



# Matching restoration tools to rare plant recovery needs in invaded Channel Island landscapes

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**U.S. Geological Survey**



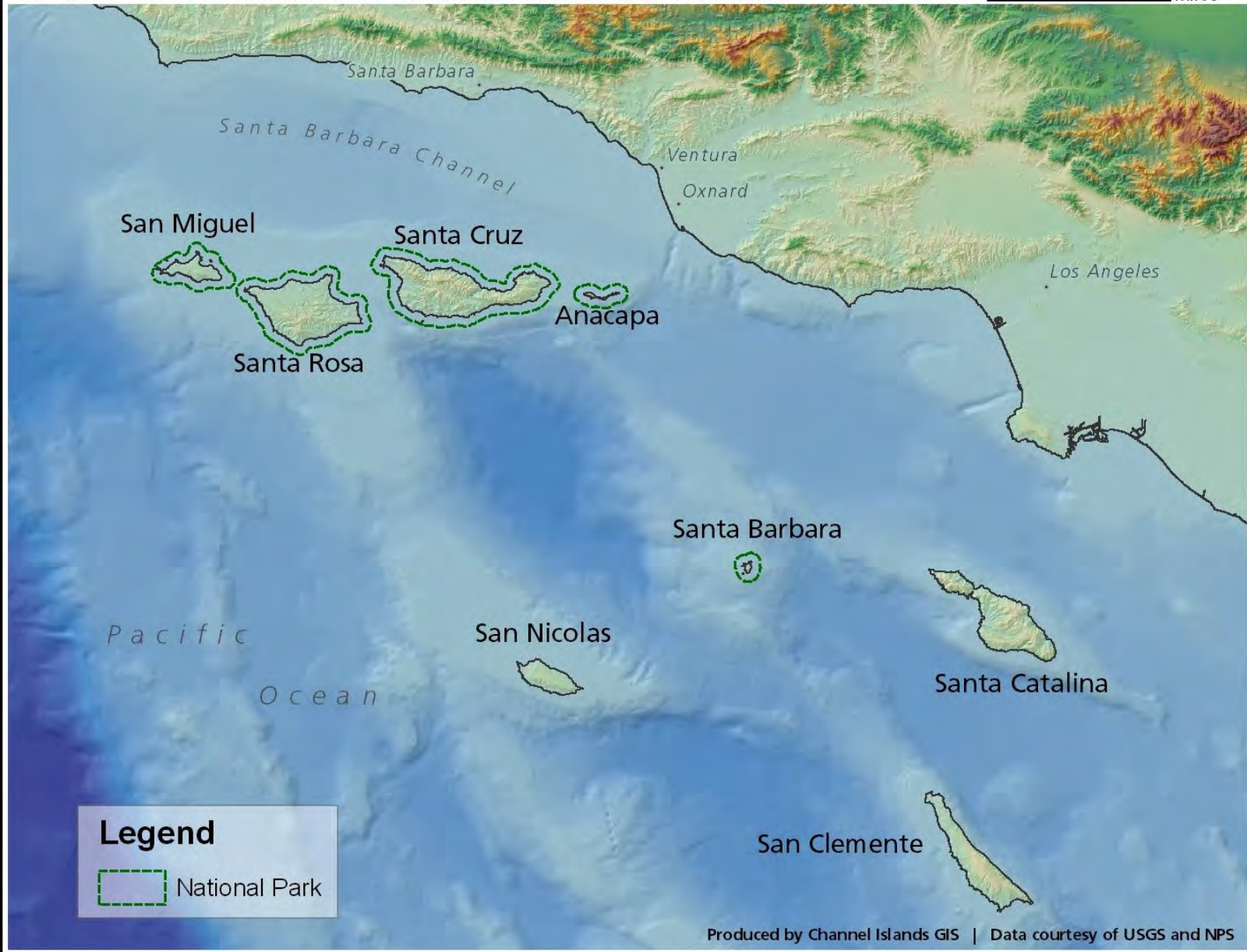
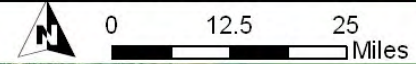
Cal-IPC Symposium November 2016

Denise Knapp photo





# The California Channel Islands







Santa Rosa Island Canyon c. 1995

NPS files





Santa Rosa Island 1995

NPS files

3 23 '95





Santa Rosa Island c. 1983

Bill Ehorn photo





Santa Rosa Island 2014

Edward Demmond photo





Santa Cruz Island 2005

Dan Richards photo



# Research Questions

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- 1. Where are the rare plant taxa?**
- 2. How do they compare to the past?**
- 3. How are populations doing now?**
- 4. Are there major threats to populations that we can do something about?**



# Research Methods

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**Herbarium archives**

**Field surveys**

**Repeated counts**

**Demographic monitoring**

**Experiments**



<b>15 Listed Taxa</b>	<b>Life History</b>	<b># Pops</b>	<b>Islands</b>
<i>Gilia tenuiflora</i> ssp. <i>hoffmannii</i>	Annual	2	SRI
<i>Malacothrix indecora</i>	Annual	6	SCI SRI
<i>Malacothrix squalida</i>	Annual	1	SCI
<i>Phacelia insularis</i> var. <i>insularis</i>	Annual	3	SRI SMI
<i>Sibara filifolia</i>	Annual	2	SCT SCL (SCI)
<i>Thysanocarpus conchuliferus</i>	Annual	8	SCI
<i>Boechera hoffmannii</i>	Perennial	6	SCI SRI (AI)
<i>Castilleja mollis</i>	Perennial	2	SRI
<i>Dudleya nesiotica</i>	Perennial	1	SCI
<i>Dudleya traskiae</i>	Perennial	10	SBI
<i>Crocanthemum greenei</i>	Perennial	36	SCI SRI SCT
<i>Galium buxifolium</i>	Subshrub	26	SCI SMI (SRI)
<i>Arctostaphylos confertiflora</i>	Shrub	3	SRI
<i>Berberis pinnata</i> ssp. <i>insularis</i>	Shrub	5	SCI SRI (AI)
<i>Malacothamnus fasciculatus</i> var. <i>nesioticus</i>	Shrub	6	SCI

AI = Anacapa Island, SCI = Santa Cruz, SRI = Santa Rosa, SMI = San Miguel, SBI = Santa Barbara, SCT = Santa Catalina, SCL=San Clemente; ( ) presumed extirpated.



## Current Condition

## Desired Future

Few  
Small  
Isolated  
Declining

*Constraints*

Many  
Large  
Connected  
Growing



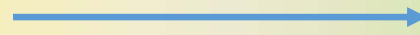
## ***Constraints***

Few plants  
Poor seed production  
Low seed viability  
Low recruitment

Invasive competition  
Altered canopy  
No seed bed

Isolation  
Habitat fragmentation  
Habitat loss

Pollinator limitation  
Herbivory & trampling  
Erosion  
Changed climate



## ***Recovery tools***

Seed increase  
Seed banking  
Hand pollination  
Tissue culture  
Augmentation

Invasive control  
Habitat management

New populations

Animal eradication  
Monitoring

**POPULATION**

**HABITAT**

**LANDSCAPE**

**ECOSYSTEM**

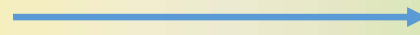
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# Santa Rosa and Santa Cruz Island recovery scenarios



Denise Knapp photo



# Scenario 1 – Passive Recovery





# Population expansion

Torrey pine  
*Pinus torreyana*  
var. *insularis*



***Constraints***

Herbivory & trampling



**ECOSYSTEM**

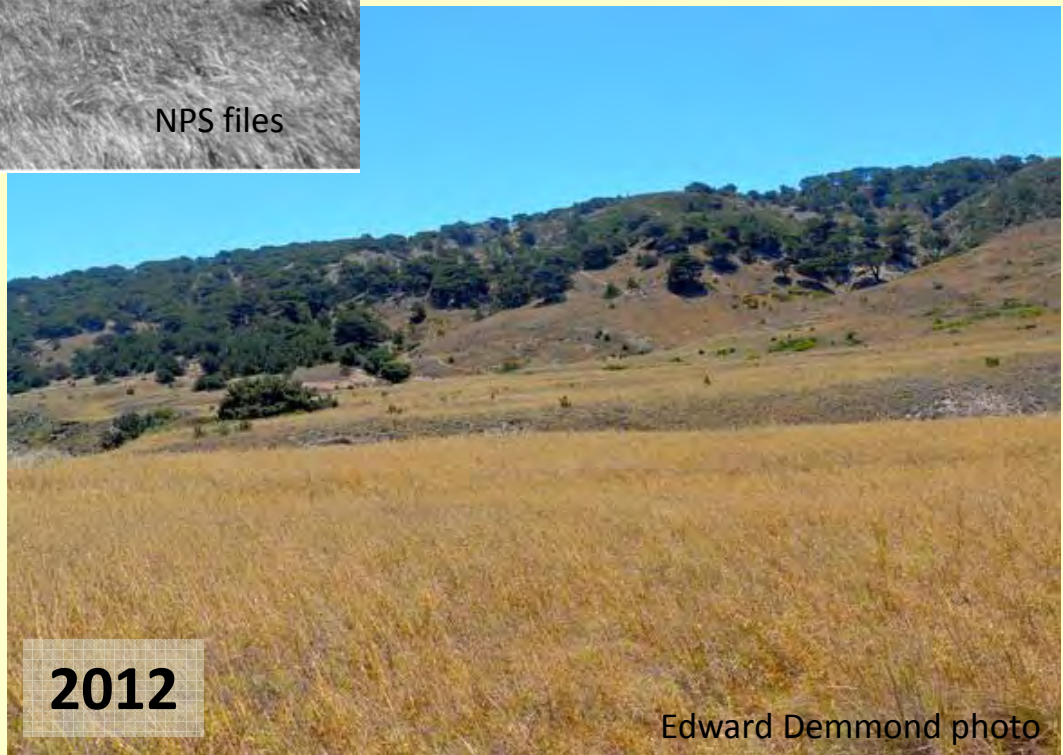
***Recovery tools***

Animal eradication



1942

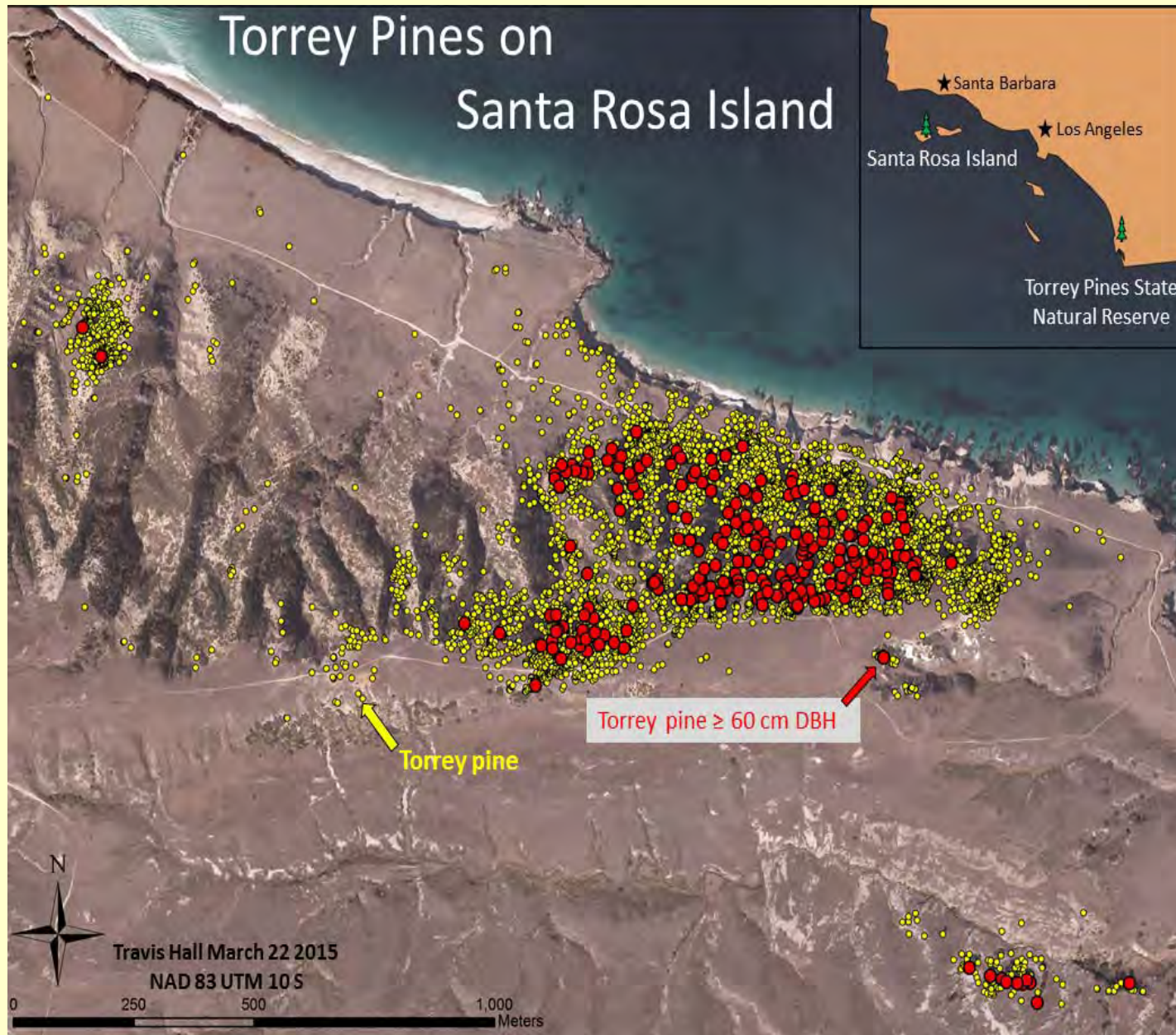
NPS files



2012

Edward Demmond photo





From: Travis Hall and Andrew Brinkman, 2015 CSUCI capstone



# Moving out of refugia

Jolla Vieja Canyon endemics, Santa Rosa Island



***Constraints***

Herbivory & trampling



**ECOSYSTEM**

***Recovery tools***

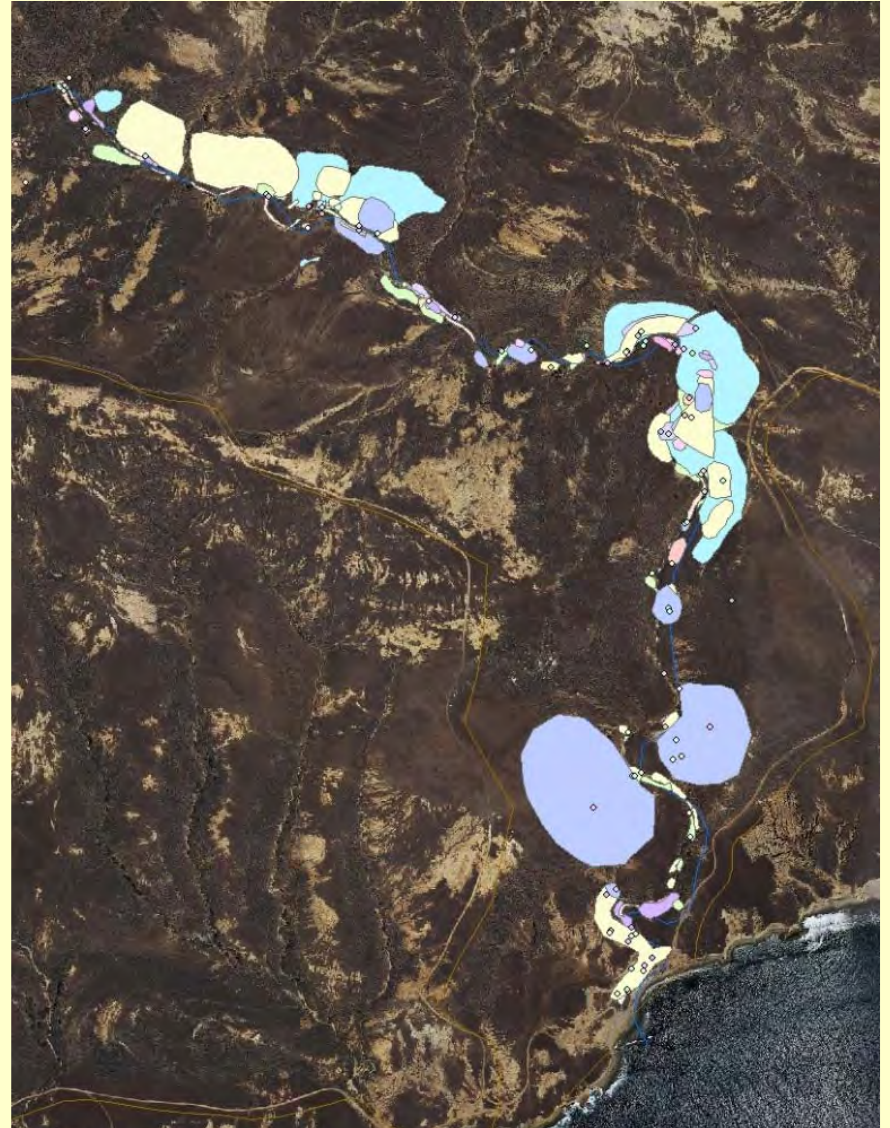
Animal eradication



1994 - 11 Species



2010 - 17 Species



270% Average percent change in abundance



# Scenario 2 – Benefitting from openness without herbivores



Denise Knapp photo



# Doesn't like pigs or leaf litter

Island jepsonia

*Jepsonia malvifolia*



***Constraints***



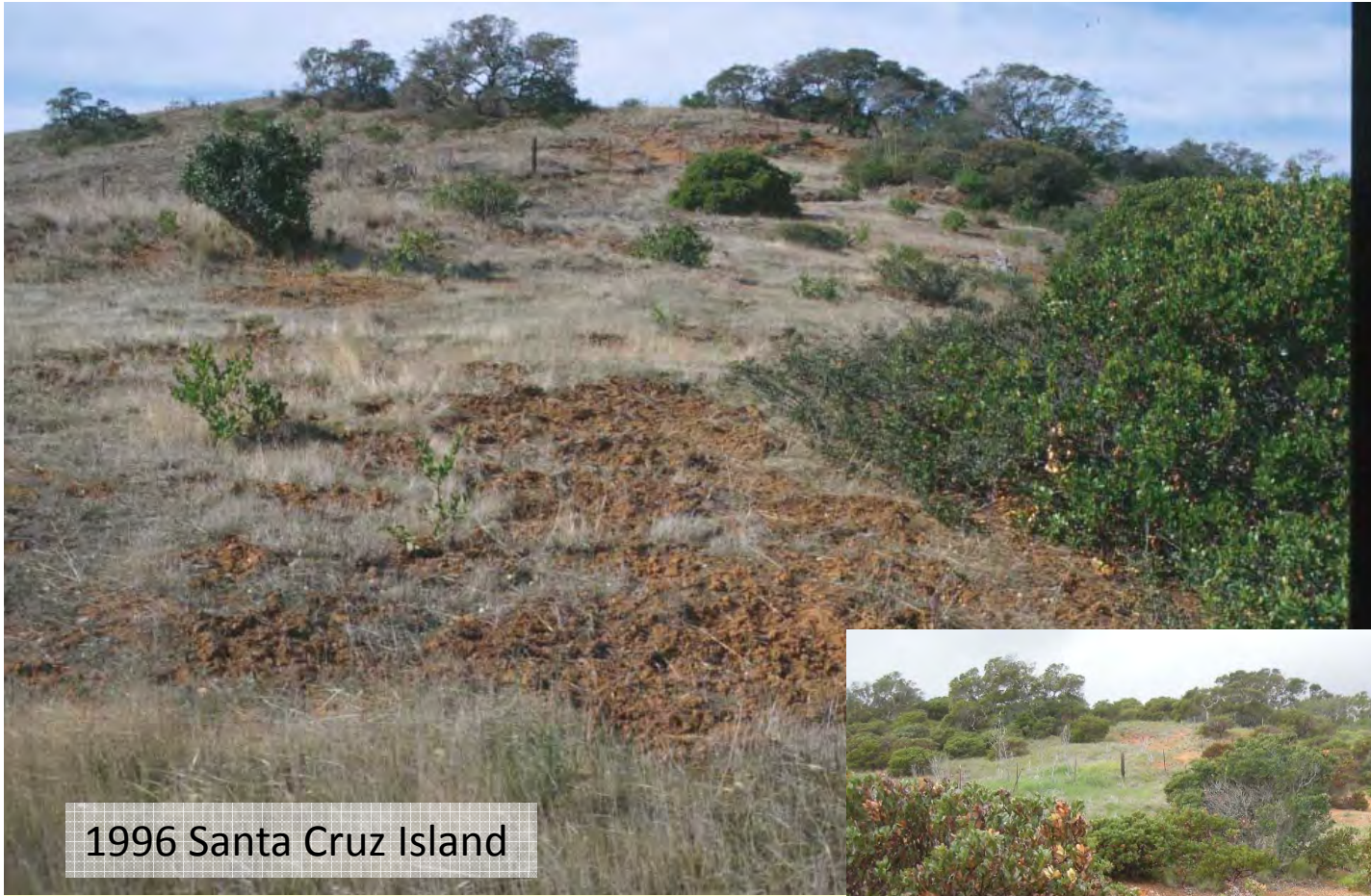
***Recovery tools***

Herbivory & trampling

**ECOSYSTEM**

Animal eradication





1996 Santa Cruz Island



2015 Santa Cruz Island



## *New Constraint – increased litter?*



***Constraints***

Altered canopy



**HABITAT**

***Recovery tools***

Habitat management

# Scenario 3 – Changed ecosystem processes



Aaron Schmidt photo



# Lost water cycle

Island oak  
*Quercus tomentella*



## ***Constraints***



## ***Recovery tools***

Altered canopy  
Erosion  
No seed bed

**HABITAT**

Habitat management

Few isolated populations

**LANDSCAPE**

New populations

Herbivory and trampling  
No fog drip

**ECOSYSTEM**

Animal eradication  
Habitat management

# Santa Rosa Island Soledad Ridge



Denise Knapp photo



# Cloud forest restoration

Capture fog, slow erosion, rebuild seedbed, plant



# Lost pollinators and fire

Island bush mallow  
*Malacothamnus*  
*fasciculatus*  
var. *nesioticus*



D Wilken photo

## ***Constraints***



## ***Recovery tools***

Few plants  
Poor seed production  
Low seed viability

### **POPULATION**

Augmentation  
Hand pollination

Few isolated populations

### **LANDSCAPE**

New populations

Pollinator loss  
Changed fire regime

### **ECOSYSTEM**

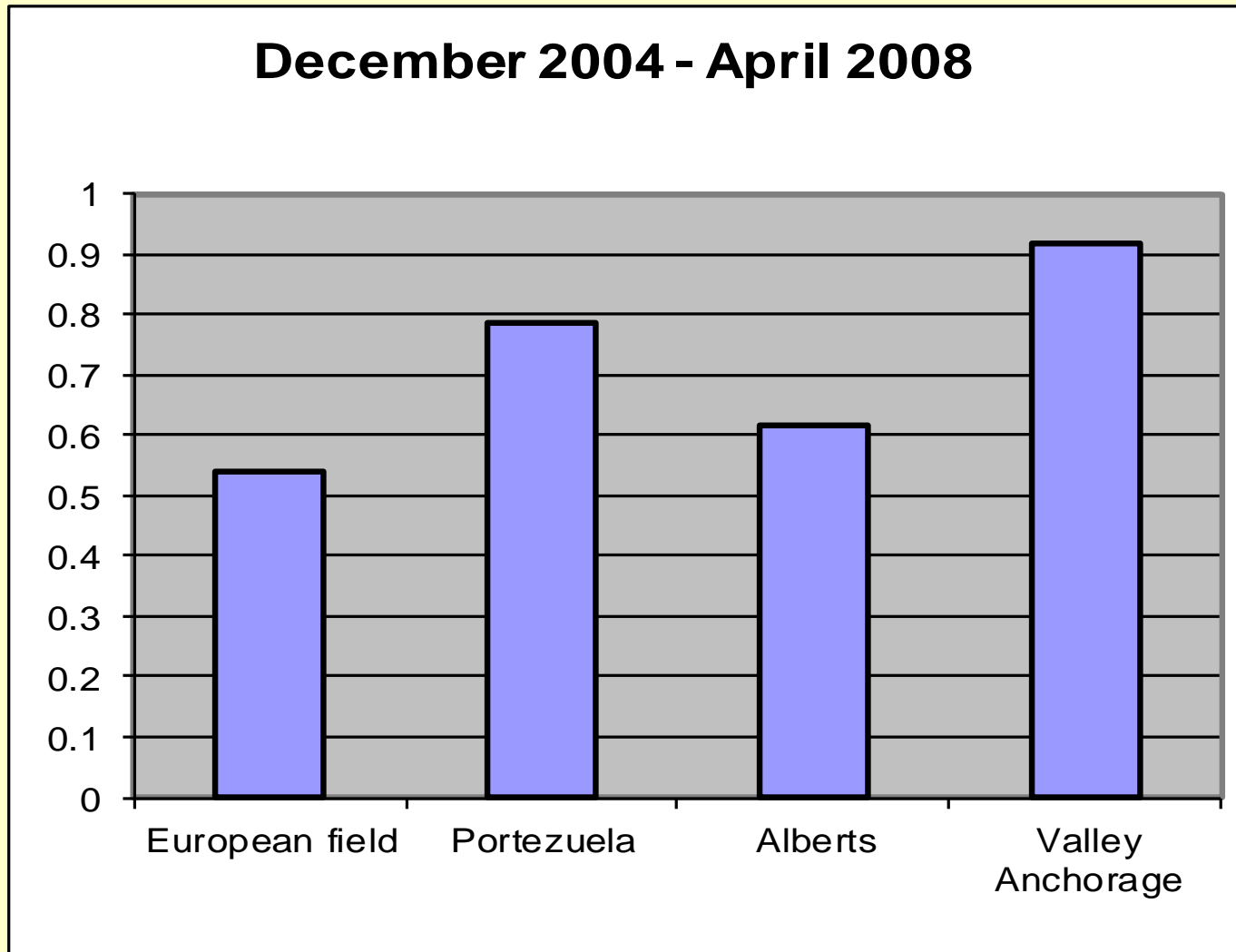
Animal eradication  
Fire management



# Out-plant Experiment



# Island bush-mallow planting survival





# Plant new populations



January 2010



July 2011

Karen Flag photos



Status Jan 2016

6 natural populations

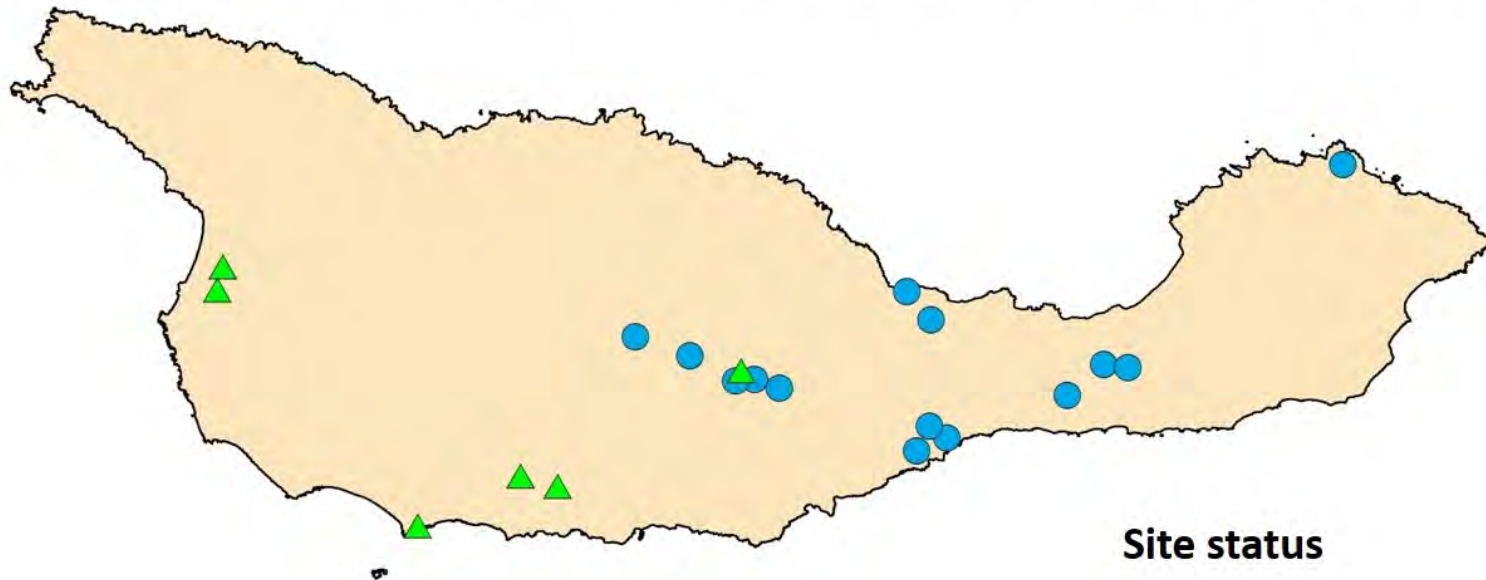
14 new sites

350 new plants





# Santa Cruz Island bush mallow *Malacothamnus fasciculatus* var. *nesioticus*



Santa Cruz Island

Site status

▲ Native

● Planted  
2004-2015



Good vegetative recruitment  
Poor recruitment from seed





# Changed climate, Competition

Island Phacelia  
*Phacelia insularis*



## ***Constraints***

Invasive competition

Changed climate



## ***Recovery tools***

**HABITAT**

Habitat management

**ECOSYSTEM**

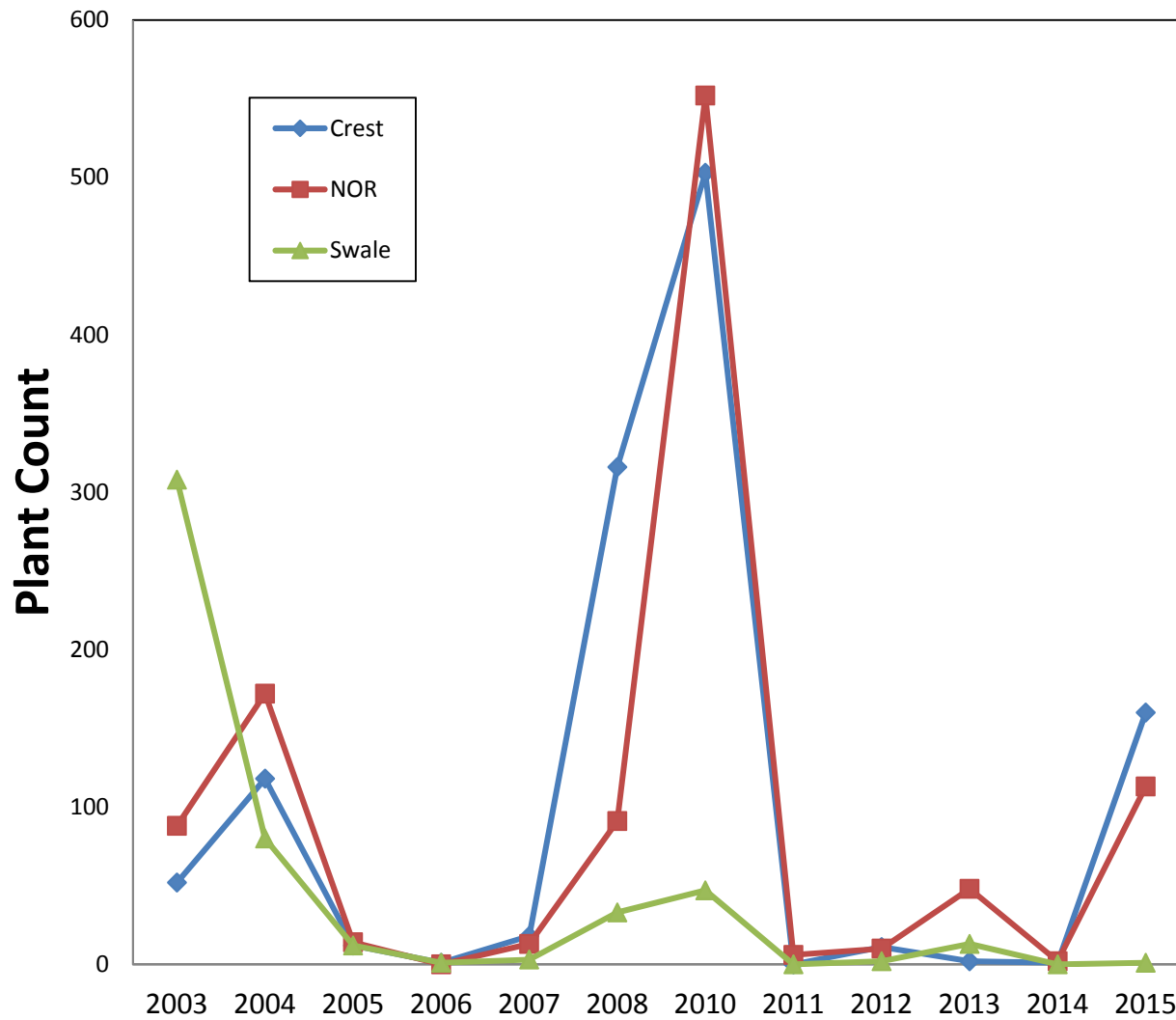
Seed banking

Looking for island Phacelia 2003





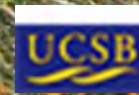
# Phacelia plot counts 2003-2015



# Competition and climate change

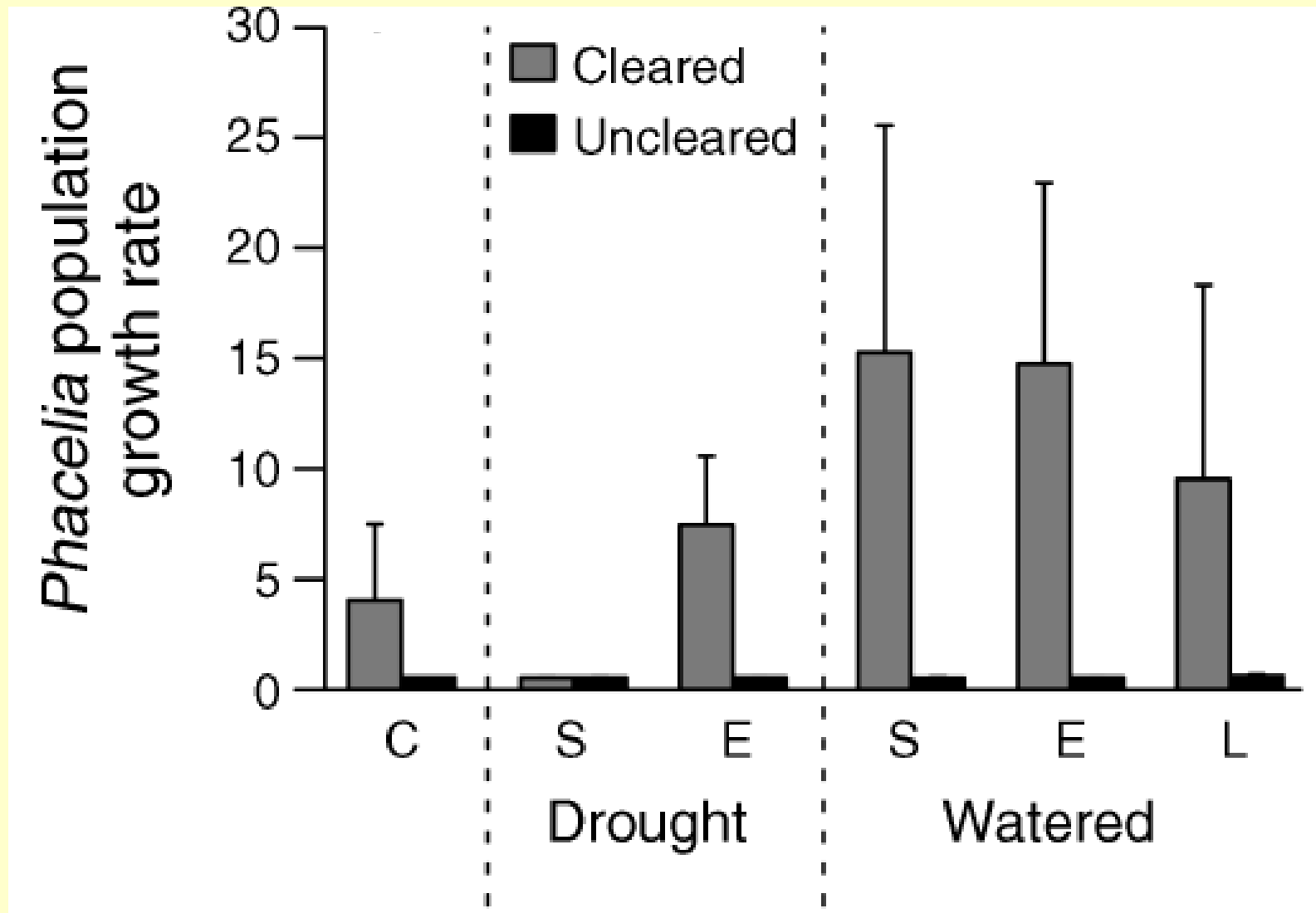


2000





# Bromus clearing and Phacelia growth



# Habitat restoration

Reduce grass and thatch, restore lupine scrub



October 2015





Dan Richards photo

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## *Constraints - Population*

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Poor seed production

Low seed viability

Low recruitment

## *Constraints - **Habitat***

Few plants

Poor seed production

Low seed viability

Low recruitment

**Invasive competition**

**Altered canopy**

**No seed bed**



## *Constraints - Landscape*

Few plants

Poor seed production

Low seed viability

Low recruitment

Invasive competition

Altered canopy

No seed bed

**Isolation**

Habitat fragmentation

Habitat loss

## *Constraints - **Ecosystem***

Few plants

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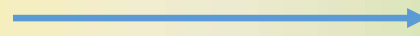
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**POPULATION**

**HABITAT**

**LANDSCAPE**

**ECOSYSTEM**

## Collaborators

Dieter Wilken	Julie Christian
Andrew Wyatt	Jonathan Levine
Connie Rutherford	Stephanie Yelenik
Tim Thomas	Nancy Vivrette
Katie Chess	Ken Niessen
Pat Corry	Diane Thomson
Steve Junak	Emily Schultz
Lyndal Laughrin	Ken Owen
Matthew Barmann	Kevin Thompson
Clark Cowan	Denise Knapp
Karen Flagg	John Knapp
Don Hartley	Numerous students
Sarah Chaney	Many many volunteers
Dirk Rodriguez	



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*Thanks!*





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