

NATIONAL PARK SERVICE
ALASKA REGION
ANCHORAGE, ALASKA

1988 BIOLOGICAL INVENTORY - BERING LAND BRIDGE NATIONAL PRESERVE

HARRIS, RICHARD V., Resource Management Specialist; Bering Land Bridge National Park/Preserve, P.O. Box 220, Nome, Alaska 99762-0220.

NATURAL RESOURCES SURVEY AND INVENTORY REPORT
AR-88/16

DECEMBER 1988

Persons intending to cite this material should obtain prior permission from the author(s) and/or the National Park Service, Alaska Region. Because this report deals with preliminary results of a continuing study, conclusions are tentative and should be identified as such. Due credit would be appreciated.

1988 BIOLOGICAL INVENTORY

The Bering Land Bridge National Preserve biological inventory crew spent six weeks in the field in 1988. The crew worked at Lava Lake from June 27 to July 18, at Kuzitrin Lake from July 18 to July 28 and Serpentine Hot Springs from July 29 to August 2.

The crew's core consisted of Renee J. Beymer, Laura Welp and Dr. William E. Ferguson, all of whom remained in the field the entire season. Other members who spent two weeks each were Dr. Marilyn Barker, Stephenie Ferguson and Richard V. Harris.

This report was prepared primarily by Welp and Beymer, with valuable assistance from Drs. Ferguson and Barker. Ferguson prepared most of the bird and many of the animal observation sections, while Barker provided the data calculations in draft form for the Lava Lake airstrip and Kuzitrin Lake.

LAVA LAKE

The study team camped on the grassy margin of a cove in the southeast corner of Section 8 for a period of three weeks. Studies were conducted there and eastward in Sections 9 and 10 and in the next tier of sections south (15, 16 and 17). (See Map 2.)

FIELD STUDIES:

1. Made a synoptic collection of plants in the area in order to determine the species present.
2. Established permanent vegetation plots and collected baseline data for comparison with future collections there.
3. Sampled the populations of small mammals and fish in order to determine which species occupy the study area.
4. Made continuous visual observations to determine presence and activities of larger mammals and birds.
5. Examined remnants of the World War II weather station in Section 10, in order to make recommendations for removal or preservation of certain remnants.
6. Examined vegetation transects at the abandoned World War II airstrip in Sections 10 and 15, in order to document the nature of the vegetative recovery since the 1940s.
7. Considered possible visitor uses of the study area and estimated the importance of visitor impact on the flora and fauna.
8. Developed ideas for future studies that will provide a more complete understanding of the area.

RESULTS:

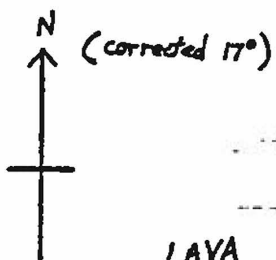
1. PLANT COLLECTION: Appendix D.
2. PERMANENT VEGETATION PLOTS.

METHODS: Three permanent vegetation plots, each containing two 25-meter transects, were established on the hillside above the southeast corner of the lake (Map 1). The plots are oriented roughly northeast-southwest along the hillside at approximately the same elevation and slope. Each is 25 meters long and 15 meters wide and marked by brass caps at three corners (excluding the southwest corner) which protrude 1-2 feet above the vegetation surface. These caps are labeled NW1, NE1, SE1 for Plot 1; NW2, NE2, SE2 for Plot 2; NW3, NE3, SE3 for Plot 3. Each southwest corner and all ends of the transects were marked with shorter aluminum nails which are not necessarily permanent or easily found.

Two transects were run lengthwise across the plots, at the 5- and 10-meter marks. (Caprio, 1981.)

Ten subplots were measured per transect (20 per plot). A Daubenmire frame was placed next to the tape measure every 2.5 meters (on the southwest side of each such point). Vegetation within each subplot was analyzed for percent of cover using the six Daubenmire categories.

Data calculations were made by the Daubenmire method (see



LAVA LAKE

2 halves of barrel

lake edge

willows

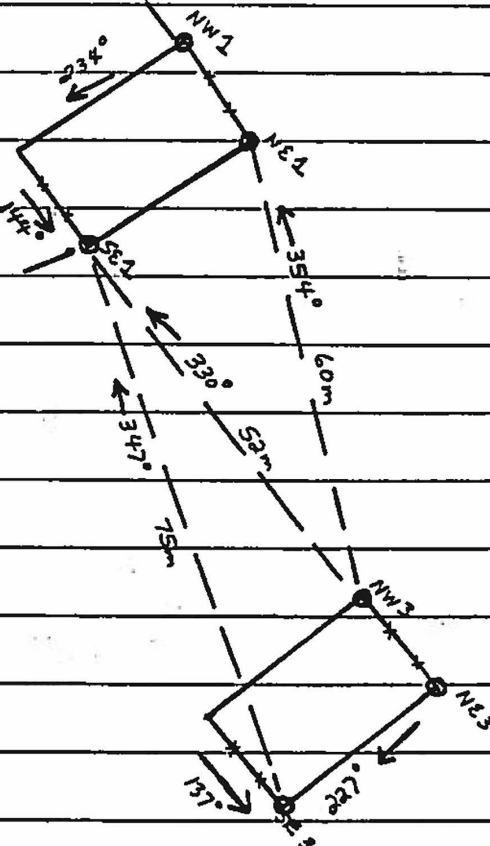
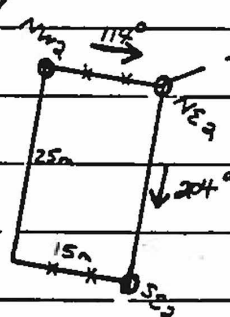
edge of hill

minor drain

Swimming / plane landing area

marsh

to camp



Permanent Vegetation Plots

July, 1988

LAVA LAKE

BE LA

Appendix A). This method seemed to overestimate the cover values for rare species. (A species that appeared only once in 20 subplots automatically had a minimum cover value of 2.5 percent.)

Cover values were calculated for all species found in the subplots using the Daubenmire method. Frequency is calculated by dividing the number of subplots in which a species occurs by the total number of subplots and multiplying by 100 percent. Importance value (IV) is the square root of frequency multiplied by cover. The same data were calculated for vascular plants, as well as for four cryptogamic plant categories: lichens, total mosses, Sphagnum mosses and other mosses.

Other measurements taken included percentage of tussock and non-tussock within the plots, tussock area and height and height of vascular plants within plots. Photographs were taken of the plots as described in Caprio: looking north along each transect and looking down onto the Daubenmire frame placed on the southwest edge of the 1- and 2-meter marks (55-mm macro lens, Kodachrome slides).

RESULTS: The overall data, averaging all three plots, describes the site as co-dominated by Carex Bigelowii and Ledum palustre, with Vaccinium vitis-idaea also important. Others with relatively high importance values (IV) are Betula nana, lichens and total mosses. According to Alaska vegetation classifications (Viereck et al., 1982), the site most nearly matches the tussock tundra association of C. Bigelowii-B. nana-Salix planifolia-L. palustre-Vaccinium spp.

All three plots show the same five dominants, but Plot 2 is different in some respects. Plot 2 has about 70 percent as much total cover as either Plot 1 or 3. Compared with the other two, it also has about 50 percent of the V. vitis-idaea and B. nana cover, 60 percent of the lichen cover, 50 percent of the woody plant cover and 65 percent of the graminoid plant cover. It also has taller sedges and 1.4 times the amount of tussocks of the other two plots. This could be due to the fact that Plot 2 is slightly lower on the hillside than the other two plots, possibly with a bit more slope and closer to a small drainage.

3. SMALL MAMMAL LIVE-TRAPPING AND FISH TRAPPING.

VOLES. Tundra red-backed voles (Clethrionomys rutilus) and tundra voles (Microtus oeconomus) are by far the dominant small mammals, with clear separation of the habitats that each species occupies. Tundra red-backed voles occupy the tussock tundra whereas tundra voles occupy the lower, wetter areas of sedges and grasses which at times have standing water between the plants. Tundra voles were especially abundant and frequently seen scurrying through grass in camp. (See Appendix E for animal specimens.)

Lemmings were not found in our traps although Lava Lake is within the known range of both species. Either our trapping methods are inappropriate for those species, or we did not find their habitats, or their population levels are too low for them to appear in our samples.

MUSKRATS. Muskrats are specifically mentioned in the literature (Hall, 1981:827) as occurring at Lava Lake. The

campsite is located at a muskrat pond where the animals' activities were observed daily in the pond and along the lake margin. One animal was captured in a live trap, photographed and released. At least one pair of adults reared four or more young to 8-10 inches in total length before observations ended. A second bank nest in the same pond is used by muskrat adults that seem to be somewhat smaller. These may be young of the previous year or even the same animals which bore young this year.

FISH. At least a dozen Alaska blackfish (Dallia pectoralis, Appendix E) were seen floating dead in Wind Drift Cove. Upon dissection, they were shown to be infested with parasites, although cause of death is unknown. One of the specimens also was live-trapped near camp. Two nine-spined sticklebacks (Pungitius pungitius) were captured live.

OTHER SMALL- AND MEDIUM-SIZED MAMMALS. Five live-traps, large enough to have caught squirrels, hares and foxes, did not yield any animals. Neither were these animals seen at Lava Lake during the entire three weeks. However, a few feces of hares, and possibly foxes, were found.

4. BIRD AND MAMMAL OBSERVATIONS

THE CAMP AREA. Most observations were made in the camp area during our daily activities there. It is an area of marsh grasses and sedges, backed on the west side by an old lava flow. The prevailing north wind piles wind-drift vegetation on shore in Wind Drift Cove, thus enabling the marsh to slowly invade the lake. Because of the rich organic material along the shore, it is a very important place for shorebirds to feed. Largest in number were western sandpipers and red-necked phalaropes, which nested there and escorted their feeding young along the lake margin and among the grasses and sedges. Golden plovers fed in the same area every day but seemed to fly in from other areas and apparently did not raise young there. Snipe (perhaps 2 to 4 pairs) were constant occupants of the marsh. Larger birds flew from the Peninsula to feed, especially when the prevailing north wind was blowing strongly and bringing the most food into Wind Drift Cove. These included mostly mew gulls, a few glaucous-winged gulls and a few arctic terns. The gulls frequently appeared to feed on dead blackfish that washed ashore. Because of the well-worn trails created through vegetation in the camp, yellow wagtails found the area attractive for walking around and feeding. In summary, the Camp Area is a very important part of the lake in which some species of birds nest and feed. It is also a very fragile environment and therefore would be subject to destruction by trampling if visitors were allowed uncontrolled use.

THE PENINSULA. This is a linear, blocky lava flow with tundra overgrowth on the basal two-thirds. The distal one-third is lower, with increasing water between the rocks. The two arms at the tip are more or less isolated by water. Mew gulls, glaucous-winged gulls and arctic terns spend much of their time in that area and strongly harass a person on foot, thus suggesting that those birds nest at the peninsula's double tip. About 16 birds of those species rose out of the area at one time

to harass a passing golden eagle. One black turnstone and one semipalmated plover were seen on The Peninsula on our one excursion there.

THE LAKE SURFACE. Throughout the three-week study period, a pair of yellow-billed loons and a pair of red-necked grebes brought their chicks to feed in the relatively shallow southeast section of Lava Lake. During the day they remained several hundred yards from camp, but at night, when people were not active, they fed much closer to camp. At least one pair of tundra swans also nested at Lava Lake. Daily they swam with their cygnets in the area bounded by The Peninsula, the north shore and Weather Station Cove.

LAVA SOUTHWEST OF CAMP: The lava is covered with lichens of many species and many of the tussock tundra plants, which grow in cracks and low places. This area was favored by redpolls which fed in small flocks on seed-bearing catkins of the two Betula species. Mosquitoes and other small insects seemed to be preferred by passerines which fed here commonly: wheatear adults accompanied by juveniles, white-crowned sparrows, American tree sparrows and one fox sparrow with young.

Fissures in the lava near the lake, between camp and the monument BELA 85-050, contain the remains of at least six reindeer. Perhaps these deaths occur in winter, when snow bridges over the fissures so that the animals cannot see them. With one or two legs in a fissure it is more likely that an animal would fall in than extricate itself.

DEPRESSION LAKE: This small lake, with about 2 acres of surface area, is surrounded by numerous small ponds. Shoreline vegetation is favored by grazing geese. Greater white-fronted geese with goslings were found, but the lake shore appeared to have been used very heavily at an earlier time by large numbers of Canada geese. Semipalmated plovers and curlews or dowitchers also were found feeding here. Thus, this small lake had a quite different avifauna than the area studied on Lava Lake, only a mile away.

5. **THE WEATHER STATION REMAINS:** Approximately 200 rusty 55-gallon fuel drums remain at the site and others litter the lake margin. Other metallic and wooden remnants are scattered about, more or less buried in the tundra vegetation. The skeletal frame of the storehouse-kitchen and its contents, together with the small one-room shack might be left as suitable relics. One or two bare 1/8-inch copper power wires extend from the station to the cove. They are buried in tundra vegetation most of the way, and present some hazard to people and wildlife.

6. **OLD ARMY AIRSTRIP:** Oriented along a north-south line, the airstrip was cleared and used during World War II. A berm of dry, peaty soil remains along the west side. The berm is well defined at the south end, but is about half as high and less well defined at the north end.

The flat top of the berm differs from the edges sloping into the airstrip. The top is dominated by B. nana and Rubus chamaemorus, while on the lower parts of the berm there are large

mats of V. vitis-idaea mixed with R. chamaemorus.

The airstrip itself is a much lower, wetter section, with a bog and small pond at the south end containing aquatic mosses, Sphagnum squarrosum and Eriophorum angustifolium. Farther north on the airstrip proper, cotton-grass species predominate, mixed with mosses such as Sphagnum spp., Aulacomnium sp. and Polytrichum juniperinum.

In the entire area, herbaceous plants are missing except for an occasional Epilobium angustifolium.

The transects here represented a good opportunity to document the recovery of vegetation after a known date of disturbance, 46 years ago.

METHODS: Daubenmire transects were run across the airstrip from west to east. During data analysis, individual plots were separated and categorized into tussock plots, wet plots or berm plots. Transects also were run down the top of the berm and called disturbed berm in order to differentiate it from the more lush sloping berm sides. A control transect also was run in the adjacent tundra outside the airstrip.

Heights of the plants and depth to permafrost (active layer) were also measured on all transects.

RESULTS:

Plant height was directly correlated with permafrost depth and amount of disturbance (Appendix B). The control plots, with the least disturbance, had the shallowest permafrost and the shortest plants (of the same species) of all plots, while the berm, with the most disturbance, had the deepest permafrost and tallest plants. The tussock plots within the airstrip were intermediate in both measurements. Plant heights were not measured for the wet area, but it did have a permafrost layer slightly deeper than the airstrip tussock plots.

CONTROL PLOTS: Of predominant importance in the control plots was cryptogamic cover, especially lichens. L. palustre dominated among the vascular plants, and C. Bigelowii and Eriophorum vaginatum were closer to being co-dominant tussock formers (compared with the C. Bigelowii-dominated tussocks in the permanent plots nearer the lake). V. vitis-idaea and B. nana were also important members of this community.

TUSOCK PLOTS: These plots inside the airstrip showed a very different community from the control. It is strongly dominated by E. vaginatum, to the almost total exclusion of Carex species. The other important species in these plots were B. nana and L. palustre, as well as V. vitis-idaea. Total cover within the airstrip was lower, only 85 percent of the control. While lichens were the most important plants on the control (75.2), their importance value dropped to 19.1 inside the airstrip. Mosses moved up in importance value from 18.7 on the control to 31.0 inside the airstrip. Both the control and the airstrip tussock plots fall into the classification of mesic graminoid herbaceous, tussock tundra (Viereck et al., 1982).

WET AIRSTRIP PLOTS: The wet plots inside the airstrip were dominated by mosses, and no lichens were present at all. Total cover was somewhat lower than in the airstrip tussock plots. Among the vasculars, sedges dominated, especially E.

angustifolium, Carex aquatilis and E. russeolum. This community would be classified as wet graminoid herbaceous, wet sedge meadow tundra.

BERM PLOTS: The sloping edges of the berms were different enough to be classified as open low shrub scrub, birch and ericaceous shrub tundra. They were dominated by B. nana, V. vitis-idaea and L. palustre. Mosses and lichens were relatively unimportant. This area had the highest total cover of all the plots inside the airstrip (still slightly lower than the control plot).

DISTURBED BERM PLOTS: The top of the berm is experiencing the slowest recovery of all, with a mere 87 percent total cover. Dry, exposed peat was present in 100 percent of the plots, as were R. chamaemorus and V. vitis-idaea. The most important plant present was B. nana, followed by R. chamaemorus and V. vitis-idaea. There were far fewer species present and mosses were absent. This community, dominated by obvious colonizers, doesn't fit well into any of the vegetation classifications.

7. VISITOR USES AT LAVA LAKE

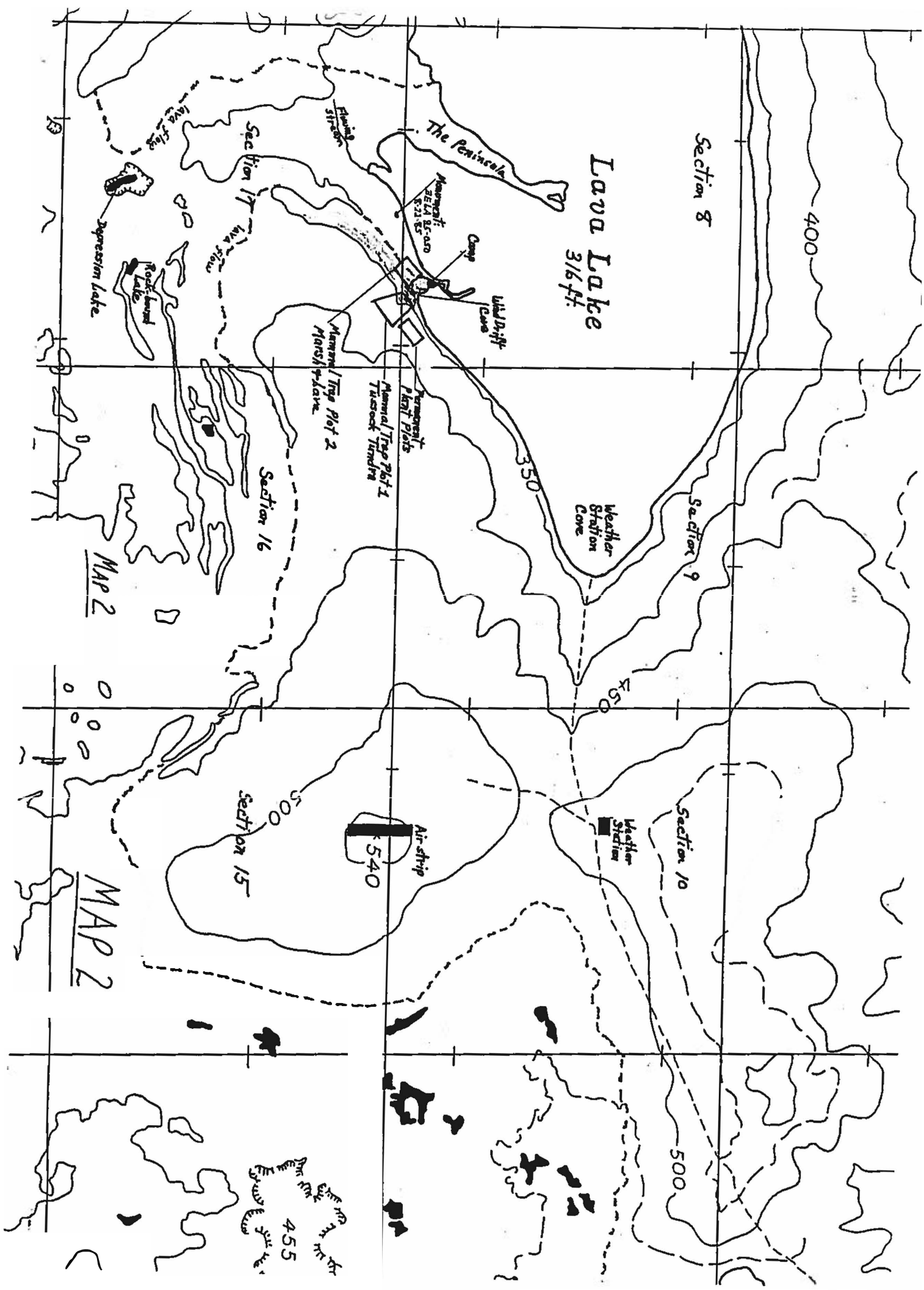
The marshy camp area and old lava southwest of camp are two areas very sensitive to human impact. The grass and sedge marshes are important breeding and feeding areas for muskrats and birds. Trampling of the marsh from year to year would gradually destroy the marsh plants which are so important as "cover" for nesting birds and their defenseless young. Furthermore, the bank nests and chambers of the muskrats can be easily broken into by foot traffic. This kind of habitat is very limited around the lake and it therefore is not an area which plane loads of visitors should use.

The old lava southwest of camp is covered more or less densely by many species of lichens. In dry weather, the lichens are very brittle and crumble under foot, thus severely damaging the fragile lichens. Some consideration should also be given to the hazards to humans posed by the many lava fissures and collapse holes from which a lone person could not climb out.

Weather Station Cove, with little improvement, is a place where float planes could be docked for exploration of the weather station remnants and the edge of the lava field beyond. The old airstrip would not be of interest to most visitors.

8. FUTURE STUDIES

In view of our findings at the small, shallow Depression Lake, in Section 17, other small lakes should be investigated for their importance as breeding places for shorebirds and waterfowl. Such lakes are present in Sections 18, 19, 20, 28, 29 and 30.



KUZITRIN LAKE

The study team camped on a narrow sand beach on the south edge of the lake for 10 days. Studies were conducted mostly between there and the summit of Mt. Boyan in the Bendeleben Mountains to the south (Map 3.) Brief hikes were also made along the north and east lakeshores.

FIELD STUDIES:

1. Made a collection of plants in the area.
2. Executed Daubenmire vegetation plots in the area of mammal traps for documentation of habitat.
3. Sampled the populations of small mammals.
4. Made continuous visual observations to determine presence and activities of larger mammals, fish and birds.
5. Broadly described vegetation types from 442 to 920 m. elevation.
6. Noted other past human uses, including an archeological site and more recent garbage.
7. Considered possible visitor uses of the study area and estimated the importance of visitor impact on the flora and fauna.
8. Developed ideas for future studies that will provide a more complete understanding of the area.

RESULTS:

1. PLANT COLLECTION: Appendix D.
2. VEGETATION TRANSECTS:

Two 60-plot Daubenmire transects were run adjacent to the small mammal trap plot. The first transect, Kuzitrin I, was in the open low shrub tundra near the east end of the mammal plot, while the other, Kuzitrin II, bordered the west edge in the wet sedge meadow. Cover, frequency and importance values were calculated by the same methods as for the transects at Lava Lake.

Kuzitrin I, the drier tundra, had more than 1.5 times the total cover of the wetter Kuzitrin II (Appendix C). Kuzitrin I was dominated by Carex Bigelowii, lichens and mosses, all with 100 percent frequencies and high importance values. Vaccinium uliginosum was also important, with a higher importance value than for any transect all summer. The almost total lack of Ledum palustre and greatly reduced dominance of Vaccinium vitis-idaea were the greatest differences between this transect and those from the tussock tundra areas of Lava Lake and the army airstrip. This area, while slightly raised above Kuzitrin II, is still wetter than Lava Lake because of the constant snowmelt from Mt. Boyan. It fits most closely into the mesic graminoid herbaceous, sedge-willow tundra classification.

Kuzitrin II was dominated by Carex aquatilis and mosses, with almost no lichen present. Other important species were Carex membranacea, Salix hastata and Eriophorum angustifolium. It fits into the wet graminoid herbaceous, wet sedge meadow tundra classification category.

3. SMALL MAMMAL SAMPLING:

METHODS: Forty-nine Sherman live traps were set out in a square grid (seven by seven traps) that encompassed approximately four different habitats: Closed Salix scrub, open low shrub tundra, wet sedge meadow and the interfaces between each type. Most traps were baited with oatmeal. However, 11 trap sites were set with two traps side by side, one baited with oatmeal, the other with peanut butter, to determine if there were any differences in capture success between bait types. Oatmeal is the preferred bait in terms of portability and ease of cleaning and baiting traps. Also, oatmeal is probably less attractive to bears.

Cone traps were not put in place due to the prohibitively wet soil and shallow rocks. The cones filled with water upon insertion into the ground.

Larger mammal traps were set at entrances to burrows found in sand and loose gravel near streams. Burrows of this type, about 8-10 cm. in diameter, were also abundant at higher elevations in the rocks and gravel.

RESULTS: The resulting sample size was small. Only five rodents were captured in the Sherman traps, all with oatmeal. The weather was cold, rainy and windy for four of the seven days of the sampling period, which may have reduced small mammal activity. Also, traps were closed during part of that time to reduce hypothermia-induced mortality. Signs of their presence (e.g., scat, burrows, runways) were few; perhaps it simply was not favorable habitat.

No ground squirrels or other large mammals were caught in the larger traps. The abundance of medium-sized burrows at slightly higher elevations on the north-facing slope of Mt. Boyan suggests that good habitat is available, but only one arctic ground squirrel was actually seen in the dirt cliffs above the large stream about one mile east of camp.

4. OTHER MAMMALS, FISH AND BIRDS

Observations at this locality cannot be compared directly to those at Lava Lake because of the following factors: they cover only about 4-1/2 days of productive field study because of time lost to stormy weather, the altitude was about 300 meters higher, the bird nesting period had ended and most of the migratory birds probably had already left this area.

BEARS: A sow and two cubs of the year were observed on a reindeer kill on the lakeshore about 2 miles west of camp. They were in the same vicinity the next day, but then not observed again until four days later when they were seen about a quarter mile east of camp. Their footprints were discovered on the beach heading west almost into camp, but the bears apparently turned around abruptly just before coming into the kitchen area. The presence of people and unfamiliar equipment possibly were a deterrent to contact, particularly since the sow had two cubs to protect and bears are actively hunted on the peninsula. There is a grayling stream on either side of camp that may have been an attraction.

REINDEER: A large herd, estimated at 300 individuals, was seen twice on the slopes south of camp and once on the west end of the lake. Reindeer sign (scat, tracks, skeletons, hair) has been observed throughout the study area from the lakeshore to the rocky higher elevations. Much of the tundra in the vicinity, particularly the first 50 meters from the shore, has been badly trampled. It was difficult to assess relative impact without more data, but evidently this area is important to them. One of the Daubenmire plots by the mammal traps had a lichen cover of about 70 percent (high in Cladonia spp.), which is a high percentage of reindeer browse.

FOX: A den with several entrances, mostly 15-20 cm. in diameter, was observed at 610 meters elevation. The remains of a ptarmigan were close by. Although no foxes were seen during the study period, their presence was considered a likely possibility.

FISH: Arctic graylings schooled and fed beneath the stream riffles in the lake and were not seen elsewhere. Four arctic graylings, ranging from 29.0 to 43.0 cm. in length, were caught in streams on either side of camp. Insects comprised most of the stomach contents, although two slimy sculpins and some small crustaceans also were noted. Sculpins may be the essential food items during winter, when insects are not available. All of the fish were infested with tapeworms.

Two slimy sculpins (Cottus cognatus, Appendix E) also were caught in minnow traps just outside the outlet of the grayling stream west of camp. The traps were set in water 1 meter deep. The substrate was fairly sedimented with pebbles and cobbles of 5-6 cm. in diameter. The slope was very gradual.

BIRDS: CAMP AREA: The southern shore of the lake appears to be a very important "staging area" for Canada geese and perhaps other species of geese. Immediately behind the sandy beach of the southern shore is a muddy substrate from a few feet in width to more than 100 meters. This is variously vegetated with mosses and low, separated willow bushes, but extensive areas lack vegetation. We could not agree whether the bare mud exposure was caused by reindeer trampling over the years, goose grazing and trampling, physical factors or combinations of these factors. Millions of goose footprints covered the muddy areas and all the grasses had been eaten to the point of preventing their identification. Also, there were abundant molted feathers and fecal deposits. No old nests were found, so the area may have been used only for feeding and resting, a "staging area" as applied to migratory waterfowl. Adults were absent from the southern shore during our stay, probably because of our presence, but large groups (more than 100 birds together) were seen with the aid of binoculars or spotting scope, on sandy beaches of the north, east and west shores, and in the middle of the lake at sunrise. No goslings were seen.

At the time of our study, the camp area apparently was used by only one "resident" pair of arctic terns. Their two flightless chicks were found on the long sand spit west of camp. The spit and adjacent sandy shores are ideal as tern nest sites and may have been used earlier by other pairs. Since nests are not built, no evidence remained. The adults foraged most

frequently in the small, shallow streams flowing from Mt. Boyan, near their mouths at the lake, as well as in the shallow water along the lake shore. The braided stream at camp was only a few centimeters deep and had a gradient without placid water. Nevertheless, the terns hovered above it many times per day and successfully caught fish, presumably usually slimy sculpins. The next two streams north of camp had placid shallows. The terns foraged there most of the time, perhaps catching small graylings as well as slimy sculpins. Winds sweeping the area make it possible for the terns to hover almost effortlessly while watching for prey.

Western sandpipers were the most common birds of the narrow, wet, sandy beach, where they could forage in the sparse wind drift. A few rock sandpipers and lesser golden plovers fed there daily, too. The latter were in mid-molt, so it was not possible to identify them to species. Water pipits sometimes foraged on the sandy beach and margin of the stream, but more often they foraged loosely, with Lapland longspur females and immatures among the dwarfed, scattered willows around camp. At Kuzitrin Lake, water pipits completely took the place of the closely related yellow wagtails, which were common at Lava Lake. In spite of the size of this lake, gulls were far less frequently seen.

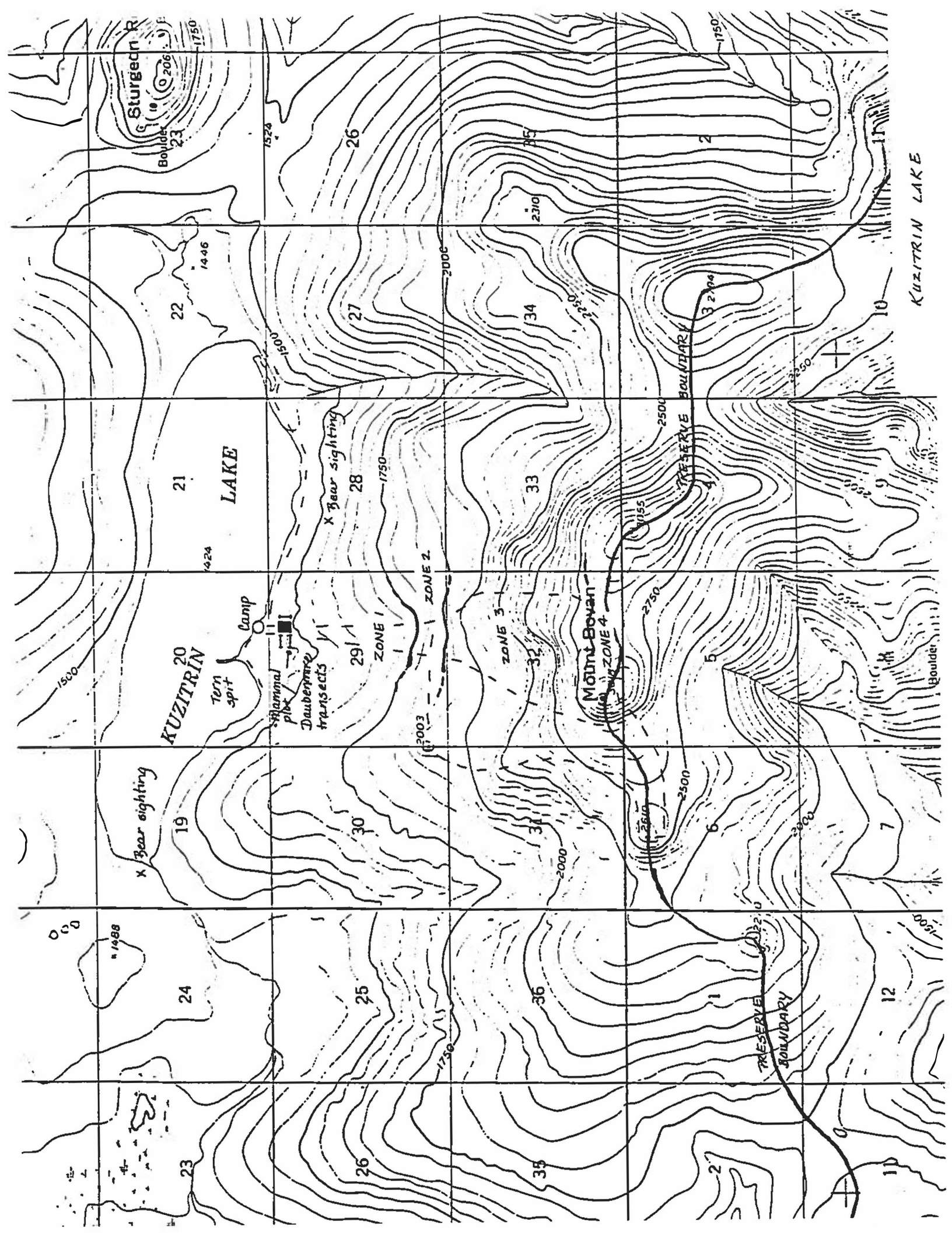
THE LAKE SURFACE: Canada geese occasionally were seen at sunrise in small to very large flocks in mid-lake. A red-throated loon, a yellow-billed loon and a common loon each was seen. Oldsquaws and pintails were seen on the lake or occasionally flying low. A pair of greater scaups were also observed east of camp in a large pond sometimes completely separated from the lake by a sandbar.

STREAM MOUTH ONE MILE EAST OF CAMP: This stream from the northeast slope of Mt. Boyan is the only one shown on the topographic map. It meanders through a shallow canyon before entering the lake and provides a greater extent and variety of shelter and feeding habitats than streams near camp. This interesting site was discovered too late for detailed study, but the following birds were seen there in passing one day: western sandpiper, rock sandpiper and short-eared owl.

NORTH-FACING SLOPE OF MT. BOYAN: The drier tundra slopes, which started about 100 meters inland from camp, seemed to be the preferred habitats of lesser golden plovers and Lapland longspurs. Small, mobil flocks of redpolls commonly fed in the low birches. Extensive sedge marsh slopes, above the drier tundra, still were very wet and occupied by snipes. On one careful observation of the large snow field and its surroundings beneath the rocky peak, rosy finches could not be found. Water pipits, wheatears and Lapland longspurs were common on the rocky tundra slopes beneath the snow field.

5. VEGETATION TYPES: Although much of the area from lakeside to the summit of Mt. Boyan was a mosaic of several community types, four major zones reflect generalized changes in the vegetation with increased altitude.

Moisture availability was an important variable in



determining community types. The plant associations in wet areas at higher elevations were often similar to those at lower elevations.

General description of community types:

Zone 1: 442-533 m.

Open low shrub scrub alternating with wet to mesic graminoid herbaceous.

Mosaic of a Salix/Betula/Vaccinium association and a Salix/Carex association with Sphagnum moss underlying both. Salix planifolia seems to be the dominant species. Several species of herbaceous plants are also present, as well as Salix chamissonis, which was not as abundant at higher elevations and not noted at any other study site. Large hummocks occur in the lower part of the zone; large boulders, covered by vegetation near the lake, begin to crop out at the upper limit of the zone in the thinner soil.

Zone 2: 533-579 m.

Open low shrub scrub (Betula) and mesic graminoid herbaceous alternating with open low shrub scrub (Salix) and wet graminoid herbaceous.

The Betula/Vaccinium uliginosum/Eriophorum association occurs in the drier areas among boulder patches. Cassiope tetragona and the lichen Cladonia appear frequently. In wetter areas, S. planifolia is the dominant species and is associated with Carex Bigelowii. There are also more herbaceous species in these areas.

Zone 3: 579-854 m.

Mesic to wet graminoid herbaceous and open low shrub scrub.

Betula, Carex and V. uliginosum are dominants, but Dryas mats, C. tetragona, Arctostaphylos alpina and Empetrum all increase in frequency at the upper part of the zone. There are also more lichens and exposed boulder fields. S. planifolia and Carex are dominant in the wetter places.

Solifluction lobes have formed between these elevations. The terraces alternate with moderately steep slopes; decumbent Salix shrubs and herbaceous species are more prominent at the junction of the terraces and the slopes, where it is wetter.

Zone 4: 854-920 m.

Open dwarf shrub and graminoid herbaceous.

Graminoid species dominate at these elevations, especially C. microchaetae. There is not a dramatic change in species composition but the dominant shrubs (S. phlebophylla and C. tetragona) and lichens are denser while forbs have dropped out. Vaccinium vitis-idaea, Betula, Ledum and Empetrum also occur less often than at lower altitudes. The area is dry, rocky and exposed.

Potentilla elegans is growing on the open, dry, rocky saddle between Mt. Boyan and a subsidiary peak to the southwest. Two of the 25 plants in the population were still reproductive. Several

seedlings were also evident. Associated species include S. phlebophylla, Luzula and the lichen Cladonia. Two other colonies were seen in the vicinity, one of about six plants at the edge of a frost boil, and the other at the base of a rock slope in undisturbed soil.

6. OTHER HUMAN USES

There is a circular ruin of rocks on the peak halfway up Mt. Boyan at about 610 meters elevation.

More recent human use is evident by the Blazo cans, bits of cloth, rusted iron and old wooden tent stakes along the beach. The three Blazo cans at the east end of the lake (where the stream feeds the lake) appeared to have liquid contents. All the other trash noted was along the south shore.

7. VISITOR USE

RECREATIONAL POTENTIAL: Summer access to Kuzitrin Lake is by float plane. In terms of convenience and low impact, camping is best along the beach. Additionally, the lake itself provides opportunities for birding, hiking along the shore and kayaking or canoeing. Grayling are abundant in two of the streams on the south side of the lake, and possibly in other streams elsewhere that were not explored.

Hiking offers opportunities farther away from the lake. Interesting destinations within a reasonable distance include Sturgeon Ridge, the Twin Calderas, Mt. Boyan and the rest of the Bendeleben range to the south. It is necessary to walk through shrub tundra at the lower elevations, but it is not extensive. Views of the Bendelebens, Imuruk Lake, Kuzitrin River and the reaches beyond are seen from the peaks within a few miles of the lake.

POTENTIAL IMPACTS: Further damage to the vegetation surrounding the lake would be minimal if camping and other activities were limited to the beach. Hiking should not be a source of concern, assuming that use remains low enough to keep the pressure spread out over a wide area. The same may be true for the fragile vegetation at higher altitudes.

Visitors to Kuzitrin Lake now are few. There are no human impact problems other than the small amount of trash that remains from previous users.

However, any future development of the area would lead to increased use, at which time potential negative effects will need to be assessed. Increased use may disturb nesting birds along the lake, and assessment of impact to the grayling fishery should also be considered.

8. RECOMMENDATIONS FOR FURTHER STUDY: The following studies are suggested to document existing conditions and provide baseline data with which to compare any future changes associated with increased public use.

A. Kuzitrin River Salmon Survey

The river is potential salmon spawning grounds, although local speculation discounts it. A brief aerial survey and/or

some time on the ground near the outlet of the lake would be of use.

B. Vegetation/Small Mammal Survey

The baseline collection and documentation of plants and small mammals should continue in the area. Potential study areas include: large stream canyon one mile east of camp, Mt. Boyan slopes (more study), Sturgeon Ridge, north beach, Twin Calderas, west beach and start of Kuzitrin River.

C. Nesting Bird Survey

Current species and population levels of nesting birds should be documented so that any future change can be measured.

D. Documentation of Vegetation Damage

Extensive areas of tundra near the lakeshore have been trampled by reindeer and possibly geese -- large numbers of both have been seen along the lake. Photos were taken, but further documentation of the impact would help in making range management decisions, especially since little information is currently available on the effects of reindeer on vegetation.

E. Documentation of Grayling Fishery

Population levels should be monitored to prevent possible overfishing.

SERPENTINE HOT SPRINGS

The study team stayed in the bunkhouse until locals arrived to use the hot springs and stay in the facility. Housing was then provided by tents set up along the airstrip.

FIELD STUDIES:

1. Collected plants not previously taken in this area.
2. Live-trapped small mammals in two areas of varying habitat to determine species present and to collect specimens of any species not already in the park small mammal collection.
3. Explored potential walking routes to recommend to visitors, noted potential human impacts and made recommendations.
4. Made continuous visual observations to determine activities and locations of larger mammals and birds, especially nesting raptors.
5. Classified the vegetation into general categories and prepared a map for four square miles (Sections 2, 11, 12 and 14 of quad map Bendeleben D-6) which encompass the main area of actual and potential visitor impact.

RESULTS:

1. PLANT COLLECTION: Appendix D.

2. SMALL MAMMAL SURVEY:

Traps were set where evidence of mammals was seen (scat, runways, burrows) or in other likely looking habitats. No specimens were kept.

Plot 1 was a quarter mile northwest from camp in a streamside meadow with several habitat types:

- sedge field with wet standing water
- moist, flat herbaceous area next to sedges
- Salix shrub around edges of plot

Traps were set in the ecotones along Salix/herbaceous and herbaceous/sedge, as well as in the habitat types themselves.

Plot 2 was along top of the ridge northeast of the bathhouse and included three habitat types:

- moist depression with Salix and graminoids
- tussock tundra
- granite slope, near burrows in rock

All small mammals were voles.

Plot 1: Most (80 percent) of the mammals caught in the riparian plot were tundra voles; only one red-backed vole was captured. Eight juveniles and 12 adults were caught. Animals were trapped along the periphery of the meadow either in the Salix/herbaceous ecotone or in the sedges by stream. None were caught in traps set in the center of the wet sedge marsh.

Plot 2: As expected, more red-backed voles were trapped in the granite and tussock tundra habitats than in the riparian area. However, tundra voles still constituted the majority of the sample size (10 of 16 total animals). Twelve of those caught were juveniles. No animals were caught on the granite slope, although burrows were seen there. Only tundra voles were caught in the traps placed in the depression and only red-backed voles

were caught in the traps placed in the tussock tundra.

3. RECREATION

SERPENTINE VALLEY: The eight-mile walk (Map 5) around the Serpentine Valley is a moderately difficult day hike that provides an opportunity to see the birds, plants, mammals and geology in the Serpentine Hot Springs area. The route begins at the bath house and heads northwest across the creek. It ascends from approximately 122 to 366 meters in elevation over a mile of moist low shrub tundra. This is the longest part of the hike over tussocks. Once at the top of the peak, the route follows the ridgetop for two miles through the granite tors that surround the valley. Walking is not strenuous and the views, especially to the south and west, are superb. The route then descends into the valley again through low shrub tundra. Tussocks can be avoided by staying close to the large granite tor midway down the slope and then hiking straight down from it down into the valley. A small stream must be crossed at this point; both it and the 6-meter strip of Salix on either side of it are easily negotiated.

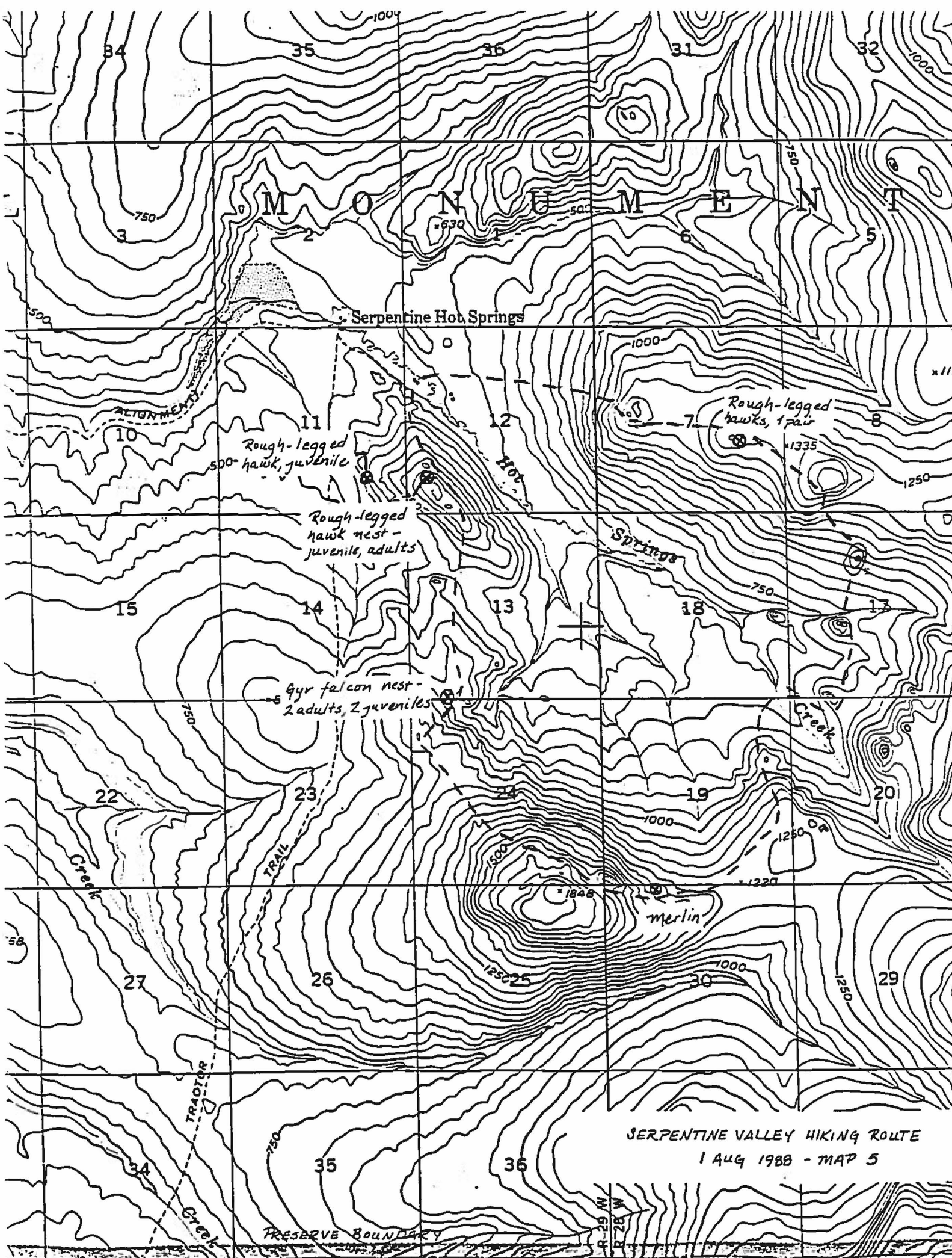
Once across the stream, a wide field of tors extends out over the valley floor. They are quite interesting but not stable, so climbing should be discouraged. The terrain is slightly rolling low shrub tundra. Small streams run through the area but they, and the associated Salix, are minor obstacles.

The route begins to ascend again on the south end of the valley, gaining 61 meters in a quarter mile. It is steep but short. The ridge then continues up more gently through tussocks and boulders. The base of the rock ridge that runs up the mountain provides firmer walking until more altitude is gained and low alpine vegetation reappears near the top the the peak. From here, there is another view of the Serpentine Valley and the ridge of tors to the north. As the route descends from the peak it passes through more tors and alpine vegetation, which remains the dominant plant community for the remainder of the hike. Walking is easy.

The Serpentine Valley hike provides a wide variety of opportunities for natural history observations. Sparrows and other passerine species can be seen in the shrubbier areas and rare raptors often use the tors for perching and nesting. Merlins, gyrfalcons, and rough-legged hawks all have been observed in the area this year. It is also possible to see arctic ground squirrels, moose, fox and bear. Those interested in botany may look for Potentilla elegans, a rare species that grows along the way, as well as other northern Alaska plants.

POTENTIAL HUMAN IMPACT AND RECOMMENDATIONS: The Serpentine Valley is important nesting habitat for raptors. Three species of raptor were seen on the ridgetops during the study period, at least two of which were nesting and/or caring for juveniles (see map for location of gyrfalcon and rough-legged hawk nests). Reports from other years also report nesting gyrfalcons.

Some species and individuals tolerate disturbance more easily than others. Rough-legged hawks, for instance, start calling at people as far away as a half mile. The gyrfalcons and their two young, in contrast, were approached to within a few



SERPENTINE VALLEY HIKING ROUTE
1 AUG 1988 - MAP 5

PRESERVE BOUNDARY

hundred feet before making any alarm response.

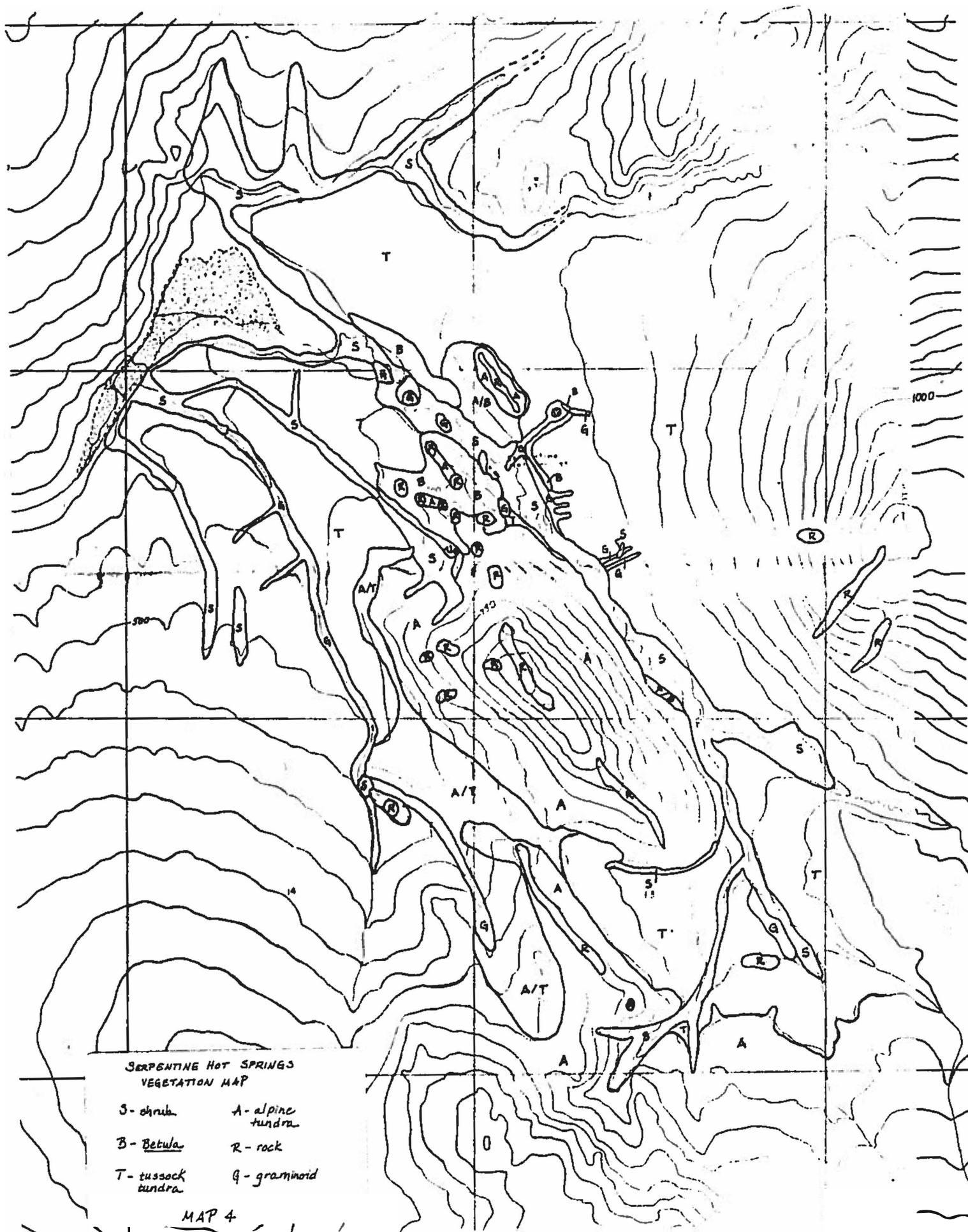
If the above hiking route is recommended to visitors, or if visitor activity appears to be increasing, nesting activity and response of raptors to disturbance should be closely scrutinized. There are not many alternate nesting habitats in this area. Possible courses of action include recording current use levels up on the tors and current raptor activity; e.g., locating nests within the areas most likely to be travelled and recording hikers in the area during peak nesting activity.

4. OTHER ANIMALS: Several moose were seen during our stay at Serpentine. A large bull moose was grazing in the willows upstream from the hot springs for several days. One cow with two calves and a cow with three calves were seen on separate occasions. (See also Section 3, paragraph 4, and Appendix F, OTHER ANIMALS OBSERVED.)

5. VEGETATION MAPPING: Map 4.
A brief explanation of the six general categories used to type vegetation follows:

S - shrub	Indicates a mosaic of predominately <u>Betula</u> and <u>Salix</u> bushes. Seen primarily in water drainages.
B - <u>Betula</u>	Distinguishes those areas of <u>Betula</u> not mixed with <u>Salix</u> ; usually higher, drier slopes.
T - tussock tundra	Broadly defines a large part of the study area, which is characterized predominantly by graminoid herbaceous species. Low shrub scrub is often associated with this type. Further specificity was not possible at this time.
A - alpine tundra	Refers to a generalized type of dwarf scrub shrub (e.g., <u>Arctostaphylos</u> , <u>Dryas</u> , <u>Cassiope</u> , <u>Empetrum</u>) and herbaceous species, with a high frequency of lichens and graminoids. These areas also have dry, rocky soil.
R - rock	Delineates the large boulders and spires found on the ridge tops, as well as the expanses of gravel between them.
G - graminoid	Defined by the mixed sedge and grass association found in the lower, wetter areas.

Areas intermediate between categories are also indicated on the map; e.g., A/T refers to a mosaic of alpine and tussock tundra.



BIBLIOGRAPHY

Caprio, Anthony C. Fire Ecology Sampling Methods, Prairies and Pinelands. Nov., 1981.

Hall, E. Raymond. The Mammals of North America, Vol. II. 1981.
John Wiley & Sons, New York.

Viereck, L.A., C.T. Dyrness and A.R. Batten. 1982 Revision of Preliminary Classification for Vegetation of Alaska. May, 1982.

APPENDIX A
Lava Lake Permanent Plots

Entire Site:

Species	% Freq	% Cover	IV
Woody plants		142.1	
Arctostaphylos alpina	13	3.7	6.9
Betula nana	82	32.3	51.5
Empetrum nigrum	62	8.2	22.5
Ledum palustre	100	42.3	65.0
Rubus chamaemorus	68	5.8	19.9
Vaccinium uliginosum	52	8.8	21.4
Vaccinium vitis-idaea	100	32.7	57.2
Salix planifolia	13	5.0	8.1
Petasites frigidum	17	3.3	7.5
Graminoid plants		65.1	
Carex Bigelowii	95	46.1	66.2
Eriophorum vaginatum	38	13.2	22.4
Arctagrostis latifolia	5	3.3	4.1
Other grasses	12	2.5	5.5
Cryptogamic plants		70.6	
Lichens	93	34.8	56.9
Total mosses	93	35.8	57.8
Sphagnum sp.	67	27.4	42.8
Other mosses	78	8.4	25.6
TOTAL COVER =		277.8	

Number of subplots analyzed: 60

APPENDIX A, continued

Plot LL1

Species	% Freq	% Cover	IV
Woody plants		165.4	
Arctostaphylos alpina	0	2.5	0
Betula nana	90	35.9	56.8
Empetrum nigrum	60	10.4	25.0
Ledum palustre	100	54.8	74.0
Rubus chamaemorus	65	5.6	19.1
Vaccinium uliginosum	50	6.8	18.4
Vaccinium vitis-idaea	100	40.3	63.5
Salix planifolia	15	6.0	9.5
Petasites frigidum	10	3.1	5.6
Graminoid plants		71.6	
Carex Bigelowii	100	52.8	72.7
Eriophorum vaginatum	30	13.8	20.3
Arctagrostis latifolia	0	2.5	0
Other grasses	5	2.5	3.5
Cryptogamic plants		68.9	
Lichens	95	36.4	58.8
Total mosses	90	32.5	54.1
Sphagnum sp.	75	27.5	45.4
Other mosses	70	5.0	18.7
TOTAL COVER =		305.9	

Number of subplots analyzed: 20

APPENDIX A, continued

Plot LL2

Species	% Freq	% Cover	IV
Woody plants		105.7	
Arctostaphylos alpina	35	4.4	12.4
Betula nana	75	20.5	39.2
Empetrum nigrum	60	7.4	21.1
Ledum palustre	100	29.3	54.1
Rubus chamaemorus	70	5.0	18.7
Vaccinium uliginosum	60	9.3	23.6
Vaccinium vitis-idaea	100	20.1	44.8
Salix planifolia	20	6.6	11.5
Petasites frigidum	15	3.1	6.8
Graminoid plants		48.1	
Carex Bigelowii	100	32.1	56.7
Eriophorum vaginatum	55	11.0	24.6
Arctagrostis latifolia	5	2.5	3.5
Other grasses	20	2.5	7.1
Cryptogamic plants		61.3	
Lichens	100	24.6	49.6
Total mosses	95	36.7	59.0
Sphagnum sp.	60	29.8	42.3
Other mosses	70	6.9	22.0
TOTAL COVER =		215.1	

Number of subplots analyzed: 20

APPENDIX A, continued

Plot LL3

Species	% Freq	% Cover	IV
Woody plants		155.6	
Arctostaphylos alpina	5	4.3	4.6
Betula nana	80	40.5	56.9
Empetrum nigrum	65	6.8	21.0
Ledum palustre	100	42.8	65.4
Rubus chamaemorus	70	6.9	22.0
Vaccinium uliginosum	45	10.4	21.6
Vaccinium vitis-idaea	100	37.6	61.3
Salix planifolia	5	2.5	3.5
Petasites frigidum	25	3.8	9.7
Graminoid plants		75.8	
Carex Bigelowii	85	53.5	67.4
Eriophorum vaginatum	30	14.9	21.1
Arctagrostis latifolia	10	4.9	7.0
Other grasses	10	2.5	5.0
Cryptogamic plants		81.8	
Lichens	85	43.4	60.7
Total mosses	95	38.4	60.4
Sphagnum sp.	65	25.0	40.3
Other mosses	95	13.4	35.8
TOTAL COVER =		313.2	

Number of subplots analyzed: 20

APPENDIX A, continued

Plots:

LL1	LL2	LL3	Site Ave.
	Total Cover (average %)		
305.6	215.0	312.9	277.8
	Total Vascular Cover (average %)		
236.7	153.7	231.1	207.2
	<u>Sphagnum</u> sp. Cover		
27.5	29.8	25.0	27.4
	Other moss Cover		
5.0	6.9	13.4	8.4
	Lichen Cover		
36.4	24.6	43.4	34.8
	<u>Eriophorum vaginatum</u> Cover		
13.8	11.0	14.9	13.2
	<u>Carex Bigelowii</u> Cover		
52.8	32.1	53.5	46.1
	<u>Ledum palustre</u> Cover		
54.8	29.3	42.8	42.3
	<u>Vaccinium vitis-idaea</u> Cover		
40.3	20.1	37.6	32.7
	<u>Vaccinium uliginosum</u> Cover		
6.8	9.3	10.4	8.8
	<u>Empetrum nigrum</u> Cover		
10.4	7.4	6.8	8.2
	<u>Betula nana</u> Cover		
35.9	20.5	40.5	32.3
	<u>Rubus chamaemorus</u> Cover		
5.6	5.0	6.9	5.8
	<u>Arctostaphylos alpina</u> Cover		
2.5	4.4	4.3	3.7
	<u>Petasites frigidum</u> Cover		
3.1	3.1	3.8	3.3
	<u>Arctagrostis latifolia</u> Cover		
2.5	4.4	4.3	3.7
	<u>Salix planifolia</u> Cover		
6.0	6.6	2.5	5.0
	Other grass Cover		
2.5	2.5	2.5	2.5
	Amount of Tussock		
41.6	55.5	38.6	45.2

APPENDIX A, continued

Plots:

LL1	LL2	LL3	Site Ave.
	Average Tussock Area (square cm.)		
571.16	619.71	1,158.3	783.1
	Average Tussock Height (cm.)		
	22.7	24.5	23.1
	<u>Eriophorum vaginatum</u> Ave. Height (cm.)		
25.2	29.3	18.9	24.5
	<u>Carex Bigelowii</u> Ave. Height		
29.9	34.5	25.4	29.9
	<u>Ledum palustre</u> Ave. Height		
9.4	13.9	16.1	13.1
	<u>Vaccinium vitis-idaea</u> Ave. Height		
4.3	3.5	N/A	3.9
	<u>Vaccinium uliginosum</u> Ave. Height		
9.4	15.4	16.8	13.9
	<u>Empetrum nigrum</u> Ave. Height		
4.3	5.8	N/A	5.1
	<u>Betula nana</u> Ave. Height		
20.5	27.7	21.5	23.2
	<u>Rubus chamaemorus</u> Ave. Height		
6.9	11.9	7.0	8.6
	<u>Arctostaphylos alpina</u> Ave. Height		
4.3	5.1	N/A	4.7
	<u>Petasites frigidum</u> Ave. Height		
7.9	12.4	8.7	9.7
	<u>Arctagrostis latifolia</u> Ave. Height		
N/A	57.3	54.9	56.1
	<u>Salix planifolia</u> Ave. Height		
36.4	40.7	36.3	37.8

Explanation of Terms:

LL1=Lava Lake Plot 1
 LL2=Lava Lake Plot 2
 LL3=Lava Lake Plot 3

APPENDIX B

Airstrip Control

Habitat: Tussock tundra

Species	% Freq	% Cov	Imp.Val.
Woody plants		65.2	
Arctostaphylos alpina	13	1.7	4.7
Betula nana	55	15.5	29.1
Empetrum nigrum	35	3.9	11.6
Ledum palustris subsp.decumbens	93	28.2	51.2
Rubus chamaemorus	63	3.2	14.1
Vaccinium uliginosum	20	2.7	7.3
Vaccinium vitis-idaea	95	10.0	30.8
Graminoid plants		42.8	
Carex bigelowii	85	22.5	43.7
Eriophorum angustifolium	7	0.4	1.6
Eriophorum vaginatum	55	19.9	33.0
Poa arctica	2	+	0.2
Perennial herbs		0.0	
Cryptogamic plants		66.9	
Lichen	97	58.3	75.2
Moss	41	8.6	18.7

TOTAL COVER = 174.9

Number of plots analyzed: 60

APPENDIX B, continued
Tussock airstrip plots

Species	% Freq	% Cov	Imp.Val.
Woody plants		64.4	
Andromeda polifolia	1	+	0.2
Arctostaphylos alpina	1	0.2	0.4
Betula nana	73	24.1	41.9
Empetrum nigrum	24	1.5	6.0
Ledum palustris subsp. decumbens	83	20.0	40.7
Rubus chamaemorus	51	2.2	10.5
Vaccinium uliginosum	47	5.0	15.3
Vaccinium vitis-idaea	67	11.4	27.6
Graminoid plants		60.5	
Carex aquatilis	3	0.1	0.5
Carex bigelowii	14	1.1	3.9
Carex rotundata	3	0.2	0.7
Eriophorum angustifolium	7	0.9	2.5
Eriophorum russeolum	3	1.4	2.0
Eriophorum vaginatum	91	56.8	71.8
unk grass Trisetum?	1	+	0.2
Perennial herbs		0.0	
Cryptogamic plants		24.8	
Lichen	43	8.5	19.1
Moss	59	16.3	31.0

TOTAL COVER = 149.7

Number of plots analyzed: 70

APPENDIX B, continued

Wet airstrip plots

Species	% Freq	% Cov	Imp.Val.
Woody plants		2.5	
Andromeda polifolia	3	0.1	0.5
Betula nana	23	2.0	6.7
Ledum palustris subsp.decumbens	5	0.1	0.7
Rubus chamaemorus	3	0.1	0.5
Vaccinium uliginosum	3	0.1	0.5
Vaccinium vitis-idaea	5	0.1	0.7
Graminoid plants		64.6	
Carex aquatilis	53	18.1	30.9
Carex rotundata	16	7.5	10.9
Eriophorum angustifolium	46	25.0	33.9
Eriophorum russeolum	53	13.4	26.6
Eriophorum vaginatum	3	0.6	1.3
Perennial herbs		0.0	
Cryptogamic plants		66.5	
Lichen	0	0.0	
Moss	90	66.5	77.5

TOTAL COVER = 133.6

Number of plots analyzed: 60

APPENDIX B, continued
 Birm plots

Association: *Betula nana* - *Vaccinium vitia-idaea* Dwarf Shrub

Habitat: raised birm

Species	% Freq	% Cov	Imp.Val.
Woody plants		138.8	
<i>Arctostaphylos alpina</i>	3	0.3	0.9
<i>Betula nana</i>	92	65.3	77.5
<i>Empetrum nigrum</i>	25	1.9	6.8
<i>Ledum palustris</i> subsp. <i>decumbens</i>	73	17.4	35.6
<i>Rubus chamaemorus</i>	95	21.6	10.7
<i>Vaccinium uliginosum</i>	12	2.0	4.8
<i>Vaccinium vitis-idaea</i>	95	30.3	53.6
Graminoid plants		8.0	
<i>Calamagrostis canadensis</i>	26	6.4	12.8
<i>Carex bigelowii</i>	6	1.2	2.6
<i>Eriophorum vaginatum</i>	5	0.3	1.2
<i>Trisetum spicatum</i> subsp. <i>m</i>	3	0.1	0.5
Perennial herbs		0.5	
<i>Epilobium angustifolium</i>	5	0.5	1.5
Cryptogamic plants		8.0	
Lichen	46	7.5	18.5
Moss	20	0.5	3.1

TOTAL COVER = 155.3

Number of plots analyzed: 60

APPENDIX B, continued
Tussock dimensions in cm.

	area	(SD)	height	(SD)
Airstrip	1423	(575.6)	29	(7.9)
Control	746	(233.9)	19	(5.8)

Height of individual species in cm

Species	Control Tussock (SD)		Airstrip			
			Tussock (SD)		Birm (SD)	
Betula nana	23.6	(9.9)	32.4	(10.9)	44.1	(15.3)
Empetrum nigrum	3.6	(1.5)	5.0	(1.7)	8.5	(3.9)
Ledum palustris	5.9	(0.9)	10.8	(3.2)	15.5	(4.3)
Rubus chamaemorus	3.7	(0.9)	5.0	(1.1)	8.0	(2.4)
Vaccinium vitis-idaea	3.6	(1.1)	3.7	(1.0)	6.2	(2.2)

Depth to Active Layer (cm)

Site	Ave. Depth	SD	Standard Range	
Control Tussock	27.8	(4.2)	23.6	32.0
Airstrip Tussock	30.1	(6.5)	23.6 - 36.6	
Airstrip Wet	32.5	(5.4)	27.1 - 37.9	
Airstrip Birm	38.7	(3.8)	34.9 - 42.5	

Disturbed birm:

	%F	%Cov	Imp.Val.
Woody plants		82.5	
Betula nana	80	35.0	52.9
Ledum palustris subsp decumbens	60	6.5	19.7
Rubus chamaemorus	100	19.5	44.1
Vaccinium uliginosum	20	3.0	7.7
Vaccinium vitis-idaea	100	18.5	43.0
Cryptogamic plants		4.5	
Lichen	80	4.5	18.9
Exposed peat	100	47.5	68.9
TOTAL PLANT COVER =		87.0	

APPENDIX C

Kuzitrin I

Species	% Freq	% Cov	Imp.Val.
Woody plants		60.9	
Betula nana	52	8.3	20.7
Cassiope tetragona	14	6.3	9.3
Diapensia lapponicum	4	0.3	1.0
Empetrum nigrum	17	4.1	8.3
Ledum palustris subsp. decumbens	29	1.1	5.6
Loiseoeuria procumbens	1	0.2	0.4
Rubus chamaemorus	36	2.8	10.0
Salix chamissonnis	6	0.6	1.8
Salix planifolia	47	12.4	24.1
Vaccinium uliginosum	83	19.3	40.0
Vaccinium vitis-idaea	83	5.5	21.3
Graminoid plants		60.1	
Arctagrostis latifolia	1	+	0.2
Carex aquatilis	4	0.3	1.2
Carex bigelowii	100	58.9	76.7
Carex podocarpa	1	+	0.2
Carex rotundata	1	+	0.2
Eriophorum angustifolium	10	0.7	2.6
Luzula sp.	1	+	0.2
Poa arctica	1	+	0.2
Perennial herbs		1.3	
Artemesia arctica	10	0.4	2.0
Gentiana glauca	1	+	0.2
Lycopodium selago	1	+	0.2
Pedicularis sudetica	1	+	0.2
Polemonium acutifolium	1	+	0.2
Polygonum bistorta	19	0.5	3.0
Polygonum viviparum	1	+	0.2
Senecio atropurpureus	3	0.1	0.5
Sedum rosea	6	0.1	0.7
Cryptogamic plants		105.5	
Lichen	100	70.1	83.7
Moss	100	35.4	59.4

TOTAL COVER = 227.8

Number of plots analyzed: 70

APPENDIX C, continued
Kuzitrin II

Species	% Freq	% Cov	Imp.Val.
Woody plants		13.1	
Betula nana	5	0.1	0.7
Salix chamissonnis	30	2.9	9.4
Salix hastata	70	10.0	26.4
Salix planifolia	5	0.1	0.8
Graminoid plants		79.1	
Carex aquitilis	97	53.2	71.7
Carex membranaceum	57	15.9	29.9
Carex rariflora	18	2.2	6.3
Carex rotundata	3	0.1	0.5
Eriophorum angustifolium	35	7.6	16.3
Juncus biglumis	1	+	0.2
Luzula wahlenbergii	5	0.1	0.7
Perennial herbs		2.5	
Equisetum arvense	22	1.8	6.2
Saxifraga foliosa	3	0.1	0.5
Saxifraga nudicaulis	13	0.3	2.1
Sedum rosea	3	0.3	0.9
Cryptogamic plants		53.0	
Lichen	2	0.2	0.6
Moss	88	52.8	68.3
TOTAL COVER =		147.7	
Number of plots analyzed:	60		

APPENDIX D

1988 plants

FAMILY	CATALOG #	Genus & species	LOCATION
APIACEAE	1831	<i>Bupleurum triradiatum</i> Adams subsp. arcticum	LAVA LAKE
ASTERACEAE	1883	<i>Antennaria</i> sp.	LAVA LAKE
ASTERACEAE	1993	<i>Antennaria</i> sp.	LAVA LAKE
ASTERACEAE	1934	<i>Arnica alpina</i> subsp. angustifolia	LAVA LAKE
ASTERACEAE	1757	<i>Artemisia Tilesii</i> Ledeb. subsp. Tilesii	LAVA LAKE
ASTERACEAE	1862	<i>Artemisia arctica</i> Less. subsp. arctica	LAVA LAKE
ASTERACEAE	1863	<i>Aster sibiricus</i> L.	LAVA LAKE
ASTERACEAE	1748	<i>Erigeron humilis</i> Graham	LAVA LAKE
ASTERACEAE	1778	<i>Petasites frigidus</i> (L.) Franch.	LAVA LAKE
ASTERACEAE	1777	<i>Petasites hyperboreus</i> Rydb.	LAVA LAKE
ASTERACEAE	1890	<i>Saussurea angustifolia</i> (Willd.) DC.	LAVA LAKE
ASTERACEAE	1926	<i>Senecio congestus</i> (R.Br.) DC.	LAVA LAKE
ASTERACEAE	1928	<i>Senecio congestus</i> (R.Br.) DC.	LAVA LAKE
ASTERACEAE	1923	<i>Senecio lugens</i> Richards	LAVA LAKE
ASTERACEAE	1891	<i>Senecio</i> sp.	LAVA LAKE
ASTERACEAE	1805	<i>Taraxacum</i> sp.	LAVA LAKE
ASTERACEAE	1920	<i>Tripleurospermum phaeocephalum</i> (Rupr.) Pobed.	LAVA LAKE
BETULACEAE	1987	<i>Alnus crispa</i> (Ait.) Pursh	LAVA LAKE
BETULACEAE	2022	<i>Alnus crispa</i> (Ait.) Pursh	LAVA LAKE
BETULACEAE	1968	<i>Betula nana</i> L. subsp. exilis (Sukatsch.) Hult	LAVA LAKE
BETULACEAE	1969	<i>Betula nana</i> L. subsp. exilis (Sukatsch.) Hult	LAVA LAKE
BETULACEAE	1766	<i>Betula nana</i> L. subsp. exilis (Sukatsch.) Hult.	LAVA LAKE
BRASSICACEAE	1931	<i>Barbarea orthoceras</i> Ledeb.	LAVA LAKE
BRASSICACEAE	1785	<i>Cardamine pratensis</i> L. subsp. angustifolia	LAVA LAKE
BRASSICACEAE	1991	<i>Rorippa islandica</i> subsp. Fernaldiana	LAVA LAKE
CAMPANULACEAE	1959	<i>Campanula uniflora</i> L.	LAVA LAKE
CAPRIFOLIACEAE	1893	<i>Linnaea borealis</i> L. subsp. americana	LAVA LAKE
CARYOPHYLLACEAE	1917	<i>Cerastium jenisejense</i> Hult.	LAVA LAKE
CARYOPHYLLACEAE	1990	<i>Melandrium affine</i> J.Vahl	LAVA LAKE
CARYOPHYLLACEAE	1958	<i>Minuartia rubella</i> (Wahlenb.) Grzebn.	LAVA LAKE
CARYOPHYLLACEAE	1933	<i>Stellaria laeta</i> Richards.	LAVA LAKE
CARYOPHYLLACEAE	1749	<i>Wilheimsia physodes</i> (Fisch.) McNeill	LAVA LAKE
CARYOPHYLLACEAE	1857	<i>Wilheimsia physodes</i> (Fisch.) McNeill	LAVA LAKE
CRASSULACEAE	1859	<i>Sedum rosea</i> (L.) Scop. subsp. integrifolium	LAVA LAKE
CYPERACEAE	1733	<i>Carex Bigelowii</i> Torr.	LAVA LAKE
CYPERACEAE	1734	<i>Carex Bigelowii</i> Torr.	LAVA LAKE
CYPERACEAE	1737	<i>Carex Bigelowii</i> Torr.	LAVA LAKE
CYPERACEAE	1755	<i>Carex Bigelowii</i> Torr.	LAVA LAKE
CYPERACEAE	2004	<i>Carex aquatilis</i> Wahlenb.	LAVA LAKE
CYPERACEAE	1915	<i>Carex aquatilis</i> Wahlenb.	LAVA LAKE
CYPERACEAE	1741	<i>Carex aquatilis</i> Wahlenb. subsp. aquatilis	LAVA LAKE-OLD AIRSTRIP
CYPERACEAE	1860	<i>Carex membranacea</i> Hook.	LAVA LAKE
CYPERACEAE	1753	<i>Carex rotundata</i> Wahlenb.	LAVA LAKE/OLD AIRSTRIP

APPENDIX D continued

1988 plants

FAMILY	CATALOG #	Genus & species	LOCATION
CYPERACEAE	1756	<i>Carex saxitalis</i> L. subsp. laxa (Trautv.) Kalela	LAVA LAKE
CYPERACEAE	2025	<i>Carex vaginata</i> Tausch	LAVA LAKE — OLD AIRSTRIP
CYPERACEAE	1738	<i>Eriophorum Scheuchzeri</i> var. <i>tenuifolium</i>	LAVA LAKE
CYPERACEAE	1739	<i>Eriophorum Scheuchzeri</i> var. <i>tenuifolium</i>	LAVA LAKE
CYPERACEAE	1803	<i>Eriophorum angustifolium</i> Honck.	LAVA LAKE
CYPERACEAE	1740	<i>Eriophorum angustifolium</i> subsp. subarcticum	LAVA LAKE
CYPERACEAE	1742	<i>Eriophorum angustifolium</i> subsp. subarcticum	LAVA LAKE-OLD AIRSTRIP
CYPERACEAE	1743	<i>Eriophorum russeolum</i> E. Fries subsp. albidum	LAVA LAKE-OLD AIRSTRIP
CYPERACEAE	1764	<i>Eriophorum vaginatum</i> L. subsp. <i>vaginatum</i>	LAVA LAKE
EMETACEAE	1780	<i>Empetrum nigrum</i> L. subsp. <i>hermaphroditum</i>	LAVA LAKE
EQUISETACEAE	1854	<i>Equisetum scirpoides</i> Michx.	LAVA LAKE
ERICACEAE	1735	<i>Andromeda polifolia</i> L.	LAVA LAKE — OLD AIRSTRIP
ERICACEAE	1765	<i>Arctostaphylos alpina</i> (L.) Spreng.	LAVA LAKE
ERICACEAE	1775	<i>Arctostaphylos alpina</i> (L.) Spreng.	LAVA LAKE
ERICACEAE	1804	<i>Cassiope tetragona</i> (L.) D. Don subsp. tetragona	LAVA LAKE
ERICACEAE	1781	<i>Ledum palustre</i> L. subsp. <i>decumbens</i> (Ait.) Hult	LAVA LAKE
ERICACEAE	2016	<i>Ledum palustre</i> L. subsp. <i>decumbens</i> (Ait.) Hult	LAVA LAKE
ERICACEAE	1779	<i>Loiseleuria procumbens</i> (L.) Desv.	LAVA LAKE
ERICACEAE	1919	<i>Oxycoccus microcarpus</i> Turcz.	LAVA LAKE
ERICACEAE	1783	<i>Vaccinium uliginosum</i> L. subsp. <i>alpinum</i>	LAVA LAKE
ERICACEAE	1784	<i>Vaccinium vitis-idaea</i> L. subsp. <i>minus</i>	LAVA LAKE
ERICACEAE	1833	<i>Vaccinium vitis-idaea</i> L. subsp. <i>minus</i>	LAVA LAKE
GENTIANACEAE	1692	<i>Gentian propinqua</i> subsp. <i>arctophila</i>	LAVA LAKE
HALORAGACEAE	1762	<i>Hippuris vulgaris</i> L.	LAVA LAKE
HALORAGACEAE	1768	<i>Hippuris vulgaris</i> L.	LAVA LAKE
JUNCACEAE	1864	<i>Juncus biglumis</i> L.	LAVA LAKE
JUNCACEAE	1967	<i>Luzula Wahlenbergii</i> Rupr. subsp. Wahlenbergii	LAVA LAKE
JUNCACEAE	1968	<i>Luzula Wahlenbergii</i> Rupr. subsp. Wahlenbergii	LAVA LAKE
JUNCACEAE	1996	<i>Luzula Wahlenbergii</i> Rupr. subsp. Wahlenbergii	LAVA LAKE
JUNCACEAE	1751	<i>Luzula multiflora</i> subsp. <i>multiflora</i>	LAVA LAKE
JUNCACEAE	2019	<i>Luzula</i> sp.	LAVA LAKE
JUNCACEAE	1861	<i>Luzula tundricola</i> Gorodk.	LAVA LAKE
LENAEAE	1957	<i>Leena minor</i> L.	LAVA LAKE
LENTIBULARIACEAE	1855	<i>Pinguicula villosa</i> L.	LAVA LAKE
LENTIBULARIACEAE	1966	<i>Utricularia vulgaris</i> L. subsp. macrorrhiza	LAVA LAKE
LILIACEAE	1885	<i>Tofieldia</i> sp.	LAVA LAKE
ONAGRACEAE	1798	<i>Epilobium angustifolium</i> subsp. angustifolium	LAVA LAKE
ONAGRACEAE	1841	<i>Epilobium angustifolium</i> subsp. angustifolium	LAVA LAKE

APPENDIX D, continued

1988 plants

FAMILY	CATALOG #	Genus & species	LOCATION
ONAGRACEAE	1752	<i>Epilobium latifolium</i> L.	LAVA LAKE
ONAGRACEAE	1922	<i>Epilobium palustre</i> L.	LAVA LAKE
POACEAE	1769		LAVA LAKE
POACEAE	2012		LAVA LAKE
POACEAE	1912		LAVA LAKE
POACEAE	2003		LAVA LAKE
POACEAE	1894		LAVA LAKE
POACEAE	1910		LAVA LAKE
POACEAE	1904		LAVA LAKE — OLD AIRSTRIP
POACEAE	1827	<i>Agrostis gigantea</i> Roth	LAVA LAKE
POACEAE	1826	<i>Arctagrostis latifolia</i> var. <i>arundinacea</i>	LAVA LAKE
POACEAE	2001	<i>Arctagrostis latifolia</i> var. <i>arundinacea</i>	LAVA LAKE
POACEAE	1787	<i>Dupontia Fischeri</i> R.Br. subsp. <i>psilosantha</i>	LAVA LAKE
POACEAE	1945	<i>Dupontia Fischeri</i> subsp. <i>psilosantha</i>	LAVA LAKE — OLD AIRSTRIP
POACEAE	2024	<i>Koeleria asiatica</i> Dowin	LAVA LAKE — OLD AIRSTRIP
POACEAE	1914	<i>Trisetum spicatum</i> (L.) Richter	LAVA LAKE
POLEMONIACEAE	1829	<i>Polemonium acutiflorum</i> Willd.	LAVA LAKE
POLEMONIACEAE	2021	<i>Polemonium acutiflorum</i> Willd.	LAVA LAKE
POLYGONACEAE	1979	<i>Keonigia islandica</i> L.	LAVA LAKE
POLYGONACEAE	1991	<i>Polygonum bistorta</i> L. subsp. <i>plumosum</i>	LAVA LAKE
POLYGONACEAE	1651	<i>Polygonum viviparum</i> L.	LAVA LAKE
POLYGONACEAE	1865	<i>Rumex arcticus</i> Trautv.	LAVA LAKE
POLYGONACEAE	1867	<i>Rumex arcticus</i> Trautv.	LAVA LAKE
POTAMOGETONACEAE	1790	<i>Potamogeton perfoliatus</i> L. subsp. <i>Richardsonii</i>	LAVA LAKE
POTAMOGETONACEAE	1759	<i>Potamogeton perfoliatus</i> L. subsp. <i>Richardsonii</i>	LAVA LAKE
POTAMOGETONACEAE	1750	<i>Potamogeton vaginatus</i> Turcz.	LAVA LAKE
POTAMOGETONACEAE	1758	<i>Potamogeton vaginatus</i> Turcz.	LAVA LAKE
PRIMULACEAE	1828	<i>Dodecatheon frigidum</i> Chas. & Schiecht.	LAVA LAKE
PYROLACEAE	1799	<i>Pyrola grandiflora</i> Radius	LAVA LAKE
PYROLACEAE	1918	<i>Pyrola grandiflora</i> Radius	LAVA LAKE
RANUNCULACEAE	1754	<i>Aconitum delphinifolium</i> DC.	LAVA LAKE
RANUNCULACEAE	1853	<i>Aconitum delphinifolium</i> subsp. <i>delphinifolium</i>	LAVA LAKE
RANUNCULACEAE	1797	<i>Anemone Richardsonii</i> Hook.	LAVA LAKE
RANUNCULACEAE	1858	<i>Anemone Richardsonii</i> Hook.	LAVA LAKE
RANUNCULACEAE	1932	<i>Anemone parviflora</i> Michx.	LAVA LAKE
RANUNCULACEAE	1767	<i>Caltha natans</i> Pall.	LAVA LAKE
RANUNCULACEAE	1796	<i>Caltha palustris</i> L. subsp. <i>arctica</i>	LAVA LAKE
RANUNCULACEAE	1782	<i>Caltha palustris</i> L. subsp. <i>arctica</i> (R.Br.) Hult	LAVA LAKE
RANUNCULACEAE	1763	<i>Ranunculus Guelini</i> DC. subsp. <i>Guelini</i>	LAVA LAKE
RANUNCULACEAE	1916	<i>Ranunculus Pallasii</i> Schlecht.	LAVA LAKE
RANUNCULACEAE	1755	<i>Ranunculus confervoides</i> (E. Fries) E. Fries	LAVA LAKE
RANUNCULACEAE	1772	<i>Ranunculus confervoides</i> (E. Fries) E. Fries	LAVA LAKE
ROSACEAE	1887	<i>Dryas integrifolia</i> M. Vahl subsp. <i>integrifolia</i>	LAVA LAKE

APPENDIX D, continued

1988 plants

FAMILY	CATALOG #	Genus & species	LOCATION
ROSACEAE	1866	Potentilla fruticosa L.	LAVA LAKE
ROSACEAE	1924	Potentilla palustris (L.) Scop.	LAVA LAKE
ROSACEAE	1929	Potentilla palustris (L.) Scop.	LAVA LAKE
ROSACEAE	2017	Potentilla palustris (L.) Scop.	LAVA LAKE
ROSACEAE	1842	Potentilla uniflora Ledeb.	LAVA LAKE
ROSACEAE	1868	Rubus arcticus L. subsp. arcticus	LAVA LAKE
ROSACEAE	1788	Rubus chamaemorus L.	LAVA LAKE
RUBIACEAE	1888	Galium trifidum L. subsp. trifidum	LAVA LAKE
SALICACEAE	1927	Populus balsamifera L. subsp. balsamifera	LAVA LAKE
SALICACEAE	1838	Salix alaxensis (Anderss.) Cov.	LAVA LAKE
SALICACEAE	1982	Salix glauca L.	LAVA LAKE
SALICACEAE	1990	Salix lanata L. subsp. Richardsonii	LAVA LAKE
SALICACEAE	1983	Salix phlebophylla Anderss.	LAVA LAKE
SALICACEAE	1976	Salix planifolia Pursh	LAVA LAKE
SALICACEAE	1984	Salix planifolia Pursh	LAVA LAKE
SALICACEAE	1832	Salix reticulata L. subsp. reticulata	LAVA LAKE
SALICACEAE	1840	Salix reticulata L. subsp. reticulata	LAVA LAKE
SALICACEAE	1898	Salix rotundifolia Trautv.	LAVA LAKE
SALICACEAE	1986	Salix rotundifolia Trautv.	LAVA LAKE
SALICACEAE	1900	Salix sp.	LAVA LAKE
SALICACEAE	1955	Salix sp.	LAVA LAKE -- OLD AIRSTRIP
SAXIFRAGACEAE	1830	Chrysosplenium tetrandrum (Lund) T. Fries	LAVA LAKE
SAXIFRAGACEAE	1921	Parnassia Kotzebuei Chas. & Schlecht.	LAVA LAKE
SAXIFRAGACEAE	1856	Parnassia palustris subsp. neogaea	LAVA LAKE
SAXIFRAGACEAE	1869	Saxifraga bronchialis subsp. Funstonii	LAVA LAKE
SAXIFRAGACEAE	1889	Saxifraga cernua L.	LAVA LAKE
SAXIFRAGACEAE	1969	Saxifraga punctata L. subsp. Nelsoniana	LAVA LAKE
SAXIFRAGACEAE	1834	Saxifraga punctata L. subsp. Nelsoniana	LAVA LAKE
SPARGANIACEAE	1800	Sparganium angustifolium Michx.	LAVA LAKE
SPARGANIACEAE	1801	Sparganium angustifolium Michx.	LAVA LAKE
SPARGANIACEAE	1802	Sparganium angustifolium Michx.	LAVA LAKE
VALERIANACEAE	1972	Valeriana capitata Pall.	LAVA LAKE
VIOLACEAE	1786	Viola epipsila Ledeb. subsp. repens	LAVA LAKE

APPENDIX D, continued

1988 plants

FAMILY	CATALOG #	Genus & species	LOCATION
ASPIDIACEAE		<i>Dryopteris fragrans</i> (L.) Schott	LAVA LAKE

1988 plants

FAMILY	CATALOG #	Genus & species	LOCATION
LYCOPODIACEAE	1760	<i>Lycopodium annotinum</i> L. subsp. <i>pungens</i>	LAVA LAKE
SELAGINELLACEAE	2053	<i>Selaginella sibirica</i>	LAVA LAKE

APPENDIX D, continued

1988 plants

FAMILY	CATALOG #	Genus & species	LOCATION
ASTERACEAE	1729	<i>Antennaria monocephala</i> D.C.	KUZITRIN LAKE
ASTERACEAE	1808	<i>Arnica Lessingii</i> Greene subsp. <i>Lessingii</i>	KUZITRIN LAKE
ASTERACEAE	1948	<i>Arnica Lessingii</i> Greene subsp. <i>Lessingii</i>	KUZITRIN LAKE - MT BOYAN
ASTERACEAE	1793	<i>Artemisia arctica</i> Less. subsp. <i>arctica</i>	KUZITRIN LAKE
ASTERACEAE	1847	<i>Petasites hyperboreus</i> Rydb.	KUZITRIN LAKE
ASTERACEAE	1947	<i>Senecio atropurpureus</i> subsp. <i>tomentosus</i>	KUZITRIN LAKE - MT BOYAN
ASTERACEAE	1730	<i>Solidago multiradiata</i> Ait. var. <i>multiradiata</i>	KUZITRIN LAKE
ASTERACEAE	1728	<i>Taraxacum kamschaticum</i> Dahstedt	KUZITRIN LAKE
ASTERACEAE	1791	<i>Taraxacum kamschaticum</i> Dahstedt	KUZITRIN LAKE
BRASSICACEAE	1943	<i>Cardamine bellidifolia</i> L.	KUZITRIN LAKE - MT BOYAN
BRASSICACEAE	1845	<i>Cardamine microphylla</i> Adams	KUZITRIN LAKE
BRASSICACEAE	1956	<i>Cardamine microphylla</i> Adams	KUZITRIN LAKE - MT BOYAN
CAMPANULACEAE	1720	<i>Campanula lasiocarpa</i> Cham. subsp. <i>lasiocarpa</i>	KUZITRIN LAKE
CAMPANULACEAE	1732	<i>Campanula lasiocarpa</i> Cham. subsp. <i>lasiocarpa</i>	KUZITRIN LAKE
CARYOPHYLLACEAE	1954	<i>Melandrium apetalum</i> subsp. <i>arcticum</i>	KUZITRIN LAKE - MT BOYAN
CARYOPHYLLACEAE	1770	<i>Minuartia arctica</i> (Ster.) Aschers. & Graebn.	KUZITRIN LAKE/MT. BOYAN
CARYOPHYLLACEAE	1859	<i>Minuartia macrocarpa</i> (Pursh.) Ostenf.	KUZITRIN LAKE
CARYOPHYLLACEAE	1717	<i>Silene acaulis</i> L.	KUZITRIN LAKE
CARYOPHYLLACEAE	1975	<i>Silene acaulis</i> L. subsp. <i>subcaulescens</i>	KUZITRIN LAKE
CARYOPHYLLACEAE	1731	<i>Wilhelmsia physodes</i> (Fisch.) McNeill	KUZITRIN LAKE
CARYOPHYLLACEAE	1871	<i>Wilhelmsia physodes</i> (Fisch.) McNeill	KUZITRIN LAKE
CRASSULACEAE	1811	<i>Sedum rosea</i> (L.) Scop.	KUZITRIN LAKE
CYPERACEAE	1773	<i>Carex laxa</i> Wahlenb.	KUZITRIN LAKE
CYPERACEAE	1715	<i>Carex membranacea</i> Hult.	KUZITRIN LAKE
CYPERACEAE	2013	<i>Carex</i> sp.	KUZITRIN LAKE
CYPERACEAE	1774	<i>Carex stylosa</i> C.A. Mey	KUZITRIN LAKE
CYPERACEAE	1721	<i>Eleocharis acicularis</i> (L.) Roem. & Schult.	KUZITRIN LAKE
DIAPENSIACEAE	1974	<i>Diapensia lapponica</i> L. subsp. <i>obovata</i>	KUZITRIN LAKE
ERICACEAE	1812	<i>Andromeda polifolia</i> L.	KUZITRIN LAKE
ERICACEAE	1946	<i>Cassiope tetragona</i> (L.) D. Don subsp. <i>tetragona</i>	KUZITRIN LAKE - MT BOYAN
ERICACEAE	1825	<i>Ledum palustre</i> L. subsp. <i>decumbens</i> (Ait.) Hult	KUZITRIN LAKE
ERICACEAE	1716	<i>Loiseleuria procumbens</i> (L.) Desv.	KUZITRIN LAKE
ERICACEAE	1837	<i>Loiseleuria procumbens</i> (L.) Desv.	KUZITRIN LAKE
ERICACEAE	1809	<i>Rhododendron kamschaticum</i> subsp. <i>glandulosum</i>	KUZITRIN LAKE
ERICACEAE	1960	<i>Vaccinium uliginosum</i> subsp. <i>alpinum</i>	KUZITRIN LAKE
ERICACEAE	1962	<i>Vaccinium vitis-idaea</i> L. subsp. <i>minus</i>	KUZITRIN LAKE
GENTIANACEAE	1711	<i>Gentiana glauca</i> Pall.	KUZITRIN LAKE
GENTIANACEAE	1836	<i>Gentiana glauca</i> Pall.	KUZITRIN LAKE
HALORAGACEAE	1719	<i>Hippuris vulgaris</i> L.	KUZITRIN LAKE
JUNCACEAE	2005	<i>Juncus</i> sp.	KUZITRIN LAKE
JUNCACEAE	1736	<i>Luzula Wahlenbergii</i> Rupr. subsp. <i>Wahlenbergii</i>	KUZITRIN LAKE
JUNCACEAE	1961	<i>Luzula multiflora</i> subsp. <i>multiflora</i>	KUZITRIN LAKE

APPENDIX D, continued

1988 plants

FAMILY	CATALOG #	Genus & species	LOCATION
LILIACEAE	1944	Lloydia serotina (L.) Rchb.	KUZITRIN LAKE - MT BOYAN
LILIACEAE	1951	Veratrum album subsp. oxysepalum	KUZITRIN LAKE - MT BOYAN
ONAGRACEAE	1823	Epilobium latifolium L.	KUZITRIN LAKE
ONAGRACEAE	1938	Epilobium latifolium L.	KUZITRIN LAKE - MT BOYAN
POACEAE	1747	Festuca altaica Trin.	KUZITRIN LAKE
POLEMONIACEAE	1824	Polemonium acutiflorum Willd.	KUZITRIN LAKE
POLYGONACEAE	1843	Oxyria digyna (L.) Hill	KUZITRIN LAKE
POLYGONACEAE	1844	Oxyria digyna (L.) Hill	KUZITRIN LAKE
POLYGONACEAE	1815	Polygonum bistorta L. subsp. plumosum	KUZITRIN LAKE
POLYGONACEAE	1846	Polygonum bistorta L. subsp. plumosum	KUZITRIN LAKE
POLYGONACEAE	1714	Polygonum viviparum L.	KUZITRIN LAKE
POLYGONACEAE	1949	Polygonum viviparum L.	KUZITRIN LAKE - MT BOYAN
POLYGONACEAE	1935	Rumex arcticus Trautv.	KUZITRIN LAKE - MT BOYAN
PORTULACACEAE	1814	Claytonia sarmentosa C.A.Mey	KUZITRIN LAKE
POTAMOGETONACEAE	1817	Potamogeton gramineus L.	KUZITRIN LAKE
POTAMOGETONACEAE	1816	Potamogeton subsibiricus Hagstr.	KUZITRIN LAKE
PRIMULACEAE	1712	Dodecatheon frigidum Chas. & Schlecht.	KUZITRIN LAKE
PRIMULACEAE	1954	Primula tschuktschorum var. tschuktschorum	KUZITRIN LAKE
PYROLACEAE	1872	Pyrola grandiflora Radius	KUZITRIN LAKE
PYROLACEAE	1940	Pyrola grandiflora Radius	KUZITRIN LAKE - MT BOYAN
RANUNCULACEAE	1807	Aconitum delphinifolium DC. subsp. paradoxum	KUZITRIN LAKE
RANUNCULACEAE	1745	Anemone narcissiflora L. subsp. interior Hult	KUZITRIN LAKE/MT. BOYAN
ROSACEAE	1776	Potentilla hyparctica Malte	KUZITRIN LAKE
ROSACEAE	1995	Potentilla palustris (L.) Scop.	KUZITRIN LAKE
ROSACEAE	1727	Rubus arcticus L. subsp. acaulis (Michx.) Focke	KUZITRIN LAKE
ROSACEAE	1713	Rubus chamaemorus L.	KUZITRIN LAKE
ROSACEAE	1953	Sedum rosea subsp. integrifolium	KUZITRIN LAKE - MT BOYAN
ROSACEAE	1925	Sibbaldia procumbens L.	KUZITRIN LAKE
ROSACEAE	1813	Spiraea Beauverdiana Schneid.	KUZITRIN LAKE
SALICACEAE	2014	Salix hastata L.	KUZITRIN LAKE
SALICACEAE	2020	Salix sp.	KUZITRIN LAKE
SAXIFRAGACEAE	1941	Saxifraga foliolosa R. Br. var. foliolosa	KUZITRIN LAKE - MT BOYAN
SAXIFRAGACEAE	1950	Saxifraga foliolosa R.Br. var. foliolosa	KUZITRIN LAKE - MT BOYAN
SAXIFRAGACEAE	1936	Saxifraga hieracifolia Waldst. & Kit.	KUZITRIN LAKE - MT BOYAN
SAXIFRAGACEAE	1718	Saxifraga nudicaulis D. Don.	KUZITRIN LAKE
SAXIFRAGACEAE	1942	Saxifraga rivularis var. flexuosa	KUZITRIN LAKE - MT BOYAN
SCROPHULARIACEAE	1746	Lagotis glauca Gaertn. subsp. minor (Willd.)	KUZITRIN LAKE/MT. BOYAN
SCROPHULARIACEAE	1939	Pedicularis capitata Adams	KUZITRIN LAKE - MT BOYAN
SCROPHULARIACEAE	1822	Pedicularis labradorica Wirsing	KUZITRIN LAKE
SCROPHULARIACEAE	1978	Pedicularis labradorica Wirsing	KUZITRIN LAKE, MT BOYAN
SCROPHULARIACEAE	1789	Pedicularis sp.	KUZITRIN LAKE
SCROPHULARIACEAE	1806	Pedicularis sp.	KUZITRIN LAKE
SCROPHULARIACEAE	1899	Pedicularis sp.	KUZITRIN LAKE
SCROPHULARIACEAE	1744	Pedicularis sudetica subsp. interioides	KUZITRIN LAKE/MT. BOYAN
SPARGANIACEAE	1794	Sparganium minimum (Hartn.) E. Fries	KUZITRIN LAKE

APPENDIX D, continued

FAMILY	1988 plants		
	CATALOG #	Genus & species	LOCATION
VALERIANACEAE	1810	Valeriana capitata Pall.	KUZITRIN LAKE
VIGACEAE	1870	Viola epipsila Ledeb. subsp. repens	KUZITRIN LAKE

FAMILY	CATALOG #	Genus & species	LOCATION
ASTERACEAE	1899	<i>Antennaria monocephala</i>	MT. BOYAN
ASTERACEAE	1913	<i>Antennaria</i> sp.	MT. BOYAN
ASTERACEAE	1819	<i>Artemisia arctica</i> Less. subsp. <i>arctica</i>	MT. BOYAN
ASTERACEAE	1850	<i>Artemisia arctica</i> Less. subsp. <i>arctica</i>	MT. BOYAN
ASTERACEAE	2011	<i>Artemisia frigida</i> Willd.	MT. BOYAN
ASTERACEAE	1896	<i>Taraxacum alaskanum</i> Rydb.	MT. BOYAN
ASTERACEAE	1886	<i>Taraxacum kamschaticum</i> Dahlstedt	MT. BOYAN
BRASSICACEAE	1592	<i>Cardamine pratensis</i> L. subsp. <i>angustifolia</i>	MT. BOYAN
CAPRIFOLIACEAE	1848	<i>Linnaea borealis</i> L. subsp. <i>americana</i>	MT. BOYAN
CARYOPHYLLACEAE	1971	<i>Moehringia lateriflora</i> (L.) Fenzl	MT. BOYAN
CARYOPHYLLACEAE	2215	<i>Stellaria</i> sp.	MT. BOYAN
CARYOPHYLLACEAE	1879	<i>Wilhelmsia physodes</i> (Fisch.) McNeill	MT. BOYAN
CYPERACEAE	1505		MT. BOYAN
CYPERACEAE	1911	<i>Carex</i> sp.	MT. BOYAN
CYPERACEAE	1507	<i>Carex</i> sp.	MT. BOYAN
CYPERACEAE	1908	<i>Carex</i> sp.	MT. BOYAN
CYPERACEAE	1969	<i>Carex</i> sp.	MT. BOYAN
CYPERACEAE	1903	<i>Eleocharis</i> sp.	MT. BOYAN
DIAPENSIACEAE	1818	<i>Diapensia lapponica</i> L. subsp. <i>obovata</i>	MT. BOYAN
EQUISETACEAE	1880	<i>Equisetum arvense</i> L.	MT. BOYAN
ERICACEAE	2010	<i>Arctostaphylos rubra</i> (Rchd. & Wilson) Fern.	MT. BOYAN
ERICACEAE	1882	<i>Loiseleuria procumbens</i> (L.) Desv.	MT. BOYAN
ERICACEAE	1873	<i>Rhododendron kamschaticum</i> subsp. <i>glandulosum</i>	MT. BOYAN
ERICACEAE	1881	<i>Vaccinium vitis-idaea</i> subsp. <i>minus</i>	MT. BOYAN
JUNCACEAE	1906	<i>Luzula</i> sp.	MT. BOYAN
LILIACEAE	1849	<i>Veratrum viride</i> Ait. subsp. <i>Eschscholtzii</i>	MT. BOYAN
POACEAE	2008		MT. BOYAN
POACEAE	1599		MT. BOYAN
POACEAE	2000		MT. BOYAN
POACEAE	1895	<i>Hierochloa</i> sp.	MT. BOYAN
POLYGONACEAE	1876	<i>Oxyria digyna</i> (L.) Hill	MT. BOYAN
POLYGONACEAE	1875	<i>Polygonum bistorta</i> subsp. <i>plumosum</i>	MT. BOYAN
PORTULACACEAE	1973	<i>Claytonia sarmentosa</i> C.A.Mey	MT. BOYAN
PRIMULACEAE	1835	<i>Dodecatheon frigidum</i> Cham. & Schlecht.	MT. BOYAN
RANUNCULACEAE	1970	<i>Anemone Richardsonii</i> Hook.	MT. BOYAN
RANUNCULACEAE	2023	<i>Anemone Richardsonii</i> Hook.	MT. BOYAN
RANUNCULACEAE	1878	<i>Ranunculus nivalis</i> L.	MT. BOYAN
RANUNCULACEAE	1877	<i>Ranunculus pygmaeus</i> Wahlenb. subsp. <i>pygmaeus</i>	MT. BOYAN
ROSACEAE	1821	<i>Dryas octopetala</i> L. subsp. <i>octopetala</i>	MT. BOYAN
ROSACEAE	2009	<i>Potentilla elegans</i> Cham. & Schlecht.	MT. BOYAN
SALICACEAE	1985	<i>Salix phlebophylla</i> Anderss.	MT. BOYAN
SALICACEAE	1994	<i>Salix phlebophylla</i> Anderss.	MT. BOYAN
SALICACEAE	2006	<i>Salix polaris</i> Wahlenb. subsp. <i>pseudopolaris</i>	MT. BOYAN
SALICACEAE	2002	<i>Salix reticulata</i> L.	MT. BOYAN
SALICACEAE	1998	<i>Salix rotundifolia</i> Trautv.	MT. BOYAN

APPENDIX D, continued

1988 plants

FAMILY	CATALOG #	Genus & species	LOCATION
SALICACEAE	1991	<i>Salix rotundifolia</i> Trautv.	MT. BOYAN
SALICACEAE	1697	<i>Salix</i> sp.	MT. BOYAN
SALICACEAE	1884	<i>Salix</i> sp.	MT. BOYAN
SAXIFRAGACEAE	1820	<i>Saxifraga punctata</i> L. subsp. <i>Nelsoniana</i>	MT. BOYAN
SAXIFRAGACEAE	1852	<i>Saxifraga punctata</i> L. subsp. <i>Nelsoniana</i>	MT. BOYAN
SAXIFRAGACEAE	2018	<i>Saxifraga rivularis</i> L.	MT. BOYAN
VALERIANACEAE	2007	<i>Valeriana capitata</i> Pail.	MT. BOYAN

1988 plants

FAMILY	CATALOG #	Genus & species	LOCATION
LYCOPODIACEAE	1955	<i>Lycopodium alpinum</i> L.	KUZITRIN LAKE - MT BOYAN
LYCOPODIACEAE	1952	<i>Lycopodium annotinum</i> subsp. <i>annotinum</i>	KUZITRIN LAKE - MT BOYAN
LYCOPODIACEAE	1937	<i>Lycopodium selago</i> L. subsp. <i>selago</i>	KUZITRIN LAKE - MT BOYAN

APPENDIX D, Continued

1988 plants

FAMILY	CATALOG #	Genus & species	LOCATION
ASTERACEAE	1723	Antennaria Friesiana (Traut.) Ekman	SERPENTINE HOT SPRINGS
ASTERACEAE	1963	Antennaria monocephala subsp. monocephala	SERPENTINE HOT SPRINGS
EMPETRACEAE	1725	Empetrum nigrum L.	SERPENTINE HOT SPRINGS
POLYGONACEAE	1724	Polygonum bistorta L. subsp. plumosum	SERPENTINE HOT SPRINGS
ROGACEAE	1722	Dryas octopetala L. subsp. octopetala	SERPENTINE HOT SPRINGS
SPARGANIACEAE	1726	Sparganium minimum (Hartm.) E. Fries	SERPENTINE HOT SPRINGS
SPARGANIACEAE	1597	Sparganium minimum (Hartm.) E. Fries	SERPENTINE HOT SPRINGS

APPENDIX E

1988 Animals

FAMILY	CATALOG #	Genus & species	LOCATION
	2163		LAVA LAKE
	2164		LAVA LAKE
CRICETIDAE	2113	Clethrionomys rutilus	LAVA LAKE
CRICETIDAE	2119	Clethrionomys rutilus	LAVA LAKE
CRICETIDAE	2117	Clethrionomys rutilus	LAVA LAKE
CRICETIDAE	2111	Clethrionomys rutilus	LAVA LAKE
CRICETIDAE	2115	Microtus oeconomus	LAVA LAKE
CRICETIDAE	2120	Microtus oeconomus	LAVA LAKE
CRICETIDAE	2122	Microtus oeconomus	LAVA LAKE
CRICETIDAE	2114	Microtus oeconomus	LAVA LAKE
CRICETIDAE	2121	Microtus oeconomus	LAVA LAKE
CRICETIDAE	2112	Microtus oeconomus	LAVA LAKE
GASTEROSTEIDAE	2156	Pungitius pungitius	LAVA LAKE
GASTEROSTEIDAE	2159	Pungitius pungitius	LAVA LAKE
UMBRIDAE	2157	Dallia pectoralis	LAVA LAKE
UMBRIDAE	2158	Dallia pectoralis	LAVA LAKE

1988

FAMILY	CATALOG #	Genus & species	LOCATION
	2161		KUZITRIN LAKE
	2162		KUZITRIN LAKE
	2164		KUZITRIN LAKE
	2165		KUZITRIN LAKE
COTTIDAE	2160	Cottus cognatus Richardson	KUZITRIN LAKE
CRICETIDAE	2118	Clethrionomys rutilus	KUZITRIN LAKE
CRICETIDAE	2116	Microtus oeconomus	KUZITRIN LAKE

1988

FAMILY	CATALOG #	Genus & species	LOCATION
--------	-----------	-----------------	----------

APPENDIX F

1988 OTHER ANIMALS OBSERVED

LAVA LAKE

reindeer	moose	muskrat
----------	-------	---------

KUZITRIN LAKE

grizzly bear	reindeer	arctic ground squirrel
arctic grayling		

SERPENTINE HOT SPRINGS

moose	fox	arctic ground squirrel
-------	-----	------------------------

APPENDIX G

1988 BIRD LIST

LAVA LAKE

Lapland longspur	golden plover	common snipe
long-tailed jaeger	yellow-billed loon	arctic tern
red-necked phalarope	glaucous-winged gull	pintail duck
Western sandpiper	American tree sparrow	mew gull
parasitic jaeger	rusty blackbird	tundra swan
greater scaup	Northern wheatear	surf scoter
white-crowned sparrow	Canada goose	rock ptarmigan
red-breasted merganser	white wagtail	yellow wagtail
Savannah sparrow	redpoll	fox sparrow
black turnstone	green-winged teal	oldsquaw
godwit	greater white-fronted goose	warbler
bluethroat	semipalmated plover	sandhill crane
red-necked grebe	rough-legged hawk	robin
golden eagle		

Uncertain identifications:

dowitcher
Lincoln sparrow
boreal owl
whimbrel or bristle-thighed curlew

KUZITRIN LAKE

ptarmigan	Canada goose	wheatear
common loon	arctic tern	lesser golden plover
raven	rock sandpiper	greater scaup
eagle	long-tailed jaeger	Western sandpiper
redpoll	yellow-billed loon	glaucous-winged gull
water pipit	parasitic jaeger	semipalmated sandpiper
Lapland longspur	greater white-fronted goose	
red-throated loon		

Uncertain identification:

red-breasted merganser
red-necked grebe
bunting

SERPENTINE HOT SPRINGS

common snipe	American tree sparrow	thrush
long-tailed jaeger	cliff swallow	Lincoln sparrow
merlin	gyrfalcon	sandpiper
harlequin duck	rough-legged hawk	Say's phoebe
Savannah sparrow		