RECLAMATION

Managing Water in the West

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Restoration of Degraded Agricultural Lands in the San Joaquin Valley Using Herbicides and Activated Charcoal

U.S. Department of the Interior
Bureau of Reclamation

Central Valley Project Improvement Act Section 3408(h) Land Retirement Program

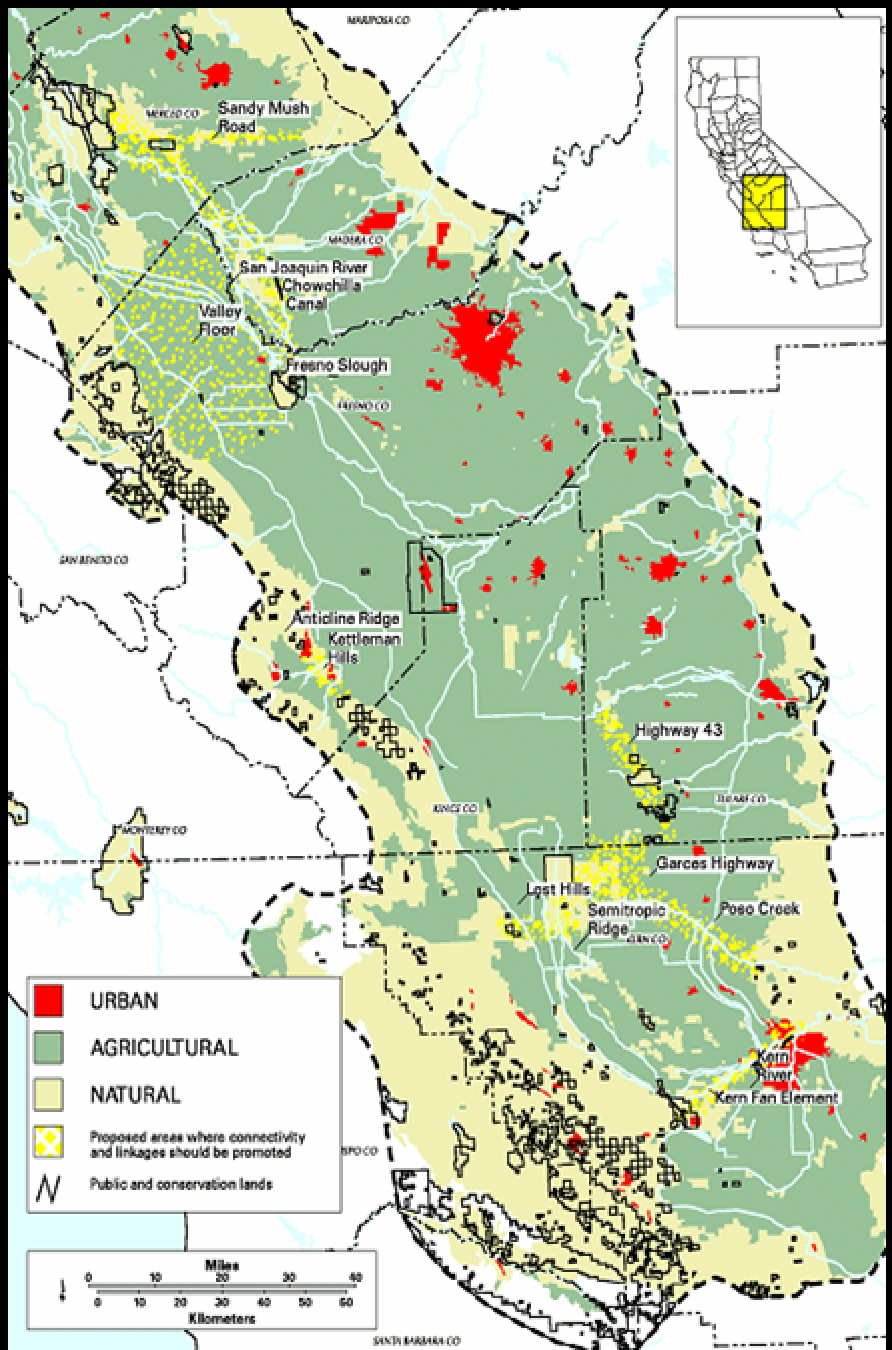
U.S. Dept. of the Interior

Land Retirement Demonstration Project

Five years of research and monitoring:

- Physical impacts
- Se exposure risk
- Water disposition
- Habitat restoration for wildlife and T&E species

Proposed linkages and corridors

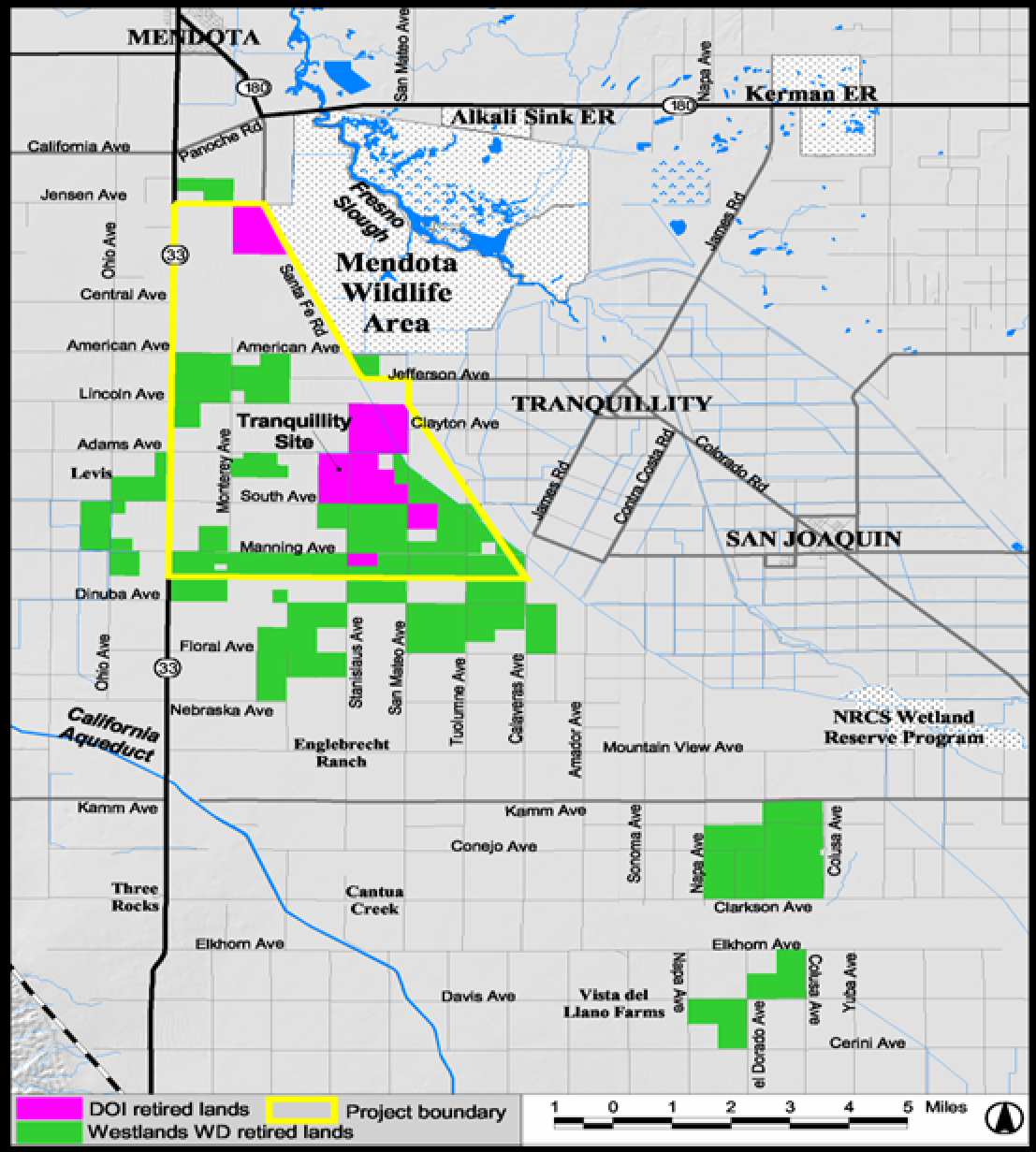


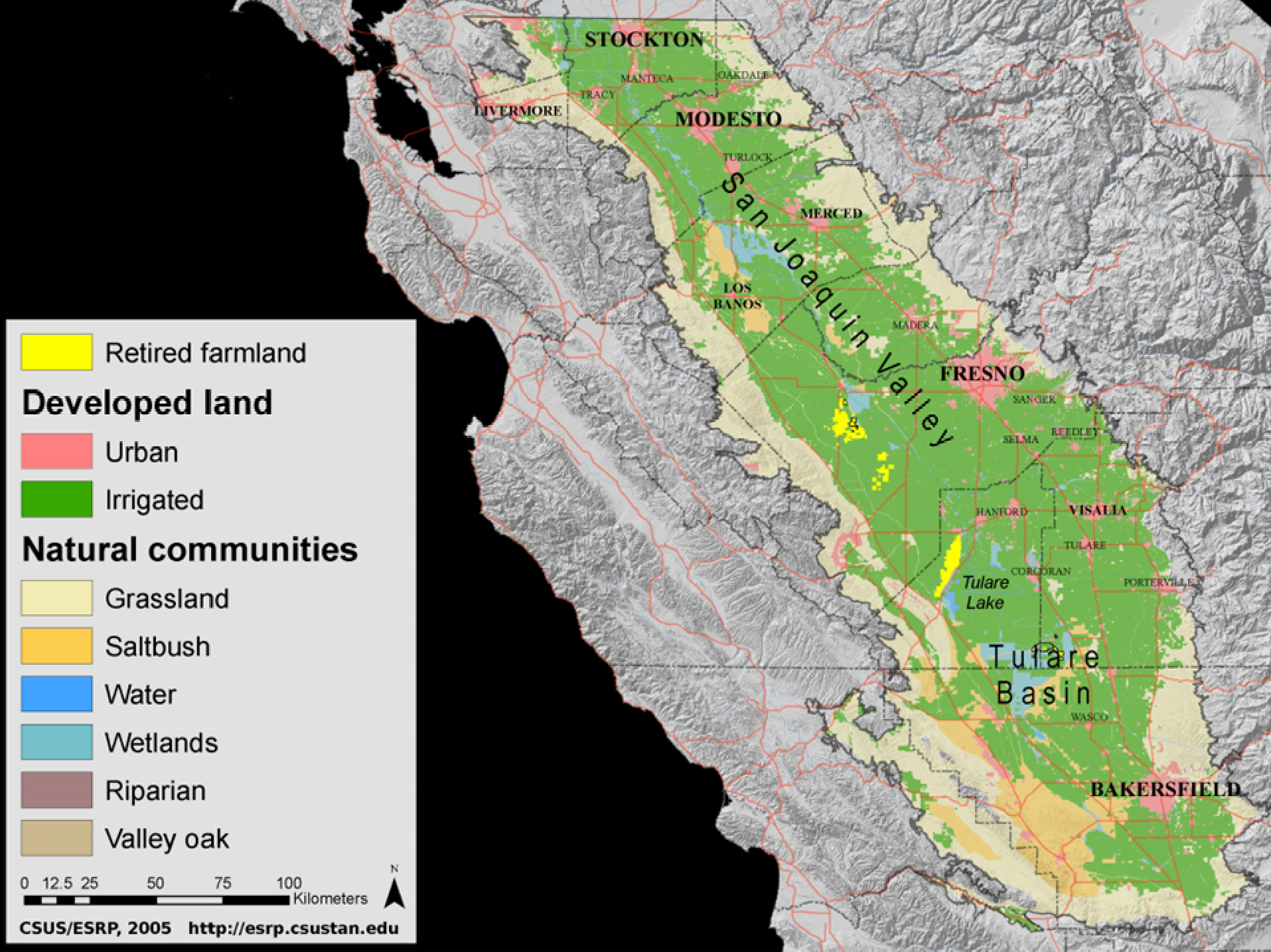
T&E Species Targets for Habitat Restoration

- ✓ **San Joaquin kit fox (*Vulpes macrotus mutica*)**
- ✓ **Kangaroo rat (*Dipodomys* spp.)**
- ✓ **Blunt-nosed leopard lizard (*Gambelia sila*)**

Land Retirement: Fresno County

- DOI: has acquired 2,090 acres
- Westlands Water District: has retired ~ 70,000 acres




STOCKTON
MANTECA
OAKDALE
TRACY
LIVERMORE
MODESTO
TURLOCK
San Joaquin Valley
MERCED
LOS BANOS
MADERA
FRESNO
SANGER
SELMA
REEDLEY
HANFORD
VISALIA
TULARE
CORCORAN
PORTERVILLE
Tulare Lake
Tulare Basin
WASCO
BAKERSFIELD
Retired farmland
Developed land
Urban
Irrigated
Natural communities
Grassland
Saltbush
Water
Wetlands
Riparian
Valley oak
0 12.5 25 50 75 100
Kilometers
N
CSUS/ESRP, 2005 http://esrp.csustan.edu

Reference Communities:

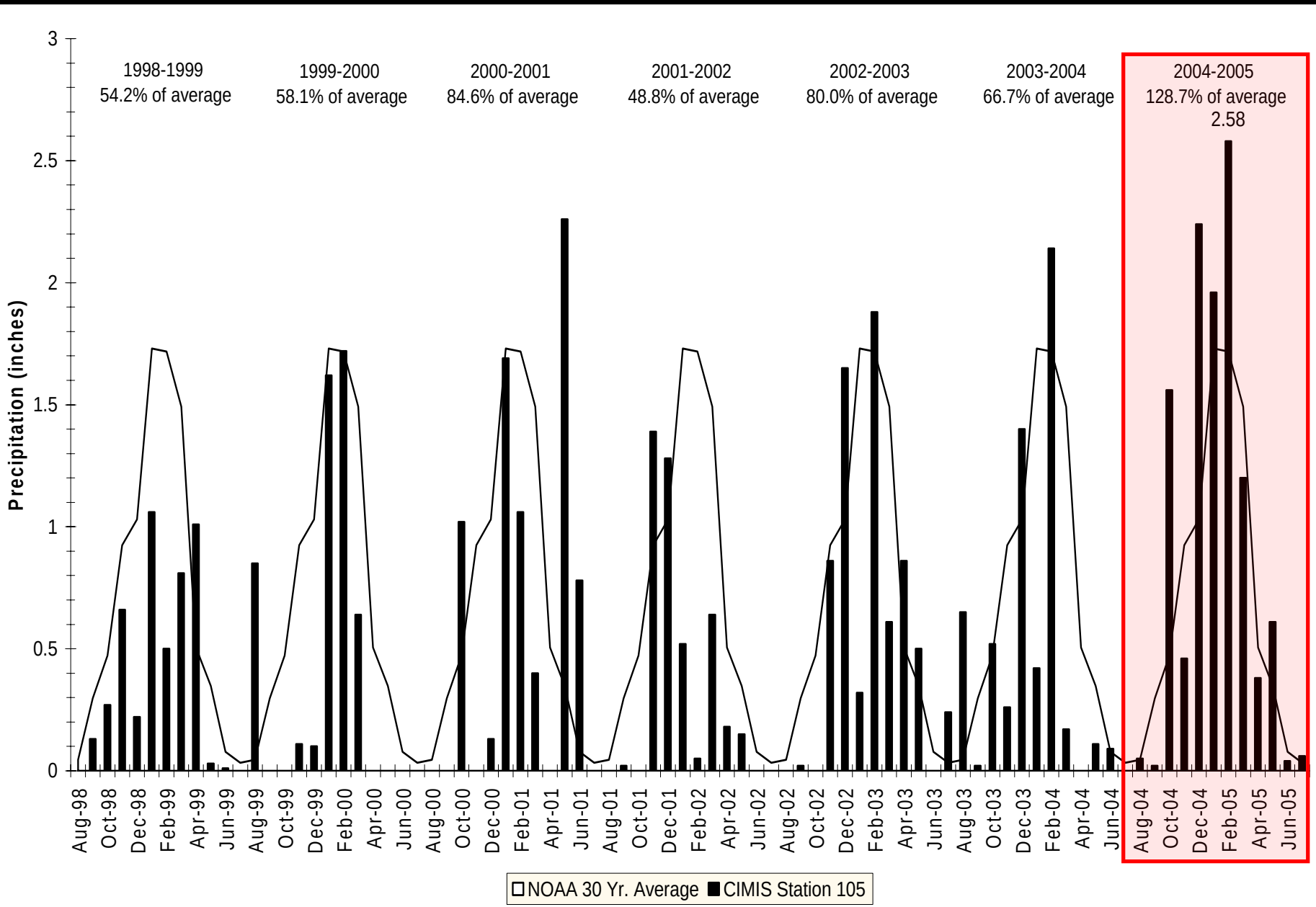
Alkali Sink Wildlife Reserve
Western Fresno County

Kerman Wildlife Reserve
Western Fresno County

Constraints

- Low precipitation (mean ~ 20 cm yr^{-1})
- Soils moderately to highly saline / sodic
- Dense clay soils with high shrink, swell potential
- Mean total Selenium in surface soils 1.05 mg/kg
  — (Mean western U.S. = 0.34 mg/kg)
- Extreme weed load immediately upon cessation of cultivation / irrigation

Precipitation during the course of the LRDP



Retired Agricultural Lands

- Extreme weed load immediately upon cessation of cultivation / irrigation

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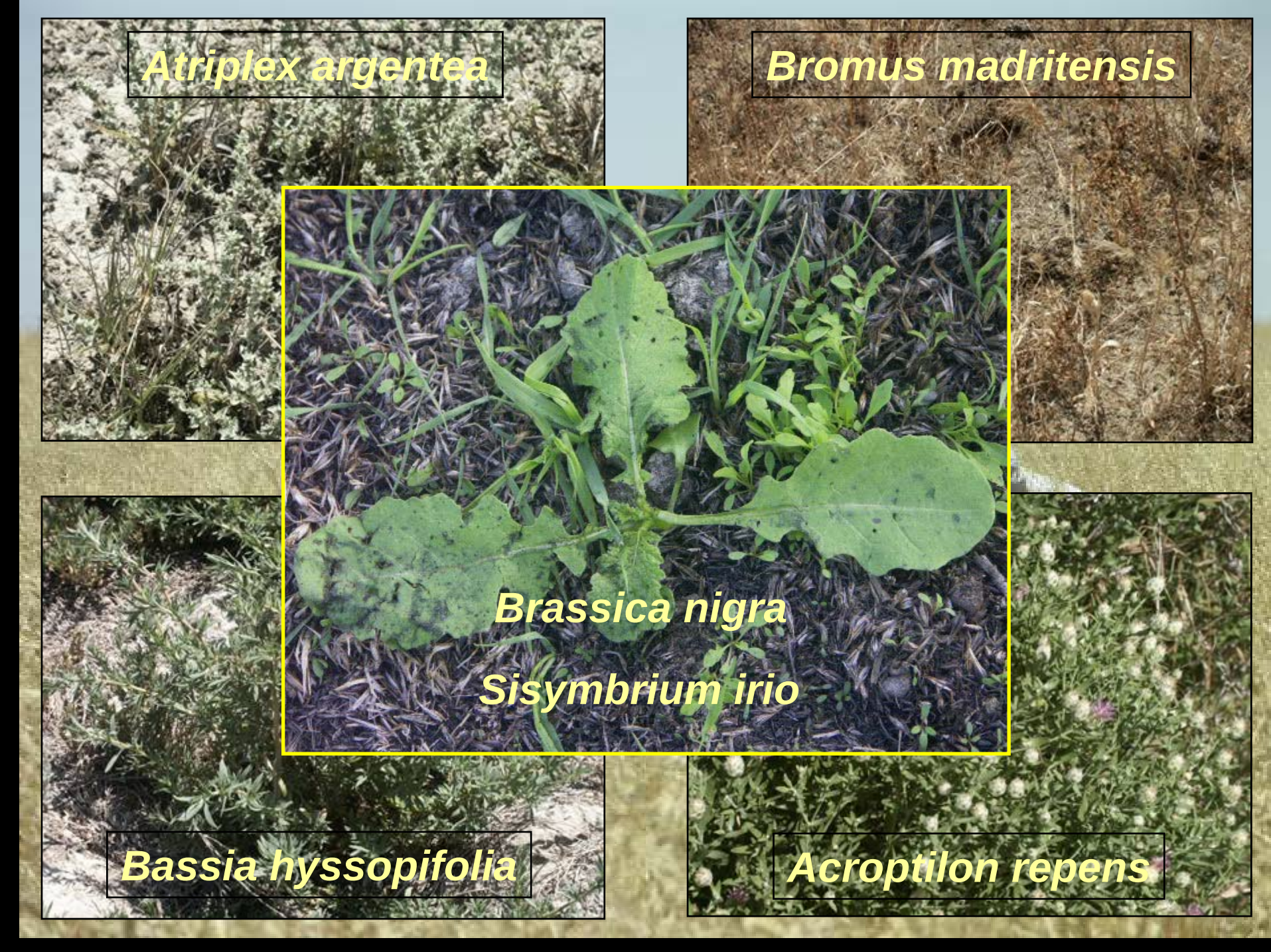

Atriplex argentea
Bromus madritensis
Brassica nigra
Sisymbrium irio
Bassia hyssopifolia
Acroptilon repens

Challenges

- **Innovative technologies for seedbed preparation:**
  - **invasive species management;**
  - **moisture capture and conservation;**
  - **nutrient and C/N manipulation;**
  - **salinity remediation;**
  - **microbial augmentation.**

(“designed disturbance” – Sheley et al. 1996)

Broadleaf weed trial:

- ✓ Black mustard (*Brassica nigra*) – A, I
- ✓ London rocket (*Sisymbrium irio*) – A, I
- ✓ Tumbling saltbush (*Atriplex rosea*) – A, I
- ✓ Silverscale saltbush (*A. argentea*) – A, N

- ➢ Early seral stage following retirement
- ➢ Study site previously imprinted

Grass weed trial:

- ✓ **Red brome (*Bromus madritensis* ssp. *rubens*) – A, I**
- ✓ **Wild oats (*Avena spp.*) – A, I**
- ✓ **Foxtail (mouse) barley (*Hordeum murinum*) – A, I**
- ✓ **Littleseed canarygrass (*Phalaris minor*) – A, I**
- ✓ **Rat-tail fescue (*Vulpia myuros*) – A, I**

- ➢ **Mid-seral stage following retirement**

Herbicide & Charcoal Treatment Trial

- **Four test species**
  - ✓ One early-season annual forb (*Phacelia ciliata*)
  - ✓ One "mid-season" perennial forb (*Grindelia camporum*)
  - ✓ Two late-season shrubs (*Atriplex polycarpa*, *Suaeda moquinii*)

- **Two charcoal treatments (plus control)**
  - ✓ Incorporated (@ 336 kg ha^{-1} equivalent rate)
  - ✓ Banded (@ 336 kg ha^{-1} equivalent rate)

Species Selection Criteria

- ✓ **Common usage; practical application**
- ✓ **Seed available (local ecotype and commercially)**
- ✓ **High germination and seedling vigor; dependable establishment**
- ✓ **Sensitive to weed competition; 'indicator species' for treatment.**

Phacelia ciliata (PHCI)
Great valley phacelia

Atriplex polycarpa (ATPO)
Desert (common) saltbush

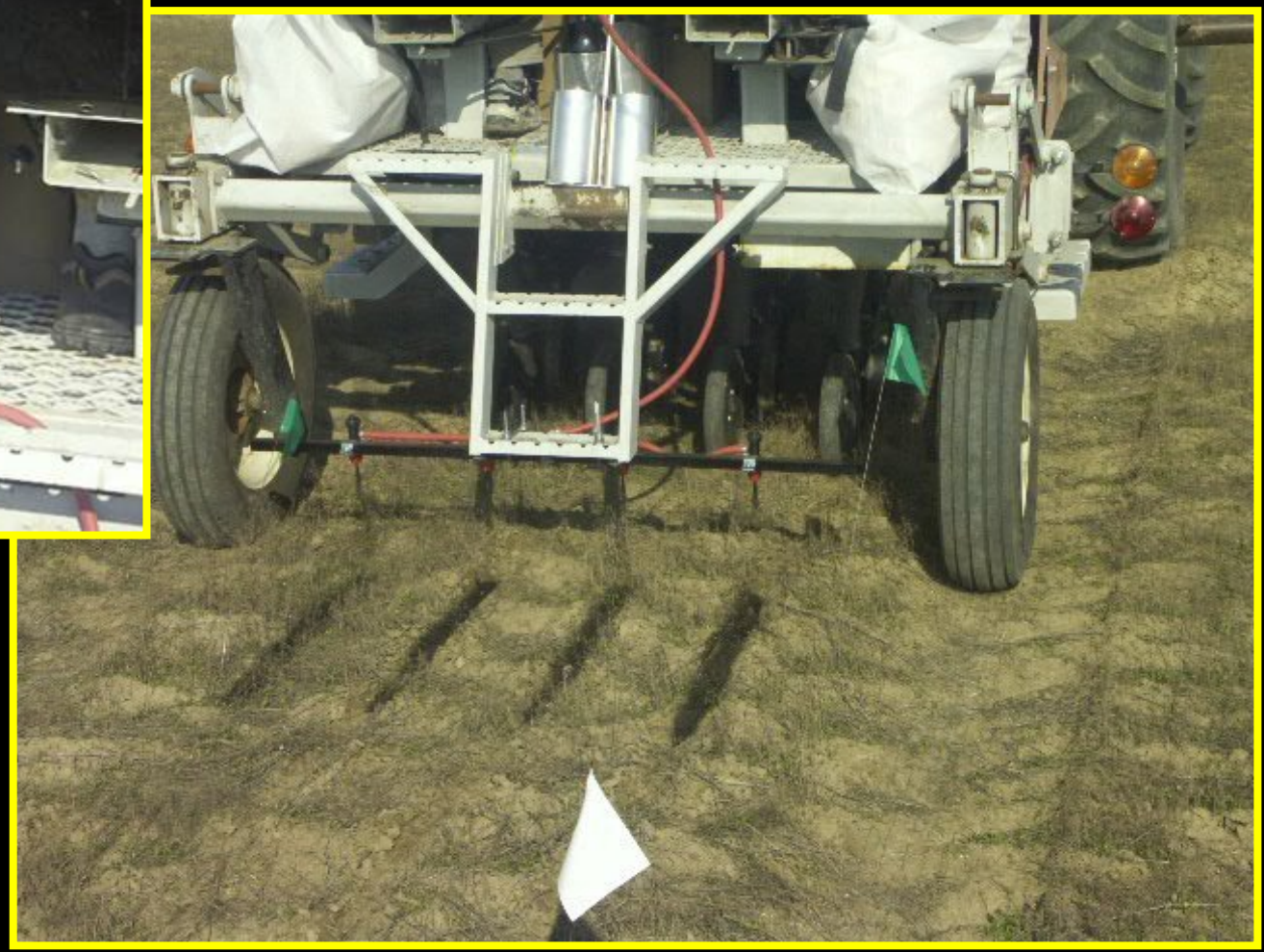
Grindelia camporum (GRCA)
Gumweed

Suaeda moquinii (SUMO)
Desert seepweed

Species seeded at 35 PLS per linear foot (116 PLS m^{-1}) – Dec. 8, 2004

✓GRCA	50.8% PLS
✓ PHCI	44.9%
✓ SUMO	11.4%
✓ ATPO	19.2%


THE UNIVERSITY OF
ARIZONA




Gro-Safe™
Agronomic Grade
Activated Charcoal
Norit-Americas, Inc.
(300 lb ac-1)
(78g per 25-ft. row)

Selected Activated Charcoal References

- Barmac. 2005. The role of Pickup activated charcoal in turfgrass management. http://www.barmac.com.au/pickup1.html.
- Fitzpatrick, G.S. 2004. Techniques for restoring native plant communities in upland and wetland prairies in the Midwest and West Coast regions of North America. White Paper, City of Eugene, Parks and Open Space Division. Eugene, OR. 51pp.
- Glaze, N.C., S.C. Phatak, and E.D. Threadgill. 1979. Spot activation of activated charcoal to increase herbicide selectivity in watermelon. HortSci. 14(5):632-633.
- Johnson, B.J. 1976. Effect of activated charcoal on herbicide injury during establishment of centipedegrass. Agron. J. 68:802-805.
- Kratky, B.A. 1975. Banding activated charcoal to increase herbicide selectivity on lettuce. HortSci. 10(2):172-173.
- Lee, W.O. 1973. Clean grass seed crops established with activated charcoal bands and herbicides. Weed Sci. 21(6):537-541.
- McCalla, J. and M. Richardson. 2002. Herbicide strategies for newly seeded bermudagrass. Pennington Pro Turf. http://www.penningtonseed.com/section/turf_02.html.
- Miller, L.C. and L.B. McCarty. 1999. Activated charcoal for pesticide deactivation. Clemson Univ. http://www.sodsolutions.com/turfmgt/charcoal.html
- Steinegger, D.H., R.C. Shearman, and L. Finke. 1987. *Veronica repens* establishment with herbicides and activated charcoal. HortSci. 22(4):609-611.
- The Ohio State University. 2005. Controlling weeds in nursery and landscape plantings – controlling plant damage from herbicide residues. Bull. 867, The Ohio St. Univ. http://www.ohioline.osu.edu/b867/b867_10.html.
- William, R.D. 2004. Testing for and deactivating herbicide residues. PNW Weed Manage. Handbook 2004. http://weeds.ippc.orst.edu/pnw/weeds?05W_HNAM14.dat.

Herbicide Treatments

Goal 2XL™
(*Oxyfluorfen*)
DowAgroScience
2 pt ac^{-1}

Plateau DF™
(*Imazapic*)
BASF
12.0 oz ac^{-1}

Landmark MP™
(*Chlorsulfuron* + *Sulfometuron methyl*)
DuPont
2.25 oz ac^{-1}

Cerano 5MEG™
(*Clomazone*)

Wilbur-Ellis
24 lb ac^{-1}

Telar DF™
(*Chlorsulfuron*)
DuPont
3.0 oz ac^{-1}

“Broadrange” 1.4G
(*Sulfentrazone*)
Wilbur-Ellis
12 lb ac^{-1}

Glyphosate (Roundup™) application – November 2004

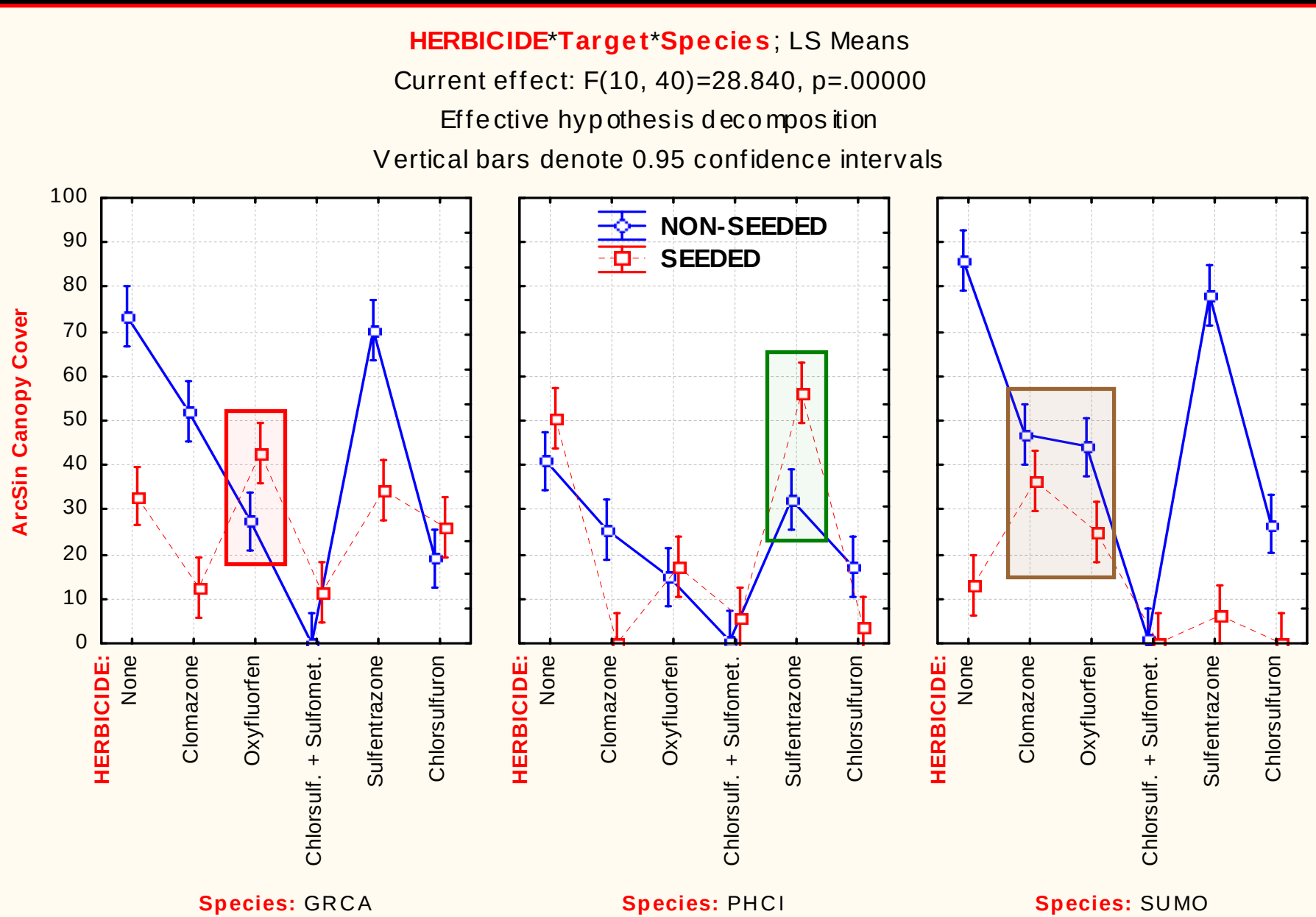
Herbicide & Charcoal Treatment Trial

- Four species (each planted in 4 rows per plot)
- Two charcoal treatments (plus control)
- Five herbicides (plus control)
- Four replicates

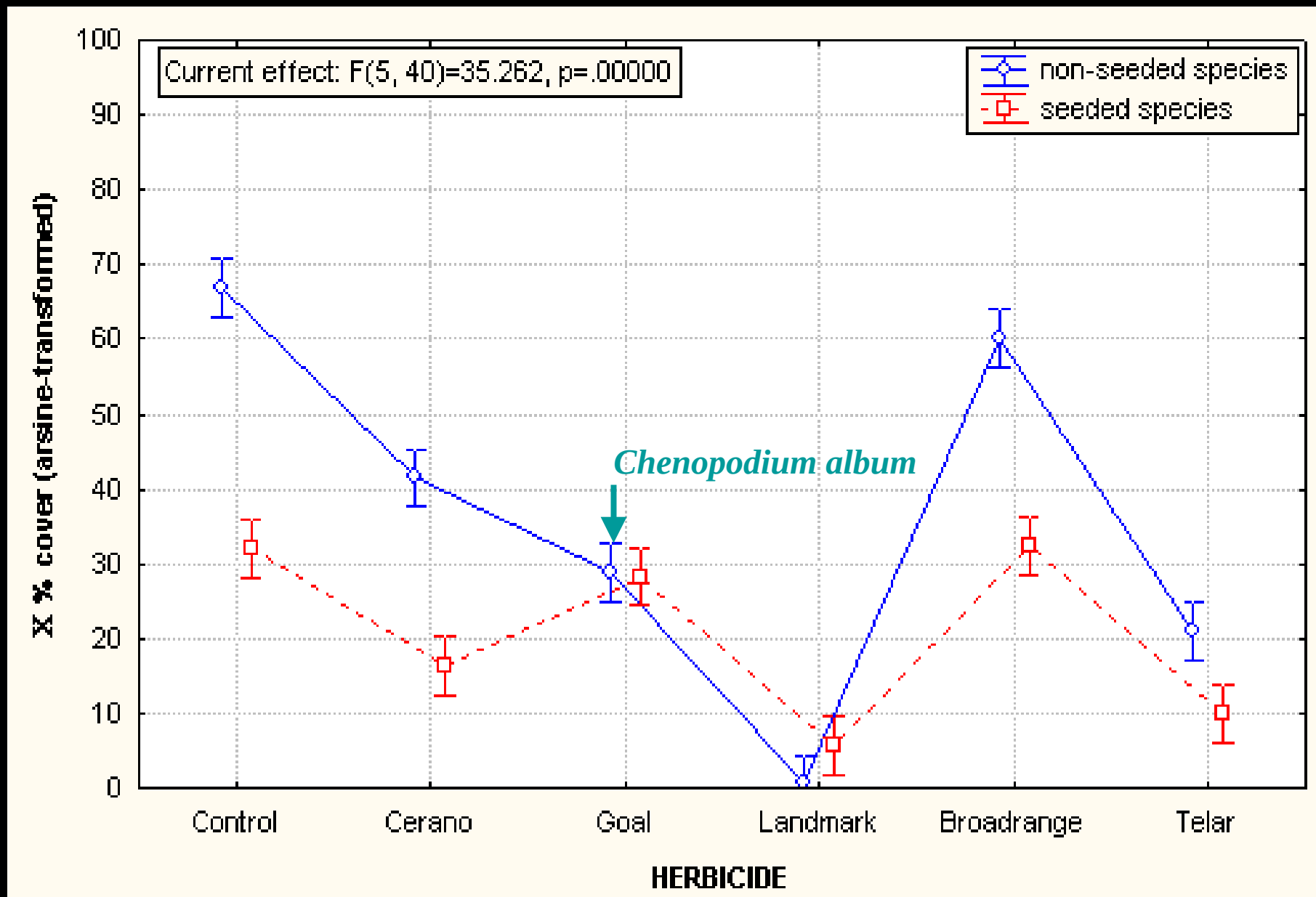
= 72 Plots (with 288 species blocks)


February 2005

RESULTS (Preliminary)

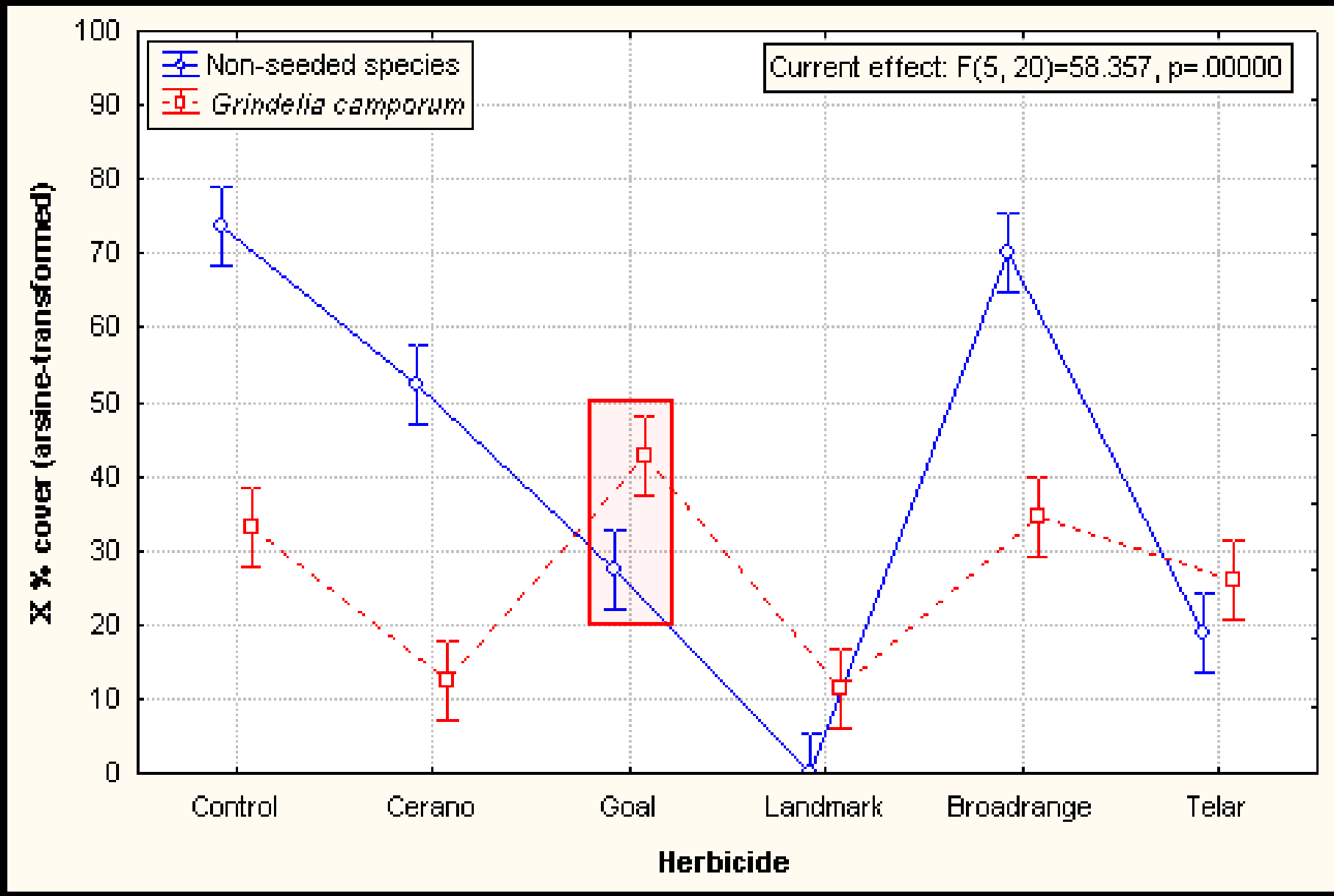


Results: GRCA, PHCI, SUMO



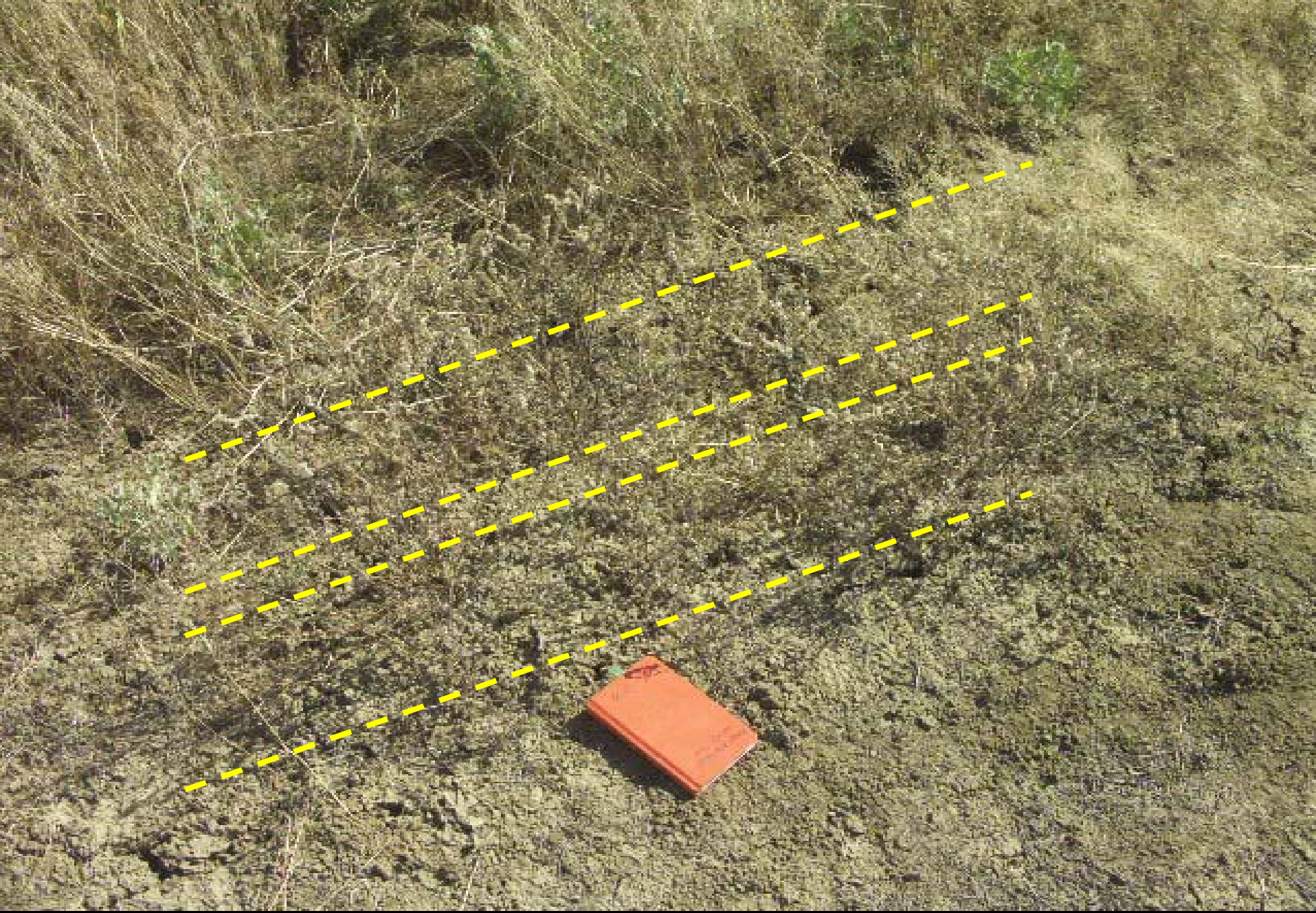
Results: *Grindelia camporum* with Goal 2XL™ (05-26-05)

Results: *Grindelia camporum* (Asteraceae)



Results: *Grindelia camporum* with Goal 2XL™ (04-13-05)

Results: *Suaeda moquinii* with Goal 2XL™ (05-26-05)



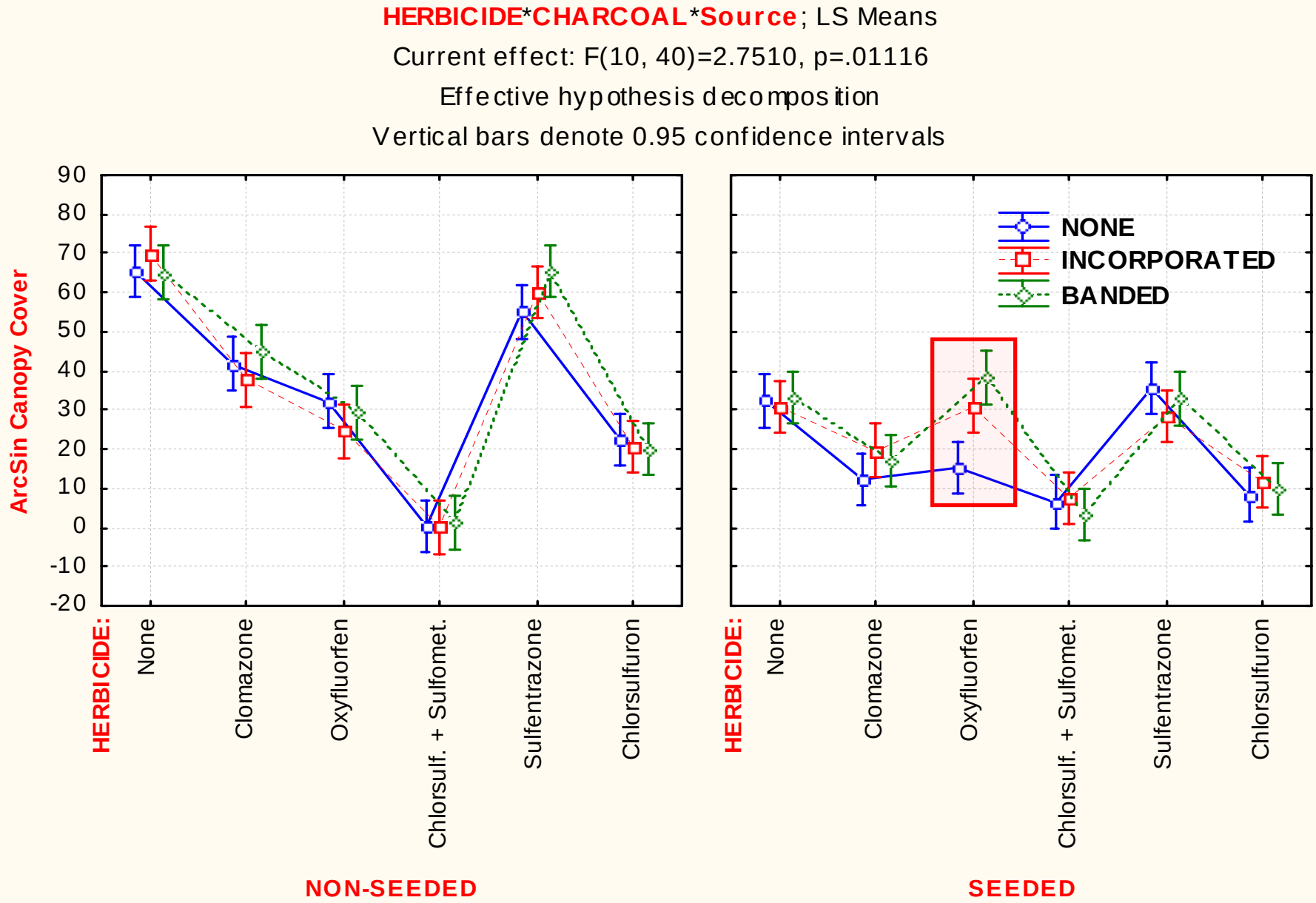
Results: *Phacelia ciliata* with Goal 2XL™ (05-26-05)

Landmark compared with Control (05-26-05)

Landmark compared with Control (05-26-05)

(*Grindelia* emerged, but vigor reduced)

RESULTS (Preliminary)



Summary

- **Oxyfluorfen (Goal 2XL™) is extremely effective on all weeds except *Chenopodium album***
- **Sulfentrazone and clomazone hold promise when effectiveness is enhanced via application as a liquid formulation**
- **No difference between charcoal application methods**
- **Charcoal treatment is effective in native plant establishment when used with the appropriate herbicide**
- **Future (2006) research will focus on refining herbicide and charcoal formulation and rates; expanding target weed applicability; expanding test species list**

Species for 2006 Herbicide Trials

1.	*Allenrolfia occidentalis*	Iodinebush [1]
2.	*Atriplex lentiformis*	Quailbush
3.	*Atriplex polycarpa*	Desert (allscale) saltbush
4.	*Grindelia camporum*	Gumweed; gumplant
5.	*Hordeum depressum*	Alkali barley
6.	*Isocoma acradenia*	Alkali goldenbush
7.	*Lasthenia chrysantha*	Alkali goldfields
8.	*Layia glandulosa*	White layia; white lady
9.	*Phacelia ciliata*	Great Valley phacelia
10.	*Sesuvium verrucosum*	Western sea-purslane
11.	*Sporobolus airoides*	Alkali sacaton
12.	*Suaeda moquinii*	Desert (bush) seepweed
13.	*Vulpia microstachys*	Desert (small) fescue

[1] Common names derived from USDA PLANTS database (www.plants.usda.gov)

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