CERTAIN ECOLOGICAL ASPECTS OF CULTIVATED HILL PASTURES IN KINGS VALLEY, OREGON

by

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CERTAIN ECOLOGICAL ASPECTS OF CULTIVATED HILL PASTURES IN KINGS VALLEY, OREGON

INTRODUCTION

This study is concerned with seeded pastures in one area of the eastern foothills of the Oregon Coast Range, in the immediate vicinity of Kings Valley, Oregon. The purpose of the study was to determine: (1) the viability of the pasture grasses and legumes seeded in this area; (2) the degree of success to which they are able to compete with the native vegetation; and (3) the efficacy of fern eradication measures utilized. To accomplish this, a floristic analysis was made of the specific area chosen, with emphasis placed on the seed forage areas themselves, and observational data taken on the surrounding native vegetation. This analysis was conducted in one area only, but the vegetation and the successional trends found would in all probability be relatively constant throughout the Coast Range, wherever a similar set of environmental conditions is encountered.

The Oregon Coast Range is one of a series of mountain ranges which border the Pacific Ocean. It is bordered on the east by the Willamette Valley, to the north by the Columbia River, and to the south by the Middle Fork of the Coquille River; the approximate boundaries are 46°15'N to 43°N and 124°30'W to 123°30'W (71,

p. 25). The topography is much less rugged than that of the Cascades or the Wallowa Mountains, due to generally lower elevations and more easily eroded formations. Elevations average from 1,500 to 2,000 feet; the highest point, Mary's Peak, rising to 4,097 feet. The predominant formations in the Coast Range are sandstones and shales, igneous rocks and flows of both basalt and andesite, some impure limestones, coal beds, all of Tertiary age, and unconsolidated sands and gravels of Pleistocene age (70, p. 26). The Eocene beds of sands, shales and limestones reach a thickness of from 7,000 to 12,000 feet. The sedimentary beds were intruded by lavas at different times, these intrusions accompanied or followed by gentle folding which raised the area above sea level. Erosion then reduced the uplifted region to the Pliocene peneplain with a few monadnocks, generally masses of lava, left rising above its surface (43, pp. 322-323). The Willamette Valley in western Oregon, lying between the Oregon Coast Range and the Cascade Mountain Range to the east, originated as a synclinal trough.

The soils of the Oregon Coast Range foothills are residual in the largest extent and have been formed by weathering in place of consolidated rock materials, in this case largely of igneous and sedimentary types. The igneous rocks are mainly of low quartz content, and consist largely of basalt. The sedimentary rocks on the

foothills bordering the Willamette Valley are generally of sandstone or shale origin. The main soils in the region near Kings Valley are Melbourne clay loam and Olympic clay loam series of the Hill Group of residual soils, the former developing from sedimentary rock and the latter from igneous rock (11, pp. 1439-1441). These residual hill soils are distinctly acid in reaction and tend to be low in available phosphates and calcium. They are rather heavy in texture, usually well drained and in general do not erode seriously (61, p. 15).

The climate of the Willamette Valley is equable, and subcoastal in nature (60, p.2) due to its proximity to the Pacific Ocean, which lies approximately fifty miles to the west. The eastern foothills of the range are quite similar to the valley in climate, showing only those differences to be expected with the higher elevations (76, p. 33). Average annual precipitation in the Coast Mountains ranges from 50 to 130 inches and above; the area of study has an average annual precipitation near 50 inches. The precipitation is seasonal, with very low precipitation during the summer months, June to September inclusive (less than 20 percent), and proportionately heavy rainfall during the winter months, November to February inclusive (67, p. 9). Precipitation during July may fall as low as one percent of the annual total. The normal annual temperature at the Corvallis station is 52.4 degrees

and ranges from 66.2 for July and August to 29.3 for January. The average maximum temperature is 74.7 degrees in September and 45.5 degrees in January, while the average minimum temperature ranges from 32.9 for January to 51.3 degrees for August (60, p. 2). The growing season averages between 150 and 200 days (67, p. 7).

The Willamette Valley and the adjacent Coast Range foothills lie in the humid Pacific Coast division of the Transition life zone (47, p. 27), and within the cedar-hemlock climax of the Coast Forest (77, p. 501). At the present time, the chief climax species, western red cedar (Thuja plicata Donn.) and western hemlock (Tsuga heterophylla (Raf.) Sarg.), are not common in the area, and much of the region is covered by dense stands of Douglas fir (Pseudotsuga taxifolia (Lambert) Britt.). The paucity of the climax dominants may be due to the low summer precipitation, to extensive forest fires of the last centuries--the result either of natural causes or repeated burning by the Indians to maintain open areas for game, or to a combination of both (72, pp. 89-90). The Douglas fir forms dense, even-aged stands which, however, are unable to maintain themselves without the intervention of some type of disturbance, since in most areas the seedlings are unable to grow under the closed forest canopy. In the absence of fire or logging operations, western red cedar, and the balsam firs, (Abies amabilis (D.)

Forbes.), A. grandis Lindl. and A. nobilis Lindl.) are able to reproduce in the shelter of the Douglas fir and ultimately supplant the latter (51, pp. 451-459). A study of forest composition made in the southern section of the Olympic National Forest, indicates that without disturbance the process of conversion from a stand of pure douglas fir to hemlock and the other shade-tolerant species would take place in perhaps five centuries (51, P. 457).

The replacement of Douglas fir by hemlock and its associates is not the inevitable climax throughout the entire Douglas fir region. In some of the drier areas, an uneven-aged stand of Douglas fir appears to be the climax formation, these stands being sufficiently open to allow for seedling growth. The Douglas fir requires less moist and cool sites than do the climax dominants (51, pp. 457-458). On the moister sites of these dry areas, lowland white fir (Abies grandis Lindl.) may become predominant (72, p. 90).

At the present time, many millions of acres of the Oregon Coast Range have been stripped of trees by logging and fires. After the logging operations have removed all of the economically important trees, it has been the practice to burn the slash. These slash fires have often been holocaustic in nature and have completely stripped the areas of vegetation. Forllowing denudation of the areas, a rather constant type of succession occurs:

fireweed (Epilobium augustifolium L.), bracken fern (Pteridium aquilinum L. var. pubescens Underw.), the blackberries (Rubus spp.) and associated minor forbs and grasses invade. These species seem indifferent to site limitation such as differences in slope, soil or aspect and appear to invade over the entire area wherever destruction of the forest occurs (35, p. 396). The presence of bracken fern gives impetus to further fires, since it dies back to the perennial rootstocks each year, leaving much brittle, dry foliage on the ground. These subsequent fires, which do relatively little damage to the underground portions of the bracken, while destroying other vegetation, may cause the area to become dominated by this plant (35, p. 402). If fires do not recur, the annual and perennial cover is almost entirely replaced by a shrubby cover within five to twelve years (58, p. 586). The next stage in succession is the invasion of the areas by the hardwoods, mainly Oregon white oak (Quercus Garryana Dougl.) in the valley proper and in the foothills themselves on the drier slopes, and bigleaf maple (Acer macrophyllum Pursh.), with Oregon ash (Fraxinus oregona Nutt.), red alder (Alnus rubra Bong.) and cottonwood (Populus trichocarpa T & G.) occurring on the floodplains. Douglas fir gradually invades the hardwood stands, and eventually supersedes the oak.

Many acres of the Coast Range at the present time

have been repeatedly burned and are covered by a dense growth of the bracken fern, thus being rendered useless, from both the economic and the conservation points of view. This plant is not palatable to livestock and the repeated fires which burn through it prevent normal succession from occurring with the eventual return of the areas to a vegetation of commercial coniferous timber.

The problem of returning these lands to a useful state has received much consideration from the standpoint of forage utilization, reforestation and conservation. There can be little dual use of the areas since in the protected state the forest canopy is closed inhibiting growth of forage species. Since reforestation is a long-range project, much consideration has been given to the possibility of establishing grasslands on these denuded hills. In its entirety, the climate of the forested regions is often better suited for grass than that of the natural grassland areas, due to its higher rainfall, less severe droughts, lesser extremes of temperature, and a higher average humidity (5, p. 144). The soils are less advantageous for grasses and pasture legumes, due to their acid reaction, low organic matter content and loss of the essential nutritive elements. In establishing grasslands in these areas, the problem of foremost importance is the prevention of the succession which would normally occur. Bracken fern and Douglas fir are always ready to invade

the area. Pechanec (58, p. 589) states that in converting forest land to grassland, man is working against nature and that conversion should be considered only on the better soils. This would leave the poorer soils and steeper slopes for timber, while still providing many areas which could successfully be used for grazing purposes.

Extensive experimentation has been undertaken to determine cultural practices necessary for establishment of permanent pastures in these areas, both in the interest of eradicating bracken fern and preventing its reoccurance, and in establishing permanent stands of high quality forage grasses. After establishement of a permanent pasture sward, it is essential that proper grazing management be employed to insure its maintenance. Species chosen for seeding in these Coast Range foothill pastures must be suited to growth under conditions more favorable for forest species. These plants must be tolerant of high acidity, precipitation which is high in the winter and low in the summer, and in the instances where fertilizers are not used, must be able to exist under conditions of low fertility of the soil. Sod formers are of special importance in this work (65, p. 602), and among those recommended for use in this area are: the bentgrasses, Seaside, Astoria, and Colonial (Agrostis spp.), the fescues, creeping, red and alta (Festuca spp.), German velvet grass (Holcus sp.), Kentucky bluegrass (Poa praten-

sis L.) and others. Since these hill soils are deficient in nitrogen, which is essential for the growth of the grasses, certain of the leguminous plants are recommended among them: the clovers, ladino and subterranean (Trifolium spp.) and alfalfa (Medicago sativa L.). Various other grasses and legumes are used in the pasture mixtures. In the opinion of some workers, the pasture mixtures should be simple, since by using such techniques the pastures will sooner reach a relatively stable state, with those more aggressive grasses assuming dominance (18, p. 174). However, other experimenters use complex mixtures under the assumption that all may thrive at first and will tend to form a sod layer, preventing invasion by undesirable species, while the cultivated grasses are competing with one another. The pasture mixture recommended for the area of study is made up of: Alta fescue (Festuca elatior L. var. arundinacea (Schreb.) Wimm.), meadow foxtail (Alopecurus pratensis L.), orchard grass (Dactylis glomerata L.), tall oatgrass (Arrenatherum elatius (L.)Mert., Tualatin Valley strain), chewings fescue (Festuca rubra L. var commutata), red creeping fescue (Festuca rubra L. Illahee strain), and perennial ryegrass (Lolium perenne L.); combined with these may be subterranean or Ladino clover, (Trifolium subterraneum L. and T. repens L.) (57, p. 4). The pasture mixture may include all of these species, or may be composed of only a few of them, depending

upon the pasture type desired.

Various cultural methods are used. In some, the seed is broadcast directly into the undisturbed native vegetation, while in others a seedbed is first prepared, by plowing or disking. Soil treatment measures also vary. Fertilization with phosphate and nitrogen fertilizers is recommended (56, pp. 5-22) and in many instances it is also advisable to apply lime compounds to the soil.

The second main problem in the establishment of these pastures is control of the bracken fern. This plant is unpalatable to animals, and if eaten may cause serious illness and death of the animal. It reproduces by spores and by rhizomes which penetrate very deeply into the soil. It is very aggressive and as stated earlier, is found in the position of a primary invader on hill lands cleared of the forest vegetation. This plant has been spreading over the world for the past few million years and never appears to have been injured by a real biotic enemy. A few insects have eaten it, a few fungi have parasitized it, but no serious epidemic has been recorded even in these times when it is of world-wide distribution (6, p. 181). It is imperative that this plant be eradicated from lands intended for permanent pasture. Due to its habit of growth and its hardy, aggressive nature this is a difficult undertaking, and many methods have been employed. If it is possible to cultivate the land,

the area should be plowed and harrowed to bring the rhizomes to the surface where they may be stacked and burned. Further cultivation should follow, with mowing early in the season (40, p. 2). The critical stage for cutting is the final stage of plant unfoldment--the point at which the formation of the frond has most fully exhausted the rhizome without manufacture of food to be stored in the underground portions for use the following year (6, p. 181). The topography of much of the fern land is too steep or rough to allow cultivation; in this case, it is recommended that the areas be burned in the fall, seeded to permanent grasses and pastured as soon as the grasses are established (40, p. 2). The trampling of the ground by cattle seems to damage the frond buds by sheer weight on soft ground (6, p. 181).

The final step in establishement of permanent pastures in the foothill regions of the Oregon Coast Range is grazing management. In the first years after seeding, it is imperative that grazing be held at a level allowing the young grasses to well establish themselves in the area. The carbohydrate reserves in the roots are decreased by heavy grazing, especially if this grazing and resultant defoliation occurs between the time of flower setting and seed maturity. In this case, growth the following year will be much decreased (23, p. 133).

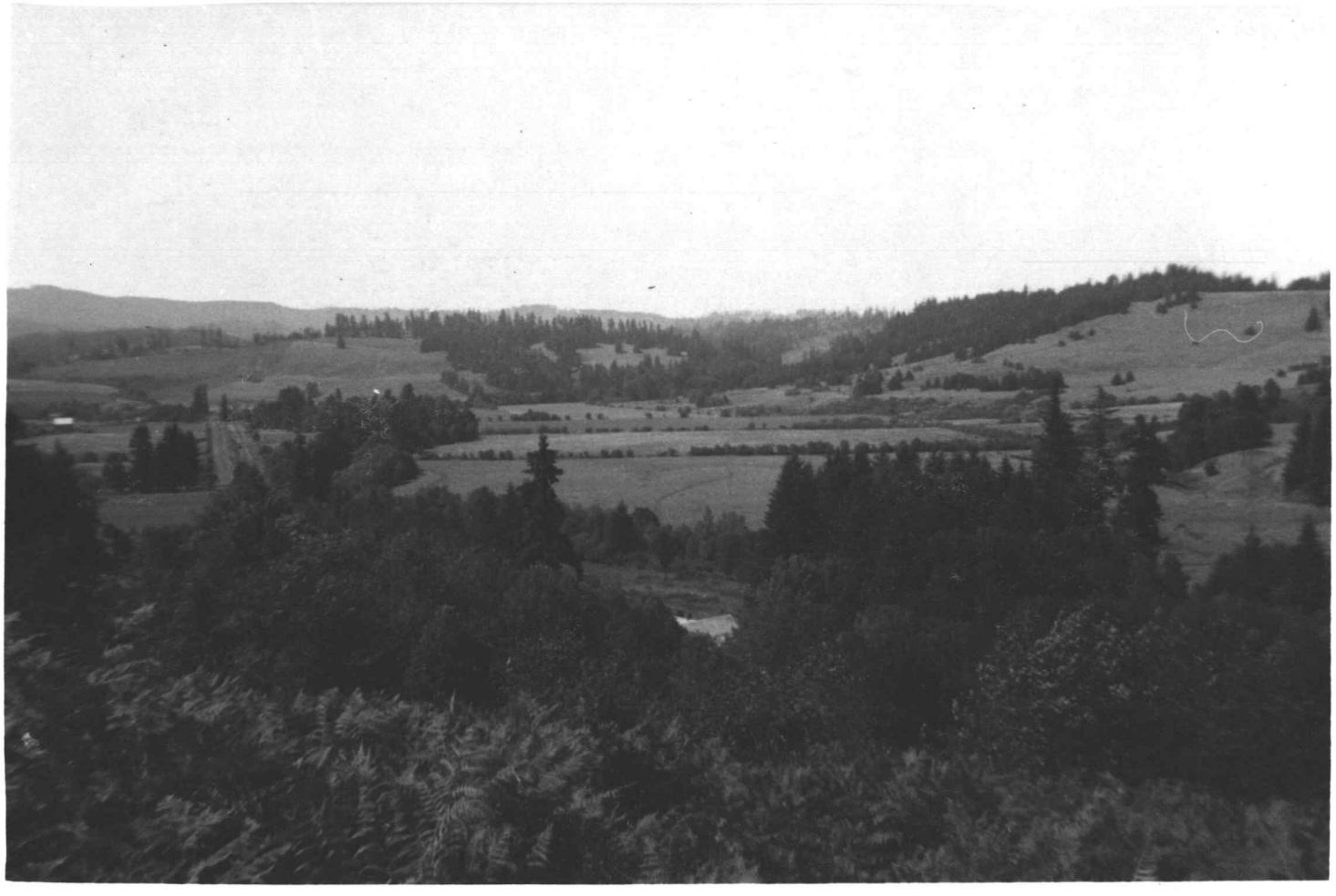
The present work was carried on to determine the

success with which cultivated grasses in different mixtures and in the same mixture in different years were able to compete with the native vegetation. It was also desired to determine the efficacy of methods of bracken fern eradication employed on the area studied, and to study the successional and ecological picture of the seeded pastures. The purpose was to determine if possible the condition of these pastures, possibly to suggest ameliorative practices, and to present data for consideration relative to the advisability of pasture establishment in these denuded hill areas. The data were collected during the growing season of 1950.

DESCRIPTION OF THE AREA OF STUDY

The hill pasture land chosen for the study comprises a portion of a farm owned by Messrs. John and William Graham of Kings Valley, and lies in the southwest quarter of section 8, Township 10 south and Range 6 west, Willamette Meridian. It is located approximately one and one-half miles northwest of the town of Kings Valley, which lies in the valley of the Luckiamute River, a tributary of the Willamette River. The pasture area studied lies in the foothills rising above the valley of the Luckiamute, and consists of an area approximately one-hundred acres in size. (Plate I).

The topography of the study area consists of many



Upper Kings Valley, north of the pasture area analyzed

PLATE I

ridges and deep watersheds, with slopes of the ridges varying from nearly level to sixty degrees. The pasture was divided into five tracts which had received different cultural treatments. Three of these tracts are on hill crests or terraces which have proven sufficiently level for cultivation, and two lie on steep slopes.

The five tracts will hereafter be designated as follows: (consult figs. 1 and 2) Area 1, containing twenty acres and lying in a long winding strip along the top of a terraced area. The entire hill had been cleared of trees, but only the level portions had been cultivated, while the steeper sides had been left undisked. The seeded area is paralleled by a tributary creek derived from another live spring. The latter creek has formed a broad shallow flood plain at the area of junction with the main creek. (Plate II).

Area 2, includes thirty acres, and lies in an "L"-shaped strip approximately thirty feet higher than Area 1. It is bordered at the southwestern tip by the head of the main creek which runs parallel to Area 1, and a small semi-permanent pool is located at the southern end. Two knolls rise near the center of the area. (Plate II)

Area 3 is the highest of the areas studied, with an elevation approximately one hundred and fifty feet above Area 1. Approximately fifteen acres are included in this tract. The area lies on the crest of the hill, on the

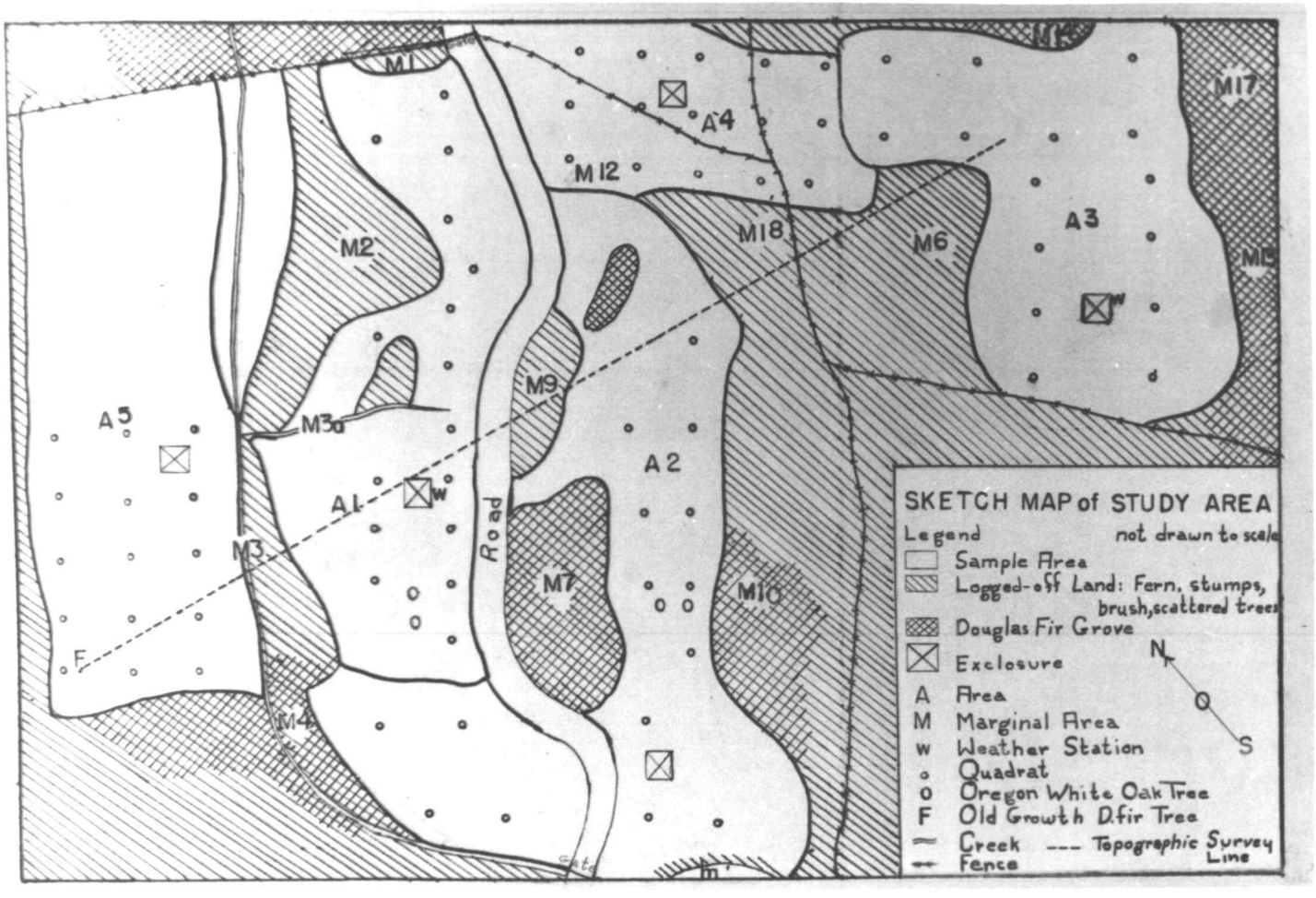

M1
M17
A4
M12
M18
M6
A3
M2
M9
A5
M3a
A2
A1
M3
Road
M7
M10
F
M4
SKETCH MAP of STUDY AREA
Legend
not drawn to scale
Sample Area
Logged-off Land: Fern, stumps, brush, scattered trees
Douglas Fir Grove
Exclosure
N
O
S
A Area
M Marginal Area
w Weather Station
o Quadrat
o Oregon White Oak Tree
F Old Growth D.fir Tree
Creek --- Topographic Survey Line
Fence

Fig. 1.

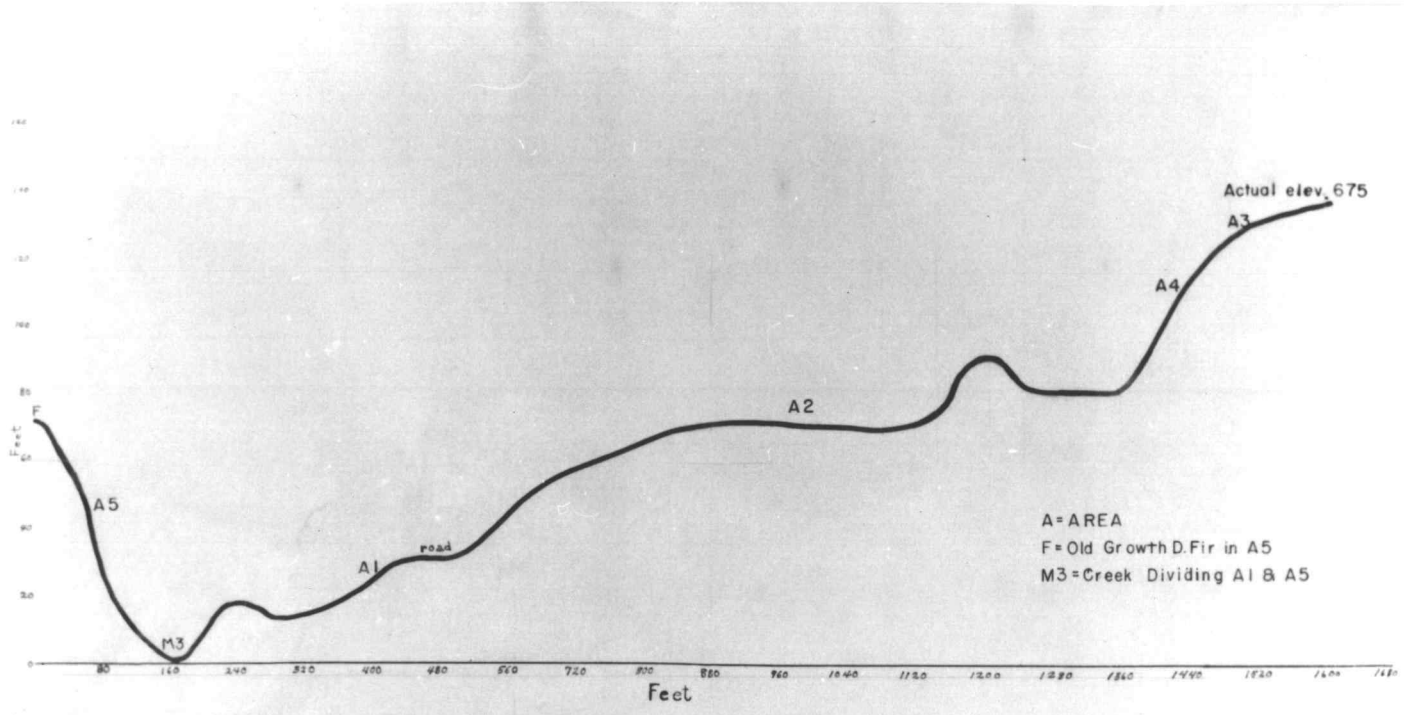


Fig. 2. Topographic profile of study area, run along a line 110°SE from old growth fir on Area 5. (see fig. 1)

View of pasture area looking north from Area 4. Area 2 in left foreground, Area 1 in right foreground, and Area 5 in extreme right background.

PLATE II

terraced sides of which are found Areas 1, 2 and 4. It is relatively level and lies in the form of an "L" with equidistant arms. No streams are found in the area, although a small swale occurs at the center and leads into a watershed (M8, fig. 1).

Area 4, containing twenty acres, lies on the side of a hill on a forty-five degree slope with southern exposure. The vegetation area lies the entire length of the hill and is unbroken by streams or watersheds.

Area 5 was placed on a long smooth hillside with southeastern exposure, which paralleled Areas 1 and 2. The slope angle is sixty degrees and this is by far the steepest slope of the entire study area. No creeks cross it, but the main creek mentioned under the description of Area 1, parallels the base of the hill. The area contains approximately twenty-five acres. (Plate III).

Vegetation and Cultural Treatment

The present owner of the farm, who has lived in this area his entire life to the present time, states that the original vegetation consisted of Douglas fir and a small amount of oak, and that the hills were originally completely forested. It is possible that lowland white fir was present, as suggested by its presence in the marginal areas at the present time, but the owner did not make this distinction. Approximately forty years ago,

View to the west of the northern end of Area 2. Area 5 in background, with a portion of Area 1 in foreground.

PLATE III

all of the timber was slashed and burned. The area has been burned at varying intervals since that time in an attempt to maintain clear areas and retard the invasions of bracken fern and Oregon white oak. It has been pastured, and at approximately six different times, pasture grass mixtures of ryegrasses, fescues and velvet grass (Holcus lanatus L.) have been scattered over the region. At the time the pastures described in this paper were established, the hills were covered by a dense stand of bracken fern, small scrubby white oak and a few young Douglas fir trees. The last burning is estimated to have been between eight and ten years ago. This study is concerned with the five areas listed above which have received diverse treatments in the past six years. Since the entire area has suffered much disturbance and no portion of it has been unseeded, the control areas chosen were those which, while cleared and burned, have not been cultivated.

The cultural treatment of the pasture has been as follows:

1. Uncultivated areas:

   Area 5: in 1944, Alta fescue and velvet grass seed was broadcast into the undisturbed vegetation.
   Area 4: the same treatment.

2. Cultivated areas:

   All pastures: the larger young Douglas fir and oak which had appeared following the last burning were cut approximately three feet from the

ground. The stumps were then pushed from the ground by use of a bulldozer. These uprooted stumps, the cut main trees, smaller trees and shrubs and debris remaining from former fires were bulldozed to the edges of the areas to be seeded. The areas were then disked four times with a heavy tandem disk to a depth of approximately six inches. Following this, the soil was harrowed twice. The seed in amounts of twenty-five to thirty pounds per acre was then broadcast on the seedbed.

Area 3: 1945; seeded to Tualatin Valley strain of tall oatgrass, highland bentgrass (Agrostis tenuis Sibth. var.) and perennial ryegrass. Hay was cut from the pasture during the years following seeding, with the exception of the summer of 1950, when it was unpastured and allowed to go to seed. Some of the seed was stripped by hand, but most was allowed to remain and be shed onto the ground.

Area 2: 1947; seeded to a pasture mixture of tall oatgrass, perennial ryegrass, creeping red fescue, alta fescue, velvet grass and subterranean clover, Mt. Barker strain (not inoculated). The area was mowed early in July 1948 to cut down the fern, but was sllowed to go to seed in 1949 and 1950.

Area 1: 1949; seeded to a pasture mixture of perennial ryegrass, creeping red fescue, velvet grass and subterranean clover. In addition to this standard pasture mixture, grey oats (Avena sativa L. var.) was broadcast by hand on the eastern portion of the area.

It was believed by the owner that the pasture grasses were mixed in approximately equal amounts, with the exception of tall oatgrass in area 2, which was added in smaller amounts.

Along the margins of these cultivated areas exist small patches of native vegetation and these will be described as follows. (Numbered letters refer to the designations as given in fig. 1).

Area1: two large Oregon white oaks occur in the

center of the southern end of the strip. At the extreme southwestern end of the area, the creek has formed a deep gorge (M4), the sides of which are covered with douglas fir, two lowland white firs, and associated species (consult Appendix I for complete species list). At the southeastern extreme of the area and paralleling the pasture approximately half of its length is found another group of Douglas fir (M7). Oak scrub and such shrubs as blackberry, elderberry (Sambucus glauca Nutt.) etc. are found on the unseeded portions of the hill adjacent to the main pasture (M9, M2, M12). In the center of the area is the tributary creek (M3a) and along both it and the main creek (M3) are found aquatic and subaquatic species such as Juncus spp., Mimulus guttatus D. C., M. dentatus Nutt., Carex spp. etc. At the northern end of the area (M1) is a small group of Oregon white oak. The entire eastern side of the area is paralleled by a summer road.

Area 2: this area is bordered at the extreme southwestern tip by the same group of Douglas fir and lowland white fir as described for Area 1 (M4, Plate IV). On the southeastern end of this marginal region are found bigleaf maple, willow (Salix spp.), Oregon ash (Fraxinus oregona Nutt.), etc. Around the pool at the southern end of Area 2 (M5) are Oregon ash, willow and black hawthorn (Crategous Douglasii Lindl.). The central portion of this area is bordered on either side by small groves of Douglas

PLATE IV

Group of Douglas fir and associated species at southwestern tip of Area 1 (M4). One individual of lowland white fir is present, as marked (x).

fir with two large oaks in the center of the pasture. Contiguous with the northern end of the area are unseeded areas composed of oak, blackberry and associated species (M12).

Area 3: on the northern, northwestern and eastern sides, the area is bordered by a heavy stand of Douglas fir and oak (M13, M6), and on the southern and southwestern sides by cuttover stump land, now covered with blackberry and fern (M7).

Area 4: The area is bordered on the northwestern side by a scrub-oak hillside and on the southwestern side by a floodplain of the ravine lying between the arms of Area 3 (M8).

Area 5: This area terminates at the edge of the creek (M3) and thus at the southern tip is bordered by a streamside grove of Douglas fir and associated vegetation. Over the crest of the hill from the tract are found young Douglas fir, and at the northern end is a grove of oak and fir. One large old-growth Douglas fir stands at the southern end of the area near the crest of the hill. (Plate III).

PROCEDURES AND APPARATUS

The study of this pasture area included both vegetational and environmental analyses.

Environmental Analysis

One of the main tenets of the survey was the determination of successional trends, using areas which had received different treatments over varying lengths of time, rather than conducting a study of one area over a period of several years. Since this would be possible if no significant habitat differences existed, it was believed advisable to determine the microclimates of each pasture. Soil studies were made in all areas. Originally, weather data were also taken for each area, but it was soon discovered that only Areas 1 and 3 varied to any significant extent and so permanent weather stations were set up in these areas only.

The soil analysis included a study and determination of the following: (1) profiles; (2) acidity; (3) moisture content, including both field capacity and actual amount determinations; and (4) mineral content. Pits were dug to the C horizon in each of the five areas to ascertain the depth and texture of the soils. Profile mapping was relatively meaningless, since the soil in the three seeded areas had been heavily disked; however, observations were made of the soil conditions at various levels. The materials comprising the substratum were identified by the Department of Geology of Oregon State College.

Soil reaction was determined with the La Motte soil pH kit, using chlorophenol red and bromcresol green

indicators. Three samples were taken from the top five inches of the soil in each area and the pH was ascertained colormetrically in the field. An additional pH determination was made by the Department of Soils, Oregon State College.

Fresh soil samples were taken from the top six inches of the soil for moisture content determinations. Each sample was placed immediately into a half-pint milk bottle and capped, the tops of the bottles then being sealed with paraffin. Four samples were taken at different locations in each area. The sealed bottles were then taken to the laboratory, unsealed and weighed, oven-dried at a temperature of 110°C for twenty-four hours and reweighed. The weights were obtained in both readings from which the percentage of moisture contained in the samples was calculated and an average moisture content for each area obtained. Moisture content was determined at two different times during the season, on July 11 and July 24. Field capacity of the soils was determined as follows: the sample was oven-dried and weighed, saturated, drained until dripping ceased and reweighed. An approximation of the absolute moisture holding capacity of the soil was determined from the weights obtained.

The percentage content of potassium and phosphorus in each of the soils was determined by the Department of Soils, Oregon State College, using standard soil

analytical methods.

Weather stations were set up in Areas 1 and 3, with some readings being taken in the other three areas. The permanent stations were placed within the exclosure fences, these latter to be described later. Data were obtained on: (1) temperature, both maximum-minimum, and air temperature at a level of six feet from the ground surface; (2) evaporation; (3) insolation and (4) relative humidity.

In Area 1, a Friez recording thermograph was installed, and a Taylor maximum-minimum thermometer was set up in Area 3, from which weekly readings were taken. Both of these instruments were placed in shelters to prevent direct sunlight from striking them. Whenever possible, air temperature readings were taken three times daily--8:00 am., 12:00 noon, and 4:00 p.m.

Evaporation and insolation data were obtained by placing two black and white bulb Livingston atmometers in each of the two areas (Plate V). These instruments were constructed according to directions given in Gates' manual (p. 81), and were supplied with mercury rain traps. Quart bottles were used as water containers and the instruments were kept in continuous operation from June 14 to September 19.

PLATE V

Black and white Livingston atmometers used in Area 1 (above) and Area 3 (below). Exclosure fences are seen in immediate background.

Vegetational Analysis

It was desired to analyze the vegetation from two points of view: (1) floristic, and (2) forage production.

The floristic composition of the communities was determined by the list count method and for this purpose, the square meter quadrat was arbitrarily chosen as the sample plot. This size is used rather consistently by many workers and has been found to give satisfactory results in homogeneous grassland communities (8, p. 11).

Possible correlation of the results found in the different pastures necessitated placing the same number of quadrats in each. This number was set at fifteen, after species-number curves were plotted for each area (10, pp. 573-581, 53, pp. 44-49). The quadrats were laid out in a one-hundred foot grid pattern. Compass lines were followed in general north-south, east-west directions and the distances between successive quadrats were determined by pacing. In one instance, in Area 2, the pasture strip was too narrow to allow the full one-hundred feet between quadrats and it was necessary to place those quadrats closer together. The minimum distance between quadrats was sixty feet. Quadrat lines were placed at least fifteen feet toward the interior of the pasture from all marginal regions, since data on only the vegetation of the seeded plots themselves were desired.

The individuals of each species within the square

meter plot were counted. Most of the grasses were of a single-stemmed growth habit, and the grass count was made by stems. Those grasses which under optimum conditions exhibit a tufted habit of growth were found in this area in very small tufts and were also counted by the number of stems. Stoloniferous plants, such as Fragaria spp. were counted by the number of rooted plants. Total abundance, frequency, density and relative abundance were determined for each species. Since most of the plants, with the exception of such species as bracken fern and common thistle (Cirsium lanceolata (L.) Scop.) were of approximately similar size, it was believed that abundance figures would adequately express the place of the species within the community and, therefore, coverage data were not obtained. These special cases only were noted and coverage data for them were estimated to the nearest ten percent.

It was desired to compare the amount of forage produced on each of the five different areas, under conditions of both pasturing and non-pasturing. "Forage" in this instance, included all grasses and forbs which were considered to be edible by the livestock. It was also desired to compare the weight of the fern on the five different areas under conditions of grazing and non-grazing. These purposes were accomplished with the use of exclosures, one of which was set up in each area. The exclosures were one hundred square feet in area and con-

structed of four steel posts with six-inch stay woven wire (Plate VI). At two week intervals one square meter plot within and without the exclosure in each area was clipped one inch from the ground. Each clipping was made on previously unclipped areas to determine the rate of production during the growing season. The clipped plants were separated into "forage" and "fern". The samples harvested were air-dried for twenty-four hours, at which time they were rolled in paper and stored for one month in a dry place. At the end of this period they were weighed to the nearest one-half gram.

Throughout the growing season, aspectional data were recorded for each species, note being taken of the time of flowering and fruiting.

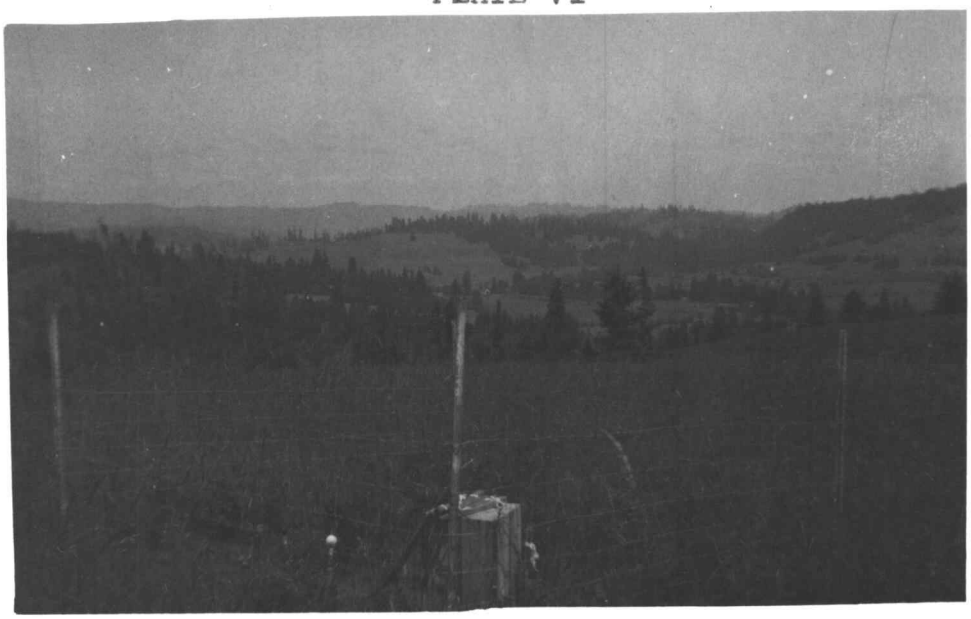
Specimens were collected of all but the most common herbaceous species in the area. Two sets of herbarium specimens were prepared; one of these was retained as the personal property of the author and the other was deposited with the Oregon State College Herbarium.

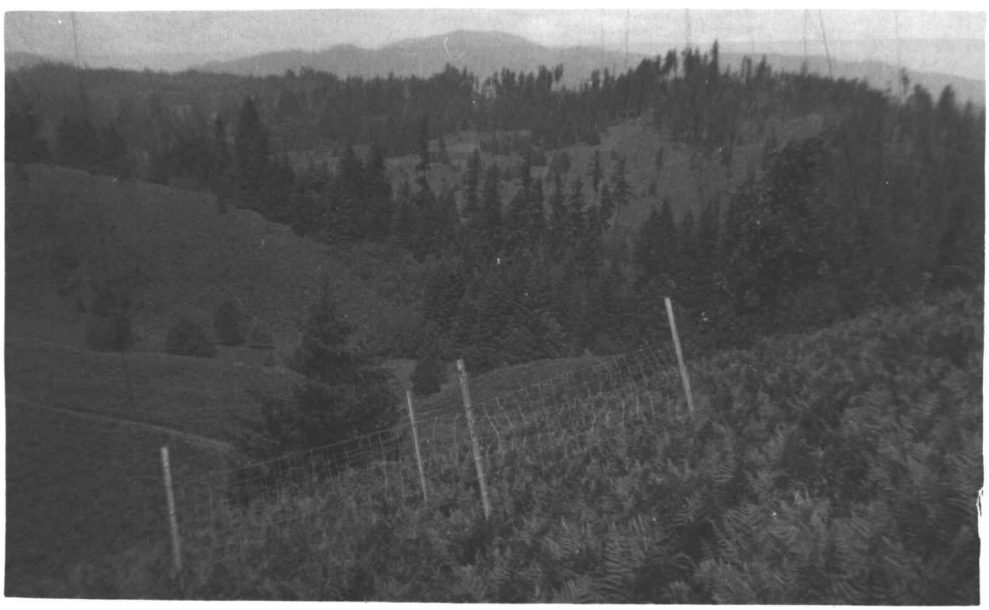
PRESENTATION AND DISCUSSION OF DATA

Environmental Analysis

The soil of the entire area of study is classified as Melbourne clay loam, and is underlain by impure sandstone, containing volcanic ash, Muscovite, quartz and

PLATE VI





Exclosures placed in Area 3 (above) and Area 4 (below). Box in Area 3 exclosure contained maximum-minimum thermometer.

feldspar. The profile surveys made in each of the five areas, revealed very similar configurations. In each area, the depth of the A and B horizons totals approximately two and one-half feet. The soil is compacted in all of the pastures, with the exception of Areas 1 and 3. In the former, it is very hard below the level of penetration of the disk, and in the latter is quite loose and crumbly to a depth of approximately six inches. In the areas where the strongly compacted condition prevails, the soil is fine and crumbly in structure when broken. The top soil is a grey-brown in color and ranges through yellow and red to the yellow-brown sandstone shale substratum in all areas, except Area 3, where a darker chocolate brown coloration is found throughout. An A_o (litter) layer is found in Areas 4 and 5 only, and consists mainly of fern residue. Area 3 possesses a surface layer of partially decayed leaf litter, which is well mixed with the upper soil layer.

Analyses were made of soil reaction, mineral content, actual moisture content, and field capacity percentages in each of the five pastures. These data together with their deviations from their means are presented in Table I.

Based upon the data obtained, it would appear that the five areas may be considered homogeneous in most of the soil characteristics. Soil moisture content figures

Table I: Results of analyses of soil reaction, moisture content, field capacity and mineral content

Area	Station	Moisture Content in Grams: actual run #1 7/11/50	actual: deviation from mean	actual run #2 7/24/50	actual: deviation from mean	Field Capacity: amt. in grams	Field Capacity: deviation from mean	pH	dev. from mean	Mineral Content: K	Mineral Content: P
1	a	14	1	10	2	32	0	5.6	.14	high	200*
	b	18	3	12	0	33	1	5.6	.14		high
	c	16	1	8	4	31	1	5.6	.14		
	d	--	-	10	2	--	-	-	-		
2	a	17	2	14	2	30	2	5.6	.14	high	55-60
	b	19	4	15	3	30	2	5.8	.06		low
	c	13	2	11	1	34	2	5.6	.14		
	d	--	-	10	2	--	-	-	-		
3	a	18	3	8	4	27	5	5.6	.14	high	25-50
	b	12	3	14	2	33	1	5.6	.14		low
	c	15	0	13	1	31	1	5.8	.06		
	d	--	-	11	1	--	-	-	-		
4	a	16	1	14	2	31	1	5.6	.14	high	80
	b	16	1	14	2	32	0	5.6	.14		medium
	c	18	3	11	1	32	0	5.6	.14		
5	a	17	2	12	0	33	1	6.4	.66	high	200
	b	15	0	11	1	35	3	6.2	.46		high
	c	11	4	11	1	35	3	6.0	.26		
Mean		15		12		32		5.74			
Standard deviation			2.3		2.1		2.0		.26		
Standard error		0.7		0.5		0.55		0.07			

*Phosphorus in available lb/acre

and field capacity data show very few deviations from the mean greater than standard deviation.

Data obtained relative to soil reaction in the five areas show that in Areas 1, 2, 3 and 4 all of the samples exhibited a deviation from the mean well within standard deviation. In Area 5, the readings were elevated as high as 0.8 of a pH unit above the average for the other areas, and show a deviation from the mean consistently above the standard deviation for the combined areas.

Potassium content was high in all areas, while the percentages of available phosphorus showed strong variations. The latter element was high in Areas 1 and 5, low in Areas 2 and 3 and medium in Area 4.

The most important differences within the areas with respect to edaphic conditions would appear to be in the content of available phosphorus. Potassium content, moisture content, field capacity, and pH in all areas are seen to correspond closely enough to nullify these factors as presenting significant differences among the pastures, noting only the fact that a higher pH was found in Area 5. The areas were widely divergent in available phosphorus alone.

Readings were taken of temperature, both air and maximum-minimum, evaporation, insolation and relative humidity in an effort to determine possible differences

in microclimatic factors in the five pastures. Evaporation and insolation data obtained by use of black and white atmometers are presented in Table II. Temperature and relative humidity measurements are presented in Table III. To better portray relationships and correlations among the data obtained in the different areas, some of the results are presented graphically (figs. 3, 4 and 5).

The most consistent weather differences among the areas were found in evaporation and insolation (Table II, figs. 3 and 4). Consideration of fig. 3 reveals that the evaporation on Area 3 was higher than that of Area 1 throughout the growing season. The difference in location of the two pastures probably constitutes the major reason for this fact, since Area 3 lies on the crest of a hill, where it is undoubtedly subjected to more wind movement than is the more protected Area 1. At the same time, due to greater insolation during the daytime regardless of the position of the sun, the former area would tend to have higher temperatures, resulting in a higher evaporating power of the air. The readings in the two areas followed the same general trend, and many times were very similar. However, it may be concluded that the evaporative power of the air in Area 3 was superior to that of Area 1 during the season in which this study was made.

Fig. 4 presents graphically the measurements of insolation during this same period of time. Until July

Table II: Evaporation and insolation data as obtained with Livingston black and white atmometers. Figures represent cubic centimeters of water lost since previous reading.

Date	Time	Evaporation: loss from white bulbs		Insolation: black bulb minus white bulb loss	
		Area 1	Area 3	Area 1	Area 3
June 4	8:10 am	14.2	10.3	1.6	5.6
20	8:15 am	44.5	50.8	27.3	34.8
21	8:10 am	11.4	12.2	7.8	9.1
24	4:30 pm	36.7	41.7	25.8	34.2
28	8:10 am	39.0	57.5	33.7	36.1
July 1	8:00 am	103.0	185.0	93.4	70.2
3	8:10 am	39.0	51.5	22.6	27.3
11	8:25 am	50.7	53.1	36.2	49.9
12	8:20 am	33.6	46.1	15.44	19.5
14	8:20 am	98.3	128.7	18.3	65.7
19	1:20 pm	117.0	126.5	65.8	90.4
23	1:35 pm	139.7	148.4	60.3	62.4
24	8:10 am	28.1	29.6	18.5	17.2
30	8:25 am	144.3	156.0	69.0	77.2
Aug 10	2:15 pm	74.5	97.9	48.5	30.1
17	2:30 pm	206.1	251.2	132.1	88.8
24	1:10 pm	213.7	277.7	23.4	18.7
31	11:55 am	171.6	217.6	100.9	94.4
Sep 12	11:30 am	96.7	102.9	48.4	56.9
17	9:20 am	63.9	70.2	34.8	36.3

24, Area 3 recorded consistently the receipt of more insolation than did Area 1. However, after this date, the positions were reversed and the lower station was found in receipt of the larger amount. No explanation is offered here for this phenomenon. In most instances, the readings did not vary greatly between the two areas, but were consistent for the periods during which the instruments of one area were registering the greater insolation than were those of the other.

Air temperatures were originally recorded for all areas, but later records were kept for only Areas 1 and 3 (Table III). In all cases, little variation was observed

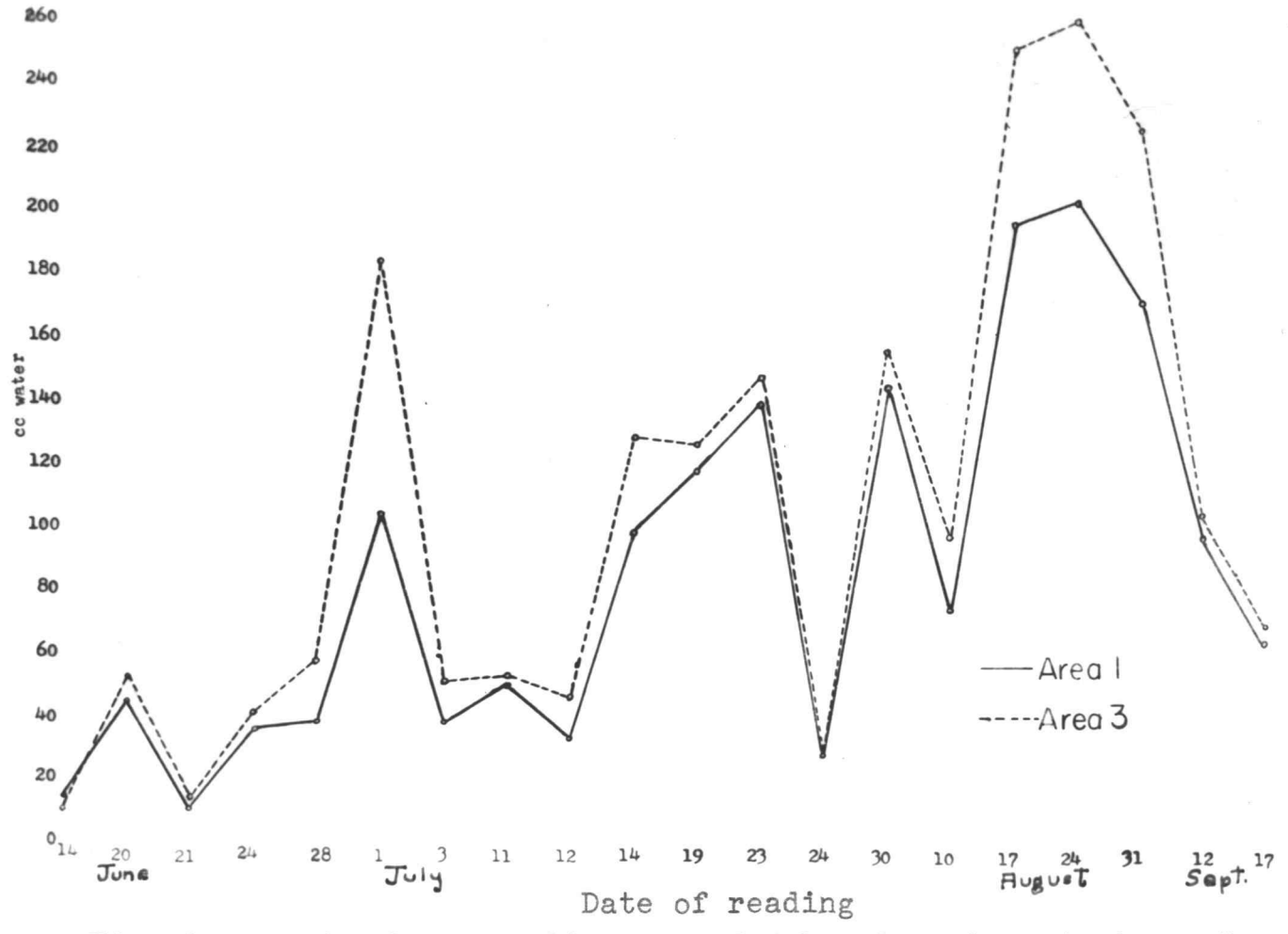


Fig. 3. Graph of evaporation recorded by atmometers in Areas 1 and 3. The x-axis is not drawn to scale, but represents the dates upon which readings were made.

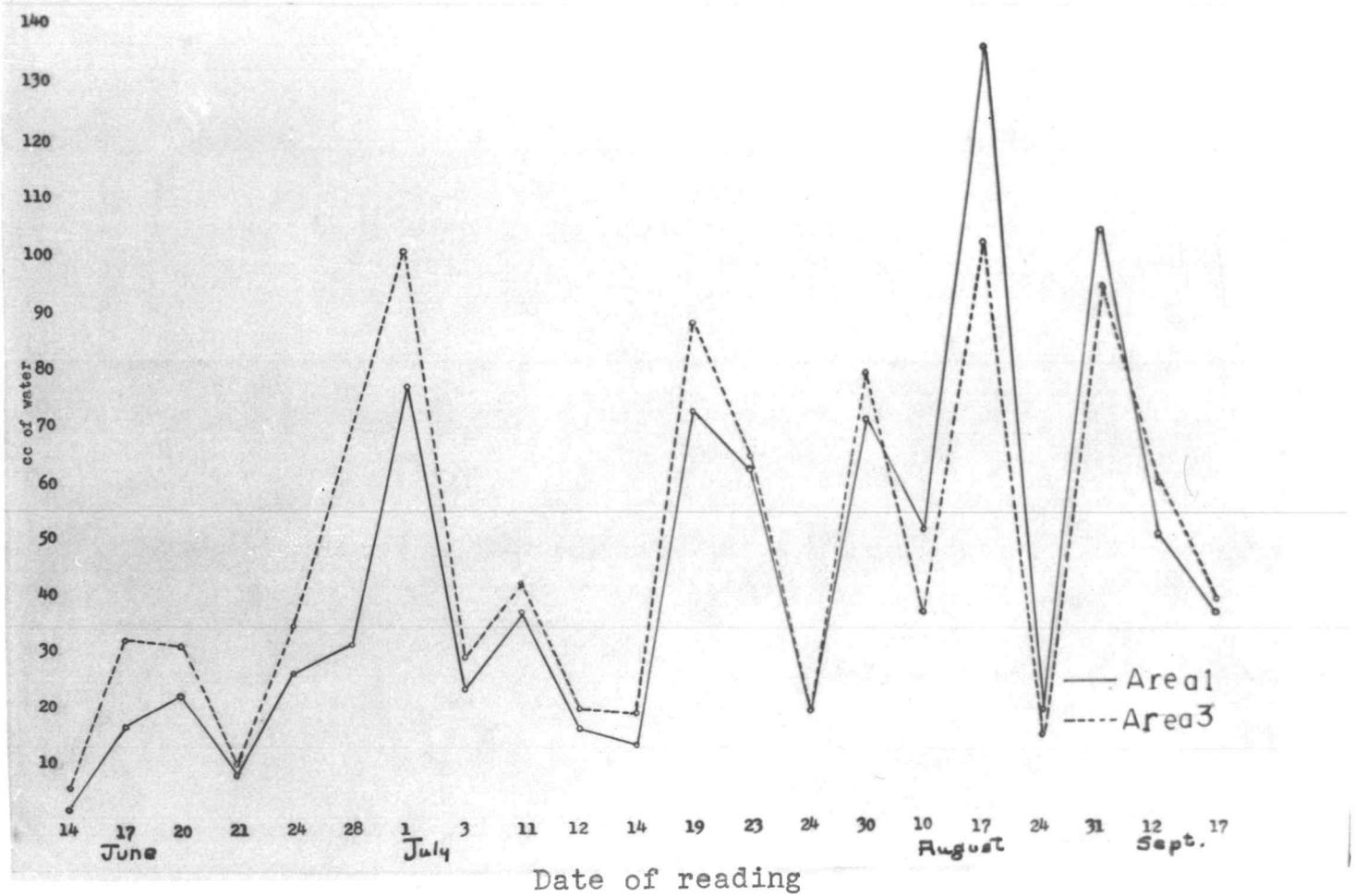


Fig. 4. Graph of insolation recorded by atmometers in Areas 1 and 3. x-axis is not drawn to scale. Note crossing of lines at time of July 30 reading.

Table III: Air temperatures, maximum-minimum temperatures and relative humidity data taken during the growing season. Maximum-minimum temperatures recorded from previous week.

Date	Time	Area	Temperature			Relative Humidity
			Air	Max.	Min.	
April 30	1:00 pm	1	54			70
	1:05	2	54			70
	1:10	3	54			70
	1:12	4	54			70
	1:15	5	54			70
May 7	8:45 am	1	48	66	46	66
	9:04	3	48	64	48	66
	9:08	2	48			66
	9:12	4	48			60
	9:15	5	49			54
12	7:55 am	1	45	79	34	93
	8:05	5	45			93
	8:25	2	47			86
	8:30	4	47			86
	8:40	3	56	84	34	76
	11:30	1	64			70
	11:40	2	64			70
	11:45	4	64			70
	11:50	3	66			60
20	7:58 am	1	49	72	34	86
	8:02	5	51			87
	8:07	2	51			87
	8:15	4	50			87
	8:20	3	53	78	36	81
28	8:00 am	1	45	84	31	86
	8:02	5	45			86
	8:05	2	45			86
	8:08	4	46			79
	8:13	3	46	88	44	76
June 13	7:50 am	2	52			87
	7:54	1	54			88
	7:61	5	54			88
	8:05	4	54			94
	8:15	3	56			76
	11:40	3	58			77
	11:45	4	58			77
	11:50	1	60			73
	11:54	5	59			72
	4:30 pm	3	60			73
	4:35	4	60			73
	4:38	1	60			73
	4:42	5	60			73
	4:45	2	62			74
June 14	8:06 am	2	55			82
	8:10	1	55			70

Table III (cont.)

Date	Time	Area	Temperature			Relative Humidity
			Air	Max.	Min.	
June 14	8:13 am	5	55			82
	8:17	4	56			70
	8:30	3	54			82
June 18	7:55 am	2	54			
	8:02	3	54	87	46	94
	8:10	4				94
	8:18	1	55	82	48	94
	8:22	5	55			88
	12:20	3	70			72
	12:25	4	70			77
	12:30	1	70			77
	12:35	2	70			77
20	8:15 am	1	60			89
	8:25	3	59			89
	4:55 pm	1	60			73
	5:05	3	60			73
21	8:02 am	1	54	84	50	76
	8:15	3	54	90	42	74
27	12:10 pm	1	77	72	40	58
	12:15	3	77	91	41	48
28	8:00 am	1	65			84
	8:07	3	64			84
July 2	8:10 am	1	63	88	45	69
	8:20	3	63	92	46	69
	5:05 pm	1	90			30
	5:10	3	90			31
3	8:10 am	1	62			74
	8:20	3	66			69
	12:00noon	1	82			38
	12:10	3	85			37
11	8:20 am	1	56			65
	8:30	3	60			82
	12:01 pm	1	67			53
	12:10	3	68			45
	4:55 pm	3	76			31
	5:05	1	78			23
12	8:15 am	1	68			58
	8:25	3	70			53
	12:01 pm	1	84			41
	12:07	3	84			38
14	8:10 am	1		97	38	
	8:25	3		96	40	
23	1:30 pm	1		91	42	
	1:35	3		92	46	
24	8:00 am	1	62			62
	8:15	3	64			64
	12:00 noon	1	84			78
	12:15	3	82			84

Table III (cont.)

Date	Time	Area	Temperature			Relative Humidity
			Air	Max.	Min.	
July 24	5:10 pm	1	85			84
	5:20	3	88			84
30		1		91	45	
		3		96	46	
Aug. 10		1		82	42	
		3		84	42	
17		1		96	44	
		3		92	46	
24		1		100	48	
		3		102	50	
31		1		88	43	
		3		92	36	
Sep. 7		1		98	40	
		3		94	38	
12		1		92	41	
		3		92	44	
17		1		79	41.5	
		3		87	40	

and none of the pastures exhibited consistently higher or lower temperatures. Maximum and minimum temperatures were recorded weekly for Areas 1 and 3 (fig. 5, Table III). These readings varied to a certain extent, but as a general trend, it was observed that Area 3 recorded slightly higher maxima and lower minima through the season. In only three instances, however, were there recorded differences greater than five degrees.

The relative humidity data obtained are probably the most unreliable of the weather records taken, due to the rapidity of change of this factor with slight changes in atmospheric conditions, and to the distances between the several stations. (Table III). The early morning readings were extremely erratic and showed little correlation, while those taken at noon and 4:30 p. m.

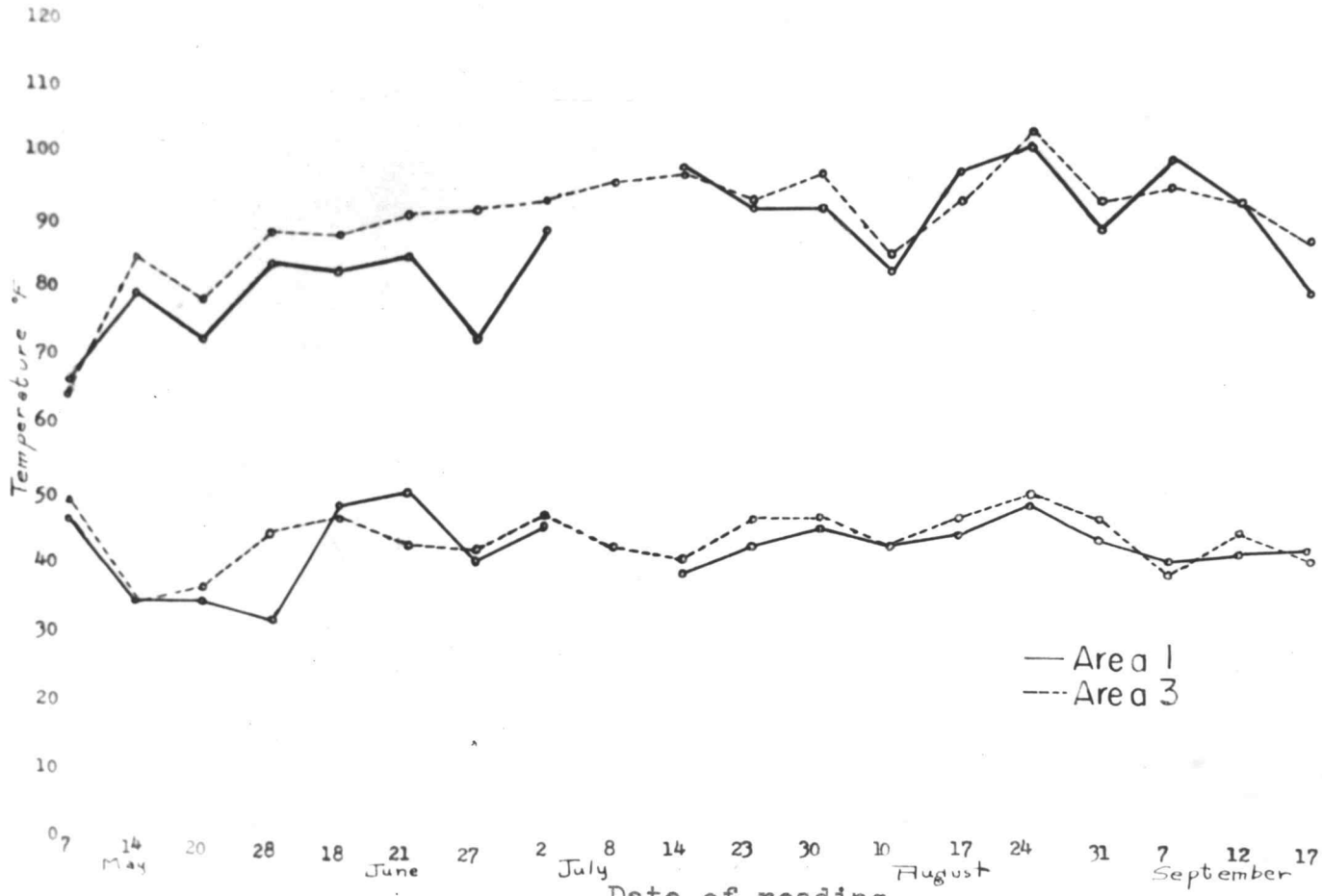


Fig. 5. Graph of maximum-minimum temperatures recorded in Areas 1 and 3. x-axis not drawn to scale. Break in Area 1 line between July 2 and 14 is due to interruption of thermograph action by a field mouse.

followed patterns more closely similar. It is probable that the wide variance in the morning readings might have an explanation in the fact that at that time early fog was often clearing rapidly and the conditions in all probability changed radically in the period of time of necessity found between the readings. At times, a half-hour elapsed between the first and last readings, due to the distances between the stations and the time required to traverse these distances. These figures show no consistent variation in the early morning, but would seem to indicate that at noon the relative humidity of Area 3 was slightly lower than that of Area 1, while the reverse was true at 4:00 p. m. For the latter data, readings were too infrequent to allow more than the suggestion of this correlation.

In summary, it would appear that although the areas are essentially homogeneous with respect to edaphic and climatic factors, several differences are evident. Area 5 possessed a higher pH and available phosphorus content than did the other pastures. Content of available phosphorus was higher in Area 1 than in Areas 2 and 3. Weather data taken in Areas 1 and 3, which of the seeded pastures possessed the most divergent locations, showed the latter area with higher maximum and lower minimum temperatures and a higher rate of evaporation than the former. Insolation in the areas was higher in Area 3

until mid-summer when Area 1 become the recipient of the greater amount. The foregoing are the most consistent variations found in the weather data. In all other factors the records show relatively close correlations, and even in these specific instances, the differences are rarely of high magnitude. It is probable that climatic factors may be considered of relatively little importance for comparison of the pastures with one another, since the variances found would in all probability be well within the tolerance ranges of the vegetation. The soil conditions, especially the content of soil nutrients, probably constitute the factors of paramount importance in this matter.

Vegetational Analysis

The complete species list for the entire area, both marginal and in the sample plots themselves, will be found in Appendix I.

In Table IV are presented the results of the quadrat measurements in the five areas. Total abundance, relative abundance, frequency and density of each species of trees, shrubs, native forbs and grasses and cultivated grasses are presented.

To facilitate description of the vegetation as it appears in these pastures, the results of the analysis will be presented and discussed for each area separately.

TABLE IV : DATA FROM QUADRAT LIST COUNTS

Species	Total Abundance					Relative Abundance					Density					Frequency				
Areas	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Trees																				
Pseudotsuga taxifolia	19	86	181	30	31	0.1	0.5	0.7	0.6	1.2	1.3	5.7	12.1	2.0	2.0	40.0	86.5	93.5	20.0	73.5
Quercus Garryana		4			2		-			0.1		0.3			0.3		13.3			13.3
Acer macrophyllum		1		5	1		-		0.1	-		0.7		0.3	0.1		6.6		26.6	6.6
Rhamnus Purshiana		3					-					0.2					13.3			
Shrubs																				
Rubus vitifolius	96	68	46	198	167	0.5	0.4	0.2	5.8	6.4	6.4	4.5	3.1	10.5	11.1	100.0	100.0	86.5	100.0	100.0
Corylus rostrata var.	3	1				13.3	-				0.2	0.7				13.3	6.6			
Rosa rubiginosa	1	1			5	-	-			0.2	0.1	0.7			0.3	6.6	6.6			33.3
Symphoricarpos albus	1	13		44	5	-	0.1		0.9	0.2	0.1	0.9		2.9	1.5	6.6	26.6		86.5	33.0
Rubus parviflorus				36	6				0.7	0.2				2.4	0.4				26.6	33.0
Grasses																				
Avena sativa	715					3.7					47.6					60.0				
Festuca rubra	352	11				1.83	0.1				23.4					79.5				
Holcus lanatus	1006	775	173	72	64	5.2	4.1	0.6	1.4	2.5	66.4	51.7	11.5	4.8	4.3	100.0	93.5	80.0	73.5	66.0
Lolium spp.	11568	3207	20	4	6	60.5	17.1	0.1	-	0.2	771.0	213.8	1.3	0.3	0.4	100.0	100.0	26.6	13.3	13.3
Arrenatherum elatius	150	955	4902	67	3	0.8	5.1	33.4	1.3	0.1	10.0	63.6	323.5	4.5	0.2	66.5	93.5	100.0	60.0	6.6
Festuca elatior var.		446			3		2.4			0.1		29.7			0.2		80.0			6.6
Festuca Myuros	1004	3108	1865	186	19	5.2	16.6	6.9	3.6	0.7	66.3	207.2	124.1	12.4	1.3	100.0	100.0	93.5	66.6	26.6
Dactylis glomerata	22					0.1					1.5					20.0				
Bromus mollis	331	3144	2982	212	36	1.7	16.8	11.0	4.2	1.4	22.0	210.0	198.5	14.3	2.4	53.0	93.5	93.5	53.2	40.0
Bromus commutatus	435	14	21	241	10	2.3	-	0.1	4.7	0.4	29.0	0.9	1.4	16.1	0.7	79.5	13.3	13.3	93.5	20.0
Bromus rigidus		1		1			-		-			0.7		0.1			6.6		6.7	
Poa pratensis	1045	1751	2659	124	13	5.5	9.4	9.8	2.4	0.5	69.6	117.0	177.0	8.3	0.9	86.5	93.5	100.0	53.2	13.3
Aira caryophylleae	170	1763	2620	264	20	0.9	9.4	9.7	5.2	0.8	11.3	117.3	174.5	17.6	1.3	66.5	93.5	100.0	66.6	20.0
Anthoxanthum odoratum		86			7		0.5			0.3		5.7			0.5		13.3			13.3
Deschampsia elongata		29					0.2					1.0					26.6			
Cynurus echinatus		12					0.1					0.8					20.0			
Forbs																				
Pteridium aquilinum	480	223	44	448	269	2.5	1.2	0.2	8.8	10.3	32.0	14.8	2.9	29.9	17.9	100.0	100.0	73.5	100.0	100.0
Trientalis europaea	4			27	104	-			0.5	4.0	0.3			1.8	6.9	6.6			53.5	53.2
Rumex acetosella	17	259	33	18	8	0.1	1.4	0.4	0.1	0.1	1.2	19.7	2.2	1.2	0.5	40.0	60.0	40.0	40.0	20.0
Veronica arvensis	97	26				0.5	0.1				6.5	1.7				66.5	26.6			
Fragaria cuneifolia	44	52	702	626	39	0.2	0.3	2.6	12.3	1.5	2.8	3.5	46.7	41.5	2.6	46.5	20.0	80.0	73.5	20.0
Fragaria bracteata	46	197	543	668	820	1.3	1.1	2.9	13.1	31.6	2.7	13.3	36.5	44.5	54.6	46.5	66.6	93.5	100.0	100.0
Trifolium subterraneum	251	446				0.3	2.4				1.7	29.7				93.5	86.5			
Trifolium dubium	674	897	5514	158		3.4	4.8	20.8	3.1		44.9	59.7	367.0	10.5		100.0	66.6	100.0	26.6	
Iris tenax	17	11	69	109		0.1	0.1	0.3	2.4		1.1	0.7	4.6	7.3		20.0	13.3	20.0	66.6	
Lotus micranthus	376	18	1197	294	38	2.1	0.1	4.1	5.8	1.3	25.1	1.2	79.8	19.6	2.2	86.5	80.0	93.5	86.5	60.0

Species	Total Abundance					Relative Abundance					Density					Frequency				
Areas	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Forbs (cont)																				
Madia sativa	18			7	27	0.1			-	1.0	1.2			0.5	1.8	66.5			20.0	60.0
Hypochaeris radicata	15	139	100	13	2	0.1	0.7	0.3	0.3	0.1	1.0	5.3	66.5	0.9	0.1	33.3	80.0	93.5	40.0	66.6
Sidalcea spicata	25	64				0.1	0.3				1.7	4.3				53.0	53.2			
Lathyrus Nuttallii	8	16	44	10	8	-	0.1	0.2	0.2	0.3	0.5	1.1	2.9	0.7	0.5	26.3	26.6	33.0	33.0	33.0
Lupula campestris var.	30	43	85	249	193	0.2	0.2	0.3	4.9	7.4	2.0	2.9	5.7	16.6	12.8	26.3	73.5	60.0	93.5	93.5
Linanthus bicolor	6	41	712	36		-	0.2	2.5	8.8		0.4	2.7	47.5	2.4		6.6	40.0	20.0	13.3	
Satureja Douglasii	5	15	26	330	122	-	0.1	0.1	6.5	4.7	0.3	1.0	1.7	22.0	8.1	13.3	20.0	13.3	80.0	46.5
Torilis arvensis	1	9				-	-				0.1	0.6				6.6	13.3			
Sherardia arvense	188	589	302	82		0.9	3.1	1.1	1.6		12.5	39.2	20.5	5.5		60.0	86.5	60.0	33.0	
Cirsium lanceolata	45	6			2	0.2	-			0.1	3.0	0.4			0.1	40.0	26.6			13.0
Ligusticum apiifolium	2		9	7	2	-		-	-	0.2	0.1		0.6	0.5	0.3	6.6		20.0	13.0	13.0
Campanula Scouleri	1	21		2	102	-	0.1		-	3.9	0.1	1.4		1.3	6.8	6.6	46.5		6.7	33.0
Prunella vulgaris	4		38	1		-		0.1	-		0.3		2.5	0.1		13.3		20.0	6.6	
Galium aparine	19		42	26	91	0.1		0.2	0.5	3.5	1.3		2.8	1.7	6.1	20.0		26.6	20.0	46.5
Vicia villosa		18	11				0.1	0.1				1.2	0.5				80.0	13.3		
Anemone oregana		17	9		7		0.1	-		0.3		1.1	0.7		0.5		33.0	26.6		20.0
Plantago lanceolata		61	356				0.3	1.4				4.1	23.7				66.6	53.2		
Hieracium albiflorum		102		6	9		0.5		-	0.4		6.8		0.4	0.6		66.6		33.0	33.0
Orthocarpus pusillus		10	1457				0.1	5.4				0.7	98.5				6.6	40.0		
Hypericum perforatum		2	92	323			-	0.3	6.3			0.1	6.1	21.5			13.3	26.6	60.0	
Geum macrophyllum		8			1		-			-		0.5			0.1		6.6			6.6
Veronica americana			159		19			0.6		0.7			10.7		1.3			53.2		60.0
Epilobium paniculatum				70	47				1.4	1.8				4.7	5.1				53.2	13.0
Crepis capillaris				23					0.5					1.5					53.0	
Collomia heterophylla				95	105				1.9	4.0				6.3	7.0				53.2	66.6
Disporum oreganum				1	26				-	1.0				0.1	1.7				6.6	13.0
Trifolium repens			3					-					0.2					13.3		
Sidalcea virgata			1					-					0.1					6.7		
Psoralea physodes					87					3.3					5.8					66.6

Concordantly, the species of each area will be discussed from the standpoint of the position they maintain in a comparative relationship with the other pastures.

Area 1: This pasture was seeded in 1949 to a pasture mixture of perennial ryegrass, Mt. Barker strain subterranean clover, creeping red fescue, and velvet grass, after preparation of the soil by disking and harrowing. Due to the recent cultivation, the ground cover in this area was relatively sparse and open spaces appeared between the perennial plants. Early in the season before the quadrat counts were made, it was observed that many low ruderals were present, greatly exceeding the numbers found in the other areas. These plants included such species as small nemophila (Nemophila sepulta Parish.), common chickweed (Stellaria media (L.) Cyr.) and little western bitter cress (Cardamine oligosperma Nutt.) The appearance of these plants in larger numbers in Area 1 than in the other pastures is believed due to the large amount of bare ground which provided ample space for seed germination, whereas in the older areas the ground was well covered.

Ostensibly, at the time of maturity of the perennial plants, the dominant species in the area was bracken fern which attained a coverage of approximately ninety percent. In height it averaged two and one-half to three feet, which was taller than that found in Areas 2 and 3, but

shorter than that in Areas 4 and 5. Bracken fern would in all probability be considered a seral dominant in this area, since it possessed a frequency value of one-hundred percent, and was recorded with the largest coverage percentage and highest relative abundance of any of the plants of this life form and size. Probably due to fragmentation of the rhizomes by the disk blades in the pre-seeding cultivation, the fern in this area possessed a higher total abundance than found elsewhere in the entire study area. In one section in the northeastern end of Area 1, the fern appeared chlorotic and died early in the season. This phenomenon has been noted by other investigators (6, p. 189), but the reasons for this condition are not as yet clear.

Groves of Douglas fir and other trees exist at the borders of the cleared and cultivated areas. Since natural succession in the Oregon Coast Range proceeds through fern replacement by arborescent species, the invasion of the latter into the cultivated areas would be expected. This is, indeed, the case, and reproduction of both conifers and hardwoods is found throughout the entire area of study. The hardwood species were represented in Area 1 by only one individual seedling of bigleaf maple. Total abundance of Douglas fir seedlings was lower in this area than in the remainder of the pastures, probably due to the heavy disking of the previous fall. All of the

plants were under two inches in height, indicating a single season's growth.

Common blackberry (Rubus vitifolius C. & S.) was the most common shrub noted. Most of the plants were under six inches in runner length or in diameter of clump, but were present in all of the fifteen quadrats and made up a significant member of the native species. Western hazel (Corylus californica (A. DC.) Rose), snowberry (Symphoricarpus albus (L.) Blake) and sweetbriar rose (Rosa rubiginosa L.) were found rarely in the pasture.

The ryegrasses were not separated specifically since it is extremely difficult to distinguish between Lolium perenne L. and L. multiflorum Lam. by vegetative characters alone. The latter species was not found on the unseeded areas and it is assumed that the larger proportion of individuals of this genus in the areas were of the seeded species, L. perenne. Ryegrass was the dominant species among the grasses, both native and cultivated, possessing high total abundance, relative abundance, density and frequency. The clumps were small, but the grass appeared more vigorous here than in the other pastures. It exhibited signs of suboptimum habitat conditions by a light green color, tall spindly growth habit and short infloresences of four to five inches in length. Under optimum conditions, this species may attain heights of four feet with spikes ranging from six to eight inches in length.

Creeping red fescue, although seeded in amounts approximately equal to that of the ryegrass, occurred in reproductive condition in only one of the fifteen quadrats. In the other plots, the species existed as very small, shallow-rooted clumps, with short, pale green and often rolled leaves. It was not found in all of the quadrats, exhibiting a frequency value of only 79.8 percent, and composed only 1.83 percent of the total abundance of all the species. Velvet grass, which grows as an introduced uncultivated plant in the general area, possessed a frequency value of one-hundred percent, and a moderately high density and relative abundance. The bunches of this plant appeared to be thriving and at times attained six to eight inch diameters. Tall oatgrass, although not seeded in the area, was found in ten of the quadrats and presented the healthiest appearance of the cultivated grasses.

Among the native grasses, Kentucky bluegrass and rattail fescue (Festuca Myuros L.) were in abundance, with soft cheat (Bromus mollis L.), downy-sheathed brome (B. commutatus Schrad.) and silvery hair-grass (Aira caryophylleae L.) making up a minor portion of this group.

With the exception of bracken fern, small annuals constituted the majority of the forbs. Small-flowered lotus (Lotus micranthus Benth.), least hop clover (Trifolium dubium Sibth.) and blue field madder (Sherardia arvensis L.) were abundant in most of the quadrats.

Another exception to the small size of the plants in the herbaceous group was common thistle (Cirsium lanceolata (L.) Scop.). Area 1, alone, contained this plant to any marked degree and although it did not present high abundance and frequency, its large size caused it to be a prominent part of the vegetation, especially in the southern end of the pasture to which it was very largely restricted. The strawberries (Fragaria cuniefolia Nutt. and F. bracteata Hel.) did not possess the high abundance and frequency of the annuals previously discussed, but due to their larger size constituted important components of the vegetation.

Subterranean clover which was seeded in the area, but without inoculation, appeared in fourteen of the quadrats, and comprised 1.3 percent of the total abundance. The plants were not large but appeared in better condition in this pasture than in Area 2, the only other plot seeded to this legume.

The size and general condition of the vegetation varied with the topography of the pasture. Quadrats 1 and 12 were located on dry knolls and the vegetation was correspondingly sparse and stunted, while in quadrats 9, 13 and 14, placed in small slumps, the grasses were tall and rank. In these slumps, at the time of counting, the ground was moist immediately under the surface.

Area 2: In 1947, this pasture was seeded to a

pasture mixture of tall oatgrass, perennial ryegrass, creeping red fescue, alta fescue, velvet grass and subterranean clover. Approximately equal amounts of seed of each species were planted, with the exception of tall oatgrass, which was a minor component of the seed. Since the seed mixture differed from that planted in Area 1 in only alta fescue and tall oatgrass, it was hoped that indications of the succession which might be expected to occur in these hill pastures would be obtained. The seedbed was prepared in similar fashion to Area 1 and the pasture had been mowed in the summer of 1948.

Again, bracken fern composed the most obvious feature of the vegetation. However, in this pasture, the average height of the species was somewhat less than in Area 1, and total abundance density and relative abundance were significantly lower. Frequency was still 100 percent, but coverage was estimated at 65 percent.

Seedlings of four tree species, Douglas fir, bigleaf maple, Oregon white oak, and cascara were in the area. Douglas fir only was of importance in the pasture in 1950. The number of seedlings of this species was 86 as compared to 19 in Area 1, while frequency reached 86.5 as compared to 40 percent in the first area. All of the seedlings were of the current season and under two inches tall.

Common blackberry was the dominant shrub, with

snowberry gaining in relative abundance and frequency values over those found in Area 1. One individual of western hazel and one of sweetbriar rose, both small and closely browsed, were present.

Of the cultivated grasses, perennial ryegrass maintained its dominant place, but was much decreased in abundance from that found in Area 1. Relative abundance for the species was 17.1 percent as opposed to 60.5 percent in Area 1. The plant also appeared less thrifty, occurring in very small clumps and at times even single-stemmed. Creeping red fescue was almost absent and its presence was noted in only two of the quadrats, both of which were located in small slumps shaded by Douglas fir or Oregon white oak during part of the day. In none of the sample plots did this species appear in other than the vegetative state. However, it was noted that at the extreme southeastern side of the area, adjacent to a large group of Douglas firs, the plant was in reproductive condition. The individuals of the latter group were not large, but had formed a relatively thick mat of leaves and roots, and produced large panicles.

Tall oatgrass was in excellent condition, and although not abundant due to having been seeded in lesser amounts, was thriving better than the other cultivated grasses. Velvet grass in this pasture was in a similar condition to that found in Area 1, although the frequency

value was slightly reduced.

The relative abundance percentages of soft cheat and rattail fescue were high in this area, and in some of the drier portions made up the main part of the herbaceous vegetation. On top of a dry knoll in the northern section of the pasture, these two species were found in seed at heights ranging from four to five inches. Silvery hairgrass made up a significant portion of this native grass group. These grasses contributed almost nothing to the vegetation from the standpoint of forage value, due to their small size, slender stems and few leaves. All of the weedy grasses found in Area 1 were present in Area 2 and in addition sweet vernal grass (Anthoxanthum odoratum L.) and ripgut brome (Bromus rigidus Roth.), slender hairgrass (Deschampsia elongata (Hook.) Munro) and bristly dog's tail grass (Cynosurus echinatus L.). Kentucky bluegrass possessed higher frequency, relative abundance, and density values in this pasture than in Areal, and was the only native grass which constituted an important part of the summer forage.

The grass population will then be seen to have been composed of many weedy grasses, some of which equaled the dominant perennial ryegrass in number. High frequency values, densities and relative abundances were obtained for many of these weedy species.

Subterranean clover attained greater relative

abundance in this area than in Area 1, although it possessed a lower frequency value. The individual plants were not as healthy as were those in the 1949 seeding, since the foliage was sparse and the stems weak, with elongated internodes. The major native forbs included blue field madder, red sorrel (Rumex Acetosella L.) and least hop clover. Although least hop clover maintained an important place in the weedy vegetation, and possessed a higher relative abundance than in Area 1, the frequency value was lower than in the latter area. Wild field strawberry and wood strawberry assumed positions of increasing importance in Area 2, with the latter especially greater in relative abundance and frequency values over those for the same species in Area 1. Many of the perennial forbs were in greater numbers in this area than in the more recently seeded pasture, among them gosmore (Hypochaeris radicata L.), Nuttall's pea (Lathyrus Nuttallii Wats.), and Scouler's campanula (Campanula Scouleri Hook.). White flowered hawkweed (Hieracium albiflorum Hook.) which did not constitute a portion of the vegetation in Area 1, was present in relatively large numbers and possessed a frequency value of 66.6 percent.

Area 3: Five years before the summer in which this study was carried on (1945) this area was seeded to a pasture mixture of Tualatin Valley strain tall oatgrass, perennial ryegrass and highland bentgrass (Agrostis tenuis

Sibth. var.). The seedbed had previously been prepared, as described for the other areas, by heavy disking and harrowing. The pasture was mowed each summer following seeding, with the exception of the summer of 1950.

Bracken fern no longer formed the most apparent species. From the purely observational, as well as the analytical, standpoint, this species had been superseded by tall oatgrass, which grew to heights varying from three to four and one-half feet, and formed panicles up to eight inches in length. Since this plant has a single-stem growth habit, the plants were moderately far apart, but presented a very healthy appearance (Plate VII).

Tree reproduction was represented only by Douglas fir, of which the highest abundance of seedlings was noted in this area. All were of current season's growth and were under two inches in height. The plant possessed a frequency value of 93.5 percent, with density of 12.1 as opposed to 5.7 in Area2. There was, however, no indication that seedlings had survived from previous seasons and observation of the pasture outside the quadrats supported this view.

Of the shrub species, only common blackberry was present and in a less important position than in any of the other areas. Only 46 plants were counted; frequency, density and relative abundance for this species were the lowest found in the five pastures. The runners were

Dense, vigorous Tall oatgrass of Area 3. Note height as compared with meter quadrat stick in foreground. Picture taken July 28.

PLATE VII

longer in some cases than in Areas 1 and 2, giving evidence of older age of the clumps, but the growth was not extensive.

As discussed previously, tall oatgrass was the dominant plant. It was found in all quadrats and exhibited relative abundance of 33.4 percent and density of 323.5. Although seeded in the area, highland bentgrass was not present in the quadrats and grew only in the extreme northeastern portion of the pasture. In this location, which lay in a low area shaded by Douglas fir much of the day, bentgrass was found along the edges of floodplains. It appeared to be reproducing well in this area, but was absent in the main body of the pasture. Perennial ryegrass was very rare in the study area, possessing a frequency value of only 26.6 percent, and a relative abundance of 0.1 percent. The plants were healthy, of a darker green color than in the other pastures, and possessed a sturdier growth habit. However, even though the individual plants were in better condition, the numbers of this species had decreased greatly, 20 individuals being found in the fifteen quadrats as opposed to 11,568 stems in Area 1, and 3,207 stems in Area 2.

The weedy grasses, including rattail fescue, soft cheat, and silvery hairgrass possessed essentially equal places in the grass strata. These grasses possessed frequency values between 93.5 and 100 percent and were

almost identical in total abundance. The only native grass of forage importance was Kentucky bluegrass, which with 100 percent frequency, density of 177, and 9.8 percent relative abundance, constituted an important subdominant in the area.

The pasture presented a far different appearance from that of the two more recently seeded areas. Oatgrass had become very well established and appeared to be maintaining itself well. Although weedy grasses were prevalent, the tall growth form of the oatgrass made their presence almost unobservable.

The forb layer was very sparse. Bracken fern had assumed a very minor position, and was encountered in only eleven of the quadrats, as opposed to frequency values of 100 percent in each of the other areas. This plant had degenerated in appearance also, the individuals averaging approximately one foot in height, while in general appearance they were stunted and at times twisted. They were completely overtopped by the oatgrass and possessed a coverage value of approximately 10 percent. Only 44 plants were counted in the quadrats and large areas of the pasture were completely free from fern.

The remainder of the forb group was composed mainly of small annuals. Least hop clover was extremely abundant and found in all quadrats. Small-flowered lotus, blue field madder, bicolored linanthus (Linanthus bicolor

(Nutt.) Greene) and English plantain (Plantago lanceolata L.) although less abundant than the hop clover, were abundant and constituted major plants in this group. Field strawberry and wood strawberry were present in greater numbers in this area than in the two preceding pastures, possessing frequency values of 80 and 93.5 percent respectively, and exhibiting relative abundance values of 2.6 and 2.0 percent as compared with 0.3 and 1.1 in Area 2 and 0.2 and 1.3 in Area 1.

The ground in some portions of the area supported large moss populations of such plants of dry, acid habitats as Polytrichum sp. In quadrats 94, 96, 99 and 111 were portions of old stumps which had decayed almost to the level of the ground and in these areas, the mosses were especially abundant.

Area 4: This section of the pasture was chosen as one of the uncultivated areas. It had been included in the general clearing and burning, but never had been subjected to disking. Various grass seeds, among them velvet grass and alta fescue, had been broadcast into the undisturbed vegetation at various times in the past.

In comparison with the seeded pastures, this area contained very little vegetation. The main constituent of the plant community was again, bracken fern, which grew to heights of four feet, and was the most abundant plant of its growth form and size. Surpassed only by the

strawberries, the species comprised 8.8 percent of the total abundance and possessed a frequency value of 100 percent. Total abundance for this plant was higher than in any of the other areas, with the exception of Area 1. Although shorter than the fern in Area 5, the plants were sturdy and appeared to be thriving.

Douglas fir reproduction was low in this pasture, attaining a density of 2.0 and a frequency value of 20 percent. The larger proportion of plants was of current season's growth, but a few individuals were observed which reached heights of approximately four feet. These plants were heavily browsed and possessed twisted, knarled lower branches. Five small seedlings of bigleaf maple were present.

Common blackberry was the most important shrub species, and at times the vines reached lengths of one and one-half to two feet. Although bracken fern possessed crown cover of approximately 100 percent, the slender petioles left much open ground, which to a large extent was filled with common blackberry. Snowberry and thimbleberry (Rubus parviflorus Nutt.) appeared in the shrub group but had been browsed so closely that they did not attain heights surpassing three to four inches, even though the size of the stems gave indication that they were of several years' growth.

Several species of grass were present, although

none attained a very important place. Most of the plants of this group were of the single-stemmed type, and even Kentucky bluegrass, which on the cultivated areas formed moderately large clumps, appeared in this growth habit. Most of the grasses were of the weed type, with soft cheat, rattail fescue, downy-sheathed brome and silvery hairgrass the most abundant species. None of these plants possessed frequency values above 66.6 percent or densities above 17.6. Silvery hairgrass with a relative abundance of 5.3 was the most abundant grass, but due to its very small size and slender stems did not constitute an important member of the forage vegetation. In the northeastern section of the area, the influence of Area 3 was apparent in the presence of a small number of tall oatgrass plants which had established themselves and, although very sparse, were maintaining themselves in good condition.

The forb layer was dominated by common field strawberry and wood strawberry which possessed frequency values of 73.5 and 100 percent respectively. In some places, the petioles and pedicels of wood strawberry attained heights of six to seven inches as they rose above the deep ground litter of fern residue.

Second in importance in the forb layer was common St. John's-wort (Hypericum perforatum L.), with a frequency value of 60 percent and density of 21.5. Least hop clover and small-flowered lotus were also among the more abundant

species, but did not attain the numbers found in the seeded areas. Common wood rush (Luzula campestris (L.) DC var.) and yerba buena (Satureja Douglasii (Benth.) Brig.), relatively unimportant in the seeded areas, were prevalent, possessing frequency values of 60 and 80 percent respectively and relative abundance percentage of 4.9 and 6.5 respectively.

The vegetational composition of Area 4 was very different from that of the seeded pastures. The area was dominated by bracken fern, with the open spaces under the fern occupied mainly by the strawberries and common blackberry. Herbaceous vegetation other than the fern and strawberries was very sparse and composed mainly of weed grasses and small perennial forbs. None of the cultivated grasses once seeded on this area were present.

Area 5: The second uncultivated area studied, Area 5 had been cleared and burned in the past. The ground had not been cultivated, but alta fescue and velvet grass seed were at one time broadcast into the undisturbed vegetation. The vegetational composition was much the same as that of Area 4.

The main difference between Areas 4 and 5 lay, not in the vegetational composition, but in the vigor attained by the plants. In this pasture, bracken fern reached the maximum growth found in the entire study area, attaining heights of six to seven feet and averaging approximately

five and one-half feet in height. It was the dominant plant in the area, and although not as abundant as in Area 4, possessed a much larger growth habit. The petioles were large in circumference and the fronds at times measured twelve inches across the base. Due to the overlapping of the fronds, crown coverage was easily 100 percent.

Tree species reproduction was not high. Douglas fir seedlings possessed a higher frequency value than did this species in Area 4, but approximated the latter area in density and relative abundance percentage. Many of the seedlings were of previous years' germination, as shown by heights of six to eight inches. Within the general area, although outside of the quadrats, were Douglas fir saplings up to four feet in height. As in Area 4, these trees had been closely browsed. The northern portion of the slope on which Area 5 is located is partially covered by a scrubby growth of Oregon white oak. These clumps are composed of stump sprouts from trees which have been cut down, but have attained heights of six to ten feet in some instances. Only four small Oregon oak seedlings were found in the area actually designated as Area 5.

As in all of the pastures, common blackberry was the dominant shrub. Many of the stems were long and formed a low tangled mat on the ground. Relative abundance and density for this species were higher in this area than in

the other areas. Sweetbriar rose, snowberry, and thimbleberry were also present, but of low abundance.

Grasses were almost absent from the area and present mainly on the lower portions of the slope approaching the main creek. Velvet grass, once seeded in the area, attained the greatest abundance of the grasses, but even this species was sparse, possessing a frequency value of 66.6 and relative abundance percentage of 2.5. Only three stems of alta fescue were counted, although this plant, too, had at one time been seeded on the slope. The other wild grasses present were not abundant, none of them totaling more than 36 stems, the figure found for soft cheat.

Forbs, also, were neither abundant nor homogeneously distributed. Wood strawberry was far more abundant than field strawberry and was the dominant member of the forb group. It was present in all quadrats and possessed a density of 54.6 with a relative abundance of 31.6. The plants were very large and formed a dense mat under the fern. Broad-leaved star flower (Trientalis latifolia Hook.) wood rush, yerba buena, campanula, and varied-leaved collomia (Collomia heterophylla Hook.) all to a greater or lesser degree sylvestrian species, were the abundant of the smaller forbs.

The native vegetation of the pasture reached its greatest development in Area 5. Bracken fern, common

blackberry and wood strawberry were the dominant plants in this pasture and possessed the largest sizes and most extensive development to be found in the general area. Native grasses were rare, and when present were relatively unimportant in the community in its entirety. Major forbs included many species of wooded areas. Invasion by Oregon white oak and Douglas fir had begun, even though it appears to have been retarded by close browsing of the sheep and deer of the area. However, some few of these trees have become established and are growing despite adverse conditions.

In the foregoing descriptions of the vegetational composition of the five areas studied, the community status of bracken fern has been discussed on the basis of its aerial parts. It was found very dense and luxuriant on Areas 4 and 5, of shorter growth but vigorous on Area 1, of lower abundance and still shorter height on Area 2, and very sparse and short on Area 3. (Consult Plates VIII, IX and X for general vegetational picture of the five pastures). The pits dug in each area to aid in soil profile analysis revealed a correlary to this situation among the underground parts. In Areas 4 and 5, the rhizomes were large in diameter and formed a heavy maze in the soil extending to the C horizon. In Area 1, the rhizomes near the surface had been broken and torn by disking, but were still healthy and formed a tight network in the soil. In

PLATE VIII

General appearance of vegetation in Area 1 (above) and Area 2 (below). Note greater abundance of grasses in Area 1 and the denseness of fern in both areas.

PLATE IX

General appearance of vegetation in Area 3. Note small, sparse fern and rank, thickly-growing tall oatgrass.

PLATE X

General appearance of vegetation in Area 4 (above) and Area 5 (below). Note tall, dense bracken fern and scattered grasses.

Area 2, much the same situation prevailed, but many of the rhizomes were dead and the dense situation of many ramifying underground stems was not found, while in Area 3 the condition was even more extreme. Many of the larger rhizomes were dead and decaying, while those that were alive were small in diameter. No extensive network of rhizomes was observed and the depth of penetration of the remaining stems was not great.

The quadrat data were taken in late June and early July, and concerned with the community composition at the time of maturity of the native and cultivated perennial species. However, the general appearance of the entire area varied during the growing season. The spring rains, accompanied by cool temperatures, continued until early in May and the grasses were late in beginning growth. By the end of April, growth of the grasses was well established. No fern plants or only small coiled fronds less than two inches high were apparent until approximately the middle of April. By the first of June, this species had attained heights of two to three feet and by the end of the same month was at the maximum heights varying from two to seven feet on the different areas.

On July 2, the grasses in Areas 2 and 3 were mature, and many of them were shattering. Area 1 at the same time was still green and only the weedy annual grasses rattail fescue, soft cheat and silvery hairgrass were

mature. At this time, a second crop of smaller oatgrass plants grew in Areas 1, 2 and 3. The panicles were much shorter than those of the earlier growth, but did mature and form seed. At the same time, all of the grasses in all areas were mature, many were brown and appeared to be dormant. Only the fern, blue field gilia (Gilia capitata Hook.) and the late composites were green. The fern was beginning to turn brown and shedding of spores had begun.

Following two light showers and the onset of cooler temperatures, on August 31, it was observed that fall growth had begun in the pasture plants. In Area 1 a very good growth of the native and cultivated perennial plants was attained. Foliage growth was luxuriant and the coloration of the grasses was much darker green than in the spring and summer growth. Development of the grasses had begun in Area 2, but was slower than that of Area 1. Ryegrass was especially retarded in beginning this growth, but new leaves had appeared. Small clumps of alta fescue were present in very good vegetative condition.

In Area 3, oatgrass, bluegrass and velvet grass showed new development, and in Areas 4 and 5, the native perennials where present had put out new leaves. In all areas, the fern had turned yellow and in some instances completely brown. By this date, all of the spores had been shed.

On September 12, many of the Douglas fir seedlings were brown and dead. On September 17, it was observed that in areas where the fern had been cut, as in the clip quadrats and in the new areas disked for fall seeding, new fronds had appeared. These plants averaged approximately twelve inches in height and were small and delicate in appearance.

After this date, the fall rains began. Continued high temperatures and heavy rainfall stimulated continued growth of the grasses, which were maintained in relatively rank condition throughout the winter.

Phenological data were kept for the entire pasture, including both the sample areas and the marginal regions. These results will be found in Appendix II.

Forage Production

Since the pasture was seeded for the purpose of improving the grazing conditions in these cutover hill lands, it was thought pertinent to maintain a record of the weight productions on the different pastures throughout the summer. An exclosure was set up in each area to observe the effects of grazing on the vegetation. Although an exclosure was set up in Area 3, no outside clippings were made since this pasture was closed to the livestock very early in the season. Four times during the growing season, clippings were made in each area, one square

meter inside and outside of the exclosure being cut one inch from the ground. The harvested materials were separated into "fern" and "forage" (i.e. all edible herbaceous plants) and air-dried. After being stored for one month, the weight of each sample was determined. These weights are presented in Table V.

Table V: Air-dry weight in grams of vegetation clipped at four different times during the season. "A" refers to clipping made outside the exclosure; "X" to the vegetation clipped inside the exclosure.

Location	#1--June 1		#2-June 17		#3--July 1		#4--July 14	
	Fern	Forage	Fern	Forage	Fern	Forage	Fern	Forage
A1	162.0	79.0	327.5	86.0	178.0	72.0	420.0	35.0
X1	175.0	101.0	386.0	130.0	202.0	200.0	313.0	146.5
A2	61.0	92.0	87.5	138.0	199.0	133.5	198.0	86.5
X2	58.0	95.0	235.5	158.0	186.0	116.0	238.0	104.0
X3	122.0	153.5	37.0	237.0	61.5	163.0	97.0	150.0
A4	201.0	18.0	229.0	24.0	244.0	14.0	365.5	21.0
X4	215.0	24.0	274.0	30.0	345.0	30.5	200.5	30.0
A5	138.0	23.0	343.0	70.0	532.5	23.0	593.5	24.5
X5	141.0	21.0	415.5	37.5	666.5	31.5	356.0	52.5

The above results are presented graphically in fig. 6. When the first clippings were made (June 1) all of the areas had been closed to grazing for approximately three weeks, and the differences between the grazed and ungrazed plots were very small. Differences were, however, found between the production on the five areas. The weight of the forage produced on Area 3 was higher than that of any other area. Areas 1 and 2 were very similar, while the forage produced on Areas 4 and 5 was almost negligible. Fern production by weight was highest on Area 4 at the time of this sampling with Area 1 being second, followed

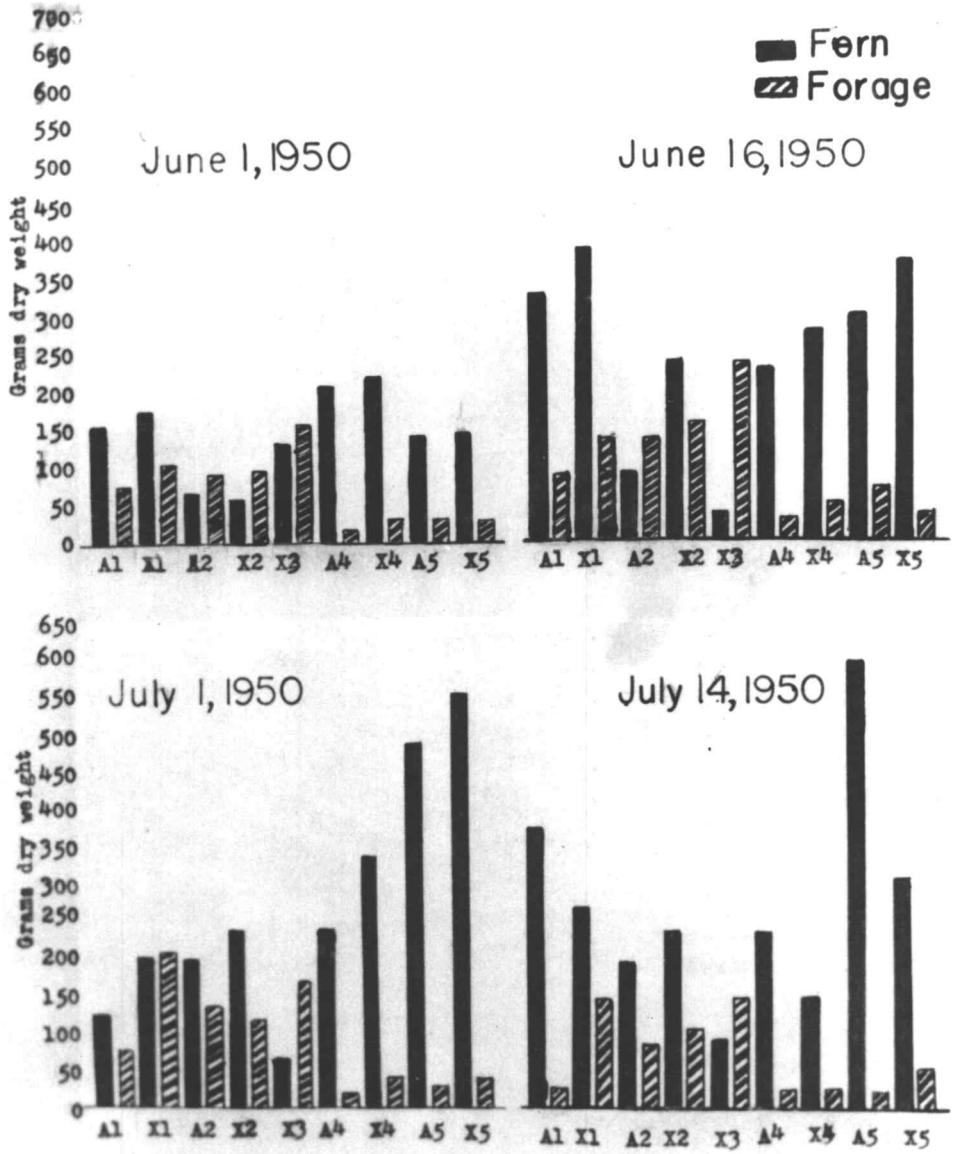


Fig. 6. Graph of air-dry weights of clipped "fern" and "forage". "X" refers to square meter plot clipped within exclosure, and "A" refers to clip made without exclosure. Date indicates time of clipping.

by Areas 2 and 5 respectively. The weights of the fern and forage for the three seeded areas were relatively close at the time of this clipping, although in Area 1, the fern outweighed the forage by a significant amount.

On June 17, the date of the second clipping, the situation was much altered. The fern by this time was rapidly maturing and in most of the area far outweighed the forage. Only in the grazed area clipping of Area 2 and in the single clipping from Area 3 was the weight of forage higher than that of the fern. In the latter area the difference was very great, and this condition was maintained in the remainder of the clippings, with the fern weight being very low as compared with that of the forage. The fern in Area 1 was more than double the weight of the forage and grazing had begun to show its effects, with the forage within the exclosure possessing more weight than that without the exclosure. In Area 2, the weight of fern was less than in Area 1 in both clippings, while forage produced was slightly higher. Again, in the former pasture, the ungrazed forage and fern possessed higher dry weights than did the vegetation harvested from the grazed portion of the plot. In Areas 4 and 5, the weight of the fern was several times that of the forage and by this time, the fern on Area 5 surpassed that of Area 4 in weight. In these two pastures, both the fern and the forage weights for the enclosed areas were higher

than those of the grazed areas.

The third clipping of the season was made on July 1. A situation similar to that described above prevailed, with the exception that the weights of fern in Area 1 were much decreased from the weights determined two weeks previously. The forage weight for the ungrazed portion of this area was much higher than that for the grazed plot. This was not true for Area 2, where the weights of the harvested materials from outside of the exclosure were higher than those taken from within the fence. The fern weight was higher in both cases than was the forage weight, but only by approximately 50 grams. Fern weight in Area 3 was still less than the forage weight, but was somewhat higher than that of the previous clipping. The fern in Areas 4 and 5 outweighed that in the other pastures, with that of the latter area weighing six hundred grams as opposed to thirty grams in Area 3. Forage in these two areas was higher in the ungrazed exclosures than in the grazed samples, but was far below the weight of the fern on the same areas in both cases.

The last clipping was made on July 14. By this time the grasses were ripe and weighed less than in the two previous clippings. The fern outweighed the forage produced on all of the areas, with the exception of Area 3, where a substantial margin was still maintained. In Area 1, the weight of the grazed forage dropped far below

that of the ungrazed. The reason for this is unknown, since the livestock had been excluded from the pasture for approximately one month at this time. It would appear probable that the sample, although contiguous with previous plots, may not have been representative of the area. In Area 2, the forage was lower than that of the Area 1 exclosure and was higher in the ungrazed than in the grazed clipping. The fern in this area weighed nearly twice as much as did the forage at this time. In Area 3, the margin maintained throughout the season was still found, with the fern weighing less than did the forage. In both Areas 4 and 5, the same condition found previously prevailed, as the fern far outweighed the forage produced.

In summary, the same general trend was found throughout the growing season with respect to relative weights of fern and forage. Forage production was consistently higher in Area 3 than in any of the other areas; at the same time, this pasture only maintained a lower fern weight than forage weight. Area 2 averaged less forage weight than Area 1 and fern weights were also higher on the latter area. Fern weight was higher in Area 5 than in the other areas, followed closely by the fern in Area 4. Conversely, in all of the samples, the weight of the forage in the two latter areas was consistently and significantly lower than that of the other three pastures. Grazing did not appear to be of great consequence, except

in Area 1. In all of the other pastures, the weights of the harvested materials of the grazed and ungrazed portions were very close or showed no consistent correlation; however in Area 1, all of the clippings showed a significantly lower yield for the grazed areas than for the plots within the exclosure. In all probability, this is due to the higher percentage of young ryegrass and fescue plants found in this pasture. It was observed that the sheep grazed more heavily on this area than on the other pastures, possibly due to their preference for this more palatable forage.

A weekly record was maintained of the grazing periods in each of the five study areas, and is presented in Table VI.

Table VI: Grazing periods during the growing season. Blank spaces indicate that the area was closed to livestock, while "x" indicates grazing.

Date	Type livestock	Head	Area 1	2	3	4	5
April 8	ewes and lambs	80	x	x	x	x	x
16	(exclosures set up)						
22	ewes and lambs	80					
	goat	1	x	x		x	x
31	same	81			x		
May 7	same	81	x	x		x	x
19	same	81					
26	same	81				x	
June 8	ewes, lambs	80					
	goat	1				x	
13	horses	7	x	x		x	x
25	ewes, lambs	80	x	x		x	x
30	(all areas closed for season)						

It is the opinion of this author and the owner of the pastures, that at no time were the areas over-grazed.

On April 31, it was observed that the early spring growth had been closely cropped. However, the livestock were excluded from the area for a week following this observation, and by the time the pastures were agin open to grazing, the grasses appeared to have made a good recovery. The livestock numbers were well below the maximum for these pastures, since at no time were more than eighty head of sheep pastured on the approximately one hundred and fifty acres. Since the owner desired to allow the pastures to reseed themselves in the summer of 1950, all of the areas were closed to grazing for the year on June 30. At this time, much of the vegetation was in flower and exhibited no apparent signs of over-grazing. The number of head of livestock was at all times low for an area of this size and with the rotational grazing system which was employed, it seems doubtful that this factor was deleterious to the vegetation to any significant degree.

PASTURE VALUE AND AUTECOLOGY OF SEEDED PLANTS

Interpretation and application of the analyses made in this pasture area must be conditioned by the autecology and forage values of the cultivated grasses and legumes seeded in the areas. Information is presented as to their relative palatabilities, tolerances, growth habits and ecological requirements.

Velvet grass (Holcus lanatus L.)

Velvet grass is not exacting in its requirements and will make a good growth in most sections of western Oregon. It is tolerant of high acidity, low soil fertility and wet soil. The plant is not particularly palatable to cattle, but when young is eaten in moderate amounts by sheep. Due to its growth habit of forming dense spreading mats on the ground, it may crowd out other less aggressive grasses, and on the Pacific coast will successfully dominate over most of the more valuable forage species. For this reason, as well as its low palatability, it is rarely recommended for pasture mixtures.

Alta fescue

(Festuca elatior L. var. arundinaceae (Schred.)Wimm.)

Alta fescue is one of the better forage grasses which may be grown in the semihumid regions and produces high yields of palatable forage, even on soils of low fertility. Its deep root system allows growth during the dry summers of western Oregon, and its growth period is one of the longest of the cultivated grasses of the semihumid regions.

The plant possesses wide climatic adaptations and is very winter hardy. Best growth occurs when the species is planted on moist, rather heavy land, but it will thrive on most Oregon soil types, with the exception of those extremely light. Poorly drained conditions are tolerated

and growth is good in soils of either heavy alkali content or moderately high acidity. As a soil improver, alta fescue is excellent, since the deeply penetrating roots "open up" the soil below the plow depth and deposit much organic matter due to a partial renewal of root systems each year. Good response is obtained to plentiful nitrogen in the soil. This may be supplied by planting in combination with an adapted legume, and subclover of either Mt. Barker or Tallarook strain has proven quite successful. On sterile hill lands, both nitrogen and phosphorus fertilizers should be applied to aid in establishment and maintenance of the plant.

Slow growth is made during the first year after seeding, and the young plants may be seriously thinned by heavy growths of volunteer grain, vetch, ryegrass and weeds. In comparison with ryegrass, alta fescue produces as much winter forage and more spring, summer and fall growth.

Creeping red fescue (Festuca rubra L.)

Both Rainier and Illahee strains of creeping red fescue are good sod-formers and have been much utilized for stabilization of poor, burned-over, logged land. The plant is tolerant of low levels of fertility and of moderately high acidity. Since it is not as deep-rooted as alta fescue, it is not as drouth resistant as is the latter species, and will often be found on moister sites

in dry areas.

The plant is highly palatable to livestock and may succumb to heavy grazing pressure, if care is not taken to prevent over-grazing. Creeping red fescue is one of the best grasses for both sheep and cattle from the standpoint of forage value, and although it does not appear to maintain itself as well under adverse conditions as do some of the hardier grasses, is strongly recommended for use as a component of pasture mixtures for seeding such areas as the denuded foothills bordering the Willamette Valley.

Perennial Ryegrass (Lolium perenne L.)

The most valuable use of this species in Oregon is in permanent pasture mixtures, since perennial ryegrass starts growth early and furnishes grazing while the longer lived and slower starting grasses are becoming established. Ryegrass seedings may be ready for pasturage in as little as three months after planting. Plantings from commercial seed often disappear in three to four years, probably due to hybrids of perennial and Italian ryegrass (L. multiflorum Lam.) contained in the seed. The latter of these plants is an annual and usually very short-lived. Stands from pure perennial ryegrass seed will usually not maintain themselves over a very long period of time.

Perennial ryegrass is not as winter hardy as many of the other grasses and may be killed out by cold winters.

It possesses a wide range of soil adaptability, although production usually declines as drainage becomes poorer. The plant requires soils of medium to high fertility, but will make growth equal to most grasses on soils of low fertility. On these poorer soils, the plants do not stool as much as on more fertile soils.

Heavy pasturing is desirable, since it maintains the grass in a succulent condition and utilizes fully its short production period. Heavy grazing, however, may injure the slower developing grasses and caution must, therefore, be exercised in planning the grazing program.

Tall oatgrass (Arrenatherum elatius (L.) Mert.)

Of the many strains of tall oatgrass in use, Tualatin valley strain has proven the most successful in pasture mixtures in the hill lands bordering the Willamette Valley.

It is a highly palatable plant, and produces abundant, nutritive forage. Growth is rapid and once a stand is well established, the abundant seed produced is capable of maintaining the pasture indefinitely if conditions are favorable. Its tall growth habit and leafy culms permits it to shade lower plants and eventually to predominate over those species intolerant of such conditions. The plant, itself, is very shade tolerant and the seedlings develop well under a fairly dense herbaceous cover such

as often is present on fern lands.

The species possesses wide adaptations in semihumid regions, and is tolerant of moderately acid or moderately alkaline soils. Phosphorus and nitrogen fertilizers usually cause increased growth, but good growth is obtained on soils of low fertility. The single-stemmed growth habit of the plant permits cespitose species to thrive in the same pasture, thus providing complete ground coverage. The hardiness of the oatgrass usually prevents its being crowded out by these tufted forms and the mixture provides a very good pasture.

Highland bentgrass (Agrostis tenuis Sibth. var.)

Highland bentgrass occurs as an escape from cultivation over most of western Oregon. It is one of the best grasses for stabilizing difficult sites, such as areas possessing acid clay soils, and invades on heavy cold soils. It is a very good sod former and is highly recommended for denuded areas subject to erosion. While the plant will grow on soils of low fertility, it is not highly shade tolerant. However, it has been found on almost every type of site in the Willamette Valley and adjacent foothills.

The plant is not very palatable to livestock, and is recommended for pasture mixtures only on areas where the better grasses cannot be established. If highland bentgrass becomes well established, it may crowd out the

more palatable grasses, such as the fescues and ryegrasses.

Early growth is slow in this species and the seedlings are weak. Frost heaving, and freezing, during the first winter season after planting may result in a lack of establishment of the species. The species is persistent under heavy grazing, and once a stand is well established in an area, it will usually maintain itself well.

Subterranean clover (Trifolium subterraneum L.)

Both the mid-season variety, Mt. Barker, and the late strain, Tallarook, of subterranean clover have proven very successful in pasture mixtures for seed in fern lands in conjunction with such grasses as tall oatgrass, alta fescue, creeping red fescue, etc. Mt. Barker has proven particularly successful for forage or seed on unirrigated lands of fair to good drainage that may be depleted in fertility.

It is adapted to a climate with warm, moist winters and dry summers, and is not tolerant of poor drainage. The plant will thrive on moderately acid to neutral soils. Wherever white, red, crimson or alsike clovers grow successfully, subterranean clover will generally develope nodules even though not inoculated, but where these plants do not grow inoculation is required. Subterranean clover is not tolerant of low soil fertility and applications of both lime and phosphorus fertilizers are recommended to

maintain high production of forage and seed in areas of depleted soils.

The plant is highly palatable and is relished by all livestock. The season of green forage production for Mt. Barker strain extends from late March to mid-July. After this time, the heads are buried in the soil and the vegetative portions of the plant die.

CONCLUSIONS

The seeded pastures far exceed the unseeded areas in forage production, and they have been brought to a much higher state of economic value by cultivation and seeding. Nutritive forage production on the unseeded fern hills was almost negligible since, as shown by the data, very few of the native grasses were present. Even when present in the stand, their small size and rapid attainment of maturity caused them to be of slight pasture value. The seeded areas, at the time the study was made, were supporting relatively good grass stands and providing much valuable forage.

The establishment of permanent pasture swards in these areas, however, does not appear to have been entirely successful in every case. Area 3 supported a heavy stand of tall oatgrass, and gave every indication of continuing persistance, since the grass was reseeding itself well and appeared well adapted for growth under

the prevailing environmental conditions. The reason for failure of highland bentgrass to become established in the area is unknown, since this plant is among the hardiest of the grasses. The weak phase in the life cycle of this species is the seedling stage and it may be that during the severe winter conditions of the year following seeding, frost heaving and freezing prevented the plants from becoming established. Perennial ryegrass was almost absent from the area, even though at one time it had formed a rather significant component of the vegetation (verbal information, Mr. John Graham). Its failure to persist would be expected in view of the ordinarily short life of this grass if not reseeded, for perennial ryegrass stands rarely maintain themselves in excess of four to five years, even under optimum conditions. The soil content of available phosphorous was low and only weedy legumes were present, suggesting low nitrogen supplies, and yet the dominant tall oatgrass appears to have become well established. Under the present scheme of management, this plant will probably maintain itself indefinitely.

Areas 1 and 2 will be discussed simultaneously. The same pasture mixture was seeded in both and since the habitat factors are very similar, it will be presumed that the three-year old Area 2 may be considered representative of developmental stages through which the one-year old Area 1 will eventually pass. Investigation during subsequent

years will be necessary before definite conclusions can be presented relative to pasture development in Area 1, but it is believed that the analysis of Area 2 provides the possibility of hypotheses on this subject. Area 1 during the current study supported a good stand of forage grass, mainly composed of perennial ryegrass. The plants were not particularly large, but from the pasture standpoint the area was producing well. The higher phosphate levels in Area 1 might alter the successional trends somewhat from those found in Area 2, but from consideration of the known behavior of perennial ryegrass, it is probable that the condition of this plant in Area 1 would eventually follow similar trends as found in Area 2. In the latter pasture, perennial ryegrass declined in abundance during the three years after seeding. It was reported to the author that during the first year after planting, this species became well established and provided a pasture very similar in appearance to that of Area 1 at the time of the present analysis. However, in the summer of 1950, perennial ryegrass decreased in forage production and possessed much lower abundance than found for the same species in the younger area.

Creeping red fescue appears to be poorly adapted for present conditions in these pastures. It was seeded in Area 1 in the fall preceding this analysis, and yet was in low abundance and poor vegetative condition. The

species was noted to be fruiting in Area 1 in very few instances. The plants were shallow-rooted and the leaves usually rolled, indicating insufficient moisture. Creeping red fescue was almost absent from the quadrats in Area 2 and present only in shaded areas, which presumably possessed a higher moisture content than the surrounding exposed lands. The plant was found reproducing along the margins of this area and also in a watershed paralleling Area 4. Higher moisture content and conditions of partial shade were found in both of these sites. Alta fescue had been seeded in Area 2 only. This grass is reported to be one of the hardiest of the grasses used in the Willamette Valley area and due to its deep root system, can usually exist where more shallow-rooted grasses cannot. The species had become established in Area 2, but the tufts were rather widely separated, and although green throughout the summer, were very small and gave little evidence of increasing in size to any extent. During the first season of growth, alta fescue is often unsuccessful in competition with heavy growths of native vegetation, and successful establishment may have been prevented by dense growth of fern and other native plants.

It seems probable that the failure of the fescues to become established is due to a combination of factors, rather than any one factor of the environment. Even though moisture relations would appear to be the immediate

cause of the poor condition of creeping red fescue, this plant is known to be tolerant of low moisture supplies. The content of available phosphorus in the Area 2 soil is known to be low and while nitrogen content was not determined, the general appearance of the vegetation would indicate that this element was in suboptimum amounts. It is very probable that a combination of low soil nutrients, low available moisture, soil reaction at the lower levels of tolerance of these plants, and strong competition from native vegetation is responsible for the only moderate success of alta fescue and the lack of success of creeping red fescue in becoming established. In the case of the latter species, it is also possible that grazing pressure during the first stages of growth may have resulted in further retardation, since it was observed that the sheep pastured the young, succulent forage rather heavily. However, since the plant failed to become a prominent element of the vegetation in the one-year old area also, it would appear more probable that the habitat is too unfavorable to allow successful establishment of the species without further cultural aid.

Subterranean clover was seeded in both Areas 1 and 2, and in neither pasture had it become well established. The reasons for this probably are directly related to three factors: (1) low soil fertility; (2) high acidity; and (3) lack of inoculation. Since this species is an

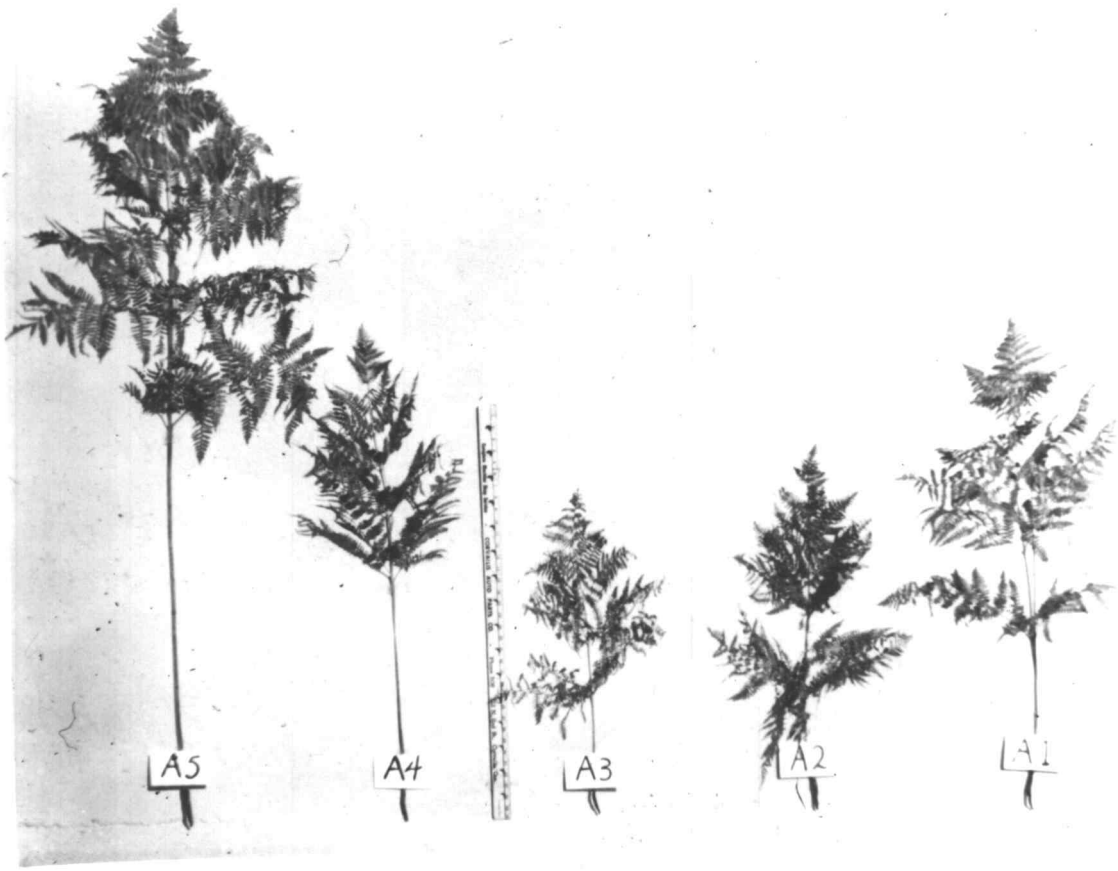
annual and completes its life cycle before drouth conditions become critical it is doubtful if moisture relations were involved in the lack of development of the plant in Areas 1 and 2. Subterranean clover is reported to be intolerant of low fertility and low pH, both conditions prevailing in the pastures analyzed. The acidity probably was not above the range of tolerance of the plant, but approached the upper levels. This, combined with low soil fertility in Area 2 might be quite adequate to explain the lack of success of this species. Area 1 possessed a much higher content of available phosphorus than did Area 2, but even in this pasture, subterranean clover was not of importance. The lack of inoculation of the seed may explain this phenomenon. If red, crimson, alsike or white clovers are found growing in an area, it may be assumed that the soil contains organisms which will invade subterranean clover roots and cause nodulation. These species were not present to any significant degree in the Kings Valley foothills. Small hop clover was the only legume growing in abundance, and while it is of the same genus (Trifolium) as the cultivated subterranean clover, no reference was found regarding the success of the latter when hop clover is present. Further investigation would be necessary before the lack of inoculation could be presented as decisive in the establishment of subterranean clover in this area, but it would appear to be a

possible factor.

With respect to methods of seeding, the preparation of a seedbed appears to be almost mandatory in this specific area. In the past, seed had been broadcast into the undisturbed vegetation on both Areas 4 and 5, yet at the time these investigations were made, cultivated grasses (with the exception of invading tall oatgrass) were rarely present. Competition with well established native vegetation and the unfavorable germination conditions of an unprepared seedbed probably account for this lack of success.

The fern-eradication measures utilized appear to have been successful. In Area 3, fern has assumed a very minor place in the vegetation, even though at the time of seeding of the area, bracken fern was the dominant species. Annual mowing, combined with pasturage and competition from tall oatgrass appear to have reduced the abundance and vigor of bracken fern in the area, and present conditions suggest that in the near future the plant may be completely eliminated from the pasture. Plate XI illustrates the relative average heights of the fern in the five pastures. The specific plants photographed were selected as average of the areas after a series of measurements of standing fern. Mowing, pasturing and the grass competition show their effects in Area 2, also, where the fern is shorter and less abundant

PLATE XI



Comparative heights of fern in the five areas. These plants were chosen as average for the areas, after measurements were made of the standing fern. Note decrease in height and size of the plant with increase in years of cultivation, and also the extreme development of the fern in Area 5.

than in the uncultivated areas. In Area 1, the fern was strong and in high abundance, probably due to breaking and dispersal of the rhizomes during disking. This area had not been mowed, but the possibility is strong that after successive seasons' mowing, the fern in this area also, will decrease. The fern in Area 5 was taller and larger than in Area 4, the other uncultivated pasture. The reason this is unknown, but since all of the vegetation in Area 5 was of larger size and development than elsewhere in the pasture, the logical conclusion would appear to be that the microhabitat of this site was more favorable than in the other areas. The highest pH of the entire pasture was encountered in Area 5, as well as the highest levels of available phosphorus, and it may be that these two factors, combined with the eastern exposure of the slope and possible greater insolation explain the differences in vegetational development.

Invasion by native vegetation other than bracken fern is apparent in all of the pastures. Blackberry, strawberry, weedy grasses and forbs are present in all of the areas. However, the oldest seeded area--Area 3--is remarkably free from these plants, and it is probable that continued mowing, pasturing, and establishment of sturdy stands of grass will prevent successful invasion of these species. Douglas fir and Oregon white oak seedlings were found in the pasture, but none appeared to have established

themselves, since nearly all of the seedlings were of current season's growth. Even in the uncultivated areas, invasion has been slow, possibly due to browsing by the sheep. Douglas fir reproduction was much higher in the cultivated areas than in those uncultivated, presumably due to the favorable seedbed, but very few of these plants were observed to exist throughout the growing season. In Area 3, no fir saplings were found and it is therefore assumed that although the seeds germinate, up to the present time they have been unsuccessful in maintaining and establishing themselves under cultural practices.

Natural successional trends typical of the Oregon Coast Range are to be seen on the uncultivated areas, which are covered with bracken fern, blackberries, strawberries and associated minor herbs. Former coniferous forests are indicated by the presence of such species of wooded areas as common wood rush, broad-leaved star flower, Oregon fairy bells (Disporum oreganum (Wats.) B & H) and wood strawberry. Those species highly specific for the heavy shade, low temperatures and high moisture of the closed coniferous stands have vanished in the long interim since the area was cleared, but the above species, more tolerant of open conditions and yet indicative of former forests, have persisted. Presence of small size classes of oak and Douglas fir, as well as the presence of large trees of these species and lowland white fir on areas

which have not been maintained in the cleared state give evidence of the eventual vegetational succession which would occur were the areas allowed to remain undisturbed for a long period of time.

It would appear that only moderate ameliorative measures would need to be practiced to establish pastures in this area. The grasses will germinate and establish themselves to a limited degree without aid. Tall oatgrass thrives with no further cultural aid, but the fescues and ryegrass appear to be poorly equipped to maintain themselves without some additional support. The methods of fern eradication employed seem adequate and it would appear that only a continuation of mowing and pasturing would be necessary to remove this plant. Further investigations need to be carried out in this specific area to determine the practices necessary for successful establishment and maintenance of a grass sward on these hills, but work in other similar areas indicates that the application of lime, and nitrogen and phosphorus fertilizers is advisable. Application of these fertilizers would probably provide the necessary impetus required by the grasses for development of permanent pastures of good quality.

Subterranean clover or other legumes planted where the better legumes do not grow naturally should be inoculated. It is possible that the soil contains sufficient organisms and that in time the plants would nodulate

without inoculation, but since competition from the native vegetation is intensive, it would be advisable to provide all of the seeded plants with every measure which might aid in immediate establishment. The seeded grasses and legumes are not native to these areas and few grow as escapes from cultivation. Growth is possible on these hill lands, but since succession in most instances appears to favor the native plants, the environment should be made as conducive as possible to the rapid germination and establishment of the valuable, cultivated species, if permanent pastures of high forage quality are to be created.

SUMMARY

Fifteen sample plots were taken in each of five pastures in the Oregon Coast Range foothills bordering Kings Valley in western Oregon, to ascertain the success with which cultivated grasses and legumes have been able to establish themselves in this area, to obtain an ecological picture of the region and possibly to discover means by which these areas could be more successfully converted into pastureland. The entire area had been cleared and burned. Two of the sample pastures were uncultivated while the other three had been disked and seeded. The seed mixtures used in Areas 1 and 2 were similar, consisting of creeping red fescue, perennial ryegrass, velvet grass and subterranean clover, with, in addition,

alta fescue in Area 2 and winter grey oats in Area 1. These two areas had been seeded in different years, Area 2 in 1947 and Area 1 in 1949. Area 3, the third cultivated pasture, in 1945 was seeded to a mixture of Tualatin valley strain tall oatgrass, perennial ryegrass and highland bentgrass. Areas 4 and 5 were uncultivated, but at one time alta fescue and velvet grass seed had been broadcast into the undisturbed vegetation.

Vegetation analyses were made by use of the list-count method. Forage production of the areas was measured with clip quadrats, taken within and without exclosures semi-monthly. Phenological data were recorded for the entire area throughout the growing season. Environmental analyses including soil studies, soil moisture and pH, temperature, insolation, evaporation and relative humidity observations were obtained in an effort to determine similarities in the several areas.

It was found that the climatic and edaphic factors of the areas were very similar. Variations were present, but only the content of available phosphorus varied to any significant extent. Of the cultivated grasses, tall oatgrass alone appeared to be maintaining itself vigorously and spreading. Perennial ryegrass, although well established in Area 1, was much less abundant in Area 2 and almost absent in Area 3. Creeping red fescue appeared in very poor condition in Area 1, and was present in only

one of the fifteen quadrats in Area 2. Alta fescue, although a significant member of the vegetation in Area 2, appeared to be only maintaining itself and had formed small clumps. The unsuccessful establishment of all of the grasses with the exception of tall oatgrass may be due to a combination of factors, suboptimum for this plants, rather than to any one of the environmental conditions. Subterranean clover was present in both areas where seeded, but the plants extremely lacking in vigor and in Area 2, especially, this legume constituted only a minor part of the vegetation. Low fertility, high acidity and lack of inoculation may have contributed to this condition.

The measures employed for bracken fern eradication appear to have been successful, as the vigor and abundance of this plant diminish directly proportionally to the increase in age of the cultivated pastures. Mowing, pasturing and establishment of grass swards appear to be adequate measures for use in destruction of this plant.

Successional trends of the native vegetation of this locality were observed in the unseeded areas, and the blackberries, strawberries, bracken fern and arborescent species of these pastures were also present in the cultivated tracts. However, the arborescent species have been retarded by mowing and pasturing and it appears unlikely under the present management scheme that they will invade

to any great extent.

Ameliorative practices, including application of lime, and phosphorus and nitrogen fertilizers were recommended in the interest of providing a more favorable habitat in which the cultivated grasses and legumes might become established, thus aiding in production of permanent pastures of high quality in these hill lands.

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APPENDIX I -- COMPLETE SPECIES LIST

The following list includes the species found in the entire pasture area, in both the marginal regions and sample plots. Plant listing is by families.

Dryopteris arguta (Kaulf.) Watt.
Anthyrium Felix-femina (L.) Roth
Polystichum munitum (Kaulf.) Presl.
Pteridium aquilinum (L.) Kuhn var. pubescens Underw.
Equisetum arvense L.
Pseudotsuga taxifolia (Lambert) Britt.
Abies grandis Lindl.
Bromus marginatus Nees.
Bromus mollis L.
Bromus racemosa L.
Bromus sterilis L.
Bromus rigidus Roth.
Festuca Myuros L.
Festuca elatior L. var. arundinacea (Schreb.)Wimm.
Festuca rubra L.
Festuca occidentalis Hook.
Poa compressa L.
Poa pratensis L.
Poa nervosa (Hook.) Vas.
Dactylis glomerata L.
Cynosurus echinatus L.
Hordeum Gussoneanum Parl.
Lolium multiflorum Lam.
Lolium perenne L.
Trisetum canescens Trin.
Deschampsia elongata (Hook.) Munro.
Aira caryophyllea L.
Avena sativa L. var. winter grey
Arrenatherum elatius (L.) Mert. Tualatin Valley
Holcus lanatus L.
Agrostis palustris Huds.
Agrostis alba L.
Phleum pratense L.
Phalaris canariensis L.
Anthoxanthum odoratum L.
Carex stipa Muhl.
Eleocharis obtusa (Willd.) Schult
Juncus effusus Wiks.
Juncus Covellei Piper
Juncus Bolanderi Engelm.
Juncus ensifolius Wiks.
Luzula campestris (L.) DC var. multiflorum (Ehr.)

Luzula campestris (L.) DC var. congesta Thuill
Brodiaea coronaria (Salisb.) Jeps.
Brodiaea pulchella (Salisb.) Greene
Lilium columbianum Hans.
Erythronium oreganum Appleg.
Trillium ovatum Pursh.
Iris tenax Dougl.
Disporum oreganum (Wats.) B & H
Salix (Tourn.) L. spp.
Corylus californica (A. DC) Rose.
Quercus Garryana Dougl.
Rumex conglomeratus Murr.
Rumex acetosella L.
Polygonum Hydropiper L.
Montia sibirica L.
Montia perfoliata (Donn.) How.
Stellaria borealis Bigel.
Stellaria media (L.) Cyr.
Cerastium arvense L.
Cerastium vulgatum L.
Ranunculus orthorynchus Hook.
Ranunculus occidentalis Nutt.
Ranunculus Bongardii Greene
Anemone oregona Gray
Aquilegia formosa Fisch.
Brassica campestris L.
Dentaria tenella Nutt.
Cardamine oligosperma Nutt.
Ribes Lobbii Gray
Spiraea Douglasii Hook.
Holodiscus discolor (Pursh.) Maxim.
Fragaria cuniefolia Nutt.
Fragaria bracteata Hel.
Geum macrophyllum Willd.
Rosa rubiginosa L.
Rosa Nutkana Presl.
Rubus leucodermis Dougl.
Rubus parviflorus Nutt.
Rubus vitifolius C & S
Rubus laciniatus Willd.
Rubus thyrsanthes Focke
Amelanchier florida Lindl.
Crategous Douglasii Lindl.
Osmaronia cerasiformis (T & G) Greene
Prunus emarginata (Dougl.) Walp.
Lupinus micranthus Dougl.
Trifolium bifidum Gray var. decipiens Greene
Trifolium hybridum L.
Trifolium dubium Sibth.
Trifolium subterraneum L. Mt. Barker strain
Trifolium pratense L.

Trifolium variegatum Nutt.
Psoralea physodes Dougl.
Lotus micranthus Benth.
Erodium cicutarium (L.) L'Her.
Vicia americana Muhl.
Vicia villosa Benth.
Lathyrus Nuttallii Wats.
Acer macrophyllum Pursh.
Acer circinatum Pursh.
Rhamnus Purshiana DC.
Sidalcea campestris Greene
Sidalcea virgata How.
Sidalcea spicata (Regel.) Greene
Hypericum perforatum L.
Hypericum anagalloides C & S
Viola Howellii Gray
Viola glabella Nutt.
Viola sempervirens Greene
Epilobium augustifolium L.
Epilobium paniculatum Nutt.
Epilobium glandulosum Lehm.
Circaea pacifica Asch. & Mag.
Torilis arvensis (Huds.) Link.
Ligusticum apiifolium (Nutt.) Gray
Cornus Nuttallii And.
Trientalis latifolia Hook.
Dodocatheon latifolium (Hook.) Piper
Fraxinus oregana Nutt.
Gilia capitata Hook.
Collomia heterophylla Hook.
Linanthus bicolor (Nutt.) Greene
Navarretia squarrosa (Esch.) H & A
Nemophila pedunculata Dougl.
Nemophila parviflora Dougl.
Nemophila sepulta Parish
Myosotis versicolor (Pers.) Reich.
Myosotis macrosperma Engelm.
Prunella vulgaris L.
Satureja Douglasii (Benth.) Hel.
Collinsia grandiflora Dougl.
Collinsia parviflora Dougl.
Tonella tenella (Benth.) Hel.
Mimulus dentatus Nutt.
Mimulus guttatus DC.
Veronica americana (Raf.) Schwein.
Veronica serpyllifolia L. var. humifusa Dicks.
Veronica arvensis L.
Orthocarpus pusillus Benth.
Plantago major L.
Plantago lanceolata L.
Galium cymosum Wieg.

Galium triflorum Michx.
Galium Aparine L.
Sherardia arvensis L.
Sambucus glauca Nutt.
Symphoricarpos albus (L.) Blake
Echinocystis oreganas Cogn.
Campanula Scouleri Hook.
Psilocarphus elatior Gray
Anaphalis margaritaceae (L.) B & H var. occidentalis Greene
Madia sativa Molina
Achillea millefolia L.
Anthemis cotula L.
Senecio Jacobaea L.
Senecio canus Hook.
Cirsium lanceolata (L.) Scop.
Cirsium edule Nutt.
Cirsium arvense (L.) Scop.
Centaurea Cyanus L.
Hypochaeris radicata L.
Sonchus asper (L.) Hill.
Taraxacum officinale L.
Hieracium albiflorum Hook.
Crepis capillaris (L.) Wallr.
Crepis setosa Hal.f.

APPENDIX II -- PHENOLOGY CHART

O flower
Ø flower & fruit
/ fruit

Species	Date observation made																								
	April				May				June				July					August				Sept.			
	3	9	23	30	7	14	20	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	17
Collinsia parviflora	O	O	O	Ø	Ø	Ø	/	/	/															
Dentaria tenella	O	O	O	Ø	/	/	/																	
Fragaria cuniefolia	O	O	O	O	Ø	Ø	Ø	/	/	/	/	/												
Brassica campestris	O	O	O	Ø	Ø	/	/	/	/															
Nemophila sepulta	O	O	Ø	Ø	/	/	/																	
Cardamine oligosperma	O	O	Ø	Ø	/	/	/																	
Taraxacum officinale	O	O	Ø	Ø	Ø	/	/	/	/	/	/	/												
Luzula campestris	O	O	O	Ø	Ø	/	/	/	/	/	/	/	/											
Stellaria media	Ø	Ø	Ø	Ø	Ø	/	/	/	/															
Viola glabella	O	O	Ø	Ø	Ø	Ø	/	/	/															
Anemone oregona	O	O	Ø	/	/	/	/	/	/															
Montia sibirica	O	O	O	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/	/
Osmaronia cerasiformis	O	O	Ø	Ø	Ø	/	/	/	/															

Species	Date observation made																								
	April				May				June				July				August				Sept.				
	3	9	23	30	7	14	20	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	17	
Trillium ovatum	0	0	0	ø	ø	/	/	/	/																
Ranunculus occidentalis	0	0	0	0	ø	ø	ø	/	/	/	/														
Erythronium oreganum		0	0	0	ø	ø	/	/	/																
Erodium cicutarium		0	ø	ø	ø	ø	ø	ø	/	/	/	/	/	/											
Montia perfoliata		0	0	0	ø	ø	ø	ø	ø	ø	ø	ø	ø	ø	ø	/	/	/							
Corylus califomica			0	0	ø	ø	ø	/	/	/	/														
Fragaria bracteata			0	0	0	ø	ø	ø	/	/	/	/	/	/											
Viola Howellii			0	0	0	ø	ø	ø	/	/	/														
Veronica serpyllifolia			0	0	ø	ø	ø	/	/	/	/	/	/	/											
Nemophylla parviflora			0	0	ø	ø	ø	ø	/	/	/														
Iris tenax			0	0	0	0	0	ø	ø	/	/	/	/	/	/	/									
Veronica arvensis			0	0	ø	ø	ø	ø	ø	/	/	/													
Tonella tenella			0	0	ø	ø	ø	ø	/	/	/														
Ranunculus Bongardii			0	0	0	ø	ø	ø	/	/	/	/	/												
Salix spp.			0	0	ø	ø	ø	/	/	/	/	/													

Species	Date observation made																								
	April				May				June				July					August				Sept.			
	3	9	23	30	7	14	20	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	17
Collinsia grandiflora			O	O	O	Ø	Ø	/	/	/															
Acer macrophyllum			O	O	O	Ø	Ø	/	/	/	/	/	/	/	/	/	/								
Acer circinatum			O	O	O	Ø	Ø	Ø	/	/	/	/	/	/	/	/									
Cornus Nuttallii					O	O	O	Ø	Ø	/	/	/	/												
Lupinus micranthus					O	O	O	Ø	Ø	Ø	/	/	/	/											
Dodocatheon latifolium					O	O	O	Ø	Ø	Ø	/	/	/												
Lathyrus Nuttallii					O	O	O	Ø	Ø	/	/	/	/												
Disporum oreganum					O	Ø	Ø	Ø	/	/	/	/													
Sherardia arvensis					O	O	O	O	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/	/					
Rumex acetosella					O	O	O	O	Ø	Ø	Ø	Ø	Ø	Ø	Ø	/	/								
Poa compressa					O	O	O	Ø	Ø	Ø	Ø	/	/	/											
Amelanchier florida					O	O	Ø	Ø	Ø	/	/	/	/												
Anthoxanthum odoratum					O	O	O	Ø	Ø	Ø	Ø	Ø	/	/	/	/	/								
Plantago lanceolata						O	O	O	Ø	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/	/						
Ranunculus orthorynchus							O	O	O	O	Ø	Ø	Ø	/	/	/	/								
Galium aparine							O	O	O	Ø	Ø	Ø	Ø	Ø	/	/	/								

Species	Date observation made																								
	April				May				June				July					August				Sept.			
	3	9	23	30	7	14	20	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	17	
Cerastium vulgatum							o	o	o	o	ø	ø	ø	/	/	/	/	/	/	/					
Bromus rigidus							o	o	o	ø	ø	/	/	/	/	/	/	/	/						
Vicia americana							o	o	ø	ø	ø	ø	ø	ø	/	/	/	/							
Trifolium dubium							o	o	ø	ø	ø	ø	ø	ø	ø	/	/	/							
Myosotis versicolor							o	o	o	ø	ø	ø	ø	ø	/	/	/								
Trientalis europeae							o	o	o	ø	ø	ø	/	/	/	/	/								
Rubus laciniatus							o	o	o	ø	ø	ø	ø	ø	ø	ø	ø	ø	ø	/	/	/	/	/	
Rubus vitifolius							o	o	o	ø	ø	ø	ø	ø	ø	/	/	/	/	/	/	/	/		
Rubus parviflorus							o	o	o	ø	ø	ø	ø	ø	ø	ø	/	/	/	/	/	/	/		
Ribes Lobbii							o	o	o	ø	ø	ø	ø	ø	ø	ø	/	/	/	/	/	/	/		
Rubus thyrsanthes							o	o	o	ø	ø	ø	ø	ø	ø	/	/	/	/	/	/	/	/		
Vicia americana							o	o	ø	ø	ø	ø	/	/	/	/	/								
Lotus micranthus							o	o	o	ø	ø	ø	ø	ø	ø	/	/	/	/	/					
Bromus mollis							o	o	ø	ø	ø	ø	ø	ø	ø	/	/	/	/	/					
Lolium perenne							o	o	o	ø	ø	ø	ø	ø	ø	ø	ø	/	/	/	/				

Species	Date observation made																								
	April				May				June				July					August				Sept.			
	3	9	23	30	7	14	20	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	17	
Lolium multiflorum							O	O	O	O	Ø	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/					
Deschampsia elongata							O	O	O	Ø	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/	/					
Athemis cotula							O	O	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/	
Dactylis glomerata							O	O	O	Ø	Ø	Ø	/	/	/	/	/	/	/						
Geum macrophyllum								O	O	Ø	Ø	Ø	Ø	Ø	/	/									
Trifolium subterranean								O	O	O	Ø	Ø	Ø	Ø	Ø	/	/	/	/	/					
Echinocystis oregana								O	O	O	Ø	Ø	Ø	Ø	/	/	/	/	/	/	/				
Myosotis macrosperma								O	O	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/							
Arrenatherum elatius								O	O	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/	/	/					
Holcus lanatus								O	O	Ø	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/	/					
Festuca Myuros								O	O	O	Ø	Ø	Ø	Ø	Ø	/	/	/	/	/					
Hypericum perforatum										O	O	O	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/	/	/	/	
Ligusticum apiifolium										O	O	O	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	
Hypochaeris radicata										O	O	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/	/	/	/	/	
Orthocarpus pusillus										O	Ø	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/					

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	3	9	23	30	7	14	20	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	17	
Linanthus bicolor									o	o	ø	ø	ø	ø	ø	/	/	/							
Trifolium repens									o	o	o	ø	ø	ø	ø	/	/	/	/	/	/	/			
Sidalcea virgata									o	o	ø	ø	/	/	/	/	/	/	/	/	/				
Brodiaea pulchella									o	o	ø	ø	ø	ø	/	/									
Satureja Douglasii									o	o	o	ø	ø	ø	ø	ø	/	/	/	/					
Prunella vulgatum									o	o	o	ø	ø	ø	ø	ø	/	/	/	/					
Lilium columbianum									o	o	o	ø	ø	ø	/	/	/	/	/						
Achillea millefolia									o	o	o	ø	ø	ø	ø	ø	/	/	/	/	/				
Agrostis alba									o	o	o	ø	ø	ø	ø	ø	ø	/	/	/	/	/			
Trisetum canescens									o	o	ø	ø	ø	ø	ø	/	/	/		/	/				
Torilis arvensis									o	o	o	ø	ø	ø	/	/	/	/	/						
Sidalcea spicata									o	ø	ø	ø	ø	ø	ø	/	/	/	/	/	/	/	/	/	
Cynosurus echinatus									o	o	ø	ø	ø	ø	/	/	/	/	/						
Cerastium arvense									o	o	o	ø	ø	/	/	/	/	/							
Vicia villosa									o	ø	ø	ø	ø	/	/	/									
Sambucus glauca									o	o	o	ø	ø	ø	ø	ø	/	/	/	/	/	/	/	/	

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	3	9	23	30	7	14	20	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	17	
Festuca elatior									O	O	O	Ø	Ø	Ø	/	/	/	/	/						
Aira caryophylleae									O	O	O	Ø	Ø	Ø	Ø	Ø	/	/	/						
Holociscus discolor									O	O	O	Ø	Ø	Ø	/	/	/	/	/	/					
Aquilegia formosa									O	O	Ø	Ø	Ø	Ø	/	/	/	/							
Festuca rubra									O	O	Ø	Ø	Ø	Ø	Ø	/	/	/	/						
Circaea pacifica										O	O	Ø	Ø	Ø	/	/	/	/							
Nemophila pedunculata										O	O	Ø	Ø	/	/	/	/	/	/						
Hypericum anagalloides										O	O	O	Ø	Ø	Ø	Ø	Ø	/	/	/	/	/	/	/	
Juncus Corvellei										O	O	O	Ø	Ø	Ø	Ø	/	/	/	/	/	/	/	/	
Epilobium glandulosum										O	O	O	Ø	Ø	Ø	Ø	/	/	/	/					
Veronica americana										O	O	Ø	Ø	Ø	/	/	/	/	/						
Mimulus dentatus										O	O	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/	/	/	/	/	
Mimulus guttatus										O	O	Ø	Ø	Ø	Ø	Ø	Ø	/	/	/	/	/	/	/	
Trifolium variegatum										O	O	O	Ø	Ø	/	/	/								
Juncus Bolanderi										O	O	O	Ø	Ø	Ø	/	/	/							
Stellaria borealis										O	O	O	Ø	Ø	/	/	/								

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	3	9	23	30	7	14	20	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	17	
Juncus effusus											O	O	Ø	Ø	Ø	/	/	/	/	/	/	/	/		
Festuca occidentalis											O	O	O	Ø	Ø	/	/	/	/						
Bromus sterilis											O	O	O	Ø	Ø	Ø	/	/	/	/	/	/	/	/	
Bromus racemosa											O	O	O	Ø	Ø	Ø	/	/	/	/	/	/	/	/	
Trifolium pratense											O	O	Ø	Ø	Ø	/	/	/	/	/	/	/	/		
Hordeum gussoneanum											O	O	Ø	Ø	Ø	Ø	/	/	/	/	/	/	/	/	
Campanula Scouleri												O	O	O	Ø	Ø	/	/	/	/					
Madia sativa												O	O	O	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	
Lotus americana												O	O	Ø	Ø	Ø	Ø	/	/	/					
Senecio canus												O	O	Ø	Ø	Ø	Ø	/	/	/	/	/	/	/	
Trifolium hybridum													O	O	Ø	Ø	Ø	/	/	/					
Galium trifolium													O	O	Ø	Ø	Ø	Ø	/	/	/				
Galium cymosum													O	O	Ø	Ø	Ø	Ø	/	/	/				
Linanthus ciliatus													O	Ø	Ø	Ø	/	/	/						
Centaurea cyanus													O	O	Ø	/	/	/	/						

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	3	9	23	30	7	14	20	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	17	
Brodiaea coronaria													o	o	ø	/	/	/	/	/					
Cirsium lanceolata													o	o	ø	ø	ø	ø	ø	ø	ø	ø	ø	ø	
Phleum pratense													o	o	ø	ø	ø	/	/	/	/				
Philaris canariensis													o	o	ø	ø	ø	/	/	/	/				
Epilobium augustifolium													o	o	ø	ø	ø	/	/	/	/	/	/		
Polygonum Hydropiper													o	o	ø	ø	ø	/	/	/	/	/	/	/	
Cirsium arvense													o	ø	ø	ø	ø	ø	/	/	/	/	/	/	
Spiraea Douglasii													o	o	ø	ø	ø	ø	ø	ø	/	/	/	/	
Rosa Nutkana													o	o	ø	ø	ø	/	/	/	/	/	/	/	
Rosa rubiginosa													o	o	ø	ø	ø	/	/	/	/	/	/	/	
Sidalcea campestris													o	o	ø	ø	ø	ø	/	/	/	/	/	/	
Poa nervosa													o	o	o	ø	ø	ø	/	/	/	/	/	/	
Rumex conglomeratus													o	o	ø	ø	ø	/	/	/	/	/	/		
Psibcarpus elatior													o	o	ø	ø	ø	/	/	/	/	/	/		
Gilia capitata													o	o	ø	ø	ø	/	/	/	/	/	/		
Navarretia squarosa														o	o	o	o	ø	ø	ø	ø	ø	ø	/	

	Date observation made																						
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	3	9	23	30	7	14	20	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	17
Hieracium albiflorum															o	ø	ø	ø	/	/	/	/	/	/
Sonchus asper															o	ø	ø	ø	/	/	/	/	/	/
Crepis setosa															o	o	ø	ø	ø	ø	ø	ø	ø	ø
Senecio Jacobaea																			o	ø	ø	ø	ø	ø
Epilobium paniculatum																			o	ø	ø	ø	ø	ø
Cirsium edule																			o	o	ø	ø	ø	ø
Plantago major																			o	ø	ø	ø	ø	ø
Anaphalis margaritacea																			o	ø	ø	ø	ø	ø
Carex stipa																			o	o	ø	ø	ø	ø