system pingos also occur in subarctic regions.

POLYGONS
One of the forms of patterned ground characteristic of earth underlain by permafrost and subject to intensive frost action.

Ice wedge polygons: Polygons bounded by ice wedges. Large-scale polygonal features (up to 10 metres in diameter) commonly outlined by shallow trenches underlain by ice wedges.

Nonsorted polygons: Patterned ground whose mesh is dominantly polygonal and with a nonsorted appearance due to the absence of a border of stones or coarse materials such as that characterizing sorted polygons.

Sorted polygons: Patterned ground whose mesh is dominantly polygonal and with a sorted appearance due to a border of stones or coarse material surrounding finer material.

ROCK GLACIER
A tongue-like body of angular boulders, resembling a small glacier, generally occurring at high altitudes in rugged terrain and heading out of a cirque or steep walled amphitheatre.

ROCK SPIRE
Nearly vertical exposure of bedrock face or column associated with ridge tops or mountain summits.

continued...

Table 3. continued

SOLIFLUCTION Downslope movement ("flowing soil") of earth materials resulting from frost action characteristic of areas underlain by near-surface permafrost. A potent agent of mass-wasting, more effective than those generally operating in temperate regions, solifluction produces contorted soil profiles and modifies the development of plant cover.	TARN Small lake occupying the bottom of a cirque basin. THERMOKARST A permafrost related landscape characterized by a peculiar topography of pits, hummocks, depressions, and small ponds caused by the melting of ground ice and the settling or caving of the ground surface.	TOR Isolated mass of bedrock composed of either a single or numerous joint blocks standing above unaltered bedrock and the surrounding terrain; tors usually contain numerous blocks piled one upon the other forming castellated piles or fingers of rock; an isolated valley-side crag or rocky peak, often assuming fantastic shapes; associated with deep weathering of adjacent rock and subsequent exhumation by periglacial processes but not removed by glaciers.

VEGETATION COMMUNITIES

Woodsia ilvensis

A wide range of vegetation communities, encompassing vegetation as diverse as mixed coniferous/deciduous treed stands to *Eriophorum* cottongrass tussocks, are established throughout the inventory area. Twenty-five communities are described, grouped into five physiognomic classes, listed below. The name assigned to each community is based on floristic dominance of the overstory and understory species.

Table 4. ***Vegetation communities listed by physiognomic class.***

TREED vegetation communities	**MEDIUM-TALL SHRUB vegetation communities**	**LOW SHRUB vegetation communities**	**GRAMINOID vegetation communities**
1. *Picea glauca/ Hylocomium*	9. *Alnus crispa-Populus balsamifera/Epilobium*	16. *Rhododendron/Cetraria*	23. *Carex/Salix phlebophylla*
2. *Picea glauca/Betula-Salix*	10. *Salix/Carex*	17. *Betula/Cassiope*	24. *Eriophorum/Cassiope*
3. *Picea glauca/Cladina*	11. *Salix/Festuca*	18. *Betula-Ledum/ Eriophorum*	**LICHENS vegetation communities**
4. *Picea glauca-Picea mariana/Hylocomium*	12. *Salix-Betula/Dryas*	19. *Salix reticulata/Dryas*	25. *Umbilicaria/Draba*
5. *Picea mariana/ Sphagnum*	13. *Betula-Ledum/ Eriophorum/(Picea mariana)*	20. *Cassiope/Dryas*	
6. *Picea mariana/Cladina*	14. *Betula-Salix/Eriophorum*	21. *Cassiope/Carex*	
7. *Populus tremuloides/ Festuca*	15. *Betula/Cladina*	22. *Salix arctica/Dryas/ Artemisia*	
8. *Betula papyrifera-Picea glauca /Hylocomium*			

Table 5. ***Summary table of vegetation community descriptions, associated terrain descriptions and sampling site distribution in the Tombstone Inventory Area.***

Vegetation community and sampling sites	Vegetation description	Terrain description
TREED		
Community 1 ***Picea glauca/Hylocomium splendens*** White Spruce/Feathermoss Sites 13, 20, 26	Open tree canopy comprised of mature *Picea glauca*; *Salix* spp. and *Betula glandulosa* dominate a sparse medium-tall shrub understory; low shrubs include *Rosa acicularis* and *Ledum groenlandicum;* a continuous and well-developed moss groundcover (dominated by *Hylocomium splendens*) supports a few sparse groundshrubs such as *Salix reticulata*, and *Empetrum nigrum*; forbs are diverse; *Equisetum* is typically present.	Establishes on lower slopes and level alluvial sites on valley floors; soils medium to coarse textured and moderately to well-drained (Regosols and Brunisols); may be subject to periodic flooding.
Community 2 ***Picea glauca/Betula-Salix*** White Spruce/Shrub Birch-Willow Sites 6, 32	Very sparse canopy of low tree *Picea glauca*; well-developed understory of low-medium shrubs, including *Betula glandulosa, Salix* spp., *Ledum groenlandicum* and *Vaccinium uliginosum*; groundcover comprised of mosses and groundshrubs such as *Salix reticulata, Arctostaphylos alpina* and *Empetrum nigrum*; forbs, graminoids and lichens present, but often sparse.	Occurs at treeline on upper tributary drainages, typically on moderately steep slopes with a south-facing aspect; loamy to gravelly soils which are moderately well to imperfectly drained (Brunisols/Cryosols).

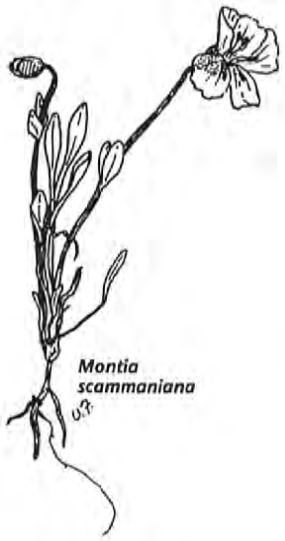
Vegetation community and sampling sites	Vegetation description	Terrain description
TREED (continued)		
Community 3 ***Picea glauca/Cladina stellaris*** White Spruce/Lichen Site 23	*Picea glauca* dominant throughout the tree and shrub understory, characteristically of very low species diversity; *Betula glandulosa* and *Ledum groenlandicum* are common; a continuous lichen groundcover comprised mainly of *Cladina stellaris* is diagnostic; groundshrubs include *Empetrum nigrum* and *Vaccinium vitis-idaea*; forbs and graminoids absent or extremely sparse.	Establishes on valley bottoms at low elevations; sites are comprised of coarse-grained materials of fluvial or glaciofluvial origin; soils are well to rapidly drained Brunisols.
Community 4 ***Picea glauca-Picea mariana/ Hylocomium splendens*** White Spruce-Black Spruce/ Feathermoss Sites 12, 40	*Picea glauca* and *Picea mariana*, of varying dominance, comprise an open tree canopy and are both present throughout the understory; ericaceous shrubs (such as *Ledum groenlandicum* and *Vaccinium uliginosum), Salix* spp., *Betula glandulosa* and *Rosa acicularis* are commonly present. Lichens or mosses (including *Sphagnum* spp.) dominate the groundcover, depending on the moisture regime	Establishes on broad valley floors at lower elevations, on sites of fluvial or glaciofluvial origin; drainage is variable: finer textured soils are imperfectly drained and permafrost is probable (Turbic Cryosols); coarser textured soils are moderately well drained.
Community 5 ***Picea mariana/Sphagnum*** Black Spruce/Sphagnum Sites 22, 39	*Picea mariana* dominant throughout a sparse tree and shrub understory; *Betula glandulosa, Salix* spp., *Ledum groenlandicum* and other low ericaceous shrubs are typical; extensive moss groundcover (including *Sphagnum* spp.) usually present; lichens sparse.	Establishes on imperfectly drained, finer textured soils of alluvial, glaciofluvial or morainal origin; permafrost is characteristic of these soils (Turbic Cryosols), situated on seepage slopes and valley bottoms.
Community 6 ***Picea mariana/Cladina stellaris*** Black Spruce/Lichen Site 43	*Picea mariana* comprises an open tree canopy and occurs throughout the understory; *Betula glandulosa, Salix* spp., *Ledum groenlandicum* and *Vaccinium uliginosum* dominate the shrub layers; ericaceous groundshrubs are common; feathermoss is overlain with extensive cover of foliose lichens.	Establishes on well-drained sites at lower elevations; surficial materials are coarse or rubbly textured, of glacial or fluvial origin; soils classified as Brunisols.
Community 7 ***Populus tremuloides/Festuca altaica*** Aspen/Fescue Site 10	*Populus tremuloides* dominant in the tree and shrub overstory; low shrub and groundshrub layers notably diverse and robust; *Betula glandulosa, Rosa acicularis, Juniperus communis* and *Arctostaphylos uva-ursi* are typically present; forbs also diverse; lichen and moss layer poorly developed due to leaf litter.	Typically established on steep slopes with south-facing aspects at lower elevations; soils are comprised of coarse-grained materials which are well-drained (Eutric Brunisols).
Community 8 ***Betula papyrifera-Picea glauca/Hylocomium*** Paper Birch-White Spruce/ Feathermoss Sites 38, 44	Both tree canopy and shrub understory are dense and diverse; species include *Betula papyrifera, Populus tremuloides, Picea glauca, Populus balsamifera, Salix* spp. and *Betula occidentalis*; groundshrubs are common; forbs are diverse and robust; feathermoss dominates the groundcover.	Establishes on gentle to steeply sloping sites at lower elevations; soils (Brunisols) are comprised of well-drained materials of colluvial or glacial origin.

Vegetation community and sampling sites	Vegetation description	Terrain description
MEDIUM-TALL SHRUB		
Community 9 ***Alnus crispa-Populus balsamifera/Epilobium*** Alder-Balsam Poplar/Fireweed Site 42	An early successional riparian community with a low tree canopy comprised of *Alnus incana, Populus balsamifera* and *Salix* spp., which occur throughout the shrub understory; groundshrubs, moss and lichen layers poorly developed; forbs numerous and diverse.	Develops on floodplains of major rivers and their tributaries at lower elevations; site materials range from fine-grained silts to coarse sands and gravels; drainage is moderate to well-drained; soils are Regosolic.
Community 10 ***Salix/Carex*** Willow/Sedge Sites 1, 4, 34, 35	A riparian or wetland vegetation community with a moderate to dense overstory of low or medium height *Salix* spp.; understory of *Carex* spp. and other graminoids; forbs diverse, but sparse; groundcover is dominated by mosses, commonly includes *Sphagnum* sp.	Establishes along creek drainages and lake margins, over a broad elevation range; soils vary in texture and drainage from well to imperfectly; generally classified as Cryosols.
Community 11 ***Salix/Festuca*** Willow/Fescue Site 36	Overstory of tall and medium shrub *Salix* spp.; other shrubs scant and low in diversity; forbs diverse and robust; *Festuca altaica* is the dominant graminoid; well-developed moss groundcover.	Occurs from low to mid elevations, on level or gently sloping sites; soils are moderately well-drained and classified as Turbic Cryosols.
Community 12 ***Salix-Betula/Dryas*** Willow-Shrub Birch/*Dryas* Site 8, 17	*Salix* spp. and *Betula glandulosa* dominate the shrub overstory; low ericaceous shrubs and groundshrubs common; *Dryas* typically present; variable groundcover of feathermosses, lichens and graminoids.	Established on well-drained soils with permafrost at one to two metres depth (Turbic Cryosols); occurs over a broad elevation range, often forming extensive cover on colluvial or morainal materials on gentle slopes and broad valleys in mountainous ecosections.
Community 13 ***Betula-Ledum/Eriophorum/ (Picea mariana)*** Shrub Birch-Labrador Tea/ Cottongrass (Black Spruce) Site 11	Sparse overstory of low shrubs is dominated by *Betula glandulosa* and *Ledum groenlandicum; Picea mariana* may be present; ericaceous groundshrubs are abundant in depressions between tussocks of *Eriophorum vaginatum; Rubus chamaemorus* is dominant forb; *Sphagnum* is diagnostic in a well-developed moss layer; lichens also present.	Develops on gently sloping pediments at low elevations; fine to medium textured soils (Turbic Cryosols) are imperfectly to moderately drained; frost boils common, indicating near-surface permafrost and active cryoturbation.
Community 14 ***Betula-Salix/Eriophorum*** Shrub Birch-Willow/ Cottongrass Site 33	Dense medium shrub overstory dominated by *Betula glandulosa*; other shrubs include *Salix* spp. and *Ledum groenlandicum*; well-developed tussocks of *Eriophorum vaginatum*; forbs include *Petasites frigidus* and *Rubus chamaemorus; Sphagnum* is diagnostic and dominant in the moss layer; numerous foliose lichens present.	Establishes on morainal deposits blanketing lower slopes and broad valley bottoms at mid-elevations; soils (Turbic Cryosols) are imperfectly drained.

Vegetation community and sampling sites	Vegetation description	Terrain description
MEDIUM-TALL SHRUB (continued)		
Community 15 ***Betula/Cladina*** Shrub Birch/Lichen Sites 21, 35	Dense overstory of medium-tall shrubs is dominated by *Betula glandulosa*, with *Salix* spp. consistently present; other low ericaceous shrubs are present; scant conifers may also occur; forbs and graminoids scarce; lichen groundcover is continuous and diverse, over a layer of feathermoss.	Establishes on well-drained sites over a broad elevation range, typically on gentle slopes of colluvial or morainal material; soils classified as Turbic Cryosols.
LOW SHRUB		
Community 16 ***Rhododendron/Cetraria*** Rhodendron/Lichen Site 28	*Rhododendron lapponicum* is diagnostic in a diverse overstory of low shrubs; forbs are also notably diverse, but scant; species-rich lichen strata comprises the dominant groundcover.	Typically establishes on bedrock knobs and outcrops slightly elevated above valley floors of major rivers; sites are well-drained.
Community 17 ***Betula/Cassiope*** Shrub Birch/Heather Sites 2, 15, 18, 25, 31	Well-developed low shrub overstory is dominated by *Betula glandulosa*; other shrubs include *Cassiope tetragona, Vaccinium uliginosum* and *Salix* sp.; forbs, graminoids and mosses are notably scant; extremely well-developed and diverse groundcover of foliose lichens.	Develops on coarse textured soils at mid to high elevations; soils (Turbic Cryosols) are well-drained, often formed on surficial materials of glacial origin.
Community 18 ***Betula-Ledum/Eriophorum/ Sphagnum*** Shrub Birch-Labrador Tea/ Cottongrass/*Sphagnum* Sites 5, 19, 30, 37	Low and medium shrub overstory comprised of *Betula glandulosa* and *Ledum groenlandicum*; other low ericaceous shrubs also present; *Rubus chamaemorus* comprises most of a low diversity forb layer; *Eriophorum* present; *Sphagnum* is diagnostic in the moss cover; lichens are diverse and well-developed.	A strongly mounded, hummocky landscape, comprised of peat, developed on level to very gently sloping valley bottoms at higher elevations with cold air drainage; permafrost is present; soil drainage is poor (Organic Cryosols).
Community 19 ***Salix reticulata/Dryas*** Netted Willow/*Dryas* Sites 9, 16	A groundshrub/forb community dominated by *Salix reticulata*; forbs and graminoids are extremely well-developed; *Dryas* is the main ground-covering forb; mosses and lichens are sparse.	Establishes extensive groundcover on solifluction slopes in mountainous regions; aspect is typically south-facing; soils (Turbic Cryosols) are imperfectly drained, comprised of loamy materials of colluvial origin.
Community 20 ***Cassiope/Dryas*** Heather/*Dryas* Site 24	A low shrub overstory of *Cassiope tetragona*, with a groundcover of *Dryas octopetala* comprises the main vegetation; graminoids and lichens are scant; mosses establish in hollows; much of the ground remains unvegetated.	Establishes at high elevations on moderate to steep slopes with north-facing aspects; parent material is typically talus or rubble of colluvial origin, such as occurs on rock glaciers; drainage is rapid.

Vegetation community and sampling sites	Vegetation description	Terrain description
LOW SHRUB (continued)		
Community 21 ***Cassiope/Carex*** Heather/Sedge Site 14	Low shrub canopy dominated by *Cassiope tetragona* and *Phyllodoce empetriformis*; ericaceous groundshrubs and forbs comprise a dense and continuous groundcover; graminoids are also well represented; moss layer well-developed, but lichens very sparse.	Establishes at high elevations where snow is very slow to melt, such as cirque basins and sheltered north-facing slopes; soils (Turbic Cryosols) are well-drained, comprised of material of colluvial origin.
Community 22 ***Salix arctica/Dryas/ Artemisia*** Arctic willow/*Dryas*/Sage Site 7	Ground is densely vegetated with a continuous cover of prostrate willows and diverse forbs; graminoids are well represented; bryophytes and lichens are present; bare and rocky ground is common.	Develops on steep, mountainous slopes with south-facing aspects; soils (Regosols) of colluvial origin are well-drained.
GRAMINOID		
Community 23 ***Carex/Salix phlebophylla*** Sedge/Skeleton Willow Sites 3, 27	Prostrate *Salix* spp. and a groundcover of *Carex* spp., established over a layer of mosses, dominate this vegetation community; forbs are scant; lichen cover is very diverse and continuous.	Develops at high altitudes, with severe exposures, such as summits and mountain saddles; substrate is comprised of bedrock or colluvial material which is well-drained; soils are classified as Regosols or Regosolic Cryosols.
Community 24 ***Eriophorum/Cassiope*** Cottongrass/Heather Site 29	A cottongrass tussock community dominated by *Eriophorum vaginatum*; low shrubs, such as *Cassiope tetragona* and *Salix* spp., are scant; ericaceous groundshrubs, forbs and other graminopids develop over mosses between the tussocks; *Sphagnum* is diagnostic; lichens diverse.	Establishes on gentle slopes at high elevations; medium-textured soils (Turbic Cryosols) are imperfectly to poorly drained; shallow depth to permafrost; frost boils commonly present.
LICHENS		
Community 25 ***Umbilicaria/Draba*** Lichen/*Dryas* Site 41	Lichen vegetation cover comprised of crustose and foliose species, dominated by rock-colonizing species such as *Umbilicaria*; forbs, graminoids and bryophytes established in scant amounts in sheltered hollows.	Develops on steep talus slopes with severe exposures; material is rubbly and colluvial in origin; drainage is extremely rapid.

VEGETATION SUMMARY



The inventory area hosts an abundance of habitats, rich in both species diversity and vegetation communities, due to physiography and climate. The vegetation landscape is representative of the dense and diverse boreal forest of the central and southern Yukon as well as parts of the arctic tundra of the Yukon's north slope. The rugged mountainous terrain hosts a diverse alpine flora with elements of lichens, graminoid and forb communities representative of high altitude sites in the southern, central and northern parts of the territory.

In addition to the vegetation diversity due to the physiographic setting, the Tombstone area is characterized by a high degree of endemism, and a high density of species of limited occurrence in the Yukon.

A species list of vascular plants recorded within the inventory area boundary is presented in Appendix A. This list represents collections reported in the following references: Brooke and Kojima, 1985; Cody, 1981, 1984 and 1996; Douglas, et al, 1981; Gneiser, 1997; Kennedy, 1993; Kojima and Brooke, 1985; Porsild, 1975. Species have been verified by Cody (pers. comm., 1999).

PLANTS OF SPECIAL INTEREST

In this paper, plants of special interest are considered to be those which are:

- endemic — a species which only occurs in a very specific geographic region. These plants evolved to a species or subspecies level within this geographic region.
- non-endemic but of limited distribution within the species' range in the Yukon. This range typically extends far outside the Yukon (e.g. Amphi-Beringian, Circumpolar, North America).
- at the limit of their range.

A rare taxon (or species) has been defined as one that occurs in a limited geographical area and/or in low numbers (Douglas *et al*, 1981; Argus and Pryer, 1990). Application of this definition is subjective, as a continuum of abundance occurs in nature, and information on population size is often unavailable or incomplete. The size of the geographical area is also often subjective.

The definition of rare as used in this report does not imply that a species is presently endangered or imperiled, nor does it rank a species as to its vulnerability now or in the future. It indicates a species occurs with very limited distribution as known at the present time.

Table 6 (page 32) lists vascular plants occuring in the Tombstone Inventory Area which are of limited distribution in the Yukon. Species considered rare, both endemic and non-endemic, are indicated.

Endemic species

The endemic species which occur in the inventory area are often, but not exclusively, associated with terrain in northwestern North America that remained unglaciated during the Pleistocene. This terrain, referred to as Beringia, extended across northern and central Alaska and northern and central Yukon.

However, numerous endemic species occurring in the Tombstone Inventory Area also occur in the Kluane Ranges of southwestern Yukon.

The Tombstone area hosts some endemic species which are considered rare, while other endemics are of common occurrence in their range.

Non-endemic species

There are a number of species of rare or uncommon occurrence in the inventory area which are considered rare throughout their entire range, or throughout the part of their range in the Yukon. Occurrence may be circumpolar (e.g. Greenland, Canada, Alaska, Russia); Amphi-Beringian (occurring on both sides of the Bering Strait), or North American.

Species at the limit of their range

Some species are of rare or uncommon occurrence because they occur at the limits of their geographic range. In the Tombstone Inventory Area, such species are usually at the northern limit of a population which is more common or widespread further south.

ASSESSMENT OF GEOGRAPHIC DISTRIBUTION OF VEGETATION FEATURES

To protect plant species of limited distribution as well as the diversity of vegetation communities and species within this inventory area would require inclusion of a number of different ecosections.

Numerous rare plants (both endemic and non-endemic) have been collected in the Dempster Highway corridor, in the North Klondike Valley and North Fork Pass Ecosections. The Seela Range, Blackstone Range, and Cloudy/Tombstone Range Ecosections also host sites where rare alpine endemic plants have been collected.

Limited plant collecting has taken place in most other ecosections due to the difficulty of accessing the rugged and remote terrain; new records of rare species are to be expected. As recently as 1996, a species of *Draba* was collected in the Cloudy/Tombstone Ranges Ecosection which was previously unknown to exist in the flora of the Yukon (Cody, pers. comm.; Gneiser, 1996).

The Lower Chandindu Valley and North Klondike Valley Ecosections host eight treed communities which are very representative of the boreal forest of the central Yukon. The rugged mountain ecosections (i.e. West Chandindu Range, Seela Range, Blackstone Range, Cloudy/Tombstone Range, Prospector Range and Snowy Range) all host a diversity of shrub, graminoid and lichen communities typical of high elevations. Pediments of sedge tussocks with scattered black spruce occur in the Upper Chandindu Valley Ecosection.

Parts of the Blackstone Valley and North Fork Pass Ecosections host a vegetation landscape almost indistinguishable from those of arctic latitudes, although situated in the central Yukon. The vegetation patterns and species composition of the high and low centre polygons and ice wedge channels bear a close resemblance to the sedge tussock communities of the arctic tundra of the Yukon's north slope.

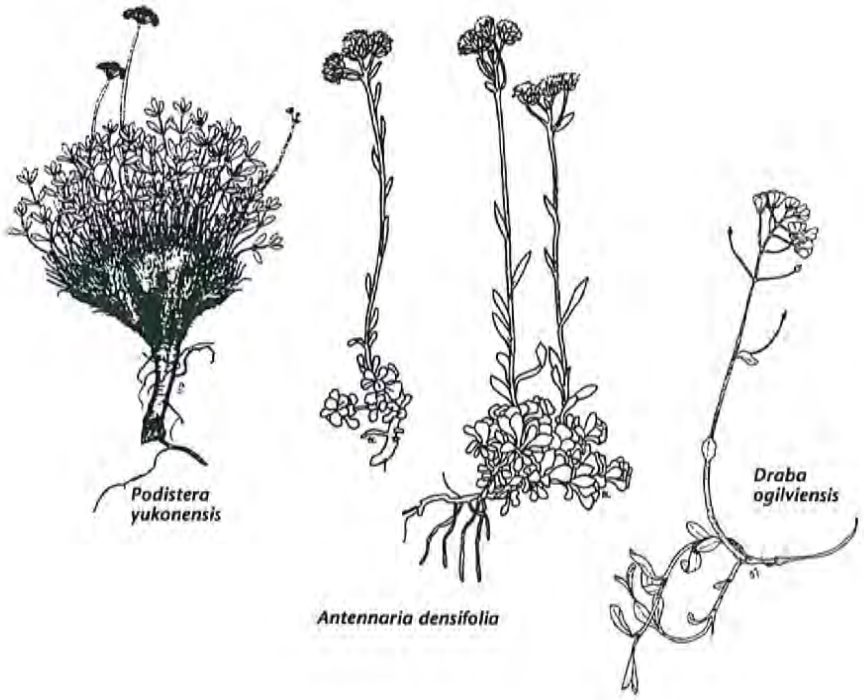
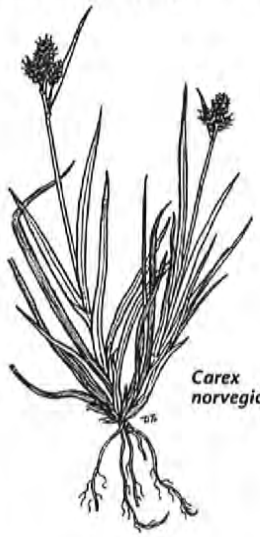
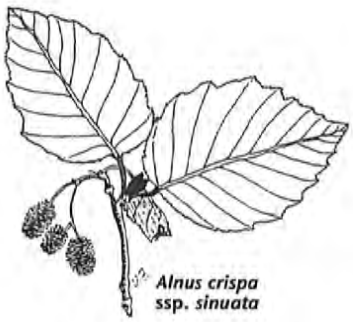


*Table 6. **Vascular plants recorded in the Tombstone Inventory Area which are of special interest due to limited distribution in the Yukon.[1] Species considered rare (Cody 1996,1999) are indicated with an asterisk*.[2]***

ENDEMIC	NON-ENDEMIC	LIMIT OF RANGE
• ***Alaska, Yukon (generally Richardson and Ogilvie mountains, Kluane Ranges) and Northwest Territories (Mackenzie Mountains)***	• ***Circumpolar***	• ***northern limit of range***
Boykinia richardsonii	**Carex bicolor*	*Alnus crispa* ssp. *sinuata* (Amphi-Beringian)
Douglasia gormanii	**Carex chordorrhiza*	*Draba crassifolia* (North America; northwest Europe)
**Draba ogilviensis*	**Carex heleonastes*	*Saxifraga adscendens* ssp. *oregonensis* (Cordilleran)
**Erigeron grandiflorus* ssp. *arcticus*	**Carex lapponica*	• ***western limit of range***
**Montia scammaniana*	**Carex livida*	*Carex norvegica* (Amphi-Atlantic)
Oxytropis nigrescens ssp. *lonchopoda*	**Carex microglochin*	
Oxytropis scammaniana	**Carex rariflora*	
Papaver mcconnellii	**Cryptogramma crispa* var. *sitchensis*	
**Phacelia mollis*	**Epilobium davuricum*	
**Podistera yukonensis*	**Erigeron uniflorus* ssp. *eriocephalus*	
Senecio hyperborealis	**Festuca vivipara* ssp.*glabra*	
Synthyris borealis	**Gymnocarpium dryopteris* ssp. *dryopteris*	
• ***North America (Yukon, Alaska, Northwest Territories, northern British Columbia, mountains of western Alberta)***	**Koenigia islandica*	
Erigeron pallens	**Pedicularis lapponica*	
	**Phippsia algida*	
• ***Cordilleran***	**Potentilla bimundorum*	
Draba macounii	**Sagina nivalis*	
	**Saxifraga nivalis*	
	**Utricularia minor*	
	**Woodsia ilvensis*	
	• ***Amphi-Beringian***	
	**Aconitum delphinifolium* ssp. *paradoxum*	
	Alyssum americanum	
	**Carex eleusinoides*	
	Chrysosplenium wrightii	
	**Draba stenopetala*	
	**Rorippa barbareifolia*	
	**Salix fuscescens*	
	• ***North American***	
	**Antennaria densifolia*	
	**Arabis exilis*	
	**Carex capillaris* ssp. *robustior*	
	**Carex williamsii*	
	**Draba densifolia*	
	**Luzula groenlandica*	


Draba macounii


Carex norvegica


Alnus crispa* ssp. *sinuata

[1] The compilation of this list is according to Cody (1996). All the species listed have been recorded at other localities in the Yukon outside of the Tombstone Inventory Area, with the exception of *Draba densifolia* (Cody, pers. comm., 1999; Gneiser, 1997).

[2] A rare species is defined in this report as one that occurs in a limited geographical area and/or in low numbers (Douglas *et al*, 1981; Argus and Pryer, 1990). This definition does not imply a ranking or status of any kind with regard to present or future vulnerability of the species or population.

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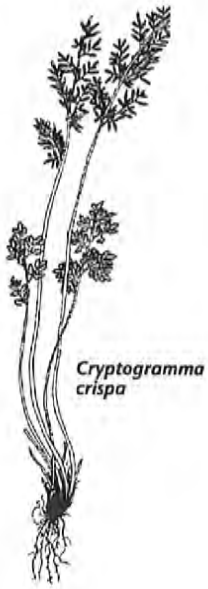
Cryptogramma crispa

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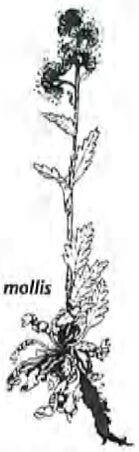
APPENDIX A


Phacelia mollis

SPECIES LIST OF VASCULAR PLANTS OCCURRING IN THE TOMBSTONE INVENTORY AREA

Nomenclature for vascular plants follows Cody (1996). This species list incorporates vascular plant records from the following sources: Brooke and Kojima (1995); Cody (1981, 1984 and 1996): Gneiser (1998); Kennedy (1993); Kojima and Brooke (1995); Porsild (1975). All specimens have been verified by Cody (pers. comm., 1999).

***Lycopodiaceae* - Club Moss Family**
Lycopodium alpinum L.
Lycopodium annotinum L. var. *pungens* (La Pylaie) Desv.
Lycopodium clavatum L. var. *monostachyon* Hook. & Grev.
Lycopodium complanatum L.
Lycopodium selago L.

***Selaginellaceae* - Spike-Moss Family**
Selaginella selaginoides (L.) Link
Selaginella sibirica (Milde) Hieron.

***Equisetaceae* - Horsetail Family**
Equisetum arvense L.
Equisetum fluviatile L.
Equisetum pratense Ehrh.
Equisetum scirpoides Michx.
Equisetum sylvaticum L.
Equisetum variegatum Schleich. ssp. *variegatum*

***Ophioglossaceae* - Adder's-Tongue Family**
Botrychium lunaria (L.) Sw.
Pteridaceae - A Fern Family
Cryptogramma crispa (L.) R. Br. var. *sitchensis* (Rupr.) C. Chr.
Cryptogramma stelleri (Gmel.) Prantl

***Aspidiaceae* - A Fern Family**
Cystopteris fragilis (L.) Bernh.
Cystopteris montana (Lam.) Bernh.
Dryopteris fragrans (L.) Schott.
Gymnocarpium dryopteris (L.) Newm. ssp. *dryopteris*
Woodsia alpina (Bolton) S.F. Gray
Woodsia glabella R. Br.
Woodsia ilvensis (L.) R. Br.

***Cupressaceae* - Cypress Family**
Juniperus communis L. ssp. *alpina* (Neilr.) Celak.

***Pinaceae* - Pine Family**
Picea glauca (Moench) Voss s.l.
Picea mariana (Mill.) B.S.P.

***Sparganiaceae* - Bur-Reed Family**
Sparganium hyperboreum Laest.

***Potamogetonaceae* - Pondweed Family**
Potamogeton alpinus Balbis ssp. *tenuifolius* (Raf.) Hultén
Potamogeton filiformis Pers. var. *borealis* (Raf.) St.John
Potamogeton friesii Rupr.
Potamogeton praelongus Wulf.
Potamogeton richardsonii (Benn.) Rydb.

***Poaceae (Gramineae)* - Grass Family**
Agrostis mertensii Trin. ssp. *mertensii*
Agrostis scabra Willd. var. *scabra*
Alopecurus aequalis Sobol.
Alopecurus alpinus J.E. Smith
Arctagrostis latifolia (R. Br.) Griseb. s.l.
Arctophila fulva (Trin.) Rupr.
Beckmannia syzigachne (Steud.) Fern.
Bromus pumpellianus Scribn. var. *arcticus* (Shear) A.E. Porsild
Bromus pumpellianus Scribn. var. *pumpellianus*
Calamagrostis canadensis (Michx.) Beauv. ssp. *canadensis*
Calamagrostis canadensis (Michx.) Beauv. ssp. *langsdorffii* (Link) Hultén
Calamagrostis lapponica (Wahlenb.) Hartm.
Calamagrostis purpurascens R. Br. var. *purpurascens*
Calamagrostis stricta (Timm) Koeler ssp. *stricta*
Calamagrostis stricta (Timm) Koeler ssp. *inexpansa* (Gray) C.W. Greene
Danthonia intermedia Vasey
Deschampsia brevifolia R. Br.
Deschampsia caespitosa (L.) Beauv.
Elymus macrourus (Turcz.) Tzvelev
Elymus trachycaulus (Link) Gould ex Shinners ssp. *violaceus* (Hornem.) A. and D. Löve
Festuca altaica Trin.
Festuca baffinensis Polunin
Festuca brachyphylla Schultes & Schultes fil.
Festuca brevissima Jurtz.
Festuca hyperborea Holm ex Frederiksen
Festuca richardsonii Hook.
Festuca rubra L. s.l.
Festuca vivipara (L.) Sm. ssp. *glabra* Frederiksen
Hierochloë alpina (Sw.) R. & S. ssp. *alpina*
Hierochloë hirta (Schrank) Borbas ssp. *arctica* G. Weim.
Hordeum jubatum L.
Leymus innovatus (Beal) Pilger
Phippsia algida (Sol.) R. Br.
Phleum alpinum L.
Poa alpina L.
Poa arctica R. Br. ssp. *arctica*
Poa arctica R. Br. ssp. *caespitans* (Simmons) Nannf.
Poa arctica R. Br. ssp. *lanata* (Scribn. & Merr.) R.J. Soreng
Poa arctica R. Br. ssp. *longiculmis* Hultén
Poa arctica R. Br. var. *vivipara* Hook.
Poa glauca Vahl
Poa leptocoma Trin.
Poa palustris L.
Poa porsildii Gjaerevoll

Poa pratensis L. ssp. *pratensis*
Poa pratensis L. ssp. *alpigena* (Fries) Hiit.
Puccinellia nuttalliana (Schult.) Hitchc.
Trisetum spicatum (L.) Richt.

***Cyperaceae* - Sedge Family**
Carex aquatilis Wahlenb.
Carex atrosquama Mack.
Carex aurea Nutt.
Carex bicolor All.
Carex brunnescens Poir.
Carex capillaris L.
Carex capillaris L. ssp. *robustior* (Drej. ex Lange) Böcher
Carex capitata L.
Carex chordorrhiza Ehrh. ex L. f.
Carex consimilis Holm
Carex eleusinoides Turcz.
Carex heleonastes Ehrh.
Carex lachenalii Schk.
Carex lapponica O.F. Lang
Carex livida Willd.
Carex lugens Holm
Carex macloviana d'Urv.
Carex media R. Br.
Carex membranacea Hook.
Carex microchaeta Holm
Carex microglochin Wahlenb.
Carex misandra R. Br.
Carex nardina Fries
Carex norvegica Retz.
Carex obtusata Liljeb.
Carex petricosa Dewey
Carex podocarpa R. Br.
Carex pyrenaica Wahlenb.
Carex rariflora (Wahlenb.) Sm.
Carex rupestris All.
Carex saxatilis L.
Carex scirpoidea Michx.
Carex supina Wahl. ssp. *spaniocarpa* (Steud.) Hultén
Carex tenuiflora Wahlenb.
Carex vaginata Tausch
Carex williamsii Britt.
Eleocharis acicularis (L.) Roem. & Schult.
Eleocharis palustris (L.) Roem. & Schult.
Eriophorum angustifolium Honckn.
Eriophorum brachyantherum Trautv.
Eriophorum russeolum Fries var. *albidum* Nyl.
Eriophorum scheuchzeri Hoppe
Eriophorum triste (Fries) Hadac & A. Löve
Eriophorum vaginatum L. ssp. *vaginatum*
Kobresia myosuroides (Vill.) Fiori & Paol.
Kobresia sibirica Turcz.
Kobresia simpliciuscula (Wahlenb.) Mack.
Scirpus caespitosus L. ssp. *austriacus* (Pallas) Asch. & Graeb.

***Juncaeae* - Rush Family**
Juncus balticus Willd. var. *alaskanus* (Hultén) A.E. Porsild
Juncus biglumis L.
Juncus castaneus Smith ssp. *castaneus*
Juncus triglumis L. ssp. *triglumis*
Luzula arctica Blytt ssp. *arctica*
Luzula arctica Blytt ssp. *latifolia* (Kjellm.) A.E. Porsild
Luzula arcuata (Wahlenb.) Sw. ssp. *unalaschkensis* (Buch.) Hultén
Luzula confusa Lindebl.
Luzula groenlandica Böcher
Luzula multiflora (Retz.) Lej. ssp. *frigida* (Buch.) Krecz. var. *contracta* Sam. ex Kartesz & Gandhi
Luzula parviflora (Ehrh.) Desv. ssp. *parviflora*
Luzula rufescens Fisch. & Mey.
Luzula spicata (L.) DC.
Luzula wahlenbergii Rupr.

***Liliaceae* - Lily Family**
Lloydia serotina (L.) Rchb.
Tofieldia coccinea Richards.
Tofieldia pusilla (Michx.) Pers.
Zygadenus elegans Pursh

***Orchidaceae* - Orchid Family**
Platanthera obtusata (Pursh) Lindl.


Luzula groenlandica

***Salicaceae* - Willow Family**
Populus balsamifera L. ssp. *balsamifera*
Populus tremuloides Michx.
Salix alaxensis (Anderss.) Cov. ssp. *alaxensis*
Salix alaxensis (Anderss.) Cov. ssp. *longistylis* (Rydb.) Hultén
Salix arbusculoides Anderss.
Salix arctica Pall.
Salix barclayi Anderss.
Salix barrattiana Hook.
Salix fuscescens Anderss.
Salix glauca L. var. *acutifolia* (Hook.) Schneid.
Salix hastata L.
Salix lanata L. ssp. *richardsonii* (Hook.) Skvortsov
Salix phlebophylla Anderss.
Salix planifolia Pursh ssp. *pulchra* (Cham.) Argus var. *pulchra*
Salix planifolia Pursh ssp. *pulchra* (Cham.) Argus var. *yukonensis* (Schneid.) Argus
Salix polaris Wahlenb.
Salix reticulata L. ssp. *reticulata*
Salix rotundifolia Trautv. ssp. *dodgeana* (Rydb.) Argus

***Betulaceae* - Birch Family**
Alnus crispa (Drylander ex Ait.) Pursh ssp. *crispa*
Alnus crispa (Drylander ex Ait.) Pursh ssp. *sinuata* (Regel) Hultén
Alnus incana (L.) Moench ssp. *tenuifolia* (Nutt.) Breitung
Betula glandulosa Michx.
Betula occidentalis Hook.
Betula papyrifera Marsh.

***Santalaceae* - Sandalwood Family**
Geocaulon lividum (Richards.) Fern.

***Polygonaceae* - Buckwheat Family**
Koenigia islandica L.
Oxyria digyna (L.) J. Hill
Polygonum alaskanum Wight ex Hultén
Polygonum bistorta L. ssp. *plumosum* (Small) Hultén
Polygonum viviparum L.
Rumex arcticus Trautv.

***Portulacaceae* - Purslane Family**
Claytonia arctica Adams
Claytonia tuberosa Pall.
Montia scammaniana (Hultén) Welsh

***Caryophyllaceae* - Pink Family**
Cerastium beeringianum Cham. &Schlecht.
Minuartia arctica (Stev.) Aschers. & Graebn.
Minuartia biflora (L.) Schinz. & Thell.
Minuartia dawsonensis (Britt.) House
Minuartia elegans (Cham. & Schlecht.) Schischk.
Minuartia rubella (Wahlenb.) Graebn. ex Asch. & Graebn.
Minuartia yukonensis Hultén
Moehringia lateriflora (L.) Fenzl
Sagina nivalis (Lindbl.) Fries
Silene acaulis L. ssp. *acaulis*
Silene acaulis L. ssp. *subacaulescens* (F.N. Williams) Hultén
Silene involucrata (Cham. & Schlecht.) Bocquet spp. *involucrata*
Silene noctiflora L.
Silene uralensis (Rupr.) Bocquet ssp. *uralensis*
Stellaria borealis Bigelow
Stellaria crassifolia Ehrh.
Stellaria longipes Goldie s.l.
Stellaria umbellata Turcz
Wilhelmsia physodes (Fisch.) McNeill

***Ranunculaceae* - Crowfoot Family**
Aconitum delphinifolium DC. ssp. *delphinifolium*
Aconitum delphinifolium DC. ssp. *paradoxum* (Rchb.) Hultén
Anemone drummondii S. Wats. var. *lithophila* (Rydb.) C.L. Hitchc.
Anemone narcissiflora L. s.l.
Anemone parviflora Michx.
Anemone richardsonii Hook.
Caltha palustris L. ssp. *arctica* (R. Br.) Hultén
Delphinium glaucum S. Wats.
Ranunculus aquatilis L. var. *eradicatus* Laest.
Ranunculus aquatilis L. var. *subrigidus* (W.B. Drew) Breitung
Ranunculus eschscholtzii Schlecht.
Ranunculus flammula L.
Ranunculus gelidus Karel. & Kiril. ssp. *grayi* (Britt.) Hultén
Ranunculus hyperboreus Rottb.
Ranunculus nivalis L.
Ranunculus pygmaeus Wahlenb.
Ranunculus sulphureus Sol.
Thalictrum alpinum L.
Thalictrum sparsiflorum Turcz. ssp. *richardsonii* (Gray) Cody

***Papaveraceae* - Poppy Family**
Papaver lapponicum (Tolm.) Nordh.
Papaver macounii Greene ssp. *discolor* (Hultén) Randel
Papaver mcconnellii Hultén

***Fumariaceae* - Fumitory Family**
Corydalis pauciflora (Steph.) Pers.
Corydalis sempervirens (L.) Pers.

***Brassicaceae (Cruciferae)* - Mustard Family**
Alyssum americanum Greene
Arabis drummondii Gray
Arabis exilis A. Nels.
Arabis holboellii Hornem. var. *retrofracta* (Grah.) Rydb.
Arabis kamchatica (Fisch.) Ledeb.
Barbarea orthoceras Ledeb.
Cardamine bellidifolia L.
Cardamine digitata Richards.
Cardamine microphylla Adams
Cardamine occidentalis (Wats.) Howell
Cardamine oligosperma Nutt. ssp. *kamtschatica* (Regel) Cody
Cardamine pratensis L. s.l.
Cardamine purpurea Cham. &Schlecht.
Descurainia sophioides (Fisch.) O.E. Schulz
Draba alpina L.
Draba cana Rydb.
Draba crassifolia Grah.
Draba densifolia Nutt.
Draba fladnizensis Wulfen
Draba glabella Pursh
Draba kamtschatica (Ledeb.) N. Busch
Draba lactea Adams
Draba longipes Raup
Draba macounii O.E. Schulz
Draba nivalis Liljebl.
Draba ogilviensis Hultén
Draba palanderiana Kjellm.
Draba praealta Greene
Draba stenopetala Trautv.
Erysimum cheiranthoides L.
Erysimum pallasii (Pursch) Fern.
Eutrema edwardsii R. Br.
Lepidium densiflorum Schrad.
Parrya nudicaulis (L.) Regel
Rorippa barbareifolia (DC.) Kitagawa
Rorippa palustris (L.) Besser s.l.
Smelowskia calycina (Stephan) C.A. Mey. s.l.

***Crassulaceae* - Stonecrop Family**
Rhodiola rosea L. ssp. *integrifolia* (Raf.) Hara

***Saxifragaceae* - Saxifrage Family**
Boykinia richardsonii (Hook.) A. Gray
(Chrysosplenium tetrandum (Lund) Fries
Chrysosplenium wrightii Franch. & Sav.
Parnassia kotzebuei Cham. & Schlecht.
Parnassia palustris L. var. *neogaea* Fern.
Ribes hudsonianum Richards.
Ribes triste Pall.
Saxifraga adscendens L. ssp. *oregonensis* (Raf.) Bacigalupi
Saxifraga caespitosa L. s.l.
Saxifraga cernua L.
Saxifraga flagellaris Willd. ssp. *setigera* (Pursh) Tolm.
Saxifraga hieracifolia Waldst. & Kit.
Saxifraga hirculus L.
Saxifraga nelsoniana D. Don ssp. *nelsoniana*
Saxifraga nelsoniana D. Don ssp. *porsildiana* (Calder & Savile) Hultén
Saxifraga nivalis L.
Saxifraga oppositifolia L. ssp. *oppositifolia*
Saxifraga oppositifolia L. ssp. *smalliana* (Engler & Irmsch.) Hultén
Saxifraga radiata Small
Saxifraga razshivinii Zhmylev
Saxifraga reflexa Hook.
Saxifraga rivularis L. s.l
Saxifraga rufopilosa (Hultén) A.E. Porsild
Saxifraga serpyllifolia Pursh
Saxifraga tricuspidata Rottb.


Boykinia richardsonii

***Rosaceae* - Rose Family**
Dryas alaskensis A. E. Porsild
Dryas crenulata Juz.
Dryas hookeriana Juz.
Dryas integrifolia M. Vahl s.l.
Geum rossii (R. Br.) Ser.
Potentilla biflora Willd.
Potentilla bimundorum Sojak
Potentilla fruticosa L. ssp *floribunda* (Pursh) Elkington
Potentilla hyparctica Malte s.l.
Potentilla nivea L.
Potentilla norvegica L.
Potentilla palustris (L.) Scop.
Potentilla uniflora Ledeb.
Rosa acicularis Lindl. s.l.
Rubus arcticus L. ssp. *arcticus*
Rubus arcticus L. ssp. *acaulis* (Michx.) Focke
Rubus chamaemorus L.
Rubus idaeus L. s.l.
Sibbaldia procumbens L.
Spiraea beauverdiana Schneid.

***Leguminosae* - Pea Family**
Astragalus alpinus L.
Astragalus australis (L.) Lam.
Astragalus eucosmus Robins. ssp. *sealei* (Lepage) Hultén
Astragalus umbellatus Bunge
Hedysarum alpinum L.
Lupinus arcticus Wats.
Oxytropis campestris (L.) DC. ssp. *jordalii* (A.E. Porsild) Hultén
Oxytropis deflexa (Pall.) DC. ssp. *foliolosa* (Hook.) Cody
Oxytropis maydelliana Trautv.
Oxytropis nigrescens (Pall.) Fisch. ssp. *nigrescens*
Oxytropis nigrescens (Fisch.) DC. ssp. *lonchopoda* (Barneby) Cody
Oxytropis scammaniana Hultén
Oxytropis viscida Nutt. s.l.

***Callitrichaceae* - Water Starwort Family**
Callitriche hermaphroditica L.
Callitriche verna L.

***Empetraceae* - Crowberry Family**
Empetrum nigrum L. ssp. *hermaphroditum* (Lge.) Böcher

***Violaceae* - Violet Family**
Viola epipsila Ledeb. ssp. *repens* (Turcz.) Becker

***Elaeagnaceae* - Oleaster Family**
Shepherdia canadensis (L.) Nutt.

***Onagraceae* - Evening Primrose Family**
Epilobium anagallidifolium Lam.
Epilobium angustifolium L. s.l.
Epilobium davuricum Fisch. ex Hornem.
Epilobium hornemannii Rchb.
Epilobium latifolium L.
Epilobium palustre L.

***Hippuridaceae* - Mare's-Tail Family**
Hippuris vulgaris L.

***Haloragaceae* - Water-Milfoil Family**
Myriophyllum sibiricum Komarov

***Apiaceae (Umbelliferae)* - Parsley Family**
Heracleum lanatum Michx.
Podistera yukonensis Mathias & Const.

***Cornaceae* - Dogwood Family**
Cornus canadensis L.

***Pyrolaceae* - Wintergreen Family**
Moneses uniflora (L.) Gray
Orthilia secunda (L.) House s.l.
Pyrola asarifolia Michx.
Pyrola chlorantha Sw.
Pyrola grandiflora Radius
Pyrola minor L.

***Ericaceae* - Heath Family**
Andromeda polifolia L.
Arctostaphylos alpina (L.) Spreng.
Arctostaphylos rubra (Rehd. & Wils.) Fern.
Cassiope tetragona (L.) D. Don ssp. *tetragona*
Kalmia polifolia Wang. s.l.
Ledum decumbens (Ait.) Lodd.
Ledum groenlandicum Oeder
Loiseleuria procumbens (L.) Desv.
Oxycoccus microcarpus Turcz.
Phyllodoce empetriformis (Sm.) D. Don
Rhododendron lapponicum (L.) Wahlenb.
Vaccinium uliginosum L. s.l.
Vaccinium vitis-idaea L. ssp. *minus* (Lodd.) Hultén

***Primulaceae* - Primrose Family**
Androsace chamaejasme Host ssp. *lehmanniana* (Spreng.) Hultén
Dodecatheon frigidum C. & S.
Douglasia gormanii Constance

***Gentianaceae* - Gentian Family**
Gentiana algida Pall.
Gentiana glauca Pall.
Gentiana prostrata Haenke
Gentianella propinqua (Richards.) J.M. Gillett ssp. *propinqua*

***Menyanthaceae* - Buckbean Family**
Menyanthes trifoliata L.

***Polemoniaceae* - Phlox Family**
Phlox alaskensis Jordal
Polemonium acutiflorum Willd.
Polemonium boreale Adams
Polemonium pulcherrimum Hook.

***Hydrophyllaceae* - Waterleaf Family**
Phacelia mollis Macbr.

***Boraginaceae* - Borage Family**
Eritrichium aretioides (Cham. & Schlecht.) DC.
Mertensia paniculata (Ait.) G. Don var. *paniculata*
Myosotis alpestris Schm. ssp. *asiatica* Vestergr.

***Scrophulariaceae* - Figwort Family**
Castilleja caudata (Pennell) Rebr.
Castilleja hyperborea Pennell
Castilleja yukonis Pennell
Lagotis glauca Gaertn. ssp. *minor* (Willd.) Hultén
Pedicularis capitata Adams
Pedicularis labradorica Wirsing
Pedicularis lanata Cham. & Schlecht.
Pedicularis langsdorfii Fisch. ssp. *arctica* (R. Br.) Pennell ex Hultén
Pedicularis lapponica L.
Pedicularis sudetica Willd. s. lat.
Synthyris borealis Pennell
Veronica wormskjoldii Roem. & Schult.

***Orobanchaceae* - Broom-Rape Family**
Boschniakia rossica (Cham. & Schlecht.) Fedtsch.

***Lentibulariaceae* - Bladderwort Family**
Pinguicula villosa L.
Utricularia minor L.

***Plantaginaceae* - Plantain Family**
Plantago major L.

***Rubiaceae* - Madder Family**
Galium boreale L.

***Caprifoliaceae* - Honeysuckle Family**
Linnaea borealis L. ssp. *americana* (Forbes) Hultén var. *americana* (Forbes) Rehd.
Viburnum edule (Michx.) Raf.

***Adoxaceae* - Moschatel Family**
Adoxa moschatellina L.

***Valerianaceae* - Valerian Family**
Valeriana capitata Pall.

***Campanulaceae* - Bluebell Family**
Campanula lasiocarpa Cham.
Campanula uniflora L.

***Asteraceae (Compositae)* - Composite Family**
Achillea millefolium L. ssp. *borealis* (Bong.) Breitung
Achillea sibirica Ledeb.
Antennaria alpina (L.) Gaertn.
Antennaria densifolia A.E. Porsild
Antennaria friesiana (Trautv.) Ekman ssp. *friesiana*
Antennaria monocephala DC. ssp. *monocephala*
Antennaria rosea Greene ssp. *pulvinata* (Greene) Bayer
Arnica angustifolia Vahl in Hornem. ssp. *angustifolia*
Arnica griscomii Fern. ssp. *frigida* (C.A. Mey ex Iljin) S.J. Wolf
Arnica lessingii Greene
Artemisia alaskana Rydb.
Artemisia norvegica Fries ssp. *saxatilis* (Bess. ex Hook.) Hall & Clem.
Artemisia tilesii Ledeb. s.l.
Aster alpinus L. ssp. *vierhapperi* Onno
Aster sibiricus L.
Crepis nana Richards.
Erigeron acris L. ssp. *politus* (Fries) Schinz & Keller
Erigeron elatus (Hook.) Greene
Erigeron grandiflorus Hook. ssp. *arcticus* A.E. Porsild
Erigeron humilis Graham
Erigeron lonchophyllus Hook.
Erigeron pallens Cronq.
Erigeron purpuratus Greene
Erigeron uniflorus L. ssp. *eriocephalus* (Vahl ex Hornem.) Cronq.
Hieracium gracile Hook.
Petasites frigidus (L.) Fries ssp. *frigidus*
Saussurea angustifolia (Willd.) DC. ssp. *yukonensis* (A.E. Porsild) Cody
Senecio atropurpureus (Ledeb.) Fedtsch. ssp. *frigidus* (Richards.) Hultén
Senecio congestus (R. Br.) DC.
Senecio cymbalaria Pursh
Senecio hyperborealis Greenm.
Senecio kjellmanii A.E. Porsild
Senecio lugens Richards.
Senecio pauciflorus Pursh
Senecio triangularis Hook.
Senecio tundricola Tolm.
Senecio yukonensis A.E. Porsild
Solidago multiradiata Ait.
Taraxacum ceratophorum (Ledeb.) DC. s.l.
Taraxacum lyratum (Ledeb.) DC.

APPENDIX B

PHOTOGRAPHS OF VEGETATION COMMUNITIES

Erigeron grandiflorus ssp. *articus*

Photo 11. Vegetation Community 1:*Picea glauca/Hylocomium* North Klondike Range Ecosection, Site 26, Elev.1,036 m.a.s.1.

Photo 12. Vegetation Community 2:*Picea glauca/Betula-Salix* Blackstone Valley Ecosection, Site 6, Elev.1,227 m.a.s.1. Note the tors on the unglaciated summits of hills in the background.

Photo 13. Vegetation Community 3:*Picea glauca/Cladina* North Klondike Valley Ecosection, Site 23, Elev.884 m.a.s.1. The community is generally associated with permafrost-free soil conditions.

Photo 15. Vegetation Community 5:*Picea mariana/Sphagnum* North Klondike Valley Ecosection, Site 22, Elev.884 m.a.s.1. Typically, the soil thaws to a depth of less than one metre from the surface.

Photo 14. Vegetation Community 4:*Picea glauca-Picea mariana/Hylocomium* North Klondike Valley Ecosection, Site 40, Elev.853 m.a.s.1.

Photo 16. Vegetation Community 6:*Picea mariana/Cladina* Lower Chandindu Valley Ecosection, Site 43, Elev.792 m.a.s.1.

Photo 17. Vegetation Community 7:*Populus tremuloides/Festuca* Upper permafrost-free Valley Ecosection, Site 10, Elev.1,067 m.a.s.l.

Photo 18. Vegetation Community 8:*Betula papyifera-Picea glauca/Hylocomium* Lower Chandindu Valley Ecosection, Site 44, Elev.792 m.a.s.1.

Photo 19. Vegetation Community 9:*Alnus crispa-Populus balsamifera/Epilobium* Lower Chandindu Valley Ecosection, Site 42, Elev.640 m.a.s.1. Note the robust growth of white spruce in this permafrost-free alluvial site.

Photo 20. Vegetation Community 10:*Salix/Carex* North Klondike Range Ecosection, Site 45, Elev.1,341 m.a.s.1.

Photo 21. Vegetation Community 11:*Salix/Festuca* North Fork Pass Ecosection, Site 36, Elev.1,311 m.a.s.l.

Photo 22. Vegetation Community 12:*Salix-Betula /Dryas* Seela Range Ecosection, Site 8, Elev.1,280 m.a.s.1. Note the well developed colluvial fan emanating from upper slope gullies.

Photo 23. Vegetation Community 13:*Betula-Ledum/Eriophorum (Picea mariana)* Upper Chandindu Valley , Site 11, Elev.914 m.a.s.1.

Photo 24. Vegetation Community 14:*Betula-Salix/Eriophorum* North Fork Pass Ecosection, Site 33, Elev.1,204 m.a.s.1. The valley floor is covered with a variety of glacial sediments related to the most recent McConnell glaciation.

Photo 26. Vegetation Community 16:*Rhododendron/Cetraria* Upper Chandindu Valley Ecosection, Site 28, Elev.1,067 m.a.s.l.

Photo 28. Vegetation Community 18:*Betula-Ledum/Eriophorum* Prospector Range Ecosection, Site 19, Elev.1,265 m.a.s.l. Note the formation of small hummocks in the soil as the result of intense frost churning (cryotubation).

Photo 25. Vegetation Community 15:*Betula/Cladina* North Fork Pass Ecosection, Site 35, Elev.1,311 m.a.s.l.

Photo 27. Vegetation Community 17:*Betula/Cassiope* West Chandindu Range , Ecosection, Site 15, Elev.1,417 m.a.s.l.

Photo 29. Vegetation Community 19:*Salix reticulata/Dryas* Seela Range Ecosection, Site 9, Elev.1,402 m.a.s.l.

Photo 30. Vegetation Community 20: *Cassiope /Dryas* Snowy Range Ecosection , Site 24, Elev.1,463 m.a.s.1.

Photo 31. Vegetation Community 21: *Cassiope /Carex* West Chandindu Range Ecosection , Site 14, Elev.1,463 m.a.s.1. Note the active erosion on the slopes, producing coarse colluvium.

Photo 32. Vegetation Community 22:*Salix arctica/Dryas/Artemisia* Seela Range Ecosection, Site 7, Elev.1,615 m.a.s.1. Site is located on colluvium typical of steep upper slopes in the ecosection.

Photo 34. Vegetation Community 24: *Eriophorum/Cassiope* Seela Range Ecosection , Site 29, Elev.1,676 m.a.s.l.

Photo 33. Vegetation Community 23: *Carex/Salix phlebophylla* North Klondike Range Ecosection, Site 27, Elev.1,676 m.a.s.l. The linear arrangement of stones on the slope in the foreground is largely a function of intense frost action.

Photo 35. Vegetation Community 25: *Umbilicaria/Draba* Seela Range Ecosection , Site 41, Elev.1,494 m.a.s.l.

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ISBN 1-55018-913-1