A PRELIMINARY ECOLOGICAL SURVEY OF BIG BEAVER VALLEY, NORTH CASCADES NATIONAL PARK COMPLEX

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Cover photograph: View down-valley from Big Beaver Bog. Jack Mountain and Pumpkin Mountain in background.

ACKNOWLEDGMENTS

The writers wish to thank George W. Douglas of the University of Alberta and Drs. Arthur R. Kruckeberg and John Hill of the University of Washington for their assistance in the identification of plant species. We also thank Dr. Frank Richardson of the Burke Memorial Museum, University of Washington, for his help with the identification of vertebrates. Dr. Dale W. Cole of the University of Washington and Dr. Jerry F. Franklin of the U. S. Forest Service Pacific Northwest Forest and Range Experiment Station kindly reviewed portions of the manuscript. We thank Dr. James C. Powers of the University of Georgia for his kind permission to use the photograph in Figure 7.

We should like to express our appreciation, too, for the advice and encouragement offered in this project by Roger J. Contor, first superintendent of the North Cascades National Park. We also sincerely thank Ed O'Leary, Ross Lake ranger, for his cheerful and untiring assistance in providing water transportation to and from Big Beaver Valley and for all the welcome cups of coffee he furnished two weary naturalists.

We wish to give special thanks to our loyal friend, Emily Huddart Haig, for inspiring us to devote our energies to the study of such a wild and wonderful place as Big Beaver Valley.

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A PRELIMINARY ECOLOGICAL SURVEY OF BIG BEAVER VALLEY, NORTH CASCADES NATIONAL PARK COMPLEX

I. Purposes and limitations of survey

In the early summer of 1969 the writers offered their services to Roger J. Contor, then superintendent, for the conduct of any needed studies of a biological nature in the North Cascades National Park complex of the state of Washington. Mr. Contor expressed a belief that the most critical need was for a complete ecosystem survey of the valley of Big Beaver Creek, since the lower portion of this valley was threatened with inundation by Seattle City Light's proposed High Ross Dam.

In July and August of 1969 the writers spent 15 days in the valley, examining only that portion below 1725 feet elevation, the proposed new water level. In June, July, and August of 1970, 20 more days were spent in the valley, and the entire drainage, from Beaver Pass to Ross Lake, was examined.

The following report makes no pretense to being the complete ecosystem survey desired by Superintendent Contor. Not only do the writers lack competence in several of the disciplines required for such a survey, but time and manpower have also been insufficient. The report does contain a fairly complete description of the vascular plant communities in Big Beaver Valley, together with listings of the mammals found, the avifauna, and the lower vertebrates. An effort is made to describe the interrelations of the faunal populations with the complex plant communities. However, still needed for an adequate understanding of the ecology of Big Beaver Valley are studies of the soil types,

including the bogs, studies of the very rich thallophytic and bryophytic floras, studies of the microfauna and macrofauna, and much more complete work with the vertebrates. It is the hope of the writers that their efforts will serve to stimulate the interest of workers in these disciplines in this threatened area.

II. Physical Characteristics of Study Area

Big Beaver Creek is one of the major tributaries of the upper Skagit River. It has its origin in Sec. 16, R. 12E, T. 39N, below Beaver Pass and empties into Ross Lake in Sec. 14, R. 13E, T. 38N. The valley is 12 miles in length and varies in elevation from about 3600 feet at the headwaters to 1602.5 feet at full reservoir level of Ross Lake. Approximately 6 miles of the lower valley is in the Ross Lake National Recreation Area, the upper portion lying in the North Cascades National Park. Two main tributaries, Luna and McMillan Creeks, drain the northeast slopes of the southern Picket Range and provide the major portion of the run-off carried by the stream. A smaller tributary, Thirtyninemile Creek, drains the southern slopes of Mt. Prophet and flows into the north side of Big Beaver Creek 4 miles up-valley. Another small tributary, Pierce Creek, enters Big Beaver Creek near its confluence with the flooded Skagit Valley, although at high water level, it flows directly into the reservoir.

Geology

Although the writers were unable to find in the literature a detailed geological description of Big Beaver Valley, it is possible to interpret the history of the valley from the writings of Misch (1952, 1966) and others who have studied the formation of the North Cascades. Almost the entire length of the valley lies in the Skagit Gneiss, a Pre-Upper Jurassic rock metamorphosed from sediments deposited in an ancient

geosyncline in presumed Paleozoic time. At the extreme upper end of the valley, for a sort distance, the stream has cut through the Tertiary granite of the Chilliwack Composite Batholith. Within the Skagit Gneiss are numerous small granitic intrusive bodies, and one of these, located at the present mouth of Big Beaver Creek, has markedly influenced the present topography of the valley.

When the uplift of the Cascade Range began, early in the Pliocene, the elevation of the highest peaks was between 3-4,000 feet above sea level (Mackin and Cary, 1965). The rate of uplift has exceeded the rate of erosion, resulting in the present heights of 8-9,000 feet. At the end of the Pliocene, the stream occupied its present valley, but the topography was vastly different. Landforms were rounded and rolling, resembling those of the Appalachians. The subsequent modeling of the valley and the surrounding peaks has been almost entirely the result of the Pleistocene glaciation.

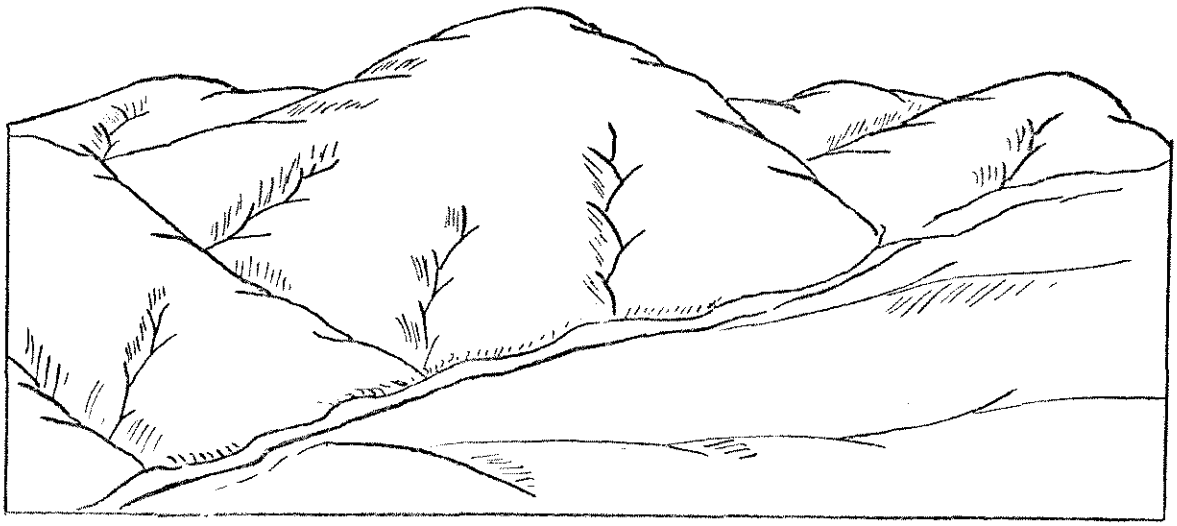


Figure 1. Hypothetical view of Big Beaver Valley at end of Pliocene.

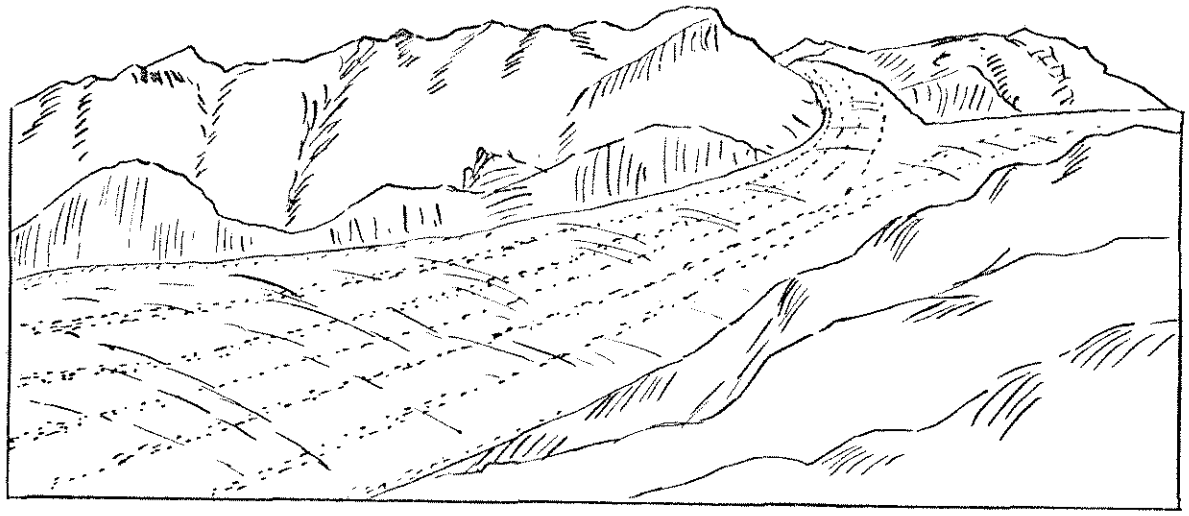


Figure 2. Hypothetical view of Big Beaver Valley during Pleistocene glaciation.

During the recurring major periods of glaciation, the interior portions of the Picket Range were so deeply covered with ice that only the highest peaks and ridges stood out above an ice mass that flowed east and west from the divide areas (Mackin and Cary, 1965). From the upper end of Big Beaver Valley there was apparently a continuous ice mass extending to Little Beaver Valley, with narrow rivers of ice extending down both valleys to join the Skagit River glacier (Tabor and Crowder, 1968).

The grinding action of the moving ice deepened the valley and gave it its present classical U-shape. However, because of the resistant granitic intrusion at the valley mouth, the ice was never able to cut down to the level of the Skagit. As a result, when the glacier retreated, Big Beaver remained as a hanging valley almost 300 feet above the floor of the Skagit. Its stream descended in a series of spectacular falls and cascades until the construction of Ross Dam drowned the falls and brought the reservoir level to the valley mouth.

Physiography

Behind the granite barrier at its mouth, the floor of Big Beaver Valley widens out to about 2/3 mile at its widest point. The walls are

Figure 3. Mouth of Big Beaver Creek, head of drowned falls.

Figure 4. Big Beaver Creek entering bay.

extremely steep, with vertical rock faces on the south side. The valley is floored with various alluvial materials: peats, silt, sand, gravel, and glacial deposits. Large erratic boulders, some exceeding 700 cubic feet in volume, are found at the confluence of one of the steep side valleys 3 miles up-stream. At the foot of the cliffs are many extensive talus slopes accumulated since the retreat of the valley glacier. Because of the steep valley walls, little snow accumulates, and there are no year-round side streams in the lower valley.

Big Beaver Valley, in its lower 5 miles, is very flat, and the stream sweeps through it in wide meanders. Apparently, at the end of the last glacial era, the floor of the lower valley had been scoured out

Figure 5. Big Beaver Valley from Ross Lake

Figure 6. View of Big
Beaver Valley from
north wall

to a lower level than the granite sill, and with the retreat of the ice, a large lake formed behind this barrier. There are now six permanent bodies of water in this portion of the valley, five of them lying on the south side of the stream. They would appear to be residuals of the large post-glacial lake, now filled with decaying vegetation and gradually being

Figure 7. View of valley from Pumpkin Mountain

reduced in size by the encroachment of the sedges on their borders. It would appear to the writers that they are replenished at periods of high water by Big Beaver Creek, although their surface may lie below the level of the water table, seepage helping to keep them filled. They appear connected by water channels, but all were quite stagnant during the summer months of the investigation. They may possibly also receive supplies of fresh melt-water trickling beneath the talus slopes at the foot of the south valley wall.

There are two other unusual bodies of water in the lower valley. Two miles above the largest of the six lower ponds is a sphagnum peat bog with areas of open water. Unlike the lower ponds, this one has a constant supply of fresh water provided by a small stream entering from the north. The level of the pond is maintained by beaver dams, and the water level appears to be in excess of six feet. A population of sphagnum moss has formed floating mats extending well out into the pond.

One-fourth mile east of the Tenmile shelter there is a very large beaver pond of approximately five acres in extent. The beaver here have dammed a side channel of Big Beaver Creek, and the pond has the same turquoise color as the waters of the stream. This impoundment seems to be of fairly recent origin, not appearing on the 1956 U. S. Forest Service aerial photographs of the valley. It will be described more fully in the section of this report covering the activity of the beaver in the valley. For convenience, all the bodies of water in the lower valley have been assigned numbers on the map in Figure 8.

Because of the steeper topography of the upper valley, there has been less opportunity for the formation of bodies of water. The writers examined one small beaver pond and one very small sphagnum bog. There are probably other beaver ponds near the confluence with McMillan Creek--the terrain is such as to preclude the existence of glacially created ponds.

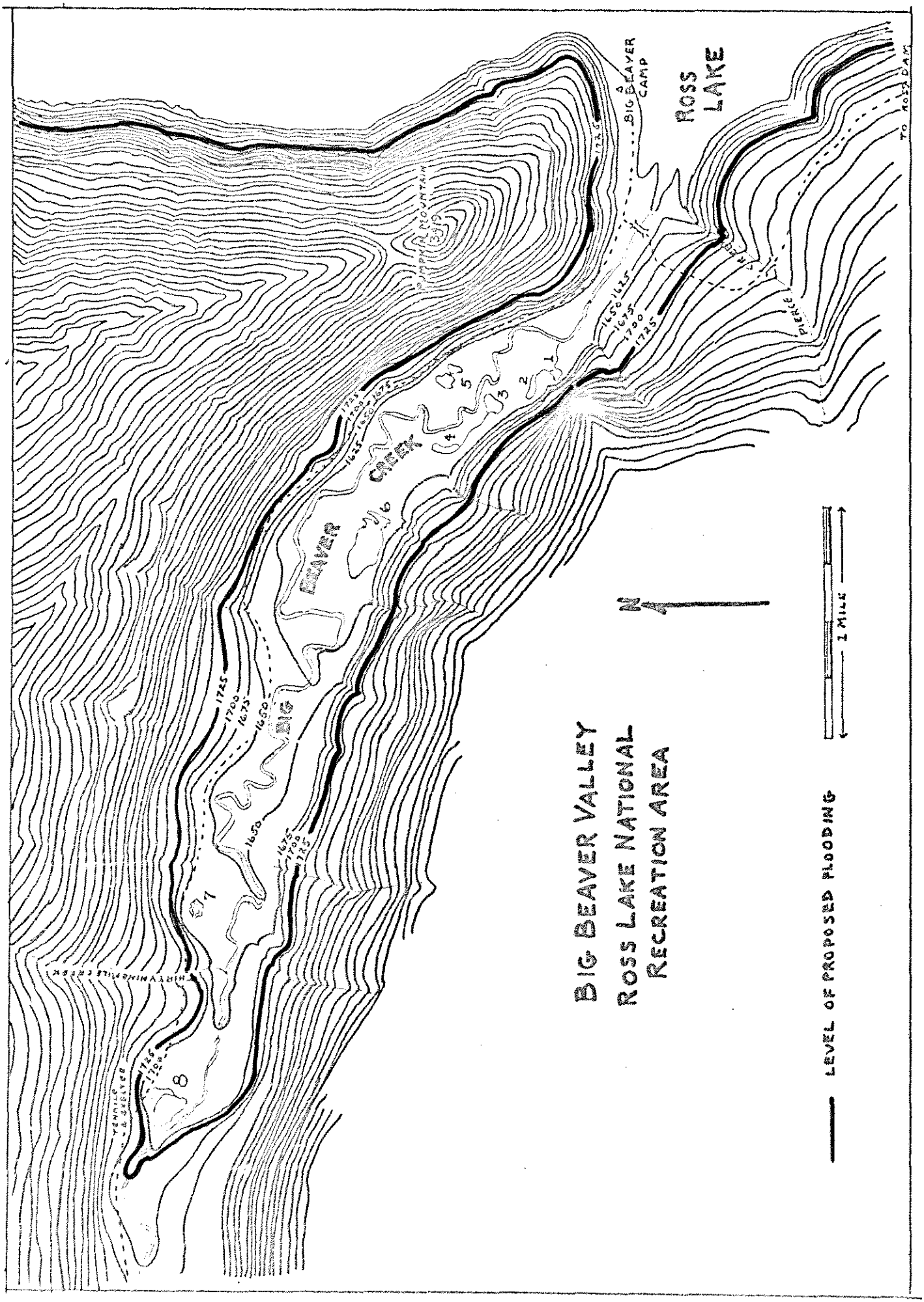

BIG BEAVER VALLEY
ROSS LAKE NATIONAL
RECREATION AREA
LEVEL OF PROPOSED FLOODING
1 MILE
N
ROSS LAKE
BIG BEAVER CAMP
BIG BEAVER CREEK
PIERCE MOUNTAIN
TO ROSS DAM
1725
1700
1675
1650
1625

Figure. 8

Big Beaver Creek is a deep, powerful stream carrying a large volume of glacial melt water during the summer months. It cannot be waded at any point in the lower valley, although there are a few log jams which permit its crossing. Its drop is 25 feet per valley mile in the lower portion—because of its meanders, about 15 feet per mile of river. Above the 1725 foot level the valley becomes steeper and narrower. Instead of the broad, flat floor, one finds the valley walls sloping down to the stream and the stream itself often flowing in a deep slot. The rate of stream fall in this portion of the valley is approximately 150 feet per mile.

Disturbed Areas

Big Beaver Valley has so far been but lightly marked by the activities of man. The trail from Ross Dam enters the valley at the falls of Pierce Creek, crosses Big Beaver Creek on a footbridge near its mouth, and parallels the north bank to the headwaters below Beaver Pass. An old U. S. Geological Survey snow survey cabin and a gaging station are located immediately below the footbridge, and there is a cable crossing above the bridge. On the point north of the bay at the stream mouth is a floating boat dock and a well-developed Park Service campground with seven campsites and two pit toilets. Old maps show the McMillan ranch located south of the stream about a mile above the existing mouth. The writers were unable to find any trace of structures, although the old trail leading from the lakeshore may still be followed through the forest with some difficulty.

In the upper valley, the only developments other than the trail are two U. S. G. S. snow survey cabins at Tenmile and above the confluence with McMillan Creek and shelters at Tenmile and just below Beaver Pass. The National Park Service, through the issuance of fire permits, has been able to localize camping at the campground and the two shelters. The marks

of old improvised campsites along the trail are rapidly disappearing under the lush growth of the forest floor.

The great Skagit fire of 1926 had its origin several miles up the Big Beaver Valley. It burned intermittently downstream and then travelled up the Skagit valley all the way to the Canadian border. The primitive fire fighting methods of the day and the lack of access did not permit its control, and the fire was allowed to burn unhindered until extinguished by the autumn rains. The fire has had profound effects on the plant communities of the valley, and interesting contrasts are afforded between the areas of old-growth forest and those areas opened by the fire.

Figure 9. Relict Douglas-fir.
Fire scars from 1926 Skagit fire.

III. Plant Communities and Their Relation to the Environment

Ecological Classification

Big Beaver Valley, like the other lowland valleys of the western slope of the North Cascades, lies in the Humid Transition life zone (Merriam,

1998; Piper, 1906). This zonal classification, based on altitudinal belts, has proven to be difficult to apply to this complex and highly dissected region, and later workers have developed zonal classifications more closely related to vegetative characteristics. Franklin and Dyrness (1969) place the area in a Northern Cascades Province, and most of the valley would fit in the Tsuga heterophylla Zone described by these authors. At the extreme upper end it grades into their Abies amabilis Zone, or the Canadian Zone of earlier writers. In an earlier work, Franklin (1965) divided the North Cascades complex into two different ecological provinces: the Mt. Baker Province west of the Cascade crest and the Wenatchee Province east of the crest. Big Beaver Valley would be a part of the Mt. Baker Province, but in its lower reaches it has many of the vegetative characteristics of the Wenatchee Province. Before its flooding, the valley of the upper Skagit supported an interesting blend of the floras of the wet western slopes and the dry eastern slopes of the Cascades (Douglas, 1970), and some of these floral features are still to be found in lower Big Beaver Valley.

Climate

The climate of the valley may be described as wet, mild, and maritime. Annual precipitation varies from less than 50 inches at the lakeshore to more than 70 inches at Beaver Pass, and most of this occurs in the winter months. The summer months are generally dry and warm, and in the unusually warm summer of 1970, frequent daily maximums in excess of 90° f. were noted. Mean daily minimums for the coldest month, January, at the nearest weather station at Diablo Dam are 26.5° f., and it may be presumed that winters are generally equable in Big Beaver Valley.

Hydric Habitats of Stream, Ponds, and Bogs

The banks of Big Beaver Creek provide several miles of hydric habitat, reflected in the dense and tangled border of trees and shrubs overhanging the stream. Dominant trees are red alder, Alnus rubra, black cottonwood, Populus trichocarpa, and western redcedar, Thuja plicata. Principal shrubs are Acer circinatum, Cornus stolonifera, Lonicera involucrata, Salix lasiandra, and Sambucus racemosa. Other common shrubs are Corylus cornuta, Oplopanax horridum, Physocarpus capitatus, Rhamnus purshiana, Rosa nutkana, Rubus spectabilis, and Viburnum edule. This is a difficult habitat to investigate, particularly in the lower valley, where the stream-side thicket constitutes an almost impenetrable barrier up to 100 yards in depth.

Figure 10. Stream-side vegetation along Big Beaver Creek.

At various intervals along the stream, usually at sharp bends, there are bars of sand or gravel. These bars, generally of only a few feet in width, but occasionally up to 25 feet wide, appear to be flooded most years

during spring run-off. However, because they are not shaded by the dense stream-side thickets, they support an unusually rich population of herbs. Many of the most colorful flowering plants of the valley were found in this favorable habitat.

Figure 11. Mimulus lewisii, Monkeyflower.

The following herbs were collected from a number of these bars, particularly from the very large bar below the confluence of Thirtyninemile Creek: Anaphalis margaritacea, Arabis hirsuta var. glabrata, Artemisia michauxiana, Aster campestris, A. modestus, Athyrium filix-femina, Barbarea orthoceras, Campanula rotundifolia, Cerastium arvense, Collinsia parviflora, Collomia heterophylla, Epilobium alpinum, E. angustifolium, E. glaberrimum, E. latifolium, Equisetum arvense, E. hymale var. affine, Galium triflorum, Geum macrophyllum, Glyceria elata, Goodyera oblongifolia, Habenaria dilata var. leucostachys, Lilium columbianum, Menthe arvensis, Mimulus lewisii, Montia parvifolia, M. sibirica, Osmorhiza chilensis, Phacelia heterophylla, Polygonum minimum, Ranunculus macounii, Sedum lanceolatum, Tofieldia glutinosa var. brevistyla, and Thalictrum occidentale.

The ponds in the lower valley are conspicuous features of the landscape, particularly from moderate elevations on the valley walls. Wolcott (1965) lists three of them and estimates their acreages as 15.0, 4.0, and 3.0. The other three ponds are much smaller, with estimated acreages of 1.0, 1.5, and 1.5. The writers were able to approach close to the shores of the five smaller ponds, but because of the depths of water and mud at the marshy borders, were unable to make extensive plant collections. Future investigators of these ponds would find a small pneumatic raft a valuable means of studying them. The use of a peat coring tool would also add materially to knowledge of the history of the ponds and the nature of the plant communities that have shaped them. Corings in other peat areas of the state have disclosed a pumicite layer attributed to the Mt. Mazama eruption of 6600 years ago (Fryxell, 1965). Finding such a layer here and measuring its depth from the surface would tell us much about the development of the area.

In the absence of such detailed investigations and depending on observations only, a few generalizations may be made. In the summer months the smaller ponds are completely covered with floating leaved species, two of which were identified as Nuphar polysepala and Potamogeton natans. This would indicate their depths to be less than that of the large pond (number 6 on the map in Figure 8), which has open water save at the margins. All the ponds are surrounded by a girdle of Equisetum spp., which occupy the shallower depths, and beyond this marginal border, various Cyperaceae extend on to dry ground. The various sedges and rushes appear to be building up accumulations of decomposed organic matter and are gradually reducing both the depth and area of the ponds.

It is probable that the areas surrounding these ponds should be classified as "marsh" rather than as "peat bog". Dansereau and Segadas-Vianna (1952) distinguish between these two ecosystems on the basis of the

presence in the bog and absence in the marsh of floating mats of vegetation and mosses. Neither one of these features was noted by the writers. It may be that the washing in of mineral matter by the stream, together with the extensive disintegration and decay of the bottom-rooting plants, is contributing to the formation of muck rather than peat (Rigg, 1958).

In addition to the plants noted above, the following were collected from the marshy borders of the ponds: Cornus stolonifera, Dulichium arundinaceum, Habenaria dilatata var. leucostachys, Mimulus moschatus, Sanguisorba sitchensis, Spiraea douglasii var. menziesii, Veronica americana.

In the writers' opinion, one of the most interesting areas in the valley from a floristic viewpoint is the sphagnum bog in Sec. 5, R. 13E, T. 38N, approximately 1/4 mile east of Thirtyninemile Creek (number 7 on the map in Figure 3). Sphagnum bogs were once numerous in lowland areas of the Puget Sound physiographic province, but they are relatively uncommon in the Cascades (Rigg, 1917, 1922a, 1922b, 1922c, 1925, 1958). Almost all of the sphagnum bogs studied by Rigg during his lifelong work with this ecosystem have since been severely disturbed by man, and many have been completely destroyed by mining for peat or by being drained and filled to support construction. Because this bog in Big Beaver Valley has been completely untouched by man, it has a valuable potential for research.

Again, it will be necessary to take corings in this bog for a complete understanding of its history. As in the case of the post-glacial ponds described above, only general observations can be made at this time. It is probable that a depression or poorly drained flat existed here before the beaver dams were built. Generally such a depression in an area like this would be the work of water or ice, with the work of the beaver

as a secondary agent (Rigg, 1958). That the dams of the beaver have extended the area of the bog is evidenced by the ring of standing, water-killed western redcedars.

Figure 12. View down-valley from sphagnum bog.

Figure 13. Sphagnum bog.

The writers would consider this bog to be in the earlier stages of its development. Such stages are characterized by a mixture of swamp and bog species such as Drosera rotundifolia, Lysichitum americanum, Menyanthes trifoliata, Potentilla palustris, various orchids, rushes, and sedges. Only in later stages do the ericaceous bog plants such as Kalmia polifolia, Ledum groenlandicum, and Vaccinium oxycoccus become abundant (Rigg, 1925, 1958). There is still a considerable amount of deep open water, and some of the sphagnum mats in the center appear to be detached.

The floating mats on sphagnum bogs are enlarged by the activity of several species which grow forward into the water at the margin of the mat. Fitzgerald (1966) found the woody bog plants, Kalmia polifolia and Ledum groenlandicum, to be the pioneer species in her study of King's Lake Bog. Rigg (1925) found Menyanthes trifoliata functioning as a pioneer plant forming the floating mat on which the bog association advances. This latter species, as well as Potentilla palustris, appear to be the chief floating species advancing the growth of the mats on Big Beaver Bog. None of the three ericaceous bog plants so common in lowland sphagnum bogs were noted here. The only Ericaceae seen were Menziesii ferruginea and Vaccinium ovalifolium, both growing on firmer sites away from the water's edge.

The charming insectivorous sundews, Drosera rotundifolia, are considered the indicator plants for living sphagnum bogs for the entire Northwest region (Rigg, 1925), although they are not always found in such abundance as in Big Beaver Bog. Here they are so numerous as to give a reddish cast to the surface of the sphagnum mats. These plants are seldom found growing outside of bogs, and with the rapid disappearance of this ecosystem, they are certainly deserving of a high order of protection. Growing in the sphagnum mats along with the sundews are also numerous tall orchids, Habenaria dilatata var. dilatata, H. dilatata var. leucostachys

and H. hyperborea all being noted.

Figure 14. Drosera rotundifolia, the Sundew

Figure 15. Habenaria dilatata
var. leucostachys,
Bog orchid

Between the bog and the upland areas is a marshy area which may correspond to the "marginal ditch" described by other workers with this ecosystem. Turesson (1916) considered this marginal ditch to be caused by the shade from trees and fallen leaves, both of which tend to suppress the light-loving sphagnum. Lysichitum americanum, common in this marshy section, was considered by Turesson to be a relict from the swamp flora and not related to the group of plants which in more recent times have succeeded in entering the bog by reason of partial drainage. In older bogs the skunk cabbage tends to grow in deep pits in the sphagnum, although still rooted in the bottom. Such a habit of growth was not noted in Big Beaver Bog.

The following plants were collected from the floating mats, asterisks indicating those species found nowhere else in the valley: Angelica arguta, Carex spp., Drosera rotundifolia*, Dulichium arundinaceum, Equisetum arvense, E. hyemale var. affine, Eriophorum polystachion*, Habenaria dilatata var. dilatata, H. dilatata var. leucostachys, H. hyperborea*, Lycopus uniflorus*, Lysichitum americanum, Menyanthes trifoliata*, Potentilla palustris*, Rhynchospora alba*, Scheuchzeria palustris var. americana*, Scirpus microcarpus, Tofieldia glutinosa var. brevistyla, Trientalis arctica*.

On firmer sites the following were collected or noted: Alnus rubra, Athyrium filix-femina, Cornus stolonifera, Epilobium watsonii var. occidentale, Geum macrophyllum, Menziesia ferruginea, Salix scouleriana, Vaccinium ovalifolium.

There are large unforested areas at various locations on the flat valley floor. The six lower ponds, particularly, are surrounded by these open areas which, from a distance, give the appearance of meadow. Closer examination discloses a typical Carex-Salix community, a successional stage from the open water of the ponds. The willows, Salix lasiandra,

S. scouleriana, and S. sitchensis, preferred food plants of the beavers, have been kept at a low height by these animals. Besides the willows and sedges, the next most common member of this community is Spiraea douglasii var. menziesii which combines with the willows to form dense tangles. Throughout the open valley bottom are islands of large western redcedar and occasional patches of black cottonwood. Additional plants to the above collected or noted in this community were: Angelica arguta, Aster modestus, Epilobium watsonii var. occidentalis, Geum macrophyllum, Menthe arvensis, Polygonum phytolaccaefolium, Scirpus microcarpus, Urtica dioica var. gracilis, and various Cyperaceae and Gramineae.

Figure 16. Carex-Salix flats in bottom of Big Beaver Valley

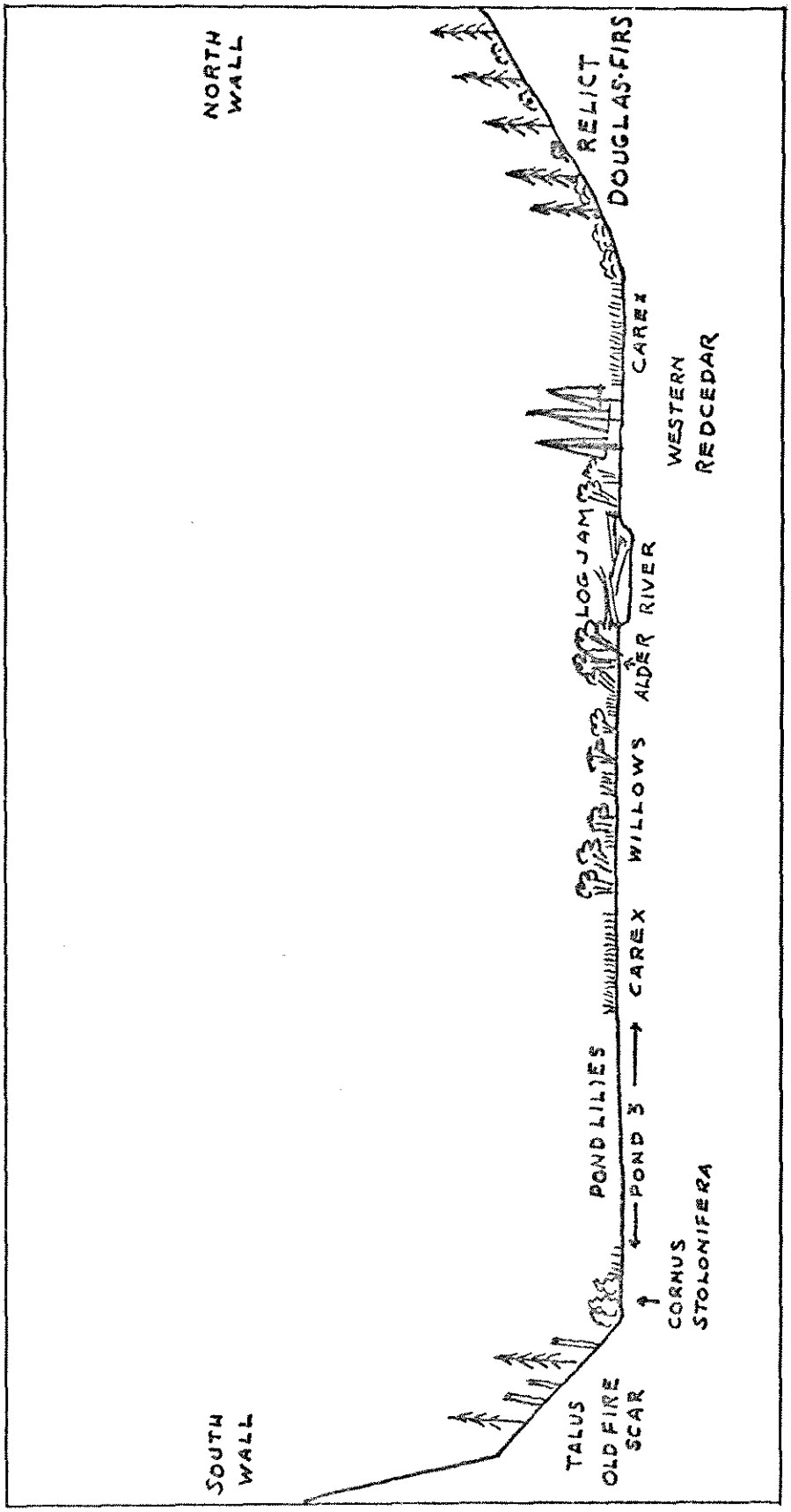


Figure 17. Transect across valley bottom in vicinity of Pond 3

Another hydric habitat of limited extent occurs along the banks of Pierce Creek, the steep mountain stream that enters the lake at the mouth of Big Beaver Valley. The cooling spray from the falls and cascades maintains a microclimate very different from any other in the valley, and plants were collected here that occurred at no other site examined. Some of these plants are more usually found at much higher elevations. The following species were collected or noted, those marked with an asterisk being unique to this habitat within the valley: Alnus sinuata, Athyrium distentifolium*, Berberis nervosa, Blechnum spicant, Cornus canadensis, Cystopteris fragilis*, Epilobium alpinum var. lactiflorum*, Gymnocarpium dryopteris, Lupinus latifolius, Menziesia ferruginea, Pachystima myrsinites, Pinguicula vulgaris*, Pseudotsuga menziesii, Pyrola asarifolia, Ribes lacustre, Romanzoffia sitchensis*, Rubus pedatus, R. spectabilis, Saxifraga ferruginea var. macounii, S. punctata var. cascadensis*, Thuja plicata, Tsuga heterophylla, Vaccinium ovalifolium.

Figure 18. Falls of Pierce Creek

Forest Communities

Much of the interest of Big Beaver Valley to the ecologist derives from its extremely varied forest communities. To walk the trail from the lake shore to Beaver Pass is to enjoy a constantly changing floristic scene as site characteristics grade from one to another or, as often, shift abruptly. The following discussion will attempt to examine the valley's forest floras along increasing moisture gradients from east to west.

Lodgepole Pine Forest

The area immediately adjacent to Big Beaver Campground at the lakeshore and extending a short distance up the lower slopes of Pumpkin Mountain supports an unusual young stand of lodgepole pine, Pinus contorta. This species, which also occurs at various other points along the shores of Ross Lake, is not a common tree of the Northern Cascades Province. The coastal variety, P. contorta var. contorta, is abundant in the Puget Sound area, but these trees in Big Beaver Valley appear to be var. latifolia, the interior form (Tackle, 1958). Stands of P. contorta are common on the eastern slopes of the Cascades and constitute a major seral species in both the Pseudotsuga menziesii Zone and the Abies grandis Zone (Franklin and Dyrness, 1969). However, these authors list the species for the western slope only on the ultramafic outcrops of Twin Sisters Mountain, where Kruckeberg (1964, 1967) found the species to be a characteristic of the Twin Sisters dunite as well as of other serpentine soils in the Wenatchee Mountains and the San Juan Islands. As none of the other plants considered by Kruckeberg to be serpentine indicators were found in this stand, and the vegetation was not typically stunted and sparse, some other reason than highly basic soil must be sought as the explanation for the presence of P. contorta.

Heusser (1965) considered that the vegetation immediately following the withdrawal of the glaciers in the Pacific Northwest consisted of lodgepole pine parkland. Only as the climate became warmer in the postglacial period did alders and more tolerant coniferous trees like the hemlocks displace the pine parkland. It is thus possible that these lodgepole stands may be postglacial relicts. In any event, they constitute still another example of the eastside flora mingling with the flora of the wet westside.

Generally P. contorta stands in eastern Washington are seral, following fire, logging, or other disturbance (Franklin and Dyrness, 1969), and these trees are no exception. Following the 1926 Skagit fire, the lodgepole pine served as the pioneer species. The fire appeared to have crowned in this area, as there are no large relict Douglas-firs standing, although numerous prone logs remain. The largest lodgepole pine examined with a coring tool showed an age of 42 years and the largest Douglas-fir in the stand 36, both having diameters of 12+ inches. The P. contorta occurs only sparsely above 1725 feet on the slopes of Pumpkin Mountain. Gail and Long (1935) found the species largely limited to protected sites because of its shallower and less extensive root system and the excessive increase in its rate of transpiration when subjected to wind. These characteristics could be responsible for the absence of lodgepole pine from the higher and less protected slopes.

Although Howell (1931) found the species occurring in the eastern Cascades mainly on wet flats and poorly drained soil, P. contorta has wide edaphic adaptability and also prospers on well drained soil. This area appears to be the most xeric portion of the valley bottom, as evidenced by the numerous sclerophyllous plants associated with the pines. The stand has not suffered from excessive regeneration, and it is quite

open, with shrubs and herbs equally well spaced. A 10-meter quadrat surveyed in a typical area showed 36 Pinus contorta up to 12" dbh, 3 Pseudotsuga menziesii, 1 Pinus monticola, and 3 Salis lasiandra. Plants of the forest floor were 300 Berberis nervosa, 250 Chimaphila umbellata, 200 Pachystima myrsinites, 30 Trientalia latifolia, and 12 Goodyera oblongifolia.

Figure 19. Arctostaphyllos uva-ursi, Kinnikinick, under P. contorta, seedling P. monticola.

In other parts of this forest there are extensive mats of Arctostaphyllos uva-ursi and Gaultheria ovatifolia. Cornus canadensis, also common in this area, bore ripened fruit several weeks before the plants of the same species on shaded, more hydric sites had dropped their floral bracts. It is interesting to note that this disturbed area in and around the Big Beaver Campground and on the lower slopes of Pumpkin Mountain supports a more varied flora than the other less xeric areas in the valley. The greater light and lessened competition in this dry area more than outweigh the advantages of more adequate moisture and deeper soils in the areas of mature forest.

Figure 20. Gaultheria ovatifolia, Oregon Wintergreen, under P. contorta

Figure 21. Cornus canadensis, Bunchberry, in fruit under P. contorta

Species collected or noted in the P. contorta stands were: Abies amabilis, A. grandis, Acer glabrum, Alnus rubra, A. sinuata, Betula papyrifera, Pinus contorta, P. monticola, Populus trichocarpa, Prunus emarginata, Pseudotsuga menziesii, Salix lasiandra, S. scouleriana, Thuja plicata, Tsuga heterophylla,

Shrubs and herbs: Acer circinatum, Achillea millefolium, Amelanchier alnifolia, Antennaria neglecta var. attenuata, Apocynum androsaemifolium, Arctostaphyllos uva-ursi, Berberis aquifolium, B. nervosa, Ceanothus sanguineus, C. velutinus, Chimaphila menziesii, C. umbellata, Clintonia uniflora, Collomia heterophylla, Cornus canadensis, Corylus cornuta, Cryptogramma crispa var. acrostichoides, Epilobium angustifolium, Fragaria virginiana var. platypetala , Gaultheria ovatifolia, G. shallon, Goodyera oblongifolia, Heuchera micrantha var. diversifolia, Hieracium albiflorum, Holodiscus discolor, Juniperus communis, Linnaea borealis, Luina hypoleuca, Pachystima myrsinites, Penstemon serrulatus, Philadelphus lewisii, Polygonum douglasii var. douglasii, P. douglasii var. latifolium, Pteridium aquilinum, Pyrola asarifolia, P. picta, P. secunda var. secunda, P. virens, Rosa gymnocarpa, R. nutkana, Rubus parviflorus, R. ursinus, Shepherdia canadensis, Spiraea douglasii var. menziesii, Trientalis latifolia, Vaccinium membranaceum, V. parvifolium.

Figure 22. Plants of the dry forest floor: Cornus canadensis, Bunchberry; Linnaea borealis, Twinflower; Berberis nervosa, Oregon Grape

Mixed Forest South of Stream

At the lower end of Big Beaver Valley the stream apparently acted as a barrier to the 1926 fire, and the forest south of the stream was unaffected. East of the trail to Ross Dam the site is relatively dry, and the forest is very open in appearance with an inconspicuous shrub story. Corings of trees in the most xeric site near the lake shore indicate a maximum age of 215 years. The forest in this area is a mixed stand of western hemlock, Douglas-fir, and western redcedar, with isolated examples of western white pine and Pacific silver fir. Regeneration largely consists of the more tolerant hemlock. The forest floor is extensively covered with mosses in which grow numerous Orchidaceae and Ericaceae.

West of the trail the site is more mesic, with western redcedar as the dominant species. This species appears to be succeeding Douglas-fir, as there are numerous large specimens of the latter, undoubtedly relicts of an earlier forest that followed a fire of the distant past. The shrub story is more extensive than that of the drier forest described above but still depauperate by comparison with the understory found in the mature western redcedar stands farther up the valley. This forest ends at the talus slopes beneath the vertical wall above Pond 1.

Species collected or noted in these stands south of the stream were: Abies amabilis, Acer circinatum, Allotropa virgata, Antennaria neglecta var. attenuata, Arctostaphyllos uva-ursi, Asarum caudatum, Athyrium filix-femina, Berberis nervosa, Cardamine pennsylvanica, Chimaphila menziesii, C. umbellata, Circaea alpina, Clintonia uniflora, Corallorhiza maculata, C. mertensiana, Cornus canadensis, Disporum smithii, Epilobium minutum, E. watsonii var. occidentale, Galium triflorum, Gaultheria shallon, Goodyera oblongifolia, Gymnocarpium dryopteris, Habenaria orbiculata, Hypopitys monotropa, Linnaea borealis, Listera cordata, Lonicera ciliosa,

Lycopodium annotinum, Menziesii ferruginea, Montia sibirica, Oplopanax horridum, Osmorhiza chilensis, Pedicularis racemosa var. alba, Pinus monticola, Polystichum munitum, Pseudotsuga menziesii, Pteridium aquilinum, Pterospora andromedea, Pyrola asarifolia var. asarifolia, P. asarifolia var. purpurea, P. secunda var. secunda, P. dentata, P. picta, Rosa gymnocarpa, Smilacina stellata, Symphoricarpus albus, Taxus brevifolia, Tiarella unifoliata, Tsuga heterophylla, Thuja plicata, Trientalis latifolia, Trillium ovatum, Vaccinium membranaceum, V. ovalifolium, V. parvifolium.

Figure 23. Allotropa virgata, Sugarstick

Figure 24. Habenaria orbiculata, Green Rein Orchid

Alder Forest

West of the dry lodgepole pine forest at the present ~~river~~ CREEK mouth is a burned-over area in which, because of greater available moisture, red alder, Alnus rubra, has been the pioneer species (Worthington, 1957). This is a very dense alder forest with a few large relict Douglas-firs, survivors of the 1926 fire. There is some regeneration of western redcedar, but because of the dense canopy, none of the Douglas-fir. In the areas with higher water table Lysichitum americanum is common. This stand, part of which could be classified as "alder swamp", extends for about one-quarter mile along the trail.

Xeric Outcrops and Talus Slopes

The very steep rock faces of the north valley walls and the talus slopes have plant associations quite different from those of other sites in the valley. Soils here are shallow to non-existent, many of the rock outcrops being exposed or covered only with pioneer lichens and mosses. There are many large Douglas-firs, all marked by fire. It is probable that the 1926 fire, by destroying the lower story plant communities, allowed the slowly built up soils to wash away and caused these outcrops to become still more barren. The sites are now extremely xeric, and during the summer months of the investigation, the moss covering was so parched as to be brittle and crumbling. Gaultheria shallon, found by Douglas (1969) to be the only constant shrub on xeric outcrops in the Tsuga heterophylla Zone, was not present here. This species occurs only at the mouth of the valley and apparently has been unable to colonize this community.

The ground level plants of this association are particularly interesting, several being found nowhere else in the valley. Two most unusual finds were Berberis repens and Calochortus tolmiei, both plants of the dry country east of the Cascades and not previously reported from the

park complex. The following species were collected or noted, asterisks indicating those plants not seen elsewhere in the valley: Acer macrophyllum (habit as shrub), Agrostis scabra*, Allium cernuum*, Arctostaphyllos uva-ursi, Arenaria macrophylla, Berberis repens*, Betula papyrifera (habit as shrub), Calamagrostis rubescens*, Calochortus tolmiei*, Castilleja spp. (2)*, Collomia heterophylla, Cryptogramma crispa, Epilobium alpinum, Eriophyllum lanatum, Fragaria virginiana var. platypetala, Fritillaria lanceolata*, Habenaria saccata, Heuchera micrantha var. diversifolia, Hieracium albiflorum, H. scouleri*, Holodiscus discolor, Lilium columbianum, Lomatium ambiguum*, Montia parvifolia, Penstemon davidsonii var. menziesii*, Polystichum lonchitis*, Prunella vulgaris, Pseudotsuga menziesii, Sedum lanceolatum, S. oreganum*, Sorbus sitchensis, Spiraea betulifolia*, Symphoricarpos albus, Vaccinium parvifolium, Zigadenus venenosus*.

Figure 25. Moss covered rock outcrop on north valley wall with Cryptogramma crispa, Parsley Fern

Mixed Forest

Proceeding westward up the valley from the last evidence of the 1926 fire, one encounters successive stands of western hemlock and Douglas-fir, alternating with extensive stands of large western redcedar. Understory species confirm the modality or even dryness of the sites bearing the western hemlock/Douglas-fir stands. Numerous ericaceous plants and some Orchidaceae characteristic of dry forest sites were abundant here but were generally lacking beneath the cedars. Plants collected or noted in this mixed forest were: Acer circinatum, A. macrophyllum, Actaea rubra, Adenocaulon bicolor, Antennaria neglecta var. howelii, Aquilegia formosa, Arenaria macrophylla, Arnica latifolia, Campanula rotundifolia, Ceanothus sanguineus, Chimaphila umbellata, Circaea alpina, Corallorhiza maculata, C. mertensiana, Cornus canadensis, Disporum smithii, Epilobium watsonii var. occidentale, Fragariavirginiana var. platypetala, Gaultheria ovatifolia, Goodyera oblongifolia, Hieracium albiflorum, Holodiscus discolor, Lilium columbianum, Linnaea borealis, Lycopodium clavatum, L. complanatum, L. selago, Menziesia ferruginea, Monotropa uniflora, Osmorhiza chilensis, Penstemon serrulatus, Phacelia heterophylla, Pinus monticola, Polystichum munitum, Potentilla glandulosum, Pterospora andromedea, Pyrola asarifolia, Rosa gymnocarpa, Rubus idaeus, R. parviflorus, Rumex acetosella, Smilacina stellata, Sorbus sitchensis, Tellima grandiflora, Tiarella unifoliata, Vaccinium ovalifolium, V. parvifolium, Veronica americana.

Figure 26. Pterospora andromedea, Pinedrops

Western Redcedar Forest

In an earlier paper, the writers discussed at considerable length the western redcedar stands of Big Beaver Valley (Miller and Miller, 1970). These groves are perhaps the best known natural features of the valley, since the trail has been sited to pass immediately beneath some of the larger specimens, and no visitor can fail to be impressed by their size. The stands are not continuous in the valley but occur as islands of trees on the valley floor, separated by bodies of water and non-forested willow bottoms. Substantial cedar stands were also found on river terraces and a short way up the gentler slopes of the valley walls. The western redcedar type extends about one mile up the valley from the 1725 foot level to the confluence of McMillan Creek.

Figure 26. Western redcedars on Big Beaver trail

Figure 27. Large western redcedar on Big Beaver trail

The writers believe the western redcedar stands to represent an edaphic climax, brought about by the ample summer soil moisture in the sites on which they occur. An interesting, if somewhat puzzling finding,

was the dominance of Acer circinatum in the understory beneath these stands. This species has been considered by several writers (Franklin and Dyrness, 1969) to constitute a character species for mesic sites. On the basis of their quantitative studies of the plant communities of these western redcedar stands, the writers hypothesized a Thuja/Acer association. The characteristic union of this association is dominated by Acer circinatum with Tiarella unifoliata being the next most conspicuous member. Oplopanax horridum and Rubus parviflorus are shrubs with high degrees of constancy, and the other dominant herbs in order of importance are Clintonia uniflora, Smilacina stellata, Athyrium filix-femina, Galium triflorum, Osmorhiza chilensis, Gymnocarpium dryopteris, and Disporum smithii.

The principal herb of this union, Tiarella unifoliata, has been considered by Kern (1964), who studied the genus extensively, to constitute a major geographical unit east of the Cascades, with T. trifoliata dominant west of the Cascades. She found the two taxa overlapping in the Cascades and intergrading more or less continuously in the area of overlap. This was not the experience of the writers, who found only a single specimen of the trifoliate form in Big Beaver Valley.

Little is known about optimum soil texture classes and types for western redcedar (Boyd, 1959), and it would appear that Big Beaver Valley might provide a desirable natural laboratory for studies of edaphic factors affecting the species. Although the species on most sites is characterized by a widely flaring, buttressed trunk, numerous specimens were seen in these stands with a diameter at ground level very little greater than at breast high. Whether this is an indication of a rising ground level from soil washed in by past floods or a growth habit peculiar to deep soils is unknown to the writers. By contrast with these straight trunked trees, a large cedar with an exaggerated "bottle shape" was

observed higher up the valley. Its diameter at breast high was 10 feet, but at 10 feet above the ground, it was less than 4 feet in diameter.

Figure 28. Large western redcedar in Big Beaver Valley

Plants collected or noted in the western redcedar stands were: Abies amabilis, A. grandis, Acer circinatum, Actaea rubra, Adenocaulon bicolor, Adiantum pedatum, Alnus rubra, Arenaria macrophyllum, Aruncus sylvester, Asarum caudatum, Athyrium filix-femina, Berberis nervosa, Botrychium lanceolatum, Circaea alpina, Clintonia uniflora, Cornus canadensis, C. stolonifera, Dicentra formosa, Disporum smithii, Fragaria virginiana var. platypetala, Galium triflorum, Geum macrophyllum, Goodyera oblongifolia, Gymnocarpium dryopteris, Hieracium albiflorum, Linnaea borealis, Listera caurina, L. cordata, Lysichitum americanum, Menziesia ferruginea, Montia sibirica, Oplopanax horridum, Osmorhiza chilensis, Polystichum munitum, Prunella vulgaris, Pseudotsuga menziesii, Pyrola asarifolia, Rhamnus purshiana, Ribes lacustre, Rosa gymnocarpa, Rubus parviflorus, R.

pedatus, R. spectabilis, R. ursinus, Sambucus racemosa, Smilacina racemosa, S. stellata, Sorbus sitchensis, Spiraea douglasii var. menziesii, Streptopus amplexicaulis, S. roseus, Thalictrum occidentale, Thuja plicata, Tiarella trifoliata, T. unifoliata, Tsuga heterophylla, Trillium ovatum, Vaccinium ovalifolium, V. parvifolium, Viburnum edule, Viola glabella.

Pacific Silver Fir Forest

Above the confluence of McMillan Creek with Big Beaver Creek, the valley makes a pronounced bend northward, and its character changes markedly. The stream flows in a deep, narrow gorge, and the valley walls slope steeply down to the tream. Forests are largely western hemlock until about 2500 feet elevation when they grade into Pacific silver fir. On the broad, flat saddle of Beaver Pass are numerous pure, very dense stands of Pacific silver fir with very little understory. Dimock (1958) found the edaphic requirements of this species to be a well drained soil with an abundant moisture supply. Mean annual precipitation in excess of 70 inches at the Pass and average April 1 snow depths of 33 inches (Appendix 4) would certainly satisfy the moisture requirement.

The forest communities from the Luna Creek confluence to Beaver Pass are extremely mixed, with western white pine, Douglas-fir, western hemlock, and western redcedar mingling with Pacific silver fir and occasional examples of Alaska-cedar and mountain hemlock. These species were found by Franklin (1965) to be the characteristic trees of the Abies amabilis Zone of the Northern Cascades, although the latter two are found here at an unusually low elevation, indicating some vertical compression of the Zone. There are numerous unforested areas on the steeper slopes below the Pass where the shrub communities appear to be maintained as topographic climaxes by recurrent avalanches (Franklin and Trappe, 1963). Alnus sinuata and

Acer circinatum are characteristic shrubby species in the avalanche Zones.

Plants collected or noted from the confluence of Luna Creek to Beaver Pass were: Abies amabilis, Acer circinatum, Adenocaulon bicolor, Adiantum pedatum, Alnus sinuata, Arnica latifolia, Asarum caudatum, Aster modestus, Athyrium filix-femina, Blechnum spicant, Chamaecyparis nootkatensis, Chimaphila menziesii, C. umbellata, Clintonia uniflora, Corallorhiza mertensiana, Cornus canadensis, C. stolonifera, Dicentra formosa, Epilobium angustifolium, Gaultheria ovatifolia, Goodyera oblongifolia, Gymnocarpium dryopteris, Habenaria saccata, Linnaea borealis, Listera cordata, Lysichitum americanum, Menziesia ferruginea, Oplopanax horridum, Osmorhiza chilensis, Pachystima myrsinites, Parnassia fimbriata, Pinus monticola, Populus trichocarpa, Pseudotsuga menziesii, Pteridium aquilinum, Pyrola asarifolia, P. picta, P. secunda, Ribes laxiflorum, Rubus parviflorus, R. pedatus, R. spectabilis, Salix sitchensis, Sambucus racemosa, Smilacina stellata, Sorbus sitchensis, Stenanthium occidentale, Streptopus streptopoides, Taxus brevifolia, Thalictrum occidentale, Thuja plicata, Tiarella unifoliata, Tsuga heterophylla, T. mertensiana, Vaccinium alaskaense, V. membranaceum, V. ovalifolium, Valeriana sitchensis, Veratrum virides, Viola glabella.

IV. Faunal Components of the Ecosystems

The various communities of Big Beaver Valley are so varied and their interrelations so complex that even a descriptive study as contrasted to a functional or "community metabolism" study (Odum, 1959) presents problems that are somewhat overwhelming. The writers can only hope to attempt to show in the following discussion how the animals of the valley are related

to the various floral communities and to each other to make up a unified system. It is an interesting ecological concept that in every forest the living creatures that make up the community are actually selected by the dominant trees and lesser plants that determine the environment in which they must live (Storer, 1956). This process of selection of the community's animals is carried out, not only by the dominant plant species, but by certain other important animals. Thus the beaver, most important of the valley's mammals, is highly important to other organisms and even determines their presence and abundance.

Animals of Hydric Habitats

No animal, no matter how insignificant, fails to affect its environment to some degree, but it is difficult to think of another animal (man excluded) whose works so nearly resemble a geologic force as those of the beaver. This interesting mammal has undoubtedly lived in Big Beaver Valley since the first willows returned to the valley following the retreat of the glacier that had occupied it, and evidence of its activity is to be seen everywhere on the valley floor. In the lower valley all of the six postglacial ponds have been occupied by beavers in the past, but evidence of present occupation was found by the writers only in the channel connecting ponds 3 and 4 (map in Figure 8). There was a large occupied lodge here that rose 4 feet above the water, and a beaver was observed swimming across pond 3 on August 4, 1969. The willow flats that separate the ponds from each other and from the river are crossed and recrossed with beaver canals, and fresh willow cuttings were observed downstream from pond 3. The willow brush in the flats has been pruned to a low level by beavers which also feed on the abundant yellow pond lilies

(Ingles, 1965).

In the lower valley no dams were found on channels of the stream itself. There are many cuttings along the stream, however, and it would appear that these have been the work of bank dwelling beavers. Ingles (1965) states that most native beavers living in valleys with deep streams build their nests in burrows in the banks since they do not need the dams and the resulting ponds for winter protection.

Figure 29. Reflection of Southern Pickets in beaver pond.

The level of the sphagnum bog pond is maintained by beaver dams, but in the summer of 1969 there appeared to be no current occupancy of this area. However, between August of 1969 and June of 1970 a family of

beavers constructed a new lodge in this pond, located adjacent to the shore and even blocking the Big Beaver trail. Seton (1953) found such bank lodges to be a transitional structure from the bank burrow. The animals construct a roofing of sticks to protect the ventilator of the burrow, and this gradually is expanded into the bank lodge.

The large beaver pond, marked 8 on the map in Figure 8, is the most recent work of the beaver in converting an area of mature forest into marsh. Here the animals have succeeded in throwing a long dam across a channel of Big Beaver Creek itself, and the rising water has killed many large trees. The dead timber will eventually fall and decay, the pond will fill with mineral sediment and decaying vegetation, and the processes of hydrarch succession will return the area to a terrestrial habitat. In the distant future, the cycle will be complete, and the cedars will grow there once more.

Figure 30. Large beaver pond with ring of water-killed trees.

Careful observation of this area during both summers did not disclose any fresh cuttings nor were any beavers seen. It seems probable that the residents of this pond very recently ate the last of the willows and migrated elsewhere. Hall (1960) found that beavers can thrive indefinitely on willow by a form of "block cutting" or shifting their foraging periodically up and down the stream, allowing the overbrowsed sections time to recover. Unlike the aspen, which is a preferred food in other parts of the West, the willow is not killed by the beavers, since it sprouts from the roots. They still eat it more rapidly than it grows, so that sprouting vigor gradually declines.

Figure 31. 20" Douglas-fir partially felled by beavers at Pond 8.

A most interesting feature of this area is the large number of mature Douglas fir and western redcedar trees which were felled or partially

girdled by the beavers, apparently, to judge from the color of the chips, within the last few years. Those trees which fell were stripped of their bark. Many early observers stated flatly that beavers never ate conifers (Seton, 1953), but Hall (1960) in his study of beavers in the California Sierra, found them frequently felling white fir, Abies concolor. He concluded they were seeking some ingredient present in the bark or basal sap of the conifer. It would be interesting to learn whether the beavers of Big Beaver Valley were finding some tasty substance in the bark or sap of these firs and cedars or were only driven to this food source by the lack of the more palatable willows.

On July 23, 1969, two adult river otters, Lutra canadensis, were sighted swimming upstream beneath the footbridge across Big Beaver Creek. These uncommon animals were not seen again that summer, nor were they seen during the summer of 1970. On November 24, 1969, one of the writers briefly visited the valley with a television crew. Two otters, perhaps the same pair, were on the bank downstream from the bridge. They dived into the water and swam toward the bridge, raising their heads from the water for a closer look at the men on the span and getting their pictures taken for the edification of the television audience.

River otters are known to travel as much as 50 to 60 miles along streams in the course of a year (Ingles, 1965), and the writers consider themselves most fortunate to have seen these unusual and supremely graceful animals. Although the river otter is not among the rare mammals listed by the Washington Game Department and indeed is trapped extensively (Larrison, 1970, estimates 750 pelts in the 1967-1968 season), the writers believe it to be sufficiently uncommon as to warrant complete protection. The river otter seldom conflicts with man's interest since, although fish comprise a large part of its diet, it catches mostly fish not of game

quality, "rough" fish that actually eat trout eggs (Ingles, 1965). Other small aquatic animals such as frogs and insects are taken in quantity, and it probably would not turn down a mouse, shrew, or young bird.

Tracks of mink, Mustela vison, were seen commonly along the stream as the water level dropped and left bars covered with fine silt. On July 4, 1970, at 8 AM, the writers encountered a mink on the footbridge near the mouth of Big Beaver Creek. The animal, desiring to cross the bridge, but anxious to avoid the humans, made three attempts before abandoning its journey and disappearing into the brush on the south bank. The habitat along Big Beaver Creek is apparently well suited to this medium sized mustelid because of the availability of fish, frogs, mice, and nesting birds upon which it feeds (Ingles, 1965).

The generally nocturnal raccoon, Procyon lotor, was not seen in the valley, but it is impossible to mistake its small, child-like hand prints for the tracks of any other native mammal (Murie, 1954). Tracks were seen only along the stream where it was helping to decimate the frog populations, but it probably foraged well away from the stream as well. Apparently, even though the raccoon and the mink live in the same streamside habitat, they do not occupy the same niche. The mink is strictly carnivorous and a semi-aquatic mammal, while the raccoon is the most omnivorous of all carnivores except the black bear and does much foraging on land (Ingles, 1965).

These larger fur-bearing mammals, beaver, river otter, mink, and raccoon, that live in the river communities probably have few enemies besides internal parasites and man. In the early days the valley's pioneer rancher, McMillan, trapped extensively in the valley. McMillan's only neighbor, the "hermit" who lived at what is now Roland Point, also visited

the valley and ran traplines (O'Leary, 1970). Although the valley has since been difficult of access for fur trappers, the fact that its lower reaches lie in the Ross Lake Recreation Area rather than the North Cascades National Park means that trapping pressure is still a potential threat.

Many smaller animals besides the large furbearers frequent the streamside habitat. The white footed deer mouse, Peromyscus maniculatus, was live-trapped along the stream. This ubiquitous small beast no doubt contributes to the food supply of many predators, mammals, birds, and reptiles. Insects and other invertebrates at the stream's edge were probably being sought for food by the deer mouse in its nightly forays along the mud and sand banks (Larrison, 1970).

During the summer months, the belted kingfishers patrol the river for minnows, while the underwater insect patrol, the dippers, and the streamside insect probers, the spotted sandpipers, share the same stretch of water. The three commonly rest on old snags caught at the river's edge, on sandbars, or on logjams in the stream. In July yellow warblers flit in and out of the willows and alders along the river seeking caterpillars and plant lice (Davison, 1967). In the same month flocks of band-tailed pigeons feed their young in the clusters of western redcedars in the river bends, keeping close to a favorite food, red elderberry, a plant of the streamside thickets (Wetmore, 1965). Western tanagers chase yellow jackets and search for beetles in the willows (Collins, 1965).

The garter snake, Thamnophis spp., hides in the wild flowers of the sandbars to wait for the abundant toads and frogs. On June 23, 1970, a large garter snake, T. sirtalis, was seen attempting to swallow an oversized (13cm) Northwest toad, Bufo boreas. Most snakes, owing to the looseness of the skull bones, large gap, recurved teeth, and reinforced trachea, have the ability to swallow objects several times their own

diameter (Stebbins, 1954). This snake, however, had exceeded its capacity, and the unfortunate pair were found dead the following day (O'Leary, 1970).

Figure 32. Garter snake, T. sirtalis, attempting to swallow Northwest toad, B. boreas.

The young toads migrate en masse away from their birthplace in Big Beaver Creek to the relatively safer uplands. The writers were privileged to see thousands of these small (1 cm) creatures making this hazardous first journey on August 7, 1969, and again on August 15, 1970. The frogs commonly seen along the river were the red-legged frog, Rana aurora, and the Pacific tree-frog, Hyla regilla. The red-legged frog was found both in the water and on sand bars where it was probably searching for isopods and beetles, while the tree-frog was seen in the overhanging shrubs where it finds leafhoppers and catches midges and craneflies (Stebbins, 1962).

Two attractive and common streamside butterflies are the swallowtail,

Papilio spp., and the Parnassian, Parnassius clodius. The former is dependent on the Umbelliferae and the latter on the sedums and saxifrages found on the bars and river banks (Holland, 1931).

One of the benefits derived from the impoundment of water by the beavers of lower Big Beaver Valley is the provision of habitat, food, and protection for bird life. Here the water is relatively shallow, quiet, and slow in velocity, providing areas for aquatic plants to flourish. Many bird species were observed nesting, feeding young, or foraging near the ponds. With them occurs a rich water community of insects, spiders, crustaceans, frogs, and fish upon which they depend for food.

The Vaux's swifts and tree swallows sweep insects from the air above the ponds. Dabbling ducks such as mallards and divers such as lesser scaups and Barrow's goldeneyes feed on potamogeton and join hooded mergansers in enjoying the myriad aquatic insects (Pough, 1951). The little hooded mergansers, uncommon tree-nesting ducks, also take a few small fish but many more frogs. A family of these rare little waterbirds was seen on Pond 8 on August 19, 1970, and a family of Barrow's goldeneyes, a new sight record for the park complex, was sighted the previous day on the same water.

Hairy woodpeckers and yellow-bellied sapsuckers work the dead trees standing in the beaver ponds, and flycatchers feed from snags at the edges. A western wood pewee was observed on July 6, 1970, nesting on a dead branch of a red alder in Pond 7. The nest was astride a horizontal limb, 8 feet above the water, on an inundated alder. Another bird of the same species was chasing flies in low shrubs near the nesting site.

Redwinged blackbirds feed in tall grasses and reeds on small islets in the beaver ponds. On July 7, 1970, three young were being fed by a female on an islet in Pond 8. Orians(1961) found that their diet includes

emerging dragonflies and stoneflies and that they also take diptera larvae by turning over rocks and bits of wood at the pond edges with their beaks.

Audubon's warblers were seen busily searching for insects among the shrubby Spiraea douglasii and Cornus stolonifera growth at the edge of the ponds and making erratic sallies into the air like flycatchers. Song sparrows were seen feeding near the sphagnum bog in the summer months. They probably eat the achenes of the sedges and rushes, and Davison (1967) has found that they enjoy Polygonum spp. as well as taking some summer insects. The spotted sandpipers frequent this pond habitat as well as the river, and they were seen bobbing along the half-submerged logs seeking insects and crustaceans.

Not only the vertebrates carry out predation on the abundant insect populations, but there are many insect predators as well. The stoneflies of the ponds eat the mayfly nymphs (Fernald, 1945), and dragonflies of several species sweep the air above the ponds' surface for mosquitoes and other diptera as they emerge from their incubator of mud and water. There are a host of relationships in the water environment, and the interaction of plants and animals in this ecosystem is an area needing much more study. The writers have enjoyed but brief visits to this fascinating and complex aquatic world and thus can speak only in general terms of the ordered and beautiful systems involved.

Animals of Upland Forest Habitats

The valley appears to be well stocked with deer, as their tracks and scat were seen in every part that was visited. Three does, Columbian black-tails, Odocoileus hemionus columbianus, and their fawns of the year

were frequent visitors to the Big Beaver Campground during July and August of 1969. A doe with a small spotted fawn was also seen in the campground area during late June of 1970. The black-tailed deer lives most of its life in the area where it was born and does not migrate 50 miles or more like other mule deer (Ingles, 1965). Dasman and Tabor (1956) found the individual territory to be 800 yards in diameter for females and 1,000 yards in diameter for males, with summer and winter ranges one mile or less apart. This territory apparently disappears under food stress in late winter but reforms upon the birth of the fawns. It would appear that the sharing of the campground area by three does was an example of the distortion of natural social systems by the presence of man and the availability of his unnatural foods.

Figure 33. Columbian black-tail doe, Odocoileus hemionus columbianus in Big Beaver Campground

No tracks of elk were seen in the valley, but on August 5, 1969, a bull was heard bugling on the valley wall south of the stream in the vicinity of Pierce Creek. The elk is an exotic in this part of the state, and this bull may have been a wanderer from the large herds of Rocky Mountain elk in the hills near Yakima.

Food supply for these large mammals is plentiful in the valley: huckleberry, salal, blackberry, and snowbrush, Ceanothus velutinus, for deer (Ingles, 1965), and browse in the form of deciduous trees and shrubs for elk. There are, however, no true meadows in the valley bottom for the grazing of elk.

No black bears, Ursus americanus, were seen in the valley, although they are apparently common. Tracks were seen at several places, on sandbars along the stream, muddy spots in the alder swamps, and in the dust of the trail leading through Big Beaver Campground. A plaster cast was taken in 1969 of a bear's front footprint measuring 5 inches in length. The only evidence of a bear's conflict with man's interests occurred in July of 1970 when one disintegrated the panniers of a Seattle City Light packer in the vicinity of Thirtyninemile Creek. Fresh bear scat on the trail in numerous places indicated a diet of huckleberries and the green berries of Berberis nervosa. The latter appeared to pass through the animals in an undigested state. Investigation of older scats of the black bear showed that much of its food was animal matter, as the scats contained hair and insect remains.

Tracks of cougar, Felis concolor oregonensis, were seen in two places in 1970. On June 22, a big cat had walked in loose sand along the edge of the lake beneath a steep bank in the Pierce Creek area. On August 20 tracks were seen in the dust of the trail for a distance of nearly a mile in the lower end of the valley. This greatest of American predators, the

animal Seton (1956) described as "lithe and splendid beasthood", is now so rare that most naturalists can spend a lifetime in field studies without ever glimpsing one. The cougar is listed among the rare mammals of Washington by the State Game Department, although their numbers seem to have increased somewhat in the last five years (Lauckhart, 1970).

Hornocker (1970) in his studies of the dynamics of lion populations in the Idaho Primitive Area, concluded the species was characterized by strong territoriality. Each resident adult confined itself to a definite range, which varied from 5 to 25 square miles for females and 15 to 30 square miles for males. It is thus probable that Big Beaver Valley is home to not more than 1 or 2 cougars. Although the cougar takes deer in addition to smaller mammals and even grasshoppers, its numbers are so few that no predation problem exists. Hornocker concluded that predation by cougars clearly benefited deer populations. Errington (1963) also stated that predation on animals with well developed territories or home ranges (such as the deer of Big Beaver Valley) is limited to the young, crippled, or diseased. Excess animals that never find a suitable home range are also taken. The existence of this shy and splendid cat in Big Beaver Valley is a matter for rejoicing on the part of those individuals who value an ecosystem with none of its components missing.

Smaller mammals seen frequently in the wooded sections of the valley were the Douglas squirrel, Tamiasciurus douglasii, golden-mantled ground squirrel, Callospermophilus lateralis, and chipmunk, Eutamias townsendii. Hardly a hiker into the fir or pine forests of the valley fails to be announced by the chattering of the Douglas squirrel whose staple food is the seeds from the conifer cones. The little Townsend's chipmunks were often seen in the Big Beaver Campground and in the dry relict Douglas-fir stand up the valley. They nibble the abundant mushrooms (Boletus spp.) of

the woods as well as taking seeds, leaves, stems, and fruits (Larrison, 1946.)

Single individuals of the snowshoe hare, Lepus americanus, were seen both summers, one near the lake and one in the lodgepole pine forest. This animal is subject to widely fluctuating population cycles, and the writers believe it to be at a low point of its abundance in the valley.

Figure 34. Deer mouse, Peromyscus maniculatus, in a hurry.

Peromyscus maniculatus, the common deer mouse, was found in numerous habitats throughout the valley. All specimens trapped in the lower valley measured well under 200 mm in length, indicating they were not the mountain deer mouse, P. oreas, which would be the expected species. Doubtless the latter takes over in the higher reaches of the valley. Live-trapped specimens offered various native berries seemed to prefer Cornus canadensis to others, or even to peanuts. Apparently they are widely omnivorous, eating seeds, leaves, grass, fruit, insects, other invertebrates (Larrison, 1970), or the food supplies of the improvident

camper. Their numbers in the valley are undoubtedly enormous, and they entered the writers' live traps and snap traps to the exclusion of all other small mammals. These prolific little animals form the basis of the predator food chain and are preyed upon by weasels, minks, hawks, owls, and snakes.

The dried body of a shrew, probably Sorex trowbridgei, complete with talon marks, was found on August 20, 1970, in the dry area disturbed by the 1926 fire. Larrison (1970) states it probably eats various insects, arachnids, sowbugs, and other small invertebrates as well as the seeds of Douglas-fir. A possible cause of the shrew's demise could have been the sparrow hawk previously seen in this area. The fact that the shrew had been killed but not eaten would tend to verify Larrison's remark that it is preyed upon by numerous animals, although few of its enemies will eat it.

Making a complete mammal census of an area as large and varied as Big Beaver Valley will require much more concentrated effort than the writers have been able to devote to it. Undoubtedly, several other shrews are present as well as other Microtidae, the meadow mice and their relatives. The bushy-tailed wood rat is sure to be present, at least in the vicinity of the shelters, and probably muskrats share the aquatic habitat of the beavers. To participate in the abundant food supply provided by the deermice, larger predators of the cat and dog families would be expected, and a winter trip to the valley would probably show tracks of bobcat and perhaps coyote or red fox.

Birds are less retiring than mammals and their presence is much easier to record. Probably the bird which does most to call the visitor's attention to itself is the ruffed grouse. As the writers travelled up and down the valley, they were repeatedly startled by the explosive flight of grouse from their path. At least half a dozen separate families of hen

and 4-8 chicks were seen on any particular day. They were observed in such diverse habitats as the dry lodgepole pine forests, the wet bottoms near the river, hemlock-fir forests, and the western redcedar groves. Their food of the fruit of thimbleberry, red-osier dogwood, and huckleberry, rose hips, fern fiddleheads, willow and alder buds, conifer tips, and insects (Wetmore, 1965) is available in every part of the valley.

Higher up on the south wall in the area disturbed by the fire, a blue grouse was observed drumming on the morning of June 20, 1970. His white neck ruff was very prominent against the dark background of the dense stand of young Douglas-fir. The drumming occurred at intervals of about 5 to 6 minutes. Fruits of snowberry, mountain ash, and huckleberry, as well as self-heal, Prunella vulgaris, are favorite local foods of blue grouse (Davison, 1967), and this bird prefers the margins of the forest with open areas and broken habitats (Larrison and Sonnenberg, 1968).

Another ubiquitous bird of Big Beaver Valley is the cedar waxwing. On June 26, 1970, a bird was seen nesting in a Douglas-fir at a campsite in Big Beaver Campground, but by July 2 the young were gone. Adult cedar waxwings were observed feeding fully fledged young in late July of both summers, both in the cedar groves up-valley and in the dead trees at the lakeshore. According to Davison (1967), 75% of their summer food is plant material. However, both Jewett (1953) and Larrison and Sonnenberg (1968) recorded the activity noticed by the writers, that of fluttering high in the air in pursuit of winged prey. Flying insects are included in the diet of the young along with the many kinds of berries and fruits that occur in the valley.

The little winter wren was seen several times, and its amazing cascade of song heard much more often, in the dense old-growth forest stands of the valley. This dark habitat, with ample supplies of ants,

beetles, and leaf-hoppers for foraging (Davison, 1967), the availability of water, and the presence of old stumps for nesting sites, explains the abundance of this small feathered mite with such trememdous vocal powers.

A nesting female rufous hummingbird was observed during the period of June 22 - July 4, 1970, incubating eggs in a nest on a low hemlock branch overhanging the water in the Pierce Creek area. Both males and females of the species were seen in other places in the valley. They were observed feeding on fireweed on the talus slopes south of the river. Other food preferences are columbine and penstemon, both common flowering plants of the valley, and they take small flies and ants as well (Davison, 1967).

Figure 35. Nest and eggs of Rufous hummingbird, Selasphorus rufus

Brightly colored western tanagers were seen flying in and out of the conifers near Pond 8, in the dense hemlock-fir forest, and also foraging on the ground in open, burned-over areas. Their food is almost exclusively insects, and they search out ants, wasps, and beetles such as the pests of

the Douglas-fir, the buprestids (Jewett et al, 1953).

The brown creepers, red-breasted nuthatches, red-shafted flickers, yellow-bellied sapsuckers, and hairy woodpeckers all frequent the trunks of the lodgepole pines and the relict firs. These birds with similar feeding habits do not compete for food. Even though all may be seen on the trunk of the same tree, they confine their hunting to various parts (Storer, 1953). Their physical adaptations also permit this co-existence. The woodpeckers, with barbed tongues many times the length of their beaks (Farb, 1961), seek larvae and borers far inside the bark layer, while the nuthatches and creepers are confined to the surface cracks. The sapsuckers, of course, invite their own insect meals by drilling holes in the bark and feeding on the exuding sap and the attracted prey.

In the same way the seed eaters, the evening grosbeaks, pine siskins, and chipping sparrows divide up the niches within the forest community. The chipping sparrows prefer the brushier areas where they can add caterpillars and insects to their diet, while the grosbeaks consume the larger seeds of vinemaple and mountain ash (Jewett et al., 1953). The siskins feed in the conifers, occasionally lighting on the ground to feed on Douglas-fir seeds. The siskins apparently have a close association with the western redcedar stands of Big Beaver Valley. Although the seeds of this conifer are consumed by birds and mammals in appreciably smaller amounts than those of Douglas-fir and western hemlock, they do constitute an important food of one species, the pine siskin (Gashwiler and Ward, 1966, Gashwiler, 1967). The gaudily marked evening grosbeaks were not seen at all in the valley in the summer of 1969 but were abundant in the lodgepole pine stands during all three summer months of 1970. It is an interesting and mysterious phenomenon that flocks of this species will breed in an area one season and not appear at all during another. The writers noted no

differences in the availability of food sources that would account for this.

Stellers's jays in late June and early July were seen quietly flying in among the lodgepole pines. This contrasting behavior to their usual raucous actions indicated that they were nesting in the Big Beaver Campground area. The other jay of the Cascades, the gray jay, prefers denser forests and was only seen 3 miles or more up-valley. The thrushes of Big Beaver Valley, Swainson's, varied, and the robin, seem to prefer the darker forests to the more open areas.

With such varied and abundant bird populations, avian predators are bound to exist. On several occasions while traversing the Big Beaver trail, the writers found feathers where a hawk had plucked its dinner. Plumage of Steller's jay, red-shafted flicker, yellow-bellied sapsucker, and varied thrushes were found, and on one occasion the secondaries and down of a duck of unknown species were found in the trail. The only hawk identified was the small and colorful grasshopper-eating sparrow hawk, but a large hawk was seen from a distance flying through dense forest. We would not attempt to venture a guess as to what had plucked and eaten the duck.

Numerous garter snakes were observed in upland as well as hydric habitats. The writers identified 3 species of the genus Thamnophis in the valley: T. elegans vagrans, T. ordinoides, and T. sirtalis pickeringi. Stebbins (1954) shows T. sirtalis fitchii as inhabiting the Northern Cascades and states that its zones of integration with T. sirtalis pickeringi are not worked out. However, the Wrights (1957) show fitchii as being found only in northeastern Washington. Inasmuch as the specimens examined were quite dark, with the venter marked in black and with a narrow dorsal stripe, the writers would attribute it to T. sirtalis pickeringi rather than to T. sirtalis fitchii. The literature does not contain records of collections

made by herpetologists in the Northern Cascades.

On July 6, 1970, the writers were pleased to find a fine large (22" snout to tail) specimen of the seldom seen rubber snake or rubber boa, Charina bottae. Upon its release, this docile and attractive snake entered a mouse-sized hole at the base of one of the giant cedars. Stebbins (1954) lists small mammals and lizards as their food, but they seem so slow they must take other less active prey as well.

The northern alligator lizard, Geirhonotus coeruleus, is the only member of the lizard tribe seen in the Big Beaver Valley. One was seen in the lodgepole pine stand in early June (Powers, 1970). Stebbins (1954) records in their diet ants, beetles, butterflies, craneflies, mosquitoes, millepeds, and spiders, all of which were collected in the valley. According to Stebbins and to Wetmore (1965) the species is eaten by ravens, kingfishers, and the rubber boa. Its rarity in the valley is difficult to explain.

V. Values of Big Beaver Valley

Considering the impending controversy relating to the possibility of flooding the lower portion of Big Beaver Valley, it is difficult to conclude this paper without making value judgments. Rather than attempt to apply purely economic measurements to this valley (board feet of cedar and fir, number of deer available for harvest, number of beaver to be trapped, et cetera), the writers prefer to look at this place in non-economic terms. As Leopold (1949) pointed out, only a very small percentage of the native plants or animals can be sold, fed, eaten, or otherwise put to economic use. Yet these organisms are members of the biotic community and, as such, entitled to continued existence.

The Big Beaver Valley is a place of extremely varied ecosystems, some of which are now rare, and all of which are interesting. But it is more than the simple sum of its parts. Together these ecosystems make up a highly complex but unified valley system. Such a system offers great opportunities for ecological investigation, research which in itself has economic value insofar as it gives man the necessary knowledge to restore to health the land he has abused.

The writers believe fervently that the principal value of National Park lands is as outdoor museums rather than as areas for intensive recreation. The interpretive activities of the National Park Service are its raison d'être, for only these can educate the American public into an appreciation of the great values inherent in its holdings. The opportunities in Big Beaver Valley for nature trails and for displays to explain the varied communities are virtually limitless. The true value of Big Beaver Valley lies in its potential for these educational activities.

VI. Summary

A preliminary survey of the ecosystems of Big Beaver Valley in the North Cascades National Park complex was carried out in the summers of 1969 and 1970. The valley has been extensively glaciated and, because of its unusual geological characteristics, has a flat valley floor with numerous postglacial ponds and beaver impoundments.

Floristically, the lower end of the valley lies in the Tsuga heterophylla Zone and the upper end in the Abies amabilis Zone. It appears to contain a mingling of eastside and westside floras as collections disclosed a number of species characteristic of the dry eastern slopes of the Cascades. A total of 223 different vascular plants were collected, of which 21 had not been previously reported for the park complex (Douglas, 1969b).

The floor of the valley is composed of a mosaic of aquatic and semi-aquatic communities of which the most interesting is a large sphagnum bog pond in the early stages of its development. This untouched representative of an increasingly rare ecosystem deserves the strictest protection.

The forest plant communities are extremely varied, resulting from the many different site characteristics present in the valley. Two of the most important communities are an unusual lodgepole pine forest on the dry site at the mouth of the valley and the well-known climax western redcedar stands on the valley floor and lower slopes. Other communities include interesting xeric outcrops on the valley walls, alder swamps, mixed hemlock-Douglas fir forests, and the Pacific silver fir forests in the area of Beaver Pass.

The valley supports large faunal populations of which the most important animal is the beaver. The activities of this mammal have helped to "select" other species that occupy the community. The presence of 13 mammals was verified, and sight records were obtained of 51 birds. Of the latter, 8 species had not previously been reported from the park complex (Douglas, 1969a).

Big Beaver Valley, because of its unusually varied ecosystems, has great potential as a natural laboratory for ecological research. It is also a valuable area for the extension of the National Park Service's interpretive activities.

Appendix 1

Checklist of Vascular Plants

Asterisk denotes species not previously reported from North Cascades National Park complex. Nomenclature from Hitchcock et al,(1955, 1959, 1961, 1964, 1969).

LYCOPODIACEAE

Lycopodium annotinum L.

Lycopodium clavatum L.

Lycopodium complanatum L.

Lycopodium selago L.

EQUISETACEAE

Equisetum arvense L.

Equisetum hyemale L. var. affine (Engelm.) A.A. Eat.*

OPHIOGLOSSACEAE

Botrychium virginianum (L) Swartz

POLYPODIACEAE

Adiantum pedatum L.

Athyrium distentifolium Tausch ex Opiz var. americanum (Butters) Cronq.

Athyrium filix-femina (L.) Roth

Blechnum spicant (L.) With.

Cryptogramma crispa (L.) R. Br. var. acrostichoides C. B. Clarke

Cystopteris fragilis (L.) Bernh.

Gymnocarpium dryopteris (L.) Newm.

Polypodium hesperium Maxon

Polystichum lonchitis (L.) Roth

Polystichum munitum (Kaulf.) Presl var. munitum

Pteridium aquilinum (L.) Kuhn var. pubescens Underw.

TAXACEAE

Taxus brevifolia Nutt.

CUPRESSACEAE

Chamaecyparis nootkatensis (D. Don) Spach

Juniperus communis L. var. montana Ait.

Thuja plicata Donn.

PINACEAE

Abies amabilis (Dougl.) Forbes

Abies grandis (Dougl.) Lindl.

Pinus contorta Dougl. ex Loud. var. latifolia Engelm.

Pinus monticola Dougl. ex D. Don

Pseudotsuga menziesii (Mirbel) Franco var. menziesii

Tsuga heterophylla (Raf.) Sarg.

Tsuga mertensiana (Bong.) Carr.

SCHEUCHZERIACEAE

Scheuchzeria palustris L. var. americana Fern.*

POTOMOGETONACEAE

Potamogeton natans L.

CYPERACEAE

Eriophorum polystachion L.

Rhynchospora alba (L.) Vahl.*

Scirpus microcarpus Presl.

GRAMINEAE

Agrostis scabra Willd.

Calamagrostis rubescens Buckl.*

Dulichium arundinaceum (L.) Britt.*

Glyceria elata (Nash) M. E. Jones

ARACEAE

Lysichitum americanum Hulten & St. John

LILIACEAE

Allium cernuum Roth

Calochortus tolmiei Hook. & Arn.*

Clintonia uniflora (Schult.) Kunth

Disporum smithii (Hook.) Piper

Fritillaria lanceolata Pursh

Lilium columbianum Hanson

Smilacina racemosa (L.) Desf.

Smilacina stellata (L.) Desf.

Stenanthium occidentale Gray

Streptopus amplexifolius (L.) DC var. americanus Schult.

Streptopus roseus Michx. var. curvipes (Vail) Fassett

Streptopus streptopoides (Ledeb.) Frye & Rigg

Tofieldia glutinosa (Michx.) Pers. var. brevistyla (Hitch.) C. I. Hitch.*

Trillium ovatum Pursh.

Veratrum virides Ait.

Zigadenus venenosus Wats.

ORCHIDACEAE

Corallorhiza maculata Raf.

Corallorhiza mertensiana Bong.

Goodyera oblongifolia Raf.

Habenaria dilatata (Pursh) Hook. var. dilatata

Habenaria dilatata (Pursh) Hook. var. leucostachys (Lindl.) Ames

Habenaria hyperborea (L.) R. Br.

Habenaria orbiculata (Pursh) Torr.

Habenaria saccata Greene

Listera caurina Piper

Listera cordata (L.) R. Br.

SALICACEAE

Populus trichocarpa T. & G. ex Hook.

Salix lasiandra Benth.

Salix scouleriana Barratt

Salix sitchensis Sanson

BETULACEAE

Alnus rubra Bong.

Alnus sinuata (Regel) Rydb.

Betula papyrifera Marsh. var. commutata (Regel) Fern.

Corylus cornuta Marsh. var. californica (DC) Sharp

URTICACEAE

Urtica dioica L. var. lyalli (Wats.) C. L. Hitch.

ARISTOLOCHIACEAE

Asarum caudatum Lindl.

POLYGONACEAE

Polygonum douglasii Greene var. douglasii*

Polygonum douglasii Greene var. latifolium (Engelm.) Greene

Polygonum minimum Wats.

Polygonum phytolaccaefolium Meisn. ex Small*

Rumex acetosella L.

PORTULACEAE

Montia parvifolia (Moc.) Greene var. parvifolia

Montia perfoliata (Donn) Howell*

Montia sibirica (L.) Howell var. sibirica

CARYOPHYLLACEAE

Arenaria macrophylla Hook.

Cerastium arvense L.

Silene douglasii Hook.

NYMPHAECEAE

Nuphar polysepalum Engelm.

RANUNCULACEAE

Actaea rubra (Ait.) Willd.

Aquilegia formosa Fisch.

Ranunculus flammula L. *

Ranunculus macounii Britt. var. macounii

Thalictrum occidentale Gray

BERBERIDACEAE

Berberis aquifolium Pursh

Berberis nervosa Pursh

Berberis repens Lindl.*

FUMARIACEAE

Dicentra formosa (Andr.) Walpers

CRUCIFERAE

Arabis hirsuta (L.) Scop. var. glabrata

Barbarea orthoceras Ledeb.

Cardamine pennsylvanica Muhl.

DROSERACEAE

Drosera rotundifolia L.

CRASSULACEAE

Sedum lanceolatum Torr. var. lanceolatum

Sedum oreganum Nutt.

SAXIFRAGACEAE

Heuchera micrantha Dougl. ex Lindl. var. diversifolia (Rydb.) R. B. & L.

Parnassia fimbriata Konig var. fimbriata

Saxifraga ferruginea Grah. var. macounii Engelm. & Irmsch.

Saxigraga punctata L. var. cascadensis (Calder & Savile) C.L. Hitch.

Tellima grandiflora (Pursh) Dougl.

Tiarella trifoliata L.

Tiarella unifoliata Hook.

GROSSULARIACEAE

Ribes lacustre (Pers.) Poir

Ribes triste Pall.

HYDRANGEACEAE

Philadelphus lewisii Pursh

ROSACEAE

Amelanchier alnifolia Nutt. var. semiintegrifolia (Hook.) C. L. Hitch.

Aruncus sylvester Kostel.

Fragaria virginiana Duchesne var. platypetala (Rydb.) Hall

Geum macrophyllum Willd. var. macrophyllum

Holodiscus discolor (Pursh) Maxim. var. discolor

Physocarpus capitatus (Pursh) Kuntze

Potentilla glandulosa Lindl. var. glandulosa

Potentilla palustris (L.) Scop.

Prunus emarginata (Dougl.) Walpers var. emarginata

Rosa gymnocarpa Nutt.

Rosa nutkana Presl var. nutkana

Rubus idaeus L. ssp. sachalinensis (Levl.) Focke var. sachalinensis

Rubus leucodermis Dougl. ex T.& G.

Rubus parviflorus Nutt. var. parviflorus

Rubus pedatus J. E. Smith

Rubus spectabilis Pursh

Rubus ursinus Cham. & Schlecht. var. macropetalus (Dougl.) Brown

Sanguisorba sitchensis C. A. Meyer*

Sorbus sitchensis Roemer var. sitchensis

Spiraea betulifolia Pall

Spiraea douglasii Hook. var. menziesii (Hook.) Presl

LEGUMINOSAE

Lupinus latifolius Agardh. var. latifolius

Trifolium repens L.

CELASTRACEAE

Pachystima myrsinites (Pursh) Raf.

ACERACEAE

Acer circinatum Pursh

Acer glabrum Torr. var. douglasii (Hook.) Dippel

Acer macrophyllum Pursh

RHAMNACEAE

Ceanothus sanguineus Pursh

Ceanothus velutinus Dougl. ex Hook. var. laevigatus (Hook.) T. & G.

Rhamnus purshiana DC.

VIOLACEAE

Viola glabella Nutt.

ELAEGNACEAE

Shepherdia canadensis (L.) Nutt.

ONAGRACEAE

Circaea alpina L.

Epilobium alpinum L. var. alpinum

Epilobium alpinum L. var. lactiflorum (Hausskn.) C. L. Hitch.

Epilobium angustifolium L.

Epilobium glaberrimum Barbey

Epilobium latifolium L.

Epilobium minutum Lindl. ex Hook.

Epilobium watsonii Barbey var. occidentale (Trel.) C. L. Hitch.

ARALIACEAE

Oplopanax horridum (J. E. Smith) Miq.

UMBELLIFERAE

Angelica arguta Nutt.

Heracleum lanatum Michx

Lomatium ambiguum (Nutt.) Coult. & Rose

Osmorhiza chilensis H. & A.

CORNACEAE

Cornus canadensis L.

Cornus stolonifera Michx. var. occidentalis (T. & G.) C. L. Hitch.

ERICACEAE

Allotropa virgata T. & G. ex Gray

Arctostaphyllos uva-ursi (L.) Spreng.

Chimaphila menziesii (R. Br.) Spreng.

Chimaphila umbellata (L.) Bart. var. occidentalis (Rydb.) Blake

Gaultheria ovatifolia Gray

Gaultheria shallon Pursh

Hypopitys monotropa Crantz

Menziesia ferruginea Smith var. ferruginea

Monotropa uniflora L.

Pterospora andromedea Nutt.

Pyrola asarifolia Michx. var. asarifolia

Pyrola asarifolia Michx. var. purpurea*

Pyrola aphylla Smith

Pyrola dentata Smith

Pyrola picta Smith

Pyrola secunda L. var. secunda

Pyrola virens Schweigg.

Vaccinium alaskaense Howell

Vaccinium ovalifolium Smith

Vaccinium membranaceum Dougl. ex Hook.

Vaccinium parvifolium Smith

Vaccinium scoparium Leiberg

PRIMULACEAE

Trientalis arctica Fisch. ex Hook.

Trientalis latifolia Hook.

MENYANTHACEAE

Menyanthes trifoliata L.

APOCYNACEAE

Apocynum androsaemifolium L.

POLEMONIACEAE

Collomia heterophylla Hook.

HYDROPHYLLACEAE

Phacelia heterophylla Pursh var. heterophylla

Romanzoffia sitchensis Bong.

LABIATEAE

Mentha arvensis L. var. glabrata (Benth.) Fern.

Prunella vulgaris L.

SCROPHULARIACEAE

Collinsia parviflora Lindl.

Mimulus guttatus DC. var. depauperatus (Gray) Grant *

Mimulus lewisii Pursh

Mimulus moschatus Dougl.

Pedicularis racemosa Dougl. ex Hook. var. alba (Pennell) Cronq.*

Penstemon davidsonii Greene var. menziesii (Keck) Cronq.

Penstemon serrulatus Menzies ex Smith

Veronica americana Schwein ex Benth. *

LENTIBULARIACEAE

Pinguicula vulgaris L.

RUBIACEAE

Galium triflorum Michx.

CAPRIFOLIACEAE

Linnaea borealis L. var. longiflora Torr.

Lonicera ciliosa (Pursh) DC

Lonicera involucrata (Rich.) Banks ex Spreng.

Sambucus racemosa L. var. arborescens (T. & G.) ex Gray

Symphoricarpos albus (L.) Blake var. laevigatus (Fern.) Blake

Viburnum edule (Michx.) Raf.

VALERIANACEAE

Valeriana sitchensis Bong.

CAMPANULACEAE

Campanula rotundifolia L.

COMPOSITAE

Achillea millefolium L. ssp. lanulosa (Nuut.) Piper var. lanulosa

Adenocaulon bicolor Hook.

Anaphalis margaritacea (L.) B. & H.

Antennaria neglecta Greene var. attenuata (Fern.) Cronq.

Antennaria neglecta Greene var. howellii (Greene) Cronq.*

Arnica amplexicaulis Nutt.

Arnica latifolia Bong. var. latifolia

Artemisia michauxiana Bess.*

Aster campestris Nutt. *

Aster modestus Lindl.

Eriophyllum lanatum (Pursh) Forbes var. lanatum

Hieracium albiflorum Hook

Hieracium scouleri Hook. *

Iactuca muralis (L.) Fresen

Luina hypoleuca Benth.

Appendix 2

Checklist of Mammals

Nomenclature from Hall and Kelson (1959) with modifications.

Lepus americanus cascadensis Nelson. Snowshoe hare

Eutamias townsendii (Bachman). Townsend's chipmunk

Callospermophilus lateralis saturatus (Rhoads). Cascade golden-mantled ground squirrel

Tamiasciurus douglasii mollipilosus (Aud. and Bach.). Douglas squirrel

Castor canadensis leucodontus Gray. Beaver

Peromyscus maniculatus (Wagner). Common deer mouse

Ursus americanus altifrontalis Elliot. American black bear

Procyon lotor pacificus Merriam. Raccoon

Mustela vison energumenos Bangs. Mink

Lutra canadensis pacifica Rhoads. River otter

Felis concolor oregonensis Rafinesque. Cougar

Cervus canadensis nelsoni V. Bailey. Rocky Mountain elk

Odocoileus hemionus columbianus (Richardson) Columbia black-tailed deer

Appendix 3

Checklist of Birds

Nomenclature from Larrison and Sonnenberg (1968) and classification from Jewett et al. (1953). Asterisks indicate those species not previously reported from the park complex (Douglas, 1969a).

GAVIDAE

Gavia immer (Brunnich) Common loon

ANATIDAE

Anas platyrhynchos Linnaeus Common mallard

Athya affinis (Eyton) Lesser scaup

Bucephala islandica (Gmelin) Barrow's goldeneye*

Lophodytes cucullatus (Linnaeus) Hooded merganser*

FALCONIDAE

Falco sparverius Linnaeus Sparrow hawk

TETRAONIDAE

Dendragapus obscurus (Say) Blue grouse

Bonasa umbellus (Linnaeus) Ruffed grouse

SCOLOPACIDAE

Actitis macularia (Linnaeus) Spotted sandpiper

LARIDAE

Larus californicus Lawrence California gull*

COLUMBIDAE

Columba fasciata Say Band-tailed pigeon

CAPRIMULGIDAE

Chordeiles minor (Forster) Common nighthawk

APODIDAE

Chaetura vauxi (J. K. Townsend) Vaux's swift

TROCHILIDAE

Selasphorus rufus (Gmelin) Rufous hummingbird

ALCEDINIDAE

Megaceryle alcyon Linnaeus Belted kingfisher

PICIDAE

Colaptes cafer (Gmelin) Red-shafter flicker

Dryocopus pileatus (Linnaeus) Pileated woodpecker

Sphyrapicus varius (Linnaeus) Yellow-bellied sapsucker

Dendrocopus villosus (Linnaeus) Hairy woodpecker

TYRANNIDAE

Tyrannus tyrannus (Linnaeus) Eastern kingbird*

Tyrannus verticalis Say Western kingbird*

Epidonax difficilis Baird Western flycatcher

Contopus sordidulis Linnaeus Western wood pewee

Nuttalornis borealis (Swainson) Olive-sided flycatcher

HIRUNDINIDAE

Tachycineta thalassina (Swainson) Violet-green swallow

Iridoprocne bicolor (Vieillot) Tree swallow

Stegidopteryx ruficollis (Vieillot) Rough-winged swallow*

Hirundo rustica Linnaeus Barn swallow*

CORVIDAE

Perisoreus canadensis (Linnaeus) Gray jay

Cyanocitta stelleri (Gmelin) Steller's jay

Corvus corax Linnaeus Common raven

PARIDAE

Rarus rufescens J. K. Townsend Chestnut-backed chickadee

SITTIDAE

Sitta canadensis Linnaeus Red-breasted nuthatch

CERTHIDAE

Certhia familiaris Linnaeus Brown creeper

CINCLIDAE

Cinclus mexicanus Swainson Dipper

TROGLODYTIDAE

Troglodytes troglodytes (Linnaeus) Winter wren

TURDIDAE

Turdus migratorius Linnaeus Robin

Ixoreus naevius (Gmelin) Varied thrush

Hylocichla ustulata (Nuttall) Swainson's thrush

BOMBYCILLIDAE

Bombycilla cedrorum Vieillot Cedar waxwing

PARULIDAE

Dendroica petechia (Linnaeus) Yellow warbler

Dendroica auduboni (Townsend) Audubon's warbler

Dendroica townsendi (Townsend) Townsend's warbler

ICTERIDAE

Agelaius phoeniceus (Linnaeus) Redwinged blackbird*

THRAUPIDAE

Piranga ludoviciana (Wilson) Western tanager

FRINGILLIDAE

Hesperiphona vespertina (W. Cooper) Evening grosbeak

Spinus pinus (Wilson) Pine siskin

Junco oreganus (Townsend) Oregon junco

Spizella passerina (Bechstein) Chipping sparrow

Melospiza melodia (Wilson) Song sparrow

Zonotrichia leucophrys (Forster) White-crowned sparrow

Appendix 4

Snow Depths (SD) and Water Equivalents (WE)

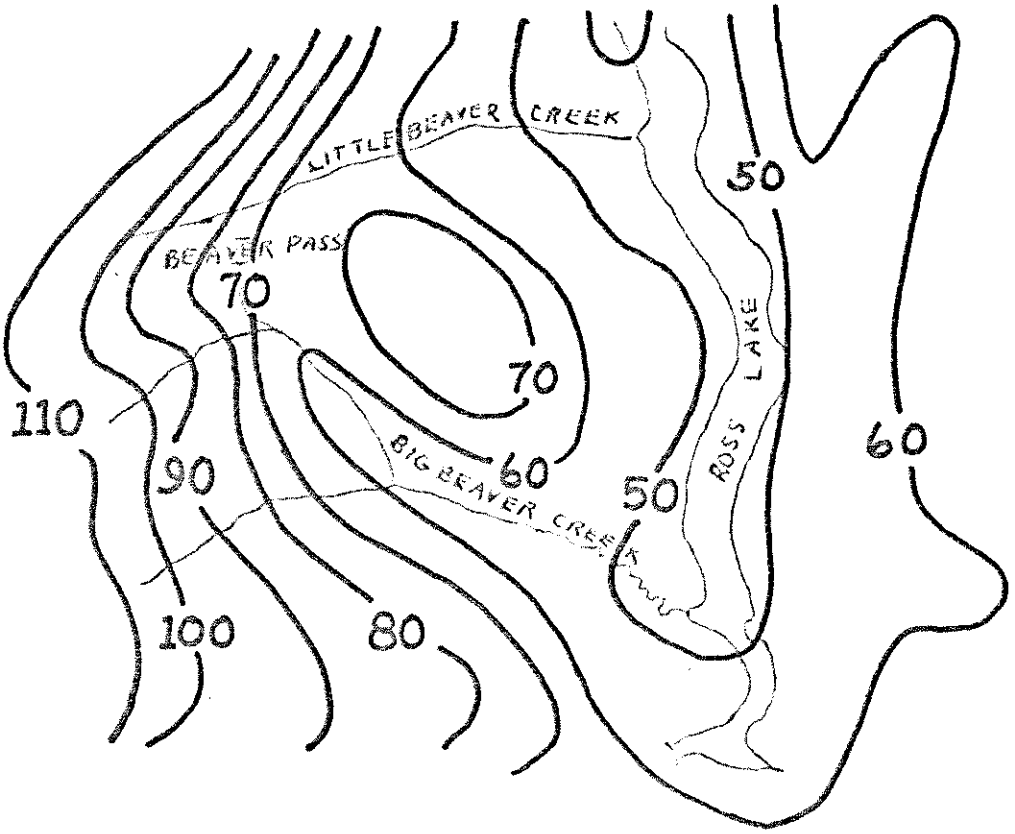
in Big Beaver Valley (inches)

Beaver Creek Trail, Sec. 35, T. 39N, R. 12E

	March		April		May	
	Max.	Med.	Max.	Med.	Max.	Med.
SD	71	39	86	32	51	11
WE	28	14	36	14	23	5

Beaver Pass, Sec. 9, T. 39N, R. 12E

	March		April		May	
	Max.	Med.	Max.	Med.	Max.	Med.
SD	128	75	181	90	133	78
WE	47	28	73	33	63	34



Mean Annual Precipitation in Inches

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