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The study of the vegetation of one of the natural coastal prairies in Oregon was undertaken for the purpose of describing some of its synecological features. Specific objectives of the study were to describe certain plant assemblages in the study area, present phenological relationships on some of the assemblages, and discuss and illustrate some examples of evidence of succession on the study area.

The study area is a prairie located on a headland about one mile north of the Tillamook-Lincoln county line (Sec. 3 in T6S, R11W). This prairie is one of the many situated on the headland bluffs and slopes along the northern Pacific coast.

During an initial period of reconnaissance, familiarization with the plant species and communities in the study area was gained. Several surveys along most of the Oregon coast were made to compare the study area with other coastal prairies.

A total of 38 distinctive stands of vegetation within the prairie were sampled in a series of five repetitive sessions from January to October in 1966. Presence and vegetative cover of species were recorded. In addition, soil depths in these stands were recorded.

Seven transects from the prairie through the ecotone to the forest were established and the presence of species along them was recorded.

With the aid of an association table five distinctive communities were differentiated in the sampled stands. These were:

1. *Equisetum maximum* community, restricted to sites with high soil moisture during the entire year.

2. *Polystichum munitum*-*Rubus parviflorus* community, usually on soils 18 inches deep or less. Species in this community form the major part of the ecotone vegetation.

3. *Carex obnupta* community, usually on soils 12 inches deep or less. *Carex* is the only important species in this community.

4. *Artemisia suksdorfii*-*Solidago canadensis* community, found on the exposed, south-facing end of the prairie on deep soils. It is a community found commonly in prairies farther north on the coast.

5. *Solidago canadensis* community, situated farther up in the prairie than the *Artemisia*-*Solidago* community, on deep soils. It was judged to be an earlier successional stage of the *Artemisia*-*Solidago* community.

Two more groups were apparent in the table, but these were judged not to be distinct communities in the field. These were:

6. *Lupinus littoralis* group, considered part of the internal pattern of one or more of the large grassy communities

not sampled. The peculiar grouping of _Lupinus littoralis_ is attributed to the large, heavy seeds of that species which always drop directly to the ground, rather than being distributed farther by the wind.

7. _Angelica lucida-Rubus spectabilis_ group, judged to be an aberrant form of the _Polystichum-Rubus parviflorus_ community.

A discussion of successional aspects of this and other coastal prairies on the Pacific coast was based on the results of field work carried out during this study, a knowledge of activities on this prairie from 1916 to the present time, and on historical accounts and old photographs concerning the coastal vegetation. It was tentatively concluded that the coastal prairies were maintained for long periods in the past mostly by fires set by the coastal Indians who lived on them. When the white settlers arrived with their cattle and sheep, many prairies, including the study area, were maintained by grazing pressure, and the spread of hardy introduced grasses was encouraged.

The stands sampled in the study area were thought to have become established during a period of no stock grazing from 1938 to the present time.

It was suggested that the _Polystichum munitum-Rubus parviflorus_ community may provide sites for the growth of _Picea sitchensis_ within this prairie.

SYNECOLOGICAL FEATURES OF A NATURAL HEADLAND PRAIRIE ON THE OREGON COAST

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
REVIEW OF LITERATURE	5
DESCRIPTION OF STUDY AREA	13
METHODOLOGY	25
Reconnaissance	25
Sampling of Stands	25
Prairie to Forest Transects	30
RESULTS	32
Equisetum maximum Community	35
Polystichum munitum-Rubus parviflorus Community	38
Carex obnupta Community	45
Lupinus littoralis Community	46
Angelica lucida-Rubus spectabilis Community	47
Solidago canadensis Community	51
Artemisia suksdorfii-Solidago canadensis Community	52
DISCUSSION AND CONCLUSIONS	54
SUMMARY	65
BIBLIOGRAPHY	68
APPENDIX	76

LIST OF FIGURES

Figure		Page
1	Photograph of the study area	14
2	Diagram of the "bowl-shaped" ecotone	17
3	Diagram of the stand-sampling grid	27
4	Diagram of the sampled area along the transects	31
5	Map of the study area, showing the locations of the sampled stands and the transects	34
6	Graph of seasonal cover trends of some species in the *Equisetum maximum* community	37
7	Graph of seasonal cover trends of some species in the *Polystichum munitum*-*Rubus parviflorus* community	39
8	Graphs of the average distributions of six species of the *Polystichum munitum*-*Rubus parviflorus* community along seven transects	44
9	Graph of seasonal cover trends of some species in the *Lupinus littoralis* community	48
10	Graph of seasonal cover trends of some species in the Angelica lucida-Rubus spectabilis community	50

LIST OF TABLES

Table		Page
1	Soil depths in sampled stands	36
2	Distributions of six species of the *Polystichum munitum-Rubus parviflorus* community in seven transects	42

LIST OF APPENDIX TABLES

Table		Page
1	The association table	79

SYNECOLOGICAL FEATURES OF A NATURAL HEADLAND PRAIRIE ON THE OREGON COAST

INTRODUCTION

Some of the most productive grasslands in North America are found in the coastal Pacific Northwest. These grasslands have supported an important dairy industry in Oregon for nearly 100 years, mainly in coastal river valleys. Farmers who arrived in this area in the mid-1800's used much of this area for dairy and crop farming without having to clear it of brush and trees. Areas which did require clearing, nevertheless, made good pasture when maintained.

In addition to grasslands found in coastal river valleys, prairies are also found on the headlands and bluffs along the coast. The extent of these headland prairies at the time of arrival of the first settlers can be determined only with difficulty. Old photographs and accounts, plus observation of relic headland prairies along the Oregon coast indicate surely that they were common. Since then, varying degrees of disturbance and periods of no disturbance have altered the vegetation so as to make a conception of the natural vegetation as it appeared before the white man's arrival and disturbance extremely difficult to acquire.

On the northern Oregon coast where the dairy industry has been concentrated, the lush river valleys of the Tillamook and Nehalem

Rivers, plus numerous smaller river valleys, have served the dairy farmers' needs, and the natural headland prairies have been largely undisturbed, at least in recent years. The result has been the almost total disappearance of these prairies, through succession to a brushy or forested vegetation. Farther south, sheep and beef cattle range is generally more important than dairy cattle pasture, and the hilly prairies have been used to advantage. Therefore, over the years, these prairies have been subjected to intensive grazing pressure, and some have been increased in size by clearing and fires. Because of this disturbance, it is often more difficult to discern the original prairie areas on the southern Oregon coast than on the northern coast.

The purpose of this study was to describe some synecological features of the natural vegetation on the Oregon coastal prairies. In an effort to describe natural prairie vegetation, a prairie was found that was not obviously on its way toward becoming a forest, and yet was not so disturbed as to make a study of "natural" vegetation meaningless. This prairie is located in the southwestern tip of Tillamook county adjacent to the Cascade Head Natural Area in the Siuslaw National Forest.

It is partially out of scientific curiosity that this study has been made. However, noting the ever-increasing use of more lands for recreation and other activities by a fast-growing population, the author feels a need to study and describe such a phenomenon as the natural prairies while they still exist. This is a familiar "hue and cry" ridiculed or disregarded by many, but the author feels it is becoming increasingly applicable to many areas of natural beauty and interest in the United States as well as in the rest of the world. Studying and describing the vegetation of such areas in their natural states may be important for two reasons. The first is for posterity's sake. Succeeding generations will be curious about what used to be here and "what it used to be like." Just as today, researchers will find accurate records of vegetation valuable. A second and perhaps more important reason for studying such areas is for management purposes. Since the land will undoubtedly receive increasingly greater use, its proper management could permit this greater use without serious disruption of the vegetation. Good management or land-use programs are probably best formed through some initial knowledge of the natural or undisturbed vegetation.

Certainly the Oregon coast is no exception to this forecast. Its beauties will continue to attract more people. The open areas on the bluffs and headlands would make admirable parks, camps, and homesites.

The specific objectives in this thesis are:

1. to describe certain plant assemblages in the study area;

2. to present phenological relationships on some of the assemblages;
3. to discuss and illustrate some examples of evidence of succession on the study area.

It should be emphasized here that this is a vegetation study, and its scope is limited mainly to one area of analysis. It, together with its bibliography, can be regarded as an introductory reference to studies of greater depth, which deal with the coastal headland vegetation.

REVIEW OF LITERATURE

Little has been written concerning the coastal prairies of Oregon. However, many facts and ideas contained in the general literature on grasslands are pertinent to this thesis. Particular attention is paid to papers on grassland succession in this review.

Grasslands make up approximately one-fifth of the land on earth. Barnes (1948) and many others have described the grassland moisture regime as generally between that of woodland and that of desert, although Barnes noted that lack of moisture does not explain marshland, or the fact that there are some desert trees. He went beyond moisture as the single controlling factor, saying that grasslands occupy greater extremes in aridity, cold temperatures, and high moisture than do forests. He said that soil moisture throughout the year, rather than total rainfall, governs the distribution of grasslands. Finally, he introduced the time factor, saying that grasslands are found in some areas not because forest trees will not grow there, but because they have not had time enough or opportunity to invade and occupy them. He distinguished between the short grass prairie, characteristic of the dry plains where rainfall is variable and not plentiful enough to wet the soil deeply, and the tall grass or true prairie where soil moisture is deeper than in the short grass prairie. He noted that the true prairie occupies both humid and subhumid lands, and that trees often do well if planted. Later, Barnes (1956) further broadened the criterion for a grassland habitat by saying that natural grasslands remain primarily in regions of climatic extremes. He also pointed out that the distribution of cultivated grassland bears little resemblance to that of natural grassland. He observed that the most productive grasslands are seen under cultivation in cool, humid, mild climates such as that in the coastal Pacific Northwest and in northwestern Europe. Barnes (1956, p. 245) stated:

> This (fact) merely reflects the more abundant moisture supply of these regions, a characteristic favorable to higher grassland production under cultivation, as well as to occupancy by forest under natural competition.

Eyre (1963) discussed soils of grasslands compared to those of forests. In the grassland soil, more humus is formed because of grass roots close to the surface, resulting in a fine crumb structure. He added that grasses generally take up greater quantities of mineral nutrients, especially calcium, than do forest trees. This fact, plus that of more rapid humus formation, results in the maintenance of a richer nutrient cycle in grasslands. Kellogg (1948) noted that the percentage of mineral plant nutrients in the organic remains from grass is richer than in those from forests. Grasses return to the soil more bases, whereas the decomposition of forest litter results in more organic acids. Because of the formation of humus, grassland soils tend to be more clayey and granulate than forest soils.

Grassland soils are generally black and full of organic matter due to the chemical nature of grass humus and the dense, fibrous root systems of grasses.

An important aspect of the grassland, especially in those of the rhizome-forming grasses is the formation of a thick sod. This, plus the abundance of roots close to the surface of the ground, has much to do with the stability and composition of the grassland. Ellison (1960) said that this heavy accumulation of mulch tends to produce pure stands of grass or at least to simplify the floristic composition of stands. Weaver and Rowland (1952) found that the excessive sod layer on protected natural grassland plots promoted rapid infiltration of water and retarded evaporation. They noted that, under the conditions of excessive sod cover, nearly pure stands of the dominant sod former, Andropogon, resulted, germination was delayed, fewer flower stalks developed, yields from Andropogon were from 25-50% less, and none of the typical understory, and only a few taller forbs, remained.

Because grasslands are economically important to man, they have been created and maintained by man in many parts of the world. In areas where these artificial grasslands are left undisturbed, succession back to the former wooded state is commonly observed. McQuilkin (1940) described the natural reforestation of Loblolly Pine in abandoned farm fields in the southeastern United States. Johnson

(1945) studied the natural revegetation of abandoned crop land in the northeastern Rocky Mountains. He hypothesized the sequence of stages as: bare soil to annual weeds, to perennial forbs, to mixed grass and forb, to subclimax bunch grass, and finally to climax Ponderosa pine forest.

Succession in natural grasslands toward a wooded, forested, or brushy condition is another widespread occurrence. In Wood Buffalo Park, Alberta, Canada, Jeffrey (1961) noted that a formerly mesophytic prairie is rapidly becoming wooded with the influx of brushy species and quaking aspen. The prairie is known as a former meeting place of Indians and may have been maintained by fires which are now suppressed. Habeck (1961) concluded that control of Indian-set fires in the Willamette Valley, Oregon, has permitted the development of oak-forests from former openings. Ovington (1964) pointed out a slow, long-term increase in both the amount of tree cover in the savanna and in the abundance of shrubs in both savanna and oakwood in the prairie-woodland ecotones in western Minnesota. A quote from Ovington (1964, p. 44):

> The most noteworthy factors controlling the vegetation pattern are past differential burning by Indians, and local differences in site condition, particularly the height of water table and the character of the soil which ranges from a base-rich sand to peat.

Chavennes (1941) discovered that there had been a disappearance of 60% of the Wisconsin prairie in the 25 years from 1829 to 1854 (prior to cultivation), owing to the invasion of trees and brush following the cessation of fires in that area. Gleason (1932) wrote that forests advance into Illinois grasslands one to two miles in 30 years, and also that northwestern Illinois and southwestern Wisconsin, now heavily forested where not cultivated, were 80-90% prairie grassland when first visited by Europeans. Stewart (1956) stated that 75,000,000 acres of grassland in Texas and neighboring states have become covered with mesquite jungles. He added that sagebrush and juniper have invaded parts of the drier grasslands from the west, and aspen forests have crept hundreds of miles into the northern Texas prairies as a prelude to pine. He attributed the recent suppression of fire as the main factor allowing these examples of succession to occur.

These authors have pointed to the fact that at least some grasslands exist as a result of frequent fire. Moore (1964) explained how grasses are adapted to grow under conditions of frequent fires: First, the perennating organs are often beneath the ground. Next, the seeds are produced, and they fall before autumn and the frequent fires of that season. Finally, by autumn, grasses have finished growing and reproducing, and fires only burn the dried up remains. Where fires are frequent, these characteristics of the grasses give them the advantage over the slower-growing and slower-reproducing woody plants. Hadley and Kieckhefer (1963), comparing recently burned and protected areas of prairie, noted that grasses in the recently burned area have greater biomass and flowering stalk production, more rapid rate of phenological development, and increased root production. They suggested removal of litter as a major factor determining these results. Obviously these changes in the growth of grasses have the effect of increasing their vigor in an area. Sauer (1950, 1956) suggested that all natural grasslands have come about because of frequent man-caused fires, and he believed that the span of human disturbance has been long enough to allow for the evolution of new grassland species and for the development of the characteristic profiles and structures of prairie soils in the Great Plains. Malin (1956) emphasized the incorrectness and inadequacy in the use of the term "climax" for the Great Plains grasslands, because it implies a climatically controlled vegetation. He concluded that the Great Plains grasslands are, for the most part, in a "stable state" maintained by fire, either light~~e~~ning or man-caused.

Most botanists have taken less rigid stands, however. Stewart (1951) reported that even when Texas ranchers use frequent fire, the brush soon takes over because grazing has reduced the litter required for effective fires. He concluded that the importance of fire relative to other ecological factors in maintaining a grassland varies with the location. Generally, the drier the climate, the less important are frequent fires. Moore (1964) wrote that changes in the vegetation of native grasslands following settlement must commonly be attributed to the combined effects of fire and grazing. Ellison (1960) noted that selective grazing by stock handicaps some species and encourages others. He stated (1960, p. 54):

> The effect of grazing in both reducing standing herbage and accumulation of mulch, is to encourage evaporation loss and to create a lighter, warmer, and drier microclimate. (This)...permits invasion of weedy species.

Lotspeich, et al. (1961) noting young stands of Sitka Spruce on a coastal prairie in western Clallam county, Washington, concluded that the most influencial factor in forest encroachment seems to be disturbance of the original prairie vegetation by recent plowing, burning, or stock grazing by white settlers.

Grassy prairies within forests or woodlands have been objects of numerous studies in various parts of the world. Explanations for the maintenance of these prairies or of changes in their size apply to the general questions on grassland maintenance and succession just discussed. Webb (1964) found evidence to deny the "fire maintenance" theory which had been commonly applied to the grass balds of the Bunya Mountains in South Queensland, Australia, and he offered an alternate explanation in terms of soil differences. Since the balds had chernozen soils, and the prevailing rain forests of that area were in latosols, he hypothesized that during a climatic drying period, the rain forest dried and burned off on the drier slopes, allowing the latosols to wash away. In these spots only grass could grow, and the chernozem soils developed under the new grass vegetation.

Billings and Marks (1957), in their study of montane treeless balds, made the important distinction between bald origin and bald maintenance. They found in their studies that in nearly all cases of persistent balds, the balds are near the upper or lower altitudinal limits of a forest type zone. They stated that "almost no balds are embedded in the matrix of a given kind of forest, and the few exceptions seem to be relatively short-lived successional areas" (1957, p. 140).

Camp (1931), finding stable grassy balds at upper-middle elevations in the Smoky Mountains, attributed their stability to the dry winds occupying these elevations.

This small review demonstrates that a variety of environmental conditions have been found to contribute to the occurrence of grasslands, that grasslands are often stable seral forms of vegetation which can be swiftly replaced when a subtle balance of environmental factors changes, and that the activities of man most certainly have a place in the creation, maintenance, and succession of many grasslands.

DESCRIPTION OF STUDY AREA

The study area is located about one mile north of the Tillamook-Lincoln county line, just south of the resort town of Neskowin, in a natural area within the Siuslaw National Forest (Sec. 3 in T6S, R11W). The general area is a large headland formed from a basaltic intrusion pushing partially through Astoria shales. Therefore, parent materials are generally basaltic, but are occasionally sedimentary in origin.

The study area is a grassy headland prairie similar to many found along the Oregon coastal headlands. The composition of these prairies varies from brushy to grass species, and the study area has both life forms. The prairies on this coast are most often found on the basaltic headlands in exposed areas where the effects of winds and salt spray are strongly felt. The study area is south-facing on a moderate slope and widens from an apex at the top to a base facing the sea on the southwest, to form a crude triangle. It is about 1600 feet long and covers approximately ten acres, a relatively large prairie (Figure 1).

The forest surrounding the study area is composed chiefly of *Picea sitchensis* (Sitka Spruce) and *Tsuga heterophylla* (Western Hemlock), typical of the forests on the coast from middle Oregon northward. *Picea sitchensis* is predominant close to the ocean and is the

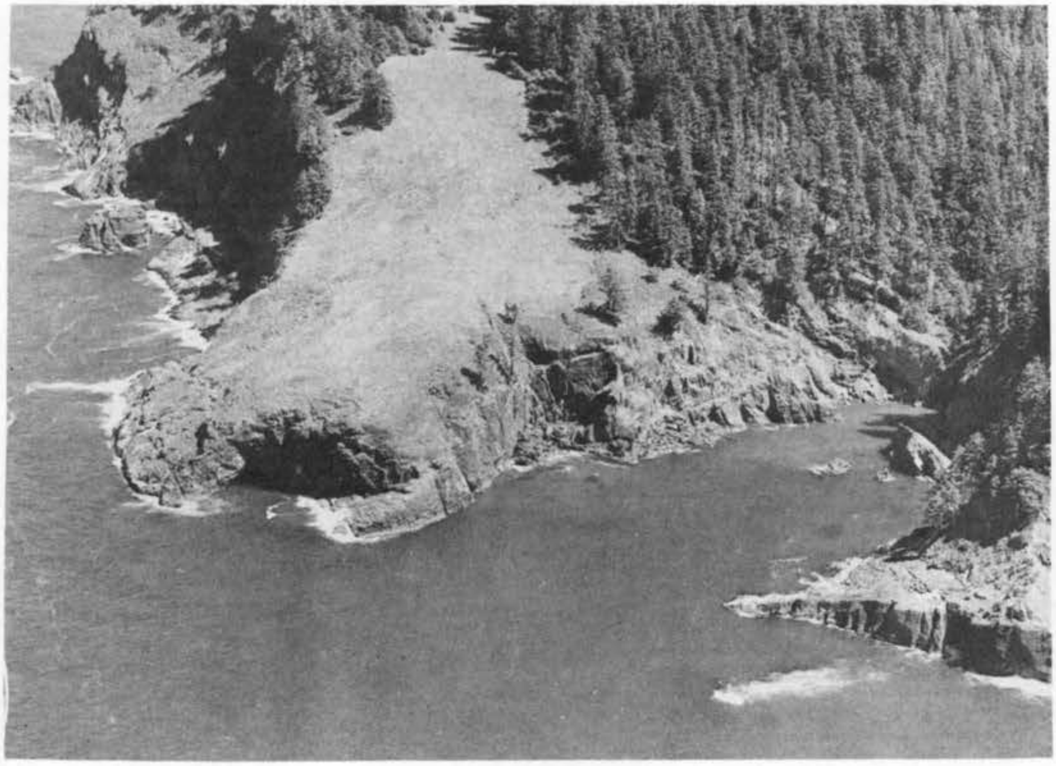


Figure 1. Photograph of the study area.

dominant conifer in the immediate vicinity of the study area. The forest understory may include _Rubus parviflorus_, _Rubus spectabilis_, _Vaccinium parvifolium_, _Menziesia ferruginea_, _Polystichum munitum_, and various forbs. Where the overstory is closed sufficiently, the understory is mainly restricted to _Polystichum munitum_ and _Oxalis oregana_.

Rainfall, recorded at Three Rocks, a nearby weather station (Ruth, 1954) from 1936 to 1952 showed an average annual total of 69.54 inches. Isaac (1946) pointed out an important difference between rainfall recorded in the open versus rainfall recorded under the forest canopy: Water from light rains, common during the winter months is largely caught and evaporated in the canopy of the forest, scarcely reaching the forest floor. The total amount of these rains would be recorded in the open, as at Three Rocks. Conversely, however, fog, most common during the summer months, is condensed on the canopy, and much drips to the forest floor. Relatively little moisture from fog is condensed in the open; thus, more moisture reaches the ground in open areas than in the forest during the winter months, whereas more moisture is available to the forest floor than to open areas during the summer.

Average monthly precipitation from 1936 to 1952 at Three Rocks varies from 1.12 inches in July to 11.12 inches in December.

Average monthly temperatures at Three Rocks from 1936 to

1952 vary from 40.1°F. in January to 60.9°F. in July. The minimum temperature recorded during that period was 11°F., and the maximum was 97°F.

The prairie is generally lined with 200 to 300-year-old Picea sitchensis which exhibit open-growth habit, i.e., abundant lateral growth of branches, reflecting no shading from surrounding trees. In some areas, however, 20 to 50-year-old Picea are present in a narrow margin between these old trees and the prairie, and where this occurs, some large lower lateral branches of the old Picea have died, presumably from a lack of sunlight caused by the presence of the younger trees.

Either because of windthrow, or because former occupants who lived here cut them down, a number of these large Picea bordering the prairie have fallen into the open area, most often perpendicular to the margin. On these fallen trees, where enough time has passed for decay to set in, small Picea have grown. At a distance, the appearance of this phenomenon is that of ranks of trees extending out from the forest into the prairie. The "nurse-log" effect is possibly the most common way in which both Picea and Tsuga heterophylla, as well as Vaccinium parvifolium (red huckleberry), germinate in this coastal forest.

The margin of the prairie has an ecotone composed mainly of brushy species which are also present in the forest understory where fallen trees have opened the forest canopy. On the ecotone, these species generally grow more vigorously than in the forest, presumably because of greater light intensity. However, the extent to which these ecotone species extend into the prairie seems to depend in part on the presence of a Picea overstory. This effect may be seen especially where the ranks of young Picea have extended into the prairie on nurse logs: The ecotone species grow out beside these logs. Thus, the ecotone is "bowl-shaped" between the rows of trees (Figure 2).

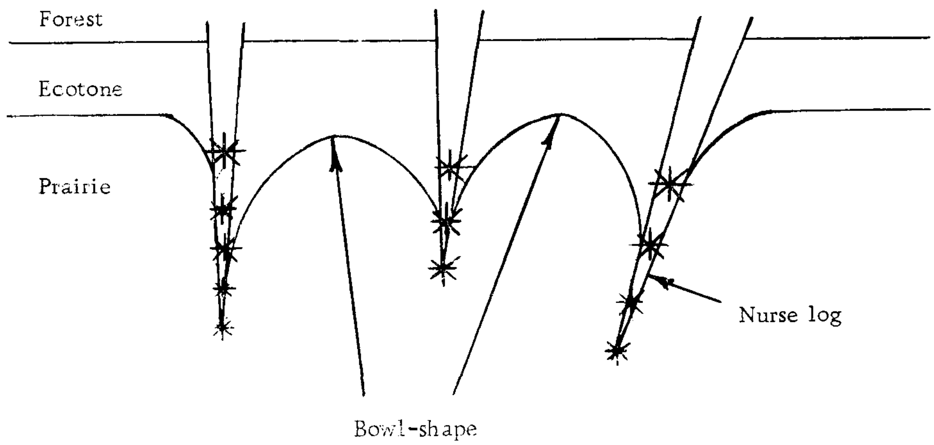


Figure 2. Diagram of the "bowl-shaped" ecotone.

The upper northern apex of the prairie is decidedly boggy in the winter and spring months (refer to Figure 1). This is due to several springs, only gentle slope, and poor soil drainage. Moisture from this area apparently drains to the side into the forest, rather than down father into the prairie. In the margin of this area, the ecotone is not pronounced; instead, a rather wide band of *Picea* less than 50 years old generally rings the margin. Also, several clumps of these *Picea* are present within the upper prairie. *Holcus lanatus*, *Agrostis tenuis*, *Phleum pratense*, *Ranunculus occidentalis*, and *Pteridium aqui~~lifolium~~lina* are the important members of the vegetation here.

Another boggy area is a drainage located in the lower east side of the prairie. Here year-round seepage results in vegetation dominated generally by *Equisetum maximum*.

Still another generally boggy area is on the lower west-facing end of the prairie. Here also, year-round seepage occurs, and the slope is quite steep. Vegetation is predominantly *Vicia gigantea*, with *Equisetum maximum* in the lower, wettest spots.

Most other areas in the prairie are dominated by *Agrostis tenuis* and *Holcus lanatus*, two introduced grasses. However, on the lower south-facing end of the prairie, *Festuca rubra* becomes the dominant grass, with *Bromus sitchensis* contributing to the cover significantly. These two grasses, plus the occasionally-found *Calamagrostis nutkaensis* and the more common *Elymus glaucus*, are the only native grasses found on this prairie. On the relic prairies farther north, these grasses are much more prevalent.

Of primary importance in this thesis are the various non-grass stands of forbs and shrubs in the predominantly grassy prairie. They are generally not difficult to discern from the normal grassy vegetation, although grasses are present in almost all stands. The appearances of these stands vary markedly during the seasons.

In October grass species resume growth following a late summer dry period, and from this time until April, the prairie appears most homogeneously grassy. Only stands which contain the shrub, Rubus parviflorus, or the sedge, Carex obnupta, can be easily seen during the winter months. From April continuing through the summer and early fall, stands which can be readily seen increase in variety as well as number.

The average size of these stands is 30 to 40 feet across; a few are less than 10 feet across, and one is more than 100 feet across. They occur in any shape. Often they merge, one into another, but close examination allows them to be differentiated.

The occurrence of some types of these stands is correlated with particular site characteristics; a good example is the vegetation in which Equisetum predominates, where the soil is boggy during the entire year. Most stands, however, lack obvious site characteristics.

Many of these features of the study area are seen in other prairies on the coast, and some are not. Also, of course, other prairies have their own distinguishing characteristics. However, in an attempt to describe the natural or undisturbed form of these prairies, the study area has certain advantages over any other prairie that has been seen on the Oregon coast. As has been mentioned in the Introduction, many relic prairies, especially on the northern Oregon coast, have been left relatively undisturbed, apparently resulting in a succession toward brushy vegetation and trees. On the other hand, prairies, mostly on the southern half of the Oregon coast, which are currently being used for grazing purposes, are often in such a disturbed condition that an idea of the natural state of the vegetation is difficult to achieve. The study area has been maintained by farmers and stockmen, yet has undergone a 25 year period of no disturbance.

Nevertheless, the fact that the study area has undergone unnatural grazing pressure and farming in the past makes generalizations about the natural state of its vegetation risky. In addition, most of the grass species which make up this grassy prairie are introduced. Holcus lanatus and Agrostis tenuis, the two most prevalent grass species, were introduced from Europe.

Some cursory investigation into the appearances of soils and into soil depths was made. No striking differences between soils of the prairie and soils of the forest were detected, although soils of the prairie show the influence of grasses in their upper 12 inches. Soil depth varies from four to more than 48 inches. Some of the deepest and shallowest soils are grass-covered. At the upper east border of the prairie, soil depth increases sharply from prairie to forest, but other prairie-forest boundaries in the study area do not. Parent materials in the upper portion of the prairie are either basaltic or sedimentary in origin, while basaltic rock is beneath soils in the lower portion of the prairie, and occasionally it protrudes as outcrops. Although no recent remains of trees are found in the prairie proper, charcoal is present from six inches below the soil surface to the "C" horizon in many places in the upper portion of the prairie. Charcoal is not as consistently found in the lower portion of the prairie.

The degree to which the influence of coastal Indian populations has affected coastal vegetation is not known. Carey (1922) estimated the Indian population along the Oregon coast at the beginning of the 19th century to be near 50,000. Strong (1906) judged that from the evidence of excavated campfires and burial grounds the Indian populations in western Oregon, including the coastal regions, were greater in times past than they were when first observed by the white man. Buried mounds of shells deposited by Indians have been found near most beaches along the Oregon coast; the author has found one in the study area.

Dix (1964) emphasized the universal use of fire by North American Indians to control vegetation. Head (1910) and Cotton (1915) stated that Indians burned the vegetation in specific areas in and around Nehalem in Tillamook county.

The possibility has been considered, therefore, that fires set intentionally or accidentally by Indians, who populated the Oregon coast for perhaps thousands of years, have influenced the vegetation, and that the effects of that influence may still be seen, if interpreted properly.

The first settlers came to Tillamook county in the early 1850's, mostly settling in the Nehalem Valley. They brought some cattle and planted a few subsistence crops. Dairying grew to be the major industry, and butter was the main export. Dairying has continued to be an important industry on the coast, and the chief use of arable land on the coast has been pasture for dairy and beef cattle. Steep and mountainous grasslands have also been used for sheep range. It is for sheep and beef cattle pasture that most of the headland prairies of the coast have been used.

The author has been fortunate in acquiring a rather comprehensive history of the use of the study area since the early 1900's.

In 1896, a man named James Taggert homesteaded about 160 acres which included the study area. Although he served as postmaster in Neskowin, his activities in the study area are not known. In 1916 he sold the 160 acres to Charles Hart, a young school teacher. Hart farmed on the prairie until 1935 and sold the land to the U. S. government in 1938 at which time the area became part of the Siuslaw National Forest. In 1941, a small forested area around the prairie was made a Natural Area because of the undisturbed state of the forest. The prairie itself is not part of this Natural Area. Since 1941, however, no stock grazing has been allowed, and disturbance by man has been minimal since that time.

Charles Hart's activities at the study area have been very interestingly related to the author by Mr. Hart himself.

During the 19 years that he farmed there, he carried out the following activities (refer to Figure 1):

1. He cleared most of the brushy ecotone on the east side of the prairie back to the forest.
2. He divided the upper boggy end and the upper half of the drainage area on the east side, from the remainder of the prairie with a fence. In the upper portion and along the east boundary he pastured calves and grew potatoes and onions. He pastured his horses and cattle in the lower portion.
3. He built a small barn on a rock outcrop in the middle of the prairie.
4. In the forest north and west of the prairie he felled a number of large _Picea_, both for lumber for building purposes and for the ready-made corrals they created when felled at right angles to each other.

5. He built a small barn in the forest west of the upper portion of the prairie. He also built a house near this barn, but later built another house on a small knoll overlooking a stream about 100 feet north of the prairie. He cleared the vegetation back to this knoll.

After 25 years of relatively undisturbed conditions, few remains of Hart's activities may now be seen. Only a small number of fence posts remain. The barns have been removed, and the remains of the house on the knoll can be found only with difficulty. The ecotone has grown back, and all areas which were cleared are thickly overgrown with brush, and are already being shaded by alder or tall young Picea.

METHODOLOGY

Reconnaissance

The initial step in this study was a period of familiarization with the vegetation. Most of the summer of 1965 was spent collecting plant specimens at the study area and identifying these specimens. Eventually over 100 species were identified. Much time was spent in reconnaissance in and near the study area, and a knowledge of the important plant species and plant groups was gained. Also, in September, a reconnaissance trip was made over most of the Oregon coast in an attempt to compare and contrast the vegetation of other prairies with that of the study area.

During this period of reconnaissance and familiarization, certain forb and shrub stands which stood out conspicuously from the generally homogeneous grass prairie were noted, and it was decided that these stands should be sampled and described.

Sampling of Stands

Beginning in January 1966, a number of stands were established and sampled according to a procedure which will be described. From January through the month of March, this sampling was carried out in 16 different stands. In the month of April more stands became apparent and the number rose to 28. In June the number of stands was 34, and in July the number was 38. In October 30 stands were sampled. The stands sampled from January through March were considered parts of the winter prairie vegetation. These stands were characterized by shrubs or sedge, which are conspicuous during the entire year. Stands included in the later samplings were characterized by various forbs, which are not readily discerned during the winter months.

Almost every stand was sampled more than once. Most of the stands established during the winter period (January through March) were again sampled in April, June, July, and October. Stands established in April were sampled one less time, and so on. By this repeated sampling throughout the season, some idea of how these stands may have changed during the season was gained.

The sampled area was the same for all stands, regardless of stand dimensions. A quadrant size of one-meter square divided into four subquadrants was used (Figure 3). A heavy wire grid was constructed for this purpose, and was placed unsystematically in four different locations in each stand. These locations were determined through the discretion of the author. They were areas of uniform vegetation in the stand, and were of the vegetation judged by the author to be characteristic of the stand as a whole. Since the stands were generally quite homogeneous, this method of placement of quadrants in the stands may be considered valid.

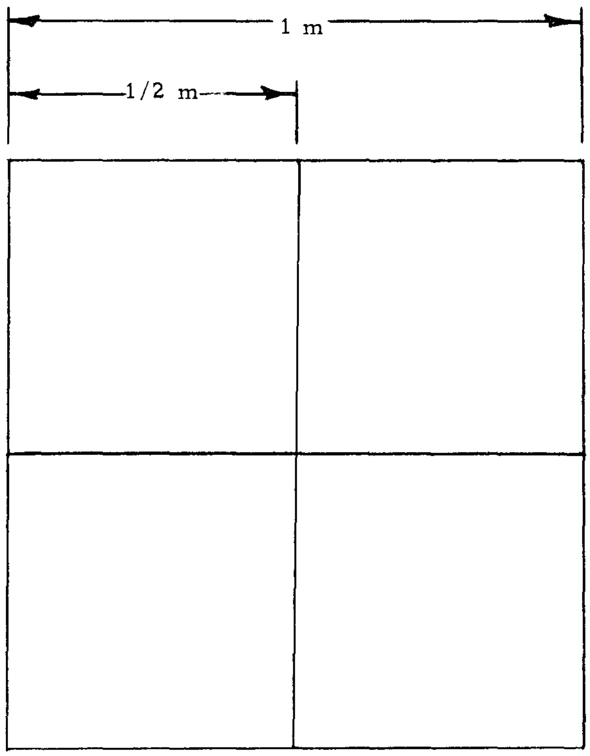


Figure 3. Diagram of the stand-sampling grid.

Presence of all species in each subquadrant was recorded and designated as a percent frequency in a total of 16 subquadrants in each stand.

Vegetative cover for each species in each of the 16 subquadrants in each stand was recorded in cover classes ranking from one to seven.

one	equaling	0- 5%
two	equaling	5- 10%
three	equaling	10- 25%
four	equaling	25- 50%
five	equaling	50- 75%
six	equaling	75- 90%
seven	equaling	90-100%

The cover values obtained for each species in all subquadrants in which it is present in a stand were averaged to the nearest whole number. Then the two statistics, percent frequency and cover, were represented as a fraction, percent frequency over the average cover value. All species found in a stand by this sampling method were represented by this fraction.

An association table was assembled for the purpose of differentiating types of plant communities, or assemblages, and to establish an ordination of the communities, if possible. Frequency and cover values of all species were taken from the sampling done in July whenever possible, since the flora was judged to be richest at that time.

The general method for arranging this association table is reviewed briefly here: Stands were arranged horizontally with the list of species arranged vertically on the association sheet (refer to Appendix Table 1). Stands whose species composition appeared similar were grouped together. Mere presence or absence of species was the criterion used for this initial arrangement. The stands having been grouped, species in these groups were arranged together so that a spacial distribution could be discerned. A relocation of ubiquitous species and sparsely distributed species toward the bottom of the sheet clarified the spacial distribution of the groups of species on the upper portion.

When general groups of species had been established, an ordination of these groups was arranged. That is, they were made to appear (according to tradition) from the top left-hand corner of the sheet to the lower right, representing a gradient. The arrangement is such that each group is placed adjacent to that group with which it has most species in common. Thus, the ordination is made not on the basis of any specific environmental gradient, but on the basis of the over-all species composition of the stands. The species composition of each stand reflects its environmental and successional state. The ordination is an expression of the combined environmental and successional gradients resulting from the interaction of all environmental factors and all stages of succession in the stands sampled in this prairie.

Prairie to Forest Transects

Seven transects were established from the prairie through the brushy ecotone into the forest for the purpose of comparing ecotone vegetation with that of the community types established within the prairie. This was done in mid-August 1966. The vegetation on each transect was sampled rather intensively, and each transect was established to sample what was judged to be a distinctive type of ecotone.

One square meter on both sides of the transect line was used, and every meter length was sampled along the line, except where obvious repetition in the sampling of vegetation was deemed unnecessary. Each square meter was divided into four square 1/2-meter subquadrants, making a total of eight square 1/2-meter subquadrants on every meter length of the transect (Figure 4). All species within every subquadrant were recorded, and each species recorded in each meter length along the transect was given a number representing the number of subquadrants in which it was present, out of eight subquadrants.

In addition to these vegetation data, an investigation of soil depths was made in August and September of 1966. Auger holes were dug in most of the stands sampled and in the prairie proper. Holes were also dug in the forest and along the ecotone transects. Data on soil depth were taken, and parent materials were noted.

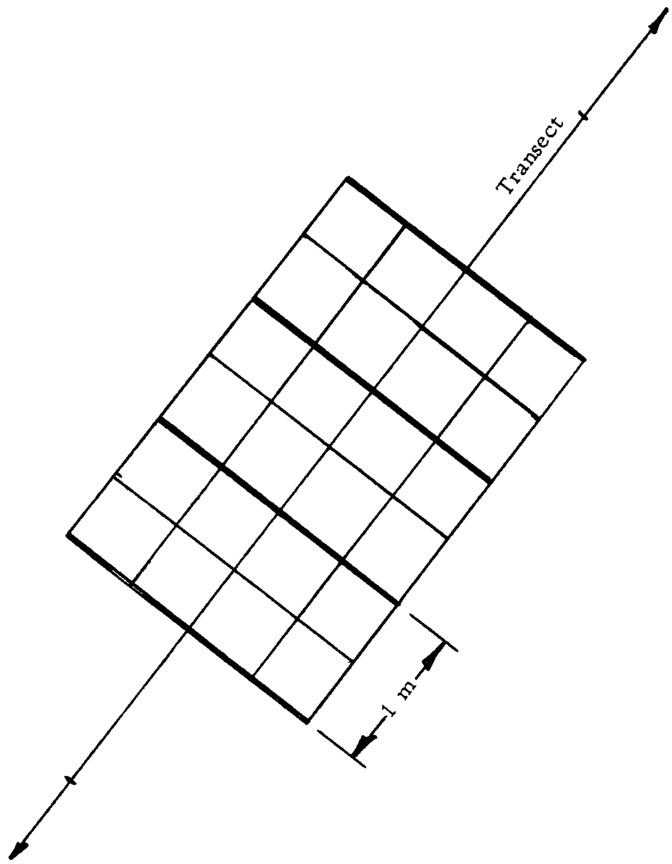


Figure 4. Diagram of the sampled area along the transects.

RESULTS

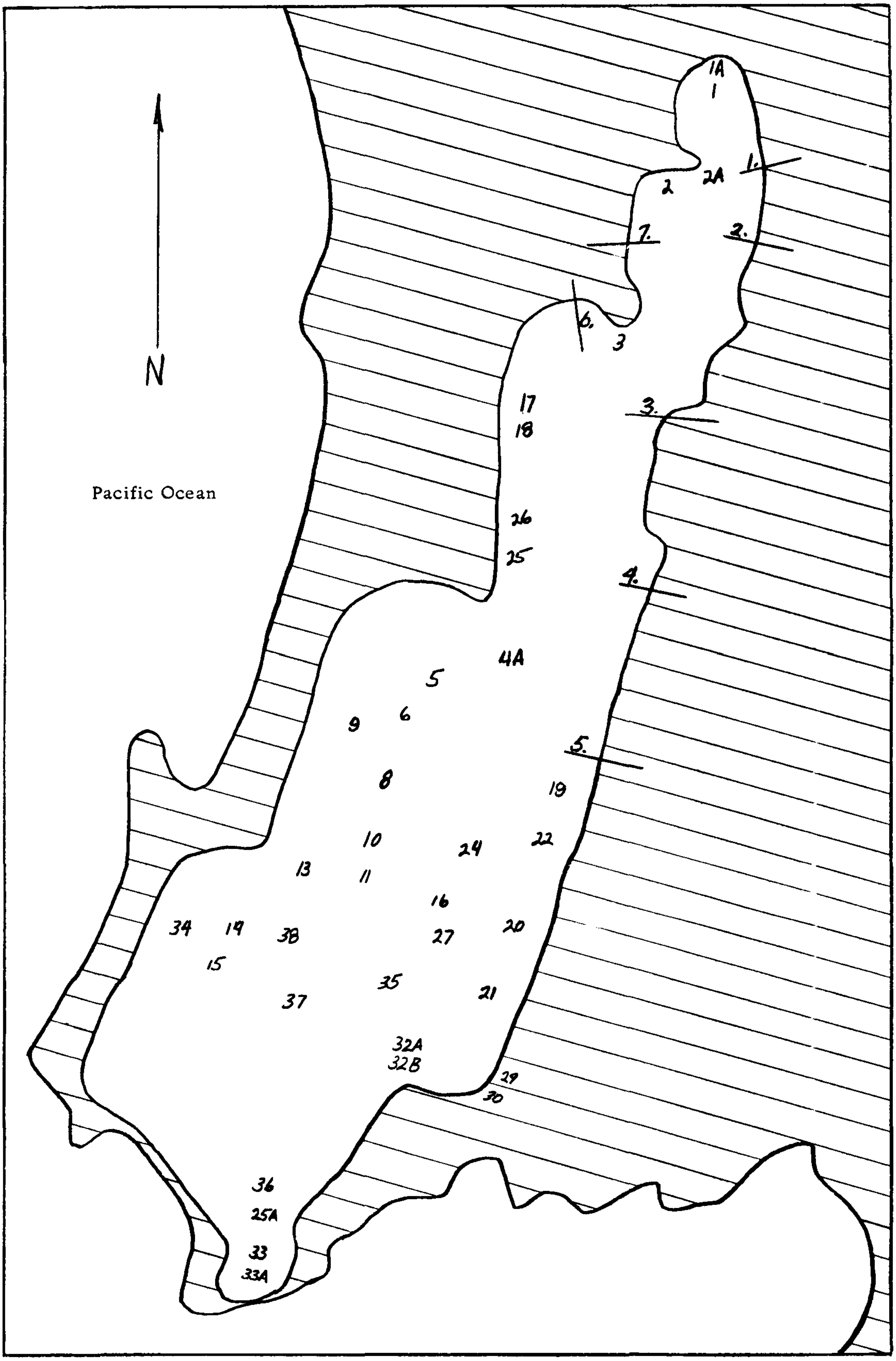
An association table was constructed using all stands sampled. Seven communities were differentiated in this table (Appendix Table 1). A map of the study area shows the locations of the sampled stands (Figure 5).

Use of the term, "definitive species," is made in this section. A definitive species is one which is consistently found in a particular community, and is not often found in others. The upper portion of the association table is comprised mostly of definitive species; species which are important members of two or three adjacent communities are also included in this upper portion to illustrate similarities between these communities.

The term "undifferentiated prairie" is also occasionally used here. It denotes those remaining areas of the prairie not belonging to the communities differentiated and sampled in this study. This is not to imply that pattern cannot be found in these areas. Generally they are vegetated by a variety of grass species; these species are commonly present in the sampled stands.

Frequent reference to Appendix Table 1 will be necessary while reading the remainder of this section.

Figure 5. Map of the study area, showing the locations of the sampled stands and the transects.


N
Pacific Ocean
1A
1
2
2A
1.
2.
7.
6.
3
3.
17
18
26
25
4.
4A
5
6
9
5.
8
19
10
24
22
13
11
16
34
14
3B
27
20
15
35
37
21
32A
32B
29
30
36
25A
33
33A

Equisetum maximum Community

The Equisetum maximum community is represented by four stands located along a drainage on the east side of the prairie. It appears to be restricted to soils which are wet the entire year. Soils vary in depth from eight inches to more than four feet, and parent materials are basaltic in origin (Table 1). Definitive species are Equisetum maximum and Ranunculus occidentalis. Important species that are common in other communities include Heracleum lanatum, Stachys emersonii, Galium aparine, and Pteridium aquili~~folium~~num.

The affiliation between this community and the Polystichum-Rubus parviflorus community can be seen in the association table. Cardamine oligosperma, a native annual common in this community, is recorded in four of ten stands of the Polystichum-Rubus parviflorus community. Also, stand #13 has important species from both communities.

Aspection data on selected species in this community is summarized in Figure 6. Species such as Ranunculus occidentalis, Galium aparine, and Cardamine oligosperma, plus several species of grass contribute to a low, lush vegetation through most of the winter. In April Heracleum lanatum adds to this. In June, while many of these winter-growing or early-appearing species have

Table 1. Soil depths in sampled stands.

Soil depth (inches)	*Equisetum maximum*				*Polystichum munitum- Rubus parviflorus*										*Carex obnupta*				*Lupinus littoralis*		*Angelica lucida- Rubus spectabilis*		*Solidago canadensis*				*Solidago canadensis- Artemisia suksdorfii*	
	20	19	21	23	5	9	6	3	8	10	5	24	14	11	17	18	26	2A	16	4A	32A	32B	25A	36	38	35	33A	33
0- 6				X																								
6-12			X		X	X	X			X	X	X	X	X	X	X	X	X			X	X						
12-24								X	X										X	X				X				
24-36																							X		X			X
36	X	X																								X	X	

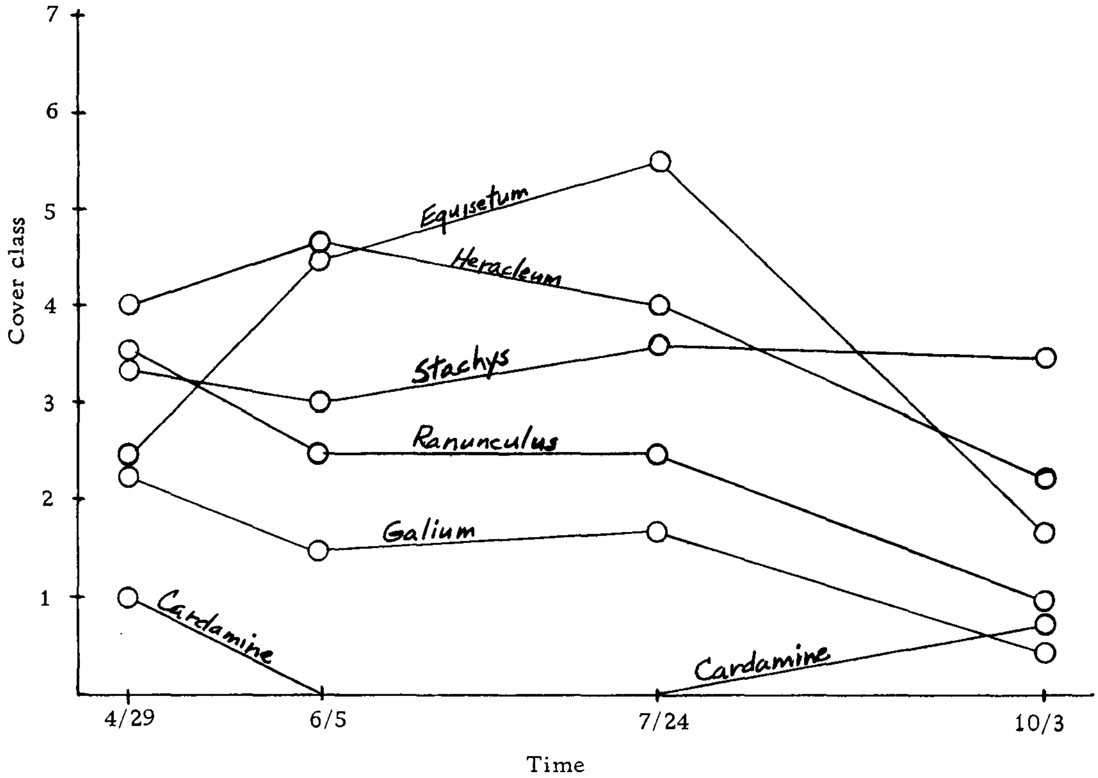


Figure 6. Graph of seasonal cover trends of some species in the Equisetum maximum community.

leveled off in growth or have died out, *Heracleum* sends up its fruiting stalks. In late July and in August, *Equisetum* dominates this community. In September, *Equisetum* dies, and its stalks lie heaped on the ground. The cycle appears to start over almost immediately and the cover values recorded on October 3 for *Galium*, *Cardamine*, and *Stachys* represent the new season's growth.

Polystichum munitum-Rubus parviflorus Community

Definitive species in this community are *Polystichum munitum*, *Rubus parviflorus*, *Tellima grandiflora*, and *Disporum smithii*. Unidentified species of moss are also present in all stands of this community. Other species which occur frequently in this community, but which are not considered definitive, include *Heracleum lanatum*, *Stachys emersonii*, *Marah oreganus*, *Pteridium aquilinum*. *Conioselinum chinense*, *Montia sibirica*, *Holcus lanatus*, *Agrostis tenuis*, and *Poa pratensis*. *Rubus spectabilis*, while only occurring in six of the ten stands, contributes significantly to the shrub layer of those in which it is present.

The appearance of this community varies greatly during the seasons (Figure 7). In the winter months, it is the only community which can be readily discerned in the prairie, the brown stalks of *Rubus parviflorus* and *Rubus spectabilis* contrasting with the new green grass. In April, *Heracleum lanatum*, a large-leafed,

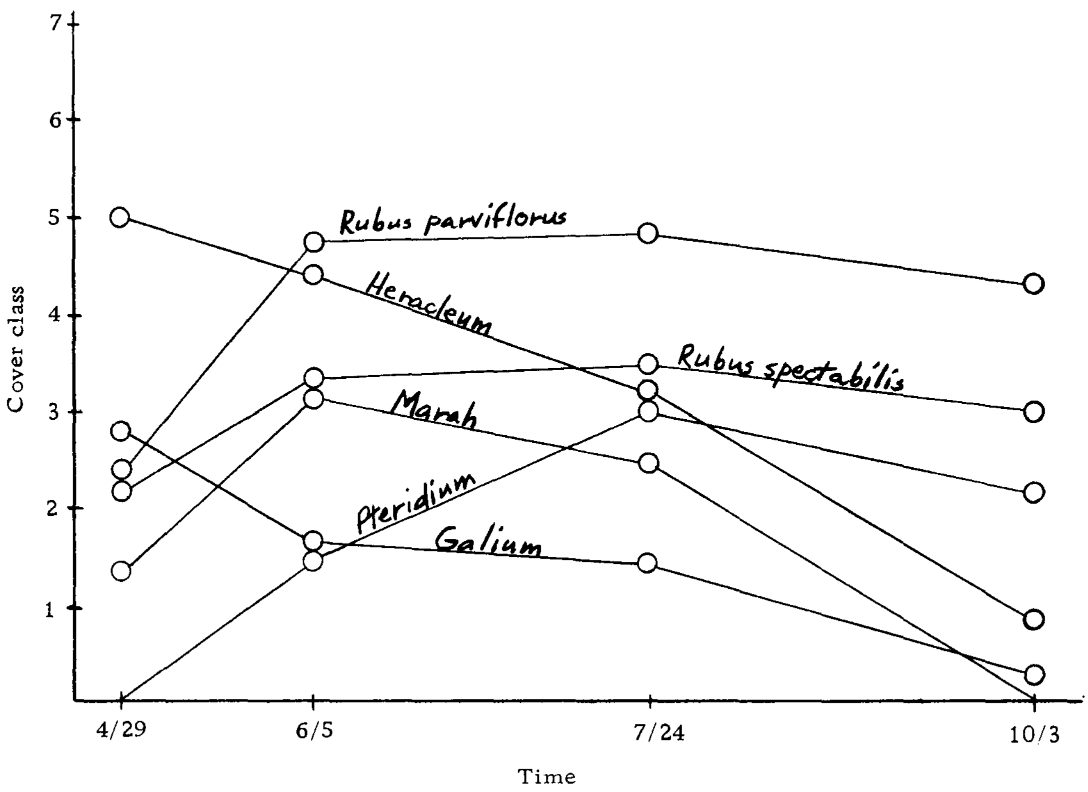


Figure 7. Graph of seasonal cover trends of some species in the Polystichum munitum-Rubus parviflorus community.

coarse-stalked forb in the Umbelliferae emerges and dominates this community until well into July at which time it begins to die back. Galium aparine also exhibits early vegetative growth. Other species gradually catch up in June and July. Marah oreganus, Rubus parviflorus, and Rubus spectabilis replace Heracleum lanatum as dominants, and by September Galium, Heracleum, and Marah are gone, leaving Rubus parviflorus as the dominant species in this community, or co-dominant with Rubus spectabilis where it is present.

Polystichum munitum is present as clumps and changes very little in appearance throughout the year. Although it is found in no other stands than those of this community, it is also seen in clumps by itself in the prairie. However, these usually occur in the general vicinity of the Polystichum-Rubus parviflorus community.

The presence of mosses in this community is significant because none are found elsewhere with the exception of stand #32A, a representative of the Angelica lucida-Rubus spectabilis community. Corresponding with the growth of mosses, cover and vigor of grasses is low. The shrub layer may be responsible for the growth of mosses and the decreased vigor of grass, for beneath the extremely heavy cover of foliage is a dark, relatively open area, where mosses may be encouraged to grow, but where lack of light inhibits growth of grasses. The Angelica-Rubus spectabilis community is the only other community with such a condition.

Results of the soil depth survey are shown in Table 1. Although some variation in depth of soil is seen in the _Polystichum_-_Rubus parviflorus_ stands, later additional digging suggests a close correlation between soil depths of 12-18 inches, and the presence of this community. The parent material is basaltic except in stand #3, where the parent material is sedimentary in origin. Stands #24 and #14 are on basalt outcrops having very shallow soil. Significantly, in these two stands, _Polystichum_ has much higher frequency and cover values, while _Rubus parviflorus_ has lower frequency and cover values than is normal in this community.

The studies of the transects from prairie to forest reveal that many species in the _Polystichum_-_Rubus parviflorus_ community are present in the ecotone vegetation. Few species from any of the other communities are present to an important degree in these transects. Table 2 shows the distributions of some species in the _Polystichum_-_Rubus parviflorus_ community. Each number represents the frequency with which a species was present in each quadrant along the transect. In Figure 8, each graph shows the average distribution of one of six species in the _Polystichum_-_Rubus_ community along seven transects. The vertical line on each of these graphs in Figure 8 represents where cover from _Picea sitchensis_ (Sitka Spruce) and/ or _Tsuga heterophylla_ (Western Hemlock)

Table 2. Distributions of six species of the Polystichum munitum-Rubus parviflorus community in seven transects. (Note: Each number represents the frequency with which a species was present in each quadrant (eight subquadrants) along the transect. Spaces with no number indicate that the species was not encountered.)

Meters (prairie to forest)

Transect 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rubus parviflorus	Prairie												Forest		
Rubus spectabilis	boundary			1	4			2					boundary		
Conioselinum chinense		1	5	7	8	8	8	6	7	3	2				
Montia sibirica						2		4	4	3		3			
Tellima grandiflora															
Polystichum munitum						1		3	5	8	8	8	8		

Meters (prairie to forest)

Transect 2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rubus parviflorus															
Rubus spectabilis							2	7	7	7			4		
Conioselinum chinense						6	8	3							
Montia sibirica								3		5	4				
Tellima grandiflora															
Polystichum munitum				1	7	6	6	5	8	3	8	8	8		

Meters (prairie to forest)

Transect 3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rubus parviflorus											8	8	1		
Rubus spectabilis					4	2	2	5		8	6				
Conioselinum chinense															
Montia sibirica							1	2	2	1			8		
Tellima grandiflora															
Polystichum munitum						3	5	1	3	8	8	8	6	3	

Meters (prairie to forest)

Transect 4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rubus parviflorus				1	3	3	2	8	8	3					
Rubus spectabilis			1	7	6	8	5	6	5	4	1		3	8	6
Conioselinum chinense												2			
Montia sibirica											1				
Tellima grandiflora				1	3	6	6	1	1	1	1		2		
Polystichum munitum									8		4	6	8	8	8

Table 2. (continued)

	Meters (prairie to forest)														
Transect 5	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rubus parviflorus					3	8	7	4				3	2		
Rubus spectabilis					3	8	8	7	4		4	8	8		
Conioselinum chinense															
Montia sibirica									2	3					
Tellima grandiflora						3	4	4		2					
Polystichum munitum									2	4	7	8	8	8	

	Meters (prairie to forest)														
Transect 6	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rubus parviflorus				4	2										
Rubus spectabilis		1	6	7	8	7	5	2							
Conioselinum chinense							2								
Montia sibirica							1								
Tellima grandiflora							2								
Polystichum munitum						6	7	4							

	Meters (prairie to forest)														
Transect 7	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rubus parviflorus															
Rubus spectabilis			4	8	7	7	6								
Conioselinum chinense					3	5									
Montia sibirica				2	6	3	1								
Tellima grandiflora			2	5	3										
Polystichum munitum						2	4								

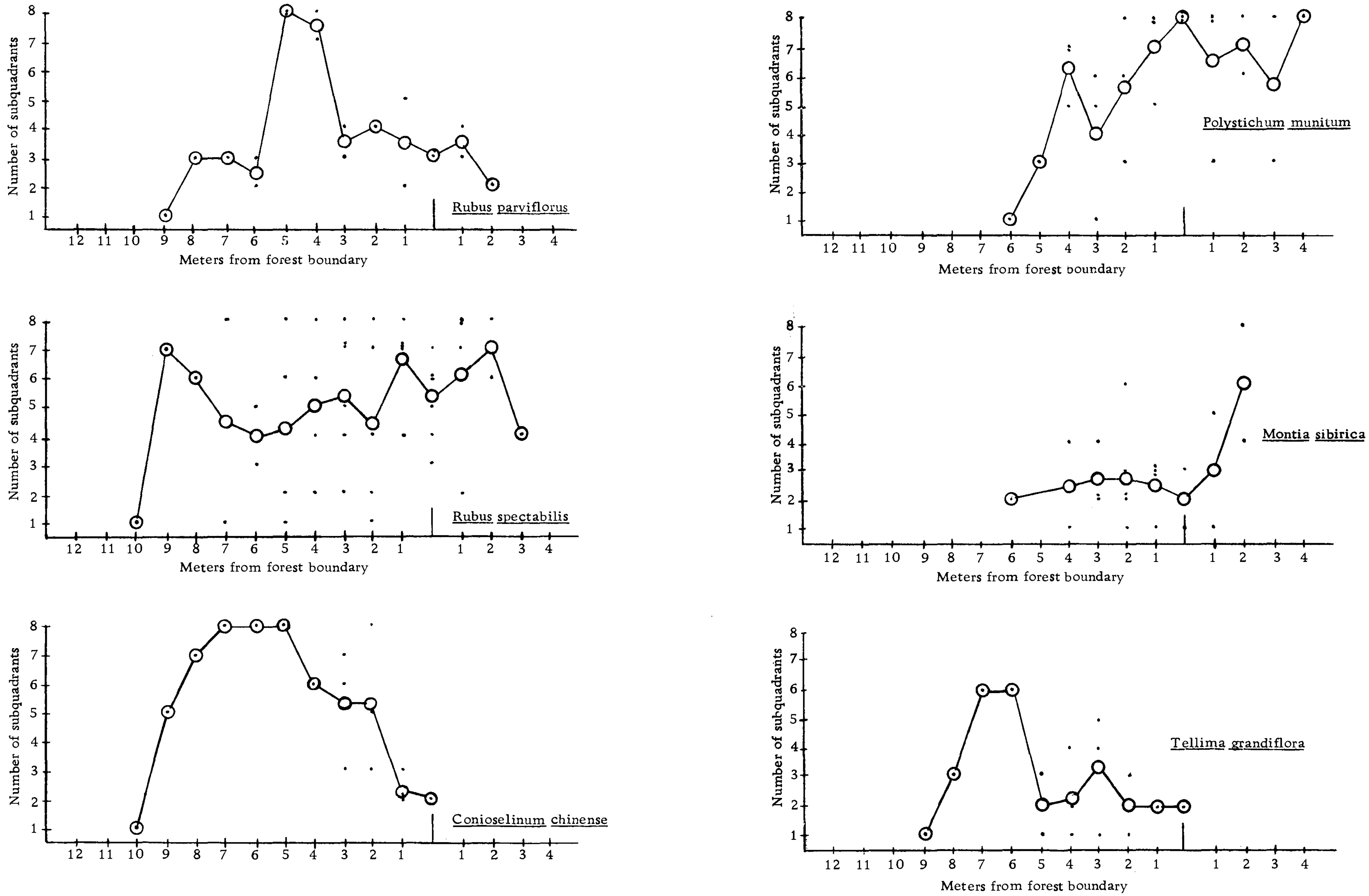


Figure 8. Graphs of the average distributions of six species of the Polystichum munitum-Rubus parviflorus community along seven transects.

commences.

It is obvious from these data and from field observations that these species are generally a part of the ecotone vegetation, not of the prairie or the forest. Both Rubus species are usually found in the high brushy layer in the ecotone. Conioselinum chinense, present mainly in the upper transects (1, 2, and 7 in Figure 5) forms part of the forb understory along with Lysichitum americanum, the skunk cabbage. Its highest frequency values were recorded well within the ecotone vegetation. Montia sibirica forms part of the very low forb vegetation and exhibits highest frequency values close to or in the forest, being a common species in light spots in the forest. Tellima grandiflora, of the same stature as Montia, is generally restricted to well within the ecotone vegetation. Polystichum munitum may be present all along a transect, but like Montia, is encountered more frequently toward the forest side of the ecotone, being a common member of the forest understory.

Carex obnupta Community

The only definitive species in this community is Carex obnupta, which generally forms dense cover from the ground surface to approximately two feet above the ground. Heracleum lanatum, Stachys emersonii, Marah oreganus, and Pteridium aquilinum are common, but low cover values were recorded for them.

Vegetationally, the connection between this community and the Polystichum-Rubus community can be seen on the association table. Carex is fairly common in some stands belonging to the Polystichum-Rubus community, and stand #11 appears to be intermediate between the two. In the other direction in the ordination, stands #37 and #25A show the affiliation between the Carex and Solidago canadensis communities, since Carex and Solidago are both present in these two stands.

Since the appearance of the Carex community changes only slightly during the seasons, aspection data are not presented. Carex itself is green and grows all year; in the early fall the patches of Carex stand out in the otherwise tawny-colored grassy prairie.

Soil depths are usually not more than 12 inches and are sometimes less (Table 1). Soils are generally more moist than those in the Polystichum-Rubus community. Parent materials are basaltic in origin.

Lupinus littoralis Community

This community is recognized by the presence of Lupinus littoralis. Because all other associated species are ones which make up the surrounding grassy prairie, the status of this community is an uncertainty. Cerastium arvense is present in no other sampled stands, but is common in the undifferentiated prairie. Achillea millifolium and Plantago lanceolata are also common in the undifferentiated prairie, as well as being present in other sampled communities. The absence of Stachys emersonii, Marah oreganus, and Galium aparine in this community is significant because these species are very common in the other sampled stands, but are not as common in the undifferentiated prairie. In these respects, except for the presence of Lupinus littoralis, this community greatly resembles the surrounding undifferentiated grassy prairie.

Achillea millifolium forms the connection that links the Lupinus community to the Angelica lucida-Rubus spectabilis and Solidago canadensis communities. Although Achillea millifolium is quite ubiquitous in the sampled stands, in none of the other stands are frequency values as high as in the stands representing these three communities.

Figure 9 shows seasonal trends on five species in the Lupinus community. The cover values taken on October 3 for Lupinus, Heracleum, Achillea, and Plantago represent, for the most part, vegetative cover of the new season's growth of the three species.

Soil depths for this community are about 36 inches (Table 1). Parent material is basaltic in origin.

Angelica lucida-Rubus spectabilis Community

This community is the most restricted in area, being comprised

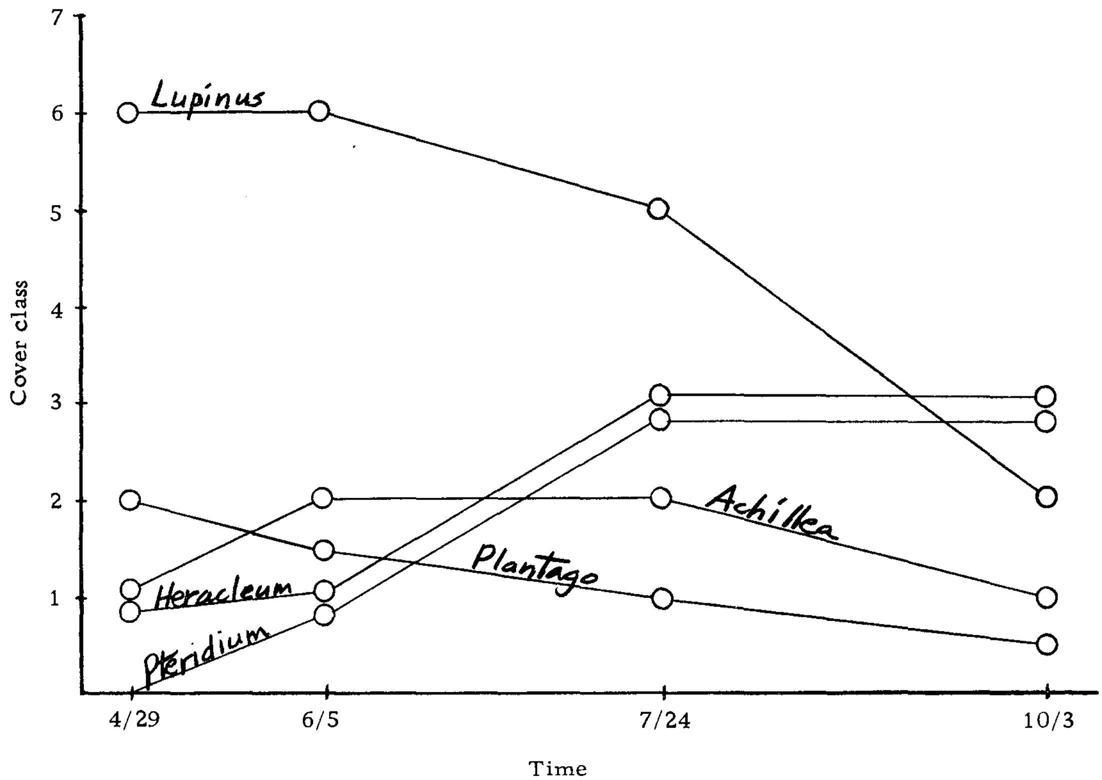


Figure 9. Graph of seasonal cover trends of some species in the Lupinus littoralis community.

of only two small stands situated close together (Figure 5). The one definitive species is Angelica lucida, an umbelliferous plant closely resembling Heracleum lanatum. Some non-definitive species are Rubus spectabilis, Achillea millifolium, Stachys emersonii, Marah oreganus, Pteridium aquilifolium, Holcus lanatus, Agrostis tenuis, and Dactylis glomerata.

Aspection data for several important species in this community is presented in Figure 10. In much the same manner as Heracleum lanatum in the Polystichum-Rubus parviflorus community, cover values of Angelica lucida decrease in the summer when cover values of Rubus spectabilis, Rubus parviflorus, and Pteridium aquilifolium increase. Angelica is more durable than Heracleum, which almost disappears in the fall. Although Angelica is not nearly as common on this prairie as Heracleum, in undisturbed prairies farther north on the coast, Angelica is very common, and Heracleum is rarely seen.

Certain similarities can be seen between this community and the Polystichum-Rubus parviflorus community besides the growth habits and phenologies of Heracleum and Angelica. Rubus parviflorus is strongly represented in stand #32B, and Rubus spectabilis, found in six of ten stands in the Polystichum-Rubus parviflorus community, is an important species in both stands of the Angelica-Rubus spectabilis community; these two Rubus species form a definite shrub layer, which encourages the growth of moss, just as in the

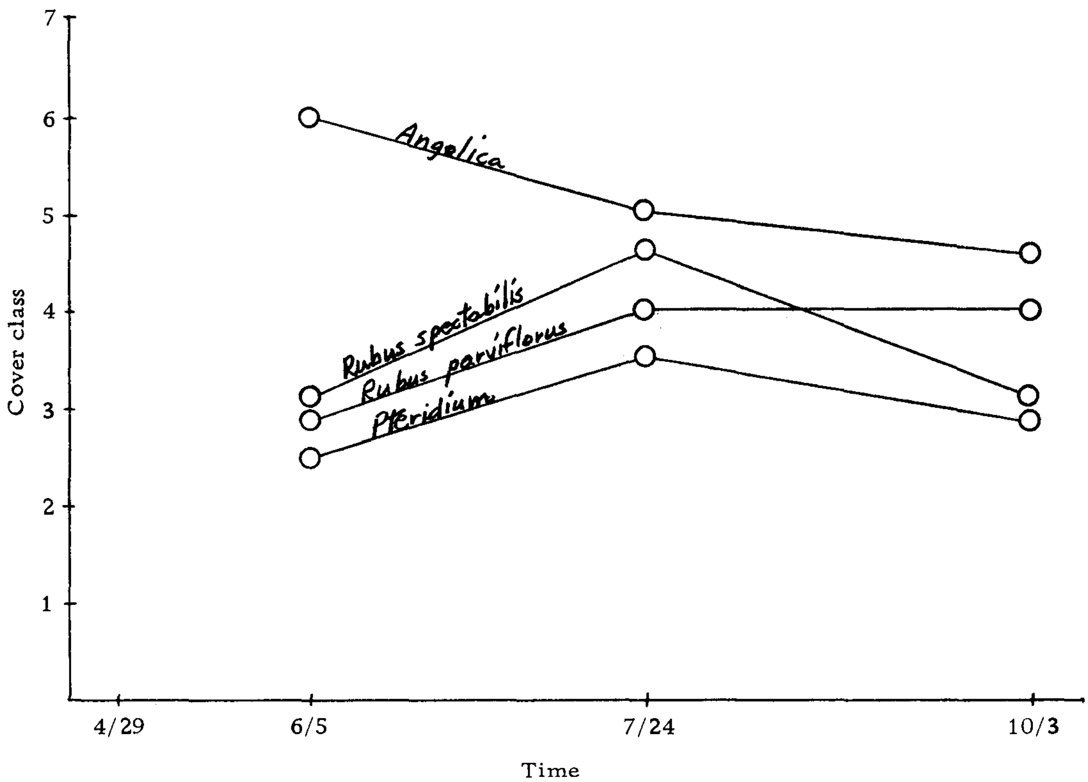


Figure 10. Graph of seasonal cover trends of some species in the Angelica lucida-Rubus spectabilis community.

Polystichum-Rubus parviflorus community. However, the presence of Angelica in place of Heracleum, and the absence of Polystichum munitum and Tellima grandiflora are conspicuous differences.

Solidago canadensis Community

This community is rather late-appearing because its only definitive species, Solidago canadensis, does not appear until late April or early June. The striking yellow inflorescence, hence the name "goldenrod," appears from July through September, making recognition of this community not difficult. Non-definitive species include Agrostis tenuis, Elymus glaucus, Anthoxanthum odoratum, Dactylis glomerata, Holcus lanatus, and Festuca rubra. Achillea, always present, links it to the Lupinus littoralis and Angelica lucida-Rubus spectabilis communities. In this ordination, stand #25A is considered intermediate between the Angelica-Rubus and Solidago communities. Although stand #25A contains Solidago with high frequency and cover values, it is not considered to be in the Solidago community because it has a number of species not present in the three Solidago stands, including Carex obnupta, Angelica lucida, Artemisia suksdorfii, Heracleum lanatum, Galium aparine, and Pteridium aquilinum.

On the other end of its ordination, the Solidago community is affiliated with the Artemisia suksdorfii-Solidago canadensis community through Solidago and Festuca rubra.

The soil depths survey showed the Solidago community to be rather consistently on deep soils with basaltic parent material (Table 1).

Artemisia suksdorfii-Solidago canadensis Community

This community is seen only on the steep south-facing end of the prairie (Figure 5). It appears to be closely affiliated with the Solidago canadensis community because of the close proximity in which the two are found, and because Solidago is an important species in both. Definitive species are Artemisia suksdorfii, Festuca rubra, and Bromus sitchensis. Non-definitive species include Marah oreganus, Galium aparine, and Elymus glaucus. In this area, the Artemisia-Solidago community grades into a shrubby vegetation made up of Rubus parviflorus, Rubus spectabilis and Rosa nutkana, among other species. This latter vegetation was not sampled because of the proximity to dangerous cliffs. However, it closely resembles the vegetation in stands #29 and #30 in the Polystichum-Rubus parviflorus community.

Soils are three to four feet deep in this community (Table 1), and parent material is basaltic in origin.

Stand #34 represents a very large area of vegetation on the west-facing end of the prairie (Figure 5). Because it lacks Solidago and *Artemisia* it is not included in the *Artemisia*-*Solidago* community, but it is closely affiliated with it because *Festuca rubra* and *Bromus sitchensis* are present. The significance of *Festuca rubra* will be discussed in the Discussion section. Stand #34 has deep soil as do the stands in the *Artemisia*-*Solidago* community.

Aspection data for this community are inadequate for presentation. However, trends are as follows: *Festuca rubra* plus other grasses, and some forbs such as *Vicia gigantea*, *Sidalcea hirtipes*, *Heracleum lanatum*, *Stachys emersonii*, and *Marah oreganus* are present in late spring. Later, *Solidago* and *Artemisia* emerge and in late July the foliage from all species is high and dense. Most early-appearing species die back in August and September, while *Artemisia*, *Solidago*, and *Festuca* remain. By October, the resulting vegetation appears relatively sparse and open.

DISCUSSION AND CONCLUSIONS

Because this study is mainly restricted to one prairie, caution is used in making general conclusions about Oregon coastal prairies from the data obtained. Insofar as a description of synecological features of this particular prairie is adhered to, the methods used in obtaining the data appear adequate. An exception may be the methods used for the aspection data. Discrepancies appeared in the data taken at intervals on several stands, which could only be attributed to the fact that the sampling grid was not dropped in exactly the same place in the stands from one time to the next. For the most part these discrepancies were unexplainable changes in cover or frequency values, not the appearance or disappearance of a species.

The arrangement of the ordination on the association table should not be considered the only or best arrangement. As explained in the methods section, it is based on how the over-all species composition of each stand compares to others, on the assumption that the total species composition of stands is an expression of the total environmental complex in that stand, plus its relative successional stage. All considerations of environmental factors were made after this ordination was completed. Somewhat different ordinations might result if made on the basis of individual factors, such as moisture, soil depth, or succession.

In discussing the communities that have been differentiated in this prairie, it has been assumed that 40 years ago they were not present in the prairie. Charles Hart said, when the author questioned him, that grasses rather homogeneously covered the prairie, and he emphasized that Rubus parviflorus was not growing within the prairie. He also mentioned that at times the prairie was rather heavily grazed. On other coastal prairies that are currently heavily grazed, none of the communities described in the study are present. It is reasonable to assume that these communities became established when the grazing pressure ceased.

Since then, grasses on the prairie have recovered, and now have a firm hold on most areas. The sod and litter formed by the grasses in most areas of the prairie have become so thick and inpenetrable that further invasion of forbs and shrubs of the communities described seems, at most, to be a slow process.

There are indications that some of the stands sampled may have become established in areas on the prairie where grazing pressure or disturbance was especially great. Five or six stands of the Polystichum munitum-Rubus parviflorus community occur along a former fence line where stock may have congregated or traveled. Mr. Hart planted onions in the vicinity of the drainage on the east side of the prairie where stands representing the Equisetum maximum community are found. Although the exact locations of such disturbances are impossible to establish, this is a reasonable explanation for the occurrence of many stands whose boundaries correspond to no obvious changes in soils or topography.

Thus, the processes that may have occurred since 1938 can be explained as follows: Without grazing pressure and other disturbances, much of the prairie was open to a denser and more diversified vegetation. Grass species, plus _Plantago lanceolata_, _Achillea millifolium_, _Circium vulgare_, _Hypochaeris radicata_, and a few other weedy forbs already occupied most of the prairie, probably in a somewhat depauperate state. The grasses, especially, rapidly increased their above-ground cover and their root systems, and a thick layer of litter was formed. In areas where grasses were in particularly poor condition, and were unable to recover quickly, forbs and brush species invaded, and rapidly increased their influence over these areas. These precursors to present-day communities created conditions favorable for the establishment of other species, and, in most cases, the grasses did not achieve the high degree of dominance in the resulting communities that they have in the grassy prairie. Grasses and the invading forbs and shrubs have gradually filled most available niches in the prairie, and most of the present-day communities appear quite stable.

In addition to the factor of the poor condition of grasses in these areas which allowed for invasion of new species, other factors determined the kinds of communities which would develop. Site factors such as available moisture, and soil depth and condition, were important. The establishment of the particular kinds of communities depended also on the availability of propagules and the circumstances of their distribution and germination.

Future changes and developments in the communities described are difficult to forecast. The Equisetum maximum community appears quite stable, in that encroachment of foreign species on its boundaries appears minimal. It is specialized for its habitat of year-round wet soil. On fallen Picea sitchensis which have become nurse logs across the wet zone, young Picea appear to be doing well. Yet, ecotone species have not followed the spruce into the Equisetum stands as they do in the prairie above the drainage (refer to Figure 5). Since the soil is usually deep here, the young Picea may develop sufficiently strong root systems to resist blowdown in these exposed sites, and eventually may provide the protection and environment for further spruce invasion into this community.

The Artemisia suksdorfii-Solidago canadensis community is represented in this prairie by only two stands, but is commonly seen on prairies farther north which are very near the shore. The absence of Holcus lanatus and Agrostis tenuis is notable, and the presence of the two native grasses, Festuca rubra and Bromus sitchensis, seems significant. Festuca rubra, in particular, is common on prairies and other open areas all along the coast, but it appears not to survive heavy grazing as well as the more common introduced species, Holcus lanatus and Agrostis tenuis. Also, where it is seen, it appears to increase in importance very close to the shore. Greater resistance to salt spray may partially explain this distribution of Festuca rubra in relation to the other grasses.

The Solidago canadensis community described on this prairie is usually adjacent to the Artemisia suksdorfii-Solidago canadensis community. On other prairies as well as this one, Solidago is usually seen along with most of the species in the Artemisia suksdorfii-Solidago canadensis community. The Solidago canadensis community has fewer species compared to the Artemisia-Solidago community. The absence of Artemisia suksdorfii and the presence of Agrostis tenuis are conspicuous. The Solidago canadensis community is always found farther up on the hill where disturbance was probably greater. Soils are deep just as they are in the Artemisia-Solidago community. For these reasons the Solidago canadensis community may be considered a less advanced successional stage of the Artemisia suksdorfii-Solidago canadensis community.

The small representation of the Angelica lucida-Rubus spectabilis community raises questions as to its status as a distinct community. Only two small stands are found in the entire prairie. The results section points out some similarities to the Polystichum munitum-Rubus parviflorus community, and although two definitive species, Polystichum munitum and Tellima grandiflora are missing in the Angelica-Rubus spectabilis community, it is suspected that this community may be an aberrant form of the Polystichum munitum-Rubus parviflorus community. Angelica lucida, appropriately called "sea watch." is mainly restricted to bluffs overlooking the sea and is only rarely seen farther up in this prairie. Because its growth habit and phenology are so similar to those of Heracleum lanatum, it may be occupying the approximate niche of Heracleum in this location.

The presence of Solidago canadensis in the two Angelica-Rubus spectabilis stands has little significance other than the fact that a large Solidago canadensis stand (not sampled) occupies an area immediately adjacent to them. An abrupt increase in the depth of soil from 12 inches to about 36 inches accompanies the transition between the two communities, Solidago canadensis and Angelica-Rubus spectabilis.

The similarities between the Lupinus littoralis community and the surrounding prairie have been mentioned in the Results section. Lupinus littoralis appears to be the only species which distinguishes this community from the surrounding undifferentiated prairie. This observation led to the conclusion that Lupinus littoralis is a weed which can invade and occupy one or more communities in the undifferentiated prairie. Stands #16 and #4A are presented as the

Lupinus littoralis community in the Results section because they appeared as a definite group in the association table. However, the author prefers not to elevate this group to the status of a definite community on the basis of one species, _Lupinus littoralis_. This species often does occur in stands of many individual plants. Nevertheless, this is not as much a reflection of a peculiar environment in the prairie, as it is a result of the heavy _Lupinus_ seeds which fall directly to the ground when released, rather than being distributed by the wind. Stands #16 and #4A apparently represent internal patterns in one or more unsampled grassy communities in the prairie.

Carex obnupta is present in many places in the prairie, being common in and near the _Solidago canadensis_, _Artemisia suksdorfii-Solidago canadensis_, and _Polystichum munitum-Rubus parviflorus_ communities. However, stands #17, #18, #26, and #2A are distinctive because _Carex obnupta_ grows very densely to the exclusion of most other species (refer to Table 1.)

Weidemann (1966) showed that _Carex obnupta_ is present only in the wettest spots in the deflation plains of sand dunes along the Oregon coast. The _Carex obnupta_ stands on this prairie do not appear to be in exceedingly wet sites. Stands #17 and #18 are actually on a small knoll and drainage would appear to be away from them. However, under all the _Carex obnupta_ stands, the soil is quite shallow, and the basaltic rock underneath may serve as a pan which holds water in the soil during the winter and spring seasons.

The Polystichum munitum-Rubus parviflorus community seems significant because it is so similar to the ecotone vegetation lining the edge of the prairie. Because of this, it evokes the question of whether it may be part of a successional sequence toward the reforestation of the prairie. This is a difficult question, and only insights, not answers, can be presented here.

The question of what the ecotone on this prairie represents should be discussed. In most places it appears quite stable. Although Mr. Hart cleared the ecotone back to the trees in an effort to make more area available for farming and stock-grazing, it has quickly advanced to about its original position, and does not appear to be invading the prairie any further. At least on a short-term time basis, this ecotone does not express succession. Rather, it appears to be a stable intermediate form of vegetation between the forest and prairie. Picea sitchensis is only rarely seen growing in the ecotone, presumably because it is relatively shade-intolerant and cannot grow up through the high, dense ecotone vegetation. However, where large trees have fallen through the ecotone into the prairie, rows of young Picea are growing in the prairie on these logs. Where the trees have produced enough shade to reduce the vigor of the surrounding grasses, the ecotone vegetation has followed Picea into the prairie along the nurse logs. What appears essential, therefore, to the movement of *Picea* and the ecotone vegetation into the prairie is a decrease in the influence of the grasses. Seedlings of deeper-rooting shrubs and trees cannot survive where the roots of vigorous grasses monopolize the upper six to eight inches of soil moisture. Any manner in which the vigor of grasses is decreased paves the way to the movement of *Picea* and the ecotone vegetation into the prairie.

In other prairies on the Oregon coast, however, ecotone vegetation appears to be actively moving into prairie. Where it has extended out a considerable distance from the forest boundary, it takes on the low appearance of the *Polystichum munitum*-*Rubus parviflorus* community described in the study area. Most significantly, young *Picea* are often seen emerging through this vegetation. Close examination shows that very little, if any, grass grows in these areas where the ecotone vegetation has become established, just as in the case of the *Polystichum munitum*-*Rubus parviflorus* community. It appears that within this ecotone vegetation which is lower in stature than that near the forest border, *Picea* seedlings may grow without competition from grasses and other low forbs, and, under the proper conditions, may quickly emerge up through the low brushy vegetation into more favorable light conditions. Whole hillsides which were once grassy prairies are now covered with groups of young *Picea* which have grown up through brushy vegetation.

It is concluded, then, that the Polystichum munitum-Rubus parviflorus community can provide sites for the growth of Picea sitchensis within the prairie being studied.

The invasion of this prairie by the communities described in this study is assumed to have occurred following the period of disturbance from stock grazing, clearing, and farming prior to 1938. What would have occurred here without such disturbance during this period is impossible to know. The stability of the grasses in many areas of the prairie is apparent, but they are mostly introduced species. On the northern coast where natural prairies seem to be disappearing, the introduced grasses are not so common. This suggests that the native grasses are not as resistant to invasion by forbs and brush species. In any case, as it has been mentioned, invasion into much of this prairie by these forbs and brush species to form the communities described seems to have been quite swift immediately following the cessation of the disturbance in 1938, but as the grasses have recovered from grazing, further invasion of the grassland appears to have been checked.

The abundance of charcoal in the soils of the upper portion of the prairie points to a long history of fires. Since grasses cannot produce charcoal which remains visible in the soil, the upper part of the prairie must have been covered by trees or brush at times. The author believes that fires set intentionally or unintentionally by the coastal Indians living on this prairie are mostly responsible for this charcoal. It seems probable that these fires, plus the effects of strong and constant salt-laden winds may have maintained parts of this prairie and others like it for hundreds of years. With the sharp decline in coastal Indian populations during the early 19th century, this fire maintenance ceased, and many northern prairies have been slowly overcome by forest species. Farther south, the grazing of stock animals from the late 19th century on, has maintained the prairies and has encouraged the spread of introduced grasses which can withstand grazing pressure.

Many of the stands sampled in the study prairie, therefore, are seen as resulting first, from the disturbance of grazing and farming, then, from the decrease of this disturbance. The disturbance from grazing and farming may be considered as much a form of maintenance of this prairie as fires may have been in the past. The discontinuance of these activities in 1938 has amounted to a partial cessation in the maintenance of this prairie. It seems probable that at least one of the communities described in this study, the *Polystichum munitum*-*Rubus parviflorus* community, is a stage in the succession of the prairie vegetation toward a forested state.

It is hoped that this study will encourage more detailed investigations into these and other aspects of natural coastal prairies.

SUMMARY

The study of the vegetation of one of the natural coastal prairies in Oregon was undertaken for the purpose of describing some of its synecological features. Specific objectives of the study were as follows:

1. to describe certain plant assemblages in the study area;
2. to present phenological relationships on some of the assemblages;
3. to discuss and illustrate some examples of evidence of succession on the study area.

The study area is a prairie located on a headland about one mile north of the Tillamook-Lincoln county line (Sec. 3 in T6S, R11W). This prairie is one of the many situated on the headland bluffs and slopes along the northern Pacific coast.

During an initial period of reconnaissance, familiarization with the plant species and communities in the study area was gained. Several surveys along most of the Oregon coast were made to compare the study area with other coastal prairies.

A total of 38 distinctive stands of vegetation within the prairie were sampled in a series of five repetitive sessions from January to October in 1966. Presence and vegetative cover of species were recorded. In addition, soil depths in these stands were recorded.

Seven transects from the prairie through the ecotone to the

forest were established and the presence of species along them was recorded.

With the aid of an association table five distinctive communities were differentiated in the sampled stands. These were:

1. Equisetum maximum community, restricted to sites with high soil moisture during the entire year.

2. Polystichum munitum-Rubus parviflorus community, usually on soils 18 inches deep or less. Species in this community form the major part of the ecotone vegetation.

3. Carex obnupta community, usually on soils 12 inches deep or less. Carex is the only important species in this community.

4. Artemisia suksdorfii-Solidago canadensis community, found on the exposed, south-facing end of the prairie on deep soils. It is a community found commonly in prairies farther north on the coast.

5. Solidago canadensis community, situated farther up in the prairie than the Artemisia-Solidago community, on deep soils. It was judged to be an earlier successional stage of the Artemisia-Solidago community.

Two more groups were apparent in the table, but these were judged not to be distinct communities in the field. These were:

6. Lupinus littoralis group, considered part of the internal pattern of one or more of the large grassy communities not sampled. The peculiar grouping of Lupinus littoralis is attributed to the large, heavy seeds of that species which always drop directly to the ground, rather than being distributed farther by the wind.

7. Angelica lucida-Rubus spectabilis group, judged to be an aberrant form of the Polysticum-Rubus parviflorus community.

A discussion on successional aspects of this and other coastal prairies on the Pacific coast was based on the results of field work carried out during this study, a knowledge of activities on this prairie from 1916 to the present time, and on historical accounts and old photographs concerning the coastal vegetation. It was tentatively concluded that the coastal prairies were maintained for long periods in the past mostly by fires set by the coastal Indians who lived on them. When the white settlers arrived with their cattle and sheep, many prairies, including the study area, were maintained by grazing pressure, and the spread of hardy introduced grasses was encouraged.

The stands sampled in the study area were thought to have become established during a period of no stock grazing from 1938 to the present time.

It was suggested that the *Polystichum munitum*-*Rubus parviflorus* community may provide sites for the growth of *Picea sitchensis* within this prairie.

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APPENDIX

SPECIES LIST

Trees

Alnus oregona (Bong.) Nutt. BETULACEAE
Picea sitchensis (Bong.) Carr. PINACEAE
Sambucus callicarpa Greene. CAPRIFOLIACEAE
Tsuga heterophylla (Raf.) Sarg. PINACEAE

Shrubs

Amelanchier florida Lindl. ROSACEAE
Baccharis pilularis DC. COMPOSITAE
Berberis aquifolium Pursh. BERBERIDACEAE
Gaultheria shallon Pursh. ERICACEAE
Lonicera involucrata (Rich.) Banks. CAPRIFOLIACEAE
Menziesia ferruginea J. E. Sm. ERICACEAE
Rosa gymnocarpa Nutt. ROSACEAE
Rosa nutkana Presl. ROSACEAE
Ribes bracteosum Dougl. SAXIFRAGACEAE
Ribes laxiflorum Pursh. SAXIFRAGACEAE
Rubus parviflorus Nutt. ROSACEAE
Rubus spectabilis Pursh. ROSACEAE
Rubus vitifolius C. & S. ROSACEAE
Urtica lyallii Ait. URTICACEAE
Vaccinium parvifolium J. E. Sm. ERICACEAE

Forbs

Achillea millefolium L. COMPOSITAE
Allium sp. LILIACEAE
Anaphalis margaritacea (L.) B. & H. COMPOSITAE
Angelica lucida L. UMBELLIFERAE
Artemisia suksdorfii Piper. COMPOSITAE
Aster foliaceus Lindl. COMPOSITAE
Cardamine angulata Hook. CRUCIFERAE
Cardamine oligosperma Nutt. CRUCIFERAE
Carex hendersonii Bail. CYPERACEAE
Carex obnupta Bail. CYPERACEAE
Castilleja littoralis Penn. SCROPHULARIACEAE
Cerastium arvense L. CARYOPHYLLACEAE
Cerastium glomeratum Thuill. CARYOPHYLLACEAE (introduced)
Cerastium holosteoides Fries. CARYOPHYLLACEAE (introduced)
Chrysosplenium glechomaefolium Nutt. SAXIFRAGACEAE
Circium vulgare (Savi) Airy-Shaw. COMPOSITAE (introduced)
Corydalis scouleri Hook. FUMARIACEAE
Crepis capillaris (L.) Wallr. COMPOSITAE (introduced)
Conioselinum chinense (L.) B. S. P. UMBELLIFERAE
Dentaria tenella Pursh. CRUCIFERAE
Disporum smithii (Hook.) Piper. LILIACEAE

Dryopteris filix-mas (L.) Schott. POLYPODIACEAE
Epilobium adenocaulon Haussk. ONAGRACEAE
Equisetum maximum Lam. EQUISETACEAE
Eriophyllum lanatum (Pursh) Forbes. COMPOSITAE
Erysimum capitatum (Dougl.) Greene. CRUCIFERAE
Galium aparine Cleavers. RUBIACEAE
Galium trifidum L. var. pacificum Wieg. RUBIACEAE
Galium triflorum Michx. RUBIACEAE
Heracleum lanatum Michx. UMBELLIFERAE
Hydrophyllum occidentale (Wats.) Gray. HYDROPHYLLACEAE
Hypochaeris radicata L. COMPOSITAE (introduced)
Hypopitys fimbriata (Gray) How. ERICACEAE
Juncus effusus L. var. pacificus Fern. & Wieg. JUNCACEAE
Lupinus littoralis Dougl. LEGUMINOSAE
Luzula parviflora (Ehr.) Desv. JUNCACEAE
Lysichitum americanum Hult. & St. John. ARACEAE
Maianthemum bifolium DC. var. kamtschaticum (Gmel.) Jeps. LILIACEAE
Marah oreganus (T. & G.) How. CUCURBITACEAE
Mimulus guttatus DC. SCROPHULARIACEAE
Montia sibirica (L.) How. PORTULACACEAE
Oplopanax horridum (J. E. Sm.) Mig. ARALIACEAE
Osmorhiza nuda Torr. UMBELLIFERAE
Oxalis oregana Nutt. OXALIDACEAE
Plantago lanceolata L. PLANTAGINACEAE (introduced)
Polemonium carneum Gray. POLEMONIACEAE
Polystichum munitum (Kaulf.) Presl. POLYPODIACEAE
Prunella vulgaris L. LABIATAE (introduced)
Pteridium aquilinum (L.) Kuhn. var. pubescens Underw. POLYPODIACEAE
Ranunculus occidentalis Nutt. RANUNCULACEAE
Rumex acetosella L. POLYGONACEAE (introduced)
Rumex crispus L. POLYGONACEAE (introduced)
Rumex obtusifolius L. POLYGONACEAE (introduced)
Sagina procumbens L. CARYOPHYLLACEAE
Sanicula septentrionalis Greene. UMBELLIFERAE
Scrophularia californica C. & S. SCROPHULARIACEAE
Senecio jacobaea L. COMPOSITAE (introduced)
Sidalcea hirtipes C. L. Hitch. MALVACEAE
Smilacina sessilifolia (J. G. Bak.) Nutt. LILIACEAE
Solidago canadensis L. COMPOSITAE
Stachys emersonii Piper. LABIATAE
Stellaria crispa C. & S. CARYOPHYLLACEAE
Synthyris reniformis (Dougl.) Benth. SCROPHULARIACEAE
Tellima grandiflora (Pursh) Dougl. SAXIFRAGACEAE
Tiarella trifoliata L. SAXIFRAGACEAE
Tolmiea menziesii (Pursh) T. & G. SAXIFRAGACEAE
Trifolium dubium Sibth. LEGUMINOSAE (introduced)
Trifolium repens L. LEGUMINOSAE (introduced)
Vicia gigantea Hook. LEGUMINOSAE
Viola glabella Nutt. VIOLACEAE

Grasses

Agrostis tenuis Sibth. AGROSTIDEAE (introduced)
Agrostis semiverticillata C. Christ. AGROSTIDEAE (introduced)
Anthoxanthum odoratum L. PHALARIDEAE (introduced)
Bromus sitchensis Trin. FESTUCEAE
Calamogrostis nutkaensis (Presl.) Steud. AGROSTIDEAE
Dactylis glomerata L. FESTUCEAE (introduced)
Elymus glaucus Buckl. HORDEAE
Festuca arundinacea Schreb. FESTUCEAE (introduced)
Festuca elatior L. FESTUCEAE (introduced)
Festuca rubra L. FESTUCEAE
Glyceria leptostachya Buckl. FESTUCEAE
Holcus lanatus L. AVENEAE (introduced)
Lolium multiflorum Lam. HORDEAE (introduced)
Lolium perenne L. HORDEAE (introduced)
Melica subulata (Griseb.) Scribn. FESTUCEAE
Phleum pratense L. AGROSTIDEAE (introduced)
Poa pratensis L. FESTUCEAE (introduced)

Appendix Table 1. The association table.

Stand Number:	20	19	21	23	13	5	9	6	3	8	10	24	14	30	29	11	17	18	26	2A	37	16	4A	32B	32A	25A	35	36	38	33A	33	34	27	25	15	1	1A
Equisetum maximum	56/3	88/5	100/7	100/7	19/2																											19/4					
Ranunculus occidentalis	6/2		50/3	50/2																																50/1	6/1
Cardamine oligosperma	6/1	13/1	13/1	38/1	88/2		44/1			6/2		6/1	19/1																							56/1	
Tellima grandiflora							6/1	38/1	19/2	13/2			6/2			25/1																					
Disporum smithii									6/1		25/2	44/2	31/3	25/1	25/1			6/1																			
Polystichum munitum						6/1	6/2	.3/2	25/3	38/2	19/4	69/5	100/6	100/4	100/5	6/3																					
Moss sp.					75/3	6/1	88/2	75/3	75/2	38/3	56/2	25/2	44/3	25/3	44/2										13/1												
Rubus parviflorus					81/4	100/5	100/6	00/6	25/4	81/4	100/5	13/3	81/4	100/5	75/4	100/4								13/1						13/1	31/4				81/4		
Conioselinum chinense			6/2		6/2		19/2	6/1				6/1	25/2	25/1																	6/1	13/2					
Montia sibirica		6/1		6/1			6/1		6/1			13/1	6/1																		13/1						
Rosa nutkana														88/3	50/4		13/2	31/4																			
Carex obnupta				6/3				6/1		6/1	94/2			75/1	50/1	100/7	100/6	100/6	100/7	100/7	100/2					88/2											
Cerastium arvense																						6/1	6/1														
Lupinus littoralis																						100/5	100/5		13/1												
*Plantago lanceolata	6/2					6/1		6/1	6/2	6/2												44/1	31/1		25/1		38/2		13/1				38/1			19/1	25/1
Rubus spectabilis						44/3			56/2		6/4	88/4	38/3		100/5									75/4	38/5												6/2
Angelica lucida			13/4		6/1		13/4						6/1											100/5	75/5	13/2											
*Achillea millifolium			19/1						19/1	13/1			6/1				6/1		6/1			25/1	50/2	13/3	25/2	19/2	38/1	38/1	25/1					6/1		25/1	38/1
Solidago canadensis			13/3											75/3							100/4			38/1	100/4	100/5	100/6	100/5	100/6	88/3	50/3						
Artemisia suksdorffii																						13/1				13/2				100/5	63/3		100/5				
Vicia gigantea									19/2				63/2	19/3															13/2	38/3	88/4	81/4			81/3		
Sidalcea hirtipes												6/1	13/2										13/1			31/4	13/1			63/3	25/1	6/3			81/3		
Festuca rubra																									50/2			25/1	88/2	75/2	50/3	25/1					
Bromus sitchensis														13/1									31/1							25/1	38/1	19/2		13/1			
Heracleum lanatum	63/4	69/4	19/4	19/2	44/3	100/5	63/4	56/3	56/3	88/5	88/5	19/4	43/3	25/2		19/2	6/2	19/3	19/2	6/4	25/3	25/3	6/1		25/2	63/3					25/3	25/3	25/2	50/3	13/2		
Stachys emersonii	100/5	88/4	25/3	75/3	100/4	6/1	38/2	75/3	100/4	6/3	13/1	81/3		88/3		38/3	50/2	69/2		50/3				25/3	38/2	75/2			50/2		63/2	88/4		100/3	19/4	75/3	25/1
Marah oregana	25/4	69/4			19/5	6/1	56/3	38/3	6/2		69/3	69/3	13/4		25/4		56/4	75/2	63/4					75/4	63/2	38/2		13/3		88/4	38/3	25/4		63/3	94/3		
Galium aparine	50/2	63/2	13/2	13/1	19/2	13/1			13/1			56/1	6/2	13/1	63/2				6/1					25/1	38/2	75/1				75/2	100/3					6/1	
Pteridium aquilifolium	88/4	63/3	6/1		13/3	88/3	44/2	75/3	38/2	38/3	31/3	44/4	6/4			18/1	6/1	81/4	75/3	13/1	63/5	31/3	25/3	25/4	63/3	31/4						94/4	63/3	100/5	75/3	100/7	100/6
*Holcus lanatus	81/2	31/1	100/1	100/2	44/1	100/2	25/1	38/1	94/2		31/2	44/2								38/1	75/1	31/1	50/2	38/1	13/1	75/1		13/1	38/2		25/1		100/2	50/1		94/2	100/2
*Agrostis tenuis	25/1			38/2		31/1	6/1		50/1			25/1					19/1		13/1	63/1	38/1	100/5	13/1	38/1	25/1	25/1	100/4	88/3	100/2		38/1		100/1	75/2	6/1	100/3	100/3
*Poa pratensis	6/1	50/2	25/1	25/1	63/1	31/1	25/1	6/1	75/2											38/1	13/1	38/1	6/1	25/1		13/1						69/1	50/1	38/1	25/1	50/1	25/1
*Dactylis glomerata	19/1		31/2		19/1	75/1	31/1		6/1		6/1	6/1		13/1			6/1				88/1		50/1	38/1	13/1	81/1		38/1	13/1		38/1			13/1	3/1		
*Anthozanthum odoratum	6/1		13/1			50/1			25/1												13/1	56/1	19/1	13/1	13/1	6/1	25/1		38/1				38/1	6/1	13/1	38/1	13/1
Elymus glaucus			6/1		19/1	38/1	13/1	6/4					13/1								75/1	81/1	13/1	13/1	25/1	50/1	50/1	63/1	25/1	13/2	38/1	6/1	13/1		19/2		
Scrophularia californica						25/2			63/3								81/4	6/1														31/5	1	88/3	38/2		
*Festuca elatior	63/2							6/1	13/1																									31/1			
*Lolium multiflorum	13/1			63/1																																	
*Agrostis semiverticillata																						13/1								13/1							
*Lolium perenne																																		13/1			
*Festuca arundinacea																																					
Calamagrostis nutkaensis															13/1																						
Lonicera involucrata							6/2		38/2																												
Dentaria tenella						31/1																															
Gaultheria shallon														13/2																							
Anaphalis margaritacea									19/1					25/1															75/3								
Dicentra formosa									13/1																												
Stellaria crispa				56/1					6/1				13/2																								
*Circium vulgare	13/2	13/2	6/2						13/1			6/1						13/2		38/1				6/1	25/2		13/1			13/1	19/2	6/1	13/4	6/1		13/1	13/1
*Cerastium holosteoides																																				6/1	
Urtica lyallii		6/3																																			
Mimulus guttatus			31/3																											25/3							
*Rumex crispus			6/2																				6/1														
Hydrophyllum occidentale	31/1																																				
Rubus vitifolius																																					
Viola glabella																																					
Galium triflorum																																					
Osmorhiza nuda																				6/1																	
Aster foliaceus																						25/2		13/1	38/2						13/1						
*Crepis capillaris																																					
*Cerastium glomeratum			6/1	6/1																																	

*Introduced species