Big projects, small monitoring budgets: Assessing treatment effectiveness for control of *Cortaderia jubata*

California Invasive Plant Council Symposium
Riverside, CA
October 17, 2019
Ellen Hamingson, Point Reyes National Seashore

All photos: NPS
Assessing control of *Cortaderia jubata*

- What did we treat where?
- What treatment methods did we use?
- Were methods effective?
- How did we know if methods were effective?
- Management implications
Point Reyes National Seashore

- 90,000 acres under NPS management
  - Elevation 0-438 meters
  - Diverse ecosystems
  - 1000 plant taxa, about 2/3 native
  - 33,000-acre Phillip Burton Wilderness
  - 20 FE species (#10 in NPS)
  - 49 special status plants
Jubata grass (*Cortaderia jubata*)

- Large clumping perennial grass
- Apomictic
- Abundant short-lived seedbank
- Can flower 2x/year
- Wind-dispersed up to 20 miles
- Adventitious roots in moist soil
- Relatively long-lived plants
- Fire hazard
- 1 of PRNS’s TOP 10 priority invasive plant species
Control Jubata Grass in Point Reyes Wilderness 2016-18

- Within central zone of Wilderness
- Project area: 16,000 landscape acres

Treatments July 2016-February 2019

- **11** watersheds across **3300** landscape acres
- **9** Gross Infested Acres
- ~ **3.3** Net Infested Acres (NIA)
- **278** patches
  - 0.5 sq meters to 2 acres
3% Round-up Custom®
1.5% Habitat®
1% Competitor®

15% of patches treated chemically, 85% manually
Management Questions

• Did management significantly reduce jubata grass among treated patches?

• Did treatments differ in effect?
  • Manual x None
  • Manual x Retreatment
  • Chemical x None
  • Chemical x Retreatment

• What factors might explain variability in treatment effects?
How did we know if methods were effective?

• Observational
• Not controlled, balanced, fully replicated study with treatments randomly assigned

Jubata grass percent cover
Pre-treatment vs. post-treatment (2019 Monitor)
• Patch level
• Spatial data
Sampling unit = Patch

**Response variables**

- Jubata % cover over original area
  - Ocular estimate
- Regrowth YES/NO
- New Plants YES/NO

**Patch 1:** 50+ plants
125 sq. m, 5-25% cover

**Patch 2:** 1 plant,
8 sq m. 75-95% cover

**Patch 3:** 2 plants,
10 sq m. 50-75% cover

**Patch 4:** 3 points, ea. 1-3 plants,
Total 12 sq m. @ 75-95% cover
### 71 patches monitored

<table>
<thead>
<tr>
<th>TRT</th>
<th>Chemical x None</th>
<th>Chemical x Retrt</th>
<th>Manual x None</th>
<th>Manual x Retrt</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of all treated patches</td>
<td>9.5%</td>
<td>5.9%</td>
<td>79.5%</td>
<td>5.1%</td>
</tr>
<tr>
<td>% of total sampled</td>
<td>31%</td>
<td>15.5%</td>
<td>38%</td>
<td>15.5%</td>
</tr>
<tr>
<td># monitored</td>
<td>22</td>
<td>11</td>
<td>27</td>
<td>11</td>
</tr>
</tbody>
</table>

Patches from 9 of 11 treated watersheds

June 25 – July 11, 2019
Hypotheses

Q1: **Mgt. reduced jubata grass % cover**
EVENT = Trt1, Trt2, Monitor

Q2: **No effect difference among treatment combinations**
• TRT =
  Chemical x None
  Chemical x Retrt
  Manual x None
  Manual x Retrt

Possible explanatory variables
• Slope
• Soil type (sandy v. loamy)
• Plant community type
• Initial patch size
• Plant distribution: isolated to clustered
• Distance to nearest jubata grass

• Plant life stage
• Timing relative to rain
• Trt1 Julian date or month
• Trt1 treatment type
• Trt2 treatment type
Statistical analyses

• R 3.6.1

Ordinal logistic regression on ordered cover classes
• Response variable = Cov.class:
  0%, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, >95%

• Random effect of Location: (1|Subgrp/Patch):
  Pairs Patch PRE/POST; controls spatial correlations

• Exploratory analyses and graphs using PCTcover as response variable
• Model comparison for effects of EVENT, TRT, & explanatory factors
Q1: EVENT effect

Highly significant all models

P-values
$1.33 \times 10^{-8}$ to $2.33 \times 10^{-16}$
Q2: No significant difference in TRT effects
### Q3: Effects of explanatory variables

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Model: Cov.class ~ x</th>
<th>AIC</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trt1, Trt2, Monitor</td>
<td>EVENT * Sq. m</td>
<td>532.70</td>
<td>EVENT = 2 x 10^{-16} *** EVENT * Sq.m = 0.0205 *</td>
</tr>
<tr>
<td>Trt1, Monitor</td>
<td>EVENT * Distribution</td>
<td>429.93</td>
<td>EVENT = 1.33 x 10^{-8} *** EVENT * Distribution = 0.0007 ***</td>
</tr>
<tr>
<td>Monitor only</td>
<td>SOIL + Distribution + Sq. m</td>
<td>199.51</td>
<td>SOIL = 0.028 *</td>
</tr>
<tr>
<td>Monitor only</td>
<td>TRT + SOIL + Distribution + Sq. m</td>
<td>200.06</td>
<td>SOIL = 0.028 * Distribution = 0.0177 *</td>
</tr>
<tr>
<td>Monitor only</td>
<td>TRT * SOIL + Distribution + Sq. m</td>
<td>201.89</td>
<td>SOIL = 0.028 * Distribution = 0.0177 *</td>
</tr>
<tr>
<td>Monitor only</td>
<td>SOIL</td>
<td>201.94</td>
<td>SOIL = 0.046 *</td>
</tr>
</tbody>
</table>
POST-treatment PCT cover
~ SOIL TYPE

N = 62

N = 9
Elimination?

Regrowth = TRUE/FALSE

Generalized linear mixed effect regressions, binomial

Explanatory variables:

- TRT
- Soil, Sq.m, Distribution, Plant Community
- RainPost1, RainPre1
- Trt1.type, Trt2.type

**Best model?**  Regrowth ~ SOIL2 + scale (Sq.m) + (1|Subgrp/Patch)

$p$ (Sq.m) = 0.0637

$AIC = 70.4$  (cf. highest $AIC = 97$ w/ 4 parameters)
Regrowth among patches treated 2X

If Trt2 dominant plant stage = Seedling or Immature: 0 regrowth

If Trt2 @ Mature, Flowering, or Seeds dispersed stage:

- 100% of patches >449.5 sq.m. regrew
- 60% of <499.5 sq.m. regrew.

n = 21

Terminal nodes: % of patches Regrowth = YES

81% of deviance explained
Conclusions

• Management actions significantly reduced jubata grass % cover

• Manage adaptively: All treatments can be effective

• No clear explanatory factors for post-treatment variability but...
  • Patch size matters?
  • Results vary by SOIL and DISTRIBUTION?
  • Worth investigating:
    • Soil moisture and/or rain timing
    • Treatment timing (Julian dates)
    • Soil type interacting w/ treatment type
Management Implications

• Species-specific treatment effectiveness monitoring design

• Standardize pre- and post-treatment measurements

• No significant effect ≠ no ecological impact

• Further investigations: soil type, timing, weather
  • Controllable vs. measurable factors—why bother?

• Collaborate: Meta-analyses + connect with researchers
Thanks for invaluable help with ... 

- **Challenging fieldwork**
  Corbin Gentzler, Joey Negreann, Elliot Gunnison, Rachael Turner, Brad Morin, Alison Haddad, Kim Nguyen, Lynette Norman, David Ely, Michael Hernandez, Michael Spaeth, Miriam Golding

- **Statistical analyses**
  Dr. Ben Becker

- **NPS Funding**
  Jay Goldsmith, Denise Louie, Terri Hogan

- **Scouting & mapping**
  Mike Zeiss, Patricia Matson, Jerry Meral

- **Inspiration**
  Dr. Timothy Babalis
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Percent cover by EVENT

**Table:**

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<thead>
<tr>
<th></th>
<th>TRT 1</th>
<th>TRT2</th>
<th>Monitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean PCTcover</td>
<td>53%</td>
<td>16%</td>
<td>5%</td>
</tr>
<tr>
<td>Median PCTcover</td>
<td>63%</td>
<td>2%</td>
<td>1%</td>
</tr>
</tbody>
</table>
Q2: No TRT significant effect

Post-treatment cover classes

<table>
<thead>
<tr>
<th>POST-trt cover</th>
<th>Chemical x None</th>
<th>Chemical x Retrt</th>
<th>Manual x None</th>
<th>Manual x Retrt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean PCTcover</td>
<td>4%</td>
<td>1%</td>
<td>8%</td>
<td>4%</td>
</tr>
<tr>
<td>Median PCTcover</td>
<td>0.5%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>