

# RECLAMATION

*Managing Water in the West*

## Where the Rubber Meets the Road – Why we Need (Better) Seasonal Forecasts (especially for drought)

*When the Rain Stops: Drought on Subseasonal and  
Longer Timescales*

*Aspen Global Change Institute*

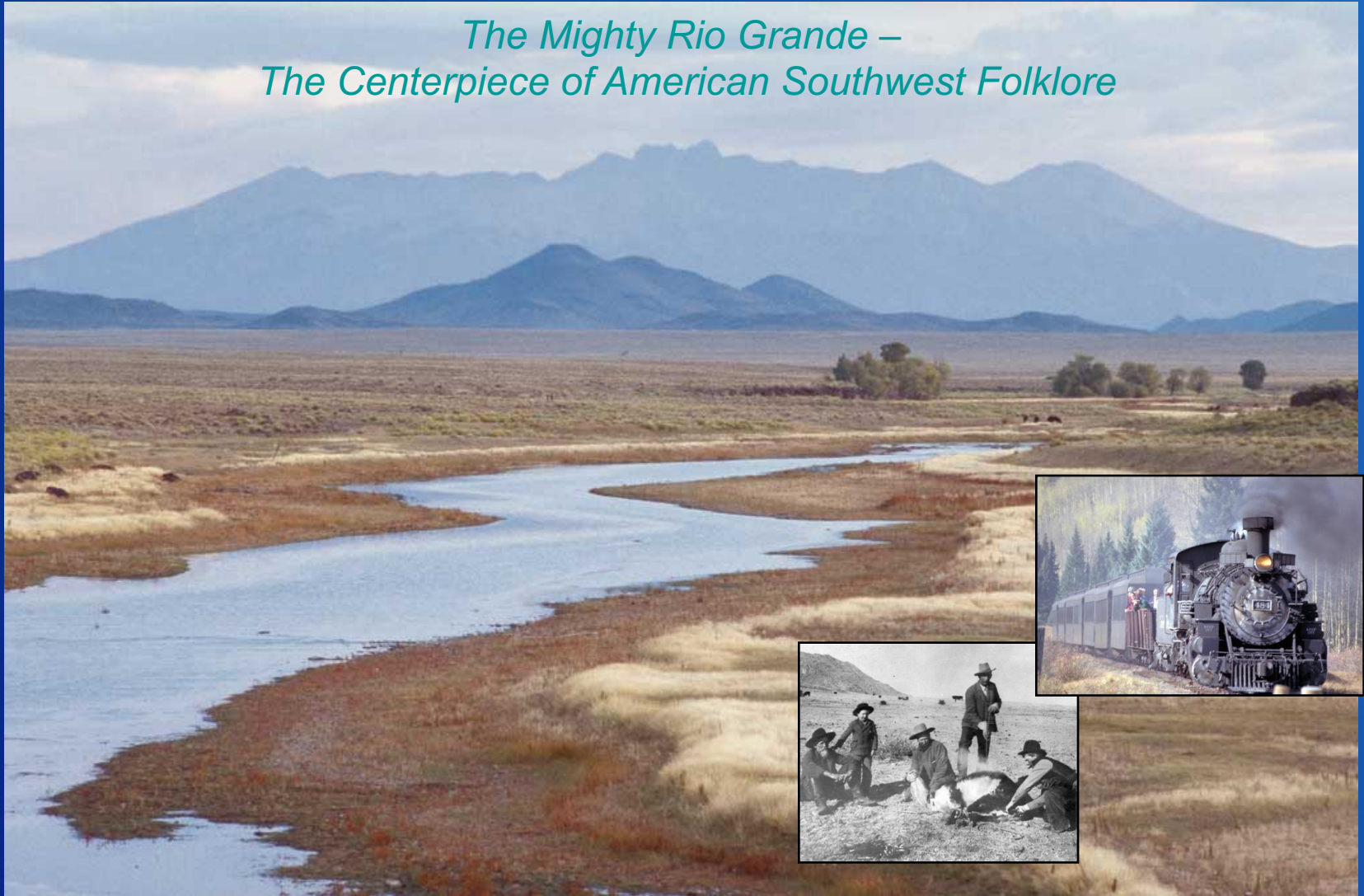
*September 11, 2018*



U.S. Department of the Interior  
Bureau of Reclamation

Dagmar Llewellyn,  
Reclamation Albuquerque Area  
Office

*The Mighty Rio Grande –  
The Centerpiece of American Southwest Folklore*



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New York Times this week:  
***“The Rio Grande is Dying, Does  
Anybody Care?”***



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# Recent literature on the impacts of climate change on western water

## ESA CENTENNIAL PAPER

*Ecological Applications*, 25(8), 2015, pp. 2069–2093  
© 2015 by the Ecological Society of America

### Western water and climate change

MICHAEL DETTINGER,<sup>1,4</sup> BRADLEY UDALL,<sup>2</sup> AND ARIS GEORGAKAKOS<sup>3</sup>

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<sup>3</sup>Georgia Water Resources Institute, Georgia Institute of Technology, Atlanta, Georgia 30332 USA

“The Rio Grande Offers the best example of how climate-change induced flow decline might sink a major system into permanent drought”

The western United States is a region long defined by water challenges. Climate change challenges, but does not, for the most part, introduce entirely new challenges. It is likely to stress water supplies and resources already in many ways. Projections are for continued and, likely, increased uncertainty of continuing changes in seasonality of water. attendant increases in evaporative demand, although likely the northern United States sees declines. However, precipitation increases are projected in the western United States, but the projected increases in water

basin. Finally, California is one of the region's most vulnerable to climate change impacts expected as sea level rise and rising sea levels.

**Key words:** Centennial Paper; climate change; Sacramento–San Joaquin Bay Delta; water resources.

*If climate change is the shark, then water is its teeth.*  
—Paul Dickinson, CEO of Carbon Disclosure Project

#### INTRODUCTION

The western United States has always been a nexus of great opportunity and great challenge for the Nation. The region is notable for burgeoning human settlements

Manuscript received 21 May 2015; accepted 26 May 2015.  
Corresponding Editor: D. S. Schimel.

**Editors' Note:** This paper was commissioned by the journal editors to commemorate the ESA Centennial celebration. A virtual Table of Contents with links to all the Centennial Papers will be available on the journals web site ([esajournals.org](http://esajournals.org)) in late 2015.

<sup>4</sup>E-mail: [mddettin@usgs.gov](mailto:mddettin@usgs.gov)

and its “wide open” spaces and disturbances and native species, complex terrain and diverse climates; abundant resources and its scarce ones. Water has played a pivotal role in its development, so that, to an extent unmatched elsewhere, water has been a limiting factor in where agriculture was undertaken, in where and how large its settlements have grown, and in the character and survival of many of its natural landscapes. And now, like so much of the Earth, social and natural conditions in the western United States are changing rapidly due to a variety of influences, including its long history of recurrent and severe droughts, floods, water-quality contamination, environmental degradation and endangered species, strong competition for the often limited water supplies that exist among a diverse set of





- Infrastructure designed to capture snowmelt on tributaries.
- Above Elephant Butte, there is no water storage on the mainstem.
- Available storage generally does not exceed one year's needs.

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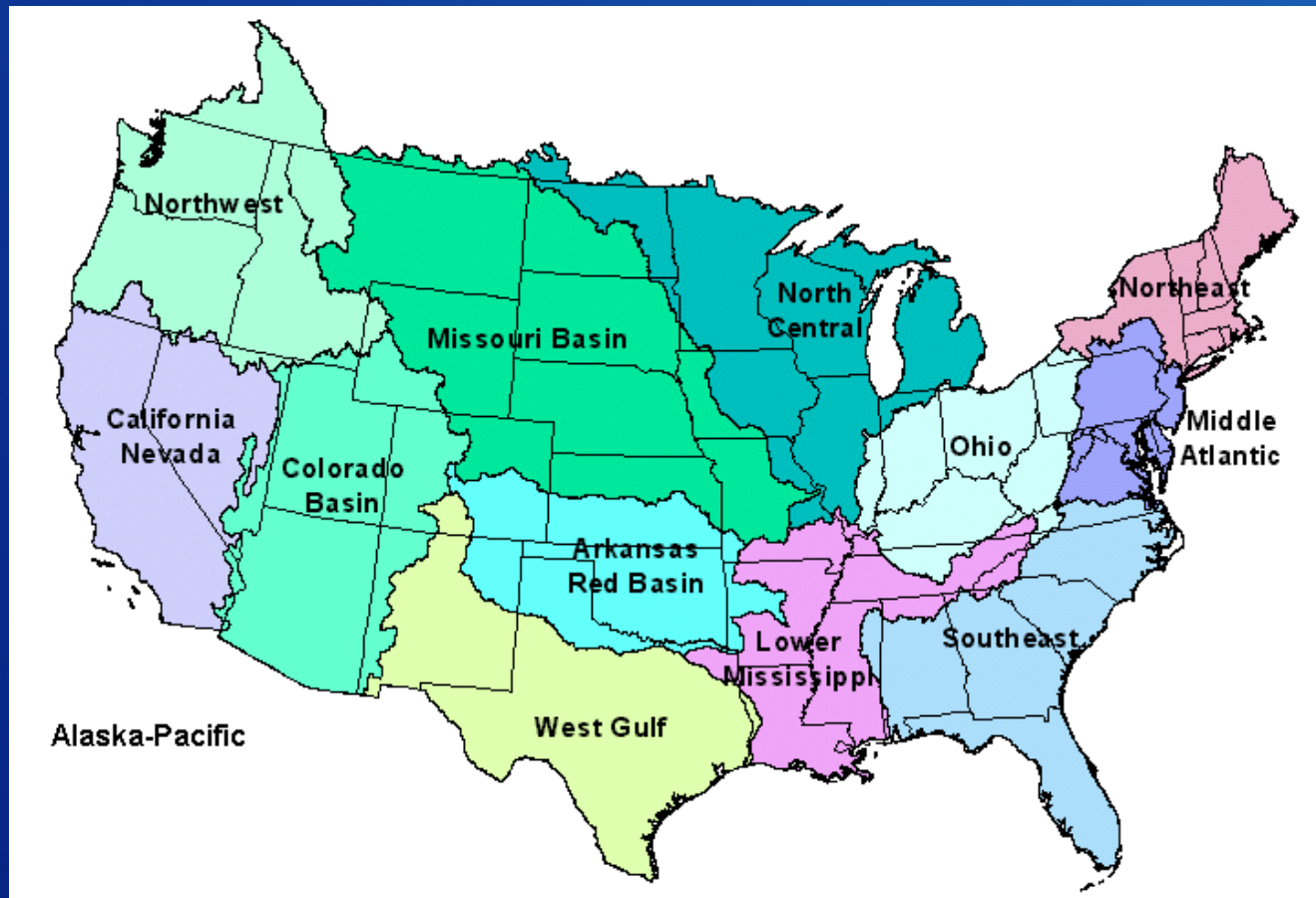
# A highly variable system....



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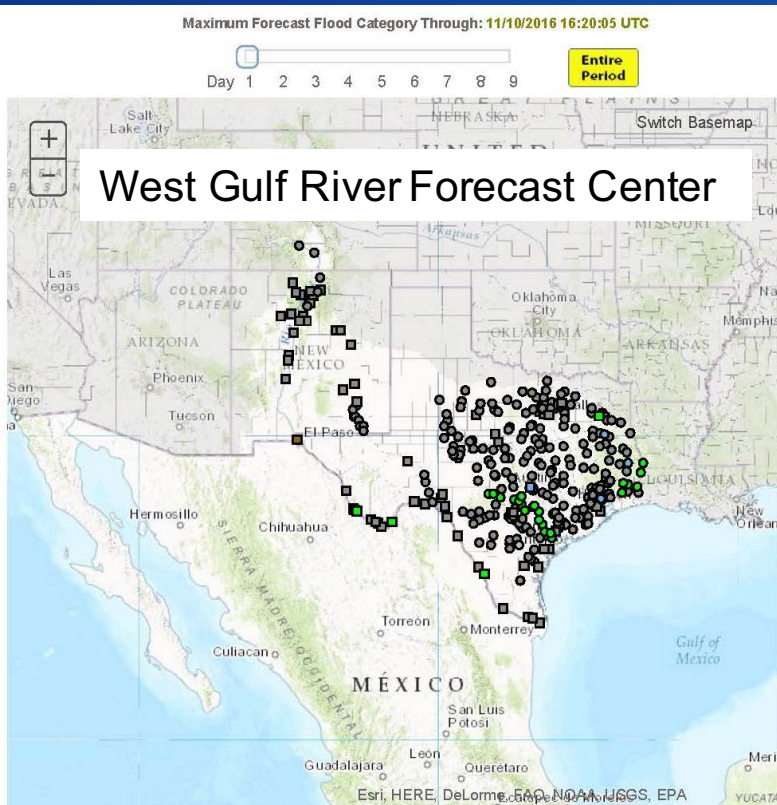
# Differences in forecast information in different regions of the country



NOAA River  
Forecast  
Centers

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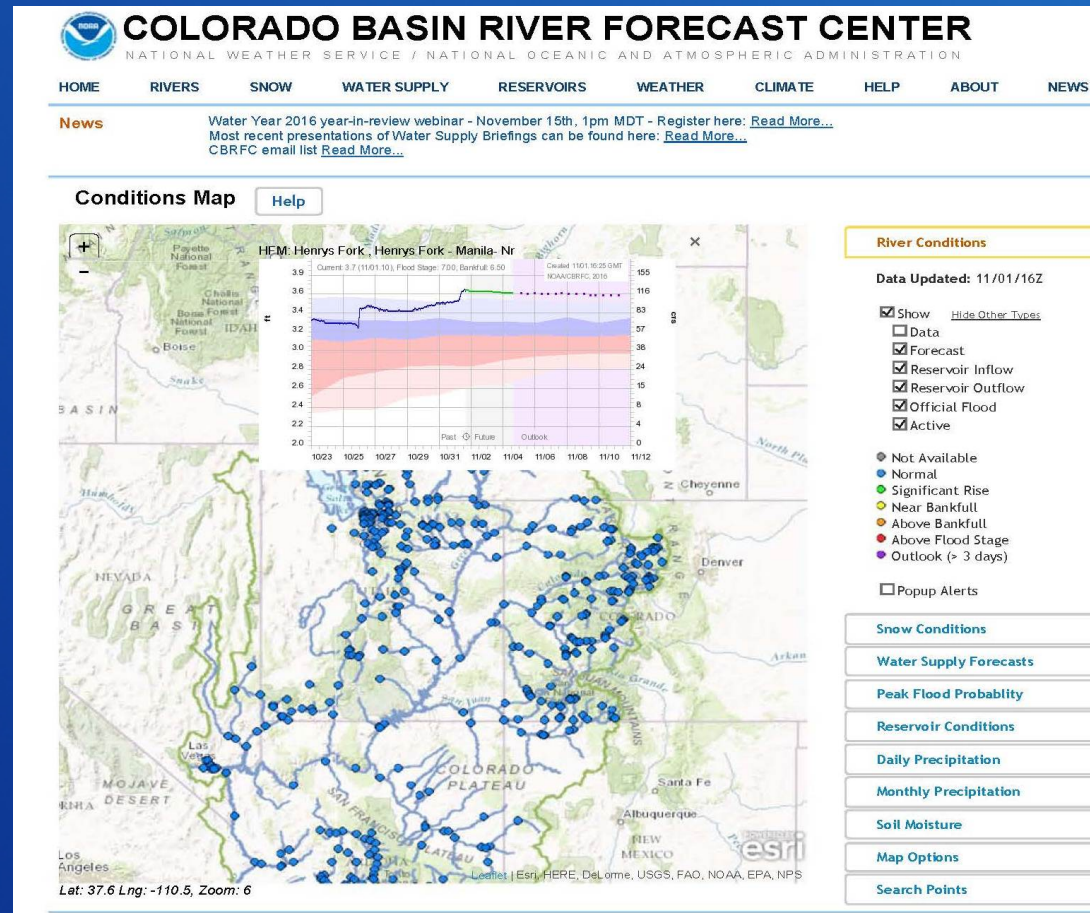
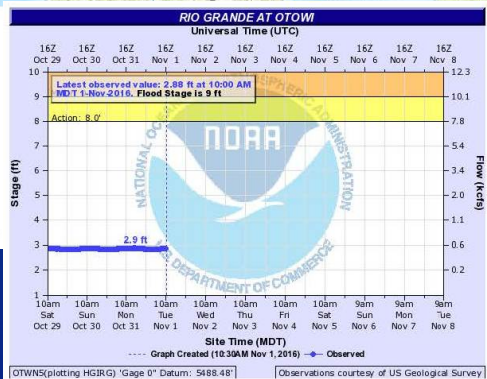
# Information available from NOAA River Forecast Centers



☐ Probability and forecasts available  
☐ Forecasts available

317 total gauges  
[Show all locations in flood \(0\)](#)

☐ 0 Gauges: Major Flooding  
☐ 0 Gauges: Moderate Flooding  
☐ 0 Gauges: Minor Flooding  
☐ 0 Gauges: Near Flood Stage  
☐ 29 Gauges: No Flooding  
☐ 4 Flood Category Not Defined  
☐ 1 At or Below Low Water Threshold



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# Have we experienced “flash drought”?

Greenwire

AN E&E PUBLISHING SERVICE

## DROUGHT:

### 'Across most of the West, snowpack isn't just low -- it's gone'

Scott Streater, E&E reporter

*Published: Friday, May 8, 2015*

Higher temperatures have already melted most of the mountain snowpack across the West, according to a sobering new report from the Department of Agriculture that warns this could lead to water supply shortfalls this summer.

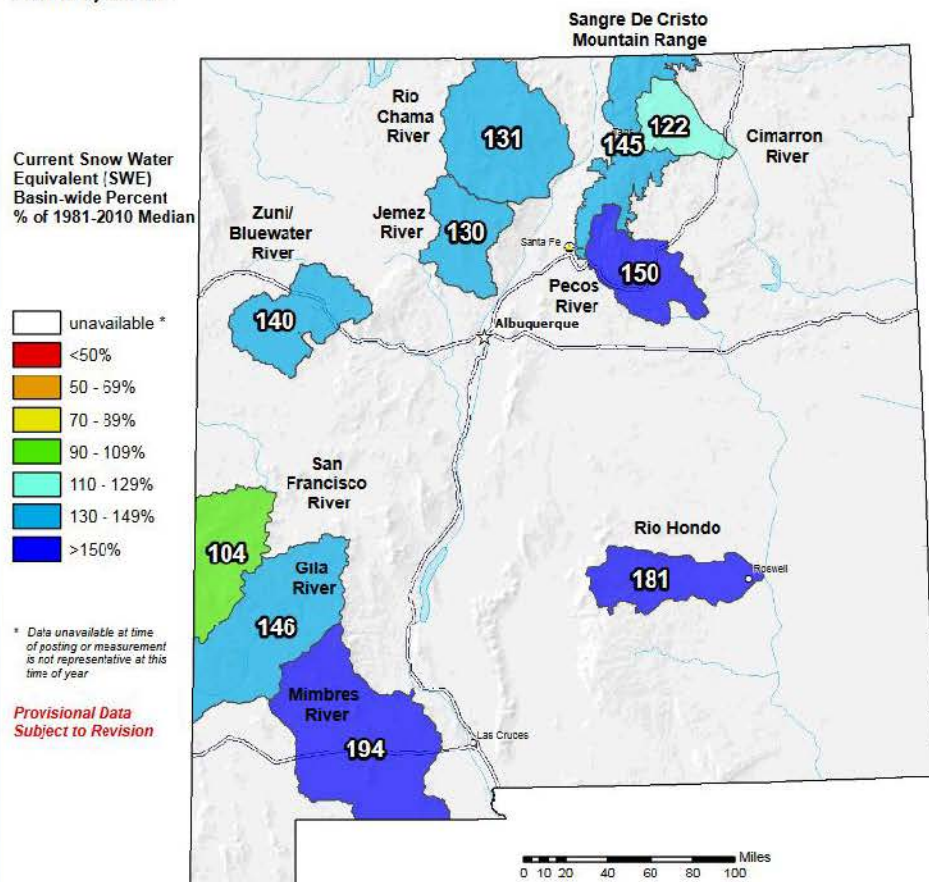






# New Mexico's Disappearing Snowpack - 2016

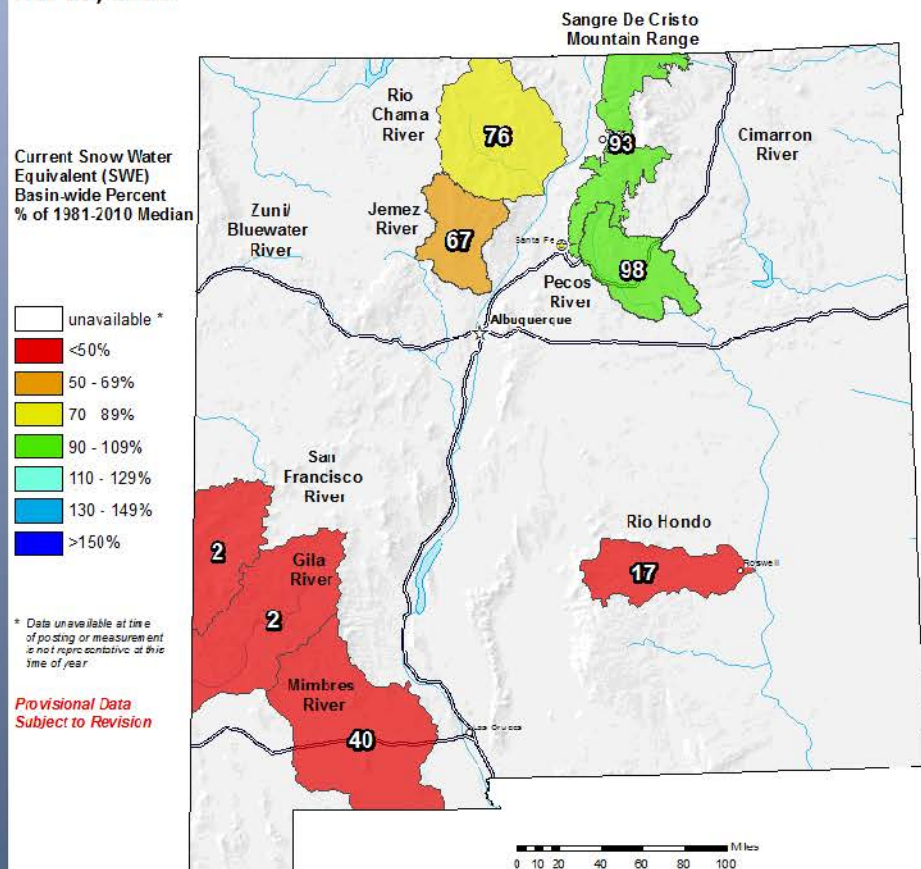
Jan 01, 2016



JAN 1, 2016



Mar 19, 2016

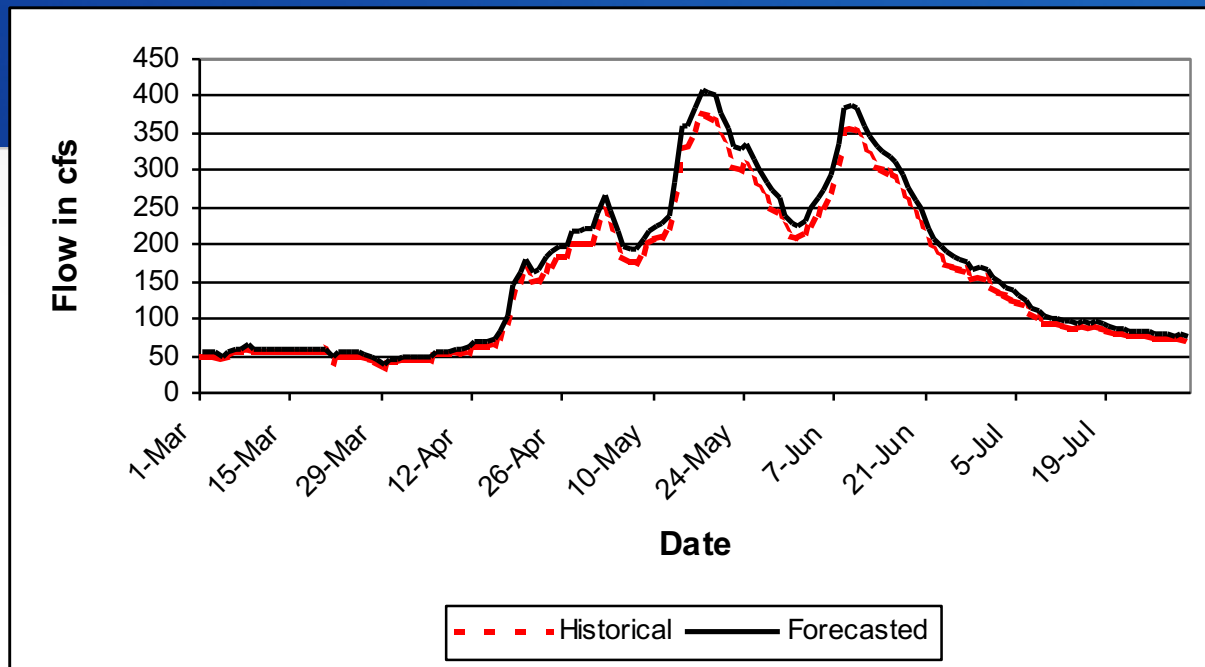


MAR 19, 2016





# How do we use this science on drought forecasting? And when do we need the information



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# Early (January – February) Forecast Related Decisions by Reclamation



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# How much water do we need to acquire for endangered species?

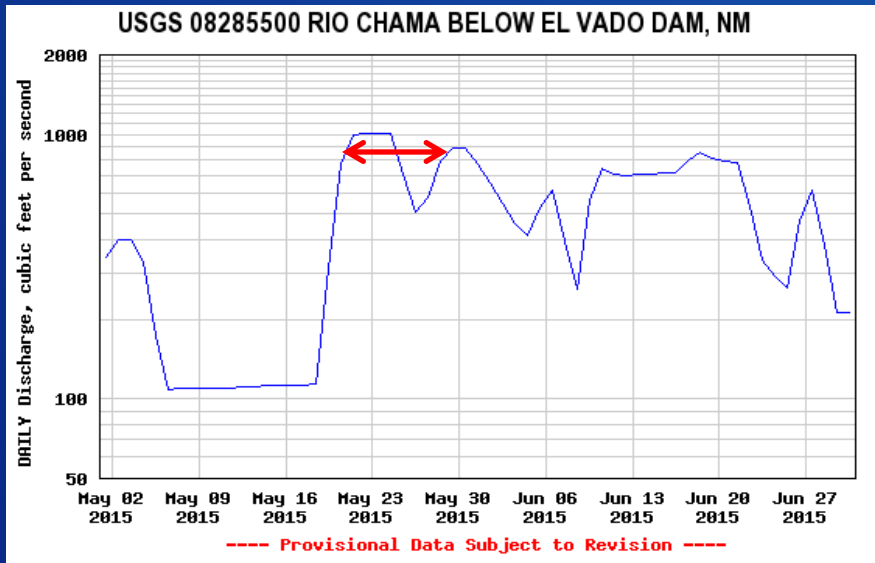


- **Spring Pulse** to support minnow spawning, floodplain connection, riparian health, and nutrient exchange.
- Lease of water for Reclamation's supplemental water program to support **summertime flows**.

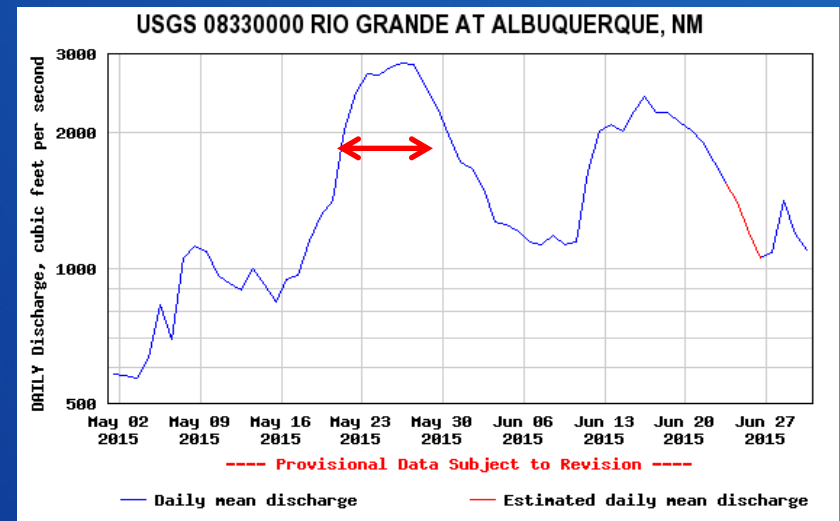


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# Example of additional flexibility: 2015 El Vado Operations



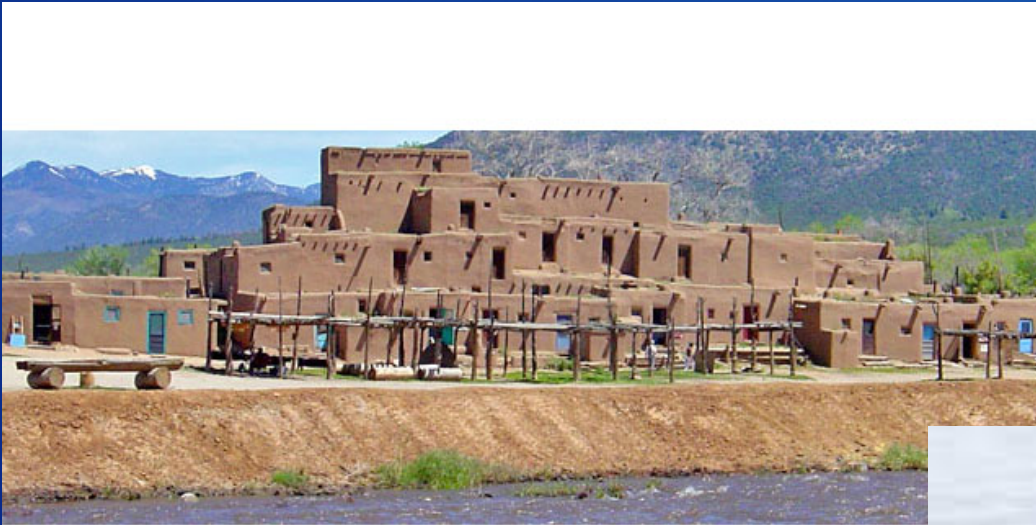
Water stored under  
March 24 resolution,  
subsequently  
released May 20 –  
29 to support spring  
pulse



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# How much water can we save to meet the needs of the Middle Rio Grande Pueblos' Prior & Paramount Water Rights?



Can be stored even under Rio Grande Compact Storage Restrictions (Article VII)



**When should we store in El Vado Reservoir to maximize storage but still maintain flood storage capacity until end of runoff period?**

El Vado Reservoir, near Chama, NM



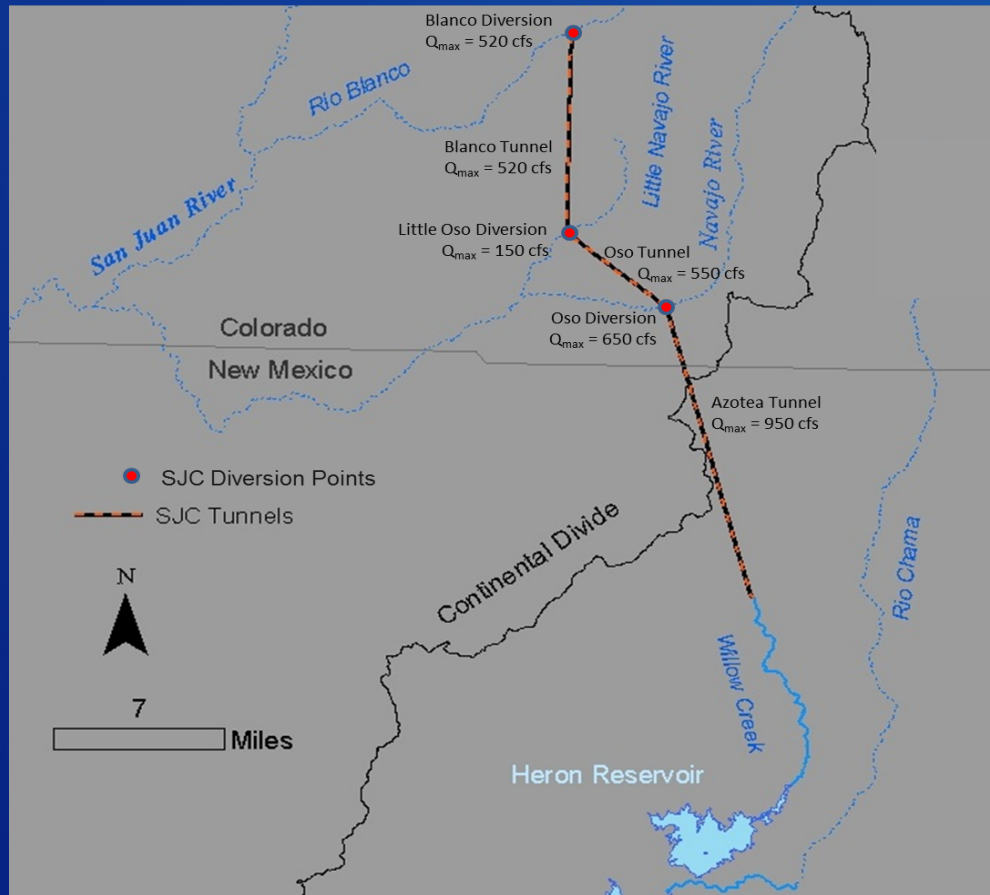
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# What will be our staffing needs for river monitoring and for supplemental pumping from drains?



# How much we will be able to allocate to Reclamation's San Juan-Chama Project Contractors?

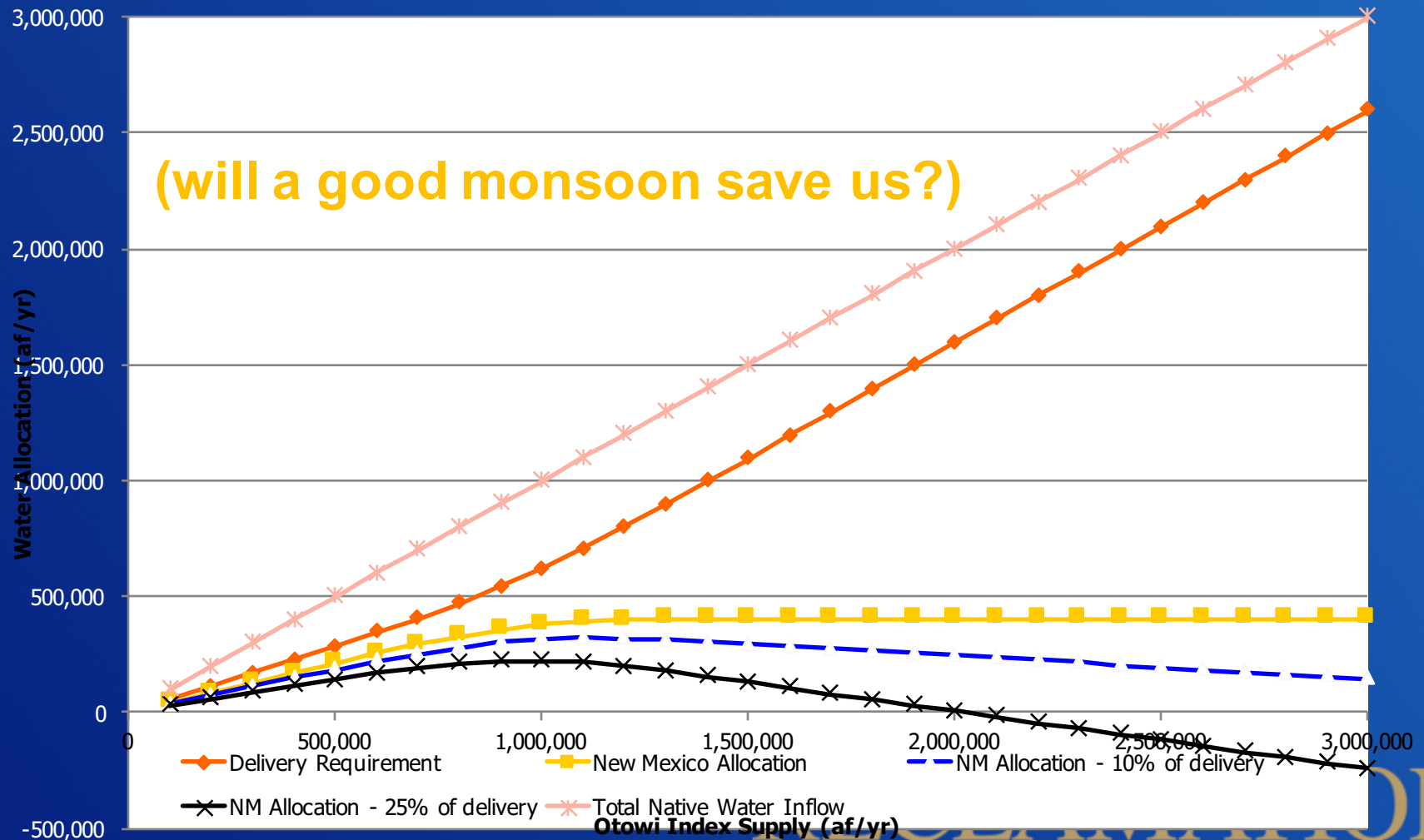


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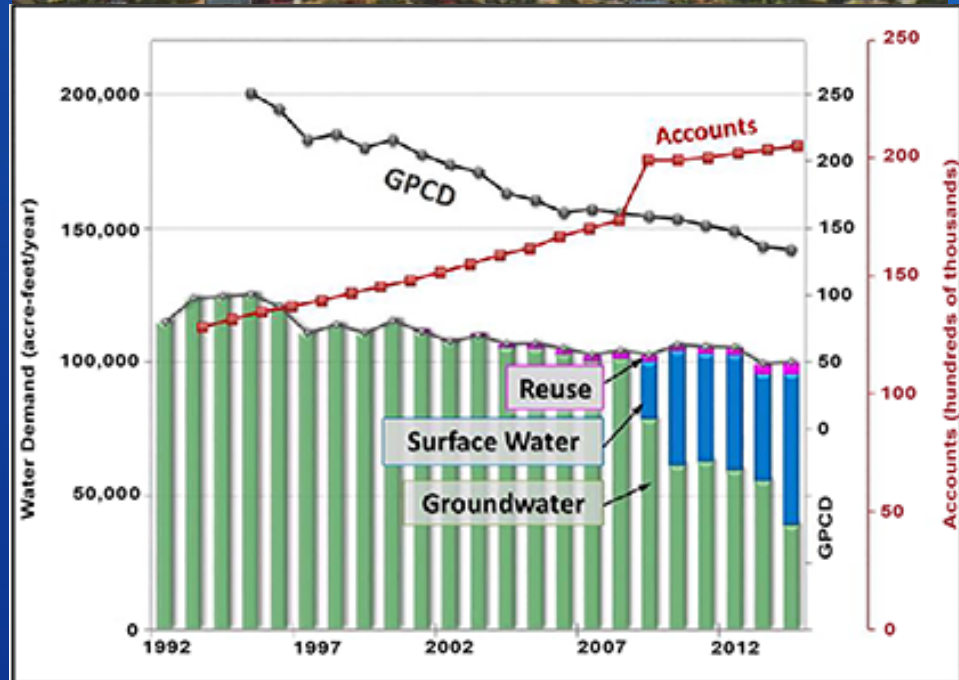
# State of New Mexico:

What will be our delivery obligations under the Rio Grande Compact, and when should we make deliveries



# Municipalities (Albuquerque, Santa Fe...)

- Will there be sufficient **carriage water** to allow diversion of drinking water from the Rio Grande?
- How much of the year will the city be reliant on **groundwater**?
- How much surface water will the city need to set aside to make up for **past impacts of groundwater pumping**?
- Will there be sufficient water to store any **relinquishment credits** under the Rio Grande Compact?





# Irrigation District (Middle Rio Grande Conservancy District)

- How much water can we store before we enter **Compact Storage Restrictions** – for Pueblos and for non-Indians?
- Will we be able to store **Compact relinquishment water**?
- Should we Implement **water bank for farmers** who have sold their water rights?



# Farmers

- Will there be sufficient water for a full season?
- What should we plant?
- Note – in the Middle Rio Grande, almost all farming is alfalfa or native pasture. I postulate that this is largely due to the unreliability of the supply.



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# Fish & Wildlife Service

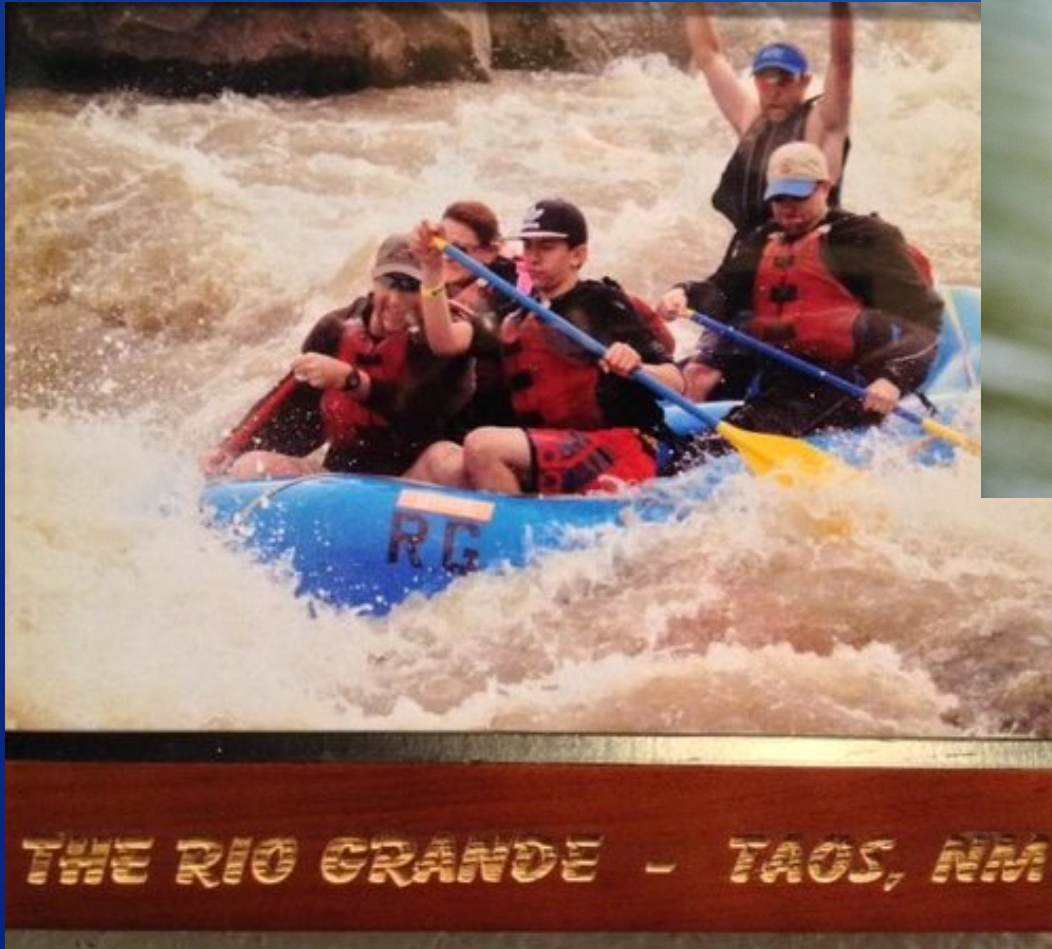
- “Incidental Take” allowance for silvery minnow
- Staffing needs for minnow rescue in locations where the river dries.



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# Recreation Industry



Will there be water  
for **rafting**? **Fishing**?  
What will be our  
**staffing** requirements  
for guides?

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And everyone asks – what is the chance  
of a good monsoon?

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© JRSphotos.com

*Questions?*

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**Are these New Mexico forests sustainable?  
Are they resilient? What is the difference?**



Photo: Mason Cummings



dbaron/Flickr

**Is resilience always a good thing?**

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# *Resilience*

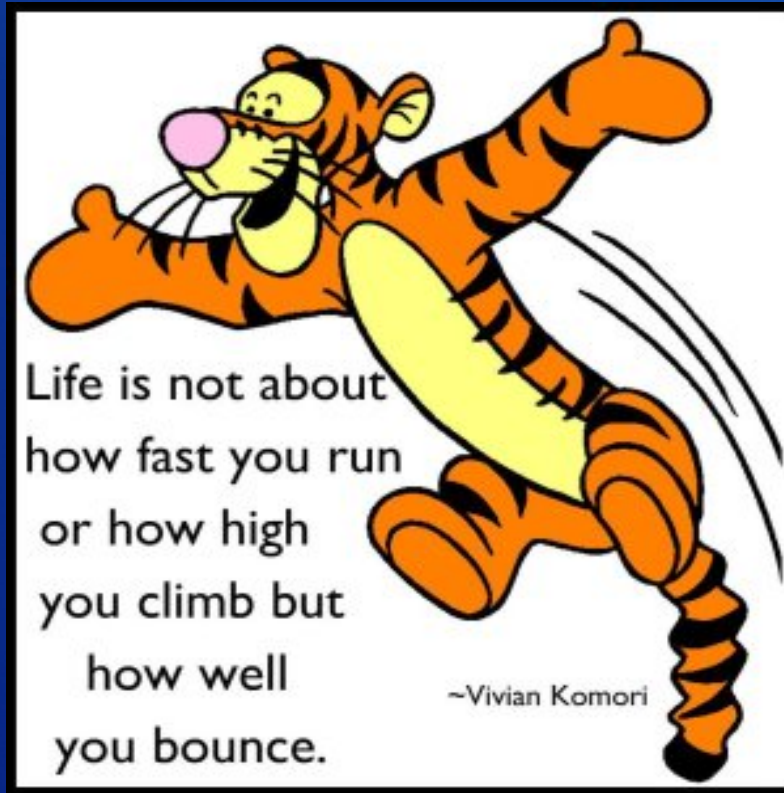
The capacity of a system to absorb a spectrum of disturbances and reorganize so as to retain essentially the same function, structure, and feedbacks—to have the same identity (Walker and Salt 2012).



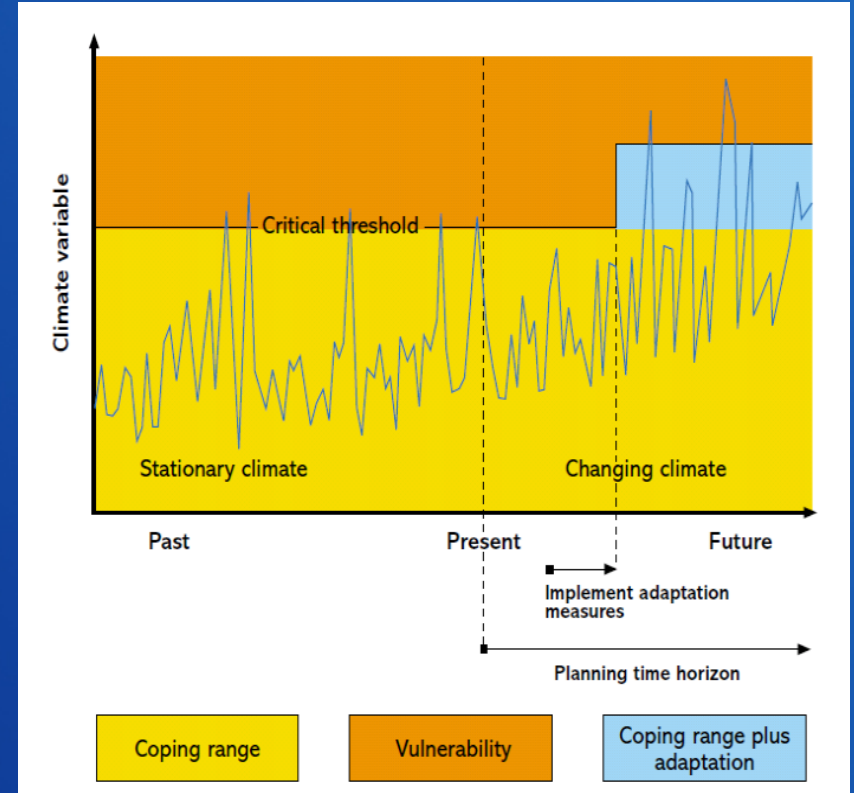
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# Or at Tigger says – “how well we bounce”!



Source: Pinterest



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# And why do we hear so much about resilience these days?



“Climate change undermines a basic assumption that historically has facilitated management of water supplies, demands, and risks.”

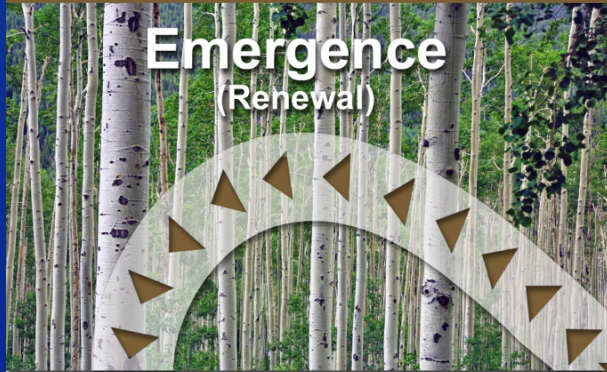
**Stationarity** assumes that the statistical properties of hydrologic variables in future time periods will be similar to past time periods

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# ***Systems are dynamic, constantly changing.***

Successful aspen establishments will require stronger, more effective management of species that browse on aspen seedlings and bark.



**Emergence**  
(Renewal)

Northern New Mexico Forest uplands are a mature pine dominated landscape. This forms a natural reservoirs that captures snow during the winter and releases the moisture as runoff in the spring and summer.



**Consolidation**  
(Maturity)



**Birth**

Successional forest has grown over many years.



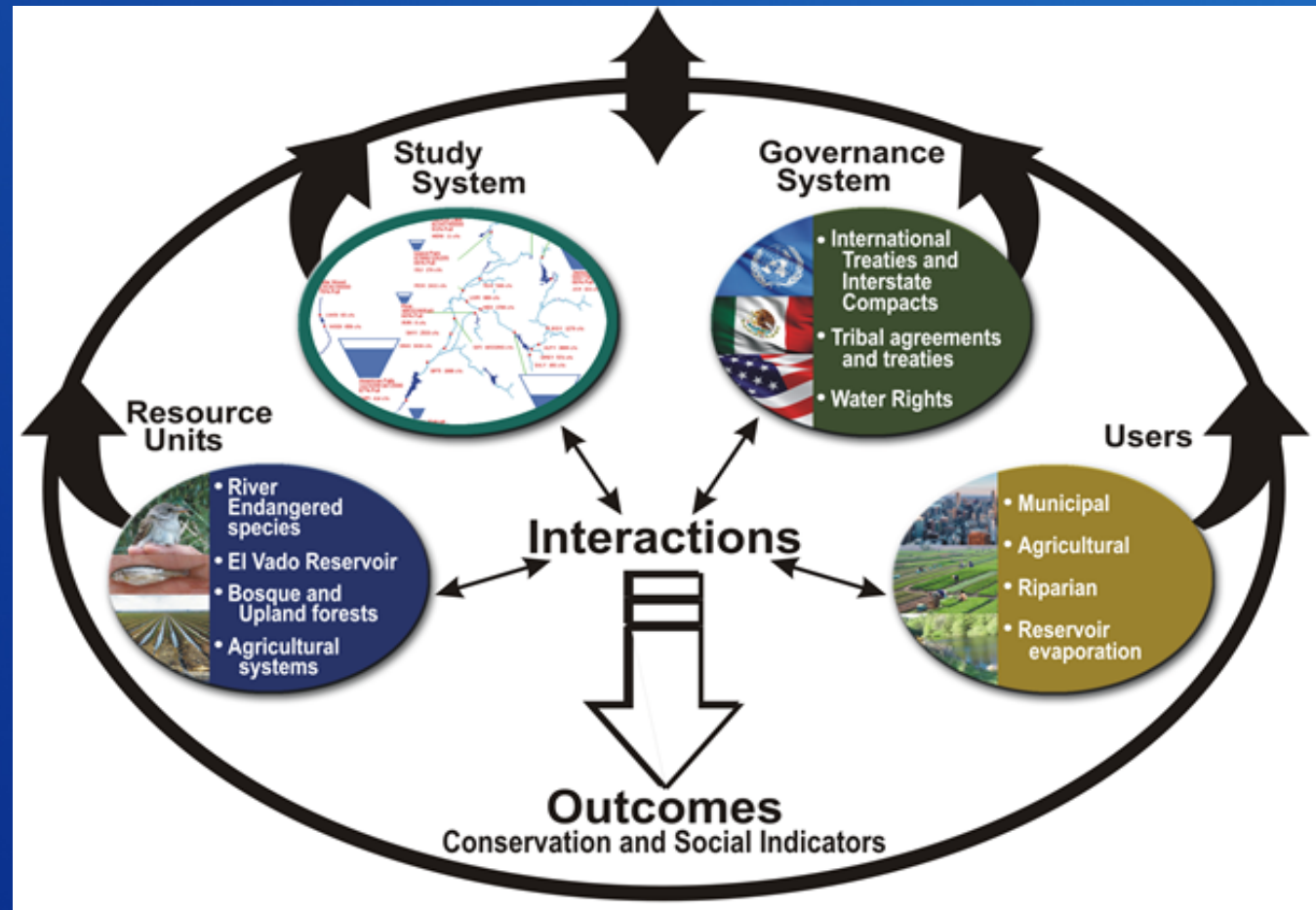
**Creative Destruction**

Forest fires are a part of the adaptive cycle, clearing the way for emerging growth and continuing this adaptive cycle.

**The adaptive  
cycle of a  
healthy, resilient  
system.**

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# Thinking in socio-ecological systems...

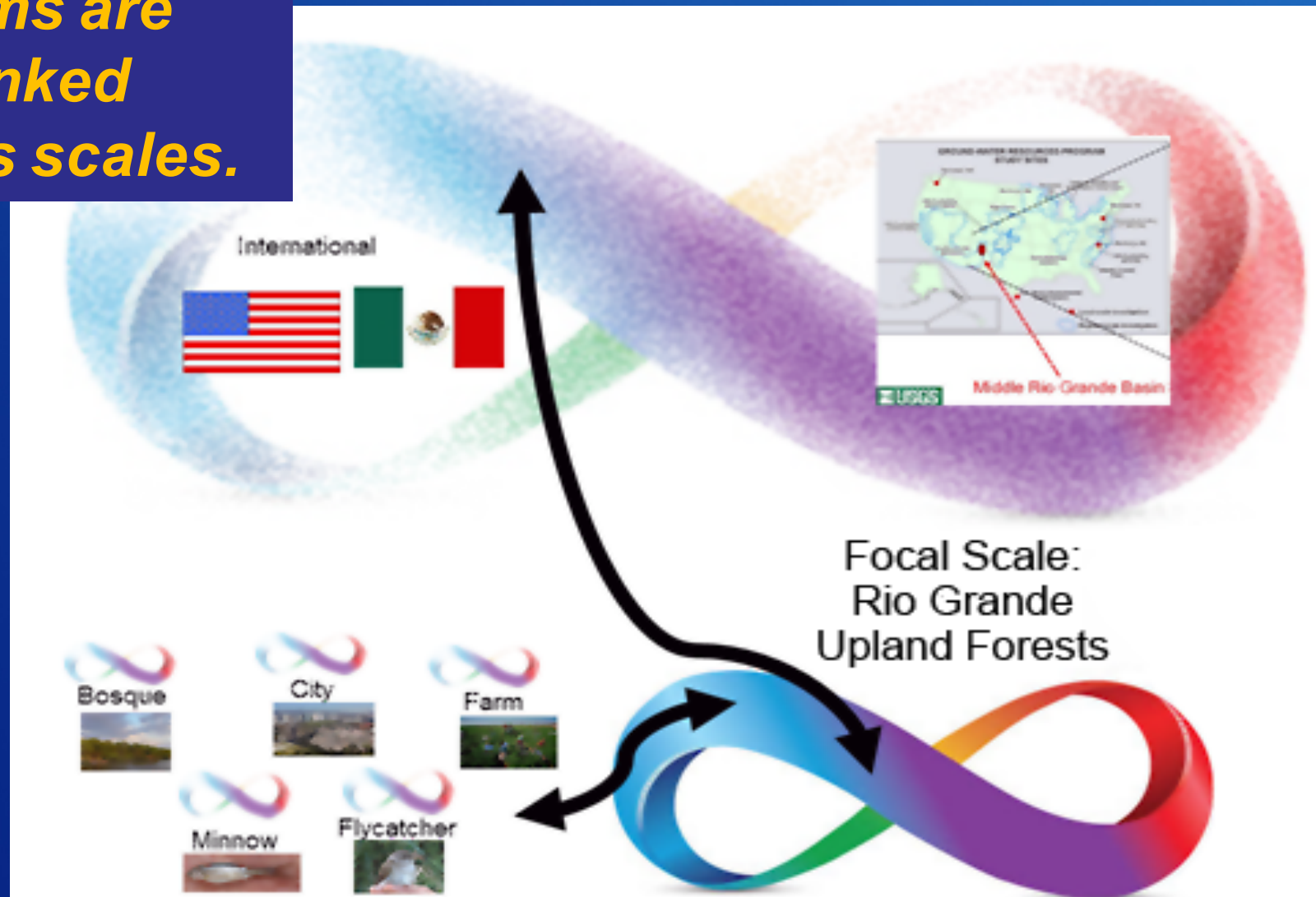


*Humans are part of ecological systems, and ecological components are part of human systems, with numerous components that are interlinked and interdependent.*



# Panarchy – thinking across scales...

*And the  
systems are  
interlinked  
across scales.*



# What makes Rio Grande Upland Forests vulnerable to disturbance?

Exposure: The resource and the change it is experiencing.

- Temperature increase,
- Decrease in snowpack,
- Loss of soil moisture.

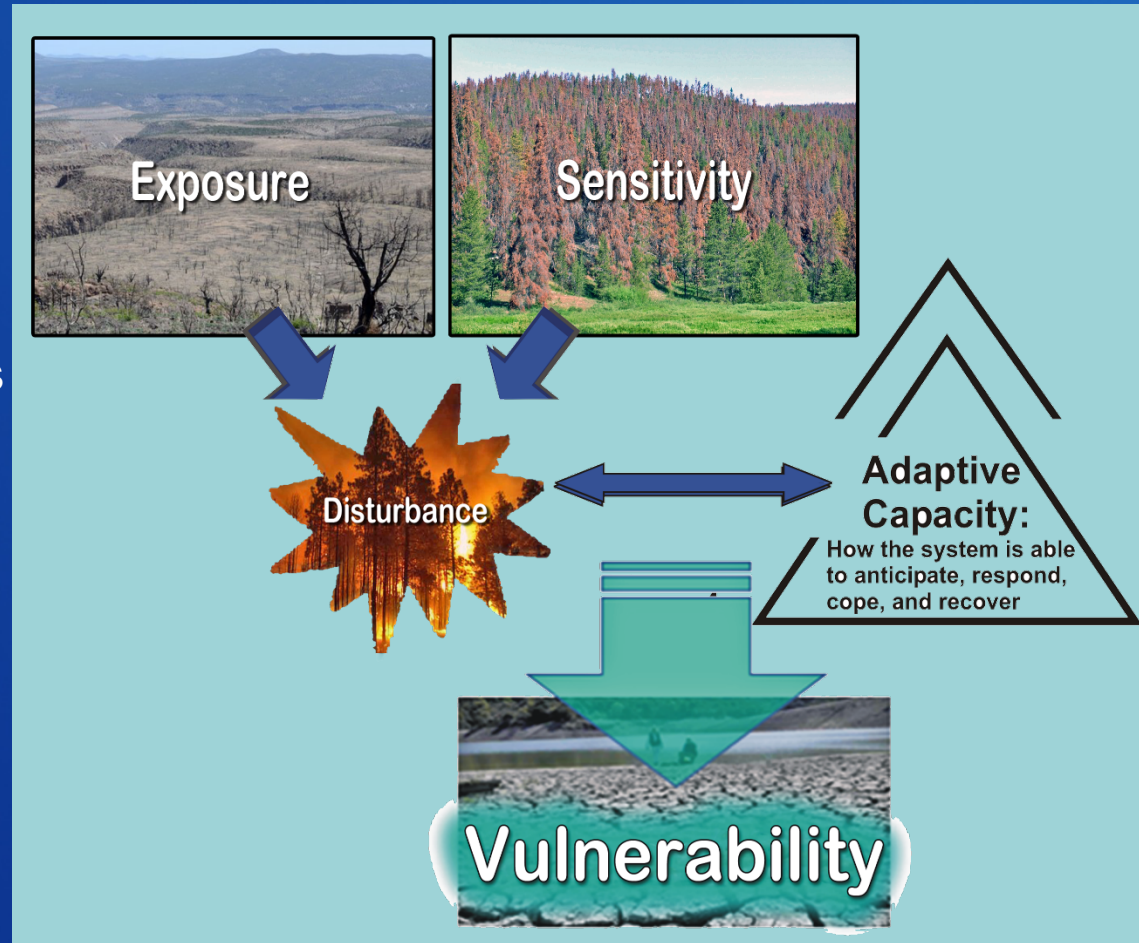
Sensitivity – How a resource fares when exposed to change.

Sensitivity is affected by:

- Forest overgrowth,
- Moisture-stress of trees.

Adaptive Capacity – How the system is able to anticipate, respond, cope and recover.

- Ecological diversity,
- Available seed sources,
- Patchiness.



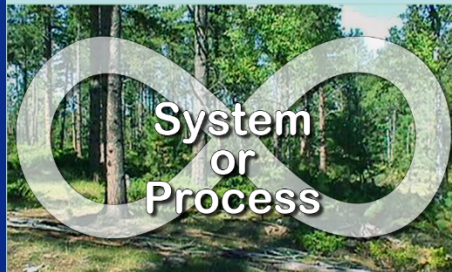
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# Rio Grande Upland Forests

## 1. Context

Rio Grande Upland Forest



Resilience of  
what?

## 2. Disturbance

Event that might or might not  
result in crossing a threshold



Resilience to  
what?

## 3. Resilience

Will that disturbance  
cross over a threshold?

Exposure

Sensitivity

Adaptive  
capacity

## 4. Reaction to disturbance

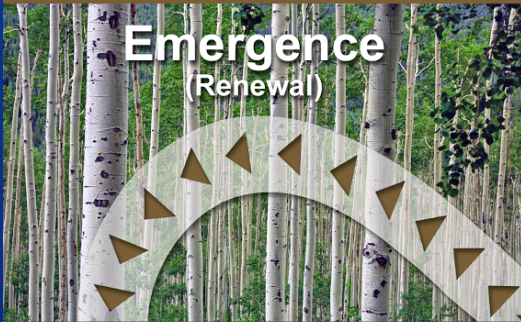
Maintain the same system or transform a  
new system with different structure and  
function (e.g., cope, recover, learn)



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# Transformation!

Successful aspen establishments will require stronger, more effective management of species that browse on aspen seedlings and bark.



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Successional forest has grown over many years.



Forest fires are a part of the adaptive cycle, clearing the way for emerging growth and continuing this adaptive cycle.



Disturbance

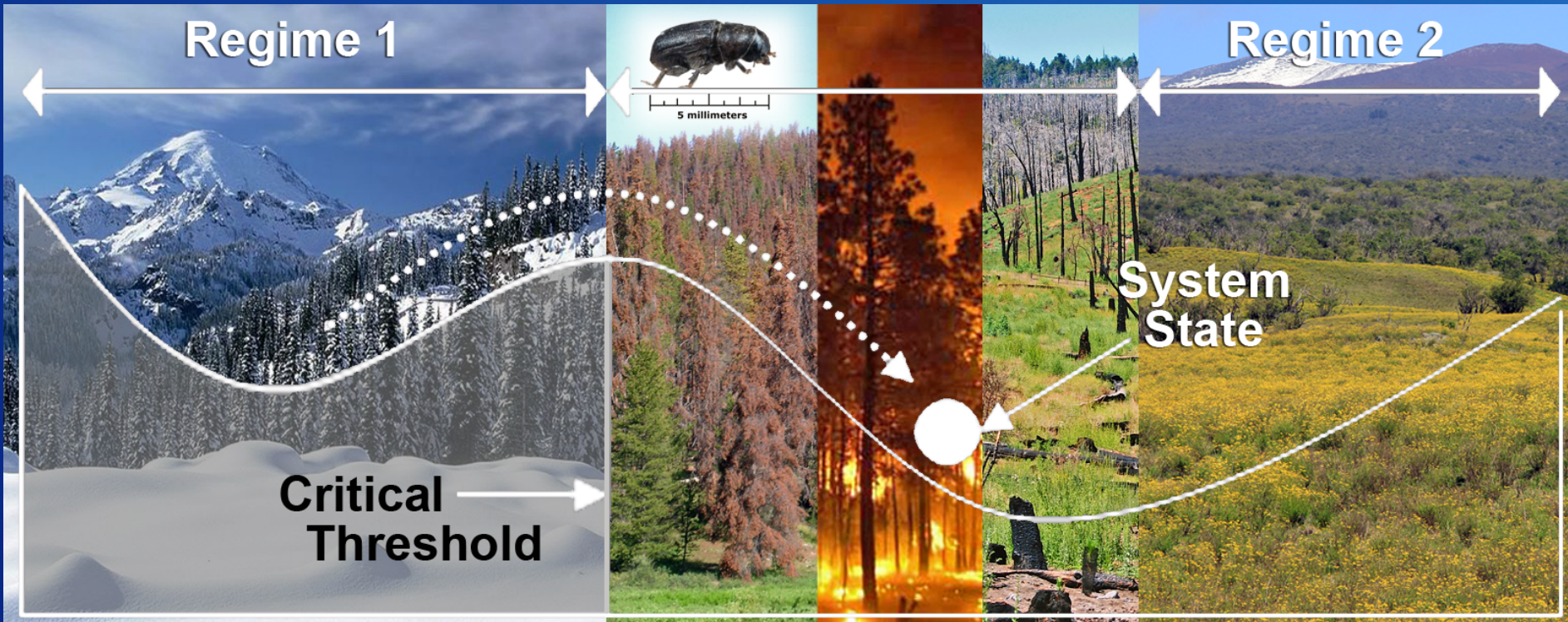


New system with  
new adaptive cycle

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# Transformation!



Regime 1

Transition

Regime 2

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