Giselle Block
USFWS
San Pablo Bay
National Wildlife Refuge

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Spartina Project

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Ducks Unlimited

Native tidal marsh plants

Control of Perennial Pepperweed (*Lepidium latifolium*)

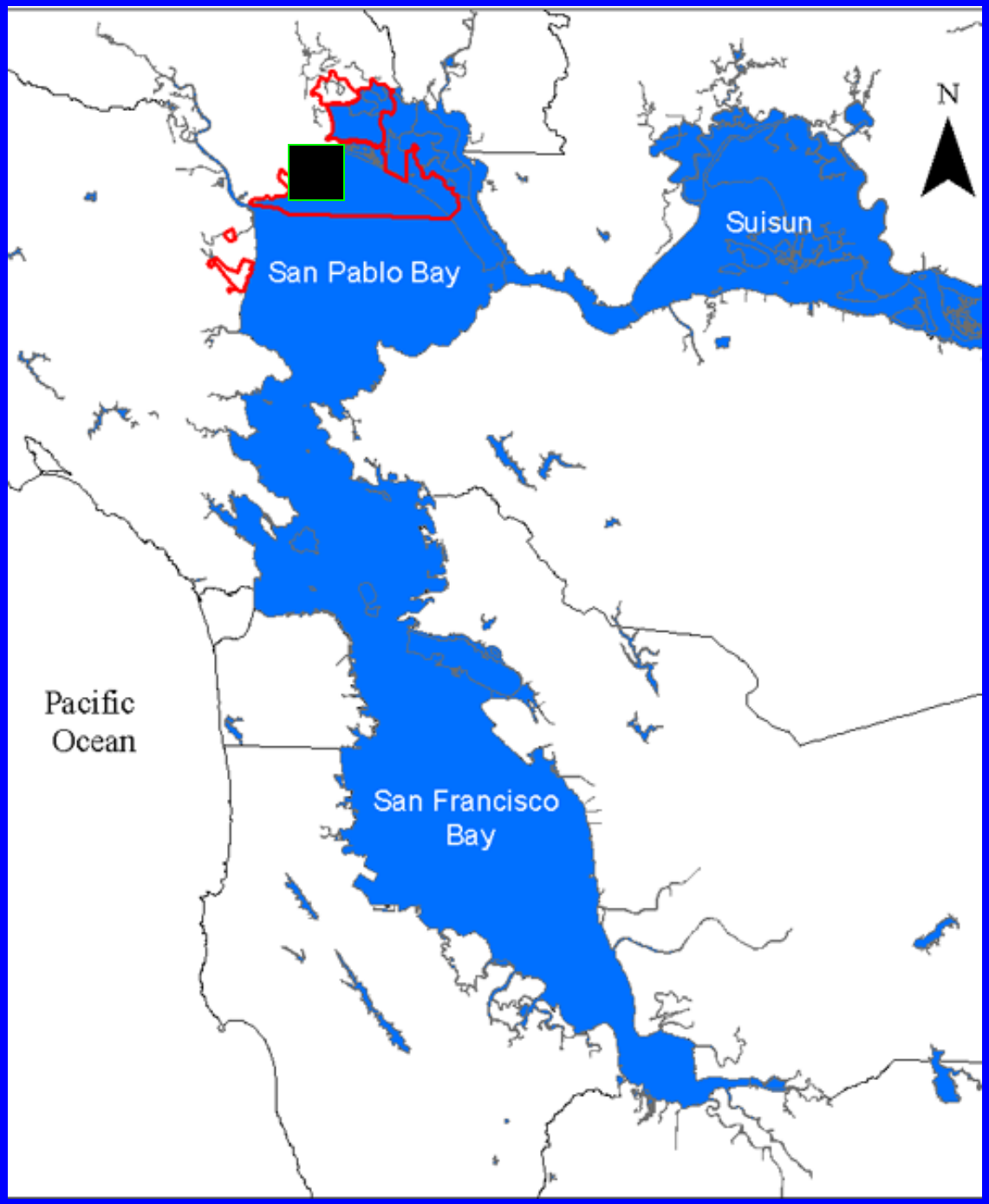
in

Tidal Marsh of San Pablo Bay

Pepperweed *(Lepidium latifolium)*

Highly invasive herbaceous perennial

Forms monocultures and displaces native species

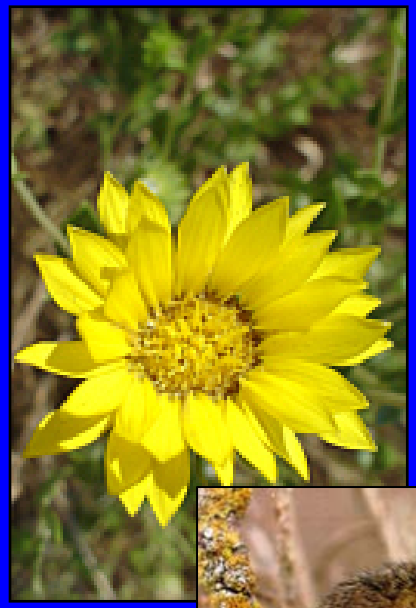

N
Suisun
San Pablo Bay
Pacific
Ocean
San Francisco
Bay

Sarcocornia pacifica

Frankenia salina

Grindelia stricta

Spartina foliosa



Control Program Goals

1. Significantly reduce the abundance of pepperweed in tidal marsh of San Pablo Bay

2. Prevent reinfestion of pepperweed

   (spatially expand control efforts, native plant restoration)

Control Program Objectives

- Determine distribution and abundance
- Develop a plan for control
- Implement control actions
- Evaluate efficacy of control
- Adapt plan

Distribution and Abundance:
USFWS Volunteer Invasives Monitoring Program

Train volunteers and interns

GPS: Trimble Geo XT's

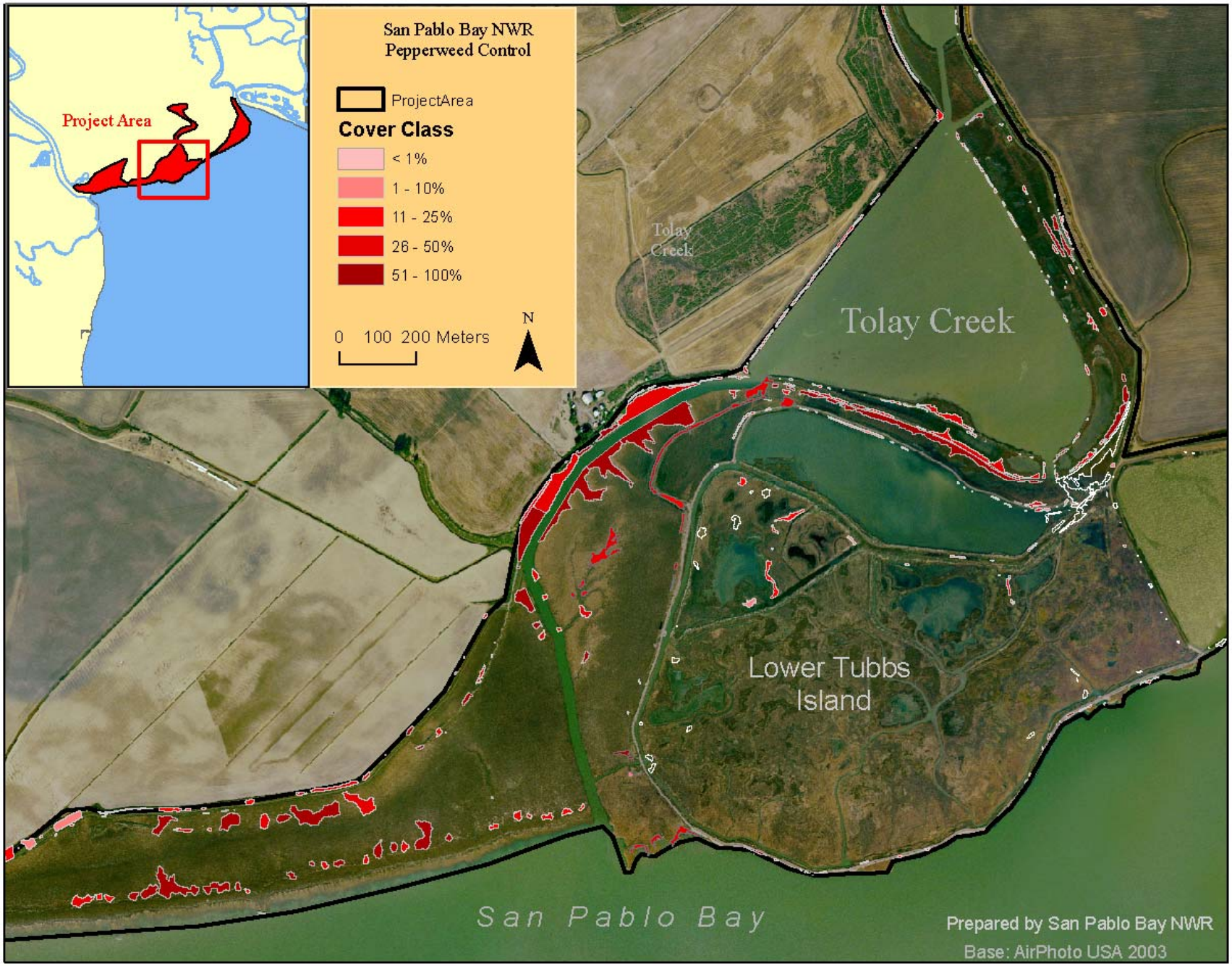
ArcPad software

Weed Information Management System (WIMS)

Mapping Results

- 1,500 acres of tidal marsh surveyed (2005)
- Result: 60 gross acres
- Patterns:
  - Levees (45%), bay edge (31%), channels (18%)
  - Areas of tidal disturbance
  - All restoration sites
  - Absence patterns

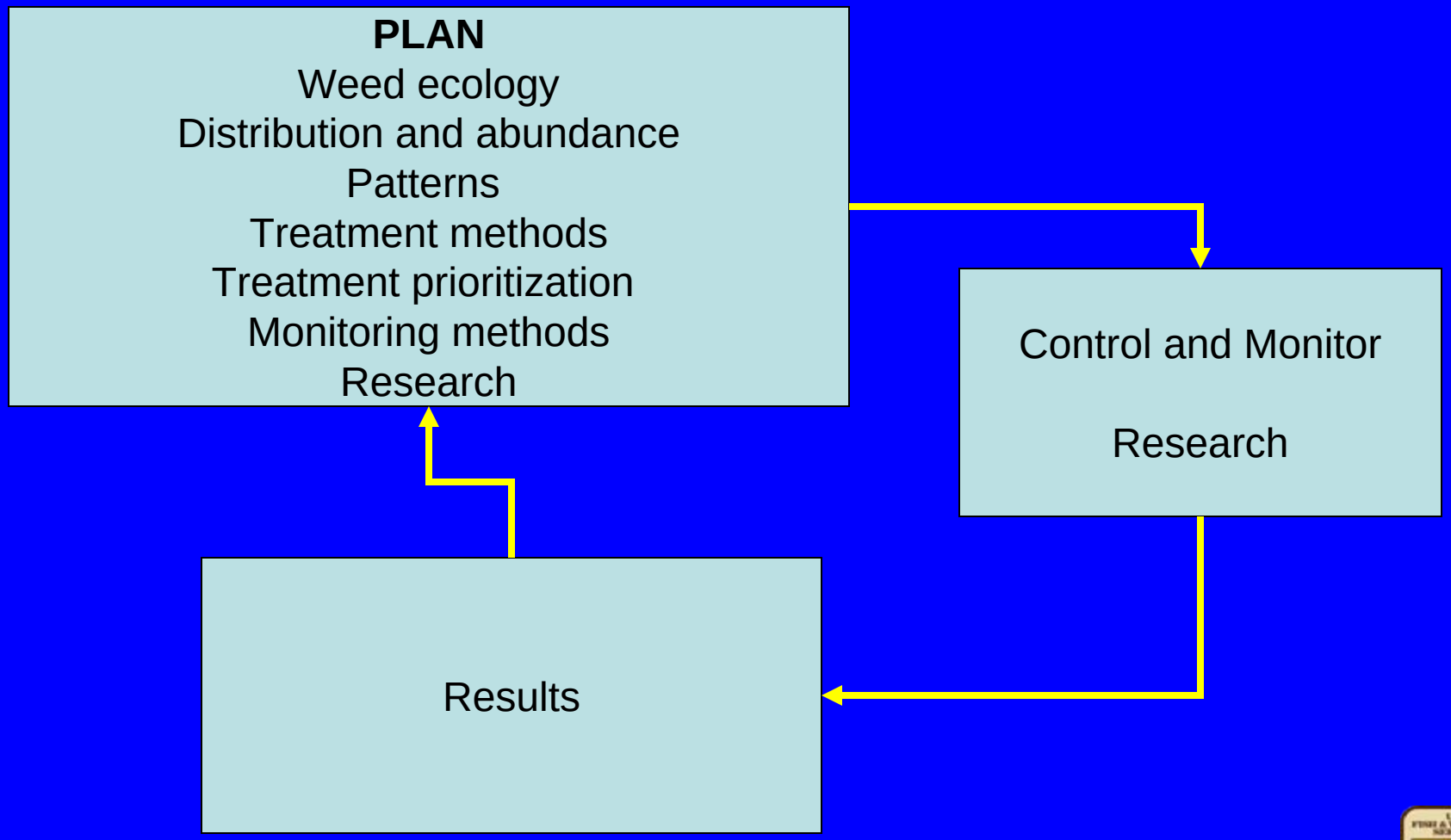

Study Area
San Pablo Bay
San Francisco Bay
Pacific Ocean
San Pablo Bay
Lepidium
Control Project
Study Area 2005 - 2006
Study Area
Lepidium Presence
Base: AirPhoto USA 2004
Meters
0
250
500
4_3_06
STATE HWY 37
STATE HWY 116
Reclamation Road
Tolay Creek
Tubbs Island
Setback
Lower
Tubbs Island
Sonoma Baylands
Restoration Site
Port
Sonoma
Petaluma River
San Pablo Bay
Map produced by Sonoma Land Trust
in partnership with the
San Pablo Bay National Wildlife Refuge


San Pablo Bay NWR
Pepperweed Control
ProjectArea
Cover Class
< 1%
1 - 10%
11 - 25%
26 - 50%
51 - 100%
0 100 200 Meters
N
Project Area
Tolay Creek
Tolay Creek
Lower Tubbs Island
San Pablo Bay
Prepared by San Pablo Bay NWR
Base: AirPhoto USA 2003

Objectives

1. Determine distribution and abundance
2. Develop a plan for control
3. Implement control actions
4. Evaluate efficacy of control
5. Adapt plan

Control Plan: Adaptive Approach (2006)



Control (2007-2008)

Herbicide: Habitat (imazapyr)

Late bud to flower stage (May)

Backpack sprayers (2007)

Helicopter + backpack (2008)

Cost: approximately $250/acre

Objectives

1. Determine distribution and abundance
2. Develop a plan for control
3. Implement control actions
4. **Evaluate efficacy of control**
5. Adapt plan

Study Questions

Effects of imazapyr on pepperweed cover?

Effects of herbicide mixture (imazapyr+glyphosate) on pepperweed cover?

Does efficacy vary by environment?

Effects on native plants?

Methods

Random spatial sampling (N = 36)
Stratified by Environment

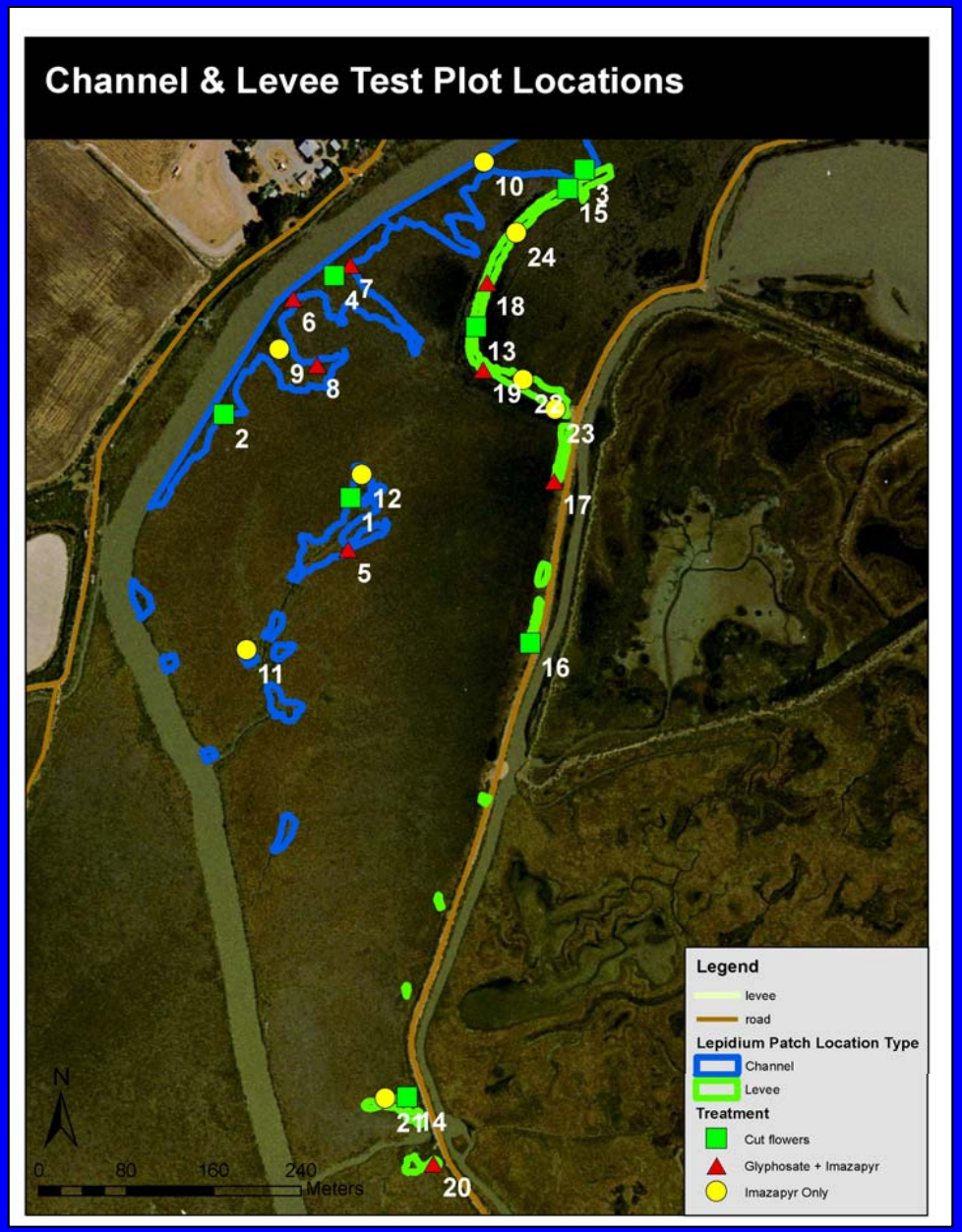
1m^2 monitoring plots nested within 16m^2 treatment plot

Random assignment of treatments within each environment:

1. imazapyr
2. imazapyr+glyphosate
3. control-influorescence removal

Measures: pepperweed stem count, % native cover

Analysis: ANOVA, Comparison of means (Tukey's HSD), Least Squares fit test

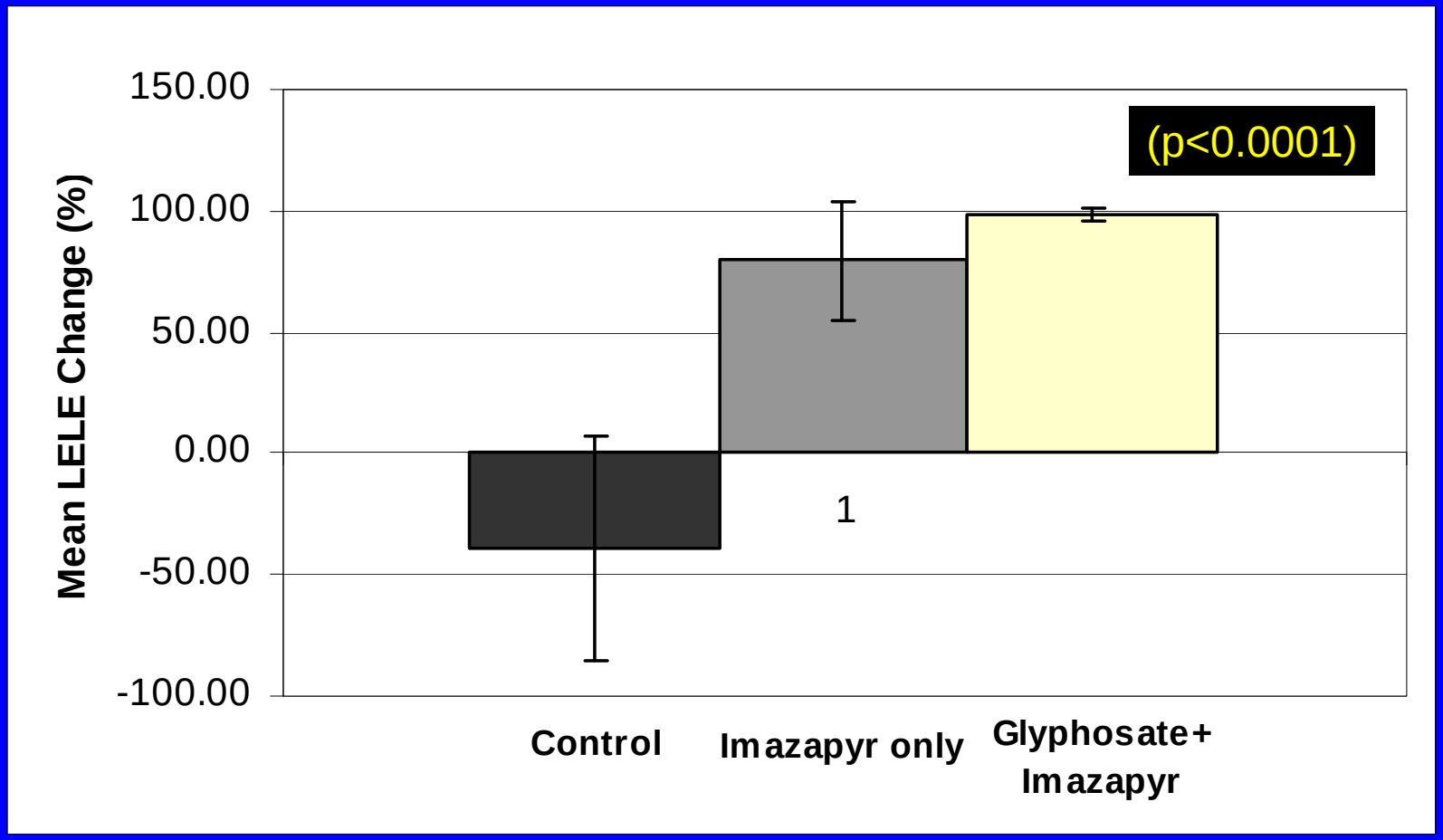


2007 Results-1st year

Treatment	% Reduction	Mean Reduction	SE
Imazapyr (N = 9)	(-20)-100	79.4	12.7
Imazapyr + Glyphosate (N = 11)	86-100	98.5	1.21
Control (N = 16)	(-308)-67	-39.2	23.6

Positive values indicate a reduction in pepperweed

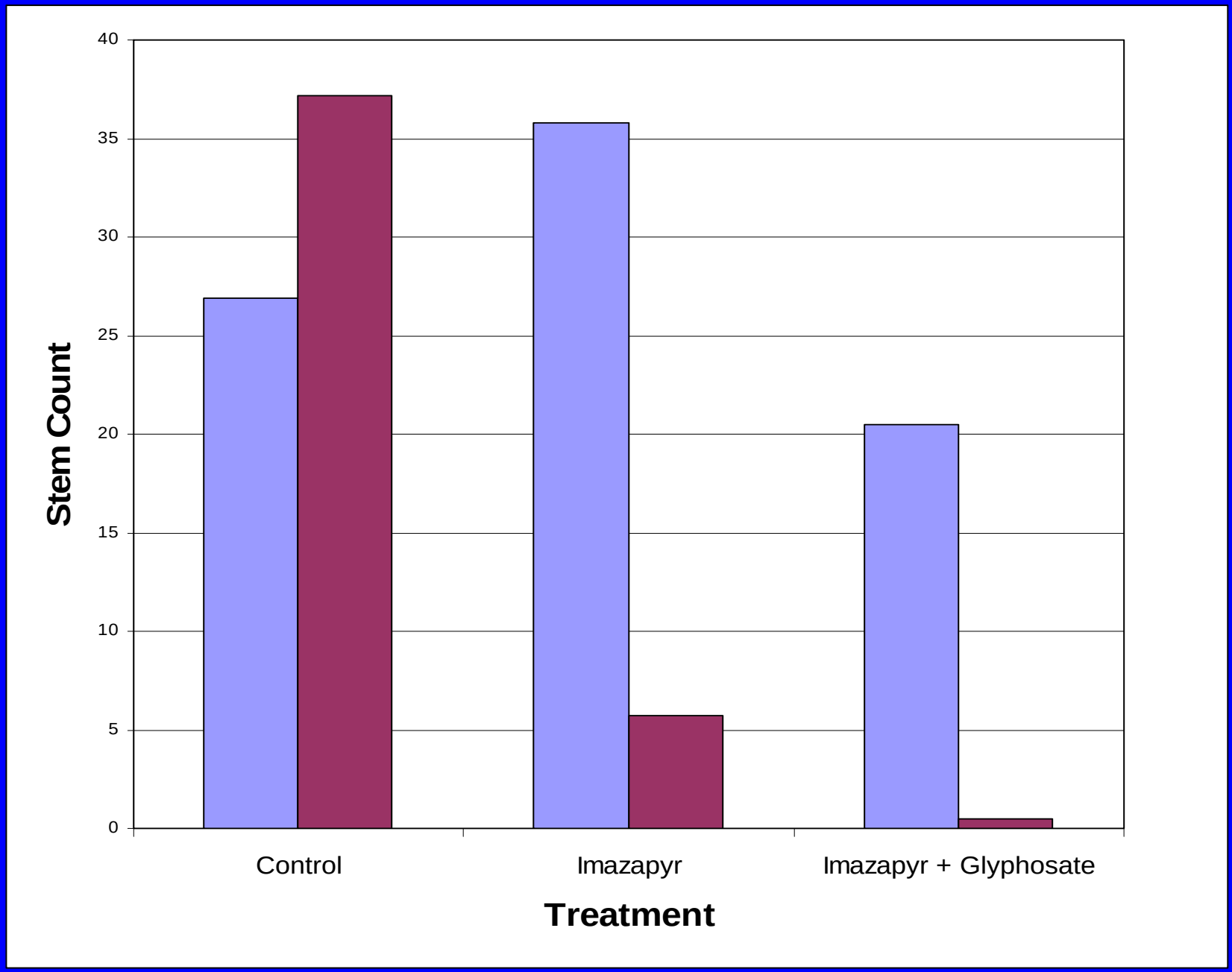
(2007)



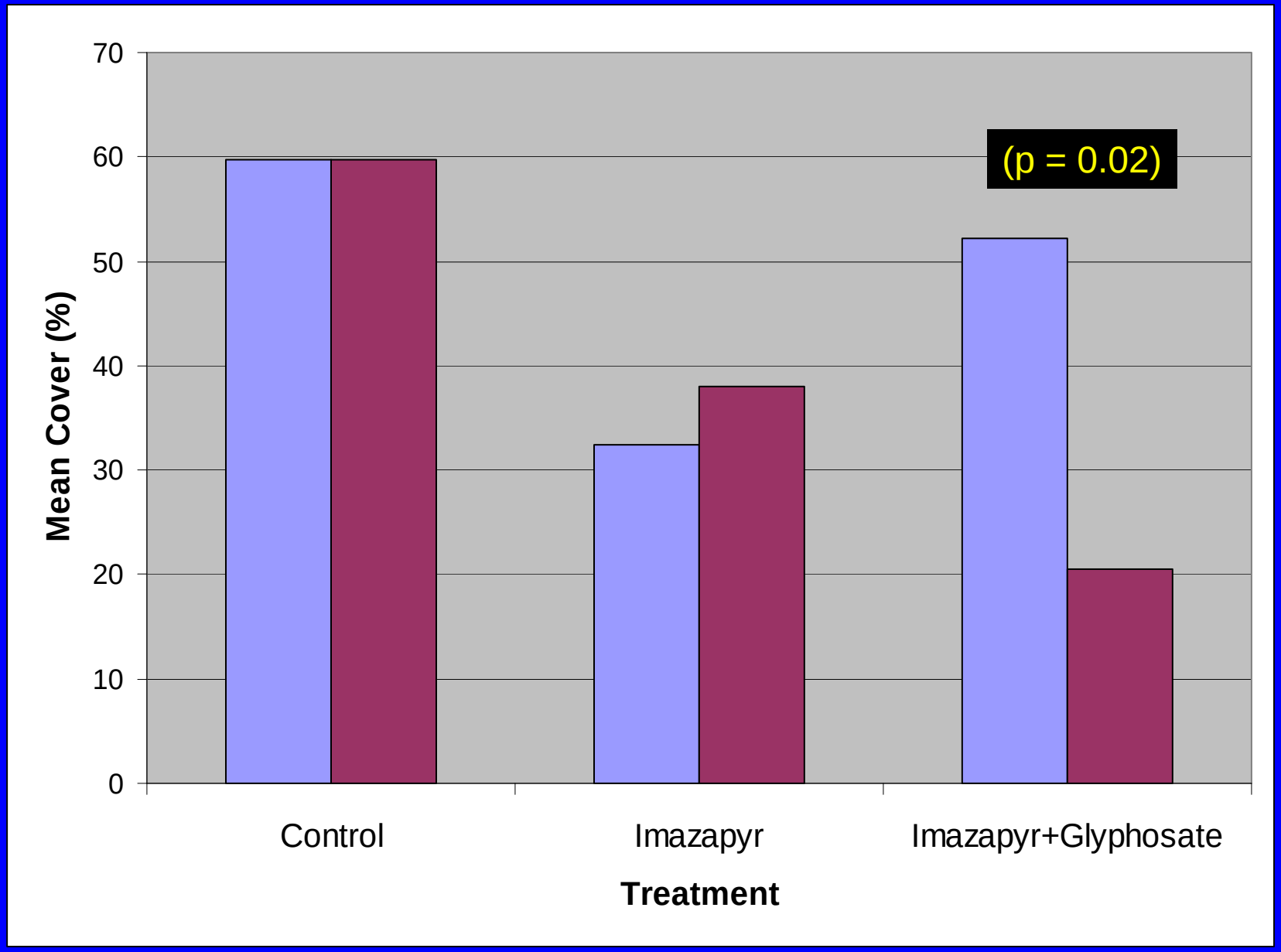
Positive values indicate a reduction in pepperweed

Error bars = +/-1.96*SE

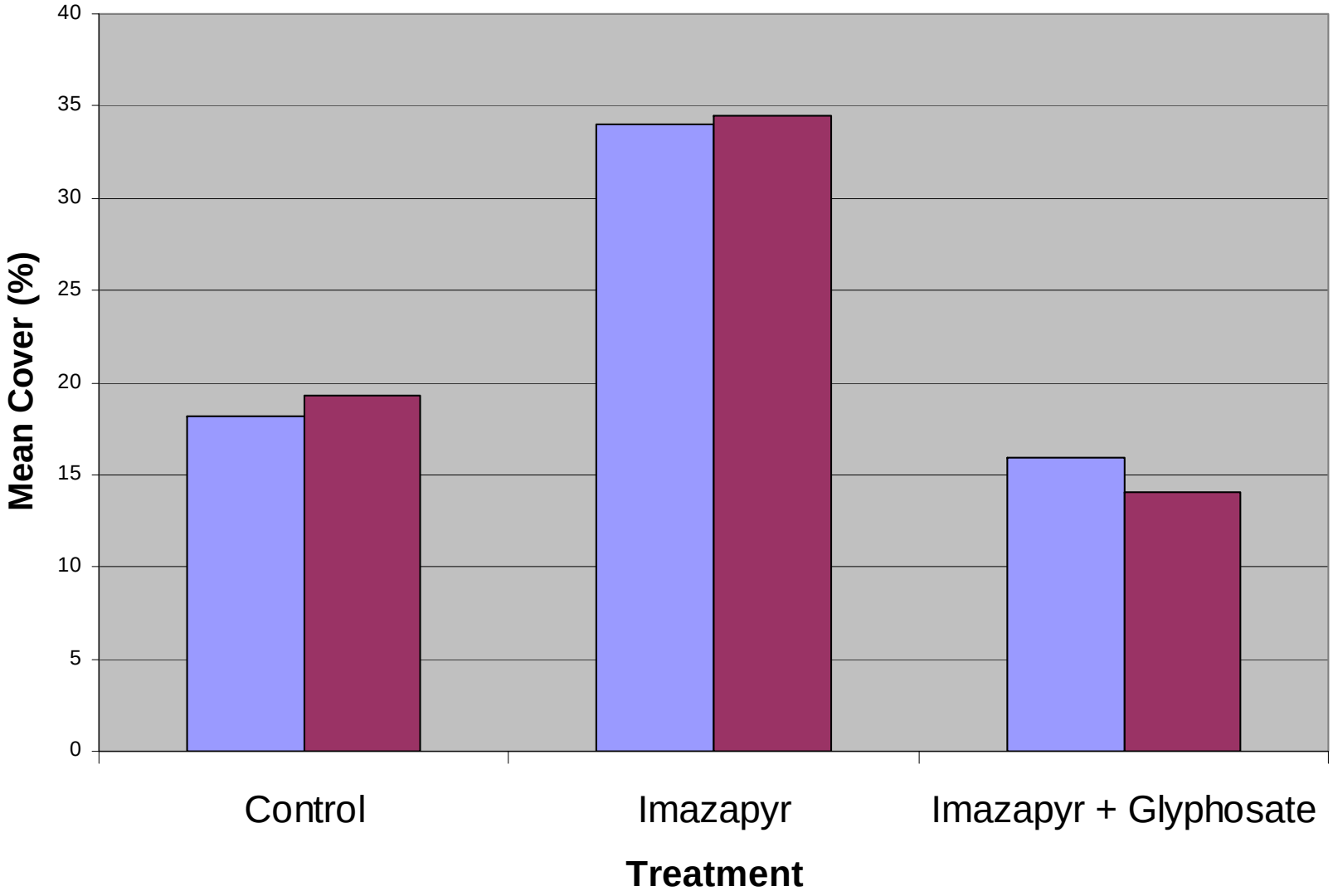
Treatment (p = 0.0001), Environment (p = 0.13), Environment x treatment (p = 0.06)


40
35
30
25
20
15
10
5
0
Stem Count
Control
Imazapyr
Imazapyr + Glyphosate
Treatment

Pickleweed (*Sarcocornia pacifica*)



Alkali heath (*Frankenia salina*)



Native Plant Cover

Scientific Name	Common Name	Number of Plots (pre-/post-treatment)
Sarcocornia pacifica	perennial pickleweed	31/31
Frankenia salina	alkali heath	18/23
Grindelia stricta	gumplant	8/11
Jaumea carnosa	jaumea	3/4
Distichlis spicata	**saltgrass**	**1/0**
Atriplex triangularis	**fat hen**	**0/5**

Management Implications
Next Steps

Continue study (1-2 years)

Continue large-scale treatment and monitoring

Treatment methods?

Plant Restoration-species?

Expand scope of control

Acknowledgements

Funding (2004 to present):

USFWS Invasives Program
USFWS Coastal Program
NFWF Pulling Together Initiative
CA Wildlife Conservation Board

Partners:
Sonoma Land Trust
CA Dept of Fish and Game
Friends of San Pablo Bay NWR
The Bay Institute
Marin-Sonoma Mosquito and Vector Control District

Volunteers: Jim O'Neill, Tish Adams and many others!

Christy Smith, Refuge Manager

Volunteers are Awesome!

Education and Outreach

Invasive Plant Mapping

Plant Restoration