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Abstract

The McKee Preserve is a new conservation area at Bandon Dunes Golf Resort, located on the southern Oregon coast. The Preserve is 250 acres in size and is made up of 13 different natural resource communities. One important resource is silvery phacelia (*Phacelia argentea*), which is a state threatened plant species and is a species of concern federally. The goal of this project was to perform plant inventories for silvery phacelia and kinnikinnick that will be used to establish a functional management plan for the Preserve. Other resources of interest to the Preserve have been included in the literature review and management plan. A proposed par 3 golf course has also been included in the analysis and management plan of the report. Using Geographical Information Systems and Global Positioning Systems to conduct the silvery phacelia inventory showed that there are 6,803 individual plants at the Resort and 5,078 plants on the Preserve. A silvery phacelia community was found north of Cut Creek, which has not been listed as a historical site for this species. The species most likely established itself through fill materials that were seed rich, when building the second golf course on the property, Pacific Dunes. The kinnikinnick meadows have been reduced from building and opening Bandon Trails Golf Course. The remaining meadows are 1.4 acres in size. The par 3 golf course, if built, will be located in the northern portion of the Preserve and would share access with Bandon Trails Golf Course. Out of the 11 proposed holes, 9 have been approved so that impacts to the silvery phacelia will be minimized.

THE McKEE PRESERVE MANAGEMENT OPTIONS AT BANDON DUNES GOLF RESORT

by

ASHLEY MARIE EDWARDS

A report submitted in partial fulfillment of the
requirements for the degree of

MASTER OF ENVIRONMENTAL MANAGEMENT

Portland State University
2009

Edwards/ii

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Working with the golfing community is something I greatly enjoy and hope to continue in the future. My thanks are extended to Tom Jefferson and Janet Rogers who both showed me around the Resort and provided extensive knowledge about the natural resources on the property and how golf ties into this natural aspect at Bandon Dunes. I also appreciate the funding the Resort provided me during the summer there. Thank you, Tracy Paris, for working in the Preserve with me last summer.

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Introduction

Master's Program Objectives

I started the Masters of Environmental Management (MEM) during the fall of 2007 at Portland State University. A requirement of the MEM program is to complete a project working with a community partner. In my case, the McKee Preserve project at Bandon Dunes Golf Resort fulfills the needs for the degree. Before starting project work at Bandon Dunes, my preferred project would include recreational land management (including working with the public) and Geographical Information Systems (GIS) mapping. During the two year MEM program, class work emphasized land resources and control of invasive species. In addition to completing the MEM class requirements, I fulfilled the GIS certificate requirements from the geography department providing the desired analytical and cartography skills.

The project at Bandon Dunes Golf Resort (Resort) provided the desired mix of skills and learning opportunities for me to complete the MEM project requirement. I found out about the potential project from a member of Orchard Hills Golf and Country Club. After speaking with Tom Jefferson, the supervisor of the McKee Preserve (Preserve), it was clear that the Resort had goals that needed to be completed during the summer of 2008. A major goal for the Resort was to learn more about a state threatened plant, silvery phacelia, that is found on the property. They wanted an extensive inventory of the plants and observational studies to learn more about them. The Preserve is also in need of a management plan that focuses on major goals.

The McKee Preserve project was able to combine previously identified variables (recreational lands, GIS, and working with the public) that I wanted to work with when completing the MEM program. In addition to learning how the Resort functioned, I found it was important to learn how to meet the objectives of the Preserve while not impacting play on the

golf course, an essential task when working at a golf resort. The knowledge gained by the Bandon Dunes project surpassed the initial goals of the project.

The McKee Preserve is a new component at the Resort. Previous reports (Kagan 1994) gave the Resort a baseline of the natural resources present, but they needed a more extensive inventory. This MEM project report presents the results of a plant inventory of silvery phacelia and kinnikinnick, two natural resources found on the Preserve. The Preserve and the Resort also wanted to map several of the natural resources found on the Preserve includes:

- silvery phacelia,
- kinnikinnick,
- port orford cedar, and
- Fahey Lake and Creek.

To bring together the plant inventory and mapping of the listed natural resources, a management plan will be produced to evaluate management strategies for:

- silvery phacelia,
- kinnikinnick,
- port orford cedar,
- Fahey Lake and Creek,
- hiking trails,
- the proposed par 3 golf course.

The Preserve's areas of interest are shown in Figure 1. An additional map of the hiking trails has been included in the management plan as Figure 24.

Figure 1: Areas of interest for the Preserve at the Resort

The Resort

The Resort, located near the small town of Bandon on the Southern Oregon Coast, has three award-winning golf courses, all designed in the links style (Figure 2). The owner, Mike Keiser, sought to build a golf course that would resemble the Old Course at St. Andrews in ruggedness, climate, and playing style. Links golf courses are found along coasts and have rolling hills, few trees, and deep rough (Walter 2006). All of the golf courses at the Resort reflect the owner's preference to the type of golf course style and his desire to create a pure golfing experience (Goodwin 2006).

The first golf course to open at the Resort was Bandon Dunes in 1999. Designed by David McKay Kidd, a Scotsman, this course offers numerous views of the Pacific Ocean and gives every golfer a challenge (Goodwin 2006). Its sister course, Pacific Dunes, opened in 2001

and follows the coastline north of Bandon Dunes. Tom Doak designed this course, also in the links style, but the prevailing winds add another obstacle to the golfer's round (Goodwin 2006). Bandon Trails, the third course at the Resort varies greatly from the previous two golf courses. Designers Coore and Crenshaw wind their golf holes through three different ecosystems and the course has been open for play since 2005. The final golf course at the Resort has yet to open, Old MacDonald, but is scheduled to begin play in 2010. This links course is located northeast of Pacific Dunes and follows the coastline north for several holes. When experiencing golf at Bandon Dunes, guests play the game in the traditional form, meaning golfers walk the courses. Caddies can be hired to provide knowledge and directions around the courses.

The entire Resort is the combination of Keiser's and his partner's, Howard McKee, work and dedication to make the property a destination for golfers worldwide. Keiser involved himself in every aspect of building the golf courses, while McKee designed the Resort's community (Gunther 2007). Figure 2 is a map of the Resort, including golf courses, guest lodging, and other amenities. Also, included in this figure is a location map showing the location of the Resort in the state of Oregon. Bandon Dunes Golf Resort is profitable because of the dedication from Keiser and McKee and the natural beauty of the property even though it is not located near any major city, a potential drawback of this location (Goodwin 2006). While both men appreciated the beauty of the land, McKee, a naturalist, realized the value of the natural resources on the property and established conservation goals in the Resort's master plan (Rogers 2008, H.L. McKee Preserve 2008).

Figure 2: Bandon Dunes Golf Resort Map, insert map is where the Resort is located in Oregon (Bandon Dunes Golf Resort 2009).

Preserve

The H.L. McKee Preserve (Preserve) is located on the southern end of the Resort. The Preserve is a memorial to Howard McKee, Keiser's partner in developing and building the Resort. McKee lost his battle with cancer December of 2007, encouraging Keiser to establish and fund the Preserve in memory of his late partner. The initial master plan for the Resort

dedicated a portion of the resort to natural area. The Preserve has been established as this natural area; it is 250 acres (the entire Resort is 2,400 acres) and is home to important natural resources. However, many of these resources are competing directly with invasive species that can alter habitats and can out compete native species. Legally the Preserve has been established as a natural area that has no further development occurring on these lands (Rogers 2008).

The Preserve is home to many different plant communities. Found on the Preserve are several types of wetlands, open sand dunes, Cut Creek and its delta, kinnikinnick meadows, and different types of forest. The locations of these resources are provided in Figure 3, showing the complexity of these natural resources and how Bandon Trails golf course interacts with them. Out of the identified communities, silvery phacelia is a state threatened species (Oregon Natural Heritage Information Center 2007), kinnikinnick is of concern on the Resort, and remaining communities are species of concern to the Resort. Mixed among these resources are invasive species that can cause drastic impacts to these native resources (H.L. McKee Preserve 2008).

Figure 3: Map of plant communities found on the southern part of the Resort, including Bandon Trails Golf Course and the McKee Preserve (H.L. McKee Preserve).

The Preserve is open to any guests and visitors to the Resort. Currently there are hiking trails that allow these individuals to see the different wetlands, forests, and open dunes found on the Preserve. The southern portion of the Preserve is less accessible because there are no roads or hiking trails.

Keiser purchased this coastal property for a golf resort and it will continue to operate with golf as its main purpose. The addition of the Preserve to the Resort will help to protect natural resources but it will be second to golf, which is the Resort's main enterprise. However, the Resort has always operated in an environmentally conscious manor due to the influence of McKee and his views on the natural environment.

Preserve Objectives

The motivation for the Resort in establishing the Preserve is to have a memorial for McKee and to protect rare natural resources on the Resort. The Resort also wants to gain knowledge of the natural resources found on the Preserve, particularly the silvery phacelia population. Establishing an accurate inventory of silvery phacelia, its extent, and learning more about the species is important to the Preserve and the Resort. The goal of this MEM project is to produce viable management suggestions for the Preserve. These management suggestions will identify the most critical natural resources and provide ways to manage the land for the needs of these resources. The spatial extent and population of two plant species will be evaluated in detail. The resulting suggestions will focus on the key habitat areas for the species of concern, improvements that could be made on the hiking trails that are already present at the Resort, and potential impacts of a proposed par 3 golf course on the Preserve.

A long-term goal for the Preserve is to continue to gain knowledge about the threatened silvery phacelia plant, through experiments and available research. The inventory conducted will

be used as the base population number for future analysis. At this time, the species is only threatened at the state level which does not require permits to study the plants (Oregon Natural Heritage Information Center 2007).

Species / Areas of concern Background

The Preserve encompasses many different natural resources (Figure 2). The open dune sheet and the associated deflation plain is the largest ecosystem in the Preserve. Several independent wetland complexes, forests (shore pine, Douglas fir, and port orford cedar), kinnikinnick meadows, Cut Creek and its delta, Fahey Lake, and Fahey Creek are also found on the Preserve. Four natural resources of interest will be discussed: silvery phacelia (*Phacelia argentea*), Kinnikinnick meadows (*Arctostaphylos uva-ursi*), Port Orford Cedar (*Chamaecyparis lawsoniana*), and Fahey Creek.

A. Silvery phacelia (*Phacelia argentea*)

Figure 4: Silvery phacelia (*Phacelia argentea*)

The common name for *P. argentea* is silvery phacelia, given to the plant because the leaves appear silver in color due to the appressed hairs producing this color (Brian 2006). Deep veins are prominent on the leaves as well (Brian 2006). This is a perennial evergreen herb that produces decumbent stems forming a mat on the sand dune (Brian 2006). Given these

characteristics, silvery phacelia is easy to recognize in the field. Flowers are present May through August and the plant produces fruit June through August (Brian 2006). Flowers are white to cream in color with five exserted stamens in a rounded head formation at the tips of the stems (Brian 2006). Pollination by the leafcutter bee (*Anthidium palliventre*) and the bumble bee (*Bombus*) is needed for successful seed production (Rittenhouse 1994). Silvery phacelia is an early successional plant from the dune mat community. It, also, has a low fecundity rate, producing only one seed per capsule (Rittenhouse 1994).

This plant species has a very narrow habitat range, extending from Del Norte County, California north to Coos County, Oregon (Brian 2006). The federal government considers this a 'Species of Concern' but it does not receive any protection (Oregon National Heritage Information Center 2007). The U.S. Fish & Wildlife Service considers this species a 'Species of Concern' and the Bureau of Land Management views it as a 'Sensitive Species' (Kalt 2008). The Oregon Department of Agriculture has listed silvery phacelia as a threatened species and in California it is defined in the California Natural Diversity Database as rare, threatened, and endangered species (Kalt 2008). In the 2008 survey, 30 populations of silvery phacelia were observed, 26 of which are located in Oregon with the remaining 4 found in California (Kalt 2008). Within this range, the plant is found on coastal sand dunes (Rittenhouse 1994). Most of the 130 miles of shoreline habitat for silvery phacelia is unacceptable for the species due to the lack of free moving sand (Rittenhouse 1994). Rittenhouse (1994) showed that silvery phacelia can be found above the high tide line or on partially stabilized sand dunes farther inland. Figure 5, shows a typical dune profile consisting of foreshore, backshore, foredune, and interdune. Overlaid on the image are areas where silvery phacelia are typically found.

Figure 5: Dune profile, silvery phacelia is usually found in the foredune region and can include parts of the backshore and interdune area (O'Connell 2000).

The active dune sheet on the Resort is affected by seasonal winds. Dune formation is directly related to these winds (Wiedemann and Pickart 1996). Vegetative communities are present on dunes and are affected by stability and the amount of water present (Wiedemann and Pickart 1996). These authors (1996) also explain that the typical community types found on dunes are seral meadow, shrub, and forests. The dunes at the Resort and on the Preserve are winter transverse dunes that are the result of winter winds (Wiedemann and Pickart 1996). This type of dune system can be up to 60 meters tall and extend up to 2000 meters long, and 300 meters spacing between these dunes is typical (Wiedemann and Pickart 1996). Winter transverse dunes are shown below in Figure 6.

Figure 6: Winter transverse dune photograph (Wiedemann and Pickart 1996)

The Preserve is home to the world's largest known population of silvery phacelia. Out of the limited range of this species, this is also the northern most occurrence (Kalt 2008). Kalt conducted the Federal Status Review of silvery phacelia in 2008. The results of this limited survey are shown in Figure 7. The eight points shown represent silvery phacelia locations.

Sand Dune Phacelia (*Phacelia argentea*) at Bandon Coastal Property, Bandon, Oregon. June 29, 2007.

Figure 7: Kalt's prelim map of silvery phacelia

Silvery phacelia is part of the native dune mat community. On the Preserve, many dune mat species are found in close association with silvery phacelia: yellow sand verbena (*Abronia latifolia*), beech knotweed (*Polygonum paronychia*), beach lupin (*Lupinus littoralis*), European beachgrass (*Ammophila areanaria*), and others (Brian 2006, Rittenhouse 1994). The dune mat community is adapted to the seasonal sand movement; winter and summer winds dictate dune migration found throughout the west coast (Widemann and Pickart 1996). Threats to silvery phacelia include coastal development, recreational vehicles, harm from livestock, and loss of pollinators (Brian 2006). Brian (2006), also showed that a low reproduction rate can negatively affect the population size of silvery phacelia. A major threat to the species is habitat loss due to

invasive plants, particularly European beachgrass (*A. areanaria*) and gorse (*Ulex europaeu*) (Kalt 2008).

European beachgrass, native to Europe, has been used in coastal regions all over the world as a dune stabilizer, which is the reason it was brought to the United States (NPS 2001a). It was extensively planted in coastal zones from 1868 through the 1960's to halt sand movement (Wiedemann and Pickart 1996). In addition to stabilizing dunes, colonization of European beachgrass has lead to a reduction in recreational areas by changing the landscape of the dune systems (USDA Forest Service 1994). This species is able to stabilize sand very effectively, allowing less seasonal sand movement and changing the native habitat for dune mat plant species and native shore birds (Wiedemann and Pickart 1996).

The addition of European beachgrass to coastal areas has influenced the habitat of native plant communities as well as the dune systems in which it establishes itself. On a large scale, the species is able to change the morphology of the dunes. First, European beachgrass has the ability to bind sand in greater quantities than native species (D'Antonio and Vitousek 1992). This is shown in Figure 8 part a, on the left side is the typical sand binding patterns of a native sedge (*Desmoschenus spiralis*) native to New Zealand. Sand is being bound closer to the sedge allowing for open sand movement away from plants. This is in comparison to the right side of this figure, showing how European beachgrass binds sand in greater quantities and at a greater spatial extent. Because of this sand binding ability, the species is able to change the foredune formation. Native foredunes have a gentle slope and are partially open allowing sand movement inland (Russo et al. 1988). Foredunes invaded by European beachgrass are steeper and taller than those inhabited by native species as seen in Figure 8 part b, as the foredunes change they lose the sand blowout areas allowing sand to move inland (Hilton et al. 2005). This ability of

beachgrass to change the native foredune community to one of a monoculture could lead to extinction of the native community (not necessarily the individual plants in the community) (Wiedemann and Pickart 1996). With an increase in the height of the foredune, the dune ecosystems are in danger of dying because there is no new sand being added to the system (Wiedemann and Pickart 1996). These active dunes will become stable without the input of new sand. They will become vegetated resulting in a loss of their scenic value and a reduction in their recreational purposes (Wiedemann and Pickart 1996). The addition of European beachgrass to coastal areas has the ability to influence the habitat of native plant communities as well as the dune systems in which it establishes itself (shown in Figure 9a and 9b).

Figure 8a: Sand binding properties of European beachgrass (represented by triangles) and a native sand binding sedge (*Desmoschenus spiralis*) shown by circular points from New Zealand (Hilton et al. 2005).

Figure 8b: Demonstrates how European beachgrass can change the height of foredunes by making them steeper and not allowing sand past the plants (Hilton et al. 2005).

The primary method of dispersion once the European beachgrass becomes established is by rhizomes. Rhizomes will spread both vertically and horizontally, so the spread of the species is very fast given the rhizome productivity (Aptekar and Rejmanek 2000). In addition to the underground activity, the grass also produces flowers, by which the seeds are able to propagate (Pickart 1997). The grass is stimulated when buried by loose sand, increasing growth rates (Pickart 1997). European beachgrass has become a naturalized species in Northern California. Buell et al. (1995) were able to show that the percent cover on the North Spit of Humboldt Bay increased by 574% between 1939 and 1989. The species is also able to expand its range with the help of ocean currents. Studies have shown that the dormant rhizomes can travel to new beaches and still have buds that are able to produce plants (Wiedemann and Pickart 1996). With the accelerated reproduction rate of this invasive, a limiting factor for European beachgrass is high levels of salt in the soil (Aptekar and Rejmanek 2000).

Figure 9a: European beachgrass and silvery phacelia habitat

Figure 9b: European beachgrass in dune sheet

In the northern range of silvery phacelia's habitat, gorse (*Ulex europaeu*) poses a threat to viable habitat. Gorse is native to Western Europe and forms dense impenetrable stands that can grow up to 5 meters in height (Coombs et al. 2006). Introduction of gorse in the Bandon region was by George Bennett, an Irishman, in 1873 (Goodwin 2006). After Bennett's introduction of

the plant, it spread throughout the region. Gorse is flammable, it contains an oil content of 2 – 4% (Coombs et al. 2006). The town of Bandon experienced first hand the flammability of gorse, when a fire fueled by this invasive plant in 1936 burning the town and killed 13 people (Coombs et al. 2006, Goodwin 2006).

These stands are a serious threat to many native species due to gorse's ability to alter the surrounding habitat including the soil characteristics (Ditomaseo et al. 2006). As gorse moves into a region, it will consume all available resources, outcompeting any natives that might be present displayed in images 10a and 10b (Washington State Weed Board 2007). The aggressive ability of gorse to invade will greatly impair the survival of silvery phacelia. The decrease of silvery phacelia will occur because of the low fecundity rate and its inability to compete directly for resources with gorse (Rittenhouse 1994, Washington State Weed Board 2007).

Figure 10a: Gorse found along Beach Hiking Trail

Figure 10b: Gorse surrounding trail marker post

Known Occurrences

The majority of the silvery phacelia population is located in the designated Preserve land. However, individuals and small clusters of plants are located on three of the golf courses and in flowerbeds around the Resort. While plants do occur in other locations, the critical habitat is in the open dune sheet, which is mostly southwest of Bandon Trails (Jefferson 2008). When

discussing the silvery phacelia population, it is in regards to the plants found in the Preserve habitat. The active dune sheet moves to a point, the southern ridge above Cut Creek, which is an important juvenile site of silvery phacelia.

B. Kinnikinnick Meadows (*Arctostaphylos uva-ursi*)

Figure 11: Kinnikinnick (*Arctostaphylos uva-ursi*)

Kinnikinnick is extensive throughout North America and is found in many different forest types. This understory species associates with many different kinds of trees. In the northwest it is typically found in conjunction with Douglas-fir forests (Crane 1991). On the Preserve, kinnikinnick is found in association with red fescue (*Festuca rubra*), shore pine (*Pinus contorta*), and Douglas fir (*Pseudotsuga menziesii*) (H.L. McKee Preserve 2008).

Kinnikinnick is an evergreen species that produces many trailing branches resulting in dense mats, and small dark green leaves that are leathery in texture (Crane 1991). Bright red flowers are produced prior to fruit (Crane 1991). Bears eat the fruit leading to the common name, Bearberry. In addition to generating fruit, kinnikinnick is able to reproduce from stolons, producing roots at nodes allowing for greater dispersal during the growing season (Crane 1991). This species is readily found in areas with substrates that have fast drainage or sandy soils (Crane 1991).

One of the common plants kinnikinnick is associated with is red fescue. Historically, red fescue was found throughout the southern Oregon coastal region. It is an early dune succession species (H.L. McKee Preserve 2008). Meadows of red fescue can persist for many years before moving to the next sucessional stage, typically kinnikinnick (Kagan 1994). The process of succession on southern Oregon dunes is red fescue, kinnikinnick, hairy manzanita (*Atctostaphylos columbiana*), and ending with shore pine producing a forested environment (Kagan 1994). The association between shore pine and kinnikinnick, and red fescue and kinnikinnick, is now rare on the coastal landscape (Kagan 1994). These plant relationships are rare due to the plantings of European beachgrass and other invasive species found in the coastal region (Kagan 1994).

Known Occurrences

The natural occurrence of kinnikinnick is between an ancient, now stabilized, sand dune and the western side of the active dune ridge. This is now a highly fragmented area; Bandon Trails has several golf holes moving through this location and South Bandon Dunes Drive (the Resort's access road) divides the meadow area. In addition to the meadows formed by kinnikinnick, two separate wetland complexes are present, and mixed forests are found along both dune ridges.

The possible historic extent of kinnikinnick is greater than what is seen today (Figure 12). Although this extent would not have been continuous, it would have been broken up with red fescue, hairy manzanita, and shore pine. The current extent of kinnikinnick is displayed in Figure 12 as an overlay, which shows that the resource has been greatly reduced by eight golf holes. Rogers (2008) indicates that only a fraction of the original meadows are present today. The remaining meadows are interwoven in this area and can continuously be impacted by golf

play. While kinnikinnick is not threatened on a large scale, it is, however, threatened locally on the Preserve by golfers.

Heavy foot traffic by golfers and caddies can cause damage to kinnikinnick plants. Jefferson was able to show where kinnikinnick plants were planted along bunkers and greens of golf holes. But the plant is not able to survive with heavy foot traffic from golfers. Prior to opening the golf course, nursery stock kinnikinnick was planted around the course's bunkers. Since play began at Bandon Trails, many of these plants have since died due to golf play (Jefferson 2008). A decline of kinnikinnick has been observed only in these localized bunker areas and in areas where there is increased foot traffic.

Figure 12: The remaining kinnikinnick meadows in yellow, possible historic extent of species in orange (Rogers 2008).

C. Port Orford Cedar (Chamaecyparis lawsoniana)

Port orford cedar has a relatively small habitat range, found throughout southwestern Oregon and the northern part of California (Jules et al. 2002). The trees are specific in their moisture requirements resulting in a limited distribution. Winters in this area tend to be cool and wet while the summers are warm and dry (Jules et al. 2002). Since the summers tend to be dry and port orford cedar prefer to have water available throughout the entire year, they are generally found in areas close to streams or rivers (Jules et al. 2002).

These trees have a high economic value on the export market. Because of this demand, port orford cedar has been heavily logged and the remaining populations are threatened by disease (H.L. McKee Preserve 2008). The Resort is home to one remaining old growth stand of port orford cedar. The stand is a small but a high quality example of this type of old growth forest (Kagan 1994).

The biggest threat to port orford cedar is a water mold (root rot, *Phytophthora lateralis*) that has the ability to kill the host. The fungus has zoospores that are distributed through water and infect the host through contact with its roots (Jules et al. 2002). Once the tree is infected, death can occur as quickly as one to four years in larger trees and as little as two to three weeks for seedlings (Jules et al. 2002). To move into different watersheds, the disease requires the help of chlamydospores (a resting spore), which are tolerant to drier conditions and are able to be transported in mud or organic matter (Jules et al. 2002). Spread of the fungus over landscapes can take place primarily in two ways, one being the use of mechanized equipment associated with logging, and the other minor cause of spread is by foot traffic (Jules et al. 2002, H.L. McKee Preserve 2008). Foot traffic includes human (hikers and workers in forested environments) as well as wildlife and domestic grazers. Logging equipment and foot traffic can

carry the disease to new areas by driving or walking on infected soils and not cleaning equipment or shoes before moving to a new unaffected site (Jules et al. 2002). Moving on its own, the fungus can infect new areas by flowing downstream with water currents. Zoospores are not able to move upstream a significant distance so new infections will be downstream or downhill from roads or infested locations (Jules et al. 2002).

Known Occurrences

The stand of port orford cedar is located on the southern part of the Preserve. The stand continues into Bullard Beach State Park, the Resort's immediate neighbor, however the majority is located in the Preserve. Given port orford cedar's preference to high water availability, the stand is just east of a wetland complex (H.L. McKee Preserve 2008). Because of the port orford cedar susceptibility to root rot, access into the stand is highly limited and not encouraged among Resort guests. Figure 13 indicates the area where the stand is, however no GPS position locations were taken for this resource, because the Resort wants to limit knowledge of it.

Figure 13: The location of the Port Orford Cedar on the Preserve

D. Fahey Creek

Figure 14: Southern end of Fahey Lake and beginning of Fahey Creek

Fahey Creek flows out of Fahey Lake, and both features are located in the southeastern part of the Resort, shown in Figure 1. Fahey Creek flows out of the southern end of the lake and

the creek is a tributary to the Coquille River, which empties into the Pacific Ocean just south of the Resort. The eastern shore of the lake is home to a residential community, which is not affiliated with the Resort in any way. In contrast, the western shore of Fahey Lake is undeveloped and surrounded by mixed forest species. These mixed forests continue as the creek flows out of the Preserve and the Resort.

Many native fish species have not been able to utilize this creek for some time, due to the culvert under Highway 101, which acts as a barrier. Historically, this creek was used by salmonidae species for spawning, currently native cutthroat use the stream (H.L. McKee Preserve 2008). The Preserve is working with Oregon Department of Transportation (ODOT) and U.S. Department of Fish and Wildlife (USFWS) to find ways to successfully remove the culvert for fish passage. A fish ladder is needed on the Preserve so that fish can move above the creek's falls. To do this, the Preserve would be working in conjunction with nearby Bandon Marsh National Wildlife Refuge, which is currently working on a large estuary restoration project (Rogers 2008). Providing a way for fish to enter the creek is just one step in the restoration process, and studies indicate that the general health of the forest surrounding a creek plays a role in salmon viability (Russell 2009).

Two main types of invasive species surround Fahey Creek. The invasive English ivy (*Hedera helix*) is found along the creek, and has the potential to harm riparian areas and the trees it infects (Swearingen and Diedrich 2006). English ivy is native to Europe and surrounding regions (Schnitzler and Heuze 2006). This is the only area on the Resort where English ivy is found, having escaped from the nearby homestead site (Rogers 2008). Since the distribution of this species is limited, eradication is possible if the homestead site is also contained. In addition to English ivy, Scot's broom (*Cytisus scoparius*) is found in abundance along the creek. The

native range for this species is Western Europe and has been imported to many countries worldwide (NPS 2001b). Scot's broom invades previously disturbed habitats and is commonly found along roads (Coombs et al. 2006). In the riparian zone along Fahey Creek, this species has the ability to form areas of monocultures that force out natives (NPS 2001b).

Methods

Plant Inventories

To conduct the silvery phacelia inventory, a Garmin HCx etrex Global Positioning Unit (GPS) was used. This is a midline recreational GPS unit that was used to collect positional data on silvery phacelia. A minimum of four satellites were used for the inventory, allowing for the most precise locations. The accuracy of this Garmin GPS unit is approximately nine feet, resulting in any individual plants falling in that radius to be counted as the same location. Due to the accuracy of the GPS, one latitude longitude coordinate can represent more than one silvery phacelia plant. A single silvery phacelia, completely surrounded by sand, was categorized as one individual plant. The number of plants within a 9-foot radius was recorded. To produce the most accurate latitude and longitude reading, a minimum of 50 point locations were used when collecting positional data in the WGS84 datum. Each of the 50 points consists of one-second GPS data, which includes latitude and longitude location and its specific time. Using a large number of points increases precision when averaging all point locations to get the overall coordinates.

The entire Resort was investigated for any occurrences of silvery phacelia. I walked the active dune sheet from south to north, in a zig-zag west to east orientation, and plants were inventoried as they were encountered. Portions of the dune sheet that are heavily invaded by

European beachgrass received a less thorough search due to silvery phacelia's inability to compete for resources with this invasive species. Because of this competition silvery phacelia are smaller and hidden by dense stands of European beachgrass.

After collecting point information on the silvery phacelia population, data was saved in an Excel spreadsheet. All of the data from the spreadsheet was imported into ArcGIS, version 9.2 (proprietary ESRI software) as the attribute table for the silvery phacelia locations. Due to the accuracy of the GPS unit being nine feet, the number of plants in any given location can be found in the GIS attribute table. As a result, each point has a number of plants associated with each set of coordinates. Latitude and longitude coordinates were then converted from degree minute seconds into decimal degree coordinates, allowing the information to be displayed spatially in ArcGIS. Prior to this step, the Excel spreadsheet was saved as a database file (.dbf) format, which can be imported into a personal geodatabase and added to an ArcMap (.mxd) window. After pre-processing the data, a spatial location was assigned to all locations using decimal degrees coordinates in the WGS84 datum. Data was then projected into Harn International Feet State Plane Oregon South to overlay correctly with additional GIS data.

Observational Studies of Silvery Phacelia

In addition to collecting an inventory of silvery phacelia, transect and several experimental plots were set up in the Preserve. Transects are being used to evaluate how silvery phacelia responds to a higher rate of foot traffic and close proximity to Bandon Trails Golf Course. Test plots of silvery phacelia were established to evaluate the plant's reaction to different inputs. The Preserve team (Resort employees working on the Preserve) will monitor these experiments and document any changes to the plants along transect or in the test plots.

Four transects were set up in different areas to study the occurrence rate of these plants in viable habitat areas. These transects will also be used to see how silvery phacelia responds to competition (European beachgrass) or if the plants are producing viable seedlings in the area. Monitoring of transects will take place four times a year or seasonally, and picture records will also be taken to visually see how silvery phacelia responds to competition. Two transects were placed among golf holes on Bandon Trails to determine survival rate of silvery phacelia around higher volumes of foot traffic. The remaining two transects were set in high quality silvery phacelia habitat in the dune sheet. The length of all transects was 99 feet and plant species were recorded every 3 feet along the tape. Wooden stakes were used to indicate transect start and end points, and GPS location positions were taken at each boundary.

To increase knowledge about this species the Preserve team set up three different types of test plots to see how silvery phacelia would react to different environmental conditions. All plots have recorded locations with the same Garmin GPS receiver that was identified above. The first plot, set up in prime habitat conditions, evaluates the survival rate of silvery phacelia given the removal of European beachgrass. This plot was randomly chosen because the aspect and slope were roughly equal in both the control and the treatment areas. This test plot consists of a control and treatment plot that is 50 feet by 50 feet and was known to have both species established. Also, the plots contained a representative sample of the dune mat community found on the Preserve. A percent cover of European beachgrass was found in both plots before any manual removal of the invasive species. Using a 3 feet by 50 feet sections and manually establishing the number of European beachgrass clusters present in each section was used to determine the percentage cover of the invasive species in both sections of the test plot. These numbers were used to find the total percent cover of European beachgrass for each plot. Manual

removal of European beachgrass was performed in the north plot (treatment) to see how silvery phacelia thrives without competing with the invasive species for resources. The southern plot (control) has been left alone so that a direct comparison can be made on the silvery phacelia in a localized environment.

The second test plot is investigating if human planted seeds would produce viable seedlings of silvery phacelia. This was a much smaller test plot, 9 feet by 9 feet, located immediately south of the first experiment. Hundreds of seeds from silvery phacelia plants were collected and dried overnight on paper. After drying the seeds, they were planted at a shallow, moderate, or deep depth at laterally spaced intervals of three, six, or nine inches. Starting during spring, this plot will be monitored visually for new plants every two weeks.

The final set of test plots evaluated how silvery phacelia reacts to irrigation. This final observational study consists of four irrigation test plots, two that receive treatment and two that do not receive the treatment. It has been observed that silvery phacelia plants are found along the boundary of the first tee box of Bandon Trails. The sandy fill used to build the tee probably had viable silvery phacelia seeds in it. These plants are thriving even though they are found amongst dense stands of European beachgrass. The survival of these plants amongst the European beachgrass could be due to the increased water resources available (from irrigation) in this location. Two different observational experiments were set up as a result of these observations. The first one, consisting of an experiment and a control plot is located at the juncture of Bandon Trails first tee box and the beach access hiking trail. Both plots were set up with similar slope and aspect and were 9 feet by 18 feet. For this experiment, Bandon Trails irrigation resources supplied water. A previously installed irrigation head (that was not currently being used for the golf course) was used to water the silvery phacelia in the desired locations. A

sprinkler head, with a 360° radius and a 65 foot range, has been watering the test plots. Before starting the treatment at either plot, the baseline number of silvery phacelia was recorded along with their size. Using the irrigation computers, a program was written to water the experimental plots for 12 minutes each night, while the control plots did not receive any water. The second sets of irrigation experimental plots were set up near the seed stock nursery for Bandon Trails, which is located east of their second golf hole. The methodology for conducting the experiment was the same as the irrigation plots discussed above.

Initial observations were recorded for the experiments. Appendix C shows the mapped locations of transects and the different experimental plots. Ongoing monitoring and data collection will be provided by the Preserve team and will not be included in the results of this paper.

Kinnikinnick Meadows

When determining the current extent of the kinnikinnick the same Garmin GPS unit was used. Methods of acquiring point locations were the same as described above. In this case, it was impractical to collect individual plant locations given the ability of this plant to produce a continuous ground cover. Point location information was collected and used to create polygons in ArcGIS and used to find the current area associated with kinnikinnick. Data for kinnikinnick was imported into ArcGIS and displayed in the same manor discussed above.

GPS locations were used to determine the remaining kinnikinnick acreage. However, GPS locations were collected in degree minute second format and had to be converted into Universal Transverse Mercator (UTM) coordinate system to find the area. Finding the change in x and the change in y was the next step. The next calculation is $(x\Delta y - y\Delta x) \cdot 0.5$ to find the total area in feet squared. To find the total amount of kinnikinnick at the Resort, the final figure was

divided by 43,560 ft² to calculate an acreage amount (University of Kentucky viewed August 2008). This methodology was used to determine the acreage of the current kinnikinnick meadows.

Fahey Lake and Creek

GIS data for the lake and stream was available from 3Di West located in Eugene, Oregon. This company has previously performed surveys on the Resort and has an extensive GIS database available. Resort files were provided in ArcGIS shapefile format merging seamlessly with data collected by the Garmin GPS unit.

Results

A. Silvery Phacelia (Phacelia argentea)

The population of silvery phacelia is centered near a partially stable sand dune, located near the junction of the dune and ridge hiking trails that the Preserve maintains. The location of the weighted mean population is at 43° 10'56.753"N and 124°23'37.126"W, shown below as a purple circle in Figure 15. After conducting the silvery phacelia inventory at the Resort, the number of plants was much higher than the limited survey conducted by Kalt (2008) for the federal status review. Several of the points collected from Kalt's 2008 status review overlap with major population areas found through the Preserve's extensive survey. To compare the inventory results with Kalt's survey, Figure 16 has both data points overlayed together. Kalt's points, in yellow, mostly overlap with the inventory results. Both surveys are able to show a significant number of plants found in the area where the par 3 course has been proposed.

The total number of silvery phacelia plants found on the Resort is 6,803 individual plants. The majority of this population is located in the Preserve, 5,078 individual plants. The next

largest grouping of silvery phacelia is found on Bandon Trails with 1,263 plants followed by Pacific Dunes 420 plants, Bandon Dunes with 27 plants, and no plants were found at this time on the partially constructed Old MacDonald course. Figure 15 shows the overall distribution of silvery phacelia on the Resort. Figure 17 illustrates the frequency of location points (plants found within a 9 foot radius). This figure suggests that there are a larger number of individual plants than previous surveys of this plant at the Resort have indicated.

The results from the inventory show silvery phacelia communities located north of Cut Creek, displayed in Figure 18. This population north of Cut Creek is made up of 447 individual plants. Rogers and Kalt were both unaware of any silvery phacelia plants found north of Cut Creek, which was considered a barrier. This group of plants is located among golf holes on both Bandon Dunes and Pacific Dunes.

Figure 15: Point locations of silvery phacelia and the weighted mean location for this plant species

Figure 16: Silvery phacelia locations overlaid with Kalt's survey

Figure 17: Frequency of plant occurrences on Bandon Dunes Golf Resort

The migration of silvery phacelia north of Cut Creek is important, because this has not been identified as a historical site for this species. Humans most likely influenced the plant's movement north specifically by moving fill material. Most likely fill material that contained a seed bank of silvery phacelia was used when constructing Pacific Dunes resulting in this new plant population. Plants found along Bandon Dunes, probably had a similar migration (through the construction material for building Pacific Dunes or Bandon Dunes) as they are found on the boundary between the two courses. The group of silvery phacelia at Pacific Dunes is producing juvenile plants. Figure 18 shows the extent of silvery phacelia plants on Pacific Dunes and Bandon Dunes.

Figure 18: The silvery phacelia location on Bandon Dunes and Pacific Dunes, north of Cut Creek

Another significant finding was along the irrigation pond of Bandon Trails. Several silvery phacelia plants were found at this location, in an area that was previously forested. Likely, these plants resulted from the movement of fill inland when building the golf course. Figure 19 shows the distance these plants are from the dune area. These plants are an area that was historically forested, which is another indication that they were moved into this area recently.

Figure 19: Bandon Trail Irrigation pond

B. Kinnikinnick Meadows (Arctostaphylos uva-ursi)

Kinnikinnick is currently found in several individual locations around the eight golf holes fragmenting the meadow community. The remaining habitat for kinnikinnick is 1.4 acres. This area has reached a new equilibrium with the foot traffic from golfers and should be able to

persist at this level (Jefferson 2008). Figure 20 shows how the meadows have adapted to areas where golf course management occurs.

Figure 20: Current kinnikinnick areas

C. Port Orford Cedar (*Chamaecyparis lawsoniana*)

Minimal data was collected on the port orford cedar stand. This is an old growth stand and does not need active management (Kagan 1994, H.L. McKee Preserve 2008). The stand appears to be in good condition and has not been infected with the fungus at this time (Paris 2008). Although, the fungus could become a problem in the port orford cedar stand since other individual trees have been affected on the Resort's property. In particular, the fungus has killed port orford cedar trees around The Grove Suites (guest lodging).

Further assessment of the port orford cedar will take place during the summer of 2009. Jerry Becker from Elk River Land Trust and Dave Imper from USFWS in California, will be visiting the stand to determine the health of the trees and the monitoring that is needed (Rogers 2008).

D. Fahey Creek

Results for Fahey Creek will be ongoing. A Restoration effort for the Creek is dependent on the Preserve and their agency partners. The first restoration step would be removing the culvert under Highway 101 with ODOT and USFWS. The next major step in the restoration process will be to add a fish ladder at the stream's falls, with the help of Bandon Marsh National Wildlife Refuge. Finally, the Preserve teams should continue to remove invasive species along the stream's riparian area. The GIS location for the stream was identified by 3Di West, a consulting firm located in Eugene, Oregon.

Figure 21: Fahey Lake and Creek connecting to the larger watershed

Preserve's Par 3 Golf Course

A par 3 golf course, located on the Preserve, has been proposed. The addition of a par 3 golf course is a logical extension of the Resort. Construction of a golf course on the Preserve is not currently in agreement with its legal status. Keiser anticipates if the course is built, that a portion of the revenue from the par 3 will be used to fund other restoration efforts on the Southern Oregon Coast (Rogers 2008). A change in the legal status would need to be approved prior to the Preserve building the course in the northern section of the dune sheet.

Designers Coore and Crenshaw returned to the Resort to find a potential routing for the Preserve's par 3 course. The course would be located in the northwest part of the Preserve, sharing access with Bandon Trails Golf Course. The area where the course would be built is

shown in Figure 1 in the introduction. The initial Coore and Crenshaw routing had eleven holes and two possible loops guests could choose to play. However, this plan is impractical for several reasons. First, one loop goes into Bullards Beach State Park, which does not follow the park's land use requirements. As a result, this loop was removed from consideration. Secondly, the other loop incorporates part of Cut Creek Delta, which is highly invaded by gorse and is currently impenetrable. Finally, two holes are located in juvenile silvery phacelia habitat that should not be disturbed.

Coore and Crenshaw use a minimalist philosophy when building any golf course. They prefer to move the smallest amount of dirt possible, instead allowing the land to dictate where the golf holes are located (Coore 2008). These ideals are clearly shown in their design at Bandon Trails, as the golf holes visually fade into the background. This is unlike most manicured courses where the golf holes stand out. Utilizing this design team will also help to minimize both visual and plant impacts to the Preserve land during the construction phase.

The proposed par 3 would be located on the western boundary of Bandon Trails. Several holes would be in close proximity to Bandon Trail's first hole. Having the par 3 located close to Bandon Trails will reduce construction impacts. Since the course will be located on the Preserve, it can be used as a platform to educate guests on the natural resources found on the Resort, the threats to these resources, and what individuals can do to help reduce impacts to these resources. Through these education efforts, guests can see first-hand how the Resort, and the Preserve in particular, are working to become environmentally and socially responsible.

GPS positions were taken using the Garmin handheld device for the proposed eleven holes in Coore and Crenshaw's routing. The locations of the greens and tees were gathered in the same way described in the methods. Lines were digitized in ArcMap to denote where the

fairway will be, yellow circles represent tee boxes, and yellow flags represent greens. The routing for the Preserve's proposed par three golf course is shown in Figure 15. All eleven holes have been included in this figure along with silvery phacelia plants found in this location.

Figure 22: Coore and Crenshaw routing with silvery phacelia

Building a 9 hole golf course will impact silvery phacelia plants found in the northern part of the Preserve. Three holes will have a substantial impact on juvenile plants. Construction has the potential to harm other silvery phacelia plants, as well. Figure 22 also shows the point locations of silvery phacelia overlaid with the locations of the golf holes. When looking at the impacts to the silvery phacelia population from the proposed par 3 course a 100 yard buffer is being used. This buffer extends away from the digitized fairway line 100 yards. Using the original 11 hole design by Coore and Crenshaw, the impacts to the silvery phacelia population is

2,504. In comparison, removing two holes (#10 and #11) will reduce the number of silvery phacelia plants impacted to 2,068, however this is not a considerable difference. Another option would be to remove holes 1 and 11 from the routing, replacing the 10th hole as the first hole. This 9 hole course has the potential to impact 2,013 plants. Through the impacts are still large, it does affect the smallest number of plants out of these three options. This is a 20% smaller impact than the original proposal of 11 holes.

These values represent the maximum number of plants that could be disturbed. This par 3 course will have designated tees and green with limited turf (fairways) areas in between. The average width of a par 3 hole at the Resort is 30 yards (Jefferson 2009). Given the much smaller width of fairways, the impacts to silvery phacelia on the par 3 course would be much smaller than the estimates above. Non-turf areas will be left as open sand areas to promote the native dune mat community (Jefferson 2009). The suggested par 3 routing for the Preserve is shown in Figure 23. The suggested changes would reduce additional impacts to the silvery phacelia in this area. A major goal of the Preserve is to protect the habitat for this plant, and converting a large amount of known habitat into golf holes goes against this goal. The other holes proposed in Coore and Crenshaw's routing have minimal impacts on the silvery phacelia population. These other holes will help remove areas infested with European beachgrass.

Figure 23: Revised par 3 hole locations, removed #1 and #11 and would change #10 into the first hole

McKee Preserve's Management Suggestions

Of the natural resources that are found throughout the Preserve, three sensitive resources come into contact with people, either employees or guests, on a regular basis. To minimize the influence of people to silvery phacelia, kinnikinnick, and Fahey Creek, the Preserve team should educate guests and employees on the dangers of harming the resources. Due to the threats of introducing a fungal pathogen (*Phytophthora lateralis*) to the Port Orford Cedar stand, only invited individuals should be allowed to visit the stand. To ensure the survival of these resources, several steps must be taken: the preferred habitats of the species need to be protected, invasive

species encroaching on the resources of interest need to be removed, and employees and guests must be educated about these resources of interest.

Management for the Preserve should be focused on preserving habitat for the natural resources of interest and removal of invasive species found throughout the Resort. The Resort and the Preserve need to agree on the status of invasive species on the property to make the removal process effective. The Preserve employees and the Resort should encourage local community members to take part in the different restoration processes in the active sand dunes, where the Preserve is concentrating.

A. Silvery Phacelia (Phacelia argentea) Habitat and European Beachgrass (Ammophila arenaria)

The total population of silvery phacelia seems to be increasing at the Resort. The inventory results show a total of 6,803 plants at the Resort. The majority of this population is found in the Preserve, which has been established as a natural area. However, due to the reproductive strategy of this species, it is unable to compete with the multiple reproduction strategies of European beachgrass (Brian 2006, Wiedemann and Pickart 1996). Since European beachgrass has high level of colonization and ability to alter the dune system, this species will have a negative impact on silvery phacelia on the Resort and the Preserve in the future, if not removed.

The Preserve team is focusing a lot of energy on silvery phacelia habitat and the dune mat community. Survival of this community, including silvery phacelia, means the whole dune mat community and native insects need to be protected. To completely restore the open dune habitat would take a major long-term commitment by both the Preserve team and the Resort. To make this restoration process effective, the Resort would need to agree that the presence of European

beachgrass is harmful to coastal ecosystem. The time and cost associated with removing European beachgrass from the silvery phacelia habitat would be high and completely useless if the Resort continues to hand plant this invasive species throughout the golf courses on the Resort.

Several methods to remove European beachgrass are possible. Each strategy involves multiple treatments over time to fully eradicate this invasive species. Hand pulling is effective on a small scale or when there is a significant number of natives present that should not be disturbed (Pickart 1997, Gadgil 2006). After initial pulling of European beachgrass, rhizomes present in the sand will grow with increased vigor due to the ground disturbance (Gadgil 2006). Mechanical removal is successful in areas of high European beachgrass density and where there are very few native plants present (Pickart 1997). Point Reyes National Seashore (2006) has had success removing European beachgrass using heavy equipment. Using the equipment to dig the European beachgrass, including rhizomes, up to a depth of 3 meters and then burying the invasive species and then covering it with a cap of clean sand (1.5 meters deep) (PRNS 2006). They found that this technique takes between 50 and 60 hours to clear an acre of European beachgrass sand (PRNS 2006). Chemical applications have also been effective when removing European beachgrass (Pickart 1997). A study in New Zealand found this method useful when removing European beachgrass to increase habitat for a threatened shore bird, Chatham Island Oystercatcher (*Haematopus chatamensis*) (Moore and Davis 2004). Treatment occurred over a three year time period, with Roundup (broadscale herbicide) being used for the initial spraying and two applications of Gallant (grass specific herbicide) (Moore and Davis 2004). Since the clearing of European beachgrass in their study area, the shore bird has utilized the now opened dunes for nesting sites.

To remove European beachgrass in the Preserve all three processes should be used. Dense areas of silvery phacelia require hand pulling of European beachgrass in this species dormant season (Kalt 2008, Pickart 2008). Once pulled, the grass should be piled for onsite burning. Burning should be conducted in a responsible manor, using permits and alerting the Coast Guard and/or Bandon Fire Department. Burning of European beachgrass onsite should not significantly affect the soil properties or native dune plant communities (Pickart 2008). When possible the Preserve should use mechanical removal and either bury or burn the resulting duff. Working with Bullards Beach State Park for mechanical removal would be beneficial to both parties, since access from the Resort site is limited and the Resort could help remove European beachgrass from the Park's dunes. Finally, the use of chemical applications should be applied to prevent any re-growth of European beachgrass. Individuals conducting the spraying should be educated on native species and only spray the invasive species.

Removing European beachgrass from the Preserve's dunes could trigger the movement of the semi-stabilized sand formations. To prevent massive sand movement, native sand binding species should be planted as European beachgrass is removed. Another option would be to use European beachgrass as a protective shield for native sand binding species to become established prior to removing it (Bergin 2008). While there is concern of moving sand, there are no buildings or plans for structures being built in this area of the Resort, resulting in minimal impact on humans. Dune ridges close to Bandon Trails should be stabilized with native sand binding species prior to removal of European beachgrass (Bergin 2008). The western boundary of the active dunes is covered in mixed forest and should remain stable after removal of European beachgrass (Bergin 2008).

Continued removal of other invasive species, specifically gorse, in the open dunes is essential to protecting silvery phacelia. Bullards Beach State Park has money in their budget to remove gorse in the northwestern portion of the deflation plane that borders the Preserve land (Rogers 2008). The Resort continues to remove gorse from the property by mechanical, chemical, and manual removal processes (Jefferson 2008). Using a combination of these three methods appears to be effective on the gorse population. For full eradication of gorse on the deflation plane, multiple removal treatments will be required. There are individuals that would like to see some stands of this invasive species remain on the golf courses for the yellow flowers. As a result the Resort and the Preserve, again, need to agree in the complete eradication of gorse.

B. Kinnikinnick Meadows (Arctostaphylos uva-ursi)

The remaining kinnikinnick meadows appear to be in equilibrium with the golf course. To prevent further destruction, caddies need to be educated about this resource and inform their golfers of the importance of staying out of these meadows. Although in some areas, such as hole number 16 at Bandon Trails, kinnikinnick extends from the ridge of an ancient dune down to the fairway rough, it is impractical to rope off from golfers and some continued damage will occur (Jefferson 2008).

To ensure that these meadows remain at equilibrium, active management should be focused on the early stages of succession keeping the land open for the meadows to survive. This includes removing shore pine when it starts to impact the succession stage of kinnikinnick habitat. Enhancing the ridge trail with informational signs about kinnikinnick and the native wildflowers and pollinators would increase awareness among guests about this resource. In addition to maintaining the natural habitat of kinnikinnick, the Resort can incorporate greater quantities of this ground cover plant into landscaping projects. Kinnikinnick does well in edge

habitat and would function well in parking lot flowerbeds and other areas after removal of European beachgrass.

Placing a fence might reduce foot traffic into areas with kinnikinnick, however this would not be acceptable all of the time. It might be useful to place a fence around a tee box, yet not along the whole length of the fairway. A fence that runs the length of a fairway would change the character and design of the golf hole. Placing a fence along the ridge trail where kinnikinnick is found would ensure that hikers would stay on the trail and not cause harm to the plants.

C. Port Orford Cedar (*hamaecyparis lawsonian*)

The old growth stand of port orford cedar, does not need any active management at this time. Using expert knowledge provided by Jerry Becker or Dave Imper on any precautions for the stand is recommended. It would be helpful if either of these individuals could determine the risk of the fungus infecting the stand from other infected trees on the Resort. Access to the stand should be limited. When people visit the stand, shoes should be sanitized (going in and out) so that the fungus does not spread. The Preserve needs to work with Bullards Beach State Park on a common set of goals for the port orford cedar stand since it does occupy land on both properties. The Preserve and the Park should agree on the number of visitors going to the stand and that these visitors receive a guided tour.

D. Restoration of Fahey Creek

Restoration of Fahey Creek will be a joint effort between the Preserve and its agency partners. The Preserve will be working with ODOT and USFWS to remove the culvert under Highway 101. The Preserve has also partnered with Bandon Marsh National Refuge to add a fish ladder to the stream to improve fish habitat. The main task needed from the Preserve team is

the removal of invasive species found along the stream banks. Returning the riparian areas to a more natural landscape will provide better habitat and enhanced visual appeal. Figure 14, in the Results section, shows the proximity of Fahey Creek to Highway 101.

Removal of English ivy should be a priority of the Preserve, because of the limited distribution. English ivy has been designated as a weed by Oregon Department of Agriculture (ODA 2009). Eradication of this species, on the Preserve, is still possible given its current extent. Removal of English ivy should focus on the girdle and full lifesaver method (City of Portland 2009). The girdle method requires individuals to cut away ivy near the base of the tree and at shoulder height and strip away all ivy in that area to cut off all resources to the ivy above (City of Portland 2009). The full lifesaver method starts with the girdle and continues to clear all ivy stems within a 6 foot radius of the tree trunk (City of Portland 2009).

Invasive species removal in other areas of the Preserve is also important to the natural resources of concern. Specifically removing Scot's broom plants found along the Resort's access road and Fahey Creek. To remove this species, individual plants should be manually pulled if possible. Otherwise it should be removed by cutting at the base and stacked for burning, and chemical application should be applied to the remaining stems to kill root mass. Burning of Scot's broom should be similar the burning methods of European beachgrass, as discussed for silvery phacelia. Manual removal of Scot's broom is most effective when the plant is already stressed (King County Noxious Weed Control Program 2008). Although, King County (2008) does caution that removing these plants during the late summer may spread Scot's broom seeds. The use of chemical applications should take place during its growing season prior to seed production so that seeds are not able to spread (King County Noxious Weed Control Program 2008).

E. Hiking Trails

Currently there are close to six miles of hiking trails found at the Resort. These trails are marked with wooden posts that have a ring of color painted at the top of the post. Each color represents a specific trail, shown on the trail map (Figure 24). Prior to establishing the Preserve, the Common Grounds Crew performed any maintenance on the trails. Now, this responsibility falls to the Preserve team. Many areas along the trails offer amazing view of the Pacific Ocean and the ruggedness of the Oregon Coast. However, the trails have not been maintained in top condition. Invasive species, including gorse and European beachgrass, have invaded some of the trails making walking difficult. Along these trails, continued efforts to remove these invasive species should persist.

Providing destinations to the trails can encourage use by Resort guests. An example would be the trail going to the southern end of Fahey Lake; once there hikers can look at the lake and turn around and leave. There are no picnic tables, benches, or any reason to stay near the lake for long. The addition of a small picnic area and a trail that follows the edge of the lake can enhance the trail system. The Resort can promote trail use from guests by providing box lunches so guests could enjoy destinations along the trails. Several different lunch options could be provided, family oriented to a romantic lunch. Having these box lunches available at different price points mean any guest could find something that fits their needs.

The addition of infrastructure along trails could enhance the experience for the guests. Providing benches at viewpoints would give hikers a place to rest while enjoying the breath taking views of the Oregon Coast. Also, adding restroom facilities (actual facilities or an outhouse) and a phone at the juncture of the ridge trail and the dunes trail would be beneficial. The Resort currently provides guests shuttles from hotel rooms to golf courses, restaurants, or the

practice facility. Increasing the stops to include this trail location would only involve adding a turn around area. These additions would enhance guests' hiking experience at the Resort.

Figure 24: Bandon Dunes Trail map (Bandon Dunes Golf Resort 2009)

F. The Par 3 Golf Course

The proposed par 3 golf course on the Preserve is a natural extension of the Resort. Using the revenue, from greens fees, to maintain the course and fund additional restoration projects is a unique way to produce the needed money for the Preserve. The design produced by Coore and Crenshaw will ensure that the golf course will be a natural addition to the landscape, not a groomed golf course that sits on the land. The nine-hole par 3 course can benefit the Preserve allowing for education about the native dunes and giving beginning golfers a course to play that is not as intimidating as the other courses at the Resort.

Profits from the course should be used to fund restoration project on the Preserve before funding any other outside restoration projects. Removal of European beachgrass in the dune sheet and in other areas of the Resort will be a labor and time intensive project (Pickart 1997). This should be one of the first projects looked at by the Preserve since it is the leading cause of reduction of critical habitat for silvery phacelia (Kalt 2008). Restoring the native dune community could have many benefits to both the Preserve and the Resort, particularly with education and having a native dune community to showcase.

The par 3 golf course could play an important role in educating guests and visitors about the native ecosystems found on the Preserve. After restoring the open dunes, the Preserve can showcase this ecosystem as an example of a native dune community. To bring awareness to the threatened silvery phacelia, having a boardwalk move through northern most part of the dune sheet bringing attention to the young plants growing there and the invasive species that are threatening the survival of silvery phacelia. This location, also, has a stunning view of Cut Creek, Bandon Dunes, the Lodge, Pacific Dunes, and the Pacific Ocean it should have benches for people to take in the natural beauty of the area. Information signs on the boardwalk can also talk about the community groups that have helped in the restoration of the Preserve's dune system.

During the construction of the par 3 course, effort should be made that silvery phacelia plants are not harmed. The building phase will impact plants, however tagging individual plants or clusters of plant will be important when identifying plants that workers should avoid, if at all possible. Educating the construction workers about what the plant looks like and its state threatened status will also help to reduce the potential impacts to silvery phacelia population in the par 3 area.

Minimizing impacts to silvery phacelia from golfers will be important after the construction and opening of the par 3 course. The greens crew, pro-shop employees, starters, and caddies should all be educated as to what the plant looks like so that they do not cause any additional harm to the plants when performing their job or informing guests about the plant. Prior to playing the course, guests should be shown either by the pro-shop employees or the starters what the plants look like and that they should not walk on them. Another way to minimize impacts to silvery phacelia on the par 3 course would be to have golf balls available (at tees and greens) for golfers to use in case they lose their ball. This would reduce the amount of people walking through the silvery phacelia habitat, potentially harming additional plants.

The Par 3 course can provide additional recreational opportunities to guests, which is important to recognize. People are already traveling a long distances to visit the Resort, a golf course promoting restoration projects and bringing awareness to environmental issues can show guests the dedication the Resort is to these concerns. The par 3 can enhance the stay of beginner golfers, by providing a course to play that is not as intimidating as the 18 hole courses yet still play at a world famous golf resort.

G. Monitoring

The Preserve will need monitoring to ensure that its goals for the natural resources are being met. The majority of the monitoring will take place during the specie's dormant season so removal, if needed, will occur before the plant produces flowers continuing its spread. Monitoring is necessary for all ecosystems of the Preserve. The Preserve's monitoring schedule should evolve as the goals are met or new ones added.

The silvery phacelia habitat will, potentially, have the longest monitoring in place. After successful removal of European beachgrass, the Preserve team should go out to the site monthly

and continue to remove any new stands of the invasive species. As the new occurrences of European beachgrass slow down, monitoring can decrease until the Preserve has eradicated the species. The Preserve team should also note any new silvery phacelia plants in the Preserve or in other areas of the Resort. A database of new plant should be kept so that the Preserve knows the populations trends.

Kinnikinnick will not need as much surveillance since the species has reached equilibrium. Kinnikinnick along the ridge trail will need to be watched the greatest, since hikers might impact the species in this location. However, monitoring should be minimal unless there is a sharp increase in use of the hiking trails at the Resort.

At this time, the port orford cedar stand does not need any active supervision. This old growth forest is stable and to minimize the potential of spreading the root fungus should be visited infrequently. A monitoring schedule from Jerry Becker or Dave Imper should be implemented.

Monitoring for Fahey Creek involves removal of invasive species. Due to the invasive species present, checking the creek should take place during the winter months so that removal of new invasive species can take place before the plants spread further. During the summer, the Preserve team should walk along the creek to see if any new invasive species sprout so they can be removed promptly. As invasive species slow down, monitoring can also decline.

The hiking trails that are throughout the Resort, should walked by the Preserve team seasonally. During spring, employees should ensure that the trails are open and not blocked by vegetation so guests can easily use the trails. Winter months provide opportunity for invasive species removal, similar to Fahey Creek.

H. Implementation

The first step in implementation of the Management Plan would necessarily be a change in the zoning for this portion of the resort, from Conservation Open Space to a zoning signifying development as a golf course. This zoning process involves submittal to, and approval from, Coos County (the lead agency for the resort). Subsequent to zoning change, construction of the Par 3 Course would be the second step. The final step would be opening the course for play, which will result in a revenue source for ongoing Preserve management.

While the par 3 is being built many other activities on the Preserve can be started. The first would be to start pulling, either manually or mechanically, European beachgrass in areas where many silvery phacelia plants are located. Clearing back the European beachgrass in these prime habitats will help established plants expand as well as encourage juvenile plants to take root. Pulled grass should be stacked for future burning. Secondly, continued removal of other invasive species from roadways or other disrupted areas is important to reduce the spread of these plants. Finally, employees can continue to improve the quality of the hiking trails by keeping the trail clear of either invasive species or early successional plants wanting to re-establish in the trail. These areas are identified below in Figure 25.

Upon completion of the par 3 course, more extensive clearing of invasive species should be able to occur. Specifically in the active dune sheet by use of mechanical equipment, sensitive areas should have already been cleared by manually pulling. The less sensitive areas can be overhauled much faster with mechanical equipment and the Resort could potentially help Bullards Beach State Park clear some of the invasive species on their lands.

Completing these first two steps would be a major accomplishment for the Preserve and the Resort. The Preserve would then have its own golf course, which would presumably follow

the other golf courses at the Resort as beautiful and play-able golf courses. Also, the Preserve would have a recovering dune system that would showcase the silvery phacelia population and educating guests about this ecosystem. Long term goals for the Preserve might be to build an interpretative center and to continue its research on their silvery phacelia population.

Figure 25: Invasive species removal

I. Future Work

As the Preserve continues to mature and defines its goals, opportunities for research will become available. The Preserve and Resort has the ability to work closely with universities, specifically their students and faculty. Through this mutually beneficial relationship more knowledge can be gathered and documented on silvery phacelia and the native dune community,

assessment can be made at Fahey Creek on how the stream responds to restoration, and new areas for research might present themselves in the future.

With removal of invasive species in the active dune sheet, there might be an increase in number of silvery phacelia. As the sand is opened up when European beachgrass is being removed silvery phacelia can begin to repopulate that area. If this does happen, the Preserve might want to conduct an updated plant inventory for this species. This would document the change in population of this species. Using a GPS unit with a higher level of accuracy could potentially improve the database for silvery phacelia. Also, the person evaluating the distribution of silvery phacelia might be able to determine clustering of this plant species. Specifically, future studies can look for juvenile plants in the newly opened sand and investigate whether the seedlings are growing in close proximity to each other. Over time it would be interesting to see if the silvery phacelia population will form large clusters of small plants or have larger plants remain dispersed throughout the active dune sheet.

As restoration proceeds at Fahey Creek it would be interesting to see if the stream's characteristics change. These restoration studies could evaluate how improved riparian conditions affect water quality and use by native fish species. The studies could also investigate how these improvements impact the lake. The Preserve would benefit by working with agency partners, as well as universities on this restoration project.

The Preserve will evolve over time. Working with the public should be an important part of the Preserve. Interested parties have the ability to donate their time, knowledge, and momentum to many projects in the Resort's natural area. In addition to working with the public, the Preserve could extend its outreach to school aged children so that they can learn about their

natural environment. Outdoor education would be another opportunity for university students to become involved with the Preserve and the Resort.

Over time, the Preserve will have extensive knowledge about its natural resources. This information is invaluable when learning about specific resources and documenting associated studies. Continued utilization of GIS data will allow the Preserve to see trends in plant communities and make management decisions to maximize benefits to the ecosystem and the resort.

Appendix A – Silvery phacelia transects

Silvery Phacelia Transect #1

90ft long sampled every 3ft

GPS Location:

Start: 43° 10'43.5"N and 124° 23'40.5"W

End: 43° 10'42.7"N and 124° 23'41.2"W

Figure 26: Transect one

Location on measuring tape	Plant present
3ft	silvery phacelia 10in diameter
6ft	open sand
9ft	open sand
12ft	open sand
15ft	open sand
18ft	open sand
21ft	open sand
24ft	open sand
27ft	open sand
30ft	open sand
33ft	open sand
36ft	open sand, silvery phacelia ~1ft away
39ft	open sand
42ft	open sand
45ft	beach lupin
48ft	beach lupin
51ft	European beachgrass
54ft	weeds
57ft	weeds
60ft	open sand
63ft	beach lupin
66ft	weeds/beach lupin
69ft	beach lupin
72ft	beach lupin, silvery phacelia ~1ft away
75ft	European beachgrass/weeds
78ft	open sand
81ft	European beachgrass/weeds
84ft	European beachgrass
87ft	beach lupin
90ft	beach lupin
93ft	beach lupin

96ft
99ft

beach lupin
beach lupin, silvery phacelia 1in diameter

Silvery Phacelia Transect #2

90ft long sampled every 3ft

GPS Location:

Start: 43° 10'54.9"N and 124° 23'37.8"W

End: 43° 10'54.4"N and 124° 23'38.7"W

Figure 27: Transect two

Location on measuring tape

3ft
6ft
9ft
12ft
15ft
18ft
21ft
24ft
27ft
30ft
33ft
36ft
39ft
42ft
45ft
48ft
51ft
54ft
57ft
60ft
63ft
66ft
69ft

Plant present
silvery phacelia 3in diameter
open sand
beach lupin
large silvery phacelia (greater than 1ft)
same silvery phacelia plant
open sand
beach lupin
open sand/European beachgrass
open sand
open sand
open sand
open sand
beach lupin
beach lupin
small silvery phacelia
open sand
weeds
open sand
weeds/yellow sand verbena
open sand
silvery phacelia 12in diameter
yellow sand verbena

72ft	yellow sand verbena
75ft	beach flower
78ft	open sand
81ft	sand verbena
84ft	sand verbena
87ft	yellow sand verbena
90ft	yellow sand verbena and small silvery phacelia
93ft	weeds
96ft	open sand
99ft	beach lupin, silvery phacelia 1in diameter

Silvery Phacelia Transect #3

90ft long sampled every 3ft

GPS Location:

Start: 43° 10'54.3"N and 124° 23'30.1"W

End: 43° 10'53.3"N and 124° 23'30.7"W

Figure 28: Transect three

Location on measuring tape	Plant present
3ft	open sand/weeds
6ft	open sand/weeds
9ft	European beachgrass/beach lupin
12ft	weeds
15ft	European beachgrass
18ft	weeds
21ft	open sand
24ft	small silvery phacelia/European beachgrass
27ft	European beachgrass
30ft	open sand
33ft	beach lupin
36ft	beach lupin
39ft	European beachgrass/beach lupin
42ft	European beachgrass/beach lupin
45ft	beach flower
48ft	open sand
51ft	beach lupin
54ft	European beachgrass/beach lupin
57ft	open sand
60ft	open sand

63ft	open sand
66ft	dead weeds
69ft	European beachgrass
72ft	beach lupin
75ft	beach lupin
78ft	European beachgrass
81ft	beach lupin
84ft	small silvery phacelia
87ft	European beachgrass/beach lupin
90ft	open sand
93ft	open sand
96ft	weeds
99ft	silvery phacelia 2ft diameter

Silvery Phacelia Transect #4

90ft long sampled every 3ft

GPS Location:

Start: 43° 10'45.7"N and 124° 23'31.6"W

End: 43° 10'46.6 "Nand 124° 23'31.4"W

Figure 29: Transect four

Location on measuring tape	Plant present
3ft	silvery phacelia 4in diameter
6ft	European beachgrass
9ft	open sand
12ft	silvery phacelia <1in /European beachgrass
15ft	European beachgrass
18ft	weeds
21ft	silvery phacelia <1in/European beachgrass
24ft	open sand
27ft	beach flower
30ft	open sand
33ft	weeds
36ft	weeds
39ft	European beachgrass
42ft	silvery phacelia 3in diameter
45ft	European beachgrass
48ft	European beachgrass
51ft	weeds

54ft	beach flower
57ft	open sand
60ft	open sand
63ft	open sand
66ft	dead weeds
69ft	weeds
72ft	weeds
75ft	8in pine tree
78ft	weeds
81ft	weeds
84ft	open sand
87ft	moss
90ft	weeds
93ft	weeds
96ft	weeds
99ft	open sand

Appendix B – Irrigation Plots

Control Plot – Beach Trail

Working from north to south – each block is a 3ft x 3ft section

Identifier	Length	Width	Seeding
1A-1	18in	18in	No seeds
2A-1	16in	14in	No seeds
3A-1	23in	23in	Seeds/blooming
1B-1	7in	6in	No seeds
2B-1	18.5in	16in	Seeds/blooming
3B-1	18in	12in	Seeds/blooming
1C			No silvery phacelia
2C-1	15in	12in	Seeds/blooming
3C-1			No silvery phacelia
1D			No silvery phacelia
2D-1	9.5in	12in	No seeds
3D-1	2in	1.5in	No seeds
1E			No silvery phacelia
2E-1	19in	16in	No seeds
3E			No silvery phacelia
1F-1	9in	4.5in	No seeds
1F-2	15in	11in	No seeds
2F-1	3.5in	3.5in	No seeds
3F-1	14in	13.5in	Seeds/blooming

Treatment (irrigation) plot – Beach Trail

Working from north to south – each block is a 3ft x 3ft section

Identifier	Length	Width	Seeding
1A-1	6in	6in	Seeds/blooming
2A			No silvery phacelia
3A-1	1.5in	3in	No seeds
1B-1	3.5in	4.5in	No seeds
1B-2	12in	11in	No seeds
2B-1	4in	3in	No seeds
3B-1	10in	12in	Seeds/blooming
3B-2	1in	1in	No seeds
3B-3	3in	3in	No seeds
1C-1	11in	8in	Seeds/blooming
2C			No silvery phacelia
3C-1	2in	1.5in	No seeds
3C-2	2.5in	1.5in	No seeds

3C-3	2.5in	2in	No seeds
1D			No silvery phacelia
2D-1	8in	7in	Seeds/blooming
2D-2	6in	7in	Seeds/blooming
2D-3	2.5in	3in	No seeds
3D-1	7in	6in	Seeds/blooming
3D-2	1in	.5in	No seeds
1E-1	2in	2in	No seeds
1E-2	3.5in	3in	No seeds
2E-1	7in	5.5in	No seeds
2E-2	3in	3in	No seeds
2E-3	5.5in	5in	No seeds
2E-4	9in	7in	Seeds/blooming
2E-5	.5in	.5in	No seeds
2E-6	1in	1in	No seeds
3E-1	1.5in	1.5in	No seeds
1F-1	4in	4in	No seeds
2F-1	.5in	.5in	No seeds
2F-2	.5in	.5in	No seeds
3F-1	.5in	.5in	No seeds

Control Plot – Nursery Area at Bandon Trails

Working east to west – each block is a 3ft x 3ft section

1A-1	.5in	.5in	No seeds
2A			No silvery phacelia
3A-1	15in	12in	Seeds/blooming
1B			No silvery phacelia
2B			No silvery phacelia
3B-1	3in	5in	No seeds
3B-2	16in	13in	No seeds
3B-3	16in	13in	No seeds
1C			No silvery phacelia
2C			No silvery phacelia
3C-1	8in	8.5in	No seeds
3C-2	5.5in	7in	No seeds
1D-1	1in	1in	No seeds
1D-2	3in	2in	No seeds
2D-1	14in	6in	Seeds/blooming
3D-1	12in	13in	Seeds/blooming
1E			No silvery phacelia
2E			No silvery phacelia
3E-1	20in	19in	Seeds/blooming
1F-1	2.5in	2in	No seeds

1F-2	2.5in	1in	No seeds
2F-1	2in	2in	No seeds
3F-1	4in	3in	No seeds
3F-2	7in	6in	No seeds
3F-3	14in	20in	Seeds/blooming

Treatment (irrigation) Plot – Nursery area Bandon Trails

Working east to west – each block is a 3ft x 3ft section

1A			No silvery phacelia
2A-1	2in	2in	Seeds/blooming
3A			No silvery phacelia
1B			No silvery phacelia
2B			No silvery phacelia
3B			No silvery phacelia
1C			No silvery phacelia
2C			No silvery phacelia
3C-1	3.5in	3.5in	Seeds/blooming
1D			No silvery phacelia
2D-1	38in	25in	Seeds/blooming
3D-1	4in	3in	No seeds
1E			No silvery phacelia
2E			No silvery phacelia
3E			No silvery phacelia
1F-1	13in	18in	Seeds/blooming
2F			No silvery phacelia
3F-1	2in	2in	No seeds

Appendix C – Experimental test plots and transect locations

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