

# State and Transition Models For Desert Ecosystems

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Todd C. Esque  
Western Ecological Research Center

The Climate and Deserts Workshop:  
Adaptive Management of Desert Ecosystems  
in a Changing Climate

11 April 2008

# Acknowledgements

B. Bestelmeyer

J. Belnap

L.A. DeFalco

P.A. Medica

D. Merkler

D. Miller

R.H. Webb

# **Introduce State and Transition Models**

**Components of 1 simple model**

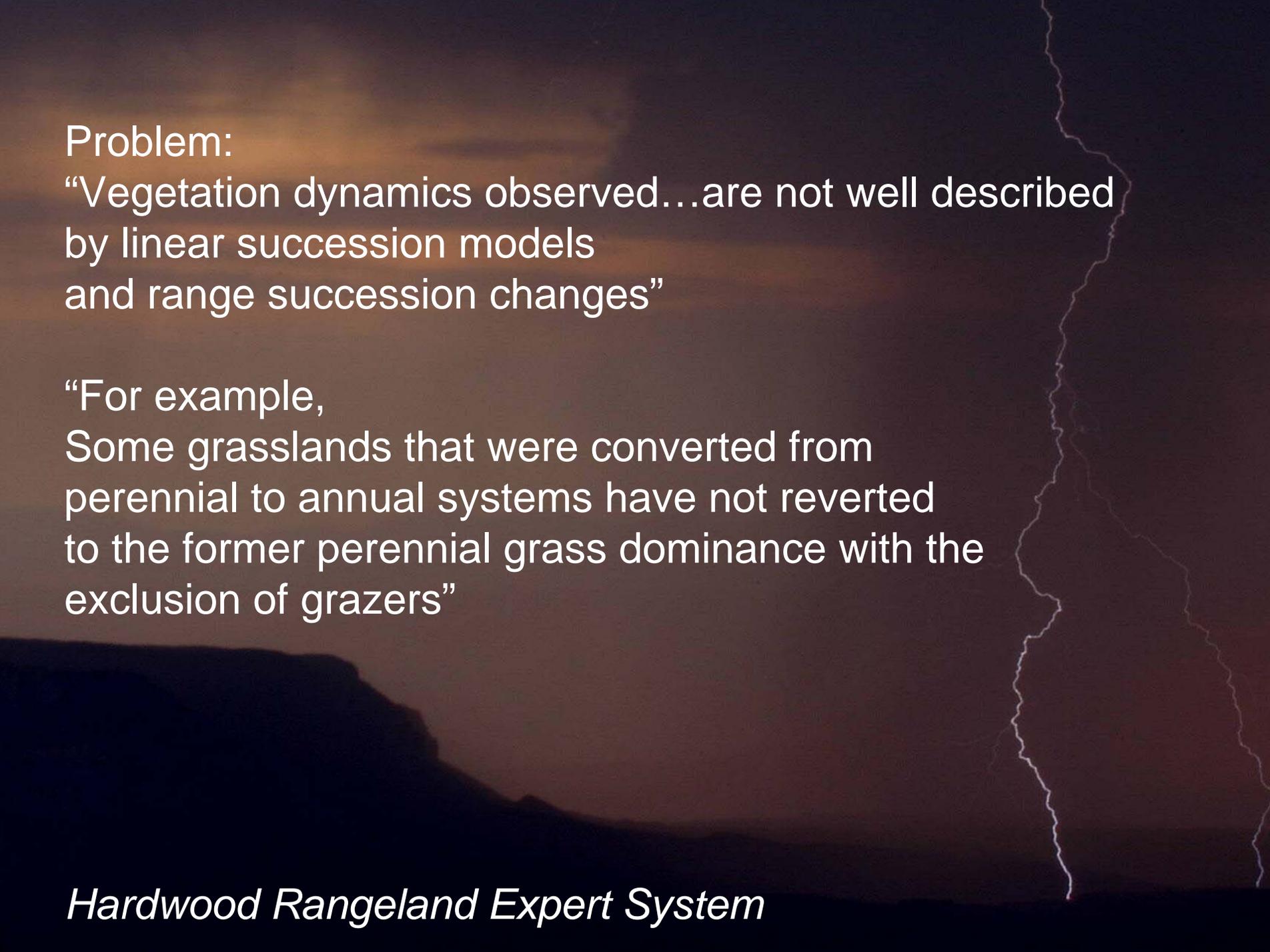
**Consider how to use the model to  
explore options**

Assess effects of  
climate variability and other natural fluctuations,  
and human activities on ecosystems  
to manage landscapes on behalf of the public

Western lands yield goods and services and  
when there is a perceived  
loss of productivity, diversity, or change in processes  
We seek explanations

We have, modified systems, added to systems,  
altered practices, ceased some  
counter-productive practices, incorporated  
new laws, observed, monitored, and  
experimented, repeatedly

100+ years of organized science and management  
has not provided entirely satisfactory results



Problem:

“Vegetation dynamics observed...are not well described by linear succession models and range succession changes”

“For example,  
Some grasslands that were converted from perennial to annual systems have not reverted to the former perennial grass dominance with the exclusion of grazers”

*Hardwood Rangeland Expert System*

# State and Transition Model For A Mojave Desert Vegetation Type

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Conceptual models to

- assess landscape condition (states)

- drivers of changes (transitions)

- weigh costs and benefits of management actions

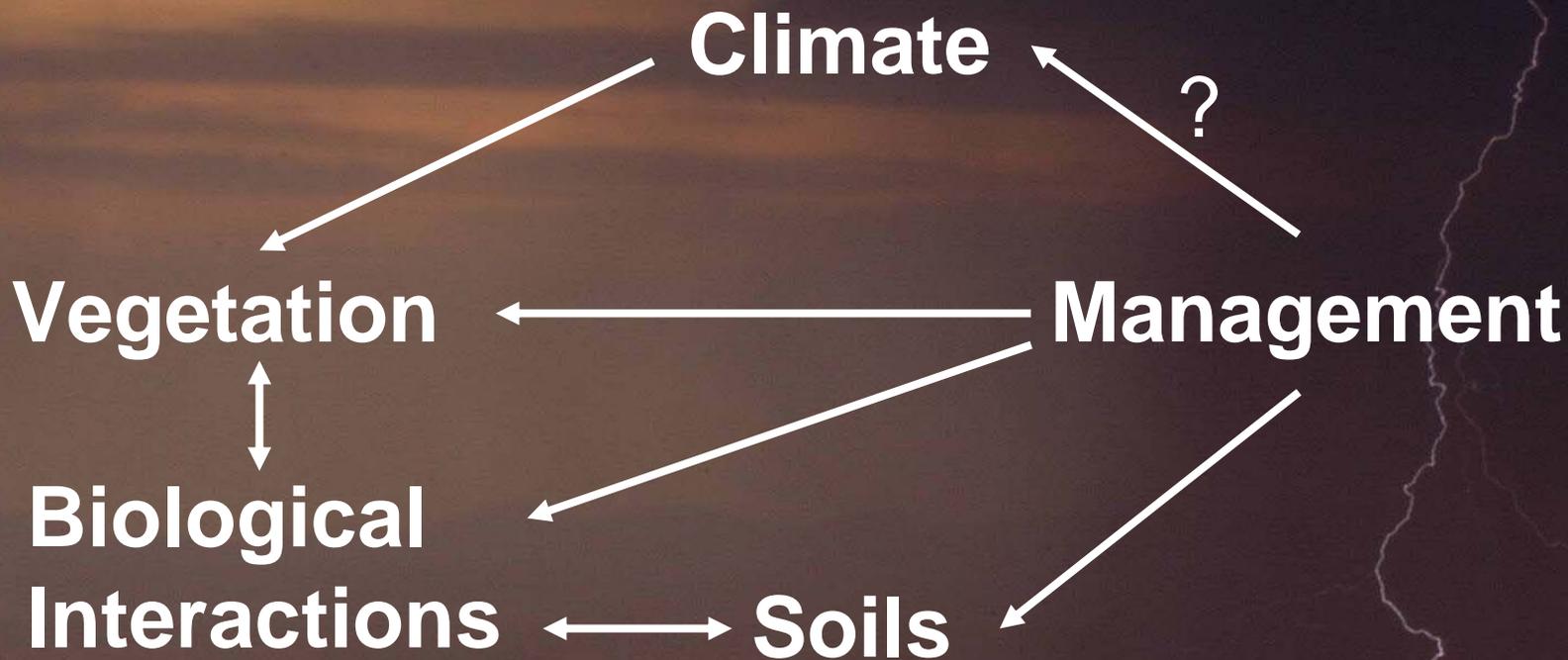
ID locations where actions could have high probability of restoration success, or could instead cause degradation

Facilitate integration of disciplines

- ecology, geomorphology, climatology, management

Value is in getting interested parties to think broadly and critically about assumptions

Flexibility with scale



# Vegetation Type

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## Mojave Desert Shrub Community

*Dominant Vegetation:*

Creosotebush (*Larrea tridentata*)

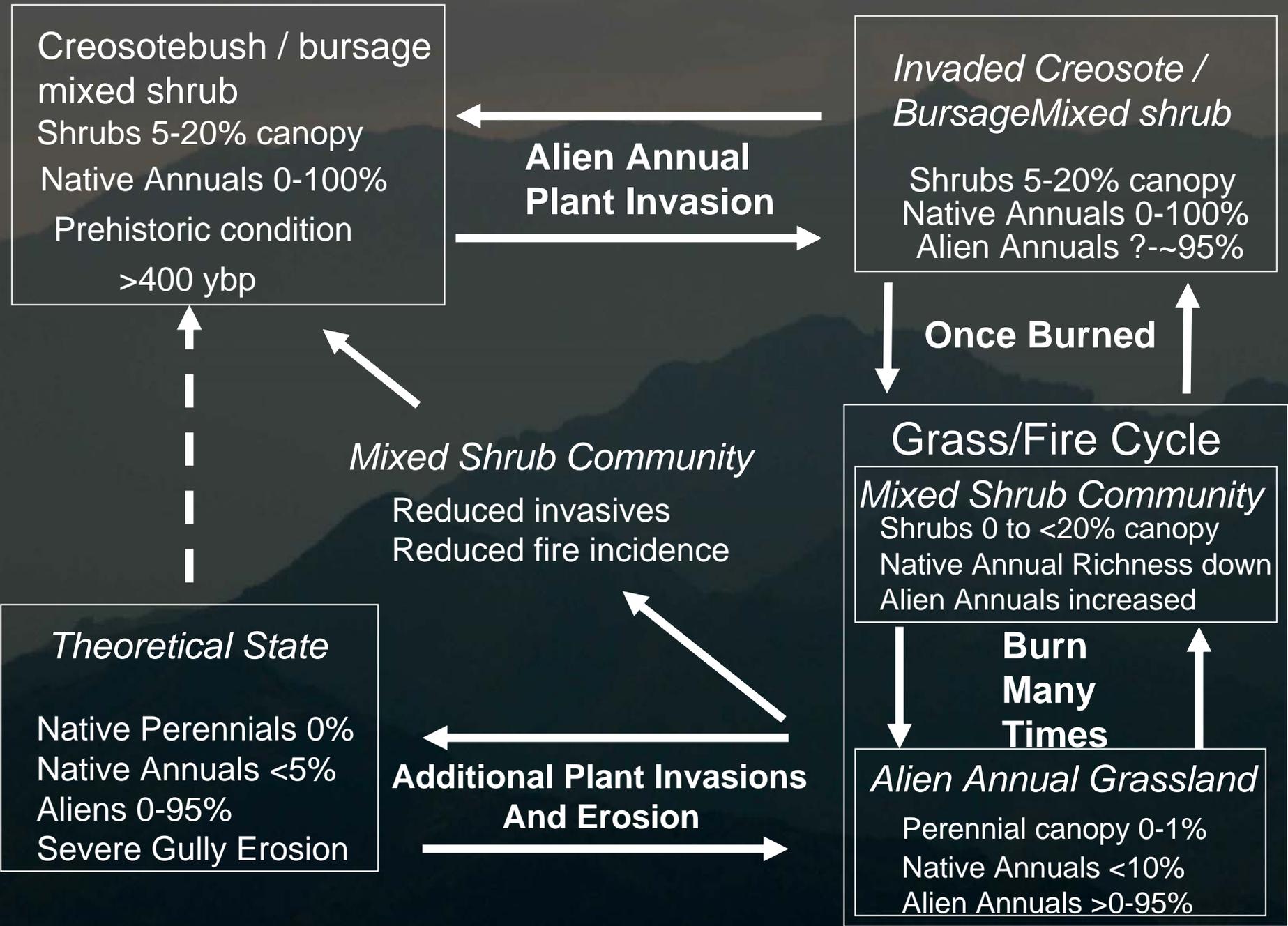
White bursage (*Ambrosia dumosa*)

*Subdominants:* shrubs, succulents, perennial grasses, annual plants (winter and summer)

*Lycium* spp., *Psoralea* spp., *Isomeris arborescens*, *Hymenoclea salsola*, *Opuntia* spp., *Pleuraphis rigida*, *Achnatherum hymenoides*, *Krameria* spp., *Eriogonum* spp., *Thamnosma montana*

# Catalog States

- I. Prehistoric. Prior to invasion of Mediterranean grasses and others. Expansive shrublands with 5-20% cover, and 0 - 100% native annual plant cover
- II. Post invasion. Similar to state I, with the addition of Mediterranean grasses and other invasives with 0-95% cover
- III. Alien annual grassland. Single to multiple fire history. Results in loss of most perennial plants and 0-1% perennial plant cover. Variable but dominant alien annuals in some years. Few natives
- IV. Theoretical vegetation state.



Creosotebush / bursage  
mixed shrub  
Shrubs 5-20% canopy  
Native Annuals 0-100%  
Prehistoric condition  
>400 ybp

*Invaded Creosote /  
Bursage Mixed shrub*  
  
Shrubs 5-20% canopy  
Native Annuals 0-100%  
Alien Annuals ?-~95%

**Grass/Fire Cycle**  
*Mixed Shrub Community*  
Shrubs 0 to <20% canopy  
Native Annual Richness down  
Alien Annuals increased

*Alien Annual Grassland*  
Perennial canopy 0-1%  
Native Annuals <10%  
Alien Annuals >0-95%

*Theoretical State*  
Native Perennials 0%  
Native Annuals <5%  
Aliens 0-95%  
Severe Gully Erosion

*Mixed Shrub Community*  
Reduced invasives  
Reduced fire incidence

**Additional Plant Invasions  
And Erosion**

**Alien Annual  
Plant Invasion**

**Once Burned**

**Burn  
Many  
Times**

# Modified Model

## ***I. Creosote/Bursage Mixed shrub***

Shrubs 5-20% canopy  
Native Annuals 0-100%  
Prehistoric condition  
>400 ybp

## ***II. Invaded Creosote / Bursage Mixed shrub***

Shrubs 5-20% canopy  
Native Annuals 0-100%  
Alien Annuals ?-~95%

### **1. Alien Annual Plant Invasion**

*Once Burned*

### **2. Grass/Fire Cycle**

Shrubs 0 to <20% canopy  
Native Annual Richness down  
Alien Annuals increased

*Mixed Shrub Community*

*Burned Many  
Times*

## ***III. Alien Annual Grassland***

Perennial canopy 0-1%  
Native Annuals <10%  
Alien Annuals >0-95%

### **3. Additional Invasions & Erosion**

### **5. Theoretical**

*Mixed Shrub Community*

4. Reduced invasives  
Reduced fire incidence

## ***IV. Theoretical State***

Native Perennials 0%  
Native Annuals <5%  
Aliens 0-95%  
Severe Gully Erosion

# *I. Creosotebush / Bursage Mixed Shrub*

QuickTime™ and a  
decompressor  
are needed to see this picture.

# 1. Alien Annual Plant Invasion

Copyright 2000

QuickTime™ and a  
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# Modified Model

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Shrubs 0 to <20% canopy  
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Alien Annuals increased  
*Mixed Shrub Community*

*Burned Many  
Times*

*Mixed Shrub Community*  
4. Reduced invasives  
Reduced fire incidence

### **5. Theoretical**

## ***IV. Theoretical State***

Native Perennials 0%  
Native Annuals <5%  
Aliens 0-95%  
Severe Gully Erosion

### **3. Additional Invasions & Erosion**

## ***III. Alien Annual Grassland***

Perennial canopy 0-1%  
Native Annuals <10%  
Alien Annuals >0-95%

## ***II. Invaded Creosote / Bursage Mixed shrub***

QuickTime™ and a  
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## 2. Grass/Fire Cycle



Gass Peak Fire, Desert National Wildlife Refuge 2005

# Modified Model

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### **3. Additional Invasions & Erosion**

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# *III. Alien Annual Grassland*



Parashant National Monument

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Alien Annuals >0-95%

### **3. Additional Invasions & Erosion**

*Mixed Shrub Community*  
4. Reduced invasives  
Reduced fire incidence  
**Management Actions**

## **5. Theoretical**

## ***IV. Theoretical State***

Native Perennials 0%  
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# Management Component



4. Reduced invasives  
Reduced fire incidence

# *I. Creosotebush Bursage Mixed shrub*

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# Modified Model

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## **5. Theoretical**

*Mixed Shrub Community*  
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Reduced fire incidence  
**Management Actions**

## ***IV. Theoretical State***

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Native Annuals <5%  
Aliens 0-95%  
Severe Gully Erosion

## II. Invaded Creosote/Bursage Mixed shrub

Shrubs 5-20% canopy  
Native Annuals 0-100%  
Alien Annuals ?-~95%

Winter rain	↓	↓	↑
Summer rain	↓	↑	↓
Temperature	↑	↑	↑

Fewer opportunities for winter perennials

Reduction in winter alien annuals

Reduction in winter native annuals?

Fewer fires?

More opportunities for some summer perennials

More opportunities for some summer annuals

More summer invasives?

## 2. Grass/Fire Cycle?

# Modified Model

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Management Actions

## ***IV. Theoretical State***

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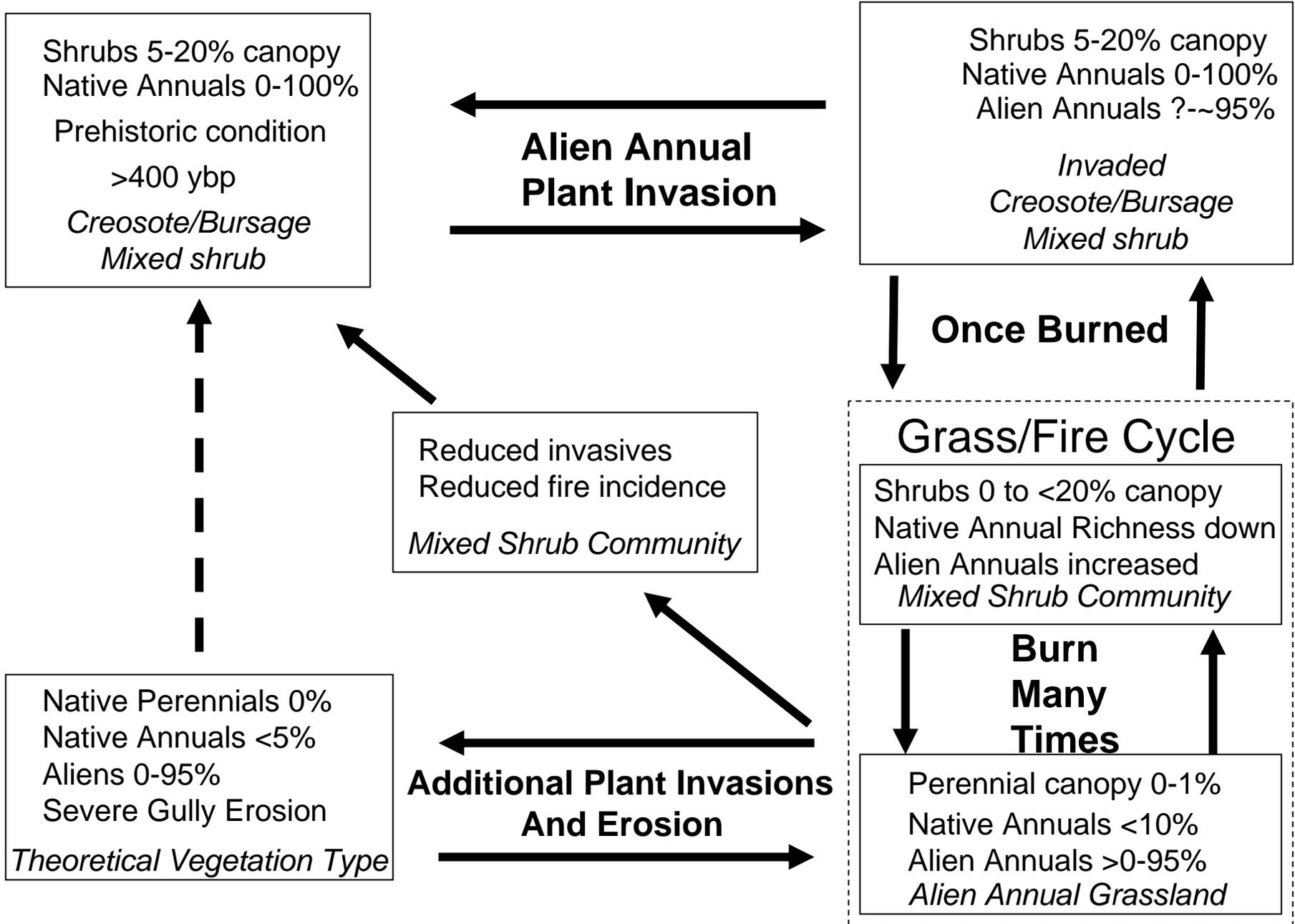
# Draft Lookup Table

<i>Management Options</i>	<i>Relative Cost</i>
Prescribed burning	Medium
Herbicide control of non-native shrubs	High
Herbicide control of non-native grasses	High
Rock and wire gabions	High
Earthen retention dams	Medium
Seeding of sacaton	High
Seeding of non-natives	Medium
Grubbing	High
Wood harvesting	Low
Deferred rotation grazing (infrastructure in place)	Low
Deferred rotation grazing (infrastructure not in place)	High
Rest rotation grazing (infrastructure in place)	Low
Rest rotation grazing (infrastructure not in place)	High



**Thank You**





# Catalog of Transitions

1. Introduction of Mediterranean and other winter invasives.
2. Fire and invasives burn
3. Additional invasives and erosion (theoretical)
4. The management scenario.  
Reduced invasives, reduced fire incidence
5. Unknown, theoretical