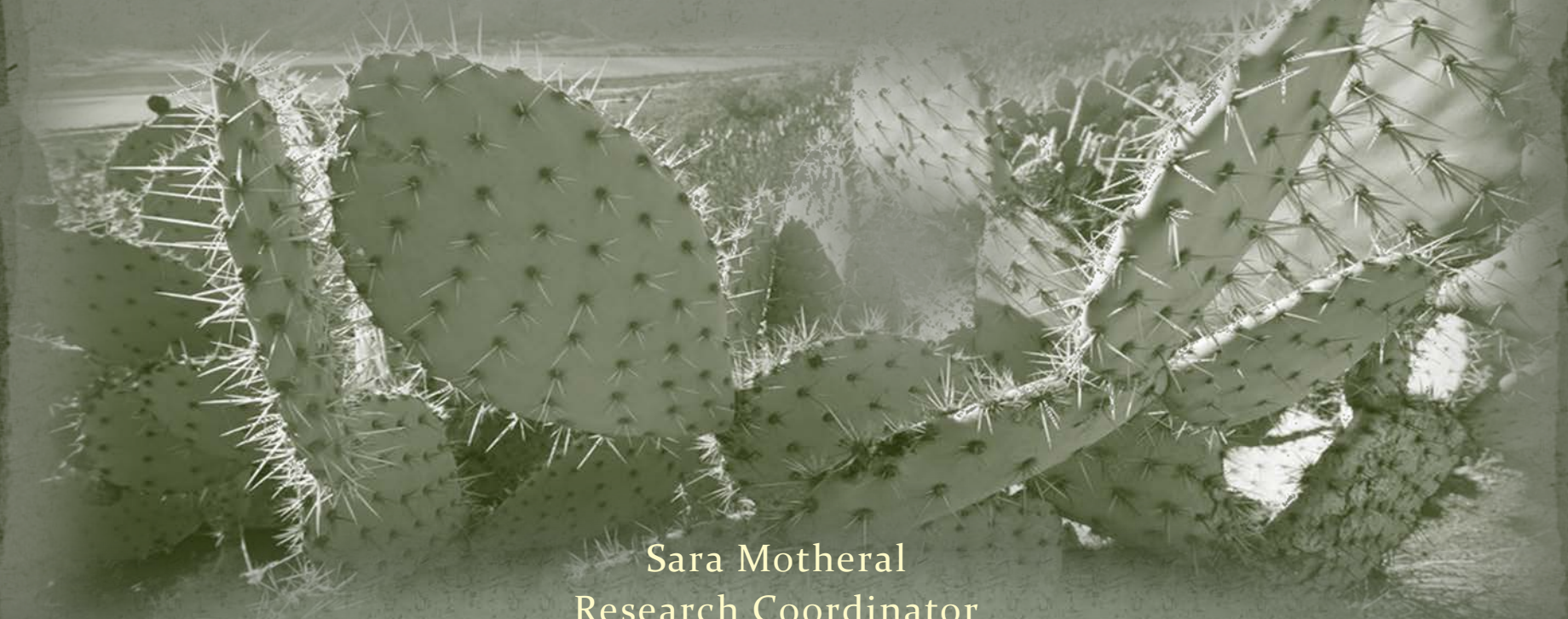
Evaluating Best Practices for Cactus Establishment in the Field

Preliminary Results of a Long-term Experiment



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Cactus Restoration

- Cactus important for cactus wren

- Challenges:
  - Very slow growth rate
  - Herbivores
  - Logistically difficult & expensive to plant large mature cacti

6 Months

Goals

- To evaluate different combinations of practical management scenarios over time and use our findings to develop best practices for successful cactus establishment in restoration sites.

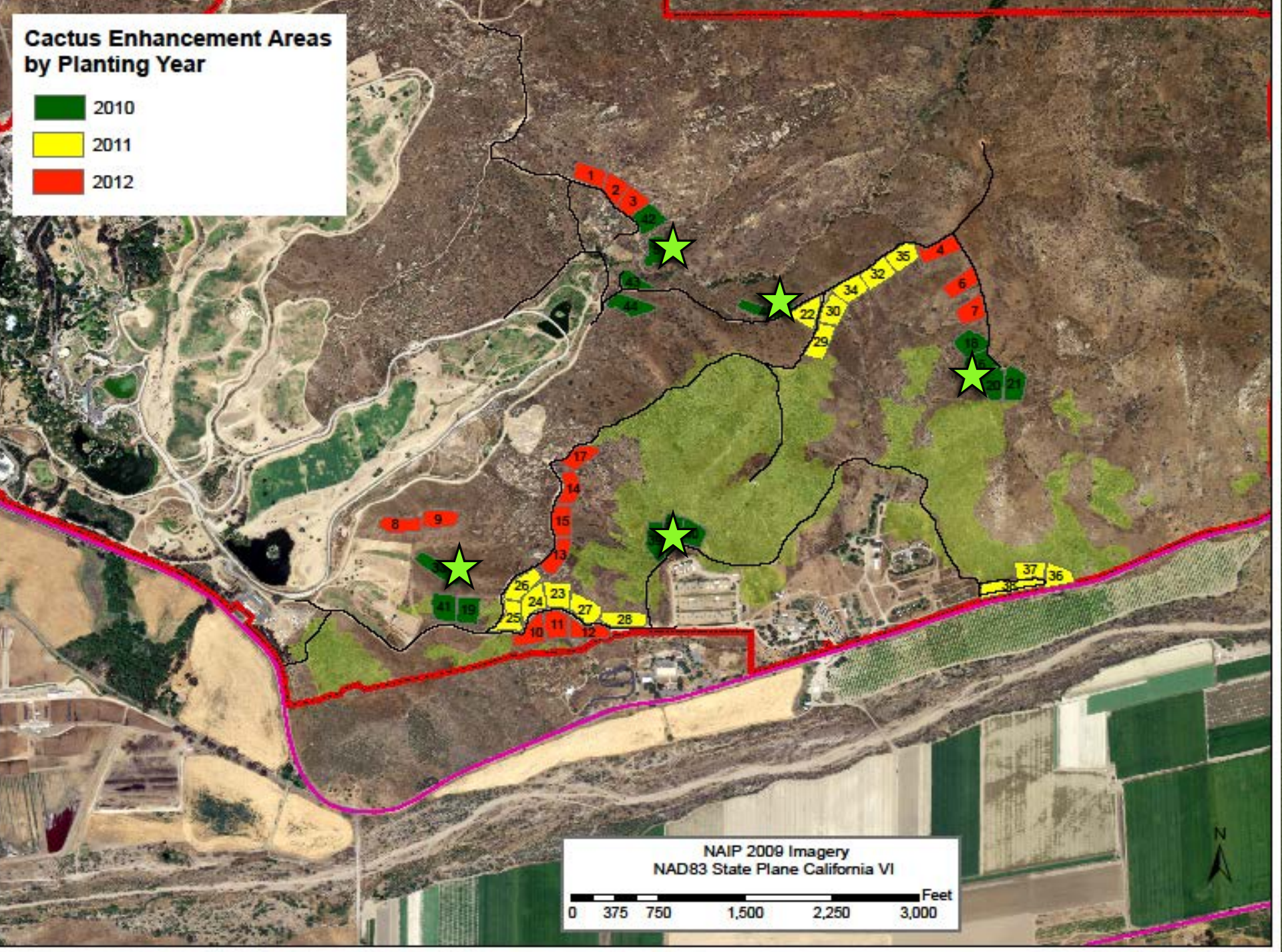
Experimental Treatments

- Propagation Methods:
  - Propagated cacti
  - Fresh pads
  - Dry-rooted pads
- Herbivore Exclosures (wire mesh cages)
- Supplemental Watering
  - Tested different watering regimes:
    - no water
    - every 4wks
    - every 6wks
    - every 8wks

    **only during first summer after planting

Propagation Methods:

Type	Pros	Cons
Propagated 	• Developed root system • More complex = more resistance to herbivores • Start out taller	• Space/time/labor commitment • Expensive: cost of soil, pots, irrigation, etc.
Dry-rooted 	• Developed root system • Less expensive than propagated • No irrigation	• Showing signs of stress due to water loss • Start out smaller than Propgated and Fresh Pads
Fresh pads 	• Quick • Less holding time = temp. storage • No irrigation required	• Start out smaller than propagated • No root system


Cactus Enhancement Areas
by Planting Year
2010
2011
2012
1
2
3
42
43
44
4
35
32
34
6
7
22
30
29
16
20
21
17
14
15
13
8
9
26
24
23
27
28
25
10
11
12
41
19
37
36
NAIP 2009 Imagery
NAD83 State Plane California VI
Feet
0
375
750
1,500
2,250
3,000
N

Experimental Design

Sample Size: 375 cacti

	Caging Treatment:	No Cage	Cage			
	Watering Regime:	No Water	No Water	4 Weeks	6 Weeks	8 Weeks
Pre-treatment	Fresh Pads	25	25	25	25	25
	Dry-rooted Pads	25	25	25	25	25
	Propagated	25	25	25	25	25

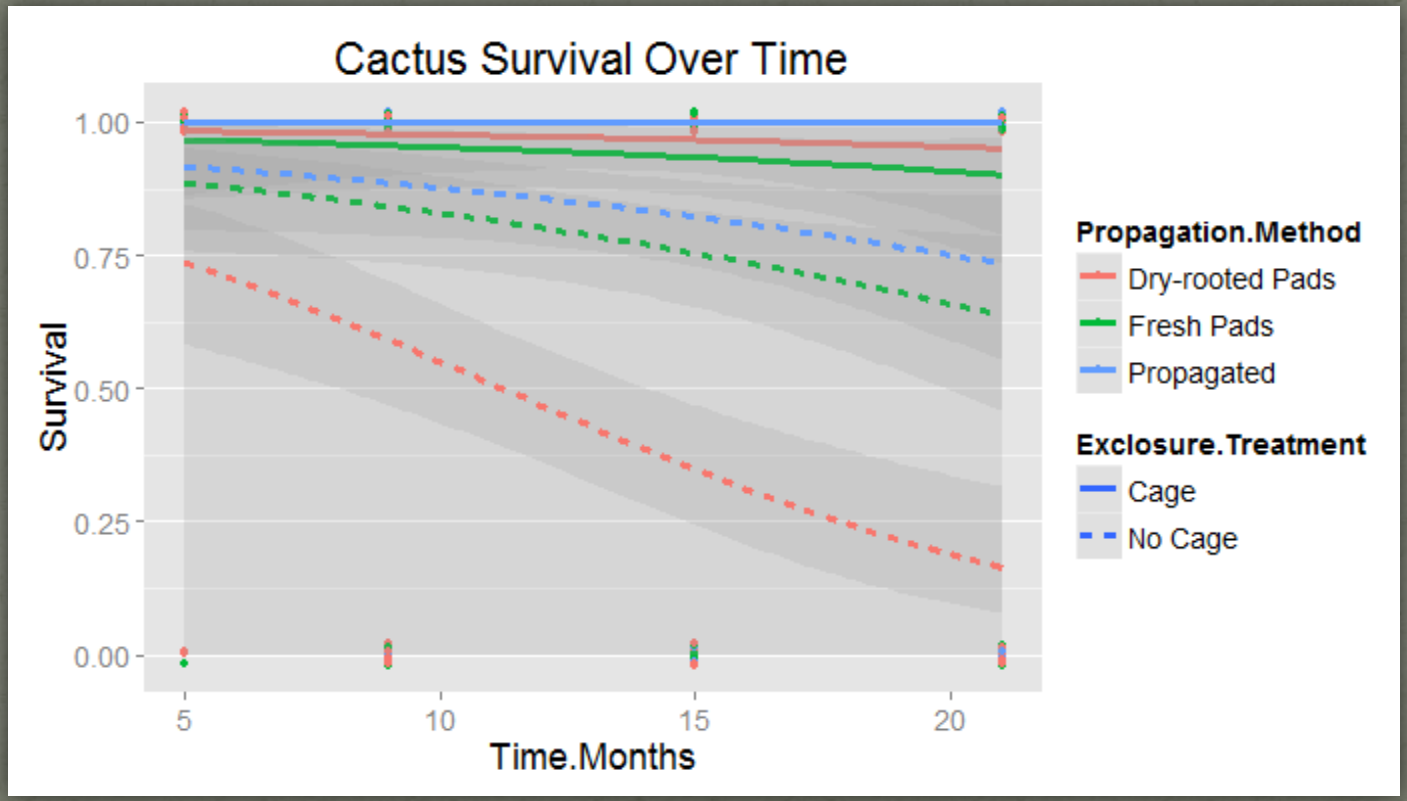
Cacti were randomly selected and treatments were randomly assigned.

Variables Measured

- Survival
- Condition Scale:
  - **Healthy: green in color, no signs of water stress**
  - **Stressed: visible water loss (i.e. wrinkled pads); yellowing**
  - **Severely Stressed: discolored and dry – nearly all water has been lost**
  - **Dead: completely consumed or removed by herbivores**
- Height (cm)
- Number of Pads

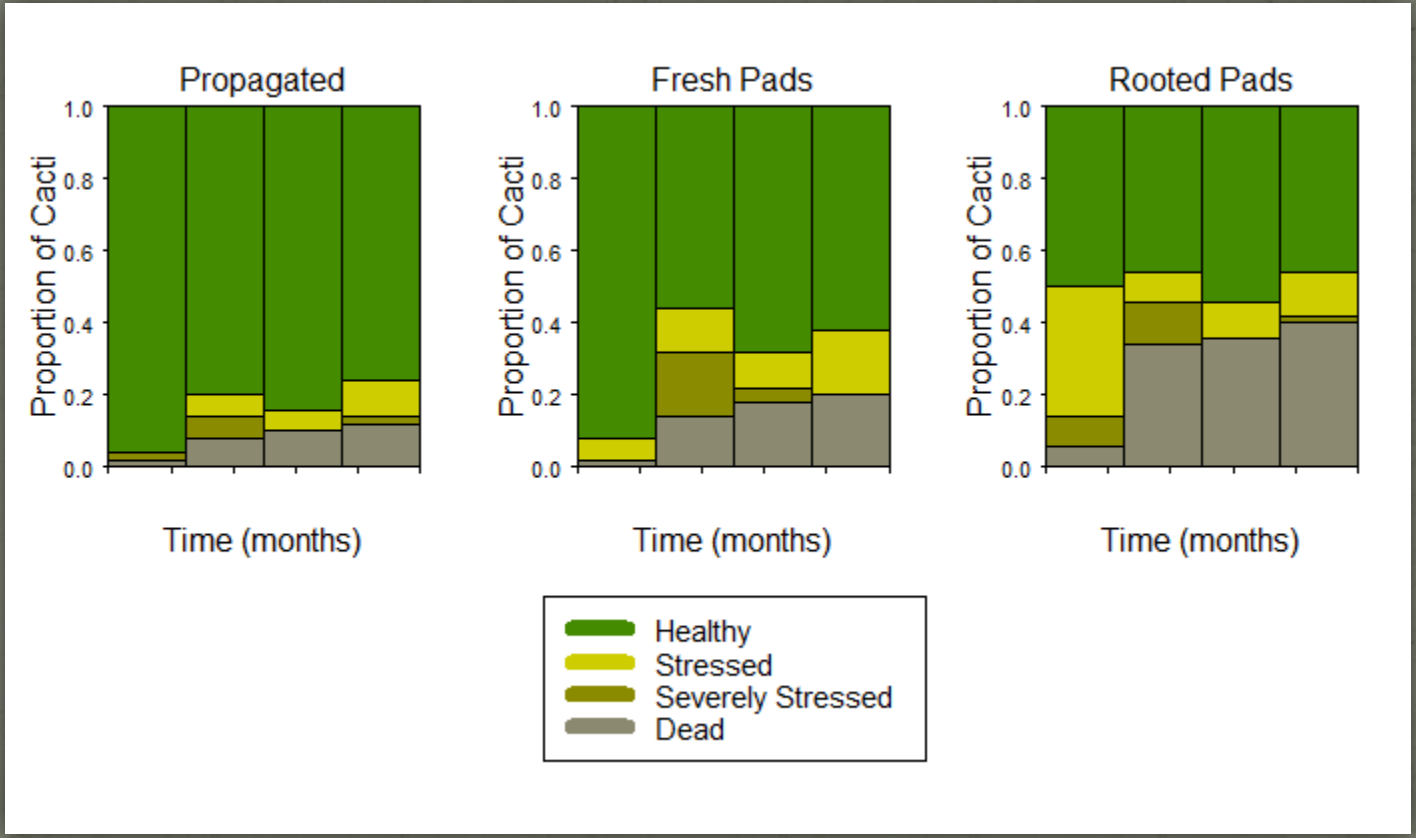
Survival

- Herbivore exclosures are an effective means of increasing survival.
- Uncaged cacti from dry-rooted stock had very low survival .



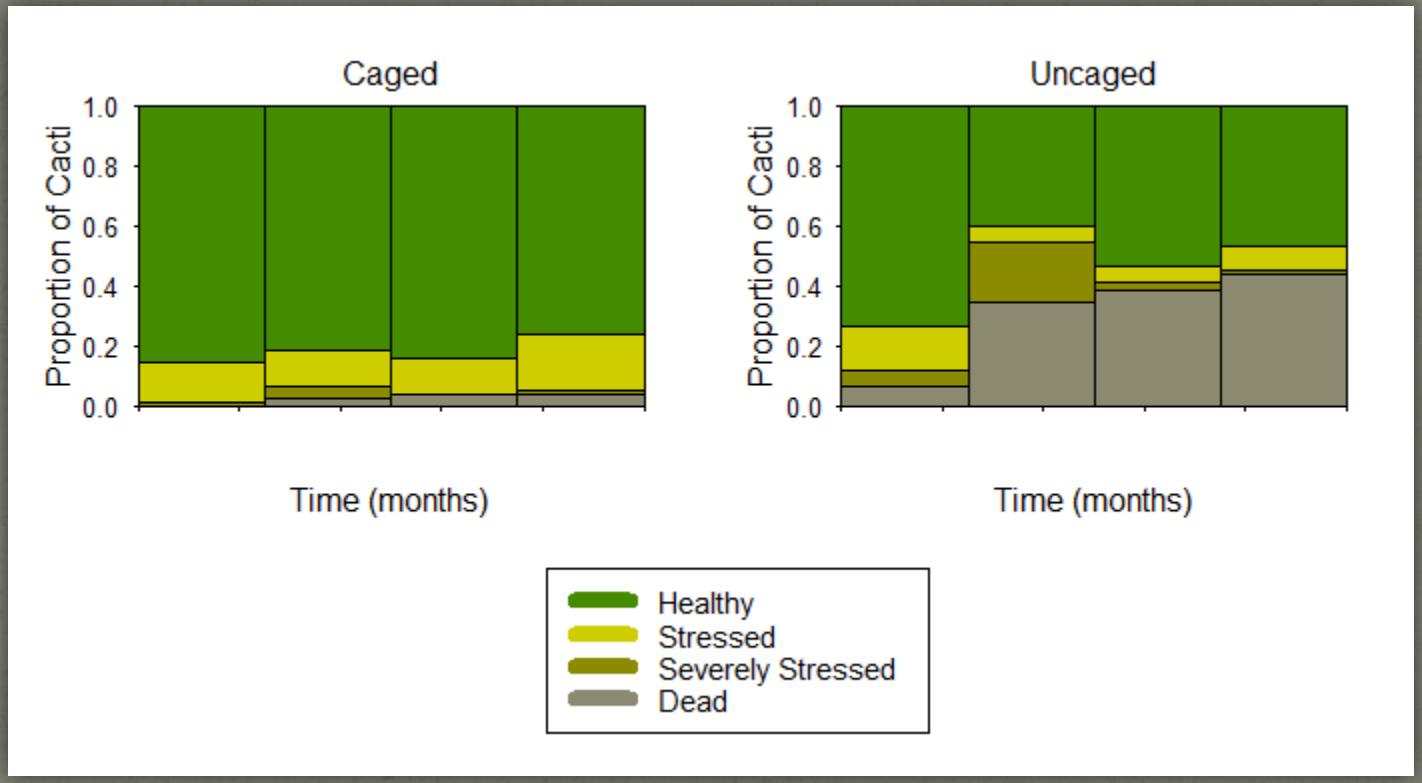
Condition

- Greater proportion of propagated cacti rated as healthy.
- Rooted cacti had poorer condition and reduced survival.



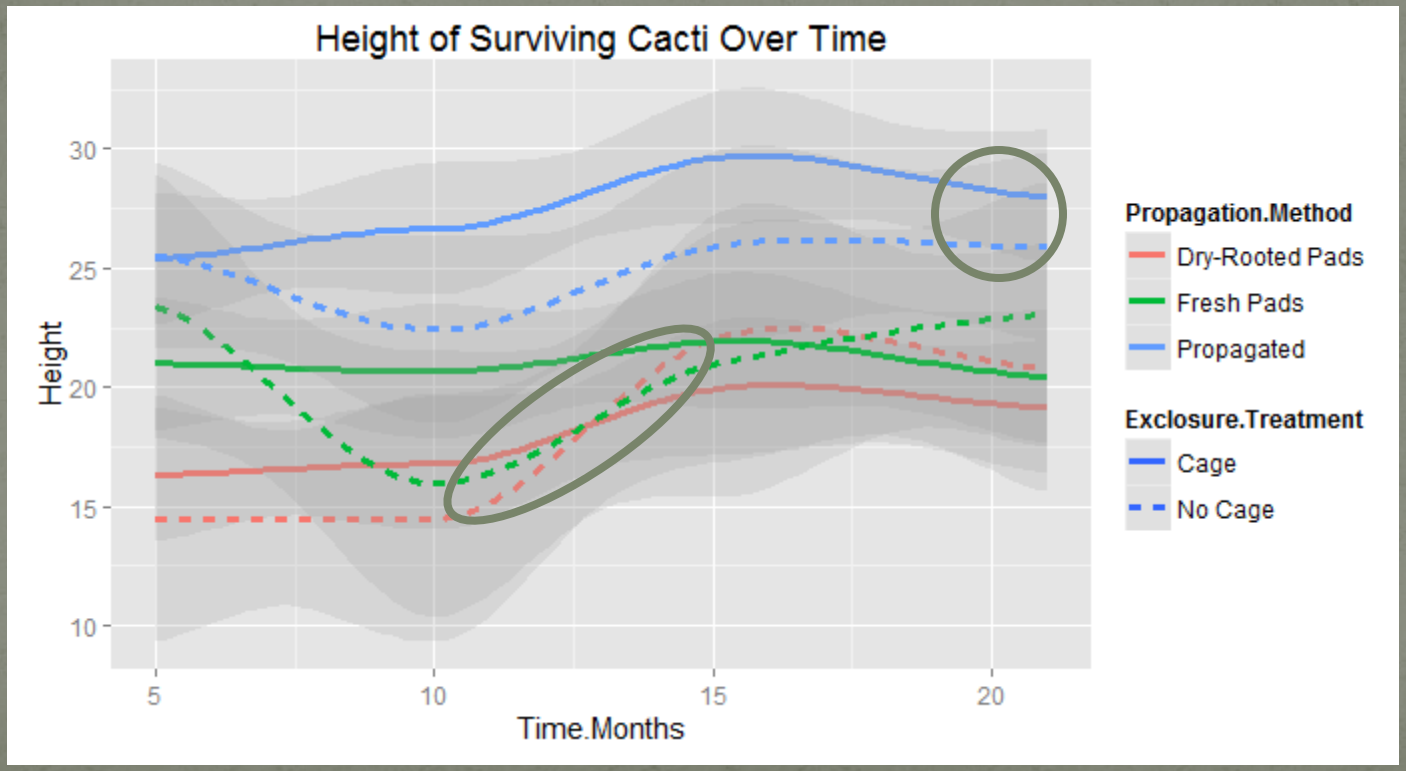
Condition

- Caged cacti had significantly better condition ratings than cacti without cages.



Growth (Height) of Surviving Cacti

- Propagated cacti start out taller and maintain height.
- Dry rooted cacti experienced the greatest change in height over time.



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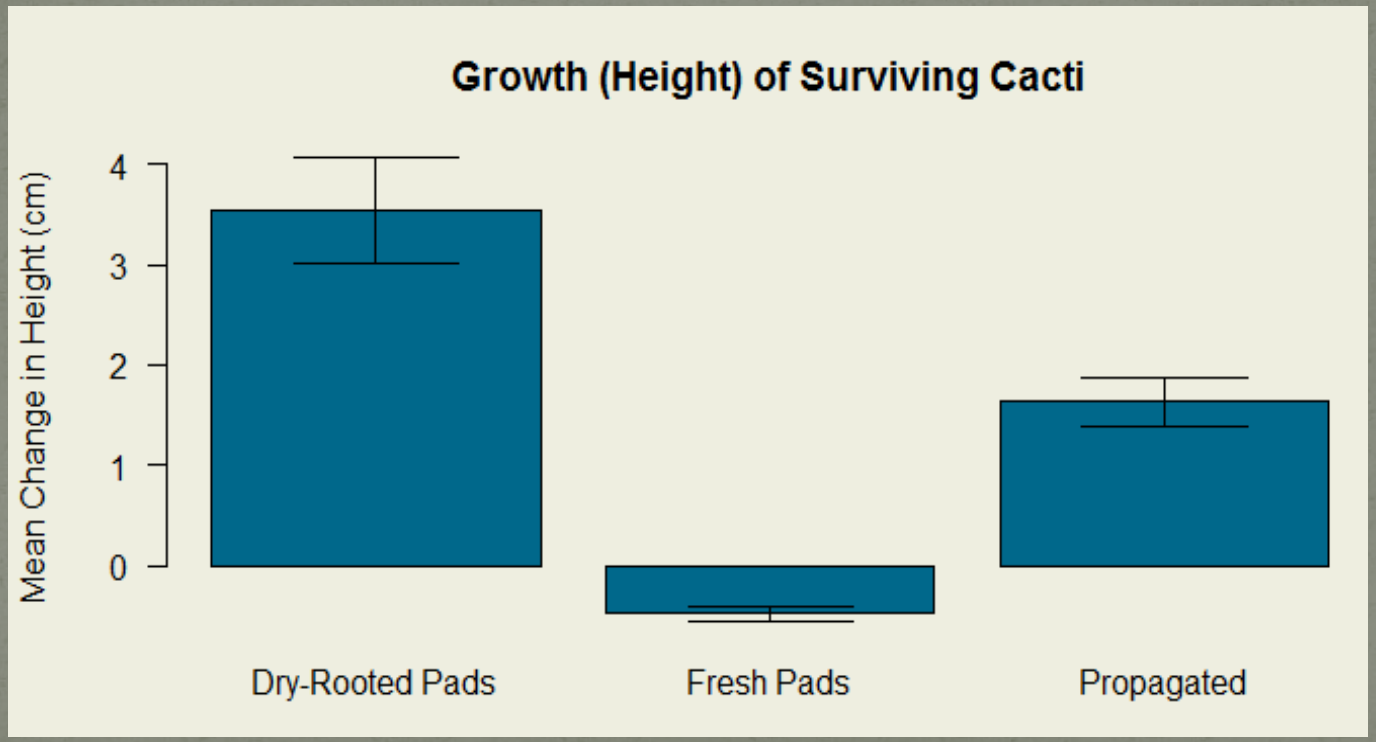
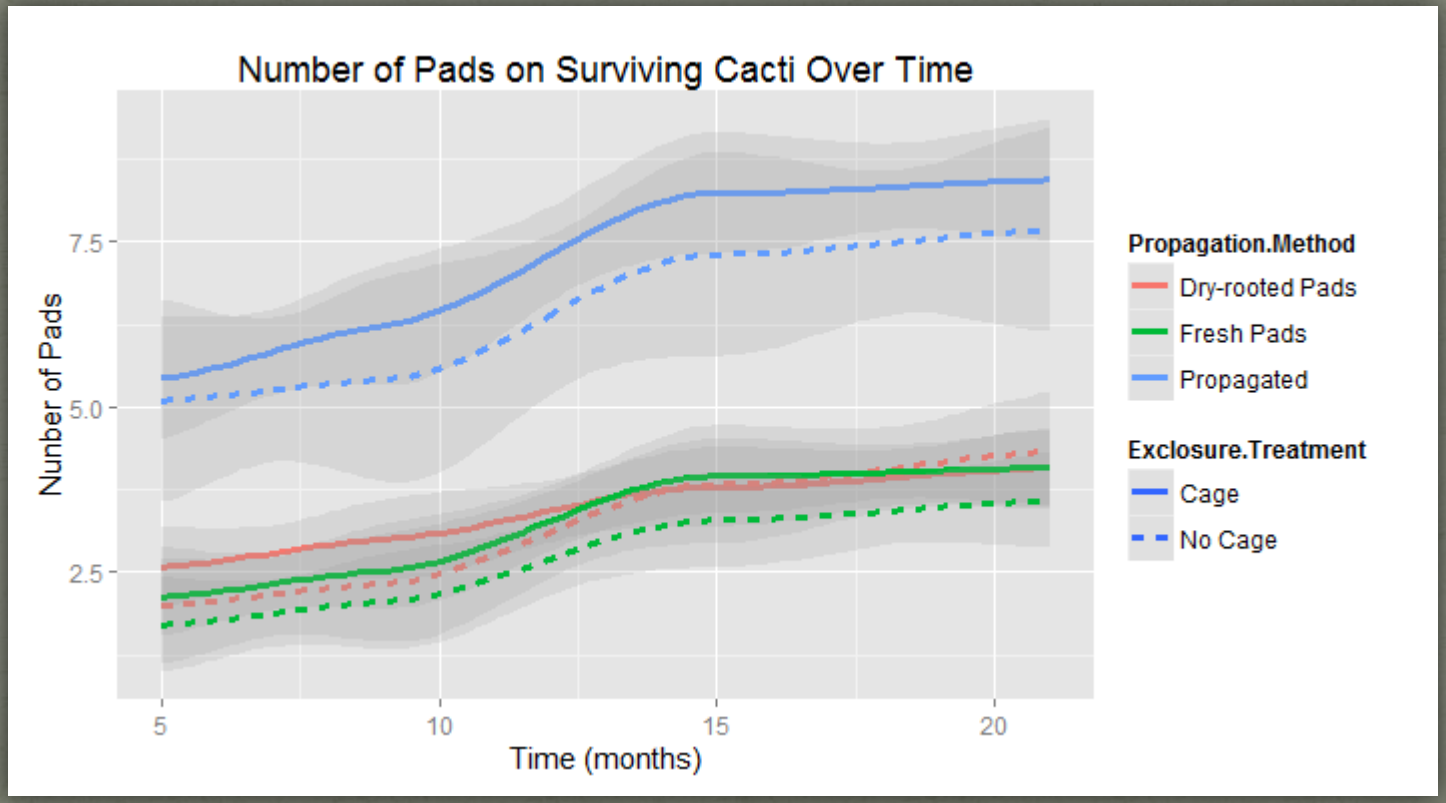


Growth

- Growth can also be measured as the change in number of pads

Growth (# of Pads) of Surviving Cacti

- Propagated cacti start out with more pads and experience the greatest increase in number of pads.



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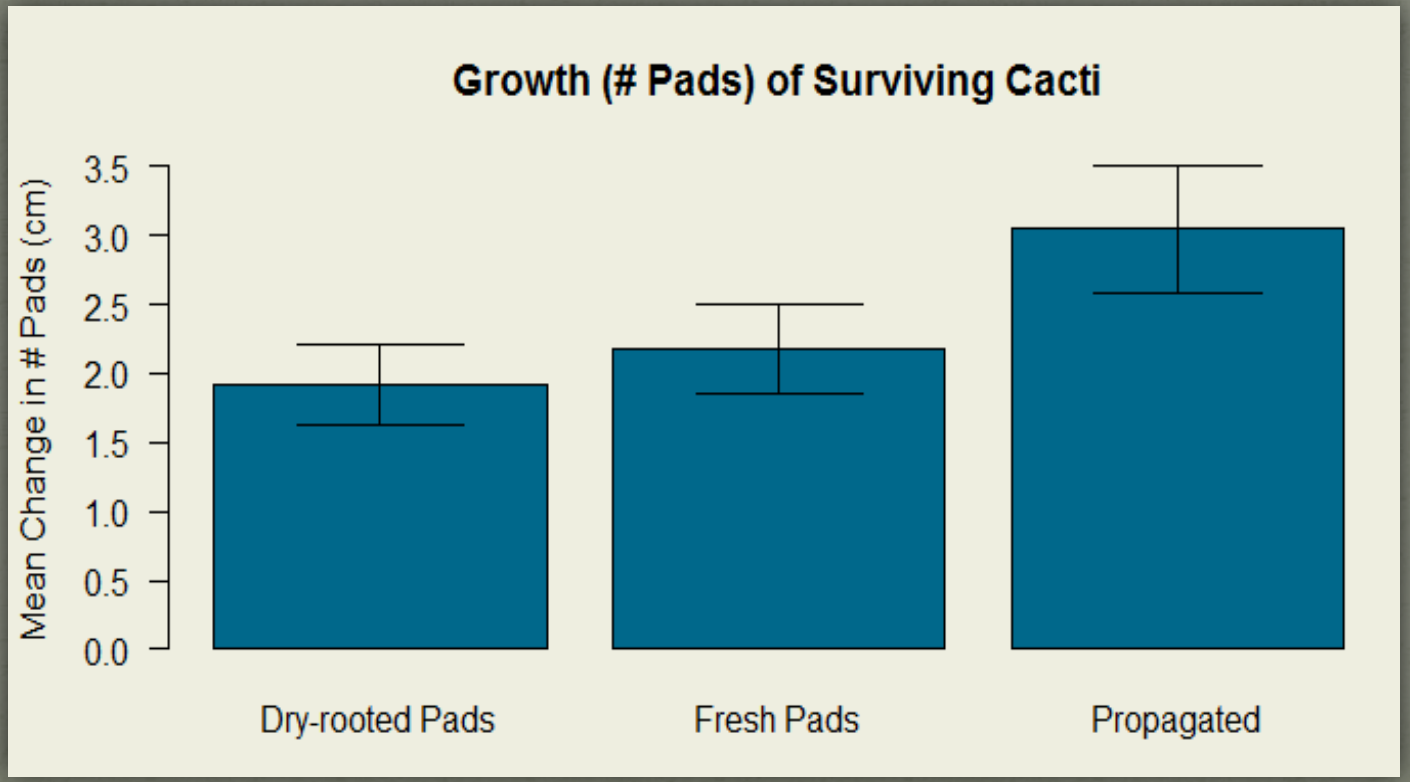
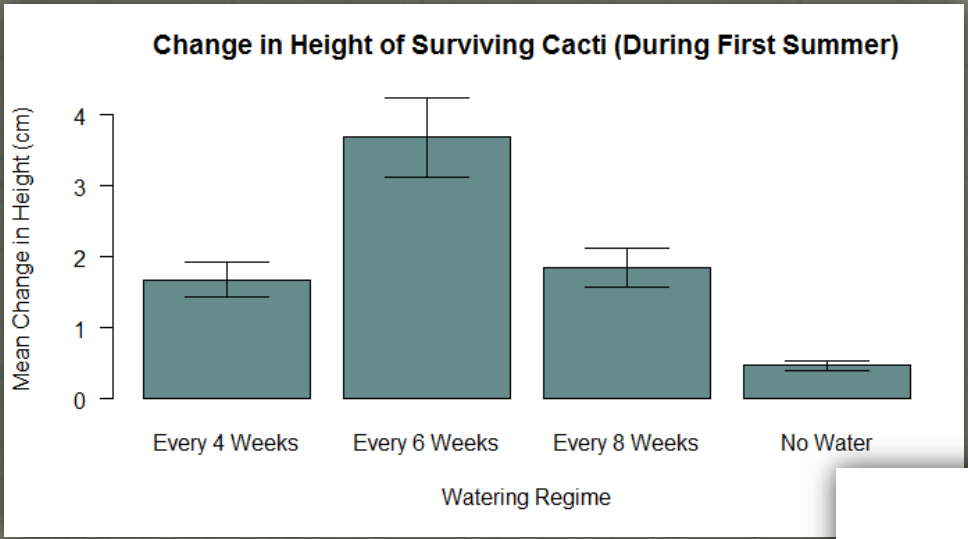


Watering

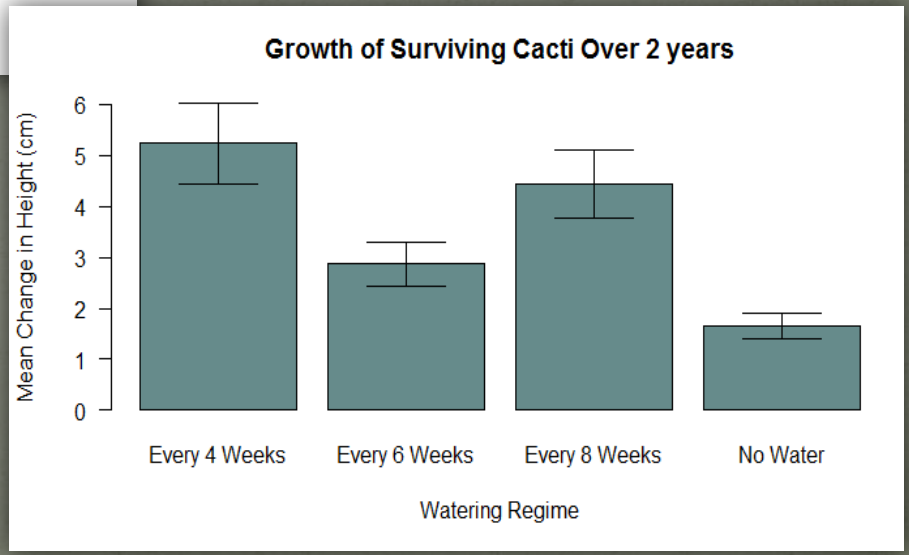
- No significant affects of watering on condition or survival.
  - All watered cacti were caged and there was very high survival among caged cacti in general.
- Positive affect of watering on growth in terms of change in height.
- No differences in growth of new pads.

Watering – Height



- Cacti watered every 6 weeks experienced the greatest increase in height during the first year of growth (when water treatments were administered).

- Cacti that were watered during through the first summer experienced a greater increase in height over time, but differences among watering regimes observed at 1 year were not maintained.



Management Recommendations

- Propagated cacti are best:
  - High survival probability
  - Start out taller and maintain height advantage
  - Greater rate of pad production
- Supplemental watering during the first summer may increase growth rate.
- If herbivore pressure is high in your site, consider using cages to protect your cacti during the first year or two after planting.







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