BRITISH COLUMBIA FOREST SERVICE

A PRELIMINARY STUDY OF SMALL MAMMALS
AND VEGETATION IN WELLS GRAY PARK
WITH SPECIAL REFERENCE TO
CONIFER SUPPRESSION BY RODENTS
1952

R. Webb

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Introduction

In accordance with an active program of wildlife investigation and research instigated by the Parks and Recreation Division of the British Columbia Forest Service, a small mammal survey was conducted in Wells Gray Park during the interval May 15th to September 15th, 1952.

The survey took two forms. First, general observations of all small mammals were made whenever possible. Occurrence of the various species, their behaviour and identification, and their effect upon the plant biota in which they were found, were particularly noticed and have been recorded in an appendix to this report.

Second, trapping by a standard trapline method was carried out on ten ecological zones arbitrarily chosen for their uniqueness and the manner in which they represented plant communities found in Wells Gray Park.

Because the moose (*Alces americana*) is probably the most important animal in the park from both an economic and recreational standpoint, particular care was taken to sample areas constituting their best winter range.

With this in mind, comparative descriptions of the ten zones have been presented. The major browse species, utilization of that browse, and the percent regeneration of less favoured coniferous tree species were contrasted for each zone.

Finally, relative small mammal population figures were obtained by trapping each zone. These have been included in a separate section. *Peromyscus maniculatus,* the deer mouse, because of its wide adaptability and preference for the seeds of coniferous trees, was chosen to illustrate any apparent relationship between conifer-suppressing mammal species and good moose range.

Included in the discussion was a brief review of small mammal damage to vegetation, as extracted from the literature on the subject.

Materials and Methods

Two sources of material were utilized for this investigation. First, vegetative descriptions provided a basis for the selection of ten distinct ecological zones. These ten zones were chosen primarily because of their convenience and the manner in which they represented sections of the park. Limitations on the time and effort at my disposal made convenience a selection factor. Special caution was taken to sample the maximum number of plant cover types used by moose in winter. For contrast, certain alpine and densely wooded areas were trapped, essentially because they were little used by moose under usual conditions.

The ten zones chosen were ranked and described briefly in order of utilization by moose, on the basis of three obvious criteria. First, the presence of moose browse; second, the availability of that browse; and third, the degree to which the browse has been used in the past.

The latter was determined by both visual estimation of the degree of browsing and by the presence of pellet groups. Visual estimates were deemed adequate for the purpose of this comparison, only because meticulous selection of the sample areas ensured marked zonal differences. Thus, for the most part, the zones were sufficiently distinct to allow mere ocular tabulation of their moose value. Zones 4 and 5, however, showed almost equal moose usage, and thus could be interchangeable in the scale shown in Figure II.

The second source of material consisted of the catch totals of small mammals for each zone, converted to a comparable trap-night basis, which were obtained using a standard trapline method of sampling.

Ten to twenty Museum Special snap-back traps, baited with walnuts, were set in the same manner on each zone.

The traps were set in pairs, each pair four paces apart every twelve paces along a straight line chosen to traverse the desired area. Each trap was placed at right angles to the line of direction, and two paces from it. One pace averaged 2.7 feet. Strong white cord anchored each trap.

A line of traps was usually set in the evening twilight period and visited early the following morning. This timing, although the most favourable, was often not possible.

Whenever possible a trapline was rebaited for a second or third night without changing location.

The total catch of each species on a single zone was then divided into the total number of nights trapped on that zone. The resultant figure, termed trap-nights for one individual, puts catch figures on a comparative basis.

Trap-night figures for each species from every zone are presented in Table I.

Certain weaknesses inherent in this system of sampling merited attempts at compensation. One was the effect of climate upon rodent activity and thus upon rodent catches. Obviously variable over the two month trapping period, the weather could not be controlled. A solution would involve sampling all ten zones simultaneously. Even then temperature, air pressure, etc. would vary in each zone. In any case, this was neither physically possible nor economically feasible. Instead, trapping under severe climatic conditions was avoided. If snow or rain came unexpectedly while trapping was in progress, the results from that night were not used. Repetition for two or three nights on each zone was attempted as another method of error control.

If for some reason a line could not be attended early in the morning, a second factor sometimes operated to limit the catch. Larger diurnal species of rodents, along with birds, would "rob" traps. The same situation occurred when lines were set early in the afternoon before cessation of chipmunks, ground squirrel and red squirrel activity. The effects were even more pronounced. Traps sprung then were useless for the evening and thus unavailable to nocturnal species.

Trapping was staggered over a two month period, June 23rd to August 23rd. Conceivably the normal seasonal growth of a rodent population would bias comparisons made between zones sampled early and those sampled late. However, it was hoped that since population growth usually begins to "level off" or slacken by July, (M.F. Jackson, personal communication), and since the trapline is relatively insensitive to superabundances of animals (Dice, 1938) error of this sort would be offset or at least minimized.

Zone 10 constituted a marked exception. There the altitudinal effect of weather delayed the spring season. As a result, July populations at upper levels corresponded with May populations at Hemp Creek.

As mentioned above, superabundance of animals could remain undetected by the trapline method. Traps set in areas of high *Peromyscus densities*, for example, would tend to "fill" early in the evening. Once sprung, each trap would cease to operate as a sampling device. Consequently other mice ranging in the same territory at a later hour would not be recorded. Repetition for at least two nights was deemed necessary to partially eliminate this weakness.

Due consideration was also allotted to possible variation in the size of cruising ranges of a single species on different areas. L.F. Stickel (1948) found the *Peromyscus* in one habitat differed in average individual cruising distance from members of the same species in a second habitat. these differences were not necessarily subspecific, but could have been functions of the food supply on the population density of the animals involved. What is most important, she found that the trapline method failed to distinguish between wide ranging small populations and larger populations not so inclined towards travel.

Fortunately, however, this would not invalidate positive differences found in mammal populations. That is to say, if population differences were revealed by the trapline method they would be valid ones, because the error introduced by variations in cruising radii tends to minimize rather than exaggerate.

Many factors limit the interpretation of trapline results, and caution must be exercised when making that interpretation.

The investigation outlined in this report was designed solely to point out obvious differences in mammal densities, as selected ecological types in Wells Gray Park. Detailed generalizations on the basis of results derived from the investigation are generally circumscribed by the weaknesses of the trapline system. Thus it was not meant to be a comprehensive, all-factor, study and should not be construed as such.

Selection of the types sampled hinged largely upon their respective relationships to moose in winter. Any observed variations in small mammal numbers will be contrasted with relative “moose values” for each zone.

Description of Ecological Zones

Zone I

Flat topography east of the Murtle River, bisected by Blackwater Creek, supported plant cover almost solidly upland willow. These were of standard height (three to twelve feet) and usually evenly spaced.

Shepherdia canadensis, small, young aspen (*Populus tremuloides*), and some Oregon grape (*Mahonia repens*?) formed the major part of the shrub layer. The ground was bare, with practically no grasses established. Dense stands of alder continuously flooded by beaver damming created an almost impenetrable tangle near the creek bed. Many snags still stood, and burnt Douglas fir (*Pseudotsuga taxifolia*) logs littered the earth.

Burned in 1926, and reburned since, this area represented a young stage in normal fire succession, particularly useful to crowded winter, fall and spring moose populations.

Zone II

The top of Green Mountain approximately 1000 feet higher than zone 4, provided strikingly similar forest cover.

However, minor differences occurred. Evidently burned only lightly by the same fire, zone 2 contained more tall cedar snags and undecomposed windfall. Due to unconfirmed factors, plant succession was retarded, resulting in a seral stage less advanced than exists in zone 4.

Alder swamps filled the moist hollows. Lodgepole pine (*Pinus contorta*) up to thirty feet high dotted the knolls between them. Other conifers were present in limited numbers, indicating poor reseeding success thus far.

Willows (*Salix spp*) formed a higher percentage of the total cover than in zone 4, but less than in zone 1, and were as heavily browsed.

Zone III

Primarily a deciduous type located in Hemp Creek valley, altitude 2200 feet, it can best be described as semi-open cattle range. "Islands" of treeless ground comprise fifty percent or more of the total area, on which ground vegetation, windfalls, and snags are lacking or scarce.

The area has been grazed by range cattle since the removal of heavy coniferous cover by fire in the year 1926, and short grasses and clover are now prevalent. These plants support large ground squirrel populations, (*Cilellus columianus*).

Willow bushes ten to twenty feet high make up thirty-fifty percent of the upper storey. All have been extensively browsed and broken by winter-feeding moose. Aspens (*Populus tremuloides*) grow in much the same proportion and are similarly broken but browsed to a lesser degree. Birches (*Betula papyrifera*) are few in number.

The remainder of the upper storey consists of light conifer regeneration; Douglas fir, spruce (*Picea spp*.), and alpine fir (*Abies lasiocarpa*), in an approximate ratio of 3:2:1.

Coniferous seed sources are distant due to the intensity and scope of the original fire, except for a few swamp-edge spruce 125 yards north.

Zone IV

An "all species-willow competition" plot, partially cleared by hand a few weeks earlier, situated on a steep side-hill sixty yards west of the Hemp Creek Ranger Station was trapped as zone 4.

Conifer regeneration could be termed good in comparison with most other areas sampled. Although burned the same time as zones 2 and 3, Douglas fir apparently here found conditions more suitable and became better established. Approximately fifteen percent of the upper storey was composed of this species, varying in height from six to twenty feet.

A small fraction of the original number of cedar snags left by the fire were still standing. Willow, aspen, and birch from five to thirty feet high completed the thin canopy.

Ground cover was heavy except where cleared this year. Plants such as *Shepherdia*, *Pachystima* and young cottonwood litter the "cut" section in heaps. Widely scattered in small numbers were maples (*Acer spp*.), alders, serviceberry, spruces and small cedars.

One-half of the line was placed outside the cut-over plot area, but in a similar vegetational type, while one-half crossed the plot. No discernible difference in catch on the two portions occurred.

Moose range through this area for two or three winter months, causing heavy damage primarily to willow.

Zone V

Arid, open country heavily stocked with even-aged stands of lodgepole pine (*Pinus contorta*) interspersed with frequent clearings fringed by birch, aspen, alder or willow, made up zone 5.

Grasses, serviceberry and Oregon grape were typical ground cover species found widely distributed beneath the canopy of pine.

Shepherdia and huckleberries (*Vaccinium spp*.) grew sporadically in clearing.

There was scattered recent regeneration of spruce and Douglas fir in small pockets.

Zone VI

Heavy conifer regeneration in the form of evenly spaced Douglas fir, spruce (*Picea Engelmannii*) and alpine fir dominated this zone. Burned near the turn of the century, it probably represents the successional phase or stage following a mature deciduous forest. In fact, a few isolated paper birch still stretched for light between shadowing conifers, and were probably the residue of formerly extensive hardwood stands.

Shepherdia, Vaccinium, and others constituted dense shrubby growth in clearings.

Little is known about the degree of moose utilization. In the light of present studies, however, it is probably slight in mid-winter becoming greater in the spring, summer and early fall.

Zone VII

Trap line three, sampling zone 7, was at Hemp Creek in a grassy ecotone between the hillside aspen-birch-upland willow type, zone 3, and the creek-edge border of flooded alder and willow (*Salix spp.*)

Heavy grazing by cattle has kept it free from most underbrush. Some low willows, alpine fir, lodgepole pine, alder, and *Lonicera sp*. occur. One of the largest ground squirrel populations of the vicinity exists there amid clover and a short, dense rhizomatus grass.

Several snags and fallen trees dotted the clearings, providing ample trap-sites.

The few browse species inhabiting this strip are hard-hit by moose in winter.

Zone III

Best typified by the term “cedar-spruce-swamp”, zone 8 consisted of a moist bottomland ten to twelve acres in size, apparently missed by the fire of 1926 because of its proximity to Hemp Creek.

Mature or over-mature spruce (*Picea sp*.) and red cedar (*Thuja plicata*) approximately fifty feet high formed a dense even-aged stand that dwarfed its fringe of tall alder. Alder trees also encircled small sedge-filled swamps scattered throughout as moist hollows.

Typically, underbrush was notably lacking. A bare, needle-covered forest floor criss-crossed by huge moss covered windfalls resulted. This trapline covered both swampy and dry areas.

Although many seeds must fall in this region no regeneration other than a few hemlock and cedar has occurred.

The site has little or no value as a moose feeding ground.

Zone IX

At Hemp Creek traps were set in dense grass, fifteen to thirty inches high, dotted throughout with dandelions and clover.

The line ran a few yards from a thick swamp willow-alder stand that was choked near the edge with fireweed and *Lonicera*.

Moose utilization has never been recorded for this zone. However it represents a considerable proportion of valley bottom, and as such was sampled.

Zone X

Zone 10 represents large areas of alpine meadow near timberline at Battle Mountain, Mica Mountain and the Azure Forest Service lookout.

A climax alpine fir forest occupied “islands” of drier land amid large, sloping moist and partially snow-covered meadows.

Partly dwarfed, these firs averaged twenty to thirty feet in height, and formed more or less uneven-aged stands. Individual trees grew close together, sprouting lateral branches from the main trunks near the ground. These eventually died, perhaps because of light deficiency. No undergrowth occurred in the dense mat of dead twigs.

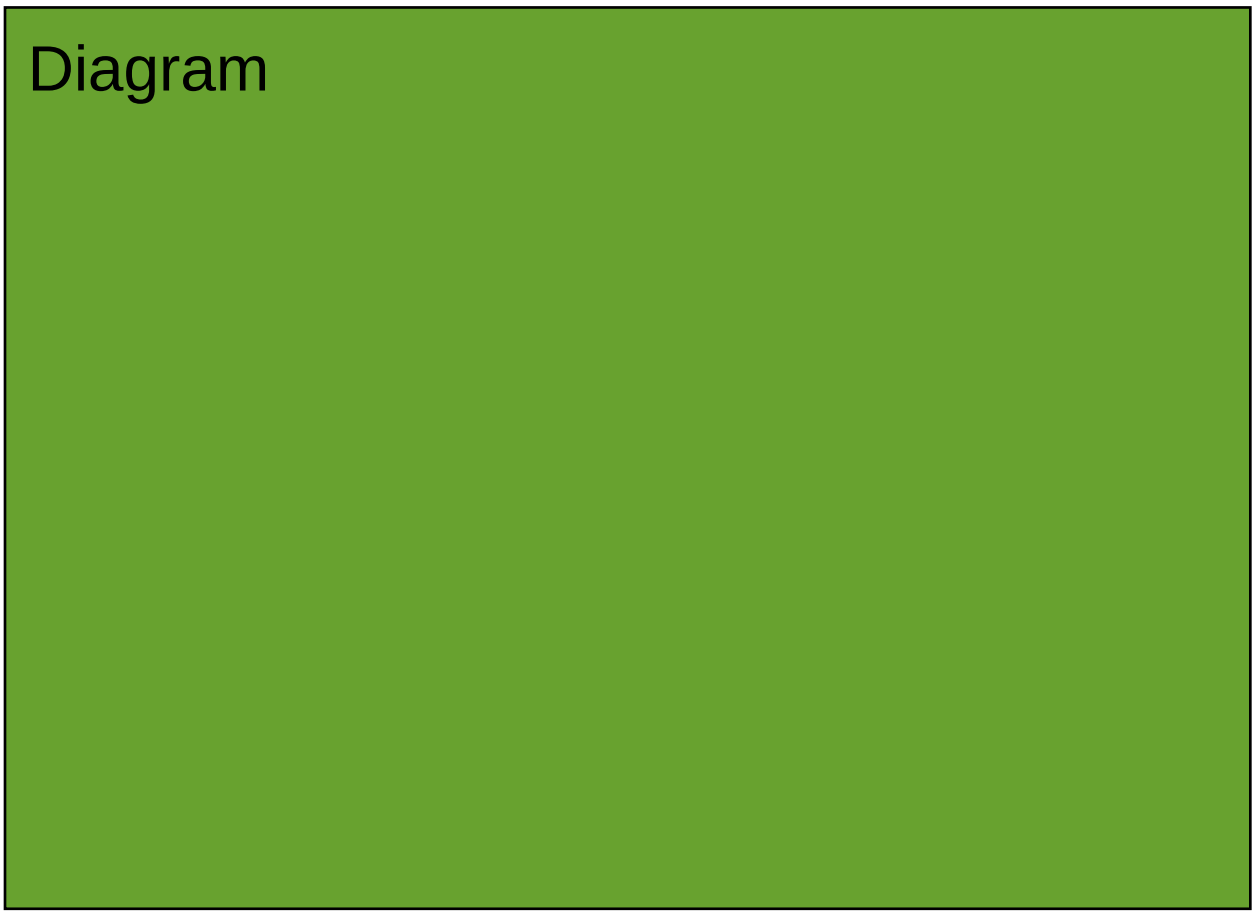
Snow still covered portions of adjacent meadows on July 1st. Ground squirrels were making their first appearance. *Anemones*, sedges (*Carex spp.*), and alpine grasses predominated on the snow-free sections at this early date.

Due to the lack of deciduous tree species and the presence of adverse climatical conditions these situations are not used by moose in winter, although are regularly so in the summer.

The trapline was placed near winter mouse workings on a meadow. It extended into a dense clump of fir.

Summary of Zonal Descriptions

Ten zones have been described comparatively with direct reference to general species composition, degree of moose utilization, and other distinguishing characteristics.



Zones 1, 2, 3, 4, 5 and 7 were burned by the same fire of 1926, as far as could be determined. Fire has not touched zones 8, 9 and 10 in recent years. Zone 6 was burned approximately fifty years ago.

Conifer regeneration is evident to varying degrees in all except zone 9. Zone 1 has practically no conifers, young or old. Zones 2, 3 and 4 support some Douglas fir, Engelmann spruce, alpine fir, and lodgepole pine twenty-five years old or less. Lodgepole pine dominates in zone 5, with alder, willow, birch, and lesser deciduous species growing in clearings. Zone 6 holds a dense canopy of tall conifers that are "squeezing out" the remnants of a hardwood forest. Zone 8 and 9 are essentially grassland, while zone 10 is approximately 50 percent dense alpine fir and 50 percent alpine meadow.

Moose utilization varies widely from zone to zone. Zone 1 is used in late fall, winter, and early spring by large numbers of moose. Zones 2, 3 and 4 are also heavily used but for shorter periods. Deer as well as moose feed heavily on the browse species in zone 5 during the mid-winter months. Practically no utilization of zones 7, 8, 9 and 10 by moose in winter has been recorded. Zone 6 is possibly early fall habitat for small numbers of moose.

Vegetation Control by Small Mammals

Rodents, shrews and bats exert an influence on the flora of all plant communities, largely through their search for food. The effect of that influence varies from locality to locality, with the type and size of the mammal population, with the type and age of the flora, and with other factors that direct the growth of plants independent of mammalian interference.

Ways in which small mammals affect tree growth, with particular reference to coniferous trees, are as follows.

1. "Girdling" or cambium damage.

Microtine rodents such as the meadow and red back voles occasionally gnaw bark, usually during winter periods. Tree mortality results if the circuit is completed (Hatt, 1930). Meadow voles have caused extensive damage to plantations of pine and spruce. Similarly red back voles have attacked alpine fir in Wells Gray Park. The red squirrel has also been known to girdle conifers (Mitchell, 1950).

2. Insect consumption.

Many species feed on insects, some of which are harmful to forests.

Graham (1928) found that *Microtus* could prevent larch sawfly from becoming epidemic under certain conditions. Jameson, in a 1952 study of the food of California deer mice, defended the group as important in the control of damaging forest insects. Insects,

predominately cutworms, composed 1/5 of the average diet over twelve month periods. Small mammals, active on an area for the whole year, probably make greater inroads on insect densities than do insectivorous birds.

The shrews, so called insectivores, consume slightly more insects on the average than rodents. Thirty-eight percent of the diet of shrews in the Oregon Douglas fir belt consisted of insects (Moore 1942).

Bats were seen feeding on adult June beetles in Wells Gary Park.

3. Effects on regeneration and growth.

Cone depredations on lodgepole pine, Douglas fir, and other conifers by squirrels can produce serious deviations in the ultimate “effective cone crop”. E.I. Roe (1948) stated that squirrels can turn the possibility of a fair pine cone crop to a failure by removing conelets. The damage to cones is magnified by the loose storage habits of squirrels. Many cones are cached in places unfavourable to germination and never relocated by the storer.

Chipmunks occasionally remove cones from trees (Moore 1950).

Seed dissemination is aided by the “caching” habits of squirrels (Hatt, 1922) but not significantly.

Deer mice, shrews, ground squirrels, chipmunks, meadow mice, tree squirrels, and woodrats all tend to prevent adequate conifer seed survival. (Moore, 1949-50; Howard, 1950; Horn, 1938).

Peromyscus, because of its great adaptability and abundance in areas on which seed is sometimes required, constitutes the greatest menace to natural and artificial reproduction. Damage of 90% or more has been recorded on artificially seeded logging areas (Moore, op. cit.). Apparently deer mice can cause delay of the coniferous phase of forest succession, but only under some conditions. That is to say, in years of heavy seed crops the seeds consumed by mice would not be missed, and general conifer reproduction could and does become fact despite the action of large rodent populations.

Chipmunk seed depredations approached 61% of the total attributable to rodents in one jackpine burn of the northwest States, (Smith and Aldous, 1947).

Ground squirrels (*Citellus columbianus*) consumed nearly all ponderosa and western white pine seeds sown on burns in Idaho, (Smith and Aldous, op. cit.).

Jumping mice do eat conifer seeds, but prefer those of herbaceous plants (Quimby, 1951).

Shrews and red back voles, typical forest dwellers, diet on insects and succulent vegetation respectively, and only occasionally destroy Douglas fir seeds in large quantities (Moore, 1942).

Squirrels, possibly when present in high concentrations, effect forest structure by "nipping" terminal buds on coniferous trees. (Hatt, 1930; personal observation, 1952). Increased metabolism follows in the plant, with an increase in lateral branching, producing a "broom effect". This can be a factor in causing crooked growth.

Small Mammals in Ten Wells Gray Park Ecological Zones

Eighty-seven individuals representing four species of rodents and one or two of shrews were caught in 391 nights of trapping on ten zones. Fifty-seven were *Peromyscus* and eighteen *Sorex spp*. (Table I).

Shrews proved to be most abundant in coniferous zones with a grassland influence, (Zones 7 and 8). *Microtus* were caught only in grass meadows, usually near the edges, (Zone 7 and 9). *Zapus* were also restricted to grassy ecotones at Hemp Creek. The one red back vole was obtained on Battle Mountain in the mature stand of alpine fir.

In brief, the less abundant species were found to be somewhat restricted as to habitat tolerance.

In direct contrast, the abundant and easily trapped deer mouse was found in most deciduous and mixed deciduous-coniferous zones.

Because of great adaptability and abundance, plus a marked tendency to consume large quantities of coniferous tree seeds when available, *Peromyscus* is considered to be the rodent with the most lasting effect on vegetation.

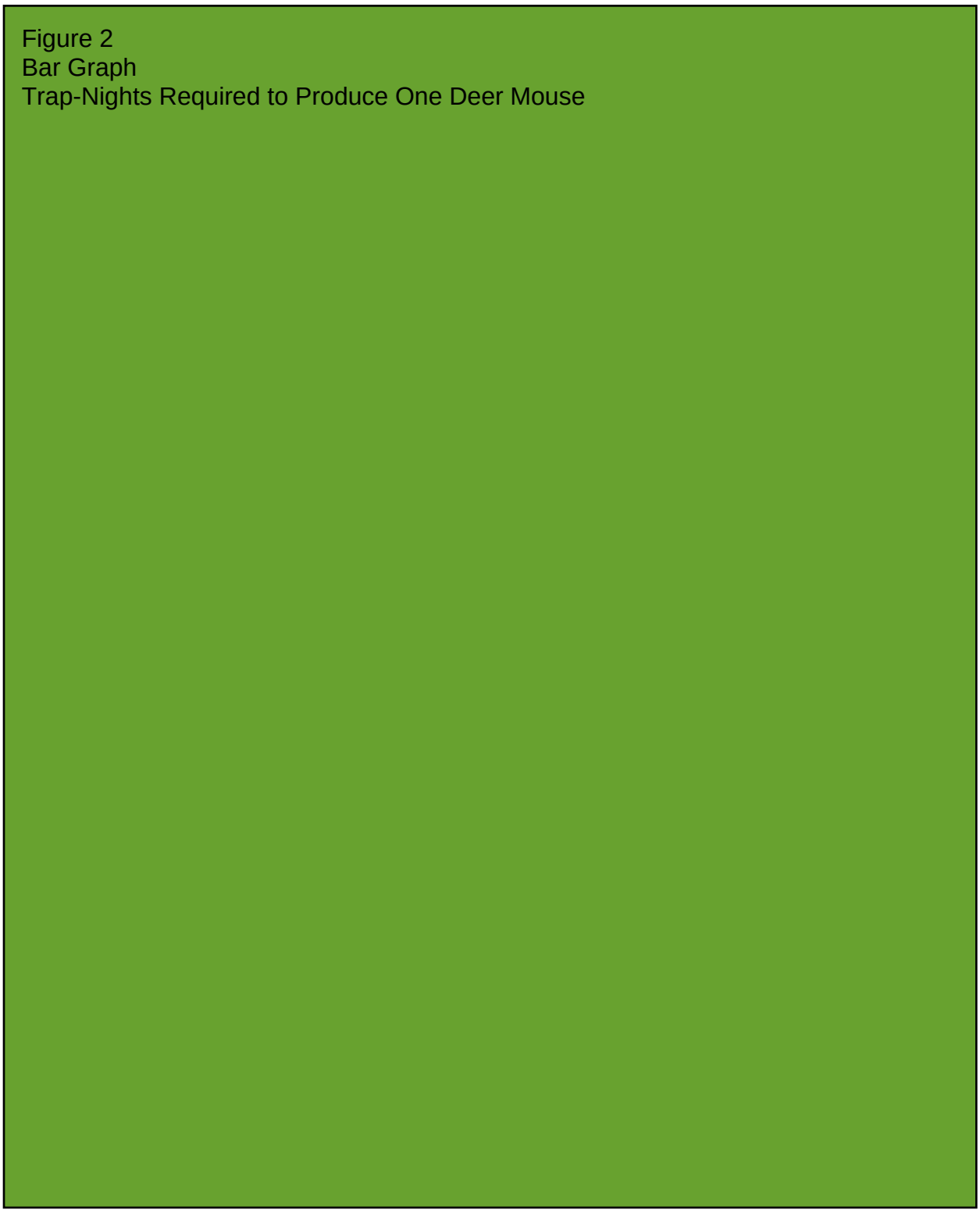
Figure 2 shows *Peromyscus* abundance for the ten zones, abundance being expressed as "trap nights required to produce one individual". The zones are arranged in order of probable importance as winter moose range.

Figure 2 clearly indicates that larger deer mouse populations exist for zones 1, 2, 3, 4 and 5, the zones most important as moose winter range. Conversely, the non-moose areas, zones 6-10 inclusive yield few conifer-suppressing rodents.

Table I
Catch records of small mammals
for ten vegetational zones in Wells Gray Park

Zone	Catch					Month	Total nights trapped	Trap nights for each Peromyscus
	Sorex	Microtus	Peromyscus	Zapus	Clethr-ionomys			
1	1		29			August 13-23	63	2.2
2	1		6			August 6	28	4.7
3			13			June 23	40	3.1
4	1		2			August 2-3	40	20.0
5	1		6			August 10	13	2.2
6	2					July 25-27	20	
7	4	1		1		July 10-13	25	
8	7		1			July 10-13	40	40.0
9	1	8		1		August 2-4	42	
10					1	June 30 & July 21	60	
Total	18	9	57	2	1	June 23 to August 23	391	

Figure 2
Bar Graph
Trap-Nights Required to Produce One Deer Mouse



The correlation probably exists in two phases; first, between rodents and early seral stages in plant succession and second, between early seral stages and moose. The inference remains, however, that small mammals, specifically deer mice, could through their retardation effect on conifer regeneration, lengthen the life span of good moose winter range. Research directed along this line is needed before all factors involved can be evaluated.

Summary and Conclusions

A small mammal survey was conducted in Wells Gray Park and vicinity during the summer months of 1952.

Behaviour and ecological notes on sixteen rodent, bat, and insectivore species have been presented as an appendix to this preliminary inquiry into relative small mammal population numbers in ten distinct ecological zones. A standard trapline method was used to determine densities.

The trapline method is described and certain weaknesses in its operation discussed. Some factors influencing the interpretation of relative population figures obtained by this method were:

1. weather variability
2. the presence and activity of larger diurnal species of rodents and birds
3. the seasonal increase in small mammal populations
4. altitudinal effect
5. the superabundance of small mammals under suitable conditions
6. the individual variation in nightly cruising radii of certain small mammals.

It was concluded that positive results would tend to be valid, but that caution should be observed when interpreting figures obtained in this manner.

The ten ecological zones sampled are described and the descriptions summarized, (see summary of zone descriptions).

A resume of the methods by which small mammals can affect vegetation is presented. The main influences with which we are concerned deal with coniferous trees. They are:

1. the girdling of seedling and adult trees
2. insect consumption
3. retardation of forest regeneration through cone crop destruction and seed consumption
4. damage to plant growth through the terminal buds, lateral buds and foliage.

Population densities of five species were compared for ten ecological zones on a trap night per one individual basis. Relative zonal densities for *Peromyscus* were arranged in descending order of probable importance of moose winter range.

It was found that *Zapus, Clethrionomys, Microtus*, and *Sorex* were restricted in their distribution and abundance to a greater extent than was *Peromyscus*.

Shrews were trapped most often in coniferous forest types, sometimes with a grassy influence. Jumping mice preferred grassy ecotones as did meadow voles. One red back vole was captured in a climax coniferous forest stand near timberline. Deer mice were common in the majority of the areas burned within the last thirty years, although sometimes they overlapped into adjacent coniferous woods. Greatest abundance was indicated for those zones most useful to moose; i.e. those supporting young deciduous seral stages.

Rodents can successfully suppress the regeneration of conifers if other conditions coincide. It is therefore probable that moose winter yards have been sustained in Wells Gray Park for a longer period than would have occurred had small mammals been absent.

Appendix I

Land Shrews (*Sorex spp*.)

Shrews seemed particularly abundant in coniferous and grassland habitats this year.

Individuals were seen regularly on the road at night and even occasionally during the day. Two or three daylight observations were made in shaded places under dense forest canopy, either indicating abundance or a marked tolerance towards dispersed light as compared with the common rodent species.

Two or more forms may exist in Wells Gray Park, among which the dusky shrew (*Sorex obscurus*) probably is most common (M.F. Jackson, personal communication). In line with this, populations were found to frequent varied types of habitat. Seven were taken in zone 8, the spruce-cedar swamp at Hemp Creek. In this area shrews constituted 87 percent of the total catch, indicating a high relative abundance when compared with *Peromyscus* (Table I).

Walnut bait lured shrews successfully whenever the traps were laid near a fallen log or brush pile on the dry forest floor. “Sets” made on floating mats of sedges in swampy hollows under the same high canopy also produced good results.

Shrews were also captured frequently in a grass fringe between the brush-lined shore of Hemp Creek and the vast deciduous brush-land (Zone 7). Records from the brush-land itself (Zones 2, 4 and 5) indicated a scattered population.

One was obtained in zone 1, the best moose winter range, far from the nearest stand of conifers.

Although probably present in large numbers, and with a possible taste for tree seeds, the near absence of this animal from newly burned areas must exonerate it from blame attached to rodents as conifer limiting factors.

Water Shrew (*Sorex palustris*)

This seclusive shrew, rarely observed because of its nocturnal habits and aquatic habitat, was recorded only four times.

One adult male was procured from the rocky bank of Grouse Creek in early August, where it lay, apparently drowned a few yards below a small cataract.

Hemp Creek, a slower stream with many meandering side channels was the site for three separate observations in one late August evening.

All three were seen at dusk feeding along the shorelines of creek diversions 300 yards apart.

One, perhaps not conscious of our presence, approached to within six feet. It fed as it came, randomly searching first one way and then the other, alternating between stream edge and stream. Its movements on land were quick, almost furtive, changing to smooth liquid progress when it chose to slip into the water.

Upon sighting us it ceased its land foraging and entered the stream. It swam away beneath the surface.

The food of the water shrew probably is mostly animal, its limited habitat requirements curtailing tree seed depredation.

Little Brown Bat (*Myotis lucifugus*)

Possibly the most common bat at lower levels in the park, this species appeared first in early June, finally reaching a peak of abundance in August. Bats were always evident at dusk in fair weather along the few stretches of road during July, August and early September. During the third week of August, four bats were counted along a one-quarter mile section of winding road through "open" but partly regenerating "burned over" land. This probably constituted a maximum population figure.

Large willows, alder and aspen dotted the roadside. Bats circled incessantly about these, swooping across and along the roadway at altitudes of five to thirty feet. Definite territories were patrolled each evening, presumably by the same individuals.

Small bats, one definitely of this species likewise frequented various sections of Hemp Creek. One adult was taken August 12th.

Small bats were also abundant over the south end of Clearwater Lake in July.

On June 15th, in the Blackwater Creek area, bats were repeatedly observed on clear nights in a dense clump of lodgepole pines. Two consistently circled a favoured tree, the denseness of the stand forcing the bats to execute sharp turns as a matter of course, sometimes together. "Chasing" was observed at this time.

Later in the summer bats appeared earlier in the evening. As a result they were more easily observed. On August 26th, a juvenal brown bat was shot from two that circled the barn at the Blake place, which they frequently entered at the open end. No bats were seen in the barn in daylight. Possibly the many dead, dried, snags in adjacent forests provided space in which to await darkness. This belief was partially substantiated by G.G. McDiarmid who reported "flushing" a small bat from an inch-wide opening leading to a small cavity beneath the bark of a Douglas fir snag.

In the early summer months June beetles were eaten by bats. Through this trait damaging insects could be kept at harmless levels, although bats are possibly not abundant enough to constitute a limiting factor in themselves.

Silver-Haired Bat (*Lasionycteris noctivagans*)

One adult was taken July 8th as it hunted around the hay shed at the Blake place, Hemp Creek. It held a June beetle in its interfemoral membrane, apparently freshly captured. June beetles may form an integral part of the early summer diet of this and other deciduous brush-land bats.

Distributional data for all Chiropterans existing in Wells Gray Park is scarce, as is specific ecological information. Difficulty in identifying morphologically similar species in the field necessitates further collecting on a wide scale. Without basic information supplied in this manner the economic status of bats in relation to forests will never become clear.

Hoary Bat (Lasiurus cinereus)

Clear, calm evenings in mid-July found numbers of large bats skimming close to the surface of Clearwater Lake at its southern end.

Larger than the commonly observed “little brown” and “silver-haired” species, with slower wing beats, they were observed apparently feeding five to forty yards from shore.

Columbian Ground Squirrel (*Citellus columbianus*)

The “gopher” according to local residents, inhabited many portions of the fresh lowland burns ten to fifteen years ago. Forest regeneration and the subsequent disappearance of forest grasses and forks since that time apparently has resulted in a reduction of ground squirrel distribution and numbers. In 1953 they thrived at low elevations solely in man made clearings at Hemp Creek, the Majerus ranch, and the Ray ranch.

Colonies of several hundred animals lived in semi-open and open pastures at Hemp Creek, always near grasses or clover. Those plants comprised most of the stomach contents of three adults examined early in May.

The data of first general appearance in the spring was not ascertained. However females were found to be pregnant the second week of May. After a gestation period of twenty-four days (Rand, 1948) plus a one to three week period of nest growth, the young commenced diurnal foraging above ground. The first were seen near the middle of June.

Predation by humans reached a peak at this time; the 100 or more killed by guns and traps at Hemp Creek in three months probably was the greatest mortality factor influencing population abundance.

By August 10th, all the local animals had begun hibernation, or at least had become noticeably absent.

In addition to the scattered colonies at Hemp Creek larger populations occupied alpine meadows on Battle, Azure and Mica Mountains. These meadows were usually between five and seven thousand feet above sea level.

Grass, sedge and forb filled meadows and boulder-strewn slides on Battle Mountain contained ground squirrels on July 1st, evidently making their first appearance of the altitudinally delayed spring. Tunnels scratched upwards through swiftly melting snow banks were common at this time. Later, near Azure and Mica peaks, burrows were found well hidden inside the outer fringe of clumps of dwarfed alpine fir. Rock piles and slides also provided cover.

In the three alpine sections visited the gopher apparently was a staple item in the diet of grizzly bears (*Ursus horribilis*). Large excavations to remove animals hibernating in the early fall were commonplace. The energy expended to dig such holes must often surpass the increment received upon consumption of the prey.

Gophers in alpine areas probably are a valuable “buffer” species in the wolf/coyote-rodent-ungulate predation complex. Harassment of calves and fawns by canine carnivores must be diverted to a considerable extent in the summer months by this abundant rodent.

Columbian Chipmunk (*Eutamias amoenus*)

Myriads of chipmunks inhabited the aspen-birch-willow association at low altitudes throughout the park. Diversity of plant species in a seral stage twenty to thirty years of age usually meant good chipmunk representation. Criss-crossed mazes of dead fall provided seemingly ideal cover conditions,especially if free from tall coniferous trees.

Scattered individuals were seen existing on windswept stretches of loose rock near timberline on Azure and Mica Mountains.

Active throughout the summer and early fall, this animal could perceivably reach concentrations detrimental to tree regeneration.

Red Squirrel (*Tamiasciurus hudsonicus*)

Perhaps near a cyclic peak in Wells Gray Park, it was extremely abundant in 1953. Although found in many biomes, its highest concentrations seemed to exist in lodgepole pine forests of the southern section of the Clearwater Valley (Zone 5).

At Hemp Creek squirrels were present in mixed coniferous stands but were usually absent from deciduous brush-land.

Local centres of abundance included the spruce-cedar swamp (Zone 8), and near mature hemlock-cedar-spruce stands between Hemp Creek and the Murtle River.

Not many were seen in the heart of decadent, even-aged cedar and hemlock forests on the west shore of Clearwater Lake. In fact, distributional observations gave the impression that coniferous stands thirty to sixty years old interspersed with hardwoods afforded optimum squirrel habitat.

Although active all year they were most conspicuous during September when their noisy chattering echoed through the woods. Food in alarming quantities was stored during this period.

At Hemp Creek, one or two rugged individualists made several trips daily to the roof of the Blake cabin, evincing outstanding regularity as to the route taken. Succeeding trips followed a specific path each time, utilizing the same branches and twigs.

By mid-September mushroom and toadstool cashes, sometimes of many pounds, were seen securely lodged several feet from the ground in shrubby willow, aspen, and alder bushes. These caches were primarily in “open” stands low in coniferous species content near Hemp Creek.

Caches of cones were prevalent in the densely conifered sections. These were hidden in humus beneath large surface roots of old conifers. Remnants of cones torn apart at an earlier date sometimes littered the ground near such caches.

Considerable seed consumption undoubtedly can be attributed to this species in Wells Gray Park. However, it seems likely that only minor populations exert this influence on areas young in seral stage, which ostensibly are the ones on which conifer succession may occur.

Their habit of burying seeds in cones could aid in seed dispersal under certain conditions. The benefit derived from this action is conceivably minute, however, in Wells Gray Park.

Damage to live conifers was also observed, especially in the case of lodgepole pine near Grouse Hill. Both terminal and lateral shoots from live trees were “nipped” and dropped to the ground. From three to six inches long, the twigs later were stripped of needles, cones and buds as they lay in scattered groups beneath the despoiled tree. However it was not discovered whether the latter “stripping” was the work of ground inhabiting rodents of of the squirrels themselves.

Flying Squirrel (*Glaucomys sabrinus*)

A nocturnal Sciurid seldom observed, this species afforded no basis for an estimate of relative species abundance. However nests were rare.

Two specimens were collected at Hemp Creek by R. Helset; one a pregnant female.

Stomach analysis was not undertaken. Rand (194), states they prefer “seeds but with a pronounced fondness for meat”. It is therefore doubtful that these animals exist in sufficient numbers in Wells Gray Park to significantly retard tree growth or reproduction.

Deer Mouse (*Peromyscus maniculatus*)

Easily trapped and extremely abundant, this mixed forest dweller was discovered in all zones sampled (Fig.I) except 6, 7, 9 and 10.

Forest cabins were overrun. In consequence everything remotely edible was destroyed or damaged if left unprotected.

Mixed deciduous forests, the type regenerating extensive lower level “burns” of the park, held the densest population. Young seral stages, composed largely of upland willow (Zone 1), required only 2.2 trap nights to produce one mouse. However, all forms of mixed coniferous and deciduous stands that were trapped, except zone 6, yielded a few of this species. A dry forest floor pervaded all areas of occurrence, and may be requisite to optimum habitat.

The first young of the year were captured in the Blake cabin on May 16th. Thereafter, juveniles and subadults formed thirty to one hundred percent of the catch, indicating a rapid population turnover. One of the 29 caught in zone 1 was definitely an adult. Pregnant females were still being obtained in mid-August, most of them subadults.

Peromyscus provided little opportunity for the observation of feeding habits under natural conditions. However the success of walnut as bait indicates seed eating tendencies.

Bushytail Woodrat (Neotoma cinerea)

The “packrat” was recorded from two types of habitat in Wells Gray Park; first, from rocky river banks of the Murtle and Clearwater Rivers, and second, in cabins at Bear Creek, Hemp Creek and the Majerus ranch.

The habit of occupying cabins during the fall and winter plus an innate desire to “borrow” makes it a familiar animal. Its conspicuous habits give an impression of wide distribution and extreme abundance. Probably only the first is true.

In June one was live trapped in a cage set for mink along the rocky shore of the Murtle River near the Pyramid Mountain. This constituted the record furthest from civilization, a matter of a few miles.

G.G. McDiarmid reported an unusual abundance along the Clearwater River. Seven were shot in one shelter during August and September, the last on September 2nd. Apparently a wandering tendency spurs the species to travel from summer habitat in the early fall, at least in some years.

Northern Bog Lemming (*Synaptomys Borealis*)

Not recorded in 1953, but a probable resident in some of the remote areas visited while trapping conditions were generally poor. Even the technique employed seemed not the best for capturing *Synaptomys*, (R.Y. Edwards, 1952).

Red Back Vole (*Clethrionomys Gapperi*)

Apparently at a cyclic low, only one individual of this formerly abundant forest species (P. W. Martin, 1950) was obtained. It inhabited a one acre stunted alpine fir stand on Battle Mountain slopes.

Had weather conditions been less severe when trapping was undertaken, and had late summer trapping been economically feasible, the same biome may have yielded others.

Damage to small conifers, usually alpine fir (*Abies lasiocarpa*) three to five feet high, was noted on Mica Mountain near timberline and tentatively blamed on the winter foraging of this species. The seedlings had been partially stripped of bark and needles, resulting in death. Of irregular occurrence in remote areas these depredations were not economically important.

Meadow Mouse (Microtus pennsylvanicus)

Nine specimens of this species were procured in grassy meadows and clearings at Hemp Creek. Fewest trap nights were required to capture one animal in zone 9. Sets were made in a lush grass and forb mixture 18 to 24 inches high that flourished on lowland flats regularly flooded by the spring freshet.

In August, after the completion of haying by the local ranchers, marsh and sparrow hawks cruised the lowlands presumably hunting this species.

The species was also recoded in zone 7, inside the edge of adjacent deciduous brush-land. No girdling of trees was noticed in this or any other zone.

Other populations of meadow voles probably exist in alpine areas near Battle and Azure peaks. Winter workings, the remains of a winter food supply, were common along small creeks and streams. However it is possible they represent a closely related species, the long-tailed meadow vole (*Microtus longicaudus*), or even *Synaptomys borealis*, the bog lemming.

Richardson Vole (*Microtus Richardsoni*)

Trapping to take this species was undertaken the first week of July on Battle Mountain. Probably because of inclement weather and the early season no success was attained.

Along the banks of glacial streams just below timberline networks of holes and runways were seen. The holes were filled with water, and varied from three to five inches in diameter. It was felt they represented the work of this vole.

Isolated populations could occur on similar ground in other alpine areas. Only extensive late season trapping will prove or disprove this theory.

Meadow Jumping Mouse (*Zapus hudsonius*)

Two adults were taken at Hemp Creek, July 12th and August 3rd, (Fig. I). Their measurements and general appearance showed them to be representatives of *Hudsonius*. No *Princeps* were recorded in the park.

The former species is a regular inhabitant of the grass-deciduous forest edge at lower levels, sometimes in damp situations. As these conditions render conifer regeneration unlikely, any seed consumption on the part of these animals should have no visible effect on that type of vegetation.

Appendix II

Location of Trapping Samples

Zone 1

Opposite Pyramid Mountain, 50 to 100 yards from Murtle River, east bank, 1/4 mile further along trail from pine stands at washout on Murtle.

Zone 2

20 yards north of lookout on Green Mountain, run east and west (over trail).

Zone 3

200 yards east of Blake homestead, and above the cattle fence on the hillside.

Zone 4

Set half in the “All Species-Willow Competition Plot”, above Ranger Station (south west corner of plot).

Zone 5

1/2 mile towards Grouse Hill from McDiarmids, line set 50 yards from McDiarmids old trail, running north and south towards top of Grouse Hill.

Zone 6

100 yards south of Clearwater Lake ranger cabin, then 75 yards east of trail, line parallel to lake.

Zone 7

100 yards west of Blake homestead, set parallel to road and on Hemp Creek side of it, line at edge of creek edge willows, etc., but set in grass.

Zone 8

1/4 mile east of Blake homestead, line started east end of swamp and ran west through heart of swamp towards Hemp Creek.

Zone 9

Set on west side of large, central hay meadow, approximately 100 years north west of hay rigging and near willow clumps.

Zone 10

Running north and south on east slops Battle Mountain, about a mile from the peak, line half in meadow, half in dense alpine fir. Lime crossed winter vole workings.

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