

# Controlling the spread of *Holcus lanatus* in California coastal prairie: the constraints and benefits of six management techniques



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# Outline

- **Management Treatments**
- **Monitoring Methods**
- **Analysis**
- **Preliminary Results**
- **Benefits & Constraints of Management Practices**

## Management Sites



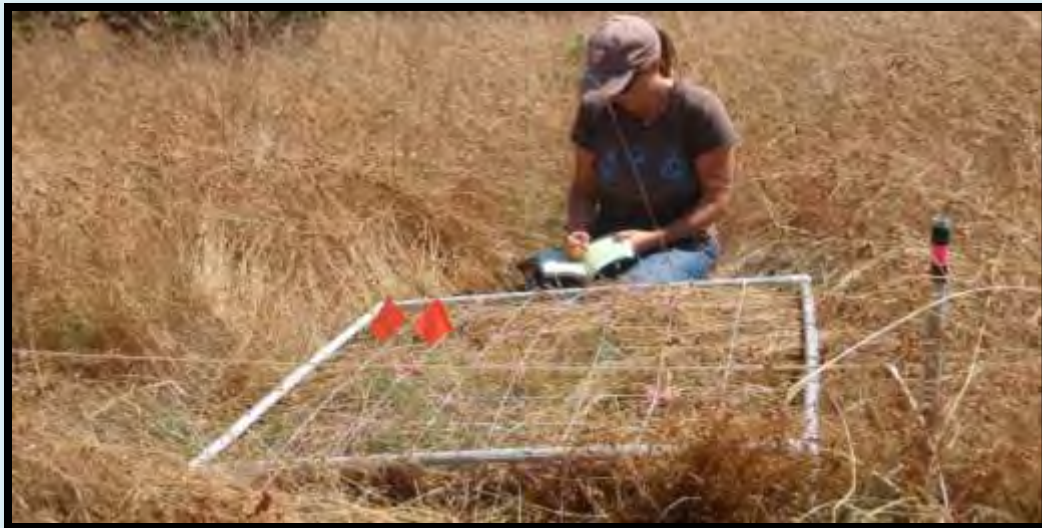
- **Objective: conduct habitat enhancement activities across 6 sites**
- Monitoring to assess effectiveness of treatments: *NOT a scientific experiment!*
- Different management method(s) per site, led by managers from each location, using available infrastructure & staffing
- Project employs techniques property owners are likely to continue
- Treatments ongoing 2010 – 2012 at all sites; Final monitoring in Spring 2013

# Management Methods (Treatments)



# Monitoring Methods

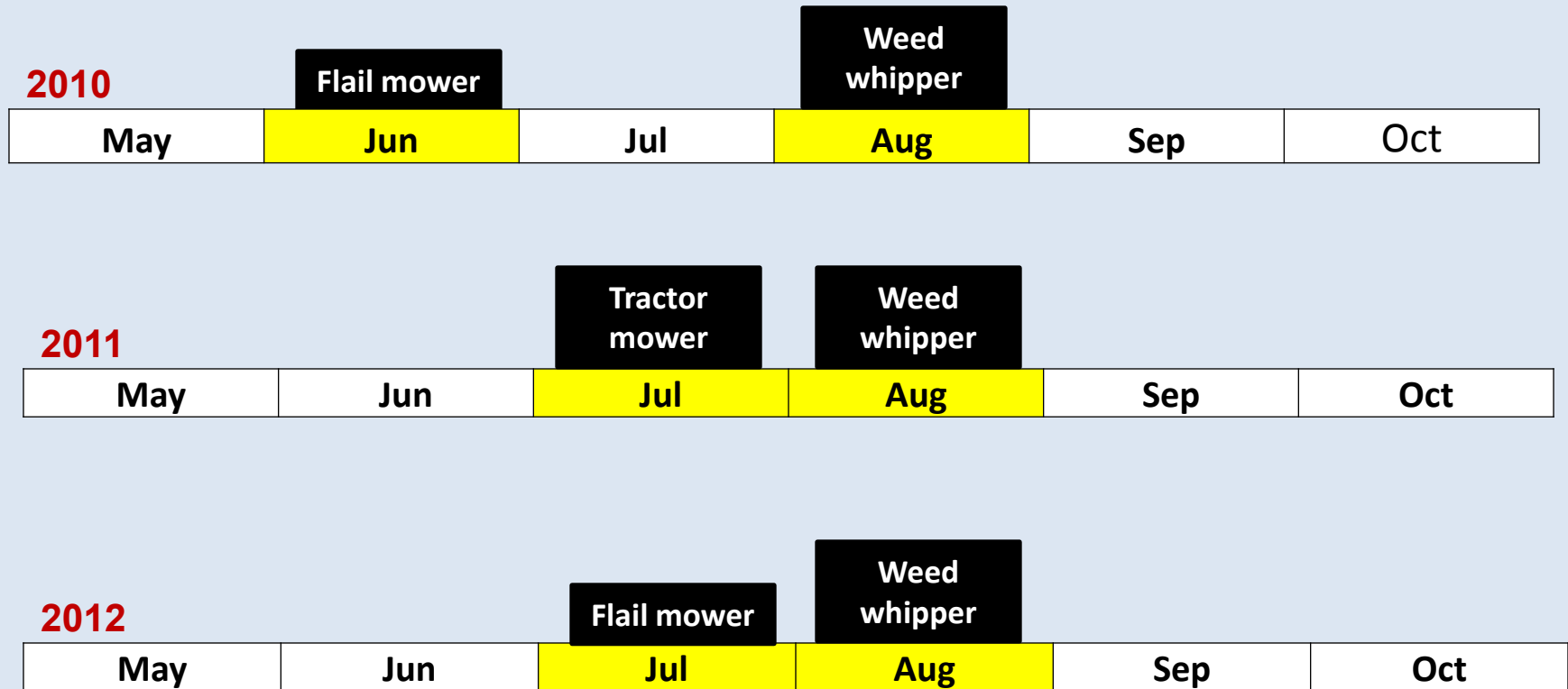
- Baseline data 2010
- Sampled same permanently marked transects each Spring (May & June) until 2013
- Multiple 1x1 m quadrats per transect
  - unit of replication is transect
- Measured HoLa frequency & % Cover (Daubenmire Cover Classes)
- Monitoring was led by the same team the entire time



# Ocean Song Farm & Wilderness Center:

Can mowing reduce HoLa frequency, % cover?

Does this treatment affect community composition?



\* Seed set prevented every year

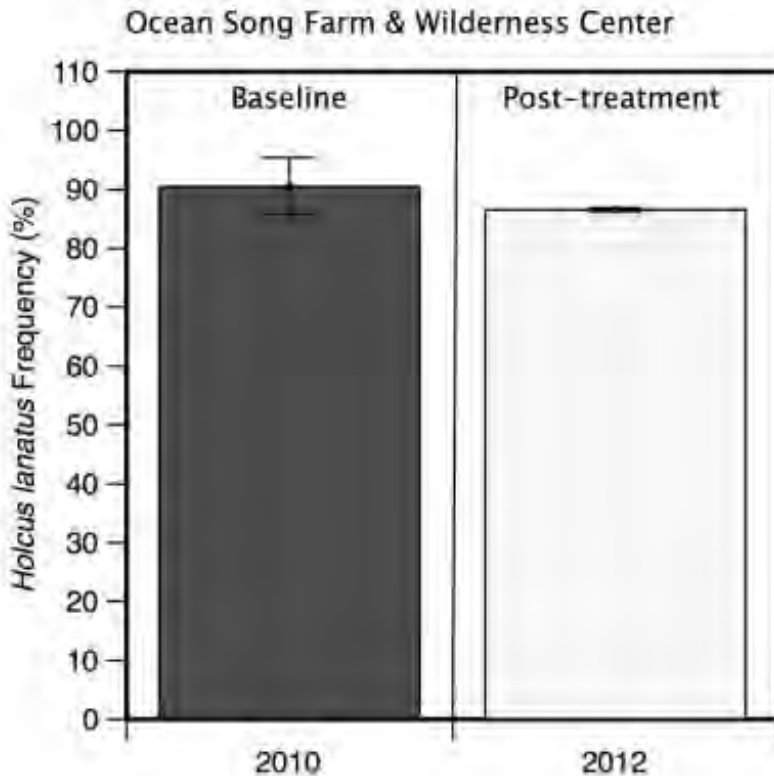
# MOWING: Ocean Song Farm & Wilderness Center



# Ocean Song Farm & Wilderness Center

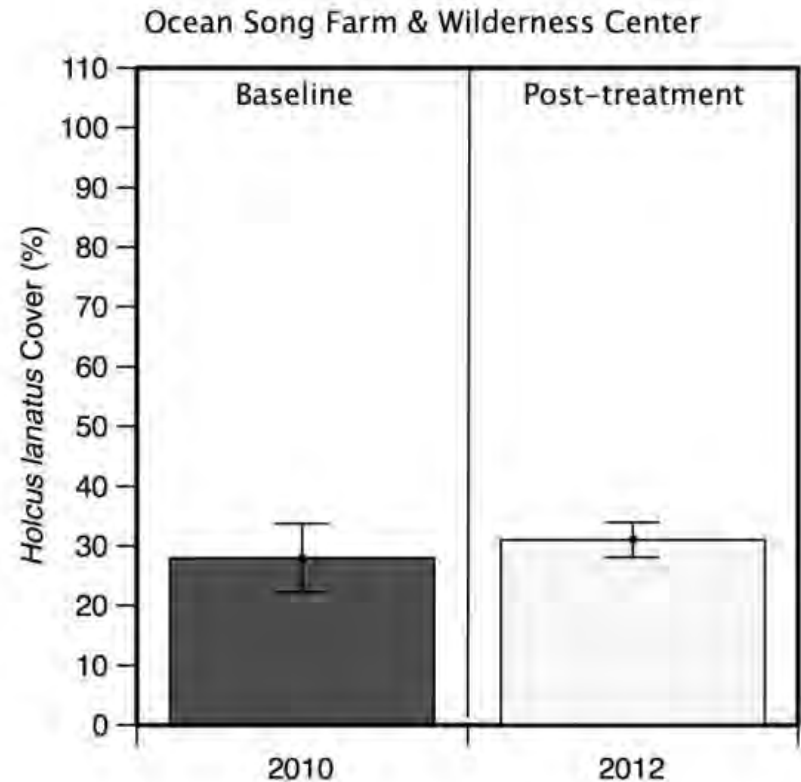
Can mowing reduce HoLa frequency, cover?

Frequency



- Frequency high (~90%)
- No significant change over time

Cover



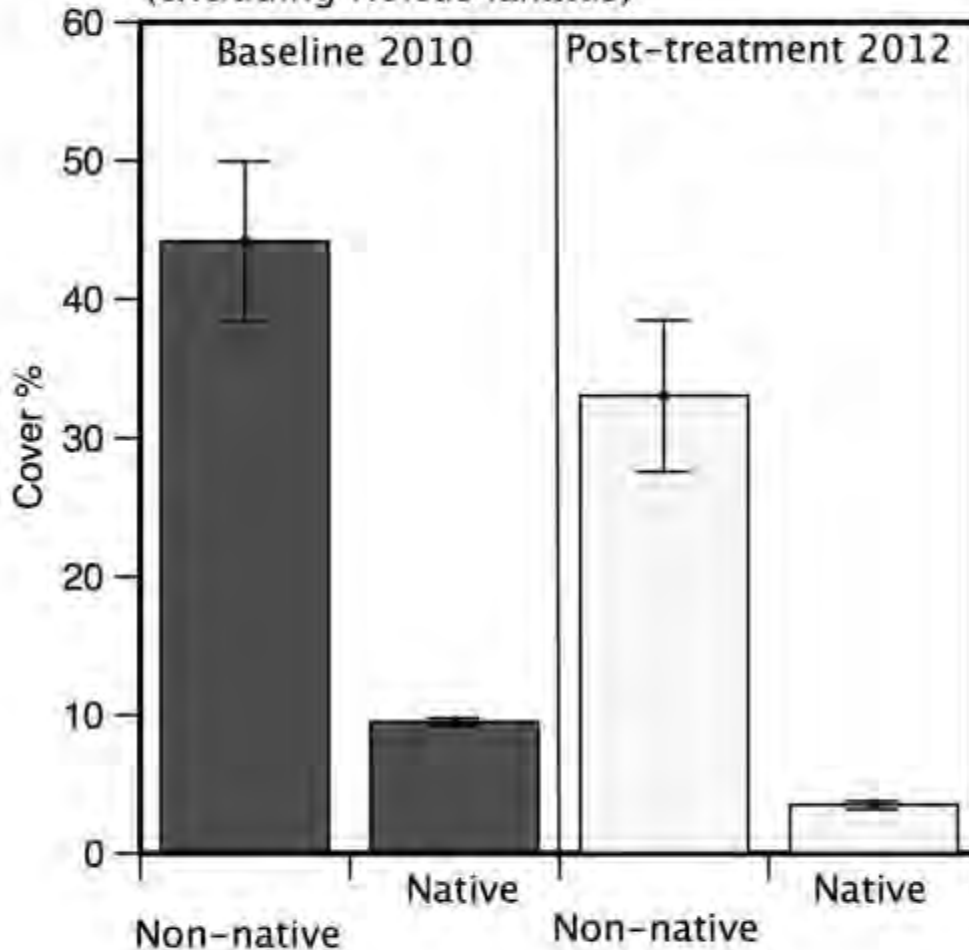
- Cover relatively low (~30%)
- No decrease over time
- But no increase either\*



# Ocean Song Farm & Wilderness Center

## How does mowing affect community composition?

Ocean Song Farm & Wilderness Center  
(excluding *Holcus lanatus*)



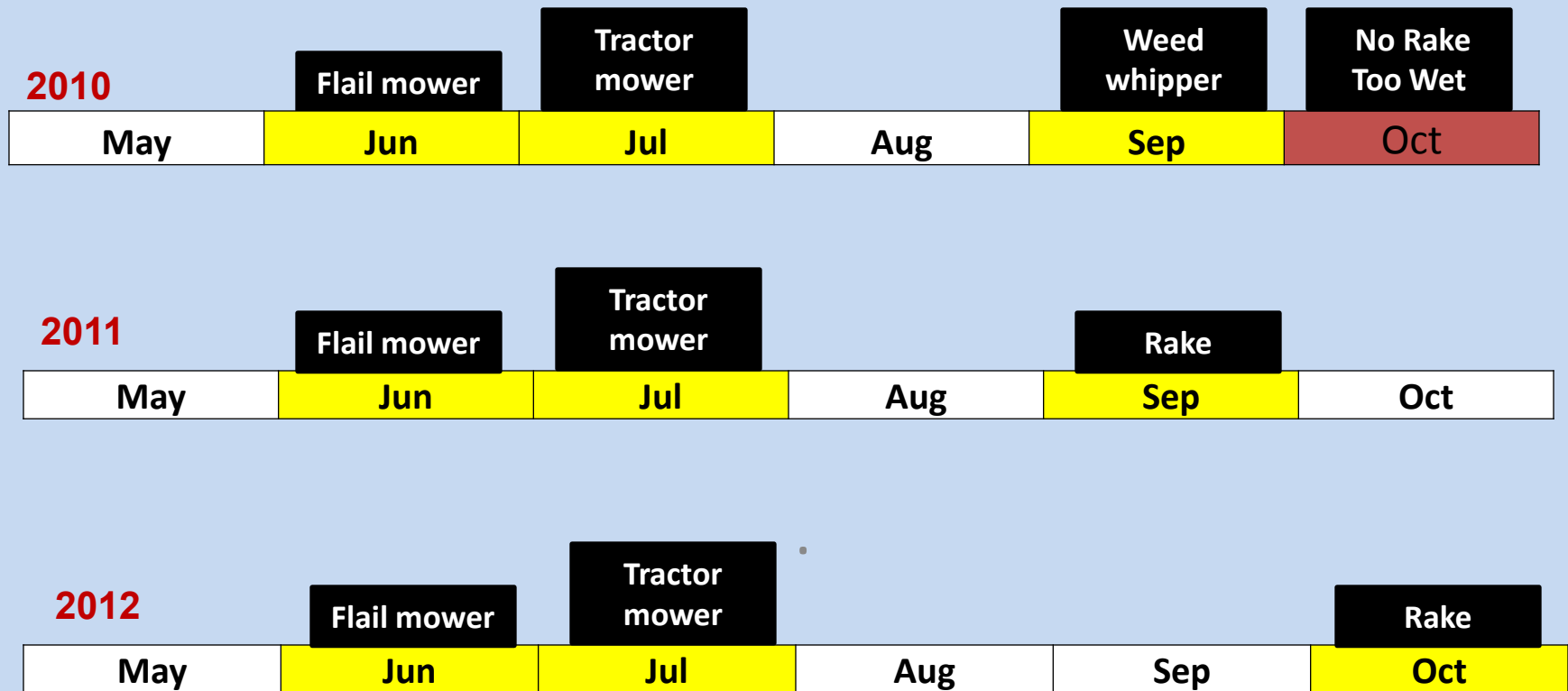
- No change in non-native % cover
- Decrease in native % cover

Non-native cover n.s.

# Occidental Arts & Ecology Center – Mowing & Late Season Raking

Is raking an effective removal method for HoLa ?

Does mowing & raking affect the plant community?



\* Seed set prevented every year

# MOWING & Late Season RAKING: Occidental Arts & Ecology Center

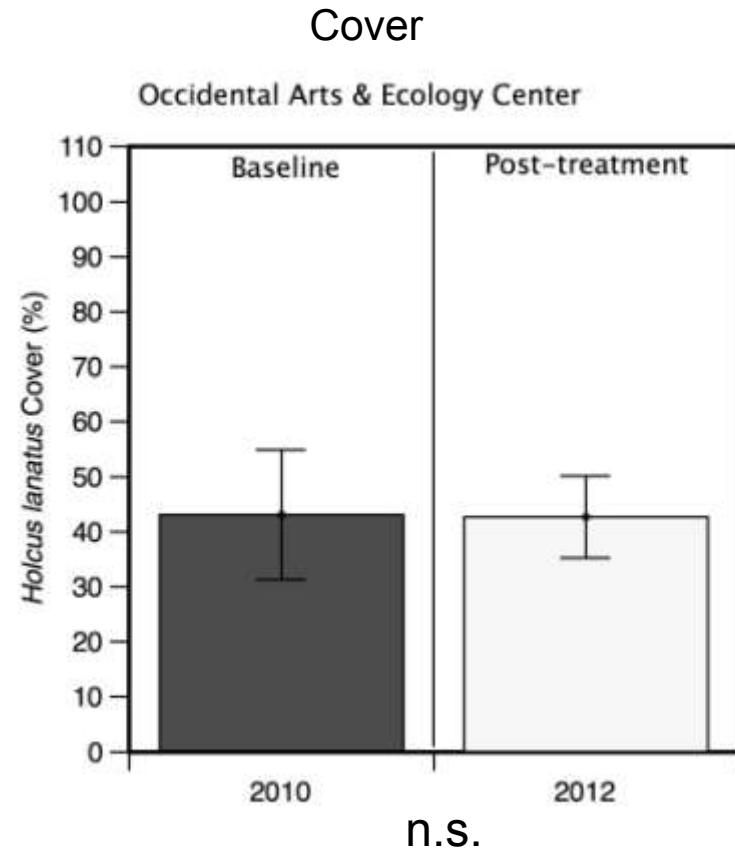
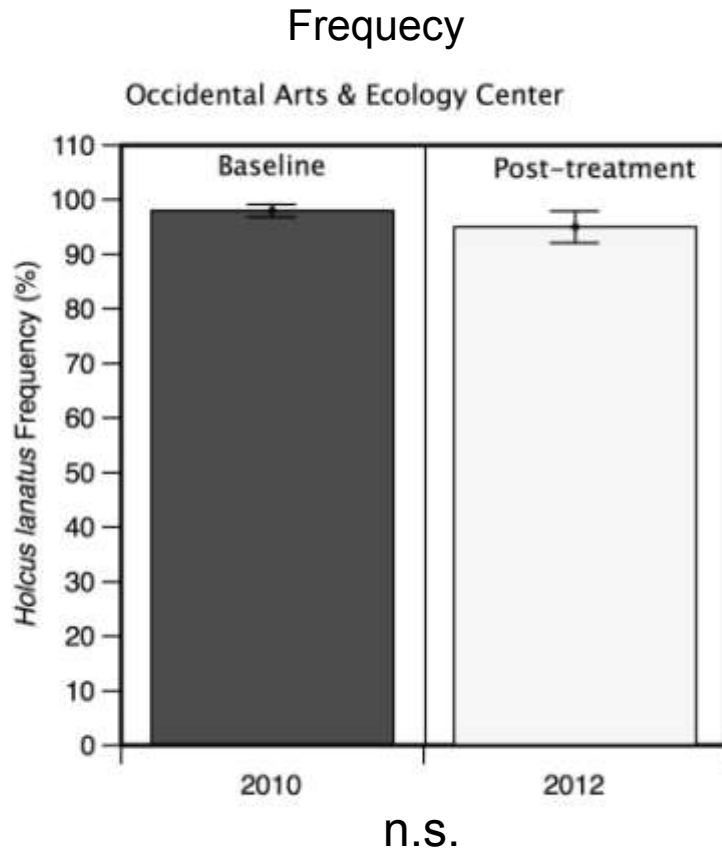
May 2011



Sept 2011

# Occidental Arts & Ecology Center – Mowing & Late Season Raking

## Is raking an effective removal method for HoLa ?



- Nearly identical results to the mowing-only effort at Ocean Song -no decrease in *Holcus* cover but no increase either\*
- Additional raking effort did not reduce *Holcus*
- No significant changes in native vs. non-native cover

# Sonoma Land Trust – Estero Americano Preserve

**Does cattle grazing reduce Hola frequency, % cover? Does it affect community?**

12 cow/calf pairs &  
6-8 yearlings - IN

Total Pasturage = 95 acres

**2010**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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OUT

**2011**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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10 yearlings - IN

**2012**

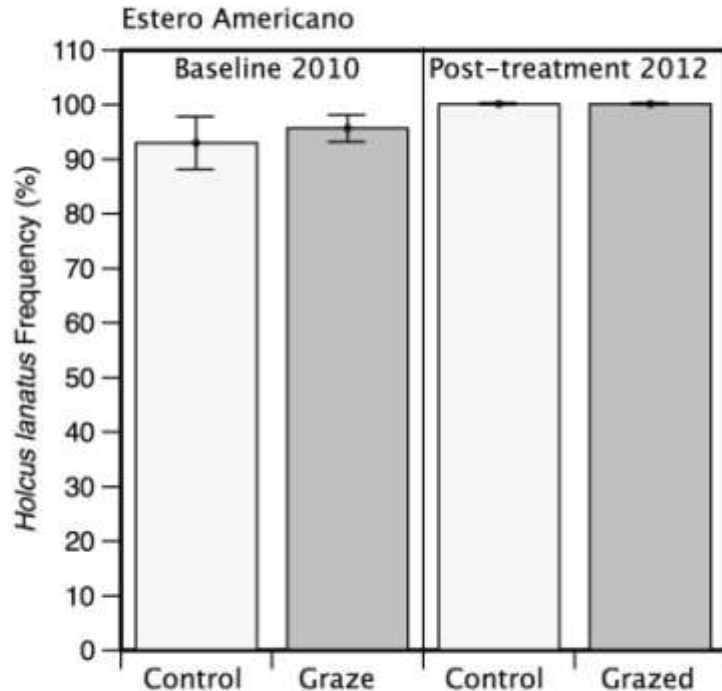
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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April 2010

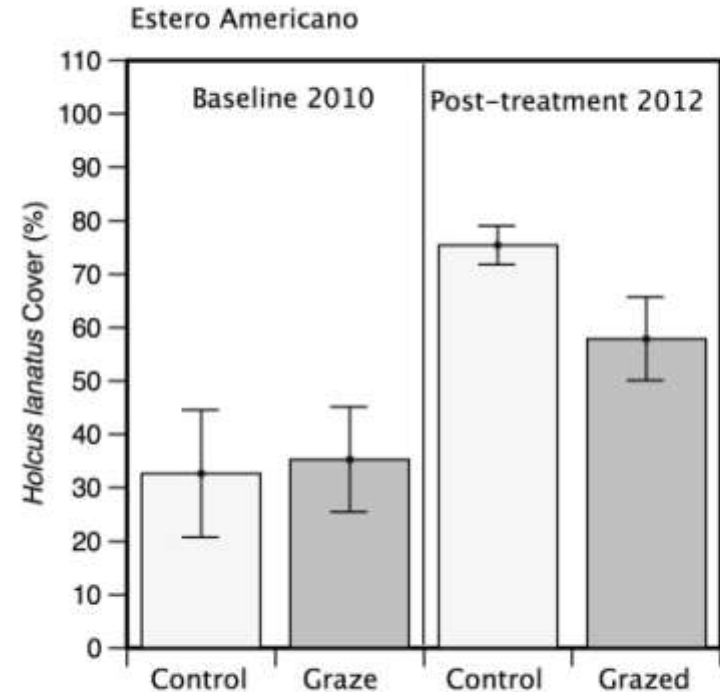


# Sonoma Land Trust – Estero Americano

Does cattle grazing reduce *Hola* % cover? Does it affect community?



n.s.

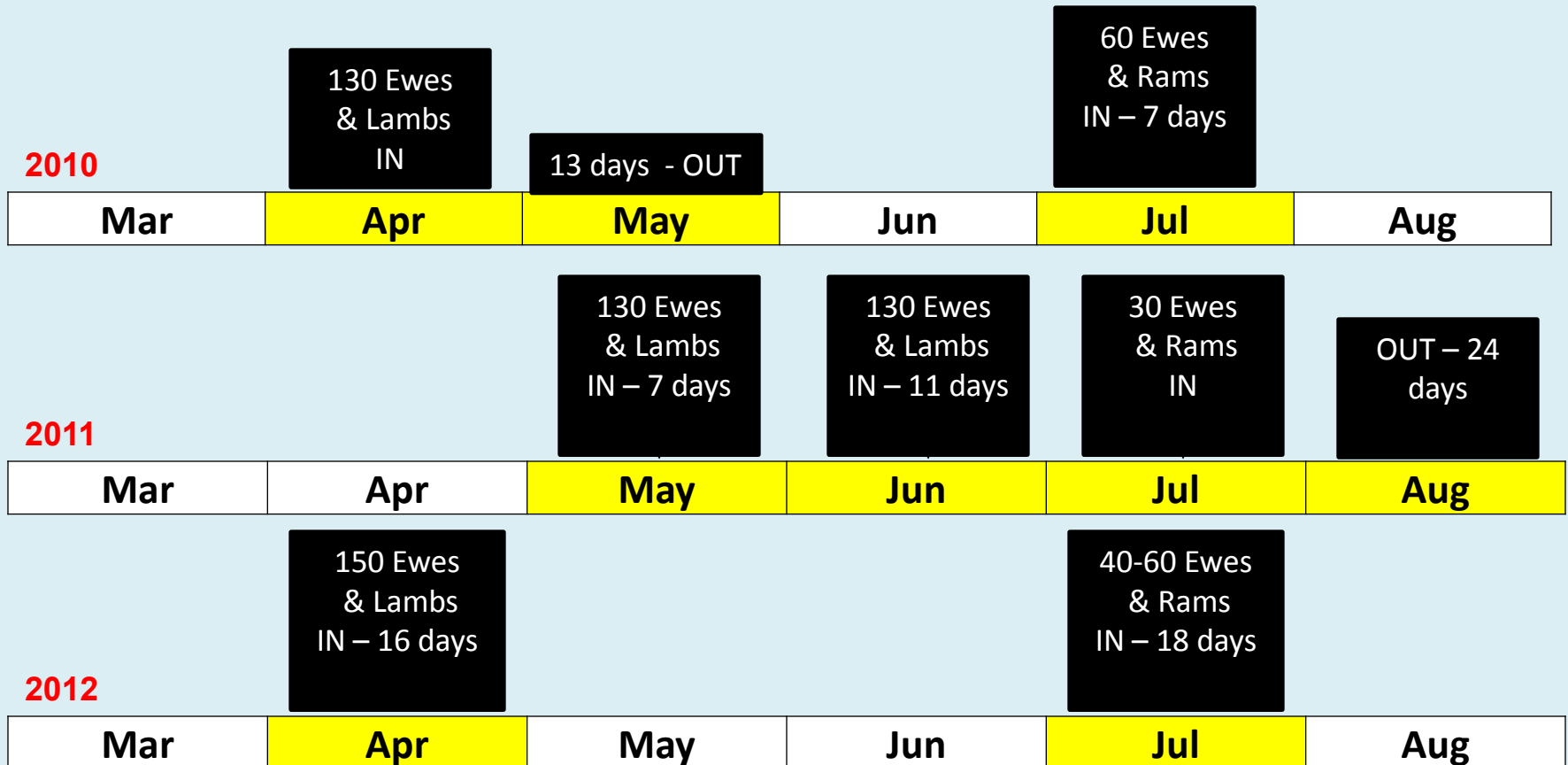


ANOVA: Year  $p=0.0015$   
Treatment n.s.

- Frequency started high, no significant change over time
- No significant difference in HoLa cover b/n. grazed & control plots
- ~24% increase in *Hola* cover over time in treatment plots
- *Holcus* cover in controls increasing over time (more than 2X)

# Bodega Pastures – Sheep Grazing

Can sheep grazing reduce HoLa frequency, % cover? Does it affect community?



\*Total Pasturage = 6-9 acres

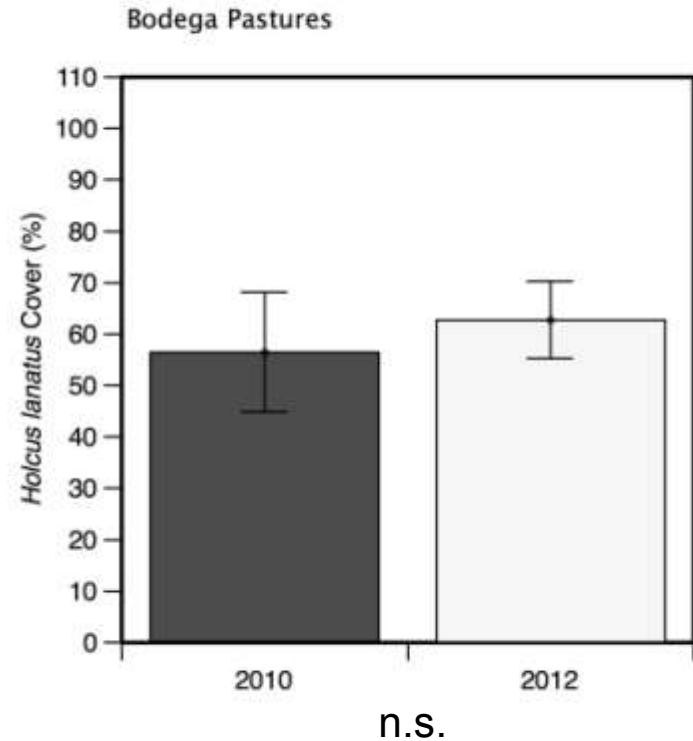
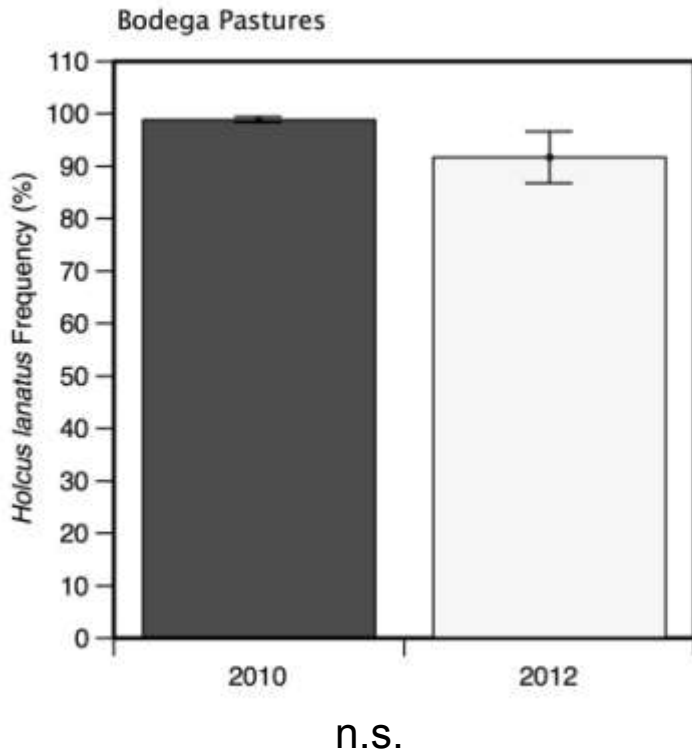
# SHEEP GRAZING: Bodega Pastures





# Bodega Pastures – Sheep Grazing Results

Can sheep grazing reduce HoLa frequency, % cover? Does it affect community?



Started with high freq. (~99%); No significant change over time

Lower cover (60% - 65%) despite high freq; No change over time

No significant changes in community

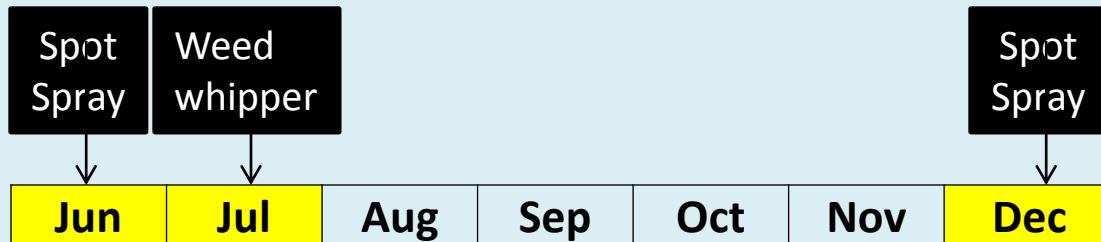
# Bodega Head – Poast vs. Aquamaster

Does herbicide use reduce HoLa frequency, % cover?

Does it affect community?



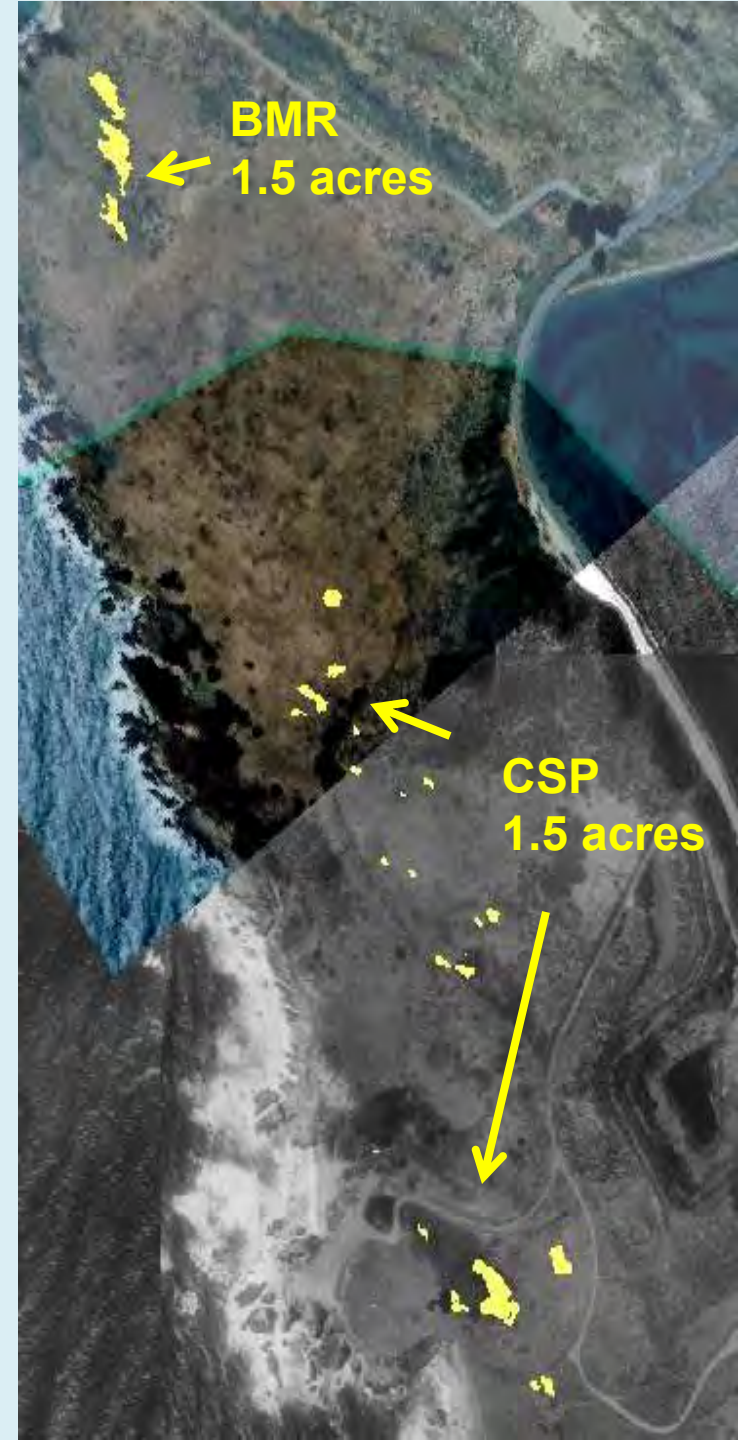
2010



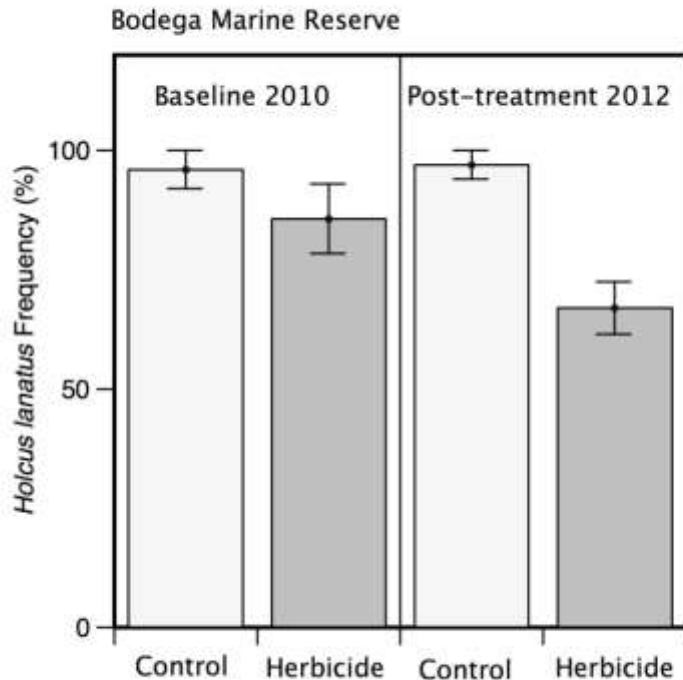
2011



2012



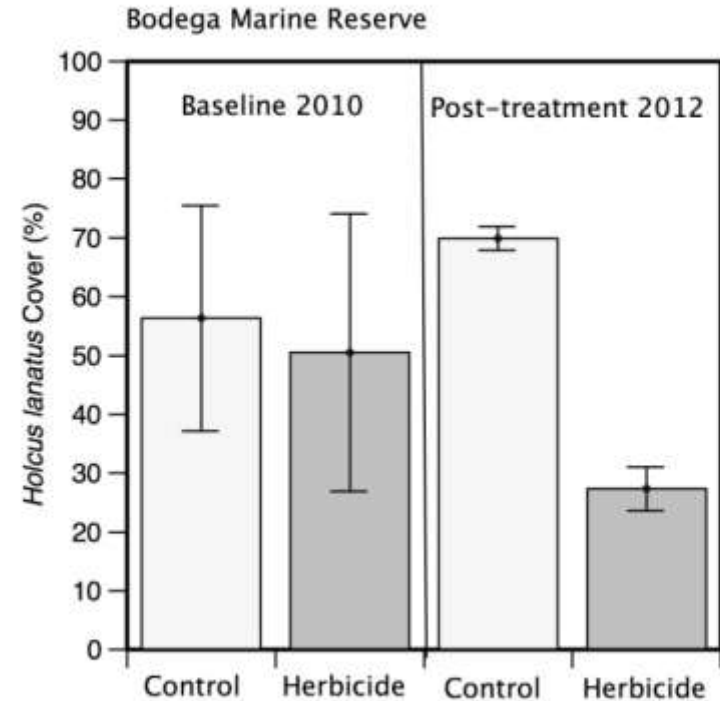
# BMR Monocot Specific Herbicide Results (2010-2012)



ANOVA: Treatment  $p=0.0048$

## HoLa Frequency

- Control: no change
- Treatment: 20% reduction

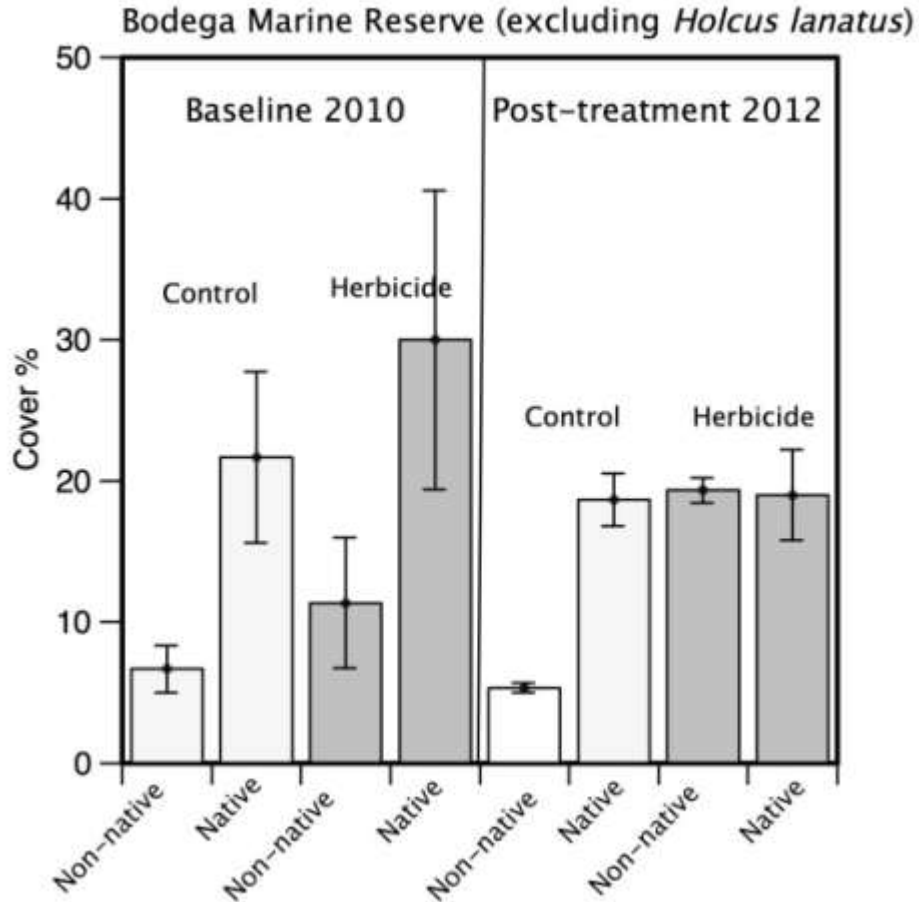


ANOVA: n.s.

## HoLa % cover

- Control: increasing trend, no sig. change due to variability
- Treatment: decrease in mean cover, but n.s.

# BMR Monocot Specific Herbicide Results (2010-2012)

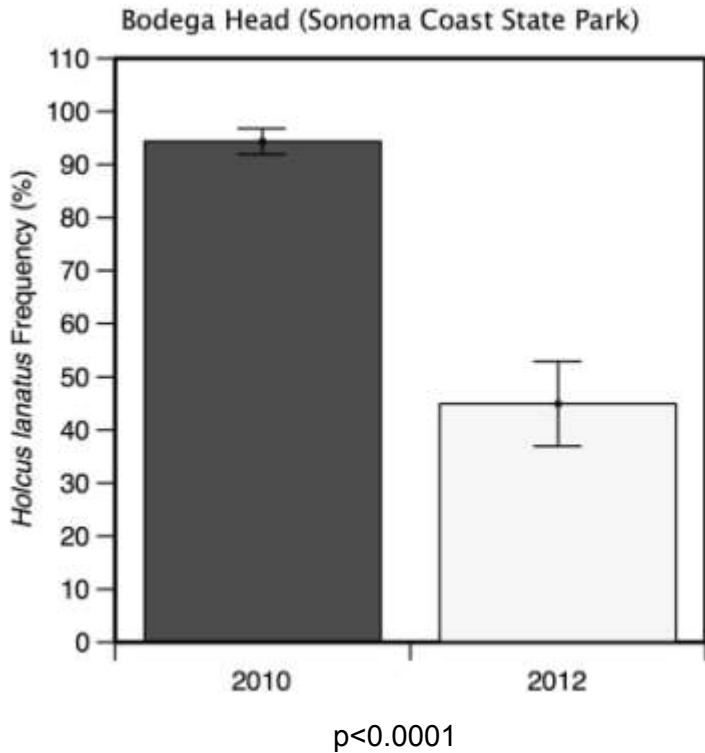


## Native vs. Non-Native Cover (excl. HoLa)

- Control: no change
- Treatment: no significant change in Native cover & significant increase in Non-Native cover (due to increase in *Poa Pratensis* and *Cirsium vulgare*)

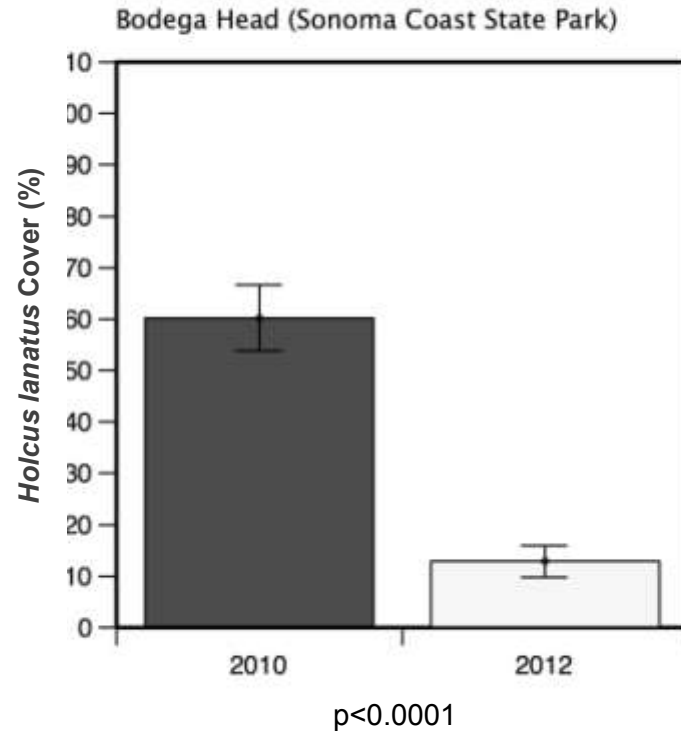
Non-native  $p = 0.0058$   
Native n.s.

# CSP Non-Selective Herbicide Results (2010 -2012)



HoLa frequency:

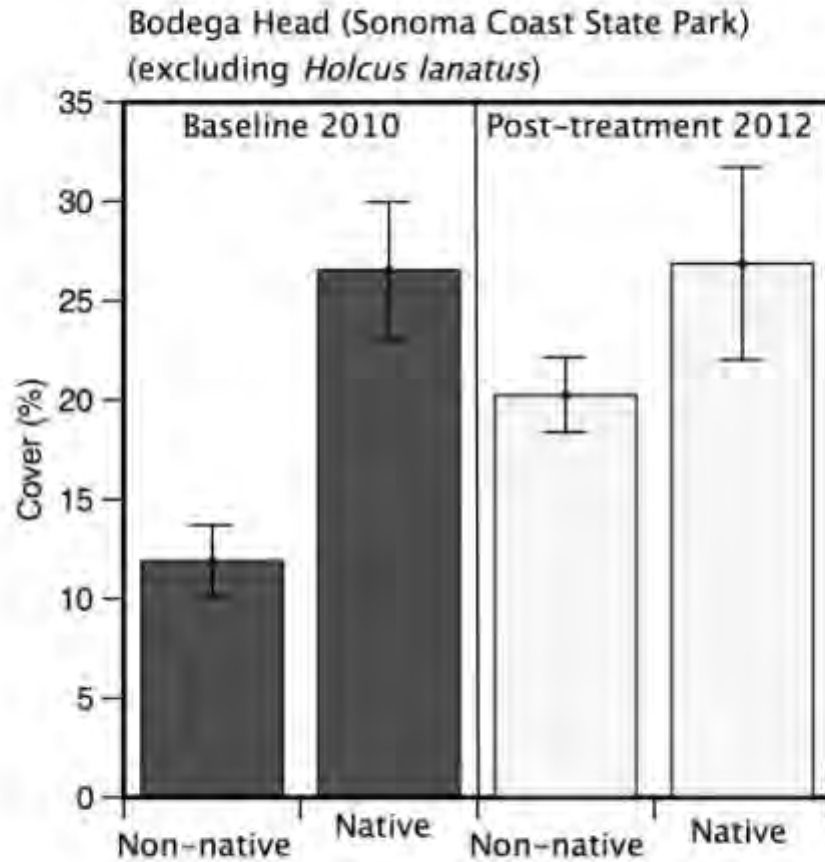
- Started off high ~95%
- Decreased ~40% after treatment



HoLa % cover:

- Started off at ~60%
- Decreased ~40% after treatment

# CSP Non-Selective Herbicide Results



non-native cover  $p < 0.0001$

- No change in native cover (~25%) after treatment
- Increase (~10%) in non-native cover

# Management Treatment Benefits & Constraints

## BENEFITS

## CONSTRAINTS

### MOWING

- Prevent increase in cover
- Reduce seed source, potentially prevent further spread or at least reduce the rate
- a way to hold the line

- Does not kill or eliminate *Holcus*
- Hasn't reduced *Holcus*
- Potentially stimulating clonal reproduction
- Equipment can be costly
- Time consuming
- Decrease in native spp.

### MOWING & Late Season RAKING

- Same as mowing

- Same as mowing
- No additional benefit from raking
- Difficult to find appropriate weather window for raking

# Management Treatment Benefits & Constraints

## BENEFITS

## CONSTRAINTS

### GRAZING

- Sheep grazing potentially holding the line
- Ranches abundant in Sonoma & Marin counties. 57%-80% of CA's grasslands are privately owned & managed by ranchers
- Can reduce shrub encroachment and litter accumulation
- Livestock removal efforts have largely resulted in grasslands dominated by non-natives
- Can cover large tracts of land and access relatively difficult terrain
- Food & other production
- Light cattle grazing hasn't controlled *Holcus*
- Livestock management and grassland enhancement objectives not always in line.
- Low forage quality of *Holcus*
- Infrastructure needs (fencing, water, etc.)
- Costly & Labor intensive



# Management Treatment Benefits & Constraints

## BENEFITS

## CONSTRAINTS

### HERBICIDES

- Relatively effective at reducing *Holcus* frequency & cover
- Kills or eliminates *Holcus*, although not 100%
- Can target species somewhat selectively
- Herbicide use is not appropriate for all sites, eg., near bluff edges, riparian areas & wetlands
- Increase in non-native spp.
- Restrictive weather conditions, especially on coast – wind & rain
- Phenological timing must be right
- Can be difficult to correctly ID target species in spring when all grasses are green
- Need applicator's license for most herbicides
- Licensed contractor availability and scheduling can be limited

# Thank you to our funding agencies & site managers:

California State Coastal Conservancy

Sonoma County Agricultural  
Preservation & Open Space District

UC Natural Reserve System  
UC Davis Office of Research

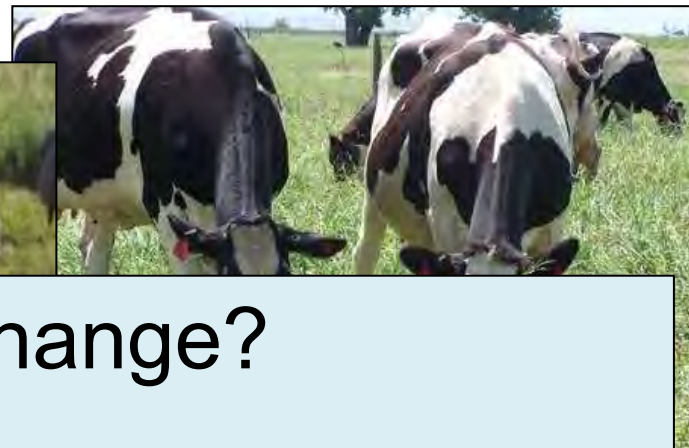
Ocean Song Farm and Wilderness  
Center – ***Kathleen Kraft & Kyle Doron***  
California State Parks – ***Brendan O’Neil***  
Bodega Pastures – ***Hazel Flett***  
Sonoma Land Trust – ***Shanti Wright***  
Occidental Arts and Ecology Center –  
***Jim Coleman & Brock Dolman***



# Preliminary Management Summary

- *Holcus lanatus* is a serious threat to coastal prairie, it is spreading aggressively and difficult to control
- Mowing appears to be an effective way to hold the line and prevent increase in HoLa cover
- Light cattle grazing is not adequate to reduce or control *Holcus*, even at lower levels of *Holcus* cover (30%).
- Sheep grazing may be an adequate way to hold the line when the infestation is already high.
- Herbicides were the most effective at reducing *Holcus*.

# Monitoring Questions



1. Does *Holcus* frequency change?

2. Does *Holcus* percent cover change?

- Daubenmire cover classes

3. Does cover of other species change?

4. Others (rate of spread, survival)

# Monitoring Methods

Sample 1m x 1m quadrats:

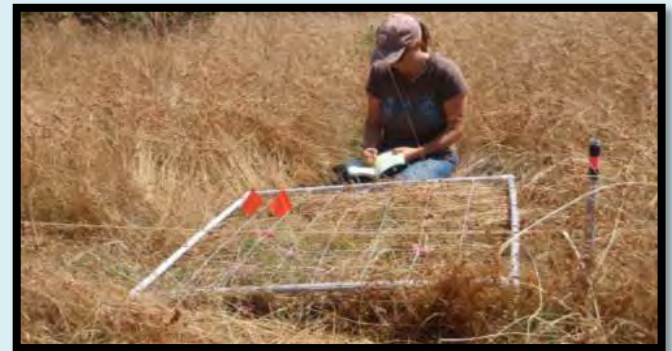
## 1. *Holcus* frequency:

- Probability of finding a species in a particular area
- Sensitive to change
- Only appropriate for comparing change in one species

## 2. *Holcus* cover (%)

(Daubenmire cover classes)

- Most common attribute measured
- Expresses dominance
- Can compare across species



3. ID and cover of all other species, thatch & bare ground

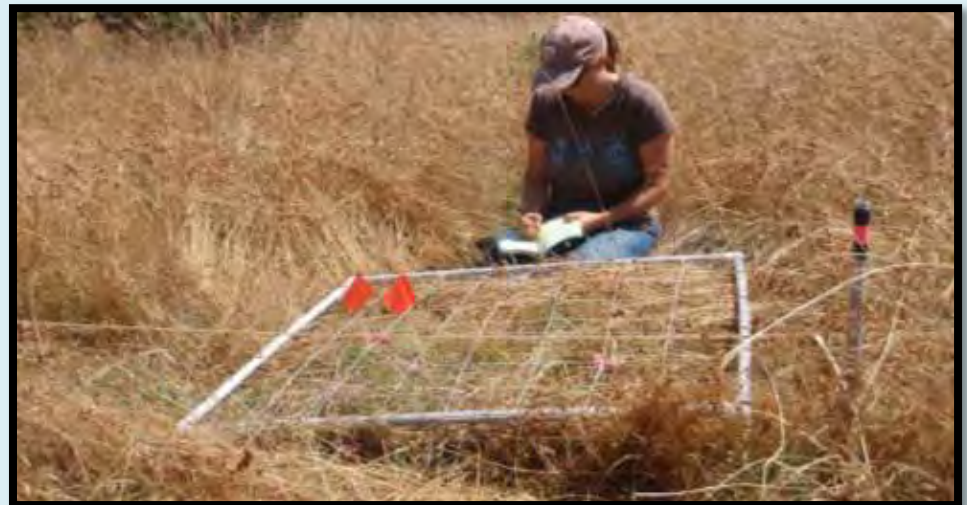
# Monitoring Data Analyses

## Data Analyses

- Four of six sites are before-after comparisons
  - change across time
  - paired t-test
- Two sites have controls where we monitored areas that did not receive the management treatment
  - BACI design: Before-After-Control-Impact
  - ANOVA
    1. Estero Americano
    2. Bodega Marine Reserve

**ONGOING!**

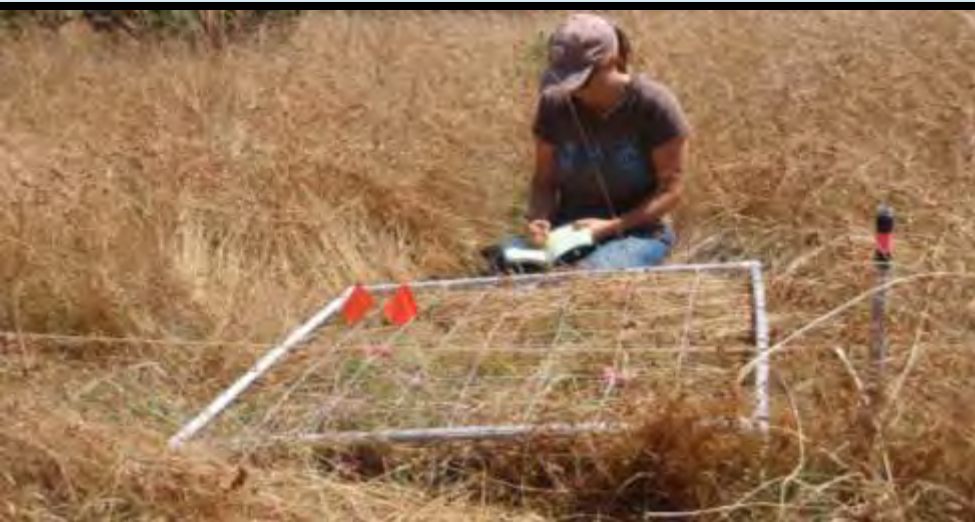
**Preliminary results only**



# Ocean Song Farm & Wilderness Center: Monitoring Description

## Mowing Site:

- Established two 18 m long transects in ~ 1 acre site
  - Collected pre-treatment data & measured same parameters each Spring since 2010
  - HoLa freq, Species % cover (Daubenmire cover class method)
- Multiple 1x1 m quadrats per transect
  - unit of replication is transect



# Occidental Arts & Ecology Center – Mowing & Late Season Raking

## Monitoring Description:

- Established four 12 m long transects in ¼ acre site:
  - Collected pre-treatment data & measured same parameters each Spring since 2010
  - HoLa freq, Species % cover (Daubenmire cover class method)





# Bodega Head – Herbicide monocot specific vs. non-selective

- Monitoring – BMR
  - 3 treatment transects & 3 control transects in similar communities
  - Measured HoLa freq. & species % cover every Spring
- Monitoring – CSP
  - 1 treatment transect running longest length of 9/20 patches ranging in size from  $39\text{m}^2$  –  $1831\text{m}^2$
  - Measured HoLa freq. & species % cover every Spring

# Bodega Pastures – Sheep Grazing

## Monitoring Description:

- Established 8 – 8 m long transects in ~2 acre area:
  - Collected pre-treatment data & measured same parameters each Spring since 2010
  - HoLa freq, Species % cover (Daubenmire cover class method)



# Sonoma Land Trust – Estero Americano

## Monitoring Description:

- 6 fenced 16 sq. ft. control plots grouped in two sets of 3 replicates
  - 3 replicates on East slope, 3 replicates on West slope
- All treatment plots located 3 meters from controls
  - Similar slope and vegetative community
- Measured HoLa freq. and Species % cover each Spring from two 1x1 meter quadrats /plot
  - 2 subsamples for each control and treatment plot

July 2011



# Bodega Head – Herbicide Treatment

Does herbicide use reduce HoLa frequency, % cover?

Does it affect community?

## Benefits:

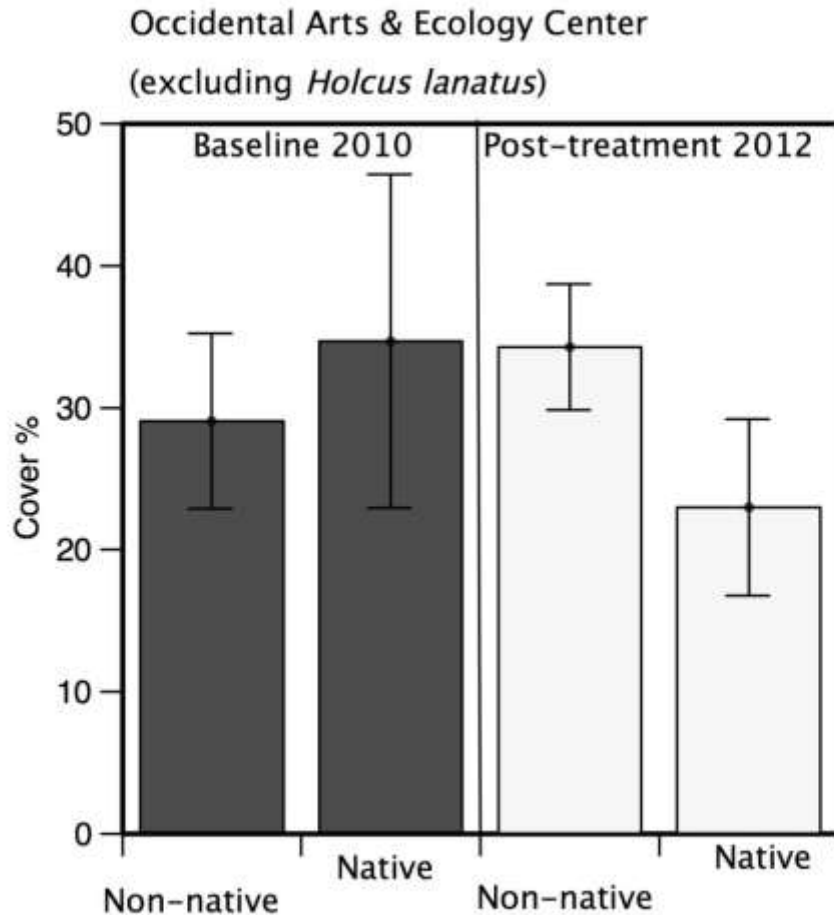
- Relatively effective at reducing HoLa frequency & % cover
- Kills or eliminates HoLa
- Can target species somewhat selectively; saw no decrease in native % cover

## Constraints:

- Not all sites permit herbicide use; especially near bluff edges, riparian areas & wetlands
- Can be difficult to correctly ID target species in Spring when all grasses are green
- Restrictive weather conditions, especially on coast – wind & rain
- Phenological timing must be right
- Contractor availability and scheduling can be limited
- Need applicator's license for most herbicides

# Occidental Arts & Ecology Center – Mowing & Late Season Raking

## How does mowing & raking affect the plant community?



Non-native cover n.s.

Native cover n.s.

- No significant changes in native vs. non-native cover

- More support for mowing as a possible control method to prevent further increase in % cover, reducing seed source, potentially preventing further spread or at least reduce the rate, a way to hold the line.

- Constraint = Difficult to find appropriate weather window for raking at this site. Same mowing constraints.

# Sonoma Land Trust – Estero Americano

## Constraints:

- Site grazed too little to have any effect on HoLa % cover, freq. or rest of community
- Livestock management and grassland enhancement objectives not always in line. Can result in levels of grazing too high or too low if primarily concerned with grassland management.
- Other constraints include infrastructure (fencing, water...), timing, health, predators, and low forage quality of HoLa.

## Benefits:

- Cattle ranches abundant in Sonoma & Marin counties. 57%-80% of CA's grasslands are privately owned & managed by ranchers
- Can reduce shrub encroachment and litter accumulation; livestock removal efforts have largely resulted in grasslands dominated by non-natives
- Can cover large tracts of land and access relatively difficult terrain
- Food production

# Coastal Prairie Enhancement Feasibility Study

- Prepare initial conservation recommendations for coastal prairie resource conservation in Marin & Sonoma Counties
  1. Regional scale, digital map classifying 100,000 acres of CP in Sonoma & Marin counties
  2. Develop educational materials, conduct tours, train CP interns, and promote regional coordination
  3. Undertake treatments at 6 Project Sites to test different methods of controlling *Holcus lanatus* (velvet grass)
    - Approaches monoculture, rapidly advancing , changes soil to detriment of native spp, no clear BMP's



# Coastal Prairie Status

- **Most diverse of any grassland in N. America**  
(Stromberg, et al. 2001)
- **Only 1% native CP remains**
  - ~80 spp. are endemic to CP
- **6<sup>th</sup> most endangered ecosystem in North America** (Noss and Peters 1995)





# Bodega Pastures – Sheep Grazing Results

Can sheep grazing reduce HoLa frequency, % cover? Does it affect community?

## Constraints:

- HoLa % cover; frequency; cover of native & non-native spp. did not change significantly
- Livestock management and grassland enhancement objectives not always in line. Can result in levels of grazing too high or too low if primarily concerned with grassland management.
- Other constraints include infrastructure (fencing, water...), timing, health, predators, and low forage quality of HoLa.

## Benefits:

- Ranches abundant in Sonoma & Marin counties. 57%-80% of CA's grasslands are privately owned & managed by ranchers
- Potentially holding the line, no increase in HoLa % cover and frequency
- Can reduce shrub encroachment and litter accumulation; removal efforts have largely resulted in grasslands dominated by non-natives
- Can cover large tracts of land and access relatively difficult terrain
- Food and other products

- *Holcus lanatus* is a serious threat to coastal prairie, it is spreading aggressively and difficult to control
- Mowing appears to be an effective way to hold the line and prevent increase in HoLa cover. Look at data for OS and OAEC again. Compare native & non-native starting point.
- Light grazing using cattle is not adequate to reduce or control *Holcus*, even at lower levels of *Holcus* cover (30%).
- Grazing using sheep is not adequate to reduce or control *Holcus*, when the infestation is high.
- Herbicide can be effective at reducing *Holcus*. The type of herbicide you choose depends on whether you have some native community present or not. Will require more than one treatment due to recruitment from seed bank; expect need for long-term removal of resprouts (spot spraying or manual removal).
- We know that *Holcus* spreads by sending out satellite plants and removal of these is critical for preventing spread. The window to remove satellites is between late spring when plants become visible (definitely by the time flowers become visible) but before seed set in late summer. There is a time when plants are easier to remove, peak flowering stage. Run risk of plant advancing to stage of seed shattering if you miss this window.

# Additional BMR Coastal Prairie Enhancement Activities

Hand pulled over 4500 HoLa satellite plants from ~ 25 acres btn. 2008-2012

Collected native grass seed – Summer & Fall 2008 & 2010

Propagated 6000 native grasses – Fall & Winter 2010

*-Elymus glaucus , Bromus carinatus, Danthonia californica, Hordeum brachyantherum*

Removed 1000's of *Lupinus arboreus* shrubs – 2011 & 2012

From saplings to mature adult plants

Planted 5000 native grasses – Winter 2011

Lupine removal & annual grass dominated sites

Expanded herbicide treatment by 1 acre

*Cirsium vulgare* control efforts - 2011 & 2012

60 hours

CP Demonstration garden restoration

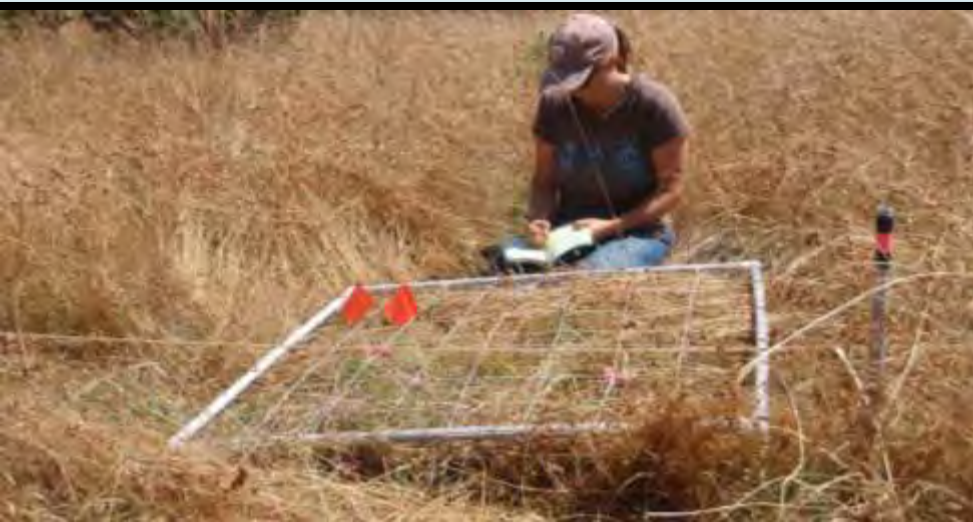
Recruited 2 dedicated volunteers



# Ocean Song Farm & Wilderness Center: Monitoring Description

## Mowing Site:

- Established two 18 m long transects in ~ 1 acre site
  - Collected pre-treatment data & measured same parameters each Spring since 2010
  - HoLa freq, Species % cover (Daubenmire cover class method)
- Rate of HoLa spread monitored at this site as well
  - One site, ran two transects in opposite directions, both beginning at the center of a HoLa patch, and ran them out past the edges
  - Measured HoLa frequency and % cover every Spring since 2010



# Ocean Song Farm & Wilderness Center- Rate of Spread Results

## **2010 - North Transect (30m)**

HoLa % Cover in center of patch = 44%  
Edge of patch @ 12.6 m  
No satellite plants

## **2012 - South Transect (30m)**

HoLa % Cover in center of patch = 91%  
Edge of patch @ 15.0 m  
No satellite plants

## **2010 – South Transect**

HoLa % Cover in center of patch = 39%  
Edge of patch @ 6.7 m  
Satellites plants found @ ~22 m

## **2012 – South Transect**

HoLa % Cover in center of patch = 84%  
Edge of patch @ 20 m  
Satellite plants found @ ~26 m

- HoLa average % cover at center of patch more than doubled in two years
- The edges of the patch expanded on both north and south edges by 2.4 and 12.3 meters respectively

# CPEFS Origins

- **Sonoma – Marin Coastal Grasslands Working Group**
  - Landscape level conservation through education, research and effective management
- **Sonoma/Marin CP Workshops 2006 & 2012**
  - 24 agencies, academic institutions, land managers & planners, conservation groups & private land owners
- **Developed prioritized list of conservation, management, and research priorities for CP**

## Conservation Priorities for Coastal Prairie in Sonoma and Marin Counties

Proceedings of the Sonoma–Marin Coastal Prairie Workshop  
November 6, 2006  
UC Davis Bodega Marine Laboratory, Bodega Bay, California



A Project of:  
the Sonoma–Marin Coastal Grasslands Working Group

# Exotic Perennial Grasses

- Especially difficult to control
  - Form dense sod & thick litter layers
  - Greatly or entirely eliminating competition
  - Relatively long lived, clonal reproduction
  - Can't “mow away seed bank” over time



Recognizing the importance of this diminished habitat, a group of like-minded researchers, managers, educators, and community members concerned about the ongoing loss and degradation of CP in Sonoma and Marin counties formed the Sonoma-Marin Grasslands Working Group, a collective dedicated to landscape-level conservation of coastal grasslands. The working group's mission is to “conserve, protect and restore native coastal grasslands through education, research and effective management.” Aware that a collaborative, inclusive approach to conservation is needed to conserve cp in our region, their first project was to coordinate the SM cp workshop. This document is both a summary of the workshop proceedings and working plan for a coordinated approach to cp conservation in our region.



# Ocean Song Farm & Wilderness Center:

**Can goat grazing &/or mowing reduce HoLa frequency, cover?  
How do these treatments affect community composition?**

## Goat Grazing Site (~ .?? Acre)

### 2010

June – July; 6 goats for 173 hrs;  
prevented seed set

### 2011

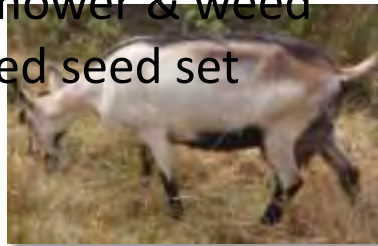
May – June; 6 goats for 44 hrs\*

August - hand scythed-material  
collected, piled and tarped;  
prevented seed set

### 2012

July & August – flail mower & weed

\*Goats were prevented  
to manage, refused to  
return to site



## Mowing Site (?? Acre)

### 2010

June & August – Flail mower & weed  
whacker; prevented seed set

### 2011

July & August – Tractor & weed  
whacker; prevented seed set

### 2012

July & August – Flail mower & weed  
whacker; prevented seed set  
July 2011

- This project was not designed to be a scientifically controlled, replicated study. Rather, each site undertook a management project specific to the opportunities and existing resources available at the site. Different methods were conducted at each site, led by the site managers from each location. The monitoring parameters remained constant for all sites and was led by the same team the entire time, but the questions addressed and the monitoring methods were individualized for each management strategy. Treatments have been applied for the past two seasons (2010-2012) and are mostly completed. The last phase of monitoring will be conducted in Spring 2013.

# Coastal Prairie Enhancement Feasibility Study

Three main components:

- Regional scale, digital map classifying 100,000 acres of CP in Sonoma & Marin counties
- Education & Outreach
- Implement and monitor different *Holcus lanatus* management techniques at 5 regional sites
  - *H. lanatus* recognized as posing greatest immediate threat to CP of all perennial grasses



- **Monitoring Parameters at all Sites**
  - HoLa frequency
  - Species richness
  - Species % cover
  - Plant height
  - Thatch height

### **Different Methods / Site**

- Estero – Cattle Grazing
- OS – Goat Grazing, Mowing and Hand Pulling
- OAEC – Mowing and Raking
- BP – Sheep Grazing
- Bodega Head - Herbicide (non-specific, Aquamaster & monocont specific, POAST)

# Cooperators

Audubon Canyon Ranch

Salmon Creek School

Pt. Reyes National Seashore

Gold Ridge Resource Conservation District

Marin Resource Conservation District

California Native Grasslands Association

Marin Agricultural Land Trust

Marin Municipal Water District

Marin County Open Space District

Private Landowners



# Exotic Perennial Grasses

- Especially difficult to control
  - Form dense sod & thick litter layers
  - Greatly or entirely eliminating competition
  - Relatively long lived, clonal reproduction
  - Can't "mow away seed bank" over time
  - Similar growth cycle of native perennial grasses





# Conservation & Management Planning

- Landscape level understanding of CP distribution, processes, and threats is needed
  - how environmental factors (slope, aspect, soil type...) distinguish different community types





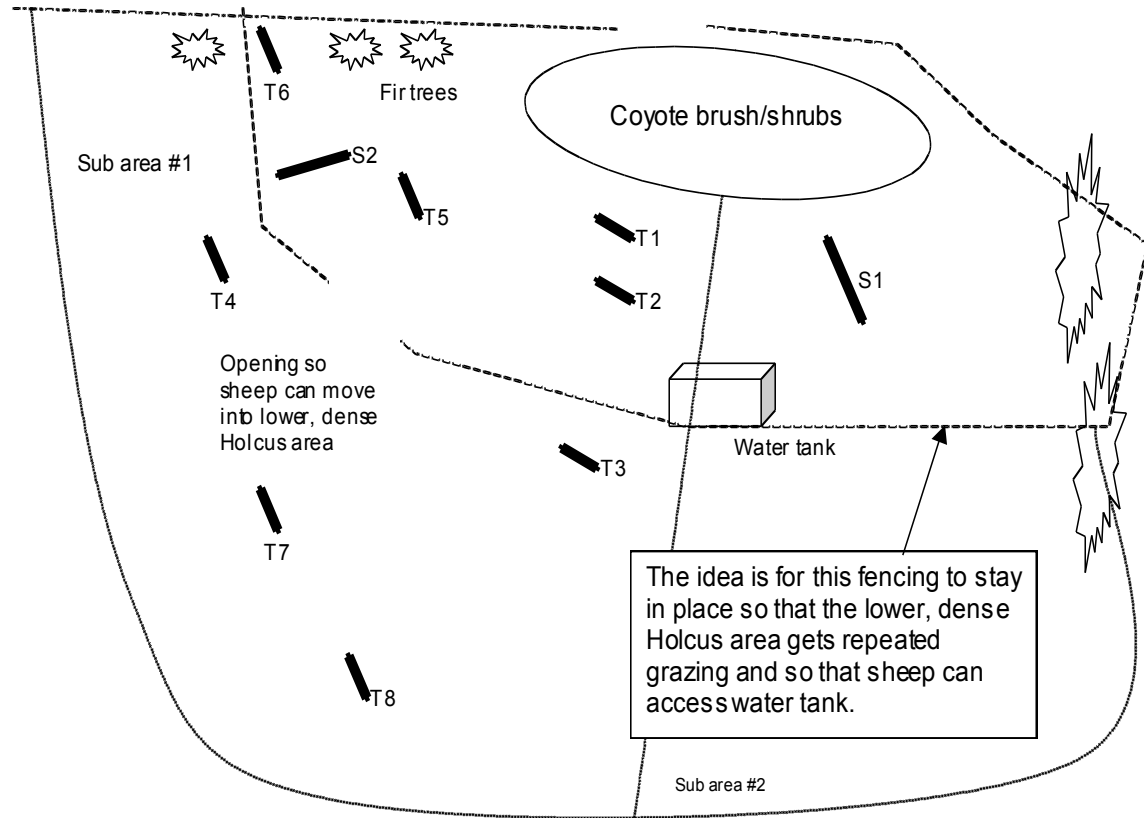
# Bodega Pastures – Sheep Grazing

Can sheep grazing reduce HoLa cover?

How does it effect community?

Set up pasture fencing and transects

	High-density HoLa	Lower-density HoLa
Heavier Grazing	T1, T2	T5, T6
Lighter Grazing	T7, T8	T3, T4



<b>DATE IN</b>	<b>DATE OUT</b>	<b>PASTURE</b>	<b>DURATION</b>	<b>STOCKING RATE</b>	<b>NOTES</b>
January 18, 2009	Early March	All	1-1.5 months	12 stocker cows	Cows escaped to Bottarini Ranch. Fence has been repaired.
2009		All	Intermittent	1-8 "trespassing cows"	Intermittent grazing by cattle from Manuel Brazil's operation at neighboring Bottarini Ranch.
March 20, 2010	August 8, 2011	All		12 cow/calf pairs; 8 yearlings	12 Heifers: 550-600lbs when brought on – 1100lbs when removed 12 Calves: 150lbs when brought on – 400lbs when removed 8 Yearlings: 400lbs when brought on – 900lbs when removed.
March 20, 2010	May 23, 2010			2 Yearlings	2 dead cows discovered. Probably missed being vaccinated.
Mid-May	September	All	4 months	1 bull	Bull present on property, seen roaming and "bellowing". On property through September.
	August 8, 2011			12 cows, 10 calves, 6 yearlings	Cows removed: 12-1100lb heifers, 12-400lb calves, in addition to 6-900lb yearlings.
August 2011	October 2011			Two calves	2 remaining calves removed.
June 1, 2012		All		10 yearling Angus animals	

Velvet grass (*Holcus lanatus*)



