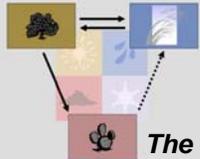
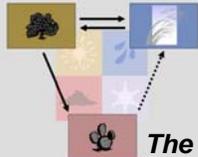


The Game of States and Transitions: Exploring Land Management in a Changing Climate



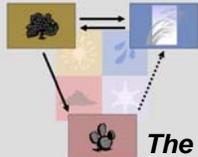
Objectives

1. **Examine potential climatic changes with a focus on land management decision-making**
2. **Explore how state and transition models are constructed**
 - highlight strengths/weaknesses
 - assumptions
 - utility in long-term planning
3. **Assess needs**
 - research
 - applications
 - tools
 - data



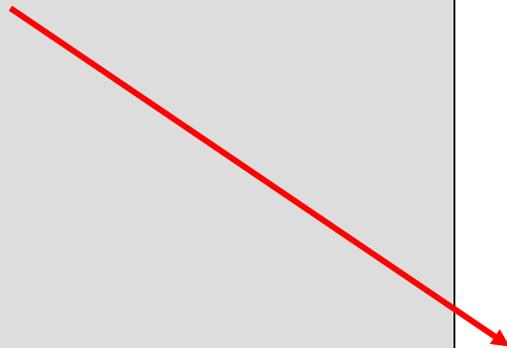
Situation

- **Small groups are management teams**
- **1000 acre low desert shrub-dominated site**
- **‘birdseye view’ of 60-year management period with 10-year decision windows**
- **management objective (e.g. preservation, recreation, grazing) can be chosen by team**



What you need to play

- **Instruction Sheet**



The Game of States and Transitions – Instruction Sheet

Objectives

- Use state and transition models to illustrate the complex interactions between climate variability/change and land management activities
- Explore how state and transition models are constructed highlighting strengths/weaknesses, assumptions, and where more information is needed to make useful in everyday applications with respect to climate variability and change
- Assess additional research and application needs to integrate climate change information into land management planning and decision-making

Situation

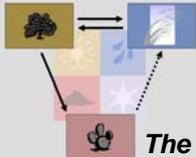
- Small groups are tasked to manage a 1000 acre low desert shrub-dominated site over a 50 year period into the future taking into account changes in temperature and precipitation. The group can choose the overall management objective for site (e.g. preservation, recreation, grazing...).

How does the game work?

- Each group will begin with their land management unit at one of the model states. The initial state for the first decision period will be assigned to each group. Disturbances and budget will be determined by rolling dice and looking up numbers on a table.
- Climate data are presented in 10-year decision periods. Each decision period has a corresponding time series of artificial precipitation and temperature data generated to simulate future potential climate changes based on model projections for the area.
- Transitions are determined by analyzing the climate time series for each decision period. Each group should discuss how the current state may transition to other states with the interaction between disturbances and the climate time series over the decision period. Will exceptionally dry or wet periods drive a transition to another state? How may increasing temperatures interact with precipitation amounts to affect soil moisture and vegetation condition?
- Each group may also decide to actively manage their 1000 acre unit with the sample management options provided on the lookup table sheet. They should make note of their desired state on their worksheet and use their budget condition as a constraint on which management options are possible to use.
- Results from each group are discussed and transcribed at the end of the breakout period.

Step-by-step instructions on how to play:

1. Each group needs a State & Transition worksheet, a packet of climate information for six 10-year decision periods, a lookup table, and one die.
2. The State & Transition worksheet is where all notes will be kept throughout the exercise. Assign one person in the group to keep notes on the worksheet.
3. Begin the exercise by filling out the first line of the worksheet. Your group number will be found on your table. Choose an overall management objective for site and an initial state. List both of these on the top of the worksheet.
4. Look at the first entry on your worksheet labeled '1' under the decision period column. If this is the first decision period, list your initial state. List the ending state from the previous decision period if you are beyond the first period.

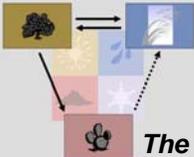
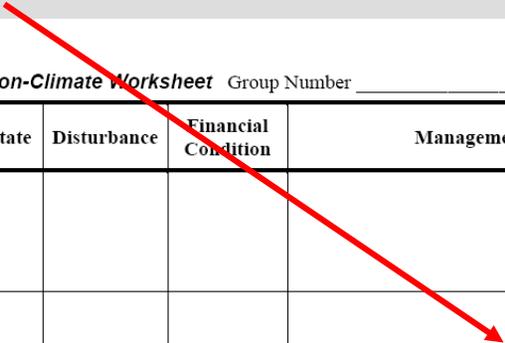


What you need to play

- **Worksheet**

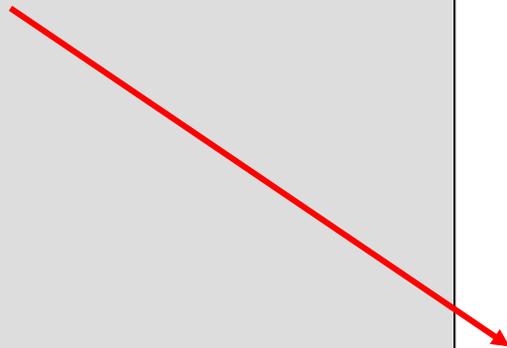
State and Transition-Climate Worksheet Group Number _____ Management Objective _____ Desired State _____

Decision Period	Initial State	Disturbance	Financial Condition	Management Decisions	Reasons for Transition	Ending State
1						
2						
3						
4						
5						
6						



What you need to play

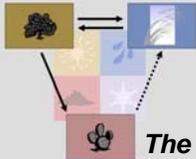
- Lookup Table



Lookup Table

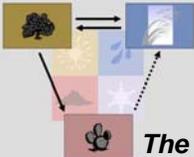
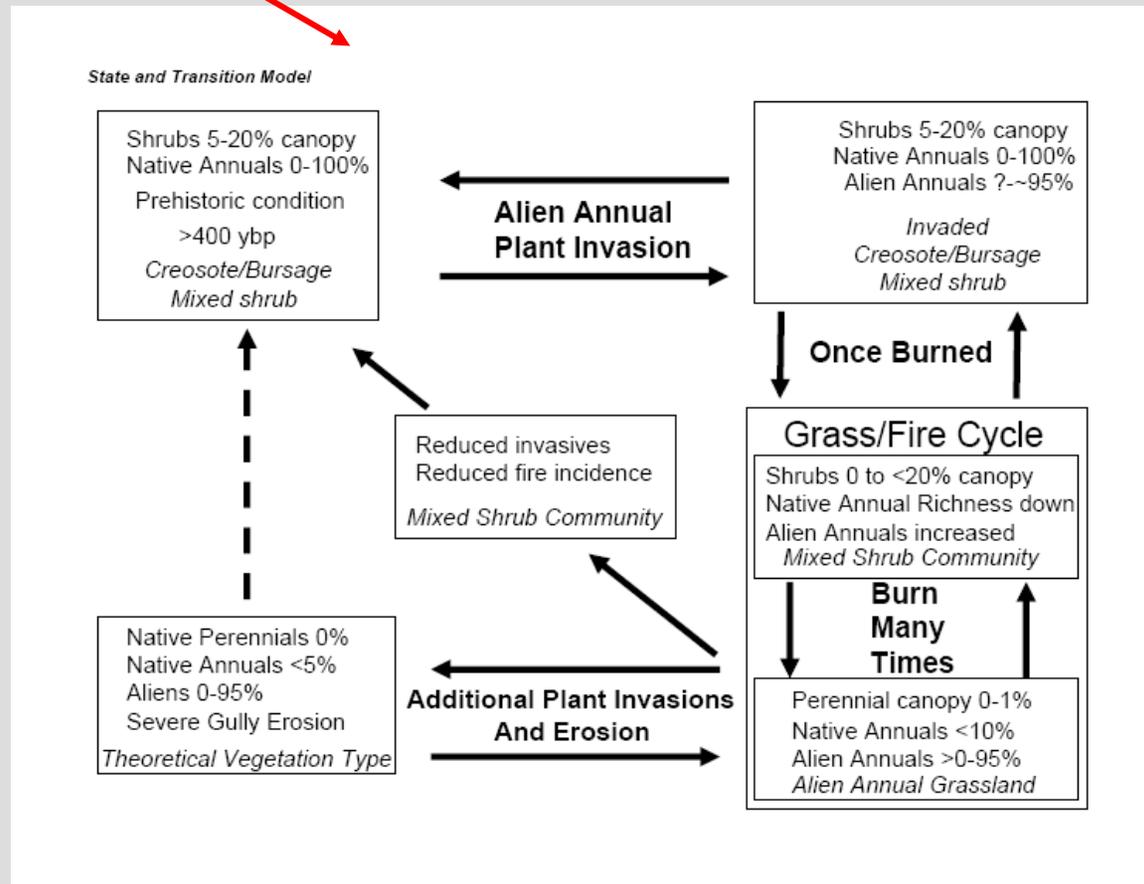
	<i>Budget</i>	<i>Disturbance</i>
<i>Number Rolled</i>	Every decade	Every decade
1	Good	Climate & Wildfire
2	Poor	Climate Only
3	Poor	Climate & Invasive Species Introduction
4	Good	Climate & Invasive Species Introduction
5	Poor	Climate Only
6	Good	Climate & Surface Disturbances (e.g. Roads, Recreation Activities)

<i>Management Options</i>	<i>Relative Cost</i>
Active site restoration (seeding and watering)	High
Area and/or road closures	Low
Increase OHV Management/Law Enforcement	Medium
Herbicide control of non-native species	High
Develop erosion control structures	High
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
Enter your own...	



What you need to play

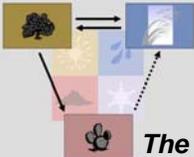
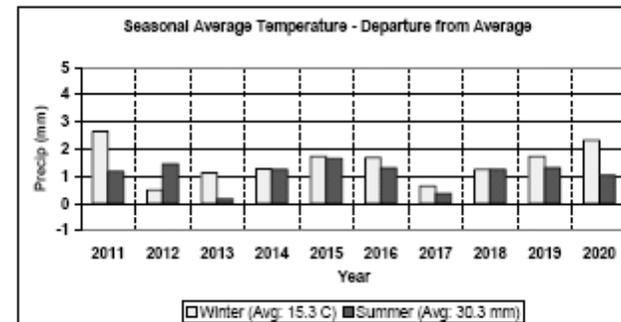
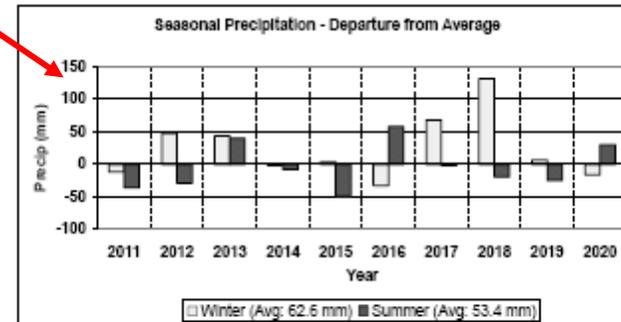
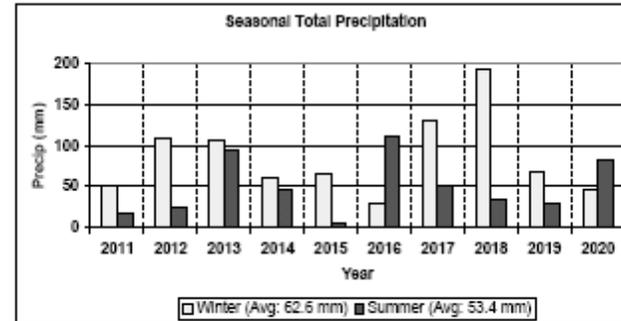
- State & Transition Model (**Game board**)



What you need to play

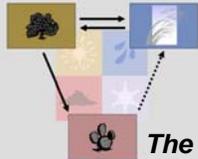
- Climate Data

Decision Window 1: 2011-2020



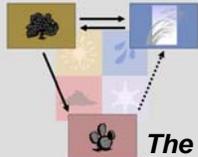
Overview

- **Use a state & transition model as the framework to discuss the complex interactions between climate and management actions.**
 - **Choose initial state**
 - **10-year decision windows**
 - **Disturbances and budget condition are determined by chance for each decision**



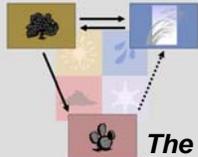
Overview

- **Climate data are presented in 10-year decision periods**
 - **Weather generator output for Needles, CA**
 - **Climate change scenarios based on 5-model ensemble mean for grid cells over Needles, CA**



Overview

- **Transitions are determined by analyzing the climate time series for each decision period**
 - Patterns in temperature and precipitation (wet vs. dry periods)
 - Seasonality (winter vs. summer)
 - Interactions between temperature and precipitation (higher temperatures mean higher evapotranspiration rates)
 - Interactions with disturbances and management actions (budget condition governs possible management actions)
- **Results from each group are discussed and transcribed at the end of the breakout period.**

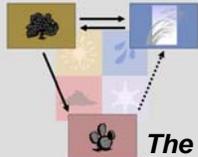


Instructions

- Get all of the game parts organized and assign one person in the group to keep notes on the worksheet.
- Fill out first line of worksheet

State and Transition-Climate Worksheet Group Number 7 Management Objective recreation Desired State Mixed shrub

Decision Period	Initial State	Disturbance	Financial Condition	Management Decisions	Reasons for Transition	Ending State
1						
2						

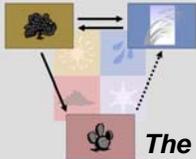


Instructions

- Look at the first entry on your worksheet labeled '1' under the decision period column. If this is the first decision period, list your assigned initial state. List the ending state from the previous decision period if you are beyond first period.

State and Transition-Climate Worksheet Group Number 7 Management Objective recreation Desired State Mixed shrub

Decision Period	Initial State	Disturbance	Financial Condition	Management Decisions	Reasons for Transition	Ending State
1	Mixed shrub					
2						

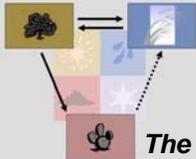


Instructions

- Roll to determine your disturbance and budget condition for the decision period

State and Transition-Climate Worksheet, Group Number 7, Management Objective recreation, Desired State Mixed shrub

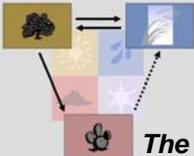
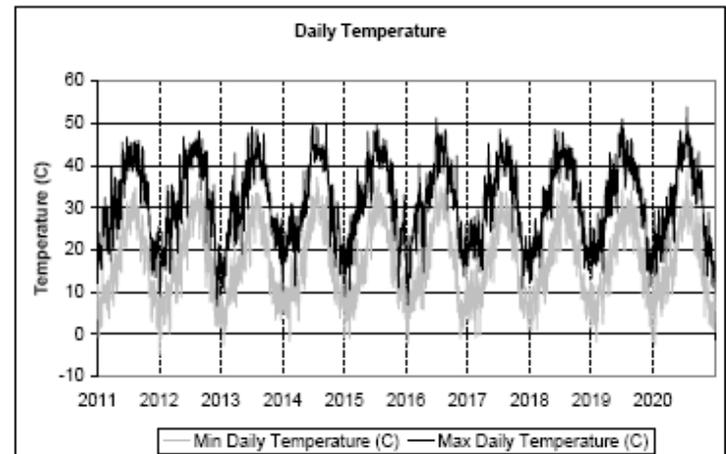
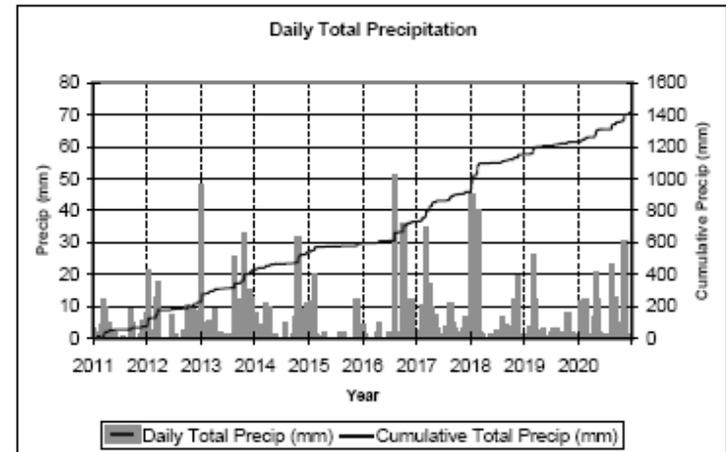
Decision Period	Initial State	Disturbance	Financial Condition	Management Decisions	Reasons for Transition	Ending State																								
1	Mixed shrub	Climate & Invasives	Good	<p style="text-align: center;">Lookup Table</p> <table border="1"> <thead> <tr> <th></th> <th>Budget</th> <th>Disturbance</th> </tr> <tr> <th>Number Rolled</th> <th>Every decade</th> <th>Every decade</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Good</td> <td>Climate & Wildfire</td> </tr> <tr> <td>2</td> <td>Poor</td> <td>Climate Only</td> </tr> <tr> <td>3</td> <td>Poor</td> <td>Climate & Invasive Species Introduction</td> </tr> <tr> <td>4</td> <td>Good</td> <td>Climate & Invasive Species Introduction</td> </tr> <tr> <td>5</td> <td>Poor</td> <td>Climate Only</td> </tr> <tr> <td>6</td> <td>Good</td> <td>Climate & Surface Disturbances (e.g. Roads, Recreation Activities)</td> </tr> </tbody> </table>				Budget	Disturbance	Number Rolled	Every decade	Every decade	1	Good	Climate & Wildfire	2	Poor	Climate Only	3	Poor	Climate & Invasive Species Introduction	4	Good	Climate & Invasive Species Introduction	5	Poor	Climate Only	6	Good	Climate & Surface Disturbances (e.g. Roads, Recreation Activities)
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4	Good	Climate & Invasive Species Introduction																												
5	Poor	Climate Only																												
6	Good	Climate & Surface Disturbances (e.g. Roads, Recreation Activities)																												
2																														



Instructions

- Analyze climate data for decision period (don't peek ahead!)
 - Sequences of wet and dry years
 - Prolonged periods of above/below average temperature and/or precipitation
 - Extremes and their potential impact within the decision period
 - Seasonality of temperature and precipitation

Decision Window 1: 2011-2020



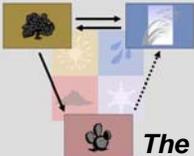
Instructions

- **Disturbance within decision period?**
(Determine when you think the disturbance is most likely to occur with respect to the climate information given and use this in your discussions)

Lookup Table

	Budget	Disturbance
Number Rolled	Every decade	Every decade
1	Good	Climate & Wildfire
2	Poor	Climate Only
3	Poor	Climate & Invasive Species Introduction
4	Good	Climate & Invasive Species Introduction
5	Poor	Climate Only
6	Good	Climate & Surface Disturbances (e.g. Roads, Recreation Activities)

Management Options	Relative Cost
Active site restoration (seeding and watering)	High
Area and/or road closures	Low
Increase OHV Management/Law Enforcement	Medium
Herbicide control of non-native species	High
Develop erosion control structures	High
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
Enter your own...	



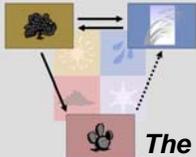
Instructions

- Use management options on lookup table
 - Manage to move to another state or stay at current state
 - Use management options in concert with climate data and potential disturbances
 - You can not use expensive management options during a decision period if you have a poor budget!

Lookup Table

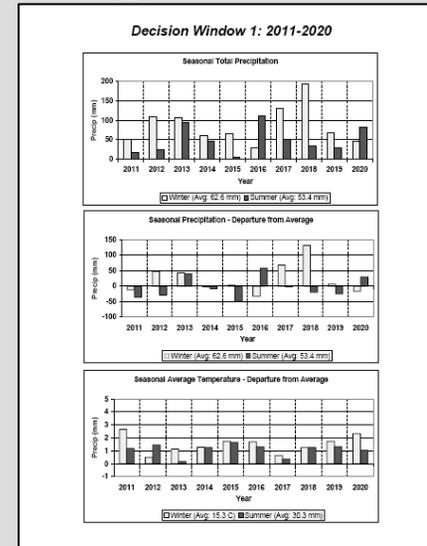
	Budget	Disturbance
Number Rolled	Every decade	Every decade
1	Good	Climate & Wildfire
2	Poor	Climate Only
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Management Options	Relative Cost
Active site restoration (seeding and watering)	High
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Rest rotation grazing (infrastructure in place)	Low
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Enter your own...	



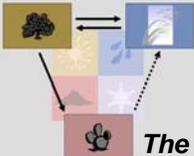
Putting it all together!

Management Options	Relative Cost
Active site restoration (seeding and watering)	High
Area and/or road closures	Low
Increase OHV Management/Law Enforcement	Medium
Herbicide control of non-native species	High
Develop erosion control structures	High
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
Enter your own...	



State and Transition-Climate Worksheet Group Number 7 Management Objective recreation Desired State Mixed shrub

Decision Period	Initial State	Disturbance	Financial Condition	Management Decisions	Reasons for Transition	Ending State
1	Mixed shrub	Climate & Invasives	Good	Herbicide control of non-native species	No change; adequate precip through period; herbicide control effective	Mixed shrub
2						

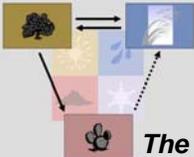


Move on to next decision period...

- Discuss as a group the interaction between the climate time series, the disturbance, management options used and the state & transition model. This is a thought exercise with no right answers, so be creative!
- When finished with a decision period, move on to the next (repeat steps 4-7). There are a total of six decision periods that cover the period from 2011 to 2070.
- After all groups are finished with as many decision periods as possible in the time allotted, we will discuss results from each group worksheet.

State and Transition-Climate Worksheet Group Number 7 Management Objective recreation Desired State Mixed shrub

Decision Period	Initial State	Disturbance	Financial Condition	Management Decisions	Reasons for Transition	Ending State
1	Mixed shrub	Climate & Invasives	Good	Herbicide control of non-native species	No change; adequate summer precip through period; quick recovery after fire	Mixed shrub
2	Mixed shrub					

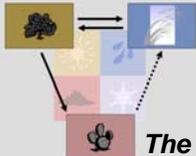


Continue with next decision period or finish up...

State and Transition-Climate Worksheet Group Number 7 Management Objective recreation Desired State Mixed shrub

Decision Period	Initial State	Disturbance	Financial Condition	Management Decisions	Reasons for Transition	Ending State
1	Mixed shrub	Climate & Invasives	Good	Herbicide control of non-native species	No change; adequate summer precip through period; quick recovery after fire	Mixed shrub
2	Mixed shrub					
3						
4						
5						
6						

- When finished with a decision period, move on to the next (repeat steps 4-7). There are a total of six decision periods that cover the period from 2011 to 2070.
- After all groups are finished with as many decision periods as possible in the time allotted, we will discuss results from each group worksheet.



Let the games begin!

