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Threatened and Endangered Plants in selected areas of the BLM Fortymile Planning Unit Alaska

by Alan R. Batten, David F. Murray, and Janice C. Dawe
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U. S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
ALASKA STATE OFFICE

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Podistera yukonensis
(Yukon podistera) in fruit

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16. Abstract (Limit: 200 words)

Four study areas in the Bureau of Land Management (BLM) Fortymile Planning Unit were searched for rare (threatened or endangered) plant taxa. These study areas were 1) Black Rapids, 2) Eagle Bluff, 3) Kathul Mountain, and 4) Chicken. A total of eight rare taxa were found: 1) Eriogonum flavum var. aquilinum, 2) a Draba sp. new to North America, 3) Draba porsildii, 4) Erysimum asperum var. angustatum, 5) Lesquerella arctica var. scammanae, 6) Podistera yukonensis, 7) Phacelia sericea, and 8) Cryptantha shackletteana. Evidence is presented that Lesquerella arctica var. scammanae (Black Rapids study area) is not a valid taxon, but is instead identical with L. arctica var. arctica. Descriptions, summaries of distributions and habitats, evaluations of taxonomic status and threatened or endangered status, and information on environmental requirements, population size, and population vigor are presented for each taxon.

Draba porsildii grows on sparsely vegetated alpine taluses in the Black Rapids study area. The remaining six valid taxa grow on steep, south-facing, dry, treeless slopes along the Yukon River. All populations of rare plants discovered consist of about one hundred to several tens of thousands of plants, except for Draba porsildii; fewer than five plants of this species were found in the study area.

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SUMMARY

During the summer of 1978 four study areas in the Bureau of Land Management (BLM) Fortymile Planning Unit were searched for rare plant taxa. The results of this research are presented in two sections. The first section includes descriptions, diagnoses, summaries of distribution and habitat characteristics, evaluations of taxonomic status, and evaluations of proposals for threatened or endangered status for each rare taxon found. The second section presents details on environmental characteristics for each study area of sites where rare taxa were found. Information on the numbers of individuals of each of these taxa and a subjective evaluation of the general condition of each population is included. Information on the floras of the study areas and an annotated bibliography to the rare taxa discovered are contained in appendixes.

The four study areas and the numbers of rare taxa found in each are Black Rapids (2), Eagle Bluff (4), Kathul Mountain (5), and Chicken (0). A total of eight rare taxa were found: 1) Eriogonum flavum var. aquilinum (Eagle yellow eriogonum) at Eagle Bluff and Kathul Mountain, 2) a species of Draba that is new to North America at Kathul Mountain, 3) Draba porsildii (Porsild draba) at Black Rapids, 4) Erysimum asperum var. angustatum (narrowleaf plains erysimum) at Eagle Bluff and Kathul Mountain, 5) Lesquerella arctica var. scammanae (Scamman arctic bladderpod) at Black Rapids, 6) Podistera yukonensis (Yukon podistera) at Kathul Mountain, 7) Phacelia sericea (silky phacelia) at Eagle Bluff and Kathul Mountain, and 8) Cryptantha shackletteana (Shacklette cryptantha) at Eagle Bluff. Evidence is presented that Lesquerella arctica var. scammanae is not a valid taxon, but is identical with the widespread L. arctica var. arctica. If this view is accepted, L. arctica var. scammanae cannot be considered threatened or endangered.

In the Black Rapids study area Porsild draba grows on sparsely vegetated unstable alpine taluses, and Scamman arctic bladderpod was found only at the type locality at Gunnysack Creek. The rare taxa at Eagle Bluff and Kathul Mountain grow on steep, south-facing, dry treeless slopes along the Yukon River. Dry treeless slopes similar to, though smaller than, those at Eagle Bluff and Kathul Mountain are present in the Chicken study area, but these apparently do not support rare taxa. Landform, soil drainage, and microclimate appear to be important controls on the distributions of these rare plants; the chemical nature of the soil does not seem to be important.

Most populations of rare taxa discovered consisted of several hundred to several tens of thousands of plants. They appeared to be healthy and maintaining their numbers. Fewer than five plants of

Porsild draba were discovered, but since this is an inconspicuous taxon widely dispersed in a rugged, inaccessible habitat, it is likely that more are present in the vicinity. The population of Eagle yellow eriogonum at Kathul Mountain consists only of about 100 individuals but appears to be stable.

Since both Eagle Bluff and Kathul Mountain support large populations of several possibly threatened or endangered plant species, we recommend that these areas be included in the ecological reserve system. We also recommend that roads, pipelines, and other developments be routed away from all treeless, south-facing slopes along the Yukon River.

INTRODUCTON

The Problem

The Endangered Species Act of 1973 offers certain legal protection to plants as well as animals. A relatively small number of plants has been selected for either endangered or threatened status from the Alaskan vascular flora (Ayensu and DeFilipps 1978), but the lists published to date are provisional. In addition, there are taxa that are truly rare or show very restricted distributions for a number of reasons that may not be entirely biological. The intent of the act is not simply to protect the plants, but to protect their habitats which by definition become critical habitats. Therefore, management proposals can best be developed when the exact ranges and habitat requirements of these species are known. Unfortunately, this is a problem not easily solved.

Methods

This report summarizes information on the taxonomy, distribution, and habitats of rare taxa in the BLM Fortymile Planning Unit. This information is based on published reports, specimens in the Herbarium of the University of Alaska Museum (ALA), and field research conducted during the summer of 1978. The summer research effort was conducted primarily in four study areas selected by BLM. These study areas, located near Black Rapids Roadhouse, Eagle, Kathul Mountain, and Chicken, were either known to support, or suspected of supporting, populations of plants proposed for threatened or endangered status. Since these taxa are site specific, we concentrated our attention on the appropriate habitats, which in some cases represented a relatively small part of the landscape. When populations of rare taxa were located, the sites were analyzed to refine our knowledge of their specific characteristics. This improved our ability to predict where we might locate additional populations. In this way, plant-site descriptions were made more detailed. The site characteristics analyzed included bedrock geology, topography, elevation, aspect (azimuth), slope (Brunton accuracy), soil type, plant community, and specific plant associates. In addition, each population of rare plant was assessed for number of individuals, reproductive success, and general condition. During these investigations we kept alert in all habitats for unusual species that should be considered for inclusion on the lists of threatened and endangered taxa.

The Smithsonian Lists of Threatened and Endangered Plants

The Endangered Species Act of 1973 charged the Smithsonian Institution with determining which plant species in the United States are

endangered or threatened. Accordingly, the Institution prepared lists of taxa on a national basis; only vascular plants have been considered to date. Although the lists have been updated and revised several times, the latest version (Ayensu and DeFilipps 1978) still must be considered provisional.

The Smithsonian Institution has defined an endangered taxon as one that is in danger of extinction throughout its range or a significant portion of it. Plants may be endangered because of the destruction, drastic modification, or severe curtailment of their habitat, or because of overexploitation, disease, or even for unknown reasons. Taxa that occur in very limited areas and those that grow in restricted habitats are usually listed as endangered by the Smithsonian Institution (Ayensu and DeFilipps 1978). A threatened taxon has been defined as one that is likely to become endangered within the foreseeable future throughout its range or a significant portion of it. Taxa known only from the type locality are automatically considered rare and were proposed for protection by the Smithsonian Institution. Several taxa have been named and described so recently that the scientific community has not had adequate time to assess their taxonomic validity or to determine their distributions. In time, some of these names will likely disappear (reduced to synonomy under another name); others may eventually be found in additional localities.

The apparent rarity of some small and inconspicuous plants or plants in difficult taxonomic groups might be more a reflection of our ignorance than indicative of the true conditions. For this reason we propose to follow Fairbrothers and Hough (1973) and use a third category of undetermined in addition to the endangered and threatened categories.

Critical habitats of threatened and endangered taxa are also given legal protection under the Endangered Species Act. Habitats are defined as critical "if the destruction, disturbance, modification, or subjection to human activity of any constituent element of the habitat might be expected to result in a reduction in the numbers or distribution of that species [any threatened or endangered species], or in a restriction of the potential and reasonable expansion or recovery of that species" (Ayensu and DeFilipps 1978).

To be included on the lists, taxa must be threatened or endangered on a national basis within the United States. Taxa rare in the United States, but present in other countries, are excluded unless they are known to be rare throughout their ranges. Most species with ranges extending beyond the borders of the United States have been excluded from the lists because data on their statuses and ranges are not available (Ayensu and DeFilipps 1978). No introduced or domesticated species are included, nor are forms, minor variants, or hybrids. Well-

recognized subspecies and varieties are included, however. This has serious implications for populations of plants disjunct from their main ranges; those of several rare taxa in Alaska are excellent examples. If these populations are regarded as distinct taxa at the specific, subspecific, or varietal level, they can be placed on the national list. If they are not considered taxonomically distinct at one of these levels, they cannot be placed on the national list, even though they may be very rare in Alaska and disjunct several thousand kilometers from their main ranges.

Threatened and Endangered Plants in the State of Alaska

No State regulations address the problem of threatened and endangered species so far as we have been able to determine. State statutes and statewide lists of threatened and endangered taxa would be very desirable because some rare and interesting taxa in Alaska do not qualify for Federal protection and because there may be delay in getting some taxa added to the Smithsonian lists even though they meet all criteria. Rare taxa treated in this report are evaluated for placement on both State and national lists of threatened and endangered plants.

THE THREATENED AND ENDANGERED TAXA

In this section of the report, the rare taxa present in the study areas are described and information on distribution and habitat of these taxa is summarized. The taxonomy and threatened or endangered status of these taxa are evaluated, and a summary of these evaluations is found in Table 1. The botanical terminology used in the species descriptions conforms to the definitions in Harrington and Durrell (1957).

Eriogonum flavum var. aquilinum (Polygonaceae)

Description

Eagle yellow eriogonum has a strong taproot and grows in clumps (Fig. 1). The leaves are small (8-15 mm long by 5-10 mm broad), obovate to oblanceolate in shape, with a dense white tomentum (a felt-like mat of short interwoven hairs) on the lower surface and a less dense cover of soft, wavy, and relatively long hairs on the upper surface. Persistent dead, gray to brown leaves form a dense mat at the base of the plant. The leafless flowering stems are 4-8 cm tall and thinly floccose-tomentose (with patches of long, entangled, delicate cobwebby hairs in addition to a thin tomentum). The inflorescence (the arrangement in which the flowers are grouped) is umbelliform, with several rays about 1 cm long subtended by 4-6 narrow leaflike bracts (Fig. 2). At the distal end of each ray is a deeply four-lobed involucre (whorl of united bracts), surrounding the bases of the many short (1-3 mm) pedicels (stalks supporting the individual flowers). The bright yellow perianth is six-parted in two whorls, is 3-5 mm long, and has long, soft, straight hairs on the outer surface. The perianth is persistent in fruit and disperses with the fruit, which is a three-angled achene about 4-5 mm long by 1 mm broad.

The chromosome number of Eriogonum flavum var. aquilinum has not yet been determined. Counts of 2n=38 and 2n=76-80 have been determined for E. flavum in southern British Columbia and southern Alberta, respectively (Taylor and Brockman 1966).

Distribution and habitat

This taxon grows on steep, dry, south-facing treeless slopes in Alaska and is known from only two localities. A large population of several thousand individuals is present on Eagle Bluff and about 100 plants are present on Kathul Mountain.

Fig. 1. Eriogonum flavum var. aquilinum (Eagle yellow eriogonum) in flower (Eagle Bluff, 14 July 1978).

Fig. 2. Eagle yellow eriogonum, close-up of inflorescence. The yellow perianth persists until the fruit is ripe and then falls with the fruit (Eagle Bluff, 14 July 1978).

Table 1. Summary of threatened and endangered status of rare plants of the selected areas of the Fortymile Planning Unit. T indicates threatened, E indicates endangered, U indicates undetermined.

Taxon	Smithsonian List (Ayensu and DeFilipps 1978)	Federal Register 41 (117) 16 June 1976	Status recommended in this report	Comments
Eriogonum flavum var. aquilinum	E	E	T	----------
Draba sp.	----------	----------	T	----------
Draba porsildii	----------	----------	U	----------
Erysimum asperum var. angustatum	----------	----------	T	----------
Lesquerella arctica var. scammanae	T	----------	remove from list	not a valid taxon
Lesquerella calderi	----------	----------	not evaluated	not known to be present in any of the study areas
Podistera yukonensis	----------	----------	T	----------
Phacelia sericea	----------	----------	T (on State list only)	----------
Cryptantha shackletteana	E	E	T	----------

Diagnoses

The buckwheat family (Polygonaceae) is characterized by flowers with an undifferentiated more or less colorful perianth and a single superior ovary of 2-3 carpels with an equal number of styles, ripening into an achene. The genus Eriogonum is easily distinguished from all other Alaskan genera of the family by its bright yellow flowers and umbelliform inflorescence.

Eriogonum flavum var. aquilinum is the only representative of this genus in the Alaska-Yukon flora and is not likely to be confused with any other species. Bupleurum triradiatum subsp. arcticum (Umbelliferae) has an umbel of bright yellow flowers and is locally common on dry treeless slopes of interior Alaska. Although Bupleurum is sometimes a very small plant in arctic and alpine settings, on dry slopes of interior Alaska where it and Eriogonum can be found together, it grows much taller (30-70 cm) than the Eriogonum. It also differs from Eriogonum in having few basal leaves, many stem leaves, and leaves that are both linear and hairless.

Evaluation of taxonomic status

Eriogonum is a large and taxonomically complex genus, with a distribution centered in the western contiguous United States. Eriogonum flavum var. aquilinum differs from other varieties of this species primarily in that the involucres (bracts at the base of the pedicels) are deeply divided into four lobes (Hultén 1968, Reveal 1967). Reveal (1967) pointed out that var. aquilinum is quite similar to var. xanthum of the alpine zone of the Colorado Rocky Mountains and implied that a substantial part of the rationale for giving the Alaskan plants varietal status came from their disjunct location, 2,100 km (1,300 mi) north of the main range of the species. His estimate that the Alaskan plants have been isolated for a million years or more is probably greatly exaggerated. There is no reason to suppose that the range of this species was not continuous during the Sangamon Interglaciation, which ended approximately 70,000-80,000 years ago (Hopkins 1972). The Alaska-Yukon plants might even have been more or less connected to the main range by a series of minor disjunctions during an early Holocene warm interval.

Evaluation of threatened or endangered status

Ayensu and DeFilipps (1978) list this taxon as endangered. Nevertheless, since two widely separated populations are now known to exist, and since the Eagle Bluff population is fairly large, we feel the threatened status would be more appropriate.

Draba sp. (Cruciferae)

This species in the genus Draba is new to North America, and its name has not yet been determined (G. A. Mulligan, in litt. 1979). The following description draws from a manuscript kindly made available to us by G. A. Mulligan (Agriculture Canada, Ottawa).

Description

These plants are taprooted perennials. The numerous, compact basal leaves are entire to sparsely toothed, obovate to ovate, 6-25 mm long by 3-9 mm broad, and densely hairy with coarse simple, forked, and cruciform (cross-shaped) hairs. The stems are 10-35 cm tall with 0-3 stem leaves. The flower color is unknown. The hairless fruits are borne on a raceme, are relatively long and narrow for this genus (8-13 mm long by 1.5-2.0 mm broad), and have long styles (1.0-1.5 mm). The chromosome number is 2n=48, a number shared by only two other North American species of Draba, neither of them closely related to this one.

Distribution and habitat

This species is common on dry, south-facing treeless slopes of Kathul Mountain. This is the only known North American locality.

Diagnoses

The large and taxonomically complex mustard family (Cruciferae or Brassicaceae) is characterized by radially symmetrical flowers with four sepals and four separate petals, six stamens (four long, two short), and a single superior ovary ripening into a two-celled silique (a dry, two-celled fruit opening by the outer wall splitting longitudinally into two halves and pulling away from the persistent partition that separates the two cells). The genus Draba is separated from other members of this family in having an ovate to lanceolate-ovate fruit, flattened parallel to the partition, and less than three (to four) times as long as broad.

This genus is renowned for taxonomic difficulty; many taxa are separated mainly by differences in the hairs of the basal leaves. This species could easily be confused with several others unless it is carefully examined under a microscope. In the Alaska-Yukon flora this species is probably most similar to D. glabella and D. longipes. The surfaces of the basal leaves of both of these species are pubescent only with cruciform or branched cruciform hairs; simple and forked hairs, though sometimes present on the leaf margins, are absent from the surfaces (Mulligan 1970), whereas simple and forked hairs as well as cruciform hairs are abundant on the leaves of the new species.

Evaluation of taxonomic status

G. A. Mulligan has determined that this species represents a taxon new to science.

Evaluation of threatened or endangered status

Taxa known from only one locality are usually considered endangered by the Smithsonian Institution (Ayensu and DeFilipps 1978). Nevertheless, because plants of the genus Draba are small, inconspicuous, and taxonomically difficult, they are not often collected and are often more widespread than distribution maps indicate. Only in recent years has our knowledge of distributions of species of Draba in Canada and Alaska begun to be appreciated. For these reasons we recommend that this species be given threatened status on national and Alaska State lists.

Draba porsildii Mulligan (Cruciferae)

Description

Porsild draba is a perennial that grows in tufts or clumps and has entire, oblanceolate, basal leaves 3-12 mm long by 1.5-2.0 mm broad. The surfaces of the leaves support simple, forked, cruciform (cross-shaped), and stellate (with slender rays radiating from a common center, in this case 4-8 rays) hairs. The flowering stems are 2.0-6.5 cm tall, with 0-1 oblanceolate leaf. Stems and pedicels are usually hairless. The four sepals are 1.5-2.0 mm long, and the four white petals are 2-3 mm long. The siliques (fruits) are obovate, hairless, 4-8 mm long and 2-3 mm broad, with styles about 0.25 mm long. Although the chromosome number of Alaskan material has not been determined, in Canada this species is consistently 2n=32 (Mulligan 1974, 1976).

Distribution and habitat

This species extends from the Rocky Mountains of southern Alberta and British Columbia to southwestern Yukon and eastern Alaska. In Alaska it had been known only from the Sheenjek Valley (Batten, unpublished). In the course of our field studies, we found it in the Alaska Range where it grows on steep, unstable taluses above timberline.

Diagnoses

This species shares the characteristics of the genus Draba already listed. The small plant size, single stem leaf (or absence of one), white flowers, and hairless fruits set this species apart from many

species of Draba in the Alaskan flora and place it in a group of species closely allied with D. nivalis. Of this group it is perhaps most similar to D. fladnizensis, D. lactea, D. lonchocarpa, and D. nivalis, but differs from them in several ways. The leaves of D. fladnizensis lack cruciform and stellate hairs, contrasting with the simple, forked, cruciform, and stellate hairs on the leaves of D. porsildii. According to Mulligan (1974, 1976), D. lactea and D. nivalis have stellate hairs less than 0.2 mm in diameter with spreading rays, contrasting with stellate hairs more than 0.2 mm in diameter with rays parallel to the leaf surface in D. porsildii. In addition, the leaves of D. nivalis lack the simple, forked, and cruciform hairs (stellate hairs only are present) found on leaves of D. porsildii. The basal leaves of D. lonchocarpa lack cruciform hairs (simple, forked, and stellate hairs are present) and the stellate hairs have nine or more rays in contrast to the eight or fewer rays of the stellate hairs of D. porsildii (Mulligan 1974, 1976). The densely hairy pedicels of D. nivalis and D. lonchocarpa further contrast with the hairless pedicels of D. porsildii.

Evaluation of taxonomic status

The identification of our specimen of Draba porsildii has been confirmed by G. A. Mulligan. Distinction between species of this genus is often based on minute characteristics of the hairs on the basal leaves. Once recognized, however, these differences are remarkably consistent. Draba porsildii appears sufficiently distinct to warrant treatment as a separate species.

Evaluation of threatened or endangered status

This species is known from only two locations in Alaska and appears to be rare, but because it is small and inconspicuous, occupies a remote habitat, and is difficult to recognize, we propose that it be given an "undetermined" status, i.e. it may indeed qualify as threatened on a State list, but not enough is known about it yet to decide with confidence. It cannot be included on the national lists because it is known from several localities in Canada.

Erysimum asperum (Nutt.) DC. var. angustatum (Rydb.) Boiv. (Cruciferae)

Description

Narrowleaf plains erysimum is a perennial with a large taproot and a well-developed basal rosette of leaves. The basal leaves are characteristically 1-3 mm broad and entire, but at Eagle Bluff coarsely toothed leaves up to 1 cm broad were common. The flowering stems are single or multiple, simple or branched, and 10-45 cm tall. Stem leaves are present. The inflorescence is a many-flowered raceme. The flowers

have four distinct (not united), bright yellow petals, 12 mm long or longer. The fruit is a very long (2-9 cm) silique, with a prominent beak 3-5 mm long (Figs. 3, 4). Leaves, stems, pedicels, sepals, and fruits are covered with two-pronged, very short-stalked, appressed hairs characteristic of the genus (Fig. 5). The chromosome number of a plant from Eagle Bluff has been determined to be 2n=36.

Distribution and habitat

Narrowleaf plains erysimum grows on rubble slopes and dry grassy bluffs. It is known from widely scattered localities along the Yukon River and its tributaries between the vicinity of Circle and southeastern Yukon Territory.

Diagnoses

In Alaska, the genus Erysimum is distinguished from all other genera of the mustard family by the presence of characteristic two- or three-pronged, very short-stalked, appressed hairs attached by their middles on stems, leaves, and other plant parts (Fig. 5). With a little practice, one can easily recognize these hairs with a hand lens; consequently recognition of the genus is comparatively easy.

Classification within the genus is more difficult. Authorities agree that four species of this genus are present in Alaska, but the names of these species and the disposition of infraspecific categories vary (cf. Hultén 1968, Welsh 1974). Erysimum pallasii is a purple-flowered plant of arctic-alpine taluses and gravel bars. Even in fruit, this species is not likely to be confused with E. asperum var. angustatum, since its range and habitat are so different. Erysimum cheiranthoides is annual or biennial, has very small yellow flowers (petals 4-5 mm long), and has predominantly three-pronged hairs (Fig. 5). It is a species of grassy slopes, forest openings, and disturbed sites and can sometimes be confused with E. inconspicuum, but rarely with E. asperum var. angustatum.

Erysimum inconspicuum has predominantly two-pronged hairs and is the species most similar to E. asperum in the Alaska-Yukon flora. It differs primarily in having shorter petals (8-12 mm) and has a shorter beak on the fruits (0.3-1.0 mm). Fruiting specimens are sometimes difficult to distinguish. The fruits of Erysimum asperum var. angustatum are normally very long-beaked (3-5 mm), but a few specimens with beaks as short as 0.5 mm were found at Eagle Bluff. Erysimum inconspicuum grows on dry grassy bluffs, but is usually found in areas more completely covered by vegetation than is E. asperum, although they sometimes grow on the same slopes.

Fig. 3. Erysimum asperum var. angustatum (narrowleaf plains erysimum). The long slender fruits (siliques) can be seen below the flowers (Eagle Bluff, 12 July 1978).

Fig. 4. Narrowleaf plains erysimum (Eagle Bluff, 12 July 1978).

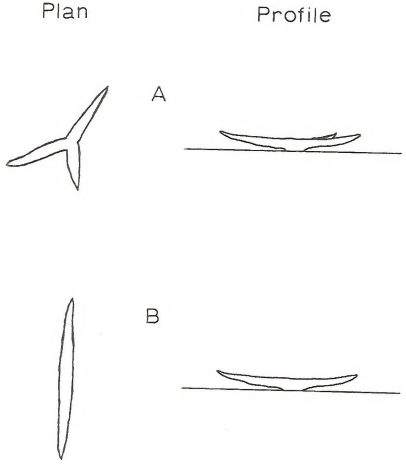


Fig. 5. Hairs characteristic of the genus Erysimum, approximately x100. A. Three-pronged hairs characteristic of E. cheiranthoides. B. Two-pronged hairs characteristic of E. asperum and E. inconspicuum.

Welsh (1974) maintained that E. asperum var. asperum is present in southcentral Alaska and southern Yukon Territory. He separated this taxon from var. angustatum on the basis that E. asperum var. asperum has stems (10)20-80 cm tall (as opposed to 10-20(35) cm), leaves more than 2 mm broad (as opposed to 1-2 mm broad), and silique beaks 1-3 mm long (as opposed to 3-5 mm long). As already noted, the leaf width and the silique beak length vary considerably in the Eagle Bluff population of var. angustatum, spanning the combined range of variation attributed to both varieties by Welsh (1974).

Evaluation of taxonomic status

Erysimum is a taxonimically complex genus and the taxon angustatum Rydb. has been given different treatments. Rydberg (1901) named and

described it as a new species, and this rank was retained by Hultén (1941-50, 1968) and Rossbach (1958). Boivin (1968) and Welsh (1968), however, both reduced E. angustatum to a variety of the more widespread E. asperum. Erysimum asperum sens. lat. (except the Alaska-Yukon populations) is common from California north to southern British Columbia and east on a broad front to Minnesota, Kansas, and Oklahoma (Hitchcock et al. 1955-69). It has a chromosome number of 2n=36 (Mulligan 1966) as does the Eagle Bluff population of var. angustatum, a number shared by relatively few taxa in this genus.

Erysimum asperum var. angustatum apparently differs from var. asperum in having linear-lanceolate to oblanceolate, entire leaves (as opposed to narrowly oblanceolate, often toothed leaves), and longer-beaked, less sharply four-angled siliques growing obliquely upward (as opposed to widely spreading or diverging) (Hitchcock et al. 1955-69, Hultén 1941-50, Rossbach 1958, Welsh 1974). Nevertheless, leaf width and shape in the Cruciferae are quite variable features, and many plants at Eagle Bluff had broad, coarsely toothed leaves. Without a large quantity of comparative material of E. asperum from all parts of its range, it is impossible for us now to evaluate the taxonomic status of the Alaska-Yukon plants. Because of the variability present in the Alaska-Yukon plants, our inclination is to treat this population at an infraspecific level within E. asperum and to retain our plant distinct from more southern taxa at the rank of variety (var. angustatum).

Evaluation of threatened or endangered status

Erysimum asperum var. angustatum is recommended for threatened status on State and national lists.

Lesquerella arctica (Wormsk.) S. Wats. var. scammanae Rollins (Cruciferae)

Description

Scamman arctic bladderpod is a perennial with a strong taproot and a well-developed rosette of basal leaves. These leaves are obovate, entire, 1-6(10) cm long and 3-7(8) mm broad. They appear silvery-gray from a dense covering of multirayed stellate hairs (Fig. 6). The stems are single to several, simple, erect to spreading or sometimes prostrate, and 5-15(25) cm tall. The flowers are borne on racemes, and have four bright yellow petals (Fig. 7). The fruit is a spherical silique (Fig. 8). The chromosome number has been determined to be 2n=60.

Distribution and habitat

Lesquerella arctica is fairly common on calcareous fell-fields, taluses, and alluvial fans in the Brooks Range and on the Seward Pen-

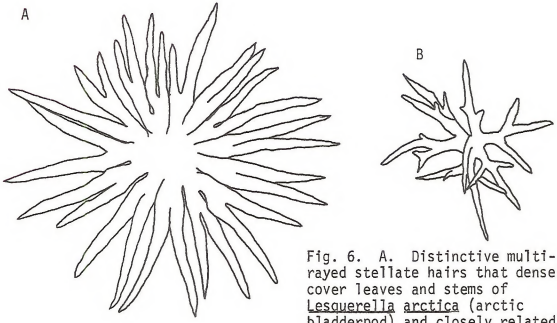


Fig. 6. A. Distinctive multi-rayed stellate hairs that densely cover leaves and stems of Lesquerella arctica (arctic bladderpod) and closely related taxa, x200 (after Rollins and Banerjee 1975, Plate 11). B. Stellate hair of the genus Draba (D. nivalis) for comparison, x270 (after Mulligan 1976, Fig. 7).

insula. It is also present in reduced numbers on sandy and gravelly soils on the Arctic Coastal Plain, reaching the coast at Prudhoe Bay and points east. It is rare in interior and southern Alaska and Yukon, usually occurring there on coarse alluvium and dry grassy slopes. It extends east to northwest Greenland, west to disjunct localities in central Siberia, and south to northern British Columbia and Jasper National Park in Alberta (Hultén 1968, Rollins and Shaw 1973). Lesquerella arctica var. scammanae has long been known only from the type locality at Gunnysack Creek near Black Rapids Roadhouse on the north side of the Alaska Range.

Diagnoses

The dry spherical fruit sets the genus Lesquerella apart from all other Alaskan members of the mustard family (Cruciferae). In addition, the stellate hairs (easily seen with a hand lens) that densely cover the leaves and stems (Fig. 6) resemble those of no other genus in the Alaskan flora except Alyssum (also in Cruciferae). Alyssum americanum, the only Alaskan species, has broader and shorter leaves than Lesquerella, and a round, flattened fruit. Some species of Draba (Cruciferae) have yellow flowers and densely hairy leaves, but the fruits are oblong and flattened and, although stellate hairs might be present, they are not similar to the distinctive hairs of Lesquerella

(Fig. 6). The basal leaves of Cryptantha shackletteana are superficially similar to those of Lesquerella, but are longer and narrower and are densely covered with simple hairs rather than the distinctive stellate hairs characteristic of Lesquerella. If flowers or fruits are present, no possibility of confusion exists.

Lesquerella is a large genus with approximately 80 species and half again as many infraspecific taxa. Most of these are concentrated in the southwestern United States; only four taxa have been reported from Alaska-Yukon (Hultén 1941-50, 1968; Mulligan and Porsild 1969, Rollins and Shaw 1973). These taxa are Lesquerella arctica var. arctica, L. arctica var. purshii S. Wats., L. arctica var. scammanae, and L. calderi Mulligan and Porsild. All of these taxa are similar to each other.

Lesquerella arctica var. purshii is not generally recognized as a valid taxon by current taxonomic concepts. According to Hultén (1941-50, 1968) and Rollins and Shaw (1973), this taxon in the past has been separated from var. arctica on the basis of its slightly hairy fruits and longer leaves. It has been given the southern part of the range of L. arctica sens. lat., extending from interior Alaska southeast to the Gulf of St. Lawrence (Hultén 1941-50, 1968; Rollins and Shaw 1973). These characteristics are now known throughout the range of L. arctica (Hultén 1973, Rollins and Shaw 1973). In their monograph of the genus, Rollins and Shaw (1973) give a thorough discussion of the reasons for reducing this taxon to synonomy under L. arctica var. arctica.

Lesquerella calderi is quite similar to L. arctica and has been treated as an infraspecific taxon of that species by Hultén (1973) and Welsh (1974). A fundamental difference between the two is that L. calderi has a chromosome number of 2n=20 and L. arctica has 2n=60. Other differences are in the shapes and sizes of the petals and fruits, and in the sizes of the hairs on the flowering stems. Lesquerella calderi has petals that are (6)7-9(10) mm long, nearly as broad above the middle as the total length, and narrow abruptly below the middle to a base about 1 mm wide (as opposed to L. arctica with petals (4)5-6(7) mm long, about half as broad above the middle as the total length, and narrow gradually to a base about 1 mm wide). The fruits of L. calderi are up to 8 mm long and are frequently constricted at the partition between the two cells (less than 7 mm long and rarely constricted at the partition in L. arctica). The stellate hairs on the flowering stems are mostly 0.2-0.3 mm in diameter on L. calderi vs. 0.4-0.5 mm on L. arctica (Mulligan and Porsild 1969, Rollins and Shaw 1973). Lesquerella calderi is known from west-central Northwest Territories, central Yukon Territory, and one locality near Eagle in eastern Alaska (Hultén 1973, Mulligan and Porsild 1969, Rollins and Shaw 1973).

Fig. 7. (left) Lesquerella arctica var. scammanae (Scamman arctic bladderpod) in flower (Gunnysack Creek, late June 1978).

Fig. 8. (below) Scamman arctic bladderpod in fruit (Gunnysack Creek, late June 1978).

Lesquerella arctica var. scammanae is similar to var. arctica, differing chiefly in that all parts of the plant are larger (Rollins 1939, Rollins and Shaw 1973). It has longer and broader basal leaves (5-15 cm long by 1-2 cm broad, vs. 2-4 cm long and 2-8 mm broad in var. arctica) and longer fruiting pedicels (1.5-4 cm vs. 1-3 cm) (Rollins and Shaw 1973).

Because both Lesquerella calderi and L. arctica var. scammanae are characterized by larger plant parts than L. arctica var. arctica, we have been interested in the relationship between these two taxa. Seeds collected at the type locality of var. scammanae were used to determine the chromosome number, which is 2n=60. This shows that the relationship of the Gunnysack Creek plants is with L. arctica and not L. calderi.

Rollins (1939) described L. arctica var. scammanae on the basis of specimens collected by Edith Scamman near the Richardson Highway at Gunnysack Creek (Scamman 1940) on the north slope of the Alaska Range (in the Black Rapids study area). These collections represented a disjunction of several hundred miles from the main range of that species, which at that time was known in Alaska only from the Bering Sea region. The large size of these specimens combined with their apparent isolation made them quite a conspicuous entity, apparently worthy of varietal status. Now we know that although L. arctica is relatively rare in interior Alaska, its distribution is more or less continuous throughout its Alaska-Yukon range (Hultén 1968, Rollins and Shaw 1973). It is also apparent that large plants occur in favorable sites throughout the range of this species.

Evaluation of taxonomic status

For the reasons stated above, we have been skeptical of the validity of maintaining the varietal status of the Gunnysack Creek plants. Several authorities have already synonomized this taxon completely under L. arctica (Hultén 1941-1950, 1968, Welsh 1974). Since numerous plants are present at Gunnysack Creek, we made several collections from different habitats to compare with specimens of L. arctica var. arctica. Measurement of the 30 plants collected showed that only 7 plants would key to var. scammanae on the basis of leaf length, no plants on the basis of leaf width, and 6 plants on the basis of fruiting pedicel length. In fact, a paratype of L. arctica var. scammanae (Scamman 1000, ALA) has leaves 2-4 cm long by 4-6 mm broad, and fruiting pedicels 12-20 mm long; consequently, it would key to var. arctica in Rollins and Shaw (1973). The characteristics attributed to var. arctica and var. scammanae are summarized in Table 2, along with our measurements of the Gunnysack Creek plants.

A number of specimens of Lesquerella arctica from northern Alaska and the Seward Peninsula at ALA are as large as the collections from

Table 2. Comparison of Lesquerella arctica var. arctica, L. arctica var. scammanae, and specimens from the type locality of L. arctica var. scammanae.

Character	Diagnoses of Rollins and Shaw (1973) and Rollins and Banerjee (1975)		Paratype of Lesquerella arctica var. scammanae (Scamman 1000)	Other plants from type locality of Lesquerella arctica var. scammanae (30 plants)
	Lesquerella arctica var. arctica	Lesquerella arctica var. scammanae		
stem length	usually 20 cm	10-30 cm	11-13 cm	(4)6-15(25) cm
basal leaf length	usually 2-4 cm	5-15 cm	1.5-4.5 cm	(1)2-7(10) cm
basal leaf width	2-8 cm	1-2 cm	3-6 mm	3-6(8) mm
fruiting pedicel length	generally 1-3 cm	1.5-4.0 cm	1-2 cm	1.0-3.5(4.0) cm
density of hairs	hairs densely overlapping in several layers	hairs overlapping in a single layer	generally dense (overlapping in several layers), but lighter (overlapping in a single layer) fairly commonly	generally dense (over lapping in several layers), but lighter (overlapping in a single layer) fairly commonly
appearance of hairs	hairs regular	hairs irregular	hairs regular except for a very few slightly irregular ones	hairs regular except for a very few irregular ones

Gunnysack Creek. The best examples are Racine 815 from the Great Kobuk Dunes (leaves 4-6 cm by 5-7 cm, pedicels 7-13 mm) and Murray and Johnson 6498 from a fertilizer test plot at Prudhoe Bay (colonized, not planted; leaves 2-6 cm by 4-9 mm, pedicels 15-25 mm). Large specimens from farther south include Welsh and Moore 7823 from Mile 1,022 Alaska Highway (leaves 2-3 cm by 3-6 mm, pedicels 10-20 mm).

Rollins and Banerjee (1975), in their atlas of Lesquerella hairs, pointed out differences between the hairs of L. arctica var. arctica and var. scammanae. They maintained that the hairs of var. arctica are regular and overlap in several layers, whereas those of var. scammanae are irregular and overlap in a single layer. Our observations have been that plants from Gunnysack Creek as well as elsewhere in Alaska-Yukon are generally densely hairy (hairs overlapping in several layers), but that most plants have a few leaves or parts of leaves with lighter hairiness (hairs overlapping in a single layer).

Hairs with bent and twisted rays such as those illustrated as typical of var. scammanae on Plate 11 in Rollins and Banerjee (1975), can be found (albeit rarely) on plants throughout the range of L. arctica. They were quite unusual on all specimens examined (including Scamman 1000, a paratype of var. scammanae) and showed no increase in frequency on the Gunnysack Creek plants.

It appears to us that there is no consistent difference between var. scammanae and var. arctica. The features attributed to var. scammanae are found throughout the range of L. arctica, but become more common in the southern, more continental part of its range. Therefore, we would not recognize var. scammanae as a valid taxon, but would reduce it to synonomy under L. arctica. After seeing our specimens Dr. Rollins has agreed (in litt. 1978) that var. scammanae can be accommodated within the range of variation of L. arctica var. arctica. He added that the apparent isolation of the Gunnysack Creek plants is no more difficult to explain than the isolation of many other populations of L. arctica.

Evaluation of threatened or endangered status

If our recommendation to absorb Lesquerella arctica var. scammanae into L. arctica var. arctica is accepted, then L. arctica var. scammanae must be removed from national and State lists of threatened or endangered taxa.

Lesquerella calderi Mulligan & Porsild (Cruciferae)

Calder bladderpod was recently described by Mulligan and Porsild (1969) based on specimens from the Ogilvie and Richardson Mountains in Yukon and Northwest Territories (Rollins and Shaw 1973). Hultén (1973) reported it from the "Upper Yukon R. near Eagle," in Alaska. The

Canadian collections are mostly from sparsely vegetated, rocky alpine summits and slopes between 600 and 1,600 m (2,000-5,200 ft) in elevation, usually on limestone (Mulligan and Porsild 1969). Hultén's (1937) brief geographic description quoted above suggests that the specimen he was reporting came from one of the dry bluffs overlooking the Yukon River. A description of Lesquerella calderi is contained in the "diagnoses" section of the discussion on L. arctica var. scammanae. We were unable to locate L. calderi in any of the study areas.

Podistera yukonensis Math. & Const. (Umbelliferae)

Description

Yukon podistera is a tufted perennial with a strong taproot (Figs. 9,10). The erect or ascending (growing obliquely upward) basal leaves are blue-green in color, 3-12 cm long, 1.5-3 cm broad, pinnate with 3-6 pairs of opposite leaflets, the lowermost leaflets usually ternate (compound with three equal divisions), the others simple. The leaflets are obovate to narrowly lanceolate and end in an abrupt, slender, unstiffened tip. They are 6-20 mm long by 1.5-5mm broad and are smooth and hairless except for the veins and margins, which are roughened with short, sharp projections. The stems are 10-40 cm tall, leafless, and tinged with red in fruit. The inflorescence is a compound umbel with several to many rays 5-10 mm long, subtended by an involucre of one or two small, linear, entire bracts (these sometimes lacking, at least in fruit). The many stout, short (1-5 mm) pedicels are subtended by an involucel of 5-10 linear-acuminate, entire, purplish bractlets 2-5 mm long, united to each other at their bases. The five petals are small (about 1 mm long) and white. The fruits are ovate-oblong, about 3-7 mm long by 1.5-3 mm broad, flattened, initially reddish but weathering to a straw color before dispersing. They have prominent slender ribs. The chromosome number has not yet been determined.

Distribution and habitat

This is a narrowly endemic species known from only four localities, all in the vicinity of the Yukon River near the Alaska-Yukon border. The type locality (Mathias and Constance 1950) is on the south side of the Little Klondike River, near McQuesten, at an elevation of 1,500 m (5,000 ft). The other three localities are 1) "near Eagle," 2) 58-Mile on the Sixtymile Road (Dawson-Jack Wade Junction Road) near the Alaska-Yukon border (in Yukon, 64°05'N, 140°59'W), and 3) Kathul Mountain (Hultén 1967, Young 1976). At Kathul Mountain, the only site we visited, this species is abundant on dry, south-facing rubble slopes and grasslands at low elevations, and a few plants are present as high as 885 m (2,900 ft). The plant is also known to grow in alpine settings [the type locality at 1,500 m (5,000 ft) and the Sixtymile Road locality at approximately 1,200 m (4,000 ft)], probably in well-drained rocky soils on south-facing slopes.

Fig. 9. Podistera yukonensis (Yukon podistera) in fruit. The reddish-colored stems and fruits become light brown with increasing age (Kathul Mountain, 19 July 1978).

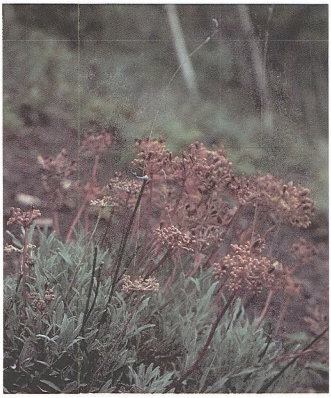


Fig. 10. Yukon podistera in fruit (Kathul Mountain, 19 July 1978).

Diagnoses

The family Umbelliferae is characterized by inflorescences of umbels, flowers with separate petals and inferior ovaries with two styles, and fruits consisting of a dry schizocarp of two halves (mericarps) united by their faces. The genus Podistera is separated from most other genera of Umbelliferae in Alaska-Yukon by the absence of stem leaves. Glehnia littoralis, a plant of coastal sand dunes in southern Alaska, has a very short leafless stem, but is densely hairy in contrast to the hairless Podistera. In addition, most species of the family are more than half a meter tall, whereas Podistera rarely exceeds 30 cm in height. Bupleurum triradiatum subsp. arcticum can be short in arctic and alpine habitats, but it has bright yellow flowers, stem leaves, and simple (as opposed to pinnately compound) basal leaves. The Asian species Phlojodicarpus villosus is similar to Podistera yukonensis, but has winged fruits and deeply divided leaflets. It has not yet been found in Alaska, but might occur on the tundra of northwestern Alaska.

The genus Podistera consists of only four species, all of which are geographically separated and apparently quite distinct taxonomically (Mathias and Constance 1942, 1950). The only other species of this genus present in Alaska-Yukon is Podistera macounii (as Ligusticum mutellinoides subsp. alpinum in Hultén 1968), a plant of dry, stony tundra settings in easternmost Chukotka, western Alaska, and the Alaska Range (Hultén 1968, 1973). It differs from P. yukonensis in that it has deeply divided leaflets, as opposed to the entire leaflets of P. yukonensis. The known ranges of these two species do not overlap, although they approach each other near the Yukon River in eastern Alaska.

Evaluation of taxonomic status

Podistera yukonensis is a very distinct taxon and its treatment at the species level has never been questioned. The only taxonomic issue has been whether the taxon Podistera should be maintained at the generic level or incorporated into some other genus (Hultén 1973, Mathias and Constance 1942).

Evaluation of threatened or endangered status

This species is proposed for threatened status on both the national and State lists because of the few localities at which it is known.

Phacelia sericea (Graham) A. Gray (Hydrophyllaceae)

Description

Silky phacelia is a perennial with a stout taproot and stems 10-50 cm tall (Figs. 11, 12). The leaves are mostly basal, 1.5-8(10) cm long, deeply pinnately lobed, the lobes often coarsely and deeply cleft into several acute and relatively narrow teeth (2-5 mm broad). The leaves appear silvery blue-green and are densely hairy with relatively short, stiff, appressed hairs. Stem leaves decrease markedly in size toward the top of the stem. The flowers are borne on a narrow inflorescence of several to many cymes. The united petals are blue to purple or lavender, showy, bell-shaped, hairy inside and out, and about 5-8 mm long by 7-11 mm broad. The stamens have hairless filaments and are long-exserted, about twice as long as the petals. The fruit is a many-seeded capsule. The chromosome number of our Alaskan material of P. sericea has been determined to be 2n=22. Plants from the southern range of this species share this number, as do all species of the Phacelia franklinii group (to which all Alaska-Yukon taxa of this genus belong) for which the chromosome number is known (Gillett 1960).

Distribution and habitat

This species is common in the mountains of southern British Columbia and Alberta south to northeastern California, Nevada, Arizona, and Colorado (Gillett 1960). In Alaska it is locally common on south-facing treeless slopes along the Yukon River between Eagle and Kathul Mountain, and is also present in the vicinity of Haines (Welsh 1974). A specimen (Bostock 10) from an elevation of 1,675 m (5,500 ft) in the Dawson Range of Yukon Territory (62°N, 138°W) was identified by L. Constance as P. sericea (Porsild 1951), but the same specimen was later referred to P. mollis by Gillett (1960) in his monograph of the Phacelia franklinii group.

Diagnoses

The family Hydrophyllaceae is characterized by flowers with united petals, superior ovaries, five stamens alternating with the petals, and two-cleft styles. Phacelia differs from the other two genera of this family present in the Alaska-Yukon flora (Nemophila and Romanzoffia) in having a perennial habit and elongate leaves (as opposed to round or kidney-shaped leaves). Neither of these genera is similar in general appearance to Phacelia.

Three species of Phacelia are present in Alaska-Yukon. These are P. franklinii, P. mollis, and P. sericea. Phacelia franklinii is a weedy annual or biennial, widespread in North America and fairly common on roadsides in southeastern Yukon Territory and adjacent Alaska

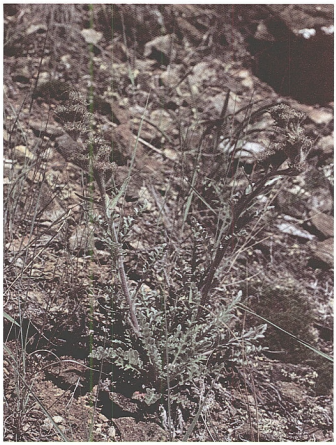


Fig. 11. (left) Phacelia sericea (silky phacelia) in fruit (Eagle Bluff, 11 July 1978).

Fig. 12. (below) Silky phacelia, showing one inflorescence in flower and one in fruit. The plant in flower has fewer flowers in its inflorescence than is normal (Eagle Bluff, 12 July 1978).

and British Columbia. It differs from P. sericea in its annual habit, in having stamens about as long as the petals (as opposed to twice as long), and in having hairy filaments (as opposed to hairless filaments). The long-exserted stamens of Phacelia sericea also set this species (along with the closely related P. mollis) apart from all other plants with showy blue to purple flowers that might appear superficially similar.

Phacelia mollis is closely related to P. sericea and is narrowly endemic to a small area of Alaska, Yukon, and northwesternmost British Columbia. More specifically it is known from the Ogilvie Mountains, the Dawson Range, the Taylor Highway (near Dawson and Chicken), the upper White River drainage in the St. Elias Mountains, the Haines-Skagway area, and several localities along the Alaska Highway between the Alaska-Yukon border and the Johnson River (Gillett 1960; Hultén 1941-50, 1968; Porsild 1951, 1975; Welsh 1974, specimens at ALA). It is found in dry sandy and rocky soils from the lowlands to the alpine, and is locally abundant as a roadside weed near Chicken on the Taylor Highway.

Phacelia mollis and P. sericea are quite similar to each other. Features useful in differentiating between them are summarized in Table 3. These criteria must be used together in determining specimens, since no one of them is completely reliable.

Evaluation of taxonomic status

The differences between P. mollis and P. sericea listed in Table 3 are subtle and difficult to quantify. When more is known of the distributions and variability of these two taxa, it might be deemed appropriate to consider P. mollis a subspecies of P. sericea. A parallel situation exists in the Rocky Mountains of the contiguous United States where a narrow-leaved high-altitude form (P. sericea subsp. sericea) and a broad-leaved low-altitude form (P. sericea subsp. ciliosa) exist (Gillett 1960, W. A. Weber in litt. 1978). Phacelia sericea in Alaska-Yukon appears to be substantially taller and to have a more interrupted inflorescence (i.e. there are flowerless gaps in the inflorescence instead of continuous flowers from the bottom to the top) than is characteristic of this species in its main range (Hitchcock et al. 1955-69).

Evaluation of threatened or endangered status

Because Phacelia sericea has a restricted distribution in Alaska-Yukon and is disjunct by at least 1,000 km from its main range, it is proposed for threatened status on a State list, even though it is common at the few localities where it is present. The species is abundant elsewhere in its range (the western United States) and cannot appear on the national list.

Table 3. Comparison of *Phacelia sericea* and *P. mollis*.

Phacelia sericea	*Phacelia mollis*
basal leaves 5-10 cm long, drying silvery blue-green	basal leaves 6-15 cm long, drying dull brown
leaves relatively stiff, texture not as soft	leaves lax with soft, velvety texture
primary leaf lobes usually deeply cleft into 2-4 narrow teeth	primary leaf lobes usually entire
ultimate leaf divisions (teeth) relatively narrow (2-4 mm), narrowly acute	ultimate leaf divisions (teeth) relatively broad (3-8 mm), broadly acute to obtuse or rounded
leaves densely hairy with stiff hairs; long appressed hairs on upper surface, appressed to spreading hairs on lower surface	leaves densely hairy with long, soft, spreading hairs (or sometimes hairs slightly appressed on upper surface)
petals purple, lavender, or dark blue	petals cream to yellowish, often tinged with blue

Fig. 13. Cryptantha shackletteana (Shacklette cryptantha) in fruit, but with faded petal remnants visible (Eagle Bluff, 11 July 1978).

Fig. 14. Shacklette cryptantha in fruit (Eagle Bluff, 11 July 1978).

Our specimens of Cryptantha shackletteana appear to have leaves no longer or narrower, inflorescences no more capitate, and nutlets little or no narrower than descriptions and illustrations of C. spiculifera (Higgins 1971, Hitchcock et al. 1955-69 as C. interrupta, Payson 1927). Long, appressed, bristlelike hairs originating from conspicuous pustules are abundant on the dorsal surfaces of the leaves, but are indeed apparently absent from the ventral surfaces. They are said to be abundant on both surfaces of the leaves of C. spiculifera (Higgins 1971, Hitchcock et al. 1955-69 as C. interrupta, Payson 1927).

The Eagle Bluff population has been determined to have a chromosome number of 2n=24. This has been the number most commonly reported for Cryptantha subgenus Oreocarya (Higgins 1971), and has been reported for one species (C. thyrsiflora) from the same species group as C. shackletteana. Taylor and Brockman (1966) reported a number of 2n=18 for C. macounii (synonomized under C. celosioides by Higgins 1971, and under C. interrupta by Hitchcock et al. 1955-69), a taxon also closely related to C. shackletteana.

Higgins (1969, 1971) took rather a narrow species concept by current taxonomic standards. Hitchcock et al. (1955-69), taking a broad species concept, synonomized C. spiculifera under C. interrupta, along with several other taxa also maintained at the species level by Higgins (1971) and Payson (1927), who both regarded C. interrupta as narrowly endemic to northern Nevada. It is probable that C. shackletteana would also be synonomized under this taxon using the species concept of Hitchcock et al. (1955-69). Since we have seen no comparative material and are unfamiliar with the genus, we are for the time being accepting Higgins' (1969, 1971) treatment of the Alaskan plants as a separate species.

Evaluation of threatened or endangered status

Ayensu and DeFilipps (1978) placed Cryptantha shackletteana on the national endangered species list. Since it is now known from two localities, at least one of which supports a large population, we feel that listing it as threatened would be more appropriate. If future taxonomic treatment should reduce this taxon to synonomy, the Alaskan plants should still be considered threatened on a State list because of their widely disjunct range.

THE STUDY AREAS

Four study areas were surveyed for rare taxa during the summer of 1978. These are the Black Rapids study area along the Richardson Highway on the northern flanks of the Alaska Range, the Eagle Bluff study area along the Yukon River in eastern Alaska, the Kathul Mountain study area 145 km (90 mi) down the Yukon River from Eagle, and the Chicken study area along the Taylor Highway. This section of the report provides general descriptions of the geology, topography, and vegetation of each study area. The vegetation units described are compatible with the provisional classification framework for Alaskan vegetation (Dyrness and Viereck 1978a, 1978b). The framework name of each vegetation unit is included in parentheses after our name if it differs substantially. This section also addresses the autecology of each rare taxon present in each study area, presenting information on distribution within the study area, approximate numbers of plants present, habitat requirements (in terms of landform, topography, elevations, and soils), and species associates. Scientific and common names are listed in Appendixes C and D.

Black Rapids Study Area

Setting

This study area is located on the north slope of the Alaska Range adjacent to the Richardson Highway in the vicinity of Donnelly and Rapids roadhouses (Fig. 15). It extends from the Delta River to approximately 9.5 km (6 mi) east of the river on a north-trending ridge paralleling the Delta River. Elevation varies between 520 m (1,725 ft) on the flood plain of the Delta River to 2,160 m (7,150 ft) on the summit of foothills of the Alaska Range in the southeast corner of the study area. Bedrock is predominately Birch Creek schists and gneisses of Precambrian or lower Paleozoic age. At lower elevations is a large deposit of poorly consolidated coal-bearing gravel and clay sediments of Tertiary age (Péwé 1977). The area has been repeatedly glaciated, although peaks in the southern part presumably protruded above the ice as nunataks during at least the most recent major glaciation. The northern third of the study area consists of a terminal moraine dating from the Donnelly Glaciation of late Wisconsin age (Péwé 1977). It forms a broad plateau about 305 m (1,000 ft) above the Delta River, and has pronounced kame and kettle topography with abundant lakes. A ridge of rugged mountains supporting a few small glaciers occupies the southern two-thirds of the study area. Lateral moraines of various ages extend along the lower slopes of the ridge. Streams tributary to the Delta River have incised deep canyons in the western flank of this ridge and have built large alluvial fans superimposed on the flood plain of the Delta River.

Cryptantha shackletteana Higgins (Boraginaceae)

Description

Shacklette cryptantha is a taprooted perennial reaching 8-20 cm in height (Figs. 13, 14). The basal leaves are linear to linear-oblanceolate, about 3-12 cm long, persistent several years, with blue-green color that weathers first to silvery gray and then brown. The flowers are borne on narrow cymes that are somewhat capitate (flowers concentrated at the top of the inflorescence) at flowering, but elongate to occupy approximately half of the total stem length in fruit. All parts of these plants are densely hairy with entangled, spreading, stiff hairs. In addition, the lower (dorsal) surfaces of the leaves have abundant long, appressed, stiff, bristlelike hairs (setae) originating from pustules (pale blistery structures on the leaf surface). The upper (ventral) surface has similar appressed, but slightly thinner and weaker, less bristlelike hairs not associated with pustules. The stems and sepals have long, weak, divaricate, flattened (in cross-section) hairs rising above the ubiquitous, dense, entangled, spreading hairs, and the sepals also have erect, bristlelike nonpustulate hairs. The hairs of leaves and stems are white, those of the inflorescences yellowish. The united petals are small and white, about as long as the united sepals. The basal united portion of the petals (the tube) is 3-4 mm long, and the lobes are equally as long and 5-6 mm broad. The sepals at flowering are 3-5 mm long, linear or narrowly lanceolate, elongating to 7-10 mm in fruit. The ovary is prominently four-lobed, separating into four lanceolate nutlets at maturity. The nutlets are 3.3-3.6 mm long, 1.6-2.0 mm wide, and the dorsal and ventral surfaces are muricate (roughened with short hard points) and rugulose with low and inconspicuous ridges. The scar on each nutlet marking the point of attachment to the gynobase (an extension of the receptacle) is open and awl-shaped, narrowly tapering to a sharp point.

Distribution and habitat

Cryptantha shackletteana grows on dry, steep, unstable, south-facing (or sometimes east-facing) rubble slopes, even extending into sparsely vegetated grasslands. A large population of this species is present at Eagle Bluff, and a population of unknown size is present at Calico Bluff, 19 km (12 mi) down the Yukon River from Eagle.

Diagnoses

The family Boraginaceae is characterized by flowers with united petals and superior four-lobed ovaries that separate into four nutlets at maturity. Cryptantha is separated from other Alaska-Yukon genera by its small, leafy-bracted white flowers, nutlets with a ventral groove scar and without prickles or teeth, by its lack of retrorse (pointing

backward down the stem) prickly hairs, and by its united sepals not enlarging in fruit.

Cryptantha is a very difficult genus taxonomically, consisting of about 150 species in western North and South America. Only two of these taxa are present in Alaska-Yukon. Cryptantha torreyana is an introduced weed that has been found at Skagway. It differs from C. shackletteana in having an annual habit, slender branched stems, few-flowered inflorescences, much smaller flowers, and smooth nutlets.

Amsinckia menziesii and A. lycopsioides are somewhat similar to Cryptantha shackletteana, but are introduced weedy annuals, with few basal leaves, many stem leaves, much taller stems, yellow petals, and racemose (rather than cymose) inflorescences. A racemose, or indeterminate, inflorescence has the youngest flowers at the top of the stem whereas a cymose, or determinate, inflorescence has the youngest flowers at the base. The basal leaves of Lesquerella arctica and related taxa are superficially similar to those of Cryptantha shackletteana and confusion in identifying them could occur if no flowers or fruits were present. Examination of the leaves with a hand lens would reveal on Cryptantha the simple hairs so unlike the distinctive stellate hairs of Lesquerella.

Evaluation of taxonomic status

Cryptantha shackletteana is distinct from all other taxa in the Alaska-Yukon flora. Its taxonomic relationship to other perennial species of this genus in the contiguous United States is not quite so clear, however. It is a member of the subgenus Oreocarya, which has long been known for taxonomic difficulty. Except for C. shackletteana, this subgenus reaches its northern limit in southern British Columbia, Alberta, and Saskatchewan (Higgins 1971).

Although first discovered only 18 years ago, the population at Eagle Bluff has already acquired a taxonomic history. Shacklette (1966), who first discovered the population, referred it to C. sobolifera, a species narrowly endemic to central Montana according to Higgins (1971) and Payson (1927). Hultén (1967, 1968) examined Shacklette's specimens and referred them to C. spiculifera, a plant with a fairly broad range in Washington, Oregon, and Idaho. Higgins (1969, 1971) agreed that the Alaskan plants are most closely related to C. spiculifera, but considered them distinct enough to be regarded as a separate species, C. shackletteana. Cryptantha shackletteana is distinguished by having longer and narrower leaves with inconspicuous pustulate hairs, a more capitate inflorescence, weaker stems, and longer and narrower nutlets with less evident markings than C. spiculifera. Hultén (1973) pointed but that these characteristics differ only in degree and that no fundamentally different characteristics separate the two taxa.

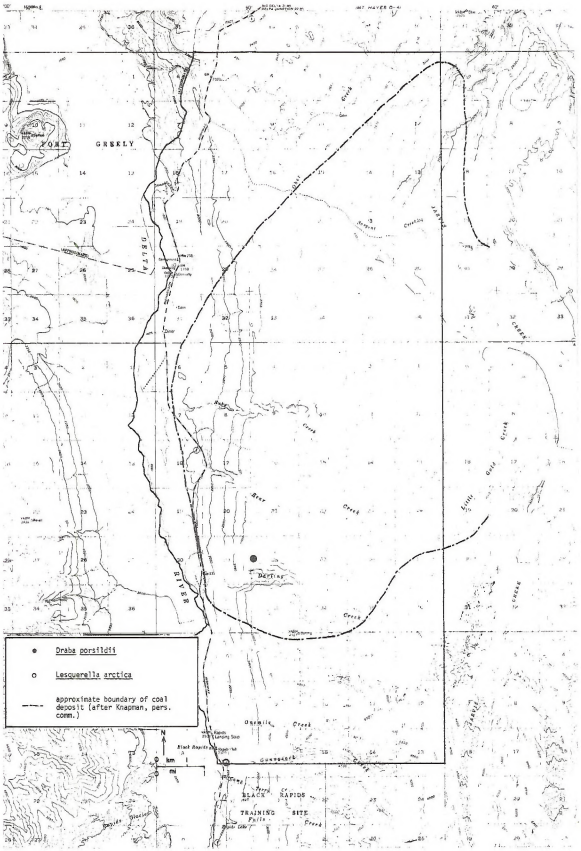


Fig. 15. U. S. Geological Survey 1:63,360 topographic map series, Mt. Hayes C-4 quadrangle, showing the Black Rapids study area.

Vegetation

White spruce (Picea glauca) forest occupies stable portions of the Delta River flood plain and tributary alluvial fans, and extends to an elevation of approximately 915 m (3,000 ft) on the valley walls. Some Betula papyrifera (paper birch) is scattered throughout this forest, and Alnus crispa (American green alder) 2-4 m tall commonly occupies openings. A number of species can be important in the understory, depending on site characteristics, but Cornus canadensis (bunchberry) and Pyrola asarifolia (liverleaf wintergreen) are usually common.

A large area of this forest above the Richardson Highway between Camp Terry Creek and just north of Darling Creek was burned in 1950 (Péwé 1977). Shrubs 2-5 m tall dominate the burn. Young white spruce trees 2-3 m tall are scattered throughout. Important shrubs include Salix planifolia subsp. pulchra (diamondleaf willow), Alnus crispa and Betula glandulosa (resin birch). Cornus canadensis, Epilobium angustifolium (fireweed), and Ledum groenlandicum (Labrador tea) are common in the understory. Openings in the shrub canopy support dense stands of Calamagrostis canadensis (bluejoint reedgrass) and Epilobium angustifolium.

Locally, poorly drained benches at low elevations support black spruce (Picea mariana) woodland. These open stands of trees 2-8 m tall are often mixed with alders and have understories rich in ericaceous shrubs and mosses.

Much of the flood plain (mid-grass grassland, low shrub and tall shrub shrubland) of the Delta River consists of unvegetated gravels. Relatively stable sites near the edges have been colonized by a number of shrubs and herbs. Important shrubs include Salix alaxensis (felt-leaf willow) and Elaeagnus commutata (silverberry). A wide variety of herbs is present. Some of the most characteristic are:

Polygonum viviparum
Astragalus alpinus
Astragalus adsurgens
Oxytropis campestris
Oxytropis deflexa var. foliolosa
Epilobium latifolium
Pedicularis verticillata
Artemisia borealis
Aster sibiricus

An open shrubland (open shrub birch shrubland) dominated by Betula glandulosa 1-2 m tall occupies much of the kame and kettle topography of the Donnelly moraine in the northern part of the study area as well as gently sloping benches near timberline farther south. Salix glauca (grayleaf willow) 1-2 m tall is interspersed with the birch, and white spruce a few meters tall are scattered among the shrubs. Other common species include:

Festuca altaica	Empetrum nigrum
Hierochloe alpina	Arctostaphylos alpina
Anemone narcissiflora	Ledum palustre subsp. decumbens
Lupinus arcticus	Vaccinium uliginosum
Epilobium angustifolium	Vaccinium vitis-idaea

Lichens are abundant in openings. Small lakes and marshes lie in the numerous kettles. Copses of willow (primarily Salix planifolia subsp. pulchra) and alder (Alnus crispa) are found along drainages and on sheltered slopes. Alpine tundra occurs on windblown kame summits.

At and just above timberline a belt of alder thickets (Alnus crispa) occurs. The steep sidewalls of canyons cut by tributaries of the Delta River also support alder thickets which are especially dense and extensive on north-facing slopes.

Subalpine meadows (mesic mid-grass-herb grassland) are common at timberline, especially on south and west slopes. These have an extremely diverse flora of lush grasses, sedges, and forbs.

On the slopes above timberline at approximately 915 m (3,000 ft), the vegetation is alpine tundra (sedge-grass, herbaceous, shrub, and mat and cushion tundra). Most of this tundra is a fell-field dominated by Dryas octopetala (white mountain-avens). Other common species include Saxifraga oppositifolia (purple mountain saxifrage), Oxytropis nigrescens (blackish oxytrope), Diapensia lapponica (arctic diapensia), and Pedicularis capitata (capitate lousewort). Sheltered depressions support fens in which sedges and a number of other herbs are found. Important species on these sites include Carex bigelowii (Bigelow sedge), C. membranacea (fragile sedge), Eriophorum triste (cotton-grass), Claytonia tuberosa (tuberous spring-beauty), Corydalis pauciflora (few-flowered corydalis), and Pedicularis sudetica subsp. albolabiata.

The landscape at elevations greater than 1,525 m (5,000 ft) consists almost exclusively of taluses and bedrock outcrops (alpine herbs, herbaceous tundra). These features interrupt tundra and even forest at lower elevations. Plant cover is sparse, but a relatively large number of species are represented, including Stellaria alaskana (Alaska starwort), Anemone drummondii (Drummond anemone), Astragalus aboriginorum (Indian milkvetch), Epilobium latifolium (river beauty), Cnidium cnidiifolium, Artemisia furcata, and Erigeron purpuratus.

Two other vegetation types of minor extent occur in the study area on dry south-facing slopes. Populus forests (aspen and balsam

poplar closed deciduous forest)[1] dominated by Populus tremuloides (quaking aspen), P. balsamifera (balsam poplar), or a mixture of the two occur on these warm slopes. Species common in the understory include Rosa acicularis (prickly rose), Shepherdia canadensis (buffaloberry), Epilobium angustifolium, and Arctostaphylos uva-ursi (kinnikinnick). On still drier and warmer slopes, a grassland (grass-shrub, dry mid-grass grassland or dry slope Elymus grassland) dominated by Calamagrostis purpurascens (purple reedgrass) or Elymus innovatus (downy ryegrass) occurs. Common associates include Carex supina subsp. spaniocarpa, Zygadenus elegans (elegant death-camas), Arenaria capillaris (beautiful sandwort), Saxifraga reflexa (Yukon saxifrage), and Bupleurum triradiatum (thoroughwax).

Autecology of threatened and endangered species

Draba porsildii (Porsild draba) and Lesquerella arctica var. scammanae (Scamman arctic bladderpod) are present in the study area. The geomorphologic setting, soil characteristics, and other environmental factors of sites in the study area occupied by each taxon are summarized in Table 4.

Draba porsildii (Porsild draba). This species was found on a steep, unstable, west-facing talus of small shaley sliderock at an elevation of 1,050 m (3,500 ft) north of Darling Creek Canyon. Only a few plants were noticed (fewer than five), but since the plant was not recognized at that time as belonging to this species, an intensive search was not made. The site in which it was growing was very sparsely vegetated, but Festuca rubra (red fescue), Arenaria capillaris, Draba lactea (milky draba), Saxifraga eschscholtzii (ciliate saxifrage), S. tricuspidata (prickly saxifrage), Dryas octopetala, Astragalus polaris (polar milkvetch), Hedysarum alpinum (alpine sweetvetch), and Epilobium latifolium were also growing in the general area.

This is a species which grows in rock crevices and sparsely vegetated taluses and is likely to occur in small numbers on many of the abundant outcrops and taluses above timberline in the study area. It could occur on slopes of any exposure.

Lesquerella arctica var. scammanae (Scamman arctic bladderpod). As noted in the first section of this report, var. scammanae appears not to be a valid segregate of Lesquerella arctica. Since this is to some extent a matter of taxonomic opinion the following information on this taxon is presented.

[1]Both species are included in this unit since the understory is roughly the same in pure stands of each as well as mixed stands.

Table 4. Summary of environmental characteristics of sites supporting threatened or endangered taxa in the Black Rapids study area.

Taxon	Landscape feature	Elevation	Aspect (azimuth)	Slope angle	Slope texture	Soil drainage
Draba porsildii	taluses	1,050 m (3,500 ft)	270° (but probably not restricted)	30°-50°	shaley rock fragments	good to excessive
Lesquerella arctica var. scammanae	bluffs and flood plains	670 m (2,200 ft)	160°-220°, (but one plant at base of north slope)	level to overhanging	fine sand to cobbles	good to excessive

Fig. 16. South-facing bluff at Gunnysack Creek. Lesquerella arctica is abundant in the small swale on top of the bluff seen in the center of the photo. It also extends along the bluff edge to the left and right of the swale beyond both edges of the photograph and is scattered on the bluff face. A few plants are also present on the flood plain of Gunnysack Creek and on level alluvium behind and to the right of the camera.

Scamman arctic bladderpod was found only at the type locality near the mouth of Gunnysack Creek in the southwest corner of the study area, at an elevation of 680 m (2,250 ft). The center of this population is in a sandy swale on top of the bluff north of Gunnysack Creek just upstream from the Richardson Highway (Fig. 16); it grows abundantly both in open grassland vegetation and in a small stand of young (3-4 m tall) Populus balsamifera at this site (Fig. 17). It is fairly common along the edge of the bluff in both directions from the swale, but does not extend at all into the white spruce forest back from the bluff edge. It extends approximately 200 m east of the swale to the trans-Alaska pipeline and 100 m west to the Richardson Highway, but was not found beyond either of these features. In all, several hundred plants grow on top of the bluff, and about one-third of them are in the sandy swale.

Several tens of plants grow on the steeply south-facing bluff face of coarse alluvium (Fig. 18), and a few scattered plants grow on level coarse alluvium on both sides of the active flood plain of Gunnysack Creek. No plants were found on the west-facing roadcuts along the Richardson Highway north or south of Gunnysack Creek or on the north-facing bluff overgrown with alder on the south side of Gunnysack Creek. No plants were found west of the Richardson Highway or east of the trans-Alaska pipeline.

Abundant seed was being produced and many young plants were present. On the top of the bluff L. arctica had colonized mineral soil exposed when a large spruce tree fell down, probably 5-25 years ago. The plants on the Gunnysack Creek flood plain are on sites presumably purged by catastrophic floods several times per century, indicating that they have colonized these sites subsequent to the last such occurrence.

Lesquerella arctica occurs essentially in two plant communities at the Gunnysack Creek site, in a stand of Populus balsamifera on one side of the swale on top of the bluff (Fig. 17), and in adjacent grassland vegetation (grass-shrub dry mid-grass grassland) dominated by Elymus innovatus and a number of herbs. Common species include:

Elymus innovatus	Oxytropis viscida
Zygadenus elegans	Epilobium latifolium
Stellaria longipes	Gentiana propinqua
Draba glabella	Artemisia borealis
Hedysarum alpinum	Solidago multiradiata
Oxytropis campestris	

The grassland reaches its best development in the swale near the balsam poplar, and narrow strips extend both directions along the bluff edge. The grassland vegetation extends essentially unchanged into the poplar stand and becomes the understory, but does not

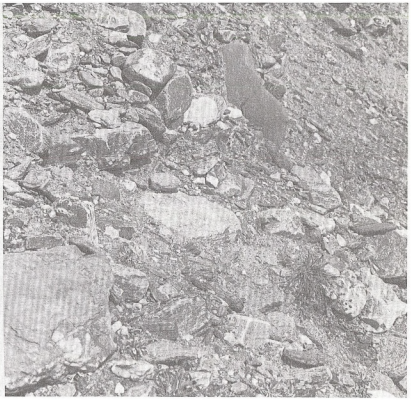


Fig. 17 (left). Stand of balsam poplar on the south-facing slope bordering the swale on top of the Gunnysack Creek bluff. Arctic bladderpod is common in the understory of this stand.
Fig. 18 (right). Arctic bladderpod on eroding alluvial fan deposits on the Gunnysack Creek bluff.

penetrate into the white spruce forest back from the bluff edge. The bluff face and the coarse alluvium on the flood plain of Gunnysack Creek are essentially unvegetated (Fig. 16). Hedysarum mackenzii (Mackenzie sweetvetch), Epilobium latifolium, and Crepis nana (tiny hawksbeard) have colonized these sites along with L. arctica. In addition, a few small and widely scattered shrubs and woody plant seedlings are present on the flood plain, including white spruce, balsam poplar, feltleaf willow, and American green alder.

No other populations of Scamman arctic bladderpod were found despite an extensive search throughout the study area and a check of readily accessible potential sites north and south of the study area. Habitats searched include treeless south-facing bluffs, open quaking aspen and balsam poplar stands on south-facing slopes, blowouts near timberline at canyon edges, bedrock outcrops at high and low altitudes, alpine taluses and fell-fields, kames on the Donelly moraine, the Delta River flood plain, and tributary flood plains. The nearest known occurrence of this species to Gunnysack Creek is Big Delta (Rollins and Shaw 1973).

Effects of development of a surface coal mine on threatened and endangered taxa

Application has been made to BLM for permission to develop the coal deposit in the northern half of the study area. The effects of the proposed mine on each taxon are discussed below.

Draba porsildii (Porsild draba). The only population found of this species was near Darling Creek, within the limits of the coal deposit. More populations of this species could be present anywhere in taluses of the rugged mountains south of the north wall of Ruby Creek canyon. If the surfaces on which these plants grow is removed, the plants will certainly be destroyed.

Lesquerella arctica var. scammanae (Scamman arctic bladderpod). The only population found of this taxon lies outside the limits of the coal deposit and consequently would not be affected by the development of a coal mine. This site is marked as a materials reserve by the Alaska Department of Transportion, however. Removal of gravel from the bluff at Gunnysack Creek could conceivably destroy the entire population of Lesquerella arctica there. Hydraulic mining of the bluff would cause a similar result. Widening or rerouting the Richardson Highway would also pose threats to these plants. If our recommendation to reduce Lesquerella arctica var. scammanae to synonomy under L. arctica var. arctica is accepted, however, these plants will not be protected by the Endangered Species Act. The destruction of this population would mean the loss of part of the gene pool of Lesquerella

arctica and the elimination of an interesting isolated population which poses questions about the nature of plant dispersal, establishment, and persistence.

Eagle Bluff Study Area

Setting

The Eagle Bluff study area is a relatively small one, encompassing approximately 14 km^2 (5.5 mi^2) on the west bank of the Yukon River just north of the town of Eagle (Fig. 19). Elevation ranges from 260 m (850 ft) to 700 m (2,300 ft). Eagle Bluff is the central feature of the study area, rising abruptly 410 m (1,350 ft) above the Mission Creek Valley. The crest of the bluff is a ridge trending at an azimuth of 125°-305°.

Rolling uplands north of Eagle Bluff are underlain primarily by mudstone, sandstone, gritstone, and conglomerate of the Nation River Formation, with local occurrence of the McCann Hill Chert. The bluff itself is composed of limestone and greenstone. The greenstone outcrops primarily at the top of the bluff and the limestone primarily at the base. Thick deposits of alluvium and colluvium mantle the lowlands south of the bluff (Foster 1976). Erosion by Mission Creek has oversteepened the lower part of the bluff locally. The Yukon River has truncated the east end of the bluff, where cliffs descend directly into the water. The Tintina Fault lies in the Mission Creek Valley below the bluff and is at least partially responsible for the existence of the bluff.

Vegetation

White spruce forest is extensive in the study area, occurring on the lowlands south of Eagle Bluff, on well-drained parts of the rolling uplands north of Eagle Bluff, and locally on draws and benches on the south face of Eagle Bluff itself. A few paper birch trees and alder shrubs are scattered in these stands, and on south slopes quaking aspen and balsam poplar are present. The understory varies considerably with slope steepness, aspect, and other factors of site, but species generally common include Equisetum arvense (meadow horsetail), Rosa acicularis (prickly rose), Cornus canadensis (bunchberry), Pyrola asarifolia (liverleaf wintergreen), and Viburnum edule (highbush cranberry).

Poorly drained gentle slopes on the rolling upland north of the bluff support black spruce (Picea mariana) woodland. A few willow and alder shrubs 1-2 m tall are scattered among the trees. The understory consists of a thick mat of mosses, locally including sphagnum and several species of ericaceous shrubs.

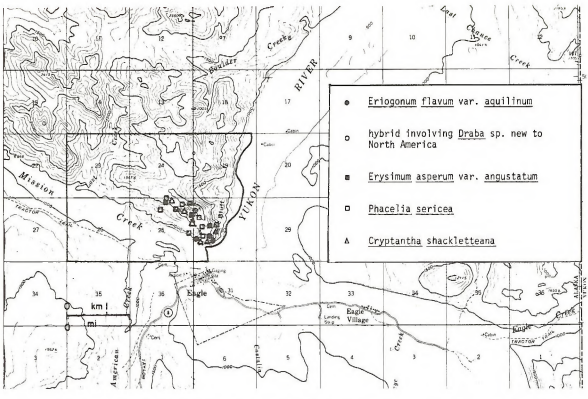


Fig. 19. U. S. Geological Survey 1:63,360 topographic map series, Eagle D-1 quadrangle, showing Eagle Bluff study area.

Mission Creek is lined by a flood plain forest (balsam poplar-willow closed deciduous forest) of balsam poplar and tall willows. Farther from the creek stands of alder often are found.

A few bogs (sphagnum-shrub freshwater bog) are present in depressions on the lowland south of the bluff. Mosses (including sphagnum), ericaceous shrubs, and sedges characterize this vegetation type.

A Populus forest (aspen and balsam poplar closed deciduous forest), dominated by Populus balsamifera (balsam poplar), P. tremuloides (quaking aspen), or a mixture of both, occupies draws, benches, and mesic slopes of Eagle Bluff. Scattered individuals of Picea glauca (white spruce) and Betula papyrifera (paper birch) are often present on relatively moist sites. Rosa acicularis generally dominates the understory. Other common plants include Juniperus communis (common juniper), Festuca altaica (Altai fescue), Astragalus eucosmus (elegant milkvetch), Lupinus arcticus (arctic lupine), Shepherdia canadensis (buffaloberry), Cornus stolonifera (red-osier dogwood), and Viburnum edule.

Grassland (grass-shrub dry mid-grass grassland) occupies extensive south-facing slopes too dry to support the Populus forest. Stunted individuals of quaking aspen and balsam poplar can be scattered over this vegetation type. In general, the grassland is dominated by Agropyron spicatum (bluebunch wheatgrass), Calamagrostis purpurascens (purple reedgrass), Festuca altaica, Artemisia frigida (fringed sagebrush), or some combination of these species. Zygadenus elegans (elegant death-camas), Minuartia yukonensis, and Bupleurum triradiatum (thoroughwax) are also locally dominant or codiminant.

The three important grasses give some indication of environmental characteristics at a site. Festuca altaica is most abundant on relatively mesic slopes that are not as steep or not as directly south-facing as slopes dominated by the other two grasses. It is dominant (or often codominant with Calamagrostis purpurascens) in a relatively small proportion of the grasslands at Eagle Bluff. Plant cover reaches a maximum in this type, but is still less than continuous. Calamagrostis purpurascens is dominant or codominant over most of the grassland at Eagle Bluff and indicates drier conditions than Festuca altaica. Plant cover is discontinuous, with bare soil exposed between plants. Agropyron spicatum is common on the driest, steepest, most unstable slopes capable of supporting grassland vegetation. It occurs on slope angles as high as 45°. Artemisia frigida is often codominant with Agropyron spicatum and Calamagrostis purpurascens, but is rarely abundant in the same sites as Festuca altaica. Other common grassland species include:

Poa glauca	Androsace septentrionalis
Silene repens	Phacelia sericea
Pulsatilla patens	Galium boreale
Arabis holboellii	Campanula aurita
Saxifraga reflexa	Senecio ogotorukensis
Potentilla pensylvanica	Solidago decumbens
Linum lewisii	Solidago multiradiata
Epilobium angustifolium	

Rubble slopes (grass-shrub dry mid-grass grassland) are too steep, dry, and unstable to support anything but scattered plants. Plant cover is very low (less than 5 percent) on these sites, but a wide variety of species is present. The term "rubble slope" is used to refer to thick sheets of small, highly weathered rock fragments often mixed with much silt and supporting sparse vegetation. The slopes are similar to taluses and probably represent a form of talus, but the rubble is weathered in place (with slow downslope movement) and has not fallen from bedrock exposures upslope as has the sliderock in most taluses. Rubble slopes occur on steep slopes at relatively low elevations on ancient surfaces. Usually, river erosion at the foot of the slope is responsible for keeping the slope steep. Most species found

in the grassland also grow on rubble slopes, but in greatly reduced numbers. Common species include:

Minuartia yukonensis	Phacelia sericea
Aconitum delphinifolium	Cryptantha shackletteana
Braya humilis subsp. richardsonii	Campanula aurita
Saxifraga reflexa	Artemisia alaskana
Saxifraga tricuspidata	Artemisia frigida
Astragalus aboriginorum	Senecio ogotorukensis
Linum lewisii	Solidago multiradiata

Autecology of threatened and endangered species

Four rare taxa, Eriogonum flavum var. aquilinum (Eagle yellow eriogonum), Erysimum asperum var. angustatum (narrowleaf plains erysimum), Phacelia sericea (silky phacelia), and Cryptantha shackletteana (Shacklette cryptantha), are present in this study area. Environmental characteristics of the sites are summarized in Table 5.

All threatened and endangered taxa present in this study area are restricted to grassland and rubble slopes on south-, southeast-, or southwest-facing slopes. The soils of these slopes were investigated in detail by Shacklette (1966). On relatively gentle slopes supporting grassland vegetation, a soil profile has developed in which an A horizon 45 cm (17.5 in) thick of a brown to reddish silt loam with a loose crumb structure overlies a 30 cm (12 in) slightly calcified, clayey B horizon which in turn lies on a C horizon of fine to coarse rubble that

Table 5. Summary of environmental characteristics of sites supporting threatened and endangered taxa in the Eagle Bluff study area.

Taxon	Landscape feature	Elevation	Aspect (azimuth)	Slope angle	Soil texture	Soil drainage
Eriogonum flavum var. aquilinum	south-facing bluffs, usually on relatively well-vegetated grassland but extending onto sparsely vegetated rubble slopes	275-485 m (900-1,600 ft)	165°-225°	30°-45°	rocky silt loam to rubble	excessive
Erysimum asperum var. angustatum	steep, unstable, sparsely vegetated rubble slopes	490-670 m (1,600-2,200 ft)	130°-200°	35°-45°	rubble	excessive
Phacelia sericea	south-facing bluffs, well-vegetated grassland and sparsely vegetated rubble	275-670 m (900-2,200 ft)	130°-225°	20°-40°	rocky silt loam to rubble	good to excessive
Cryptantha shackletteana	steep, unstable sparsely vegetated rubble slopes	275-670 m (900-2,200 ft)	130°-225° (110° at Calico Bluff)	30°-45°	rubble	excessive

merges into greenstone bedrock. Rock fragments are abundant throughout the profile. The soil is deep, and roots extend to a depth of 76 cm (30 in). Soil pH varies from 5.8 at the surface to 8.2 at depth. The soil is excessively drained and extremely dry at the surface during the growing season. The high content of nickel and chromium in this soil give it "the chemical nature of 'serpentine soil' as the term is used in ecological literature" (Shacklette 1966, p. 12). Nevertheless, the high calcium content of the soil at Eagle Bluff is not characteristic of serpentine soils elsewhere, and apparently permits the normal growth of plants in contrast to the usual inhibiting effect of serpentine soils on plant growth.

Lithosols are all that have developed on slopes steeper than approximately 35° (Shacklette 1966). Although greenstone outcrops predominantly at the top of the bluff and limestone at the base, there is quite a diversity of rock types present. The greenstone is interlayered with tuff, volcanic conglomerate, laminated quartzite, argillite, siliceous shale, and chert. The limestone is interbedded with shale, argillite, chert, calcareous siltstone, dolomite, tuff, and greenstone (Foster 1976). Carbonitic precipitates are common on rock fragments of rubble slopes at both high and low elevations, probably negating the ecological effects of the greenstone. We did not perceive any effects of greenstone and limestone rock types on plant distribution on the bluff.

Eriogonum flavum var. aquilinum (Eagle yellow eriogonum). This taxon occupies a relatively restricted area at the east end of Eagle Bluff, but is common within that area. The population consists of several thousand individuals and appears to be healthy. Most plants were flowering and setting viable seed. This eriogonum is found at elevations between 275 m and 485 m (900-1,600 ft), on slopes ranging from approximately 165° to 225° in azimuth and from 30° to 45° in steepness. Most plants grow in grassland with fairly deep, coarse, excessively drained soils with numerous small rock fragments (Fig. 20). A number of plants grow on sparsely vegetated slopes of unstable gravel-sized rubble (Figs. 21, 22).

The grassland communities in which eriogonum occurs are generally dominated by Agropyron spicatum, Calamagrostis purpurascens, and Artemisia frigida. Other species commonly present include:

Juniperus communis
Zygadenus elegans
Minuartia yukonensis
Pulsatilla patens
Braya humilis
Potentilla hookeriana
Hedysarum mackenzii
Oxytropis campestris
Linum lewisii
Bupleurum triradiatum
Phlox hoodii
Phacelia sericea
Cryptantha shackletteana
Campanula aurita
Artemisia borealis
Solidago multiradiata

Approximately the same species are associated with eriogonum on rubble slopes, but at much lower densities.

Erysimum asperum var. angustatum (narrowleaf plains erysimum). This taxon is found on unstable, sparsely vegetated rubble near the top of Eagle Bluff. The population at Eagle Bluff consists of a few hundred plants, and it appears to be healthy and maintaining itself. Seed is set and juvenile plants are present. Most of the population is on a large, southeast-facing rubble slope at the east end of the study area (Fig. 23), and another concentration of plants is on a large south-southwest-facing rubble slope near the west end of the study area (Fig. 24). This taxon was found only at elevations greater than 490 m (1,600 ft), but might occur in appropriate habitats at lower elevations. It is apparently restricted to steep, unstable rubble (35°-45°) and was found on slopes ranging from 130° to 200° in azimuth.

The substrate where this taxon was found consists of deep accumulations of shifting, unstable, gravel-sized rubble. This substrate is excessively drained and dry. These sites are sparsely vegetated. The sparse vegetation of the large rubble slope previously mentioned at the east end of the study area consists almost entirely of Erysimum asperum var. angustatum, Phacelia sericea (silky phacelia), and Cryptantha shackletteana, with Epilobium angustifolium (fireweed) and Galium boreale (northern bedstraw) near the bottom (Fig. 23). Elsewhere, other species sharing rubble slopes with Erysimum asperum var. angustatum include:

Calamagrostis purpurascens	Linum lewisii
Minuartia yukonensis	Bupleurum triradiatum
Aconitum delphinifolium	Penstemon gormanii
Pulsatilla patens	Campanula aurita
Saxifraga tricuspidata	Artemisia alaskana
Chamaerhodos erecta	Artemisia frigida
Astragalus aboriginorum	Senecio ogotorukensis
Oxytropis campestris	Solidago multiradiata

Phacelia sericea (silky phacelia). This species is common on grassland and rubble slopes, especially at high elevations. The population within the study area probably numbers several tens of thousands. Abundant seed is produced and young plants are common. Sites supporting this species range from 275 to 670 m (900-2,200 ft) in elevation, from 130° to 225° in azimuth, and from 20° to 40° in steepness. Silky phacelia grows in relatively well-vegetated grasslands (Fig. 25) as well as on sparsely vegetated rubble slopes (Figs. 21, 23, 24, 26). On rubble slopes it is usually in more stable settings than are Erysimum asperum or Cryptantha shackletteana. The substrate ranges from the rocky silt loam of the grassland to rubble, and it is well to excessively drained.

Fig. 20. (above) Grassland with Eriogonum flavum (yellow flowers) on the lower slopes of the east end of Eagle Bluff. The grassland is dominated by Agropyron spicatum, Calamagrostis purpurascens, and Artemisia frigida. Other species visible include Minuartia yukonensis (small white flowers) and Bupleurum triradiatum (tall yellow-flowered plant, scarce, in background). Cryptantha shackletteana is also present at this site, but does not show in photograph. **Fig. 21.** (right) Rubble slope low on the east end of Eagle Bluff. Plants visible include Agropyron spicatum (foreground), Eriogonum flavum (one plant with a few dull yellow-orange flowers near center of photo), Phacelia sericea (one plant in the foreground), and Cryptantha shackletteana (small plant with blue leaves). (Both photos 14 July 1978.)

Fig. 22 (left). Rubble slope low on the east end of Eagle Bluff above Mission Creek. Eriogonum flavum and Cryptantha shackletteana are present, along with Agropyron spicatum, Campanula aurita (Yukon bellflower), Artemisia borealis (northern wormwood), and Artemisia frigida (26 July 1978).

Fig. 23 (right). Southeast-facing rubble slope at 490 m (1,600 ft) overlooking the Yukon River at the east end of Eagle Bluff. Erysimum asperum, Phacelia sericea, and Cryptantha shackletteana are the most abundant species on the slope (26 July 1978).

Phacelia sericea is associated with a wide variety of species in both the grassland and rubble slope settings. It grows in grassland dominated by various combinations of Calamagrostis purpurascens, Festuca altaica, Zygadenus elegans, and Artemisia frigida. Other species include:

Agropyron spicatum	Linum lewisii
Eriogonum flavum	Epilobium angustifolium
Minuartia yukonensis	Bupleurum triradiatum
Silene menziesii	Phlox hoodii
Silene repens	Orobanche fasciculata
Aconitum delphinifolium	Galium boreale
Pulsatilla patens	Campanula aurita
Arabis holboellii	Aster sibiricus
Saxifraga reflexa	Solidago decumbens
Potentilla hookeriana	Solidago multiradiata
Oxytropis campestris	

Sometimes stunted Populus balsamifera or P. tremuloides saplings are present on these sites.

An even greater variety of species share rubble slopes with silky phacelia. These include:

Agropyron spicatum	Linum lewisii
Zygadenus elegans	Shepherdia canadensis
Eriogonom flavum	Epilobium angustifolium
Minuartia yukonensis	Bupleurum triradiatum
Aconitum delphinifolium	Cnidium cnidiifolium
Braya humilis	Cryptantha shackletteana
Saxifraga reflexa	Penstemon gormanii
Saxifraga tricuspidata	Campanula aurita
Chamaerhodos erecta	Artemisia alaskana
Potentilla nivea	Artemisia frigida
Rosa acicularis	Crepis nana
Astragalus aboriginorum	Senecio ogotorukensis
Oxytropis campestris	Solidago multiradiata

Cryptantha shackletteana (Shacklette cryptantha). This species is widely scattered over the study area, but absent from several sites that otherwise appear suitable. It occurs at high elevations at the eastern end (above the river) and western end of the study area and extends to low elevations with Eriogonum flavum (Eagle yellow eriogonum) at the eastern end (above Mission Creek) of the study area. A few thousand plants of this species are present. Seed is set, and plants that are apparently juvenile are not uncommon, indicating that the population is healthy and maintaining itself. Sites where Shacklette cryptantha was found range in elevation from 275 m to 670 m (900-2,200 ft), range in azimuth from 130° to 225° (to 110° at Calico

Bluff), and range in slope steepness from 30° to 45°. This species is found predominantly on extensive rubble slopes with thick accumulations of rubble, but can extend onto rock outcrops, adjacent thin deposits of rubble, and grassland with a deep soil of rocky silt loam. All of these substrates are dry and excessively well-drained. At high elevations (above approximately 490 m or 1,600 ft), this species grows on rubble and occasionally outcrops, usually in small rills or ravines with finer textured and more unstable rubble than the rest of the slope. It is usually associated with Artemisia alaskana (Alaska sagebrush) on these sites (Figs. 24, 26). On a large rubble slope above the Yukon River at the east end of the study area, Shacklette cryptantha is associated primarily with Erysimum asperum and Phacelia sericea (Fig. 23). Other species growing on sparsely vegetated rubble at high elevations with Shacklette cryptantha include:

Agropyron spicatum	Epilobium angustifolium
Zygadenus elegans	Bupleurum triradiatum
Minuartia yukonensis	Cnidium cnidiifolium
Aconitum delphinifolium	Penstemon gormanii
Braya humilis	Galium boreale
Saxifraga reflexa	Campanula aurita
Chamaerhodos erecta	Artemisia frigida
Astragalus aboriginorum	Crepis nana
Linum lewisii	Senecio ogotorukensis

Species sharing low-elevation rubble and outcrops (Figs. 21, 22) with Shacklette cryptantha include:

Juniperus communis	Linum lewisii
Agropyron spicatum	Bupleurum triradiatum
Calamagrostis purpurascens	Phlox hoodii
Eriogonum flavum	Penstemon gormanii
Minuartia yukonensis	Campanula aurita
Aconitum delphinifolium	Artemisia borealis
Braya humilis	Artemisia frigida
Oxytropis campestris	Erigeron compositus

Shacklette cryptantha extends into grassland only at low elevations on the same part of the bluff where Eriogonum flavum is found (Fig. 20). Agropyron spicatum (bluebunch wheatgrass), Minuartia yukonensis, Artemisia frigida (fringed sagebrush), and locally Calamagrostis purpurascens (purple reedgrass) generally dominate the parts of this grassland where Shacklette cryptantha occurs. Other species present include:

(Continued on page 63.)

Fig. 24. Rubble slope high on the west end of Eagle Bluff. A plant of Phacelia sericea is visible at the right-hand edge of the photograph. Cryptantha shackletteana is common in the foreground and middle distance. A dried, branched stem of Erysimum asperum is visible in the background near the left edge of the photograph. Other species visible include Epilobium angustifolium and Artemisia alaskana (Alaska sagebrush).

Fig. 25. Grassland on upper slope of Eagle Bluff with Phacelia sericea in the foreground. This is about as densely vegetated a site as this species inhabits. This grassland is dominated by Calamagrostis purpurascens, Festuca altaica, and Zygadenus elegans (12 July 1978).

Fig. 26. Rubble slope just east of the summit of Eagle Bluff. Phacelia sericea is present throughout the exposure and Cryptantha shackletteana is present on slopes in the middle distance.

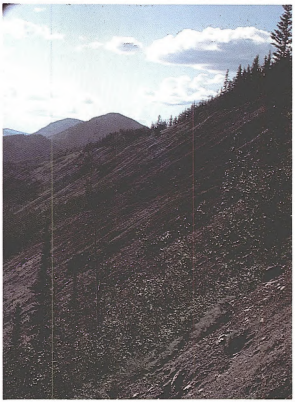


Fig. 24. Above

Fig. 25. Top right

Fig. 26. Lower right

Descriptions on facing page.

Zygadenus elegans	Hedysarum mackenzii
Eriogonum flavum	Oxytropis campestris
Pulsatilla patens	Linum lewisii
Braya humilis	Bupleurum triradiatum
Potentilla hookeriana	Solidago multiradiata

Shacklette cryptantha was also found on sparsely vegetated rubble at river level on Calico Bluff, 19 km (12 mi) down the Yukon River from Eagle. We were unable to determine the geographic extent of this population or the numbers of plants present since we were en route to Kathul Mountain at the time. This information should be obtained.

Kathul Mountain Study Area

Setting

Kathul Mountain lies on the north bank of the Yukon River roughly half-way between Eagle and Circle. It rises from an elevation of 230 m (750 ft) at the Yukon River to 953 m (3,122 ft) at its summit and lies at the west end of a long ridge bordering a northward-looping meander of the Yukon River (Fig. 27). A higher, unnamed summit east of Kathul Mountain along that ridge reaches an elevation of 973 m (3,190 ft) and is within the study area. Bedrock of Kathul Mountain and the axis of the ridge is the Kathul Graywacke, flanked by the Biederman Argillite on the lower slopes (Brabb and Churkin 1969). A terrace capped by coarse paleoalluvium extends 1.4 km (0.9 mi) west from the western end of Kathul Mountain at an elevation of 460 m (1,500 ft). The mountain and its attached ridge rise abruptly from the river with cliffs and rubble slopes separated by slightly less steep slopes supporting forest or grassland. North of the ridge crest the terrain slopes gently northward to the Kandik River.

Vegetation

White spruce forest is widespread in the study area, and the associated understory species vary considerably with physiographic setting. A gallery white spruce forest forms a narrow strip adjacent to the Yukon River at the eastern and western ends of the study area. Shrubs of Alnus tenuifolia (thinleaf alder) and willows 1-3 m tall are scattered in this gallery forest. Common understory species are:

Equisetum arvense	Lupinus arcticus
Carex bigelowii	Ledum groenlandicum
Cypripedium passerinum	Pyrola asarifolia
Potentilla fruticosa	Arctostaphylos rubra
Rosa acicularis	Saussurea angustifolia
Astragalus robbinsii	

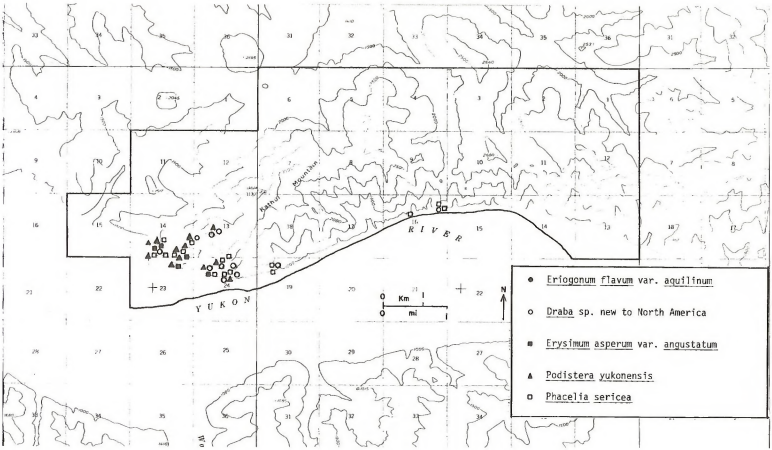


Fig. 27. U. S. Geological Survey 1:63,360 topographic map series, Charley River B-3 quadrangle, showing Kathul Mountain study area.

The forest floor is covered with the pleurocarpous mosses typical of moist forest settings in interior Alaska.

White spruce forest also occupies substantial areas on the south slopes of the Kathul Mountain ridge and terrace system, as well as well-drained sites north of the crest. It is restricted to mesic slopes that are not as steep nor as directly south-facing as those supporting Populus forest or treeless vegetation types. Scattered individuals of Betula papyrifera (paper birch), Populus tremuloides (quaking aspen), and P. balsamifera (balsam poplar) are often present.

The white spruce forest grades into a subalpine white spruce woodland near the top of the mountain on both the south and north sides. Paper birch and scattered shrubs (primarily Salix glauca and Alnus crispa) 1-3 m tall are associated with the spruce. The ground cover consists largely of such species as Festuca altaica (Altai fescue), Zygadenus elegans (elegant death-camas), Anemone parviflora (northern windflower), Hedysarum alpinum (alpine sweetvetch), Bupleurum triradiatum (thoroughwax), Gentiana propinqua, and Mertensia paniculata (tall bluebell).

Black spruce woodland is common on poorly drained parts of the flood plain of the Yukon River. Shrubs (willows, Alnus tenuifolia, and Betula nana) are common in this vegetation type. The understory is rich in mosses, sedges, and ericaceous shrubs. Black spruce woodland also occurs on poorly drained slopes to the north of Kathul Mountain.

A number of other vegetation types are present on the flood plain of the Yukon River, but these were not investigated. They include bogs (sphagnum-shrub freshwater bog), marshes (freshwater marshes), lakes (freshwater aquatic), grasslands dominated by Calamagrostis canadensis (bluejoint and bluejoint-herb tall grass grassland), and shrub thickets (open and closed willow and alder tall shrubland).

A Populus forest (aspen and balsam poplar closed deciduous forest) dominated by balsam poplar, quaking aspen, or both, occupies slopes and draws on the south face of Kathul Mountain on sites midway in moisture conditions between treeless sites and those supporting white spruce forest. The Populus forest occurs in draws, on east and west slopes, and on benches with slightly more mesic conditions than the surrounding treeless slopes. Scattered spruce are present on the most mesic of these sites. There is a transition between stands of white spruce with scattered poplar and aspen and stands of poplar and aspen with scattered white spruce. Another transition in the form of decreasing size and density of these trees leads to grassland.

Important understory species in the Populus forest include:

Juniperus communis	Pyrola asarifolia
Festuca altaica	Arctostaphylos uva-ursi
Geocaulon lividum	Polemonium acutiflorum
Cerastium maximum	Mertensia paniculata
Rosa acicularis	Linnaea borealis
Shepherdia canadensis	Viburnum edule
Epilobium angustifolium	Arnica alpina
Cnidium cnidiifolium	Aster sibiricus
Cornus stolonifera	

Grassland (grass-shrub dry mid-grass grassland) occupies extensive dry slopes at the west end of Kathul Mountain (Fig. 28) and smaller dry slopes scattered on southern exposures throughout the study area. This grassland is generally dominated by some combination of Agropyron spicatum (bluebunch wheatgrass), Calamagrostis (purple reedgrass), and Artemisia frigida (fringed sagebrush). In addition, Selaginella sibirica (northern selaginella), Festuca altaica, Minuartia yukonensis, Pulsatilla patens (pasque flower), Bupleurum triradiatum, Douglasia arctica (arctic douglasia), Galium boreale (northern bedstraw), and Solidago decumbens are sometimes sufficiently abundant to be considered codominants.

Stunted quaking aspen and balsam poplar are locally scattered in the grassland. Sometimes these trees even grow in stands and reach several meters in height, but produce so few leaves that the understory is virtually unshaded and therefore identical to the surrounding grassland.

The three common grass species show the same environmental affinities that they have at Eagle Bluff. Festuca altaica occurs on the most mesic, completely vegetated slopes, such as small draws and slopes that are less steep or less directly south-facing than those occupied by the other grasses. Calamagrostis purpurascens dominates most of the grassland and is abundant on drier and steeper slopes than Festuca altaica. Agropyron spicatum occupies the driest, steepest, most unstable, and most sparsely vegetated grassland slopes.

Other species common in the grassland include:

Poa glauca	Papaver nudicaule
Carex aenea	Arabis holboellii
Carex obtusata	Draba sp.
Carex supina	Saxifraga reflexa
Zygadenus elegans	Potentilla pensylvanica
Arenaria capillaris	Oxytropis splendens
Silene repens	Shepherdia canadensis

Podistera yukonensis	Penstemon gormanii
Androsace septentrionalis	Artemisia laciniata
Phacelia sericea	

Rubble slopes and outcrops (grass-shrub dry mid-grass grassland) too dry to support grassland vegetation are common. Most grassland species extend onto these slopes in reduced numbers. Common species on these sites include:

Dryopteris fragrans	Hedysarum alpinum
Festuca saximontana	Oxytropis splendens
Minuartia yukonensis	Podistera yukonensis
Saxifraga reflexa	Phacelia sericea
Saxifraga tricuspidata	Artemisia furcata
Potentilla hookeriana	Erigeron compositus
Potentilla nivea	Senecio ogotorukensis
Rubus idaeus	Solidago multiradiata
Astragalus aboriginorum	

Alpine tundra (mat and cushion tundra) is locally present on dry windswept ridges above 880 m (2,900 ft), and is generally dominated by Dryas octopetala (white mountain-avens) and Arctostaphylos alpina (alpine bearberry). A broad transition zone is present between grassland and alpine tundra in which an alpine floristic element occurs in a grassland matrix. Common alpine species are:

Festuca altaica	Bupleurum triradiatum
Hierochloë alpina	Empetrum nigrum
Tofieldia coccinea	Vaccinium uliginosum
Salix glauca	Pedicularis lanata
Alnus crispa	Campanula lasiocarpa
Lupinus arcticus	Arnica alpina
Oxytropis campestris	

Autecology of threatened and endangered species

The five rare taxa present in this study area are Eriogonum flavum var. aquilinum (Eagle yellow eriogonum), Draba sp., Erysimum asperum var. angustatum (narrowleaf plains erysimum), Podistera yukonensis (Yukon podistera), and Phacelia sericea (silky phacelia). All are restricted to grassland and rubble on steep south-facing slopes. Environmental characteristics of these sites are summarized in Table 6.

Eriogonum flavum var. aquilinum (Eagle yellow eriogonum). A small population of this taxon is present at the eastern end of the top of the 460 m (1,500 ft) terrace extending west from Kathul Mountain (Fig. 29). Approximately 100 plants are in this population.

Fig. 28. (above) Extensive grassland on the south slope of the west ridge of the western summit of Kathul Mountain.
Fig. 29. (below) Aerial view north to the east end of the 460 m (1,500 ft) terrace extending west from Kathul Mountain. A small population of Eriogonum flavum is present on the light-colored cap of coarse alluvium at the top of the large shale exposure in the foreground.

Table 6. Summary of environmental characteristics of sites supporting threatened and endangered taxa in the Kathul Mountain study area.

Taxon	Landscape feature	Elevation	Aspect (azimuth)	Slope angle	Soil texture	Soil drainage
Eriogonum flavum var. aquilinum	south-facing sparsely vegetated slopes	260 m (1,500 ft)	140°-190°	10°-30°	cobble and coarse gravels	excessive
Draba sp.	south-facing outcrops, rubble slopes, and grasslands	275-870 m (900-2,850 ft)	120°-210°	20°-45°	rocky silt loam to rubble	excessive
Erysimum asperum var. angustatum	south-facing rubble slopes and sparsely vegetated grasslands	275-460 m (900-1,500 ft)	120°-210°	30°-45°	rocky silt loam to rubble	excessive
Podistera yukonensis	south-facing rubble slopes and grasslands, sometimes extending short distances into Populus forests	mostly 275-580 m (900-1,900 ft), a few up to 885 m (2,900 ft)	120°-225°	05°-40°	rocky silt loam to rubble	good to excessive
Phacelia sericea	south-facing rubble slopes and grasslands	275-780 m (900-2,550 ft)	120°-225°	15°-40°	rocky silt loam to rubble	good to excessive

Although small, this population was successfully setting seed and appeared to be maintaining itself.

Eagle yellow eriogonum grows on a cap of coarse alluvium at the top of a steep slope of shale and extends to the edge of an aspen forest on top of the terrace. This site ranges in azimuth from 140° to 190° and in slope steepness from 10° to 30°. The substrate consists of alluvial sands and cobbles, apparently deposited by the Yukon River at some time in the distant past. A few plants extend into shattered shale bedrock at the west end of the site. No soil development is evident on either substrate. Vegetation is sparse and would fall into the rubble slope category (Fig. 30). Other species growing on this site include:

Selaginella sibirica
Agropyron spicatum
Festuca saximontana
Populus tremuloides (saplings less than 1 m tall, restricted to top of site)
Minuartia yukonensis
Erysimum asperum
Saxifraga tricuspidata
Chamaerhodos erecta
Rubus idaeus
Epilobium angustifolium
Podistera yukonensis
Douglasia arctica
Phacelia sericea
Artemisia laciniata (at edges of site)
Erigeron compositus

Since this population of Eagle yellow eriogonum is so small, it should be monitored every few years to detect changes in status.

Draba sp. Specimens of Draba from this study area have been determined by G. A. Mulligan to represent a taxon new to North America. The following compilation of information is based on the assumption that all references to Draba sp. in our field notebook refer to this taxon. This assumption may be justified since the only two specimens of Draba collected in this study area belong to this taxon. However, if some of the plants in this genus that we noted in reality belong to other species, the population size and the range of habitats occupied by this new Draba species would be actually smaller than reported here.

This species is widely distributed and occupies a broad elevational range in the study area. Estimation of population size is difficult, but at least several hundred and perhaps more individuals are present. The population sets abundant seed and appears to be maintaining itself. This species grows on rock outcrops, rubble slopes, and grasslands (Fig. 31) between 275 and 870 m (900-2,850 ft) in elevation. It grows on slopes ranging from 120° to 210° in azimuth and from 20° to 45° in steepness. The substrate is very dry and ranges from a silt loam with numerous small rock fragments to rubble with no soil development.

Species associated with this draba on outcrops and rubble slopes include:

Selaginella sibirica	Saxifraga tricuspidata
Dryopteris fragrans	Potentilla nivea
Juniperus communis	Hedysarum alpinum
Agropyron spicatum	Bupleurum triradiatum
Bromus pumpellianus	Douglasia arctica
Festuca saximontana	Galium boreale
Zygadenus elegans	Artemisia frigida
Minuartia yukonensis	Erigeron compositus
Papaver nudicaule	Senecio ogotorukensis
Erysimum asperum	

Grasslands supporting this draba are generally dominated by some combination of Calamagrostis purpurascens, Bupleurum triradiatum, Galium boreale, and Artemisia frigida. Common associated species are:

Selaginella sibirica	Erysimum inconspicuum
Juniperus communis	Saxifraga reflexa
Agropyron spicatum	Potentilla hookeriana
Carex aenea	Potentilla nivea
Carex supina	Potentilla pensylvanica
Zygadenus elegans	Rosa acicularis
Arenaria capillaris	Oxytropis splendens
Minuartia yukonensis	Douglasia arctica
Silene menziesii	Phacelia sericea
Silene repens	Penstemon gormanii
Pulsatilla patens	Galium boreale
Papaver nudicaule	Achillea borealis
Arabis holboellii	Artemisia laciniata
Erysimum asperum	Solidago decumbens

Erysimum asperum var. angustatum (narrowleaf plains erysimum). This species is widely distributed in the study area at elevations between 275 m and 460 m (900-1,500 ft) and might also occur at higher elevations. It usually grows on sparsely vegetated, unstable rubble (Figs. 32, 33), but sometimes occurs in crevices on outcrops and in small rubbly exposures in grasslands. Probably several hundred to a few thousand individuals of this species are present in the Kathul Mountain study area. This population sets abundant seed and juvenile plants are present.

Sites supporting this species range in azimuth from 120° to 210° and in slope angle from 30° to 45°. Substrate ranges from crevices in rock outcrops to shaley rubble to the deep, brown, rocky soil of the grassland. Associated species on rock outcrops include Dryopteris fragrans (fragrant shield-fern), Festuca saximontana, Draba sp., and Saxifraga tricuspidata (prickly saxifrage).

(Continued on page 77.)

Fig. 30. Coarse alluvium capping the east end of the 460 m (1,500 ft) terrace extending west from Kathul Mountain. Eriogonum flavum (blue leaves and low yellow flowers) and Podistera yukonensis (blue leaves and straw-colored fruits in left foreground) are present at this site. Other species visible include Festuca saximontana, Saxifraga tricuspidata (prickly saxifrage), Rubus idaeus (raspberry), and Bupleurum triradiatum (tall yellow-flowered plant in background) (23 July 1978).

Fig. 31. Rubble slope low on the west end of Kathul Mountain. Podistera yukonensis is prominent in the foreground. Other species include Oxytropis splendens (showy oxytrope), Bupleurum triradiatum, and Phacelia sericea (basal leaves in foreground at right-hand edge of photograph). The Draba sp. new to North America also grows on this slope but is not in the photograph (23 July 1978).

Fig. 32. South-facing rubble slope low on the west end of Kathul Mountain. Erysiumum asperum (inconspicuous dried stalk in center) and Podistera yukonensis (blue mat in background) are present.

Fig. 30. Above

Fig. 31. Top right

Fig. 32. Lower right

Descriptions on facing page.

Species commonly sharing rubble slopes with narrowleaf plains erysimum:

Agropyron spicatum	Astragalus aboriginorum
Zygadenus elegans	Oxytropis splendens
Minuartia yukonensis	Podistera yukonensis
Chamaerhodos erecta	Douglasia arctica
Potentilla hookeriana	Phacelia sericea
Rosa acicularis	Galium boreale
Rubus idaeus	

Grasslands supporting narrowleaf plains erysimum are usually dominated by some combination of Agropyron spicatum, Calamagrostis purpurascens, Potentilla pensylvanica (Pennsylvania cinquefoil), Bupleurum triradiatum, and Artemisia frigida. Other common species include:

Juniperus communis	Douglasia arctica
Minuartia yukonensis	Phacelia sericea
Silene repens	Galium boreale
Pulsatilla patens	Artemisia laciniata
Arabis holboellii	Solidago multiradiata
Rosa acicularis	

Podistera yukonensis (Yukon podistera). This species is common on grasslands and rubble slopes on the western end of Kathul Mountain between the elevations of 275 m and 580 m (900-1,900 ft). A few plants were found as high as 885 m (2,900 ft). The population of this species at Kathul Mountain consists of several thousand plants and appears healthy in that abundant seed is set and juvenile plants are present.

Sites supporting Yukon podistera range in azimuth from 120° to 225° and in slope steepness from 5° to 40°. This species is most common on rubble slopes, but also frequents grassland settings and extends onto rock outcrops and short distances into Populus forest.

Yukon podistera is the most conspicuous species present on some rubble slopes and rock outcrops (Figs. 30, 31, 32). Common associates are:

Calamagrostis purpurascens	Erysimum asperum
Smilacina stellata	Saxifraga tricuspidata
Populus balsamifera (scattered, 1-4 m high)	Chamaerhodos erecta
	Rosa acicularis
P. tremuloides (scattered, 1-4 m high)	Rubus idaeus
	Astragalus aboriginorum
Minuartia yukonensis	Oxytropis splendens
Papaver nudicaule	Elaeagnus commutata

Bupleurum triradiatum	Artemisia furcata
Douglasia arctica	Erigeron compositus
Phacelia sericea	Senecio ogotorukensis
Penstemon gormanii	Solidago multiradiata
Galium boreale	

Grasslands inhabited by Yukon podistera are generally dominated by some combination of Agropyron spicatum, Calamagrostis purpurascens, and Artemisia frigida (Fig. 34). Other common species include:

Selaginella sibirica	Potentilla hookeriana
Juniperus communis	Potentilla pensylvanica
Populus tremuloides (scattered and stunted)	Rosa acicularis
	Bupleurum triradiatum
	Androsace septentrionalis
Minuartia yukonensis	Douglasia arctica
Silene repens	Phacelia sericea
Pulsatilla patens	Galium boreale
Draba sp.	Artemisia laciniata
Erysimum asperum	Solidago decumbens

Locally, Yukon podistera extends a short distance into Populus forests at the fringes of grasslands where Festuca altaica dominates the understory. Other common species in these situations are:

Juniperus communis	Cnidium cnidiifolium
Silene repens	Arctostaphylos uva-ursi
Pulsatilla patens	Vaccinium vitis-idaea
Rosa acicularis	Galium boreale
Shepherdia canadensis	Viburnum edule
Bupleurum triradiatum	

At its altitudinal limit (885 m, 2,900 ft), Yukon podistera inhabits vegetation transitional between grassland and alpine tundra. Common species include:

Calamagrostis purpurascens	Hedysarum alpinum
Festuca altaica	Lupinus arcticus
Carex albonigra	Oxytropis campestris
Carex obtusata	Castilleja caudata
Zygadenus elegans	Arnica alpina
Dryas octopetala	Artemisia laciniata
Potentilla nivea	

Phacelia sericea (silky phacelia). This species is common on grasslands and rubble slopes over a wide range of elevations throughout the study area. The population consists of several tens of thousands of plants and appears to be healthy; abundant seed is set and juvenile plants are present. This species occurs on sites ranging in

elevation from 275 m to 780 m (900-2,250 ft), in azimuth from 120° to 225°, and in slope steepness from 15° to 40°. The substrate varies from shattered bedrock to rubble to the rocky silt loam of the grassland.

Common associates on rubble slopes include (Figs. 31, 33):

Agropyron spicatum	Oxytropis splendens
Smilacina stellata	Elaeagnus commutata
Minuartia yukonensis	Epilobium angustifolium
Silene repens	Podistera yukonensis
Papaver nudicaule	Douglasia arctica
Erysimum asperum	Penstemon gormanii
Saxifraga tricuspidata	Galium boreale
Chamaerhodos erecta	Artemisia furcata
Rubus idaeus	Erigeron compositus
Astragalus aboriginorum	Senecio ogotorukensis
Hedysarum alpinum	Solidago multiradiata

Grasslands occupied by silky phacelia are generally dominated by some combination of Agropyron spicatum, Calamagrostis purpurascens, Bupleurum triradiatum, and Artemisia frigida. Other common species include (Figs. 34, 35):

Selaginella sibirica	Pulsatilla patens
Juniperus communis	Papaver nudicaule
Festuca altaica	Arabis holboellii
Poa glauca	Draba sp.
Carex aenea	Saxifraga reflexa
Carex supina	Chamaerhodos erecta
Zygadenus elegans	Potentilla hookeriana
Populus balsamifera (stunted and scattered)	Potentilla pensylvanica
	Rosa acicularis
Populus tremuloides (stunted and scattered)	Epilobium angustifolium
	Douglasia arctica
Minuartia yukonensis	Galium boreale
Silene menziesii	Artemisia laciniata
Silene repens	Solidago decumbens

Silky phacelia was also found on a south-facing bluff near Montauk Bluff upstream from Kathul Mountain. No time was available to determine the extent of this population. It is probable that this species can be found on the dry slopes along the Yukon River between Eagle and Circle.

(Continued on page 83.)

Fig. 33. Southeast-facing rubble slope on the south side of Kathul Mountain. Phacelia sericea is in the foreground. Also visible are Populus balsamifera, Saxifraga tricuspidata, Elaeagnus commutata (silverberry), Epilobium angustifolium (fireweed), and Galium boreale. Erysimum asperum is also present on the slope, but does not appear in the photograph (17 July 1978).

Fig. 34. Grassland on the lower slopes of the west end of Kathul Mountain. Podistera yukonensis and Phacelia sericea are visible in the foreground. The grassland is dominated by Agropyron spicatum, Calamagrostis purpurascens, Bupleurum triradiatum (yellow flowers), and Artemisia frigida. Other species visible include Minuartia yukonensis, Pulsatilla patens, Douglasia arctica, Penstemon gormanii (Gorman beard-tongue), and Galium boreale (23 July 1978).

Fig. 35. Grassland on the lower slopes of the west end of Kathul Mountain, showing Phacelia sericea in the foreground. This grassland is dominated by Agropyron spicatum, Calamagrostis purpurascens, and Artemisia frigida. Also visible are Silene repens (pink campion) and Pulsatilla patens (23 July 1978).

Fig. 33. Above

Fig. 34. Top right

Fig. 35. Lower right

Descriptions on facing page.

Chicken Study Area

Setting

This large study area is relatively long and narrow (Fig. 36). The northern half includes portions of the valley of the South Fork of the Fortymile River and the ridge west of the river (Fig. 37). The southern half follows a gently rolling ridge system that also drains by various routes to the South Fork (Fig. 38). The elevation of the study area varies from 435 m to 1,130 m (1,450-3,700 ft).

Bedrock of the area consists mostly of greenstone, quartz-mica schist, and greenschist, with minor outcroppings of sandstone, conglomerate, and tuff (Foster 1970, 1976). This area has not been glaciated, but has a complex history of stream aggradation and erosion. High terraces and entrenched meanders are common features.

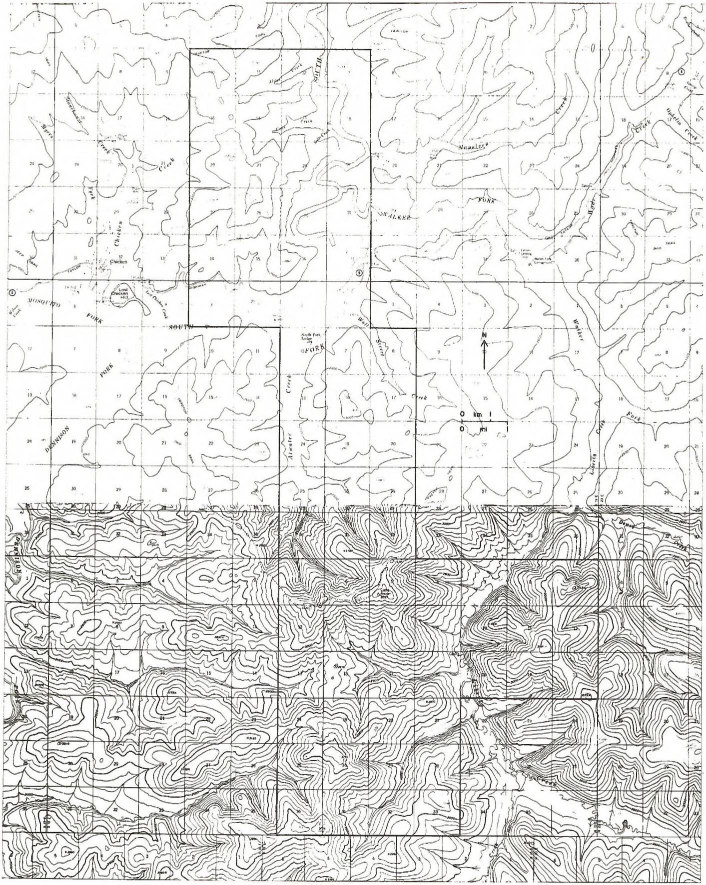
Vegetation

White spruce forest occupies well-drained ridges and slopes in the study area. Scattered trees of paper birch, quaking aspen, and balsam poplar, and shrubs of alder and willow are present locally. The understory varies considerably from place to place, but Cornus canadensis (bunchberry) and Pyrola asarifolia (liverleaf wintergreen) are generally characteristic.

Poorly drained slopes supporting black spruce woodland are extensive. Scattered paper birch, alder, and willow are present in this vegetation type. The understory is rich in mosses, sedges, and ericaceous shrubs. A large part of the southern half of the study area, in which this type predominated, was burned in the not too distant past (Fig. 38).

Bogs (sphagnum-shrub freshwater bog) are present on flood plains and on poorly drained flats. These are characterized by abundant mosses, sedges, and ericaceous shrubs. Scattered erect shrubs of alder and willow are often present.

South-facing well-drained slopes and ridges locally support a Populus forest (aspen and balsam poplar closed deciduous forest). Quaking aspen dominates most of these forests, but some stands of balsam poplar and some mixed stands are present. Festuca altaica (Altai fescue), Zygadenus elegans (elegant death-camas), Rosa acicularis (prickly rose), Lupinus arcticus (arctic lupine), Shepherdia canadensis (buffaloberry), Arctostaphylos uva-ursi (kinnikinnick), and Senecio lugens are common in the understory.


Chicken
Lost Chicken Hill
MOSQUITO FORK
SOUTH FORK
DENNISON FORK
WALKER FORK
Napoleon Creek
Walker Creek
South Fork Lodge
N
0 km 1
0 mi 1

South-facing slopes too steep and dry for forest growth support grassland (grass-shrub dry mid-grass grassland) vegetation (Fig. 39). These are dominated by some combination of Agropyron spicatum (bluebunch wheatgrass), Calamagrostis purpurascens (purple reedgrass), Festuca altaica, and Artemisia frigida (fringed sagebrush). Calamagrostis purpurascens and Artemisia frigida are overall probably the most important species. Festuca altaica dominates on the most mesic and most thoroughly vegetated grassland slopes. Agropyron spicatum is abundant on the steepest, driest, and most unstable slopes supporting grassland vegetation. Other species common in the grassland include:

Juniperus communis	Hedysarum alpinum
Poa glauca	Shepherdia canadensis
Carex supina	Epilobium angustifolium
Zygadenus elegans	Androsace septentrionalis
Pulsatilla patens	Castilleja elegans
Papaver nudicaule	Galium boreale
Alyssum americanum	Campanula aurita
Arabis holboellii	Artemisia alaskana
Potentilla hookeriana	Erigeron caespitosus
Potentilla pensylvanica	Solidago decumbens

Small areas with alpine tundra are present on the highest summits of the study area. These sites were overflown but were not visited on the ground.

Autecology of threatened and endangered species

No threatened or endangered species were found in this study area. However, several unusual and interesting species such as Alyssum americanum (American alyssum), Halimolobos mollis, Phacelia mollis, and Castilleja elegans (elegant Indian paintbrush) were encountered.

Fig. 36 (page 84). U. S. Geological Survey 1:63,360 topographic map series, Eagle A-2 and Tanacross D-2 quadrangles, showing the Chicken study area.

Fig. 37 (above). The Chicken study area along the South Fork of the Fortymile River, showing white spruce forest, black spruce woodland, and grassland. The Taylor Highway is in the distance.

Fig. 38 (opposite page, top). Burned-over black spruce woodland in the southern part of the Chicken study area. These gently rolling, poorly drained slopes do not provide suitable habitats for any threatened or endangered taxa.

Fig. 39 (opposite page, bottom). Dry, south-facing slope beside the South Fork of the Fortymile River, 3 km (2 mi) downstream from the Taylor Highway bridge at 75.3 mile. Although no threatened or endangered species were found on this or other similar slopes, a number of interesting and unusual species are present.

CONCLUSIONS

Autecology of Rare Taxa

The distributions, habitats, and associated vegetation of the rare taxa found in the study areas and treated in this report are summarized in Table 7. It shows that the majority of these taxa grow on steep, south-facing, dry, treeless slopes along the Yukon River. Not surprisingly, most of these rare taxa represent a floristic element originating from the relatively hot and dry western contiguous United States and southwestern Canada. These taxa are disjunct by a thousand kilometers or more from their main ranges or the ranges of closely related taxa.

In addition to these dry slopes, two other areas in the Fortymile Planning Unit support or might be expected to support rare taxa. Alpine areas in the Fortymile River watershed could be expected to support Podistera yukonensis (Yukon podistera), since this species has been found nearby in Yukon Territory. Sparsely vegetated alpine taluses in the Alaska Range support Draba porsildii (Porsild draba). Lesquerella arctica var. scammanae (Scamman arctic bladderpod), the other rare plant in the Alaska Range, does not appear to be a valid taxon; if this view is accepted, the plant is absorbed into L. arctica var. arctica, a common plant that is not threatened or endangered.

Relationship of Certain Rare Taxa to Greenstone Substrates

When Shacklette (1966) first discovered a concentration of rare plants at Eagle Bluff [Eriogonum flavum var. aquilinum (Eagle yellow eriogonum), Erysimum asperum var. angustatum (narrowleaf plains erysimum), Phacelia sericea (silky phacelia), and Cryptantha shackletteana (Shacklette cryptantha)], he attributed their presence there to edaphic characteristics resulting from the greenstone parent material and the fact that this area, along with the rest of interior Alaska and Yukon, has never been glaciated. The absence of glaciation means that this site could have served as a refugium for plants and animals when much of adjacent North America and Asia was covered with glacial ice. Consequently, this site could have been supporting plants continuously for a very long time, and presumably, remnants of a flora predating at least the most recent glaciation could persist there. Since most of interior Alaska has never been glaciated, Shacklette (1966) argued that it was more the edaphic characteristics of this particular site which made it unsuitable for the more aggressive species of the modern flora and enabled more tolerant but less agressive remnants of the ancient flora to persist. The edaphic factors that he considered important are the excessive drainage conditions and extreme dryness (preventing the growth of trees), the relatively high concentration of phytotoxic elements, and the low

Table 7. Summary of information on distribution, habitat, and associated vegetation of rare taxa found in the study areas of the Fortymile Planning Unit

Taxon	Distribution	Habitat	Vegetation
Eriogonum flavum var. aquilinum	Eagle Bluff and Kathul Mountain	steep south-facing treeless slopes at relatively low elevations (below 500 m, 1,600 ft)	grassland, rubble slope
Draba sp.	Kathul Mountain	steep, south-facing treeless slopes and outcrops below timberline	grassland, rubble slope
Draba porsildii	Rocky Mountains from S Alberta to SW Yukon. In Alaska known from the Sheenjek and Delta valleys	alpine taluses and outcrops	taluses
Erysimum asperum var. angustatum	upper Yukon River and tributaries between Circle, Alaska and SE Yukon	steep south-facing treeless slopes below timberline	grassland, rubble slope
Lesquerella arctica var. scammanae	Gunnysack Creek at Richardson Hwy, Alaska Range	bluff and flood plain at 670 m (2,200 ft) elevation	balsam poplar stand, grassland, and sparse flood plain vegetation
Podistera yukonensis	upper Yukon River: McQuesten area, near Eagle, 58 Mile on Sixtymile Road, Kathul Mountain	steep south-facing treeless slopes and unknown alpine habitats, elevation range 275-1,500 m (900-5,000 ft)	grassland, rubble slope, alpine tundra (?), sometimes extending into Populus stands
Phacelia sericea	W United States north to S Alberta and B.C. In Alaska, along the Yukon R. between Eagle and Kathul Mountain, and in the vicinity of Haines	in Alaska on steep south-facing treeless slopes below timberline	grassland, rubble slope
Cryptantha shackletteana	Eagle and Calico bluffs	steep south-facing treeless slopes below timberline	rubble slope

phosphorus content produced by soil-forming processes on the greenstone parent material (inhibiting the growth of many aggressive herbaceous species of the modern flora).

Our study areas provide a test on the hypothesis that greenstone substrates have favored the persistence of these particular rare taxa. Dry bluffs underlain by greenstone along the Fortymile River in the Chicken study area are similar to Eagle Bluff in climate, topography, and geology except that they are smaller, one hundred or so meters (300 ft) higher in elevation, and were formed by different geomorphic processes. The Kathul Mountain study area and other sites visited along the Yukon River are similar in climate and topograhy to Eagle Bluff but lack greenstone substrates. The presence of Eriogonum flavum on shale and coarse alluvium at Kathul Mountain, Cryptantha shackletteana on limestone and shale at Calico Bluff, Erysimum asperum and Phacelia sericea on graywacke and argillite at Kathul Mountain, and the absence of all these species on dry greenstone bluffs at Chicken indicate that factors other than the chemical nature of the substrate are responsible for the persistence of these supposed relic species at some sites and not at others. The excessive dryness and instability of the substrate on steep south-facing slopes are sufficient in themselves to prevent even the most aggressive species from forming a continuous vegetative cover. Thus, these slopes provide a habitat for species adapted to dry unstable conditions, but intolerant of competition. The reason for the presence of certain rare taxa at Eagle Bluff and Kathul Mountain and their absence at Chicken must lie in the climatic, geomorphic, and vegetational histories of these respective areas.

RECOMMENDATIONS

Suggestions for Further Research

Rare taxa may be present at a number of sites in the Fortymile Planning Unit that have not been investigated. Each additional population found adds to our knowledge of environmental requirements of the taxa and refines our knowledge of distribution. The following sites might yield information on rare taxa:

1. Eagle Bluff: Search for the Draba sp. present at Kathul Mountain.

2. Calico Bluff: Determine the size and geographic limit of the population of Cryptantha shackletteana (Shacklette cryptantha). Search for Lesquerella calderi (Calder bladderpod) and all rare taxa present at Eagle Bluff and Kathul Mountain.

3. Kathul Mountain: Because of the large size of this study area and the limited time available, some populations of rare taxa may have been overlooked here. In addition, more information on the Draba sp. at this location is needed--flower size and color and chromosome behavior during meiosis. The tiny population of Eriogonum flavum var. aquilinum (Eagle yellow eriogonum) at this site should be checked periodically (perhaps at five-year intervals) to detect as early as possible any decline in numbers of plants.

4. Other dry slopes along the Yukon River between the Alaska-Yukon border and Circle, notably some low bluffs just downstream from Eagle Bluff and dry slopes at the mouth of the Nation River: Search for Lesquerella calderi and all rare taxa known at Eagle Bluff and Kathul Mountain.

5. Dry slopes along the Porcupine River between the Alaska-Yukon border and 144°W longitude: Search for Lesquerella calderi and all rare taxa known at Eagle Bluff and Kathul Mountain.

6. Taylor Highway near Boundary, Alaska: Search for Podistera yukonensis (Yukon podistera) and Phacelia sericea (silky phacelia).

A number of rare taxa present taxonomic problems. Foremost among these problems is the relationship of Erysimum asperum var. angustatum (narrowleaf plains erysimum) to closely related southern taxa. In addition, clarification of the relationship between Cryptantha shackletteana (Shacklette cryptantha) and Eriogonum flavum var. aquilinum (Eagle yellow eriogonum) and their respective closely related taxa disjunct to the south would be desirable. More cytological information would be useful in this regard. Variation in Phacelia sericea (silky phacelia) in all parts of its range needs to be examined as well as the relationship between this taxon and P. mollis. The taxonomic affinities of the Draba sp. from Kathul Mountain need to be examined.

Rare Taxa Considerations for Management Proposals

Table 7 shows that the majority of threatened and endangered taxa of the Fortymile Planning Unit grow on steep, dry, south-facing treeless slopes along the Yukon River. Since these sites are for the most part small and widely spaced, it should be possible to route roads, pipelines, and other developments away from them. Similar dry slopes some distance from the Yukon River could conceivably support any or all of these rare taxa (even though the dry slopes at Chicken apparently do not). These slopes also should not be disturbed; if disturbance is necessary, a search for rare taxa should be made first. Alpine tundra in the Fortymile River watershed could quite possibly support Podistera yukonensis (Yukon podistera) and potential construction sites should be checked for this species. Barren alpine taluses and outcrops in the Alaska Range should be checked for Draba porsildii (Porsild draba) prior to disturbance or modification.

Since both Eagle Bluff and Kathul Mountain support large populations of several threatened or endangered plant species, we recommend that they be included in the ecological reserve system.

REFERENCES

Ayensu, E. S., and R. A. DeFilipps. 1978. Endangered and threatened plants of the United States. Smithsonian Institution and World Wildlife Fund Inc. 403 pp.

Barneby, R. C. 1952. A revision of the North American species of Oxytropis DC. Proc. California Acad. Sci. (4th Ser.) 27:177-312.

Benson, L. 1959. Plant classification. Heath and Co., Lexington, Mass. 688 pp.

Boivin, B. 1968. Flora of the prairie provinces, Part II. Digitatae, Dimerae, Liberae (con't). Phytologia 16:265-339.

Brabb, E. E., and M. Churkin, Jr. 1969. Geologic map of the Charley River Quadrangle, east-central Alaska. U.S. Geol. Surv. Misc. Geol. Invest. Map I-573.

Dyrness, C. T., and L. A. Viereck. 1978a. Provisional classification framework for Alaska vegetation, third rough draft. U.S. Forest Service, Inst. Northern Forestry, Fairbanks, manuscript. 9 pp.

_____. 1978b. A suggested classification for Alaskan vegetation. U.S. Forest Service, Inst. Northern Forestry, Fairbanks, manuscript. 16 pp.

Fairbrothers, D. E., and M. Y. Hough. 1973. Rare or endangered vascular plants of New Jersey. New Jersey State Museum Science Notes 14, Trenton. 53 pp.

Foster, H. L. 1970. Reconnaissance geologic map of the Tanacross Quadrangle, Alaska. U.S. Geol. Surv. Misc. Geol. Invest. Map I-593.

_____., compiler. 1976. Geologic map of the Eagle Quadrangle, Alaska. U.S. Geol. Surv. Misc. Invest. Map I-922.

Gillett, G. W. 1960. A systematic treatment of the Phacelia franklinii group. Rhodora 62:205-222.

Harrington, H. D., and L. W. Durrell. 1957. How to identify plants. Sage Books, Denver. 203 pp.

Heller, C. A. 1966a. Wild flowers of Alaska. Graphic Arts Center, Portland, Oregon. 103 pp.

_____. 1966b. Wild, edible and poisonous plants of Alaska. Univ. Alaska Coop. Ext. Serv. Bull. F-40. Pub. No. 28. 89 pp.

Higgins, L. C. 1969. New combinations and a new species of perennial Cryptantha. Great Basin Nat. 29:28-30.

_____. 1971. A revision of Cryptantha subgenus Oreocarya. Brigham Young Univ. Sci. Bull. Biol. Ser. 13:1-63.

Hitchcock, C. L., A. Cronquist, M. Ownbey, and J. W. Thompson. 1955-69. Vascular plants of the Pacific Northwest. Univ. Washington Press, Seattle. Five independently paginated volumes.

Hopkins, D. M. 1972. The paleogeography and climatic history of Beringia during late Cenozoic time. Inter-nord 12:121-150.

Hultén, E. 1941-50. Flora of Alaska and Yukon. Lund Univ. Arsskr., N.F. Avd. 2, in 10 parts and supplement. 1902 pp.

_____. 1967. Comments on the flora of Alaska and Yukon. Ark. Bot. (Ser. 2) 7:1-147.

_____. 1968. Flora of Alaska and neighboring territories. Stanford Univ. Press, Stanford, Calif. 1008 pp.

_____. 1973. Supplement to flora of Alaska and neighboring territories, a study in the flora of Alaska and the transberingian connection. Bot. Not. 126:459-512.

Jackson, B. D. 1928. A glossary of botanic terms, 4th ed. Hafner, New York. 481 pp.

Kelsey, H. P., and W. A. Dayton, eds. 1942. Standardized plant names, 2nd ed. Am. Joint Committee on Horticultural Nomenclature. 675 pp.

Lawrence, G. H. M. 1955. An introduction to plant taxonomy. Macmillan, New York. 179 pp.

Mathias, M. E., and L. Constance. 1942. New combinations and new names in the Umbelliferae-II. Bull. Torr. Bot. Club 69:244-248.

_____. 1950. Four new American Umbelliferae. Bull. Torr. Bot. Club 77:133-139.

Mulligan, G. A. 1966. Chromosome numbers of the family Cruciferae, III. Can. J. Bot. 44:309-319.

_____. 1970. Cytotaxonomic studies of Draba glabella and its close allies in Canada and Alaska. Can. J. Bot. 48:1431-1437.

_____. 1974. Cytotaxonomic studies of Draba glabella and its close allies in Canada and Alaska. Can. J. Bot. 52:1793-1801.

_____. 1976. The genus Draba in Canada and Alaska: key and summary. Can. J. Bot. 54:1386-1393.

_____. In press. Four new species of Draba in northwestern North America. Can. J. Bot.

Mulligan, G. A., and A. E. Porsild. 1969. A new species of Lesquerella (Cruciferae) in northwestern Canada. Can. J. Bot. 47:215-216.

Payson, E. B. 1927. A monograph of the section Oreocarya of Cryptantha. Ann. Mo. Bot. Gard. 14:211-358.

Péwé, T. L. 1977. Delta River area, Alaska Range. Pages 55-93 in T. L. Péwé, ed. Guidebook to the Quaternary geology, central and northcentral Alaska. INQUA 7th Congress, Guidebook for Field Conference F. State of Alaska Div. Geol. and Geophys. Surv. (reprint of 1965 ed.).

Porsild, A. E. 1951. Botany of southeastern Yukon adjacent to the Canol Road. Nat. Mus. Can. Bull. No. 121. 400 pp.

_____. 1975. Materials for a flora of central Yukon Territory. Nat. Mus. Can. Publ. Bot. 4. 77 pp.

Reveal, J. L. 1967. Eriogonum flavum var. aquilinum Reveal, var. nov. Page 46 in E. Hultén, ed. Comments on the flora of Alaska and Yukon. Ark. Bot. (Ser. 2) 7.

Rollins, R. C. 1939. Studies in the genus Lesquerella. Am. J. Bot. 26:419-421.

Rollins, R. C., and U. C. Banerjee. 1975. Atlas of the trichomes of Lesquerella (Cruciferae). Bussey Inst. of Harvard Univ. 48 pp.

Rollins, R. C., and E. A. Shaw. 1973. The genus Lesquerella (Cruciferae) in North America. Harvard Univ. Press, Cambridge. 288 pp.

Rossbach, G. B. 1958. The genus Erysimum (Cruciferae) in North America north of Mexico - a key to the species and varieties. Madroño 14: 261-267.

Rydberg, P. A. 1901. Erysimum angustatum Rydb. sp. nov. Bull. N.Y. Bot. Gard. 2:171.

Scamman, E. 1940. A list of plants from interior Alaska. Rhodora 42: 309-343.

Shacklette, H. T. 1966. Phytoecology of a greenstone habitat at Eagle, Alaska. U.S. Geol. Surv. Bull. 1198-F. 36 pp.

Stokes, S. G. 1936. The genus Eriogonum, a preliminary study based on geographic distribution. J. H. Neblett, San Francisco, Calif. 132 pp.

Taylor, R. L., and R. P. Brockman. 1966. Chromosome numbers of some western Canadian plants. Can. J. Bot. 44:1093-1103.

Viereck, L. A., and E. L. Little, Jr. 1972. Alaska trees and shrubs. USDA, Forest Service, Agriculture Handbook 410. Washington, D. C. 265 pp.

Welsh, S. L. 1968. Nomenclature changes in the Alaskan flora. Great Basin Nat. 28:147-156.

_____. 1974. Anderson's flora of Alaska and adjacent parts of Canada. Brigham Young University Press, Provo, Utah. 724 pp.

Young, S. B., ed. 1976. The environment of the Yukon-Charley Rivers area Alaska. Contr. Center Northern Studies 9, Wolcott, Vermont. 358 pp.

APPENDIX A

ANNOTATED LIST OF VASCULAR PLANT TAXA COLLECTED

IN THE FORTYMILE PLANNING UNIT, SUMMER 1978

This list of vascular taxa collected during the summer field activities provides a summary of the habitat for each taxon and the study areas in which each was found. It is an incomplete reflection of the flora of the Fortymile Planning Unit since we collected only plants bearing directly on the project or otherwise of interest to us. Consequently, many of the most common species, such as Picea glauca and Epilobium angustifolium, are not represented.

Plant families are arranged in the same order as they appear in Hultén (1968). Genera and species are listed alphabetically within each family. Nomenclature generally follows Hultén (1968), and exceptions are noted. Specimens of Draba were identified by G. A. Mulligan of the Biosystematics Research Institute, Ottawa. An asterisk marks taxa found outside the distribution limits mapped by Hultén (1968). Abbreviations are used to indicate the study area or areas at which each plant was seen: R (Black Rapids), E (Eagle Bluff), K (Kathul Mountain), and C (Chicken). Collection numbers in parentheses follow the designation of study area in which they were collected. These numbers refer to collections by A. Batten and J. Dawe, or A. Batten, J. Dawe, and D. Murray. Specimens are deposited in the Herbarium of the University of Alaska Museum (ALA).

Lycopodiaceae

LYCOPODIUM CLAVATUM L. subsp. MONOSTACHYON (Grev. & Hood.) Sel. In an old burn in spruce forest. R (78-166).

Selaginellaceae

SELAGINELLA SIBIRICA (Milde) Hieron. Dry slopes. Abundant at Kathul Mountain. E (78-248), K.

Ophioglossaceae

BOTRYCHIUM LUNARIA (L.) Sw. Subalpine meadows, dry bluffs. In well-drained substrates. R (78-73, 78-140).

Athyriaceae

CYSTOPTERIS FRAGILIS (L.) Bernh. In slumped soil near the base of a steep, east-southeast-facing treeless slope, elevation 460 m (1,500 ft). C (78-400).

CYSTOPTERIS MONTANA (Lam.) Bernh. In subalpine alder thicket in moist swale on south slope. R (78-142).

*WOODSIA ILVENSIS (L.) R. Br. Dry bluffs and rocky slopes. At 760 m (2,500 ft) on Kathul Mountain. R (78-64), K (78-339).

Aspidiaceae

DRYOPTERIS FRAGRANS (L.) Schott. Stabilized blocky taluses. K (78-289).

GYMNOCARPIUM ROBERTIANUM (Hoffm.) Newm. Dry talus, rare. K (78-324A).

Cupressaceae

JUNIPERUS COMMUNIS L. subsp. ALPINA (Neilr.) Celak. Dry slopes. R, E (78-242), K. C.

Juncaginaceae

TRIGLOCHIN PALUSTRIS L. Common on the Delta River flood plain. R (78-430).

Gramineae (Poaceae)

AGROPYRON MACROURUM (Turcz.) Drobov. Banks of South Fork Fortymile River. C (78-416).

*AGROPYRON SPICATUM (Pursh) Scribn. & Sm. Common on very steep, excessively drained, treeless south-facing bluffs. E (78-202, 78-375), K (78-301, 78-332, 78-348), C (78-385, 78-401), Calico Bluff (78-257).

AGROPYRON VIOLACEUM (Hornem.) Lange. Delta River flood plain. R (78-435).

ALOPECURUS ALPINUS Sm. Margins of tundra pools. R (78-56).

BROMUS CILIATUS L. Dry slopes. K (78-349).

BROMUS PUMPELLIANUS Scribn. Dry slopes, Populus forests. E, K (78-274), C.

CALAMAGROSTIS PURPURASCENS R. Br. Abundant on dry slopes. R (78-50, 78-114), E (78-367), K, C, West Fork Dennison Fork Fortymile River (78-174).

ELYMUS INNOVATUS Beal. Flood plains, dry slopes, and open forests in well-drained soils in the Alaska Range. R (78-431).

FESTUCA ALTAICA Trin. Subalpine shrublands, mesic sites on dry treeless bluffs. R, E (78-194), K, C.

FESTUCA SAXIMONTANA Rydb. Outcrops and rubble on dry slopes. Since no anthers were present on these specimens, it is difficult to determine whether they belong to this taxon or to F. brachyphylla. However, they have the stiff-haired leaf pubescence of F. saximontana, in contrast to the glabrous leaves of F. brachyphylla. K (78-290, 78-338).

POA ALPIGENA (E. Fries) Lindm. Populus forest. R (78-125).

POA ALPINA L. Flood plains and taluses. R (78-5), Isabel Pass (78-98).

POA GLAUCA M. Vahl. Subalpine meadows, dry slopes. R (78-116, 78-135), E (78-203), K (78-329, 78-340), C (78-394).

Cyperaceae

CAREX AENEA Fern. Dry slopes. It was very difficult to determine whether these specimens represent this taxon or the closely related taxa, C. petasata or C. praticola. Descriptions of these species and their habitats given by Hultén (1968) and Hitchcock et al. (1955-69) are somewhat at variance. Our plants have more or less ovate perigynia 3.5-5.0 mm long, nerved on both sides, flattened, winged, serrulate almost to the tip, but with an entire scarious beak 0.2 mm long. The scales are very light brown in color. Carex petasata has larger and narrower (more lanceolate) perigynia. Carex praticola is more difficult to contrast, but generally has dark brown scales. E, K (78-281, 78-328).

*CAREX ALBONIGRA Mack. Subalpine meadows (also at Black Rapids airstrip). In grasslands-alpine tundra ecotone at 885 m (2,900 ft) on Kathul Mountain. R (78-4, 78-139), K (78-344).

CAREX ATRATIFORMIS Britt. subsp. RAYMONDII (Calder) Pors. Waste ground at Delta Junction (78-106).

CAREX AUREA Nutt. Common on moist sites on the Delta River flood plain. R (78-157, 78-426).

CAREX BICOLOR All. Common on moist sites on the Delta River flood plain. R (78-158, 78-427).

CAREX BIGELOWII Torr. Moist tundra. Specimen 78-46, with thick, ovate spikes presents a striking contrast to the other material and may be C. scopulorum Holm. R (78-46, 78-47, 78-59).

CAREX CAPILLARIS L. Subalpine alder thickets, flood plains. R (78-143, 78-428).

CAREX ELEUSINOIDES Turcz. In sand on Mission Creek flood plain. E (78-186).

CAREX KRAUSEI Boeck. Well-drained slopes. R (78-122).

CAREX NARDINA E. Fries. Alpine taluses and fell-fields. R (78-89), Isabel Pass (78-94).

CAREX OBTUSATA Lilj. Dry slopes. K (78-336, 78-346).

CAREX PETRICOSA Dew. Flood plains, well-drained slopes. R (78-123, 78-150).

CAREX ROSSII Boott. Dry slopes. Rare, at least in habitats visited. K (78-282).

CAREX STENOPHYLLA Wahlenb. subsp. ELEOCHARIS Bailey. Dry slopes, apparently very locally distributed. West Fork Dennison Fork Fortymile River (78-172).

CAREX SUPINA Willd. subsp. SPANIOCARPA (Steud.) Hult. Common on dry slopes and other well-drained soils. R (78-7, 78-115, 78-128), E (78-211), K (78-319, 78-334), C (78-411).

KOBRESIA SIBIRICA Turcz. Scarce in alpine tundra. R (78-42).

KOBRESIA SIMPLICIUSCULA (Wahlenb.) Mack. Delta River flood plain. R (78-159).

Juncaceae

JUNCUS sp. Delta River flood plain at Donnelly Campground. The identity of this specimen has not been determined, but it appears to be part of the J. alpinus complex, although the bract subtending the inflorescence is very long. R (78-77).

Liliaceae

ALLIUM SCHOENOPRASUM L. var. SIBIRICUM (L.) Hartm. River banks. K, C (78-414).

*SMILACINA STELLATA (L.) Desf. Dry shaley rubble. Horizontal rhizomes run for great distances a few centimeters beneath the surface. K (78-299).

ZYGADENUS ELEGANS Pursh. Subalpine meadows, dry slopes, flood plains. R, E, K, C (78-396), Delta Junction (78-109).

Orchidaceae

CYPRIPEDIUM PASSERINUM Richards. Gallery white spruce forests. K (78-311).

GOODYERA REPENS (L.) R. Br. Alder thickets, moist spruce forests. R (78-130).

PLATANTHERA HYPERBOREA (L.) Lindl. Delta River flood plain. R (78-131).

PLATANTHERA OBTUSATA (Pursh) Lindl. Moist spruce forests. E (78-201).

Salicaceae

SALIX ALAXENSIS (Anderss.) Cov. Flood plains. R, E, K (78-357), C.

SALIX SETCHELLIANA Ball. Delta River flood plain. R (78-78).

Polygonaceae

*ERIOGONUM FLAVUM Nutt. var. AQUILINUM Reveal. Dry slopes. E (78-251), K (78-354).

RUMEX SIBIRICUS Hult. River banks. K, Yukon River near Montauk Bluff (78-263).

Chenopodiaceae

CHENOPODIUM ALBUM L. Dry slopes, eroding banks. K (78-271, 78-322).

CHENOPODIUM CAPITATUM (L.) Aschers. River banks. K, Yukon River near Montauk Bluff (78-266).

Portulacaceae

CLAYTONIA SARMENTOSA C. A. Mey. Snowbed near stream on Donnelly moraine. R (78-108).

CLAYTONIA TUBEROSA Pall. Tundra fen. R (78-41).

Caryophyllaceae

*ARENARIA CAPILLARIS Poir. Dry slopes. Although it extends to fairly low elevations, this species was found only in areas where alpine tundra was present nearby. R (78-30), K (78-314).

*CERASTIUM ARVENSE L. Dry slopes. E (78-379), C (78-409).

CERASTIUM BEERINGIANUM Cham. & Schlecht. Taluses and flood plains. R (78-86, 78-156).

CERASTIUM MAXIMUM L. Moist Populus forests. K (78-350).

MINUARTIA RUBELLA (Wahlenb.) Graebn. Taluses and flood plains. R (78-1).

MINUARTIA YUKONENSIS Hult. Dry slopes. In exposed locations (specimen 78-317) the inflorescence is often single-flowered and the leaves are shorter and more abruptly acute than is typical of this species. In these conditions it resembles M. arctica. E (78-210, 78-377), K (78-308, 78-317, 78-335).

SAGINA INTERMEDIA Fenzl. Flood plains. R (78-25).

SAGINA SAGINOIDES (L.) Karst. Flood plains. R (78-61).

SILENE MENZIESII Hook. subsp. WILLIAMSII (Britt.) Hult. Dry slopes. R (78-112), E (78-380), K (78-288). C (78-410).

SILENE REPENS Patrin subsp. PURPURATA (Greene) Hitchc. & Maguire. Dry slopes. E (78-191), K (78-303), C (78-183, 78-249, 78-406).

SILENE TAYLORAE (Robins.) Hult. (= Melandrium taylorae in Hultén 1968). River banks C (78-413).

STELLARIA ALASKANA Hult. Alpine taluses. R (78-80).

STELLARIA CALYCANTHA (Ledeb.) Bong. Cutbanks and flood plains. R (78-26).

STELLARIA CRASSIFOLIA Ehrh. River banks. C (78-388).

STELLARIA LONGIPES Goldie. Flood plains and bluffs. R (78-17, 78-436).

STELLARIA MONANTHA Hult. Taluses and flood plains. R (78-16).

WILHELMSIA PHYSODES (Fisch.) McNeill. River banks and gravel bars. E, C (78-389).

Ranunculaceae

ACONITUM DELPHINIFOLIUM DC. Moist Populus forests, subalpine woodlands, and at Eagle Bluff common on very dry, sparsely vegetated rubble. E (78-208), K.

ANEMONE NARCISSIFLORA L. subsp. INTERIOR Hult. Alpine tundra and subalpine meadows and shrublands. R (78-31).

AQUILEGIA BREVISTYLA Hook. Dry, open Populus forests. E (78-365).

PULSATILLA PATENS (L.) Mill. subsp. MULTIFIDA (Pritz.) Zamels. Common on dry slopes. R (78-147), E (78-366), K, C, West Fork Dennison Fork Fortymile River (78-175).

RANUNCULUS ESCHSCHOLTZII Schlecht. Snowbeds. R (78-90), Isabel Pass (78-93).

*RANUNCULUS OCCIDENTALIS Nutt. Snowbed at Isabel Pass (78-92).

RANUNCULUS SCELERATUS L. subsp. MULTIFIDUS (Nutt.) Hult. In silt on banks of Yukon River. K (78-321).

Papaveraceae

PAPAVER NUDICAULE L. Dry slopes, roadsides. One specimen (78-295) is much more densely pubescent than other material of this taxon at ALA. K (78-295), C (78-382), 70.5 mile Taylor Highway (78-185).

Cruciferae (Brassicaceae)

A weedy crucifer apparently new to the flora of Alaska growing on the trans-Alaska pipeline right-of-way at Gunnysack Creek has not yet been identified. R (78-24).

ALYSSUM AMERICANUM Greene. Dry slopes. C (78-392, 78-402).

ARABIS HOLBOELLII Hornem. Dry slopes. E (78-192, 78-199), K (78-283), C.

ARABIS LYRATA L. subsp. KAMCHATICA (Fisch.) Hult. Flood plains and cutbanks. R (78-20).

BARBAREA ORTHOCERAS Ledeb. Roadsides. R (78-69).

BRAYA BARTLETTIANA Jordal. Flood plains and sparsely vegetated, windblown sandy slopes. The identification of these specimens is tentative. They may be the closely related B. americana (Hook.) Fern. R (78-75, 78-145, 78-151).

BRAYA HUMILIS (C. A. Mey.) Robins. subsp. RICHARDSONII (Rydb.) Hult. Flood plains and dry bluffs. Specimens from Eagle Bluff are very densely and coarsely pubescent. They appear markedly different from other Alaska-Yukon material of this taxon. R (78-129, 78-152, 78-153), E (78-188, 78-240).

CARDAMINE UMBELLATA Greene. Flood plains. R (78-60).

*DRABA sp. Dry slopes and outcrops. This taxon is new to North America according to G. A. Mulligan (in litt. 1978) and an appropriate specific name has not yet been determined. E (78-244, a hybrid), K (78-272, 78-291).

DRABA AUREA M. Vahl. Subalpine meadows and shrublands. R (78-107, 78-141).

DRABA BOREALIS DC. Taluses, bluffs, and cutbanks. R (78-29, 78-68, 78-97).

DRABA CANA Rydb. (= D. lanceolata in Hultén 1968). Taluses and dry slopes. R (78-66, 78-87).

DRABA GLABELLA Pursh. (= D. hirta in Hultén 1968). Bluffs and subalpine meadows. R (78-22, 78-134).

DRABA LACTEA Adams. Taluses and windswept slopes. R (78-67), 78-148, 78-161).

DRABA NIVALIS Liljebl. Taluses. McCallum Creek (78-95).

DRABA PALANDERIANA Kjellm. (= D. caesia in Hultén 1968). Outcrops and taluses. R (78-163).

ERYSIMUM ASPERUM (Nutt.) DC. var. ANGUSTATUM (Rydb.) Boiv. (= E. angustatum in Hultén 1968). Dry slopes. E (78-220, 78-245, 78-370), K (78-278, 78-292, 78-298).

ERYSIMUM INCONSPICUUM (S. Wats.) MacM. Dry slopes. E (78-247), K, C (78-395).

HALIMOLOBOS MOLLIS (Hook.) Rollins. Dry slopes and outcrops. C (78-384), West Fork Dennison Fork Fortymile River (78-176).

LESQUERELLA ARCTICA (Wormsk.) S. Wats. Bluffs, cutbanks, and flood plains. Apparently very local in the Alaska Range. Found only at the type locality of var. scammanae on Gunnysack Creek. R (78-18, 78-21, 78-154, 78-440).

PARRYA NUDICAULIS (L.) Regel. Alpine tundra, extending into subalpine shrublands. R (78-70).

RORIPPA PALUSTRIS (L.) Bess. (= R. islandica in Hultén 1968). River banks. Yukon River near Montauk Bluff (78-267).

Crassulaceae

SEDUM ROSEA (L.) Scop. subsp. INTEGRIFOLIUM (Raf.) Hult. Alpine fens and fell-fields. R (78-43).

Saxifragaceae

SAXIFRAGA ESCHSCHOLTZII Sternb. Alpine outcrops. R (78-38).

SAXIFRAGA REFLEXA Hook. Outcrops and dry slopes. R (78-12), E (78-193), K, C.

SAXIFRAGA TRICUSPIDATA Rottb. Outcrops, taluses, and dry slopes near outcrops. R, K, E (78-286), C.

Rosaceae

AMELANCHIER ALNIFOLIA (Nutt.) Nutt. Dry slopes. K (78-304).

*CHAMAERHODOS ERECTA (L.) Bunge subsp. NUTTALLII (Torr. & Gray) Hult. Dry slopes and outcrops. E (78-209, 78-378), K (78-320, 78-353).

DRYAS DRUMMONDII Richards. Found once on an outcrop on Eagle Bluff. E (78-372).

DRYAS INTEGRIFOLIA M. Vahl subsp. SYLVATICA (Hult.) Hult. Well-drained slopes at relatively low elevations in the Alaska Range. R (78-127).

DRYAS OCTOPETALA L. subsp. ALASKENSIS (Pors.) Hult. Sheltered tundra settings, such as subalpine meadows and below outcrops. R (78-45).

DRYAS OCTOPETALA L. subsp. OCTOPETALA. Exposed tundra settings, such as outcrops and fell-fields. R (78-32).

*FRAGARIA VIRGINIANA Duchesne subsp. GLAUCA (S. Wats.) Staudt. Woodlands on dry, south-facing slopes. K (78-360).

POTENTILLA HOOKERIANA Lehm. Dry slopes and outcrops. E (78-250), C (78-412), West Fork Dennison Fork Fortymile River (78-168).

POTENTILLA MULTIFIDA L. Flood plains. When growing in continuous or near-continuous vegetation, this species loses its decumbent habit and grows nearly erect. However, the acute leaflet lobes, tomentum on the underside of the leaflets, and filiform styles serve to differentiate this species from P. virgulata even when the decumbent habit does not. R (78-2), Delta Junction (78-101, 78-104).

*POTENTILLA NIVEA L. Taluses, dry slopes, and outcrops. Usually in more exposed situations than P. hookeriana. R (78-3), E, K (78-306, 78-333).

POTENTILLA PENSYLVANICA L. Dry slopes. E (78-376), K (78-331), C (78-415), West Fork Dennison Fork Fortymile River (78-169).

ROSA WOODSII Lindl. Dry slopes. K (78-325, 78-359).

SANGUISORBA OFFICINALIS L. River banks. K, C (78-386).

Leguminosae (Fabaceae)

ASTRAGALUS ABORIGINORUM Richards. Taluses, fell-fields, and dry rubble slopes. R (78-37), E (78-212, 78-243), K (78-313).

ASTRAGALUS ADSURGENS Pall. Flood plains. R (78-15, 78-423).

ASTRAGALUS ALPINUS L. Flood plains, roadsides, and woodlands. R (78-9, 78-10), C (78-408), West Fork Dennison Fork Fortymile River campground (78-182), 69.4 mile Taylor Highway (78-184).

ASTRAGALUS EUCOSMUS Hornem. Populus forests, moist to dry. E (78-217, 78-374).

ASTRAGALUS POLARIS Benth. Alpine taluses and outcrops. R (78-162).

ASTRAGALUS ROBBINSII (Oakes) Gray. Moist forests and alder thickets. R (78-126), K (78-310, 78-312).

ASTRAGALUS WILLIAMSII Rydb. Shaley rubble on banks of Yukon River at Calico Bluff (78-259).

LUPINUS ARCTICUS S. Wats. Populus forests, well-drained spruce woodlands, subalpine meadows. R, E (78-218), K, C.

OXYTROPIS BOREALIS DC. Alpine taluses, fell-fields, and outcrops. This taxon is very difficult to distinguish from O. viscida, and Hultén's (1968) criterion of stipule pubescence is used here more or less uncritically to separate the two. The stipules of this material are mostly glabrous on the surfaces, but some young stipules are densely pubescent. R (78-13, 78-36, 78-48, 78-49, 78-58, 78-88, 78-165).

OXYTROPIS CAMPESTRIS (L.) DC. Flood plains, roadsides, and dry slopes. The following specimens are typical examples of O. campestris subsp. gracilis (Nels.) Hult. and are clearly referable to it. R (78-14, 78-422), K (78-342), Delta Junction (78-103), 1,275.5 mile Alcan Highway (78-420). Several specimens tentatively referred to this species have the viscid calyx lobes characteristic of O. borealis and O. viscida. Specimens from Eagle Bluff were additionally unusual in that fasciculated leaflets were fairly common: R (78-433, 78-434, 78-439), E (78-215, 78-252, 78-361, 78-369), Calico Bluff (78-260).

OXYTROPIS DEFLEXA (Pall.) DC. var. FOLIOLOSA (Hook.) Barneby. Common on flood plain of the Delta River. R (78-76, 78-421).

OXYTROPIS DEFLEXA (Pall.) DC. var. SERICEA Torr. & Gray. Roadsides at 49 Mile Taylor Highway. The long-villous pubescence of this plant gives it a strikingly different appearance from O. deflexa var. foliolosa. (78-181).

OXYTROPIS MAYDELLIANA Trautv. Mesic alpine tundra. R (78-39).

OXYTROPIS SCAMMANIANA Hult. Alpine fell-fields. R (78-55).

*OXYTROPIS SPLENDENS Dougl. Common on dry slopes at Kathul Mountain. The strongly fasciculated leaflets of these specimens clearly mark them as this taxon. However, the flowers of this material are all yellow, in contrast to the pink to purple color typical of the taxon (Barneby 1952, Hitchcock et al. 1955-69, Hultén 1968, Welsh 1974). K (78-297, 78-314, 78-315).

OXYTROPIS VISCIDA Nutt. Fell-fields, dry slopes, and river banks. Intergades with O. borealis and apparently also with O. campestris. R (78-23, 78-81), C (78-390).

Linaceae

LINUM LEWISII Pursh (= L. perenne L. subsp. lewisii in Hultén 1968). Flood plains and dry slopes. R (78-74), E (78-373).

Violaceae

VIOLA EPIPSILA Ledeb. subsp. REPENS (Turcz.) Becker. Moist alder thickets and streamsides. R (78-71).

Elaeagnaceae

*ELAEAGNUS COMMUTATA Bernh. Flood plains and dry slopes. R (78-79, 78-424), K (78-352), Yukon River near Montauk Bluff (78-268).

SHEPHERDIA CANADENSIS (L.) Nutt. Flood plains and dry Populus forests. R, E, K, C (78-398).

Onagraceae

CIRCAEA ALPINA L. Moist rocky bank of tiny rivulet where it enters the Yukon River. K (78-323).

EPILOBIUM HORNEMANNII Rchb. Moist roadside. R (78-65).

Umbelliferae (Apiaceae)

BUPLEURUM TRIRADIATUM Adams subsp. ARCTICUM (Regel) Hult. Subalpine meadows and dry slopes. R (78-111), E (78-190), K, C.

CNIDIUM CNIDIIFOLIUM (Turcz.) Schischk. Taluses, subalpine meadows, and Populus forests. R (78-83), E (78-198), K, C, Delta Junction (78-99).

HERACLEUM LANATUM Michx. Alder thickets and moist forests. R (78-91).

*PODISTERA YUKONENSIS Math. & Const. Dry slopes. Also reported from alpine areas. K (78-309, 78-316, 78-343).

Cornaceae

CORNUS STOLONIFERA Michx. Populus forests. E, K (78-305).

CORNUS SUECICA L. Abundant in a subalpine opening fringed by Alnus crispa subsp. sinuata and scattered white spruce. R (78-160).

Pyrolaceae

MONESES UNIFLORA (L.) Gray. Spruce forests. R (78-119).

Ericaceae

ARCTOSTAPHYLOS UVA-URSI (L.) Spreng. Dry Populus forests. R (78-27), E, K, C.

Primulaceae

ANDROSACE CHAMAEJASME Host subsp. LEHMANNIANA (Spreng.) Hult. Taluses and fell-fields. R (78-149), K.

ANDROSACE SEPTENTRIONALIS L. Dry slopes. E, K (78-280), C, West Fork Dennison Fork Fortymile River (78-171).

DODECATHEON PULCHELLUM (Raf.) Merr. Dry Populus forests. K (78-293, 78-327).

DOUGLASIA ARCTICA Hook. This otherwise rare alpine plant is abundant on dry treeless slopes at Kathul Mountain at relatively low elevations. K (78-275, 78-318).

DOUGLASIA GORMANII Constance. Rare on taluses and fell-fields. R (78-54).

Gentianaceae

GENTIANA PROPINQUA Richards. Dry slopes and Populus forests. R (78-124, 78-437), K, C (78-391).

Polemoniaceae

PHLOX HOODII Richards. Locally common on dry slopes at Eagle Bluff (restricted to same part of bluff as Eriogonum flavum). E (78-253).

POLEMONIUM PULCHERRIMUM Hook. Dry slopes and outcrops. E (78-241), K, C, West Fork Dennison Fork Fortymile River (78-170).

Hydrophyllaceae

*PHACELIA SERICEA (Graham) A. Gray (not treated in Hultén 1968). Dry slopes. E (78-205, 78-219, 78-371), K (78-277, 78-300, 78-330, 78-347).

PHACELIS MOLLIS Macbr. Scarce in openings in well-drained Populus and white spruce forests. Locally common on roadsides. C (78-417, 78-418), West Fork Dennison Fork Fortymile River (78-179).

Boraginaceae

*CRYPTANTHA SHACKLETTEANA Higgins (= C. spiculifera in Hultén 1968). Dry slopes and unstable rubble. E (78-206), Calico Bluff (78-258).

MERTENSIA PANICULATA (Ait.) G. Don. Subalpine meadows, alder thickets, and moist Populus forests. R, E, K (78-351), C.

MYOSOTIS ALPESTRIS F. W. Schmidt subsp. ASIATICA Vestergr. Subalpine meadows. R (78-136).

Labiatae

SCUTELLARIA GALERICULATA L. In lush vegetation in dried lake bed on Yukon River flood plain. K (78-356).

Scrophulariaceae

CASTILLEJA CAUDATA (Pennell) Rebr. Abundant on roadsides and flood plains in the Alaska Range. Scarce on the upper slopes of Kathul Mountain. The calyx lobes on this material are only 2-4 mm long, much shorter than is typical of this taxon in northern Alaska. R (78-62), K (78-337), West Fork Dennison Fork Fortymile River (78-180).

*CASTILLEJA ELEGANS Malte. Dry slopes. It is possible that these specimens could be more properly referred to C. raupii, but their linear calyx lobes, even though short (2-3 mm) seem to place them with C. elegans. C (78-381).

CASTILLEJA HYPERBOREA Pennell. Alpine fell-fields. R (78-164).

LAGOTIS GLAUCA Gaertn. Moist, hummocky alpine tundra. R (78-57).

PEDICULARIS LABRADORICA Wirsing. Populus forests. K (78-355), C (78-405).

PEDICULARIS LANGSDORFFII Fisch. Alpine tundra. R (78-53).

*PEDICULARIS SUDETICA Willd. subsp. ALBOLABIATA Hult. Alpine fens. R (78-44, 78-146).

PEDICULARIS SUDETICA Willd. subsp. INTERIOR Hult. Flood plains and well-drained forests. R (78-113, 78-425).

PEDICULARIS VERTICILLATA L. Flood plains and subalpine meadows. R (78-121).

PENSTEMON GORMANII Greene. Dry slopes. E (78-200, 78-216), K (78-302), C, West Fork Dennison Fork Fortymile River (78-178).

Orobanchaceae

BOSCHNIAKIA ROSSICA (Cham. & Schlecht.) Fedtsch. Alder thickets and moist forests with scattered alder. R, E, K, C, (78-404).

*OROBANCHE FASCICULATA Nutt. Associated with Artemisia frigida on dry slopes. E (78-207), K (78-279).

Lentibulariaceae

PINGUICULA VULGARIS L. Flood plains and dry rocky slopes. R (78-144, 78-429).

Plantaginaceae

PLANTAGO CANESCENS Adams. Dry slopes. West Fork Dennison Fork Fortymile River (78-177).

Rubiaceae

GALIUM BOREALE L. Dry slopes. R (78-118), E, K (78-287), C.

GALIUM TRIFIDUM L. River banks. C (78-387).

Campanulaceae

CAMPANULA AURITA Greene. Dry slopes. Abundant at Eagle Bluff but absent at Kathul Mountain. E (78-189, 78-368), C (78-383).

Compositae (Asteraceae)

ANTENNARIA ROSEA Greene. Dry slopes. K (78-326).

ARNICA ALPINA (L.) Olin. Populus forests and subalpine slopes. K (78-345).

ARNICA FRIGIDA C. A. Mey. Subalpine meadows, shrublands, and alpine fell-fields. R (78-132).

ARTEMISIA ALASKANA Rydb. Dry slopes. E (78-204), K, C (78-407), Calico Bluff (78-256), West Fork Dennison Fork Fortymile River (78-167).

ARTEMISIA BOREALIS Pall. Dry slopes and outcrops. R (78-8, 78-63, 78-432, 78-438), E (78-254, 78-364), Calico Bluff (78-255).

ARTEMISIA FRIGIDA Willd. Abundant on most dry slopes. E (78-187, 78-214), K, C (78-397).

*ARTEMISIA FURCATA Bieb. Taluses, outcrops, and dry slopes. R (78-28, 78-52, 78-85), K (78-307).

*ARTEMISIA LACINIATA Willd. Dry slopes and Populus forests. K (78-294, 78-296).

ARTEMISIA TILESII Ledeb. Flood plains, river banks, and moist willow thickets and Populus forests. R, E, K, C, Yukon River near Montauk Bluff (78-264).

ASTER COMMUTATUS (Torr. & Gray) Gray. River banks. Yukon River near Montauk Bluff (78-265, 78-269).

CHRYSANTHEMUM BIPINNATUM L. River banks. K, Yukon River near Calico and Montauk Bluffs (78-262).

CREPIS ELEGANS Hook. Roadsides. C (78-419).

CREPIS NANA Richards. Flood plains, taluses, and dry bluffs. R (78-19), E.

ERIGERON CAESPITOSUS Nutt. Dry slopes. C (78-393).

ERIGERON COMPOSITUS Pursh. Dry slopes and outcrops. These specimens have twice-ternate basal leaves. E (78-213), K (78-276).

ERIGERON GLABELLUS Nutt. subsp. PUBESCENS (Hook.) Cronq. Dry slopes and Populus forests. E (78-246), K (78-358), Delta Junction (78-102).

ERIGERON GRANDIFLORUS Hook. Outcrops at timberline. R (78-33).

ERIGERON HUMILIS Graham. Limestone talus. Isabel Pass (78-96).

ERIGERON PURPURATUS Greene. Flood plains and taluses. R (78-51, 78-72, 78-155).

*PETASITES PALMATUS (Ait.) Gray. Moist rocky river bank. No flowers or fruits were present in this population, but the rhizomes and leaves clearly identify it as this taxon. Yukon River between Calico and Montauk Bluffs (78-270).

SENECIO FUSCATUS (Jourd. & Fourr.) Hayek. Subalpine meadows. R (78-40).

SENECIO LUGENS Richards. Subalpine meadows and well-drained forests. R (78-117, 78-137), E, C (78-403).

SENECIO OGOTORUKENSIS Packer (= S. conterminus in Hultén 1968). Taluses, dry slopes, and outcrops. R (78-6, 78-82), E (78-196, 78-221), K (78-273), Delta Junction (78-100).

SOLIDAGO DECUMBENS Greene var. OREOPHILA (Rydb.) Fern. Dry slopes, usually more completely vegetated and more stable than sites occupied by S. multiradiata. E (78-197, 78-363), K (78-284, 78-324B), C, Delta Junction (78-110), West Fork Dennison Fork Fortymile River (78-173).

SOLIDAGO MULTIRADIATA Ait. Dry slopes and outcrops. R, E (78-195, 78-362), K, C, Yukon River between Calico and Montauk Bluffs (78-261).

TARAXACUM CERATOPHORUM (Ledeb.) DC. Airstrip at Black Rapids Roadhouse. R (78-11).

APPENDIX B

ANNOTATED BIBLIOGRAPHY ON THREATENED AND ENDANGERED TAXA

All authorities known to us for these taxa are included.

Eriogonum flavum var. *aquilinum*

Hitchcock et al. 1955-69	description and distribution of *E. flavum* (more thorough than Hultén 1968 or Welsh 1974)
Hultén 1968	description and distribution
Reveal 1967	type description
Shacklette 1966	distribution and ecology
Stokes 1936	description and distribution of *E. flavum*
Welsh 1974	description and distribution

Draba sp. (new to North America)

Not yet treated in any literature, authority is G. A. Mulligan, Agriculture Canada, Ottawa.

Draba porsildii

Mulligan 1974	type description, cytology, distribution, and key to species in *D. nivalis* group
Mulligan 1976	key to genus *Draba* in Canada and Alaska

Erysimum asperum var. *angustatum*

Hitchcock et al. 1955-69	description of *E. asperum*
Hultén 1941-50	distribution and discussion of taxonomic affinities
Hultén 1968	description and distribution

Porsild 1951	distribution
Rossbach 1958	key to genus Erysimum in North America
Rydberg 1901	type description
Shacklette 1966	distribution and ecology
Welsh 1974	description, distribution, relationship with E. asperum var. asperum

Lesquerella arctica var. scammanae

Hultén 1941-50	discussion of relationship with L. arctica var. arctica
Hultén 1968	description and distribution of L. arctica
Rollins 1939	type description
Rollins and Banerjee 1975	SEM photographs of Lesquerella hairs
Rollins and Shaw 1973	description, distribution, and ecology
Scamman 1940	distribution
Welsh 1974	description and distribution of L. arctica

Podistera yukonensis

Hultén 1967	distribution
Hultén 1968	description and distribution
Mathias and Constance 1942	discussion of genus Podistera (P. yukonensis not discussed)
Mathias and Constance 1950	type description
Porsild 1951	distribution

Welsh 1974	description and distribution
Young 1976	distribution
Phacelia sericea	
Hitchcock et al. 1955-69	description and distribution
Gillett 1960	description and distribution
Porsild 1951	distribution (report of specimen identified as *P. sericea* by L. Constance; this specimen subsequently identified as *P. mollis* by Gillet 1960)
Shacklette 1966	distribution and ecology
Welsh 1974	description and distribution
Cryptantha shackletteana	
Higgins 1969	type description
Higgins 1971	description and distribution
Hitchcock et al. 1955-69	taxonomic treatment of closely related taxa (*C. shackletteana* not discussed)
Hultén 1967	distribution and discussion of taxonomic affinities
Hultén 1968	description and distribution
Hultén 1973	discussion of taxonomic affinities
Payson 1927	taxonomic treatment of closely related taxa (*C. shackletteana* not discussed)
Shacklette 1966	distribution and ecology
Welsh 1974	description and distribution

APPENDIX C

SPECIES CITED IN THE TEXT (EXCLUSIVE OF APPENDIXES)

AND EQUIVALENT COMMON NAMES

The common names were taken primarily from Welsh (1974) and Kelsey and Dayton (1942). Other sources used were Heller (1966a, 1966b), Hulten (1968), and Viereck and Little (1972). For this report, a few common names (those of most of the threatened and endangered taxa as well as taxa of the subspecific and varietal ranks) were either invented outright or modified from existing names of close relatives. Several species have no known common names.

Achillea borealis	northern yarrow
Aconitum delphinifolium	monkshood
Agropyron spicatum	bluebunch wheatgrass
Alnus crispa	American green alder
Alnus tenuifolia	thinleaf alder
Alyssum americanum	American alyssum
Amsinckia lycopsoides	tarweed fiddleneck
Amsinckia menziesii	Menzies fiddleneck
Androsace septentrionalis	- - - - - - - - - -
Anemone drummondii	Drummond anemone
Anemone narcissiflora	narcissus anemone
Anemone parviflora	northern windflower
Arabis holboellii	Holboell rockcress
Arctostaphylos alpina	alpine bearberry
Arctostaphylos rubra	red-fruit bearberry
Arctostaphylos uva-ursi	kinnikinnick
Arenaria capillaris	beautiful sandwort
Arnica alpina	alpine arnica
Artemisia alaskana	Alaska sagebrush
Artemisia borealis	northern wormwood
Artemisia frigida	fringed sagebrush
Artemisia furcata	- - - - - - - - - -
Artemisia laciniata	- - - - - - - - - -
Aster sibiricus	Siberian aster
Astragalus aboriginorum	Indian milkvetch
Astragalus alpinus	alpine milkvetch
Astragalus adsurgens	standing milkvetch
Astragalus eucosmus	elegant milkvetch
Astragalus polaris	polar milkvetch
Astragalus robbinsii	Robbins milkvetch
Betula glandulosa	resin birch
Betula nana	dwarf arctic birch
Betula papyrifera	paper birch
Braya humilis subsp. richardsonii	Richardson low braya
Bromus pumpellianus	arctic brome

Bupleurum triradiatum	thoroughwax
Calamagrostis canadensis	bluejoint reedgrass
Calamagrostis purpurascens	purple reedgrass
Campanula aurita	Yukon bellflower
Campanula lasiocarpa	mountain harebell
Carex aenea	- - - - - - - - -
Carex albonigra	- - - - - - - - -
Carex bigelowii	Bigelow sedge
Carex membranacea	fragile sedge
Carex obtusata	- - - - - - - - -
Carex supina subsp. spaniocarpa	- - - - - - - - -
Castilleja caudata	- - - - - - - - -
Castilleja elegans	elegant Indian paintbrush
Cerastium maximum	great chickweed
Chamaerhodos erecta subsp. nuttallii	Nuttall American chamaerhodos
Claytonia tuberosa	tuberous spring-beauty
Cnidium cnidiifolium	- - - - - - - - -
Cornus canadensis	bunchberry
Cornus stolonifera	red-osier dogwood
Corydalis pauciflora	few-flowered corydalis
Crepis nana	tiny hawksbeard
Cryptantha celosioides	- - - - - - - - -
Cryptantha interrupta	- - - - - - - - -
Cryptantha macounii	- - - - - - - - -
Cryptantha shackletteana	Shacklette cryptantha
Cryptantha sobolifera	- - - - - - - - -
Cryptatha spiculifera	- - - - - - - - -
Cryptantha thyrsiflora	- - - - - - - - -
Cryptantha torreyana	- - - - - - - - -
Cypripedium passerinum	northern ladyslipper
Diapensia lapponica	arctic diapensia
Douglasia arctica	arctic douglasia
Draba sp.	- - - - - - - - -
Draba fladnizensis	arctic draba
Draba glabella	- - - - - - - - -
Draba lactea	milky draba
Draba lonchocarpa	- - - - - - - - -
Draba longipes	- - - - - - - - -
Draba nivalis	snow draba
Draba porsildii	Porsild draba
Dryas octopetala	white mountain-avens
Dryopteris fragrans	fragrant shield-fern
Elaeagnus commutata	silverberry
Elymus innovatus	downy ryegrass
Empetrum nigrum	crowberry
Epilobium angustifolium	fireweed
Epilobium latifolium	river beauty
Equisetum arvense	meadow horsetail
Erigeron caespitosus	tufted fleabane

Erigeron compositus	fernleaf fleabane
Erigeron purpuratus	- - - - - - - - -
Eriogonum flavum var. aquilinum	Eagle yellow eriogonum
Eriophorum triste	cottongrass
Erysimum asperum var. angustatum	narrowleaf plains erysimum
Erysimum cheiranthoides	treacle erysimum
Erysimum inconspicuum	smallflower erysimum
Erysimum pallasii	Pallas erysimum
Festuca altaica	Altai fescue
Festuca rubra	red fescue
Festuca saximontana	- - - - - - - - -
Galium boreale	northern bedstraw
Gentiana propinqua	- - - - - - - - -
Geocaulon lividum	northern commandra
Glehnia littoralis	- - - - - - - - -
Halimolobos mollis	- - - - - - - - -
Hedysarum alpinum	alpine sweetvetch
Hedysarum mackenzii	Mackenzie sweetvetch
Hierochloe alpina	alpine holygrass
Juniperus communis	common juniper
Ledum groenlandicum	Labrador tea
Ledum palustre subsp. decumbens	narrowleaf Labrador tea
Lesquerella arctica var. scammanae	Scamman arctic bladderpod
Lesquerella calderi	Calder bladderpod
Linnaea borealis	twinflower
Linum lewisii	Lewis flax
Lupinus arcticus	arctic lupine
Mertensia paniculata	tall bluebell
Minuartia yukonensis	- - - - - - - - -
Orobanche fasciculata	cluster cancer-root
Oxytropis campestris	field oxytrope
Oxytropis deflexa var. foliolosa	- - - - - - - - -
Oxytropis nigrescens	blackish oxytrope
Oxytropis splendens	showy oxytrope
Oxytropis viscida	viscid oxytrope
Papaver nudicaule	Iceland poppy
Pedicularis capitata	capitate lousewort
Pedicularis lanata	wooly lousewort
Pedicularis sudetica subsp. albolabiata	- - - - - - - - -
Pedicularis verticillata	whorled lousewort
Penstemon gormanii	Gorman beardtongue
Phacelia franklinii	Franklin phacelia
Phacelia mollis	- - - - - - - - -
Phacelia sericea	silky phacelia
Phlojodicarpus villosus	- - - - - - - - -
Phlox hoodii	moss phlox
Picea glauca	white spruce
Picea mariana	black spruce
Poa glauca	Greenland bluegrass

Podistera macounii	- - - - - - - - -
Podistera yukonensis	Yukon podistera
Polemonium acutiflorum	- - - - - - - - -
Polemonium pulcherrimum	pretty jacobs-ladder
Polygonum viviparum	viviparous bistort
Populus balsamifera	balsam poplar
Populus tremuloides	quaking aspen
Potentilla fruticosa	shrubby cinquefoil
Potentilla hookeriana	Hooker cinquefoil
Potentilla nivea	snow cinquefoil
Potentilla pensylvanica	Pennsylvania cinquefoil
Pulsatilla patens subsp. multifida	pasque-flower
Pyrola asarifolia	liverleaf wintergreen
Rosa acicularis	prickly rose
Rubus idaeus	raspberry
Salix alaxensis	feltleaf willow
Salix glauca	grayleaf willow
Salix planifolia subsp. pulchra	diamondleaf willow
Saussurea angustifolia	- - - - - - - - -
Saxifraga eschscholtzii	ciliate saxifrage
Saxifraga oppositifolia	purple mountain saxifrage
Saxifraga reflexa	Yukon saxifrage
Saxifraga tricuspidata	prickly saxifrage
Selaginella sibirica	northern selaginella
Senecio lugens	- - - - - - - - -
Senecio ogoturukensis	- - - - - - - - -
Shepherdia canadensis	buffaloberry
Silene menziesii subsp. williamsii	Williams campion
Silene repens	pink campion
Smilacina stellata	starry solomonplume
Solidago decumbens var. oreophila	- - - - - - - - -
Solidago multiradiata	northern goldenrod
Stellaria alaskana	Alaska starwort
Stellaria longipes	longstalk starwort
Tofieldia coccinea	northern asphodel
Vaccinium uliginosum	bog blueberry
Vaccinium vitis-idaea subsp. minus	mountain cranberry
Viburnum edule	highbush cranberry
Zygadenus elegans	elegant death-camas

APPENDIX D

COMMON NAMES OF PLANTS CITED IN TEXT

AND EQUIVALENT SCIENTIFIC NAMES

Alaska sagebrush	Artemisia alaskana
Alaska starwort	Stellaria alaskana
alpine arnica	Arnica alpina
alpine bearberry	Arctostaphylos alpina
alpine holygrass	Hierochloe alpina
alpine milkvetch	Astragalus alpinus
alpine sweetvetch	Hedysarum alpinum
Altai fescue	Festuca altaica
American alyssum	Alyssum americanum
American green alder	Alnus crispa
arctic brome	Bromus pumpellianus
arctic diapensia	Diapensia lapponica
arctic douglasia	Douglasia arctica
arctic draba	Draba fladnizensis
arctic lupine	Lupinus arcticus
balsam poplar	Populus balsamifera
beautiful sandwort	Arenaria capillaris
Bigelow sedge	Carex bigelowii
black spruce	Picea mariana
blackish oxytrope	Oxytropis nigrescens
bluebunch wheatgrass	Agropyron spicatum
bluejoint reedgrass	Calamagrostis canadensis
bog blueberry	Vaccinium uliginosum
buffaloberry	Shepherdia canadensis
bunchberry	Cornus canadensis
Calder bladderpod	Lesquerella calderi
capitate lousewort	Pedicularis capitata
ciliate saxifrage	Saxifraga eschscholtzii
cluster cancer-root	Orobanche fasciculata
common juniper	Juniperus communis
cottongrass	Eriophorum triste
crowberry	Empetrum nigrum
diamondleaf willow	Salix planifolia subsp. pulchra
downy ryegrass	Elymus innovatus
Drummond anemone	Anemone drummondii
dwarf arctic birch	Betula nana
Eagle yellow eriogonum	Eriogonum flavum var. aquilinum
elegant death-camas	Zygadenus elegans
elegant Indian paintbrush	Castilleja elegans
elegant milkvetch	Astragalus eucosmus
feltleaf willow	Salix alaxensis
fernleaf fleabane	Erigeron compositus
few-flowered corydalis	Corydalis pauciflora

field oxytrope	Oxytropis campestris
fireweed	Epilobium angustifolium
fragile sedge	Carex membranacea
fragrant shield-fern	Dryopteris fragrans
Franklin phacelia	Phacelia franklinii
fringed sagebrush	Artemisia frigida
Gorman beardtongue	Penstemon gormanii
grayleaf willow	Salix glauca
great chickweed	Cerastium maximum
Greenland bluegrass	Poa glauca
highbush cranberry	Viburnum edule
Holboell rockcress	Arabis holboellii
Hooker cinquefoil	Potentilla hookeriana
Iceland poppy	Papaver nudicaule
Indian milkvetch	Astragalus aboriginorum
kinnikinnick	Arctostaphylos uva-ursi
Labrador tea	Ledum groenlandicum
Lewis flax	Linum lewisii
liverleaf wintergreen	Pyrola asarifolia
longstalk starwort	Stellaria longipes
Mackenzie sweetvetch	Hedysarum mackenzii
meadow horsetail	Equisetum arvense
Menzies fiddleneck	Amsinckia menziesii
milky draba	Draba lactea
monkshood	Aconitum delphinifolium
moss phlox	Phlox hoodii
mountain cranberry	Vaccinium vitis-idaea subsp. minus
mountain harebell	Campanula lasiocarpa
narcissus anemone	Anemone narcissiflora
narrowleaf Labrador tea	Ledum palustre subsp. decumbens
narrowleaf plains erysimum	Erysimum asperum var. angustatum
northern asphodel	Tofieldia coccinea
northern bedstraw	Galium boreale
northern commandra	Geocaulon lividum
northern goldenrod	Solidago multiradiata
northern ladyslipper	Cypripedium passerinum
northern selaginella	Selaginella sibirica
northern windflower	Anemone parviflora
northern wormwood	Artemisia borealis
northern yarrow	Achillea borealis
Nuttall American chamaerhodos	Chamaerhodos erecta subsp. nuttallii
Pallas erysimum	Erysimum pallasii
paper birch	Betula papyrifera
pasque-flower	Pulsatilla patens subsp. multifida
pennsylvania cinquefoil	Potentilla pensylvanica

pink campion	Silene repens
polar milkvetch	Astragalus polaris
Porsild draba	Draba porsildii
pretty jacobs-ladder	Polemonium pulcherrimum
prickly rose	Rosa acicularis
prickly saxifrage	Saxifraga tricuspidata
purple mountain saxifrage	Saxifraga oppositifolia
purple reedgrass	Calamagrostis purpurascens
quaking aspen	Populus tremuloides
raspberry	Rubus idaeus
red fescue	Festuca rubra
red-fruit bearberry	Arctostaphylos rubra
red-osier dogwood	Cornus stolonifera
resin birch	Betula glandulosa
Richardson low braya	Braya humilis subsp. richardsonii
river beauty	Epilobium latifolium
Robbins milkvetch	Astragalus robbinsii
Scamman arctic bladderpod	Lesquerella arctica var. scammanae
Shacklette cryptantha	Cryptantha shackletteana
showy oxytrope	Oxytropis splendens
shrubby cinquefoil	Potentilla fruticosa
Siberian aster	Aster sibiricus
silky phacelia	Phacelia sericea
silverberry	Elaeagnus commutata
smallflower erysimum	Erysimum inconspicuum
snow cinquefoil	Potentilla nivea
snow draba	Draba nivalis
standing milkvetch	Astragalus adsurgens
starry solomonplume	Smilacina stellata
tall bluebell	Mertensia paniculata
tarweed fiddleneck	Amsinckia lycopsoides
thinleaf alder	Alnus tenuifolia
thoroughwax	Bupleurum triradiatum subsp. arcticum
tiny hawksbeard	Crepis nana
treacle erysimum	Erysimum cheiranthoides
tuberous spring-beauty	Claytonia tuberosa
tufted fleabane	Erigeron caespitosus
twinflower	Linnaea borealis
viscid oxytrope	Oxytropis viscida
viviparous bistort	Polygonum viviparum
white mountain-avens	Dryas octopetala
white spruce	Picea glauca
whorled lousewort	Pedicularis verticillata
Williams campion	Silene menziesii subsp. williamsii
wooly lousewort	Pedicularis lanata

Yukon bellflower	Campanula aurita
Yukon podistera	Podistera yukonensis
Yukon saxifrage	Saxifraga reflexa

APPENDIX E

GLOSSARY OF BOTANICAL TERMS

The following definitions of terms used in this report are taken largely from Harrington and Durrell (1957). Other excellent glossaries are contained in Benson (1959), Jackson (1928), and Lawrence (1955).

Achene. A small dry single-seeded fruit that disperses in its entirety and does not open or release the seed.

Anther. The pollen-bearing part of the stamen.

Appressed. Lying flat or bent consistently in one direction; commonly used to describe hairs. The appressed hairs of Erysimum lie flat along the surface, but the long appressed hairs of Phacelia and Cryptantha are merely leaning in a consistent direction.

Capitate. In a globular or headlike cluster; concentrated at the top.

Capsule. A dry fruit that is made up of more than one carpel and that opens to release its seeds.

Carpel. A single ovule-bearing unit of an ovary, having evolved from a single spore-bearing leaf (sporophyll) in the evolutionary development of the flower.

Compound. Of two or more parts or components. A compound leaf is one made up of a number of separate and distinct leaflets. Compare simple.

Cruciform. Cross-shaped. Cruciform hairs are common on some plants in the mustard family (Cruciferae).

Cyme. A determinate inflorescence with various shapes and degrees of branching, but with the oldest flower always on the end of the branch.

Divided. Deeply lobed, the sinuses extending to the base of the leaf or to the midrib; nearly compound.

Divaricate. Spreading or diverging.

Entire. Margins without teeth or lobes.

Filament. The stalk of a stamen (supporting the anther).

Gynobase. An extension of the receptacle. Common in the Boraginaceae where it extends between (and is attached to) the nutlets and superficially appears to be part of the ovary.

Inferior ovary. An ovary surrounded by and attached to a structure formed by the fusion of the basal portions of sepals, petals, and stamens. The unfused upper portions of the sepals, petals, and stamens appear to be attached at the top of the ovary.

Inflorescence. A cluster of flowers; the arrangement in which the flowers are grouped.

Involucel. A secondary involucre. See umbel.

Involucre. A whorl of distinct or united leaves or bracts subtending a flower or an inflorescence.

Lanceolate. Lance-shaped; several times longer than wide, broadest toward the base and tapering to the apex.

Muricate. Roughened with short hard points.

Oblanceolate. Inversely lanceolate, attached at the tapered end.

Oblong. Two to four times longer than wide and the sides parallel or nearly so.

Obovate. Inversely ovate, attached at the narrow end.

Ovary. The ovule-bearing (seed-producing) part of the female reproductive organ; develops into the fruit.

Ovate. Egg-shaped in outline, attached at the wide end.

Partition. Used here to refer to the thin translucent wall separating the two cells of a silique, persisting after the two halves of the fruit have fallen away.

Pedicel. The stalk to a single flower in an inflorescence.

Perianth. The floral envelope consisting of sepals and petals however incomplete or modified. Used particularly when the sepals and petals cannot be readily distinguished.

Pinnate. Compound leaf with the leaflets on two opposite sides of an elongated axis.

Pustule. Pale blistery structures on the leaf surfaces of some species of Cryptantha.

Raceme. An indeterminate inflorescence with pedicelled flowers borne along a more or less elongated axis with the younger flowers nearest the apex.

Ray. The branch of an umbel or similar inflorescence. Also used for the arms of stellate hairs.

Receptacle. The more or less expanded portion of the flower stalk that bears the organs of a flower.

Rosette. A dense basal cluster of leaves arranged in a circular fashion like the leaves of the common dandelion.

Rugulose. With a minutely wrinkled or creased surface.

Schizocarp. A dry fruit of two or more carpels, splitting at maturity into an equivalent number of one-seeded segments (mericarps) that do not open or release the seed.

Silique. The dry, two-celled fruit of the mustard family (Cruciferae). The two halves of the fruit pull away from the persistent thin translucent partition separating the two cells, exposing and dispersing the seeds.

Simple. Of only one part, not completely divided into separate segments. Compare compound.

Stamen. One of the pollen-bearing organs of a flower. Made up of filament and anther.

Stellate. Refers to hairs that are starlike with slender arms or rays radiating out from a common center.

Style. The usually stalklike part of the female reproductive organ, attached to the ovary; often persistent on the fruit.

Superior ovary. An ovary with sepals, petals, and stamens inserted at its base.

Ternate. Arranged in three's; in this case composed of three leaflets.

Umbel. An indeterminate convex or flat-topped inflorescence, the flowers all arising from one point, the younger in the center. The inflorescence of Podistera yukonensis is a compound umbel consisting of an umbel of rays (subtended by an involucre), each of which supports an umbel of pedicels (subtended by an involucel).

Umbelliform. Closely resembling an umbel.