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Soap Lake ER.

BASELINE BOTANICAL SURVEY OF CATTLE ENCLOSURES<sup>x</sup>

SOAP LAKE ECOLOGICAL RESERVE No. 3

1991

Ministry Control No. CGKPRS 06

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## BASELINE BOTANICAL SURVEY OF CATTLE ENCLOSURES

### SOAP LAKE ECOLOGICAL RESERVE, No. 3

1991

#### 1.0 INTRODUCTION

For the 20 years since Soap Lake Ecological Reserve has been in existence and for an unknown number of years prior to that, cattle have been able to range throughout without hindrance thereby introducing an artificial element undesirable in an ecological reserve. Late in 1990 five enclosures were constructed covering examples of diverse vegetation composition with the object of excluding livestock and allowing natural processes to operate unimpeded by outside influences.

The present service contract calls for an unspecified number of permanent plots to be put in place within these enclosures and for the provision of data for comparison with findings from future periodic examinations.

#### 2.0 BACKGROUND

2.1 PURPOSE Purpose of this reserve is stated as being "To conserve an alkaline lake, its associated flora and representative ecosystems of the Interior Douglas-fir Zone" (Anon. 1989). Most of the land area carries forest mapped under the Biogeoclimatic Ecosystem Classification System as Thompson Dry Cool Interior Douglas-fir variant (Lloyd 1990), however, areas where the enclosures have been established are, in the main, open and more akin to the grassland phase of this variant which normally occurs

at lower elevations. Edaphic factors may therefore be responsible for limiting tree growth, and periodic fires for helping maintain this condition.

**2.2 STRUCTURE** Along its western border the Thompson Plateau has been uplifted by, and against, the Cascade Mountains and their northern extension - the Clear Range - so that on the basis of height a distinction between the two is obscure (Holland 1964). With uplift came vigorous erosion and from the Soap Lake area steep slopes now plunge abruptly to the Thompson River on the west and Nicola River on the east.

Structural features probably control the configuration of the prominent valley running across the reserve, causing that part of it containing Soap Lake to be aligned from SW to NE and its continuation to swing at a right angle so as to lie NW to SE. Gravelly deposits that may be from old strand lines indicate a very much higher water level at one time that would have resulted in one continuous lake before lesser inflow and increased evaporation reduced it to its present size and split off the two residual pools to the east.

**2.3 GEOLOGY** Lower Cretaceous volcanics underlie the whole reserve, divided into roughly equal parts by an assumed diagonal fault so that Kingsvale Group rocks are to the south and west (basalt and intercalated volcanic clastics), and Spences Bridge Group to the north and east (andesite, dacite, rhyolite, intercalated volcanic clastics, sandstone and shale) (Duffel and McTaggart (1952) and Monger (1980-82)). This division, and the line of the eastern portion of the valley mentioned above, follow the trace of the assumed fault.

**2.4 SALINES** Although the underlying rocks tend more to neutral than to high alkalinity, it has been leaching of them by surface and subsurface flow and concentration in undrained basins during hot summer months over a prolonged period that

has produced the salines noted at Soap Lake and elsewhere. In 1926 a sample of water from a depth of just under 1m in the main lake was reported to run 81% sodium carbonate, 10% sodium bicarbonate with minor amounts of sodium chloride, sodium sulphate and magnesium chloride. Further examination found no underlying bedded evaporites and commercial exploitation was never attempted.

**2.5 CLIMATE** Playing a greater part than geology in influencing vegetation on Reserve #3 is climate which in the rain-shadow east of the Coast Range is one of pronounced aridity. Ashcroft, 38km due north and 300m lower, reports a long-term average precipitation in the order of 180 to 200mm annually. Closer to the foot of the mountains, Lytton, 25km SW, receives slightly more than twice this much and Soap Lake, between them and somewhat higher, could be expected to be intermediate in total precipitation. As with most southern interior locations December is the peak month with a secondary peak of convective rain in June.

Nearest temperature reporting station is Lytton, some 800m lower in elevation, where the long-term mean daily figure of 10.2°C probably overstates Soap Lake's by around 3 or 4°. Extreme figures at this station have ranged to more than 44°C in summer and occasional periods in winter in the -30 to -35°C range, although zero is a more average level.

### **3.0 METHOD**

Each of the five enclosures was examined in turn to establish the reason for its having been erected at its present location, followed by a second examination to decide what data of value might be obtained from test plots within it. Each area was traversed again to locate where this information might best be obtained bearing in mind that plots in most cases should be representative of the whole, unless reasons arise for

presenting non-average sites for specific purposes.

In several instances plots within an enclosure were paired with similar plots outside unprotected from cattle in order to produce a "before and after" comparison. These should become increasingly valuable with time. An exact parallel in each of these pairs would be preferable though perhaps an ideal never obtainable exactly. Subsequent sampling did in fact show slight variations: it also indicated that the sampling process has a useful degree of sensitivity in its ability to reflect these variations.

Plots were usually located for convenience close to an edge, leaving a distance of one metre to prevent results being affected by disturbance due to fence construction, or cattle passage along its line. Exceptions to this practice were Enclosures 1 and 2 where plots were positioned well within their boundaries. Plot size was varied according to vegetation composition. Thus under homogeneous shrubby conditions sides of 10m were used to include sufficient individuals, whereas on the bank of the fresh water pond in Enclosure 1 where vegetation changes occur over a relatively short distance, the plots are 2m square.

Relative coverage of species recorded within each plot was estimated using a Braun-Blanquet scale of abundance wherein -

r = rare, 1 or 2 individuals

+ = few, less than 1% cover

1 = 1% to 5%

2 = 5 to 25%

3 = 25% to 50%

4 = 50% to 75%

5 = 75% to 100%

Additionally, an indication of distributional pattern was obtained by using the code suggested in "Describing Ecosystems in the Field" (MOE Manual #11). Actual counts of individuals along transect lines was not undertaken. Note was made of other species not within a plot but still inside an enclosure, and to a lesser extent this was also carried out during limited examinations elsewhere on the reserve.

A collection of voucher specimens of vascular plants has been deposited with Royal British Columbia Museum and of mosses and lichens forming part of the ground cover inside plots with UBC.

Appendix 1 gives a map showing general location of enclosures in Reserve #3. Appendix 2 contains sketches of plot location within each enclosure along with broad vegetation type, and Appendix 3 presents photographs showing visual appearance of vegetation in 1991.

Most of the survey was carried out in mid-July with a follow-up visit in August. From the point of view of comprehensiveness it would have been better structured to have commenced early in June or even the end of May. Undoubtedly a number of ephemeral annual or early perennials have fallen through the time gap as a result, though an attempt has been made to minimize this by identification from fruit or vegetative shoots where available, unless this could not be done with conviction.

#### 4.0 ENCLOSURE 1

Above Soap Lake to the north is a small flat carrying two ponds. Although drainage from higher ground to the north-west of the reserve trends this way, no obvious inlet is visible; a damp swale leads off to the east and has probably served as an overflow outlet in the past. It may be that the rocky ridge between these ponds and Soap Lake interrupts sub-surface flow and brings the water table closer to the surface allowing spring run-off to accumulate. In the month from mid-July to mid-August water level dropped around 15cm, probably less than evaporation would have removed. It is said that in some years little standing water remains by late in the season.

Chemical composition must be far less alkaline than in the case of Soap Lake itself although some efflorescence of evaporated salts is evident on exposed soil nearby. Visually the influence of moisture around the ponds is very noticeable with

a sharp dividing line between dry sagebrush/scattered grass and continuous green grass sod where the benefit of dampness is felt. Shelter provided by fringing bushy growth, lush grazing and the availability of water makes this a popular and well used livestock area; excluding them from part of the eastern pond will make it possible to gauge their influence.

Ostensibly a few month's protection from cattle had already induced a big effect producing lush upstanding growth on one side of the line and trampled, cropped vegetation on the other (fig. 1), but it is highly unlikely that composition and abundance has altered in so short a time and what is seen is due to lack of disturbance to vigorous annual growth from rhizomateous plants that is occurring on both sides of the fence line rather than any fundamental change.

To examine the annular distribution of plants around the pond a series of three contiguous plots was selected running down the bank, with a fourth separate plot to treat floating and emergent species. No comparison outside the enclosure was attempted as continuous grazing and trampling makes sampling and identification questionable. Dry surrounding upland vegetation corresponds to that found in other enclosures established specifically to treat that type of ecosystem and only moisture dependent communities are dealt with in Enclosure 1.

#### 4.1 PLOT 1/1 (figs. 2 and 3)

Upper part of bank...Poa pratensis-Aster ericoides association

Trees 0%    Shrubs 0%    Herbs 100%    Moss 10%

	abundance distribution	
Poa pratensis	5	9
Aster ericoides	2	5
Juncus balticus	1	7
Juncus bufonius	1	7



Erigeron lonchophyllus	1	5
Taraxacum officinale	1	4
Potentilla gracilis	1	5
Carex praegracilis	1	5
Hordeum jubatum	+	2
Astragalus tenellus	+	4
Sisyrinchium sp.	+	4
Brassicaceae sp.(?Rorippa sp.)	+	4
Agrostis stolonifera	r	2
Campyllum polygamum	10%	

4.2 PLOT 1/2 (figs. 2 and 3)

Lower bank.....Poa pratensis-Juncus balticus association

Trees 0%	Shrubs 0%	Herbs 95%	Moss 20%
Poa pratensis		4	8
Juncus balticus		2	6
Juncus bufonius		2	6
Plantago major		2	6
Taraxacum officinale		1	4
Potentilla gracilis		1	5
Aster ericoides		+	2
Carex praegracilis		+	4
Hordeum jubatum		+	2
Eleocharis palustris		+	2
Mentha arvensis		r	2
Alisma plantago-aquatica		r	2
Brassicaceae sp. (?Rorippa sp.)		r	1
Triglochin maritimum		r	1
Campyllum polygamum		20%	

4.3 PLOT 1/3 (figs. 2 and 3)

Pond edge.....Eleocharis palustris-Juncus balticus assoc.

Trees 0%	Shrubs 0%	Herbs 80%	Moss 25%
Eleocharis palustris		3	8
Juncus balticus		2	6
Mentha arvensis		2	3
Alisma plantago-aquatica		1	4
Ranunculus cymbalaria		+	3
Taraxacum officinale		r	2
Hordeum jubatum		r	2
Campyllum polygamum (damp soil)			
Leptodictyum riparium (aquatic and stranded)			

#### 4.4 PLOT 1/4 (figs. 4 and 5)

Standing water...Ranunculus aquatilis-Polygonum amphibium  
association

Ranunculus aquatilis	2	8
Polygonum amphibium	1	6
Eleocharis palustris	1	7
Alopecurus aequalis	1	5
Mentha arvensis	1	5
Juncus balticus	+	5
Beckmannia syzigachne	+	5
Alisma plantago-aquatica	+	5
Rumex maritimum	r	1

The two corner posts for this plot were placed on shore at the edge of water at mid-July. Depth at the far boundary at this time was approximately 0.5m. By mid-August water level was lower by about 20cm and the corner posts well out of the water.

4.5 Plots selected to express typical conditions cannot also be comprehensive. Minor responses to localised conditions exist that include species not listed above, for example, a small saline area occurs on the bank with a few plants of Suaeda calceoliformis surrounded by Puccinellia nuttelliana; elsewhere Hordeum jubatum forms a limited but dense stand. Other species recorded within the moist part of this enclosure but not present on any of the plots are included in Section 10 - Vascular Plant Species List.

#### 5.0 ENCLOSURE 2

This elongate block covers part of a sinuous shallow swale running down from higher ground to the north-west. At times of greater precipitation its load must have flowed with erosive power, far different from the present spring run-off which is insufficient to disturb its completely grass-covered bed. Open forest of fir and pine extends down the shaded slope into an intermittent fringe of shrubs at its base. Without interference from the presence of livestock it will be possible to monitor to what extent shrub coverage will take over the gully floor and

provide protection for the establishment of tree seedlings.

The damper environment within the gully and continuous grass and herb cover is attractive to cattle resulting in its being grazed close to the ground and rendering a comparison plot outside the enclosure not sufficiently enlightening. Two internal plots have been selected, one to cover the dampest part of the swale, the other in an exposed, unshaded position in order to provide variation of conditions.

#### 5.1 PLOT 2/1 (Figs. 6 and 7)

A small amount of water was standing in ground irregularities and hoof prints in mid-July and was the only water at surface seen anywhere in the swale at that time. Because of the narrow floor at this point, Plot 2/1 has dimensions of 10m long by only 1m wide.

Damp swale floor...Poa pratensis-Taraxacum officinale assoc.

Trees 0%	Shrubs 2%	Herbs 95%	Moss 10%
	Symphoricarpos albus		2 plants
	Rosa acicularis		1 plant
	Poa pratensis	5	8
	Taraxacum officinale	3	8
	Juncus balticus	2	6
	Ranunculus cymbalaria	2	4
	Hordeum jubatum	1	5
	Carex praegracilis	1	2
	Potentilla gracilis	1	4
	Achillea millefolium	1	5
	Agropyron pauciflorum	1	2
	Viola sp.	+	4
	Poa compressa	+	2
	Epilobium sp.	+	2
	Deschampsia elongata	+	2
	Plantago major	+	2
	Elymus glaucus	r	1
	Taraxacum laevigatum	r	1
	Vicia americana	r	1
	Phleum pratense	r	1
	Amblystegium sp.		

## 5.2 PLOT 2/2 (figs. 8 and 9)

Near the western end of this enclosure the gully broadens and is less closely invested by trees. Dampness is not so obvious although rush is still present, and greater light encourages a slightly different vegetation mix more akin to mesic grassland. Adjoining to the west is a mass of shrubby growth (*Rosa* and *Symphoricarpos*) which, as in the other plot has the potential to increase in size now freed from cattle disturbance.

Drier swale floor... Poa pratensis-Lotus denticulatus assoc.

Trees 0%	Shrubs 5%	Herbs 95%	Moss 5%
	<i>Symphoricarpos albus</i>	1	4
	<i>Rosa acicularis</i>	r	1
	<i>Poa pratensis</i>	4	9
	<i>Lotus denticulatus</i>	2	8
	<i>Taraxacum officinale</i>	2	7
	<i>Potentilla gracilis</i>	2	4
	<i>Juncus balticus</i>	1	6
	<i>Achillea millefolium</i>	1	2
	<i>Agropyron pauciflorum</i>	1	5
	<i>Carex preagracilis</i>	1	4
	<i>Geranium viscosissimum</i>	+	2
	<i>Galium boreale</i>	+	2
	<i>Plantago major</i>	+	2
	<i>Juncus longistylis</i>	+	2
	<i>Zygadenus venenosus</i>	r	1
	<i>Tragopogon dubius</i>	r	1
	<i>Campylium chrysophyllum</i>		

## 6.0 ENCLOSURE 3

On the same bench but away from the pond of Enclosure 1 sagebrush reaches an impressive size with some individuals at least 2½m high. Whether this area receives encouragement from underlying dampness or whether it is more a reflection of the time since having last been burned is not clear although the presence of several conifer saplings weighs more towards the

latter. On the other hand a much more varied group of associated herbs than in the shorter sagebrush area of Enclosure 5 argues the other way. If larger sized and denser shrub growth becomes a deterrent to cattle, this may have had the effect of reducing grazing pressure to an extent beneficial to herbaceous diversity.

Towards the east and south sides less sagebrush coverage allows for grassy openings that provide some variation. Plot 3/1 is placed within the tall sagebrush and 3/3 within the grassy phase, paired with Plots 3/2 and 3/4 on comparable terrain outside the enclosure.

An old, low rock cairn and metal survey pin is present in Enclosure 3.

#### 6.1 PLOT 3/1 (figs. 10 and 11)

Tall sage (inside)...Artemisia tridentata-Poa pratensis assoc.

Trees 0%    Shrubs 50%    Herbs 80%    Moss/lichen 15%

Artemisia tridentata	4	8
Poa pratensis	4	9
Achillea millefolium	2	6
Antennaria microphylla	1	5
Erigeron divergens	1	5
Geranium viscosissimum	1	4
Vicia americana	1	5
Lithospermum ruderale	1	4
Poa sandbergii	1	5
Agropyron spicatum	1	6
Gaillardia aristata	+	4
Stipa occidentalis	+	4
Delphinium nuttallianum	+	4
Astragalus tenellus	+	4
Aster campestris	+	4
Oxytropis sp. (?o. monticola)	+	3
Penstemon confertus	+	3
Poa compressa	+	3
Silene menziesii	+	3
(Caryophyllaceae sp.)	+	3
Koeleria macranthum	+	2
Allium cernuum	+	2
Potentilla arguta	+	2
Astragalus miser	+	2
Taraxacum officinale	+	2

Balsamorhiza sagittata	r	1
Microseris nutans	r	1
Calochortus macrocarpus	r	1
? Collinsia parviflora (remains)		

Brachythecium albicans  
Tortula ruralis  
Peltigera rufescens  
Cladonia fimbriata  
Bryum sp. (?B. caespiticium)

6.2 PLOT 3/2 (figs. 12 and 13)

Tall sage (outside)...Artemisia tridentata-Poa pratensis assoc.

Trees 0% Shrubs 50% Herbs 80% Moss/lichen 20%

Artemisia tridentata	4	8
Poa pratensis	2	7
Achillea millefolium	2	6
Astragalus miser	2	7
Balsamorhiza sagittata	2	4
Antennaria microphylla	1	5
Koeleria macranthum	+	4
Bromus tectorum	+	5
Erigeron divergens	+	5
Agropyron spicatum	+	4
Taraxacum officinale	+	4
Lithospermum ruderales	+	2
Eriogonum heracleoides	+	2
Poa sandbergii	r	2
Lomatium sp.	r	2
Arabis sp. (?A. holboelii)	r	1
Polygonum douglasii	r	1
Microseris nutans	r	1

Tortula ruralis  
Brachythecium albicans  
Bryum sp. (?B. caespiticium)

6.3 PLOT 3/3 (fig. 14)

Open grass (inside)...Poa pratensis-Artemisia tridentata  
association

Trees 0%    Shrubs 30%    Herbs 85%    Moss/Lichen unmeasured

Artemisia tridentata	3	3
Poa pratensis	5	8
Achillea millefolium	1	7
Poa sandbergii	1	7
Antennaria microphylla	1	4
Koeleria macranthum	1	4
Juncus balticus	1	7
Lomatium sp.	1	4
Astragalus miser	1	4
Aster campestris	1	4
Penstemon confertus	1	4
Taraxacum officinale	+	2
Agropyron spicatum	+	2
Delphinium nuttellianum	+	2
Polygonum douglasii	+	2
Geranium viscosissimum	r	2
Potentilla gracilis	r	2
Tragopogon dubius	r	2
Gaillardia aristata	r	2
Astragalus tenellus	r	1

#### 6.4 PLOT 3/4 (fig. 15)

Open grass (outside)... Poa pratensis-Artemisia tridentata association

Trees 0%    Shrubs 25%    Herbs 80%    Moss/Lichen unmeasured

Artemisia tridentata	2	4
Poaceae (grazed)-incl.		
P.pratensis		
P.sandbergii		
K.macranthum	5	8
Achillea millefolium	1	7
Antennaria microphylla	1	6
Juncus balticus	+	7
Aster campestris	+	4
Astragalus sp.	+	4
Potentilla arguta	r	2
Taraxacum officinale	r	2
Allium cernuum	r	1

## 7.0 ENCLOSURE 4

The only regular and continuous inflow into Soap Lake is provided by a small stream springing from the hillside near its north-east end. Where this reaches the valley floor (part of the former lake basin) lush growth results before the meandering stream loses itself by percolation into the silt. As the briny lake water appears not to be used by animals, this sweet water source is a great attraction to cattle and the irregular, hummocky nature of those parts carrying grass and Scirpus is probably due to their constant trampling rather than to any inherent clumping of the vegetation.

Visually the area included in Enclosure 4 provides a very impressive sight of rich greenery compared with the largely sterile and chemically whitened silts on each side (fig 16 is a general overall view from the north). It would be wrong, however, to suppose that this is wholly the result of cattle exclusion as practically all of the well-vegetated area was included within the wire and the remainder outside is too far from the water source ever to have been similarly endowed.

Banding by vegetation at progressively greater distances from the water is very noticeable and the sketch in Appendix 2 attempts to give a rough approximation. Only those communities close to the stream show much diversity, the remainder largely being homogeneous with one or two species only. It is unlikely that exclusion of cattle will alter that fact consequently there is little practical purpose in having plots in each band. Instead Plot 4/1 was established on mostly bare silt to gauge colonization by vegetation undisturbed by trampling, and Plot 4/2 near the stream inlet where diversity is higher and cattle use must have been extreme.



7.1 BANDING See also Appendix 2.

Band 1-Distichlis A small section at the north corner slopes up from the silt flats. Its gravelly character suggests a former beach deposit although the saline preference of Distichlis and the few Sueda show that lake chemistry is still having an effect. Sharp drainage gives scope to only a few ephemeral early season species, some of which may have already disappeared by the time of visit.

<u>Distichlis stricta</u>	<u>Lepidium virginicum</u>
<u>Sueda depressa</u>	<u>Descurania sp. (?D.pinnata)</u>
<u>Lappula sp.</u>	<u>Poa sandbergii</u>

Band 2-Sueda Below the gravelly area the surface is composed of light coloured silt which here carries only Sueda depressa.

Band 3-Unvegetated Either due to hoof-traffic or instability of surface caused by sheet flow after precipitation and snow melt, this band is practically bare. Plot 4/1 is situated near the south-east corner where sparse Puccinellia and Sueda already dot the surface, to see whether lack of disturbance allows them to spread.

Band 4 Puccinellia With increasing moisture P.nuttelliana has established to the virtual exclusion of all else.

Band 5-Puccinellia-Scirpus-Eleocharis Where water is abundant enough to stand or flow at the surface additional wetland species appear. This area is the most extensive.

<u>Puccinellia nuttalliana</u>	<u>Juncus balticus</u>
<u>Scirpus americanus</u>	<u>Puccinellia distans</u>
<u>Eleocharis palustris</u>	<u>Carex praegracilis (on hummocks)</u>

Band 6-Riparial Greatest diversity occurs along the inlet stream before its waters are greatly affected by saline evaporites in the silt. Plot 4/2 is situated in this band and a full species list appears under 7.3.

Band 7-Damp upland This category corresponds to Band 1 but is on the shady, north-facing side of the valley and closer to the water source. Good drainage leaves it dry under-foot but these other factors permit good vegetation cover. Shrub seedlings from adjoining woodland may spread into this band and already one of willow and birch can be found.

<u>Hordeum jubatum</u>	<u>Carex praegracilis</u>
<u>Poa sp.</u>	<u>Trifolium repens</u>
<u>Potentilla anserina</u>	<u>Potentilla gracilis</u>
<u>Polygonum aviculare</u>	

7.2 PLOT 4/1 (figs. 17,18 and 19)

Silt colonization...Sueda depressa-Puccinellia nuttallianum  
association

Trees 0%	Shrubs 0%	Herbs 40%	Moss 0%
		Sueda depressa	1 4
		Puccinellia nuttallianum+	4
		Scirpus americanus	+ 3
		Hordeum jubatum	r 1

7.3 PLOT 4/2 (figs. 20 and 21)

Diffuse stream...Juncus bufonius-Ranunculus sceleratus assoc.

Trees 0%	Shrubs 0%	Herbs 95%	Moss 0%
		Juncus bufonius	3 8
		Ranunculus sceleratus	3 8
		Glyceria striata	2 6
		Alopecurus aequalis	2 6
		Puccinellia nuttallianum1	4
		Hordeum jubatum	1 5
		Poa palustris	1 4
		Veronica americana	1 4
		Beckmannia syzigachne	1 4
		Equisetum arvense	+ 2
		Taraxacum officinale	+ 2
		Mentha arvensis	+ 2
		Epilobium sp.(?E.glaberrimum)+	2
		Plantago major	+ 2
		Achillea millefolium	r 1
		Trifolium repens	r 1

Most of the species in the last two categories of abundance above are dependent on hummocks to raise them above water surface. Without cattle hooves to continue earth sculpting it may be that irregularities will gradually even out and these species will face elimination.

## 8.0 ENCLOSURE 5

This area near the eastern reserve boundary provides an interesting comparison with Enclosure 3. Both are essentially sagebrush-grassland communities, both are close to a fresh-water pond and therefore well used by cattle, yet the previously described unit (see 6.0) with its tall shrub growth and well-furnished forb associates gives an appearance of prosperity compared with the short height of shrubs and generally degraded look of Enclosure 5 and surroundings.

This is rather surprising in that the location is around 70m lower and is in an open amphitheatre setting which could be expected as a positive influence on moisture; also aspect is towards the north-east reducing the effect of direct insolation. As most wet weather approaches from the west and south-west there could be some shadowing effect on the east and down-dip side of the reserve. Another difference, though one that can not be evaluated, is the fact that Enclosure 5 is underlain by Spences Bridge Group rocks and Enclosure 3 by Kingsvale Group or the fault line between them.

Fire history of Soap Lake Reserve is not known. It could be that a more recent burn around Enclosure 5 accounts for the shorter sagebrush and appearance of relative impoverishment though perhaps this is more apparent than real as bushes fully 2m high can be found by search scattered in the general area outside the wire.

More persuasive is the greater frequency of Western needle-and-thread grass (Stipa occidentalis) - an increaser under intense grazing - and Sandberg's bluegrass (Poa sandbergii) versus Kentucky bluegrass (Poa pratensis). Similarly, Dwarf pussytoes (Antennaria dimorpha) is a sign of stress (it was not present at all in Enclosure 3) and Pursh's locoweed (Astragalus purshii) one of dryness. Future changes in these ratios should be watched. Despite all these negatives this enclosure still has an extensive though sparsely distributed inventory of forbs

(not necessarily within the plots) which would act as a seminal pool to provide potential for increase under undisturbed conditions.

A few scattered pine and fir saplings have established themselves as a first stage of the diffuse savanna that can be seen on neighbouring hills.

### 8.1 PLOT 5/1 (figs. 22 and 23)

Short sagebrush (inside)...Artemisia tridentata-Achillea millefolium assoc.  
 Trees 0%    Shrubs 60%    Herbs 85%    Moss/Lichen 15%

Artemisia tridentata	4	8
Artemisia frigida	+	2
Achillea millefolium	2	8
Stipa occidentalis	1	7
Poa pratensis	1	4
Poa sandbergii	1	4
Antennaria microphylla	1	5
Lithospermum ruderales	1	4
Erigeron corymbosum	1	4
Oxytropis sp. (?O. monticola)	1	4
Arabis holboellii	+	5
Antennaria dimorpha	+	4
Astragalus miser	+	4
Lomatium sp.	+	4
Koeleria macranthum	+	2
Fritillaria pudica	+	2
Astragalus purshii	+	2
Astragalus tenellus	+	2
Erigeron compositus	+	2
Eriogonum heracleoides	r	1
Tragopogon dubius	r	1
Erysimum inconspicuum	r	1

Species noticeably missing from the Plot 3/1 list are Sticky geranium, American vetch, Field aster, White cinquefoil and Yellow penstemon, whereas the present Plot 5/1 contains Pursh's locoweed, Cut-leaved fleabane and Yellow bells not present in the other, all characteristic of thin soil and dry conditions. The moss/lichen layer percentage cover may on first sight appear high as a minute Bryum species on soil is not obvious except after rain and can be easily overlooked. This may be true also of the other similar plots - 5/2 and

those of Enclosure 3.

## 8.2 PLOT 5/2 (fig. 24)

Short sagebrush (outside)...Artemisia tridentata-Achillea millefolium assoc.

Trees 0%    Shrubs 45%    Herbs 80%    Moss/Lichen 10%

Artemisia tridentata	3	7
Rosa sp.	r	2
Artemisia frigida	r	1
Chrysothamnus nauseosus	r	1
Achillea millefolium	2	7
Poa pratensis	1	5
Antennaria microphylla	1	6
Antennaria dimorpha	1	5
Lithospermum ruderales	+	4
Arabis holboellii	+	4
Oxytropis sp. (?O. monticola)+		4
Astragalus miser	+	4
Stipa occidentalis	+	4
Poa sandbergii	+	4
Lomatium sp.	+	4
Erigeron compositus	+	2
Koeleria macranthum	+	2
Linum perenne	r	2
Erysimum incospicuum	r	2
Gaillardia aristata	r	2
Erigeron corymbosus	r	1

## 9.0 FORESTED AREAS

None of the enclosures was located to include forest, neither was this survey required to investigate these areas, however, as in gross distribution tree covered slopes make up the greater part of Soap Lake Reserve a few observations are in order for completeness.

Much of the forested area is of an open nature and, except where Pinegrass (Calamagrostis rubescens) predominates, carries

sufficient grazing to interest domestic livestock. Cattle and reserve observers tend to follow the same routes of easiest access so a slanted view of actual cattle use is not difficult to acquire. It is doubtful that either spend unnecessary time on steeper and denser slopes.

According to Lloyd (1990) most of the reserve falls into the IDF dk1 variant in which Douglas-fir predominates with some small admixture of Lodgepole pine where precipitation is higher, as for instance along the west boundary. Understory would include Common juniper, Birch-leaved spirea and Soopalallie, while herb species other than those already encountered within enclosures include Racemose pussytoes, Showy aster, Heart-leaved arnica, Kinnikinnick and possibly Twinflower with Pine-grass making up much of the ground cover.

Where moisture is present Aspen and Douglas maple put in an appearance but the only really wet conditions are around the second pond near Enclosure 1 and here Black birch and Scouler's willow prevail. Some Red-osier dogwood and Saskatoon were noted above Enclosure 2.

The more arid eastern boundary area and well drained places where bedrock reaches the surface (for instance, the ridge between Enclosures 1 and 4) are closer to Lloyd's IDF xh2 wherein Ponderosa pine is an important constituent forming small pure stands in places. Elsewhere it provides scattered individuals in exposed dry sites. Beneath Ponderosa pine Round-leaved alumroot, Three-veined fleabane, Shrubby penstemon, Wallace's selaginella and the fern Oregon woodsia are likely to be found. Nodding onion is widely distributed and Arrow-leaved balsamroot more common here than in the open.

## 10.0 VASCULAR PLANT SPECIES LIST

Only those species actually seen during visits are included below. While this list covers most of what is present on the

Soap Lake Reserve it is not comprehensive because a number of early season ephemeral plants have been missed, and forest species assumed to inhabit the variants mapped in Lloyd (1990) are included only if they were found in brief excursions in to the forest.

After each taxon are one or more numbers to give some indication of location. These are tabulated as follows -

- 01 = Enclosure 1 (outside plots)
- 011 = Plot 1/1
- 012 = Plot 1/2
- 013 = Plot 1/3
- 014 = Plot 1/4
  
- 02 = Enclosure 2 (outside plots)
- 021 = Plot 2/1
- 022 = Plot 2/2
  
- 03 = Enclosure 3 (outside plots)
- 031 = Plot 3/1 (inside enclosure)
- 032 = Plot 3/2 (outside enclosure)
- 033 = Plot 3/3 (inside enclosure)
- 034 = Plot 3/4 (outside enclosure)
  
- 04 = Enclosure 4 (outside plots)
- 041 = Plot 4/1
- 042 = Plot 4/2
  
- 05 = Enclosure 5 (outside plots)
- 051 = Plot 5/1 (inside enclosure)
- 052 = Plot 5/2 (outside enclosure)
  
- 06 = Riparian (pond near Enclosure 1)
- 07 = Douglas-fir forest
- 08 = Ponderosa pine woodland and rock exposures
- 09 = Open slopes

Aspleniaceae  
   Woodsia oregana 08

Equisetaceae  
   Equisetum arvensis 042.07

Selaginellaceae  
   Selaginella wallaceii 08

Cupressaceae  
   Juniperus communis 07.07  
     " scopulorum 03

Pinaceae  
   Pinus ponderosa 02.05.07.09  
   Pseudotsuga menzesii 03.05.07

Aceraceae  
   Acer glabrum var. douglasii 07

Apiaceae  
   Lomatium dissectum 07  
     " macrocephalum 09     *macrocephalum?*  
     " sp. 032.033.051.052  
   Sium suave 01

Asteraceae  
   Achillea millefolium 021.022.031.032.033.042.051.052  
   Agoseris glauca 09  
   Antennaria dimorpha 051.052.09  
     " microphylla 031.032.033.034.051.052  
     " racemosa 07  
   Arnica cordifolia 07  
     " fulgens 09  
   Artemisia dracuncula 09  
     " frigida 051.052  
     " tridentata 031.032.033.034.051.052.09  
   Aster campestris 02.031.033.034  
     " conspicuus 02.07  
     " ericoides 011.012.04  
   Balsamorhiza sagittata 031.032.02  
   Centaurea diffusa road verge  
     " maculosa " "  
   Chrysothamnus nauseosus 052.09  
   Circium vulgare 07  
     " undulatum 09  
   Crepis cf. atrabarba 08.09  
   Erigeron compositus 051.052  
     " corymbosus 051.052.09  
     " divergens 031.032  
     " flagillaris 08  
     " linearis



Erigeron lonchophyllus 011.04  
     "      speciosus 03.09  
     "      subtrinervis 02.07.08  
 Filago arvensis 04  
 Gaillardia aristata 031.033.052  
 Hieracium albiflorum 07  
     "      umbellatum 07  
 Matricaria discoidea 09  
 Microseris nutans 031.032  
 Senecio canus 07  
 Solidago canadensis 02  
 Taraxacum laevigatum 021  
     "      officinale 011.012.013 021.022.031.032.033.034.042  
 Tragopogon dubius 022.033.051  
     "      pratensis 02.09

Betulaceae

Betula occidentalis 04.06.07

Boraginaceae

Lappula redowskii 04.09  
 Lithospermum ruderale 031.032.051.052

Brassicaceae

Arabis sp. (?A.holboelii) 032.051.052  
     "      sparsiflora 07  
 Camelina microcarpa 09  
 Capsella bursa-pastoris 09  
 Descurania sp. (?D.pinnata) 04.09  
 Erysimum inconspicuum 051.052.09  
 Lepidium virginicum 04  
 Brassicaceae sp (?Rorripa sp.) 011.012

Cactaceae

Opuntia fragilis 09

Caprifoliaceae

Symphoricarpos albus 021.022.07

Caryophyllaceae

Arenaria serpyllifolia 09  
 Cerastium arvense 07  
     "      fontanum 09  
 Moehringia lateriflora 07  
 Silene menziesii 031  
     "      parryi 031  
 Stellaria longipes 07

Chenopodiaceae

Atriplex truncata 09  
 Chenopodium fremontii 07  
     "      hybridum 07  
     "      leptophyllum 07  
 Eriogonum heracleum 032.051  
 Sueda calceoliformis 01.041(=S.depressa)

Cornaceae  
 Cornus sericeus 07

Crassulaceae  
 Sedum lanceolatum 09

Eleagnaceae  
 Shepherdia canadensis 07

Ericaceae  
 Arctostaphylos uva-ursi 07.09

Fabaceae  
 Astragalus agrestis 01  
 " miser 031.032.033.051  
 " purshii 051.052  
 " tenellus 011.031.033.051  
 " sp. 034  
 Lotus denticulatus 01.022.04  
 Medicago lupulina 01  
 Melilotus alba 09.road  
 Oxytropis sp. (?O.monticola) 031.051.052  
 Trifolium repens 04.042  
 Vicia americana 021.031.07

Gentianaceae  
 Gentianella amarella 07

Geraniaceae  
 Geranium viscosissimum 022.031.033

Grossulariaceae  
 Ribes cereum 09  
 " sp. (?R.inermis)  
 " lacustris 07

Hippuridaceae  
 Hippuris vulgaris 06

Hydrophyllaceae  
 Phacelia linearis 08

Lamiaceae  
 Mentha arvensis 012.013.042

Linaceae  
 Linum perenne 02.052.09

Onagraceae  
 Epilobium ciliata 01  
 " sp. (?E.glaberrimum) 042  
 " paniculata 09  
 " sp. 021

Plantaginaceae

Plantago major 012.021.022.042

Polygonaceae

Polygonum amphibium 014  
" aviculare 01.04  
" douglasii 032.033.09

Ranunculaceae

Delphinium nuttallianum 031.033  
Ranunculus aquatilis 014  
" cymbalaria 013.021  
" sceleratus 042

Rosaceae

Amelanchior alnifolia 07  
Fragaria virginiana 07  
Geum triflorum 09  
Potentilla anserina 04  
" arguta 031.034  
" biennis 07  
" gracilis var. flabelliformis 05  
" " var. permollis 011.012.022.033.04  
Ribes idaeus 07  
Rosa acicularis 021.022  
" sp. 01.052

Rubraceae

Galium boreale 01.022  
" trifidum 06

Salicaceae

Populus tremuloides 07  
Salix bebbiana 01.07.04  
" scouleri 09

Saxifragaceae

Heuchera cylindrica 08

Scrophulariaceae

Collinsia parviflora 031  
Orthocarpus luteus 09  
Penstemon confertus 031.033  
" fruticosus 08  
Veronica americana 01.042

Violaceae

Viola adunca 021  
" sp. (?V.nuttalli) 07

Alismataceae

Alisma aquatica-plantago 012.013.014

Cyperaceae

Carex petasata 03  
" praegracilis 011.012.021.022.04  
" praticola 03  
Eleocharis palustris 012.013.014.04  
Scirpus americanus 04.041

Iridaceae

Sisyrinchium sp. 011

Juncaceae

Juncus balticus 011.012.013.014.021.022.033.034  
" bufonius 011.012.042  
" longistylis 01.022

Juncaginaceae

Triplachin maritimus 012

Lemnaceae

Lemna minor 04.06

Liliaceae

Allium cernuum 031.034.09  
Calochortus macrocarpa 031  
Fritillaria pudica 051.09  
Smilacina stellata 07  
Zygadenus venenosus 01.022

Orchidaceae

Goodyera oblongifolia 07

Poaceae

Agropyron x brevifolium 021  
" pauciflorum 01.021.022  
" spicatum 031.032.033.05.07  
Agrostis exerata 04  
" scabra 09  
" stolonifera 011.  
Alopecurus aequalis 014.042  
Beckmannia syzigachne 014.042  
Bromus anomalus 08  
" hordeaceus 02  
" japonicus 09  
" tectorum 032.09  
Calamagrostis rubescens 07  
Deschampsia elongata 021  
Distichlis stricta 04  
Elymus cinereus 09  
" glaucus 021  
Festuca idahoensis 09  
Glyceria borealis 06  
" striata 042

Hordeum jubatum 011.012.013.021.04.041.042  
 Koeleria macrantha 01.031.032.033.051.052  
 Phleum pratense 021  
 Poa compressa 01.021.031  
   " juncifolia var. ampla 09  
   " palustris 042  
   " pratensis 011.012.021.022.031.032.033.04.051.052  
   " sandbergii 033.04.031.032.051.052.09  
     (may include some P.scabrella)  
 Puccinellia distans 04  
   " nuttalliana 01.041.042  
 Spartina gracilis 02  
 Stipa occidentalis 031.051.052

Worthy of note are Erigeron flagillaris, Atriplex truncata,  
Potentilla gracilis var. flabelliformis, Orthocarpus luteus,  
Distichlis stricta and Spartina gracilis. One rare species  
 that should be watched for is Small-flowered gilia (Ipomopsis  
minutiflora) which was found one third of the way down the  
 access road to the west and near the bottom of the same road  
 on the east side of the reserve.

## 11.0 PLANT ASSOCIATIONS

In the 14 plots established, 11 diverse plant associations  
 are covered, some paired with similarly composed but unprotected  
 plots outside enclosure boundaries. The table below ranks  
 these associations together with the "bands" of zoned vegetation  
 of Enclosure 4 (Section 7.1) in rough order from most xeric to  
 most hygric.

Association	Type	Location
Artemisia-Achillea	Short sage	5/1, 5/2
Poa-Artemisia	Open grass	3/3, 3/4
Artemisia-Poa	Tall sage	3/1, 3/2
Distichlis		Band 1
Sueda		Band 2
Poa-Lotus	Drier swale	2/2
Poa-Aster	Upper bank	1/1
	Damp upland	Band 7
Poa-Juncus	Lower bank	1/2
Poa-Taraxacum	Damp swale	2/1
Sueda-Puccinellia	Silt colonization	4/1
Puccinellia		Band 4
Juncus-Ranunculus	Diffuse stream	4/2
Puccinellia-Scirpus-Eleocharis		Band 5
Eleocharis-Juncus	Pond edge	1/3
Ranunculus-Polygonum	Standing water	1/4

## 12.0 RECOVERY PATTERN IN ENCLOSURES

Many wetland plants extend vegetatively by rhizomes and stolons from which they regenerate readily. For this reason trampling by cattle is more likely to cause some degree of disturbance rather than total elimination, except in the most extreme cases. Change in Enclosures 1 and 4 therefore should show up more in biomass than in species alteration and it is in the sagebrush-grassland enclosures that greatest change over time will probably occur.

If it is assumed that climax on dry open land before introduction of cattle in this area was dominated by Bluebunch wheatgrass (Agropyron spicatum) with some Big sagebrush (Artemisia tridentata), then it is evident that considerable regression has taken place. More wheatgrass can now be found on slopes in open forest than in the grasslands: it is sparse around Enclosure 3 and barely present around Enclosure 5, and successful reproduction under the present grazing regime is often hindered

by poor vigour. June grass (Koeleria macrantha), another favoured species, is hardly more common but does seem to seed more regularly. Preferentially increasing under these conditions have been the bluegrasses (Poa pratensis and P. sandbergii). The area of Enclosure 5 does seem to have gone one stage further so that even these two grasses also appear to be under some stress, with Western needle-and-thread grass (Stipa occidentalis) benefitting at their expense and Low pussytoes (Antennaria dimorpha) increasing in relation to Pink pussytoes (A. microphylla).

Presumably exclusion of cattle will be reflected at Soap Lake Reserve by a mirror image reversal of this process. McLean and Tisdale (1972) determined in studies on grassland at somewhat lower elevations that anywhere from 20 to 40 years must elapse from cessation of grazing before a climax situation is approached again, depending on degree of degradation reached. Under their studies proportionately more of the recovery period was found to be taken up by first stage recovery from the nadir than by succeeding stages.

Both Enclosures 3 and 5 still retain a cadre of forbs and grasses other than the dominant species so the raw material for recovery is already in place. In this first year of enclosure a number of rash predictions can be proposed -

- the recovery period will be closer to the lower than the higher end of the range quoted above;
- recovery will be faster in Enclosure 3 than Enclosure 5;
- smaller seeded June grass will increase faster than larger seeded Bluebunch wheatgrass;
- fire would speed the process by mobilizing nutrients and removing competition from sagebrush.

Changes in Enclosure 4 and the saline valley floor generally are likely to be even longer term and are more dependent on climate. If present conditions prevail, a continued drying is likely with Soap Lake possibly splitting further into separate pools, and the two existing small pools to the east ceasing to

exist. Sueda will colonize their bare saline silt, followed in time by rainwater leaching and invasion by Saltgrass (Distichlis stricta), in the same way that the narrow grassy basin west of Soap Lake is now a saltgrass meadow.

### 13.0 KNAPWEED PROBLEM

Disturbance inevitably results in the introduction of weed species: cattle grazing, road construction and logging have all added their tithes of undesirable adventives at Soap Lake. It is very obvious how the access road has acted as a conduit for knapweed, each vehicle after seed-set helping to distribute a little farther. Diffuse knapweed (Centaurea diffusa) and White sweet-clover (Melilotus alba) are particularly thick over the road-bed on the Nicola River side, while on the west side a lighter infestation is offset by a greater number of different weedy species benefiting from the more sandy soil. Despite this it is Spotted knapweed (C. maculosa) which has made greatest inroads in the reserve. In August when flowering is in progress it is easy to see that it now extends along most of the road - lighter past the lake and saline ponds and heavier towards each boundary - and is even scattered into grassy areas near the old corral. From here to the east boundary some Diffuse knapweed joins it and possibly presents the greater hazard.

### 14.0 ANIMALS

**14.1 MAMMALS** Signs of larger animals were notable for their sparseness throughout the reserve.; scat was scarce and mostly old and few tracks were seen. This is surprising in view of the relative remoteness of the area and difficulty of access and it is tempting to suppose that use in the hunting season may



have been frequent in the past. Empty cartridge cases were noted in several places. Observations were as follows:-

deer scat (old)  
Red squirrel  
Pine chipmunk  
Coyote (heard)

14.2 BIRDS In contrast to mammals, birds seemed plentiful and casual observation while working on other matters resulted in sightings of -

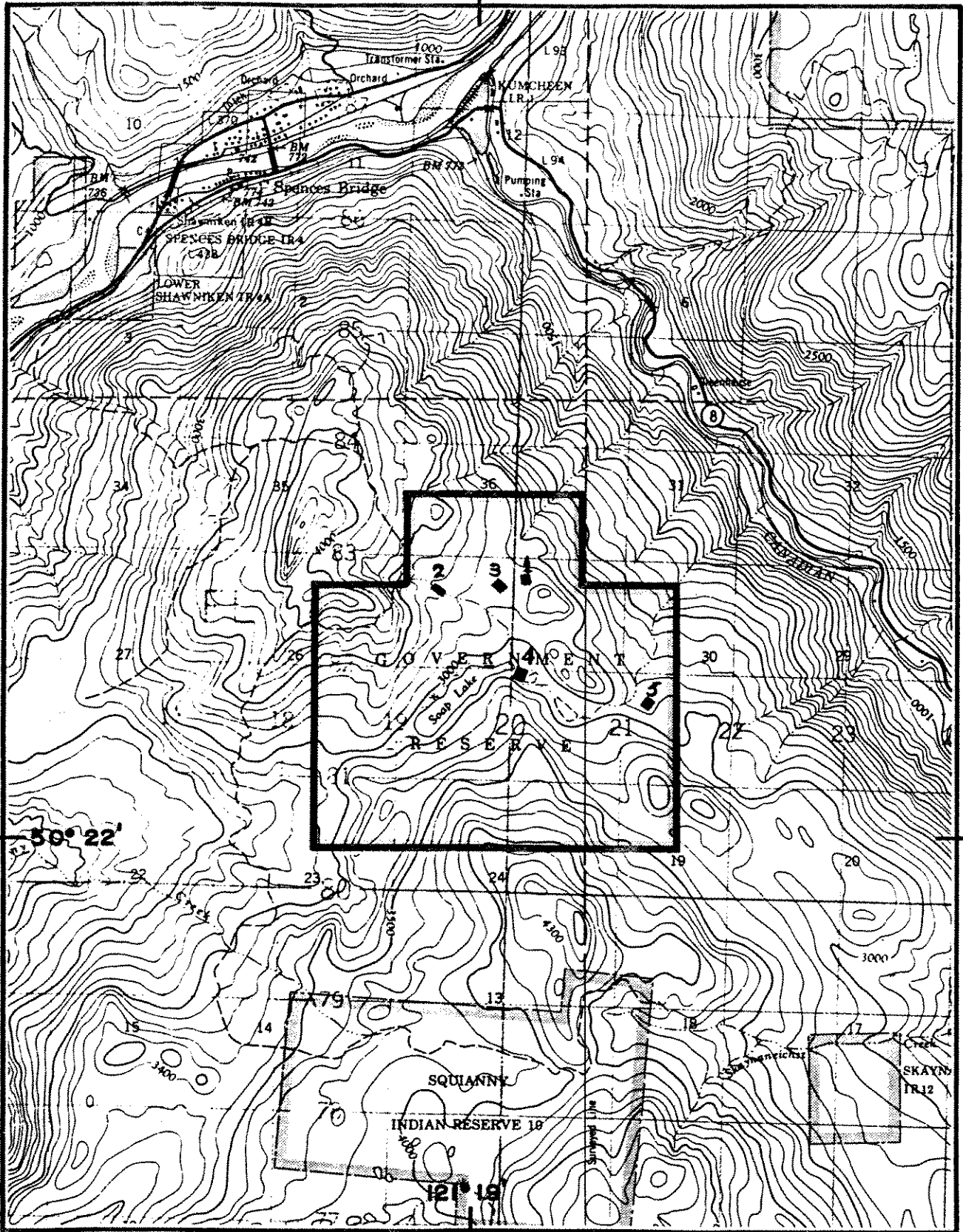
24 Mallard  
(?Coopers) hawk (crow sized)  
25 Red-tailed hawk  
26 Spruce grouse  
27 Sora  
Killdeer  
28 Spotted sandpiper  
29 Sandpiper sp. (size of Western sandpiper)  
30 Owl sp. (heard at night)  
31 Common nighthawk  
32 Rufus hummingbird  
Northern flicker  
Red-naped sapsucker  
33 Downy woodpecker  
34 Willow flycatcher  
Common raven  
35 Clark's nutcracker  
Black-capped chickadee  
Mountain chickadee  
Red-breasted nuthatch  
American robin  
36 Golden-crowned kinglet  
Cedar waxwing

Red-eyed vireo  
Yellow-rumped warbler  
37 Warbler sp. (?Nashville or Macgillivray's)  
Pine siskin  
28 Savanna sparrow  
39 Vesper sparrow  
Chipping sparrow

It is obvious that waterfowl do not (or rarely) use the saline waters of Soap Lake. The two sizes of sandpiper were feeding around the edges above the water and away from the large masses of Brine flies which one would have thought offered a ready source of food. Ducks were seen only (2 males) on the larger of the two fresh water ponds. At Enclosure 4, one of a presumed pair of Sora appeared to be in residence even though cattails, which it normally frequents, are totally absent.

14.3 OTHER An Alligator lizard was found near roadside where it runs past the middle saline pool. Outside Enclosure 5 several Tree frogs were on the ground and an immature amphibian, possibly a Western toad, nearby.

APPENDIX 1



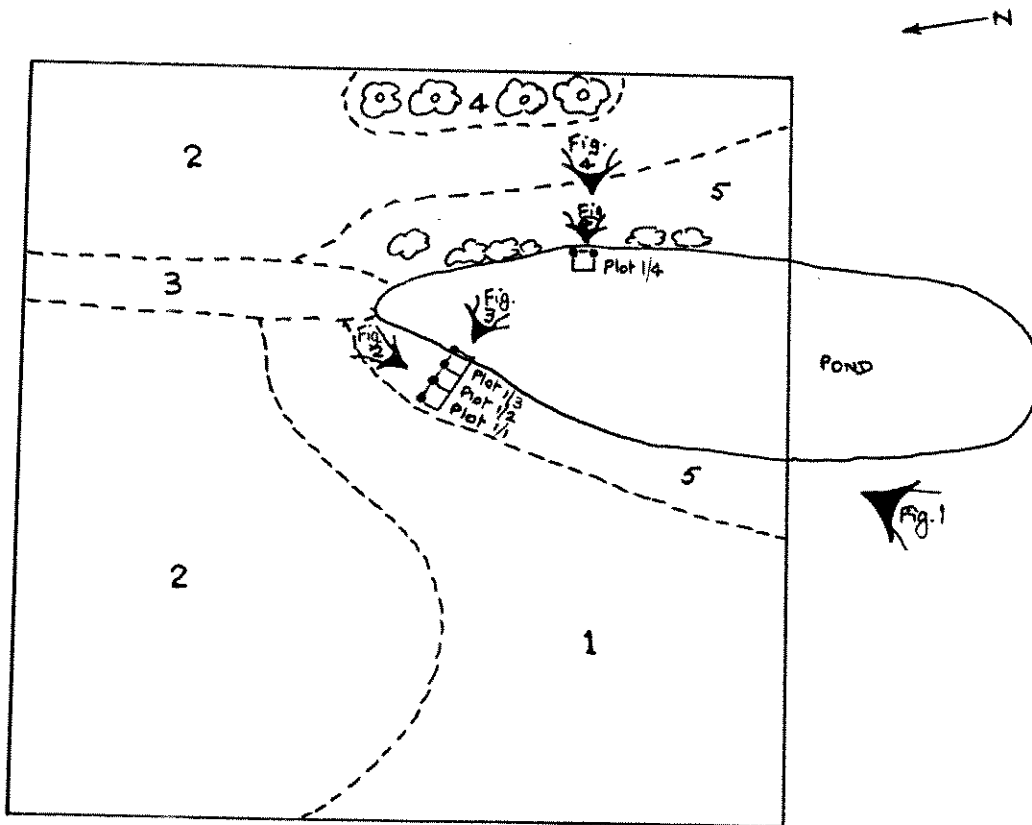
SCALE 1:50 000



## APPENDIX 2

Wooden stakes mark two adjacent corners in each plot. Distances should be measured from them and not from the pieces of ribbon on fencing or bushes as these are for indication only and are not placed accurately. Location of stakes is shown on the following sketches by a small solid circle. Sketches are not to scale.

### ENCLOSURE 1 Plots 2m x 2m

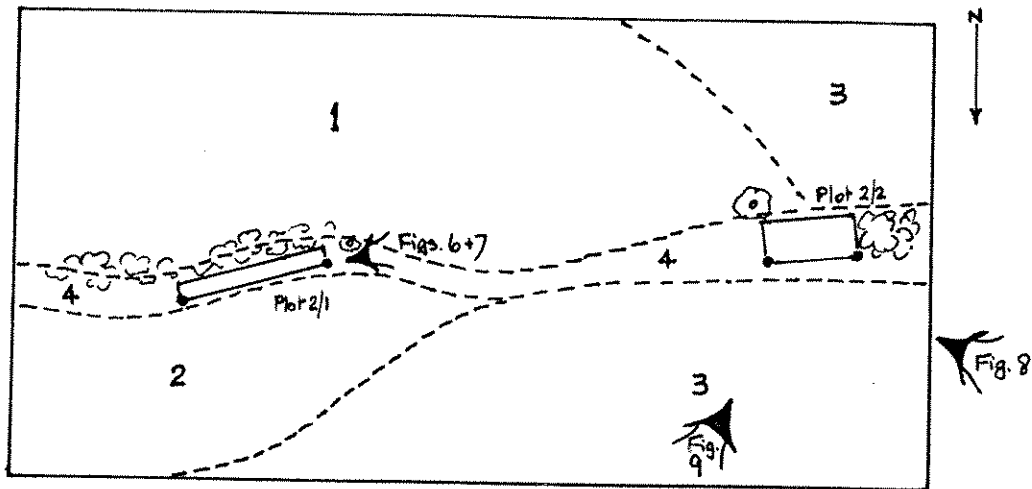


- 1 = *Hordeum jubatum*-*Poa pratensis*-*Puccinellia nuttalliana*
- 2 = *Artemisia tridentata*-*Poa sandbergii*-*Chrysothamnus nauseosus*-*Antennaria microphylla*
- 3 = Damp swale like Plot 2/2 with additional *Aster ericoides*
- 4 = Cattle loafing patch, *Bromus japonicus*-*Camelina microcarpa*-*Polygonum aviculare*-*Chenopodium* spp. under *Pinus ponderosa*
- 5 = Similar to Plots 1/1 to 1/3

ENCLOSURE 2

Plot 2/1 10m x 1m

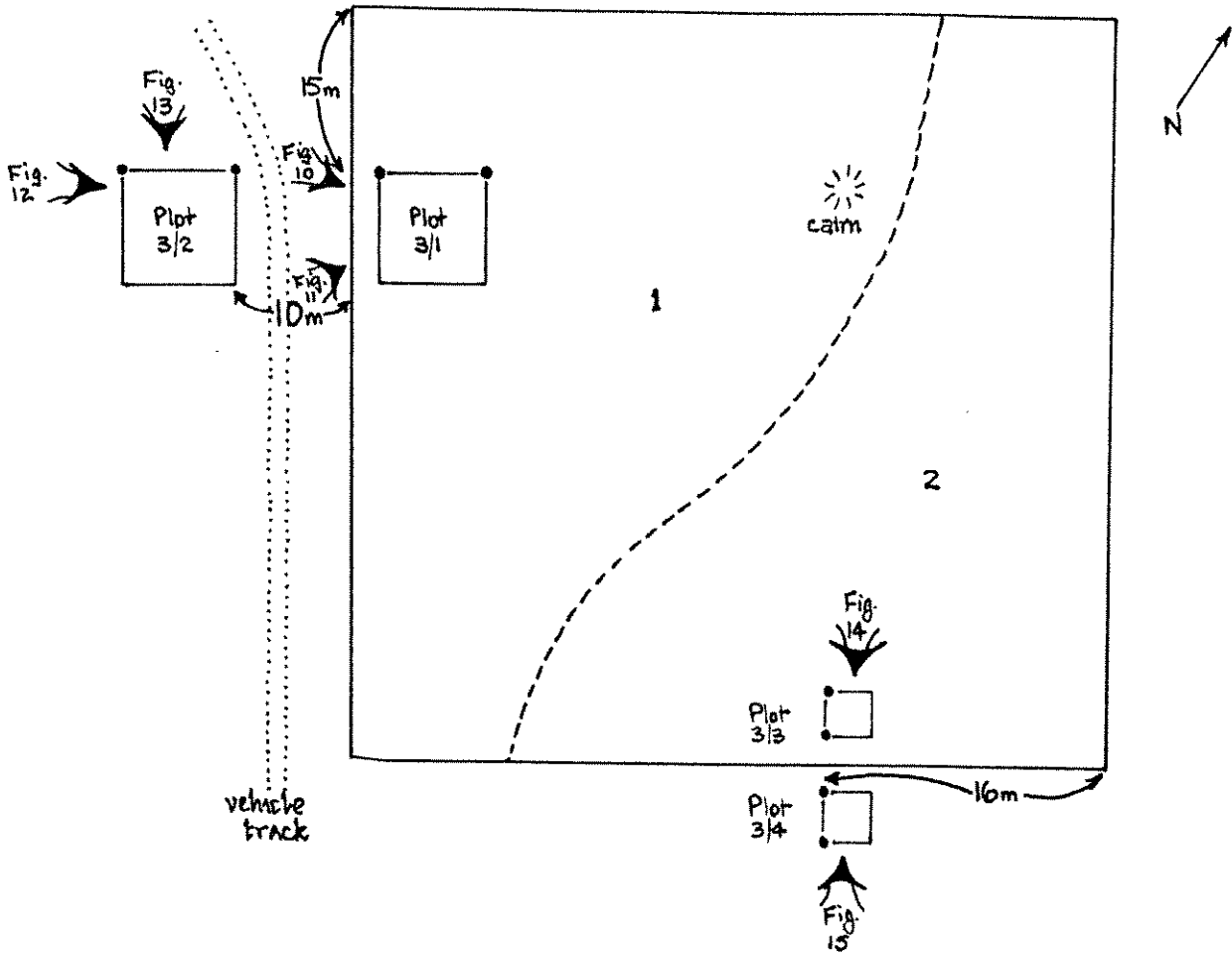
Plot 2/2 6m x 3m



- 1 = Open Douglas-fir/Ponderosa pine forest - *Balsamorhiza sagittata*-*Erigeron subtrinervis*-*Aster conspicuus*-*Symphoricarpos albus*
- 2 = Grass slope - *Poa pratensis*- *Aster ericoides*-*Achillea millefolium*-*Tragopogon pratensis*-*Aster campestris*
- 3 = Arid slope - *Chrysothamnus nauseosus*-*Poa sandbergii*-*Achillea millefolium*-*Poa juncifolia*-*Astragalus* spp.-*Lithospermum ruderales*-*Tragopogon dubius* with *Pinus ponderosa*; much bare and stoney
- 4 = Damp swale

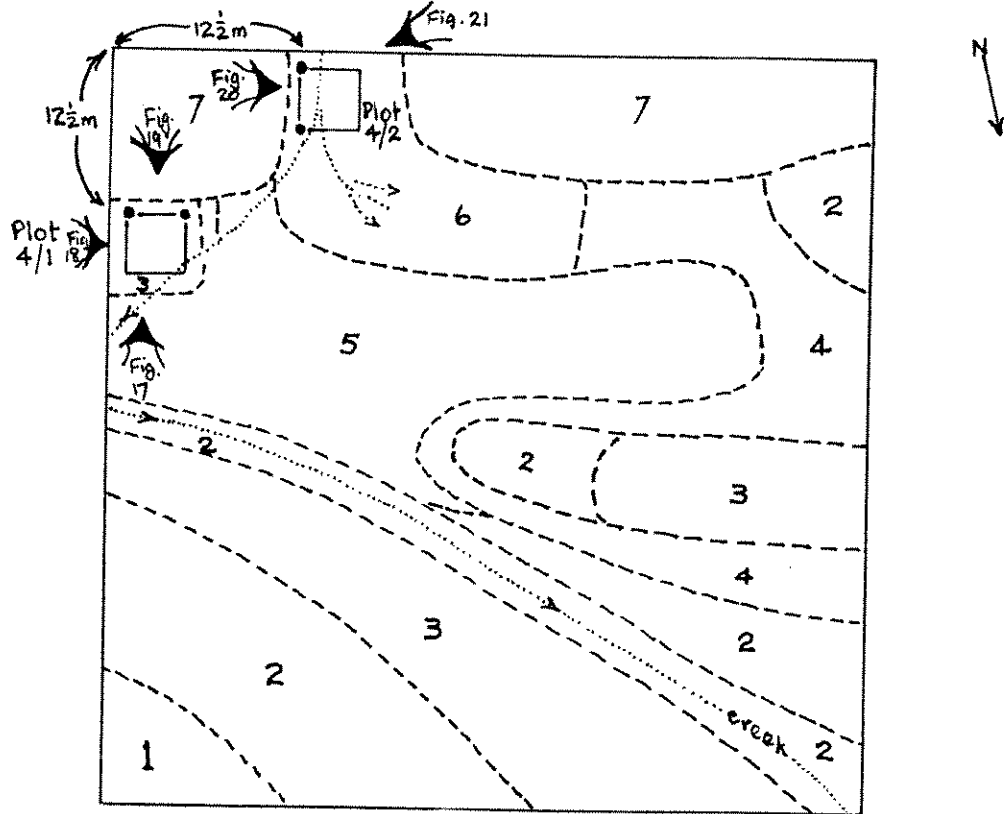
ENCLOSURE 3

Plots 3/1 and 3/2 10m x 10m  
Plots 3/3 and 3/4 4m x 4m



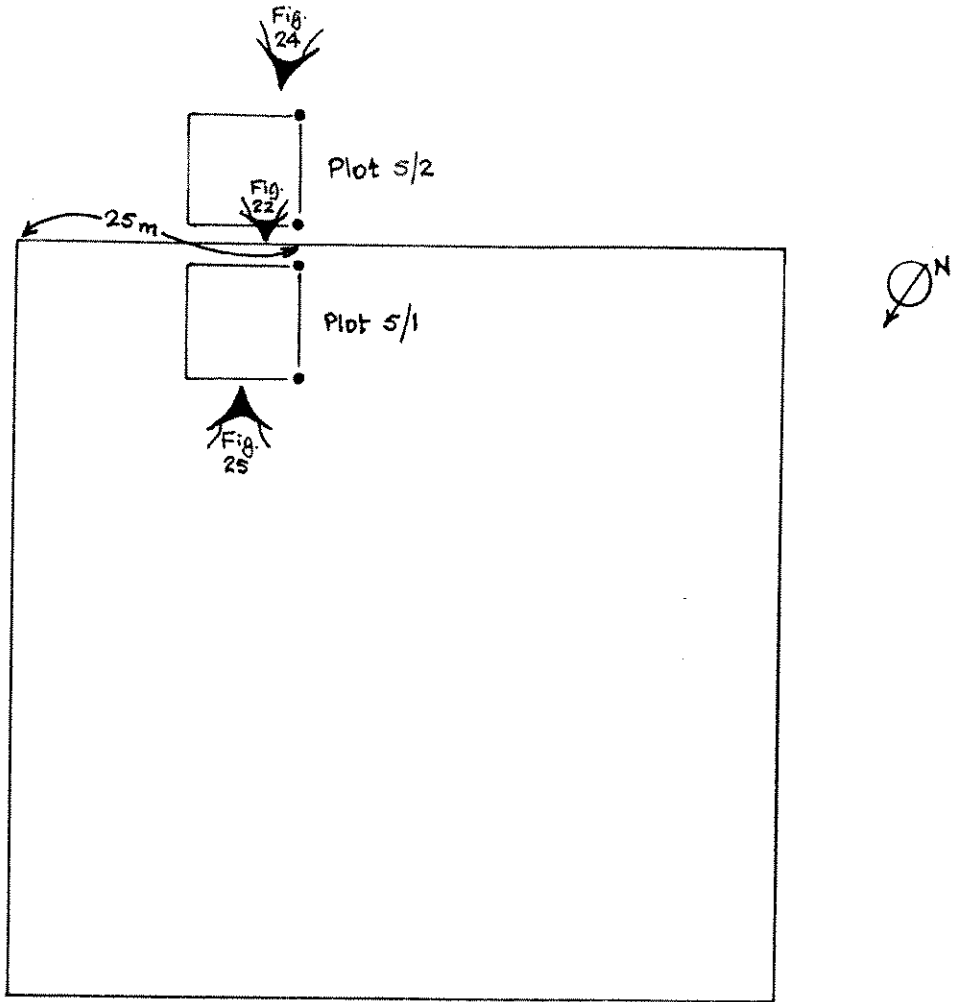
- 1 = Tall sagebrush area
- 2 = Grassy openings area

ENCLOSURE 4      Plots 4m x 4m



- 1 = Distichlis Band - Distichlis-Sueda-Poa-Lappula-Lepidium
- 2 = Sueda Band
- 3 = Unvegetated Band
- 4 = Puccinellia Band
- 5 = Puccinellia -Scirpus-Eleocharis Band
- 6 = Riparial Band - see Plot 4/2
- 7 = Damp Upland Band - Hordeum-Poa-Potentilla-Carex-Trifolium

ENCLOSURE 5      Plots 10m × 10m



Track



APPENDIX 3

Approximate direction of photographs indicated by arrows on sketches in Appendix 2. All obtained in mid-July.



Fig. 1

Enclosure 1. General view of pond; vegetation trampled in foreground. Plots 1/1, 1/2 and 1/3 at far end, 1/4 in gap between bushes along bank on the right.

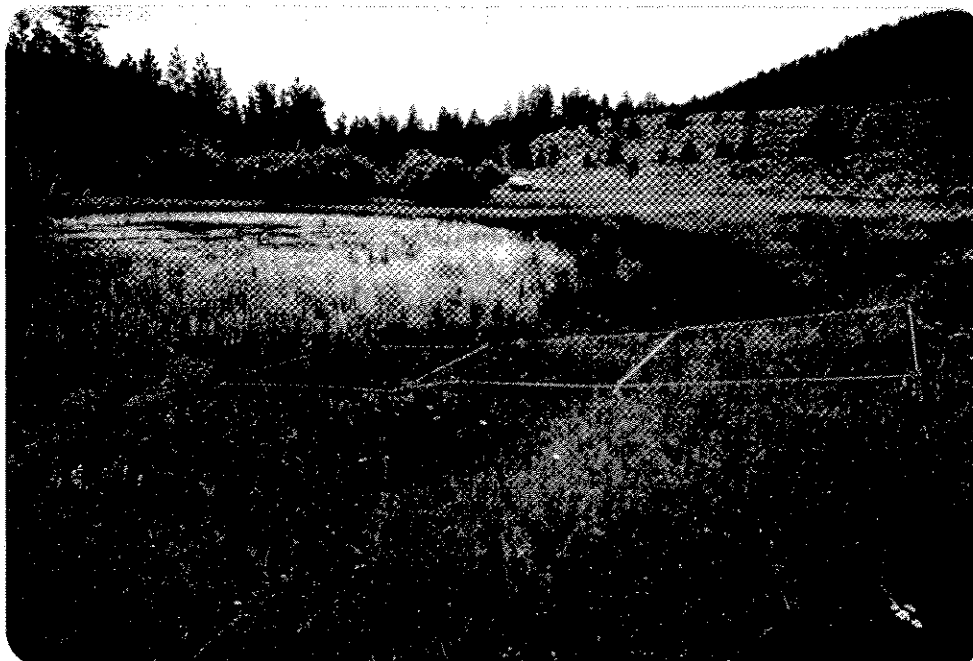


Fig. 2

Plots 1/1,  
1/2 and 1/3

Fig. 3

Plots 1/1, 1/2 and 1/3  
from pond looking up bank

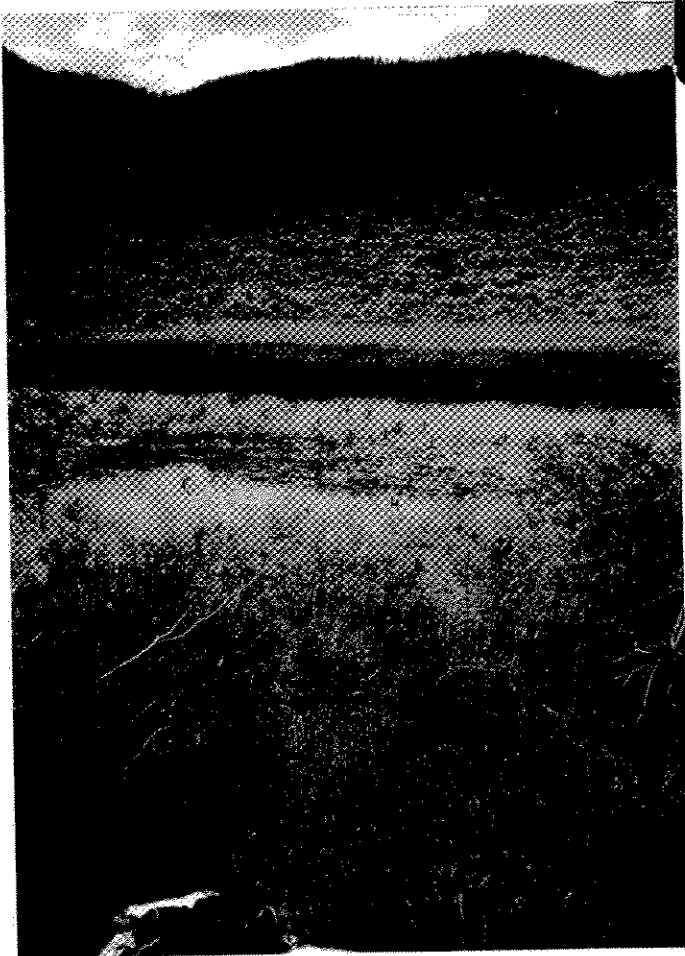
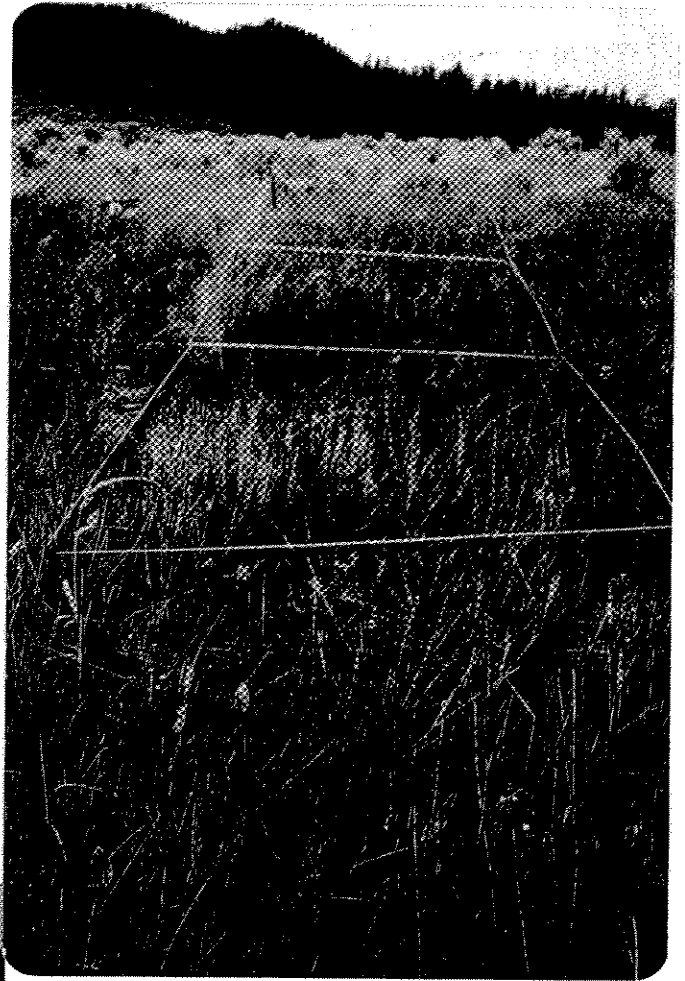
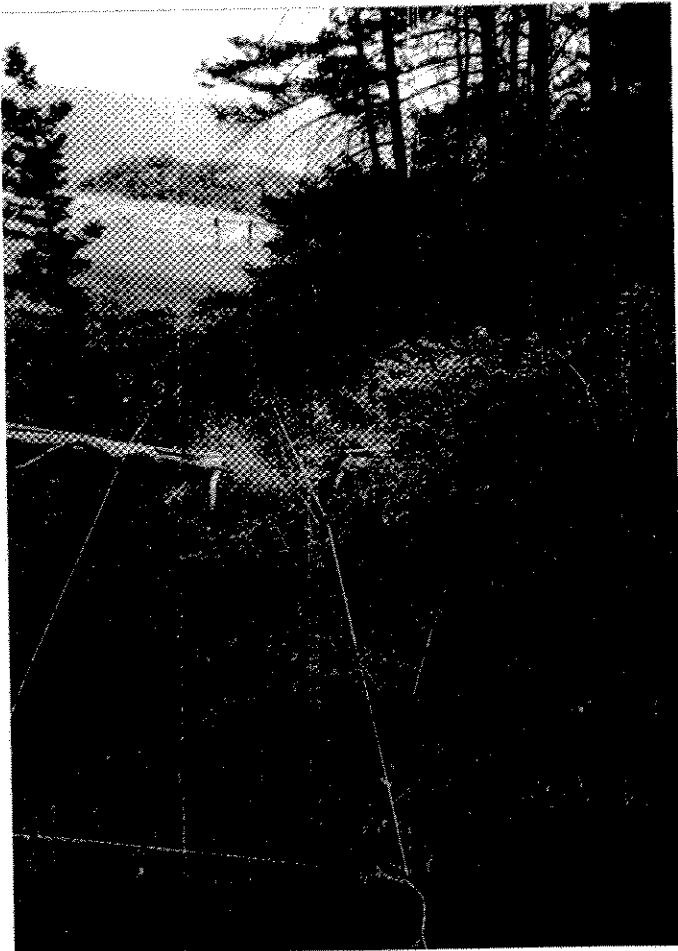


Fig. 4

Plot 1/4



Fig. 5 Plot 1/4, close-up of vegetation



(Fig. 6 withdrawn)

Fig. 7

Plot 2/1, down-slope



Fig. 8

Plot 2/2

Fig. 9





Fig. 10

Plot 3/1 Tall sagebrush (inside)

Fig. 11





Fig. 12

Plot 3/2 Tall sagebrush (outside)

Fig. 13





Fig. 14 Plot 3/3, Open grass area (inside)

Fig. 15 Plot 3/4, Open grass area (outside)

Difference in grazing pressure  
already evident.





Enclosure 4 general view: zoning of vegetation obvious even at this distance.

Fig. 17 Plot 4/1, bare silt with light Sueda/ Puccinellia colonization.





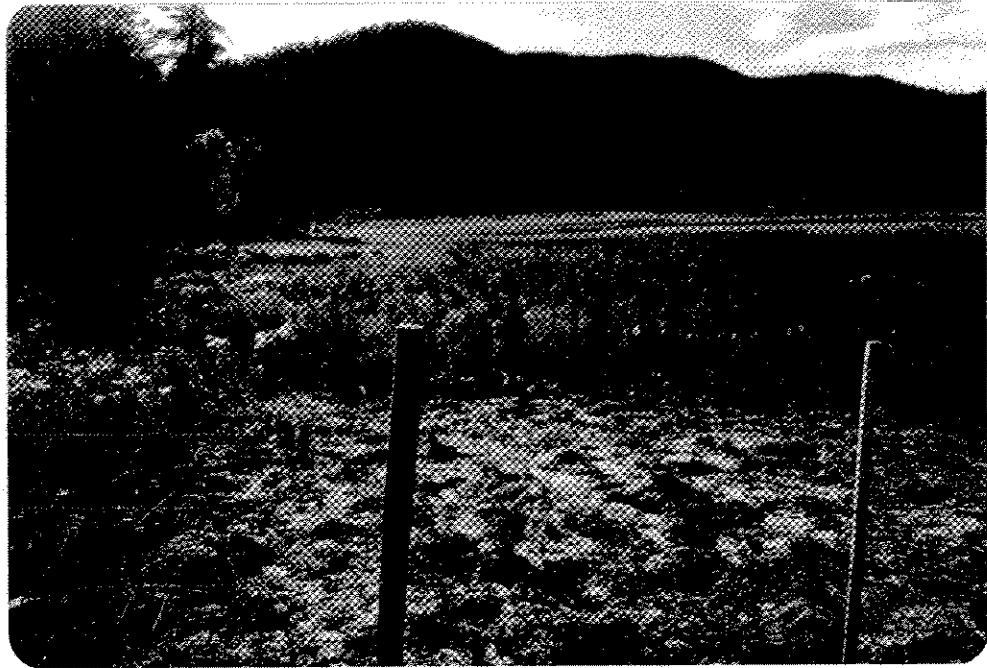


Fig. 18 Plot 4/1

Bare silt with light *Sueda-Puccinellia* colonization.

Fig. 19 Plot 4/1



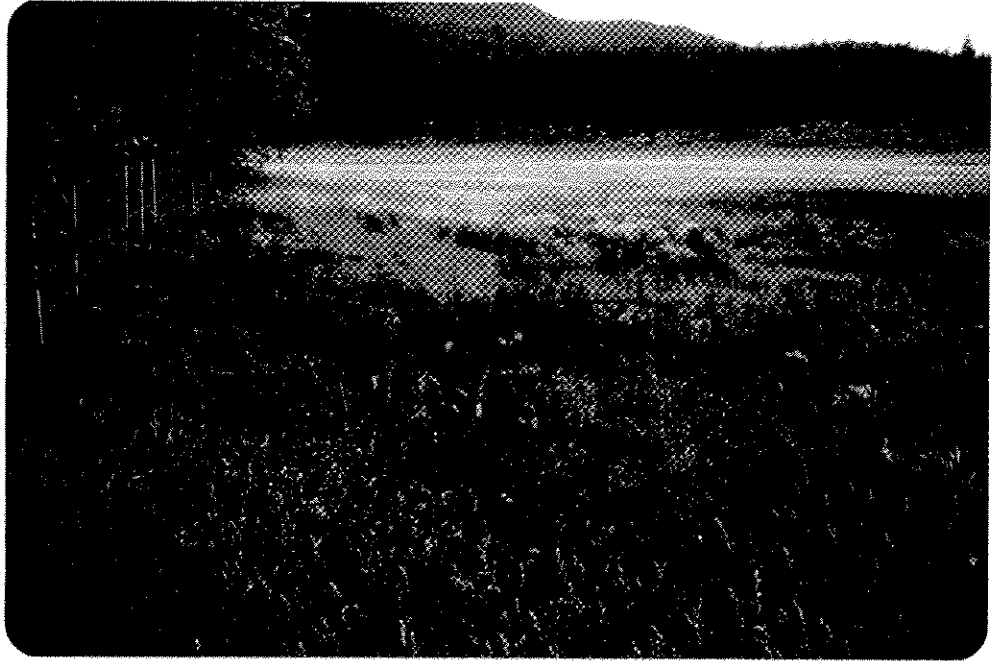


Fig. 20 Plot 4/2

Lush growth along stream  
issuing from spring on hillside above.

Fig. 21 Plot 4/2



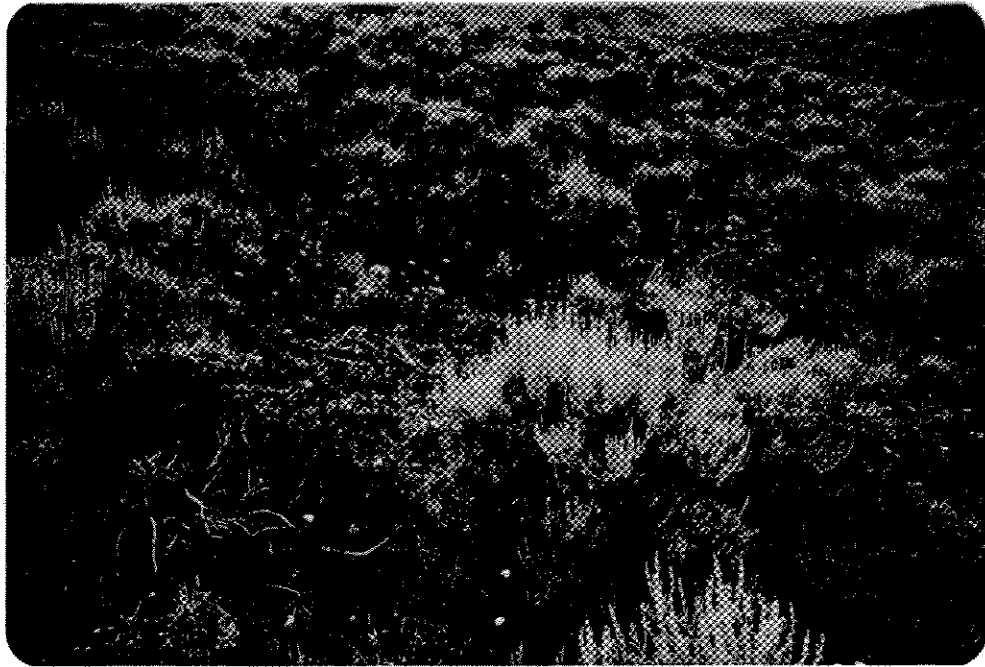


Fig.22 Plot 5/1 Short sagebrush area (inside)

Fig.23 Plot 5/1 Short sagebrush area (inside)  
Close-up of vegetation



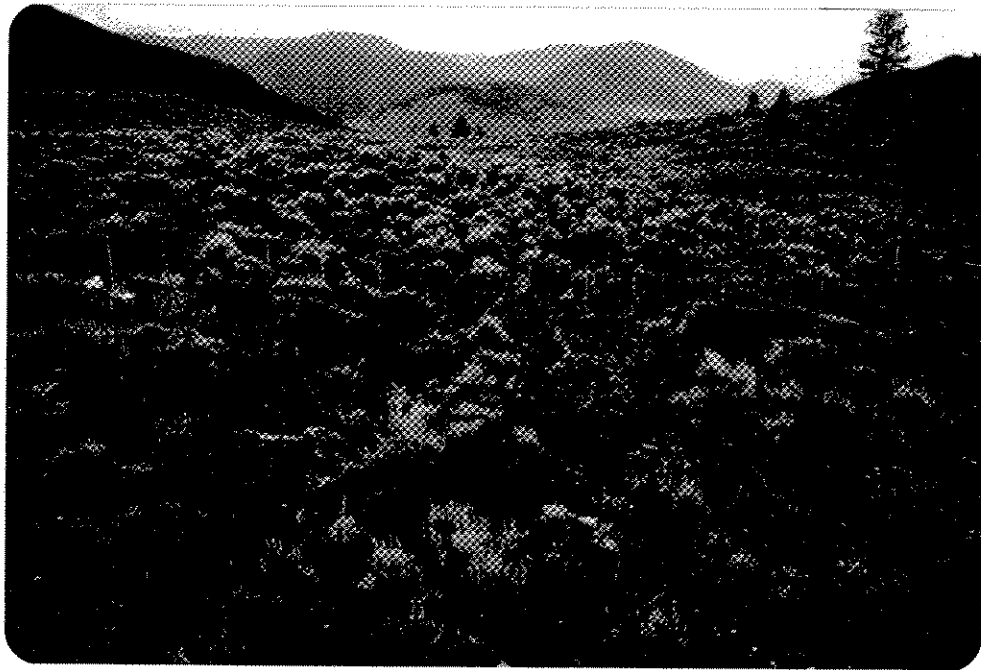


Fig. 24 Plot 5/2 Short sagebrush area (outside)  
Plot 5/1 beyond fenceline

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Botanical study comprises 50 pages.

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A handwritten signature in black ink that reads "Malcolm E. Martin". The signature is written in a cursive style with a large, stylized 'M' and a long, sweeping tail.

Malcolm E. Martin  
October 1991