THE IMPACT OF LAND MANAGEMENT DECISIONS ON DUNE PROCESSES ON THE CLATSOP PLAINS: A CASE STUDY OF CAMP RILEA, OREGON

by

Rebecca L. Flitcroft

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Abstract

This project explores the impact of land use decisions on dune processes at the Oregon National Guard's Camp Rilea, located on the north coast of Oregon. It used a combined analysis of historical and modern data sources to assess the impact of land use practices. Historical sources including the journals of Lewis and Clark and local newspaper articles were used to determine dune condition during the nineteenth century. Aerial photographs were used to track the changes in vegetation occurring during the twentieth century. This study indicates that the dune area was stabilized by native grass during the early 1800's and was disrupted during the latter half of the century by cattle grazing and construction of the Columbia River jetties. Activated dunes moved into developed areas burying homes, roads and buildings. In response to the moving sand, a massive biostabilization project was completed during the 1930's to halt dune movement. The resulting landscape is characterized by a new geomorphology and floristic distribution that reflect the impact of the introduction of high densities of plants for the biostabilization project. The final component of this project was the determination of alternate land management options for Camp Rilea that could enhance alternate land management goals including: minimization of exotic plant species, maximizing threatened and endangered species, maximum military training diversity and no action.

Introduction

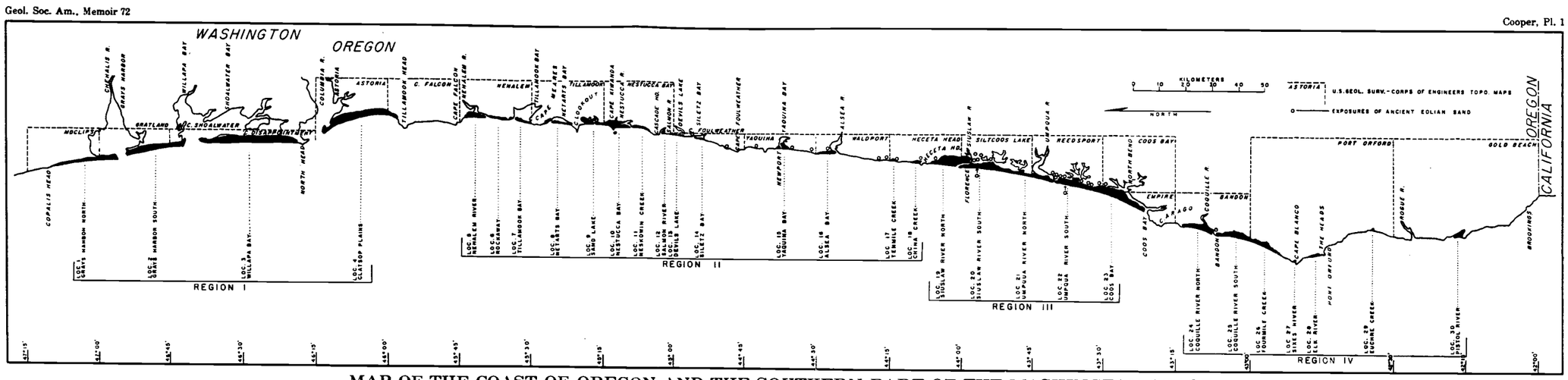
Sand dunes are a prominent feature of Oregon's 500-km coastline. Over 255 km of dunes stretch from the city of Astoria in the north to the Pistol River in the south (Cooper, 1958, 3) (Figure 1). These coastal dunes differ in shape and extent by their geologic formation and distribution. William Cooper completed the best description of Oregon's dunes in 1958. He grouped Oregon's dunes into four isoregions. The regions include the Columbia River, the Northern Oregon Dunes, the Coos Bay Dune Sheet and the Southern Oregon dunes. These regions

and their descriptions are applicable today and provide a good overview of Oregon's dune areas.

The Columbia River dune region stretches from the mouth of the Columbia River south to Tillamook Head and is characterized by a parallel-ridge system typical of an accreting coastline (Cooper, 1958, 123). The Clatsop Plains fall within this region. The Nehalem River in the north and the China River in the south bound the Northern Oregon Dune region, which is characterized as intermittent due to the rocky coastline and frequent river mouths of this portion of the coast. Most of these dunes are parabolic in nature and are slowly being eroded by the ocean (Cooper, 1958, 77). The Coos Bay Dune Sheet is a relatively unbroken dune that is divided by only two major river crossings, the Umpqua and Siuslaw. It is bounded by Heceta Head on the north and stretches 96 miles south to Cape Arago (Cooper: 87-88). The Southern Oregon dune region, between Cape Arago and the California border, is the least continuous dune formation on the Oregon coast (Cooper, 1958, 115). While these dunes are not as large or continuous as those in the north, they extend inland farther than any other grouping.

Dunes have a tendency to shift with seasonal fluctuation in the tidal and wind cycles. These variables are natural components of an environment

Figure 1: Map of the dune regions of Oregon and Southern Washington as characterized by Cooper in 1958. The Columbia Region is referred to as Region I. The Northern Oregon Dunes are Region II. The Coos Bay Dune Sheet is Region III and the Southern Oregon Dunes are Region IV. The study site is located within the Columbia River dune region at Locality 4, the Clatsop Plains.



MAP OF THE COAST OF OREGON AND THE SOUTHERN PART OF THE WASHINGTON COAST

Coastal features, dune localities, exposures of ancient eolian sediments.

characterized by disturbance. However, this instability has proven contrary to human settlement of dune areas. In order to control the natural movement of the dunes, stabilization activities attempt to create a safe environment for houses and roads. Projects to control dunes have been implemented since the middle 1850's (*The Daily Morning Astorian*, 7/26/1884 and 10/11/1884).

One unsuccessful dune stabilization technique that was attempted in the 1940's meant covering the sand with oil in order to keep it from being blown by the wind (Read, 1984). The most successful and cost effective technique, first tried in the 1870's, has been biostabilization using vegetation planting (*The Daily Morning Astorian*, 10/11/1884). Biostabilization, along with the construction of fences to trap moving sand, is the method currently favored in Oregon to curb the activation of dunes. (Carlson et al., 1991, 15-42)

Plant species that are recommended by the US Department of Agriculture for use in dune biostabilization include:

Grasses: european beachgrass (*Ammophila arenaria*), american beachgrass (*Ammophila breviligulata*), american dunegrass(*Leymus mollis*), seashore bluegrass (*Poa macrantha*), tall wheatgrass (*Thinopyrum ponticum*), barley (*Hordeum vulgare*), tall fescue (*Festuca arundinacea*)

Legumes: hairy vetch (*Vicia villosa*), perennial pea (*Lathyrus latifolius*), purple beachpea (*Lathyrus japonicus*), seashore lupine (*Lupinus littoralis*), tree lupine (*Lupinus arboreus*), birdsfoot trefoil (*Lotus corniculatus*), big trefoil :(*Lotus uliginosus*)

Marsh: creeping spike rush (*Eleocharis palustris*), lyngby sedge (*Carex lyngbyei*), sharp-fruited rush (*Juncus acuminatus*), slough sedge (*Carex obnupta*), tussock (*Juncus effusus*)

Woody: autumn olive (*Elaegnus umbellata*), kinnikinnick (*Arctostaphylos uvaursi*), coyote brush (*Baccharis pilularis*), douglas spiraea (*Spiraea douglasii*), evergreen blackberry (*Rubus laciniatus*), evergreen huckleberry (*Vaccinium ovatum*), oregon crabapple (*Malus fusca*), red alder (*Alnus rubra*), salal (*Gaultheria shallon*), hooker willow (*Salix hookerana*), salmonberry (*Rubus spectabilis*), scots broom (*Cytisus scoparius*), shore pine (*Pinus contorta*), sitka spruce (*Picea sitchensis*), pacific wax myrtle (*Myrica californica*), western hemlock (*Tsuga heterophylla*) (Carlson et al, 1991, 44-46, 50)

While the use of these plant species has been successful in the stabilization of Oregon dunes, it has had ecological side effects. Many of the plant species used for biostabilization are not indigenous to the west coast of North America. These introduced species have become well established and may, in some areas, dominate the dune environment thereby outcompeting native flora.

The geomorphology of sandy areas has changed as a result of biostabilization due to the development of large foredunes and deflation plains. These features are the direct result of sand capture by vegetation. As the sand builds up at the base of planted grasses, they grow taller, successfully avoiding burial by the sands. The resulting band of vegetation and sand, i.e. the foredune, can range in height upwards of 34 feet (Ulrich, 1986). The area beyond the foredune is cut off from sand supply and is scoured by incoming wind action. This results in a depression to the lee of the foredune referred to as the deflation plain. The development of these features has caused a change in habitat distributions along the coast for both plant and animal species. For example, the Western Snowy Plover's nesting habitat is open sand. This area has decreased as a result of dune stabilization projects. The result has been decreased nesting success that has led to the listing of this bird as a federal endangered species. (Page et al., 1991) The planting of stabilizing vegetation has also led to increased competition between native and non-native plant species. The result of this activity has been a decrease in some native flora with domination by non-native plant species characterizing dune areas.

This paper is focused on Camp Rilea, an Oregon Military Department facility, which is located in the Columbia River dune region upon the Clatsop Plains on the north Oregon coast. This area has a history of human use and management that is evident in the modern landscape. Artificially created foredune and deflation plain environments characterize the area today. These geomorphological features are the direct result of biostabilization of the dunes in the 1930's. The modern foredune and deflation plain have impacted flora and fauna of the region through habitat alteration and competition with non-indigenous species resulting in an increase in wetland and bog habitats with a decrease in open sand environments.

It is the purpose of this paper to assess the effect of management decisions at Camp Rilea upon both the physical and biological components of the environment. This provides a foundation upon which to base future land use decisions. Four issues are addressed in this paper. The first is an exploration of historical land management practices of the Clatsop County area that gave rise to the current state of the dunes at Camp Rilea. It provides a glimpse of the natural condition of the north Oregon dunes vegetation prior to 1900. Assessing the natural condition of the dunes prior to the advent of aerial photographs is difficult, but this context is important in determining the impact of long term land management practices on the area. The second issue discussed is dune vegetation succession. The third is an analysis of the vegetation changes occurring over time at Camp Rilea using aerial photographs from 1939 through 1996. The final

component is an assessment of current land management including management recommendations for Camp Rilea.

Site Description of Camp Rilea

Camp Rilea is located on the north Oregon coast between the cities of Seaside and Astoria, and directly abuts the ocean on its western boundary (Figure 2). The state of Oregon originally purchased 326 acres in 1926 for a military facility and named the site Camp Clatsop. The name was changed to Camp Rilea in 1959 and the camp has grown in size from its original 326 acres to nearly 2000 acres today. (Eckley, 1997) This increase in acreage is due to the acquisition of more property as well as the stabilization and accretion of land west of the camp. The facilities at Camp Rilea include large vehicle storage/repair buildings, living accommodations and numerous miles of roads as well as various military ranges. Camp Rilea's location near the coast and the diversity of terrain available at the site mean a wide variety of training exercises are available.

Camp Rilea is situated within the Clatsop Plains dune region where dunes are characterized by a parallel ridge system (Figure 3). This system developed along an accreting coastline. The Columbia River transported large quantities of depositional material to the coast since the last glaciation, approximately 6000 years ago (Wiedemann, 1984, 39). This material collected on the coast and was stabilized by vegetation, causing natural foredunes to develop. Deposition exceeded erosion and vegetative assimilation causing sediment to build out into the surf. This allowed for the development of additional foredunes further

Figure 2: Camp Rilea locator map.
Camp Rilea is located on the northern coast of Oregon approximately 10 miles south of the city of Astoria.

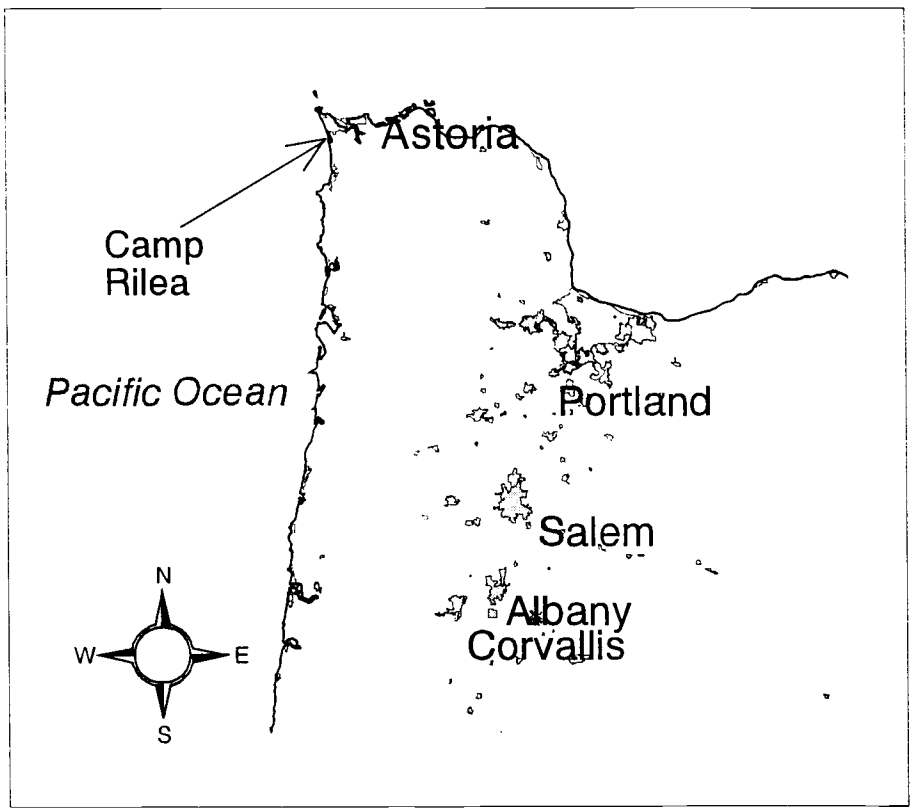
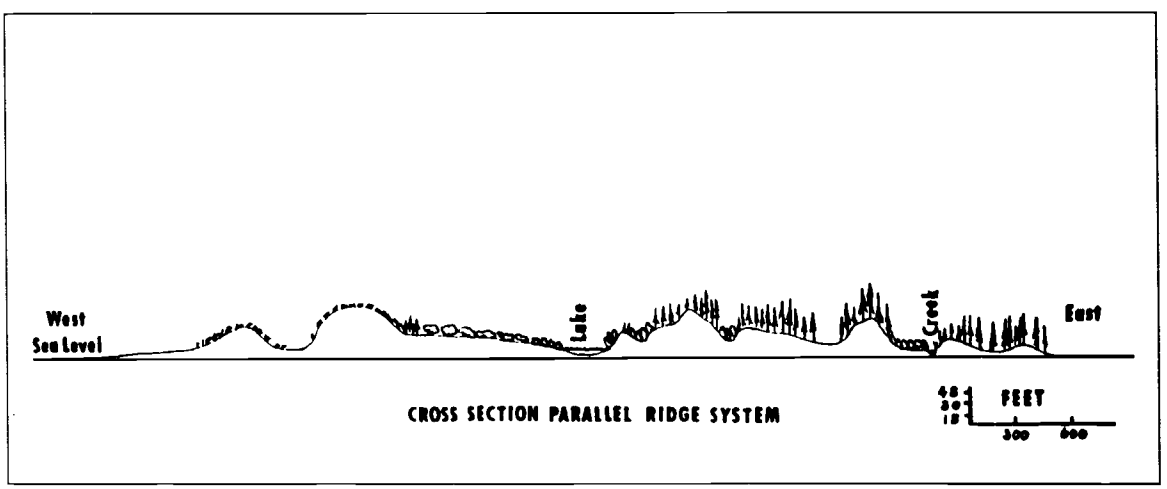


Figure 3: Parallel Ridge Schematic.
This dune system develops along an accreting coastline such as that at the site of Camp Rilea. It is the result of excess deposition and outbuilding of the coast that creates a system of foredunes that are aligned parallel to the ocean. Source Wiedemann, 1966.



seaward. The result of this process was a ridge system running parallel to the seashore. Long, narrow, low areas developed between the ridges and are referred to as swales. These swales are frequently wet and may contain ponded water or lakes. A swale lake occurs on Camp Rilea at Sunset Lake. Neacoxie Slough, which is also located on the camp, is a remnant portion of another wet swale. (Wiedemann, 1984, 39)

The location of Camp Rilea places it in the Coast Range Sitka Spruce Ecoregion. However, disturbance of the dune environment from natural and human events has not allowed for the creation of this community at Camp Rilea. Natural disturbance from sand, wind and waves along the ocean margin has prevented the generation of a forest community directly adjacent to the ocean. Also, biostabilization has introduced non-native species to the area. Many of the upland species were planted for aesthetic purposes such as grasses for lawns and landscaping shrubs. While many forest and foredune species are indigenous to the area, their geographic distribution on the site is due to plantings. For example, shore pines that naturally occur on the north Oregon coast were planted at Camp Rilea as part of the dune stabilization process. This has resulted in a forest of even aged shore pines planted in rows that cover a large extent of the camp.

Over a Century of Land Use on the Clatsop Plains: 1880's through 1990's

Lewis and Clark first visited the Clatsop area in 1805. The expedition did not report seeing large moving dunes at the beach. Rather, they found areas of "open, rangy prarie" (Thwaites, 1959, 320). They also reported the area to be boggy but with many large trees (Thwaites, 1959, 271). There were no White settlements at this time, rather settlement of the Clatsop county area occurred during the mid 1800's.

New pioneers brought their livestock and farming techniques to the area. Cattle were grazed on the dune grasses and bogs were drained for agriculture. Farm crops such as potatoes were grown along the dune margin (*Daily Morning Astorian*: 7/26/1884) and homes and roads were constructed to support the growing population. Construction began on the south jetty of the Columbia River in 1885. The north jetty followed a decade later (Cooper, 1958, 126).

Clatsop County residents during the early 1880's noticed a problem of moving sand along the dune margin. (*The Daily Morning Astorian*, July 26, 1884 and October 11, 1884). Activation of previously vegetated and stabilized dunes was beginning to occur. Historically, a variety of natural occurrences such as fire, tsunami's and the daily action of wind, wave and deposition disturbed dunes. By the turn of the century, the two primary causes for the activation of the sand dunes were the construction of the Columbia River jetties and land use activity in the area. The Columbia jetties were an important variable because they altered the

flow of sand along the Oregon coast. Cooper reported in 1958 that "outbuilding of the shore has been too rapid to permit formation of beach ridges stabilized by vegetation; most of the expanse of sand is bare" (Cooper, 1958, 126). This reflects the fact that the jetties had shifted sand transport in the area. This caused a shift in the sand cycle, which then began depositing large amounts of material on the beach area south of the mouth of the Columbia River. This was an outbuilding, or accreting, coastline before the construction of the jetties. However, the jetties encouraged even greater deposition.

The primary land use factor impacting the Clatsop plains was the introduction of livestock by white settlers. Grazing weakened the ability of the naturally occurring dune grasses to hold the daily deposits of sand by the wind. The combination of grazing and jetty construction resulted in the activation of sand dunes that began to envelop settlements. The *Oregonian* cited over-grazing as the initial reason for the incorporation of the City of Clatsop in 1870. Incorporation allowed residents to enforce regulations about livestock use on the dunes (Harper et al., 1940) with fines for grazing cattle on dune land. "A good many Clatsop farmers found it necessary to hand over the $1 per head fine to get their animals out of a three-cornered pound on the edge of the present town of Warrenton, where the vigilant marshal had herded them from the beach" (Harper et al., 1940). Grazing fines were an effective deterrent until the booming timber and shipping industries shifted attention away from dune action towards development. This allowed cattle to again range freely on the dunes (Rockie,

1936). The gains made in dune grass stabilization resulting from limits to grazing were lost. The result was encroachment by dunes into the interior.

Experimentation with dune biostabilization techniques in Clatsop County began in the 1880's. One of the first reports was of a plan to seed the beach with scotch broom. This experimental project was begun in 1884 around the vicinity of Point Adams. (*The Daily Morning Astorian*, 7/26/1884). The project introduced the use of beach grasses (a ribbon grass called *arundo* was mentioned in the newspaper article) and pines (Monterey pine, *pinus insignas*) in the stabilization process. (*The Daily Morning Astorian*, 10/11/1884). It was projects like this that provided the experimental basis for the larger dune stabilization project that was begun in 1935.

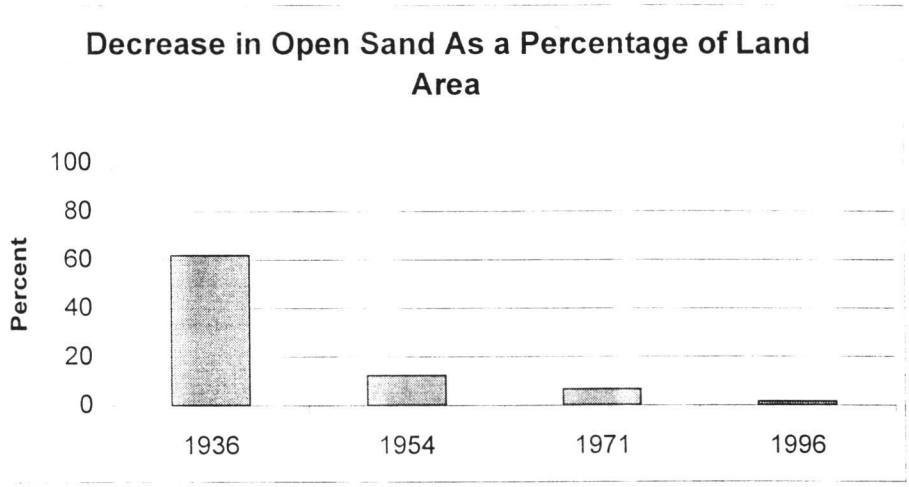
Dune encroachment in the 1930's was a great enough concern to enlist federal assistance. Residents were concerned about the loss of farmland, grazing land and the threat posed by the dunes to the military installations of Camp Clatsop and Fort Stevens. As previously described, in 1926 the state of Oregon acquired the land later to be named Camp Rilea. A total of $78,000 was spent on the construction of buildings and roads at the camp between 1926 and 1929. Therefore, not only local citizens, but also the Oregon state military had a vested interest in dune control. A Civilian Conservation Corp. (CCC) camp was established in Clatsop County in 1935 with the goal of dune stabilization (*The Morning Astorian*, 5/10/1935). The result of the project was the planting and ultimate stabilization of 3,000 acres of previously moving sand. This was accomplished by first placing fence structures on the dunes to collect sand. When

enough sand had been mounded up around the fences, grasses were planted. The planting of beach grasses was the first step toward the stabilization of the dunes for other forms of vegetation. Harry Schoth, the federal agronomist responsible for the planning and implementation of the extensive 1935 dune stabilization project was quoted by *The Oregonian* as saying, "grass is man's hope in holding back the sand dunes" (Harper et al., 1940). In following years, trees and other vegetation were planted for sod development and increased stabilization (Rockie, 1936). It was also expected that the area would become completely forested. "Fern, salal, Oregon grape and evergreen huckleberry gradually replace the Scotch broom in the chain of restoration to natural forest cover" (Osborne, 1952). Over the five-year period of the CCC project, millions of grass, shrub and tree starts were planted on the Clatsop plains (Harper et al., 1940).

The Civilian Conservation Corp. biostabilization project produced quick and dramatic results. The encroachment of the beach sands into the interior and the ability of the sand to actively move were curtailed by the planted vegetation. Camp Rilea provides a dramatic example of the change from unvegetated to vegetated land cover. Within a sixty year period, the percentage of Camp Rilea (based on the acreage in 1996) which was covered with unvegetated sand dropped from an initial high of 62% in 1936 to 12.4% in 1954. Only 6.7% of camp was unvegetated in 1971 and 1.6% in 1996 (Figure 4).

Clatsop County citizens voted to form the Warrenton Dune Soil and Water Conservation District in 1941 in order to safeguard the area from future dune destabilization (incorporated into the larger Clatsop Soil and Water Conservation

Figure 4: Decrease in Open Sand as a Percentage of land area.
The total land area compared between years is based on 1996 estimates of land area.



District in 1971). It was the duty of the District to manage the development of the dune zone. Land use planning regulations and zones that defined development were voted on by the public in 1948 (Warrenton Soil and Water Conservation District Clatsop County, OR, 1966). Throughout the 1940's and 1950's, periodic planting projects were conducted in order to maintain the work begun in the 1930's (Harper et al., 1940 and Osborne, 1952)

A difference in the perceived impact of dune biostabilization at a regional and local level is evident in a review of newspaper articles from *The Oregonian* and local Astorian newspapers. In a survey of 28 articles on dunes written between 1874 and 1984 in local Astorian newspapers, 23.5 articles refer to biostabilization in a positive manner. In 1884, the results of dune stabilization were viewed optimistically. It would allow a "great stretch of desolate wind-blown beach, and the shoal water beyond, [to] again 'blossom as the rose'" (*The*

Daily Morning Astorian, 7/26/1884). In none of the 28 articles spanning 110 years is the impact of stabilization using nonindigenous plants on native flora or fauna mentioned (Table 1). There is also no mention of preserving natural sand and successional cycles. Rather, the 4.5 articles that did not view biostabilization in a positive ecological manner were concerned with other issues including off road vehicle damage to the stabilizing vegetation, dune grading to restore ocean views or other sand stabilization efforts such as reduced grazing and building ordinances. These local attitudes contrast with those that can be traced in a regional newspaper. A survey of 22 dune related articles published by *The Oregonian* shows a shift in philosophy from a human oriented outlook to one that is more ecologically conscious. The early articles refer to biostabilization in the same positive light as the local Astorian newspapers. For instance, in one *Oregonian* article titled "Battle of the Dunes", the author describes the sand dunes as a vanquished enemy,

> "...the sand dunes of the Clatsop plains between the mouth of the Columbia River and Seaside had advanced inland to smother farms, highways, military installations and even threatened to block the mouth of the Columbia River for ocean vessels.
>
> Military roads leading to forts and gun emplacements were overtaken and buried. The military security of Oregon was in jeopardy.
>
> Because of the importance of this area to coastal defense planning and commerce, one of the most ambitious jobs of reclamation ever attempted in the western United States was executed in record time.
>
> Today this 20-mile stretch of former wasteland is the pride of the Warrenton Soil Conservation district. Shore pine, evergreen huckleberry, salal, and fern cover the former desert, and the marching sand dunes have lost the battle to men of science." (Osbourne, 1952)

The attitude displayed towards the dunes in *The Oregonian* has changed over time. In the 1980's and 1990's, the dunes were no longer presented as a threat to

people. Concern for ecological processes was presented along with technological solutions. Only one article was written before 1980 that did not present dunes as a menace. During the 1980's and 1990's nine articles were written that either discuss a wholly environmental perspective, or present both sides of dune management issues. A breakdown of articles from the local newspapers and *The Oregonian* is presented in Table 1. This simple outline shows a growing regional trend towards increased environmental awareness and concern for the protection of natural processes.

Table 1: Focus of local and regional newspapers towards human use and development of the dune margin.
A positive rating reflects an article that supports dune stabilization efforts or recreational use of the dunes. A negative rating reflects an article that was not supportive of stabilization projects and human uses due to a variety of concerns including: environmental impacts, the lack of sufficient information to conduct stabilization projects, dune grading, or the negative impacts of recreational use of dunes by vehicles. Source articles are listed in Appendix B.

Regional (*The Oregonian*)

	1870's	1880's	1910's	1930's	1940's	1950's	1960's	1970's	1980's	1990's	Totals
Negative	0	0	0	0	0	1	0	0	2.5	4.5	8
Positive	0	0	0	4	1	4	3	0	1.5	0.5	14
Totals:	0	0	0	4	1	5	3	0	4*	5*	22

Local (*The Tri-Weekly Astorian, The Daily Morning Astorian, The Morning Astorian, Astorian Evening Budget*)

	1870's	1880's	1910's	1930's	1940's	1950's	1960's	1970's	1980's	1990's	Totals
Negative	0.5	0	0	0.5	0.5	1	0	1	1	0	4.5
Positive	0.5	2	1	7.5	4.5	4	0	3	1	0	23.5
Totals:	1*	2	1	8*	5*	5*	0	4	2*	0	28

*Denotes that an article presented both sides of an issue. For the purposes of this study, half of the article was, therefore, described as "positive" and half as "negative".

Vegetation Succession on Coastal Dunes

Oregon's coastal dunes are naturally characterized by a cycle of disturbance followed by vegetative stabilization. This stabilization begins with grasses that begin to develop soil that support shrubs that are ultimately taken over by trees. The time frame for development of a forest community can be as short as 50 years. However, not many areas naturally develop into a forested community because of disturbances such as fire, wind and waves. (Wiedemann, 1984, 46) On the north Oregon coast, the process of sand stabilization by grasses and deposition of sediments from the Columbia River led to the parallel ridge topography that characterizes the area today. This process began with small foredunes created by native grasses at the high tide line capturing sand sediments from the ocean that were deposited by the wind. Deposition exceeded vegetative assimilation, which led to the deposition of sand farther westward. Over time, another stabilized foredune developed on these newly deposited sediments. The parallel ridge system that we see today developed as a result of this coastal outbuilding. (Wiedemann, 1984, 39)

The ocean border on the North Oregon coast was unstable, but the inland foredunes were not and gradually changed from a composition of grasses to a sitka spruce dominated forest community. In this context, a community represents a group of vegetation species that are in the same seral stage. The coastal edge was able to keep up with the supply of fresh sediments by

continually building outward. The grasses created new foredunes and trapped sand. The area directly adjacent to the ocean was probably never stabilized to such an extent as to maintain a climax community such as a sitka spruce forest. As previously mentioned, in 1805, Lewis and Clark reported the area closest to the ocean to be an open meadow. This is consistent with an unstable environment that could not support larger plant species such as trees. This reflects the continually changing conditions adjacent to the coastline. Wind, salt spray and sand all contribute to making the environment closest to the ocean one which cannot tolerate stability. Also, the lack of nutrients associated with a supply of raw sand is too low for the growth of species other than grasses and legumes that have low nutritional needs and can withstand the harshness of the environment. Only by continually outbuilding on the western side were eastward foredunes allowed to remain stable and build up enough nutrients in the soil for other species to survive. This allowed for the ultimate generation of a sitka spruce dominated community east of the accreting dune margin.

The natural process of foredune stabilization and coastal outbuilding has been interrupted in recent years by human land use activity. By constructing the Columbia River jetties, an alteration in the deposition of sand occurred. Increased deposition that could not be assimilated by native sand stabilizing plants resulted in excess sand. In its natural state, this excess sand built up on the coastal side and ultimately was colonized by vegetation, thereby creating another foredune. Coupled with the overgrazing of the dune grasses by cattle, the result was the activation of the dunes. By stabilizing the area with non-native plant species in

the 1930's, the Civilian Conservation Corp (CCC) effectively halted the spread of the dunes into developed areas to the east of the ocean. The newly created foredune was bigger than anything described by Lewis and Clark. By introducing non-indigenous sand stabilizing plants, there was an effective change in the dynamics of sand transport and dune building in the area. Probably the most important stabilizing plant in this process is European Beach grass *Ammophila arenaria*. Instead of dunes being controlled by sand deposition with vegetation building up later, the European Beach grass and other vegetation planted in the 1930's built the dunes themselves. This shift in dune forming momentum to a vegetative dominated system has resulted in the creation of modern dunes that appear to be much larger than those that preceded them (Wiedemann, 1966, 82). There has also been a shift in the creation of swale topography associated with foredune ridges. The swales that are apparent between older foredunes are not as large as those that seem to be developing on the lee side of modern foredunes. On the north coast, the development of lakes in the swales was noticed as early as 1938. Local officials were excited at the prospect of new lakes for recreation. However, over time, the "lakes" are relatively marshy and swamplike and not conducive to recreational pursuits. (*The Morning Astorian*, April 27, 1938)

The quick development of a forest canopy along the north Oregon coast is another impact associated with the plantings by the CCC in the 1930's. While a forest community could be expected in the area in the presence of inactive dunes, (Wiedemann, 1966, 146-7 and Byrd, 1950, 5-6) the forest which is now present adjacent to the beach is not naturally occurring. The project engineers planted

pine and spruce trees because they assumed that the grasses would die off once the sand was stabilized. They wanted to have a backup stabilization plant in place. The result has been the generation of a relatively mature forest community in a short amount of time.

Changes in Vegetation Communities at Camp Rilea

Aerial photographs of Camp Rilea were used to map various vegetative communities to closely evaluate the changes in vegetation communities that have occurred since the biostabilization of the dunes in the 1930's. Aerial photographs have been used in the delineation of wetlands, forest systems and other easily detectable vegetative formations (for example, see Pala and Boissonneau, 1982 Bakker et al., 1994 and Krumscheid et al., 1989). At Camp Rilea, aerial photographs were used to map 14 categories of vegetation communities and other important land features. Not all of the categories occurred on every set of photographs. The vegetation classes were developed in cooperation with a botanical inventory project being conducted at Camp Rilea. Scott Sundberg of the Oregon State University Botany Department characterized the floristic composition. The classes are described below:

Sanddune Related Community Types:

Accretion Foredune Meadow: West side of vegetated dune composed mainly of American beachgrass (*Ammophila brevidia*) with a small component of American dunegrass (*Leymus mollis*). This area experiences the most intense action from wind and waves during the winter months. As a result, plant growth is less dense than on the top and east sides of the foredune.

Foredune Meadow: located on the top and east portion of the foredune. This category includes a mix of species including American beachgrass (*Ammophila brevidia*), European beachgrass (*Ammophila arenaria*), American dune grass (*Leymus mollis*) and Purple beach pea (*Lathyrus japonicus*).

Interdune Complex Meadow: Located east of the foredune meadow. This category is a complex mix of species showing greater diversity than in other dune categories. It includes species associated with the foredune meadow coupled with a rich mixture of forbs. There are also scattered inclusions of scots broom and pine.

Upland Open Grass Communities:

Meadow: Composed predominantly of grasses and forbs. These areas may be heavily impacted by human activity such as mowing and planting. Oregon Silverspot Butterfly habitat is included within this category type.

Emergent wetland: Located in areas, which are wet 90% of the year. Usually an open area composed of wetland plants such as slough sedge (*Carex obnupta*) and Cusick's sedge (*Carex cusickii*). There may be scattered inclusions of shrubs (willow/scots broom) and trees (not to exceed 20% of the area).

Shrub Communities:

Shrub: Mix of shrub species including willow, scots broom (*Cytisus scoparius*) and trees that are less than 7 m in height. An understory of grasses and forbs is present.

Shrub wetland: Mix of shrub species including willow, scots broom (*Cytisus scoparius*) and trees that are less than 7 m high. The understory vegetation is composed of wetland vegetation such as sedges and rushes.

Wooded Communities:

Wooded: Mix of deciduous and coniferous trees. Some areas have been planted. These areas are mostly dominated with coniferous trees including a variety of pines (*Pinus contorta*, *Pinus nigra* and *Pinus sylvestris*) with an understory of scots broom (*Cytisus scoparius*). Naturally propagated areas include species such as sitka spruce (*Picea sitchensis*), shore pine (*Pinus contorta*), and alder (*Alnus rubra*). Understory in these areas range between grasses/forbs and scots broom (*Cytisus scoparius*).

Wooded wetland: Can have the same canopy as in Wooded category. however, understory vegetation is composed of wetland species such as slough sedge (*Carix obnupta*).

Other Classes:

Aquatic vegetation: Composed of rooted floating aquatic vegetation such as water lilies (*Nuphar polysepala* and *Nymphaea odorata*).

Unvegetated sand: Occurs both on the beach and within camp. This comprises the active dune area in the 1939 aerial photos.

Developed land: All areas that have been built upon and permanently changed from their natural state.

Open water: Includes lake and slough areas that are devoid of rooted aquatic vegetation.

Wastewater facility: Included the mixing ponds and impacted grass area surrounding the site.

Photographs of each class are available in Appendix C.

The aerial photos used in this project were acquired from a variety of sources (Table 2). Once the aerial photos were acquired, vegetation communities were delineated using a mylar overlay on a zoom transfer machine. Ultimately, four coverages were created, one for each year of aerial photography. The minimum mapping unit for this project was 1 acre. The outlined communities

were then digitized and manipulated using ArcInfo software. Rubbersheeting was used in order to correct all of the coverages to a 1996 orthophoto image of Camp Rilea. Once this process was completed. the coverages were clipped to the approximate extent of the property line for 1996 Camp Rilea. Code names were attached to the polygon id numbers in order to characterize each community type. Summary statistics that describe the extent of distribution for each vegetation community for each coverage were generated in Arc Info.

Table 2. Outline of Aerial Photo sources used for analysis of Camp Rilea from 1939 to 1996.

Photo Year	Source	Scale
1939	Army Corp. of Engineers	1:350
1958	Oregon Dept. of Transportation & Army Corp. of Engineers	1:1000
1971	Oregon Department of Transportation	1:1000
1996	Oregon Army National Guard	1:350

The coverages for this project were used for general delineation of vegetation communities. This reflects the imprecise nature of aerial photo interpretation of historical aerial photographs. Only the 1996 imagery could be ground truthed so it was necessary to extrapolate the levels of accuracy from this coverage to the other years. This was based on the assumption that misclassification of communities would have occurred consistently throughout the process of aerial photo interpretation. The 1939, 1958 and 1971 photos were black and white while the 1996 photo was a panchromatic orthophoto. This inconsistency between data sources could be a source of increased error in the

1939, 1958 and 1971 photos. Another inconsistency among the photos is found in the varying scales of each set. This could result in higher and lower accuracy levels among the photo sets.

Field checking points in each category verified the accuracy of the 1996 classification. A stratified random selection process was used in order to pick approximately 10 sites per category. The result was that most categories had between 9 and 11 sites. Two categories had very few sites in them due to their small amount of acreage. The overall accuracy of the 1996 image was 86%. A breakdown of the error per community class is given in Table 3.

The property boundaries of Camp Rilea in 1996 were used as a base in order to compare the classes from 1939 to 1996. This allows the total

Table 3: Summary of Field Verification Data.
Ground truthing was conducted for the 1996 aerial photo class delineation. Sites were sampled in December, 1997.

Class	Total Number of Sites Sampled	Total Number of Sites Correct	Percent Correct
Dune Meadow	10	7	70
Meadow	10	10	100
Shrub Wetland	9	7	78
Shrub	11	9	82
Wooded	10	9	90
Unvegetated Sand	10	10	100
Developed Land	11	8	73
Emergent Wetland	1	0	0
Accretion Foredune Meadow	9	9	100
Open Water	2	2	100
Wooded Wetland	10	8	80
Complex Dune Meadow	10	10	100
TOTAL	**103**	**89**	**86**

acreage and percentage calculations from each year to represent a similar area on the ground. For ease of analysis, some of the original categories have been lumped together into larger groupings. An overview of the acreage of each individual class is presented in Appendix A.

The coverages that were generated for this project are shown in Figures 5 through 8 (metadata for the coverages may be found in Appendix D). These coverages add an important visual context to the discussion of vegetation community distribution and temporal change. The complexity of the vegetation communities appears greater in 1939 and 1996 than in 1958 and 1971. A visual assessment of the maps shows that the community structure in 1939 was intricate with small, interspersed communities. The 1958 map shows a homogeneous distribution and class extent. The map from 1971 shows increased complexity from 1958 especially along the western corridor of the camp. The 1996 map is the most complex with small class areas interspersed with one another. This could reflect an overall change in vegetation distribution as the area assimilated the plantings from 1939.

Wetland areas have been recognized as important areas for plant and animal life therefore knowing their distribution at Camp Rilea is valuable. The areas characterized as wetlands for this study show an increase in area from 1939 to 1958 that was followed by a decrease from 1958 to 1971 (Figure 9). The acreage of wetland areas between 1996 and 1971 has remained relatively similar. However, the 1996 shrub wetland areas located along the eastern border of the dunes appear to be increasing in depth and extent over time. They also appear to

Figure 5: Camp Rilea vegetation classes based on 1939 aerial photography conducted by the Army Corp. of Engineers.

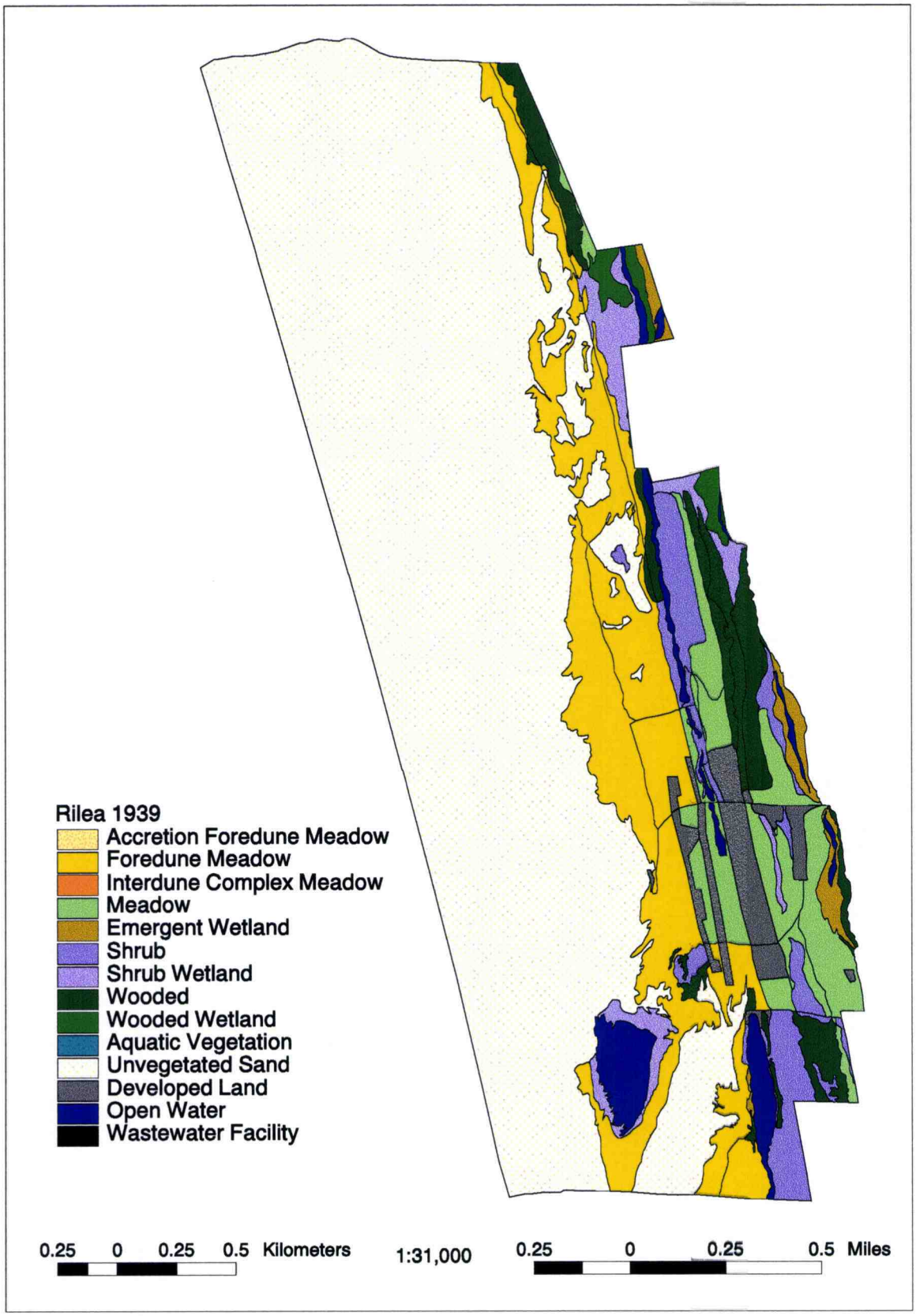


Figure 6: Camp Rilea vegetation classes based on 1958 aerial photography conducted by the Oregon Department of Transportation and the Oregon Army National Guard.

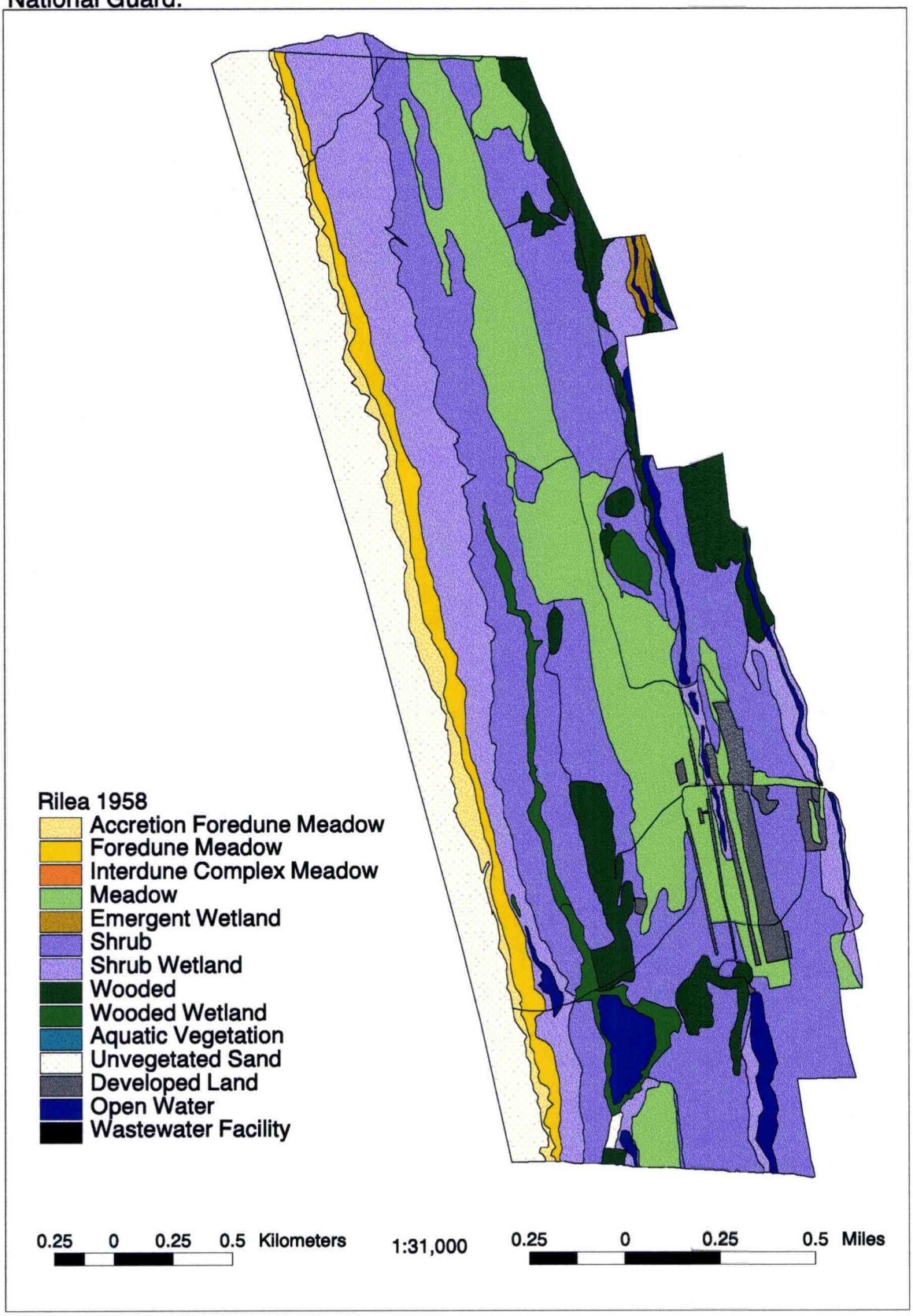


Figure 7: Camp Rilea vegetation classes based on 1971 aerial photography conducted by the Oregon Department of Transportation.

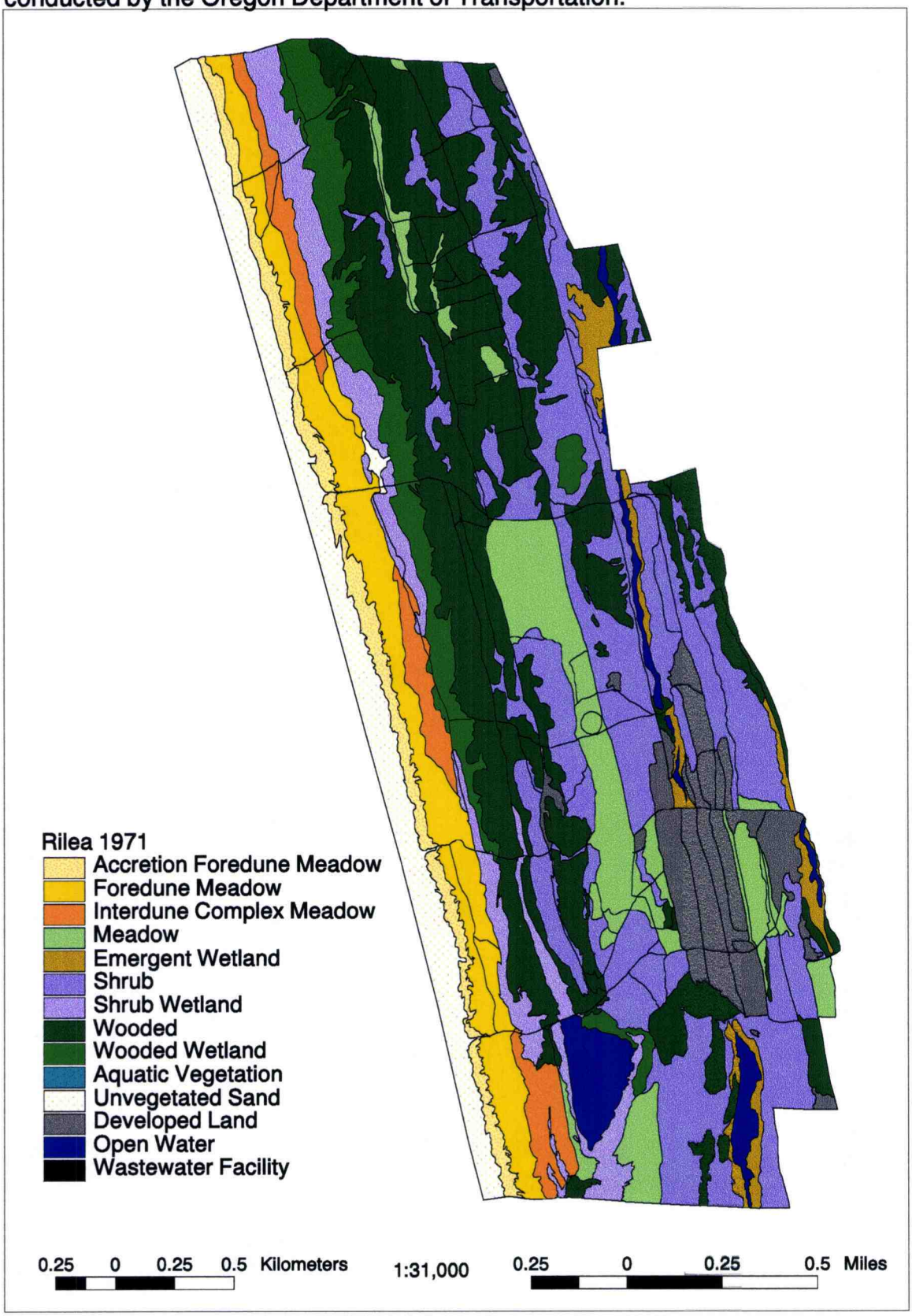
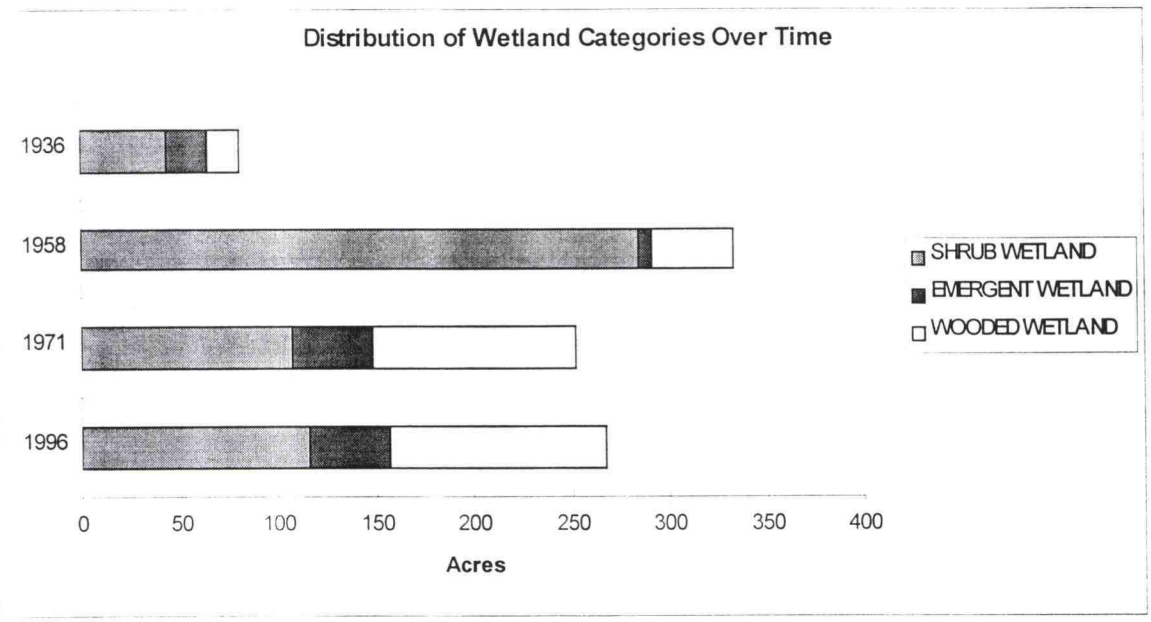


Figure 8: Camp Rilea vegetation classes based on a 1996 orthophoto of the site.

be spreading westward into the complex dune meadow area that directly abuts both wooded and shrub wetlands on their eastern border. An investigation of the water table and its seasonal fluctuations would provide a useful base from which to assess future changes in wetland distribution in this area.

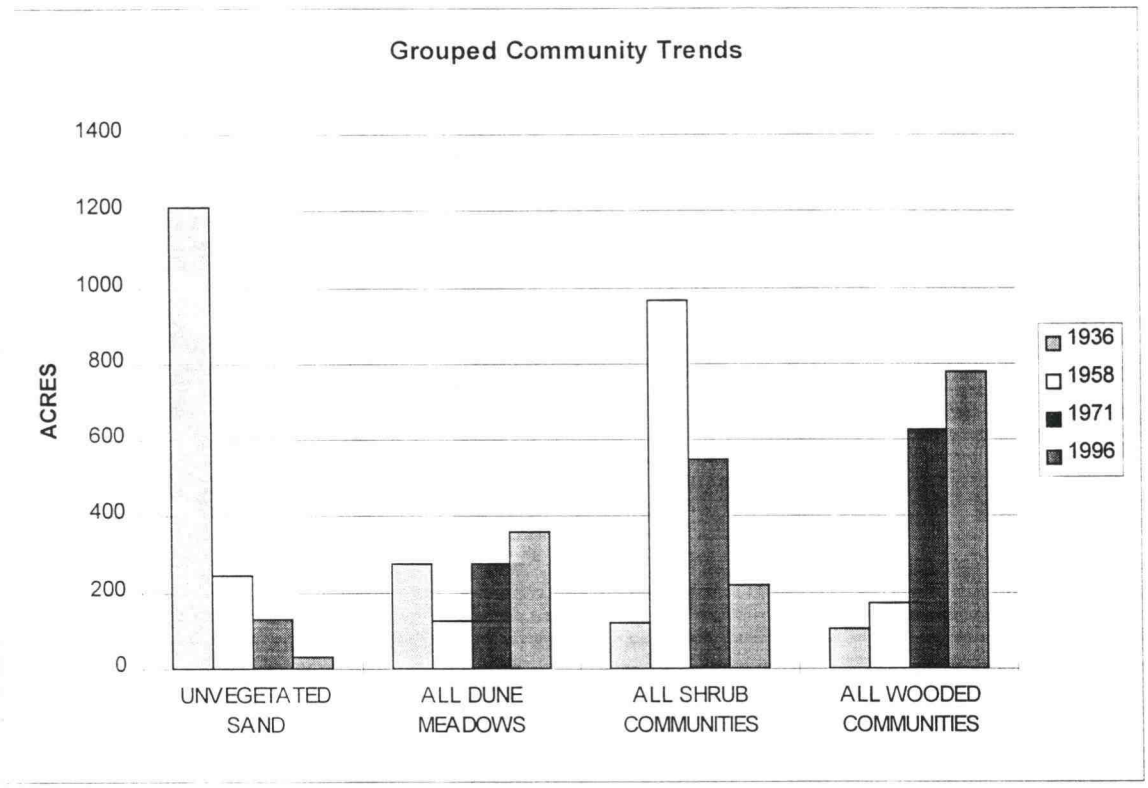
Figure 9: Acreage described as wetlands from 1939 through 1996 at Camp Rilea, Oregon.



Groupings of categories that relate to succession are shown in Figure 10. In this graph, the shift in land area dominance from unvegetated sand in 1939 to wooded in 1996 is visible. Over this sixty-year period, there has been a dramatic decline in unvegetated sand. The initial drop between 1939 and 1958 was the greatest, with a steady decline occurring in the ensuing years. Wooded communities increased most between 1958 and 1971. The dune meadow category reflects a disturbance after 1939 that reduced the amount of acreage in dune

meadow categories. This disturbance could have been the planting of vegetation in 1936. This was overcome by 1971 with dune grasslands increasing in acreage through 1996. Shrubs seem to be fairly erratic in temporal distribution. This

Figure 10. Grouped Community Trends Graph.
This graph contains groupings of individual categories. Unvegetated sand is the only one that has not been grouped. The "All Dune Meadows" category includes: Accretion Dune Meadow, Foredune Meadow and Complex Interdune Meadow. "All Shrub Communities" includes Shrub Wetland and shrub. "All Wooded Communities" includes Wooded and Wooded Wetland.



reflects the saplings that were planted in 1939. They appear as shrub sized vegetation in the aerial photographs of 1958 and 1971. This explains the high value in the shrub category in 1958 and its continued decline since that time. The shrub areas classified in the 1939 and 1996 datasets do not include the trees

planted in 1936. In 1939 the trees were too small to appear on the photos, and by 1996, the trees were large enough to be easily recognized as trees rather than shrubs.

The expected successional trend for a natural dune system is from sand to grass to shrub and finally trees. Camp Rilea appears to be following this trend. However, it is also obvious that the current vegetation communities are the direct result of vegetation plantings. The distribution of forest communities as well as the time frame under which they have developed is probably not appropriate for naturally occurring succession in this area. This has some serious implications for the maintenance and survival of some indigenous flora and fauna in the area.

While this study was able to provide useful information about changes in vegetation community composition at Camp Rilea, it was not able to differentiate between those trees which were planted as part of the 1936 biostabilization project and those that were naturally occurring. This forced the analysis to classify all wooded areas the same and the level of impact of the stabilization project on the forest canopy at the site is unclear. Likewise, the data associated with shrub areas in 1958 and 1971 were clouded by the presence of young trees. This resulted in the characterization of shrub areas that could be considered inflated by the presence of immature timber stands.

Past and Future Management at Camp Rilea

The State of Oregon has managed Camp Rilea as a military training facility since its purchase in 1926. The camp was purchased because rail rates had become too high to cost effectively transport troops to southern Oregon for military training. The solution was to create a new camp, which would be more easily accessed by troops needing to train in northern Oregon. During the 1940's, Camp Clatsop was used as a mobilization site for US soldiers deployed world wide for the Second World War. The camp became a "tent city" full of soldiers completing their entry training. During the 1950's, Camp Clatsop's training facilities were expanded and modernized. In 1959 the name of the site changed to Camp Rilea in recognition of the Adjutant General Thomas E. Rilea who had been primarily responsible for improving the camp. During the 1960's, the camp was used only sporadically. It was not until 1973 that the camp was expanded to become the multi-service training facility that it is today. (Eckley: 1997)

It is a priority to manage Camp Rilea in order to maintain a variety of environmental conditions for training purposes. Camp Rilea offers a lot of diversity including wetland, forest, open sand and shrub dominated environments. While the current distribution of these environments reflects the impact of the 1936 dune biostabilization project, their presence on camp is the result of a management scheme which did not systematically fill wetlands or develop extensive areas of the camp. An unintentional result of the management of the

site for a diversity of training environments has been the protection of important habitats for threatened species. For example, the Oregon Silverspot Butterfly, which is listed as a federal threatened species, lives on violets that occur in some meadow habitats at Camp Rilea.

Effective management at Camp Rilea may result from the consideration of different management strategies based on this project's analysis of vegetative and human history. Four alternate management goals emerge:

1) To manage for maximum endangered species at the camp.
2) To manage for minimum exotic species.
3) Management for maximum military training diversity.
4) No action alternative.

Manage for Maximum Endangered Species

Management for maximum endangered species at the camp may be accomplished at two levels, for individual species and for habitats. A good example of management for an individual species is currently being done for the Oregon Silverspot Butterfly with specific use rules for meadow habitat and mowing schedules that accommodate the butterfly. Another species that could be managed in this way is the Snowy Plover. Measures to attract Snowy Plover to the site include removal of portions of the foredune in order to enhance open sand habitat. Regulating beach use by vehicles and denying any access to the open sand during nesting periods would also be necessary to accommodate Snowy Plovers. Management recommendations for habitat enhancement focus on wetlands. Wetland habitat is important for many species of flora and fauna that have been identified as rare or threatened. Enhancement of these areas could be

accomplished by closing Gammagoat and Swamp roads to vehicle traffic in order to allow the wetlands in these areas to develop.

Manage to Minimize Exotic Species

There are various management tools that could result in the minimization of exotic species at the camp. Many exotic plant species occur at the site as a result of landscaping and biostabilization. Replacement with native species seems unrealistic. For example, removal of the current foredune and its restabilization with only native dune grasses might result in the removal of many non-native species. However. such an action would violate Clatsop Natural Resource Conservation Service rules for the sensitive dune zone (City of Warrenton, 1993). It is also unclear whether such a measure would result in the removal of the non-native planted grasses that have become well established and have a strong root system. A more practical recommendation would be to use only native plant species on the camp in the future. and to work to replace exotic plants with their native counterparts. Another recommendation would be to allow the native vegetation to take over in wooded areas as the current forest ages.

Manage for Maximum Military Training

Management for maximum military training diversity at the site may impact sensitive habitat areas such as meadows and wetlands. For example, building culverts and stabilizing Gammagoat and Swamp Roads will be necessary in order to maintain access to the beach and use the western portion of camp. Access has been jeopardized by the developing wetlands in these areas.

Therefore, construction within these areas should be carefully considered and measures taken to decrease the overall impact to wetland habitats.

No Action Alternative

The no action alternative allows activity at Camp Rilea to continue without modification. However, without culvert construction to enhance access there may be a decrease in military use of the camp. Wetland development could decline without measures for their protection. Impacts from foot and vehicle disturbance may result in decreased meadow, dune and wetland habitats.

These management recommendations are described with each management goal but they are not mutually exclusive and may be applied in concert or on their own. It is important to consider the options available and weigh them against one another in order to determine the appropriate course of action. A consideration of vegetative history and community trends may result in more appropriate uses of Camp Rilea.

Conclusion

The development and use of dune areas in Oregon has provided challenges to managers for well over a century. Dune biostabilization from the beginning of this century has effectively halted the movement of active dunes. However, this solution has consequences. The prevalence of non-indigenous vegetation, coupled with an altered landscape, has resulted in new challenges for native flora and fauna.

The issue for land managers now becomes determining priorities for the land. This project has answered part of this question at Camp Rilea by showing that there are ongoing vegetative and geomorphological changes occurring. Foredunes are continually building thereby influencing the beach margin and deflation plains. Wetlands are expanding and a forest community is coming to dominate some portions of the Clatsop Plains. Camp Rilea is located within this area of change making it a good site to monitor the progress and development of the wetland, swamps and foredunes in the area.

The ability to make informed decisions about the level of disturbance that the environment can sustain relies on a firm understanding of what has happened in the past as well as the forecasted trends in vegetation, development and human population pressure. The future land management decisions regarding dunes on the North Oregon Coast must include assessments of both the physical and human

environment. Only by including all of the variables that form the constituency of the area will appropriate decisions be made.

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Appendix B

Appendix B: Source information for newspaper article comparison of regional and local attitudes towards dune stabilization. Sources are listed chronologically.

Regional Newspaper: *The Oregonian*

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Appendix C

Appendix C: Class Descriptions and Photos for Camp Rilea.

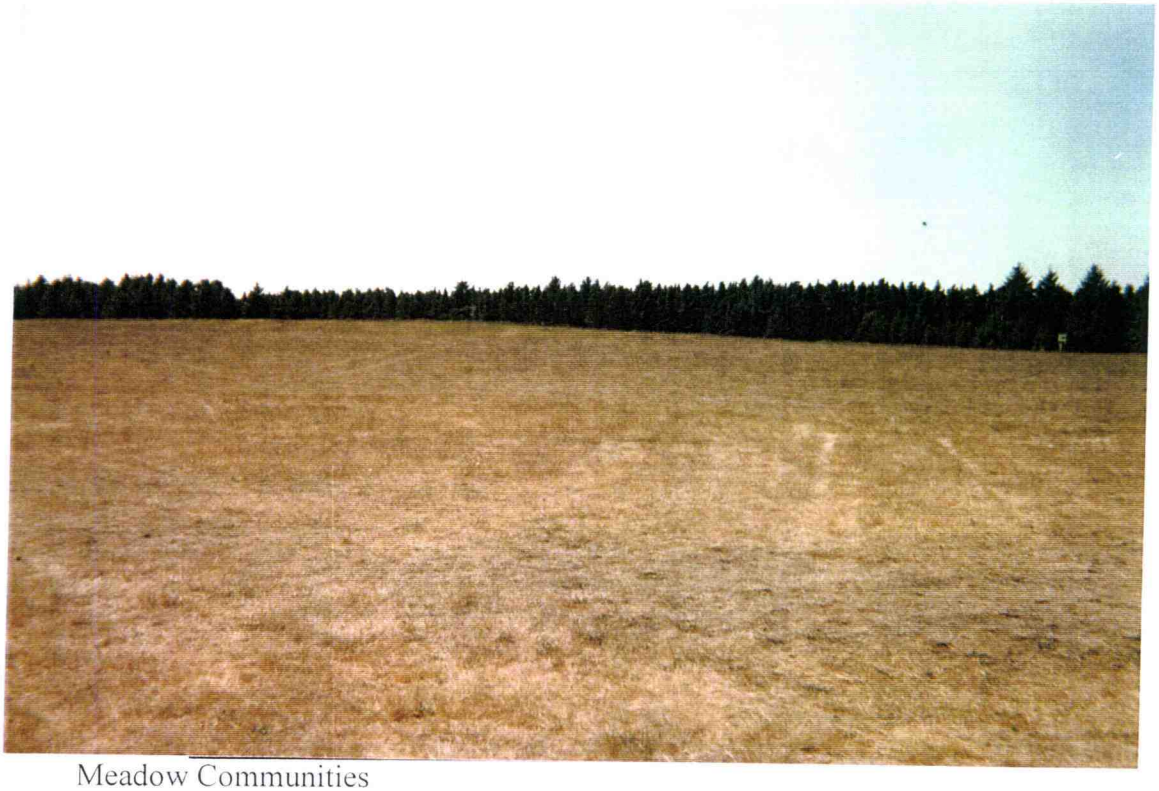
Dune Meadow Communities

Upper: Foredune Meadow: located on the top and east portion of the foredune. This category includes a mix of species including American beachgrass (*Ammophila brevidia*), European beachgrass (*Ammophila arenaria*), American dune grass (*Leymus mollis*) and Purple beach pea (*Lathyrus japonicus*).

Right: Accretion Foredune Meadow: West side of vegetated dune composed mainly of American beachgrass (*Ammophila brevidia*) with a small component of American dunegrass (*Leymus mollis*). This area experiences the most intense action from wind and waves during the winter months resulting in less dense plant growth on the top and east sides of the foredune

Interdune Complex Meadow: Located east of the foredune meadow. This category is a complex mix of species showing greater diversity than in other dune categories. It includes species associated with the foredune meadow coupled with a rich mixture of forbs. There are also scattered inclusions of scots broom and pine.
Right: A mix of beach grasses, strawberry and other forbs.

Left: A more open patch of complex interdune meadow with assorted beach grasses, scots broom and pine.



Meadow Communities

Meadow: Composed predominantly of grasses and forbs. These areas may be heavily impacted by human activity such as mowing and planting. Oregon Silverspot butterfly habitat is included within this category type.

Emergent wetland: Located in areas that are wet 90% of the year. This photo depicts a combination of habitat types including open water, aquatic vegetation and emergent wetland.

Shrub Communities

Upper: Shrub wetland: mix of shrub species including willow, scots broom (*Cytisus scoparius*) and trees that are less than 7 m high. The understory vegetation is composed of wetland vegetation such as sedges and rushes.
Below: Shrub. Mix of shrub species including willow, scots broom (*Cytisus scoparius*) and trees that are less than 7 m in height. An understory of grasses and forbs is present. In this photograph, the shrub community is composed almost entirely of scots broom.

Wooded Communities

Right: Wooded: mix of deciduous and coniferous trees. Some areas have been planted. These areas are mostly dominated with coniferous trees including a variety of pines (*Pinus contorta, Pinus nigra* and *Pinus sylvestris*) with an understory of scots broom (*Cytisus scoparius*). Naturally propagated areas include species such as sitka spruce (*Picea sitchensis*), shore pine (*Pinus contorta*), and alder (*Alnus rubra*). Understory in these areas range between grasses/forbs and scots broom (*Cytisus scoparious*). The photo depicts an area that was planted with pine and has developed an understory of scots broom.

Left: Wooded wetland: can have the same canopy as in the Wooded category, however, understory vegetation is composed of wetland species such as slough sedge (*Carix obnupta*).

Other Classes:

Aquatic vegetation: composed of rooted floating aquatic vegetation such as water lilies (*Nuphar polysepala* and *Nymphaea odorata*).

Unvegetated sand: occurs both on the beach and within camp. This comprises the active dune area in the 1939 aerial photos. This photo depicts open sand at a beach access point at Camp Rilea.

Other Classes:

Developed land: all areas that have been build upon and permanently changed from their natural state.

Open water: Includes lake and slough areas that are devoid of rooted aquatic vegetation. This photograph was taken at Slusher Lake.

Appendix D

Appendix D: Metadata for the Camp Rilea Vegetation Distribution Maps for 1939, 1958, 1971 and 1996.

Oregon Military Department
Oregon Army National Guard
Vegetation Data Coverages Metadata
Camp Rilea, Oregon
Date: July, 1998

Identification Information

Citation
Originator: Oregon Military Department
Publication Date: September, 1998
Title: Camp Rilea Vegetation Distribution Map, [1939, 1958, 1971, 1996]
Publication Information
Publication Location: Salem, OR
Publisher: Oregon Military Department

Description

Abstract: The Oregon Military Department sponsored this investigation of vegetation change over time at the Oregon Army National Guard's Camp Rilea. This project sought to document change in dune vegetation and community distribution for the site. The documented changes and successional path displayed by the vegetation on the site is the result of the large dune stabilization project conducted by the Civilian Conservation Corp between 1936 and 1937.

It is important to note that this area had been stable before the mid 1800's. Activation of the dunes was caused by pioneer ranching practices and jetty construction on the Columbia River. Pioneer ranchers allowed cattle to graze on the lush dune grasses that dominated the beach margin. This allowed sand to break through the protective vegetation barrier and be moved by wind transport. The result was moving dunes that began to envelop roads and buildings. Beach accretion on the north Oregon coast occurred before jetty construction. However, the jetties allowed for increased deposition of sediments alone the north Oregon

coast. This contributed to the rejuvenation of the dunes by providing more material for sand transport on the coast.

The post stabilization changes in vegetation community distribution and evidence of an accreting coastline are easily discernable in the four coverages generated for Camp Rilea. The 1939 coverage shows large areas of open sand that are completely vegetated by 1958. Of particular significance was a parabolic dune south of Slusher Lake that had been invading the interior of the camp. This dune was no longer a threat by the 1950's. The planting of tree species such as shore pine (*Pinus contorta*) and sitka spruce (*Picea sitchensis*) and shrub species such as scots broom (*Cytisus scoparius*) and salal (*Gaultheria shallon*) encouraged the development of a forest community. The transition of Camp Rilea from open dune to forest has occurred in 60 years.

This dataset consists of four polygon coverages generated from analysis of aerial photographs. The aerial photographs were mapped using mylar overlays on a zoom transfer machine. The maps were then digitized and rubbersheeted in ArcInfo. Each polygon contains attribute information that characterizes the vegetation community that is represented at that location.

Purpose: The purpose of this dataset is to provide information about historical vegetation distribution at Camp Rilea. This allows managers to understand the distribution of recently active sand dunes and the vegetation communities that currently occupy the area. This dataset should be used as a tool in making management decisions about the future location of training facilities and development. It is important to recognize that destabilization of the dunes in this area due to human land uses has occurred in the recent past.

Supplemental Information: there is a variety of ancillary coverages which may be used in conjunction with this dataset. A vegetation inventory completed by Scott Sundburg of Oregon State University Botany's Department generated a coverage with higher resolution vegetation communities. A point coverage of plant collection sites was also completed for this project. Roads, buildings and boundary coverages are available through the Oregon Military Department. An orthophoto of Camp Rilea which is the base for the 1996 polygon coverage is also available through the Oregon Military Department.

Time Period of Content
Time Period Information
Range of Dates: 1939, 1958, 1971, 1996
Currentness Reference: Publication Date

Status
Progress: Complete
Maintenance and Update Frequency: As needed

Spatial Domain
Bounding Coordingates:
West Bounding Coordinate: -120.000000
East Bounding Coordinate: -120.000000
North Bounding Coordinate: +43.00000
South Bounding Coordinate: +43.00000

Keywords
Theme:
Theme Keyword Thesaurus: None
Theme Keyword: Vegetation Communities
Theme Keyword: Historical
Theme Keyword: Dunes
Place:
Place Keyword Thesaurus: None
Place Keyword: Oregon
Place Keyword: Camp Rilea
Place Keyword: Clatsop Plains
Temporal:
Temporal Keyword Thesaurus: None
Temporal Keyword: 1939
Temporal Keyword: 1958
Temporal Keyword: 1971
Temporal Keyword: 1996

Access Constraints: none

Use Constraints: This data should be used only for general delineation of vegetation communities. This reflects the imprecise nature of aerial photo interpretation of historical aerial photographs.

Point of Contact
Contact Organization Primary
Contact Organization: Oregon Military Department
Contact Person: Jerry Elliott
Contact Address:
Address Type: mailing address
Address: P O Box 14350
City: Salem
State: Oregon
Postal Code: 97309-3584
Contact Voice Telephone: (503) 945-3851
Contact Facsimile Telephone: (503) 945-3584

Cross Reference: none

Data Quality Information

Attribute Accuracy

Attribute Accuracy Report: Only the 1996 imagery could be ground truthed. It was necessary to extrapolate the levels of accuracy from the ground truthing of the 1996 imagery to the other years. This was based on the assumption that misclassification of communities would have occurred consistently throughout the process of aerial photo interpretation. The 1939, 1958 and 1971 photos were black and white while the 1996 photo was a panchromatic orthophoto. This inconsistency between data sources could be a source of increased error in the 1939, 1958 and 1971 photos. Overall accuracy of the 1996 image was 80%. A breakdown of the error per community class is outlined in table 1.

Table 1: Summary of Field Verification Data. Ground truthing was conducted for the 1996 aerial photo class delineation. Sites were sampled in December, 1997.

Class	Total Number of Sites Sampled	Total Number of Sites Correct	Percent Correct	Actual Classes:
Dune Meadow	10	7	70	3@17
Meadow	10	10	100	
Shrub Wetland	9	7	78	1@4,1@8
Shrub	11	9	82	1@5,1@6
Wooded	10	9	90	1@4
Unvegetated Sand	10	10	100	
Developed Land	11	8	73	2@2,1@5
Emergent Wetland	1	0	0	1@10
Accretion Foredune Meadow	9	9	100	
Open Water	2	2	100	
Wooded Wetland	10	8	80	2@17
Complex Dune Meadow	10	10	100	
TOTAL	103	89	86	

Logical Consistency Report: Polygon topology was tested by assessment of dangling nodes. Unclosed polygons were corrected using the ArcTools polygon editing module of ArcInfo. There are no duplicate or overlapping polygons.

Completeness Report: The aerial photographs used in this project were taken during one day aerial photography missions.

Positional Accuracy Report
Horizontal Positional Accuracy
Horizontal Positional Accuracy Report: The accuracy of the polygons represented in these coverages to actual features on the ground is unknown. It is not possible to test ground level accuracy of historical aerial photographs. The positional accuracy of the 1996 aerial photographs could be determined by the collection of GPS points at key locations. This was not accomplished for this project.

Lineage
Source Information
Source Citation
Originator: Army Corp. of Engineers
Publication Date: 1939 and 1958
Title: Aerial Photographs of Coastal Oregon
Geospatial Data Presentation Form: Remotely Sensed Imagery
Publication Information
Publication Place: Portland, OR
Publisher: Army Corp. of Engineers
Source Scale Denominator: 350 and 1000 respectively
Type of Source Media: Aerial Photographs
Source Time Period of Content
Single Date/Time
Calendar Date:unknown
Source Currentness Reference: Publication Date
Source Contribution: aerial photo base for polygon classification.

Source Information
Source Citation
Originator: Oregon Department of Transportation
Publication Date: 1958
Title: Aerial Photographs of Coastal Oregon
Geospatial Data Presentation Form: Remotely Sensed Imagery
Publication Information
Publication Place: Salem, OR
Publisher: Oregon Department of Transportation
Source Scale Denominator: 1000
Type of Source Media: Aerial Photographs
Source Time Period of Content
Single Date/Time
Calendar Date: 5/15/58
Source Currentness Reference: Publication Date

Source Contribution: aerial photo base for polygon classification.

Source Information
Source Citation
Originator: Oregon Army National Guard
Publication Date: 1996
Title: Orthophoto of Camp Rilea
Geospatial Data Presentation Form: Remotely Sensed Imagery
Publication Information
Publication Place: Salem, OR
Publisher: Oregon Army National Guard
Source Scale Denominator: 350
Type of Source Media: Orthophoto
Source Time Period of Content
Single Date/Time
Calendar Date: unknown
Source Currentness Reference: Publication Date
Source Contribution: aerial photo base for polygon classification.

Process Step
Process Description: The aerial photos used in these coverages were acquired from a variety of sources. Once the aerial photos were acquired, vegetation communities were delineated using a mylar overlay on a zoom transfer machine. The minimum mapping unit for this project was 1 acre.
Process Date: 1997

Process Step
Process Description: The outlined communities were digitized and manipulated using Arc Info software.
Process Date: 1997

Process Step
Process Description: Rubbersheeting was used in order to correct the 1939, 1958 and 1971 community coverages to a 1996 orthophoto image of Camp Rilea.
Process Date: 1997

Process Step
Process Description: Once rubbersheeting was completed, the coverages were clipped to the extent of the property line for 1996 Camp Rilea. Code names were attached to the polygon id numbers in order to characterize each community type. Summary statistics that describe the extent of distribution for each vegetation community for each individual coverage was generated in Arc Info.
Process Date: 1998

Spatial Data Organization Information
Direct Spatial Reference method: Vector

Vector Object Information
Vector Object Type: Polygon

Spatial Reference Information
Horizontal Coordinate System Definition:
Planar:
Grid Coordinate System:
Grid Coordinate System name: Universal Transverse Mercator
Universal Transverse Mercator:
Scale Factor at Central Meridian: 1
Longitude of Central Meridian: -120.300000
Latitude of projection Origin: +43.400000
False Easting: 609,601.212920
False Northing: 0
Planar Coordinate Information:
Planar Coordinate Encoding Method: coordinate pair
Coordinate Representation:
Abscissa Resolution: 1
Ordinate Resolution: 1
Planar Distance Units: Meters
Geodetic model:
Horizontal Datum Name: North American Datum of 1927
Ellipsoid Name: Clarke 1866
Semi-major Axis: 6378206.4
Denominator of Flattening Ratio: 294.98

Entity and Attribute Information

Entity and Attribute Description
Entity and Attribute Overview:

Detailed Description:
Entity Type:
Entity Type Label: r<year>final.pat
Entity Type Definition: Polygon Attribute Table
Entity Type Definition Source: ArcInfo generated attributes
Attribute Label: Class
Attribute Definition: AREA
Attribute Definition Source: Internally calculated ArcInfo value
Attribute Domain Values:
Enumerated Domain:
Enumerated Domain Value Definition: numerical (12)

Enumerated Domain Value Definition Source: computed
Attribute Label: Class
Attribute Definition: PERIMETER
Attribute Definition Source: Internally calculated ArcInfo value
Attribute Domain Values:
Enumerated Domain:
Enumerated Domain Value Definition: numerical (12)
Enumerated Domain Value Definition Source: computed
Attribute Label: Class
Attribute Definition: R<year>FINAL#
Attribute Definition Source: Internally calculated ArcInfo identification value
Attribute Domain Values:
Enumerated Domain:
Enumerated Domain Value Definition: numerical (5)
Enumerated Domain Value Definition Source: ArcInfo
Attribute Label: Class
Attribute Definition: R<year>FINAL-ID
Attribute Definition Source: Internally calculated ArcInfo identification value
Attribute Domain Values:
Enumerated Domain:
Enumerated Domain Value Definition: numerical (5)
Enumerated Domain Value Definition Source: ArcInfo
Entity Type:
Entity Type Label: r<year>final.pat
Entity Type Definition: Polygon Attribute Table
Entity Type Definition Source: Project generated classifications
Attribute:
Attribute Label: Class
Attribute Definition: Class name of vegetation community.
Attribute Definition Source: Assigned during aerial photo analysis.
Attribute Domain Values:
Enumerated Domain:
Enumerated Domain Value: Accretion Foredune Meadow
Enumeration Domain Value Definition: West side of vegetated dune composed mainly of American beachgrass (*Ammophila brevidia*) with a small component of American dunegrass (*Leymus mollis*). This area experiences the most intense action from wind and waves during the winter months. As a result, plant growth is less dense than on the top and east sides of the foredune.
Enumerated Domain Value: Foredune Meadow
Enumeration Domain Value Definition: located on the top and east portion of the foredune. This category includes a mix of species including American beachgrass (*Ammophila brevidia*), European beachgrass (*Ammophila arenaria*), American dune grass (*Leymus mollis*) and Purple beach pea (*Lathyrus japonicus*).

Enumerated Domain Value: Interdune Complex Meadow
Enumeration Domain Value Definition: Located east of the foredune meadow. This category is a complex mix of species showing greater diversity than in other dune categories. It includes species associated with the foredune meadow coupled with a rich mixture of forbs. There are also scattered inclusions of scotch broom and pine.
Enumerated Domain Value: Meadow
Enumeration Domain Value Definition: Composed predominantly of grasses and forbs. These areas may be heavily impacted by human activity such as mowing and planting. Oregon Silverspot Butterfly habitat is included within this category type.
Enumerated Domain Value: Emergent wetland
Enumeration Domain Value Definition: Located in areas which are wet 90% of the year. Usually an open area composed of wetland plants such as slough sedge (*Carex obnupta*) and Cusick's sedge (*Carex cusickii*). There may be scattered inclusions of shrubs (willow/scots broom) and trees (not to exceed 20% of the area).
Enumerated Domain Value: Shrub
Enumeration Domain Value Definition: Mix of shrub species including willow, scots broom (*Cytisus scoparius*) and trees that are less than 7 m in height. An understory of grasses and forbs is present.
Enumerated Domain Value: Shrub wetland
Enumeration Domain Value Definition: Mix of shrub species including willow, scots broom (*Cytisus scoparius*) and trees that are less than 7 m high. The understory vegetation is composed of wetland vegetation such as sedges and rushes.
Enumerated Domain Value: Wooded
Enumeration Domain Value Definition: Mix of deciduous and coniferous trees. Some areas have been planted. These areas are mostly dominated with coniferouse trees including a variety of pines (*Pinus contorta*, *Pinus nigra* and *Pinus sylvestris*) with an understory of scots broom (*Cytisus scoparius*). Naturally propagated areas include species such as spruce (*Picea sitchensis*), shore pine (*Pinus contorta*), and alder (*Alnus rubra*). Understory in these areas range between grasses/forbs and scots broom (*Cytisus scoparius*).
Enumerated Domain Value: Wooded wetland
Enumeration Domain Value Definition: Can have the same canopy as in Wooded category. However, understory vegetation is composed of wetland species such as slough sedge (*Carix obnupta*).
Enumerated Domain Value: Aquatic vegetation
Enumeration Domain Value Definition: Compsed of rooted floating aquatic vegetation such as water lilies (*Nuphar polysepala* and *Nymphaea odorata*).
Enumerated Domain Value: Unvegetated sand
Enumeration Domain Value Definition: Occurs both on the beach and within camp. This comprises the active dune area in the 1939 aerial photos.
Enumerated Domain Value: Developed land

Enumeration Domain Value Definition: All areas that have been build upon and permanently changed from their natural state.
Enumerated Domain Value: Open water
Enumeration Domain Value Definition: Includes lake and slough areas that are devoid of rooted aquatic vegetation.
Enumerated Domain Value: Wastewater facility
Enumeration Domain Value Definition: Included the mixing ponds and impacted grass area surrounding the site.
Enumerated Domain Value Definition Source: Assigned during aerial photo analysis.

Distribution Information

Distributor
Contact Organization Primary
Contact Organization: Oregon Military Department
Contact Address
Address Type: Mailing Address
Address: P O Box 14350
City: Salem
State: Oregon
Postal Code: 97309-5047
Contact Voice Telephone: (503) 945-3851
Contact Facsimile Telephone: (503) 945-3584

Resource Description: Vegetation coverages of Camp Rilea for the years 1939, 1958, 1971 and 1996

Distribution Liability

Standard Order Process
Digital Form
Digital Transfer Information
Format Name: .e00
Format Version Date: 1998
Format Specification: Optional
Format Content Information: spatial
Transfer Size: varies

Metadata Reference Information:
Metadata Date: August, 1998
Metadata Contact
Contact Information

Contact Person Primary:
Contact Person: Greg Mitchell
Contact Address:
Address Type: Mailing Address
Oregon Military Department
P O Box 14350
City: Salem
State: OR
Postal Code: 97309-5047
Contact Voice Telephone: (503)
Contact Facsimile Telephone: (503) 945-3584
Metadata Standard Name: Vegetation Data Coverages Metadata
Metadata Standard Version: 1.1