United States Department of Agriculture

Forest Service

United States Department of the Interior

Bureau of Land Management

General Technical Report
PNW-GTR-271
January 1992

Alaska Research Natural Areas. 3: Serpentine Slide

Glenn Patrick Juday

United States Department of Agriculture

Forest Service

United States Department of the Interior

Bureau of Land Management

This report is published by the Pacific Northwest Research Station under an agreement with the Ecological Reserves Council and in cooperation with the Bureau of Land Management, U.S. Department of the Interior, Anchorage, Alaska.

Cover

An unvegetated alpine exposure of serpentinite blown free of snow (upper left) shows the striking toxic effects of this special natural bedrock type, and a path of destroyed vegetation (upper right) along a slope marks a large earthslide in the winter: these two characteristic features give the Serpentine Slide Research Natural Area its name. Forests of mature white spruce can be seen on the south-facing slopes along the earthslide. Beaver lodges, a dam, and a pond occur at the base of warm, dry, open limestone and dolomite slopes on the Beaver Creek flood plain (lower left). The northern wood frog (*Rana sylvatica*) is common along the edge of beaver ponds and meadows (lower right) and develops to large sizes in the long, warm days of summer.

Author

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Foreword

The concept of establishing natural areas for education and scientific research is not new. As early as 1917 in the United States, the Ecological Society of America set up the Committee on the Preservation of Natural Conditions and published its findings in 1926. Other professional societies-Society of American Foresters, the Society of Range Management, and the Soil Conservation Society of America-proposed programs to identify and set aside areas where natural forest, range, and soil conditions could be preserved and studied.

The name Research Natural Area (RNA) was adopted and, in 1966, the Secretaries of Agriculture and the Interior formed the Federal Committee on Research Natural Areas to inventory research sites established on Federal land and to coordinate their programs. A 1968 directory from the Federal committee listed 336 RNAs nationwide, of which 13 were in Alaska.

By 1969, the International Biome Program (IBP) was active across the United States, and a tundra biome team was headquarted at the University of Alaska. The IBP proposed the establishment of an ecological reserves system for Alaska—"field sites uniquely suited for natural research and education. All identified sites...to illustrate one or more ecological phenomena particularly well." Called Research Natural Areas in the United States, such areas are still called Ecological Reserves in Canada and other parts of the world.

In 1973, the Joint Federal-State Land Use Planning Commission for Alaska assumed the role of lead agency in establishing Research Natural Areas and provided badly needed funds and staff support. By fall 1976, a resource planning team of the commission had prepared a comprehensive plan for establishment and management of the RNAs. A total of 222 sites, representing a wide range of physiographic regions and planning areas in the State, was recommended.

In 1976, the commission formed the Ecological Reserves Council to represent Federal, State, and private agencies. It also entered into a contract with the University of Alaska to assist in carrying out the council's recommendations.

Present members of the Ecological Reserves Council are:

U.S. Department of the Interior:
- Bureau of Land Management
- Fish and Wildlife Service
- National Park Service

U.S. Department of Agriculture, Forest Service:
- Alaska Region
- Pacific Northwest Research Station

National Marine Fisheries Service
Alaska Department of Fish and Game
Alaska Federation of Natives
University of Alaska Fairbanks

A management-coordinator position for gathering on-the-ground data for the RNAs Alaska has been filled since 1977 by Dr. Glenn Juday-originally under the planning commission, then by contract between the University of Alaska and the USDA Forest Service.

In 1985, the Ecological Reserves Council proposed to the Director of the Forest Service's Pacific Northwest Research Station that the reports for the RNAs, be published formally by the Station. The Station agreed to publish them in the General Technical Report series.

KENNETH H. WRIGHT (Retired)
USDA Forest Service

Juday, Glenn Patrick. 1992. Alaska Research Natural Areas. 3: Serpentine Slide. Gen. Tech. Rep. PNW-GTR-271. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 66 p.

Abstract

The 1730-ha Serpentine Slide Research Natural Area (RNA) is located in central Alaska in the White Mountains National Recreation Area. It is managed by the U.S. Department of the Interior, Bureau of Land Management, Steese-White Mountains District. Serpentine Slide was selected as a Research Natural Area (RNA) because it contains an alpine exposure of serpentinite; a 9-ha natural earth flow that has destroyed most vegetation in its path; bottom-land white spruce and balsam poplar forests growing on coarse gravels and sands of a major clearwater river flood plain; and warm, dry hill prairies on steep south-facing slopes. The area also contains several beaver dams, lodges, and ponds. Beaver-created habitats support typical wetland species including ducks and the northern wood frog. Open gravel bars and the high-quality, clear water of Beaver Creek provide nesting and breeding habitat for shore birds, especially the semipalmated plover. The Beaver Creek bottom-land corridor is a locally important habitat for grizzly bear, which use the RNA intensively in particular seasons. The variety of natural features of geologic, hydrologic, botanic, aquatic, and wildlife interest and the opportunity to monitor natural change in a locally diverse environment make Serpentine Slide RNA an outstanding scientific and educational resource.

Concentric zones around serpentinite exposures in the RNA show increasingly toxic effects on plants. A widespread alpine plant in Alaska, *Bupleurum triradiatum*, is the vascular species most tolerant of serpentinite, but no special serpentine-adapted plant species have been discovered in the RNA. The center of serpentinite exposures in the RNA is naturally devoid of all plant life except an orange crustose lichen.

The earth flow has been periodically active since at least the early 1950s. Dolomite and limestone are exposed on the lower slopes in the northeast portion of the RNA. The banks and overflow channels of Beaver Creek are made up of large to mediumsized smooth, rounded gravels with little fine sediments. The flood plain and terraces along the Beaver Creek portion of the RNA are generally made up of gravels and coarse sand, in contrast to the fine silts, sands, and clays of terraces and flood plains along typical northern Alaska rivers that carry glacial sediments.

Belted kingfishers excavate nesting burrows in exposed river cutbanks along Beaver Creek. Goshawks use extensive stands of mature and old-growth white spruce forest and adjacent successional and wetland habitats

Three plants collected in the RNA, *Carex eburnea*, *Artemisia alaskana*, and *Agropyron spicatum*, are growing beyond their previously reported distribution in Alaska. A 150-year-old flood-plain white spruce forest supports about 40 m^2/ha live tree basal area and contains dominant trees from 30 to 45 cm in diameter at breast height (d.b.h.) and up to 30 m tall. An upper elevation, south-slope white spruce forest supported 36 m^2/ha, dominant trees 20 to 36 cm d.b.h. and a maximum of 19 rn tall.

Keywords: Alaska, beaver, *Castor canadensis*, earthslide, ecosystems, goshawk, *Accipiter gentilis*, grizzly bear, *Ursus arctos*, hill prairie, Research Natural Area, Natural Areas (Research), northern wood frog, *Rana sylvatica*, old-growth forest, scientific reserves, serpentine, semipalmated plover, *Charadrius semipalmatus*, white spruce, *Picea glauca*.

Contents

Introduction

Serpentine Slide is an area of the White Mountains National Recreation Area (WMNRA) in central Alaska that contains an exposure of the ultramafic rock type, serpentinite (in this area the metamorphosed form of harzburgite), and a major earthslide. Serpentine is a hydrothermally altered, iron- and magnesium-rich rock presumed to originate as new crust at seafloor spreading centers. Serpentine rocks form soils that lack calcium and have magnesium and heavy metals at levels toxic to most plants, except those specially adapted to grow on them (fig. 1). A natural zone of geologic weakness on a steep slope overlooking Beaver Creek near the serpentinite exposure has produced a large earthslide (fig. 2). The name Serpentine Slide was derived from a combination of these two features.

Serpentine Slide Research Natural Area (RNA) is managed by the Steese-White Mountain District Manager, Bureau of Land Management, U.S. Department of the Interior; district headquarters is in Fairbanks (1150 University Avenue, Fairbanks, AK 99709-3854). Permission is not needed for educational use and observational, nondestructive research, but scientists interested in using the area are urged to contact the district manager and the Alaska Ecological Reserves Coordinator, Agricultural and Forestry Experiment Station, University of Alaska Fairbanks, Fairbanks, AK 99775, to outline activities planned.

The WMNRA was established by the Alaska National Interest Lands Conservation Act (ANILCA) of 1980. Section 1312 of ANILCA recognizes the scientific and fish and wildlife values of the WMNRA and requires their protection. A list of natural features of scientific interest was developed as part of the resource inventory of the WMNRA.[1] This list was the basis for the nomination of three Research Natural Areas (RNAs): Serpentine Slide, Mount Prindle (Juday 1988), and Limestone Jags (Juday 1989).

[1] Juday, G.P.; Knapman, L.; Field, L.; Taylor, D. 1982. A preliminary report of ecological reserve project activity, Fairbanks District BLM: identification of type needs and candidate Research Natural Areas in the White Mountains NRA-Steese NCA. Fairbanks, AK: Bureau of Land Management, Steese-White Mountains District. Unpublished report on file. 9 p.

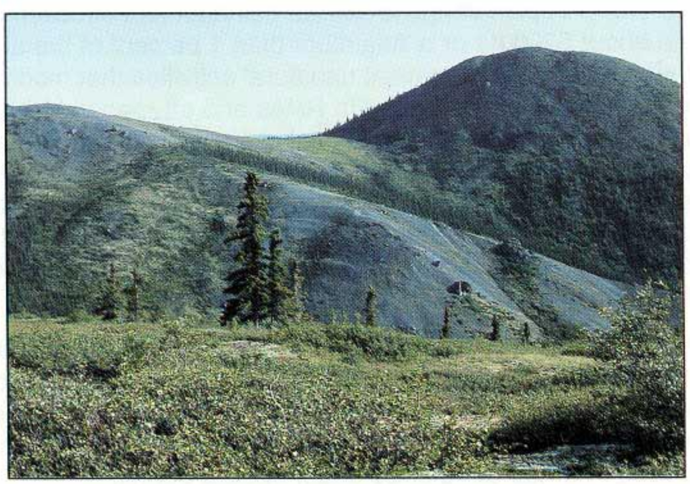


Figure 1—Barren serpentinite outcrop (middle ground and background) at 900 m in elevation in the western portion of Serpentine Slide Research Natural Area. Gray-green color of serpentine rock delimits barren areas, where soils are naturally toxic to all vegetation.

Figure 2—Large natural earthslide or debris flow on south-facing, low-elevation serpentine slope in southern portion of Serpentine Slide Research Natural Area, June 1987. The earthslide extends down to the flood plain of Beaver Creek. Active surfaces within the earthslide are tan and gray. White spruce trees killed by landslide deposits on the flood plain are rust or gray.

The draft land and resource management plan for the WMNRA proposed a 1730-ha Serpentine Slide RNA in 1984 (Bureau of Land Management 1984). After public review and comment, Serpentine Slide RNA was established by a revised plan adopted in 1986 (Bureau of Land Management 1986). The approximate center of Serpentine Slide RNA lies at 65° 43' N., 147° 31' W. (fig. 3). The setting of Serpentine Slide Research Natural Area (RNA) within the WMNRA is shown in figure 4.

The location of the RNA within the public land survey system and topographic contours are shown in figure 5. Elevations in the RNA range from 975 m in the mountains of the northern perimeter to 320 m along Beaver Creek as it flows north toward the Yukon Flats.

The WMNRA plan contains special management direction for the three RNAs, which total about 5200 ha or a little more than 1 percent of the area. The guiding principle of management is to prevent unnatural activities that modify ecological processes. No mineral leases will be issued in RNAs and off-road vehicles (ORVs) are not allowed. Scientific research and educational use are encouraged; passive recreation, including hunting, is allowed. Long-term studies can be conducted in RNAs with minimal interference and the assurance that management or resource development will not conflict with research. In return, scientists should notify the district manager of their proposed uses, abide by any applicable regulations, and provide the Bureau of Land Management with published results or progress reports.

The relation of management zones to Serpentine Slide RNA is shown in figure 6. A large, primitive recreation management zone occupying about 191 100 ha, or 47 percent of the WMNRA, borders Serpentine Slide RNA to the east and west. The primitive zone is closed to mineral leasing and to motorized vehicles other than snowmobiles in winter or vehicles under special permit.

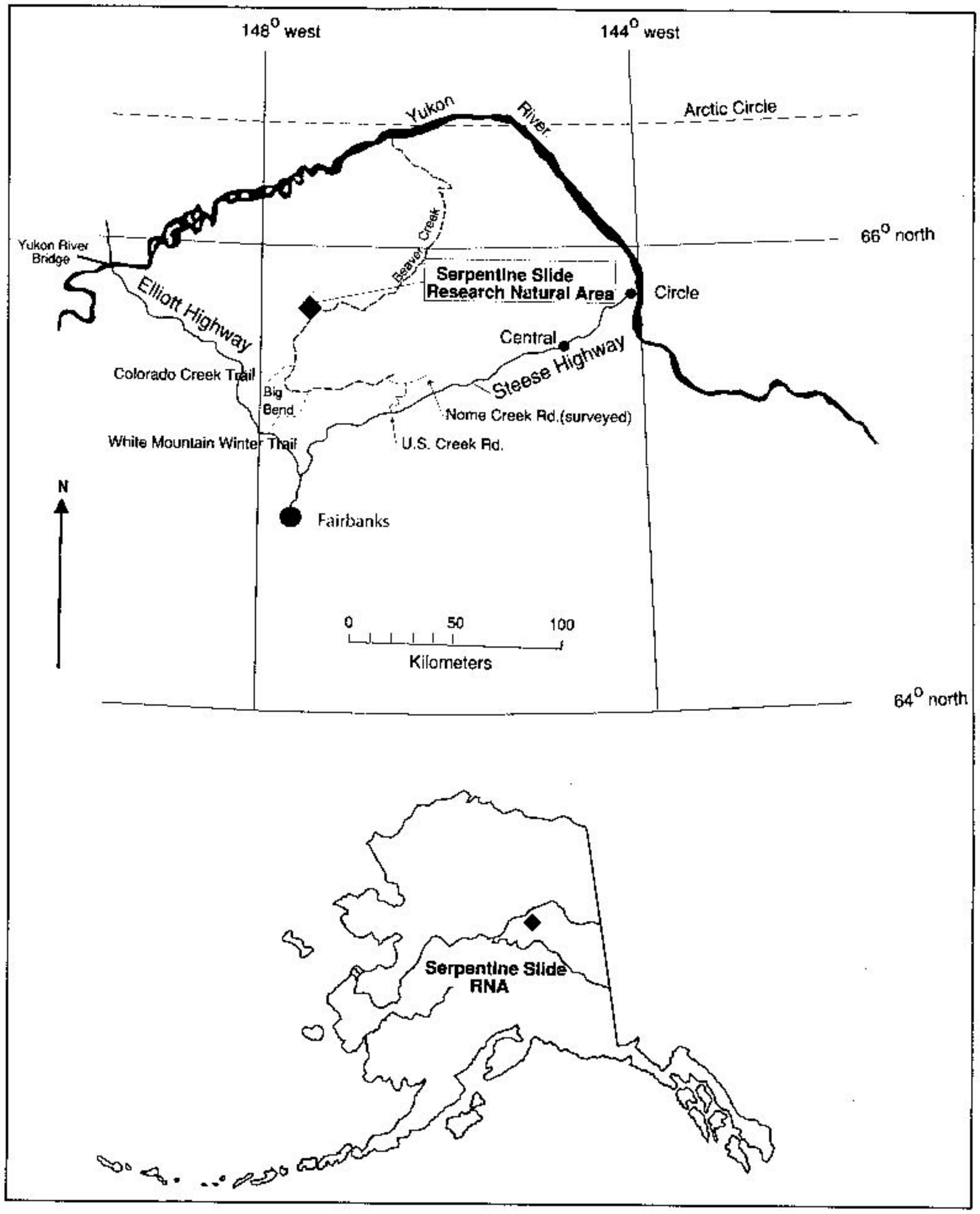


Figure 3—Location of Serpentine Slide Research Natural Area in east-central Alaska.

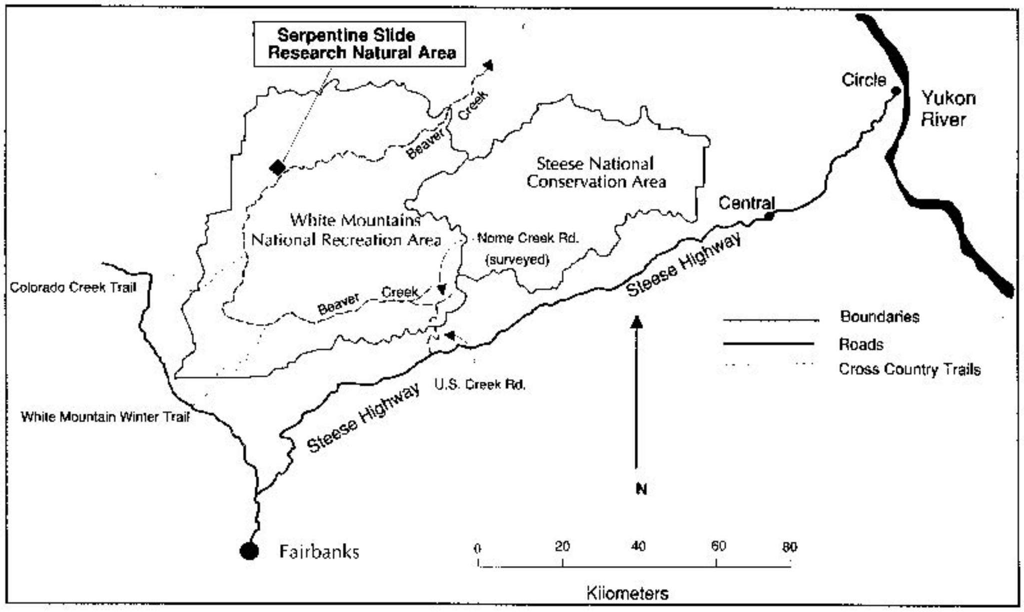


Figure 4—Position of Serpentine Slide Research Natural Area within the White Mountains National Recreation Area. Road and trail access to the area is included.

Beaver Creek was designated a National Wild River by ANILCA. The Beaver Creek Wild River corridor occupies about 28 300 ha or 7 percent of the WMNRA, and it overlaps the southern portion of Serpentine Slide RNA (fig. 6). The river corridor is generally managed in the same way as the primitive recreation zone, except that motorized boats are currently allowed on the river. The river corridor is expected to be the focus of increasing recreation activity when access improves. The WMNRA plan did not implement onsite restrictions or onsite recreation management activities, but it authorized these measures if they are needed to protect resource values and public health and safety (Bureau of Land Management 1986). A semiprimitive motorized recreation zone abuts the northern border of Serpentine Slide RNA (fig. 6); it is open to mineral leasing (other than placer mining) and to ORVs of less than 700 kg. Further details of management direction are available in the WMNRA plan (Bureau of Land Management 1984) and the Record of Decision (Bureau of Land Management 1986).

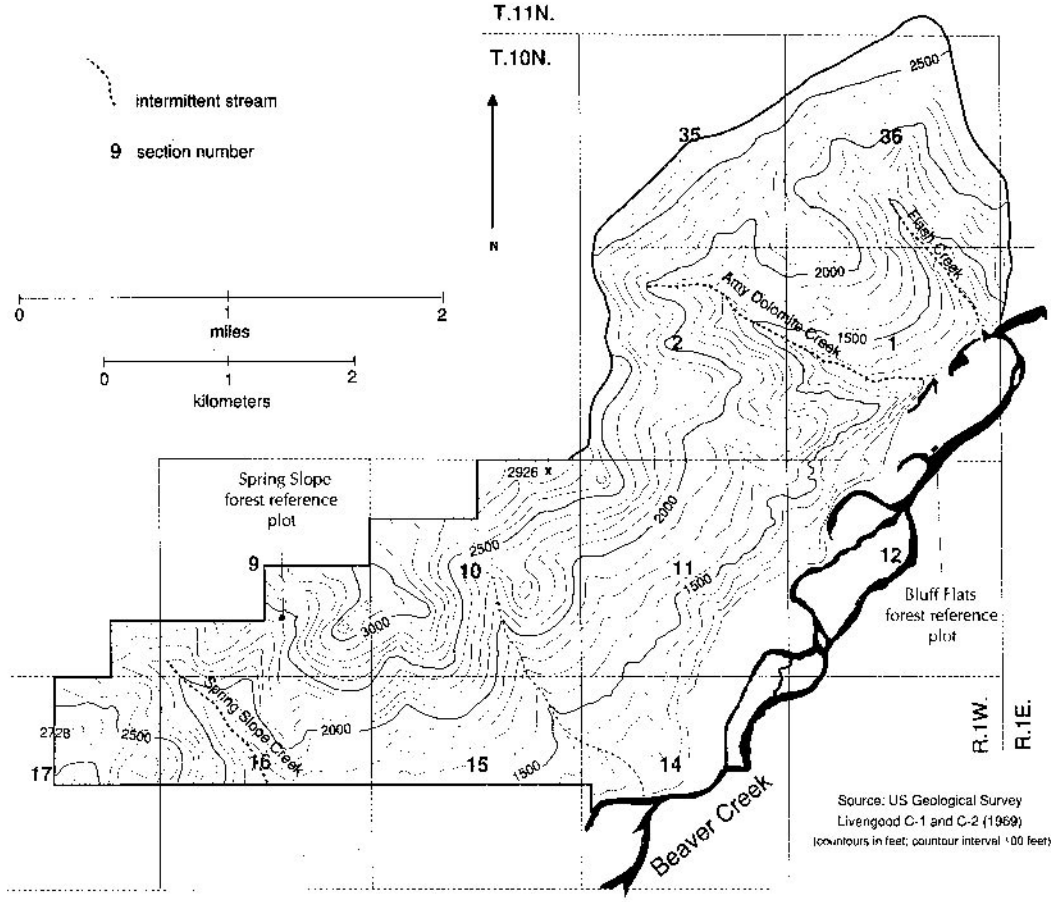


Figure 5—Topography of Serpentine Slide Research Natural Area (contours in feet) and boundary of the Research Natural Area within the public land survey grid, Fairbanks Meridian.

The principal historical uses of the Serpentine Slide RNA have been geologic study, mineral prospecting, biological research, and hunting. Mertie (1917) began geologic study and prospecting in the early 1900s. The work of Weber and Chapman in the area in the 1960s led to the first bedrock geology map of the Livengood quadrangle (Chapman and others 1971). In the 1950s and early 1960s, a Norwegian botanist, Olav Gjaerevoll (1958, 1963, 1967), conducted the first taxonomic work in this portion of the State. He collected mainly plants of mountain and limestone habitats in areas to the south, but he also collected along the Beaver Creek corridor. Serpentinite outcroppings were identified in 1967 (Foster 1968), the first of their type documented in Alaska. The documentation of the RNA in 1982, 1983, and 1987 reported here resulted in the first extensive plant collections in the RNA, observations of plant responses to serpentine in Alaska, and the establishment of permanent plots in upland forest, bottom-land forest, and at tree line. The U.S. Geological Survey evaluated the geology and mineral resources of the WMNRA in 1986 and 1987 (Weber and others 1988). Recreational activity in the area consists mainly of float trips on Beaver Creek and fly-in fishing.

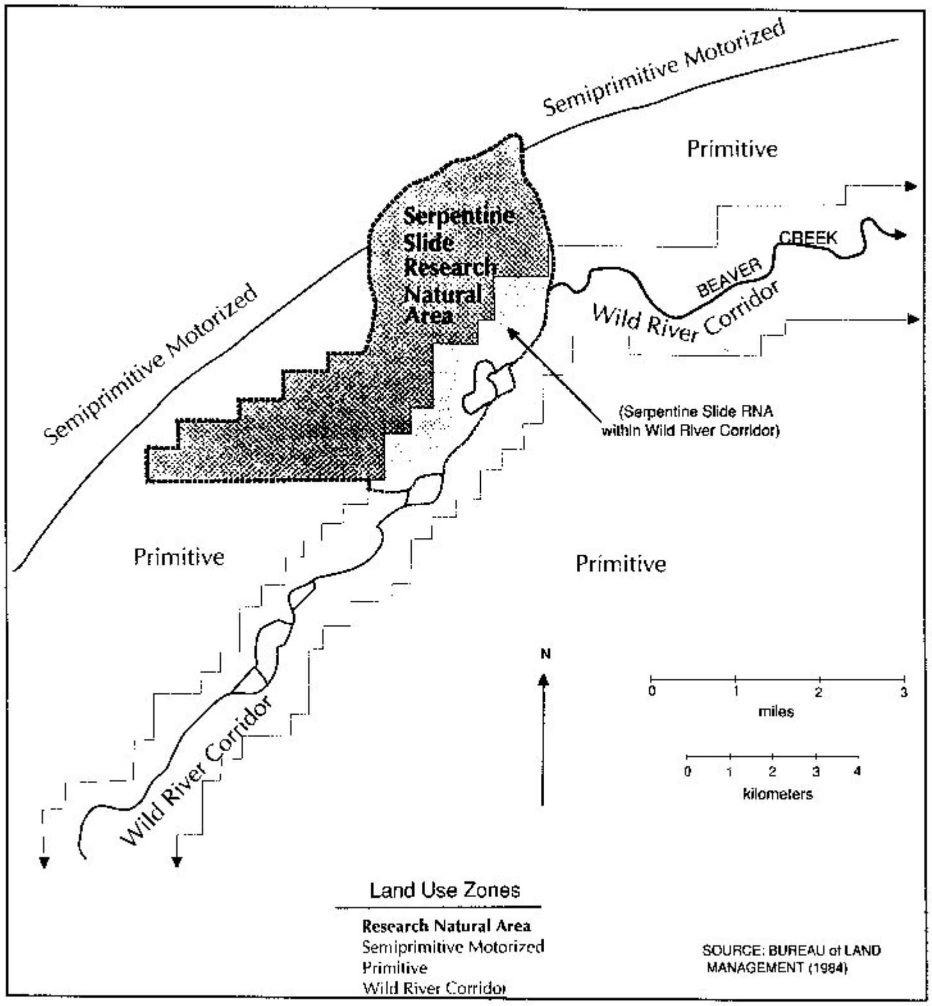


Figure 6—Land use zones of the White Mountains National Recreation Area near Serpentine Slide Research Natural Area. Note overlap of Research Natural Area and Wild River corridor.

Access and Accommodations

Parking, Roads, and Rights-of-Way

There is no road access to Serpentine Slide RNA. Visitors can reach the area by aircraft, snow machine, or a combination of river and cross-country travel. Serpentine Slide is about 115 km north of Fairbanks International Airport (fig. 4). Helicopter access to the RNA is excellent; landing zones are available in open alpine regions, on gravel bars on Beaver Creek, in beaver meadows, and on serpentinite barrens. The frozen surface of Beaver Creek can be used for skiplane landings when snow conditions are suitable. During the warm season, small fixed-wing aircraft with large tires occasionally use gravel bars along Beaver Creek for takeoffs and landings, although this form of access is not recommended. Floatplanes can use the surface of Beaver Creek near the RNA during high water. Floatplane operations are possible for nearly the entire warm season on Beaver Creek below its confluence with Victoria Creek, which is about 40 km east-northeast (downriver) from the RNA. The WMNRA plan authorizes a primitive landing strip near the mouth of Victoria Creek; the selection of a site and construction of the airstrip must await environmental analysis and funding.

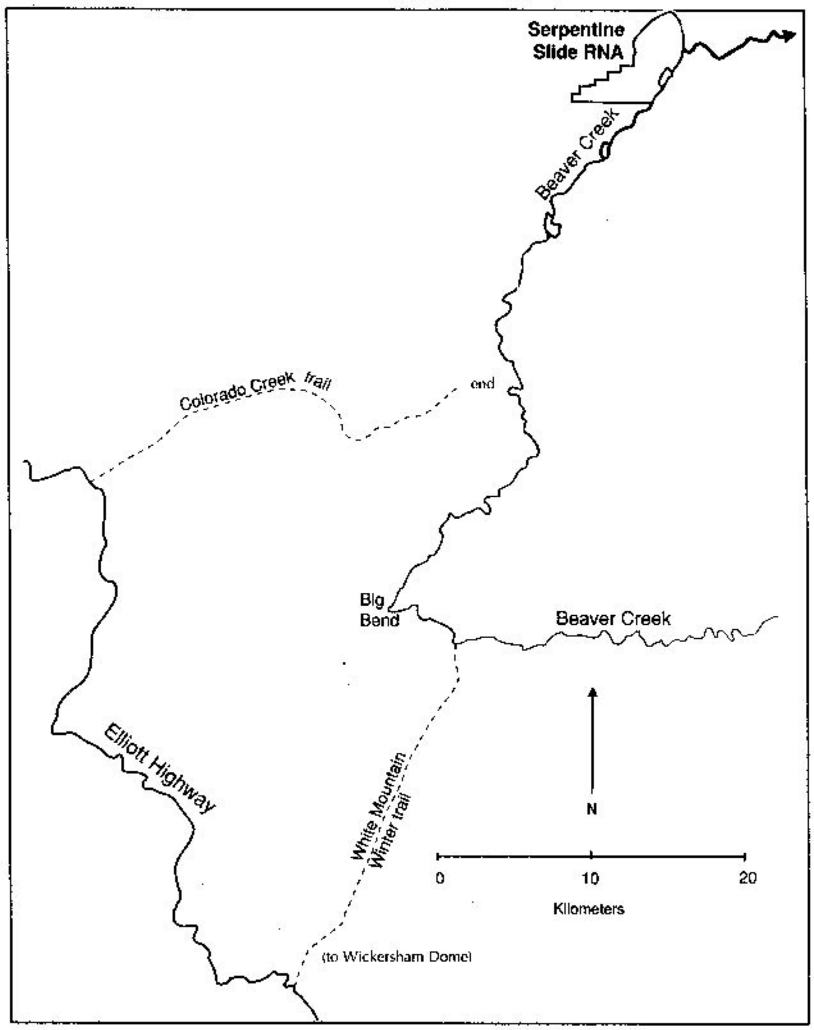


Figure 7—Cross-country travel routes to Serpentine Slide Research Natural Area from the end of the White Mountains winter trail and the Colorado Creek trail.

Winter access to the area is good. The nearest road to Serpentine Slide RNA is the Elliott Highway, 40 km to the southwest (fig. 4). Two well-used snowmobile trails, the White Mountain Winter Trail and the Colorado Creek Trail, connect the Elliott Highway to Beaver Creek (fig. 7). The frozen flood plain and surface of Beaver Creek itself make a well-used snowmobile route south of the RNA as indicated by tracks in the snow. Snowmobile travel on Beaver Creek drops off considerably from Serpentine Slide northward. Visitors should be aware of persistent open water leads or channels on Beaver Creek and check with the Bureau of Land Management (BLM) for information on current local conditions.

Beaver Creek is a highly desirable float trip destination. It is near the facilities and visitor services of Fairbanks but offers a true wilderness river experience. The summer climate includes more warm and sunny days than any other region of Alaska; occasionally Beaver Creek becomes warm enough for a brief swim. The water of Beaver Creek is exceptionally clean and clear. Aquatic productivity (including sport fish) in Beaver Creek is enhanced by buffering and nutrient enrichment from limestone in the middle and upper portions of the watershed. The Beaver Creek riparian zone is a significant wildlife corridor, thus offering viewing and hunting opportunities to visitors.

Most river expeditions to Beaver Creek are flown in because no road reaches Beaver Creek. The White Mountains Resource Plan approved construction of a road, campground, and visitor facilities at the head of Beaver Creek. The new facilities will allow boat access about 80 km upstream from Serpentine Slide RNA. The route for the road has been approved and surveyed. Construction will begin when BLM obtains an appropriation for the project. Float trips to Serpentine Slide will presumably become more numerous with improved access.

Structures and Trails

There are no structures in or immediately adjacent to the RNA. A small cabin is located along Beaver Creek about 5 km downstream, and two private cabins are 22 and 30 km upstream (south) of the RNA. None of the structures is permanently inhabited. Serpentine Slide is part of a wilderness environment, and visitors must be prepared for a high degree of self-sufficiency. The WMNRA plan approved a public use trail and a shelter or cabin to be constructed about 19 km east of the RNA in the mountains west of Victoria Mountain. Detailed site planning and construction are contingent on a Congressional appropriation.

The plan also provides for a ridge trail above Beaver Creek. One trailhead is proposed for a site along Beaver Creek about 5 km downstream from the RNA.

Reasons for Establishing the Research Natural Area

The criteria for establishing RNAs in Alaska are called type needs (Juday 1983). Type needs are plant communities, rare plants, geologic features, and animal species that are characteristic of a given region and that are necessary for a complete and representative system of RNAs. The special character of type needs, such as their rarity, habitat requirements, or sensitivity, guide the management of the particular RNAs they occur in. Juday and others (see footnote 1) defined type needs used in the search for RNAs in the WMNRA. Table 1 is a list of the type needs found in Serpentine slide RNA and includes two geologic features and nine plant communities. The significance of the RNA for wildlife was revealed by site documentation, and the five animal species in Table 1 are a supplement to the original list. These animal species are especially characteristic of the RNA and offer special research and educational opportunities; they should be given status equal to the original type needs in future management and research in Serpentine Slide RNA.

Table 1-Natural feature type needs used In the selection of the Serpentine Slide Research Natural Area

Type needs	Comments and definitions
Geologic features:	
Serpentinite	Bedrock exposure and shallow residual soils across a range of elevations from alpine uplands to Beaver Creek
Faultline features	High-angle thrust fault or suture zone providing evidence on the accretion of terranes or normal faults, or both, showing surface geomorphic evidence of faultline shifting or movement
Plant communities:	
Forest—	
Moist white spruce slope forest	*Picea glauca*/feathermoss, *Picea glauca/Linnaea borealis-Equisetum silvaticum* and *Picea glauca/Rosa acicularis*[a]
Wet black spruce-sphagnum[b]	Black spruce open needleleaf forest (includes several level V communities)[a]
Moist balsam poplar flood-plain forest[b]	Balsam poplar closed broadleaf forest (includes more than one level V community)[a]
Moist balsam poplar-spruce flood-plain forest[b]	*Populus balsamifera-Picea glauca/Alnus/Equisetum*[a]
Shrub—	
Wet willow-alder drainageway tall shrub	Alder-willow closed tall scrubs
Moist willow flood-plain tall shrub[b]	Willow closed tall shrub (includes *Salix alaxensis* and other level V communities)[a]
Moist alder slope tall shrub	Alder-willow closed tall scrub[a]
Herbaceous—	
Snowbed herb-graminoid meadow	Alpine herb-sedge (snowbed)[a]
Barren and lichen—	
Foliose lichen	Foliose and fruticose lichen[a]
Crustose lichen rocks	Crustose lichen[a]
Animal species:[c]	
Amphibian—	
Northern wood frog (*Rana sylvatica*)	

Table 1—Natural feature type needs used in the selection of the Serpentine Slide Research Natural Area (continued)

Type needs	Comments and definitions
Birds—	
Goshawk (*Accipiter gentilis*)	
Semipalmated plover (*Charadrius semipalmatus*)	
Mammals—	
Beaver (*Castor canadensis*)	
Grizzly bear (*Ursus arctos*)	

[a] Nearest unit of Alaska vegetation classification system: Viereck, L.A.; Dyrness, C.T.; Batten, A.R. 1986. The 1986 revision of the Alaska vegetation classification. Unpublished manuscript. On file with: U.S. Department of Agriculture, Forest Service, Institute of Northern Forestry, Fairbanks, AK. 112 p.
[b] Type need listed has only marginal representation in Serpentine Slide Research Natural Area.
[c] Not originally included on type needs list; were determined to be significant during site documentation.

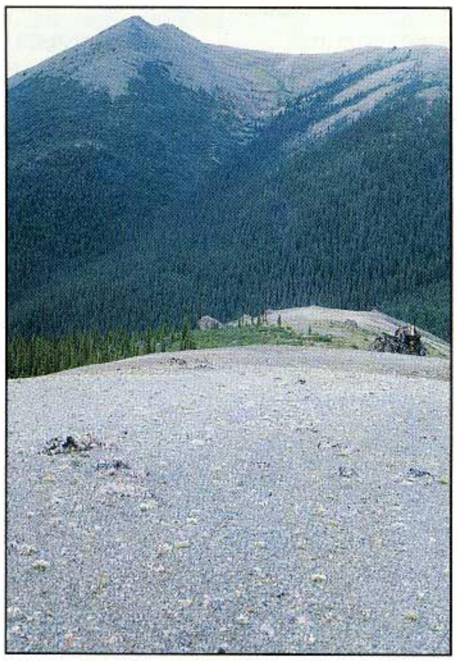


Figure 8—High-elevation serpentinite barren (foreground), looking east, July 1982. Note the very sparse vegetation cover and gravelly texture of the gray soil surface.

Serpentine Slide RNA includes portions of one of the largest surface exposures of serpentinite in Alaska, a geologically and ecologically special and interesting rock type (fig. 8). Serpentine exposures are often relatively small because they are transported fragments of deep-ocean crustal material usually wedged among slivers of unrelated terranes. Serpentine forms under very specific conditions characteristic, if not diagnostic, of crustal materials emerging at seafloor spreading centers. These diagnostic characteristics make serpentine rocks useful in understanding the origin and history of the continental landscapes they have been incorporated into. The predominant mineral in serpentine is usually olivine, which gives a shiny, lustrous, dark-green appearance; asbestos fibers are often present.

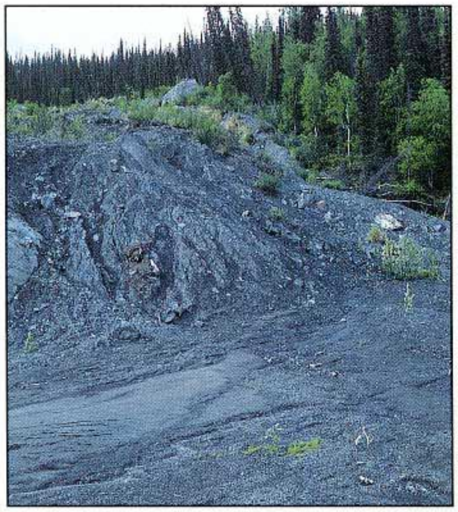


Figure 9—Fractured dark basalt, greenstone, and serpentinite bedrock fragments carved by recent erosion and deposition zone at the base of the earthslide in Serpentine Slide Research Natural Area.

In all the Earth's major biomes, from the tropics to polar regions, serpentine and other related ultramafic rocks support a very unusual flora that often includes species locally adapted to grow in the special conditions these rocks produce (Brooks 1987). Walker (1954) notes that plants growing on serpentine must be "...tolerant of low calcium levels, and, in addition, be tolerant of one or more of the following: high concentrations of chromium and nickel, high magnesium, low levels of major nutrients, low available molybdenum, drought, and other undesirable aspects of shallow stony ground."

The large earthslide found in the RNA is an unusual feature in interior Alaska and appears to be chronically active. The fractured bedrock exposed by the landslide looks much like strip mine tailings (fig. 9). Studies of natural ecological succession on the landslide might identify plant species or varieties that could be used to revegetate strip mines or other drastically disturbed lands in forest regions of interior Alaska.

Serpentine Slide includes a diversity of soils ranging from semiarid limestone and dolomite (fig. 10) to coarse flood-plain sands and gravels, alpine tundra permafrost, bottom-land permafrost, mature hardwood and conifer profiles, geochemically unique serpentine, and young, rich alluvium.

The hydrology and river morphology of the RNA are of special interest. Much of interior Alaska has a dry climate; the density of streams across the landscape is low. In interior Alaska, most large rivers that have extensive watersheds carry turbid glacial meltwater. Beaver Creek carries no glacial sediment and its water is especially clear (fig. 11). The Beaver Creek flood plain in the RNA is being formed by redeposition of alluvium rather than by the rise of the river from its bed as in a braided glacial-river flood plain.

Serpentine Slide RNA contains bottom-land old-growth white spruce (*Picea glauca* (Moench) Voss) and successional shrub and balsam poplar (*Populus balsamifera* L.) forest communities. Most studies of bottom-land forests in central Alaska have been conducted on aggrading braided glacial-river systems with nutrient-rich mixtures of

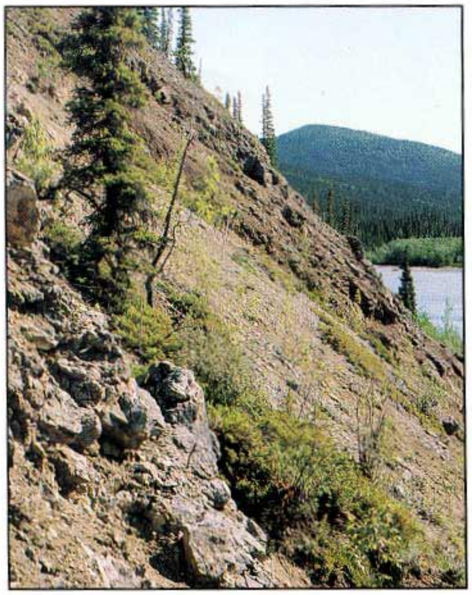


Figure 10—Steep, dry, unstable dolomite bluffs (buff colored rocks in foreground), northeast portion of Serpentine Slide Research Natural Area. Carving action of Beaver Creek (right background) maintains the slope in an oversteepened condition, which causes maximum reception of low-angle sun in this high-latitude location. Spreading evergreen shrub in foreground is common juniper (*Juniperus communis*).

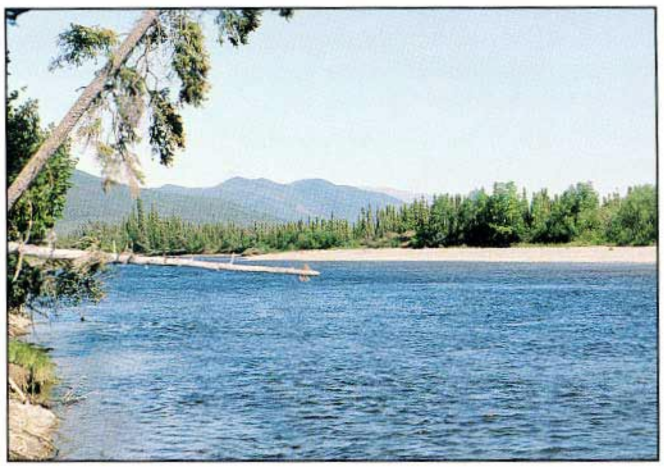


Figure 11—Deep blue color of Beaver Creek is due to its clean, clear water, which reflects (blue to violet) light from the sky. Beaver Creek is one of only a few large rivers in the semiarid interior of Alaska that does not carry glacial sediment (June 1987).

fine sands and silts. The bottom-land plant communities in the RNA represent an interesting variant of these important vegetation types in interior Alaska. The bottom lands of the RNA support forests that have developed on coarse-textured soils, predominantly smooth, rounded river gravels overlain with variable amounts of sand or a humic layer (fig. 12).

The extensive south-facing slopes of the RNA support a relatively productive mature or old-growth white spruce forest of trees notably large for the elevation and northern latitude of the area. Bluff grasslands are found on the steepest south-facing slopes at low elevations just above Beaver Creek. Bluff grasslands are rich in plant species and contain some uncommon or range-limited species at the northern limits of their distribution.

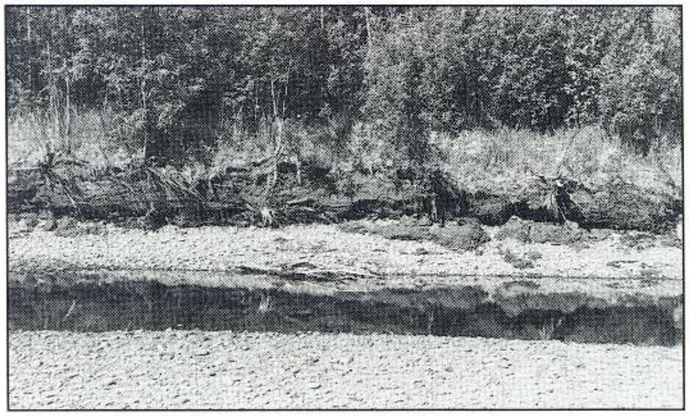


Figure 12—Profile of subsoil on a cutbank along Beaver Creek. Note the thickness of coarse rounded river gravels and the cap of laminated sand and humic material.

Figure 13—Beaver pond on the flood plain of Beaver Creek in the northern portion of Serpentine Slide Research Natural Area. Beaver dam is on the right and two lodges are in the center. Channels on the left and in the foreground make the transport of food and building materials (treetops) from long distances easier.

Exposed stony gravels along the active flood plain of Beaver Creek are ideal nesting habitat for shore birds; many shore bird species do not construct a nest but simply lay eggs that match surrounding rocks in color, size, and pattern. The semipalmated plover is conspicuous in the active flood plain of the RNA during summer as it tries to divert intruders from its eggs camouflaged among the rocks with loud cries and a display simulating an injured wing.

Goshawks have been seen in mature white spruce forests of the RNA. Goshawk nesting pairs in interior Alaska require large areas of habitat-from 40 to 370 km^2 (McGowan 1975). The Beaver Creek valley is an area of intensive grizzly bear use. Serpentine Slide RNA supports a large population of beaver that have major effects on the flood-plain environment. Beaver have constructed a network of dams and ponds that use sloughs, terraces, and water from streams draining the slope north of Beaver Creek (fig. 13). Beaver ponds create habitat for furbearers, ducks, and fish. Lush meadow habitats develop as beaver ponds fill in or when they drain after beaver dams are abandoned (fig. 14). Northern wood frogs are common in warm shallow water at the edge of meadows; frogs in the RNA are large for an area so far north.

Figure 14—Meadow habitats created by infilling of beaver ponds (left) are light green; successional riparian shrub vegetation on the right is darker green and gray green.

Environment

Climate

Serpentine Slide experiences a highly continental climate with large diurnal and annual temperature variations and generally low precipitation and humidity. The RNA is in the region of Alaska reporting the highest and lowest temperatures for the State. No climatic data are available from Serpentine Slide RNA, but a 17-year record (1963-79) is available from a National Weather Service station 122 km to the east-northeast at Central, Alaska (65° 32’ N, 144° 48’ W, 265 m elevation).

The climatic data from the Central station probably are representative of conditions along the Beaver Creek lowlands in the RNA. Serpentine Slide and Central are at low elevations on the southern edge of the Yukon Flats and at about the same latitude near the mountains of the Yukon-Tanana upland. The major climates in the RNA also can be inferred from studies of the relation of climate to vegetation and topographic position done elsewhere in interior Alaska (Haugen and others 1982, Slaughter and Viereck 1986). The major climatic types in the RNA can be characterized as (1) permafrost-dominated cold air inversion basins on the Beaver Creek lowlands, including permafrost-free forest environments along Beaver Creek; (2) south-slope taiga at 300 to 800 m elevation; (3) steep, low-elevation bluffs with strong precipitation deficits and high radiant energy budgets; and (4) cold and windy alpine tundra above 850 m elevation.

Figure 15 compares the record of mean annual temperature at Central with University Experiment Station (UES) near Fairbanks, which has the longest continuous climatic record available for any interior Alaska station. Temperature trends at Central correspond well with those at UES, although Central is distinctly colder than UES. During the 1963-79 overlap period when data are available from both stations, Central experienced a mean annual temperature of -6.6 °C (sd ± 1.25), which is 3.8 °C (sd ± 0.51) colder than UES and well within the range of temperatures at which permafrost forms. Lower elevation and midelevation south-facing slopes in the RNA support forest types typical of permafrost-free sites, thereby indicating that temperatures are warmer there. The highest elevations in the RNA support alpine vegetation on harsh wind-blown sites (fig. 16) that are typically colder than midslopes and lowlands during the summer growing season.

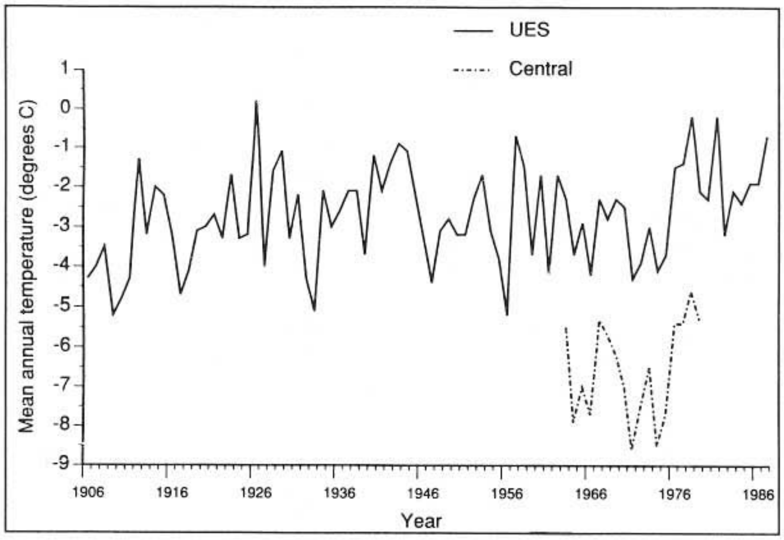


Figure 15—Mean annual temperatures at Central, Alaska, and University Experiment Station (UES) near Fairbanks, Alaska.

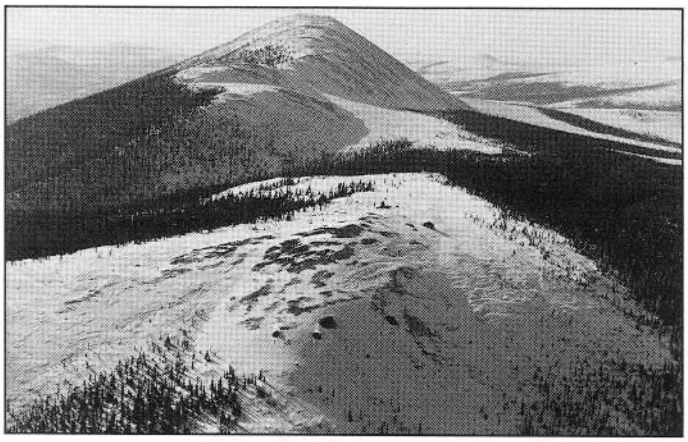


Figure 16—Wind-blown high-elevation serpentine site, section 9, T. 10 N., R. 1 W., looking southwest. Areas at the summit are blown free of snow and begin the growing season with a deficit of moisture. Concave surfaces and areas in the lee of obstacles to wind collect snow and are irrigated in the spring by melting snowbanks.

Mean annual temperatures at Central follow the trends common to interior Alaska stations (Juday 1984b), which include a strong warming trend from 1900 to 1940, cooling until 1975, and warming to record levels of sustained warmth in the 1980s.

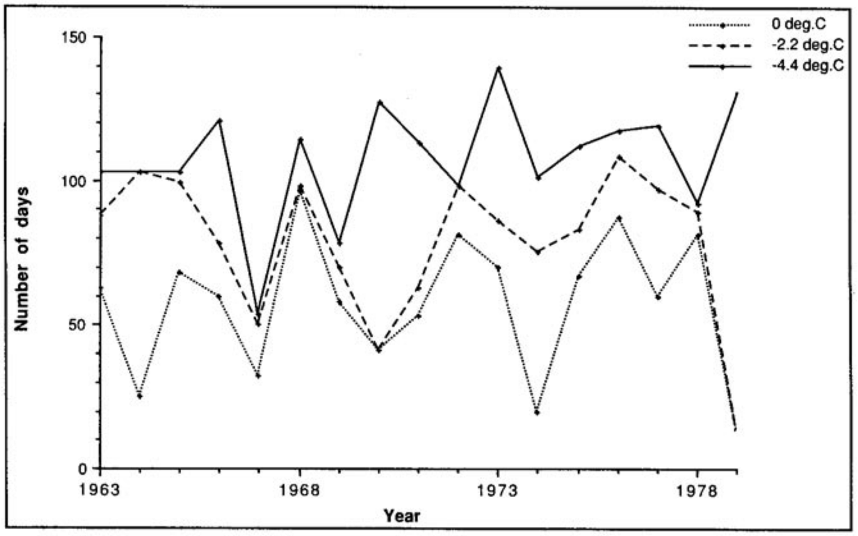


Figure 17—Growing season length at Central, Alaska, 1963-79, as measured by three threshold temperatures.

Figure 17 shows the length of the growing season at Central. Many years are interrupted by a midseason frost, although cold-adapted species tolerant of -2 to -4 °C temperatures can still experience a 70- to 100-day growing season. The Central data are characteristic of a low-elevation cold air collection "frost pocket." The RNA contains similar sites but also has midelevation south-facing slopes that probably experience a longer frost-free season. Alpine sites probably experience a somewhat less variable but consistently shorter growing season.

The primary sources of moisture reaching the Serpentine Slide area are southwesterly winds from the north Pacific Ocean and Bering Sea. Serpentine Slide RNA is in the rain shadow of both the Alaska Range and the Yukon-Tanana uplands, and annual precipitation is relatively low. Annual precipitation at Central ranges between 15 and 40 cm (mean 27.4 cm, sd 7.44) (fig. 18). Precipitation could be expected to be greater in the high elevations in the northern portion of the RNA because of orographic uplift; however, winter winds rearrange the snow pack (fig. 19) by removing snow from some sites and adding it to others, thereby making the actual moisture status highly local in the alpine zone of the RNA.

Most interior Alaska locations experience a gradual increase in monthly precipitation during the summer (monsoon) as large Pacific frontal systems replace local convective activity as the predominant source of moisture. The average precipitation for summer months at Central does not reflect the typical monsoonal pattern during the years of record (fig. 20). Locations northeast of the mountains of the Yukon-Tanana uplands, such as Central and Serpentine Slide, may experience a rain-shadow effect when moisture enters interior Alaska via southwesterly winds.

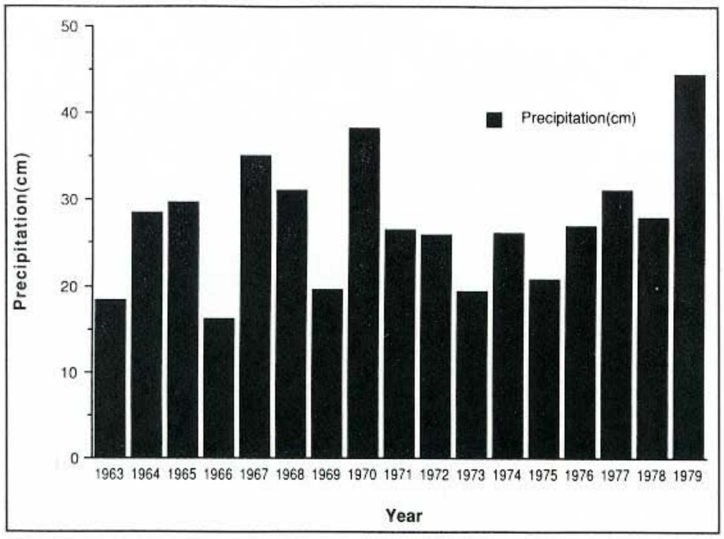


Figure 18—Annual precipitation at Central, Alaska, 1963-79.

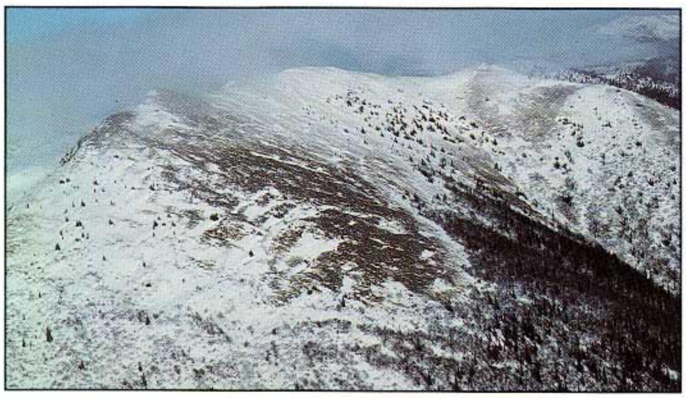


Figure 19—Late-winter snow conditions at the summit on the northern border of section 10, T. 10 N., R. 1 W., March 1986. Temperatures have remained below freezing at this elevation throughout the winter, but high winds have removed snow from the rock surfaces on the face of the mountain.

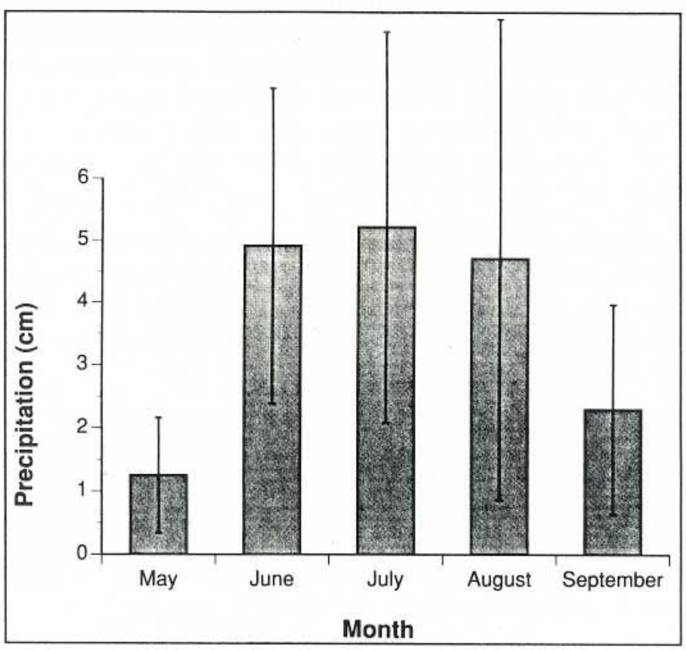


Figure 20—Average monthly precipitation, summer months, at Central, Alaska, 1963-79. Error bars indicate 1 s.d. above and below mean.

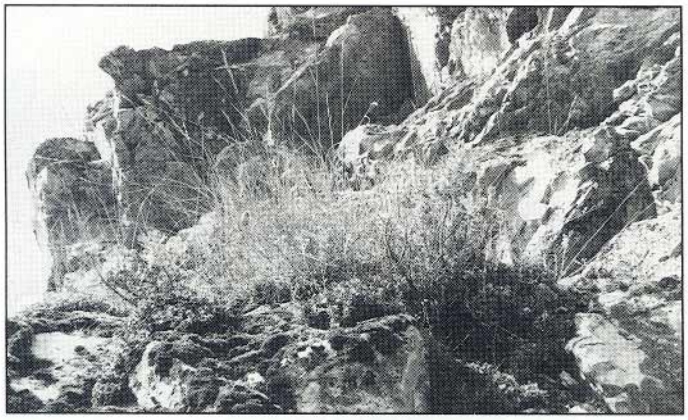


Figure 21—Chert bluffs at the toe slope overlooking Beaver Creek, Serpentine Slide Research Natural Area. South bluff environments are especially hot and dry in midsummer in interior Alaska, and sites with thin soil over rock often are completely desiccated; grass in the center of the picture is *Agropyron spicatum*, a dominant of Great Basin grasslands. The occurrence of this species here is a range extension for Alaska and one of the most northerly occurrences in its entire range.

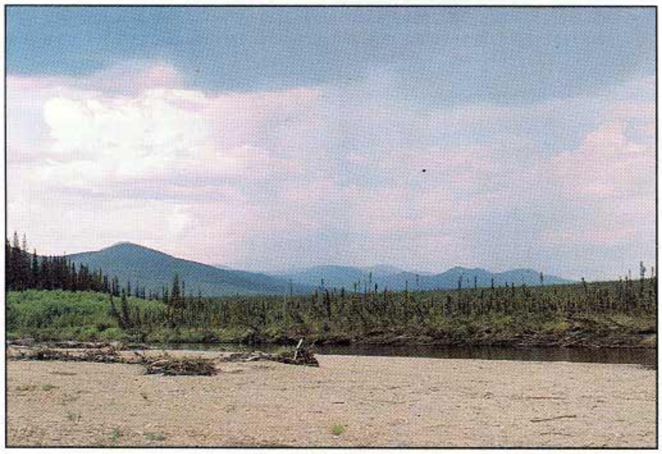


Figure 22—Isolated convective cell looking northeast from Serpentine Slide toward the southern edge of the Yukon Flats. Much of the pillar of rain falling in the center of the picture is evaporating before it reaches the ground. Picture taken at just after 10 p.m. Alaska standard time, June 25, 1987, in the long twilight hours of this area near the Arctic Circle. Low sun angle produces characteristic pastel pink and blue colors in clouds.

The RNA occurs on the edge of the Yukon Flats, the area with the warmest and driest summer climate in Alaska. Patric and Black (1968) calculated potential evapotranspiration and an index of aridity (potential evapotranspiration as a percentage of actual) for 322 weather stations in Alaska. Fort Yukon and Chalkyitsik in the Yukon Flats north and east of the RNA had the greatest moisture deficits and highest indices of aridity of all stations in Alaska. The Beaver Creek lowlands extend north and east of Serpentine Slide and connect directly into the Yukon Flats. Steep, south-facing low-elevation bluffs in the RNA are especially hot and dry (fig. 21).

Near Serpentine Slide RNA, strong surface heating during the day, aided by terraininduced convection, produces small isolated convective cells. Rain showers from these cells often can be seen evaporating before they reach the ground at Serpentine Slide (fig. 22). Early summer weather in the area includes many warm, clear, sunny days (fig. 23).

Hydrology

Vegetation patterns along the Beaver Creek flood plain indicate that the river's flow is relatively well modulated. The predominance of coarse material and the scarcity of fine sediments in the flood plain indicate that the flow of Beaver Creek is relatively clear even during high water. An annual high water stage scours and reworks a zone covered by about a 1-m rise in the average summer level of the river. Fine sands, small gravels,

Figure 23—Clear skies looking south at Serpentine Slide Research Natural Area. The area is surrounded by mountains; low-elevation sites often experience rain shadow effects.

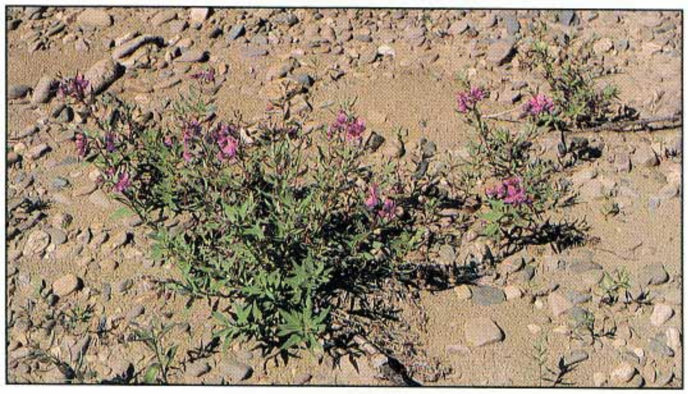


Figure 24—Coarse brown sand and rounded river gravel in the irregularly flooded zone of Beaver Creek. Plant in the center of the picture is *Epilobium latifolium*, a species of fireweed associated with disturbance habitats such as river bars in northwestern North America and far eastern Siberia.

and some silts are characteristic of the annual scour zone. Irregular high water stages that reoccur over intervals longer than 1 year rework a zone about 2 m higher than the annual scour zone. The irregularly flooded zone is highly variable in width and marked by coarse sands and rounded, medium-sized gravels (fig. 24). Sloughs and channel cutoffs, especially those receiving input from streams draining steep slopes, contain a thin cap of fine silts or clay; humus is sometimes present from the buildup of lush stands of sedges.

The entire watersheds of two small streams, Flash Creek and Amy Dolomite Creek, are located in the northwest portion of the RNA (see fig. 5). Both watersheds extend into the high-elevation alpine zone. Late-season snow melt from high elevations is an important source of midsummer stream flow in Flash Creek. Winter stream flow also occurs in Flash Creek as indicated by the buildup of aufeis indicated along the lower few meters of the stream channel just above the Beaver Creek flood plain (fig. 25). Aufeis also augments late season stream flow as it melts. The stream channels of both creeks are normally dry at the end of summer (figs. 26 and 27).

Much of the stream flow reaching the flood plain of Beaver Creek in the RNA is captured by beaver dams (fig. 28). Small deltas of angular rock protrude into the beaver ponds from the mouths of the streams, indicating that the channels are subject to flash floods. Small springs and seep slopes are found along concave portions of the main slope that rises from Beaver Creek (figs. 29 and 30).

Figure 25—Streamflow (left) and aufeis (right) in Flash Creek, Serpentine Slide Research Natural Area, June 1987. Stream is deeply shaded by dense riparian shrub canopy.

Figure 26—Same location as figure 25, late August 1988. Note dry bed of stream channel and late-season loss of hardwood shrub leaves. Steady rain at the time this picture was taken and the preceding day did not cause water to flow on the surface.

Figure 27—Mouth of Amy Dolomite Creek, June 1987. Evidence such as tilted alder shrub stems and thick beds of mostly angular rock in the channel indicates that this stream flows mostly during high-runoff conditions. Some water may be accommodated underground in dissolution joints in limestone and dolomite of the Amy Creek Unit.

Figure 28—Beaver dam below south bluff habitats, June 1987. Beavers work to maintain a full pond with the water level just below the top of the dam.

Figure 29—Spring seeps in old-growth white spruce forest understory on upper slope, Spring Slope forest reference stand.

Figure 30—Old-growth white spruce stringer near tree line. Dense stand of white spruce across the center of the picture occupies an incipient stream channel. Springs and seeps in the channel augment soil moisture and promote better forest growth than on surrounding slopes.

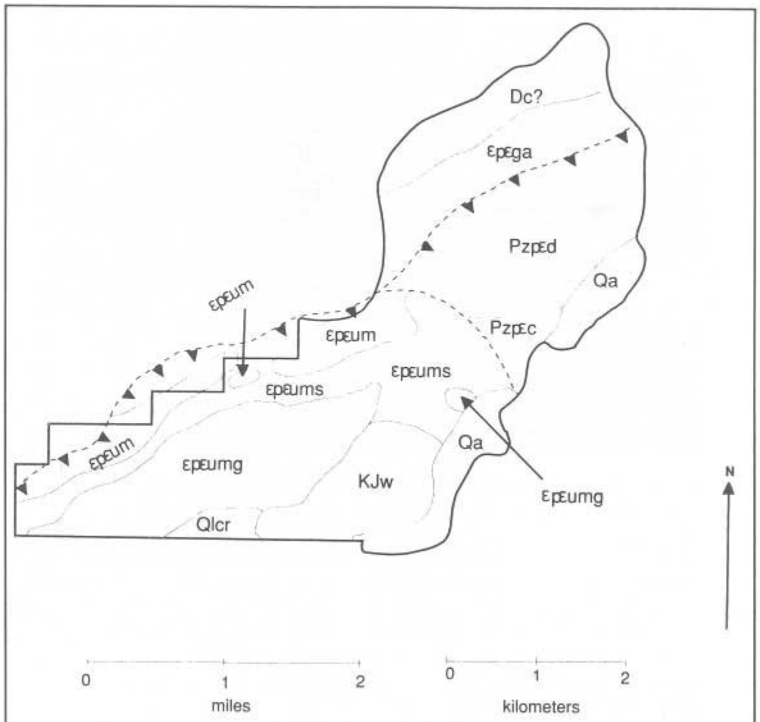
Geology

Juday (1987) describes the importance of geological features in Alaska RNA proposals by using Serpentine Slide RNA as an example. Scientific and educational values of the serpentinite exposure, the earthslide, and the juxtaposition of diverse bedrock types are all significant.

Bedrock geology-The portion of the WMNRA that includes Serpentine Slide is primarily within the Livengood terrane of Jones and others (1984), with minor amounts of the Manley terrane (Kandik Terrane of Churkin and others [1982]) and the Wickersham terrane (Beaver Terrane of Churkin and others [1982]). The composition and structural relation of bedrock units in the RNA and the surrounding area provide critical evidence for understanding the geologic history of an important and geologically complicated part of Alaska. Churkin and others (1982) interpret the existence of a complex of terranes in that portion of east-central Alaska surrounding Serpentine Slide as the result of tectonic delivery of microplates accreting to the North American plate. In their view, these terranes have formed elsewhere and moved together to account for the diversity of continental margin, island arc, and submarine rocks. Strike-slip faults mark the margins of terranes that collided obliquely, and thrust and other high-angle faults mark head-on collisions that now outline microterrane accretion zones.

Weber and others (1988) and Moore and Nokleberg (1988) identify problems with this interpretation, especially the lack of deformation and metamorphism in the Wickersham terrane and a lack of high-angle faulting in critical locations.

The surface geology of Serpentine Slide RNA is shown in figure 31. Quaternary alluvium in the RNA is restricted to the Beaver Creek corridor. The alluvium is mainly sand and granule- to boulder-sized, smooth, rounded gravel (fig. 32) up to 15 m thick; it is generally unfrozen (Weber and others 1988). The southern portion of the RNA includes small areas of loess and colluvium (unfrozen) over shallow bedrock. Even during Pleistocene glacial maxima, the Beaver Creek watershed was not extensively glaciated and glacial rock flour sources were relatively limited. Discharge of glacial meltwater placed large amounts of gravel into Beaver Creek headwater streams; meltwater also incised the the former flood-plain surface to form a prominent terrace above Beaver Creek (Weber and others 1988). Deep and extensive loess deposits are not found near Beaver Creek as is typical of populated lowelevation areas along the Tanana, Yukon, and other major braided rivers in interior Alaska.



Qa	Alluvial, active stream channels
Qlcr	Loess and colluvium over shallow bedrock
KJw	Wilber Creekunit : polymictic graywacke, conglomerate, and shale
Dc?	Cascaden Ridge (?) unit : conglomerate, graywacke, siltstone, and slate
PzpЄd	Amy Creek unit : dolomite
PzpЄc	Amy Creek unit :chert
ЄpЄum	Mafic rocks
ЄpЄumg	Greenstone
ЄpЄums	Serpentinite
ЄpЄga	Wickersham unit : maron and green argillite, grit, limestone, and chert
	Thrust fault : teeth on upper plate

Figure 31—Surface geology of Serpentine Slide Research Natural Area (adapted from Weber and others 1988).

Figure 32—Poorly vegetated gravel point bar on Beaver Creek in the northern portion of Serpentine Slide Research Natural Area, looking south-southeast to the Fossil Creek Ridge area of the White Mountains. The low valley wall on the south bank (opposite) casts shadows that promote permafrost formation, thereby restricting tall balsam poplar and white spruce forest to the north bank. In this view, Beaver Creek forms a cut bank in the black spruce that belted kingfishers use for burrows. Lesser yellowlegs nest in black spruce muskeg here and are commonly seen foraging along the adjacent length of Beaver Creek.

The Wilbur Creek unit is a Jurassic or Cretaceous sequence, or both, exposed in the southeastern portion of the RNA. It is made up of polymictic conglomerate (5 percent), graywacke (20 percent), siltstone (25 percent), and shale (50 percent) (Weber and others 1988). Evidence of submarine deposition (ripple marks, laminations, scour channels) is abundant. An area tentatively mapped as the Cascaden Ridge unit forms the northwestern ridge perimeter (fig. 31) of the RNA. The Cascaden Ridge unit of Weber and others (1985) is of Middle Devonian age. The mapped unit in the RNA includes immature, locally derived clasts of Amy Creek dolomite and chert, greenstone, and other volcanic rock fragments in a sandy matrix, which strongly suggest deposition in a fault-block basin (Weber and others 1988).

The Amy Creek unit, assigned a late Proterozoic age, makes up much of the slope above Beaver Creek in the northern portion of the RNA (fig. 31). The Amy Creek unit contains a dolomite (magnesium carbonate) and a chert member. Along much of its southern contact, the Amy Creek Unit is overthrust by a mafic-ultramafic complex. The dolomite member is largely composed of dolomitic mudstone and packstone, often marked by narrow laminations in fine muds. Rubbly outcrops of dolomite are common, and extensive silicification of the dolomite is reported by Weber and others (1988). Results of soil analyses showed that limy inclusions also are found within the Amy Creek dolomite. The chert member is made up of a black massive chert and thin interbeds of carbonaceous argillite that grade upwards into dolostone lenses.

Two thrust faults occupy the central portion of the RNA, thereby indicating the complex geology of the area. The history and circumstances of faulting in the area are not fully understood yet.

The serpentinite outcrop in the RNA is part of a complex of greenstone and layered mafic-ultramafic rocks that are mapped as three units in figure 31. Weber and others (1988) report radiometric age dates for the belt containing the three rocks as 518-633 million years old. A greenstone unit in the south-central portion of the RNA is a metabasalt. The other two units include layers of grayish-green, greenish-black, and black serpentinite derived from clinopyroxene, peridotite, and dunite; and layers of mafic rocks including clinopyroxene gabbro, microgabbro, and diorite (Weber and others 1988). The serpentinite and mafic rocks occur in a belt along the ridge summit in the southwest portion of the RNA, where most of the unvegetated serpentinite exposures are located, and extend down the main slope in the center of the RNA to Beaver Creek.

The Wickersham unit is Cambrian to Precambrian in age and is quite diverse. The Wickersham unit includes a grit; graywacke grit; maroon, green, and gray argillite; and arenaceous limestone. Outcrops of the Wickersham unit occur on the upper ridge in the northeast portion of the RNA (fig. 31). Distinctive flat, friable reddish (maroon) rocks and green pebbles make up part of the bedload of Flash Creek (see fig. 5), indicating that at least those two members of the Wickersham unit are present in the area.

Serpentine geology—Serpentine forms from a magma of ultramafic composition; that is, a solution made almost entirely of iron and magnesium minerals (especially olivine) that lack calcium and silicon oxides. As the magma nears the surface, presumably in an area of thin crust at a seafloor spreading center, it becomes hydrated in the presence of near-surface water. Hydration alters the magma to serpentine (Gilluly and others 1968). Looney and Himmelberg (1988) suggest that the serpentinite trend that includes the Beaver Creek area was emplaced as part of an ophiolite in the late Proterozoic to Cambrian, though not as a primary emplacement from the mantle but in a later event. They report that hornblende in gabbro and diorite dikes intruding serpentinite near Livengood (southeast of the RNA) is 518-633 million years old. Foster (1968) notes that a special feature of the Beaver Creek serpentinite is the presence of tectonic inclusions, especially rodingites (calcium silicate-rich rocks).

The minerals, principally olivine, that make up serpentine generally are poor clay formers. Serpentine outcrops often disintegrate into gravel, and this is the case in the RNA. The center of these outcrops is almost totally unvegetated.

Foster (1969) performed an element analysis of serpentine samples from the Beaver Creek serpentinite. Table 2 gives the results for the two stations closest to, but outside, the RNA. The samples contain high concentrations of siderophile elements, such as iron, chromium, nickel, and cobalt, that are characteristic of serpentine sites (Brooks 1987). Much of the Beaver Creek serpentine outcrop can be considered high in nickel (Foster 1969). Calcium content of the samples is very low and magnesium content is high-classic indicators of poorly weathered serpentine bodies.

The mineral clevage in serpentine is usually along only one plane, and it fractures easily into conchoidal or splintery shapes. (it is a somewhat weak rock.) The head of the large and active earthslide is in the center of the main exposure of the mafic-ultramafic complex in the RNA (figs. 31 and 33).

Table 2—Chemical analyses of Beaver Creek serpentinite

Element	Sample 1		Sample 2	
	P/m	*Percent*	*P/m*	*Percent*
Copper	7		200	
Boron	20		20	
Cobalt	150		100	
Manganese	700		1,000	
Platinum	.01		.01	
Palladium	.004		.004	
Rhodium	.005		.005	
Scandium	10		7	
Vanadium	30		15	
Chromium		0.06		0.11
Nickel		.50		.35
Iron		15		15
Magnesium		10		10
Calcium		.05		.05
Titanium		.007		.01

Source: Foster 1969.

Figure 33—Head of the earthslide, June 1987. White spruce-birch forest covers slopes above and to the left. Spruce-aspen woodland is found along the left rim of the slide and can be distinguished by yellow-green lichen cover.

Serpentinite, with small veinlets of asbestos, basalt, and shale are common in the earthslide.[2] The slide appears on aerial photos taken in July 1951, although it probably covered a smaller area then. In a 1982 site visit, the slide appeared to have been recently active and enlarged. Evidence of this included trees with green leaves and intact root wads that had fallen into the slide along the top and sides, fresh gravel surfaces throughout the slide area with little colonizing of early successional vegetation, and deep tension cracks and fissures along the sides (fig. 34). A young forest zone along the north side of the slide appeared to have experienced 20 to 40 years of succession. By 1987, plant cover had increased along the sides and at the head of the slide (fig. 35), but the floor and the deposition zone at the mouth of the slide had experienced additional transport of sediment and remained largely

[2] Chapman, Robert. 1983. Letter dated June 16 to Glenn Juday. On file with: G. Juday, University of Alaska Fairbanks, Agricultural Forestry Experiment Station, 309 O'Neill Building, Fairbanks, AK 99775.

Figure 34—Head of earthslide in July 1982. Trees have fallen from the sides to the bottom of the slide in the last year (note rootwads and leafing trees). Fresh gravel surfaces throughout the slide have little colonizing vegetation. Early successional forest is seen as light green canopy on far side of the slide.

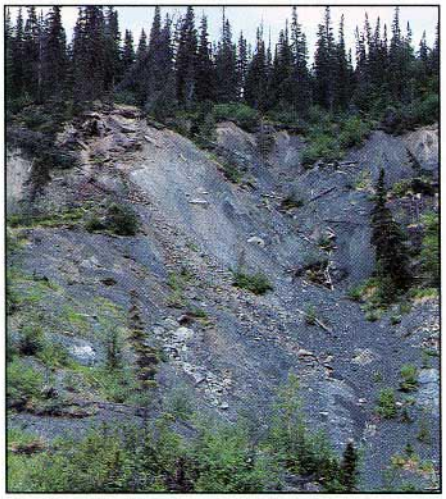


Figure 35—View from bottom to the head of slide, June 24, 1987. Patches of alder shrubs have become established on the barren sides of the slide. Serpentine rock is visible as gray or gray-green rubble on upper left portion of slide.

Figure 36—Bottom of earthslide, June 24, 1987. Debris deposits and newly flooded ground are visible with dead mature white spruce trees knocked down or killed by root suffocation in the background. Bright green patch in center is developing wetland vegetation.

unvegetated (see fig. 9). The debris piled up at the mouth of the slide has altered drainage patterns and created new ponds and wet ground; flows of debris have been great enough to knock down large mature white spruce trees and kill others through root suffocation (fig. 36).

No intensive soil surveys have been done in the RNA. The topography of Serpentine Slide includes rough, mountainous terrain and high terraces and the flood plain of Beaver Creek. Areas of serpentinite and bedrock knobs at the highest elevations exhibit poor soil development. Mass wasting processes cause talus to accumulate at the base of erosion-resistant features. Soils in talus materials are Lithic Cryorthents derived from serpentine, basalt, or metabasalt. They are very gravelly, well drained, and shallow over bedrock and may be frozen at the base, although they are not ice-rich.

The soils of valley bottoms and terraces occur over well-sorted alluvium with an abundant coarse fraction. These soils are alternating areas of well-drained, permafrost-free Cryorthepts and poorly drained permafrost-dominated Pergelic Cryaquepts. Material recently deposited by Beaver Creek is initially free of permafrost. Coarse-textured soils on well-drained sites generally remain free of permafrost. Poorly-drained sites that develop a thick humic layer generally develop permafrost with time. Steep south-facing lower slopes include areas of Typic Cryochrepts or even Mollisols under grassy vegetation with abundant coarse fraction. Limited areas of deeper silty deposits on south-facing toe slopes and benches are Loamy Aeric Cryaquepts.

Brooks (1987) describes the challenges confronting plants growing on serpentine sites that are not intensively weathered in humid tropical zones.

1. High siderophile (toxic heavy metal) content.

2. Low concentration of major plant nutrients such as nitrogen, phosphorus, and potassium.

3. Low calcium and high magnesium levels.

4. Low clay content, and the clays that are present have low exchange capacity.

Table 3 shows the properties of two high-elevation soils from Serpentine Slide. One soil was collected on barren serpentine at 730 m elevation in section 17 of T. 10 N., R. 1 W. (figs. 5 and 8), and the other from a treeline site at similar elevation and aspect 1 km east. The extreme amount of magnesium, low levels of calcium and nitrogen, and general lack of clays in the serpentine soil are obvious. Figure 37 shows the textural content of the two soils. The serpentine soil has practically no vegetation cover and consists mainly of coarse gravel (fig. 38). The treeline site is well vegetated and has a well-developed litter and humus layer at the surface (fig. 39). Two physical characteristics of serpentine soils that are important for vegetation are excellent aeration through porous gravels and extreme fluctuations in surface temperature through rapid radiant energy loss and gain (Brooks 1987).

Table 4 gives the properties of two low-elevation soils from the RNA. The Limestone Bluff soil at the base of the south-facing slope on the western edge of the RNA represents a limy phase of the Amy Creek dolomite. The Bluff Flats soil is from a forest plot on a high terrace above Beaver Creek where the creek leaves the eastern edge of the RNA. Figure 40 shows the texture of the two soils. Bluff Flats is an alluvial sand on a probable Pleistocene terrace with a small amount of silt and clay from a thin cap or upper layer. The Bluff Flats soil includes an epipedon of 2 to 5 cm that probably represents deposition from a maximum Holocene flood.

Table 3—Properties of high-elevation soils in Serpentine Slide Research Natural Area[a]

Sample locality	pH	Total nitrogen	Calcium	Magnesium
		Percent	*Meq/100 g Ca*	*Meq/100 g Mg*
Serpentinite	6.10	1.77	0.068	2.162
Treeline	4.55	5.23	.214	.506

[a] Values from Juday (1987).

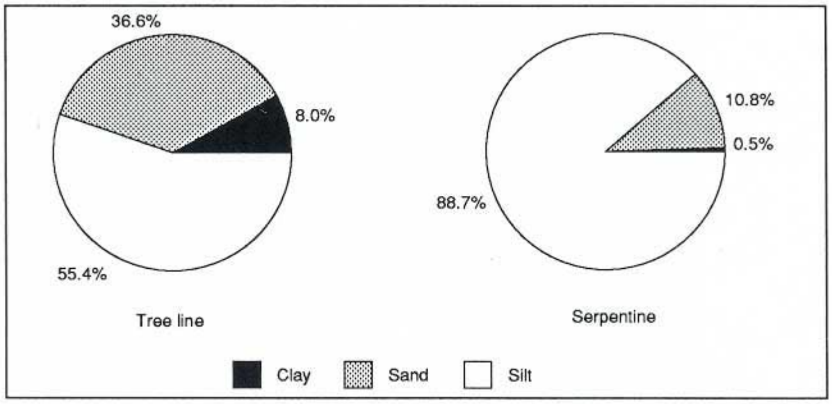


Figure 37—Particle size content of tree-line (left) and serpentine (right) soils, Serpentine Slide Research Natural Area.

Figure 38—Close view of gravelly serpentinite soil surface. Note the smooth shiny lustrous green surface of freshly fractured serpentinite rock fragment in center. Orange lichen (center) is the only living plant on portions of this naturally toxic substrate.

Table 4—Properties of low-elevation soils in Serpentine Slide Research Natural Area

Sample locality	pH	Organic matter	Course fraction (> 2 mm)	Cation exchange capacity	Phosphorus	Potassium	Calcium	Magnesium
		--- Percent ---		Meq/100g	-------- Parts per million --------			
Limestone Bluff	8.03	7.91	52.54	22.1	14	86	7,870	840
Bluff Flats	6.27	1.54	0	4.6	10	4	461	70

Figure 39—A well-developed litter and humus layer cover the surface at the tree-line soil sample site. The elevation and topographic setting are similar to the serpentinite soil sample location.

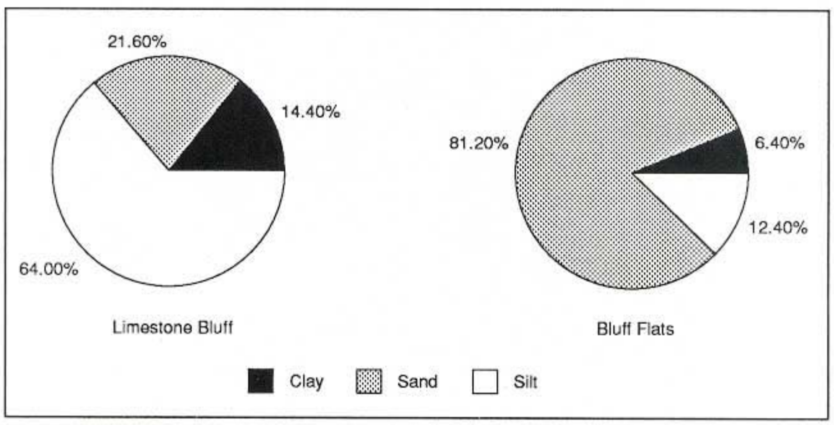


Figure 40—Particle size content of Limestone Bluff (left) and Bluff Flats (right) soils, Serpentine Slide Research Natural Area.

The Limestone Bluff soil is predominately silt with a substantial clay fraction; over half the Limestone Bluff sample consisted of coarse angular fragments (table 4). The Limestone Bluff soil has a high pH and large cation exchange capacity due to the high calcium content typical of limestone soils. The elevated magnesium level and high levels of phosphorus, potassium, and organic matter provide the basis for high productivity despite soil moisture limitation.

The Bluff Flats soil contains no coarse material and, although slightly acidic, has a high pH for the understory of a mature white spruce forest. The moderately high calcium content responsible for this high pH results from the input of either local limy beds or Tolovana Limestone from the headwaters of Beaver Creek.

Biota

Vegetation

Flora—Table 5 is a list of 124 vascular plants collected or observed in Serpentine Slide RNA or collected nearby; 35 are common, widespread species whose presence was noted in the field. Voucher specimens are available at the University of Alaska Herbarium for 55 low- and mid-elevation species and 5 species collected on higheleva-tion serpentine. The Norwegian botanist Gjaerevoll (1958, 1963, 1967) made extensive plant collections in the White. Mountains. His collections were concentrated on limestone habitats near Limestone Jags RNA (Juday 1989) 16 km south of Serpentine Slide. Only 29 species reported by Gjaerevoll are listed in table 5-the ones collected in habitats similar to those in Serpentine Slide or along the Beaver Creek flood plain near the RNA.

Three plants collected in the RNA, *Carex eburnea*, *Artemisia alaskana*, and *Agropyron spicatum*, are from areas beyond the distribution limits in Alaska given by Hulten (1968). All three species were collected on a steep south-facing slope near the Limestone Bluff soil sample location. *Carex eburnea* is a sedge of dry sand or rocky sites, usually is in calcareous soil, and is known primarily from the Tanana River drainage (Hulten 1968). The Serpentine Slide locality is a northward range extension; it is the first report of the species north of the Yukon-Tanana uplands in Alaska.

Artemisia alaskana is a sagebrush widely distributed in upland interior and northern Alaska, including much of the Brooks Range. Hulten (1968) indicates a distribution gap for this species across the extensive Yukon Flats and nearby lowlands, and Gjaerevoll (1967) did not collect it in the interior mountains. The Serpentine Slide collection indicates that *Artemisia alaskana* is found on suitable habitats in at least a portion of the gap.

Agropyron spicatum was collected on a very shallow stony soil over Amy Creek chert (see fig. 31) just above the Beaver Creek flood plain (see fig. 22). This species is a dominant grass over much of the sagebrush steppe region of eastern Oregon and Washington. Hult6n (1968) depicts the species in Alaska as restricted to a corridor along the Tanana River and the upper Yukon River in the Yukon Territory. The Serpentine Slide collection is an extension of the known range of the species north across the Yukon-Tanana uplands and represents one of the northernmost localities reported.

Table 5-Vascular plants collected or observed in Serpentine Slide Research Natural Area or the immediate vicinity[a]

Species	Habitat or collection notes
Aconitum delphinifolium DC.	Widespread species in meadows and forest openings[b]
Agropyron spicatum (Pursh) Scribn. & Sm.	Steep south-facing bluffs above Beaver Creek[c]
Agropyron subsecundum (Link) Hitchc.	Along Beaver Creek[d]
Alopecurus aequalis Sobol.	Upper elevation of Beaver Creek flood plain[c]
Artemisia furcata Bieb.	Dry rocky slopes[e]
Arctagrostis latifolia (R. Br.) Griseb.	Meadows and sandbars along Beaver Creek[b]
Arctophila fulva (Trin.) Anderss.	Wet permafrost ground, edge of ponds on flood plain[c]
Arctostaphylos uva-ursi (L.) Spreng.	Restricted to dry bluffs and aspen forest understory[b]
Arnica alpina (L.) Olin	Alpine and subalpine openings[b]
Artemisia alaskana Rydb.	Dry gravel bars and rocky south bluff[c]
Artemisia frigida Willd.	Steep south bluffs on unstable skree[b]
Astragalus alpinus L.	Meadows at forest edge and openings on slopes[c]
Betula glandulosa Michx.	Dominant alpine tundra species[b]
Betula papyrifera Marsh.	Common forest tree on slopes[b]
Boschniakia rossica (Cham. & Schlecht.) Fedtsch.	Parasite on roots of alder, in flood-plain forest plot[c]
Bromus pumpellianus Scribn.	Dry sandy soils on warm south slopes[c]
Bupleurum triradiatum Adams	Species most tolerant of serpentine[b]
Calamagrostis lapponica (Wahlenb.) Hartm.	Cache Mountain[d]
Calamagrostis purpurascens R. Br.	Forest edge and openings on slopes[c]
Callitriche verna L.	In mud at edge of beaver pond[c]
Campanula aurita Greene	Rocky habitats on low-elevation slopes[c]
Cardamine pratensis L.	Shores of beaver ponds, streams, and river flood plain[c]
Carex aquatilis Wahlenb.	Sloughs on Beaver Creek flood plain[c]
Carex chordorrhiza Ehrh.	Beaver Creek[d]
Carex eburnea Boott	Dry south bluffs at edge of Beaver Creek flood plain[c]
Carex eleusinoides Turcz.	Old slough channels on Beaver Creek-flood plain[c]
Carex rostrata Stokes	Wet sites on Beaver Creek flood-plain[c]
Carex saxatilis L.	Wet sites on Beaver Creek flood plain[c]
Carex vaginata Tausch	Wet forest understory on Beaver Creek flood plain[c]
Cassiope tetragona (L.) D. Don	Shaded snow collectiond areas, high and low elevations[c]
Chamaedaphne calyculata (L.) Moench	Beaver Creek lowlands[d]
Cicuta mackenzieana Raup	Beaver Creek lowlands[d]
Cnidium cnidiifolium (Turcz) Schischk.	Open, dry south bluff meadows[b]
Crepis elegans Hook	On river gravel of Beaver Creek[c]
Cystopteris fragilis (L.) Bernh.	Chert-limestone-dolomite rock crevice near flood plain[c]
Drosera rotundifolia L.	Beaver Creek forest at Sheep Creek[d]
Dryas octopetala L.	Calcareous substrates from low to high elevation[b]
Elymus innovatus Beal	Open, dry south bluff meadows[b]
Empetrum nigrum L.	Permafrost ground on old flood-plain terraces[b]
Epilobium anagallidifolium Lam.	Cache Mountain[d]
Epilobium homemannii Rchb.	Cache Mountain[d]
Epilobium latifolium L.	Colonizer of gravely Beaver Creek flood plain[c]
Equisetum palustre L.	On Beaver Creek[d]
Equisetum silvaticum L.	Cache Mountain[d]
Erigeron elatus Greene	Low-elevation meadows and forest edge[c]
Erigeron hyperboreus Greene	High elevations, edge of serpentine[e]
Erigeron purpuratus Greene	Open gravelly flood plain of Beaver Creek[c]
Eriophorum vaginatum L.	Wet permafrost sites on Beaver Creek lowlands[c]
Festuca altaica Trin.	Rocky meadows and forest understory[c]
Galium boreale L.	Aspen and spruce-birch forest understory[c]

See footnotes on page 34.

Table 5 Vascular plants collected or observed in Serpentine Slide Research Natural Area or the immediate vicinity[a] (continued)

Species	Habitat or collection notes
Galium trifidum L.	Moist meadows and forest understory[b]
Gentiana glauca Pall.	Cache Mountain[d]
Geocaulon lividum (Richards.) Fern.	Aspen forest understory[b]
Gymnocarpium dryopteris (L.) Newm.	Moist forest sites[c]
Hedysarum alpinum L.	Rocky sites in white spruce and on flood plain[c]
Hippuris vulgaris L.	Aquatic species in beaver pond[c]
Juncus filiformis L.	Beaver Creek[d]
Juniperus communis L.	Steep unstable skree on south bluffs[b]
Lagotis glauca Gaertn.	Open gravelly tree line and alpine tundra[e]
Ledum decumbens (Ait.) Small	Permafrost at low and high elevations[b]
Ledum palustre L.	Permafrost at low and high elevations[b]
Linnaea borealis L.	Moist spruce forest understory, low to mid elevation[b]
Lloydia serotina (L.) Rchb.	Open limestone-dolomite south bluff meadows[c]
Lupinus arcticus S. Wats.	Widespread in foyst openings[c]
Luzula arcuata (Wahlenb.) Sw.	Cache Mountain[d]
Lycopodium alpinum L.	Cache Mountain[d]
Lycopodium clavatum L.	Cache Mountain[d]
Lycopodium complanatum L.	Forest openings with thin soil over bedrock[c]
Lycopodium selago L.	Widespread on thin soils, low to high elevations[c]
Mertensia paniculata (Ait.) G. Don	Widespread in forest understory[b]
Minuartia arctica (Stev.) Aschers. & Graebn.	Collected on serpentine[e]
Moneses uniflora (L.) Gray	Beaver Creek flood-plain mature forest understory[b]
Myriophyllum spicatum L.	Submerged aquatic spedries in beaver ponds[c]
Oxycoccus microcarpus Turcz.	Beaver Creek lowlands[d]
Papaver macounii Greene	Open limestone-dolomite south bluff meadows[c]
Pedicularis labradorica Wirsing	Beaver Creek lowlands[d]
Pedicularis verticillata L.	Meadows with thin soil[c]
Picea glauca (Moench) Voss	Dominant late successional tree[b]
Platanthera obtusata (Pursh) Lindl.	Mature white spruce bottomland forest understory[b]
Poa glauca M. Vahl	Dry sandy sites at low elevations[c]
Polemonium acutiflorum Willd.	Meadows near BeaverCreek[c]
Polygonum alaskanum (Small) Wight	Bottom-land cforest and edge on Beaver Creek flood plain[c]
Polygonum viviparum L.	South bluff meadows[c]
Populus balsamifera L.	Flood plain and upland seep slopes[b]
Populus tremuloides L.	Dominant tree on driest south slopes[b]
Potamogeton alpinus Balb.	Lake between Sheep and Mascot Creeks[d]
Potamogeton berchtoldi Fieb.	Lake between Sheep and Mascot Creeks[d]
Potamogeton filiformis Pers.	Aquatic species in beaver pond[c]
Potamogeton perfoliatus L.	Lake between Sheep and Mascot Creeks[d]
Potentilla fruticosa L.	Forest edge and openings[b]
Potenfilla hookeriana Lehm.	Low-elevation south-facing gluffs[b]
Pulsatilla patens (L.) Mill.	Treeless south-facing buffs[b]
Pyrola asarifolia Michx.	Beaver Creek lowlands[d]
Pyrola minor L.	Cache Mountain[d]
Rosa acicularis Lindl.	Forest understory species of dry sites[b]
Rubus arcticus L.	Moist meadows near creeks[c]
Rumex acetosa L. ssp. *alpestris* (Scop.) Love	Collected on poorly vegetated serpentine[e]
Salix alaxensis (Anderss.) Cov.	Found on Beaver Creek flood plain[b]
Salix hastata L.	Occurs on gravelly flood Slain[c]
Salix niphoclada Rydb.	Beaver Creek flood plain[b]

See footnootes on page 34.

Table 5-Vascular plants collected or observed in Serpentine Slide Research Natural Area or the immediate vicinity[a] (continued)

Species	Habitat or collection notes
Saxifraga bronchialis L.	Lion Peak[d]
Saxifraga flagellaris Willd.	Lion Peak[d]
Saxifraga nivalis L.	Lion Peak[d]
Saxifraga reflexa Hook.	On serpentine, collected near Livengood on serpentine[b]
Saxifraga tricuspidata Rottb.	Limestone and dolomite rocks and skree[b]
Senecio atropurpureus (Ledeb.) Fedtsch.	Lion Peak[d]
Senecio conterminus Greenm.	South slope meadows with thin soils[c]
Shepherdia canadensis (L.) Nutt.	In dry aspen forests[b]
Silene repens Patrin	Rocky meadows
Solidago multiradiata Ait.	Forest edge and openings[c]
Sparganium hyperboreum Laest.	Aquatic species in beaver pond[c]
Stellaria crassifolia Ehrh.	Beaver Creek[d]
Stellaria edwardsii R. Br.	Found on high-elevation rocky skree[c]
Thalictrum sparsiflorum Turcz.	Moist meadows[c]
Trientalis europaea L.	Beaver Creek lowland forest[d]
Trisetum spicatum (L.) Richter	Tundra and forest openings[c]
Vaccinium uliginosurn L.	Primarily in muskegs
Valeriana capitata Pall.	Moist meadows and forest edge near streams[c]
Viburnum edule (Michx.) Rat.	Widespread in forest understory[b]
Viola biflora L.	Occurs on skree slopes[c]
Viola epipsila Ledeb.	Cache Mountain[d]
Wilhelmsia physodes (Fisch.) McNeill	High gravel bars of Beaver Creek flood plain[c]
Woodsia glabella R. Br.	Found in crevices in limestone
Zygadenus elegans Pursh	Dry, treeless south-facing slopes[c]

[a] Nomenclature follows Hult6n (1968).

[b] Observed and noted in the field by Glenn Juday.

[c] Collected by Glenn Juday; voucher specimen in University of Alaska Fairbanks Herbarium.

[d] Collected by Olav Gjaerevoll in habitats similar to those in Serpentine Slide RNA in the localities noted. Locality rendered as "Lion Peak" in Gjaerevoll (1958, 1963, 1967) probably represents mispronunciation of "Lime Peak," 30 km east southeast of Serpentine Slide RNA.

[e] Collected by David Murray; voucher specimen in University of Alaska Fairbanks Herbarium.

The plant species richness of Serpentine Slide RNA is due to the presence of both typical habitats containing generalist species and special habitats having species with restricted distributions. The RNA includes frequently disturbed flood plain with poorly vegetated gravel bars, serpentinite, dolomite, limestone, oversteepened river bluffs, beaver ponds and meadows, alpine tundra, bottom-land forests and shrublands, black spruce (*Picea mariana* (Mill.) B.S.P.) permafrost, and upland birch (*Betula* sp.), white spruce, and aspen (*Populus* sp.) forest. Only limited plant collections have been made in the high elevations of the RNA, in mid-elevation forests and during early springtime.

Several submerged aquatic plant species are found in beaver ponds in the RNA, despite sudden and dramatic changes in water levels and the appearance and disappearance of ponds as beavers construct new dams and abandon old ones. Dominant species in the pond depicted in figure 13 are *Myriophyllum spicatum*, *Sparganium hyperboreum*, and *Potamogeton filiformis* with *Callitriche verna* common around the shallow margins and in shoreline mud. *Sparganium hyperboreum* is known to intergrade with *S. minimum* (Hartm.) Fries across much of central Alaska, although Harms (1973) considers

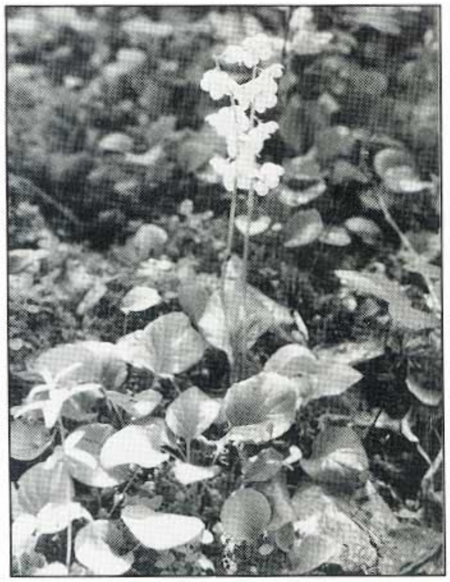


Figure 41—*Pyrola asarifolia* in flower in the understory of the Bluff Flats forest plot.

Figure 42 (left)—*Platanthera obtusata* (center) in the mossy understory of mature white spruce on the Bluff Flats forest plot.

Figure 43 (right)—*Lycopodium complanatum* on rocky low-elevation forest in Serpentine Slide Research Natural Area, June 1987. One-year-old sporangia are orange-brown; current year spikes are light green.

the two taxa distinct. Many of these aquatic species have propagules that are dispersed by migrating waterfowl; this accounts for the ability of the plants to rapidly colonize ephemeral beaver ponds.

Pyrola asarifolia (fig. 41) and *Platanthera obtusata* (fig. 42) are species of the mossy understory of mature white spruce forests. *Lycopodium complanatum* (fig. 43) is a species typical of dry forests and low-elevation rocky sites.

Serpentine vegetation—Studies of the effect of serpentine soils on vegetation have provided useful insights on plant evolution, ecology, systematics, and physiology (Brooks 1987, Krukeberg 1954). Brooks (1987) states, "...we are hardly any closer today to solving or explaining the serpentine factor, than we were 50 years ago. Although the evidence is still confusing and contradictory, a degree of consensus is starting to emerge as to some aspects of the problem. The first of these is that no single factor is responsible for the infertility of serpentine soils but rather...a combination of factors." The most important serpentine factors demonstrated to date are toxic effects of high nickel content, toxic effects of high levels of magnesium in the absence of calcium, high pH values that affect the availability of nutrients, and the physical stresses of poorly vegetated, high radiatiative environments (Brooks 1987). These distinctive serpentine conditions subject colonizing plants from adjacent nonserpentine habitats to very strong natural selection, thereby causing local adaptation that in time proceeds from ecotype to variety to species.

On serpentine sites in midlatitude and tropical regions, species have evolved that are restricted to serpentine (serpentine endemics), many regionally common species are excluded from serpentine, and some species that are habitat specific or restricted in some other way on "normal" sites are released from competitive exclusion on serpentine (Brooks 1987). Kruckeberg (1984) reports that 215 species, subspecies, and varieties of native California plants are restricted completely or in part to serpentine sites. No serpentine endemic species have been identified in Alaska, however. The pattern of serpentine plant geography and evolution is different in glaciated regions and areas with stressful climates than in areas closer to the equator.

Whittaker (1960) documents a large decrease in the number of serpentine-tolerant species from the coastal maritime to the continental climate regions of southwest Oregon, one of the largest exposures of serpentine rock in the world. The number of serpentine endemics decreases dramatically on serpentine exposures north of southwest Oregon. In central and northwest Washington and in British Columbia, Kruckeberg (1969) found that (1) serpentine vegetation assumes a typical alpine character; (2) some plants, including whole genera, are excluded from serpentine; (3) one species and two varieties of fern are faithful indicators of serpentine; and (4) only three flowering plant species are serpentine endemics, all from the Wenatchee Mountains of central Washington.

Brooks (1987) identifies a worldwide pattern in which serpentine endemics at the species level generally do not occur in areas covered by the maximum extent of glaciation, especially the Wisconsinan glacial maximum of 12,000 to 14,000 years ago. He interprets the absence of endemics in glaciated areas as the result of repeated extinction of locally adapted serpentine genotypes during glacial advances. Although Serpentine Slide was not covered by ice during glacial maxima, it did experience a harsh periglacial climate that eliminated most species, an environment comparable today only to polar desert regions of the high Arctic or Antarctic. Thus, even though local adaptation of plants to serpentine was eliminated in the geologically recent past, evolution is underway and a low level of adaptation could be expected to exist now.

Figure 44—Yellow-flowered plant growing on dark gray or black serpentinite is *Bupleurum triradiatum*, one of the most serpentine-tolerant species and a plant community character species on ultramafic sites in east-central Alaska.

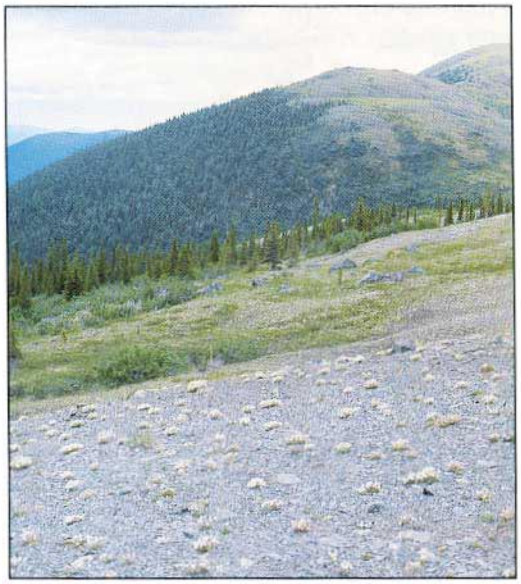


Figure 45—White-flowered plant on gray serpentinite barrens (foreground) is *Minuartia arctica*.

Plant species richness is extremely low on serpentine outcrops in the western portion of the RNA. The two species with the greatest tolerance of serpentine conditions in the RNA are *Bupleurum triradiatum* (fig. 44) and *Minuartia arctica* (fig. 45). *Rumex acetosa* also is found in open serpentine habitat. A small specimen of *Bupleurum* was the only vascular plant growing in the vicinity of the serpentine soil sample (table 3). The central portions of the serpentinite barrens lack all vascular plant cover, although an orange crustose lichen is present (see fig. 38).

A few species occupy the partially vegetated edge of serpentine exposures in the RNA. *Erigeron hyperboreus* (table 5) is found on these edges, although it occurs mainly in the Brooks Range, with a few outliers. The White Mountains specimen of *E. hyperboreus* by Gjaerevoll (1967) is one of the only central Alaska collections. *Saxifraga reflexa*, a saxifrage of relatively dry sites, was observed on serpentine edge habitat in the RNA and was collected on serpentine in the Tolovana River area 40 km west of the RNA. Two other species collected in the upper elevations of the RNA, *Artemisia furcata* and *Lagotis glauca*, may not be related to serpentine. *Artemisia furcata* is a sage of sandy and rocky slopes, irregularly distributed across Alaska and Siberia. *Lagotis glauca* is a species of stony slopes in mountain tundra.

Very little published information is available on the flora of serpentine areas in central Alaska. Shacklette (1966) investigated a south-bluff plant community on greenstone near Eagle, Alaska, along the Yukon River near the Alaska-Yukon Territory border and concludes that "soils derived from this greenstone and from serpentine probably do not differ greatly in their content of elements, and this Eagle Bluff soil has, in general, the chemical nature of `serpentine soil' as the term is used in ecological literature." His soil element analysis data show, however, that the Eagle Bluff soil is not as enriched in nickel and chromium as the soil at Serpentine Slide, contains one-tenth the cobalt, and has normal to slightly enriched amounts of calcium compared to the severe calcium deficiency at Serpentine Slide (tables 2 and 3). The two soils are similar in their physical characteristics and pH, and Eagle Bluff is somewhat enriched in siderophile elements and magnesium. Some serpentine effects could be expected at Eagle Bluff, but not to the same degree as at Serpentine Slide. Batten and others (1979) note the high calcium content of soil at Eagle Bluff and do not report perceptible greenstone effects on vegetation.

Shacklette (1966) names the greenstone community at Eagle Bluffs a *Bupleurum triradiatum-Zygadenus elegans* association. *Bupleurum triradiatum* is clearly dominant on the most stressful sites at both Eagle Bluff and the RNA, but Z. elegans is not prominent in the serpentinite barrens of the RNA. The difference in elevation between the sites may be partly responsible for the absence of *Z. elegans*. The Eagle Bluff site extends from about 300 to 550 m; the serpentinite barrens in the RNA are mostly above 600 m. *Bupleurum triradiatum* grows in meadows and stony slopes from high elevations to low; Z. elegans is more common on warm south-bluff sites.

Shacklette (1966) lists three other high-constancy and high-fidelity species in the *Bupleurum triradiatum-Zygadenus elegans* association on "mafic and ultramafic rock outcrops in the Yukon-Tanana uplands": *Calamagrostis purpurascens*, *Juniperus communis*, and *Minuartia yukonensis* Hult. The first two are present at Serpentine Slide (table 5) and prominent in low-elevation sites on or near the edge of serpentinite. Two other character species of Shacklette's association prominent at Serpentine Slide are *Saxifraga reflexa* at high elevations and *Galium boreale* at low and midslope sites. A *Rosa acicularis* understory in a white spruce-paper birch forest type also is common to both sites (Batten and others 1979).

Dearden (1979) studied the flora of serpentine sites in Newfoundland. Three species that are dominants in his "arctic-alpine" serpentine community, *Potentilla fruticosa*, *Juniperus communis*, and *Vaccinium uliginosum*, are found in Serpentine Slide. Several other Newfoundland serpentine species, such as *Androsace septentrionalis* L., *Cerastium beeringianum* Cham. & Schlecht., *Diapensia lapponica* L., *Rhododendron lapponicum* (L.) Wahlenb., *Salix arctica* Pall., *Saxifraga oppositifolia* L., and *Silene acaulis* L., are distributed across portions of Alaska that include the RNA. The serpentine vegetation of Scandinavia is similar to that of the RNA. In Sweden (Rune 1953), there are no serpentine endemics at the species level, but a few serpentine subspecies or varieties have been identified. More common is the disjunct occurrence of arctic species in southern portions of the country on serpentine. Characteristic Swedish serpentine species known to occur or that may occur in the RNA are *Campanula rotundifolia* L., *Minuartia rubella* (Wahlenb.) Graebn., *Rumex acetosa*, *Saxifraga oppositifolia*, and *Silene acaulis*. Rocky serpentine barrens in Finland include only a few lichens and the moss *Racomitrium lanugibosum*; open gravelly sites in Finland have a few serpentine specialists such as *Asplenium viride* Hudson, *Cerastium alpinum* L., and *Minuartia biflora* among others (Brooks 1987).

Plant communities—Figure 46 is a vegetation cover map of Serpentine Slide RNA. The predominant vegetation cover is upland mixed white spruce and hardwood forest. About 38 percent of the RNA is mapped as spruce-birch forest, primarily located on greenstone, mafic rocks, and serpentinite (fig. 31) on upper elevation and midelevation slopes in the southern portion of the RNA and in the Wickersham unit in the northern portion (figs. 30, 33, and 47). The spruce-birch map unit contains small inclusions of nearly pure white spruce cover. A complete reconnaissance survey of plant community types is not available, but areas of the *Picea glaucal/Linnaea borealis-Equisetum silvaticum* community (table 1) occur within this forest type.

Birch forest with a minor component of white spruce occupies an additional 6.8 percent of the RNA in the same area. Birch dominance increases above 600 m on the south-facing slope in the southern portion of the RNA. Spruce-aspen forest covers about 16 percent of the RNA, especially on Amy Creek dolomite (fig. 31) in the northern portion of the RNA below the spruce-birch forest belt (fig. 48). The internal drainage of dolomite and limestone may be partially responsible for droughty aspects of this forest type such as narrow tree crowns, wide tree spacing, and the presence of dry-site indicators such as lichen mats and *Shepherdia canadensis* (fig. 49). Amy Creek chert and dolomite outcrops also are associated with an especially open form of white spruce and aspen that has been labeled “woodland” on figure 46. Total canopy coverage in this type has not been measured, but oblique and vertical aerial photographs indicate it is close to the 25-percent threshold for woodland formations.

Black spruce woodland covers only about 8.6 percent of the RNA, considerably less than the average of the regional landscape in which Serpentine Slide is located. Black spruce plant community types are consistently found in topographic locations with little direct sunlight, including north-facing slopes and areas where low-angle sunlight is intercepted by intervening slopes (fig. 50). Several plant community types, most with high sphagnum moss dominance, are present (table 1) in the black spruce cover type.

Mature white spruce bottom-land forest is relatively restricted in extent in both Serpentine Slide RNA (2.9 percent of the area) and the Beaver Creek riparian corridor; most stands (fig. 51) are on the north and west banks of the river where they escape shading effects from the lowermost valley wall to the south (fig. 32). The most common white spruce bottom-land types are white spruce/*Rosa acicularis* and white spruce/feathermoss (fig. 42). Upland white spruce forest is more extensive; it covers 6.7 percent of the RNA. The main area of white spruce upland forest is nearly coincident with the Wilber Creek unit in the southeast portion of the RNA (figs. 31 and 46).

Shrub-dominated vegetation covers a combined 4 percent of Serpentine Slide RNA. A tree line shrub belt and shrub tundra make up most of the shrub-dominated types; riparian shrubs mainly occupy a drainage down the center of the RNA (fig. 46). Areas mapped as balsam poplar forest along the Beaver Creek flood plain contain extensive stands of emergent poplar trees that currently share dominance with alder shrubs. Within the balsam poplar type narrow stands of willow shrubs are parallel to Beaver Creek. Only limited willow shrub stands occur in the RNA. Willows are more common along the Beaver Creek flood plain outside the RNA where they provide a corridor of habitat important to several wildlife species.

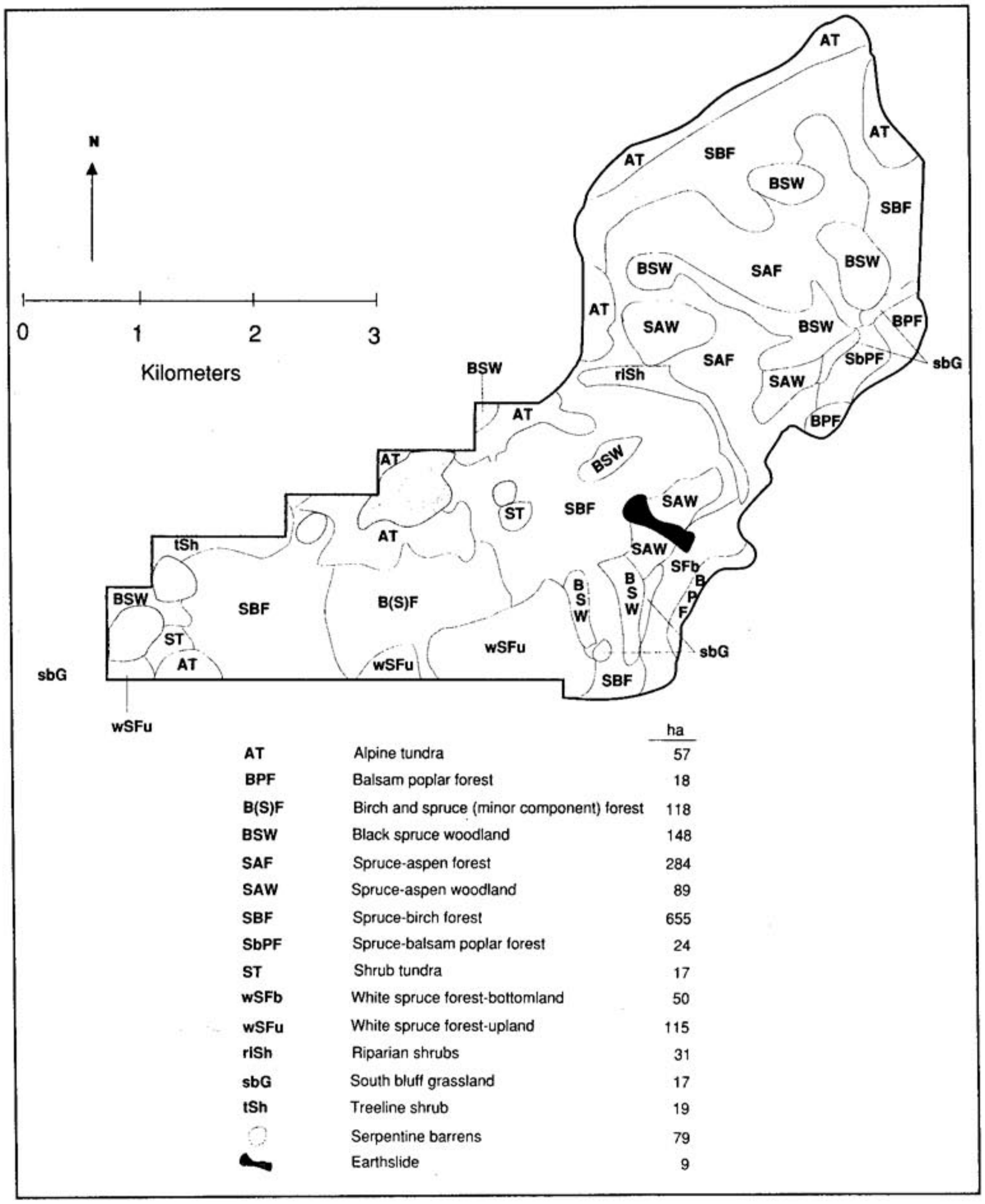


Figure 46—Vegetation cover types for Serpentine Slide Research Natural Area; total area, 1730 ha.

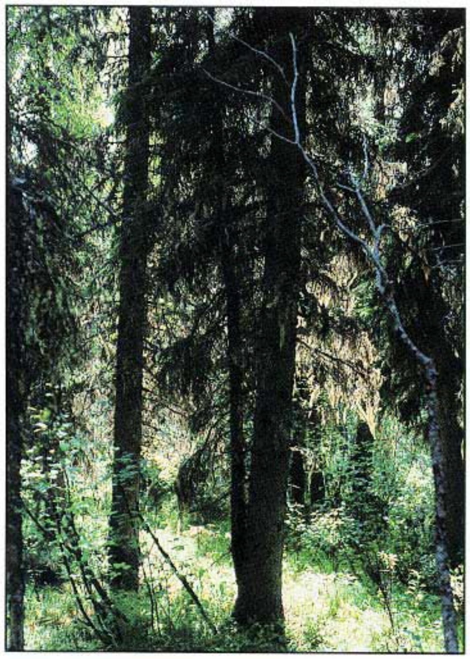


Figure 47—White spruce-birch forest on midelevation slope.

Figure 48—Main area of white spruce-aspen forest (foreground and middleground) on south-facing slopes of Amy Creek dolomite, looking west, in the northern portion of Serpentine Slide Research Natural Area, March 1986.

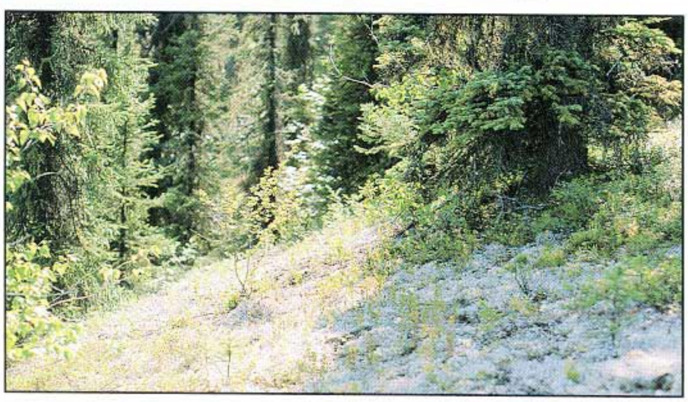


Figure 49—Edge of spruce-aspen forest and woodland types. Note wide tree spacing and lichen mat.

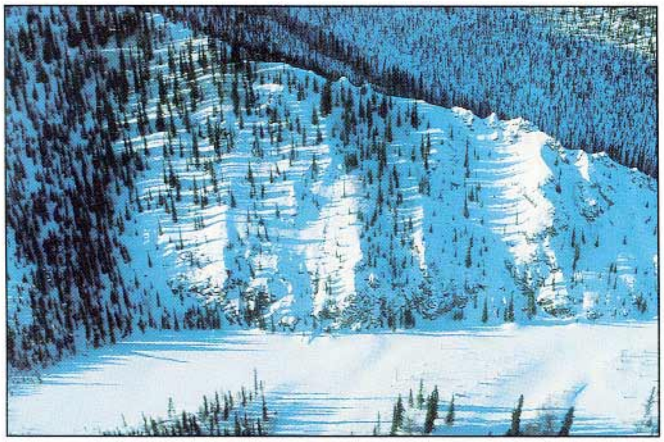


Figure 50—Winter view of south bluff community illuminated by low-angle sun. Topographic obstructions such as this bluff cast shadows to the north that promote black spruce permafrost plant communities.

Figure 51—Mature white spruce bottom-land forest on Beaver Creek. The area depicted includes the Bluff Flats forest plot. Area of intensive grizzly bear use and bank beaver activity is in willow-alder shrubland and young balsam poplar forest just out of view to the left.

About 3 percent of the RNA is alpine tundra, generally at elevations above 800 m (figs. 5 and 46). South-bluff grasslands occupy about 17 ha or 1 percent of the RNA on oversteepened toe slopes at the topographic break along the Beaver Creek flood plain. Serpentinite barrens cover 4.6 percent of the RNA and are mostly at higher elevations in the western portion of the area.

Table 6—Structural attributes of forest reference plots at Bluff Flats, June 1987, and Spring Slope, August 1983

Plot segment name and species[a]	Total live stems	D.b.h.		Total basal area	
		Maximum	Mean[b]	Live stems	Dead stems
	Number	*- - - Centimeters - - -*		*Square meters per hectare*	
Bluff Flats 110:					
White spruce	55	46.0	23.6 (±8.3)	43.1	4.1
Balsam poplar	1	13.0	13.0 (—)	.2	.7
Total	56			43.3	4.8
Bluff Flats 120:					
White spruce	28	60.0	26.4 (±14.4)	31.6	1.5
Balsam poplar	4	25.0	13.1 (±11.8)	1.4	.5
Paper birch	1	23.5	23.5 (—)	.7	0
Alder	124	10.0	4.2 (±2.4)	3.1	.1
Total	157			36.8	2.1
Spring Slope 110:					
White spruce	48	40.5	22.1 (±8.9)	34.2	6.7
Paper birch	1	12.5	12.5 (—)	.2	0
Alder	45	7.5	4.8 (±1.2)	1.4	.4
Total	94			35.8	7.1

[a] Each plot segment is 25 by 25 m (1/16th ha); values calculated for stems 2.0 cm or larger.
[b] ± the standard deviation.

Table 6 presents data from two white spruce forest reference plots. The Bluff Flats plot (fig. 5) is in the Beaver Creek bottom-land and the Spring Slope plot (fig. 5) is on the south slope above the river about 100 m below the local tree line (Juday 1984a). Both plots were marked to allow relocation; maps of tree stems, shrubs, logs, and river or stream position were produced as part of the RNA site documentation and are available from the Bureau of Land Management District Office in Fairbanks. The Spring Slope plot is in a natural catchment near a steep headwall (see fig. 30). Slope drainage is funneled down the slope; at times it spills over the natural channel of a stream 15 m from the plot and deposits new soils. Soil moisture in the plot is augmented from springs, seeps, and subsurface flow. Trees are competing intensely for light, thereby achieving good form. Alders (*Alnus* spp.) enrich the nitrogen pool of the ecosystem and have regenerated in natural overstory mortality patches. The Bluff Flats plot is next to Beaver Creek in the northeast portion of the RNA on a high terrace (fig. 51). The Bluff Flats soil sample was collected on the boundary between 1/16-ha segments of the plot.

The bottom-land Bluff Flats forest plot contains larger white spruce trees than the Spring Slope plot, although average diameters and stand basal areas are comparable. Tree density in both bottom-land plot segments is typical of maturing undisturbed forest. The lower tree density in Bluff Flats segment 120 is associated with larger average and maximum diameters at breast height (d.b.h.). The bottom-land stand has remnant balsam poplar trees from an earlier successional stage, but they are considerably smaller at maturity than are typical balsam poplar along braided glacial river systems. Alder shrubs are an important component of both stands.

Table 7 shows the age and height characteristics of dominant white spruce trees in the two forest plots. The Bluff Flats plot is dominated by 125- to 150-year-old white spruce, which is consistent with the interpretation of this bottom-land forest as a maturing spruce stand in the last stages of replacing an earlier balsam poplar successional stage (fig. 52). Dominant white spruce in the bottom-land plot are about 3 to 5 m shorter than trees of similar age on the Tanana River flood plain (Juday and Zasada 1985). White spruce in the Spring Slope plot are considerably shorter, and their crown structure indicates that they are fully mature and unlikely to achieve further height growth. Height at maturity can be taken as an approximation of site productivity. Juday (1984a) notes that the Spring Slope plot occurs at an unusually high elevation in east-central Alaska for such a large and well-developed stand; he attributes the high productivity to subirrigation by seepage (fig. 29), the unbroken south-facing slope, and the sheltered nature of the topography.

Figure 53 shows the d.b.h. size class distribution of white spruce in the two stands. The bottom-land plots (combined) contain fewer small trees and trees in larger size classes than the Spring Slope plot does, thereby reflecting the greater competition and productivity of the bottom-land environment.

Figure 54 shows one of two 10- by 50-m tree-line transects in section 9, T. 10 N., R. 1 W. Figures 55 and 56 show the position, height, and basal diameter of all woody stems 1 cm or greater in the transects. Table 8 summarizes the structure of woody vegetation in the transects. In transect 1, white spruce has the largest, although the most variable, mean diameter; alder is the tallest woody vegetation. In transect 2, alder is absent and hybrid birch is the largest woody vegetation; white spruce are short and small in diameter. The average stem characteristics suggest that transect 1 represents an alder shrub transition between forest and alpine tundra in which an early wave of spruce is emerging and recruitment of white spruce has continued in recent years. Birch stems are a hybrid of the tree and dwarf tundra species that have escaped natural pruning and are enlarging after years of suppression. Transect 2 is a patch of dwarf birch tundra where white spruce have recently become established.

Table 9 shows the average stand structural characteristics of woody vegetation in the transects. Transect 1 supported a projected 260 stems/ha of white spruce, but transect 2 had nearly three times as many. Transect 1 contained over five times the woody basal area of transect 2. These characteristics are consistent with an earlier and better established wave of spruce in transect 1 and a more recent, slow tree line advance in transect 2.

Table 7—Relation of white spruce height to diameter in forest reference plots at Bluff Flats, June 1987, and Spring Slope, August 1983

Plot name	D.b.h.	Height	Age[a]	Height-d.b.h. ratio[b]
	Centimeters	*Meters*	*Years*	
Bluff Flats	30.0	24.1	130	0.80
	28.5	23.3	117	.82
	32.5	23.7	117	.73
	29.5	24.1	126	.82
	38.5	27.6	136	.72
	46.0	30.3	139	.66
	38.5	29.0	130	.75
	36.0	29.5	130	.82
	29.5	—	133	—
	39.5	—	125	—
	31.0	27.0[c]	127	.87
	60.0	—	147	—
Mean		26.5		.78
Standard deviation		2.76		.07
Spring Slope	26.5	15.8		.59
	23.5	11.5[d]		.49
	45.0	14.6		.33
	25.0	18.9		.75
	28.0	11.1		.40
	20.5	17.1		.83
	40.5	19.9		.49
	12.5	14.0		.74
	19.0	13.5		.71
	5.0	7.0		1.40
Mean		14.3		.66
Standard deviation		3.87		.31

[a] Minimum age based on count at height of 1.4 m; add 7 to 15 years for establishment and early growth.
[b] Height-d.b.h. ratio calculated as meters per centimeter.
[c] Snag with relatively intact top.
[d] Tree had broken top.

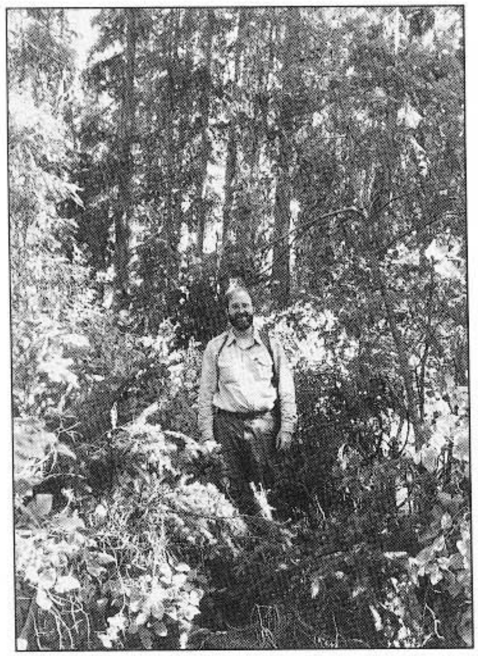


Figure 52—Edge of Bluff Flats forest plot looking west. Author is standing on a mature white spruce tree of codominant canopy position that fell to the forest floor minutes before. Weather was clear and calm at the time. The stand is in the final stages of intense competition that has resulted in replacement of balsam poplar.

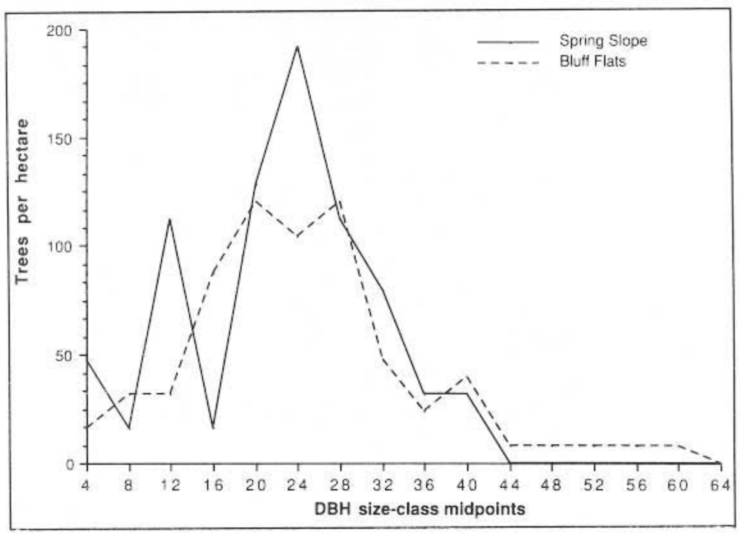


Figure 53—Diameter size-class distribution for white spruce on Spring Slope and Bluff Flats forest plots.

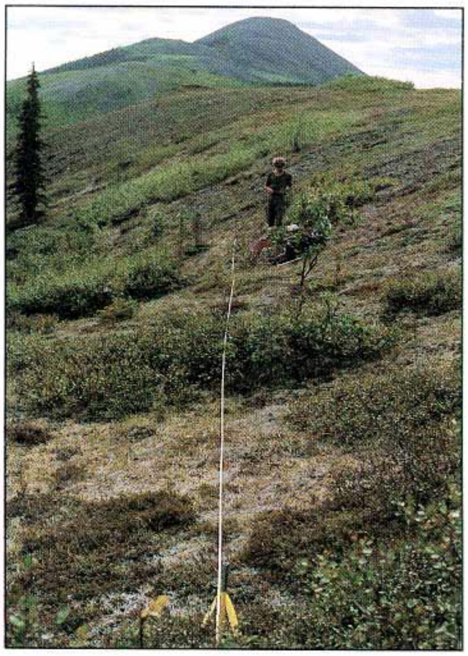


Figure 54—End segment of tree-line transect looking southwest.

Table 8—Structure of woody vegetation in 2 tree-line transects in Serpentine Slide Research Natural Area, August 1983[a]

Species	Basal diameter[b]		Height[b]	
	Transect 1	Transect 2	Transect 1	Transect 2
	- - - - *Centimeters* - - - -		- - - - - *Meters* - - - - -	
White spruce	6.9 (±5.5)	1.5 (±1.1)	1.4 (±0.3)	0.4 (±0.3)
Birch[c]	2.1 (±1.0)	2.4 (±1.0)	1.3 (±1.3)	1.7 (±0.5)
Alder	3.1 (±1.9)	—	1.9 (±1.4)	—

[a] Transects are 10 by 50 m.
[b] Values are means (± the standard deviation).
[c] Hybrid of *Betula nana* and *B. papyrifera*.

Table 9—Stand structural attributes of woody vegetation in 2 tree-line transects at Serpentine Slide Research Natural Area, August 1983[a]

Species	Stem density		Basal area	
	Transect 1	Transect 2	Transect 1	Transect 2
	– *Number per hectare* –		*Square meters per hectare*	
White spruce	260	660	1.53	0.17
Birch[b]	640	360	.27	.19
Alder	500	—	.03	—
Total	1,400	1,020	1.83	.36

[a] Transects are 10 by 50 m.
[b] Hybrid of *Betula nana* and *B. papyrifera*.

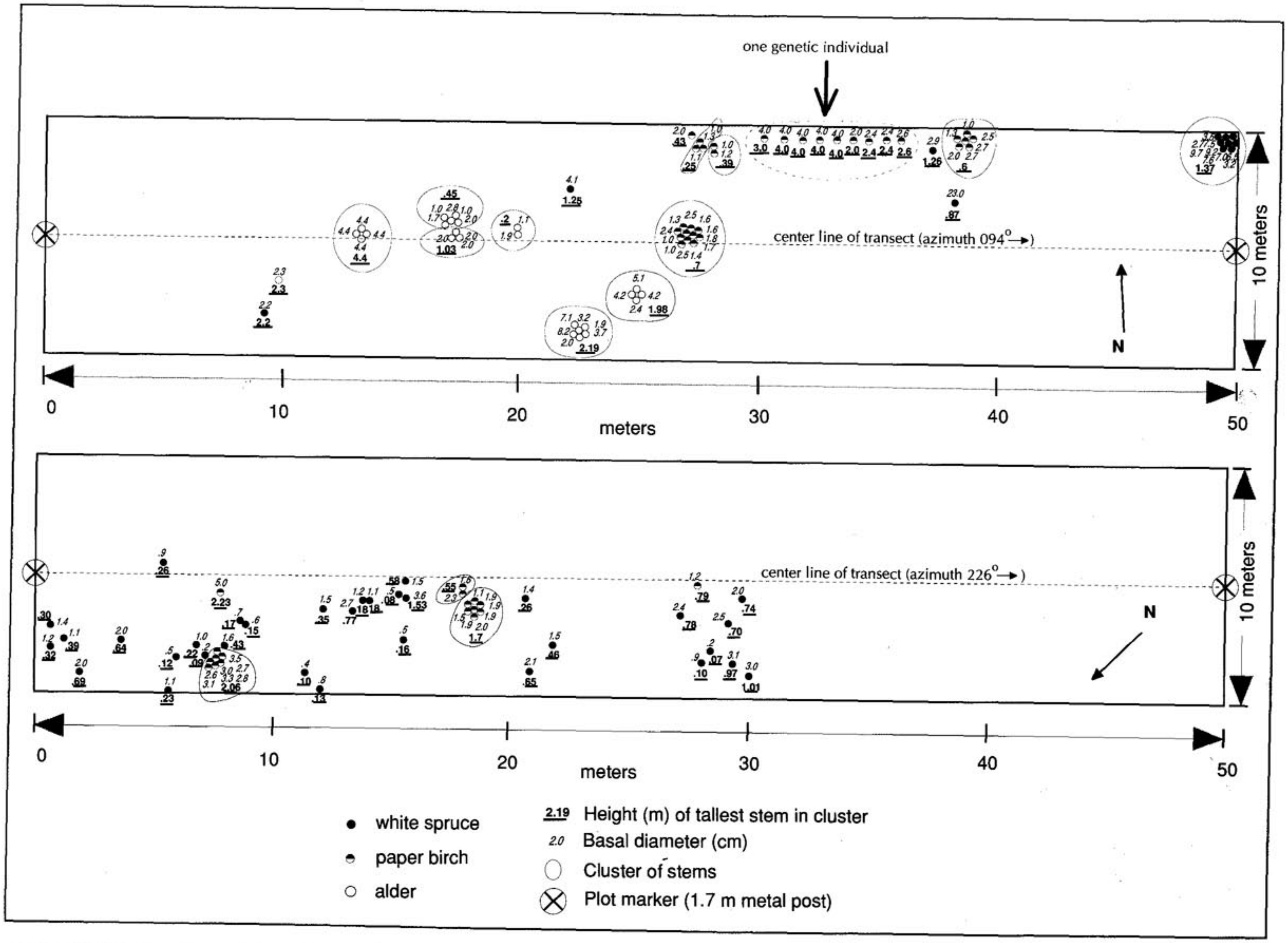


Figure 55 (top)—Location and size of trees and shrubs in tree-line transect number 1.

Figure 56 (bottom)—Location and size of trees and shrubs in tree-line transect number 2.

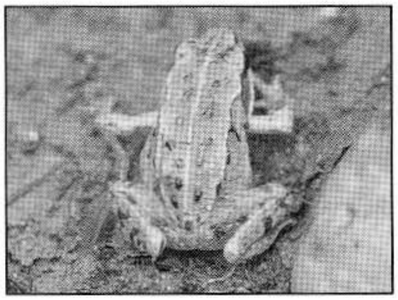
 

Figure 57 (left)—A small northern wood frog in Serpentine Slide Research Natural Area. This frog was hatched and passed through the tadpole stage earlier in the summer. Frog has been placed in the open for photographing. Frogs prefer the cover of dense vegetation at the edge or bottom of ponds, slough, and streams.

Figure 58 (right)—Mature northern wood frog in natural camouflage at the edge of a warm grassy meadow and beaver pond in Serpentine Slide Research Natural Area. Frog is located in the center at the edge of the shadows of the grass to the left. The size and maturity of this frog indicate that it has overwintered as an adult. Summer warmth is a critical factor controlling the maturation of frogs at the northern limit of their distribution.

Serpentine Slide contains a wide variety of wildlife habitats across many elevations. The pristine character of the surrounding wilderness landscape provides high-quality habitat and unimpeded movement into and out of the area. Animals that are particularly characteristic of the area, species sensitive to human activities or disturbance, and species that have important ecological roles are included on the RNA type needs list (table 1).

Fauna

Fish—The Bureau of Land Management (1984) reports the following information on fish in Beaver Creek. 3 Fish species in Beaver Creek include arctic grayling (*Thymallus arcticus*), broad whitefish (*Coregonus nasus*), burbot (*Lota lota*), longnose sucker (*Catostomus catostomus*), northern pike (*Esox lucius*), round whitefish (*Prosopium cylindraceum*), and slimy sculpin (*Cottus cognatus*). A sheefish or inconnu (*Stenodus leucichthys*) was collected in upper Beaver Creek, although it is an anomalous species for the stream. A fall run of chum salmon (*Oncorhynchus keta*) was reported in September 1982. Fish habitat is in good condition and undisturbed except for periodic sediment discharge from placer mining on Nome Creek, an upper tributary of Beaver Creek.

Amphibian—The northern wood frog (*Rana sylvatica*) (see footnote 3) is the most widely distributed reptile or amphibian in Alaska and is found throughout most of the State south of the Brooks Range (Hodge 1981). Wood frogs live in various habitats away from water but require ponds for breeding (the eggs are fertilized externally); egg masses are attached to submerged aquatic vegetation rather than deposited at the surface, to prevent damage from rapid changes in temperature (Broderson 1982). Northern wood frogs in Alaska take advantage of any warmth in their environment and become active quickly (Hodge 1981). Figure 57 shows a northern wood frog at the edge of the beaver pond shown in figure 13. Frogs were abundant and easily seen in 1987 and 1988 along the grassy edges of beaver ponds in the RNA, and some are particularly large (fig. 58). The shallow water and warm summer climate of the RNA provide ideal conditions for the rapid growth and maturation of frogs, which is critical to their survival at the northern margin of their range.

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[3] Taxonomic nomenclature follows USDA Forest Service (1979).

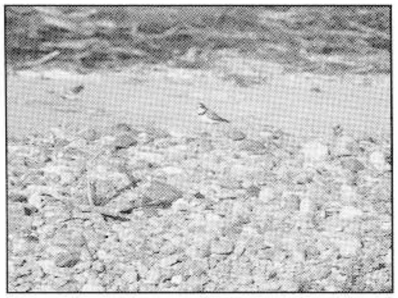

Figure 59—Semipalmated plover nesting area on the gravelly flood plain of Beaver Creek. Plover is visible in the center at the edge of Beaver Creek. Plovers lay eggs in shallow depressions among the rocks. The pattern of spots and color on the eggs of this plover's nest made them difficult to find even though the adult was clearly visible.

Birds—A comprehensive field effort to document all birds in Serpentine Slide was not made. Several species have been seen in the RNA and many others have predictable habitat relations (Kessel 1979) so that their presence can be inferred with great confidence. Table 10 lists 117 birds known to occur or that may occur in Serpentine Slide RNA.

The complex of habitats created by Beaver Creek in its flood plain and riparian corridor adds greatly to the wildlife species richness of the RNA. River gravel bars adjacent to Beaver Creek are an important shore-bird habitat. The semipalmated plover is a common nesting bird in Alaska in habitats including gravelly shorelines of large rivers and lakeshores in the interior of the State (Armstrong 1983, Gabrielson and Lincoln 1959). The semipalmated plover is a conspicuous summer resident of the annual and irregular flood zone of Beaver Creek in the RNA (fig. 59). Plovers generally scrape out a depression in sand or gravel for a nest and lay eggs that are buff in color and mottled to match sand or gravel. When a large animal (such as a person) approaches a plover nest, the adults characteristically behave as if injured and try to draw the animal away. This behavior can be observed repeatedly by any visitor walking along Beaver Creek in the summer. Semipalmated plovers largely consume small animals, especially insects and aquatic and marine creatures (Matthews 1983). Spotted sandpipers also were seen along Beaver Creek.

Breeding pairs of lesser yellowlegs were seen along Beaver Creek, and yellowleg tracks are one of the most common markings in soft sediments in the river's flood zone. Yellowlegs eat small fish and aquatic invertebrates, such as water boatmen, diving beetles, dragonfly nymphs, and flies, and often nest in black spruce muskegs (see fig. 32) (Carstensen 1984).

An arctic tern was seen above Beaver Creek (table 10) in late August 1988. The species migrates from Alaska to the high latitudes of the southern hemisphere, one of the longest migrations in the world (Terres 1980). Arctic terns eat small fish, insects, and small invertebrates (Paul 1984). Kessel (1979) identifies the arctic tern as a species typical of her grass meadow habitat. The arctic tern is not an abundant waterbird; the coastal population is probably about 25,000, with a few thousand more in the interior (Paul 1984).

Belted kingfishers nest in gravelly cut banks along Beaver Creek and dart over the river from overhanging limbs. They eat mainly fish, which they dive into the water to catch, but frogs (including the tadpole stage) can be a significant part of the diet (see ,fig. 32) (Terres 1968).

Table 10-Checklist of birds known to occur or that may occur in the Serpentine Slide Research Natural Areaa

Order and common name	Scientific name	Comments
Gaviformes:		
Common loon	*Gavia immer*	Probable nesting on beaver lodge
Arctic loon	*Gavia arctica*	
Red-throated loon	*Gavia stellata*	
Podicipediformes:		
Red-necked grebe	*Podiceps grisegena*	Possible nesting on slough, beaver ponds
Horned grebe	*Podiceps auritus*	
Anseriformes:		
Canada goose	*Branta canadensis*	Probable breeder and migrant
Snow goose	*Chen caerulescens*	Possible migrant
Mallard	*Anas platyrhynchos*	Probable breeder and migrant
Pintail	*Anas acuta*	2 pairs seen on beaver pond
Green-winged teal	*Anas crecca*	Remains of kill seen in beaver meadows
Blue-winged teal	*Anas discors*	
Northern shoveler	*Anas clypeata*	
American wigeon	*Anas americana*	
Redhead	*Aythya americana*	Occasionally nests on Yukon Flats and Tetlin
Ring-necked duck	*Aythya collaris*	Rare breeder in Alaska
Greater scaup	*Aythya marila*	
Lesser scaup	*Aythya affinis*	Nesting habitat is dry grass near shores
Common goldeneye	*Bucephala clangula*	Nests in tree cavities, Yukon Valley
Barrow's goldeneye	*Bucephala islandica*	Nests in tree cavities or rocks and cliffs
Buff lehead	*Bucephala albeola*	Seen on Beaver Creek, nests in tree cavity
Harlequin duck	*Histrionicus histrionicus*	
White-winged scoter	*Melanitta deglandi*	
Surf scoter	*Melanitta perspicillata*	
Common merganser	*Mergus merganser*	
Falconiformes:		
Goshawk	*Accipiter gentilis*	Seen in bottom-land white spruce forest
Sharp-shinned hawk	*Accipiter striatus*	Probable in RNA
Red-tailed hawk	*Buteo jamaicensis*	
Rough-legged hawk	*Buteo lagopus*	
Golden eagle	*Aquila chrysaetos*	Seen in White Mountains
Bald eagle	*Haliaeetus leucocephalus*	Seen over Beaver Creek
Marsh hawk	*Circus cyaneus*	
Peregrine falcon	*Falco peregrinus anatum*	Seen in White Mountains
Merlin	*Falco columbarius*	Uncommon in Alaska
American kestrel	*Falco sparverius*	
Galliformes:		
Spruce grouse	*Canachites canadensis*	*b*
Ruffed grouse	*Bonasa umbellus*	*b*
Willow ptarmigan	*Lagopus lagopus*	*b*
Rock ptarmigan	*Lagopus mutus*	*b*
Sharp-tailed grouse	*Pedioecetes phasianellus*	*b*

See footnotes on page 53.

Table 10-Checklist of birds known to occur or that may occur in the Serpentine Slide Research Natural Areaa (continued)

Order and common name		Scientific name	Comments
Charadriiformes:			
Semipalmated plover	*Charadrius semipalmatus*	Seen in RNA on Beaver Creek flood plain	
American golden plover	*Pluvialis dominica*	Species of dry tundra	
Lesser yellowlegs	*Tringa flavipes*	Seen in RNA along Beaver Creek	
Solitary sandpiper	*Tringa solitaria*	Possible, nests near beaver ponds in abandoned robin nests	
Wandering tattler	*Heteroscelus incanus*	Possible, species is uncommon in interior	
Spotted sandpiper	*Actitis macularia*	Seen in RNA along Beaver Creek	
Upland sandpiper	*Bartramia longicauda*	Possible on sparsely vegetated uplands and grassy meadows, not common	
Whimbrel	*Numenius phaeopus*	Possible on tundra	
Red-necked phalarope	*Phalaropus lobatus*		
Common snipe	*Gallinago gallinago*		
Long-billed dowitcher	*Limnodromus scolopaceus*	Probable migrant	
Surfbird	*Aphriza virgata*	Possible breeder in alpine tundra	
Semipalmated sandpiper	*Calidris pusilla*	Possible migrant	
Least sandpiper	*Calidris minutilla*		
Baird's sandpiper	*Calidris bairdii*	Possible migrant	
Pectoral sandpiper	*Calidris melanotos*	Possible migrant	
Long-tailed jaeger	*Stercorarius longicaudus*	Possible breeder in alpine tundra	
Mew gull	*Larus canus*		
Bonaparte's gull	*Larus philadelphia*		
Arctic tern	*Sterna paradisaea*	Seen in RNA above Beaver Creek	
Strigiformes:			
Great horned owl	*Bubo virginianus*	Probable breeder and year-round resident	
Hawk owl	*Surnia ulula*	Tree cavity nester, probable in RNA	
Great gray owl	*Strix nebulosa*		
Short-eared owl	*Asio flammeus*	Possible in tundra, marshes, and muskegs	
Boreal owl	*Aegolius funereus*		
Coraciformes:			
Belted kingfisher	*Megaceryle alcyon*	Seen in RNA on cutbanks of Beaver Creek	
Piciformes:			
Common flicker	*Colaptes auratus*	Common in interior Alaska forests	
Hairy woodpecker	*Picoides villosus*	Seen in bottom-land white spruce forest	
Downy woodpecker	*Picoides pubescens*	Sign seen in RNA, white spruce forest	
Black-backed woodpecker	*Picoides arcticus*	Probable in old-growth white spruce	
Northern three-toed woodpecker	*Picoides tridactylus*	Heard in old-growth white spruce	

See footnotes on page 53.

Table 10-Checklist of birds known to occur or that may occur in the Serpentine Slide Research Natural Areaa (continued)

Order and common name	Scientific name	Comments
Passeriformes:		
Alder flycatcher	*Empidonax alnorum*	Seen in RNA in alders along Beaver Creek
Hammond's flycatcher	*Empidonax hammondii*	
Western wood pewee	*Contopus sordidulus*	
Olive-sided flycatcher	*Nuttallornis borealis*	
Horned lark	*Eremophila alpestris*	Probable in alpine tundra
Violet-green swallow	*Tachycineta thalassina*	Seen in RNA
Tree swallow	*Iridoprocne bicolor*	
Bank swallow	*Riparia riparia*	
Cliff swallow	*Petrochelidon pyrrhonota*	
Gray jay	*Perisoreus canadensis*	Seen in RNA
Common raven	*Corvus corax*	Common year-round resident
Black-capped chickadee	*Parus atricapillus*	Seen in RNA
Boreal chickadee	*Parus hudsonicus*	
Dipper	*Cinclus mexicanus*	
American robin	*Turdus migratorius*	
Varied thrush	*Ixoreus naevius*	
Swainson's thrush	*Catharus ustulatus*	
Gray-cheeked thrush	*Catharus minimus*	Seen in RNA
Mountain bluebird	*Sialia currucoides*	Possible, uncommon
Townsend's solitaire	*Myadestes townsendi*	Uncommon, possible in alpine tundra
Ruby-crowned kinglet	*Regulus calendula*	Probable in white spruce forests
Water pipit	*Anthus spinoletta*	
Bohemian waxwing	*Bombycilla garrulus*	Seen in RNA, muskeg near Beaver Creek
Northern shrike	*Lanius excubitor*	
Orange-crowned warbler	*Vermivora celata*	
Yellow warbler	*Dendroica petechia*	Seen in RNA, riparian alder
Yellow-rumped warbler	*Dendroica coronata*	
Townsend's warbler	*Dendroica townsendi*	
Blackpoll warbler	*Dendroica striata*	
Northern watershrush	*Seiurus noveboracensis*	
Wilson's warbler	*Wilsonia pusilla*	
Rusty blackbird	*Euphagus carolinus*	Seen in RNA, riparian willows and alder
Pine grosbeak	*Pinicola enucleator*	
Hoary redpoll	*Carduelis hornemanni*	
Common redpoll	*Carduelis flammea*	Common year-round resident
White-winged crossbill	*Loxia leucoptera*	
Savannah sparrow	*Passerculus sandwichensis*	
Dark-eyed junco	*Junco hyemalis*	Seen in RNA, bottom-land white spruce
Tree sparrow	*Spizella arborea*	
White-crowned sparrow	*Zonotrichia leucophrys*	Seen in RNA, riparian shrubs
Golden-crowned sparrow	*Zonotrichia atricapilla*	
Fox sparrow	*Passerella iliaca*	
Lincoln's sparrow	*Melospiza lincolnii*	
Lapland longspur	*Calcarius lapponicus*	
Snow bunting	*Plectrophenax nivalis*	Probable migrant

[a] Nomenclature follows USDA Forest Service (1979) and American Ornithologists' Union (1957).
[b] Mapped as occurring in area by Alaska Department of Fish and Game (1978).

Beaver ponds and river cutoff sloughs are an important bird habitat in Serpentine Slide RNA. Pintail and green-winged teal were seen on beaver ponds. A nest, probably of a loon, was seen on top of an "island" beaver lodge; a "slide" extended from the nest into the water. Occasional groups of two to seven ducks were seen flying over Beaver Creek, both upstream and down, at all hours during June 1987. The Beaver Creek lowlands connect to the Yukon Flats, one of the great waterfowl areas of North America.

Species seen in riparian shrub habitats in the RNA include yellow warblers, rusty blackbird, alder flycatchers, gray-cheeked thrushes, and white-crowned sparrows. Spindler and Kessel (1980) report that their tall shrub thicket type supports the greatest bird species richness (as many as 18 breeding species) and highest occupancy levels of any bird habitat in the Tanana Valley. The most abundant species in their tall shrub plots were yellow warblers, alder flycatchers, and orange-crowned warblers; these three species along with northern waterthrushes, blackpoll warblers, fox sparrows, and savanna sparrows were most abundant in the tall shrub type of all the habitats they studied. Spindler (1976) also found gray-cheeked thrushes associated with these species in a tall shrub habitat near Fairbanks.

The Alaska Department of Fish and Game (1978) reports huntable populations of spruce grouse, ruffed grouse, sharp-tailed grouse, and willow and rock ptarmigan in a region that includes Serpentine Slide. Sharp-tailed grouse require fire-maintained early successional habitats of dense woody vegetation and grasslands in central Alaska (Ellison 1978). Ruffed grouse are closely associated with aspen forests in the winter; spruce grouse inhabit mature spruce-birch forests in interior Alaska (Ellison 1978). Both sharptail and spruce grouse habitats are restricted in the White Mountains but are particularly well represented in Serpentine Slide RNA.

At least two adult goshawks were seen flying over mature white spruce forests and Beaver Creek and in the Bluff Flats forest plot in pursuit of bird prey. Goshawks usually are found in mature forests with at least some conifers in the area, and they generally nest in the densest portion of the stand (Jones 1979). McGowan (1975) reports that goshawks near Fairbanks nest in all forest types but prefer to build nests in large birch trees and, to a lesser degree, aspen trees. Goshawks usually return to a traditional nesting area and often build several alternate nests over time (McGowan 1975). Nests usually are near an opening 50 to 100 m from the edge of the forest. Often goshawks choose to nest near a stream or lake that will provide them both habitat diversity and a clear flight path (Jones 1979).

Jones (1979) reports the main prey items in the diet of goshawks in North America. Many birds that are the prey of goshawk have been seen in or could be expected in the RNA because of excellent habitat; these include mallard, green-winged teal, grouse, ptarmigan, woodpeckers, jays, warblers, and blackbirds. Important mammals in the goshawk diet that find productive habitat in the RNA are arctic ground squirrel, flying squirrel, and snowshoe hare. Another accipiter very likely to occur in the RNA is the sharp-shinned hawk. Clarke (1984) reports that sharp-shinned hawks occur in high densities across forested landscapes of central Alaska. They nest in young conifer trees in dense, young stands of mixed deciduous and coniferous forest and regularly reoccupy old nesting areas. Sharp-shinned hawks near Fairbanks prey primarily on small birds, especially hermit, Swainson's, and gray-cheeked thrushes; dark-eyed junco; American robin; yellow-romped warbler; white-crowned sparrow; and yellow warbler (Clarke 1984).

Species seen or heard in white spruce forests of Serpentine Slide are gray jay, boreal chickadee, dark-eyed junco, and northern three-toed woodpecker. Spindler and Kessel (1980) report that for the interior Alaska mature white spruce forests they studied, the Townsend's warbler, Swainson's thrush, and dark-eyed junco were the three most abundant birds (82 percent of total density). In a comparison of all taiga bird habitats, they found that Townsend's warbler, brown creeper, and boreal chickadee were most abundant in white spruce stands. Other birds they found associated with mature spruce trees include northern three-toed woodpecker and species, such as Wilson's warbler, that use mixed deciduous-coniferous forest. Older white spruce forests have the highest incidence (expressed as a percentage of total bird existence energy) of the raptor, timber driller, and foliage searcher foraging guilds of Alaska taiga birds (Spindler and Kessel 1980). Spindler (1976) found the following additional species breeding in white spruce forests near Fairbanks: yellow-rumped warbler, fox sparrow, hoary and common redpolls, and pine grosbeak and opportunist species in more open stands having a well-developed shrub understory, including white-crowned sparrow, Bohemian waxwing, and northern waterthrush.

A Bohemian waxwing was seen in the Beaver Creek flood plain flying out of black spruce muskeg, its typical breeding habitat. No bird observations were made in alpine areas of the RNA. Violet-green swallows catching insects on the wing were seen along cliffs at high and low elevations. The same distribution could be expected of the Townsend's solitaire.

The steep bluffs and cliffs along Beaver Creek produce updrafts that attract soaring raptors. Golden eagles are widely distributed in the White Mountains, bald eagles range up and down Beaver Creek, and peregrine falcons are known to nest near the RNA (Bureau of Land Management 1984).

Mammals—Table 11 is a list of the mammals that occur, or may occur, in Serpentine Slide RNA. Two mammals, beaver and grizzly bear, are on the RNA type needs list (table 1).

Beaver have a profound effect on the character of the Beaver Creek riparian corridor, and there is little question about the appropriateness of the river's name (fig. 60). Beaver ponds in the RNA provide habitat for fish and aquatic birds. The upper edges of beaver ponds create temporary grassy meadows; ponds that fill in change the topography of the flood plain. New beaver ponds on the bottom-land flood shrubland and reverse the direction of ecological succession. Beavers in the RNA have cut large amounts of balsam poplar and aspen for food. Beavers can be an important prey for wolves. In August 1988, beavers no longer occupied the pond shown in figure 58, and the water level fell at least 1.5 m (fig. 61). At the same time, an extensive area of beaver activity near bank dens (Shepherd 1984) was discovered along Beaver Creek just upstream from the pond. Numerous young balsam poplar had been freshly felled by beaver, new pathways were present along the bank of the river, and new beaver slides led from the bank into Beaver Creek. The beavers that were in the pond in 1987 either were killed, died, or abandoned the pond for fresh new habitat.

Table 11-Checklist of mammals known to occur or that may occur in the Serpentine Slide Research Natural Areaa

Order and common name	Scientific name	Comments
Insectivora:		
Masked shrew	*Sorex cinereus*	
Arctic shrew	*Sorex arcticus*	
Pygmy shrew	*Microsorex hoyi*	
Chiroptera:		
Little brown myotis	*Myotis lucifugus*	
Lagomorpha:		
Collared pika	*Ochotona collaris*	
Snowshoe hare	*Lepus americanus*	*b c*
Rodentia:		
Hoary marmot	*Marmota caligata*	*c*
Arctic ground squirrel	*Spermophilus parryii*	*b c*
Red squirrel	*Tamiasciurus hudsonicus*	Seen in RNA[c]
Northern flying squirrel	*Glaucomys sabrinus*	*b c*
Beaver	*Castor canadensis*	Seen in RNA[b]
Northern red-backed vole	*Clethrionomys rutilus*	
Meadow vole	*Microtus pennsylvanicus*	
Tundra vole	*Microtus oeconomus*	
Long-tailed vole	*Microtus longicaudus*	
Yellow-cheeked vole	*Mocrotus xanthognathus*	
Singing vole	*Microtus miurus*	
Muskrat	*Ondatra zibethicus*	*b c*
Brown lemming	*Lemmus sibiricus*	
Northern bog lemming	*Synaptomys borealis*	*b*
Collared lemming	*Dicrostonyx torquatus*	
Meadow jumping mouse	*Zapus hudsonius*	
Porcupine	*Erethizon dorsatum*	*c*
Carnivora:		
Coyote	*Canis latrans*	*c*
Gray wolf	*Canis lupus*	*c d*
Red fox	*Vulpes vulpes*	Seen in RNA[c]
Black bear	*Ursus americanus*	Seen in RNA[d]
Grizzly bear	*Ursus arctos*	*b*
Marten	*Martes americana*	*c*
Ermine	*Mustela erminea*	
Least weasel	*Mustela nivalis*	*c*
Mink	*Mustela vision*	
Wolverine	*Gulo gulo*	*d*
River otter	*Lutra canadensis*	*b c*
Lynx	*Felis lynx*	*c*
Artiodactyla:		
Moose	*Alces alces*	Seen in RNA[b]
Caribou	*Rangifer tarandus*	Seen in RNA
Dall sheep	*Ovis dalli*	Infrequent migrant through RNA

a Nomenclature follows USDA Forest Service (1979); general distribution limits from Hall (1981). b Sign of the species has been observed in the RNA. RNA is within the species range as depicted by the Alaska Department of Fish and Game (1978). d RNA is within the species range as depicted by the Alaska Department of Fish and Game (1973).

Figure 60—Beaver dam and pond at Serpentine Slide Research Natural Area, June 1987 (same pond as in fig. 13). At the time of this picture, the pond was occupied by at least two beavers. The dam was in good repair and water level reached the top of the dam. Water below the dam is a slough channel of Beaver Creek.

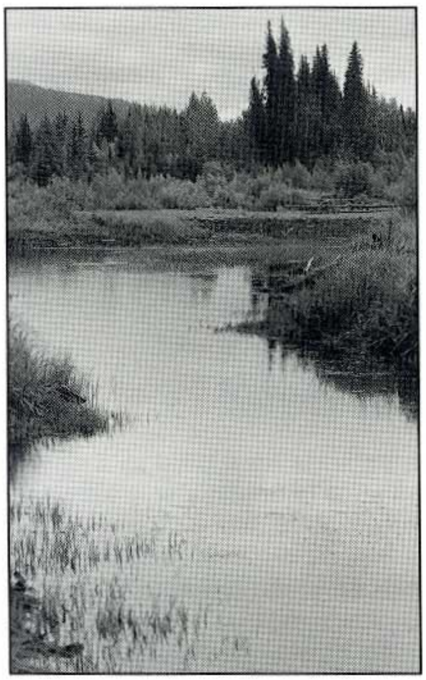

Figure 61—Same beaver pond as in figures 13 and 60, August 1988. Beaver had not been active in this pond for several months. Dam has not been repaired, and water level is 1.5 meters lower than in 1987, thereby exposing submerged aquatic vegetation. Rain was falling when the picture was taken.

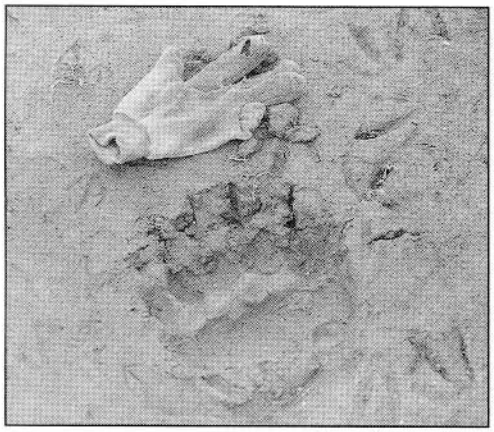

Figure 62—Track of a large grizzly bear boar in soft silt along Beaver Creek in Serpentine Slide Research Natural Area, August 1988. Claws of grizzly bears extend straight out from paw, producing a characteristic slicing claw mark when ground is soft. Tracks in this series were made within the previous 48 hours. The Beaver Creek riparian corridor is important for the seasonal (especially late summer and fall) movement of grizzly bears in the White Mountains. Older tracks of shorebirds, especially the lesser yellowlegs, are visible around grizzly track.

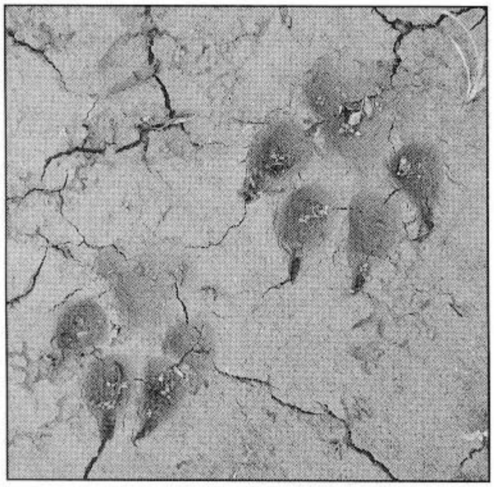

Figure 63—Wolf tracks at the edge of Beaver Creek, Serpentine Slide Research Natural Area.

Grizzly bear use the Beaver Creek floodplain as a seasonal movement corridor (fig. 62). Fresh tracks of a large boar and a sow with a young cub were observed along Beaver Creek in August 1988. Along the river were numerous grizzly bear bedding areas in riparian grass, droppings indicating a diet rich in berries and some fish, and territorial markings on young balsam poplar. New grizzly bear paths were seen along the river bank, which indicated seasonal late summer and fall use. High-productivity riparian corridors provide grizzly bears with favorable travel routes among relatively small and isolated alpine habitats in the White Mountains. A black bear sow was seen in the RNA in summer 1988 along Beaver Creek. Wolf tracks were seen in the annual flood zone of Beaver Creek (fig. 63).

Moose have been seen in the RNA along Beaver Creek. Signs of moose browse and moose tracks are common along the Beaver Creek flood plain and in the upper elevation shrub belt near treeline. Moose tracks were also seen along shores of beaver ponds and sloughs of Beaver Creek. The area of prime moose habitat, the willow-dominated riparian shrub zone along Beaver Creek, is narrow compared to rivers of similar size in northern Alaska.

Figure 64—Witches' brooms in mature white spruce trees, Bluff Flats forest plot, June 1987. Brooms are the large yellow-green balls on these trees and are caused by the abnormal growth of the spruce when infected by tree rust diseases. Witches' brooms are the most common denning site for flying squirrels in interior Alaska. Flying squirrels aggregate and sleep in torpor in these witches' brooms in the coldest part of the winter.

The presence of serveral small mammals in the RNA was verified by sign or sighting. A red fox was observed in a black spruce stand (see fig. 50) at midday in June 1987. The fox was walking and probably hunting voles, its preferred prey (Jennings 1984). Flying squirrels require habitat in old coniferous forests containing den trees with natural tree cavities, woodpecker cavities, and witches' brooms (Mowrey 1982). Figure 64 shows a white spruce tree with witches' brooms (abnormal growths caused by tree rust diseases). Witches' brooms in the Bluff Flats forest plot appeared to be used for flying squirrel denning sites.

Serpentine Slide RNA lacks sizeable areas of high-elevation alpine Dall sheep and caribou habitat that is characteristic of the other two RNAs in the WMNRA-Mount Prindle and Limestone Jags (Juday 1988, 1989). Dall sheep may occasionally pass through Serpentine Slide, but they generally avoid the area in their annual movements (Bureau of Land Management 1984). Serpentine Slide is not part of the main summer or winter habitat of the resident White Mountain caribou herd, but individuals wander through the area. A caribou was seen along the ridge crest on the RNA boundary in late August 1983. Serpentine Slide was on the edge of the calving grounds of the Steese-Fortymile caribou that in the early decades of the century was estimated to number over 500,000 (Valkenberg and Davis 1986). As recently as the late 1950s the herd-numbering over 50,000-still calved in the area. The Steese-Fortymile herd completely abandoned the White Mountains calving grounds in the early 1960s and has not calved in the area since. The small resident White Mountain herd does calve there, however. Caribou may again be numerous in the area at some time in the future.

History of Disturbance

Any continental exposures of ultramafic rocks, such as serpentinite, are of some mineral interest because these rocks have been the main source of many heavy metal ores and other rare minerals. Foster (1969) says of the Beaver Creek serpentinite body, "Although the detected amounts of platinum, palladium, and rhodium are low, their presence is noteworthy." Weber and others (1988) give probabilistic estimates for undiscovered mineral deposits in the WMNRA. The highest estimates are for placer gold deposits, with low probability for tin, thorium and rare earth elements, and lead-zinc deposits, all found in areas outside the RNA. Weber and others (1988) state, "At the present time we do not expect significant undiscovered resources of chromium, asbestos, nickel, or diamonds."

No known mineral or mining claims exist within the RNA. The designation of National Recreation Area under ANILCA precludes further mineral claims under the 1872 mining law. Old wooden posts on the serpentinite outcrop indicate that a mineral claim was staked, but it never was recorded officially. Nickel and cobalt were probably the ores of interest.

The surface exposure of nickeliferous serpentinite in the RNA is at the northeast tip of a 36-km-long body (Foster 1969). A considerable amount of the entire body is on State land, and most of the rest is within the semiprimitive motorized recreation management zone of the WMNRA. Mineral leasing is possible in the semiprimitive zone, but significant scientific, ecological, and recreational resources must be protected. The WMNRA plan maintains a mineral leasing closure for RNAs, the primitive recreation management zone, and the Beaver Creek Wild and Scenic River corridor.

Research

Opportunities for research at Serpentine Slide are numerous and varied. The RNA offers outstanding opportunities for studying serpentine geology and geoecology, geomorphology, local climatology, community plant ecology, stream ecology, and wildlife habitat relations. The area is a significant educational and interpretive resource because it contains special features and a diversity of habitats and is relatively accessible from Fairbanks yet remains in a wilderness setting.

One of the most important research topics, which should be studied before visitor facilities are constructed or monitoring activities become extensive, is naturally occurring asbestos in the RNA. Asbestos is visible in serpentinite exposed by the slide. The potential movement of asbestos into surface water and its incorporation into wildlife used for recreational or subsistence harvest should be defined. Asbestos levels in potential drinking water sources and the potential hazard of visitors coming into contact with asbestos in Beaver Creek may need to be studied.

An important basic research problem at Serpentine Slide RNA is taxonomic (biosystematic) study of local plant adaptation to serpentinite habitats. The RNA offers the opportunity for collecting species growing on serpentine and comparing their genes with collections of the same species growing on "normal" sites. Cultivation of both collections in common gardens, comparative studies of isozymes, and hybrid DNA strands would be useful. Serpentine Slide RNA is particularly suitable as a "remote" station tied to intensive research and monitoring programs at the Bonanza Creek Experimental Forest and Long-Term Ecological Research site on the Tanana River west of Fairbanks. The RNA provides good opportunities for studying plant succession on the Beaver Creek flood plain, especially studies comparing successional pathways with the well-documented Tanana River braided flood plain. It contains many ecosystems similar to those in the Experimental Forest but in a different geomorphic and hydrologic setting. The clearwater Beaver Creek system contrasts with the turbid Tanana River. The large-animal component in the ecosystem of Serpentine Slide is intact, unlike Bonanza Creek Experimental Forest where big game are subject to great human-disturbance effects.

The flora of Serpentine Slide is relatively well collected for a remote area of interior Alaska, but the great habitat diversity, the occurrence of special habitats, and the potential for specialized or intensive research projects justify more collection. Important habitats that need additional vascular plant collections are alpine tundra, wetlands, dry dolomite woodland, serpentinite barrens, south bluff grasslands in the early warm season, and midelevation white spruce-birch and aspen forest. Serpentine Slide RNA is an ideal location for monitoring the climate of south bluffs, bottomland forest, and alpine tundra. Concurrent records of climatic variables in these habitats could make important contributions to other studies in the RNA and provide data from an area not adequately represented by existing weather stations.

The geologic-geomorphic factors responsible for the origin, movement, and growth of the earthslide need to be identified. The slide provides an opportunity for studying succession and forest development along with monitoring of periodic land movements, erosion, and deposition events. Additional detailed study of the diverse bedrock units in the area will improve understanding of the geologic history of east-central Alaska.

The tree-line transect and permanent forest plots are available for periodic remeasurement. Updating the forest plots every 5 or 10 years will reveal tree growth and mortality. Mature white spruce forests along Beaver Creek are subject to losses by fire, insects, and river erosion. When these unpredictable disturbance events occur in the RNA, comparative studies with predisturbance data will be possible. Predictions of global warming make the treeline transects valuable for documenting forest advance or retreat. Serpentine Slide is a good location for studies of forest raptors and a good base for studying soaring raptors, such as eagles and the peregrine falcon.

Maps and Aerial Photographs

Serpentine Slide is on the Livengood C-1 and C-2 U.S. Geological Survey topographic quadrangle maps (Livengood C-1, Livengood C-2). Chapman and others (1971) provide a preliminary geologic map of the region that includes Serpentine Slide at 1:250,000 scale. Weber and others (1988) include a 1:63,000 scale updated geologic map of the WMNRA including Serpentine Slide. The most recent controlled vertical air photo coverage of the area (project 03012 ALK 60) is 1981 color infrared photography at a contact scale of about 1:63,000. Air photo frames 3523, 3524, and 3525 provide stereo coverage of the RNA. The 1951 black-and-white aerial photographs (at about 1:30,000 scale) that were used to prepare the topographic map base are available from archival sources. Color and black-and-white oblique air photos of the RNA taken in June 1982, August 1983, June 1987, and August 1988 are available in the archive file on Serpentine Slide at the University of Alaska Fairbanks. The Steese-White Mountain District Office of the Bureau of Land Management in Fairbanks can provide current information on maps and air photos of the area.

Acknowledgments

I thank the people who helped in the study and documentation of Serpentine Slide Research Natural Area. Dr. Ken Wright provided crucial support and encouragement. John Bacone, Director of the Indiana Division of Nature Preserves, helped to establish the Bluff Flats forest reference plot and photograph the area as a volunteer. Larry Knapman, Fairbanks District Office, Bureau of Land Management, established and measured the tree-line transects. Bruce Durtsche, Steese-White Mountain District Office, Bureau of Land Management, provided logistical support for a site visit. Alan Batten, curatorial assistant, University of Alaska Herbarium, assisted in the identification of plants collected in the area. David Murray, curator, University of Alaska Herbarium, collected and identified plants on serpentinite exposures. Rob Solomon, University of Alaska, provided field assistance in several aspects of site documentation work. Florence Weber and Karen Wheeler, U.S. Geological Survey, provided a preliminary geologic map of the area and helpful advice.

This work was supported by grants to the Agricultural and Forestry Experiment Station, University of Alaska Fairbanks, from the Bureau of Land Management, U.S. Department of the Interior, and the Pacific Northwest Research Station, Forest Service, U.S. Department of Agriculture.

English Equivalents

When you know:	Multiply by:	To find:
Celsius (°C)	1.8 (then add 32)	Fahrenheit (°F)
Centimeters (cm)	0.394	Inches
Grams (g)	0.3527	Ounces
Hectares (ha)	2.471	Acres
Kilometers (km)	0.621	Miles
Meters (m)	3.281	Feet
Millimeters (mm)	0.0394	Inches

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The 1730-hectare Serpentine Slide Research Natural Area (RNA) contains exposures of serpentinite that are toxic to most vegetation; Bupleururn triradiatum is the vascular plant most tolerant of serpentine. A 9-hectare natural earth flow has destroyed most vegetation in its path. The RNA contains 150-year-old flood-plain white spruce forest, shrubland, and open gravel bars; slope forests of white spruce, aspen, and mixed paper birch and white spruce; and treeline and alpine tundra. The area contains several beaver dams, lodges, and ponds that modify the flood plain and provide habitat for waterfowl and shore birds. The flood plain serves as a habitat corridor for grizzly bear and other wildlife. Warm, dry, south-facing bluffs support one of the northern-most known populations of the grass *Agropyron spicatum*.

Keywords: Serpentine, earthflow, grizzly bear, beaver, *Agropyron spicatum*.

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