ECOLOGICAL RESERVES UNIT
1019 WHARF ST
VICTORIA, B.C. V8W 2Y9

Ref no 7-1

ECOLOGICAL RESERVES COLLECTION
GOVERNMENT OF BRITISH COLUMBIA
VICTORIA, B.C.
V8V 1X4

A VEGETATION DESCRIPTION OF TWO ECOLOGICAL RESERVES IN INTERIOR BRITISH COLUMBIA

by

Shirley Dale Larmour

B.Sc., University of Regina, 1973

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE

in the Department

of

Botany

We accept this thesis as conforming to the
required standard

.....

.....

.....

THE UNIVERSITY OF BRITISH COLUMBIA

September, 1975

ABSTRACT

The purpose of this thesis is to provide a vegetation description of two Ecological Reserves in Interior British Columbia. The Ecological Reserves studied were Trout Creek, near Penticton and Tranquille, near Kamloops. These areas were studied using quadrats placed within community types subjectively determined on the basis of species dominance and physiognomy.

Soil samples were taken and brief profile descriptions made.

Field data were examined subjectively and modifications of the original units made where necessary. A Bray-Curtis Ordination was done on the data from each reserve.

Four communities were defined in Trout Creek. The most extensive community is the Pinus ponderosa/Agropyron spicatum community. This occurs on terraces and slopes and is dominated by Pinus ponderosa in the tree layer and Agropyron spicatum in the herb layer. Chrysothamnus nauseosus is the most common shrub.

On talus slopes is the Pinus ponderosa/Pseudotsuga menziesii/Amelanchier alnifolia community. Pinus and Pseudotsuga occur together in the overstory and Amelanchier alnifolia is the most common shrub. The ground cover is sparse.

In small areas of rock outcropping are Selaginella wallacei communities in which the ground cover is dominated by this vascular cryptogam.

In one very small, protected area, is the Pinus ponderosa/Pseudotsuga menziesii/Calamagrostis rubescens community. This community has a dense layer of young Pinus and Pseudotsuga and a ground cover of the grass Calamagrostis rubescens.

Four communities were also defined in Tranquille. On the flat valley bottom, is the Artemisia tridentata/Poa sandbergii/Stipa comata community. Artemisia tridentata dominates the shrub layer and Poa sandbergii and Stipa comata are codominants in the herb layer. There is no tree layer. This community is probably overgrazed.

Most of the lower slopes of the reserve are covered by the Pinus ponderosa/Agropyron spicatum community. This community is dominated by Pinus ponderosa in the canopy and Agropyron spicatum in the herb layer. The sparse shrub layer is composed mainly of Chrysothamnus nauseosus and Artemisia tridentata.

Also on the lower slopes, in small areas interspersed within the Pinus/Agropyron community is the Pinus ponderosa/ Aristida longiseta community, in which the grass Aristida longiseta becomes a codominant in the herb layer.

Above about 760 meters, the vegetation is predominantly the Pseudotsuga menziesii/Pinus ponderosa/Agropyron spicatum

community. Pseudotsuga becomes codominant or dominant in the canopy layer. Agropyron spicatum is still dominant in the herb layer but the clumps are smaller and more widely spaced.

The Bray-Curtis Ordinations support the community breakdowns.

The soils are Brunisols in Trout Creek and Regosols and Chernozems in Tranquille. Soil profile descriptions are given and data on various physical and chemical characteristics of the soils are presented.

A comparison of the reserves is made. It is recommended that the Trout Creek Reserve be high priority for fencing. This is not necessary for Tranquille.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

Funds for the work done in this thesis were provided by N.R.C. Grant No. 6633, the British Columbia Ecological Reserves Committee, the Government of British Columbia Careers 74 Program, and two N.R.C. Post Graduate Scholarships awarded in 1974 and 1975.

I wish to thank Dr. George Otto for the identification of the lichens, Dr. George Ledingham for the identification of the Astragalus and Carex species and Dr. W.B. Schofield for help with the identification of the moss species.

Warm and special thanks go to Miss Olivia Ng who assisted with the field work and to my supervisor, Dr. Charles E. Beil, who helped in countless ways and without whom, nothing would have been accomplished.

INTRODUCTION

Although many Ecological Reserves have been established to preserve types of vegetation and to provide areas for scientific study. few detailed vegetation descriptions have been made of them. The purpose of this thesis is to provide a detailed description of the vegetation of two Ecological Reserves. This description should serve as a basis for further study and as information to guide management.

The reserves chosen are in the dry Interior of British Columbia, one near Penticton and the other near Kamloops. They were studied in the summer of 1974.

REVIEW OF THE LITERATURE

The vegetation of the reserves falls into the Ponderosa Pine - Bunchgrass and the Interior Douglas Fir Biogeoclimatic Zones (Krajina 1965). The open, park-like forest in the Ponderosa Pine - Bunchgrass Zone is dominated by Pinus ponderosa with a grassy understory much like the communities of the adjacent more xeric grasslands. As conditions become more mesic, the ponderosa pine forest is replaced by a forest dominated by Pseudotsuga menziesii. This zone is the Interior Douglas Fir Zone (Krajina 1965).

The following is a brief review of characteristics of these two zones for background information relating to the vegetation and environment of the reserves.

The Ponderosa Pine - Bunchgrass Zone:

The climate of the Ponderosa Pine - Bunchgrass Zone is classified as BSK, Dsa and the driest Dsb (after Köppen). Winters in this zone are moderately cold and summers are warm with 80 to 200 frost free days. The annual precipitation is 18 to 36 centimeters and 19 to 42% of this falls as snow (Krajina 1969). The precipitation shows two seasonal maxima, a long diffuse maximum in winter and a shorter one in June and early July (Brayshaw 1965).

The Zone's latitudinal range is from 49° to 51°30' N. and extends approximately from 270 to 750 meters in elevation. It is developed in British Columbia in the Fraser, Thompson, Nicola, Similkameen, Okanagan and Kootenay River valleys (Krajina 1969).

This vegetation zone has been studied and the different communities within it classified by several workers. (Brayshaw 1955, 1965, 1970) studied Pinus ponderosa communities throughout British Columbia. He divided the pine communities into three associations. On coarse gravelly soils and at the foot of talus slopes he recognized a Pinus ponderosa - Rhus glabra association. He listed common associates as Rhus radicans, Philadelphus lewisii, Sambucus glauca, Amelanchier alnifolia, Panicum scribnerianum, Stephanomeria tenuifolia, Holodiscus discolor, Specularia perfoliata, Verbena bracteata and Pseudotsuga menziesii.

On more acid sands and sandy loams in the south Okanagan Valley he described a Pinus ponderosa - Purshia tridentata association with common associates, Aristida longiseta, Poa secunda, Poa cusickii, Phlox longifolia, Opuntia fragilis, Festuca octoflora, Oryzopsis hymenoides, Sporobolus cryptandrus, Leptodactylon pungens, Lewisia rediviva, Calochortus macrocarpus, Chrysothamnus nauseosus and Tortula ruralis. He defined a Pinus ponderosa - Aristida longiseta subassociation that

does not contain Purshia tridentata (possibly as a result of burning of Pinus ponderosa - Purshia stands) and has Stipa comata, Chaenactis douglasii, Gilia pungens, Eriogonum niveum and Phacelia linearis.

The most widespread community is the Pinus ponderosa - Agropyron spicatum association. Its common associated species are Festuca idahoensis, F. scabrella, Poa cusickii, Poa secunda, Koeleria cristata, Antennaria dimorpha and Bromus tectorum. Also a subassociation is the community dominated by the shrub Artemisia tridentata. This community arises from intense grazing pressure on the climax, on heavy textured soils at low elevations.

He also included communities of the grassland and a Purshia tridentata shrub-steppe community lacking Pinus ponderosa in his list of associations.

Krajina (1965) in his list of biogeocoenoses for the Ponderosa pine - Bunchgrass Zone separated a Stephanomeria (tenuifoliae) - Heuchero (cylindricae) - Amelanchiero (alnifoliae) - Ponderoso - Pseudotsugetum glaucae and also a Rhuo (glabrae and radicantis) - Purshio tridentatae - Pinetum ponderosae biogeocoenosis from his biogeocoenosis that corresponds to the Pinus ponderosa - Rhus spp. association, and included Agropyretum spicati, Stipa comatae - Opuntio (fragilis) - Aristido (longsetae) - Purshietum tridentatae, and Sporobolo (cryptandri) - Aristidetum longisetae biogeocoenoses which

lack Pinus ponderosa. He also listed equivalents of the Pinus ponderosa - Agropyron spicatum association, the Pinus ponderosa - Stipa spp. subassociation (which is accorded biogeocoenosis rank) and the Pinus ponderosa - Purshia tridentata association. He did not include any equivalent of the Pinus ponderosa - Artemisia tridentata association.

McLean (1970), working in the Similkameen Valley, divided the vegetation altitudinally into zones and within zones recognized various habitat types. In the Pinus ponderosa zone he recognized three habitat types.

The first is the Pinus ponderosa - Agropyron spicatum type. He stated that this habitat type is small and not common. Common associated species include Poa secunda, Stipa comata, Sporobolus cryptandrus, Antennaria dimorpha, Arabis holboellii, Tragopogon dubius, Bromus tectorum, Festuca octoflora, Lappula redowskii, and Plantago patagonica. He defined this type as not containing Festuca idahoensis and Eriogonum heracleoides.

The second type is the Pinus ponderosa - Festuca idahoensis habitat type. This is the type that would roughly correspond to the Pinus ponderosa - Agropyron spicatum associations described earlier. Common associated species in this type are Eriogonum heracleoides, Koeleria cristata, Poa secunda, Crepis atrabarba, Lomatium macrocarpum, Arabis holboellii, Tragopogon dubius, Achillea millefolium, Antennaria umbrinella, Collinsia

parviflora, Erigeron corymbosus, Lithospermum ruderale, Lupinus sericeus, Bromus tectorum, Microsteris gracilis and Polygonum douglasii.

The third type he called the Artemisia - Festuca idahoensis habitat type. This is very similar to the Pinus - Festuca type except there are few pines and Artemisia tridentata is a dominant shrub.

He recognized no equivalent of the Pinus ponderosa - Purshia tridentata, Pinus - Aristida, Pinus - Stipa spp. or Pinus - Rhus spp. associations. His Artemisia - Agropyron and Artemisia - Stipa types may be the treeless equivalent of the Pinus - Artemisia tridentata association mentioned earlier.

Communities dominated by Ponderosa pine are not confined to British Columbia but extend into the United States. Many of these communities are quite similar to those just described, but with distance from Canada, the similarity with British Columbian communities decreases.

In eastern Washington six Pinus ponderosa associations have been recognized by Daubenmire and Daubenmire (1968). The Pinus ponderosa - Symphoricarpos albus association is found on deep, fine-textured, fertile soils. Symphoricarpos albus, Spirae betulifolia var. lucida, Rosa woodsii and R. nutkana dominate the extensive shrub layer, while associated herbaceous species include Calamagrostis rubescens, Agropyron

spicatum, Festuca occidentalis, Poa compressa, Achillea millefolium var. lanulosa, Lithospermum ruderale, Tragopogon dubius, Brodiaea douglasii and Potentilla gracilis.

In the Pinus ponderosa - Physocarpus malvaceus association conditions are more mesic, and the community has, in addition to the shrubs mentioned earlier, a taller shrub layer of Physocarpus malvaceus, Holodiscus discolor, Ceanothus sanguineus and Amelanchier alnifolia. This association has less Agropyron, Festuca and Poa, and Calamagrostis rubescens, Bromus vulgaris, Carex geyeri, Erythronium grandiflorum, Fragaria sp., Galium boreale and Osmorhiza chilensis are more characteristically abundant species.

The other four communities they recognized correspond more closely to those described from British Columbia. The Pinus ponderosa - Festuca idahoensis community has a sparse low shrub layer composed largely of Arceuthobium campylopodum, and an herb layer dominated by Festuca idahoensis with characteristic associated species including Agropyron spicatum, Koeleria cristata, Poa sandbergii, Achillea millefolium, Tragopogon dubius, Balsamorhiza sagittata, Ranunculus glaberrimus, and Sisyrinchium inflatum.

The Pinus ponderosa - Agropyron spicatum community is dominated by the grass Agropyron spicatum and has as

characteristic species Poa sandbergii, Balsamorhiza sagittata, Ranunculus glaberrimus, Lithophragma bulbifera, Collinsia parviflora, Bromus tectorum, Montia linearis, Myosotis micrantha, Draba verna, Epilobium paniculatum and Stellaria nitens.

The Pinus ponderosa - Stipa comata association has much more of the low shrub Eriogonum niveum than the other communities, and the major grasses are Stipa comata, Stipa occidentalis and Poa sandbergii. Common associated species are Achillea millefolium, Antennaria dimorpha, Erigeron compositus, Collinsia parviflora, Bromus tectorum, Montia linearis, Myosotis micrantha, Draba verna and Epilobium paniculatum.

The Pinus ponderosa - Purshia tridentata association has a Purshia - dominated shrub layer with an understory including Festuca idahoensis, Agropyron spicatum, Stipa comata, Artistida longiseta, Balsamorhiza sagittata, Erigeron compositus, Achillea millefolium, Collinsia parviflora, Bromus tectorum and Epilobium paniculatum (Daubenmire and Daubenmire 1968).

Franklin and Dyrness (1973) stated that only the Pinus - Festuca and Pinus - Agropyron associations extended into British Columbia, but the Pinus - Stipa and Pinus - Purshia associations correspond closely to those described by

Brayshaw (1965, 1970).

In the Blue Mountains Province of Oregon six Pinus ponderosa associations have been identified. Two are the Pinus ponderosa - Agropyron spicatum and the Pinus ponderosa - Purshia tridentata - Agropyron spicatum associations which are similar to the previously described, similarly named associations.

In the extreme southern part of the area a Pinus ponderosa - Purshia tridentata - Carex rossii association is found, with common associates Sitanion hystrix and Stipa occidentalis. Pinus ponderosa - Elymus glaucas communities occur next to dry meadows, and at higher elevations next to Abies grandis forests Pinus ponderosa - Carex geyeri communities occur with their common constituent species including Cercocarpus ledifolius and Poa nervosa. The Pinus ponderosa - Festuca idahoensis association is characterized by an abundance of other grasses and sedges including Agropyron spicatum, Sitanion hystrix, Calamagrostis rubescens, Carex rossii and C. geyeri.

Other forest communities of south-central Oregon include Pinus ponderosa - Arctostaphylos patula - Festuca idahoensis, Pinus ponderosa - Cercocarpus ledifolius - Festuca idahoensis, and Pinus ponderosa - Artemisia tridentata - Bromus carinatus (see Franklin and Dyrness 1973)

Washington Pinus ponderosa forests contain communities very much like those in British Columbia. However Oregon pine communities often have different associated species. This trend continues and although Pinus ponderosa itself extends into Arizona, its associated species change considerably. Several examples of this can be cited.

Thilenius (1972), working in the Black Hills of South Dakota recognized several community types under a basically Pinus ponderosa forest. These contain such understory species as Oryzopsis asperifolia, Achillea millefolium, Galium biflorum, and Danthonia intermedia.

Cooper (1961) listed Muhlenbergia virescens, Sitanion hystrix, Blepharoneuron tricolepis, Panicum bulbosum and Stipa pringlei as some understory grasses in an Arizona ponderosa pine-dominated forest.

Whittaker and Niering (1965), working in the Santa Catalina Mountains listed some associates of the pine as being Artemisia ludoviciana, Yucca schottii, Aristida orcuttiana, Cheilanthes fendleri, Hedeoma hyssopifolium, and Muhlenbergia virescens.

The Grand Canyon area in Arizona was described by Merkle (1962) as having two units, a Pinus ponderosa - Artemisia

tridentata unit having associates such as the shrubs Chrysothamnus depressus, Cowania mexicana and Quercus gambelii and the grasses Festuca arizonica and Sitanion hystrix, and a ponderosa pine-grassland unit having associate species such as Festuca arizonica, Muhlenbergia montana, Sitanion hystrix, Bouteloua gracilis, Lupinus hillii and Eriogonum racemosum.

Halvorson (1972) also working in the Grand Canyon area listed some understory species as Poa longiligua, Poa fendleriana, Calochortus ambiguus, Koeleria cristata and Hymenopappus lugens.

Grassland Communities:

As has been stated previously, the understory vegetation of Ponderosa pine forests is very similar to grassland communities. Therefore a discussion of grassland communities is in order.

At lower elevations adjacent to the ponderosa pine forest are the more xeric grasslands. Tisdale (1947) found three grassland zones in southern Interior British Columbia. The Lower Grassland is dominated by Agropyron spicatum, Poa secunda, Artemisia tridentata and Antennaria dimorpha. Common species include Stipa comata, Sporobolus cryptandrus, Chrysothamnus nauseosus, Opuntia fragilis, Artemisia frigida, Calochortus

macrocarpus, Erigeron filifolius and Lomatium macrocarpum.

He mentioned communities derived from the climax by the pressure of overgrazing. He described an overgrazing community he called the Artemisia - Poa Associes, in which Artemisia tridentata dominates the shrub layer and Poa secunda the herb layer. Characteristic species include Chrysothamnus nauseosus, Agropyron spicatum, Sporobolus cryptandrus, Stipa comata, Koeleria cristata, Antennaria dimorpha, Lomatium macrocarpum, Opuntia fragilis, Artemisia frigida, Erigeron filifolius, Lappula occidentalis, Descurainia richardsonii, Bromus tectorum, and Balsamorhiza sagittata.

The Middle Grassland lacks Artemisia tridentata but dominants include the same species of Agropyron, Poa, Stipa and Antennaria as in the Lower Grassland plus Bromus tectorum on overgrazed areas. Common species include Chrysothamnus nauseosus, Koeleria cristata, Balsamorhiza sagittata, Achillea millefolium, Antennaria parvifolia, Festuca scabrella and Erigeron corymbosis.

In the Middle Grassland Zone two communities arise from overgrazing. One is a Stipa - Agropyron - Poa Associes in which the principal dominant is Stipa comata, and Bromus tectorum and Lappula occidentalis are much more

common than in the climax. The other is a Bromus - Poa - Stipa Associes in which the principal species is Bromus tectorum, with Poa secunda and Stipa comata as associates.

The Upper Grassland again is dominated by Agropyron spicatum, Koeleria cristata and Poa secunda, plus Festuca scabrella. It contains more mesic species such as Carex praegracilis, Juncus balticus and Zygadenus venenosus.

In the Upper Grassland Zone overgrazing causes a community in which the normally not abundant Stipa columbiana and Poa pratensis dominate, or a Poa - Bromus Associes in which Poa secunda and Bromus tectorum dominate.

Grassland associations in the Tranquille Range near Kamloops were studied by Spilsbury and Tisdale (1944). They divided the vegetation into three similar zones. They mentioned a ponderosa pine savanna, saying that it is a marked variation of normal zonal succession in the study area. They stated that it occurs above the Lower Grassland Zone and below the Montane Zone, and that the Middle and Upper Grassland Zones are not present.

McLean (1970) also included a treeless zone called the Artemisia tridentata Zone which would correspond to the Lower Grassland Zone. He described the major habitat type as being dominated by Artemisia tridentata and Agropyron spicatum, with

characteristic species including Poa secunda, Crepis atrabarba, Lomatium macrocarpum, Phlox longifolia, Bromus tectorum, Festuca octoflora, Lappula redowskii and Microsteris gracilis.

Where Stipa comata and Poa secunda are dominant grasses he recognized an Artemisia - Stipa habitat type.

The grasslands also extend into Washington and Oregon and many similar communities have been described from these areas (Daubenmire 1970, Franklin and Dyrness 1973).

The Interior Douglas Fir Zone:

The vegetation of the cooler and moister Interior Douglas Fir Zone (Krajina 1965) is of note also. The reserves partially fall in this zone, as it borders the Ponderosa pine - Bunchgrass Zone at its higher altitudinal limits. This zone has been divided into two subzones, the drier of which borders the Ponderosa pine - Bunchgrass Zone. According to Krajina (1965), this subzone has an annual precipitation of 36 to 48 centimeters. The major coniferous trees are Pseudotsuga menziesii and Pinus ponderosa, Pinus ponderosa being mainly a pioneer species.

Krajina lists several biogeocoenoses for this zone including Brachythecio (albicantis) - Calamagrostido (rubescentis) - Ponderoso - Pseudotsugetum glaucae on Gleyed

Eutric Brunisols, Tortulo (ruralis) - Agropyro (spicati) - Calamagrostido (rubescentis) - Ponderoso - Pseudotsugetum glaucae on mesic to submesic Gray Luvisols, Peltigero (caninae) - Polytricho (juniperini) - Calamagrostido (rubescentis) - Arctostaphylo (uvae-ursi) - Ponderoso - Pseudotsugetum glaucae on mesic to subxeric habitats, Tortulo (ruralis) - Agropyro (spicati) - Festuco (idahoensis) - Ponderoso - Pseudotsugetum glaucae on xeric habitats, and on some lithosols, Regosols or shallow Dystric Brunisols, Cladonio - Peltigero (caninae) - Apocyno (androsaemifolii) - Selaginello - Arctostaphylo (uvae-ursi) - Junipero (nanae) - Ponderoso - Pseudotsugetum glaucae.

Brayshaw (1970) has recognized several associations in the Douglas Fir Zone. The Pseudotsuga menziesii - Pinus ponderosa - Arctostaphylos uva-ursi association has a ground cover dominated by Arctostaphylos uva-ursi with Juniperus scopulorum, Shepherdia canadensis, Allium cernuum, Penstemon fruticosus ssp. scouleri, Carex concinnoides, Sedum stenopetalum, Fragaria virginiana, Apocynum androsaemifolium and Solidago spathulata as associated species. Pinus ponderosa dominates the overstory at the lowest elevations but Pseudotsuga menziesii is the most common canopy dominant.

In the Pseudotsuga - Calamagrostis rubescens association the understory is dominated by Calamagrostis rubescens with

characteristic associated species including Lathyrus nuttallii, Lilium columbianum, Arnica cordifolia, Antennaria anaphaloides, Antennaria rosea, Fritillaria lanceolata, Poa ampla, Hieracium cynoglossoides, Astragalus serotinus and Zygadenus venenosus. Pinus ponderosa or Pinus contorta sometimes dominate the tree layer, but these communities were interpreted as seral and given subassociation status.

Brayshaw also recognized a Pseudotsuga - Arctostaphylos - Calamagrostis rubescens association which is intermediate in character.

In moist draws, ravines and sheltered slopes a Pseudotsuga menziesii - Symphoricarpos albus association occurs. Its common associated species include Aster conspicuus, Osmorhiza chilensis, Populus tremuloides, Amelanchier alnifolia, Spiraea lucida, Mahonia aquifolium, Acer glabrum var. douglasii, Prunus virginiana, Crataegus douglasii and Clematis verticillata var. columbiana.

In his work in the Similkameen Valley, McLean (1970) delimited five communities in the Pseudotsuga menziesii Zone. The Pseudotsuga menziesii - Agropyron spicatum habitat type is found on steep slopes with coarse textured soil. Agropyron spicatum is the dominant grass. Also characteristic are Selaginella wallacei and Amelanchier alnifolia.

The Pseudotsuga menziesii - Festuca idahoensis habitat

type contains many but not all of the characteristic species of the Pinus ponderosa - Festuca idahoensis habitat type, and the tree reproduction indicates that Pseudotsuga will eventually dominate the overstory at the expense of Pinus ponderosa.

The understory of the Pseudotsuga menziesii - Calamagrostis rubescens habitat type is dominated by Calamagrostis with shrubs such as Rosa gymnocarpa, Spiraea betulifolia and Arctostaphylos uva-ursi. The Pseudotsuga - Pinus - Arctostaphylos and Pseudotsuga - Arctostaphylos - Calamagrostis associations (Brayshaw 1965, 1970) would probably fall in this habitat type.

Occuring as grassland between the Pinus ponderosa Zone and the Pseudotsuga menziesii Zone McLean found a Festuca idahoensis - Eriogonum heracleoides habitat type. This association is also much like the Pinus - Festuca association except for the absence of Pinus and Crepis atrabarba and the presence of Poa pratensis, Zygadenus venenosus and Delphinium bicolor.

The Artemisia tripartita - Agropyron spicatum habitat type occurs only at the south-eastern edge of the British Columbia Interior, at the lower edge of the Pseudotsuga menziesii Zone. The dominant shrub is Artemisia tripartita and the dominant herb, Agropyron spicatum.

Autecology of Ponderosa Pine and Douglas Fir:

The vegetation zones under consideration here are dominated by two tree species, Pinus ponderosa and Pseudotsuga menziesii. A review of some of the autecological features of these species might, therefore, be useful in gaining an understanding of the vegetation zones.

Ponderosa pine is a tree well adapted to continental cold semiarid to microthermal continental subhumid (BSk and driest Dfb and Dsb after Köppen) climates with summer warm and total annual precipitation 18 to 36 centimeters. It grows mainly as a pioneer tree in the Interior Douglas Fir Zone which has higher (36 to 56 centimeters) rainfall.

The optimum germination temperature of the pine seeds is higher than that of Douglas fir, but the young seedling is quite susceptible to heat injury. However after the first few months when this danger is high, the pine grows best in the open.

Ponderosa pine has an extensive root system consisting of, where possible a large taproot and a very wide-spreading lateral root network. This makes it very wind firm, an advantage when growing in its characteristic open stands.

The pine has thick, fire-resistant bark, and as it grows where danger of ground fires is high, this is an advantage.

It requires conditions favouring rapid transpiration and

is said to photosynthesize relatively inefficiently, (Brayshaw 1965).

Its frost resistance is low, especially when young (Cochran and Berntsen 1973), so it will not become established in areas of severe winters. It is also nutritionally very demanding, especially in the supply of nitrogen, sulphur, calcium, magnesium and potassium (Krajina 1969).

The pine is a less shade tolerant tree than Douglas fir but is shade tolerant in its zone and is shade requiring on the most xeric habitats there. This may be because in the driest habitats soil temperatures rise high enough to be lethal to young seedlings (Brayshaw 1955, 1965). The exclusion of the tree in the steppe of the valleys may also be due to inadequate soil moisture in combination with competition by more xerophytic plants (Brayshaw 1965, Larson and Shubert 1969).

Ponderosa pine is a cordilleran species that ranges from the southern British Columbia Interior to Arizona. It is a dry forest species, and unless affected in some way by man's activities forms an open parkland community (Cooper 1960, 1961, Weaver 1961).

The variety of Douglas fir that grows in the Interior, Pseudotsuga menziesii var. glauca (this is the only variety referred to in this thesis), is less drought and heat resistant than Pinus ponderosa.

It does occur in the Ponderosa pine - Bunchgrass Zone but is

usually restricted there to very coarse soils and talus where the chance of moisture during a rain penetrating the soil is greater, or other topographically moister and cooler sites. Its frost resistance is low, but it is less demanding nutritionally than Pinus ponderosa except in phosphorus, calcium and potassium. It grows best on soils rich in calcium and magnesium (Krajina 1969, Brayshaw 1955).

Douglas fir is a moderately shade tolerant tree, doesn't have as extensive lateral root development as Ponderosa pine, and usually forms a more closed forest than does the pine (Brayshaw 1955). It also is a cordilleran element.

DESCRIPTION OF STUDY AREAS

General Physiography:

The reserves discussed here are in the region designated as the Interior Plateau of British Columbia (Holland 1964). This area is a greatly dissected plateau system with large areas of rolling upland separated from each other by deep valley trenches. Bedrock of the area includes volcanic and sedimentary rocks of the Cenozoic, Mesozoic and Paleozoic Eras. Before the uplifting and later erosion in the late Tertiary, the great lava plains of Interior British Columbia are said to have been a continuation of the Columbia lavas of Washington, Oregon and Idaho. The whole area was glaciated so glacial drift of some

sort forms the parent material of most soils (Brink and Farstad 1949, Tisdale 1947).

Both reserves are in the Thompson Plateau area of this region (Figure 1). It is a gently rolling upland of relatively low relief reflecting the late Tertiary erosion surface that has been dissected by the Thompson River and its tributaries and by the Similkameen and Okanagan rivers, tributaries of the Columbia.

In this area during the later stages of the last glaciation there was gradual ice stagnation and wasting of ice in place. As a result ice marginal meltwater channels were quickly made and abandoned. On many slopes a series of channels was formed at successively lower levels as the ice melted, depositing the outwash in a terraced form. This is especially evident in the Okanagan Valley (Holland 1964).

Trout Creek:

Ecological Reserve No. 7, Trout Creek, is in the Okanagan Valley 3 miles south-southwest of Summerland and 2 miles west of the Experimental Station, north of Trout Creek and on the south slopes of Mount Conkle ($49^{o}33'$ - $33'30''$ N Lat. $119^{o}42'$ - $43'$ W Long.) (Figure 2). It is 74.9 hectares in area and ranges in elevation from 540 to 840 meters.

It is mainly in the Ponderosa pine - Bunchgrass Zone

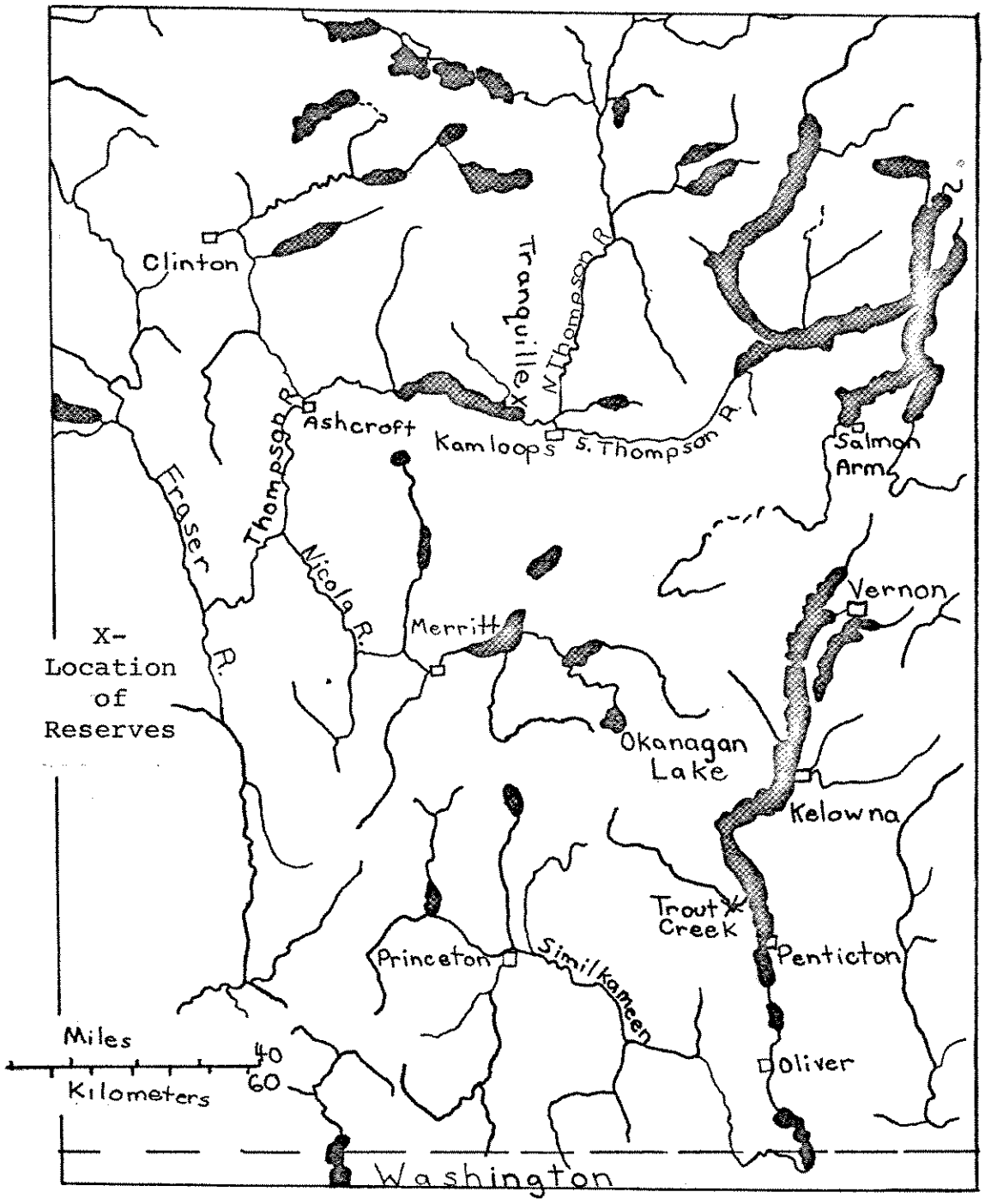


Figure 1. General Location of the Ecological Reserves.

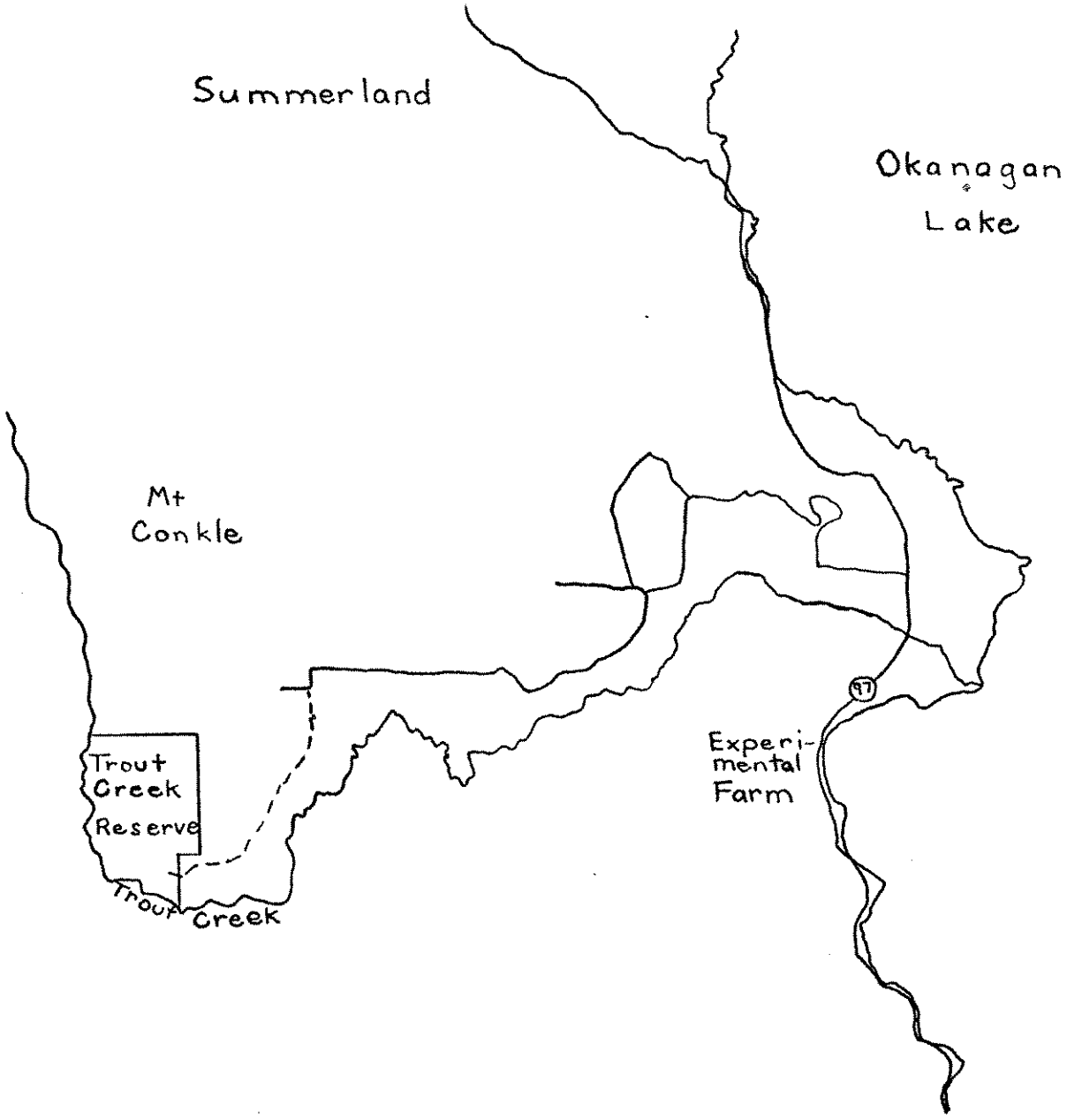


Figure 2. Location of the Trout Creek Ecological Reserve.

per Krajina (1965, 1969) (Krajina et al. 1974) although in the higher elevations it is classified as in the Interior Douglas Fir Zone.

The reserve itself is situated on an area of bedrock outcropping at higher elevations sloping to a series of Kame terraces rolling to the deep V-shaped valley of Trout Creek. Fine silts and sands are found over the outwash gravel in the lower terraces, but the upper slopes are coarser and more eroded, with more gravel and less sand and finer material. The exposure of the reserve is mainly south and west.

The area has been logged and grazed in the past and is still grazed, especially on the flatter lower terraces.

Tables 1 to 4 give an outline of the climate of the area as measured at the Summerland Experimental Station (Chapman 1974). The growing season is, on the average, about 200 days, extending from April to November, and the absolute frost free season averages 175 days (Table 2). July is the warmest month with the greatest number of hours of bright sunlight (Tables 1 and 3).

The precipitation pattern has two maxima, one through the winter and a shorter one in late spring and early summer. The annual precipitation averages about 28 centimeters (Table 4).

The year of sampling, 1974 was a warmer year than average. However early spring and midsummer were cooler than average (Table 1), and the early spring had average or above average

Table 1. Trout Creek: Average Air Temperatures for 1974 and 59 Year Average (^{o}C).

Month	Mean Temperature		Mean Maximum		Mean Minimum	
	1974	59 Yr. Ave.	1974	59 Yr. Ave.	1974	59 Yr. Ave.
Jan.	-2.2	-3.6	0.9	-0.5	-5.3	-6.7
Feb.	2.6	-0.7	5.6	3.1	0.5	-4.5
Mar.	4.3	3.9	8.2	8.7	0.4	-1.0
Apr.	9.4	8.9	14.6	14.9	4.3	3.0
May	11.6	13.7	17.3	20.2	5.7	7.2
June	18.7	17.5	25.8	23.9	11.6	11.2
July	19.1	20.9	25.8	28.1	12.4	13.9
Aug.	20.7	20.2	27.8	27.0	13.6	13.3
Sept.	16.1	15.3	22.8	21.3	9.4	9.3
Oct.	9.6	9.1	14.8	13.9	4.3	4.3
Nov.	3.7	2.6	6.7	5.8	0.8	-0.6
Dec.	0.7	-1.4	3.4	1.4	-2.0	-4.2
Year	9.5	8.9	14.5	14.0	4.6	3.8

Table 2. Trout Creek: Frost Free Days and Growing Season: 1974 and 59 Year Average.

	1974	59 Yr. Ave.
Last Spring Frost (0^{o} or lower)	May 16	Apr. 25
First Fall Frost (0^{o} or lower)	Oct. 6	Oct. 18
Last Killing Spring Frost (-2.2^{o} or lower)	Mar. 20	Apr. 6
First Killing Fall Frost (-2.2^{o} or lower)	Nov. 22	Nov. 2
Frost Free Days	143*	175
Growing Season	247	209

* 1974 was a record of the shortest number of frost free days in the recording period.

Table 3. Trout Creek: Hours of Bright Sunlight: 1974 and 59 Year Average.

Month	1974	59 Yr. Ave.
Jan.	65.9	50.0
Feb.	70.8	87.1
Mar.	127.5	143.3
Apr.	175.6	192.9
May	234.1	247.9
June	331.1	248.9
July	301.0	320.2
Aug.	322.9	282.4
Sept.	270.6	205.1
Oct.	196.7	138.2
Nov.	51.1	58.6
Dec.	44.5	40.4
Year	2191.8	2014.8

Table 4. Trout Creek: Precipitation in Centimeters (Rain and Snow Combined): 1974 and 59 Year Average.

Month	1974	59 Yr. Ave.
Jan.	3.20	2.79
Feb.	1.60	1.83
Mar.	2.64	1.65
Apr.	1.85	1.90
May	3.73	2.44
June	.51	3.18
July	2.77	2.16
Aug.	2.03	2.08
Sept.	.61	1.96
Oct.	.23	2.16
Nov.	2.56	2.51
Dec.	2.67	3.35
Year	24.43	27.96
Apr.-Oct.	11.76	15.75

rainfall (Table 4) and below the average number of hours of bright sunlight (Table 3). Although the growing season, as taken from the last date of a killing frost (-2.2°C or lower) in spring, began early that year (Table 2), the cool temperatures and moist conditions may have served to slow development and prolong the duration of spring ephemerals.

Tranquille:

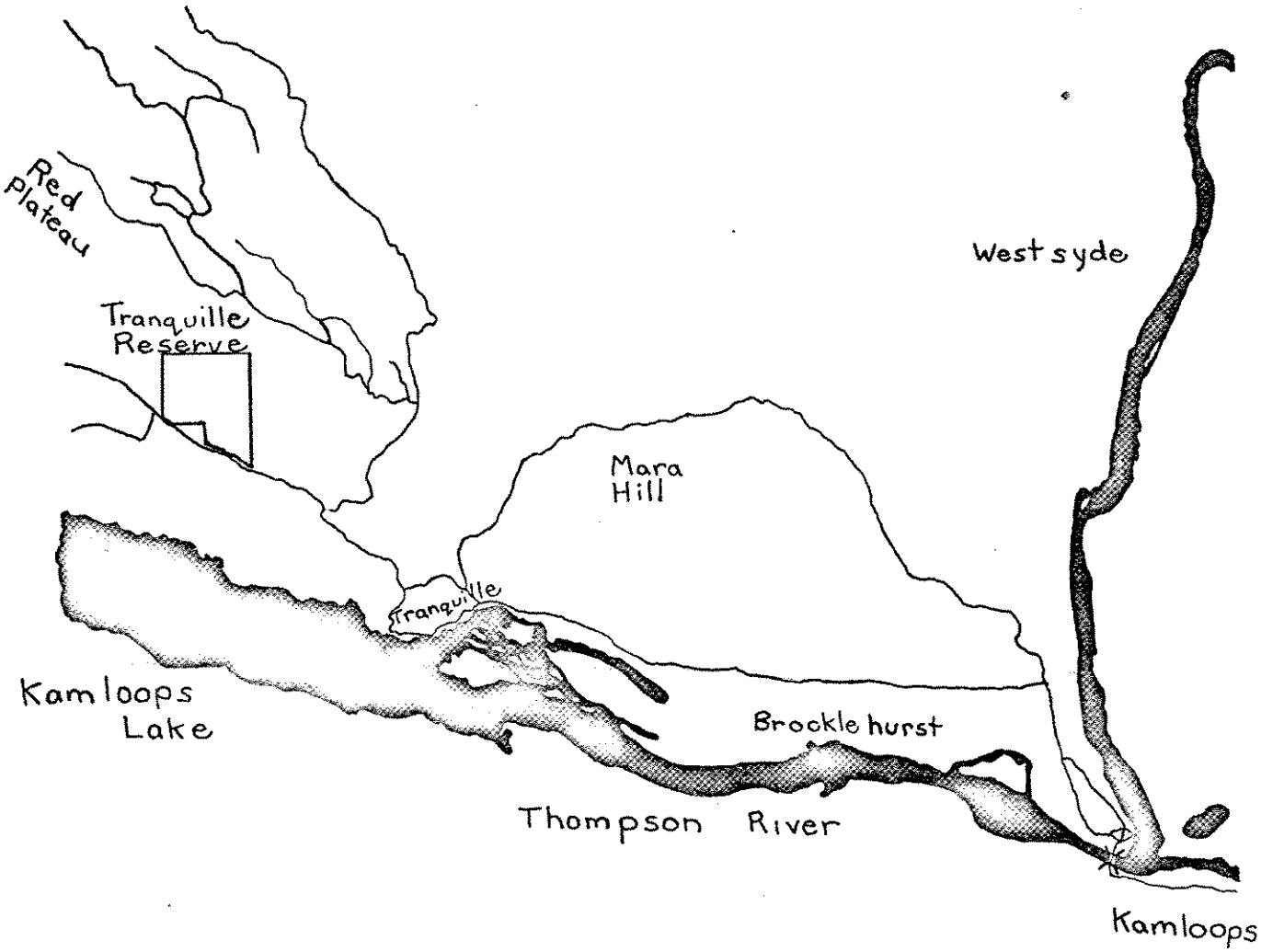
This reserve is No. 29 and has been named Tranquille. It is located 3 miles northwest of Tranquille, north of the east part of Kamloops Lake (50°45'-50°46' N. Lat., 120°34' - 35'20" W. Long). (Figure 3). It ranges in elevation from 610 to 1160 meters and covers 234 hectares (Krajina et al. 1974).

This reserve is classified in the Ponderosa pine - Bunchgrass Zone (Krajina et al. 1974).

It is situated on the edge of the Red Plateau and drops steeply to a flat valley. The higher areas are bedrock but the lower areas have a mantle of glacial till. The exposure of the area is mainly southwest.

This area has also been logged, homesteaded and heavily grazed in the past, but is now used for spring and fall grazing of breeding herds only (McLean, personal communication).

Tables 5 and 6 give a summary of various climatic



Scale 1:126,720

Figure 3. Location of the Tranquille Ecological Reserve.

Table 5. Tranquille: Monthly Mean Temperatures (°C): 1974 and 30 Year Average.

Month	Daily Average* Mean Temp. 1974	Daily Mean Temp.	Mean Daily Maximum 1974	Ave.	Mean Daily Minimum 1974	Ave.	Dewdrop** Mean Daily Max.	Mean Daily Min.	Mean Daily Temp.
Jan.	-4.3	-6.0	- .6	-2.3	-7.9	-9.7	-***	-	-
Feb.	2.2	-1.3	5.5	3.1	-1.2	-5.8	-	-	-
Mar.	4.6	3.6	9.5	9.1	- .4	-2.1	-	-	-
Apr.	10.1	9.3	16.4	16.2	3.8	2.4	13.6	1.9	7.1
May	12.2	14.3	18.6	21.8	5.7	6.8	16.0	3.1	9.6
June	19.2	18.0	26.9	25.2	11.4	10.8	26.2	9.6	17.9
July	19.2	20.8	26.4	29.1	12.1	12.7	24.7	9.8	17.3
Aug.	21.4	19.7	28.2	27.6	12.0	11.8	29.1	11.2	20.1
Sept.	16.7	15.0	24.7	22.4	8.6	7.6	23.8	6.8	15.3
Oct.	8.8	8.4	14.9	13.8	2.7	3.0	13.1	.4	6.7
Nov.	2.8	1.7	6.3	5.4	- .8	-2.0	4.0	-2.3	.8
Dec.	.2	-2.6	3.4	.7	-3.0	-5.8	3.3	-3.0	- .1
Year	9.4	8.4	15.0	14.3	3.6	2.4			

* Averages based on a 30 year period, 1941 to 1970.

** Weather station 300 yards from the Tranquille reserve in the valley. Readings for 1974.

*** No data available.

Table 6. Tranquille: Average Monthly Precipitation (Centimeters) and Hours of Sunshine: 1974 and 30 Year Average.

Month	Precipitation		Hours of Sunshine	
	1974	30 Yr. Ave.	1974	30 Yr. Ave.
Jan.	2.39	2.89	76.7	56
Feb.	1.35	1.55	74.7	97
Mar.	1.75	.81	104.7	148
Apr.	1.93	1.24	167.5	197
May	2.08	1.90	227.9	255
June	.61	3.63	302.9	243
July	2.51	2.59	290.8	320
Aug.	1.52	2.69	322.5	276
Sept.	.46	2.03	228.1	196
Oct.	.76	1.85	163.6	134
Nov.	3.25	2.03	66.9	56
Dec.	4.67	2.82	52.3	48
Year	23.29	26.06	2078.5	2032

parameters as measured at Kamloops Airport or at a climatic station about 300 meters from the reserve (Atmospheric Environment Service 1974).

July and August are the warmest months with the greatest number of hours of sunshine (Tables 5 and 6). The precipitation pattern is similar to that of the area around Trout Creek except the winter maximum begins slightly later in the year. The annual precipitation is less on the average than in Trout Creek (Table 6).

The meteorological data show the same trends as those from Trout Creek. In general the year was warmer, and the growing season longer in 1974 than average. May and July were cooler and spring was in general moister, with less sunshine than normal. This may also have had the effect postulated for Trout Creek.

METHODS

Vegetation

Field:

Sampling was done in the summer of 1974. Trout Creek was sampled in June and the first week in July; Tranquille was sampled in the remainder of July and the first week in August.

Before sampling was attempted, the vegetation was subdivided into general units or possible community types. The divisions were made on the basis of differences in community physiognomy, for example whether the community was treed or treeless, and gross differences in dominant species, for example whether a community understory was dominated by Agropyron spicatum or Calamagrostis rubescens. Sampling was done within these units.

An effort was made to avoid areas obviously disturbed by man, such as tracks, excavated areas etc. Also, in both reserves some areas were not sampled due to inaccessibility or steepness of slope.

Sample plots were located 20 meters apart on a transect through the vegetation unit. The number of plots within a vegetation unit varied according to the size of the unit and ease of sampling.

The tree-sapling and shrub strata were sampled using 10 x 10 meter plots. The number of transgressives and saplings was recorded. The diameter at breast height was measured for all trees and the percentage cover of each tree and shrub species and the tree-sapling and shrub layers was estimated using a six class scale (Daubenmire 1968). Five 1 x 1 meter plots, placed one meter apart along a line bisecting the large plot, were used to sample the herb and dwarf shrub layer and the bryophyte and lichen layer. The cover class for herbs and dwarf shrubs, lichens and bryophytes was estimated by species and by layer. Only herb and dwarf shrub species rooted in the plot were counted.

Unknown species found in the plots were collected for identification.

A number of tree cores was taken with an increment borer and the diameter at breast height and height of these trees were recorded.

Exposure and slope of the plot were recorded.

Nomenclature for vascular plants follows Hitchcock et al. (1969) and for mosses follows Lawton (1971). Voucher specimens are deposited in the Herbarium of the Department of Botany at the University of British Columbia.

Vegetation Synthesis:

Cover values for each species in the five subplots were averaged using the midpoint of the scale range. Species that occurred in more than one layer of the plot were assigned the value of the layer in which they were most abundant. These values were used in subsequent assessment of the data.

The initial sampling division of vegetation units was verified or modified by a subjective assessment and classification of the plots based on floristic differences and gross species abundance differences. This assessment was done by hand using the initial "Tabulation of Data" methods of the Zurich-Montpellier school of phytosociology as described by Shimwell (1971).

Communities were named using the dominant overstory and understory species of the community.

The term "community" was used rather than "association". The term "association" as defined and discussed by Shimwell (1971) is an abstract and generalized concept derived from the study of many areas of similar vegetation. However this study is a description of one specific area. Thus the term "community" is more appropriate.

The Bray-Curtis Ordination:

For comparative purposes and to complement the subjective

classification a Bray-Curtis Ordination was done on the quadrats of each reserve (Bray and Curtis 1957).

In this method the similarity index used is the Sorensen coefficient C=2w/a+b where 'a' is the sum of quantitative measures of species in one quadrat, 'b' is the sum for a second quadrat and 'w' is the sum of the lesser value for species common to both quadrats. Each plot is compared to every other plot.

These similarity values are then transformed into distance values. Bray and Curtis (1957) did this by subtracting the similarity value from the maximum similarity coefficient in the matrix. However Gauch (1973) supports using a maximum similarity value of 1.00, as his work has indicated that overestimating the maximum similarity value causes less distortion than underestimating it. Therefore in this study distance values were calculated by subtracting the similarity coefficients from 1.00.

From this matrix of interquadrat distances the plot with the greatest sum of distances is chosen as one end point. The quadrat with the maximum distance from that quadrat is chosen as the other end point. Every other plot is located in relation to these end points by the equation:

$$X = \frac{L^2 + D_a^2 - D_b^2}{2L}$$

where X is the distance along the axis, L is the distance between the end points and D_a and D_b are the distances between the quadrat being plotted and each of the end points.

The end points for a second axis are chosen from those plots which are spatially close together on the axis but which have a high interquadrat distance value. These are found by subtracting the distance between each pair of quadrats on the first axis from their actual interquadrat distance and selecting those which have the maximum value. Quadrats are located on this axis by the same method used for the first axis.

The similarity matrix and the sum of similarity values were calculated by an IBM 370 Model 168 computer. The rest of the ordination was carried out by hand and using a desk calculator.

Soils

Field:

Soil samples were taken after completion of the vegetation sampling in each reserve and again in May of 1975.

Sampling sites were chosen randomly within vegetation sampling units. Communities which were very small or on talus or very shallow soil were not sampled. Six pits were excavated in Trout Creek and seven in Tranquille in 1974; two pits were dug in Trout Creek and four in Tranquille in 1975.

Pits 60 to 70 centimeters in depth and about .5 square meters in area were excavated and samples taken at 10, 30 and 50 centimeter depths in 1974. Pits 90 centimeters to 1 meter in depth and about 1 square meter in area were excavated and samples taken at 10, 30, 50 and 80, 90 or 100 centimeter depths in 1975. Profile descriptions were briefly noted and horizon depths measured.

Laboratory Analysis:

The samples were put through a two-millimeter sieve. Saturated soil was subjected to 1/3 bar and 15 bar pressures for 48 hours in 5 bar pressure and 15 bar ceramic plate extractors respectively. The weight loss following drying of these samples at 105° C for 48 hours was used to calculate field moisture capacity and permanent wilting percentage.

The pH was measured with a Radiometer Copenhagen Specific Ion Meter, using a 1:1, soil to distilled water suspension which had been left 24 hours to equilibrate.

Exchangeable calcium, magnesium, potassium and sodium were extracted using an ammonium acetate buffered at pH 7 method (Harris and Lavkulich 1972). The concentration of extracted calcium ions was read on a Perkin Elmer Model 303 Atomic Absorption Spectrophotometer. Extracted magnesium, sodium and potassium ion concentrations were read on a Perkin

Elmer Model 306 Atomic Absorption Spectrophotometer.

Total exchangeable cations were extracted using the sodium acetate at pH 8.2 method (Harris and Lavkulich 1972). Concentrations were then read on an Instrumentation Laboratory Incorporated Model 143 Flame Photometer. Base saturation was calculated from these data.

Percentage organic matter was determined by weight loss following exposure of oven-dried samples to 480^{o} C for four hours.

Texture of the soil was determined using the hydrometer method (Harris and Lavkulich 1972).

TROUT CREEK VEGETATION SYNTHESIS

Community Analysis

The Pinus ponderosa/Agropyron spicatum community:

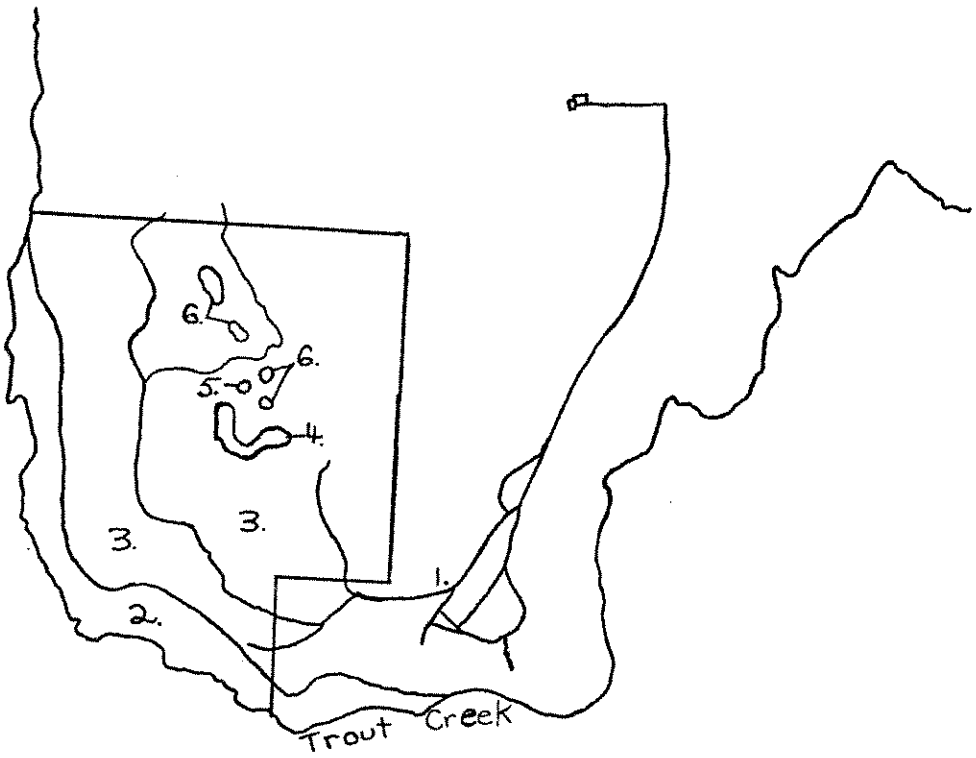
This community type occupies 80 to 90% of the reserve. It occurs on the terraces and gentle slopes above Trout Creek Canyon, which was not sampled (Figure 4). The community occurs from an elevation of 610 meters to about 740 meters.

The exposure of the community is south-easterly to westerly. The slope of the plots done in this community ranges from 0 to 20%;however on the sides of gulleys and just below the talus, the slope is much greater. For example plot 18, which is just below the talus had a slope of 37° (Table 7).

This community is a very open parklike forest (Figure 5) composed almost solely of Pinus ponderosa. However there are a very few trees of Pseudotsuga menziesii, and in the community type, although not on the reserve, a specimen of Juniperus scopulorum was noted.

The tree density is low (Table 8) and scattered stumps indicate that the area has been logged. Sapling and transgressive densities are higher than that of the trees, which may indicate that the tree density will increase. However the density figures for these may be somewhat high due to the influence of plots 10 and 11 which were in a thick stand of

Figure 4. Tentative Community Map of the Trout Creek Ecological Reserve.



1. Road
2. Canyon to Trout Creek - unsampled
3. Pinus/Agropyron
4. Pinus/Pseudotsuga/Amelanchier
5. Pinus/Pseudotsuga/Calamagrostis
6. Selaginella wallacei

Table 7. Average Cover and Frequency of Species in the Pinus ponderosa / Agropyron spicatum Community of Trout Creek.

Plot #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Elevation (meters)	620	620	620	620	620	650	655	650	655	665	665	650	655	665	665	670	730	730
Slope	1°	2°	6°	7°	0°	8°	8°	6°	7°	8°	11°	13°	10°	19°	10°	16°	10°	37°
Trees and Shrubs																		
Pinus ponderosa	15	-	-	-	2.5	-	2.5	2.5	15	62.5	37.5	-	-	-	-	15	-	2.5
Pseudotsuga menziesii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37.5
Chrysothamnus nauseosus	-	-	-	-	-	-	-	-	-	-	-	37.5	-	37.5	15	2.5	-	-
Ribes cereum	2.5	-	-	2.5	-	2.5	-	15	15	-	15	-	-	-	-	-	-	-
Rosa woodsii	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-
Amelanchier alnifolia	-	-	-	-	-	-	-	-	-	2.5	-	-	-	-	-	-	-	-
Grasses											.5/ 20	-	-	-	-	-	-	-
Agropyron spicatum	19.5/100*	19.5/100	33.0/100	19.5/100	38.0/100	19.5/100	28.5/100	24.0/100	19.5/100	5.0/100	10.0/100	10.0/100	24.0/100	.5/100	33.0/100	15.0/100	17.0/100	15.0/100
Poa sandbergii	28.5/100	10.0/100	7.5/100	7.5/100	15.0/100	12.5/100	7.5/100	7.0/ 80	19.5/100	.5/ 20	3.5/ 40	.5/ 20	7.5/100	7.5/100	12.5/100	2.5/100	3.5/ 40	-
Koeleria cristata	9.5/ 80	5.0/100	5.0/100	.5/ 20	2.0/ 80	4.5/ 80	1.5/ 60	7.0/ 80	3.0/ 20	.5/ 20	1.5/ 60	3.0/ 20	.5/ 20	-	6.5/ 60	6.0/ 40	2.0/ 80	-
Bromus tectorum	-	-	-	11.0/ 60	-	11.0/ 60	-	.5/ 20	7.0/ 80	1.0/ 40	2.0/ 80	14.0/ 80	1.5/ 60	2.5/100	1.0/ 40	4.0/ 60	2.0/ 80	1.0/ 40
Festuca octoflora	10.0/100	24.0/100	10.0/100	12.0/ 80	4.0/ 60	5.0/100	-	2.0/ 80	-	-	-	1.0/ 40	-	.5/ 20	5.0/100	3.5/ 40	4.5/ 80	-
Stipa comata	-	1.0/ 40	1.5/ 60	.5/ 20	.5/ 20	-	-	-	-	-	-	-	-	-	.5/ 20	-	-	-
Aristida longiseta	1.0/ 40	-	1.5/ 60	.5/ 20	-	-	-	.5/ 20	-	-	-	-	-	-	-	-	-	-
Festuca scabrella	-	-	-	-	-	3.0/ 20	-	2.0/ 80	-	-	-	-	-	-	-	-	1.0/ 40	-
F. idahoensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forbs																		
Tragopogon dubius	.5/ 20	6.5/ 60	.5/ 20	.5/ 20	1.5/ 60	9.5/ 80	1.0/ 40	1.5/ 60	1.0/ 40	.5/ 20	1.0/ 40	2.5/100	2.0/ 80	2.0/ 80	1.5/ 60	2.0/ 80	1.5/ 60	1.0/ 40
Arabis holboellii var. pendulocarpa	1.0/ 40	1.0/ 40	2.0/ 80	1.0/ 40	1.5/ 60	2.0/ 80	1.0/ 40	2.0/ 80	2.0/ 80	1.0/ 40	.5/ 20	-	2.0/ 80	2.5/100	1.5/ 60	1.5/ 60	.5/ 20	.5/ 20
Collinsia parviflora	16.5/100	5.0/100	28.5/100	10.0/100	-	10.0/100	5.0/100	15.0/100	15.0/100	.5/ 20	6.5/ 60	6.5/ 60	10.0/100	5.0/100	5.0/100	15.0/100	2.5/100	1.0/ 40
Phacelia linearis	7.0/ 80	.5/ 20	15.0/100	21.5/100	1.5/ 60	1.0/ 40	1.0/ 40	5.0/100	5.0/100	1.0/ 40	-	14.0/ 80	5.0/100	4.5/ 80	2.0/ 80	7.5/100	10.0/100	10.0/100
Antennaria dimorpha	1.5/ 60	1.5/ 60	10.0/100	1.0/ 40	7.0/ 80	1.0/ 40	1.5/ 60	17.0/100	7.0/ 80	-	4.0/ 60	-	1.0/ 40	.5/ 20	3.5/ 40	7.0/ 80	12.5/100	.5/ 20
Lomatium macrocarpum	-	1.5/ 60	7.0/ 80	4.5/ 80	-	5.0/100	2.0/ 80	2.5/100	1.5/ 60	-	.5/ 20	7.5/100	10.0/100	15.0/100	1.5/ 60	1.0/ 40	10.0/100	.5/ 20
Crepis atrabarba	5.0/100	7.5/100	3.5/ 40	-	10.0/100	9.5/ 80	-	.5/ 20	.5/ 20	-	1.0/ 40	4.0/ 60	2.0/ 80	.5/ 20	1.5/ 60	-	7.5/100	.5/ 20
Alyssum desertorum	-	-	1.5/ 60	9.5/ 80	-	.5/ 20	5.0/100	1.0/ 40	1.0/ 40	-	.5/ 20	4.5/ 80	1.0/ 40	.5/ 20	1.5/ 60	6.5/ 60	7.5/100	-
Balsamorhiza sagittata	-	-	-	-	-	4.5/ 80	3.0/ 20	3.0/ 20	10.0/100	3.5/ 40	14.0/ 80	6.0/ 40	1.5/ 60	7.0/ 80	.5/ 20	6.5/ 60	-	12.0/ 80
Lewisia rediviva	5.0/100	7.5/100	-	5.0/100	15.0/100	-	-	3.5/ 40	-	1.0/ 40	-	.5/ 20	7.0/ 80	5.0/100	1.5/ 60	4.0/ 60	-	-
Achillea millefolium var. lanulosa	2.0/ 80	.5/ 20	7.0/ 80	-	4.0/ 60	6.0/ 40	-	.5/ 20	3.5/ 40	4.0/ 60	-	11.5/ 80	-	1.5/ 60	-	.5/ 20	1.5/ 60	-
Astragalus miser var. serotinus	-	7.5/100	-	-	-	3.5/ 40	.5/ 20	-	-	1.0/ 40	3.5/ 40	4.5/ 80	.5/ 20	2.0/ 80	9.5/100	-	.5/ 20	-
Opuntia fragilis	-	-	-	-	-	-	.5/ 20	1.0/ 40	1.5/ 60	.5/ 20	.5/ 20	4.0/ 60	3.5/ 40	2.0/ 80	2.5/100	1.0/ 40	-	-
Plantago patagonica	15.0/100	15.0/100	12.5/100	14.0/ 80	10.0/100	1.5/ 60	-	1.0/ 40	-	-	-	4.0/ 60	1.5/ 60	-	5.0/100	-	-	-
Artemisia frigida	5.0/100	2.0/ 80	2.0/ 80	.5/ 20	1.5/ 60	-	-	.5/ 20	-	-	-	3.5/ 40	1.0/ 40	1.0/ 40	2.0/ 80	1.0/ 40	1.0/ 40	1.0/ 40
Epilobium paniculatum	-	-	-	-	-	-	.5/ 20	1.0/ 40	.5/ 20	.5/ 20	-	2.5/100	-	1.5/ 60	1.0/ 40	1.0/ 40	-	-
Lithospermum ruderale	-	-	-	-	-	3.5/ 40	4.0/ 60	-	1.0/ 40	-	.5/ 20	.5/ 20	-	-	.5/ 20	-	.5/ 20	-
Selaginella densa	6.0/ 40	.5/ 20	.5/ 20	1.5/ 60	-	-	6.5/ 60	-	-	-	-	-	3.5/ 40	-	-	-	-	-
Zygadenus venenosus var. gramineus	-	1.0/ 40	-	-	-	-	.5/ 20	.5/ 20	-	-	1.0/ 40	-	-	-	.5/ 20	-	.5/ 20	-
Lappula redowskii	-	-	-	-	-	.5/ 20	-	-	-	-	-	-	.5/ 20	.5/ 20	2.0/ 80	1.0/ 40	-	-
Erigeron pumilus	.5/ 20	1.5/ 60	1.5/ 60	-	.5/ 20	-	-	-	-	-	-	.5/ 20	-	-	-	-	-	-
Descurainia pinnata	-	-	-	-	-	-	-	-	-	-	-	.5/ 20	1.0/ 40	-	.5/ 20	.5/ 20	-	.5/ 20
Antennaria rosea	-	-	-	-	.5/ 20	3.5/ 40	3.0/ 20	.5/ 20	-	-	-	-	-	-	-	-	-	-
Lesquerella douglasii	-	-	-	-	-	-	-	-	-	-	-	1.5/ 60	-	1.5/ 60	2.5/100	-	-	.5/ 20
Antennaria parvifolia	-	-	-	-	-	.5/ 20	7.0/ 80	-	.5/ 20	-	-	-	-	-	-	-	-	-
Erigeron filifolius	1.0/ 40	-	-	-	-	.5/ 20	-	-	-	-	-	-	-	-	.5/ 20	-	-	-
Taraxacum officinale	-	1.0/ 40	.5/ 20	-	.5/ 20	-	-	-	-	-	-	-	-	-	-	-	-	-
Silene antirrhina	-	-	3.0/ 20	-	-	-	-	.5/ 20	-	-	-	-	-	-	-	-	-	-
Microseris nutans	.5/ 20	2.0/ 80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calochortus macrocarpus	-	1.0/ 40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cirsium undulatum	-	-	-	-	.5/ 20	-	-	-	-	-	-	-	-	-	-	-	-	-
Eriogonum heracleoides	3.0/ 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erigeron divergens	.5/ 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Geum triflorum	-	3.0/ 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arnica sororia	-	1.0/ 40	-	-	-	-	-	-	-	-	.5/ 20	-	-	-	-	-	-	-
Capsella bursa - pastoris	-	-	-	-	-	-	-	-	-	-	-	.5/ 20	-	-	-	-	-	-
Lactuca serriola var.integrata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
herb cover	33	43	38	33	38	52	33	42.5	33.5	10	24	33.5	37.5	24.0	52.5	28.5	28.5	28.5
Mosses and Lichens	2.0/ 80	9.5/ 80	10.0/100	7.5/100	7.5/100	-	7.5/100	2.5/100	2.0/ 80	3.0/ 20	.5/ 20	5.0/100	2.5/100	5.0/100	2.5/100	10.0/100	7.5/100	2.5/100
Cladonia spp.	7.5/100	.5/ 20	4.5/ 80	1.5/ 60	-	.5/ 20	9.5/ 80	4.5/ 80	7.0/ 80	-	3.5/ 40	-	2.5/100	1.5/ 60	-	1.5/ 60	7.5/100	-
Peltigera canina	5.0/100	7.0/ 80	2.0/ 80	6.5/ 60	1.5/100	-	-	-	-	.5/ 20	-	2.0/ 80	5.0/100	.5/ 20	2.0/ 80	.5/ 20	-	-
Diploschistes scruposus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grimmia affinis	-	-	-	3.5/ 40	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortula ruralis	-	-	-									.5/ 20	-	-	-	-	-	-

* Average cover/frequency.

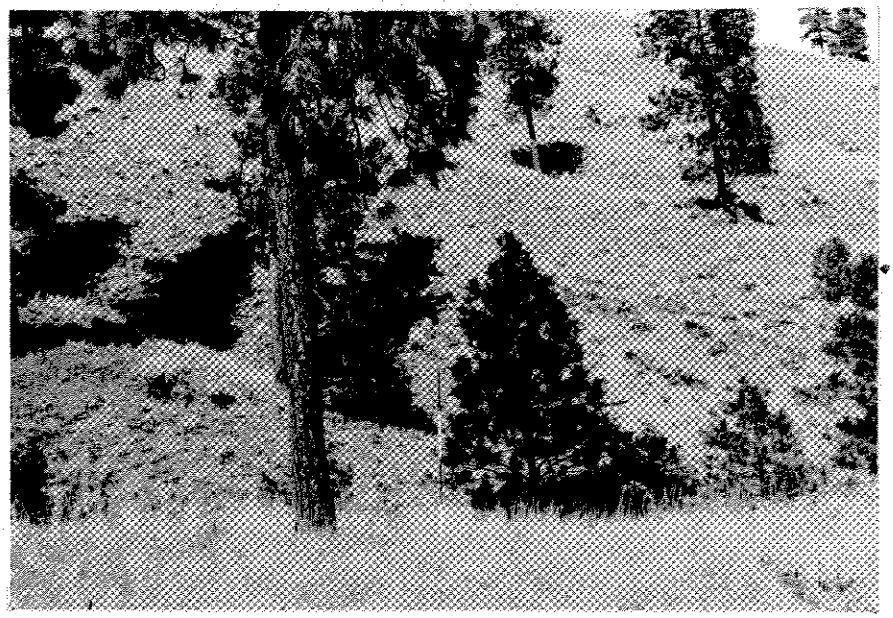


Figure 5. Trout Creek, the Pinus ponderosa/Agropyron spicatum community: The ground cover is mainly Agropyron spicatum. The bunched habit of this grass is evident. The shrub is Chrysothamnus nauseosus. The stake is marked in 50 centimeter intervals.

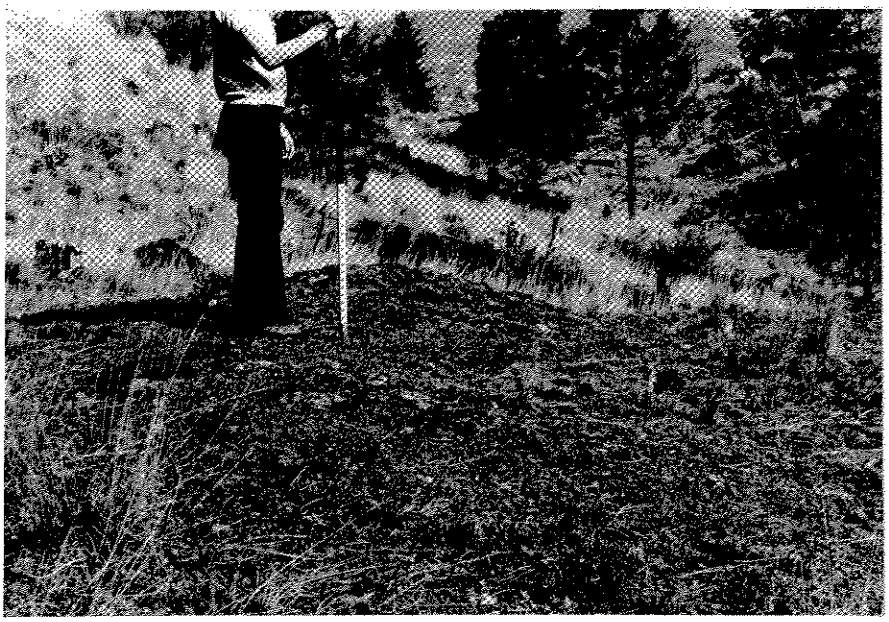


Figure 6. Trout Creek, the Selaginella wallacei community: The stake is marked in 50 centimeter intervals.

Table 8. Tree Species Data from Plots in Trout Creek.

	Pp/As Pinus	Pp/As Pseudotsuga	Pp/Pm/Aa Pinus	Pp/Pm/Aa Pseudotsuga	Pp/Pm/Cr Pinus	Pp/Pm/Cr Pseudotsuga
#seedlings in subplots	3	0	0	1	0	0
density /ha.	300			400		
#trangressives	13	0	2	0	3	1
density /ha.	65		40		300	100
#saplings	19	0	1	0	10	6
density /ha.	95		20		1000	600
#live trees	9	3	1	2	2	1
Ave. d.b.h. (cm)	21.4	19.6	47.2	34.7	15.4	15.4
Total B.A. (m^2)	.36	.09	.18	.25	.04	.02
density /ha.	45	15	20	40	200	100
#dead trees (stumps)	1	0	0	0	7	0
Ave d.b.h. (cm)	44.5	0			19.6	
Total Basal Area (m^2)	.16				.22	
density /ha.	5	0			700	

Pp/As - the Pinus ponderosa/Agropyron spicatum community

Pp/Pm/Aa - the Pinus ponderosa/Pseudotsuga menziesii/Amelanchier alnifolia community

Pp/Pm/Cr - the Pinus ponderosa/Pseudotsuga menziesii/Calamagrostis rubescens community

young Pinus, or a reproduction thicket. The densities of saplings and transgressives here are not representative of the reserve as a whole. Cattle grazing may be a limiting factor for tree reproduction indicated by the grazed off top of one of the three seedlings found in the subplots. High soil temperatures also are limiting factors for tree reproduction.

There is a characteristically sparse shrub layer composed mainly of Chrysothamnus nauseosus with small amounts of Ribes cereum and Rosa woodsii.

The grassy understory is dominated by the bunchgrass Agropyron spicatum and to a lesser extent by Poa sandbergii (= Poa secunda). Characteristic grass associates are Koeleria cristata, Bromus tectorum and Festuca octoflora. Stipa comata and Aristida longiseta are less common.

Characteristic forb associates include Tragopogon dubius, Arabis holboellii var. pendulocarpa, Collinsia parviflora, Phacelia linearis, Antennaria dimorpha, Lomatium macrocarpum, Crepis atrabarba, Alyssum desertorum, Balsamorhiza sagittata, Lewisia rediviva, Achillea millefolium var. lanulosa, Astragalus miser var. serotinus, Opuntia fragilis, Plantago patagonica, Artemisia frigida and Epilobium paniculatum (Tables 7 and 11). Some species, for example Stipa comata, Artemisia frigida, Arnica sororia, and

Microseris nutans, seem restricted or most common on the lower level terrace areas (plots 1 to 5, Table 7). Some, for example Opuntia fragilis, Balsamorhiza sagittata and Epilobium paniculatum, are most common on the slopes (Table 7). This may be a result of many factors including exposure, moisture availability, grazing pressure etc. These differences were not deemed sufficient for a classification division.

Peltigera canina, Cladonia spp. and Diploschistes scruposus form the lichen layer. Tortula ruralis and Grimmia affinis are present but their cover and constancy are low.

The Pinus/Agropyron community most closely corresponds to the Pinus - Agropyron and Pinus - Festuca communities described by McLean (1970). It would fall somewhere between the two having characteristics of both. It contains a high cover of Agropyron spicatum and Poa sandbergii (=Poa secunda) and has Crepis atrabarba, Lomatium macrocarpum, Achillea millefolium, Collinsia parviflora and Lithospermum ruderale as does the Pinus - Festuca type. However it does not contain Polygonum douglasii and Lupinus sericeus as does this type and has only very small amounts of Festuca idahoensis and Eriogonum heracleoides.

Like the Pinus - Agropyron type, this community contains Stipa comata, Antennaria dimorpha, Tragopogon dubius, much

Arabis holboellii, Festuca octoflora, Lappula redowskii and Plantago patagonica.

The community does not correspond well to the Pinus - Agropyron community described by Brayshaw (1970). Many of the associated species listed by Brayshaw, for example Festuca occidentalis, F. idahoensis, Eriogonum heracleoides, Artemisia tridentata and Lupinus sericeus are either rare or absent in the community in Trout Creek.

The understory of the Pinus ponderosa/Agropyron spicatum community in the reserve is quite similar to the Artemisia - Poa Associes as Tisdale (1947) described it in the Okanagan Valley, except that Artemisia and Sporobolus cryptandrus are not present, the amount of Stipa comata is much lower and the relative coverage values of Agropyron and Poa are reversed as in the climax sites of the Lower Grassland Zone. The Artemisia - Poa Associes is a community resulting from heavy grazing (Tisdale 1947). The fact that in some aspects the Pinus/Agropyron understory corresponds to it may indicate that the Trout Creek area is modified by grazing, or perhaps has been overgrazed in the past and is now in the process of recovering. Several years of sampling data and/or exclosure experiments would indicate whether this is the case.

The Selaginella wallacei Community:

On the highest points in the reserve there occurs a community of limited extent which is developed essentially on bedrock or very little soil (Figure 4). This community has an abundance of the mat-forming Selaginella wallacei and a lower cover of Agropyron spicatum (Figure 6). Some of the other usual associates, like Tragopogon dubius, Arabis holboellii, Achillea millefolium and Epilobium paniculatum are rare or missing. The community also has a greater abundance of Eriogonum niveum, Tortula ruralis and Grimmia affinis (Tables 9 and 11).

I feel that this is a primary successional community and will eventually tend toward the previously described Pinus/Agropyron community.

There is no reference in the literature to a Selaginella wallacei community, although Brayshaw (1955) mentioned a Selaginella Union which had associated species Tortula ruralis, Ceratodon purpureus and Polytrichum piliferum. Possibly the specificity of this study resulted in a division at a finer level of distinction than those working in larger areas would make.

Table 9. Average Cover and Frequency of Species in the Selaginella wallacei Community of Trout Creek.

Plot #	25	26
Elevation (meters)	825	825
Slope	28°	21°
Trees and Shrubs		
Pinus ponderosa	-	2.5
Chrysothamnus nauseosus	-	2.5
Grasses		
Agropyron spicatum	4.5/ 80*	12.5/100
Poa sandbergii	2.5/100	1.0/40
Bromus tectorum	2.5/100	5.0/100
Forbs		
Collinsia parviflora	0.5/ 20	0.5/ 20
Phacelia linearis	2.5/100	12.5/100
Antennaria dimorpha	-	1.0/ 40
Lomatium macrocarpum	1.5/ 60	7.5/100
Crepis atrabarba	-	0.5/ 20
Alyssum desertorum	0.5/ 20	-
Balsamorhiza sagittata	-	3.5/ 40
Lewisia rediviva	-	1.5/ 60
Astragalus miser var. serotinus	0.5/ 20	-
Lappula redowskii	1.0/ 40	2.0/ 80
Descurainia pinnata	0.5/ 20	2.5/100
Eriogonum niveum	3.5/ 40	3.5/ 40
Selaginella wallacei	4.5/100	15.0/100
herb layer	43	24
Mosses and Lichens		
Cladonia spp.	-	5.0/100
Peltigera canina	0.5/ 20	-
Diploschistes scruposus	5.0/100	0.5/ 20
Grimmia affinis	4.5/ 80	1.0/ 40
Tortula ruralis	1.0/ 40	3.0/ 20

* Average cover/frequency.

The Pinus ponderosa/Pseudotsuga menziesii/Amelanchier alnifolia Community:

This community occurs on the talus slopes just below a rock outcrop in the reserve (Figure 4). Plots 19 to 23 were taken in this community. The slope of the area is quite steep, 29 to 32°, and the substratum varies from very coarse, very unstable talus to finer, more stabilized talus. The exposure of the community varies from south-easterly to westerly. This community occupies about 5% of the area of the reserve.

Both Pinus ponderosa and Pseudotsuga menziesii are characteristically present in the tree layer. This is also the only community in which a Pseudotsuga seedling was found.

Also characteristic of the community is a much more abundant shrub layer composed of Amelanchier alnifolia, Ribes cereum, less Chrysothamnus nauseosus than in the Pinus/Agropyron community, and Ceanothus sanguineus (Tables 10 and 11). On coarse talus, as represented by plots 19 and 20, the ground cover is very sparse. The grasses and forbs occur in sheltered crevices where soil has accumulated, but the area has no grassy aspect as does the Pinus/Agropyron community (Figure 7). On finer talus which is more stabilized as represented by plots 21 and 23 more of the grass and forb associates of the Pinus/Agropyron community are present

Table 10. Average Cover and Frequency of Species in the Pinus ponderosa/Pseudotsuga menziesii/Amelanchier alnifolia Community of Trout Creek.

	Plot 19	Plot 20	Plot 21	Plot 22	Plot 23
Elevation (meters)	740	740	700	700	700
Slope	30°	30°	29°	35°	32°
Trees and shrubs					
Pinus ponderosa	-	2.5	15	-	2.5
Pseudotsuga menziesii	15	-	-	15	-
Amelanchier alnifolia	2.5	15	-	15	15
Ribes cereum	2.5	2.5	-	15	-
Chrysothamnus nauseosus	-	-	2.5	2.5	-
Ceanothus sanguineus	15	-	-	-	-
Grasses					
Agropyron spicatum	*3.5/ 40	1.0/ 40	15.0/100	10.0/100	5.0/ 80
Poa sandbergii	.5/ 20	7.0/ 80	4.5/ 80	1.5/ 60	-
Forbs					
Balsamorhiza sagittata	.5/ 20	-	3.5/ 40	6.0/ 40	-
Stephanomeria tenuifolia	-	-	1.0/ 40	.5/ 20	1.0/ 40
Penstemon fruticosus var. scouleri	1.0/ 40	-	-	.5/ 20	-
Phacelia hastata	1.5/ 60	1.0/ 40	-	-	-
Descurainia pinnata	.5/ 20	-	-	-	1.0/ 40
Arabis holboellii var. pendulocarpa	-	-	2.5/100	1.0/ 40	-
Phacelia linearis	-	-	1.0/ 40	4.5/ 80	-
Gilia aggregata	-	-	.5/ 20	1.5/ 60	-
Berberis aquifolium	8.5/ 40	-	-	-	-
Selaginella wallacei	6.5/ 60	-	-	-	-
Lomatium macrocarpum	.5/ 20	-	-	-	-
Crepis atrabarba	-	-	2.0/ 80	-	-
Lesquerella douglasii	-	-	.5/ 20	-	-
Chaenactis douglasii	-	-	.5/ 20	-	-
Achillea millefolium var. lanulosa	-	-	.5/ 20	-	-

Table X. Continued.

	Plot 19	Plot 20	Plot 21	Plot 22	Plot 23
Lithospermum ruderale	-	-	-	.5/ 20	-
Opuntia fragilis	-	-	-	-	.5/ 20
herb layer	12	9.5	19.5	15	5
Mosses and Lichens					
Grimmia affinis	1.0/ 40	4.0/ 60	-	-	4.0/ 60
Peltigera canina	3.0/ 20	-	-	-	-

* average cover/frequency.

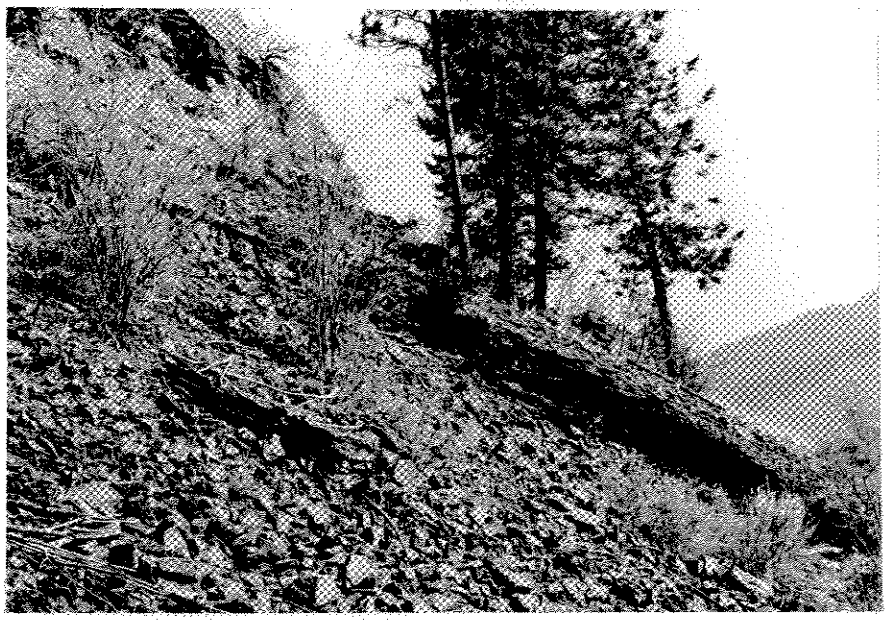


Figure 7. Trout Creek, the Pinus ponderosa/Pseudotsuga menziesii/Amelanchier alnifolia community: The tall shrubs are Amelanchier alnifolia and are approximately 2.5 meters in height. Both Pinus and Pseudotsuga occur in this community.

Figure 8. Trout Creek, the Pinus ponderosa/Pseudotsuga menziesii/Calamagrostis rubescens community: In the foreground is the edge of the community; thus Agropyron spicatum can be seen. The grass in the center of the picture is Calamagrostis rubescens. The community has a dense growth of shrubs and young Pinus and Pseudotsuga individuals. The stake is marked in 50 centimeter intervals.

linearis and Descurainia pinnata. However there are some species which seem restricted to this community, such as Stephanomeria tenuifolia, Penstemon fruticosus var. scouleri, Phacelia hastata, Gilia aggregata and Berberis aquifolium. Grimmia affinis is the most abundant moss of the community (Tables 10 and 11).

The Pinus ponderosa/Pseudotsuga menziesii/Amelanchier alnifolia community lacks most of the associates of the Pinus - Rhus spp. community (Brayshaw 1965, 1970), also on talus. It more closely corresponds to the Stephanomerio (tenuifoliae) - Heuchero (cylindricae) - Amelanchiero (alnifoliae) - Ponderoso - Pseudotsugetum biogeocoenosis (Krajina 1969), although it does not contain Heuchera cylindrica.

community and is composed of Juniperus scopulorum, Ribes cereum, Amelanchier alnifolia, Ceanothus sanguineus and Chrysothamnus nauseosus.

The distinctive feature of this community however, is that the ground cover is almost exclusively composed of the grass Calamagrostis rubescens, which is an understory species characteristic of some communities in the Interior Douglas Fir Zone (Krajina 1965, 1969, Brayshaw 1970). Agropyron spicatum occurs but is rare. Balsamorhiza sagittata, Achillea millefolium var. lanulosa and Crepis atrabarba occur in the community and Collinsia parviflora is present around its edges. The dominant moss is Rhytidiadelphus triquetris, and Cladonia spp. and Peltigera canina form the lichen layer(Table 11).

This is a community produced by the topography, the extra moisture provided by runoff from the surroundings and the

nd Constancy of Species in Communities of Trout Creek.

	Pp/As 18 plots	Sw 2 plots	Pp/Pm/Aa 5 plots	Pp/Pm/Cr 1 plot
	0-2.5/6*	-	-	-
	0-62.5/50	0-2.5/50	0-15/60	37.5
	0-37.5/56	0-2.5/50	0-2.5/40	2.5
	0-15/11	-	0-15/60	15
	0-37.5/6	+	0-15/40	15
	0-.5/6	-	0-15/80	2.5
	-	-	0-15/20	2.5
	+**	-	-	2.5
	0-24/67	-	-	-
	0-1.5/28	-	-	-
	0-1.5/22	-	-	-
	0-3.0/11	-	-	-
	0-1.0/6	-	-	-
	0-9.5/89	-	+	+
	0-14/72	2.5-5.0/100	+	-
	0-28.5/94	1.0-2.5/100	0-7/80	-
	5.0-38/100	4.5-12.5/100	1-15/100	.5
	-	-	-	37.5
	.5-9.5/100	-	-	-
	0-17/89	-	-	-
nus	0-9.5/61	-	-	-
	0-15/56	-	-	-
	0-5/56	-	+	-
	0-2.5/50	-	-	-
	0-6.5/33	-	-	-
nineus	0-1/33	-	-	-
	0-1.5/28	-	-	-

	Pp/As 18 plots	Sw 2 plots	Pp/Pm/Aa 5 plots	Pp/Pm/Cr 1 plot
	0-3.5/22	-	-	-
	0-7/17	-	+	-
	0-1/17	-	-	-
	0-1/17	-	-	-
	0-3/11	-	-	-
	0-2/11	-	-	-
	0-1/6	-	-	-
	0-.5/6	-	-	-
	0-3/6	-	-	-
	0-.5/6	-	-	-
	0-3/6	-	-	-
	0-1/6	-	-	-
	0-.5/6	-	-	-
ata	0-.5/6	-	-	-
	0-28.5/94	.5-.5/100	-	+
	0-11.5/72	0-.5/50	-	-
	0-15/61	0-1.5/50	-	-
	0-2/28	1-2/100	-	-
	0-21.5/94	2.5-12.5/100	0-4.5/40	-
	0-15/83	1.5-7.5/100	0-.5/20	-
	0-9.5/78	0-.5/50	0-2/20	.5
	0-12/72	0-3.5/50	0-6/60	6
	0-4/56	0-.5/50	0-.5/20	-
	0-1/28	.5-2.5/100	0-1/40	-
locarpa	0-2.5/94	+	0-2.5/40	-
nulosa	0-11.5/61	-	0-.5/20	1
	0-3.5/39	-	0-.5/20	-
	0-2.5/22	-	0-.5/20	-
	+	3.5-3.5/100	-	-

	Pp/As 18 plots	Sw 2 plots	Pp/Pm/Aa 5 plots	Pp/Pm/Cr 1 plot
	-	4.5-15/100	0-6.5/20	-
	-	+	0-1/60	-
ɔuleri	+	-	0-1.5/40	-
	-	-	0-1.5/40	-
	-	-	0-1.5/40	-
	-	-	0-8.5/20	-
	+	+	0-.5/20	-
	10-52.5	24-43	5-19.5	42.5
	0-7/56	.5-5/100	-	-
	0-1/11	1-4.5/100	0-4/80	-
	0-3.5/6	1-3/100	0-1.5/20	-
	0-9.5/72	0-.5/50	0-3/20	1
	0-10/94	0-5/50	-	.5
	-	-	-	8

in plots

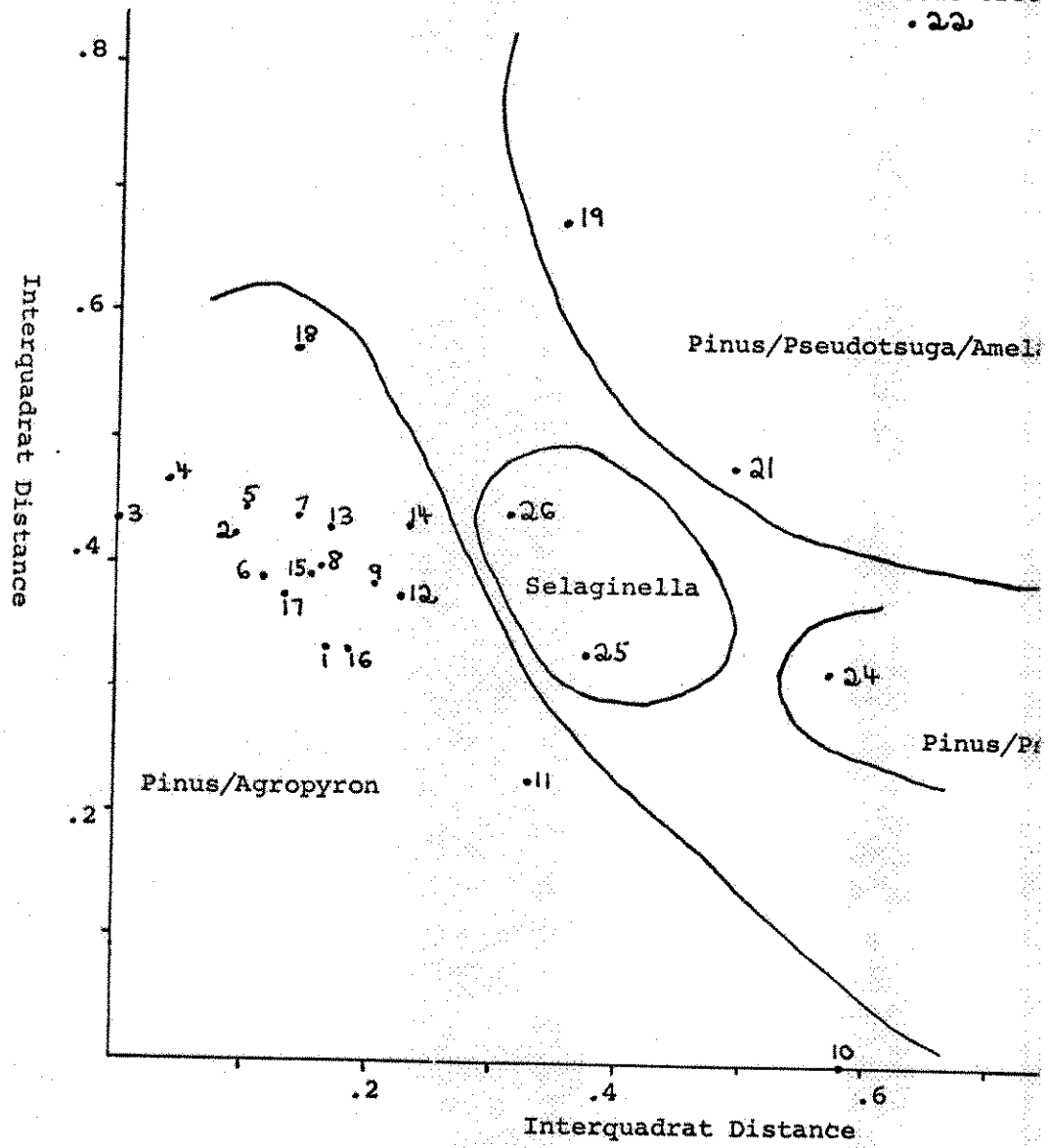
gropyron spicatum community
community
a/Pseudotsuga menziesii/Amelanchier alnifolia community
a/Pseudotsuga menziesii/Calamagrostis rubescens community

Pseudotsugetum glaucae biogeocoenosis of Krajina (1969). However the extremely small size of the community makes it difficult to compare with other work.

Bray-Curtis Ordination

This analysis technique (Figure 9) supports the community breakdown. In general the Pinus ponderosa/Agropyron spicatum community plots are clustered to the left center of the graph, with the Selaginella wallacei plots slightly more to the center. However plots 10 and 11 which were located in a reproduction thicket, are displaced more to the bottom center and are nearer plot 24 than is the main body of Pinus/Agropyron plots. Plot 18 is placed slightly above this cluster of plots, indicating its affinity with the Pinus/Pseudotsuga/Amelanchier community plots. Of these plots most are placed high on the graph except for plot 21 which is lower and nearer the Pinus/Agropyron plots and the Pinus/

Figure 9. Bray-Curtis Ordination of Plots from Trout Cree



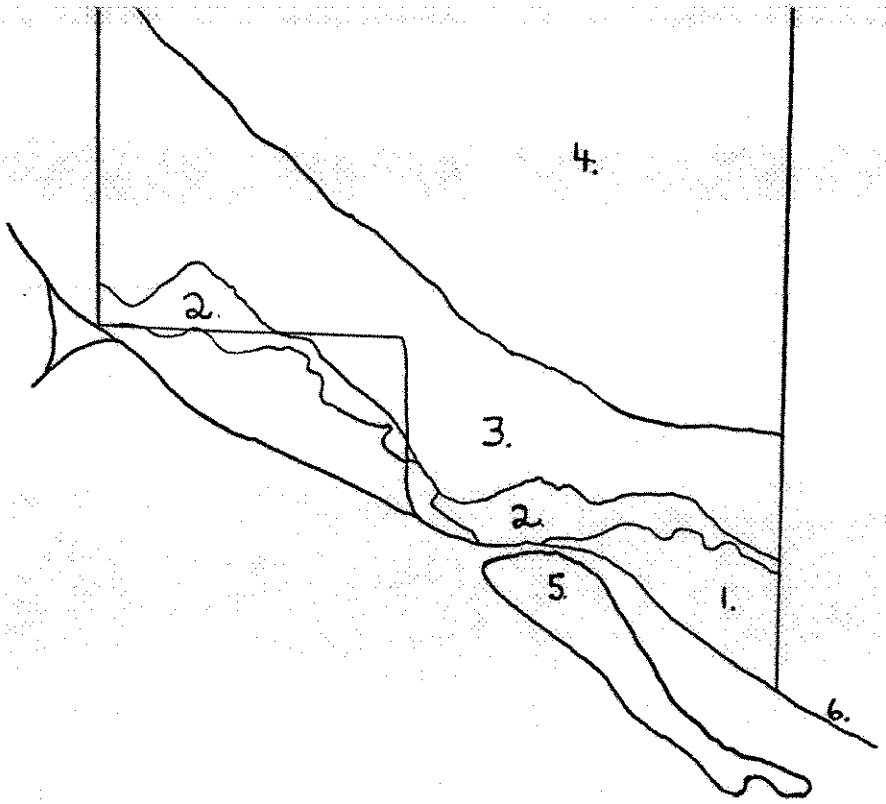
being in the Interior Douglas Fir Zone at higher elevations. However there is little evidence from the data in this study that this is the case. In both communities in which there was a significant amount of Douglas fir, the presence of the tree seems to be maintained by the topographic position of the community as in the Pinus/Pseudotsuga/Calamagrostis community or by edaphic factors as in the Pinus/Pseudotsuga/Amelanchier community, not by climate as would be the case in communities of the Interior Douglas Fir Zone.

Although it is possible that Pinus ponderosa is a successional species in some areas of the reserve, the reproduction data indicate that it will not be excluded from the overstory. I therefore conclude that the whole reserve is in the Ponderosa pine/Bunchgrass Zone.

community in the reserve. However the community is essentially treeless. This community occurs in the lowest part of the reserve, on the flat valley bottom at about 610 meters (Figure 11).

Artemisia tridentata dominates the shrub layer with lesser amounts of Chrysothamnus nauseosus. The understory is dominated by Poa sandbergii and Stipa comata, with associated grasses Sporobolus cryptandrus, Bromus tectorum and Festuca octoflora. There is little or no Agropyron spicatum.

Common associated forbs include Lappula redowskii, Androsace occidentalis, Tragopogon dubius, Opuntia fragilis, Descurainia pinnata, Artemisia frigida, Antennaria dimorpha, Lepidium virginicum and Collinsia parviflora. The bryophyte and lichen layer is mainly composed of Cladonia fimbriata and C. pyxidata, and Tortula ruralis. Diploschistes scruposus and Toninia tristis are present in lesser amounts



1. Disturbed and seeded area - unsampled
2. Artemisia/Poa/Stipa
3. Pinus/Agropyron and Pinus/Aristida
4. Pseudotsuga/Pinus/Agropyron
5. Alkaline wet area
6. Road

Figure 11. Tranquille, the Artemisia tridentata/Poa sandbergii/Stipa comata community: Most of the shrub layer is Artemisia tridentata. The light, splayed grass is Stipa comata. In the background is the Pinus/Agropyron community. The fence is a remnant of the days when this area was homesteaded. The stake is marked in 50 centimeter intervals.

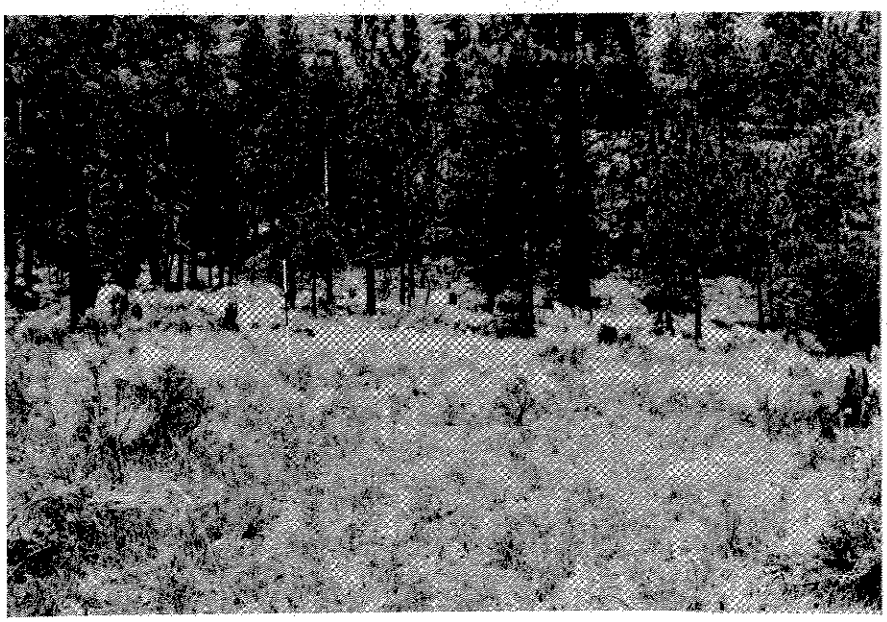


Figure 12. Tranquille, the Pinus ponderosa/Agropyron spicatum community: The ground cover is mainly Agropyron spicatum. The sparse shrub layer is mainly Chrysothamnus nauseosus. The overstory is mainly Pinus ponderosa but a few Pseudotsuga menziesii trees are in evidence. The stake is marked in 50 centimeter intervals.

(Table 12).

Brayshaw (1970) mentioned an Artemisia tridentata community which, he stated arises from heavy grazing pressure. McLean (1970) described an Artemisia tridentata Zone and stated that decreases in Agropyron spicatum and increases in Poa secunda and Bromus tectorum are associated with heavy grazing. Also he stated that increases in Stipa comata and Sporobolus cryptandrus occur with grazing if the soils are gravelly, sandy or shallow.

Tisdale's (1947) Artemisia - Poa Associes, which is similar in many species to the Tranquille community, arises from overgrazing in the Lower Grassland. However many of the associated species of the Middle Grassland overgrazing community, the Stipa - Agropyron - Poa Associes, occur in the Tranquille community also.

This indicates that this area is probably overgrazed. The presence of an alkaline wet area near the reserve in the valley bottom may account for this. This area stays green late in the summer, thus the area around it will probably be grazed to a greater degree than other areas.

The Pinus ponderosa/Agropyron spicatum Community:

This community occupies 20 or 30% of the reserve and occurs on the lower rolling slopes, extending out slightly into the flat valley bottom (Figure 10). It ranges in

Table 12. Average Cover and Frequency of Species in the *Artemisia tridentata/Poa sandbergii/Stipa comata* community of Tranquille.

Plot	1	2	3	4
Elevation (meters)	615	615	615	615
Slope	5°	6°	5°	3°
Trees and Shrubs				
Artemisia tridentata	2.5	2.5	37.5	15
Chrysothamnus nauseosus	2.5	2.5	2.5	2.5
Grasses				
Poa sandbergii	19.5/100	15.0/100	17.0/100	15.0/100
Stipa comata	12.5/100	12.5/100	2.0/ 80	5.0/100
Bromus tectorum	7.0/100	7.5/100	2.0/ 80	.5/ 20
Sporobolus cryptandrus	2.0/ 80	1.0/ 40	.5/ 20	4.0/ 60
Festuca octoflora	.5/ 20	2.0/ 80	2.5/100	-
Koeleria cristata	-	-	.5/ 20	-
Forbs				
Lappula redowskii	10.0/100	4.5/ 80	1.5/ 60	7.5/100
Androsace occidentalis	4.5/ 80	2.5/100	2.0/ 80	2.0/ 80
Tragopogon dubius	.5/ 20	.5/ 20	1.0/ 40	1.0/ 40
Opuntia fragilis	2.5/100	4.5/ 80	2.0/ 80	1.5/ 60
Descurainia pinnata	2.5/100	1.0/ 40	1.5/ 60	.5/ 20
Artemisia frigida	1.5/ 60	2.5/100	1.5/ 60	2.5/100
Antennaria dimorpha	-	12.5/100	4.0/ 60	10.0/100
Lepidium virginicum	.5/ 20	1.5/ 60	.5/ 20	-
Collinsia parviflora	-	.5/ 20	.5/ 20	.5/ 20
Calochortus macrocarpus	.5/ 20	.5/ 20	-	-
Chenopodium fremontii	.5/ 20	.5/ 20	-	-
Arabis holboellii	-	-	1.0/ 40	-
Lomatium macrocarpum	-	1.0/ 40	-	-
herb layer	33.0	37.5	28.5	28.5
Mosses and Lichens				
Cladonia spp.	2.5/100	2.5/100	10.0/100	7.0/ 80
Toninia tristis	-	-	.5/ 20	1.0/ 40
Tortula ruralis	-	1.5/ 60	-	4.0/ 60
Diploschistes scruposus	.5/ 20	-	-	-

elevation from the valley bottom at just above 610 meters to about 760 meters and the slope of the land with this community varies from 4° to over 25°.

The reproduction data in Table 13 show that the forest will probably not become any denser but will probably maintain itself. The forest, although dominated by Pinus ponderosa, contains scattered individuals of Pseudotsuga menziesii. These are few enough and scattered enough that they do not occur in any of the plots. There is some Pseudotsuga reproduction, but the amount of Pinus reproduction is much greater (Figure 12).

The shrub layer is composed mainly of Chrysothamnus nauseosus and lesser amounts of Artemisia tridentata (Table 14). Often in depressions or gulleys (represented by plots 18, 19, 22, and 23), Rosa woodsii will form a significant portion of the shrub layer. This variation however, was not considered sufficient to warrant a classification division.

The grassy understory is dominated by Agropyron spicatum. Koeleria cristata is a common associate; Poa sandbergii, Stipa comata and Sporobolus cryptandrus are less common. Aristida longiseta and Festuca octoflora are very sparse in this community.

The associated forbs are usually well scattered. These include Tragopogon dubius, Arabis holboellii var. pendulocarpa, Artemisia campestris, Achillea millefolium var. lanulosa,

Table 13. Tree Species Data from Plots in Tranquille.

	Pp/As Pinus	Pm/Pp/As Pinus	Pm/Pp/As Pseudotsuga	Pm/Pp/As Juniperus
#seedlings in subplots	3	0	0	0
density /ha.	300			
#transgressives	1	0	0	0
density /ha.	5			
#saplings	8	0	0	0
density /ha.	40			
#live trees	29	5	4	1
Mean d.b.h. (cm)	24.8	26.9	39.6	14.2
Total B.A. (m^2)	1.56	.31	.55	.02
density /ha.	145	71	57	14
#dead trees (stumps)	4	0	0	0
Mean d.b.h. (cm)	56.1			
Total Basal Area (m^2)	.99			
density /ha.	20			

Pp/As - the Pinus ponderosa/Agropyron spicatum community.

Pm/Pp/As - the Pseudotsuga menziesii/Pinus ponderosa/Agropyron spicatum community.

Table 14. Average Cover and Frequency of Species in the Pinus ponderosa / Agropyron spicatum Community of Tranquille.

Plot Number	5	6	7	8	9	10	11	12	13	14	17	20	21	31	18	19	22	23
Elevation	640	640	640	630	630	625	630	630	630	625	655	630	665	640	655	650	650	640
Slope	6°	5°	9°	8°	9°	6°	9°	8°	11°	10°	13°	10°	14°	6°	14°	16°	20°	11°
Trees and Shrubs																		
Pinus ponderosa	15	15	-	-	15	-	-	-	2.5	15	37.5	2.5	2.5	15	37.5	15	-	-
Chrysothamnus nauseosus	15	2.5	15	15	15	15	15	15	15	15	15	15	2.5	15	2.5	2.5	15	15
Rosa woodsii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.5	15	7.0/ 80	15
Artemisia tridentata	-	-	15	2.5	-	-	-	-	-	-	-	-	2.5	-	-	-	-	-
Amelanchier alnifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	2.5	-	2.5	-	-
Grasses																		
Agropyron spicatum	12.5/100*	10.0/100	5.0/100	9.5/ 80	10.0/100	12.5/100	12.5/100	15.0/100	10.0/100	19.5/100	2.0/ 80	15.0/100	15.0/100	12.5/100	4.5/ 80	7.5/100	12.5/100	11.5/100
Koeleria cristata	2.5/100	2.5/100	2.0/ 80	1.0/ 40	1.5/ 60	7.0/ 80	2.0/ 80	1.5/ 60	-	-	-	2.0/ 80	4.0/ 60	.5/ 20	1.0/ 40	.5/ 20	.5/ 20	.5/ 20
Sporobolus cryptandrus	-	-	.5/ 20	.5/ 20	-	.5/ 20	1.0/ 40	-	.5/ 20	-	-	-	-	-	-	.5/ 20	-	.5/ 20
Stipa comata	.5/ 20	.5/ 20	3.5/ 40	-	.5/ 20	.5/ 20	.5/ 20	1.5/ 60	-	-	-	-	-	-	-	-	-	-
Poa sandbergii	5.0/ 80	15.0/100	-	.5/ 20	.5/ 20	1.5/ 60	-	-	-	-	-	-	-	-	-	.5/ 20	-	-
Aristida longiseta	-	-	-	-	-	-	.5/ 20	-	.5/ 20	-	-	.5/ 20	-	-	-	.5/ 20	-	.5/ 20
Bromus tectorum	-	.5/ 20	-	10.0/100	-	-	-	-	-	-	-	-	-	-	-	-	-	.5/ 20
Festuca octoflora	.5/ 20	-	-	-	-	1.5/ 60	-	-	-	-	-	-	-	-	.5/ 20	-	-	-
Forbs																		
Tragopogon dubius	2.5/100	2.0/ 80	.5/ 20	1.0/ 40	1.0/ 40	2.5/100	1.0/ 40	.5/ 20	1.0/ 40	-	-	1.5/ 60	1.0/ 40	.5/ 20	.5/ 20	1.0/ 40	-	.5/ 20
Arabis holboellii var. pendulocarpa	1.5/ 60	1.5/ 60	2.0/ 80	2.0/ 80	1.5/ 60	2.5/100	2.5/100	2.5/100	2.0/ 80	.5/ 20	-	2.0/ 80	1.0/ 40	-	.5/ 20	-	-	1.0/ 40
Artemisia campestris	4.5/ 80	5.0/100	-	1.0/ 40	4.0/ 60	7.5/100	10.0/100	5.0/100	1.5/ 60	-	-	2.5/100	.5/ 20	-	-	1.5/ 60	1.0/ 40	.5/ 20
Achillea millefolium var. lanulosa	2.0/ 80	4.5/ 80	1.0/ 40	1.0/ 40	2.0/ 80	1.0/ 40	1.0/ 40	.5/ 20	1.0/ 40	-	.5/ 20	.5/ 20	1.5/ 60	-	-	-	-	.5/ 20
Astragalus purshii	.5/ 20	1.5/ 60	.5/ 20	1.0/ 40	.5/ 20	1.0/ 40	.5/ 20	-	.5/ 20	.5/ 20	-	.5/ 20	-	-	-	.5/ 20	-	-
Antennaria dimorpha	7.5/100	7.5/100	4.0/ 60	5.0/100	.5/ 20	2.0/ 80	1.5/ 60	-	-	.5/ 20	-	-	-	.5/ 20	.5/ 20	-	-	-
Antennaria parvifolia	1.5/ 60	5.0/100	.5/ 20	9.0/ 80	1.5/ 60	-	4.0/ 60	3.5/ 40	-	-	-	3.0/ 20	.5/ 20	1.0/ 40	-	-	-	-
Descurainia pinnata	3.5/ 40	-	2.0/ 80	-	.5/ 20	4.0/ 60	3.0/ 20	.5/ 20	.5/ 20	-	-	-	-	-	-	-	2.5/100	1.0/ 40
Gaillardia aristata	7.0/ 60	1.5/ 60	-	-	4.0/ 60	.5/ 20	.5/ 20	-	-	-	-	-	1.0/ 40	.5/ 20	.5/ 20	-	-	.5/ 20
Allium cernuum	1.0/ 40	1.5/ 60	-	-	.5/ 20	.5/ 20	.5/ 20	-	-	-	-	-	-	.5/ 20	-	-	-	-
Epilobium paniculatum	.5/ 20	-	.5/ 20	2.0/ 80	-	-	1.0/ 40	.5/ 20	-	-	-	-	-	-	-	-	.5/ 20	-
Calochortus macrocarpus	.5/ 20	1.0/ 40	.5/ 20	.5/ 20	-	-	.5/ 20	-	-	-	-	-	-	-	-	-	-	-
Chenopodium fremontii	-	.5/ 20	-	-	-	.5/ 20	-	-	.5/ 20	-	-	-	-	-	-	-	1.5/ 60	-
Cirsium undulatum	-	-	-	-	-	-	-	.5/ 20	.5/ 20	-	-	-	-	-	.5/ 20	.5/ 20	-	-
Taraxacum officinale	.5/ 20	1.0/ 40	-	-	.5/ 20	-	-	.5/ 20	-	-	-	-	-	-	-	-	-	-
Crepis atrabarba	4.5/ 80	1.5/ 60	-	-	-	-	-	-	-	1.0/ 40	-	-	-	-	-	-	-	-
Opuntia fragilis	-	-	-	.5/ 20	-	.5/ 20	-	.5/ 20	-	-	-	-	-	-	-	-	-	-
Collinsia parviflora	.5/ 20	-	-	9.5/ 80	-	-	.5/ 20	-	-	-	-	-	-	-	-	-	-	-
Comandra umbellata var. pallida	-	-	-	-	-	3.0/ 20	-	.5/ 20	-	-	-	-	-	-	-	-	-	-
Balsamorhiza sagittata	-	-	-	-	.5/ 20	-	-	-	-	-	-	-	-	.5/ 20	-	-	-	-
Erigeron flagellaris	-	-	-	-	-	10.0/100	1.0/ 40	-	-	-	-	-	-	-	-	-	-	-
Linum perenne	1.5/ 60	.5/ 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lomatium macrocarpum	-	-	-	.5/ 20	-	-	-	.5/ 20	-	-	-	-	-	-	-	-	-	-
Lithospermum ruderale	-	-	-	-	-	.5/ 20	-	-	-	-	-	-	.5/ 20	-	-	-	-	-
Oxytropus campestris	-	-	-	-	-	-	-	-	.5/ 20	-	-	.5/ 20	-	-	-	-	-	-
Anemone multifida	-	-	-	-	.5/ 20	-	-	-	-	-	-	-	-	-	-	-	-	-
Antennaria rosea	-	-	-	-	.5/ 20	-	-	-	-	-	-	-	-	-	-	-	-	-
Astragalus beckwithii var. weiserensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.5/ 20	-	-
Centaurea diffusa	-	-	.5/ 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erigeron filifolius	-	-	-	.5/ 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lepidium virginicum	-	-	-	-	-	1.0/ 40	-	-	-	-	-	-	-	-	-	-	-	-
Stephonomeria tenuifolia	-	-	-	-	-	-	-	.5/ 20	-	-	-	-	-	-	-	-	-	-
Lappula redowskii	-	-	-	-	-	1.0/ 40	-	-	-	-	-	-	-	-	-	-	-	-
Festuca scabrella	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5/ 60	-	-	-	-
Penstemon fruticosus var. scouleri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.5/ 20	-
herb layer	37.5	28.5	19.5	28.5	19.5	37.5	24.0	24.0	17.0	19.5	2.0	24.0	15.0	12.5	4.5	12.5	24.0	16.0
Mosses and Lichens																		
Cladonia spp.	7.0/ 80	17.0/100	15.0/100	5.0/100	17.0/100	10.0/100	5.0/100	4.5/ 80	-	-	1.0/ 40	7.5/100	1.0/ 40	.5/ 20	4.0/ 60	-	-	-
Grimmia affinis	-	-	-	-	1.0/ 40	-	3.0/ 20	.5/ 20	.5/ 20	-	-	-	-	-	.5/ 20	.5/ 20	-	-
Tortula ruralis	-	-	7.0/ 80	-	-	.5/ 20	1.5/ 60	.5/ 20	-	-	-	-	-	-	-	-	-	-
Diploschistes scruposus	-	-	-	.5/ 20	-	1.5/ 60	1.0/ 40	-	-	-	-	.5/ 20	-	-	-	-	-	-
Tonimia tristis	-	1.0/ 20	-	-	-	-	1.0/ 40	-	-	-	-	1.0/ 40	-	-	-	-	-	-
Peltigera canina	-	-	-	-	-	-	.5/ 20	-	-	-	-	1.0/ 40	-	-	-	-	-	-
Ceratodon purpureus	-	.5/ 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*Average cover/frequency

Astragalus purshii, Antennaria dimorpha, Antennaria parvifolia, Descurainia pinnata, Gaillardia aristata, Allium cernuum, Epilobium paniculatum, Calochortus macrocarpus, Chenopodium fremontii, Cirsium undulatum and Taraxacum officinale.

The bryophyte and lichen layer characteristically contains Cladonia fimbriata and C. pyxidata, Grimmia affinis and Tortula ruralis and the crustose lichens Diploschistes scruposus and Toninia tristis.

The area has been homesteaded and badly overgrazed in the past (McLean and Tisdale 1972), but it seems to have recovered well. Plot 31 was taken within an exclosure set up in 1935 (McLean and Tisdale 1972) and it does not differ drastically from the other plots in the community.

The Tranquille community represents the Agropyro (spicati) - Chrysothamno (nauseosi) - Pinetum ponderosae mentioned by Krajina et al. (1974). However in associated species it does not correspond well to the Pinus ponderosa communities described in the literature. It does not commonly contain Festuca idahoensis, F. scabrella, Poa cusickii and Bromus tectorum and has less Poa secunda (= Poa sandbergii) and Antennaria dimorpha than the Pinus - Agropyron community described by Brayshaw (1955, 1965, 1970).

The most common associated grass species in the Tranquille

community is Koeleria cristata which is not listed as an associate species in the Pinus - Agropyron type described by McLean (1970). This community contains Festuca octoflora, Lappula redowskii and Plantago patagonica which are rare in the Tranquille community and does not have such species as Artemisia campestris, Astragalus purshii, Descurainia pinnata and Allium cernuum which are common in Tranquille.

The Pinus - Festuca type (McLean 1970) also is missing the Artemisia, Astragalus, Descurainia and Allium species mentioned earlier, and has Eriogonum heracleoides, Crepis atrabarba, Lomatium macrocarpum, Lupinus sericeus, Microsteris gracilis and Polygonum douglasii which are rare or missing in Tranquille.

The understory contains some species, for example Stipa comata, Sporobolus cryptandrus, Koeleria Cristata, and Calochortus macrocarpus of the Lower and Middle Grasslands as described by Tisdale (1947) and Spilsbury and Tisdale (1944). Spilsbury and Tisdale worked close to this area and mentioned the Pinus ponderosa savanna, placing it between the Lower Grassland and the Montane (Douglas fir) Zones and saying that the Middle and Upper Grassland Zones do not occur and that the savanna represents a marked variation from the normal successional pattern in the area.

This pine forest is almost at the northern limits of the range of Pinus ponderosa (Krajina et al. 1974). This may be

why it does not correspond well to Pinus - Agropyron communities described in the literature.

The Pinus ponderosa/Aristida longiseta Community:

In some areas in the Pinus ponderosa forest, Aristida longiseta becomes codominant with Agropyron spicatum (Figure 13). This community has been named Aristido (longisetae) - Pinetum ponderosae by the surveyors of the reserve (Krajina et al. 1974). Tables 15 and 17 show that this community has many of the same associated species as the Agropyron community. These include the same shrub species, Chrysothamnus nauseosus, Artemisia tridentata, the grasses Koeleria cristata, Stipa comata and Bromus tectorum and the forbs Tragopogon dubius, Arabis holboellii, Artemisia campestris, Achillea millefolium, Astragalus purshii, and Descurainia pinnata. Artemisia frigida and Carex praticola also occur in this community, although they are not common in the Pinus/Agropyron community.

The bryophyte-lichen layer of the Pinus/Aristida community contains the Cladonia species, Grimmia affinis and Tortula ruralis.

In the list of biogeocoenoses for the Ponderosa pine - Bunchgrass Zone (Krajina 1969) there are two which contain significant amounts of Aristida longiseta. These are Stipo (comatae) - Opuntio (fragilis) - Aristido (longisetae) - Purshietum tridentatae and Sporobolo (cryptandri) - Aristidetum

Figure 13. Tranquille, ground cover of the Pinus ponderosa/ Aristida longiseta community: In the lower right of the picture are clumps of Agropyron spicatum. The smaller, more compact clumps are Aristida longiseta. The shrubs are Chrysothamnus nauseosus. The stake is marked in 50 centimeter intervals.

Figure 14. Tranquille, the Pseudotsuga menziesii/Pinus ponderosa/Agropyron spicatum community: The overstory is mainly Pseudotsuga menziesii. The shrub is Juniperus scopulorum. Agropyron spicatum again dominates the understory but the clumps are more widely spaced and there is less litter. The stake is marked in 50 centimeter intervals.

Table 15. Average Cover and Frequency of Species in the *Pinus ponderosa*/*Aristida longiseta* community of Tranquille.

Plot	15	16
Elevation (meters)	655	655
Slope	8°	11°
Shrubs		
Chrysothamnus nauseosus	15	15
Artemisia tridentata	2.5	-
Grasses		
Aristida longiseta	12.5/100*	12.0/100
Agropyron spicatum	10.0/100	12.5/100
Stipa comata	4.5/ 80	-
Bromus tectorum	.5/ 20	-
Koeleria cristata	2.0/ 80	-
Forbs		
Tragopogon dubius	2.0/ 80	.5/ 20
Artemisia campestris	1.5/ 60	2.0/ 80
Astragalus beckwithii	.5/ 20	.5/ 20
Achillea millefolium	3.5/ 40	.5/ 20
Descurainia pinnata	.5/ 20	1.5/ 60
Carex praticola	.5/ 20	.5/ 20
Astragalus purshii	-	.5/ 20
Lithospermum ruderale	-	.5/ 20
Cirsium undulatum	.5/ 20	-
Artemisia frigida	-	.5/ 20
Opuntia fragilis	-	.5/ 20
Arabis holboellii	2.5/100	2.5/100
herb layer	37.5	24.0
Mosses and Lichens		
Cladonia spp.	12.5/100	5.0/100
Grimmia affinis	.5/ 20	-
Tortula ruralis	-	1.0/ 40

*Average cover/frequency.

longisetae, neither of which accurately could be applied to this community.

Tisdale (1947) mentioned that on coarser soil an edaphic community which contains Stipa comata and Sporobolus cryptandrus occurs. He stated that this community is like the Purshia - Aristida community but that in the Thompson River area Purshia is absent and Aristida not common.

Brayshaw (1955) described a Pinus - Aristida association which results from the burning of a Pinus - Purshia stand. He mentioned that in the Thompson Valley Purshia does not occur, thus the Pinus - Aristida communities occur without burning.

Although the generalized Pinus - Aristida community (Brayshaw 1955, 1965, 1970) contains many species not present in the Tranquille community, one of the stands he sampled was in the Thompson Valley and closely resembles the Tranquille community. It has such species as Artemisia campestris, Astragalus purshii, Cirsium undulatum, Lithospermum ruderale, Achillea millefolium, Opuntia fragilis, Koeleria cristata, Bromus tectorum and Stipa comata all of which are present in the Tranquille Pinus/Aristida community.

The Pseudotsuga menziesii/Pinus ponderosa/Agropyron spicatum Community:

Possibly up to 50% of the reserve is occupied by this

community (Figure 10). Above about 760 meters Pseudotsuga menziesii dominates the canopy and Juniperus scopulorum and Ribes cereum become more common in the shrub layer. The community occurs both on steep slopes and on flatter plateau areas which often have very shallow soils.

Agropyron spicatum still dominates the understory but the individual clumps are smaller and more widely spaced (Figure 14). Koeleria cristata, Sporobolus cryptandrus and Bromus tectorum are associated grasses. The number of associated forb species is reduced, and includes Achillea millefolium, Arabis holboellii, Descurainia pinnata, Calochortus macrocarpus, Artemisia frigida and Selaginella wallacei. Most of the mosses and lichens of the lower slopes except Toninia tristis are found in this community (Tables 16 and 17).

This community is somewhat similar to the Pseudotsuga menziesii - Agropyron spicatum habitat type (McLean 1970) and shares some species with the Pseudotsuga menziesii - Festuca idahoensis habitat type (McLean 1970).

Beil (1974) from his work in the Cariboo Zone described a Pseudotsuga menziesii - Juniperus scopulorum community which has a shrub stratum of Juniperus scopulorum, Artemisia tridentata and Chrysothamnus nauseosus, and has an understory of Agropyron spicatum, Artemisia frigida, Stipa comata,

Table 16. Average Cover and Frequency of Species in the Pseudotsuga menziesii/Pinus ponderosa/Agropyron spicatum community of Tranquille.

Plot	24	25	26	27	28	29	30
Elevation (meters)	825	825	825	885	885	880	870
Slope	6°	12°	11°	10°	9°	22°	18°
Trees and shrubs							
Pseudotsuga menziesii	-	37.5	-	-	-	15	15
Pinus ponderosa	-	-	2.5	-	-		37.5
Chrysothamnus nauseosus	15	2.5	2.5	-	2.5	.5/ 20	2.5
Artemisia tridentata	15	2.5	-	2.5	2.5	-	-
Juniperus scopulorum	15	-	2.5	-	-	15	-
Ribes cereum	-	-	-	-	2.5	2.5	-
Grasses							
Agropyron spicatum	24.0/100*	15.0/100	10.0/100	4.0/ 60	10.0/100	1.0/ 40	4.5/ 80
Koeleria cristata	2.0/ 80	-	1.5/ 60	-	-	-	-
Sporobolus cryptandrus	-	-	-	.5/ 20	-	-	-
Oryzopsis hymenoides	-	-	-	-	-	.5/ 20	-
Bromus tectorum	-	-	-	-	-	.5/ 20	-
Forbs							
Achillea millefolium	1.0/ 40	1.0/ 40	2.0/ 80	-	.5/ 20	-	-
Descurainia pinnata	.5/ 20	-	-	2.5/100	2.5/100	-	-
Artemisia frigida	.5/ 20	-	-	.5/ 20	-	-	-
Calochortus macrocarpus	1.5/ 60	-	-	-	-	-	-
Selaginella wallacei	3.0/ 20	-	-	-	-	-	-
Arabis holboellii	2.5/100	-	-	-	-	-	-
herb layer	24.0	15.0	10.0	5.0	10.0	3.5	4.5
Mosses and Lichens							
Cladonia spp.	2.0/ 80	.5/ 20	1.5/ 60	-	1.0/ 40	-	-
Tortula ruralis	2.0/ 80	-	.5/ 20	1.0/ 40	1.5/ 60	-	-
Grimmia affinis	-	-	-	1.5/ 60	1.0/ 40	2.5/100	-
Diploschistes scruposus	.5/ 20	-	-	-	-	-	-
Peltigera canina	-	-	-	-	.5/ 20	-	-

*Average cover/frequency

Table 17. Range of Cover and Constancy of Species in Communities in Tranquille.

	Pp/As 18 plots	Pp/Al 2 plots	Pm/Pp/As 7 plots	At/Ps/Sc 4 plots
Trees and Shrubs				
Rosa woodsii	0-15/22*	-	-	-
Amelanchier alnifolia	0-2.5/11	-	-	-
Chrysothamnus nauseosus	2.5-15/100	15-15/100	0-15/86	2.5-2.5/100
Artemisia tridentata	0-15/17	0-2.5/50	0-15/57	2.5-37.5/100
Pinus ponderosa	0-37.5/61	-	0-37.5/28	-
Pseudotsuga menziesii	-	-	0-37.5/43	-
Juniperus scopulorum	-	-	0-15/43	-
Ribes cereum	-	-	0-2.5/28	-
Grasses				
Festuca scabrella	0-1.5/6	-	-	-
Aristida longiseta	0-.5/28	12-12.5/100	-	-
Agropyron spicatum	2-19.5/100	10-12.5/100	1.0-24/100	-
Koeleria cristata	0-7/83	0-2/50	0-2/28	0-.5/25
Bromus tectorum	0-10/17	0-.5/50	0-.5/14	.5-7.5/100
Sporobolus cryptandrus	0-1/39	-	0-.5/14	.5-4/100
Stipa comata	0-3.5/39	0-4.5/50	-	2-12.5/100
Poa sandbergii	0-15/33	-	-	15-19.5/100
Festuca octoflora	0-1.5/17	-	-	0-2.5/75
Oryzopsis hymenoides	-	-	0-.5/14	-
Forbs				
Antennaria parvifolia	0-9/56	-	-	-
Gaillardia aristata	0-7/50	-	-	-
Allium cernuum	0-1.5/33	-	-	-
Epilobium paniculatum	0-1/33	-	-	-
Taraxacum officinale	0-1/22	-	-	-
Crepis atrabarba	0-4.5/17	-	-	-
Comandra umbellata	0-3/17	-	-	-

Table XVll. Continued.

	Pp/As 18 plots	Pp/Al 2 plots	Pm/Pp/As 7 plots	At/Ps/Sc 4 plots
Balsamorhiza sagittata	0-.5/11	-	-	-
Erigeron flagellaris	0-10/11	-	-	-
Linum perenne	0-1.5/11	-	-	-
Oxytropus campestris	0-.5/11	-	-	-
Anemone multifida	0-.5/6	-	-	-
Antennaria rosea	0-.5/6	-	-	-
Centaurea diffusa	0-.5/6	-	-	-
Erigeron filifolius	0-.5/6	-	-	-
Stephanomeria tenuifolia	0-.5/6	-	-	-
Penstemon fruticosus	0-.5/6	-	-	-
Artemisia campestris	0-10/72	1.5-2/100	-	-
Astragalus purshii	0-1.5/61	0-.5/50	-	-
Cirsium undulatum	0-.5/22	0-.5/50	-	-
Lithospermum ruderale	0-.5/11	0-.5/50	-	-
Astragalus beckwithii	0-.5/6	.5-.5/100	-	-
Achillea millefolium	0-4.5/72	.5-3.5/100	0-2/57	-
Arabis holboellii	0-2.0/78	2.5-2.5/100	0-2.5/14	0-1.0/25
Descurainia pinnata	0-3.5/50	.5-1.5/100	0-2.5/43	.5-2.5/100
Tragopogon dubius	0-2.5/83	.5-2.0/100	-	.5-1.0/100
Opuntia fragilis	0-.5/17	0-.5/50	-	1.5-4.5/100
Artemisia frigida	-	0-.5/50	0-.5/28	1.5-2.5/100
Lappula redowskii	0-1/6	-	-	1.5-7.5/100
Androsace occidentalis	-	-	-	2.0-4.5/100
Lepidium virginicum	0-1.0/6	-	-	0-1.5/75
Collinsia parviflora	0-9.5/17	-	-	0-.5/75
Antennaria dimorpha	0-7.5/56	-	-	0-12.5/75
Chenopodium fremontii	0-.5/22	-	-	0-.5/50
Calochortus macrocarpus	0-1/28	-	0-1.5/14	0-.5/50
Carex praticola	-	.5-.5/100	-	-

Table XV11.Continued.

	Pp/As 18 plots	Pp/Al 2 plots	Pm/Pp/As 7 plots	At/Ps/Sc 4 plots
Selaginella wallacei	-	-	0-3/14	-
herb layer	2.0-37.5	24-37.5	3.5-24.0	28.5-33.0
Mosses and Lichens				
Ceratodon purpureus	0-.5/6	-	-	-
Grimmia affinis	0-3/33	0-.5/50	0-2.5/43	-
Cladonia spp.	0-17/72	5-12.5/100	0-2.0/57	2.5-10/100
Tortula ruralis	0-7/22	0-1/50	0-2/57	0-4/50
Diploschistes scruposus	0-1.5/22	-	0-.5/14	0-.5/25
Toninia tristis	0-1/11	-	0-.5/14	-

* range of cover/constancy

Pp/As - the Pinus ponderosa/Agropyron spicatum community
Pp/Al - the Pinus ponderosa/Aristida longiseta community
Pm/Pp/As - the Pseudotsuga menziesii/Pinus ponderosa/Agropyron spicatum community
At/Ps/Sc - the Artemisia tridentata/Poa sandbergii/Stipa comata community

Sporobolus cryptandrus and Tortula ruralis. The species composition of this community is similar to the Tranquille Pseudotsuga/Pinus/Agropyron community.

Bray-Curtis Ordination

This analysis technique separates the Artemisia/Poa/Stipa plots well. The Pseudotsuga/Pinus/Agropyron plots are also separate and tend to be toward the upper right of the graph, which may represent an altitudinal gradient (Figure 15).

The Pinus/Aristida community plots are not separated from the Pinus/Agropyron plots. As was mentioned previously, this community shares many species with the Pinus/Agropyron community. This may be the reason the plots of the two communities did not separate. If a multi-dimensional graph were constructed the Pinus/Aristida plots might show more distinctiveness.

Aside from this, the ordination supports the first community breakdown done.

Conclusion

The reserve is classified as being in the Ponderosa pine - Bunchgrass Zone (Krajina et al. 1974). The presence of a Pinus/Agropyron community in the lower areas of the reserve indicates that certainly this area is in that zone. However, as was stated earlier, at an elevation of about

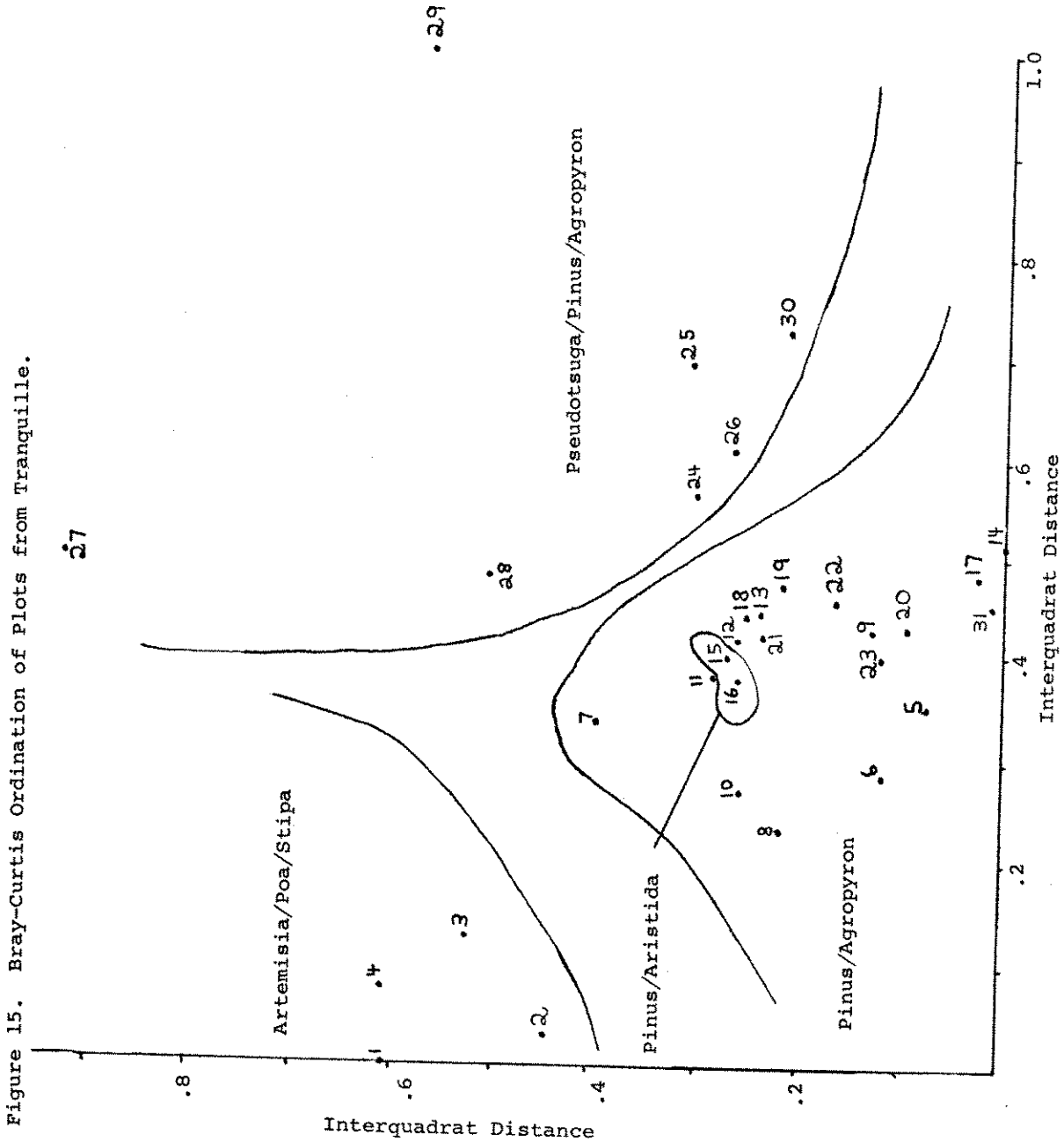


Figure 15. Bray-Curtis Ordination of Plots from Tranquille.

760 meters, Pseudotsuga menziesii dominates the canopy. Possibly up to 50% of the reserve is occupied by a community in which the canopy is predominantly Douglas fir. For this reason the higher elevations of this reserve should be classified in the Interior Douglas Fir Zone.

COMPARISON OF THE COMMUNITIES OF THE RESERVES

Both reserves contain a community dominated by Pinus ponderosa and Agropyron spicatum. The Pinus ponderosa/Agropyron spicatum community in Tranquille shares many associate species with the Pinus/Agropyron community in Trout Creek. Examples of these are Festuca octoflora, Koeleria cristata, Bromus tectorum, Antennaria dimorpha, Tragopogon dubius, Achillea millefolium, Lithospermum ruderale and Balsamorhiza sagittata.

However Trout Creek contains many major species such as Phacelia linearis, Lewisia rediviva, and Plantago patagonica which are lacking in Tranquille, and some relatively abundant species in Tranquille, such as Sporobolus cryptandrus, Artemisia campestris, Astragalus purshii and Allium cernuum are rare or lacking in Trout Creek. The relative abundance of some other species is very different in the comparable communities of the two reserves. For example Lomatium macrocarpum, Crepis atrabarba and Balsamorhiza sagittata are of major importance in the Trout Creek Pinus/Agropyron community but are minor in the Tranquille community.

This difference in floristic composition could be a result of many factors. As was stated earlier the Tranquille Reserve is near the northern limit of the range of Pinus ponderosa. It is conceivable that other species are at their northern limit also or that this area is beyond the range of a species. Since a species is likely to be less abundant near the limits of its tolerance, this may account for the relative rareness in Tranquille of some species.

Tables 4 and 6 show that Tranquille has less precipitation than Trout Creek. This also may be a factor determining differences in relative abundance of species in the two reserves.

Tables 8, 13 and 18 show that the forest is much denser and older in Tranquille than in Trout Creek. This also may be a factor in species differences between the two reserves.

There is also a difference in grazing pressure between Trout Creek and Tranquille. As has been discussed earlier there is evidence that Trout Creek has been modified by grazing pressure. The Pinus/Agropyron community in the Tranquille Reserve, on the other hand, is probably grazed very little and is modified very little. This difference also could account for species abundance differences.

Many other factors, such as differences in surrounding topography, exposure, slope, daily temperature extremes etc. would contribute to the differences in species composition and

Table 18. Height, Diameter and Age Data for Trees.

Species	Trout Creek			Tranquille		
	Height (meters)	Diameter Breast Height (cm)	Age	Height (meters)	Diameter Breast Height (cm)	Age
Pinus ponderosa	3.4	9.1	10	5.2	10.1	36
	6.7	14.2	34	10.7	14.7	56
	5.5	18.3	16	9.2	16.0	45
	9.4	20.3	45	13.1	17.8	57
	11.0	25.9	41	11.6	22.6	61
	9.2	26.0	28	12.8	28.2	65
	13.4	37.8	50	13.4	31.0	120
	17.1	43.4	45	16.8	39.6	165
Pseudotsuga menziesii	5.2	7.6	18	8.2	11.7	44
	12.5	22.6	38	20.0	16.2	45
	32.0	63.0	113	13.7	20.8	63
				13.4	22.9	38
				15.3	28.7	69
				19.8	36.3	79

relative abundance in the Pinus/Agropyron communities of the two reserves.

The Trout Creek Reserve has a greater number of species than the Tranquille Reserve (Tables 19 and 20). The various environmental differences between the reserves might contribute to this fact.

There is only one community in Trout Creek, the Pinus/Agropyron community, that is comparable to a community in Tranquille. The Tranquille Reserve has no sampled communities comparable to the Pinus/Pseudotsuga/Amelanchier, the Pinus/Pseudotsuga/Calamagrostis or the Pinus/Selaginella communities in Trout Creek, and the Trout Creek Reserve does not contain Artemisia/Poa/Stipa, Pinus/Aristida or Pseudotsuga/Pinus/Agropyron communities comparable to those in Tranquille.

Table 19. List of Plant Species in Trout Creek.

Achillea millefolium L. ssp. lanulosa (Nutt.) Piper

Agropyron spicatum (Pursh) Scribn & Smith

Alyssum desertorum Stapf.

Amelanchier alnifolia Nutt.

Antennaria corymbosa E. Nels.

A. dimorpha (Nutt.) T & G.

A. parvifolia Nutt.

A. rosea Greene

Apocynum androsaemifolium L. var. Pumilum Gray

Arabis holboellii Harnem var. pendulocarpa (Nels) Rollins

Aristida longiseta Steud.

Arnica sororia Greene

Artemisia campestris L.

A. frigida Willd.

Asparagus officionalis

Astragalus miser Dougl. var. serotinus (Gray) Barneby

A. purshii Dougl. var. purshii

A. sclerocarpus Gray

Balsamorhiza sagittata (Pursh) Nutt.

Berberis aquifolium Pursh

Bromus tectorum L.

Calamagrostis rubescens Buckl.

Calochortus macrocarpus Dougl. var. macrocarpus

Capsella bursa - pastoris (L.) Medic

Castilleja longispica A. Nels.

Ceanothus sanguineus Pursh

Chaenactis douglasii (Hook.) H & A.

Chenopodium fremontii Wats. var. fremontii

C. leptophyllum (Moq) Wats. var. oblongifolium Wats.

Chrysopsis villosa (Pursh) Nutt. var. hispida (Hood.) Gray

Chrysothamnus nauseosus (Pall.) Britt.

Cirsium undulatum (Nutt.) Spreng.

Collinsia parviflora Lindl.

Comandra umbellata Nutt. var. pallida (D.C.) Jones

Crepis atrabarba Heller ssp. originalis Babc. & Stebb.

Delphinium nuttallianum Pritz.

Descurainia pinnata (Walt.) Britt.var. intermedia (Rydb) C.L. Hitchc.

Elaeagnus commutata Bernh.

Epilobium paniculatum Nutt.

Erigeron divergens T & G.

E. filifolius Nutt. var. filifolius

E. pumilus Nutt.

Eriogonum heracleoides Nutt.

E. niveum Dougl.

Festuca idahoensis Elmer.

F. octoflora Walt. var. octoflora

F. scabrella Torr.

Gaillardia aristata Pursh.

Geum triflorum Pursh var. triflorum

Gilia aggregata (Pursh) Spreng var. aggregata

Happlopappus carthamoides (Hook.) Gray

Heuchera cylindrica Dougl.

Juniperus scopulorum Sarg.

Koeleria cristata Pers.

Lactuca serriola L. var. integrata Gren & Godr.

Lappula redowskii (Hornem) Greene var. redowskii

Leptodactylon pungens (Torr.) Nutt.

Lesquerella douglasii Wats.

Lewisia rediviva Pursh.

Lithophragma parviflora (Hook.) Nutt.

Lithospermum ruderale Dougl.

Lomatium macrocarpum (Nutt.) Coult & Rose

Microseris nutans (Geyer) Schultz - Bip.

Opuntia fragilis (Nutt.) Haw.

Penstemon fruticosus (Pursh) Greene var. scouleri (Lindl) Cronq.

Phacelia hastata Dougl.

P. linearis (Pursh.) Holz.

Philadelphus lewisii Pursh.

Pinus ponderosa Dougl.

Plantago patagonica Jacq.

Poa bulbosa L.

Poa sandbergii Vasey

Pseudotsuga menziesii (Mirbel) Franco var. glauca (Beissn.) Franco

Ranunculus glaberrimus Hook. var. ellipticus Greene

Ribes cereum Dougl. var. cereum

Rosa woodsii Lindl. var. woodsii

Selaginella densa Rydb.

S. wallacei Hieron

Silene antirrhina L.

S. douglasii Hook. var. douglasii

Stephanomeria tenuifolia (Torr.) Hall var. tenuifolia

Stipa comata Trin & Rupr. var. comata

S. occidentalis Thurb. var. minor (Vasey) Hitchc.

Symphoricarpos albus (L.) Blake

Taraxacum officinale Weber

Tragopogon dubius Scop.

Woodsia scopulina D.C. Eat.

Zygadenus venenosus Wats. var. gramineus (Rydb.) Walsh.

Mosses

Grimmia affinis Hornsch.

Tortula ruralis (Hedw.) Smith

Rhytidiadelphus triquetris (Hedw.) Warnst.

Lichens

Cladonia fimbriata (L.) Fr.

C. pyxidata (L.) Hoffm.

Diploschistes scruposus (Shreb) Norm.

Letharia vulpina

Peltigera canina (L.) Willd.

Table 20. List of Plant Species in Tranquille.

Achillea millefolium L. ssp. lanulosa (Nutt.) Piper

Agropyron spicatum (Pursh) Scribn. & Smith

A. cristatum (L.) Gaertn.

Allium cernuum Roth.

Amelanchier alnifolia Nutt.

R4 Androsace occidentalis Pursh. w. thirsy- candelabra

Anemone multifida Poir. var. multifida

Antennaria dimorpha (Nutt.) T & G.

A. parvifolia Nutt.

A. rosea Greene

Apocynum androsaemifolium L. var. pumilum Gray

A. cannabinum L. var. glaberrimum DC.

Arabis holboellii Hornem, var. pendulocarpa (Nels.) Rollins

Aristida longiseta Steud.

Artemisia campestris L.

A. frigida Willd.

A. tridentata Nutt.

Astragalus beckwithii T & G. var. weiserensis M.D. Jones

A. purshii Dougl. var. purshii

R1 A. sclerocarpus Gray Dalles milk-vetch - not previously recorded this far north

Balsamorhiza sagittata (Pursh) Nutt.

Bromus tectorum L.

Calochortus macrocarpus Dougl. var. macrocarpus

Carex praticola Rydb.

Centaurea diffusa Lam.

Chenopodium fremontii Wats. var. fremontii

Chrysothamnus nauseosus (Pall.) Britt.

Cirsium undulatum (Nutt.) Spreng.

Clematis ligusticifolia Nutt.

Collinsia parviflora Lindl.

Comandra umbellata (L.) Nutt. var. pallida (DC.) Jones.

Crepis atrabarba Heller ssp. originalis Babc & Stebb

C. occidentalis Nutt. ssp. occidentalis

Descurainia pinnata (Walt.) Britt. var. intermedia (Rydb.) C.L. Hitchc.

Distichlis stricta (Torr.) Rydb.

Elymus cinereus Scribn. & Merr.

Epilobium paniculatum Nutt.

Erigeron filifolius Nutt. var. filifolius

R4 E. flagellaris Gray *fruitig fleabane*

Festuca octoflora Walt. var. octoflora

F. scabrella Torr.

Fragaria virginiana Duchesne

Gaillardia aristata Pursh.

Juniperus scopulorum Sarg.

Koeleria cristata Pers.

Lappula redowskii (Hornem) Greene var. redowskii

Lepidium virginicum L. var. virginicum

Linum perene L. var. lewisii (Pursh) Eat. & Wright

Lithospermum ruderale Dougl.

Lomatium macrocarpum (Nutt.) Coult & Rose

Opuntia fragilis (Nutt.) Haw.

Oxytropus campestris (L.) DC.

Oryzopsis hymenoides (R. & S.) Ricker

Penstemon fruticosus (Pursh) Greene var. scouleri (Lindl) Crong.

Pinus ponderosa Dougl.

R3 Plantago elongata Pursh. slender plantain

Poa sandbergii Vasey

Pseudotsuga menziesii (Mirbel) Franco var. glauca (Beissn.) Franco

Ribes cereum Dougl. var. cereum

Rosa woodsii Lindl. var. woodsii

Selaginella wallacei Hieron.

Shepherdia canadensis (L.) Nutt.

Silene antirrhina L.

Sporobolus cryptandrus (Torr.) Gray

Stephanomeria tenuifolia (Torr.) Hall var. tenuifolia

Stipa comata Trin. & Rupr. var. comata

Taraxacum officinale Weber.

R4 Tetradymia canescens DC. gray horsebrush

Tragopogon dubius Scop.

Zygadenus venenosus Wats. var. gramineus (Rydb.) Walsh.

Mosses

Ceratodon purpureus (Hedw.) Brid.

Grimmia affinis Hornsh.

Tortula ruralis (Hedw.) Smith

Lichens

Cladonia fimbriata (L.) Fr.

C. pyxidata (L.) Hoffm.

Diploschistes scruposus (Shreb) Norm.

Letharia vulpina

Peltigera canina (L.) Willd.

Toninia tristis (Th. Fr.) Th. Fr.

SOILS

Trout Creek

The only soils sampled in this reserve were in the Pinus ponderosa/Agropyron spicatum community. The Pinus/Pseudotsuga/Calamagrostis community was deemed too small for sampling and the Selaginella and Pinus/Pseudotsuga/Amelanchier communities had too little soil.

Tables 21, 22 and 23 describe the soils. Although samples were taken in only one community, this community occurs in two physiographically distinct areas, terrace areas and slopes. The soils are sufficiently different in these areas that two descriptions are presented.

The terrace area soil is deeper, has less calcium and magnesium, a lower cation exchange capacity and lower base saturation than the soil of the slopes. It is a finer soil, containing more silt and less sand, and has a layer of loam at about 90 centimeters which the soil of the slopes lacks. It also has a greater available moisture capacity, probably accentuated by the fact that the soil contains fewer rocks.

These differences may be a factor determining the slight species differences noted earlier between the two areas.

The parent material of both soils is outwash gravel. Both soils are Brunisols.

Table 21. Profile Descriptions of Soils in Trout Creek.

Community and Location	Horizon	Description
terrace - *Pinus ponderosa*/*Agropyron spicatum* Community	LFH	0-3 cm.
	Ah	sandy loam; weak blocky; plentiful fine roots; 5-20 cm. thick.
	Bm	sandy loam; weak blocky; plentiful fine roots; 30-60 cm. thick.
	C_1	loam; single grain; loose; few fine roots; 10-15 cm. thick.
	C_2	amorphous; very hard; outwash gravel. Brunisolic Order.
slopes - *Pinus ponderosa*/*Agropyron spicatum* Community	LFH	0-3 cm.
	Ah	gravelly cobbley sandy loam; weak blocky; plentiful fine roots; 5-18 cm. thick.
	Bm	very cobbley sandy loam; amorphous; very hard; plentiful fine roots; very few medium and coarse roots; 30-50 cm. thick.
	C	very hard; outwash gravel. Brunisolic Order.

Table 22. Physical Properties of Soils in Trout Creek.

Horizon	Depth of Sample	Field Capacity (%)	Permanent Wilting Percentage	Available Moisture Capacity (%)	% sand	% silt	% clay
terrace							
A	10	19.0	8.0	11.0	68	20	12
B	30	15.2	6.0	9.2	66	22	12
B	50	14.7	5.6	9.1	64	24	12
C_1	100	-	-	-*	50	34	16
slopes							
A	10	20.6	10.8	9.8	78	10	12
B	30	20.4	10.3	10.1	78	10	12
B	50	19.8	9.6	10.2	74	12	14

* no data available.

Table 23. Chemical Properties of Soils in Trout Creek.

Horizon	Depth of Sample	% Organic Matter	pH	Ca (mEq/100 gm)	Mg (mEq/100 gm)	K (mEq/100 gm)	Na (mEq/100 gm)	Cation Exchange Capacity (mEq/100 gm)	% Base Saturation
terrace									
A	10	2.5	6.5	2.4	2.4	.9	.2	22.8	26
B	30	2.3	7.0	2.2	2.1	.6	.2	17.5	31
B	50	2.2	7.3	2.7	2.3	.5	.2	16.7	33
slopes									
A	10	2.9	6.6	4.6	4.2	.9	.1	29.0	32
B	30	2.2	6.8	4.0	5.6	.6	.1	28.4	35
B	50	1.9	7.1	6.4	6.5	.3	.2	30.7	41

Tranquille

Tables 24, 25 and 26 give a description of the soils in the Tranquille Reserve.

The Artemisia tridentata/Poa sandbergii/Stipa comata community soil is deeper than one meter. It has much magnesium, potassium, calcium, and sodium, and a high base saturation and pH. Glacial till is probably the parent material of the soil, however the C horizon was never reached in the soil pits. The soil is a Chernozem.

The soil under the Pinus/Agropyron community is not as deep and is coarser in texture. It contains more calcium but less magnesium and potassium, has a lower pH and lower base saturation values. It also is harder in consistence with lower available moisture capacity values. Calcareous glacial till is the parent material of this soil which also is a Chernozem.

The soil of the Pinus/Aristida community, also a Chernozem, is coarser in texture than that of the Pinus/Agropyron community and contains more rocks. It contains more calcium, magnesium and potassium and has slightly higher pH and base saturation values than the Pinus/Agropyron community. This tends to support the statement (Brayshaw 1970) that the Pinus - Purshia community, which, as was mentioned earlier may be a southern equivalent of the Pinus/Aristida community,

Table 24. Profile Descriptions of Soils in Tranquille.

Community	Horizon	Description
Artemisia tridentata/ Poa sandbergii/Stipa comata Community	LFH	0-5 cm.
	Ah	gravelly sandy loam; weak blocky; plentiful fine roots; 6-20 cm. thick.
	Bm	gravelly to very gravelly and cobbley sandy loam - loam; plentiful fine roots; 90 cm. thick.
	C	probably glacial till. Chernozemic Order
Pinus ponderosa/ Agropyron spicatum Community	LFH	0-3 cm.
	Ah	gravelly sandy loam; weak blocky; slightly hard; plentiful fine roots; 4-20 cm. thick.
	Bm	very gravelly and cobbley sandy loam; amorphous; hard; few fine and few medium and coarse roots; 20-40 cm. thick.
	C	very gravelly and cobbley glacial till; hard; very few medium and coarse roots. Chernozemic Order.
Pinus ponderosa/ Aristida longiseta Community	LFH	0-2 cm.
	Ah	very cobbley sandy loam; weak blocky; very few medium and coarse, plentiful fine roots; 11-20 cm. thick.
	Bm	gravelly and cobbley sandy loam; plentiful medium and coarse, few fine roots; 40-50 cm. thick.
	C	cobbley and gravelly sandy loam - loam; very hard glacial till. Chernozemic Order
Pseudotsuga menziesii/ Pinus ponderosa/ Agropyron spicatum Community	LFH	0-1 cm.
	Ah	loamy sand - sandy loam; moderate granular; hard; plentiful coarse and medium,

Table 24. Continued.

Community	Horizon	Description
		very few fine roots; 2-30 cm. thick.
	C	rock.
		Regosolic Order.

Table 25. Physical Properties of Soils in Tranquille.

Horizon	Depth of Sample	Field Capacity (%)	Permanent Wilting Percentage	Available Moisture Capacity (%)	% sand	% silt	% clay
Artemisia/Poa/Stipa Community							
A	10	34.8	20.0	14.8	68	19	13
B	30	32.2	17.1	15.1	64	24	12
B	50	18.5	13.3	5.2	56	34	10
B	90	-	-*	-	58	30	12
Pinus/Agropyron Community							
A	10	32.4	20.2	12.2	74	16	10
B	30	27.2	15.5	11.8	76	10	14
B	50	27.0	15.8	11.2	66	22	12
C	80	-	-	-	66	18	16
Pinus/Aristida Community							
A	10	28.3	17.6	10.7	80	8	12
B	30	24.7	13.9	10.6	80	6	14
B	50	27.9	17.2	10.7	72	16	12
C	90	-	-	-	56	30	14
Pseudotsuga/Pinus/ Agropyron Community							
A	10	33.6	21.5	12.1	84	2	14
A	30	-	-	-	81	6	13

* no data available.

Table 26. Chemical Properties of Soils in Tranquille.

Horizon	Depth of Sample	% Organic Matter	pH	Ca (mEq/100 gm)	Mg (mEq/100 gm)	K (mEq/100 gm)	Na (mEq/100 gm)	Cation Exchange Capacity	% Base Saturation
Artemisia/Poa/Stipa Community									
A	10	3.8	7.3	5.1	27.2	3.9	.3	63.7	57
B	30	3.7	7.6	14.4	23.6	3.5	.5	53.0	79
B	50	4.6	7.8	5.4	25.6	3.8	.8	41.8	85
Pinus/Agropyron Community									
A	10	4.1	6.9	8.0	19.5	2.8	.1	54.6	56
B	30	2.4	7.1	10.1	18.5	2.6	.2	44.9	69
B	50	1.8	7.4	16.3	17.3	2.5	.3	48.1	77
Pinus/Aristida Community									
A	10	3.4	6.9	12.5	18.9	3.0	.2	46.2	75
B	30	2.2	7.3	21.0	21.6	3.2	.2	46.2	99
B	50	1.5	7.4	10.4	21.6	2.8	.2	56.2	62
Pseudotsuga/Pinus/ Agropyron Community									
A	10	3.3	7.4	8.9	18.5	5.8	.1	57.1	52

occurs on coarser textured more alkaline soils.

The very shallow soil under the Pseudotsuga/Pinus/Agropyron community is a Regosol developed on rock. It is a coarse soil because of the structure, but has an only slightly lower base saturation value, similar amounts of calcium and magnesium and more potassium.

Conclusion

The soils in Tranquille are developed from a more calcareous parent material than those in Trout Creek, as is indicated by the much higher pH values, base saturation values and amounts of cations. They are also better developed soils. These differences may possibly be determining factors in the species and abundance differences between the two reserves discussed earlier.

SUMMARY

The areas for this study were two Ecological Reserves. Both reserves are in the Interior of British Columbia. The Trout Creek Reserve is near Penticton and the Tranquille Reserve is near Kamloops. Both reserves fall mainly into the Ponderosa Pine - Bunchgrass Biogeoclimatic Zone, Trout Creek being well inside the zone, and Tranquille being at its northern edge.

A brief literature review is presented on the Ponderosa Pine - Bunchgrass Zone, the adjacent Interior Douglas Fir Zone, and the autecology of Ponderosa pine and Douglas fir.

Before sampling community types were subjectively determined on the basis of physiognomy and species dominance. Quadrats were placed within these community types.

Tree and shrub layers were sampled using a 10 x 10 meter quadrat; herb and dwarf shrub, and bryophyte and lichen layers were sampled using five, 1 x 1 meter plots within the large quadrat. Tree diameters were measured. Percentage cover was estimated for species and for layers.

Soil pits were excavated in the communities, samples taken and profiles briefly described.

Quadrat data were examined subjectively and the initial community breakdown modified or verified. A Bray-Curtis Ordination of plots was done on the data from each reserve.

Soils were analyzed for exchangeable calcium, magnesium, potassium and sodium, cation exchange capacity, base saturation, pH, percentage organic matter, permanent wilting percentage, field capacity, available moisture capacity, and texture.

Four community types are defined in Trout Creek. The most extensive community is the Pinus ponderosa/Agropyron spicatum community. This community is an open, grassy parklike forest dominated by Pinus ponderosa in the canopy layer and Agropyron spicatum in the herb layer. The community has a very sparse shrub layer composed primarily of Chrysothamnus nauseosus. Characteristic associate species are given.

The Selaginella wallacei community occurs on small rock outcrops. This community has an abundance of the mat-forming Selaginella wallacei, and many of the characteristic associate species of the Pinus/Agropyron community are missing. This is a primary successional community.

On talus slopes in the reserve is the Pinus ponderosa/Pseudotsuga menziesii/Amelanchier alnifolia community. Pinus and Pseudotsuga occur in the tree layer. The shrub layer is more extensive than in the Pinus/Agropyron community, and has more species, Amelanchier alnifolia being the major one. The herb layer is sparse in this community.

In one very small, protected area is the Pinus ponderosa/Pseudotsuga menziesii/Calamagrostis rubescens community. This community has a dense growth of young Pinus and Pseudotsuga

individuals. The ground cover is predominantly the grass Calamagrostis rubescens.

The Bray-Curtis Ordination verifies this community breakdown.

There is evidence that this reserve should be classified wholly in the Ponderosa Pine - Bunchgrass Zone.

Four communities are also defined in Tranquille. On the flat valley bottom there occurs an essentially treeless Artemisia tridentata/Poa sandbergii/Stipa comata community. The relatively extensive shrub layer is dominated by Artemisia tridentata and Poa sandbergii and Stipa comata are codominants in the herb layer. This community is probably overgrazed.

On the lower rolling slopes of the reserve is found the Pinus ponderosa/Agropyron spicatum community. This community is dominated by Pinus ponderosa in the canopy and Agropyron spicatum in the herb layer. The shrub layer is composed of Chrysothamnus nauseosus and Artemisia tridentata.

Interspersed in the Pinus/Agropyron community is the Pinus ponderosa/Aristida longiseta community in which Aristida longiseta becomes abundant in the herb layer. There is also a slight change in associate species.

Above about 760 meters, Pseudotsuga menziesii becomes dominant or codominant in the canopy. In this community, the Pseudotsuga menziesii/Pinus ponderosa/Agropyron spicatum

community, Agropyron spicatum is still dominant in the herb layer but the individual bunches are smaller and more widely spaced. Many of the associate species of the Pinus/Agropyron community are not present in this community.

In the Bray-Curtis Ordination the Pinus/Aristida community plots do not separate well from the Pinus/Agropyron community plots. Otherwise the ordination supports the community breakdown.

This reserve should be classified in both the Ponderosa Pine - Bunchgrass Zone and the Interior Douglas Fir Zone.

A comparison of reserves is presented.

The soils of the Trout Creek reserve are in the Brunisolic Order. The soils of the Tranquille Reserve are in the Regosolic and Chernozemic Orders.

RECOMMENDATIONS

Although both reserves fall in the same biogeoclimatic zones, I feel they are different enough to warrant their retention as two distinct Ecological Reserves. The Trout Creek Reserve was meant to represent the typical Interior vegetation and Tranquille was meant to represent a zone at its northern limits (Krajina et al. 1974).

Each reserve has a community dominated by Pinus ponderosa and Agropyron spicatum. However, as was pointed out earlier these communities do not have an identical species composition. Relative abundances of the species that are shared by the two communities differ also. Each reserve has, in addition, three other communities not present in the other reserve.

Another relevant difference between the two reserves which has not been discussed to this point is the relative amount of human disturbance. The Trout Creek Reserve is very near human habitation. It is very accessible, being within easy walking distance of houses and orchards. Also there are roads traversing the reserve (Figure 4). It is being used extensively for recreational purposes, as the many motor vehicle tracks and trails, empty bottles and shotgun shells indicate.

Even between 1974 and 1975 there was a noticeable increase in evidence of human disturbance of the area.

It is my feeling that the reserve is in grave danger of being destroyed. I recommend that this area be at least well signed and fenced very soon. Even this might not have the desired effect, as there already is an obviously ignored fence several hundred meters from the eastern edge of the reserve. Regulation and enforcement might be necessary.

Tranquille is in no such danger. The reserve itself is not easily accessible and the nearest habitation is not a tourist town like Summerland, but a special school for the mentally retarded.

The major part of the reserve is much steeper and therefore less accessible than Trout Creek, and there is no road running through it. Aside from the area immediately beside the road that forms one side of the reserve (Figure 10), there is virtually no evidence of recent human disturbance in the reserve. Therefore I recommend that this reserve be lower priority for fencing.

LITERATURE CITED

Annual Meteorological Summary for Kamloops, British Columbia. 1974. Atmospheric Environment Service Department of the Environment. Government of British Columbia.

Beil, C. E. 1974. Forest associations of the southern Cariboo zone, British Columbia. Syesis 7: 201-233.

Bray, J. R. and Curtis, J. T. 1957. An ordination of the upland forest communities of southern Wisconsin. Ecological Monographs 27: 325-49.

Brayshaw, T. C. 1955. An ecological classification of the ponderosa pine stands in the southwestern interior of British Columbia. PhD. Thesis, University of British Columbia.

Brayshaw, T. C. 1965. The dry forest of southern British Columbia. Ecology of Western North America. 1: 65-75.

Brayshaw, T. C. 1970. The dry forests of southern British Columbia. Syesis 3: 17-43.

Brink, V. C. and Farstad, L. 1949. The physiography of the agricultural areas of British Columbia. Scientific Agriculture. 29: 273-301.

Chapman, F. M. 1974. Weather observations for 1974: Summaries and averages for 59 years of continuous recording. Agriculture Canada Research Station, Summerland, British Columbia.

Cochran, P. H. and Berntsen, C. M. 1973. Tolerance of lodgepole and ponderosa pine seedlings to low night temperatures. Forest Science 19(4): 272-280.

Cooper, C. F. 1960. Changes in vegetation, structure and growth of southwestern pine forests since white settlement. Ecological Monographs 30: 129-164.

Cooper, C. F. 1961. Pattern in ponderosa pine forests. Ecology 42: 493-499.

Daubenmire, R. 1968. Plant Communities. A textbook of Plant Synecology. Harper and Row Publishers, New York.

Daubenmire, R. 1970. Steppe vegetation of Washington. Washington Agricultural Experimental Station, Technical Bulletin. 62 131p.

Daubenmire, R. F. and Daubenmire, J. B. 1968. Forest vegetation of eastern Washington and northern Idaho. Washington Agricultural Experimental Station, Technical Bulletin. 60 104p.

Franklin, J. F. and Dyrness, C. T. 1973. Natural vegetation of Oregon and Washington. United States Department of Agriculture Forest Service. General Technical Report. PNW-8 417pp.

Gauch, H. G., Jr. 1973. A quantitative evaluation of the Bray-Curtis techniques. Ecology 53: 868-875.

Halvorson, W. L. 1972. Environmental influence on the pattern of plant communities along the north rim of Grand Canyon. American Midland Naturalist. 87: 222-235.

Harris, E. A. and Lavkulich, L. M. 1972. Analytical Methods used in Pedology Laboratory. Department or Soil Science, University of British Columbia.

Hitchcock, L. C., Cronquist, A., Ownbey, M. and Thompson, J. W. 1969. Vascular Plants of the Pacific Northwest. University of Washington Press. Seattle. 5 volumes.

Holland, S. S. 1964. Landforms of British Columbia: A Physiographic Outline. British Columbia Department of Mines and Petroleum Resources. Bulletin No. 48. 138pp.

Krajina, V. J. 1965. Biogeoclimatic zones and biogeocoenoses of British Columbia. Ecology of Western North America. 1: 1-17.

Krajina, V. J. 1969. Ecology of forest trees in British Columbia. Ecology of Western North America. 2(1).

Krajina, V. J., Larkin, P. A., Foster, J. B. and Pearson, D. F. 1974. Ecological Reserves in British Columbia. Canadian committee for the International Biological Programme, conservation of Terrestrial communities subcommittee. Region 1. British Columbia, Vancouver, Canada. 185pp.

Larson, M. M. and Schubert, G. H. 1969. Root competition between ponderosa pine seedlings and grass. United States Forest Service Research Paper. R.M. 54: 1-12.

Lawton, E. 1971. Moss Flora of the Pacific Northwest. The Hattori Botanical Laboratory, Japan.

McLean, A. 1970. Plant communities of the Similkameen Valley, British Columbia and their relationships to soils. Ecological Monographs 40: 403-424.

McLean, A. and Tisdale, E. W. 1972. Recovery rate of depleted range sites under protection from grazing. Journal of Range Management. 25(3): 178-184.

Merkle, J. 1962. Plant communities of the Grand Canyon area, Arizona. Ecology 43: 698-711.

Shimwell, D. W. 1971. The Description and Classification of Vegetation. University of Washington Press, Seattle.

Spilsbury, R. H. and Tisdale, E. W. 1944. Soil-plant relationships and vertical zonation in the southern interior of British Columbia. Scientific Agriculture 24: 395-436.

Thilenius, J. F. 1972. Classification of deer habitat in the ponderosa pine forest of the Black Hills, South Dakota. United States Department of Agriculture Forest Service Research Paper. R.M. 91 28pp.

Tisdale, E. W. 1947. The grasslands of the southern interior of British Columbia. Ecology 28: 346-382.

Tisdale, E. W., and McLean, A. 1957. The Douglas fir zone of southern British Columbia. Ecological Monographs 27: 247-266.

Weaver, H. 1959. Ecological changes in the ponderosa pine forest of the Warm Springs Indian Reservation in Oregon. Journal of Forestry 57: 15-20

Weaver, H. 1961. Ecological changes in the ponderosa pine forest of Cedar Valley in southern Washington. Ecology 42: 416-420.

Whittaker, R. H. and Niering, W. A. 1965. Vegetation of the Santa Catalina Mountains, Arizona: A gradient analysis of the south slope. Ecology 46: 429-452.