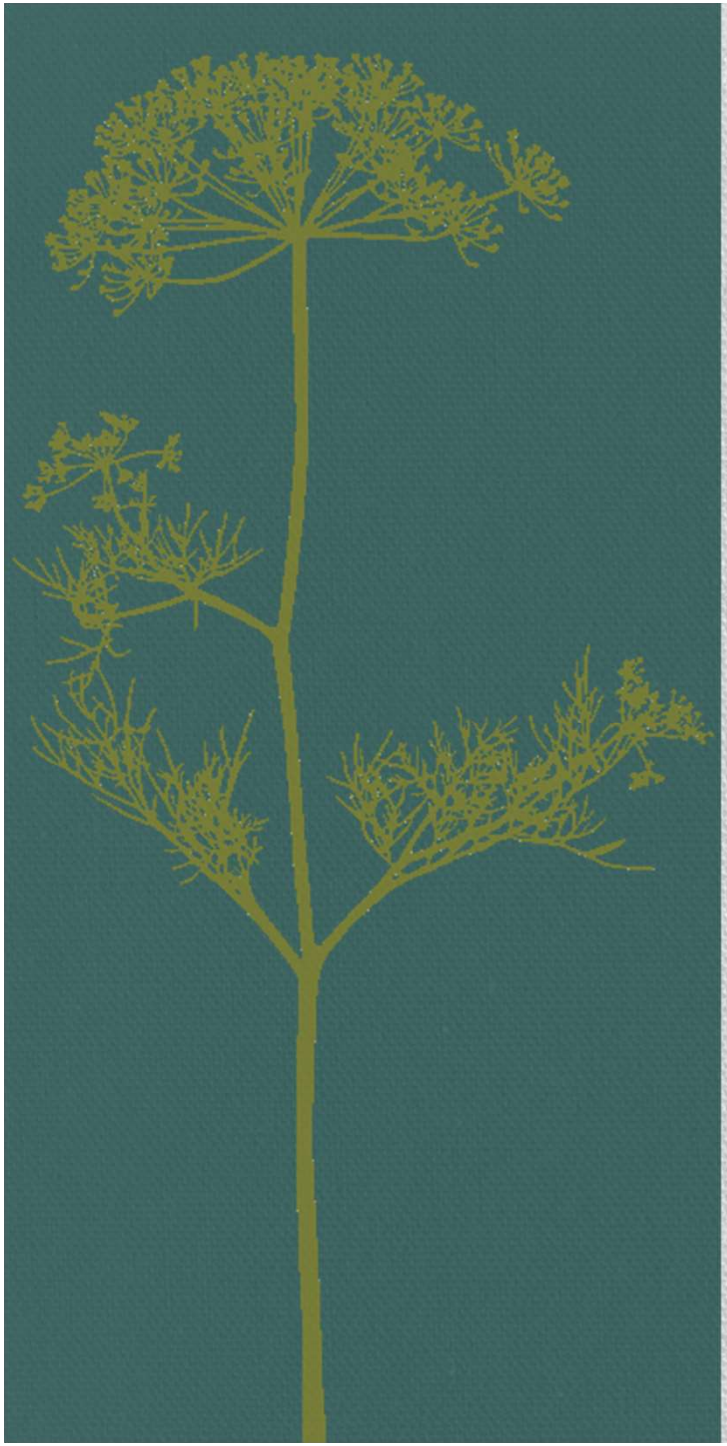

MODELING THE CONTROL OF INVASIVE FENNEL ON SAN CLEMENTE ISLAND

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[2]Soil Ecology and Restoration Group (SERG), SDSU Research Foundation
[3]San Elijo Lagoon Conservancy


Los Angeles
Palm Springs
San Diego
San Clemente Island
N
0
25
50
100
Miles
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

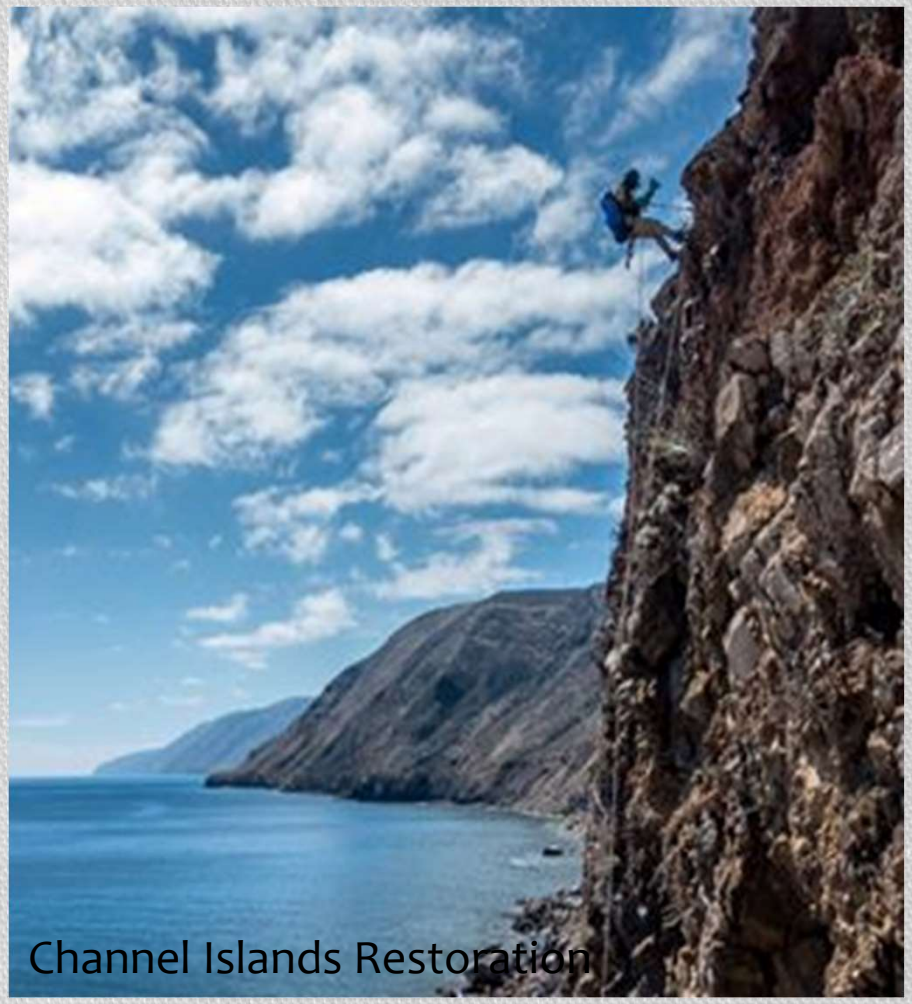
Invasive Species Control

Taxon	CAL-IPC Rank	Number of Occurrences on SCI	Treatment	2016 Goals
Asphodelus fistulosus	Moderate	4	Spray with 4% glyphosate in early spring	Treat before seed set
Brassica nigra	Moderate	Mapping needed	Spray seedlings with 0.5% glyphosate, older plants use 1-2% glyphosate	Map species extents, treat opportunistically
Brassica tournefortii	High	25	Spray seedlings with 0.5% glyphosate, hand pull once flowers appear	Treat before seed set
Carpobrotus edulis	High	Mapping needed	Hand-pull year round, 4% glyphosate Feb to October	Map species extent, treat resprouts, expand treatment area
Ehrharta calycina	High	11	Spray with 2% glyphosate in early spring	Map species extent, treat before seed set
Foeniculum vulgare	High	97	Spray with 4% glyphosate in early spring	Treat before seed set
Plantago coronopus	Not listed	7	Spray with 2% glyphosate in early spring	Map species extent, treat before seed set
Stipa miliacea	Limited	18	Spray with 2% glyphosate mid-summer to fall	Map species extent, treat before seed set
Tragopogon porrifolius	Not listed	46	Spray with 4% glyphosate in early spring	Treat before seed set

Treatment Protocol

- Visit every population 2-3x every year
    - Exceptions: locations that require rappelling equipment or Naval escort, visited 1x/year
- Clip and bag all inflorescences
- Spray with 4% Aquamaster

Data Collection

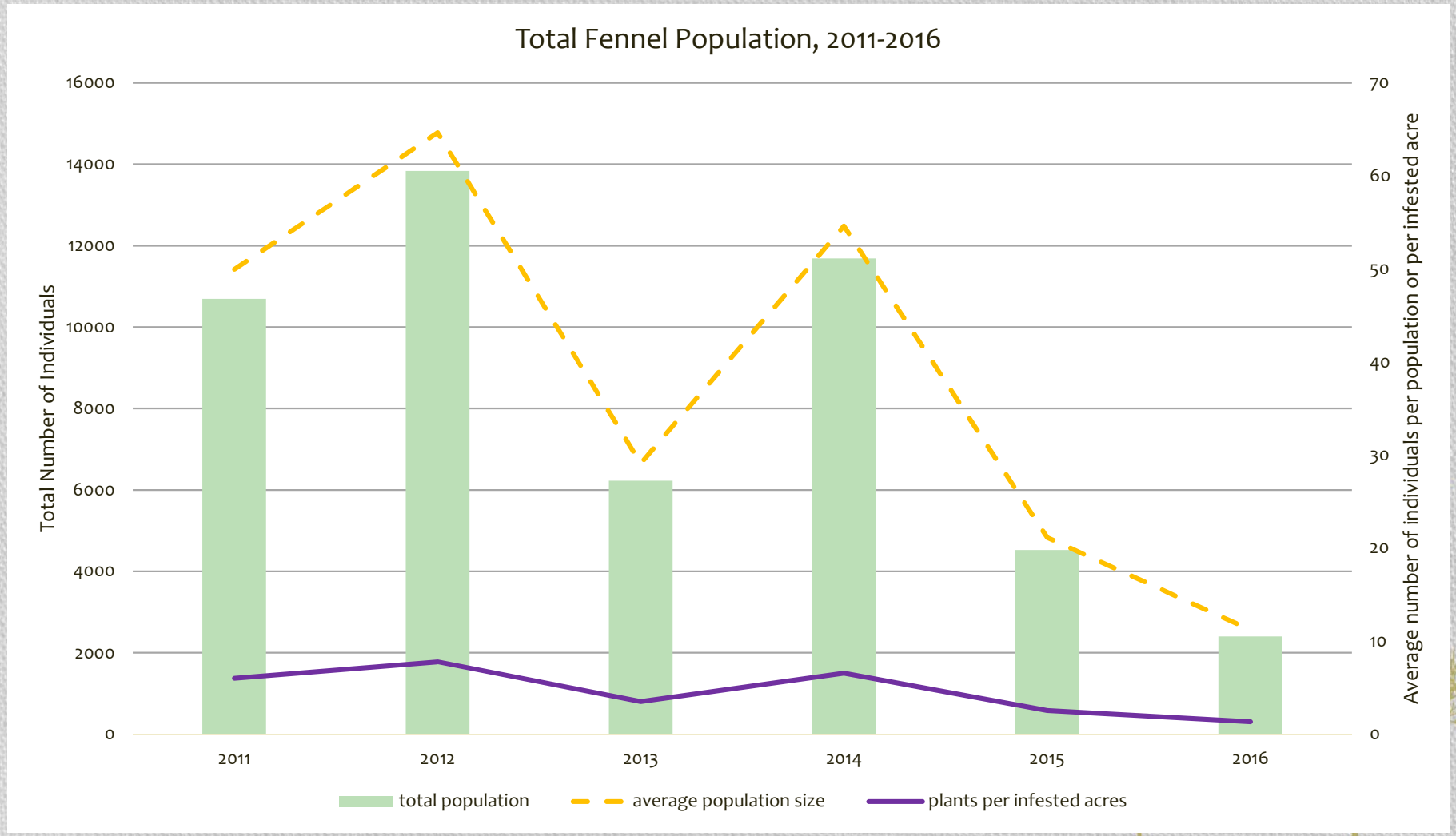

Channel Islands Restoration

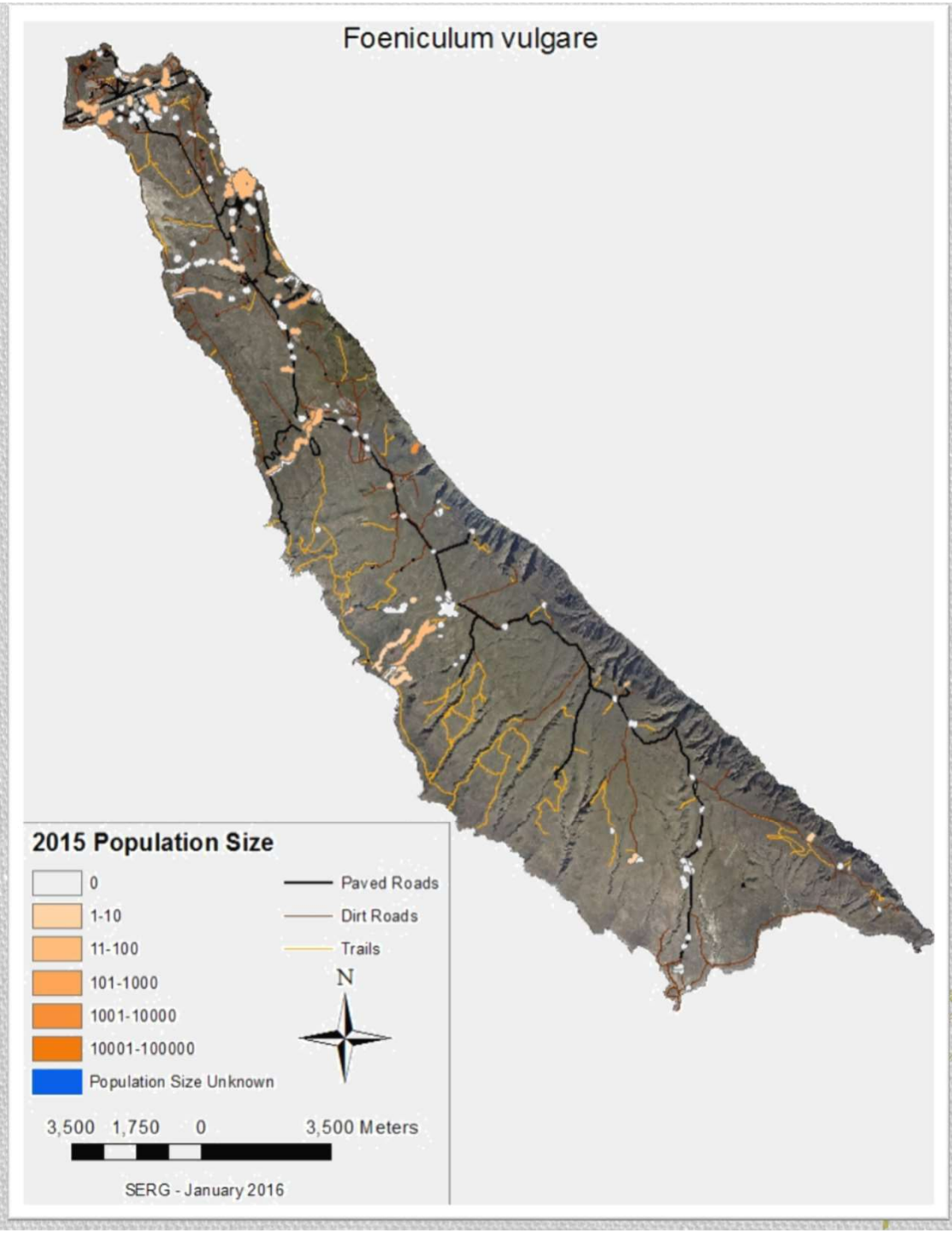
- GPS location
- Treatment type (herbicide concentration and quantity)
- Total number of plants
  - Seedlings/adults
  - Re-sprouts (previously treated)
- Phenology

Additional Survey Information

E. Havstad

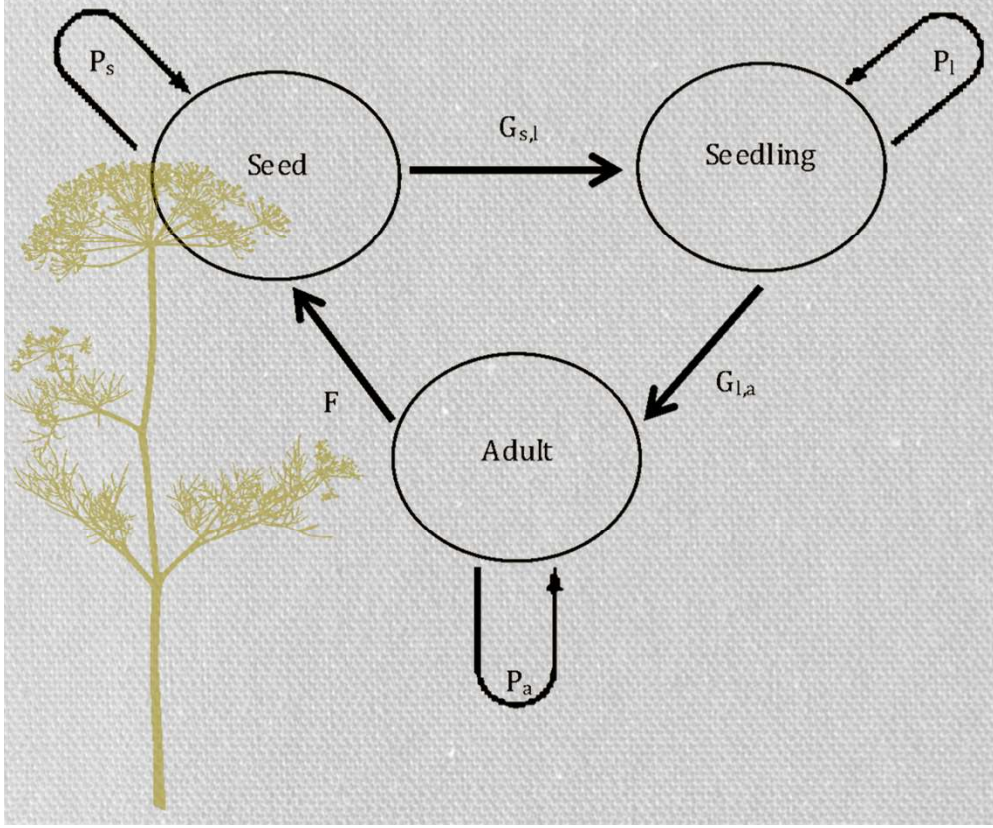
General Population Numbers




Foeniculum vulgare
2015 Population Size
0
1-10
11-100
101-1000
1001-10000
10001-100000
Population Size Unknown
Paved Roads
Dirt Roads
Trails
N
3,500 1,750 0 3,500 Meters
SERG - January 2016

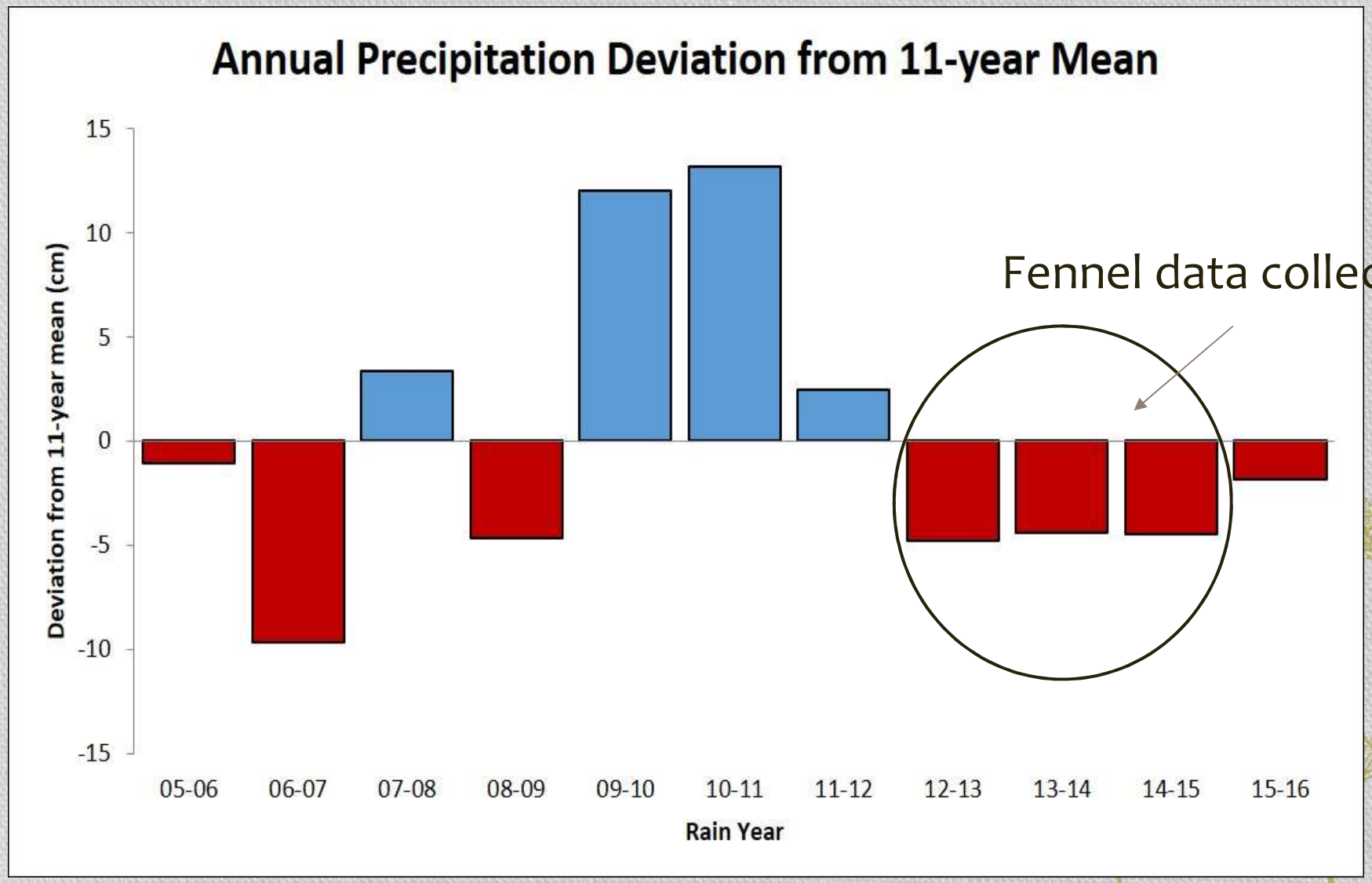
Population Growth Modeling Methods

- Parameterized a stage-structured population model using life-history structure to determine the role of treatment in population dynamics
- Retention and graduation probabilities based on:
  - Agricultural studies
  - Field data from 17 populations



Parameter	Estimated Value	Variability
P_s Seed viability-germination rate	0.234^{366}	±0.076
F Umbels/plant*seeds/umbel[355]	65.48^{355}	±64.48
$G_{s,l}$ Germination rate	0.387^{355}	±0.053
P_l	0.172	±0.035
P_a	0.478	±0.043
$G_{l,a}$	0.172	±0.035

Obligatory Drought Slide



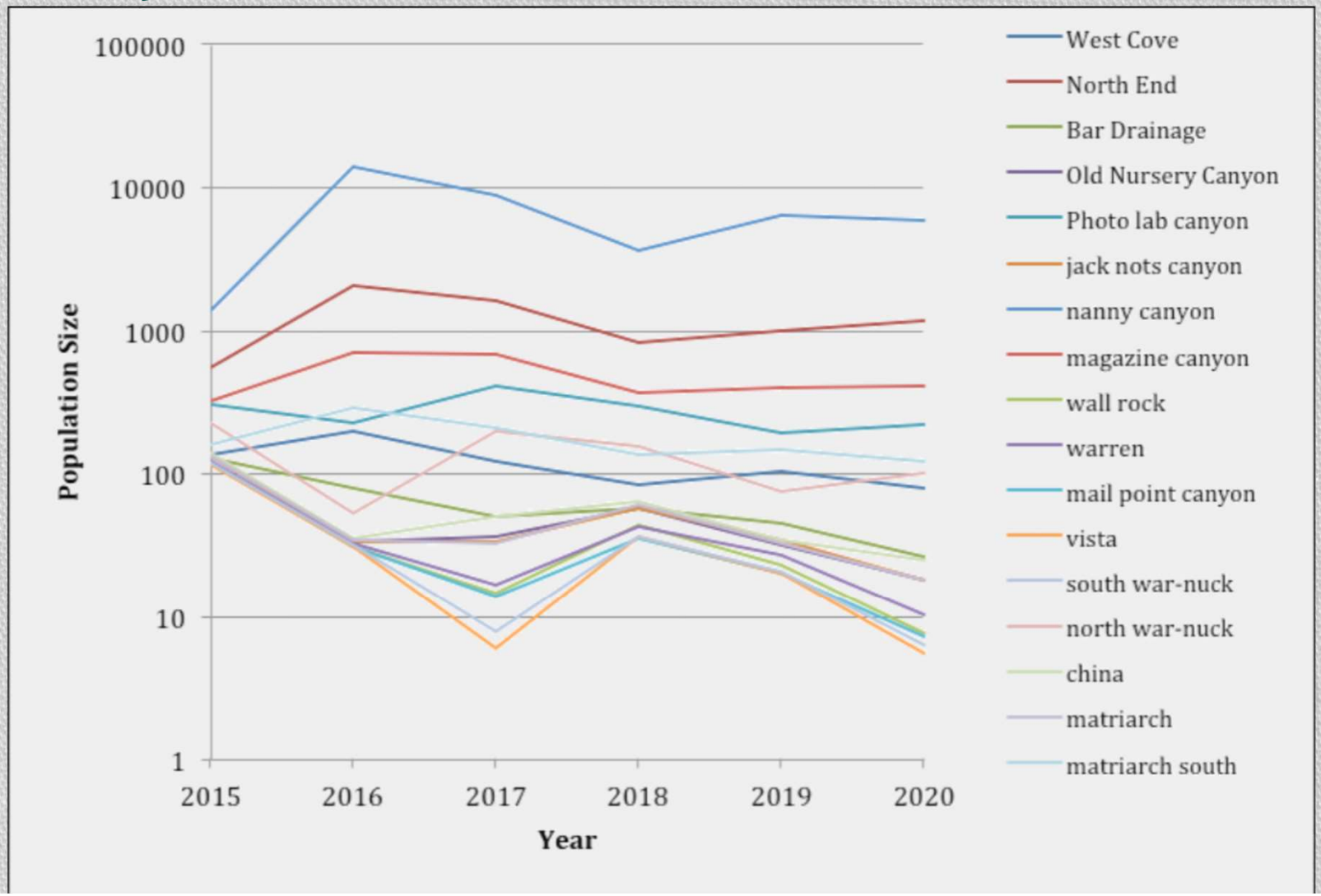
Results

- 30% of seedlings and 50% of adults are surviving despite treatment
- Comparisons of re-sprouts aligns with adult retention

Parameter	Estimated Value	Variability
P_s Seed viability-germination rate	0.234^{366}	± 0.076
F Umbels/plant*seeds/umbel[355]	65.48^{355}	± 64.48
$G_{s,l}$ Germination rate	0.387^{355}	± 0.053
P_l	0.172	± 0.035
P_a	0.478	± 0.043
$G_{l,a}$	0.172	± 0.035

Results

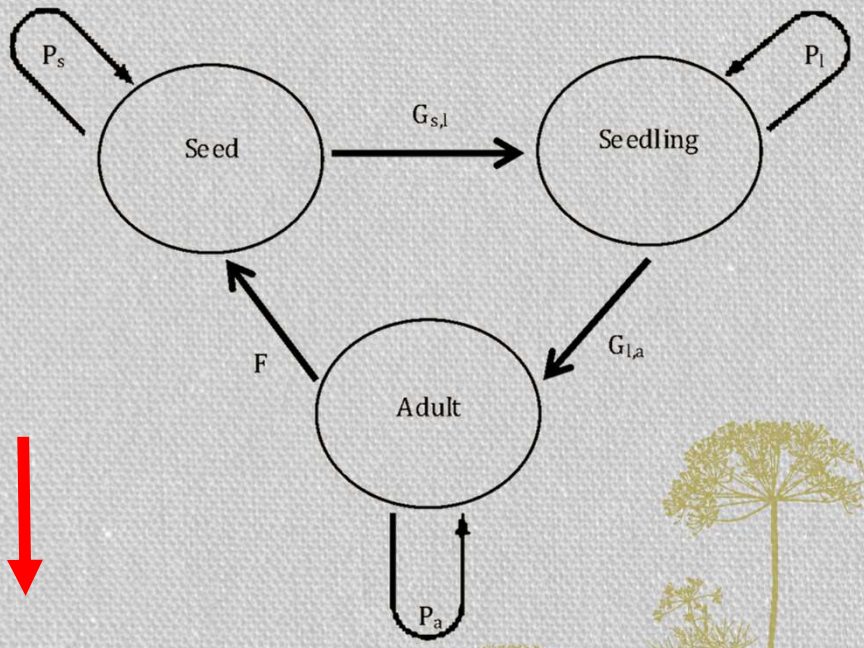
- Rate of increase varies with initial population size (N=150 cut-off)
- 9 of 17 went extinct, though eradication probability never exceeded 30%



Alternative Management Scenario 1

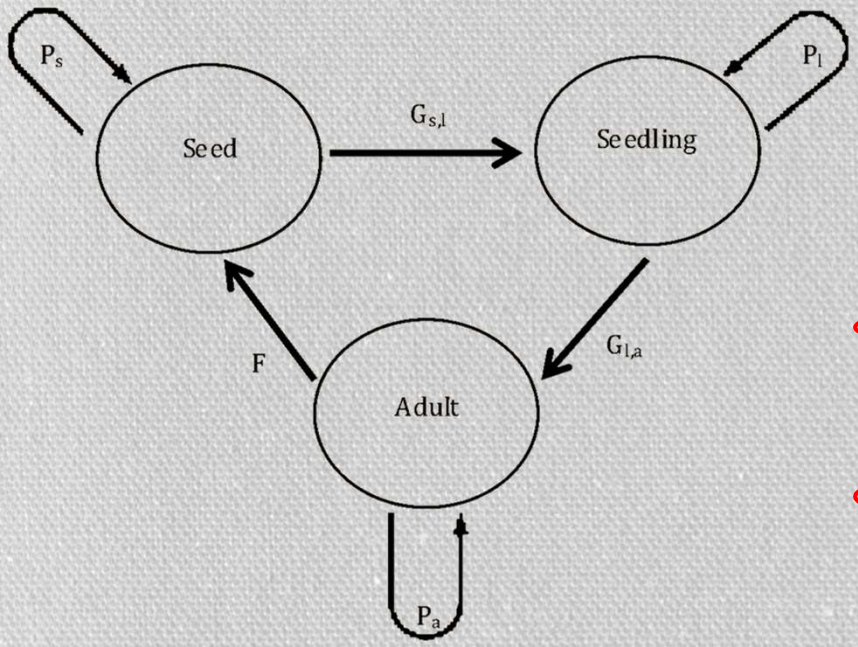
- Increase detection rate

Parameters	Management Scenario 1 Estimated Value	Variability
P_s	0.234[6]	±0.076
F	65.48[5]	±64.48
$G_{s,l}$	0.387[5]	±0.053
P_l	0.086[16]	±0.018
P_a	0.359[16]	±0.032
$G_{l,a}$	0.086[16]	±0.018



Alternative Management Scenario 2

- Increase kill rate

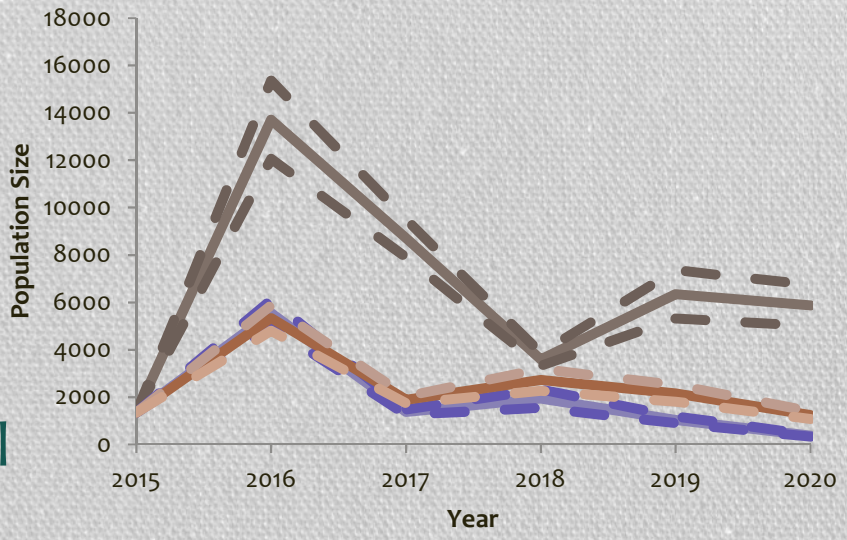


Parameters	Management Scenario 2 Estimated Value	Variability
P_s	0.234[6]	±0.076
F	52.38[5,10]	±51.58
$G_{s,l}$	0.387[5]	±0.053
P_l	0.172	±0.035
P_a	0.382[10]	±0.034
$G_{l,a}$	0.172	±0.035

Results part 2

- Both scenarios significantly decrease growth rate regardless of initial population size
- Increased detection rate had greater effect, and increased probability of eradication in small and medium populations

Nanny Canyon – large population



North War-nuck Canyon – small population

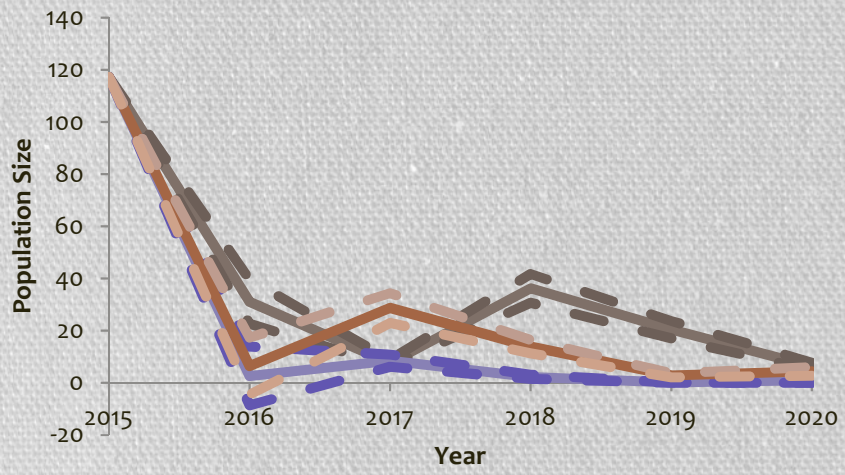
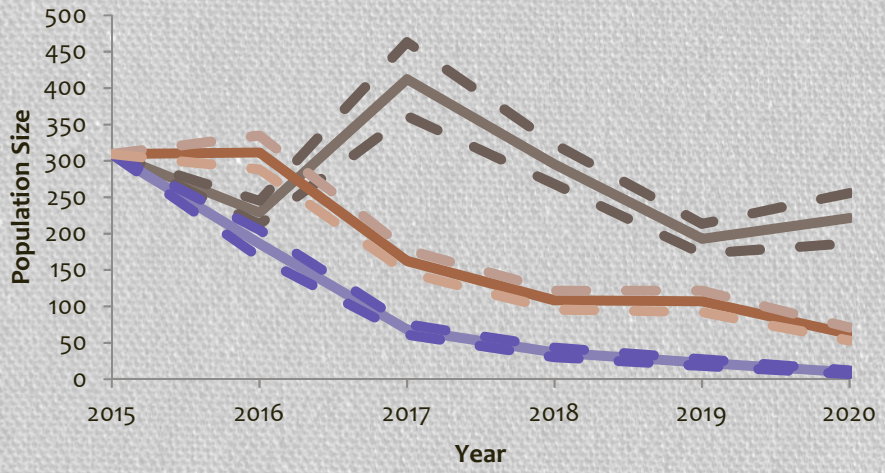


Photo Lab Canyon – medium population



Next steps

- Evaluate each population and assign treatment type based on size and accessibility
- Model improvements:
  - Better seed bank estimate
  - Non-drought year data
- Additional alternative strategies to model
  - Increase detection but not every year
  - Stop treating remote populations every year

Questions?

Thanks to:

- Emily Howe, Korie Merrill, Sue Meiman, and all current and former SERG SCI staff
- Channel Islands Restoration, Institute for Wildlife Studies, & ACS Habitat Management
- US Navy Pacific Fleet