FINAL REPORT

RARE PLANT HABITAT RESTORATION

AT HUMBOLDT BAY, NORTH SPIT (HUMBOLDT COUNTY)

Submitted to:

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INTRODUCTION

In September 1989 the California Department of Fish and Game (DFG) awarded a contract to The Nature Conservancy to "protect and restore native dune habitat on preserve land owned and managed by The Nature Conservancy that supports State-listed and candidate Endangered plants, including Menzies' wallflower (*Erysimum menziesii*) and beach tidytips (*Layia carnosa*)". Funding was provided by the California Endangered Species Tax Check-off Fund. It was agreed that work in fulfillment of the contract would be carried out at the proposed Mad River Slough and Dunes Cooperative Management Area (CMA). This area consists of dune and slough lands owned by The Nature Conservancy (TNC), the Bureau of Land Management (BLM) and Louisiana-Pacific Corporation (LP). It contains populations of both endangered species referred to above, as well as three plants on List 1B of the California Native Plant Society's Inventory of Rare and Endangered Vascular Plants (Smith and Berg 1988). Humboldt Bay owl's clover (*Orthocarpus castillejoides* var. *humboldtiensis*), Point Reyes bird's-beak (*Cordylanthus maritimus* ssp. *palustris*) and Humboldt Bay gumplant (*Grindelia stricta* ssp. *blakei*) all occur in the salt marshes of the CMA. The area was opened to the public in July 1990. The purpose of the CMA is to protect and enhance dune resources and to encourage public education through controlled use and interpretive aids such as kiosks, brochures, and docent-led tours. The DFG contract outlined specific tasks that were intended to assist in the implementation of the CMA such that the goals of endangered plant protection and enhancement could be met. These tasks fall under the general headings of Protection, Education and Public Access and Endangered Plant Habitat Restoration and Monitoring.

PROTECTION

TASKS:

1. Design and install limited vehicle barriers and interpretive signing to restrict off-highway vehicle access to sensitive habitats.

The CMA poses a difficult problem for protection due to its proximity to conflicting and potentially threatening uses. The open sand areas of the LP and BLM parcels are not included within the boundaries of the CMA because these landowners chose to permit vehicles in these areas. Therefore, it is imperative to prevent vehicular access or trespass onto the vegetated areas of the CMA, as well as the open sand area owned by TNC which is reserved for pedestrian access. Fences had been previously constructed by TNC and Humboldt State University to protect endangered plants. Protection efforts pursuant to the DFG contract consisted of creating barriers along the forest/open dune boundary at points of historical ingress/egress by OHVs (Fig. 1). Reflective signs prohibiting OHV entry were posted along the outside boundary, and those alerting pedestrians that they were leaving the protected area of the CMA were posted on the inside boundary (Fig. 2). A turnstile was created at the main trailhead to prevent OHV ingress from the parking area (Fig. 3). Since the CMA opened in July, these efforts have proven successful at preventing OHV trespass.

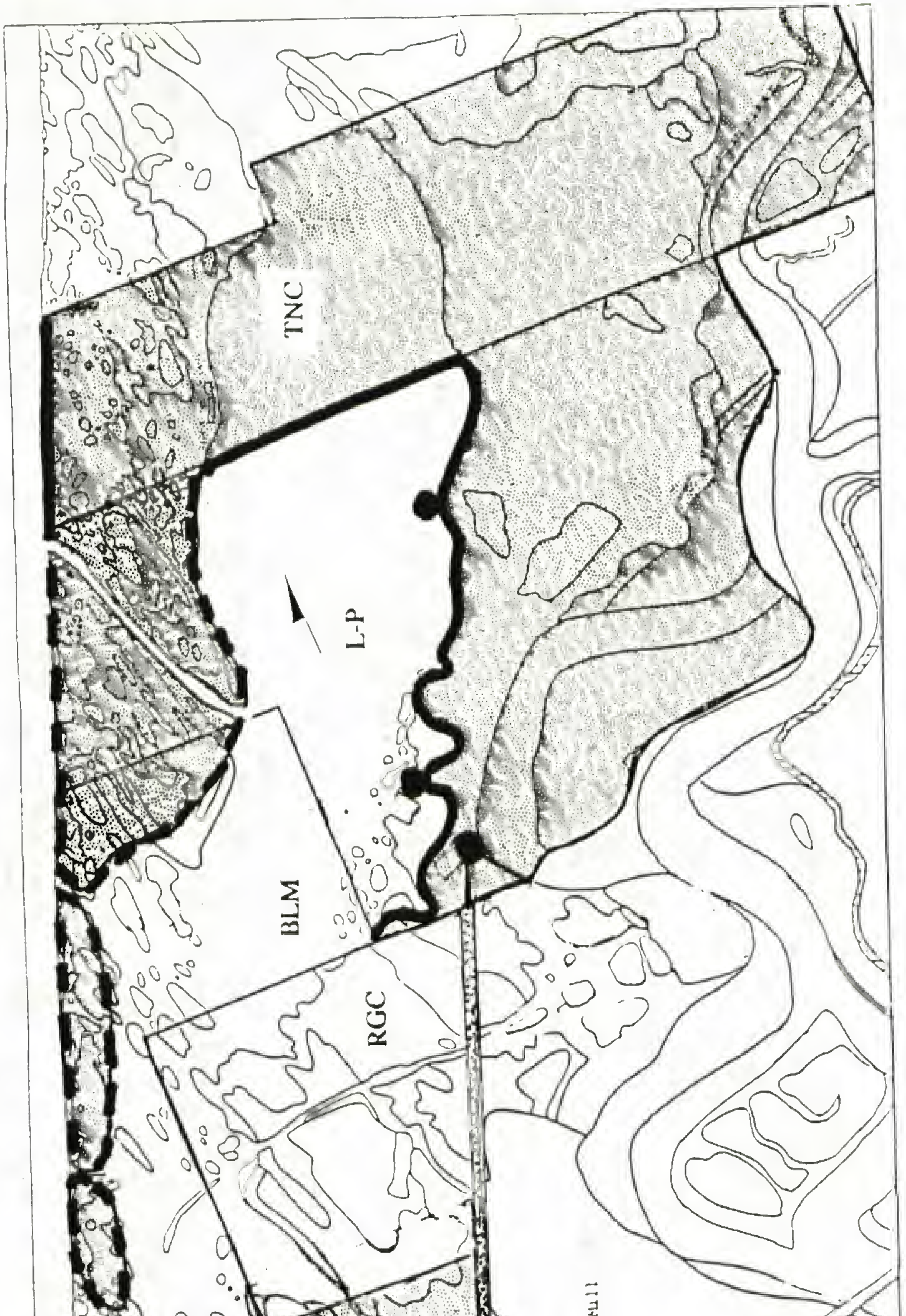

Figure 1: Map showing location of posted boundary and vehicular barriers. Solid line is posted with both inside and outside signs; dashed lines with outside signs only. Circles represent barriers at pedestrian access points or where former OHV trails cross an unfenced boundary.

Figure 2: Boundary sign placed along inside boundary of Cooperative Management Area.

Figure 3: The turnstile at the trailhead, constructed to prevent vehicular passage.

EDUCATION AND PUBLIC ACCESS

TASKS:

1. Produce and distribute an interpretive brochure to educate the public about the goals of the preserve and to encourage public participation.

Educational efforts at the site have been concentrated in three areas. An interpretive brochure was developed in concert with a trail system to expose and educate users to the diverse habitats of the CMA, including "dune mat", the habitat for Menzies' wallflower and beach layia. The brochure (Attachment A, Fig. 4), describes each habitat as it is encountered along the trail. Photographs are used to identify each habitat as well as the Menzies' wallflower. The brochure also attempts to explain the cooperative effort of the CMA and the nature of the surrounding uses in order to ameliorate potential negative perceptions and experiences. The cultural history of the site is also presented.

The Forest and Slough Trail passes through all of the habitats contained in the CMA (Fig. 5). The trail was constructed with assistance from the California Conservation Corps (Fig. 6). It originates at the parking area (Fig. 7), which is approximately 1 mile past the main entrance sign (Fig. 8).

Interpretive kiosks were placed at strategic points along the Forest and Slough trail, dealing with various subjects including endangered species, wetlands, dunes, mudflats, invertebrates and shorebirds (Fig. 9). Near the salt marsh on the TNC property, a custom panel was designed describing the rare plants of the salt marsh (Fig. 10). Benches were constructed and placed at strategic points along the trail to encourage viewing and allow resting points (Fig. 11). A cantilevered observation deck was designed to allow a viewpoint over a freshwater marsh for birdwatchers and others (Fig. 12). This deck is being constructed by volunteers with materials donated by Louisiana-Pacific. A canoe launch was developed at the parking area, with use directed along a defined trail to prevent impacts to the salt marsh.

Weekly docent-led tours are offered every Saturday morning by a local volunteer group of The Nature Conservancy, Friends of the Dunes Preserve. The CMA is open for walk-on use during daylight hours Friday through Monday, but visitors are encouraged to attend walks to obtain a more in-depth knowledge of the area.

Figure 4: Interpretive brochure developed for the Cooperative Management Area.

MAD RIVER SLOUGH AND DUNES
COOPERATIVE MANAGEMENT AREA

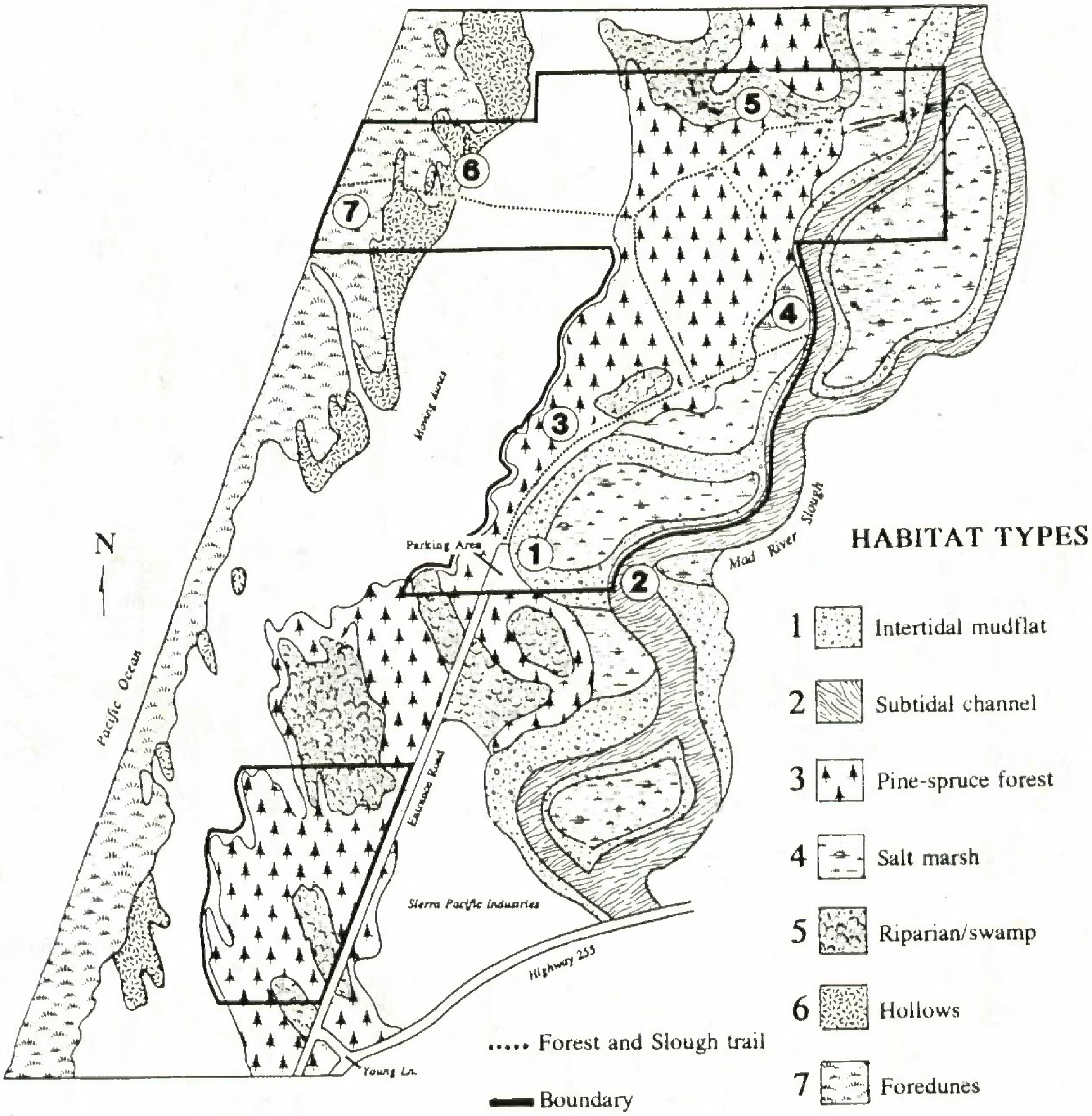

Figure 5: Map showing the trail network through the Cooperative Management Area.

Figure 6: California Conservation Corps creating the Forest and Slough Trail.

Figure 7: Trailhead of the Forest and Slough trail, located at the parking area.

Figure 8: Front entrance sign, located at south boundary of the Cooperative Management area, approximately one mile south of parking area.

Figure 9: One of four interpretive kiosks located along the trail system.

Figure 10: The customized panel located on TNC property near the salt marsh, depicting the three rare salt marsh plants.

Figure 11: One of the benches located along the trail for viewing/resting.

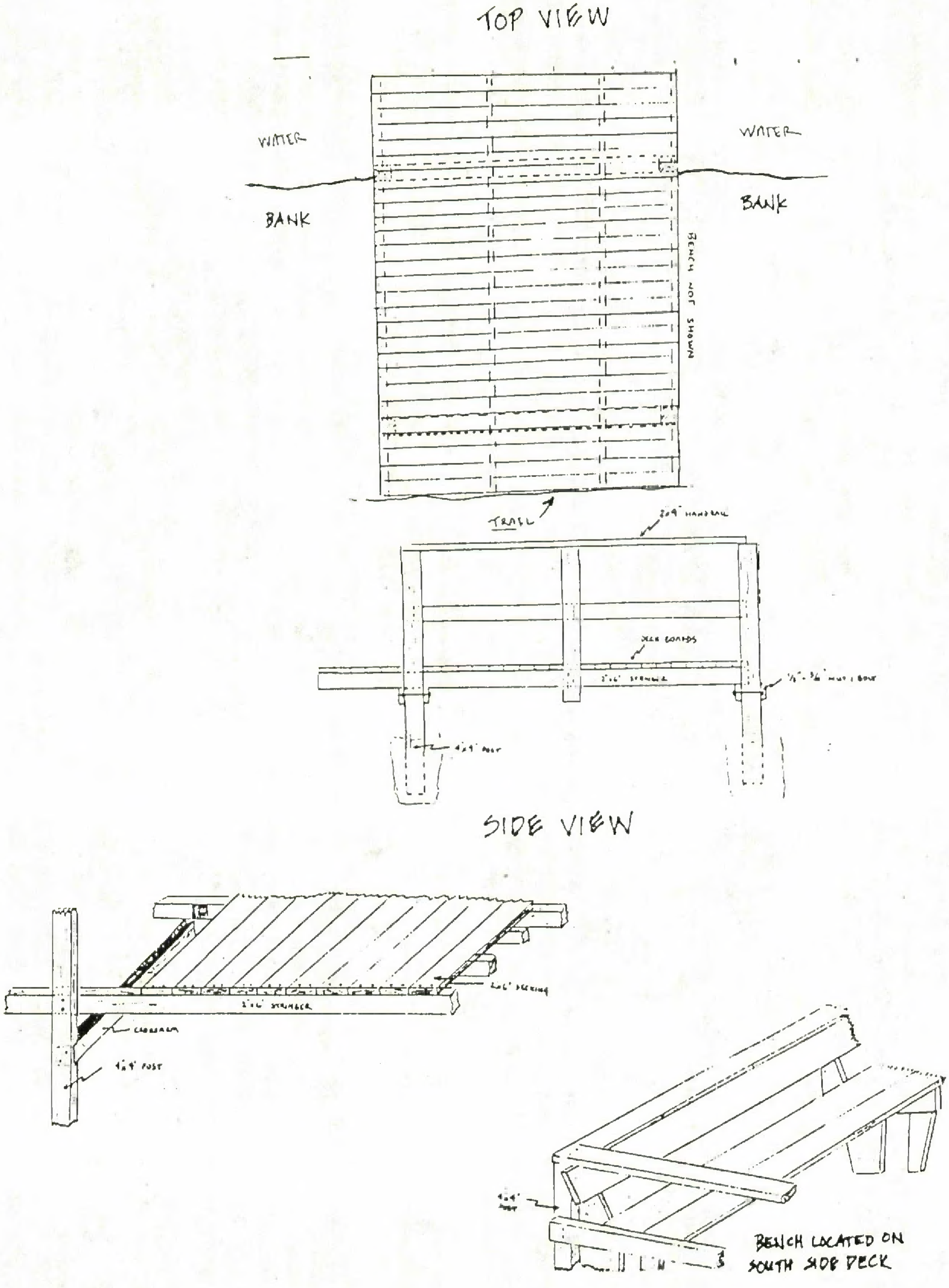

Figure 12: Plans for the observation deck located along the trail, overlooking a freshwater marsh.

ENDANGERED PLANT HABITAT RESTORATION AND MONITORING

TASKS:

1. Conduct preliminary experiments in exotic plant removal and revegetation using appropriate acceptable techniques, such as hand and mechanical clearing, or chemical and other treatments.

2. Plan and implement a monitoring program to determine baseline conditions for rare plants and native vegetation and to determine results of protection and recovery efforts.

The existing habitat for Menzies' wallflower and beach layia on the site has been severely degraded by the encroachment of European beachgrass (*Ammophila arenaria*). Previous research conducted by Humboldt State University in cooperation with The Nature Conservancy resulted in a methodology for the eradication of beachgrass by repeated manual removal of above-ground portions and the active rhizome bud bank (Pickart et al. 1990). In the course of these experiments, it was determined that seedlings sprouted from the plots in the year following eradication. This was unexpected since the literature on *Ammophila* suggests that the plant rarely spreads by seed (Huiskes 1977). Subsequently, Bencie (1990) determined that seedling emergence does occur at the CMA, particularly in the foredune areas where seed production is greater due to enhanced plant vigor. The goal of this study was to determine whether a soil emulsifier could be used to reduce seedling emergence in treated *Ammophila* plots by preventing water penetration and acting as a physical barrier to emergence. This would serve as a further refinement of the methodology, reducing the need for second or third year treatment.

1. Exotic plant removal and native plant recovery.

A. METHODS

Six relatively isolated stands of *Ammophila* were located on the Fernstrom-Root parcel of The Nature Conservancy. Baseline monitoring consisted of systematic placement of $1 m^2$ circular quadrats, with a sample size of 30 plots per stand. The sampling frame was defined as that portion of the stand containing *Ammophila*, i.e. if a plot fell within a "gap" of open sand it was discounted. The following variables were recorded for each plot: number of live leaves *Ammophila*, %cover *Ammophila*, %cover other species and total % native cover. Monitoring occurred in April 1990 and was followed by the initial dig. All *Ammophila* was removed from four stands, leaving two stands as controls. Plants were dug to a depth of 12", in order to remove as much of the rhizome bud bank as possible. Digging was repeated every two weeks through June, then monthly through October. In October one of the treated plots was sprayed with Soil Seal™, an acrylic copolymer, at a rate of 9.5 l of solution/m^2. The solution consisted of 1:26 soil seal:water. This rate was based on previous studies in which soil seal was used as a stabilizer in dune sands, and was double the maximum rate used for that purpose. Prior to the application of soil seal, monitoring was repeated to determine the success of *Ammophila* eradication and the recovery or reestablishment of natives. In April 1991, at the end of the rainy season, the plots were revisited and the number of seedlings present in each plot was recorded.

B. RESULTS

The four treatment plots were defined as a noncontiguous population, and samples from all plots were combined for the analysis. Prior to treatment, mean *Ammophila* was 196 leaves/m^2 ($\pm$12.0 S.E.). By October density had declined to 0.74 leaves/m^2 ($\pm$0.29) (Fig. 13). The change was statistically significant at $p < .00001$ ($t = 16.21$, $DF = 119$). Native cover in April 1990 was 2.5% ($\pm$0.36). In October native cover had increased to 13.6% ($\pm$2.0) (Fig. 14). This recovery was natural; no attempt at revegetation was made. The increase in native cover was significant at $p < .0001$ ($t = -5.52$, $DF = 119$). Plots were photodocumented before treatment and at the end of the treatment period (Figs. 15-18). The results of the seedling census in Spring 1991 revealed that number of *Ammophila* seedlings ranged from 10-50. The highest number of seedlings occurred in the plot treated by Soil Seal.

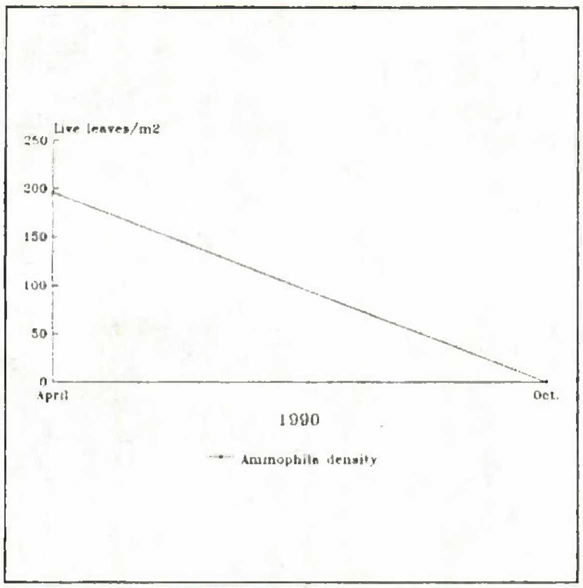

Figure 13: Changes in Ammophila density in treated plots.

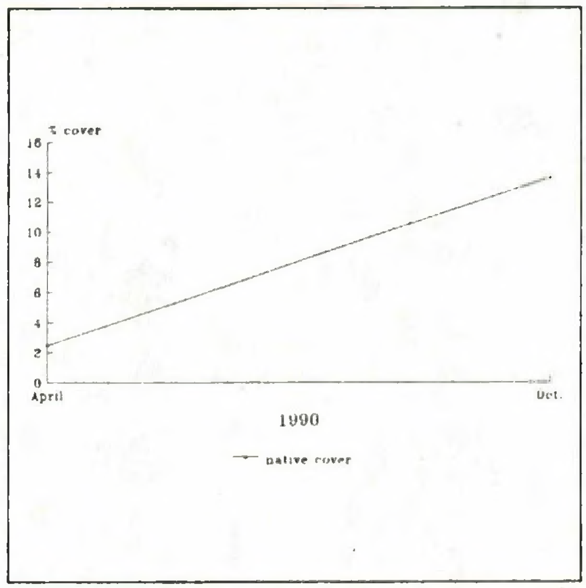

Figure 14: Changes in native plant cover in treated plots.

C. DISCUSSION

The manual removal treatment proved extremely effective at the eradication of *Ammophila*, paralleling the results of the Humboldt State University study (Pickart et al. 1990). However, native plants made a greater recovery by the end of the digging treatment in these plots (13.6%) compared with the HSU study (5.7%). The extent of native recovery is probably tied to the proximity of native plants to the plot, and this variation could account for the difference.

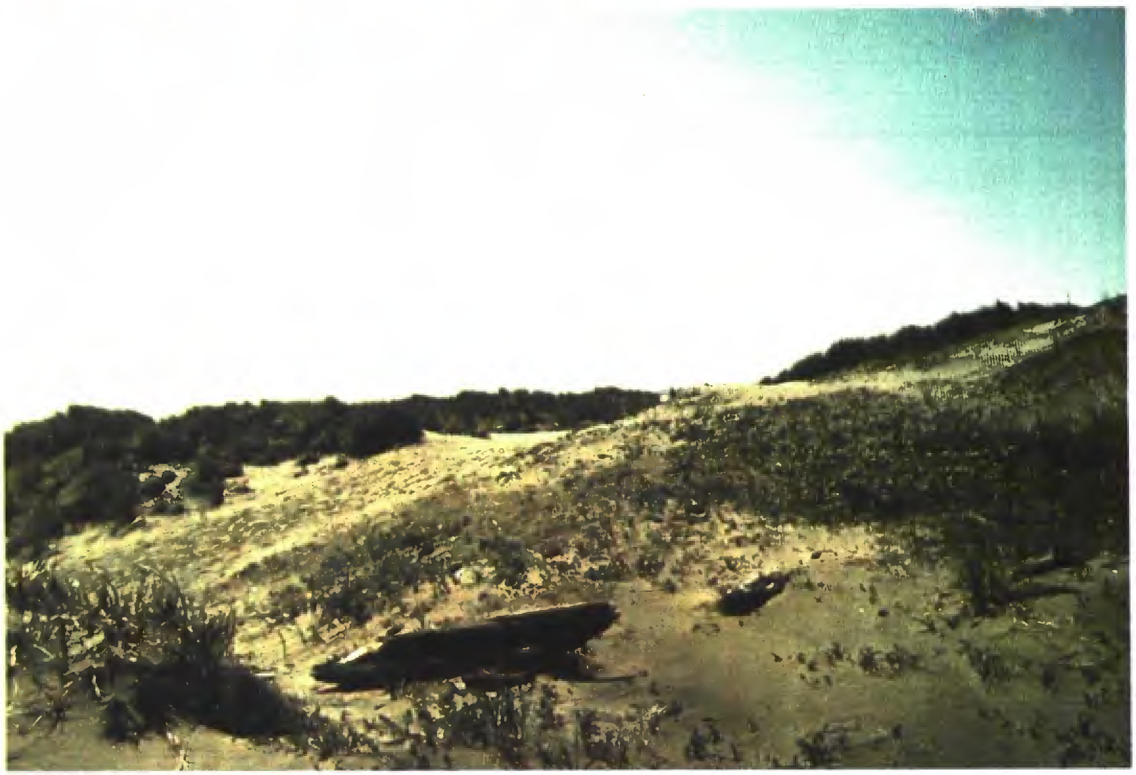

Figure 15: Plot 1 (Soil Seal) before treatment (above) and at the end of the treatment period (below).

Figure 16: Plot 2 before treatment (above) and at the end of the treatment period (below).

Figure 17: Plot 3 before treatment (above) and at the end of the treatment period (below).

Figure 18: Plot 4 before treatment (above) and at the end of the treatment period (below).

The Soil Seal treatment did not succeed in preventing or suppressing germination of *Ammophila* seedlings. In other studies and projects, Soil Seal was found to have an inhibitory effect on germination and/or emergence (Newton 1989, Miller et al., in prep.). The rate of application of Soil Seal used on this study was at least twice as high as in those situations. Possibly, *Ammophila* seedlings, for morphological or physiological reasons, were better able to pierce the physical barrier imposed by the soil seal.

D. CONCLUSIONS

This study suggests that, at the rate employed, Soil Seal is not effective at preventing seedling germination and/or emergence and is therefore not an effective tool for restoration in this capacity. Other techniques should be explored to determine if a more effective method exists. Soil solarization, which uses heat generated by sunlight and clear polyethylene sheeting, has been used successfully to kill weed seeds (Bainbridge 1990). However, this technique is also commonly used as an alternative to fumigants and its effect on soil microbiota must be taken into account.

Miller et al. (in prep.) showed that Soil Seal can have a beneficial effect on substrate stabilization for dune revegetation. Therefore, it may have a place in dune restoration if revegetation is needed. Future monitoring will determine whether revegetation is actually needed, or whether plots will recolonize with dune natives on their own given sufficient time.

2. Baseline conditions for rare plants and native vegetation.

A. METHODS

To document baseline vegetation characteristics for wallflower, occupied habitat was sampled at the Lanphere-Christensen Dunes Preserve. Transects running east-west were placed at 50 m intervals. Along each transect $10m^2$ plots were systematically placed at intervals of 10 m. Only those plots with wallflower present were included in the analysis. Previous studies have documented vegetation characteristics for both *Erysimum* and *Layia* habitat (Duebendorfer 1985, CNPS 1987, Pickart 1987); this study was intended to document characteristics of occupied habitat only. Within each plot % total cover and % cover of perennials (by species) were recorded using a cover/abundance scale. Number of wallflowers over 3 cm in diameter were tallied within a $4m^2$ subplot. The 3 cm criterion was employed to reduce error given the difficulty of locating small seedlings, and has been employed in other studies. The frequency of each species and its mean cover value (using the midpoint of the cover range) were calculated, in addition to mean total cover. This information served to define baseline vegetation conditions for occupied habitat. Densities of wallflower in occupied habitat were also obtained from this information. These densities will differ from past studies in which the sampling frame included both occupied and unoccupied habitat.

Baseline conditions for *Layia* were obtained from a separate monitoring program. This monitoring program was developed by The Nature Conservancy and has been carried out for three years. Methods consist of east-west transects placed throughout the occupied habitat on the Lanphere-Christensen Dunes Preserve, which consists of all of the Northern foredune community (Holland 1986). Transects are 20 m apart, and .25m^2 quadrats are placed every 10 m along the transect. The number of individuals is recorded for each quadrat. The habitat has been stratified into "high" and "low" density strata based on initial monitoring in 1988. The high density stratum is in the northern part of the preserve, and roughly corresponds to the area of occupied wallflower habitat.

B. RESULTS

Total cover ranged from 10-90%, with an average of 65%. Results by species are presented in Table 1. Thirteen perennial species were encountered. The dominant species in terms of both cover and frequency was *Solidago spathulata*, which occurred in 85% of the plots with a mean cover of 25%. All other species had cover values of less than 10%, although some exhibited high frequencies, particularly *Lathyrus littoralis, Eriogonum latifolium* and *Poa douglasii* . Wallflower density was 1.05/m^2.

Table 1: Results of baseline vegetation monitoring.

SPECIES	% cover	Standard error	frequency
Solidago spathulata	24.4	3.1	85%
Lathyrus littoralis	8.3	1.5	81%
Polygonum paronychia	7.3	1.4	62%
Abronia latifolia	6.2	1.4	45%
Eriogonum latifolium	4.4	0.6	81%
Fragaria chiloensis	4.4	1.6	42%
Poa douglasii	4.2	0.6	77%
Achillea millefolium	2.9	0.5	58%
Camissonia cheiranthifolia	2.1	0.5	42%
Ambrosia chamissonis	2.1	1.0	15%
Carpobrotus aequilaterus	1.2	0.4	23%
Erigeron glaucus	1.0	0.4	19%
Calystegia soldanella	0.4	0.3	8%

Results of *Layia* monitoring showed a density of 16 ($\pm$ 33, 95% Confidence intervals) individuals/m^2 in the high density stratum (n=112) and 12 ($\pm$ 28) individuals/m^2 in the low density stratum (n=465). In previous years there has been a significant difference in density between the two strata. However, in 1990 the high density stratum showed a decline in density (Miller 1990), while the low density stratum remained fairly constant. The densities at the Lanphere-Christensen Dunes Preserve were similar to those recorded in the nearby Manila Dunes in the same year and using the same methodology (Pickart 1990).

C. DISCUSSION AND CONCLUSIONS

The vegetation and rare plant monitoring documented baseline conditions that can be used to measure the success of revegetation and restoration efforts. Because our restoration efforts required a year just to remove *Ammophila*, no attempt at revegetation was made. Native recovery did occur, but fell short of cover values in the target range. Further monitoring will be needed to determine whether revegetation is needed either to obtain target cover values or to achieve the desired species composition. If reintroduction of *Erysimum* or *Layia* is desired in the future, these results will help to guide those efforts.

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