

# Habitat and population monitoring for *Chloropyron maritimum* ssp. *palustre* and *Limonium californicum* on the Coos Bay North Spit



2014

Report to the Bureau of Land Management,  
Coos Bay District

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## PREFACE

This report is the result of an agreement between the Institute for Applied Ecology (IAE) and a federal agency. IAE is a non-profit organization whose mission is conservation of native ecosystems through restoration, research and education. Our aim is to provide a service to public and private agencies and individuals by developing and communicating information on ecosystems, species, and effective management strategies and by conducting research, monitoring, and experiments. IAE offers educational opportunities through 3-4 month internships. Our current activities are concentrated on rare and endangered plants and invasive species.



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**Cover photograph:** *Chloropyron maritimum* ssp. *palustre* (Point Reyes bird's-beak), and *Limonium californicum* at the Coos Bay North Spit.

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## EXECUTIVE SUMMARY

In 2014 the estimated number of *Chloropyron maritimum* ssp. *palustre* plants on the Coos Bay North Spit land managed by the Coos Bay District of the Bureau of Land Management is ~1,511,000 (508,000 in the protected area and 1,003,000 in the unprotected area). This is the highest estimated population in the unprotected area, and the second highest in the protected area.

In 2014 the population size of *Limonium californicum* was also estimated in both the protected and unprotected areas. In the protected area, there are an estimated ~962,000 with 832,000 and 130,000 in the protected and unprotected area, respectively. In the protected area, the density of *Limonium californicum* is higher in all occupied habitat types than in the unprotected area.

In 2014, in the “*Chloropyron maritimum* ssp. *palustre* Flat” (CF) habitat, density was 76 plants/m<sup>2</sup> whereas in the unprotected area, only 16 plants/m<sup>2</sup> were noted. (This pattern was also consistent in the “*Limonium/Chrolopyron* Flat” (LCF) habitat types, with an estimated 173 *L. californicum* plants/m<sup>2</sup> in the protected area, and only 140/m<sup>2</sup> in the unprotected area.

The area occupied with these rare species is found in a long, narrow strip of appropriate habitat in a dynamic system. This narrow strip of land (~700m long with a maximum width of 50m) lies in a precarious location along the shoreline where minor fluctuations in sea level (due to natural or manmade activities), could cause significant loss of habitat. More immediate effects from ORV use are also evident.

# Habitat and population monitoring for *Chloropyron maritimum* ssp. *palustre* and *Limonium californicum* on the Coos Bay North Spit

REPORT TO THE BUREAU OF LAND MANAGEMENT, COOS BAY  
DISTRICT

## INTRODUCTION

*Chloropyron maritimum* ssp. *palustre* (Point Reyes bird's-beak, still referenced as *Cordylanthus maritimus* ssp. *palustris* in USDA Plants Database; <http://plants.usda.gov/core/profile?symbol=COMA5>; Figure 1) is a USFWS Species of Concern, listed as Endangered by the state of Oregon, considered endangered or threatened throughout its range (List 1) by the Oregon Biological Information Center, and a Bureau Sensitive Species with the Bureau of Land Management. *Chloropyron maritimum* ssp. *palustre* is known to occur at 18 sites in Oregon, primarily the Coos Bay area, Yaquina Bay, and Netarts spit (Kaye 1991). *Limonium californicum* (Western marsh rosemary) is a Bureau Sensitive species and is also listed by the State of Oregon as critically imperiled due to rarity or vulnerability to potential extinction. Both species exist together in tidal flats on the North Spit, North Bend, Oregon.



ssp. *palustre*.

The population of *C. maritimum* ssp. *palustre* at the Coos Bay North Spit has relatively recently been protected from Off Highway Vehicle (OHV) use which had caused severe damage to the population. The population at the Coos Bay North Spit is one of the only protected populations of *C. maritimum* ssp. *palustre*. The population increased substantially following protection; however, in recent years, it appears to be declining (J. Sperling, Coos Bay BLM, personal communication). It has been hypothesized that in the

absence of disturbance, the density of other salt marsh plants, *Limonium californicum* (western marsh-rosemary) and *Salicornia depressa* (pickleweed) has increased, and may be inhibiting recruitment, growth, and/or reproduction of *C. maritimum* ssp. *palustre*. Changes in the plant community and industrial use of the surrounding bay may have also altered hydrology and sand accretion rates, thus changing site microtopography, and possibly contributing to altered salinity.

There are two primary objectives of this project.

1. Through a combination of annual mapping and monitoring of the population, we will track changes in population size and location through time of both *Chloropyron maritimum* ssp. *palustre* and *Limonium californicum*.
2. Evaluate differences in density of protected and unprotected portions of the populations of both *Chloropyron maritimum* ssp. *palustre* and *Limonium californicum*.

## SPECIES BACKGROUND

### *Chloropyron maritimum* ssp. *palustre*

Background information is repeated from Kaye (1991). Additional information can be found in Brian (2002).

#### Range

*Chloropyron maritimum* ssp. *palustre* (Figure 2) occurs along the Pacific Coast of North America from Morro Bay, San Luis Obispo County, California, and north to Netarts Spit, Tillamook County, Oregon. In Oregon, the majority of the populations are located in the Coos Bay area. *Limonium californicum* follows a similar distribution pattern along the western coastline.

#### Habitat

*Chloropyron maritimum* ssp. *palustre* is a salt marsh species. It occurs in low-sand salt marshes dominated by *Salicornia depressa*, *Distichlis spicata*, and *Jaumea carnosa*. Elevations are typically at, or just above, sea level. The Pacific Ocean exerts a strong marine influence over the climate of coastal wetlands, moderating environmental extremes. The annual precipitation along the Oregon coast averages about 180 cm, with an average January minimum temperature of 2-5°C, and an average July maximum of 20°C (Franklin and Dyrness 1973). *Limonium californicum* similarly occupies salt-marsh habitat at



Figure 2. *Chloropyron maritimum* ssp. *palustre* on the Coos Bay North Spit, note the two color variants, and the salt excretions on the bracts.



elevations millimeters to centimeters above the elevations where *C. maritimum* are found (personal observation).

### **Description**

*Chloropyron maritimum* ssp. *palustre* grows to 10 to 31 cm in height. Flowers are less than 3.5 cm in length, usually pinkish to purple, though some yellowish-white color variation is also seen. Floral bracts are oblong with a pair of short teeth at the tip. Foliage is grayish green and often villous (Eastman 1990; Figure 1; Figure 2).

### **Reproductive Biology**

*Chloropyron maritimum* ssp. *palustre* is an annual, reproducing from seed each year. It blooms from June through September (or October) and forms fruits from August through November. Seedlings have been observed in February at Yaquina Bay (T. Kaye, personal observation) and seeds may germinate throughout the winter and early spring. Laboratory studies of the non-marine species of *Chloropyron* show that the seeds from low-elevation species germinate well at moderate temperatures (10°C) and not at high temperatures (27°C), and seeds of high-elevation species require a cold pre-treatment (-14 to -13°C) to germinate (Chuang and Heckard 1971). Seeds of *C. maritimum* ssp. *maritimum*, a different subspecies found in salt marshes in southern California, require fresh water and six weeks of cold storage for germination (Fink and Zedler 1990a, 1990b), and benefit from 1 or 2 years of after-ripening and scarification (Newman 1981). The flower and attendant bracts of *C. maritimum* ssp. *palustre* form showy inflorescences similar to Indian paintbrush (*Castilleja*, a related genus), but no insects have been observed visiting this subspecies to date (Kaye et al. 1990). It is possible that *C. maritimum* ssp. *palustre* flowers are pollinated by a nocturnal visitor that was not observed, but we suspect that the flowers are self-pollinating. Fruit-set and seed-set were fairly high on most individuals from which seeds were collected in 1990, a trait typical of self-pollinating, annual plants (Weins 1984). In contrast, solitary bees that nest in nearby upland habitats are required for pollination of *C. maritimum* ssp. *maritimum*, and where pollinators are lacking, seed production is reduced (Lincoln 1985).

### **Population Biology**

At several sites in the Coos Bay area, *C. maritimum* ssp. *palustre* grows in dense patches and as dispersed individuals. Known populations across the Oregon coast, while rare (and scattered), often occur in dense patches and less often as dispersed individuals. This demographic pattern may relate to seed dispersal by water and to suitability of microsites for seedling establishment. Seeds dispersed by water and wind, may either spread over a wide area or accumulate in areas where suspended particles settle from the fluid (air or water). Work with *C. maritimum* ssp. *maritimum* indicates a heterogeneous microtopography causes seed entrapment and population establishment (Fink and Zedler 1990a).

### **Host Plants**

All species of *Chloropyron* are hemi-parasites, i.e., they derive some of their resources directly through photosynthesis and also from other plants through underground root connections (Chuang and Heckard 1971). Some species of *Chloropyron* are facultative hemi-parasites in that they are capable of completing their life-cycle without a host under the favorable conditions of a greenhouse, but the plants are almost certainly parasitic in the wild (Chuang and Heckard 1971). The natural hosts for *C. maritimum* ssp. *palustre* are most likely *Salicornia depressa*, *Distichlis spicata*, *Limonium californicum*, *Deschampsia*

*caespitosa*, and *Jaumea carnosa* (Chuang and Heckard 1971). Evidently, *C. maritimum* ssp. *palustre* lack host specificity. Instead, the species may have strong habitat preferences that maintain the associations with its standard hosts (Chuang and Heckard 1971). Vanderwier and Newman (1984) have shown that haustoria of *C. maritimum* ssp. *maritimum*, from southern California, are capable of inter- and even intra-specific parasitism in the field and the laboratory. It is not known how soon after germination a seedling in the field will establish a root-connection with a host.

### **Taxonomy**

*Chloropyron maritimum* ssp. *palustre* is a member of the subgenus *Hemistegia*. Chuang and Heckard (1973) used seed coat morphology to identify relationships within the genus. They revised this species in 1973, recognizing the Oregon coastal plants as the more northern subspecies *palustre*, and retaining subspecies *maritimum* for the southern California and Baja California plants. The latter subspecies is also a candidate for listing by the USFWS.

## ***Limonium californicum***

### **Range**

*Limonium californicum* occurs along the Pacific Coast of North America from San Diego County, California to isolated populations on the Southern Oregon Coast. In Oregon, the majority of the populations are located in the Coos Bay area.

### **Habitat**

*Limonium californicum* is a salt marsh species found at elevations below 50m. It occurs in low-sand salt marshes dominated by *Salicornia depressa*, *Distichlis spicata*, and *Jaumea carnosa*. See the habitat description of *C. maritimum* ssp. *palustre* for further details on salt marsh habitats.

### **Description, Reproductive and Population Biology**

*Limonium californicum* is a perennial with a heavy, reddish, woody caudex. The leaves are oblong to oblong-obovate, mostly obtuse. The blades are generally 5-20 cm long, tapering into petioles. Flowering stems are stout and generally 20-50 cm, loosely paniculate with branches densely flowered. Flowers are pale violet to white, 5-6mm long and 2mm wide (Jepson 1993; Figure 3). Hundreds of tiny lavender flowers appear and dry on the stalks, much like its ornamental relative, *Statice* (*Limonium* spp.). There is commonly a crust of salt crystals on the underside of the leaves, and at times whole leaves are white from the dried brine. *L. californicum* reproduces both vegetatively and by seed. It is not known what pollinators play a role in *L. californicum* reproduction; however various species of bumblebees have been observed visiting *L. californicum* flowers by IAE staff during monitoring, as well as some small fly species.

### **Taxonomy**

*Limonium californicum* is a member of the Plumbaginaceae family.





Figure 3. *Limonium californicum* on the Coos Bay North Spit. On the left, *L. californicum* can be seen co-occurring with *C. maritimum* ssp. *palustre*, the flowering stems of *L. californicum* stand above the surrounding vegetation, on the right, a close-up of the loose and branching panicle with many small flowers.

## METHODS

### Overview

This project was initiated in the *C. maritimum* ssp. *palustre* population on the Coos Bay North Spit Area of Critical Environmental Concern (T25S, R13W, Section 19, NNW) in Coos County, Oregon (managed by the Coos Bay District of the B LM) in summer 2010 (Table 1). In July 2010, we surveyed the population and delineated the population boundaries using GPS. This information was used to design the sampling and experimental protocols that were initiated in August 2010, and repeated in August 2011. In August 2011, the southwestern portion of the population (beyond the protective barrier) was surveyed for appropriate plot locations. In the protected area, transects were established in 2010, and 2011, with one additional transect added in 2014. In the unprotected area, transects were installed in 2011, and 2012. Twenty meter permanent monitoring transects were installed and marked with rebar topped with plastic caps at both ends. In the unprotected area the head of the transect was marked with rebar placed on the interior side of the road to prevent damage to vehicles using the area, and the monitored portion of the transect begins at the edge of vegetation on the east side of the 'road'. A summary of all transects installed and monitored as a part of this study are listed in Table 2. Transects are oriented perpendicular to the habitat margin, and extend 20m (Figure 4).

### Habitat and Community Measurements

Community composition data was recorded for all transects in 2010-2014. Percent cover for all species was recorded in 1m<sup>2</sup> increments along the right side of the transect, when viewed from the transect's origin. At each meter, on the 'right' side of the transect when standing at the origin, habitat classes were assigned. In 2014, only 5-10 of the 1m<sup>2</sup> plots were monitored for plant community, however all were assigned habitat classes. Photopoints were taken annually looking along each transect, from both the beginning and end and are available upon request.

### Measurements of *C. maritimum* ssp. *palustre*

*C. maritimum* ssp. *palustre* sampling occurred on four transects in 2010 and all transects in 2011-2014. *C. maritimum* ssp. *palustre* measurements include counting the number plants, as well as the number of branches and flowers on each plant, in a randomly placed 0.25m x 0.25m frame. See Appendix for details regarding protocols for plant monitoring and sub-sampling, as well as habitat class assignments.

### Measurements of *L. californicum*

*Limonium californicum* monitoring occurred on all transects in 2014. In 2014, sampling was modified to include measurements of *L. californicum* in the same area sub-sampled for *C. maritimum* ssp. *palustre*. *L. californicum* measurements included the count of individuals (seedlings, vegetative or reproductive, and the presence of aborted flowering stems) in the randomly placed 0.25m x 0.25m sub-sampling frame.

Table 1. Timeline of activities from 2010-2015. Initial stages of the study were implemented in 2012 and have been both modified and augmented since that time. In 2014, monitoring protocols were adapted to include measurements of *Limonium californicum*. Items in parentheses are scheduled pending funding for 2015.

ACTIVITY	2010			2011			2012			2013			2014			(2015)		
	Summer	Fall/Winter	Spring	Summer	Fall/Winter	Spring	Summer	Fall/Winter	Spring	Summer	Fall/Winter	Spring	Summer	Fall/Winter	Spring	Summer	Fall/Winter	Spring
Delineate Population in Protected Area	x			x			x			x			x			(x)		
Design Sampling Protocol	x																	
Establish long-term monitoring transects and experimental plots	x																	
Monitor long-term transects	x			x			x			x			x			(x)		
Take photopoints along all transects	x			x			x			x			x			(x)		
Enter and analyze data, write annual progress report		x			x			x			x			x			(x)	
Delineate Population (in unprotected Area)				x			x			x			x			(x)		
Design Sampling Protocol (in Unprotected area)				x														
Establish long-term monitoring transects and experimental plots in the unprotected area							x											

Table 2. List of long-term monitoring transects established as a part of this study.

AREA	TRANSECT #	YEAR ESTABLISHED	TAG # (ORIGIN)	TAG # (END)	BEARING	DISTANCE FROM ORIGIN TO VEG START (M)	TOTAL TRANSECT LENGTH (M)
PROTECTED	0	2010	750	871	132°	N/A	20
PROTECTED	2	2011	501	870	120°	N/A	20
PROTECTED	4	2010	751	873	130°	N/A	20
PROTECTED	7	2010	752	868	168°	N/A	20
PROTECTED	11	2010	753	867	255°	N/A	20
PROTECTED	13	2011	514	865	276°	N/A	20
PROTECTED	15	2010	754	869	252°	N/A	20
PROTECTED	16	2011	515	866	250°	N/A	20
PROTECTED	17	2011	517	872	125°	N/A	20
PROTECTED	18	2012	502	864	282°	N/A	20
PROTECTED	19	2014	862	863	200°	N/A	20
UNPROTECTED	20	2012	391	N/A	114°	16	36
UNPROTECTED	21	2012	400	N/A	128°	12	32
UNPROTECTED	22	2012	388	N/A	118°	11.5	31.5
UNPROTECTED	23	2012	385	N/A	124°	16	36
UNPROTECTED	24	2014	386	N/A	130°	17	37
UNPROTECTED	25	2014	387	N/A	124°	13 (right before SADE)	33
UNPROTECTED	26	2014	389	N/A	120°	24 (R of stream)	44 (end in tidal flat)
UNPROTECTED	27	2014	390	N/A	120°	11	31
<b>TOTAL # OF TRANSECTS</b>	<b>19</b>						

## Population Estimates

In 2010, information from the sample-plots was used to estimate the total population size of *C. maritimum* ssp. *palustre* by multiplying the average number of plants  $m^{-2}$  ( $\theta$ ) by the total habitat area ( $N = 2294 m^2$ ):

$$\text{population size estimate} = \theta * N$$

In 2011, the sampling method was modified to increase sampling efficiency and accommodate the heterogeneity of the habitat at the site. In 2014, we began using the modified method to estimate the total population size for *L. californicum*. Along each 20m transect, a habitat class was assigned to each 1  $m^2$  plot (Table 3). To estimate total population size, the average number of plants per  $m^2$  in each habitat type was determined and multiplied by the area covered by each habitat type.

## Mapping

In addition to monitoring transects, the area occupied by the *C. maritimum* spp. *palustre* population was mapped by habitat class. Habitat classes were defined as described in Table 3. Boundaries between habitat classes were delineated using an Oregon GPS 450 handheld unit. Data was compiled using MapWindow, an open source GIS software, to delineate boundaries between habitat types. In 2012-2014, the unprotected area was also mapped using the same habitat class delineations used in the protected area.

Table 3. Habitat codes used for mapping in 2011-2014. Heavily disturbed areas (with rutted tire tracks) were also noted in the unprotected area.

Code	Habitat	Description
CF	<i>Chloropyron</i> flat	<i>Chloropyron</i> cover $\geq$ 50%
LCF	<i>Limonium</i> - <i>Chloropyron</i> flat	<i>Limonium</i> , <i>Chloropyron</i> codominant
LF	<i>Limonium</i> flat	<i>Limonium</i> cover $\geq$ 50%
GT	Grass transition	Differentiated by presence of <i>Ammophila</i> or <i>Leymus</i> , marks transition into small stabilized dune habitat. Some <i>Chloropyron</i> present but only in trace amounts. This is the absolute upper boundary of COMAPA habitat.
SD	<i>Salicornia</i> depression	<i>Salicornia</i> dominant species; area of higher water during the tide. Differs from waterway by abundant <i>Salicornia</i> , and little to no bare sand.
SDD	<i>Salicornia</i> - <i>Distichlis</i> depression	<i>Salicornia</i> dominant, but <i>Distichlis</i> cover $\geq$ 25%
Sand	Sand	Highest reach of the tide, but water does not linger here for long. At least some COMAPA in trace amounts.
Waterway	Waterway	Other plants may be here, but not appropriate habitat for COMAPA. Various courses throughout entire area, usually adjacent to SD, SDD.
D-Rise	<i>Distichlis</i> rise	Small hill, <i>Distichlis</i> dominated, with minor patches of <i>Jaumea carnosa</i> nearest to the ocean.
Marsh	Marshy area	Marshy area dominated by <i>Scirpus</i> sp., area inundated by tides.





Figure 4. Area surveyed for *Chloropyron maritimum* ssp. *palustre*. Blue lines indicate monitoring transects established in 2010-2012. See Appendix A for maps and information regarding all monitoring transects.



Figure 5. Monitoring transect in the protected area showing the patchiness of the habitats, which are greatly influenced by microtopography. Photopoints from each monitoring transect are included in Appendix A.

## Community Analysis

We used a common ordination method, non-metric multidimensional scaling (NMS) ordinations (Kruskal 1964), to assess relationships of individual species cover relative to primary gradients in the plant community (ordination axes). NMS is an ordination method that is best used for community analyses, often with non-normal data with non-linear relationships (McCune and Grace 2002). Due to heterogeneity in the data set, rare species that occurred in 5% or less of the plots were deleted and species cover data was  $\log(x+1)$  transformed to reduce skewness. We assessed species data relative to an environmental matrix with cover data of bare ground, litter, and algae. NMS ordinations were performed using PC-ORD version 6.0 (McCune and Mefford 2011) with the autopilot setting “slow and thorough” mode, Sørensen distance measure, and no penalty for ties. We ordinated data from 2014 only to look at trends related to the plant community in protected and unprotected areas. In addition, we conducted an ordination on data from all five years in the protected area.



Differences in plant community between protected and unprotected areas (in 2014 only) were tested with multi-response permutation procedure (MRPP; Mielke and Berry 2001) using the Sørensen distance measure, in PC-ORD. Due to differences found using MRPP, we conducted an Indicator Species Analysis to investigate if species were associated with the protected or unprotected area. Indicator Species Analysis combines relative abundance and relative frequency of a species in defined groups, and produces indicator values (IVs), which are the percentage of perfect indication for a species within a particular group (McCune and Grace 2002). Statistical significance of indicator values ( $p$ -value) is evaluated using a Monte Carlo method of randomizations; 1000 randomizations were run to determine the proportion of random trials that gave indicators equal to or greater than the observed.

## RESULTS

### Population Survey

#### *Chloropyron maritimum* ssp. *palustre*

The edges of the *C. maritimum* ssp. *palustre* population at the North Spit were defined by *Pinus contorta* var. *contorta*/*Cytisus scoparius* scrub transitioning to *Ammophila arenaria*/sand with scattered *Leymus mollis*. This drops off into an area more regularly impacted by tides/waves. *Chloropyron maritimum* ssp. *palustre* distribution is patchy, from clumps of plants scattered in dense stands of *S. virginica*, to large swathes interspersed with *L. californicum*. Until 2014, *L. californicum* was nearly absent in the disturbed area. Both color morphs (green and purple) of *C. maritimum* ssp. *palustre* were evenly represented throughout the population.

Variation in density and size of *C. maritimum* ssp. *palustre* may be due to a combination of plant community and abiotic factors. Microtopographic variations also effect the levels of inundation experienced on site. The establishment (and subsequent stabilization) of substrate has been noted particularly in the protected area, where *L. californicum* cover has increased; most likely due to decreases in disturbance to this perennial species.

We estimated that in 2010, the total number of *C. maritimum* ssp. *palustre* in the protected area at the North Spit was 380,991 plants. In 2011-2014, due to the patchiness of the population, the population size in the protected area was estimated by calculating the average number of plants per m<sup>2</sup> in all habitat classifications and then multiplying by the areal cover of each habitat class (Table 4). In the protected area, the population of *C. maritimum* ssp. *palustre* has ranged from a high of ~916,000 in 2011 to a low of ~124,000 in 2012. In 2014 the population of *C. maritimum* ssp. *palustre* is estimated to be ~508,000 (Table 5). The precipitous drop of *C. maritimum* ssp. *palustre* between 2011 and 2012 in the protected area coincides with decreases in the cover of *C. maritimum* spp. *palustre* dominated habitat classes (CF and less so LCF) and increases in the cover of *Limonium* dominated habitat types (LF).

In 2012, the population in the unprotected area was estimated to contain ~545,000 *C. maritimum* spp. *palustre* plants, and in 2013, this number decreased to ~296,000 (Table 5). Values rebounded in 2014 (Figure 6). In the unprotected area, the population of *C. maritimum* spp. *palustre* has ranged from a low of ~296,000 in 2013 to and a high of ~1,003,000 in 2014 (Table 5).

Both the protected and unprotected populations have followed similar trends indicating that similar factors are influencing the population dynamics in both portions of the population (Figure 6). Continued monitoring of transects combined with habitat surveys is recommended on at least a three-year cycle to elucidate the population trends for both listed species in the protected and unprotected portions of the site. More regular monitoring is recommended if activities that could affect microtopography at the site are to be undertaken (including but not limited to dredging activities).

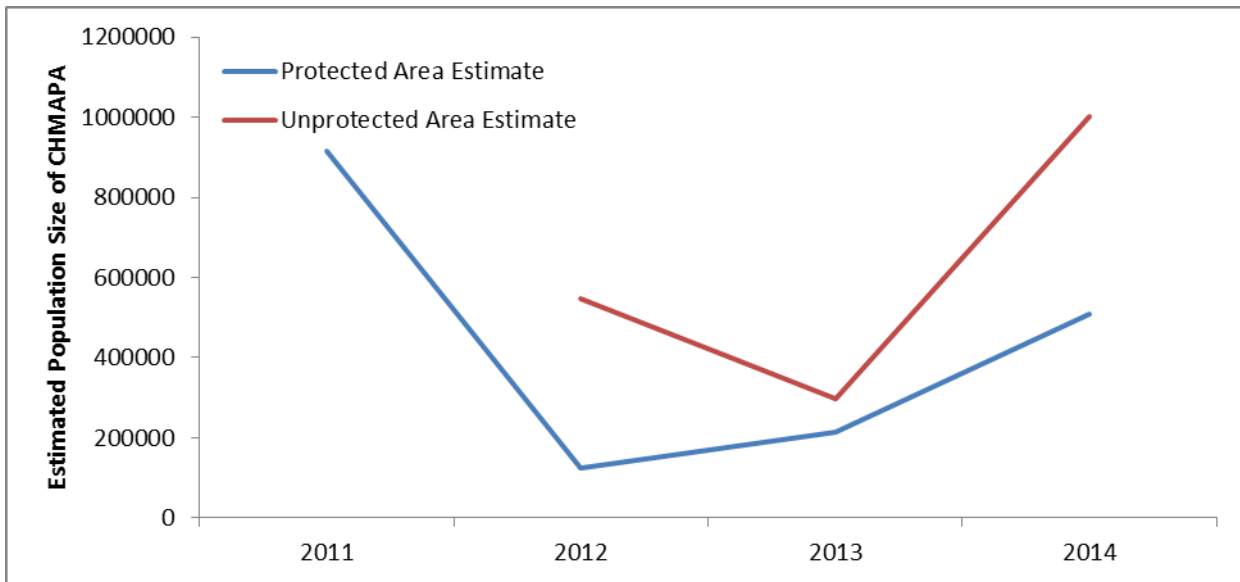


Figure 6. Estimated population size of *Chloropyron maritimum* ssp. *palustre* on the Coos Bay North Spit from 2011-2014.

Table 4. Areal cover of each habitat type and number of *Chloropyron maritimum* ssp. *palustre* plants per m<sup>2</sup> in protected and unprotected areas at North Spit from 2011-2014. The unprotected area was not mapped in 2011.

Habitat Code	Area (m <sup>2</sup> )				CHMAPA/m <sup>2</sup>				
	2011	2012	2013	2014	2011	2012	2013	2014	
PROTECTED	CF	293	3	7	8	978	256	256	1094
	DRise	393	353	271	213	0	0	0	0
	GT	928	930	435	487	0	0	0	0
	LCF	1468	337	693	576	425	254	254	577
	LF	498	1398	1386	2198	12	15.5	15	60
	Marsh	214	353	178	577	0	0	0	0
	Sand	110	72	33	417	0	0	0	0
	SD	1011	1662	2379	431	0	1.8	2	23
	SDD	747	1492	1339	2349	0	9	9	16
	Waterway	645	681	626	868	0	0	0	0
UNPROTECTED	CF		1268	973	213		331	181	784
	DRise		-	1268	1621		-	0	0
	LCF		0.0	-	719		245	-	700
	Marsh		66	36	65		0	0	0
	SD/SDD		0.0	-	0.0		19	-	17
	SD/SDD		20310	19297	20079		6	6	26
	Waterway	N/A	132	92	110	N/A	0	0	0

Table 5. Population estimates for *Chloropyron maritimum* spp. *palustre* by habitat in protected and unprotected areas at North Spit. The unprotected area was not mapped in 2011.

		CHMAPA			
Habitat Code		2011	2012	2013	2014
PROTECTED	CF	286554	768	1675	8314
	DRise		0	0	0
	GT		0	0	0
	LCF	623900	85598	175995	320206
	LF	5976	21674	20291	132019
	Marsh		0	0	0
	Sand		0	0	0
	SD		2955	4229	9968
	SDD		13428	12047	37589
	Waterway		0	0	0
<hr/>					
UNPROTECTED	CF	-	419285	176354	166678
	DRise	-	0	0	0
	GT	-	0	0	0
	LCF	-	0	0	503150
	LF	-	0	0	0
	Marsh	-	0	0	0
	Sand	-	0	0	0
	SD	-	0	0	0
	SDD	-	126373	120069	333620
	Waterway	-	0	0	0
<b>Protected Area Estimate</b>	<b>916430</b>	<b>124423</b>	<b>214238</b>	<b>508096</b>	
<b>Unprotected Area Estimate</b>		<b>545659</b>	<b>296422</b>	<b>1003448</b>	
<b>TOTAL</b>		<b>670081</b>	<b>510660</b>	<b>1511544</b>	

### **Limonium californicum**

In 2014 monitoring plots were also assessed for *L. californicum*. Over the course of this study, it was noted that the cover of *L. californicum* was increasing in both the protected and unprotected areas (Table 6, Table 7). Increased monitoring efforts allowed us to make population estimates using the same methodology employed for *C. maritimum* ssp. *palustre*; by calculating the average number of *L. californicum* plants in each mapped habitat class and scaling based on the area occupied by each habitat class. In 2014, the estimated population size of *L. californicum* in the unprotected area was 130,210 (Table 7). In the protected area, the population was estimated to be 832,518 in 2014 (Table 7).

Table 6. Areal cover of each habitat type, and number of *Limonium californicum* seedlings, vegetative and reproductive plants per m<sup>2</sup> in the unprotected and protected areas at North Spit in 2014.

	Habitat Code	seedlings/m <sup>2</sup>	veg/m <sup>2</sup>	repro/m <sup>2</sup>	Total LICA/m <sup>2</sup>
		2014	2014	2014	2014
PROTECTED	CF	10	56	13	79
	D-rise	0	37.3	21.3	58.7
	GT	6.4	0	0	6.4
	LCF	4.8	128	39.9	172.6
	LF	15.8	207.1	92.5	315.4
	SD	3	6.2	1.8	11
	SDD	0	4.7	3.3	8
UNPROTECTED	CF	2.9	8.7	4.4	16
	D-rise	0	1.5	0	1.5
	LCF	8	76	56	140
	Marsh			0	
	SD	0	1.2	0	1.2
	SDD	0.2	4.6	0.7	5.5

Table 7. Population estimates for *Limonium californicum* by habitat in protected and unprotected areas at North Spit. Areal cover of each habitat type by year are listed in Table 4.

		<b>LICA</b>
<b>Habitat Code</b>		<b>2014</b>
<b>PROTECTED</b>	CF	593
	DRise	12496
	GT	3123
	LCF	99608
	LF	693166
	Marsh	0
	Sand	0
	SD	4740
	SDD	18792
	Waterway	0
<hr/>		
<b>UNPROTECTED</b>	CF	3392
	DRise	2358
	GT	0
	LCF	100660
	LF	0
	Marsh	0
	Sand	0
	SD	23800
	SDD	0
	Waterway	0
<b>Protected Area Estimate</b>	<b>832518</b>	
<b>Unprotected Area Estimate</b>	<b>130210</b>	
<b>TOTAL</b>	<b>962728</b>	

## Community Analysis

The NMS ordination of sample units in species space (Figure 3) in the protected habitat (2010-2014) resulted in a 3-dimensional stable solution (final stress = 12, final instability = 0.000). A randomization test confirmed that final stress was lower than expected by chance ( $p = 0.02$ ). Sample units from 2010, 2011, 2012, 2013, and 2014 tended to be intermixed in species space. *C. maritimum* ssp. *palustris* (COMAPA) was strongly negatively correlated with Axis 1 ( $r = -0.47$ ), along with natives *L. californicum* (LICA;  $r = -0.87$ ), *Plantago maritima* (PLMA;  $r = -0.52$ ), and *J. carnososa* (JACA;  $r = -0.45$ ). *S. depressa* (SADE) had a strong positive correlation with Axis 1 ( $r = 0.85$ ) along with *Distichlis spicata* (DISP;  $r = 0.23$ ), the distribution of these species suggests that they do not co-occur with many others in the plant community at this site. Litter was negatively associated with Axis 2 ( $r = -0.44$ ), along with *Spergularia macrantha* (SPMA;  $r = -0.27$ ). Ordination scores were similar to those in recent years, suggesting that these species associations remain over time but can shift slightly (Figure 3). From 2010 to 2013, sample units shifted downward along Axis 2, which was most associated with *D. spicata* ( $r = -0.61$ ), *C. album* ( $r = -0.35$ ). Trends from 2010-2013 suggested that these communities could be slowly moving toward species associations that are not necessarily supportive of *C. maritimum* ssp. *palustris*. In 2014, sample units were more contained in species space. The closer proximity of sample units in species space indicates that in 2014 species composition was more similar than in previous years. This could have been the result of fewer plots being sampled fully for the plant community in 2014. *C. maritimum* ssp. *palustris* continued to be associated with species such as *L. californicum* and *J. carnososa* which are known as potential host plants for the hemi-parasite. These trends are similar to those observed in previous years. *Salicornia depressa* and *Distichlis spicata* were associated with each other but few other species, indicating that these species do not co-exist well with *C. maritimum* ssp. *palustris* or others that are prevalent in the community.

Protected and unprotected habitats differed significantly in community composition in 2014 (MRPP;  $A = 0.12$ ,  $P < 0.0000$ ). Species richness was greater in protected habitat than in unprotected habitat (15 and 12, respectively). Many species were identified as indicators of either the protected or unprotected habitats (Table 7). *Cordylanthus maritimum* ssp. *palustris* was an indicator of the protected area ( $p < 0.01$ ) in both 2013 and 2014. Indicators of the protected area also included *C. pacifica*, *J. carnososa*, *L. californicum*, *P. maritima*, *P. pumila*, *S. macrotheca*, and *T. maritima*. Similar to 2013, indicator species of the unprotected habitat were *D. spicata* and *S. depressa*. *C. maritimum* ssp. *palustris* occurred in both habitats it had higher average cover in the protected area than in the unprotected (10.9% and 3.8%, respectively). Cover in the protected area increased from that in 2013 (6.2%). *Limonium californicum* occurred in both habitats but was much more prevalent in the protected area than in the unprotected area (31.9% and 1.6%, respectively). This very large difference in cover between the protected and unprotected areas suggests that *L. californicum* may be more sensitive to disturbance.

*C. maritimum* ssp. *palustris* had patchy abundance within the untreated area. Within those patches, it was very abundant. These results were consistent with the percentage of transects composed of specific habitat classes; protected habitats had much greater composition of *Limonium* flat than unprotected in 2014 (Figure 4). Likewise, transects in the unprotected habitat had greater percentages of *Salicornia* depression and *Salicornia*-*Distichlis* depression than in protected habitats (Figure 4). *Cordylanthus* flat was close to equal in both protected and unprotected habitats. While *C. maritimum* ssp. *palustris* was present in both habitats, the dominance of *Salicornia* and *Distichlis*- suggests that *C. maritimum* will continue to struggle under these conditions.



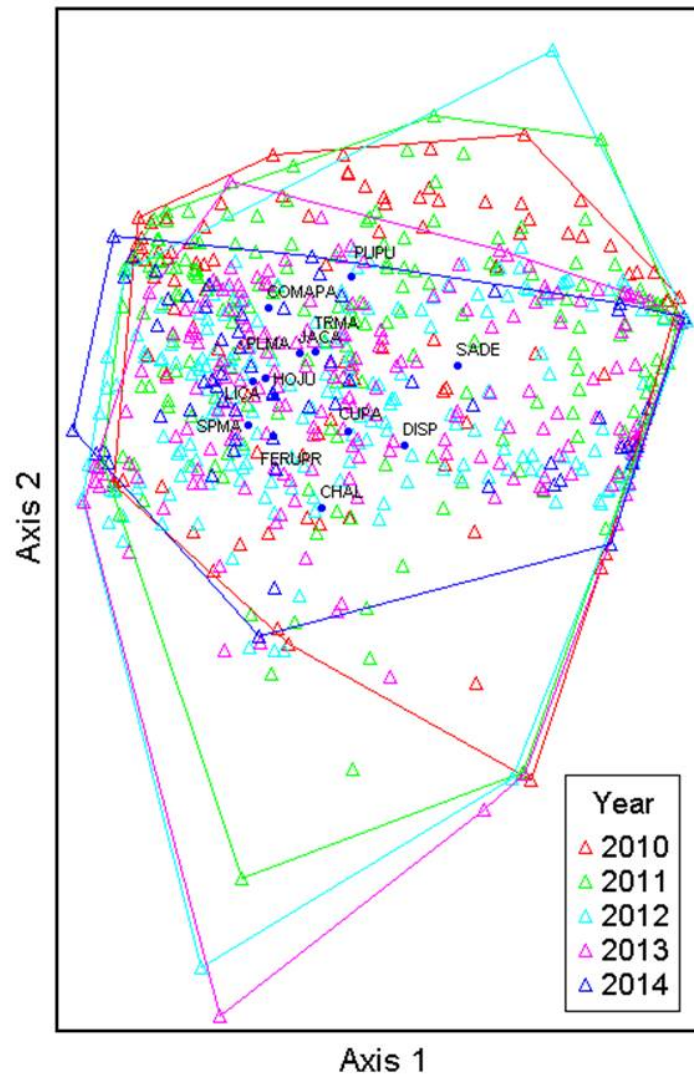


Figure 7. NMS ordination of community composition within the protected area of the *Chloropyron maritimum* ssp. *palustris* population at the Coos Bay North Spit (2010, 2011, 2012, 2013, and 2014). Triangles represent sample units (quadrats along transects) in species space, and distance between points indicates similarity of community composition by quadrat. Polygons outline the extent of all of the sample units in species space. Blue dots indicate the centroid for species locations in species space. Blue dots and species abbreviations (in black, Table 7) indicate their locations in species space. Variance explained by Axis 1 was 52%, while Axis 2 explained 22% of the variance.

Table 8. Species list including nativity from plots within the *Cordylanthus maritimum* ssp. *palustris* population at the Coos Bay North Spit in 2014. Species codes are from the USDA PLANTS database (USDA NRCS 2012). Species included in the indicator species analysis noted Indicator Species column, 'Habitat' refers to the area they indicate and 'P value' is associated with the indicator value for that species. \* indicates species that occurred in less than 5% of the sample units and were not included in the Indicator Species Analysis.

Species	Code	Nativity	Indicator species?	Habitat	P value
<i>Ammophila arenaria</i>	AMAR	Exotic	*		
<i>Cerastium glomeratum</i>	CEGL	Exotic	*		
<i>Chenopodium album</i>	CHAL	Exotic	*		
<i>Chloropyron maritimum</i> ssp. <i>palustris</i>	COMAPA	Native	Y	Protected	0.0006
<i>Cuscuta pacifica</i>	CUPA	Native	Y	Protected	0.0002
<i>Distichlis spicata</i>	DISP	Native	Y	Unprotected	0.0004
<i>Grindelia stricta</i>	GRST	Native	*		
<i>Holcus lanatus</i>	HOLA	Exotic	*		
<i>Hordeum jubatum</i>	HOJU	Native	*		
<i>Jaumea carnosa</i>	JACA	Native	Y	Protected	0.004
<i>Juncus</i> sp.	Juncus	Native	*		
<i>Leymus mollis</i>	LEMO	Native	*		
<i>Limonium californicum</i>	LICA	Native	Y	Protected	0.0002
<i>Plantago maritima</i>	PLMA	Native	Y	Protected	0.0006
<i>Puccinellia pumila</i>	PUPU	Native	Y	Protected	0.008
<i>Rumex acetosella</i>	RUAC	Exotic	*		
<i>Salicornia depressa</i>	SADE	Native	Y	Unprotected	0.0002
<i>Spergularia macrotheca</i>	SPMA	Native	Y	Protected	0.007
<i>Triglochin maritima</i>	TRMA	Native	Y	Protected	0.002

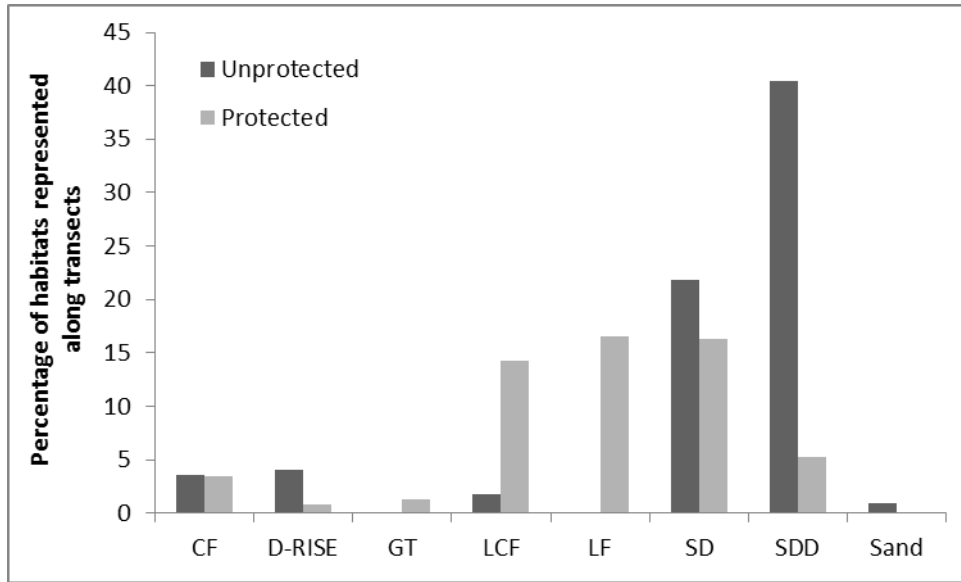


Figure 8. Percent of habitat classes represented along transects in both protected and unprotected habitats (2014). Habitat classes correspond to Table 3.

## Vegetation Removal

In 2011-2013, we compared the percent change in community composition and population size of *C. maritimum* ssp. *palustre* in treated plots to that of untreated plots to determine if vegetation removal had any effect on *C. maritimum* ssp. *palustre*. Removal of vegetation did not have a significant effect on the cover of *C. maritimum* ssp. *palustre*. There was a significant positive effect of vegetation removal on the cover of *Jaumea carnosa*, and *Limonium californicum*. Removal of vegetation had a slight negative effect on *Salicornia depressa* in the first year after vegetation removal, however this was not accompanied by increases in vegetation but rather increases in bareground. *Puccinellia pumila* and *Distichlis spicata* cover was lower in areas where vegetation removal had occurred, however the overall cover of these species is low. In the first year following treatment bare ground increased, however by 2012 vegetation had filled in and there was not a significant change in cover of bare ground. Decreases in *C. maritimum* ssp. *palustre* in 2012 and 2013 were consistent with decrease in cover of the species throughout the site.

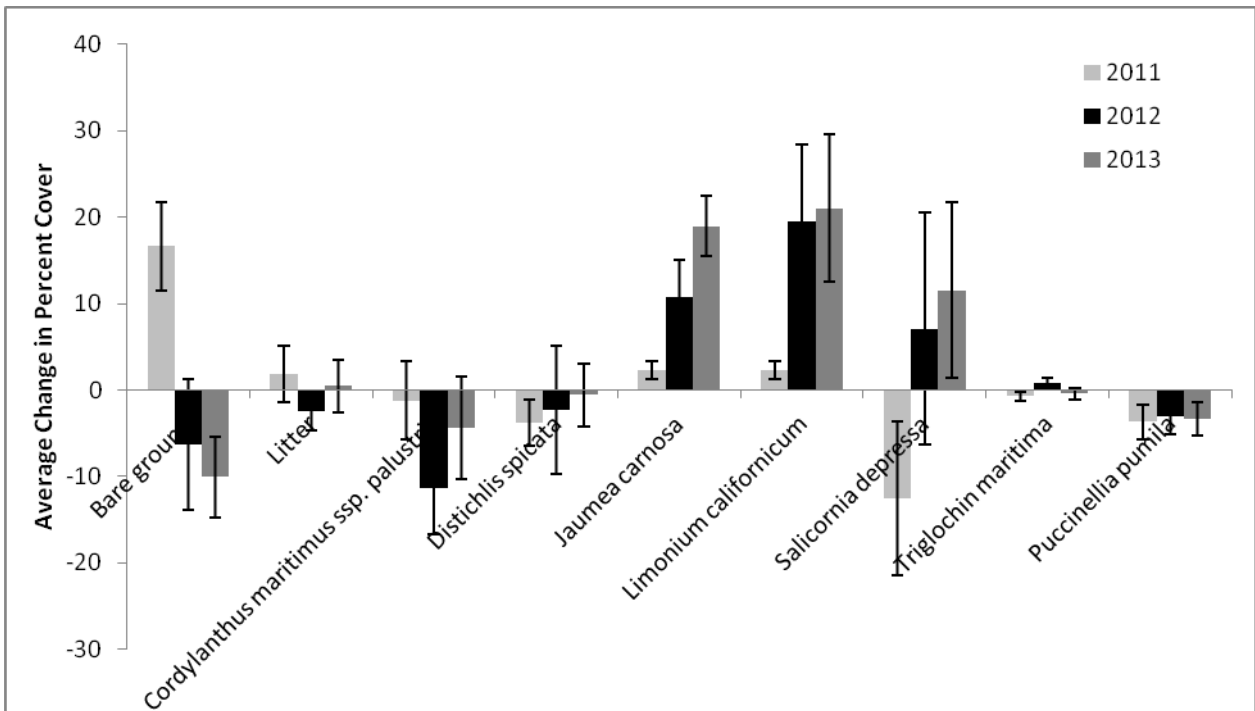


Figure 9. Average change in percent cover of select species in vegetation removal plots. Vegetation was removed so that total vegetative cover was approximately 70%. Plots were monitored in 2011-2013 to evaluate the effectiveness of vegetation removal. Species not shown above had a less than 1% change in cover from 2010 to 2013. Error bars represent  $\pm 1$  SE.

## Habitat Mapping

In 2011-2014 a habitat map was created using the habitat classes listed in Table 3 (Figure 10). The map has been updated annually to detect shifts in habitat type that may affect the success of *C. maritimum* ssp. *palustre* and *L. californicum*. In both the areas, the density of *C. maritimum* ssp. *palustre* has fluctuated annually, (range 181-1064 plants/m<sup>2</sup>), however in each year, the changes in density have been consistent between protected and unprotected areas. For example, in years where density of *C. maritimum* ssp. *palustre* was low in CF habitats in the protected area, the density was also low in the unprotected area's "CF" habitat (Figure 6, Table 4). In 2014, in the protected area, the density of *L. californicum* was consistently higher than in the unprotected area, in CF and LCF habitat types (Table 6).

### Protected Area

In 2011, we surveyed ~7,000m<sup>2</sup> of occupied habitat in the protected area, with 293 m<sup>2</sup> mapped as "Chloropyron Flat" (CF) and 1,468 m<sup>2</sup> *Limonium-Chloropyron* Flat (LCF). In 2012, there were changes in cover of all habitats associated with *C. maritimum* ssp. *palustre*; CF cover decreased to only 3m<sup>2</sup>, and the cover of LF increased considerably from 498m<sup>2</sup> in 2011 to 1398 m<sup>2</sup> in 2012. From 2011-2012, there were also increases in both the "Salicornia Depressions" (SD) and "Salicornia-Distichlis Depressions" (SDD) cover. In 2013 and 2014, this trend continued with a shift towards *Limonium* dominated plant communities and lower cover of *C. maritimum* ssp. *palustre*. In 2014, the cover of LF habitat increased, and cover of LCF habitat decreased in the protected area. From 2011-2014 the relative cover of each of the habitat types occupied by the sensitive species (CF, LCF and LF) has varied from being *C. maritimum* ssp. *palustre* dominant to *L. californicum* dominant, although the total cover of occupied habitat types has remained relatively stable at ~2,500 m<sup>2</sup> collectively in the protected area.

### Unprotected Area

In 2012, the habitat in the southern, disturbed portion of the area was also mapped using the same habitat classifications. Because the southern area is so much larger than the protected area, (~22,000 m<sup>2</sup> compared to ~7,200 m<sup>2</sup>), the habitat mapping in the unprotected area is at a much coarser resolution than that in the protected area. In the southern unprotected area the dominant habitat class is SDD with *Distichlis spicata* co-occurring with *Salicornia* in more than 90% of the habitat. "Chloropyron Flats" were the next most common habitat type covering approximately 1,200 m<sup>2</sup> in 2012 and ~1,000m<sup>2</sup> in 2013. Cover of LCF has increased since mapping began, and in 2014 700 m<sup>2</sup> of LCF was mapped in the unprotected area. In addition to habitat classes, the boundaries of the disturbed area were marked in 2012-2014 and overlaid onto the habitat map (Figure 10).

## CONCLUSIONS

There was high variability in the number *Chloropyron* from 2010-2014, with population estimates ranging from a low of ~124,000 in 2012 to ~916,000 in 2011, in the protected area. In the unprotected area, the population has ranged from a low of 296,000 in 2013 to a high of just over 1,000,000 in 2014.

Vegetation removal experiments did not elucidate any potential effects of competitors on *Chloropyron* growth. As this species is a hemi-parasite and known to be associated with higher cover of select species, it is not surprising that we did not find a positive effect of our vegetation treatment. While it is known that the

species is a hemi-parasite, with limited host specificity, it is unknown which adjacent plant species are being parasitized by *Chloropyron*.

Population and density estimates of *Limonium californicum* calculated in 2014 indicate that the population in the protected area has more plants/m<sup>2</sup> in occupied habitats, and has more areal cover than the scattered patches in the unprotected area. In the protected area, the density of plants is 79 plants/m<sup>2</sup> in the 'CF' habitat, and only 16 plants/m<sup>2</sup> in the unprotected portion. Areal cover of occupied habitats, was also greater in the protected area than in the unprotected area.

From 2011-2014 there were fluctuations in the cover of different habitat classes in the protected area; particularly in the cover of habitat types associated with *Limonium californicum*. It is likely that this perennial plant is benefitting from the lack of disturbance in the protected area. Very little *L. californicum* was found in the unprotected area, and rarely enough to classify the habitat as "LCF" or "LF" at the scale mapped. Additionally, it was noted that the *C. maritimum* ssp. *palustre* was commonly associated with the disturbed areas in the unprotected area, and patches were found in the same locations across years (Figure 11). Continued habitat mapping and population surveys will elucidate general population trends of these two bureau sensitive species, which will allow for more targeted management recommendations to be made.

## RECOMMENDATIONS

It is recommended that transects in both the protected and unprotected area continue to be monitored into the future on at least a three year cycle unless natural or manmade activities could cause substantial changes in microtopography or local sea-level. We also recommend continued (and coincident) data collection be continued on the Bureau Sensitive *Limonium californicum* in the area. The presence of *C. maritimum* ssp. *palustre* in the disturbed portion of the unprotected area, and the increasing dominance of *L. californicum* in the protected area indicates that further work may be necessary to balance the needs of both species.

Future work on the species may include further investigation and characterization of the parasitic relationship between *C. maritimum* ssp. *palustre* and its hosts; identification of pollinators (of both sensitive species) as well as microtopographical effects on the presence, abundance and establishment of both species. Future work can also begin to examine potential causes for changes in the cover of habitat classes over our study period. In the protected area, we have seen a dramatic shift towards increasing cover of *Limonium californicum*, in the protected area, whereas little to none is found in the unprotected area. Comparing the observed changes against local climate factors, land-uses changes, or other physical factors including both local and global sea level changes could potentially provide valuable information for management of these populations into the future.

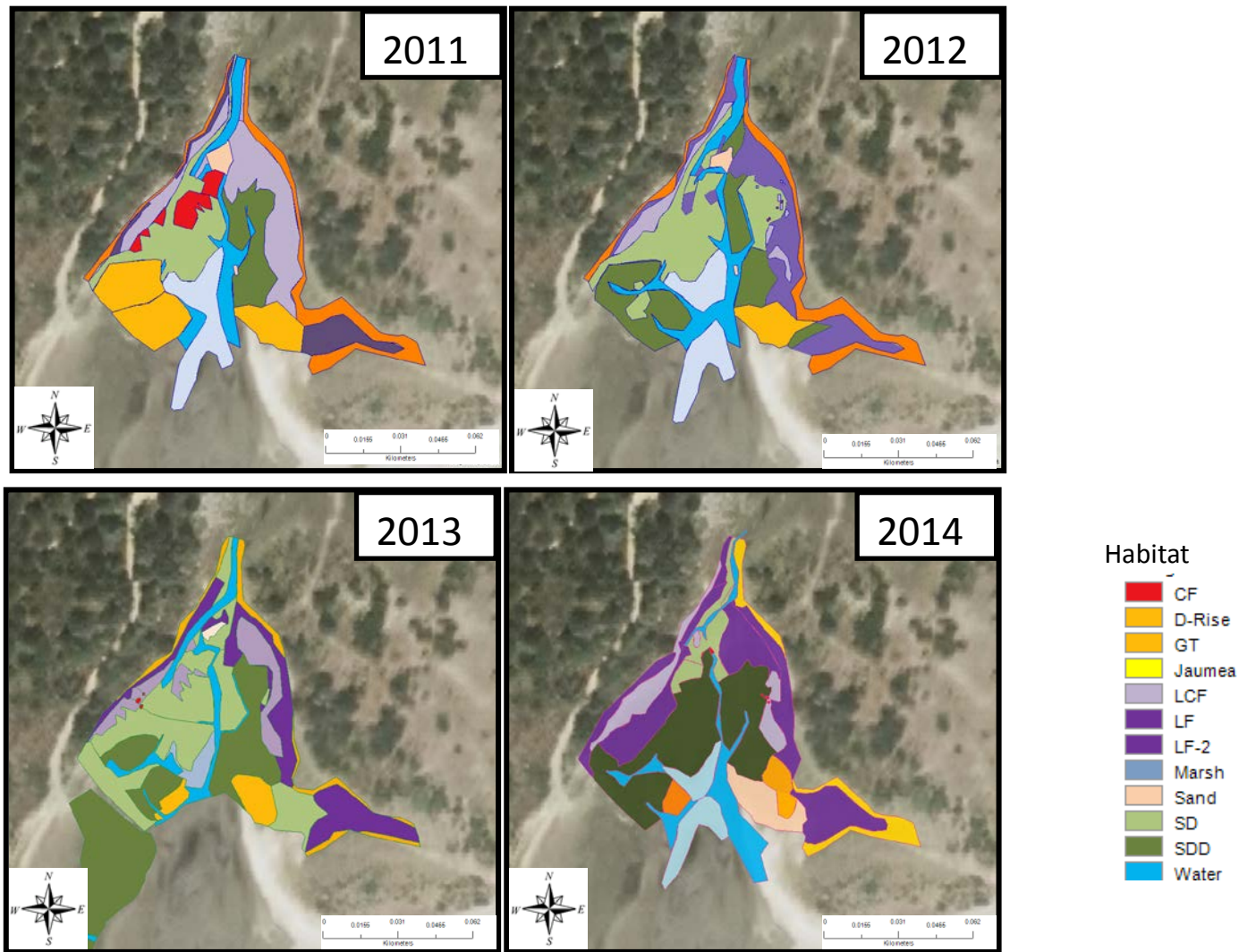


Figure 10. *Chloropyron maritimum* ssp. *palustre* population at the Coos Bay North Spit, created in 2011-2013. Habitat codes are listed in Table 3. Major changes from 2011-2013 include a decrease in the cover of both “Chloropyron Flat” (CF) and increases in the cover of “*Limonium Chloropyron Flat*, (LCF) and “*Limonium Flat*” (LF).



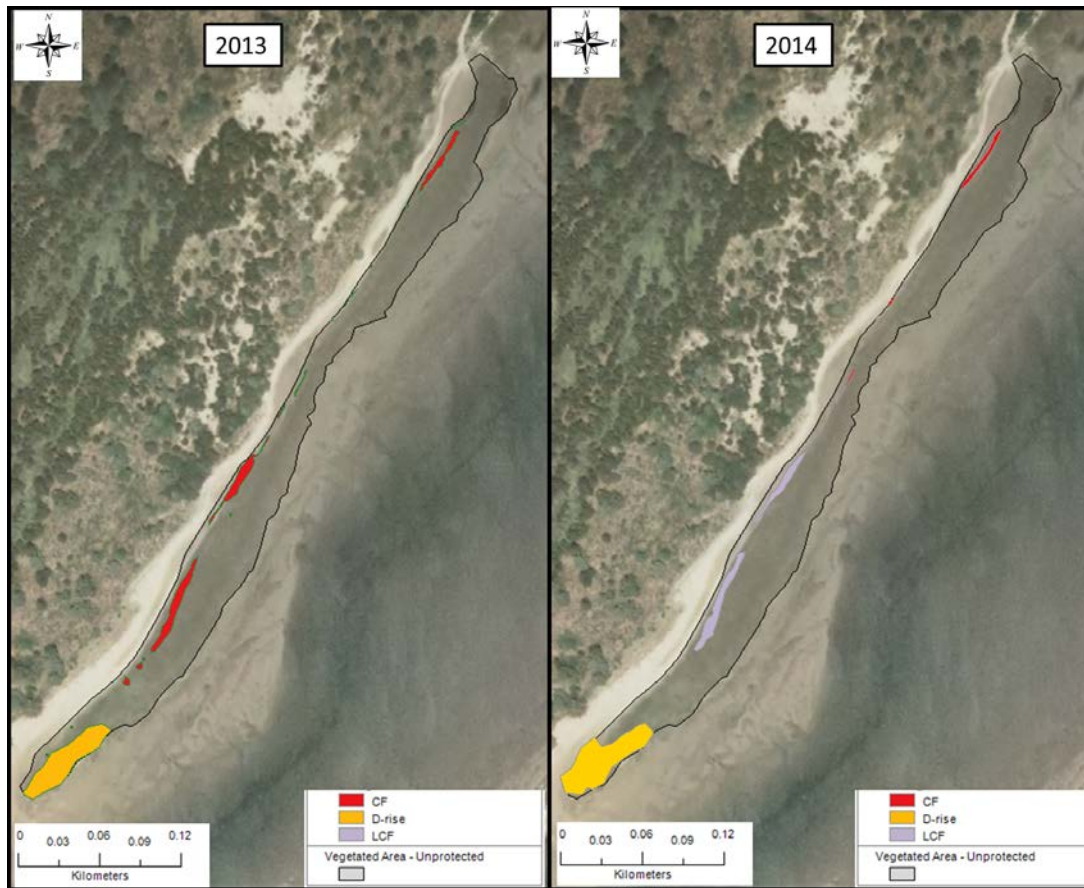


Figure 11. 2013-2014 habitat maps for unprotected area. The remaining ‘vegetated’ area is classified as either SD or SDD based on habitat classes described in Table 3. Note that while the presence of *C. maritimum* ssp. *palustre* is quite patchy in this area, the location and extent of these patches have remained relatively stable over the course of this study.





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APPENDIX A. SAMPLING TRANSECT PHOTOPOINTS

**Transect 0, Tag #750**

0m-20m	20m-0m
<b>2010</b>	
	
<b>2011</b>	
	
<b>2012</b>	






2013



2014



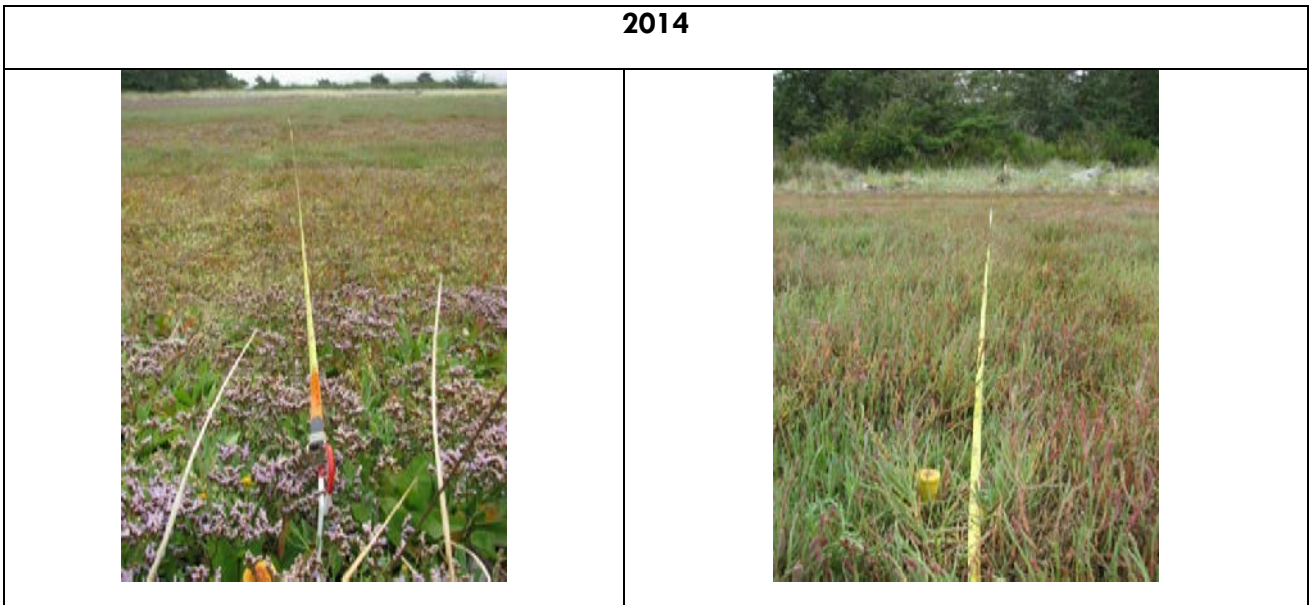
**Transect 2, Tag #516 (501)**

0m-20m	20m-0m
<b>2011</b>	
 <p>COMAPA11 Trans. 2 0-20</p>	 <p>COMAPA11 Trans. 2 20-0</p>
<b>2012</b>	
 <p>COMAPA 2012 TRANSECT 2 0-20 m</p>	 <p>COMAPA 2012 TRANSECT 2 20-0 m</p>
<b>2013</b>	









**2014**



**Transect 4, Tag #751**

0m-20m	20m-0m
<b>2010</b>	
 <p>A photograph of a grassy field with a blue tag in the foreground. The tag has handwritten text: "#751 START 8/09". A yellow measuring pole is visible in the background.</p>	 <p>A photograph of a muddy stream or wetland area with a blue tag in the foreground. The tag has handwritten text: "#751 END 8/09". A yellow measuring pole is visible in the background.</p>
<b>2011</b>	
 <p>A photograph of a grassy field with a grey tag in the foreground. The tag has handwritten text: "COMAPT II Tran. 4 0-20".</p>	 <p>A photograph of a grassy field with a grey tag in the foreground. The tag has handwritten text: "COMAPT II Tran. 4 20-0".</p>
<b>2012</b>	





2013



2014



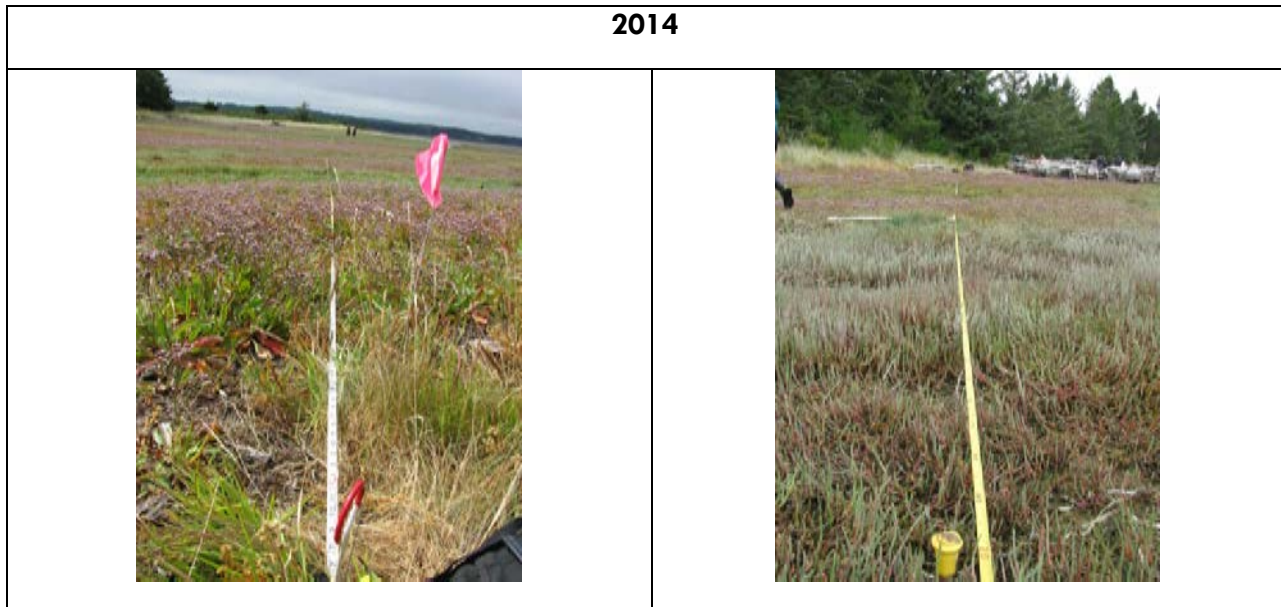


**Transect 7, Tag #752**

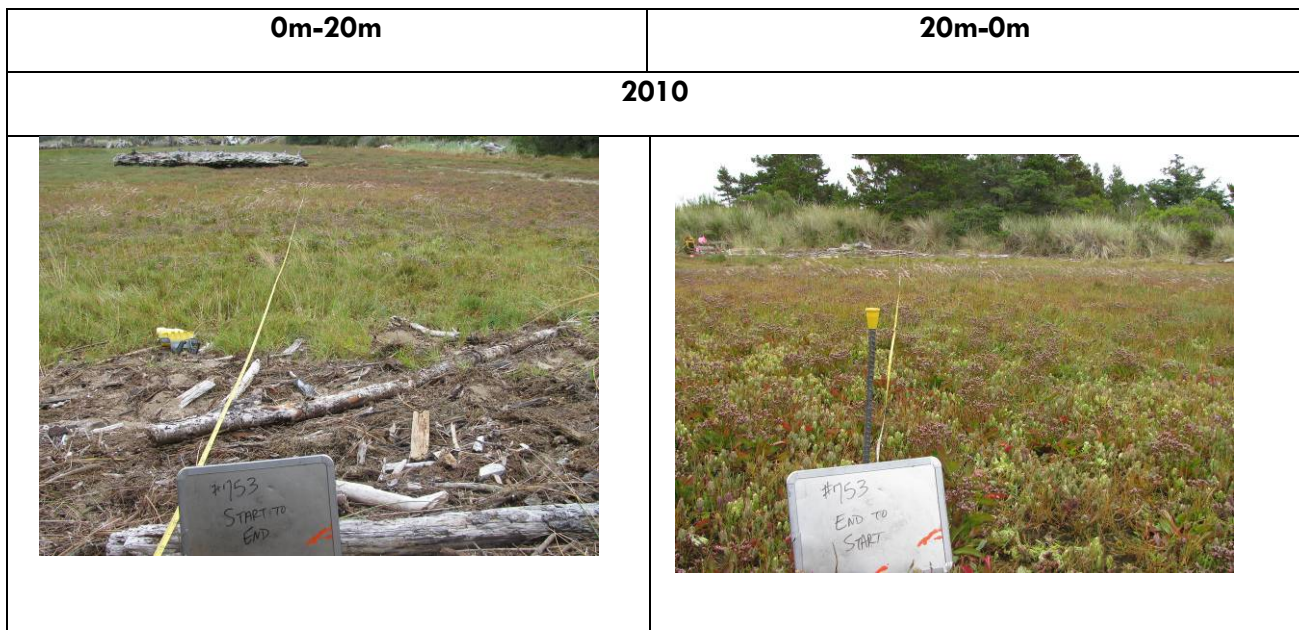
0m-20m	20m-0m
<b>2011</b>	
<b>2012</b>	







**Transect 11, Tag #753**





2011



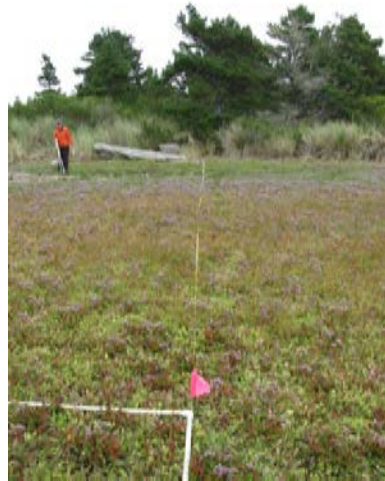
2012



2013



2014 (T11 tag753)



Transect 13, Tag #514

0m-20m	20m-0m
2011	
A photograph of a field with low-lying vegetation. In the foreground, a grey marker is visible with the handwritten text: "COMAPA 11", "Tran 13", and "0-20". A yellow measuring tape is also visible.	A photograph of a field with low-lying vegetation. In the foreground, a grey marker is visible with the handwritten text: "COMAPA 11", "Tran 13", and "20-0".
2012	



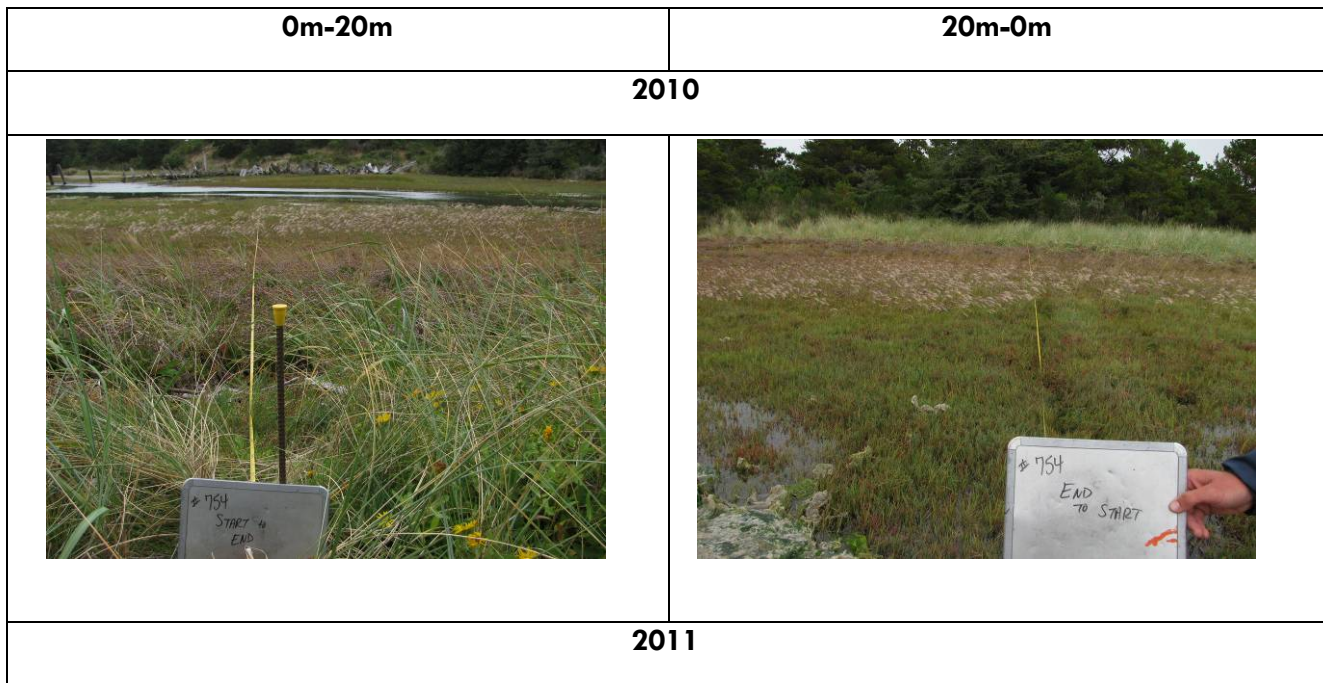


2013





**Transect 15, Tag #754**







2012



2013





2014





**Transect 16, Tag #515**

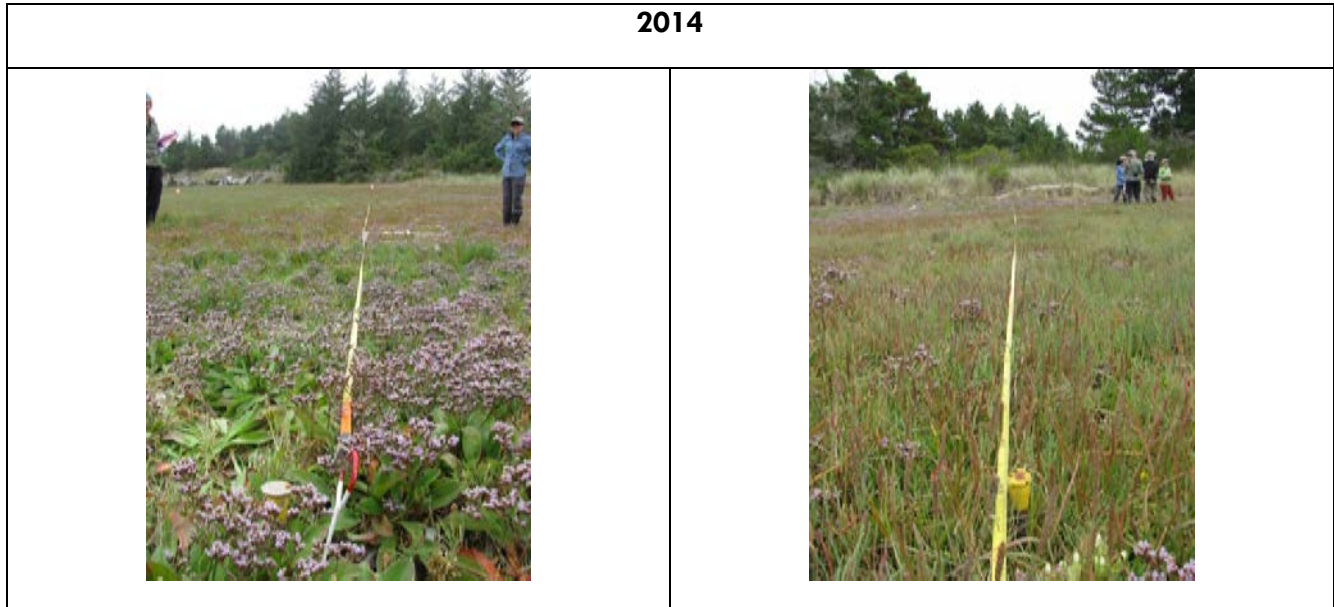
0m-20m	20m-0m
<b>2011</b>	
	
<b>2012</b>	



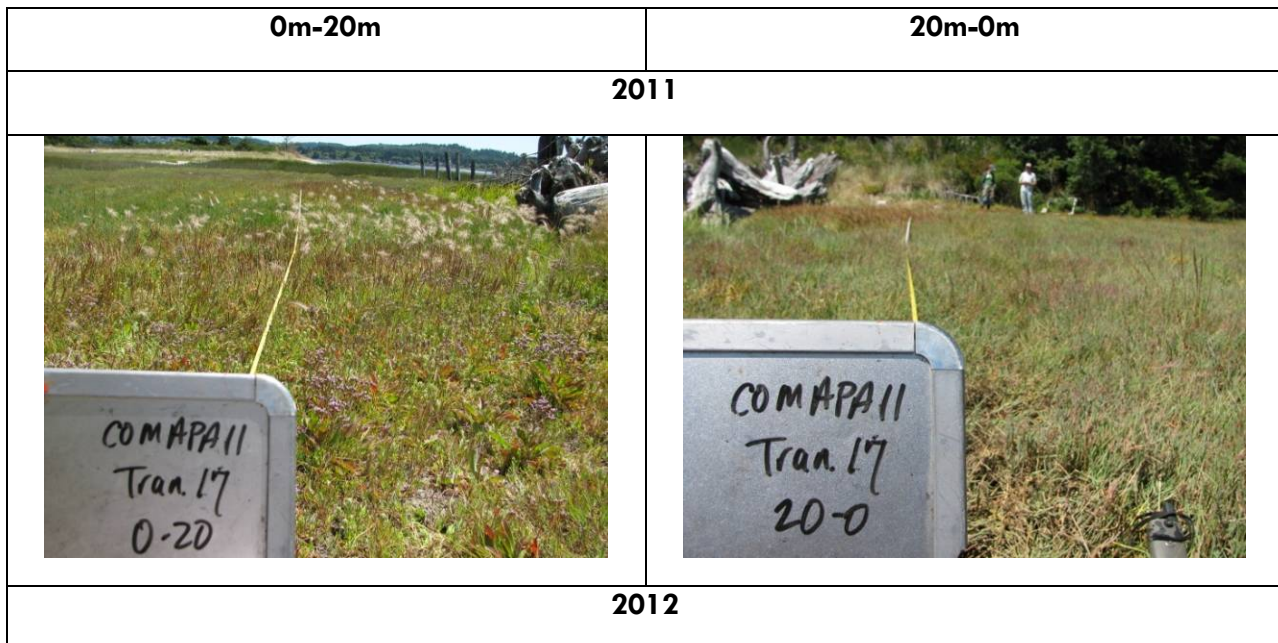
2013



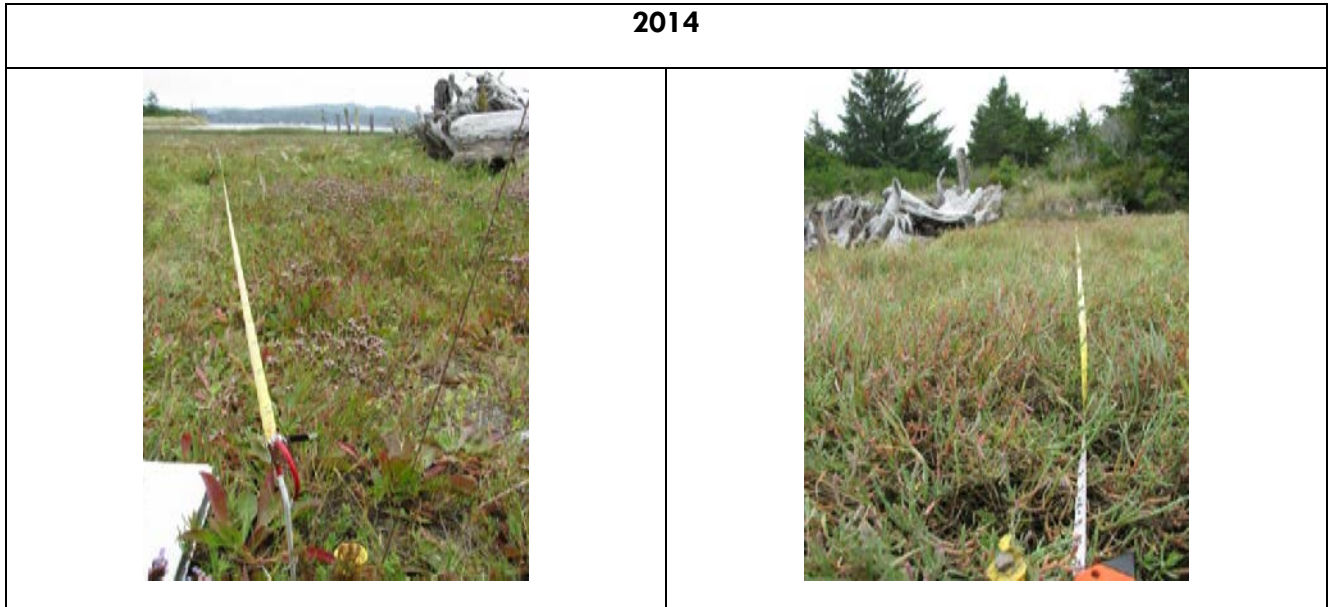




**Transect 17, Tag #517**







**Transect 18, Tag #502**

<b>0m-20m</b>	<b>20m-0m</b>
<b>2012</b>	

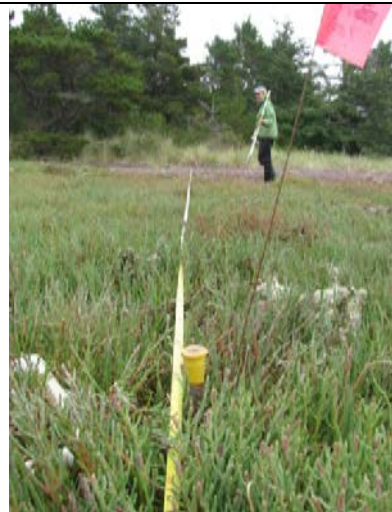




2013





2014






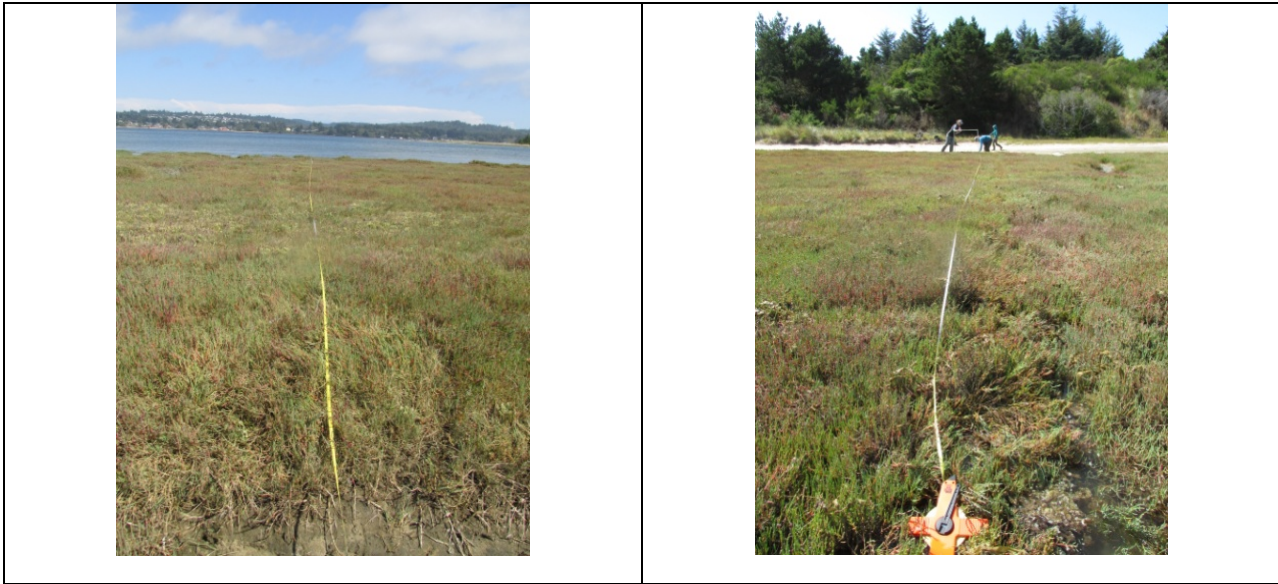




<b>Transect 19, Tag #862 **New 2014**</b>	
<b>0m-20m</b>	<b>20m-0m</b>
<b>2014</b>	
	

**Transect 20, Tag #391 (503/997)**

0m-20m (start of veg)	20m-0m
<b>2012</b>	
 <p>COMAPA 12 TRANSECT 20 Veg - 20</p>	 <p>COMAPA 12 TRANSECT 20 End-origin</p>
<b>2013</b>	
 <p>COMAPA 2013 0-20m Plot # 20 Tag # 503</p>	 <p>COMAPA 2013 20-0m Plot # 20 Tag # 503</p>
<b>2014</b>	



**Transect 21, Tag #400 (504/999)**

<b>0m-20m (start of veg)</b>	<b>20m-0m</b>
<b>2012</b>	







2013



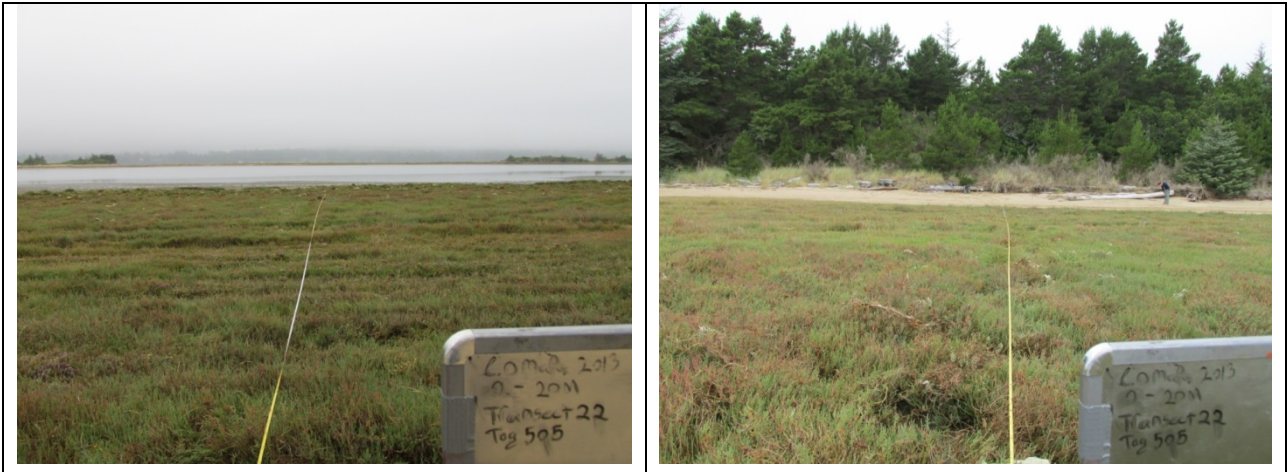
2014



**Transect 22, Tag #388 (505)**

0m-20m (start of veg)	20m-0m
<b>2012</b>	
 <p>A photograph showing two people standing in a grassy field next to a body of water. In the foreground, a grey marker is labeled 'COMAPA 13 TRANSECT 22 Veg to end'. A yellow measuring tape is visible.</p>	 <p>A photograph showing a grassy field with a yellow measuring tape stretched across it. In the foreground, a grey marker is labeled 'COMAPA 13 TRANSECT 22 End to origin'. People are visible in the background.</p>
<b>2013</b>	









2014



**Transect 23, Tag #385 (506)**

0m-20m (start of veg)	20m-0m
<b>2012</b>	
 <p>COMAPA 12 TRANSECT 23 Veg to End</p>	 <p>COMAPA 12 TRANSECT 23 End to origin</p>
<b>2013</b>	
 <p>COMAPA 2013 0-20M Transect 23 Tag 506</p>	 <p>COMAPA 2013 20-0M Transect 23 Tag 506</p>
<b>2014</b>	



(transect start photo taken from rebar, no photo of veg start available)



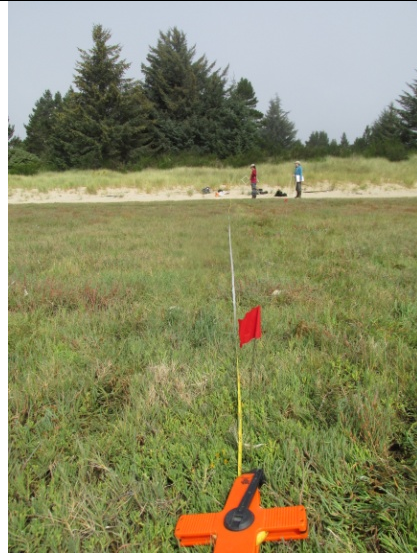
**Transect 24, Tag #386 (747) \*\*New 2014\*\***

**0m-20m**

**20m-0m**

**2014**

**(transect start photo taken from rebar, no photo of veg start available)**



**Transect 25, Tag #387 (746) \*\*New 2014\*\***

**0m-20m**

**20m-0m**

**2014**

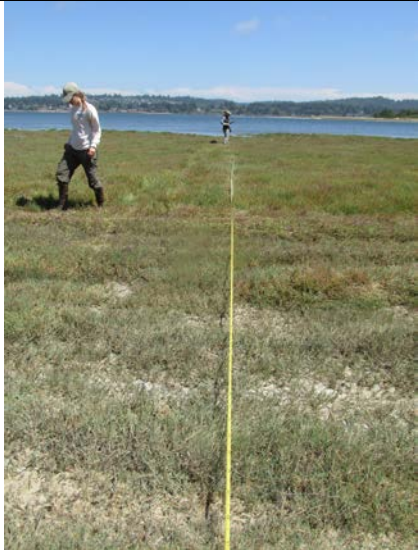
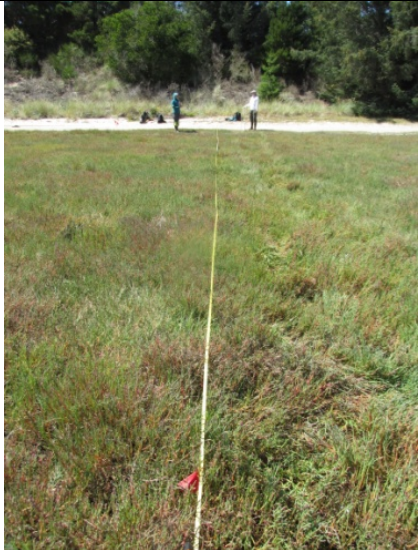
**(transect start photo taken from rebar, no photo of veg start available)**



<p><b>Transect 26, Tag #389 (1000) **New 2014**</b></p>	
<p><b>0m-20m</b></p>	<p><b>20m-0m</b></p>
<p><b>2014</b></p>	
<p><b>(transect start photo taken from rebar, no photo of veg start available)</b></p>	

<p><b>Transect 27, Tag #390 (998) **New 2014**</b></p>
--



0m-20m (start of veg)	20m-0m
<b>2014</b>	
	

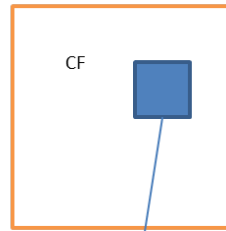


## APPENDIX B. SAMPLING METHODOLOGY FOR *C. MARITIMUM* SSP. *PALUSTRE* AND *L. CALIFORNICUM*.

### COMAPA/LICA Sub-sampling

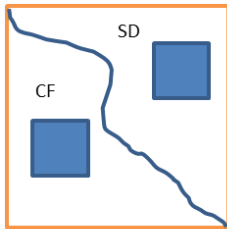
Transects are 20 m long  
Sampled on the RIGHT side when  
looking from the origin to the end  
post.

- In each 1m<sup>2</sup> you will assign a habitat class  
(See table on next page).
- In each 1m<sup>2</sup> a 25 cm x 25 cm square will be subsampled for COMAPA and LICA . (Use the list of random coordinates to place the sub-sample frame.)
  - COMAPA- count number of individuals, branches and flowers.
  - LICA- count number of vegetative and reproductive rosettes

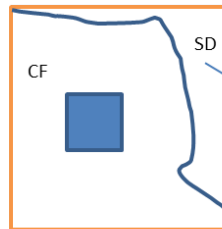


Subsample for COMAPA/LICA is placed using list of random coordinates.

- If there is more than one habitat class....



- (Example A) Two habitat types are present. Each area is large enough to accommodate the subsample frame.
- Do two subsamples. Use the random coordinates to guide your plot placement in BOTH habitat types. Skip coordinates that would place the frame in more than one habitat type.



Do not subsample in areas that cannot accommodate the sampling frame.

- (Example B) Two habitats are present, but only one area is large enough to accommodate the subsample frame.
- Do one subsample. In this example, the SD habitat can not accommodate the subsample frame, thus this portion is not subsampled.

<b>Code</b>	<b>Habitat</b>	<b>Description</b>
<b>CF</b>	Chloropyron flat	Chloropyron cover $\geq$ 50%
<b>LCF</b>	Limonium-Chloropyron flat	Limonium, Chloropyron codominant
<b>LF</b>	Limonium flat	Limonium cover $\geq$ 50%
<b>GT</b>	Grass transition	Differentiated by presence of <i>Ammophila</i> or <i>Leymus</i> , marks transition into small stabilized dune habitat. Some Chloropyron present but only in trace amounts. This is the absolute upper boundary of COMAPA habitat.
<b>SD</b>	Salicornia depression	Salicornia dominant species; area of higher water during the tide. Differs from waterway by abundant Salicornia, and little to no bare sand.
<b>SDD</b>	Salicornia-Distichlis depression	Salicornia dominant, but <i>Distichlis</i> cover $\geq$ 25%
<b>Sand</b>	Sand	Highest reach of the tide, but water does not linger here for long. Some COMAPA in trace amounts.
<b>Waterway</b>	Waterway	Other plants may be here, but not appropriate habitat for COMAPA. Various courses throughout entire area, usually adjacent to SD, SDD.
<b>D-Rise</b>	<i>Distichlis</i> rise	Small hill, <i>Distichlis</i> dominated, with minor patches of <i>Jaumea carnosa</i> nearest to the ocean.
<b>Marsh</b>	Marshy area	Marshy area dominated by <i>Scirpus</i> sp., area inundated by tides.

2015 COMAPA/LICA transect orientation (not to scale, for reference only)  
 Always monitor on the RIGHT side of the transect

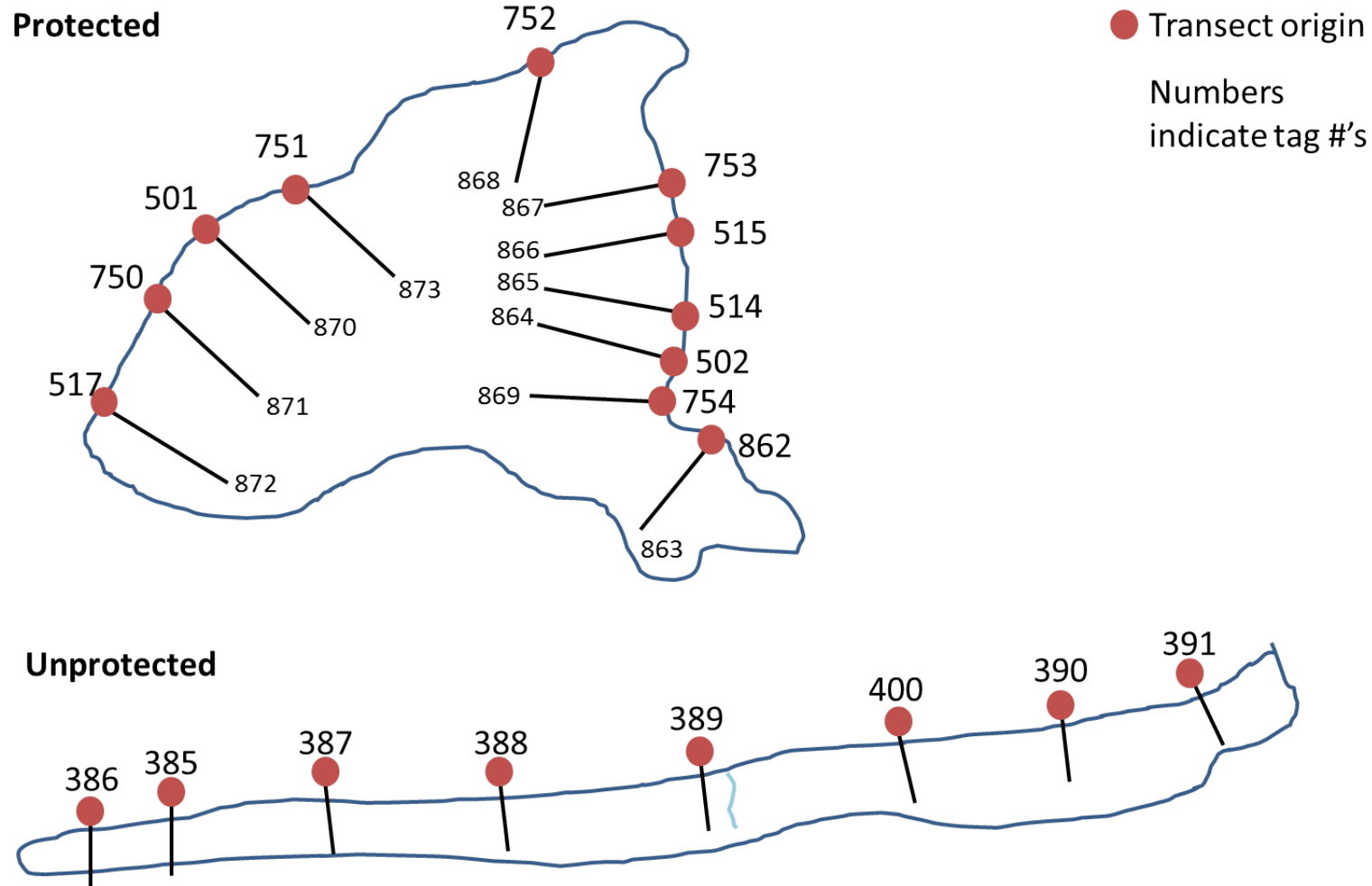


Figure 12. Schematic diagram (not to scale) of transects in both the protected and unprotected areas as of 2014.

COMAPA species ID cheatsheet

*Ammophila arenaria*-  
European beachgrass



*Festuca rubra*



*Limonium californicum*



*Chenopodium album*



*Hordeum jubatum*



*Plantago maritima*



*Cuscuta pacifica* on  
*Salicornia depressa*



*Jaumea carnosa*



*Leymus mollis*-  
American dunegrass



*Puccinellia pumila*



*Distichlis spicata*



*Spergularia macrotheca*



*Triglochin maritima*

