

10 Years of Bridal Broom (*Genista monosperma*) Applicator Data and Adaptive Management as a Model for Assessing Feasibility of Eradication



Lisa R. Ordóñez (NIWC PAC), Dawn M. Lawson (SDSU), Christy M. Wolf (US Navy)
Contributors: Eric Winchell (NIWC PAC) and John LaGrange (SDNHM)

Invasive Species: Early Detection Rapid Response

Goatgrass, *Aegilops truncialis*



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Stinkwort, *Dittrichia graveolens*



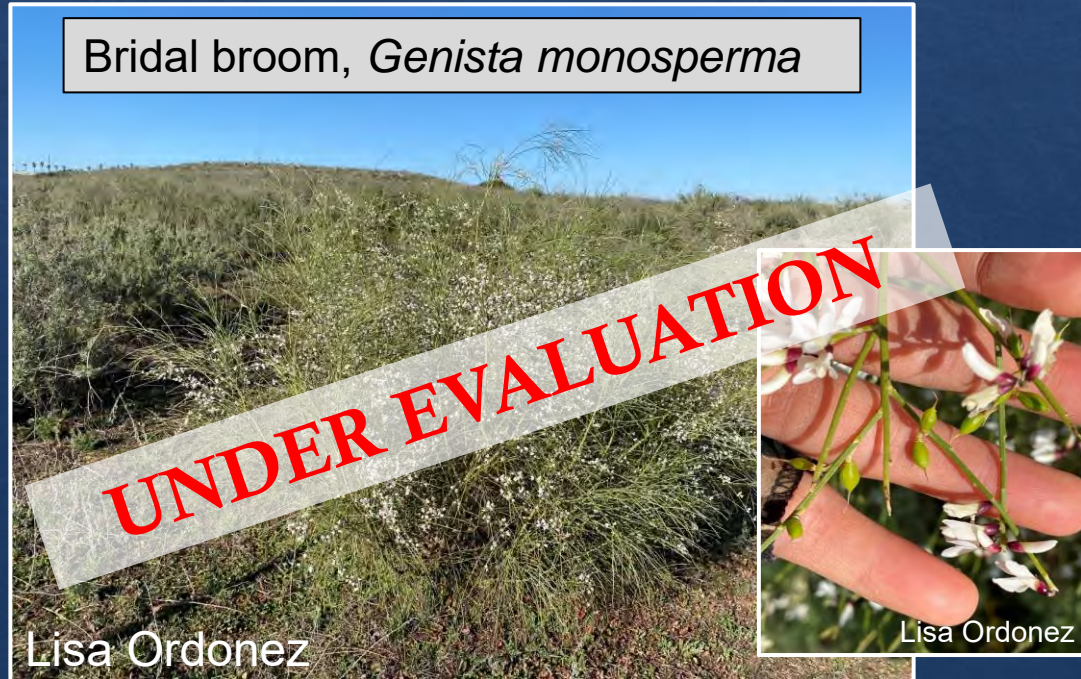
Dawn Lawson

African lovegrass, *Eragrostis echinochloidea*



Lisa Ordonez

Bridal broom, *Genista monosperma*



Lisa Ordonez

Lisa Ordonez

Bridal Broom Case Study: Detection and Response

- Circa 1990, detected by NRCS, then took two years to identify what species it was
- Thought to have spread from neighboring plant nursery, although uncertain
- In 1995, noxious weed contractor mapped its distribution and density on Detachment Fallbrook
- In 1996, herbicide treatment started



“Bridal Broom in Non-native Annual Grassland” (RECON 1996)

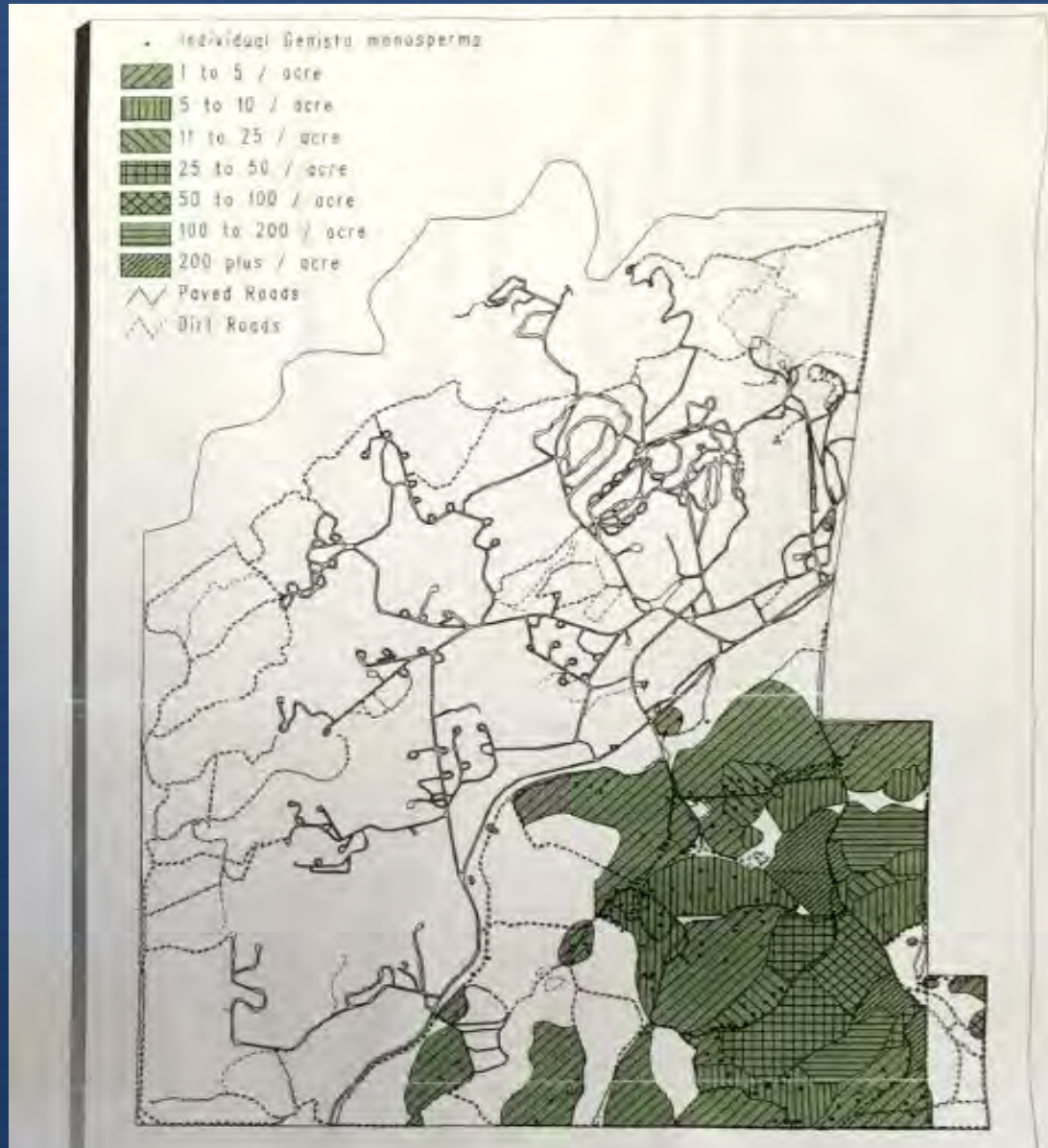


Bridal broom removal outside of base boundary fence (2015)



Current distribution

Bridal Broom Case Study: Response (Initial)



From RECON 1996

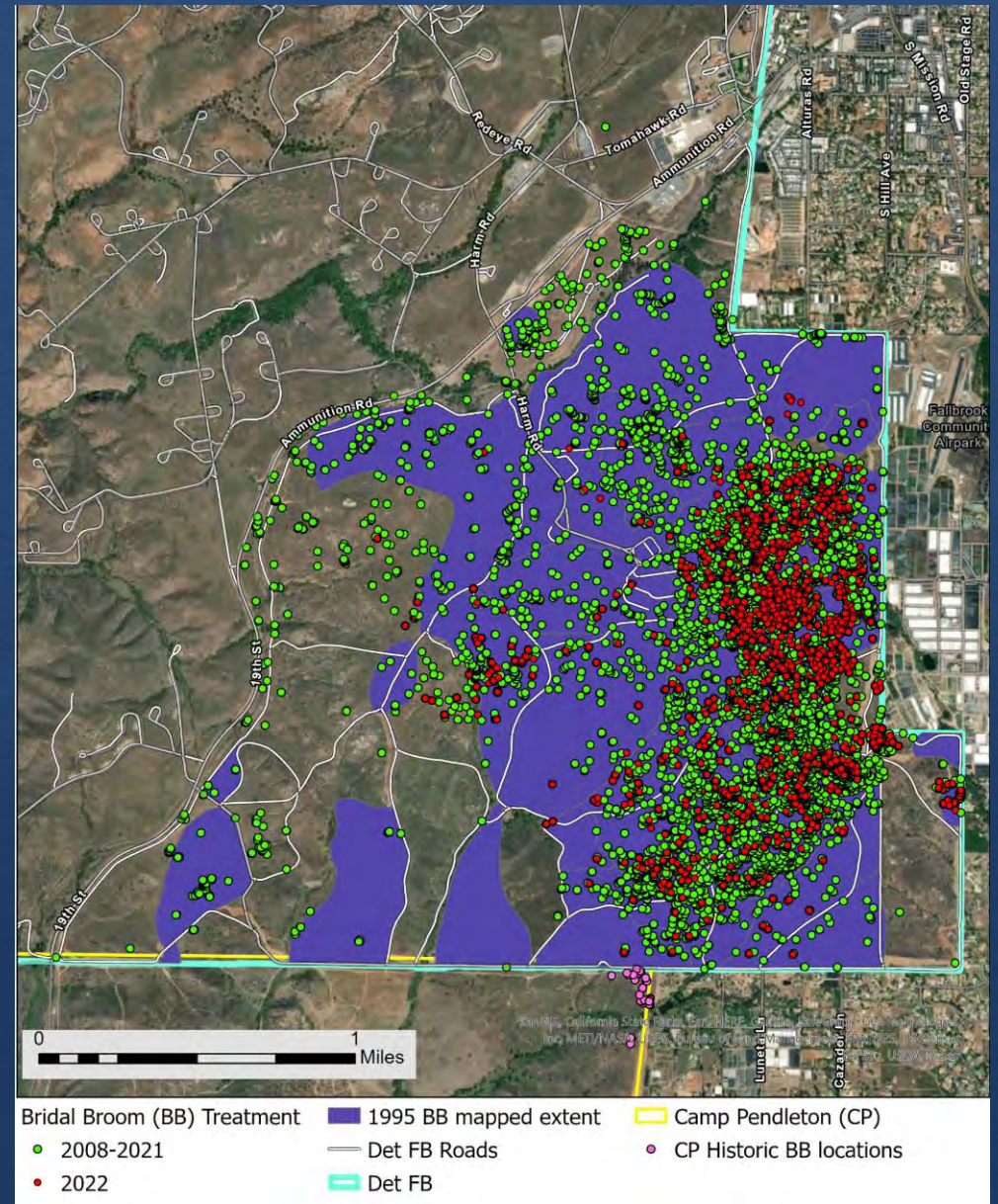


Figure 4. *Genista* stand during cut (top photo) and spray (bottom photo) treatment application.

From Agri Chemical & Supply Inc. (ACS) 1999

Bridal Broom Case Study: Response (25+ yrs later)

- Treatment continued annually, 1996 – present
- Status by 2017:
 - Dramatic declines since 1990s; now uncommon, but still widespread
 - Most plants treated before flowering
 - Still small numbers of reproducing plants discovered
- 2018 Adaptive Management Response: Re-assess eradication approach.



Adaptive Management To Do List

- ✓ Evaluate risk
 - Costs and benefits?
- ✓ Identify goals, objectives
 - Eradication or Control?
 - Evaluate species life history
 - Evaluate known treatment methods
- ✓ Surveys, treatment

Adaptive Weed Management: Initial Steps

- Bridal Broom was aggressively invading habitat that supports endangered species; mapped across approximately 1,763 acres (RECON 1996)

- Goal: Eradication

Objective: Five-year eradication plan

Life history: Little known at the time

Treatment methods: No published methods for species at the time; relied on French and Scotch broom literature

Adaptive Weed Management: Re-Assessment

Adaptive Management To Do List

- ✓ Evaluate risk
 - Costs and benefits?
- ✓ Identify goals, objectives
 - Eradication or Control?
 - Evaluate species life history
 - Evaluate known treatment methods
- ✓ Surveys, treatment
- ✓ Evaluate Assumptions
- ✓ Address Knowledge Gaps

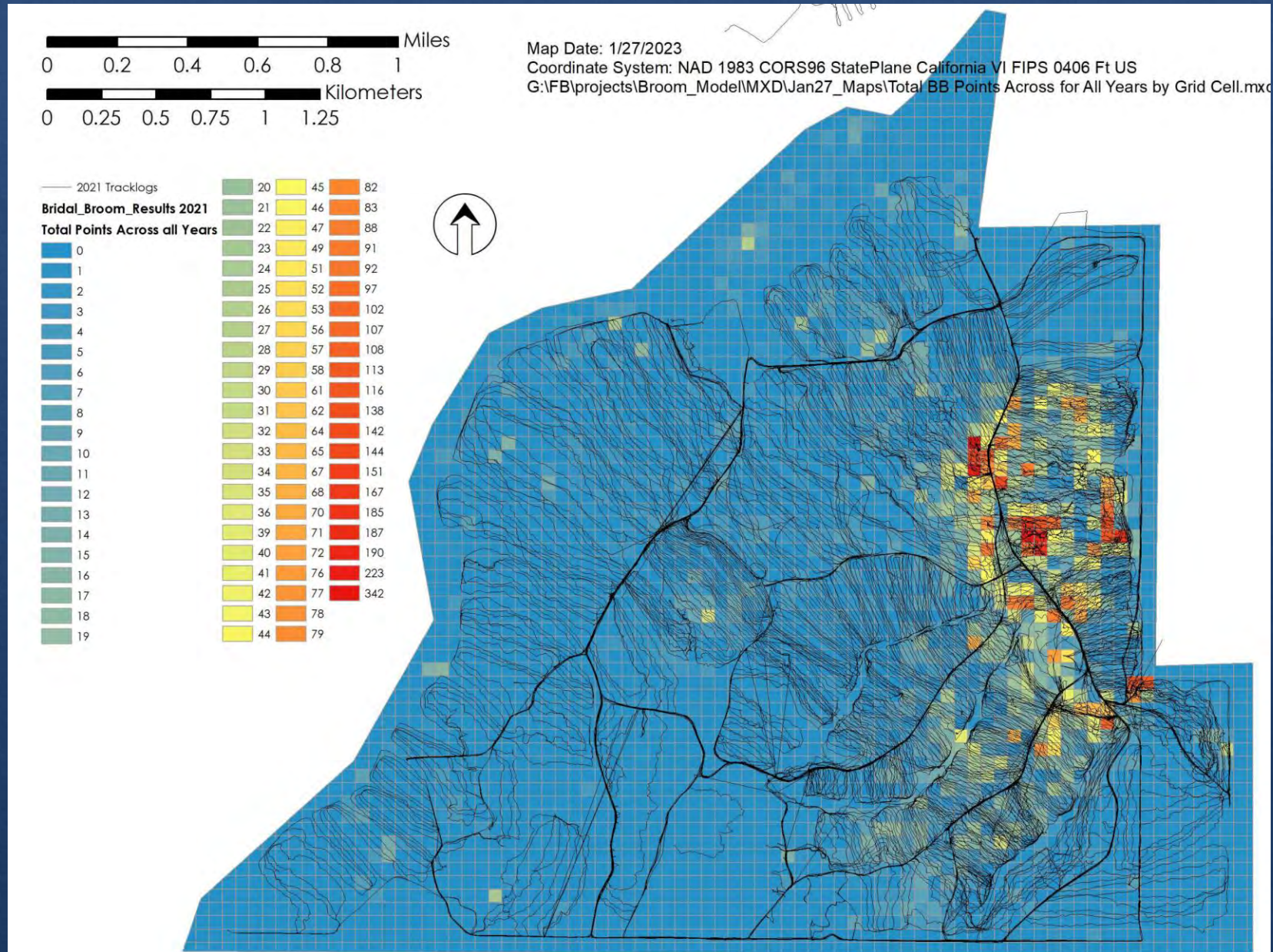
■ Initial Assumptions....

- Seedbank would be exhausted after 5 years (ACS 1998)
- *Seed longevity is 5 years or less*
- *100% detection of plants*
- *100% kill rate for herbicide treatment (no new seed added to bank)*

■ Identify Knowledge Gaps






- Develop bridal broom population demographic model
- Assess population demographics (size/age class)
- Assess life history traits (growth, flowering, seed longevity)
- Assess detection rates
- Assess treatment efficacy

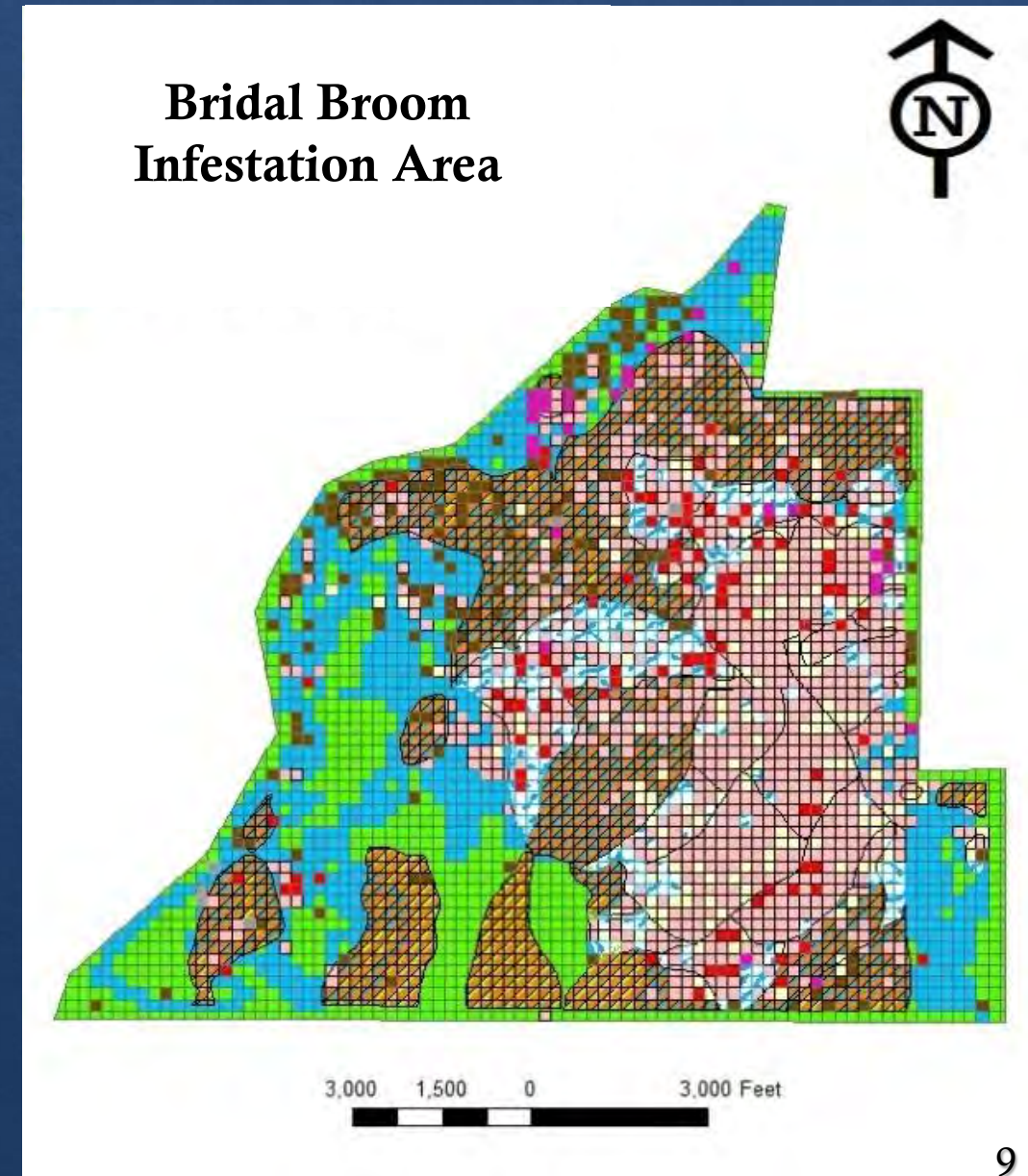
Applicator data for program evaluation



Bridal Broom Population Demographic Model (2018)

(Developed by Eric Winchell, NIWC PAC)

Status	Acres	%Total Area	Description
Never Present 	1,198	34%	Not present in 1995 and not documented post-2008.
Eradicated (post-2008) 	101	3%	Present post-2008 and surveys in last 10 years resulted in none treated.
Possibly Eradicated (pre-2008) 	1,090	31%	Present in 1995, none recorded since 2008 but few surveys post-2008.
Increasing 	167	5%	Values in 2017 or 2018 greater than values recorded previously.
Present Trend Uncertain 	998	28%	Did not fit rules for increasing, decreasing or eradicated.
TOTAL	3,554		

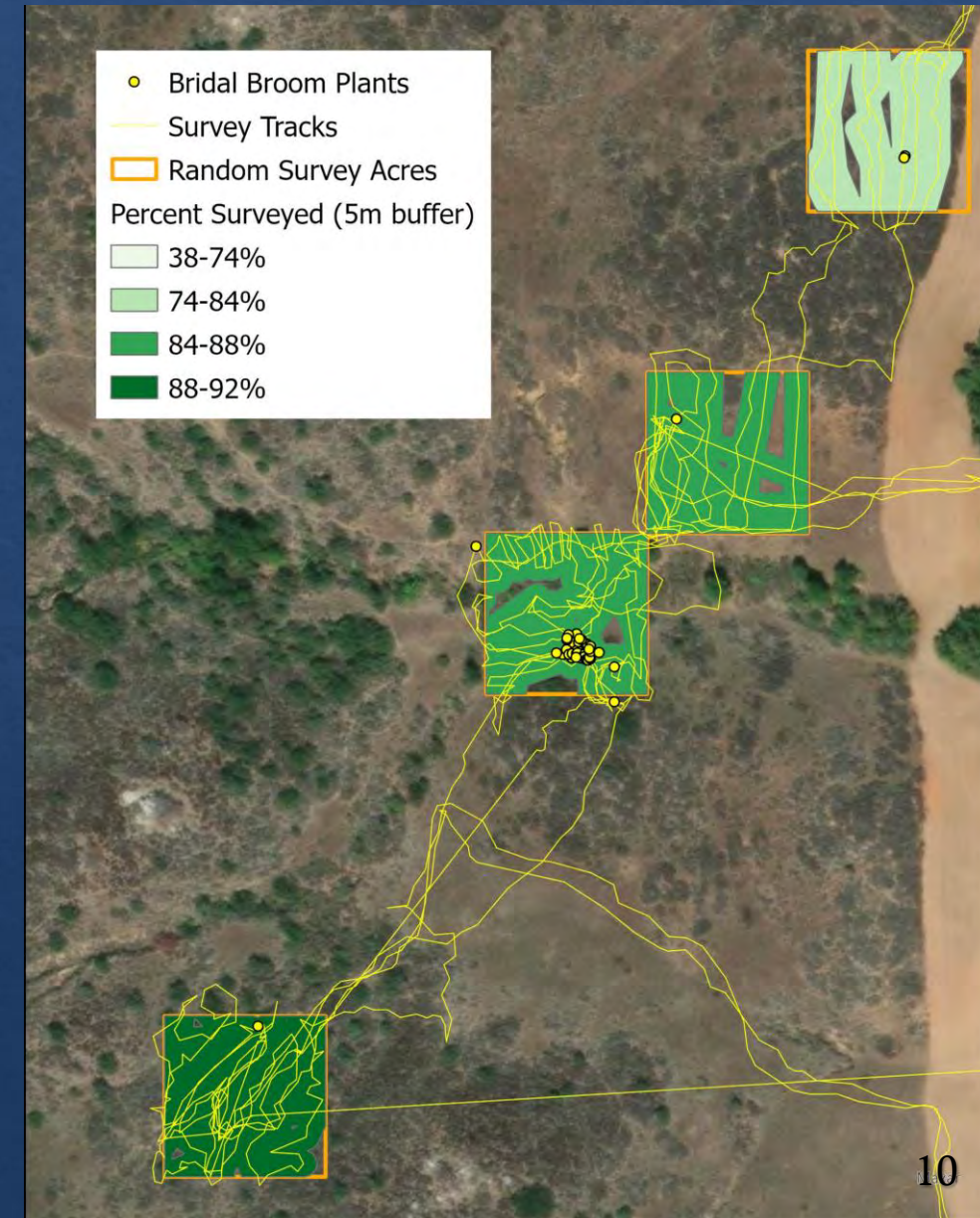


Bridal Broom Model Validation (2020)

Hypothesis: Extant bridal broom plants will be small in size and concentrated in areas where plants escaped treatment and were able to produce seed.

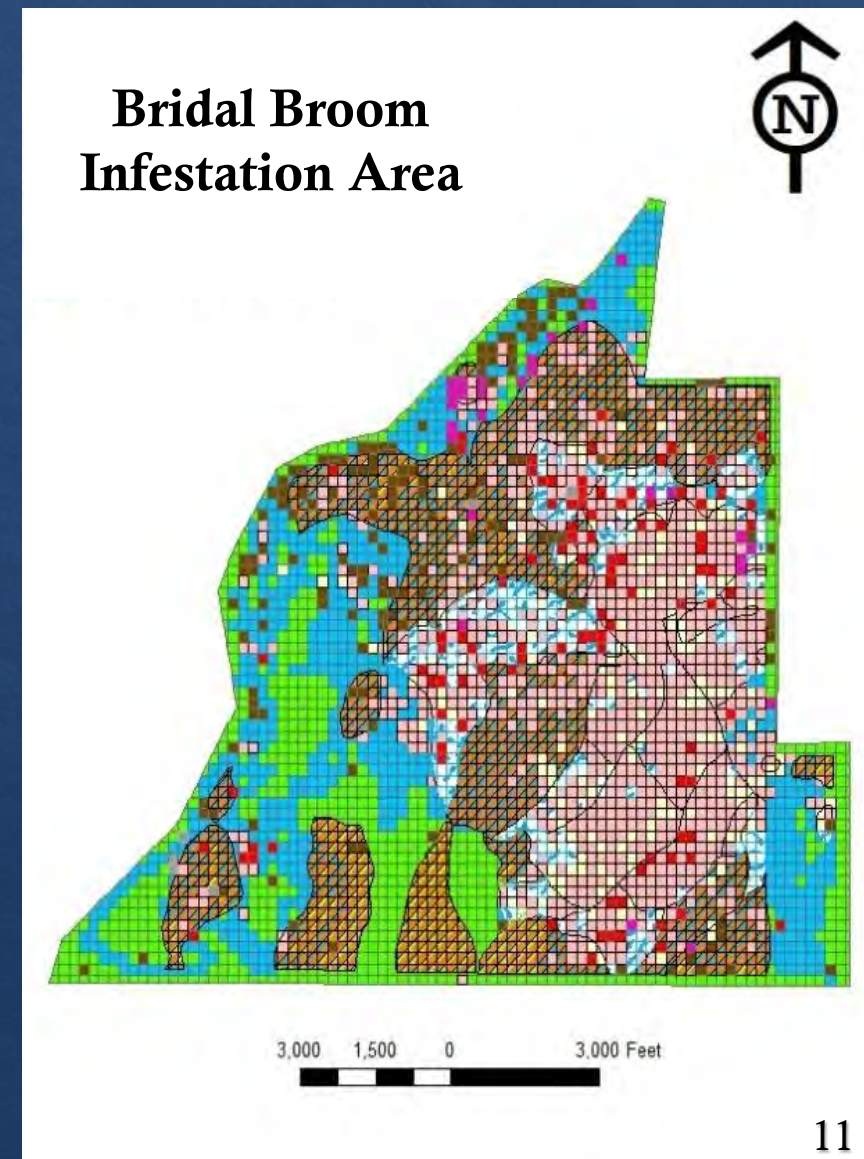
Methods:

- Survey 100 randomly selected acres (1-acre grid cells, stratified by rule assignment)
- Use 'lawnmower' survey method to get as close to 100% coverage of grid cell as possible
- Record tracklogs and points for each bridal broom plant with demographic data



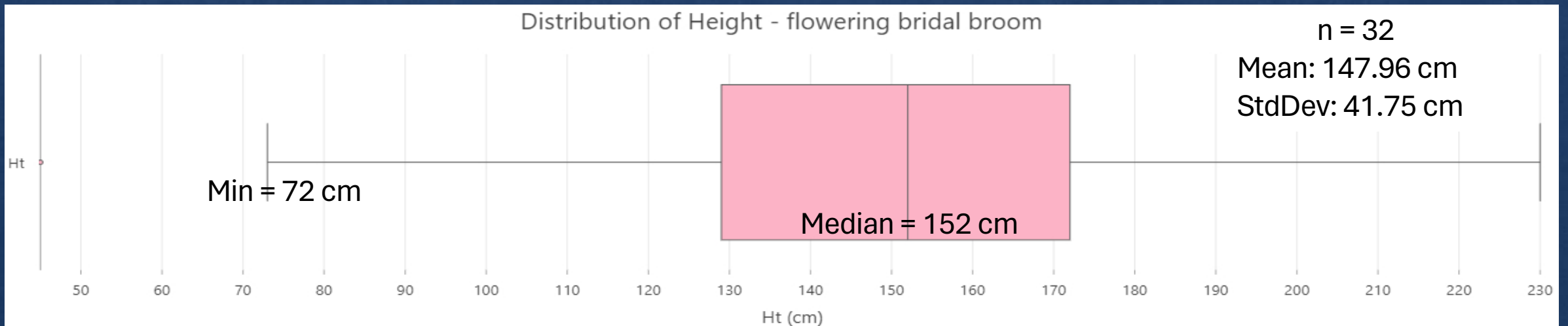
Bridal Broom Model Validation Results (2020)

Rule Description	# Live BB/ total acres	Average Height of plants (cm)	Estimated number of BB (density*acres)	Rule Fit = % true
Rule 0: Does not fit a trend	4/10	46.5 ± 9.9	325.2	-
Rule 3: Increasing	59/10	34.5 ± 2.2	985.3	20%
Rule 4: Eradicated (post-2008, no BB for previous 5 years with survey)	3/10	82.0 ± 39.9	30.3	90%
Rule 5: Possibly eradicated (pre-2008, no BB 2008-2012, no survey for last 5 years)	1/25	150.0	35.4	96%
Rule 6: Possibly eradicated (post-2008, not surveyed in previous year)	3/10	97.7 ± 23.0	8.4	80%
Rule 7: Possibly eradicated (post-2008, not surveyed in previous 2 years)	0/3	-	0	100%
Rule 8: Possibly eradicated (post-2008, not surveyed in previous 3 years)	0/10	-	0	100%
Rule 9: Never present	0/25	-	0	100%
TOTAL	70 BB/103 acres		~1,385 plants	



Height Distribution of Bridal Broom

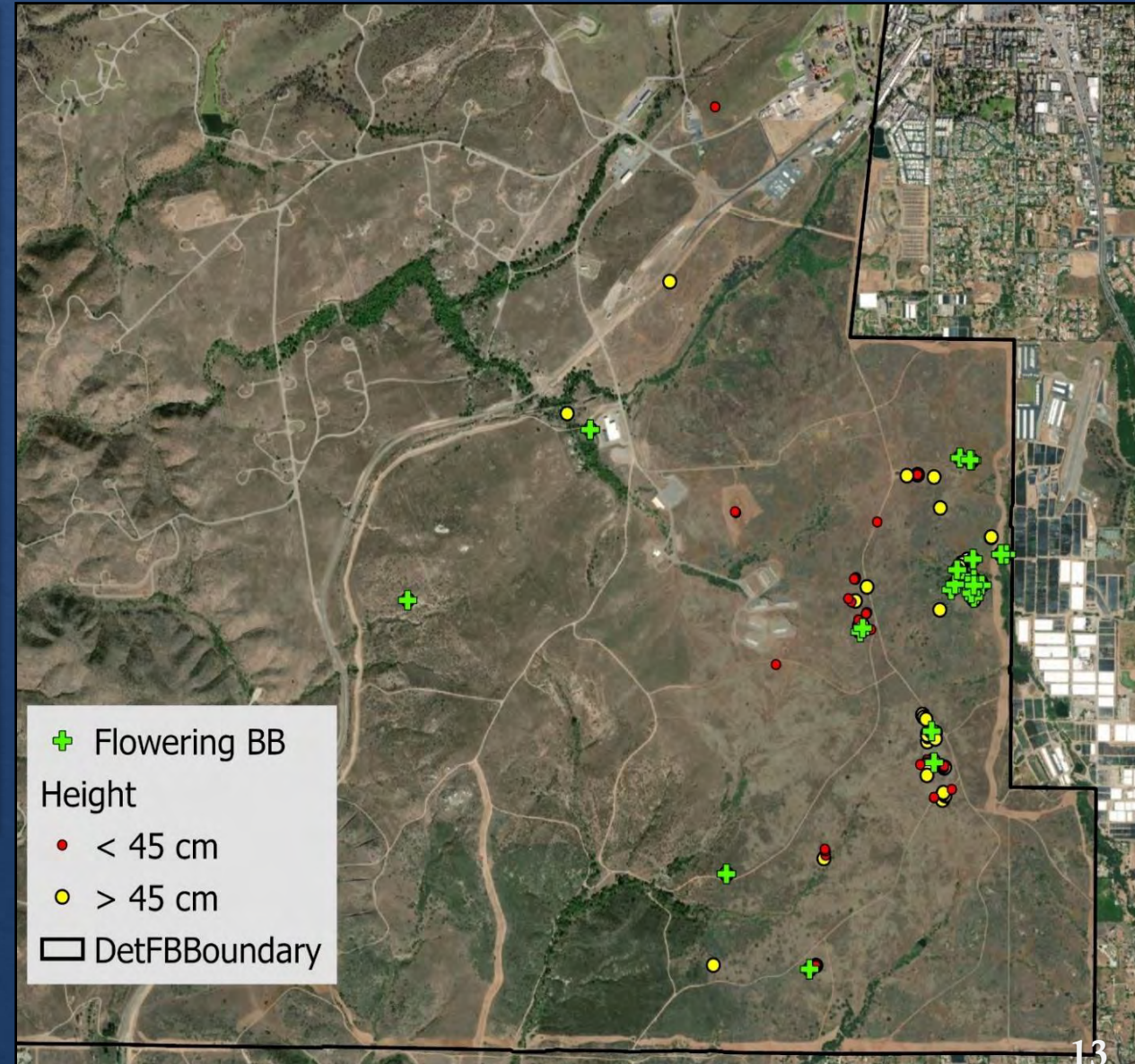
- All bridal broom plants in 103 ac sample in 2020 (n=70)
 - 48 (69%) were < 45 cm
 - 63 (90%) were < 72 cm
 - 3 (4%) flowering in 2021 (all > 130 cm)
- All flowering bridal broom plants throughout infestation area in 2021 (n=32)
 - Mean Height = 148 cm (± 7.38)
 - Shortest = 45 cm (outlier)



Height: Flowering Bridal Broom (2021)



Browsing by cows and other ungulates may produce bridal broom that are shorter than mean flowering height but are reproductively mature.



Life History Studies: Bridal Broom 'Debris Piles'



Bridal broom seedlings sprouting in debris pile.



Approx 10 cm tall
bridal broom seedling

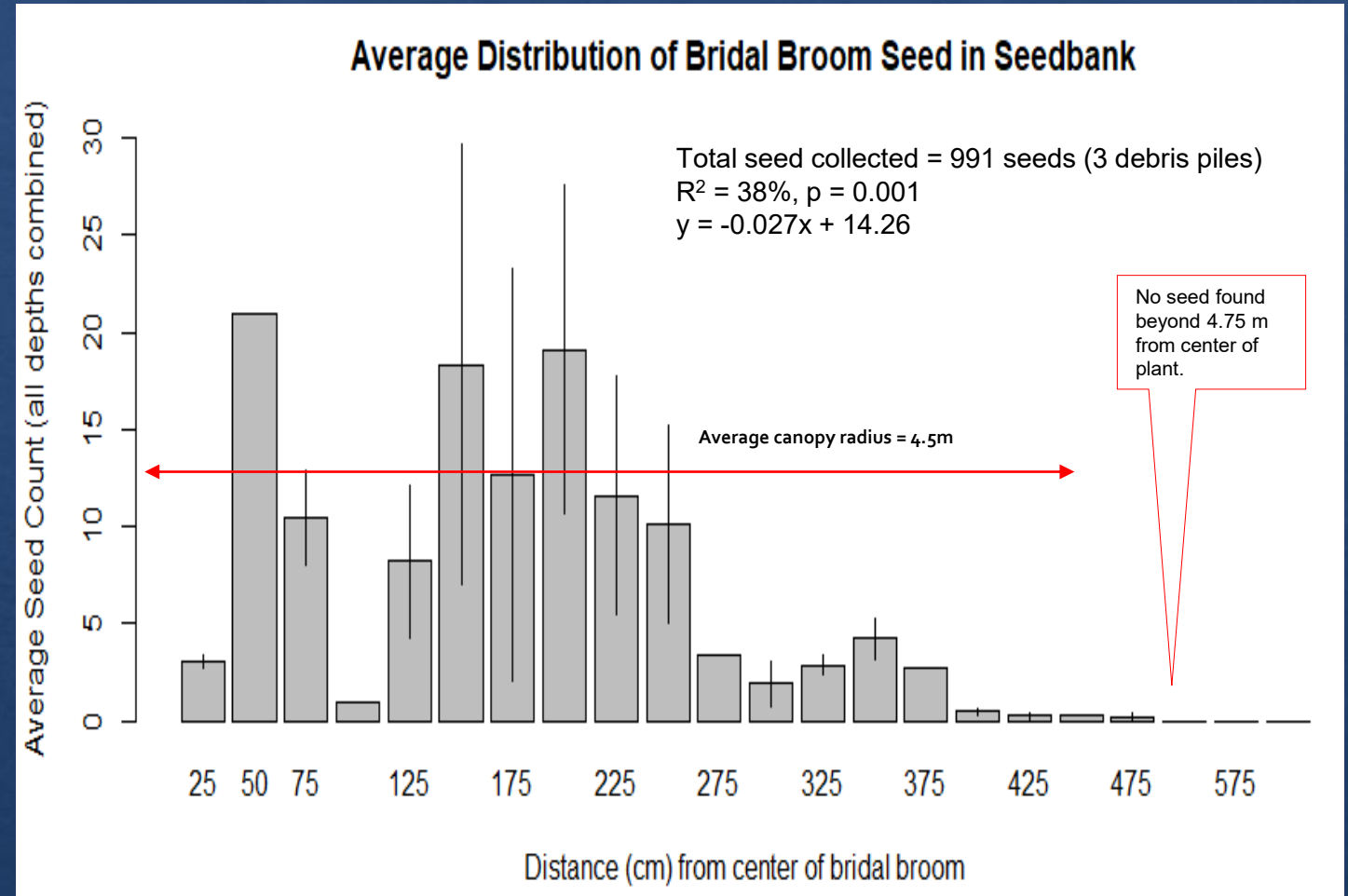
Multiple seedlings found in debris pile from large bridal broom that was cut down at ground level and stump treated in 1996-1997, 20+ years ago. (Photo: March 2, 2021, L. Ordonez)

Debris Pile Seedbank Distribution (2022)

(In collaboration with San Diego State University)



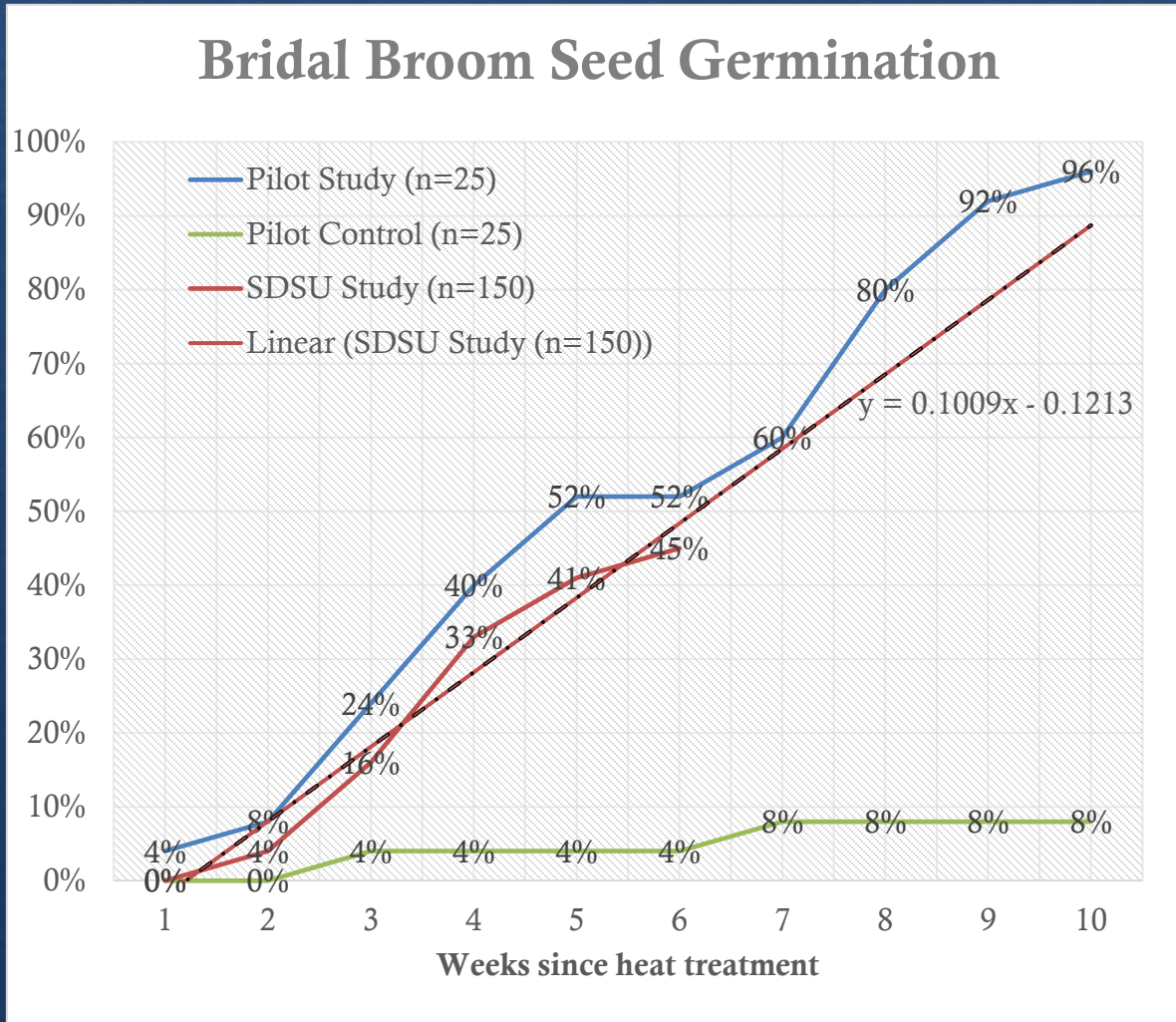
Seedbank sampling from top, counterclockwise: random locations; cut out soil 'loaf'; sift soil through a sieve



Distribution of seed, in a soil volume of 1.2 liters, from center of plant (3 debris piles, 18 sample distances per pile, 3 depths sampled per distance)

Bridal Broom Seed Germination (2022)

(In collaboration with San Diego State University)

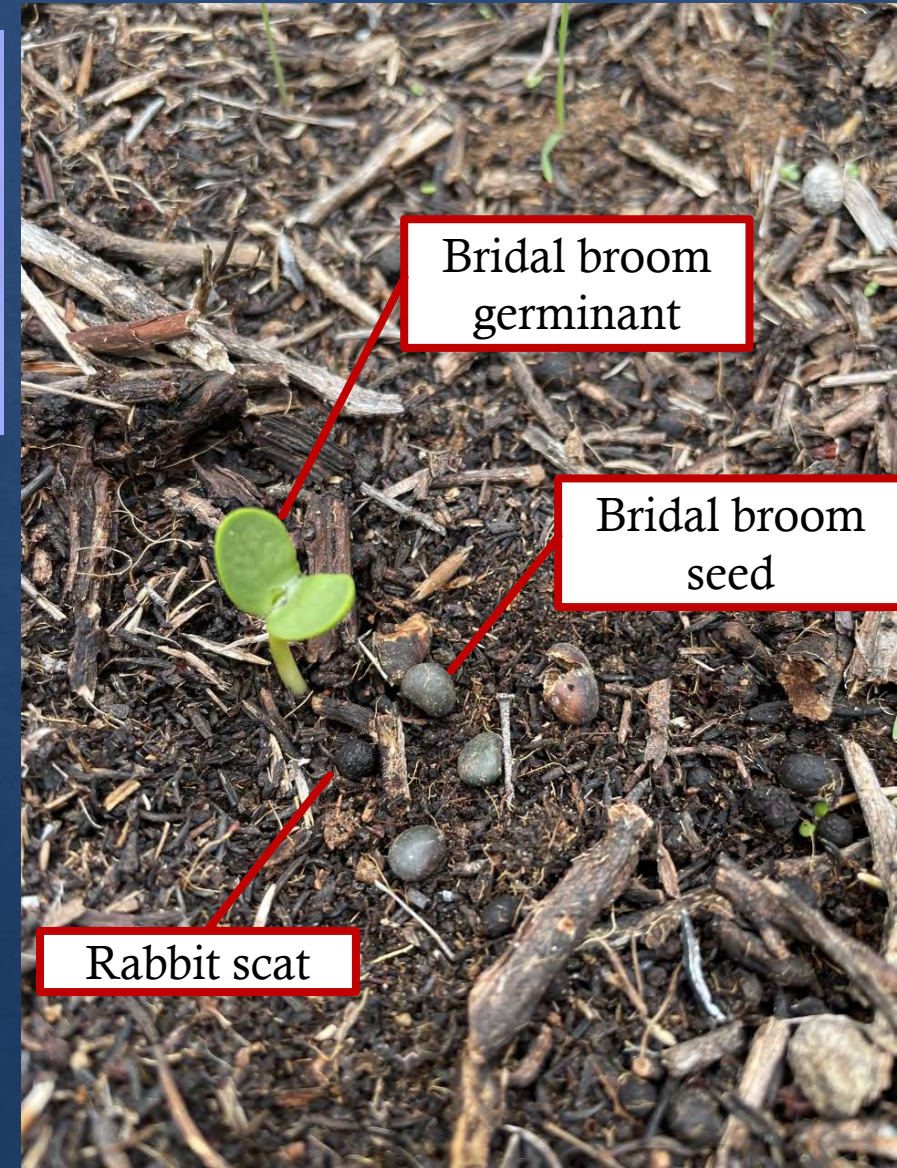
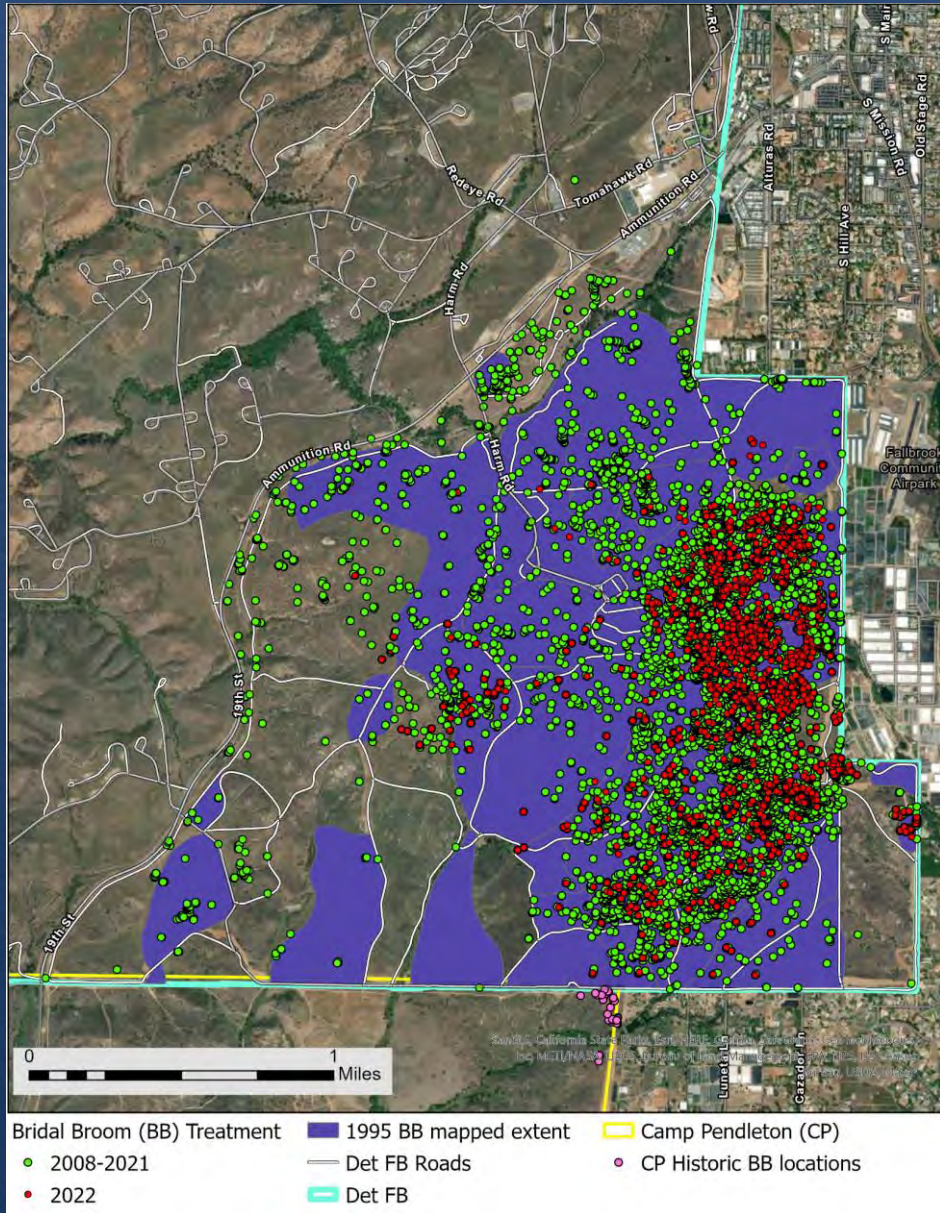


Germination studies of field-collected seed from depth 0-5cm. Heat/physical damage stimulated up to 96% germination; controls produced $\leq 8\%$ germination.



Clockwise from left: Three bridal broom seed in field soil; Bridal broom seed beginning to germinate (seed expands up to 30%); Bridal broom germinate

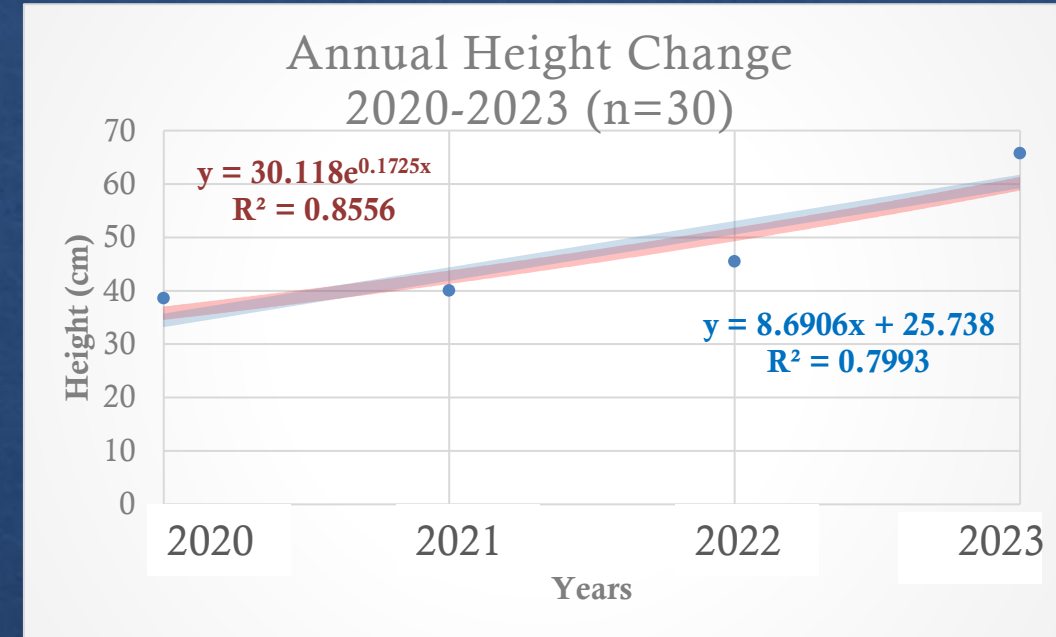
Bridal Broom Seed Predation and Long-Distance Dispersal



Bridal Broom Growth Study Site: 2020-2023



Cattle exclusion area (approx. 10m x 10m) installed April 2021 around a high density bridal broom population to study life history traits (e.g., growth, flowering, and seed production).



- Data indicate that bridal broom reach minimum flowering height (72 cm) after 6-7 years. (This is consistent with published literature.)
 - Seedling data (not shown) indicate 1-2 years growth to reach 25-30 cm
 - Immature plants take 5 additional years to reach flowering height (graph above)

Bridal Broom Growth Study Site: 2020-2023



April 21, 2023 = only 2 plants with seed development



Branches with developing seed were bagged to contain seed.



- Literature review and initial findings indicate relatively low plant fecundity and seed viability at least within first reproductive years.
 - Single seeded fruit; relatively low seed set (Herrera 1999)
 - Of the 4 plants that flowered at the Detachment Fallbrook study site in 2023, none produced viable seed. (2023 rain storms washed away flowers on 2 plants; seeds on remaining 2 plants aborted for unknown causes.)

Bridal Broom Detection (2020)



Efficacy of Detection and Treatment (2021-2022)

Assumption: Pest controllers can detect and kill all bridal broom with herbicide across 3,500+ acre area.

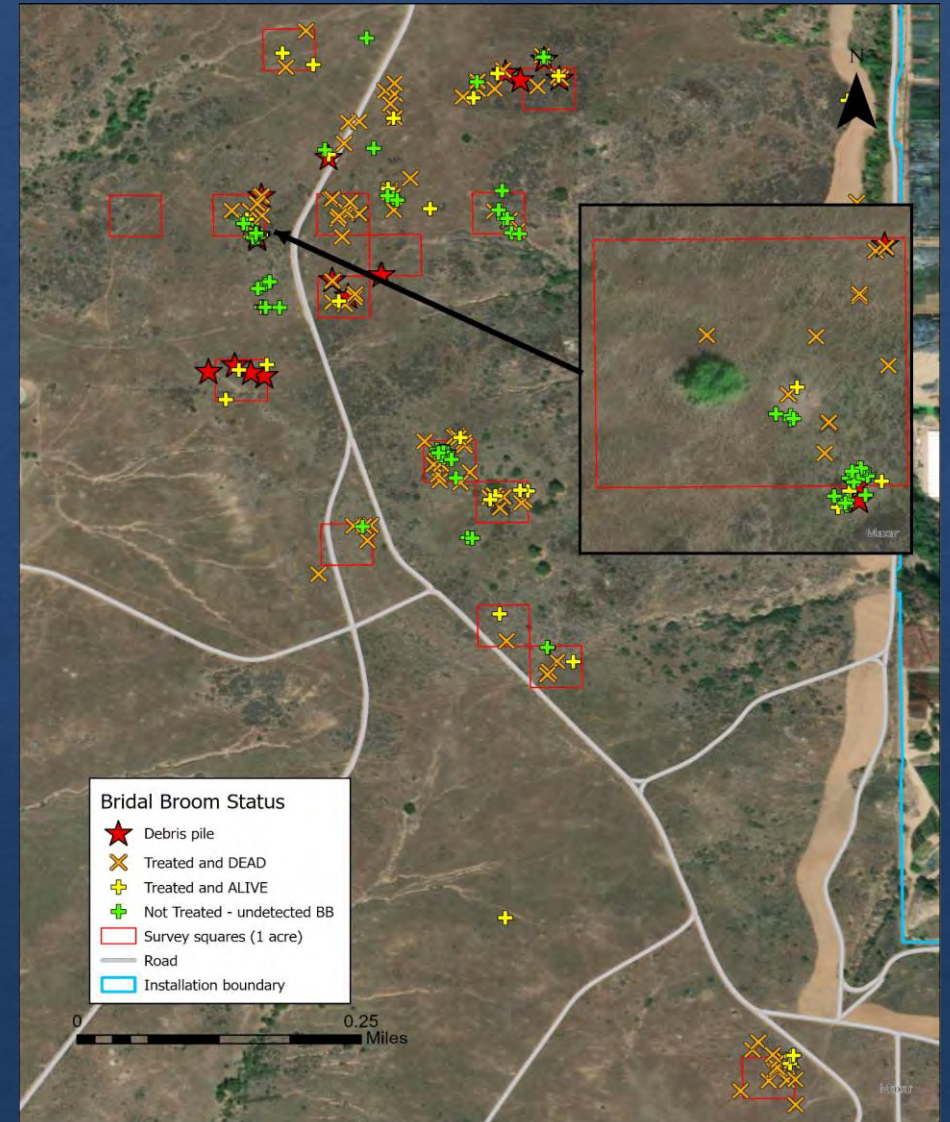
Methods: Using pest controller data, revisit treated bridal broom on 15, 1-acre plots

Results:

- Detection Rate: 77% detected (all sizes); 92% of <50 cm went undetected
- Treatment Efficacy: Average kill rate is 84%

Table: Kill rates for bridal broom treated between Oct 2020 – Jun 2021 on 15 acres in highest density area

Treatment Month/Year	Total # treated bridal broom revisited (n=189)	# treated bridal broom – ALIVE (resprouts)	Kill rate (%)
Oct 2020	6	1	83%
Apr 2021	62	7	89%
Jun 2021	47	17	64%
Unknown Date	9	0	100%
Resprouts = 19%			Avg Kill Rate = 84%
# undetected bridal broom	% survey acres with undetected plants	Density undetected plants/acre	% undetected under 50cm
38	73%	3.45	92%



**Bridal Broom Treatment Points (Oct 2020 – Mar 2021)
Revisited to Assess Eradication Efficacy**

On-going Bridal Broom Investigations

Growth Ring Study



Seedling Emergence Study (SDSU)



Solarization Study (SDSU)



Bridal broom eradication within Det Fallbrook may still be possible:

Plants take years to reach maturity and produce seed

- Herbicide applicators and biologists alike are not able to detect all bridal broom.
 - RECOMMENDATION: Re-survey an area every 4-5 years to remove plants before reproductive maturity.
- Herbicide treatment is not 100% effective.
 - RECOMMENDATION: Manually remove small plants and use 'cut' treatment on larger plants.
- Existing seedbank is viable for decades.
 - RECOMMENDATION: Investigate methods to force germination and manually remove seed from soil.
- Population is not confined to Detachment Fallbrook boundary.
 - RECOMMENDATION: Work on cross-boundary partnerships. Initiate research about secondary dispersal by rabbits and other animals, seed predation and pollination among reproductive bridal broom.

Applicator data led to targeted studies that have increased our knowledge about the species in order to reevaluate and revise goals and objectives of the eradication program.

Acknowledgements

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