

The background of the slide features a large, faint watermark of the University of Idaho seal. The seal is circular and contains the text "THE UNIVERSITY OF IDAHO" around the top and "1889" at the bottom. In the center of the seal is a shield depicting a landscape with a rising sun, mountains, a river, and a plow.

## Least-cost provision of water-derived ecosystem services: When, where, and how?

Luis Garnica Chavira, **Katherine Lee**, Alex Mayer, Greg Torell, Frank Ward

Southern Economics Association, November 23, 2019

- Water demand exceeds supply in Rio Grande River Basin
- **Problem:** Environmental benefits of surface water flow neglected in allocation
- **New policy:** Periodic surface water (environmental flow) releases to improve natural habitat
- **Questions:**
  - What is the cost?
  - Who pays?
  - What does timing of flows matter?

# Rio Grande River Basin: Setting the stage

- 13" annual precipitation, 'perennially under drought/near drought conditions'
- Water shared between Colorado, New Mexico, Texas, and Mexico
- Highly engineered, well understood hydro-economic system



# Rio Grande River Basin: Water users

- **Urban:** Las Cruces, El Paso, Ciudad Juarez (13 million people)
- **Agriculture:** chiles, onions, cereal grains, cotton, pecans, forage crops
- **Wildlife:** Critical habitat for > 30 threatened/endangered species





- Organization regulates Rio Grande water use, allocation
- **2009 Record of Decision:** mandated environmental flow releases
- **Goal:** enhance, partially restore riparian and floodplain function
- Simulate natural “pulses” of river flow
  - Spread native seeds, improve habitat for listed species



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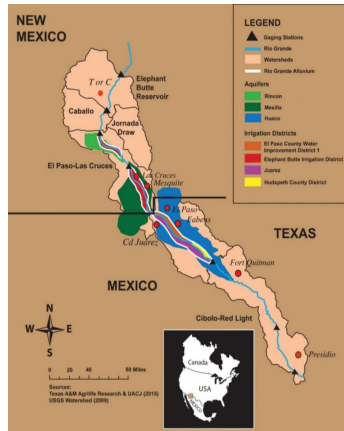
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- 227 acre-feet released annually
- 9,300 acre-feet pulse every 3 to 10 years
- Pulses flood lands adjacent to river in New Mexico
- Water will be donated or purchased from water rights holders
- Note: this is *really not* much water, but still a big deal

## Questions

- 1 How much would an environmental flow policy cost?
- 2 What activity will be impacted, and where?
- 3 Are there economically *better* or *worse* ways to time the pulse flows?

# Modeling Framework

- **Integrated model with three distinct hydrological and economic regions:**
  - New Mexico, Far West Texas, Mexico (Ciudad Juarez)



# Modeling Framework

- **Model inputs:**
  - Surface and ground water availability, flows, diversions
  - Agricultural prices and costs, water demand
  - M&I demand
  - Urban demand
  - Recreational value of reservoirs



- **Institutional constraints:**
  - Downstream supply requirements
  - Annual and pulse environmental flows



# Modeling Framework

- **Model outputs by region:**
  - Crop acreage
  - Surface, groundwater return flows
  - NPV to agriculture, urban, recreational sectors





# Scenarios

- We chose not to optimize pulse schedule
- Used 20 years of historic Elephant Butte Reservoir levels to create comparable scenarios



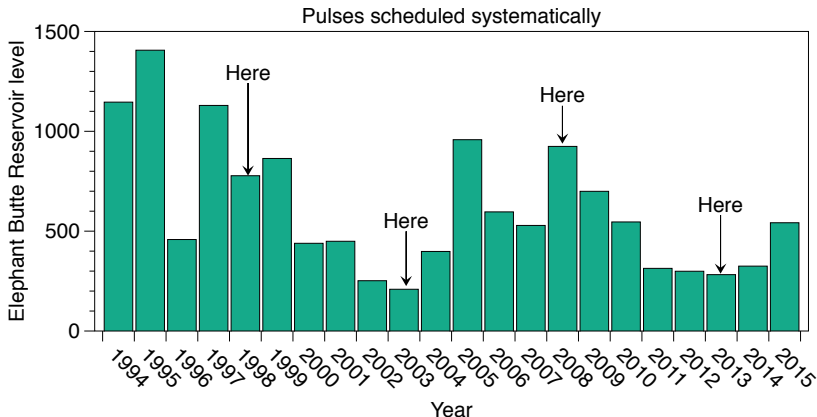


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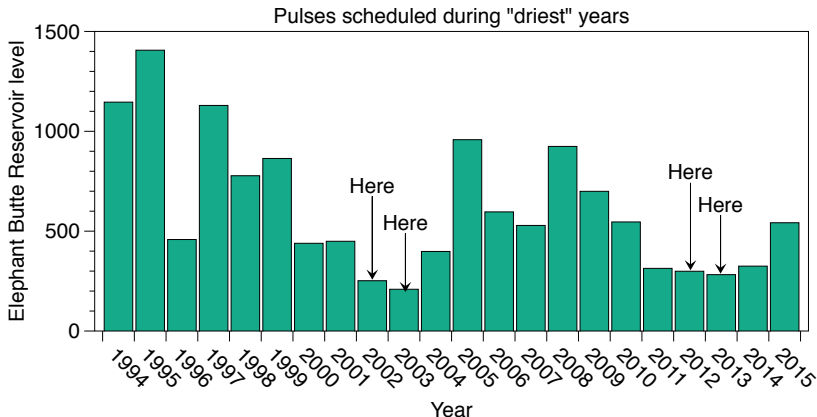
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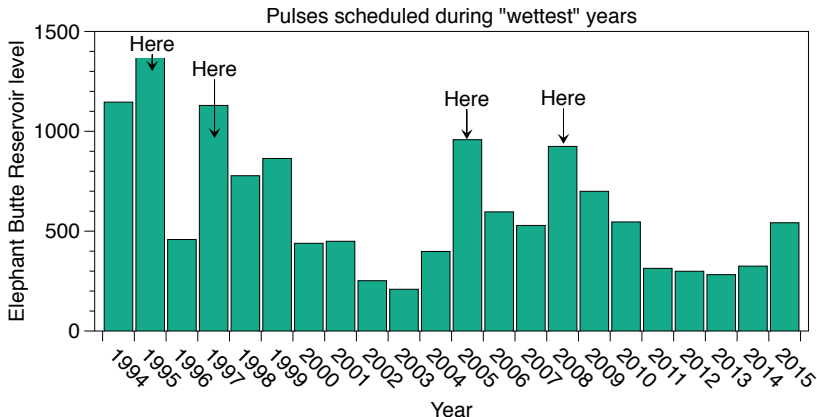
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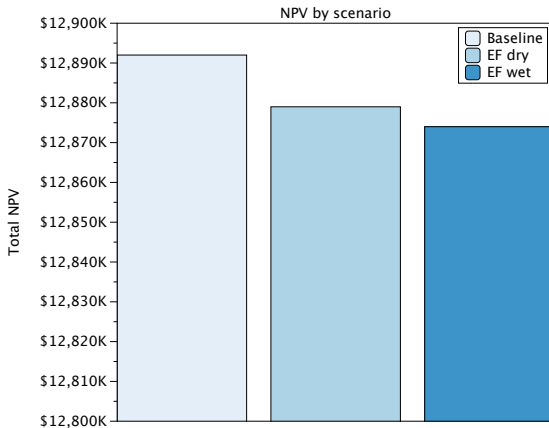
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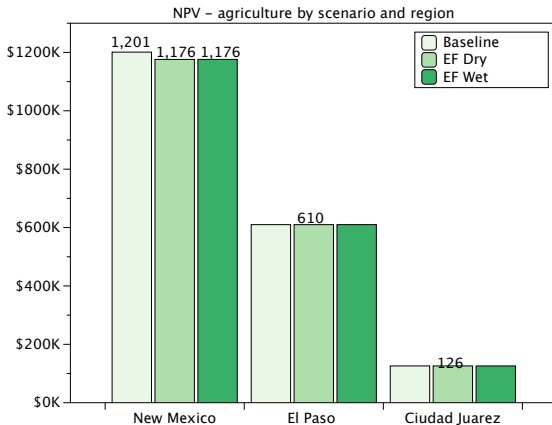
# Results: NPV

- Pulses timed in wet years have lowest NPV



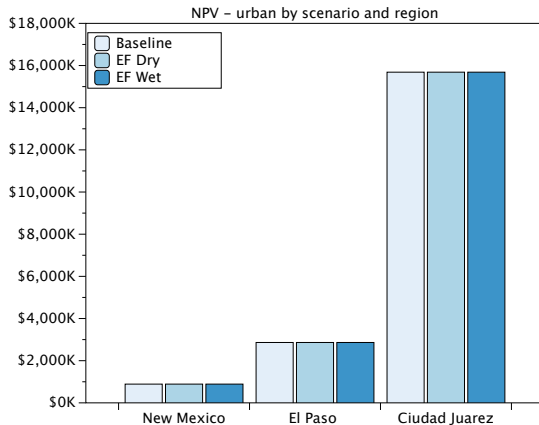
# Results: NPV where?

- Small changes in agriculture NPV, but just New Mexico



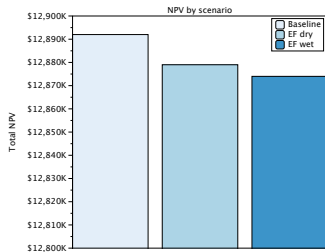
# Results: NPV where?

- All cities benefit from pulses
- Benefit more from pulses in wet years



# Results: Timing of flows

- So what's going on?
- We think:
  - Cities benefit from environmental pulses
  - EF in dry years recharge aquifers, lower pumping costs
  - Cities use groundwater





# Results summary: back to the questions

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- 3 Are there economically *better* or *worse* ways to time the pulse flows?
  - Dry years are an *OK* time to schedule pulses- aquifer recharge
  - Wet years are the *worst* time to schedule pulses- aquifers are most full

# Discussion, next steps

- Tease out results linked to the hydrology
- Climate scenarios, hydrological model estimate water supply, storage
- *Environmentally* are there better or worse ways to time pulse flows?
  - Recreational WTP from flows using discrete choice experiments
  - Use WTP and more simulations to trace out environmental MC and MB functions