A close-up photograph of the flowers of Ambrosia pumila, showing the intricate details of the petals and the central reproductive parts. The flowers are in various stages of bloom, with some showing vibrant pink and white colors. The background is a soft, out-of-focus green, suggesting a natural outdoor setting.

**Spraying over the top of  
*Ambrosia pumila*, a federally  
listed species, to control  
invasive weeds.**

Mike Kelly  
Cindy Burrascano  
Melanie Johnson Rocks

# General Information

- *Ambrosia pumila* (Nutt.) A.  
Gray San Diego Ragweed
- Distribution restricted to no.  
Baja Calif., San Diego, &  
Riverside Counties
- 15 naturally occurring  
populations in San Diego,  
Riverside Counties; unknown  
# in Baja



Source: McGlaughlin, 2006  
Simpson, 2006  
Tibor, 2001  
U.S.F.W.S. 2002

*Ambrosia pumila* flowering in pot, Sept. 2007.

# General Information , Cont.

- Herbaceous perennial,
- Clonal, rhizomatous
- Grasslands associated with upper river terraces, drainages
- More rarely, grasslands in openings in coastal sage scrub, disturbed sites



Naturally occurring population of *Ambrosia pumila* at Mission Trails Regional Park.

# Threats to *A. pumila*

- Development such as houses, roads, malls
- Invasive weeds, especially annual grasses
- Apparent lack of sexual reproduction



Weed load in drought year in MTRP site. Load was denser, taller in other parts of site. What would it look like in a wet year?

# Potential Solutions

- Listings. CNPS List 1B  
RED = 3-3-2 triggering CEQA  
analysis locally
- Federally listed as Endangered  
2002. Relatively weak protection
- No state listing as Endangered.  
Big problem
- Transplanted populations
- Restricting development. Not  
without state listing?
- Invasive weed control



*Ambrosia pumila* transplant in its “cage.”  
Experiment to reintroduce locally extirpated  
plant involving testing of soils, mulches,  
exclosures, et al. Transplant by SERG (Soil and  
Ecology Restoration Group, San Diego State  
Univ.)

# Potential Weed Impacts

- Competition from annual weeds for scarce water
- Wind pollination of *A. pumila* reduced by over towering weeds
- Loss of genetic variation through physical loss of genets (genetically distinct individuals) to weeds



Note the height of the *Avena fatua* (wild oats) and *Bromus* spp.

# Weed Control Choices 1

## Mechanical and Fire

- Hand pulling as tested by Center for Natural Lands Management. Difficult, labor intensive. (pers. comm.)
- Personal observation of mowed *A. pumila*; shows promise; mowing experiment planned by CNLM. (pers. comm.)
- Fire. MTRP population recovered nicely after fire. (pers. observ. C. Burrascano). City doesn't permit prescriptive burning. (pers. exper. M. Kelly).
- **Challenge:** the density and intermixing of *A. pumila* and weeds makes physical damage to plants unavoidable in hand pulling or spraying. Hypothesis to test: from observations of the ragweed in horse corrals, its apparent resiliency to mowing, and affinity for disturbed areas, even compacted soils (SERG 1999) may allow certain level of trampling.

# Weed Control Choices - 2

## herbicide spot spraying

- Difficult because of lack of discrete space between endangered plant and weeds
- Tall weeds would hide the San Diego ragweed from sprayers
- Slow, labor intensive if done right



Weeds have died back in this photo, but density of load is evident. 2007 rains were sparse, but lateness favored natives. Imagine weed growth, density in a wet year with early rainfall.



# Weed Control Choices - 3

## Experiment: spraying over the top with herbicide shows promise

- **Question:** is it possible to spray a grass specific herbicide, Fusilade II® (Fluazifop-P-butyl, Syngenta. CAUTION label) to control invasive annual grasses without harming *A. pumila*?
- **Question:** is it possible to do so without harming native cohort species, whether broadleaf or monocots?
- Previous experience by author and State Parks staff \* using Fusilade II® at Torrey Pines State Reserve to treat *Erharta longiflora* (annual veldtgrass) was positive. Sprayed over the top of a wide variety of native herbaceous plants, it was effective in killing veldtgrass without harming the natives, including the extremely rare *Pinus torreyana* (Torrey Pine - 1B 3-2-3 FSC). Several native grasses present were avoided and not tested with the herbicide.



Fusilade II® quart pictured with *Nassella pulchra* and *Ambrosia pumila*.

# Experimental Design: 4 Phases

- **Phase 1.** Test Fusilade II® on potted *A. pumila*.
- **Phase 2.** Test several grassland native cohort species of this ragweed, including *Nassella pulchra* (Purple needlegrass, the state grass of California).
- **Phase 3.** Test Fusilade II® on *A. pumila* in native grassland at MTRP if Phase 1 is proves safety of overspraying.
- **Phase 4.** Retest safety of Fusilade II® on *Nassella pulchra* in pots and in the field with more robust sample.



Blooming *Ambrosia pumila* used in Phase 1 of experiment. Picture taken 4 weeks after spraying.

# Phase 1: spray in pots

## Regulatory issues

- Plants were obtained from Dave Bainbridge of SERG and Alliant Univ.
- Plants had been collected from the path of a highway project **PRIOR** to federal listing
- Plants were from an abundant, surplus stock, growing in pots and on the ground where they had escaped from soil beds
- Plants were on private property when obtained for potted experiment
- Plants are not state listed as endangered, a significantly stronger legal protection than federal listing



*A. pumila* plants on bench 4 weeks after spraying. Note the new shoot emerging from bottom of pot, a frequent instance of an “escapee.”

# Phase 1: spray in pots

## Experiment design detailed - 1

- 35 plants were used, some already blooming when obtained, others bolting, others with new shoots
- Plants were divided into 7 groups of 5 plants each
- We attempted to have each group match the others in the size of the plant(s) in each pot, the growth stage (blooming, bolting, dying back, new shoots, # of shoots)
- Each group was labelled for their treatment
- All plants were watered at the same time and with the same quantity of water each time



*A. pumila* plants on bench 4 weeks after spraying. Both tongue depressors coded with color labels and paper labels are shown above.

# Phase 1: spray in pots

## Experiment design detailed - 2

- One set of 5 plants, used as a **control**, was sprayed with a plain water mix to ensure equal use of water in experiment
- Three rates of Fusilade II® were used: 0.5 oz, 0.75 oz, and 1.0 oz per gallon of water used.
- Each rate of herbicide was used twice each, once with surfactant added and once without surfactant added for a total of 6 sets of 5 pots each sprayed with herbicide



*A. pumila* plants ready for spraying.

# Phase 1: spray in pots

## Experiment design detailed - 3

- The same amount of Target Pro-Spreader Penetrator / Activator, 0.5 oz per gallon of water, was used for all 3 rates of Fusilade II
- Blazon Blue marking dye was used at rate of 0.66 oz per gallon of water
- Plants were observed at every watering and formally monitored with data sheets twice



*A. pumila* plant. Note the different growth stages, from green shoots to blooming and seed set. Each grouping was balanced to include this variety.

# Phase 1: Monitoring

- Plants sprayed once July 17, 2006
- First formal monitoring Aug. 1, 2006 (Fusilade II® is a fast acting herbicide)
- Final formal monitoring Aug. 8, 2006
- Final photos taken Aug. 15, 2006
- Monitoring involved noting the presence of blooms, green or browning foliage on mature stems, whether the mature stem was browning or green; new shoots



August 15, 2006 photo of potted *A. pumila*. Note the different growth forms about 1 month after spraying: seed set ; normal appearing dying back of older shoots, new green shoot emerging from this perennial rhizomatous plant.

# Phase 1: Monitoring

- Additional monitoring was done by two of the authors and two more experienced weed workers on different occasions to assess whether herbicide damage was occurring
- Data form with a sample of the data collected for the Control and a sprayed group are shown on the following slide.



August 15, 2006 photo of potted *A. pumila*. Monitoring was done by 2 of the authors and 2 experienced weed workers.



# Observation Form

## Observation Form for *Ambrosia pumila* Experiment Date: August 1, 2006

x mark reflects presence or affirmation

Group 1. Control. Water only (ID for tags: Group 1. W, Orange tag)

	Mature Shoot(s)							Notes
	Blooming	Seed set	Foliage green	Foliage browning	Stems green	Stems browning	New green shoot(s)	
Plant 1	—	—	—	X	—	X (5)	—	Whole plant browning normal senescence
Plant 2	—	—	X	—	X (2)	—	—	no browning
Plant 3	—	—	X	—	X (3)	—	—	no browning
Plant 4	X	—	X	—	X (2)	—	—	bud buds developing
Plant 5	—	—	X	—	X (1)	—	—	no browning

Group 2. Low rate of Fusilade II without surfactant (0.50) (ID for tags: Group 2. FL wo, Yellow tag)

	Mature Shoot(s)							Notes
	Blooming	Seed set	Foliage green	Foliage browning	Stems green	Stems browning	New green shoot(s)	
Plant 1	—	X	X	—	X	X	X (2)	12+ stems, browning normal
Plant 2	—	—	X	—	X (1)	—	—	no browning
Plant 3	X	—	X	X	X (1)	—	—	leaf tips browning
Plant 4	—	—	X	—	X	—	X	12+ stems, no browning
Plant 5	—	—	X	X	X (3)	X (1)	—	—

# Phase 1: Results

- No harmful effects of spraying Fusilade II® with or without surfactant at any rate was detected
- Plants bolted, bloomed, set seed, senesced, and sent up new green shoots despite the herbicide spraying
- It was decided to proceed to Phases 2 Cohorts and 3 Field test with in situ *A. pumila*.

August 15, 2006 photo of potted *A. pumila*. One month post spraying. Note erect stems, green leaves, and bloom.



# Phase 2: Cohorts

## Experiment Design

- Phase 2 tested 6 native grassland species that might be found with *A. pumila* with a Fusilade II® spray at 0.75 oz / gallon of water with surfactant and dye
- We flagged 10 plants of each of the species, 5 as controls, 5 to be sprayed
- The 6 cohort species were:
  - Allium* spp. (Wild onion)
  - Chlorogalum parviflorum* (Soap plant)
  - Dichelostemma capitatum* (Blue dicks)
  - Nassella pulchra* (Purple needlegrass)
  - Sisyrinchium bellum* (Blue-eyed grass)
  - Zigadenus venenosus* (Death cama)



Wild onion flowering on the left, Death cama on the right, both monocots growing from bulbs

# Phase 2: Cohorts

## Experiment Design - 2

- Plants sprayed Feb. 6, 2007
- First monitoring Feb. 22, 2007 (Fusilade II® is a fast acting herbicide)
- 2nd monitoring March 29, 2007; photos taken.
- Final monitoring April 3, 2007 photos taken
- Monitoring involved noting the presence of blooms, green or browning foliage on mature stems, whether the mature stem was browning or green; new shoots.



Healthy, unsprayed *Sisyrinchium bellum* (Blue-eyed grass), another bulb species common to native and mixed grasslands

# Phase 2: Cohorts

## Results & Implications

- *Nassella pulchra* sprayed plants appeared unharmed, all bloomed at same time as control
- **All** the other 5 species exhibited moderate to severe damage, typical of herbicide impacts. Those 5 were: *Allium* spp., *Chlorogalum parviflorum*, *Dichelostemma capitatum*, *Sisyrinchium bellum* and *Zigadenus venenosus*



Clockwise from top left: *Chlorogalum* leaf blades, *Dichelostemma* leaf blades show uncharacteristic left form, yellowing and reddening; while *Allium* is well on its way to dying.

# Phase 2: Cohorts

## Results & Implications

- Yellowing blades, limping stems, nodding flower heads, unusual curving and “corkscrewing” of blades were observed.
- Some plants died outright while others managed to bloom
- Flagging was left in place to allow a revisit to specific plants in 2008 to look for and assess any plants emerging at those flags. Such emergent plants would suggest the herbicide kill was a top kill, not a kill of the bulb.
- If the kill is only a top kill, then a land manager might allow overspraying of these species to control the invasive grasses in these dense, intermixed grasslands. Or spot spraying where partial overspraying of natives is accepted.



A healthy *Zigadenus*  
in a mixed grassland

# Phase 3: Test Fusilade® in the field on *Ambrosia pumila*

- City of San Diego Multiple Species Conservation Program staff approved testing Fusilade II® on a naturally occurring *A. pumila* at Mission Trails Regional Park in 2008
- MSCP staff also approved the experimental design
- Experiment was installed and monitored with final results in 2008
- Historically, one could see a sea of grey green *A. pumila* in parts of San Diego\*



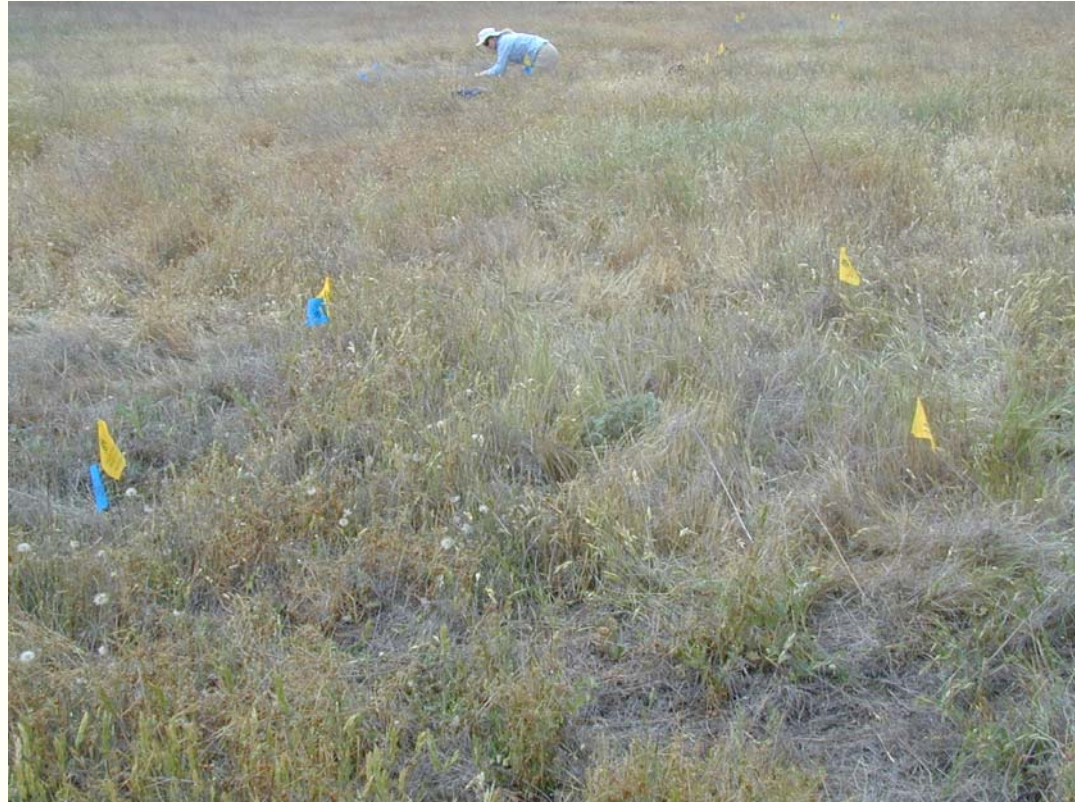
*A. pumila* in mixed annual grassland in Mission Trails Regional Park. Native shrubs border the site. Note the flagged plots mid ground.

\*Source: Tom Oberbauer (pers. Comm.)

# Phase 3: Test Fusilade® in the field

## Experiment design detailed - 1

- Five 2 meter square test spray plots were set up and marked with blue flags at the four corners
- Five 2 meter square control plots were set up immediately adjacent to the spray plots and marked with yellow flags at the four corners
- Attempts were made to match the adjacent plots for species composition
- Attempts were made to match the rough number of shoot counts of *A. pumila* for all the plots. However, Plot 3 was decidedly different in number of *A. pumila* shoots in adjacent plots. See following chart.



Flagged plots. Note common border of blue (spray plot) and yellow (control plot). Melanie Johnson Rocks, City of San Diego MSCP staff is in background



# Phase 3: Test Fusilade® in the field

## Experiment design detailed - 2

- M. Kelly photographed each plot prior to spraying and during monitoring
- Overall cover of the plots was noted and *Ambrosia pumila* shoot counts were performed by C. Burrascano.
- M. Kelly, a licensed pesticide Qualified Applicator, sprayed the five test plots with the herbicide 3/17/07. Using the 0.75 oz per gallon rate of Fusilade II® with the same surfactant and dye used in the potted experiment, Kelly sprayed to wet the entire spray plot, including the *A. pumila*.
- C. Burrascano monitored the spray plants using the dye as an indicator and had Kelly spray any missed spots to ensure 100% coverage within the blue flagged plots.



Backpack sprayer and other tools next to plot marked by blue spray. Blue spray shows coverage, missed spots for consistent treatment. Note the adjacent, yellow flagged plot that was left unsprayed. The proper spray nozzle allows for relatively precise line on the plots common border.

# Phase 3: Test Fusilade® in the field

## Experiment design detailed - 3

Plot 1	100% total cover	
	Spray	127 shoots
	Control	92 shoots
Plot 2	100% total cover	
	Spray	43 shoots
	Control	61 shoots
Plot 3	90% total cover	
	Spray	169 shoots
	Control	30 shoots
Plot 4	100% total cover	
	Spray	186 shoots
	Control	208 shoots
Plot 5	90% total cover	
	Spray	23 shoots
	Control	44 shoots

**There were a total of 548  
*Ambrosia* shoots in the spray plots  
and 435 in the controls**



# Phase 3: Test Fusilade® in the field

## Monitoring - 1

- Author M. Johnson, who had not participated in laying out or spraying the plots, joined with City Ranger Paul Seiley, a Qualified Applicator and experienced weed worker, to examine all of the plots 4/4/07
- Johnson and Seiley observed no apparent damage to *A. pumila* in any of the plots and a good initial control of invasive grasses
- A surprise for all was to see *Erodium cicutarium* appear to be dying



April 4, 2007 photo shows C. Burrascano with City Ranger Paul Seiley and MSCP staff Melanie Johnson next to sprayed oats plot. Johnson participated in monitoring while incubating a potential future weed scientist. She later delivered a baby girl - thankfully not in the field.

# Phase 3: Test Fusilade® in the field

## Monitoring - 2

- Interim and final monitoring confirmed excellent control of the *Erodium cicutarium* pictured (top) and the weed load (bottom).
- The *City of San Diego 2006 MSCP Rare Plant Monitoring Report* identifies the grasses in the area as *Bromus hordeaceus*, *Bromus diandrus*, *Vulpia myuros* var *myuros*, *Bromus madritensis*, *Avena barbata*, and *Avena fatua*. There are smaller amounts of the weed species Tocolote (*Centaurea melitensis*), and Henbit (*Lamium amplexicaule*) and the native perennial grass, Purple needlegrass (*Nassella pulchra*) in addition to the San Diego ambrosia (*Ambrosia pumila*). One unidentified grass seemed to resist the herbicide, yellowing up, but not dying.
- Broadleaves besides the *Erodium* were not controlled by the *Fusilade II*®. Managers must watch for a simple shift from one weed to another. This herbicide is not a panacea for the entire weed load.



# Phase 3: Test Fusilade® in the field

## Final Monitoring Results - 1

	Spray			Control		
	3/17/07	4/22/07	% Increase	3/17/07	4/22/07	% Increase
Plot 1	127	212	167	92	105	114
Plot 2	43	46	107	61	75	123
Plot 3	169	273	162	30	73	243
Plot 4	186	324	174	208	245	118
Plot 5	23	98	426	44	57	130
Totals	548	953	177	455	555	122
	+ 405 shoots			+100 shoots		

April 22, 2007 a formal monitoring was conducted by Mike Kelly, Cindy Burrascano, Heidi Davis, and Fred Kramer (MTRP Trail Guide), all volunteering their time. The table above shows the shoot count for the *Ambrosia* in sprayed and control plots. Mann-Whitney Rank Test and ANOVA confirmed there was no negative effect of Fusilade II® on *A. pumila* but couldn't detect a significant difference in the different numbers for the plant increase of the Spray vs. Control plots due to the variation in the original differences in data points for the plots.

# Phase 3: Test Fusilade® in the field

## Discussion

- Fusilade II® is safe to use over the top of *A. pumila* to control annual weeds.
- Unexpectedly, the herbicide gave good control of the broadleaf *Erodium*. *Erodium* is a significant problem in other populations of *Ambrosia*.
- Phase 4 will be a further study of the effect of this herbicide on *Nassella pulchra* as results from the cohort and field studies were conflicting.
- Avoid spraying bulb species until further data is collected as discussed earlier.



Borderline between sprayed and unsprayed plots

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- Fred Kramer, MTRP Trail Guides
- Heidi Davis
- **Note:** all photos by M. Kelly







# Author Contacts

Mike Kelly: [mkelly1@san.rr.com](mailto:mkelly1@san.rr.com)

Cindy Burrascano: [cindyburrascano@cox.net](mailto:cindyburrascano@cox.net)

Melanie Johnson Rocks:

[msjohnson@sandiego.gov](mailto:msjohnson@sandiego.gov)