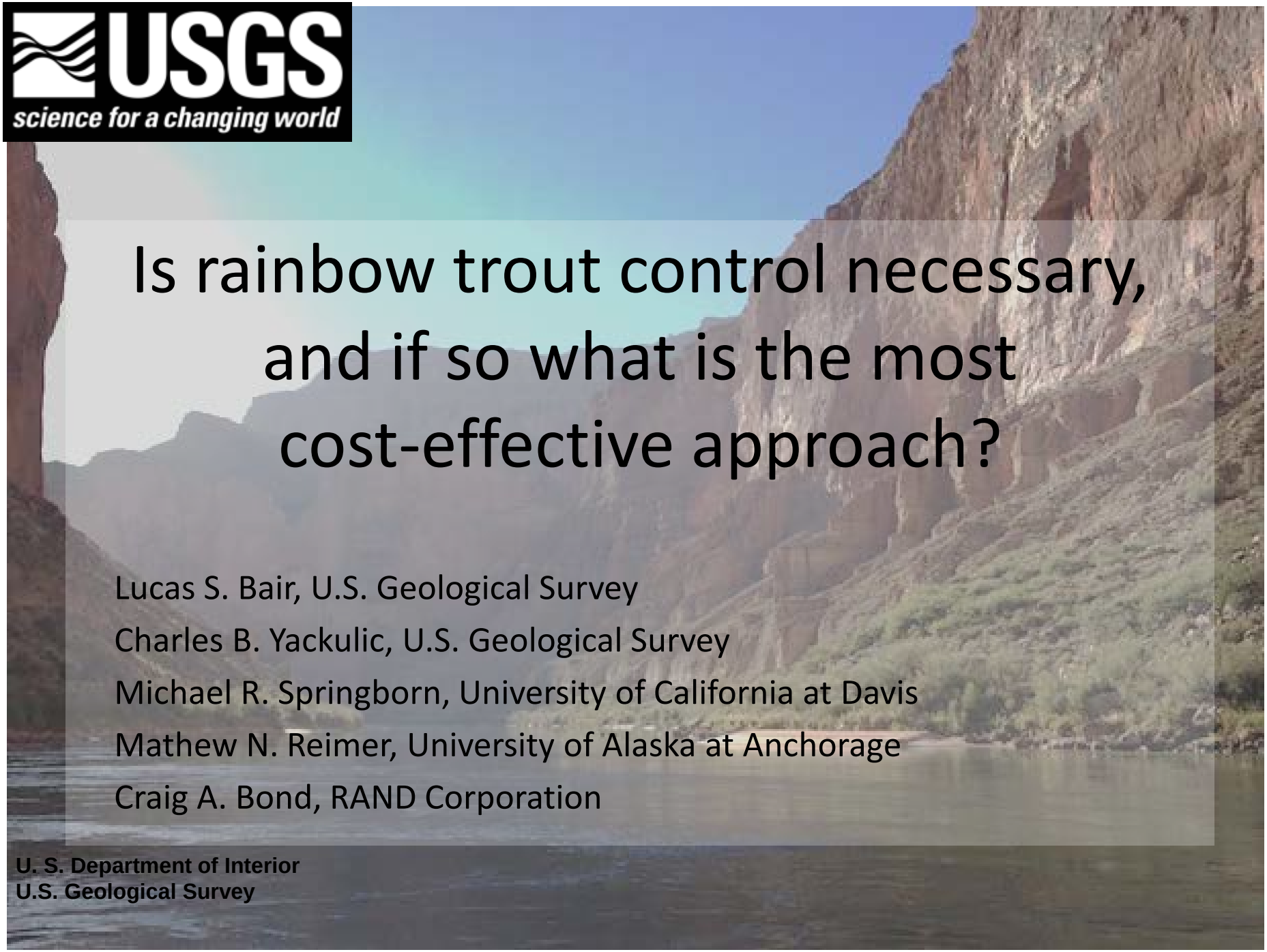


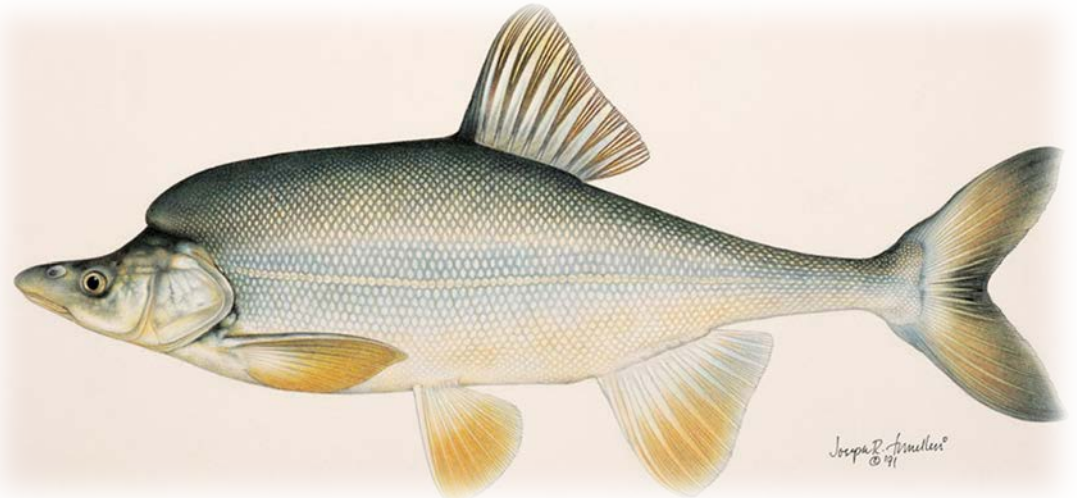
Is rainbow trout control necessary, and if so what is the most cost-effective approach?

Lucas S. Bair, U.S. Geological Survey
Charles B. Yackulic, U.S. Geological Survey
Michael R. Springborn, University of California at Davis
Mathew N. Reimer, University of Alaska at Anchorage
Craig A. Bond, RAND Corporation

U. S. Department of Interior
U.S. Geological Survey

Project 13.3: Applied Decision Methods

- Develop a bioeconomic model to identify the cost-effective management strategy for rainbow trout that achieves humpback chub population goals.



http://www.coloradoriverrecovery.org/general-information/the-fish/humpback-chub.html

USGS science for a changing world

Presentation Outline

- Importance of cost-effectiveness analysis
- Bioeconomic model with population and management components
- Ongoing and future workplan research

USGS science for a changing world

Cost-effectiveness Analysis

- Comparing the costs of alternative means to achieve goals set through a political or public process (Sagoff 2009)
- Example: Determine an operation at GCD that limits impact to hydropower while meeting recovery and long-term sustainability of downstream resources (Reclamation, 1996).

Sagoff, M. 2009. Regulatory review and cost-benefit analysis. Philosophy & Public Policy Quarterly. 29(3/4):21-26.

U.S. Department of the Interior. 1996. Operation of Glen Canyon Dam, Record of Decision. Upper Colorado Region, Salt Lake City, Utah.

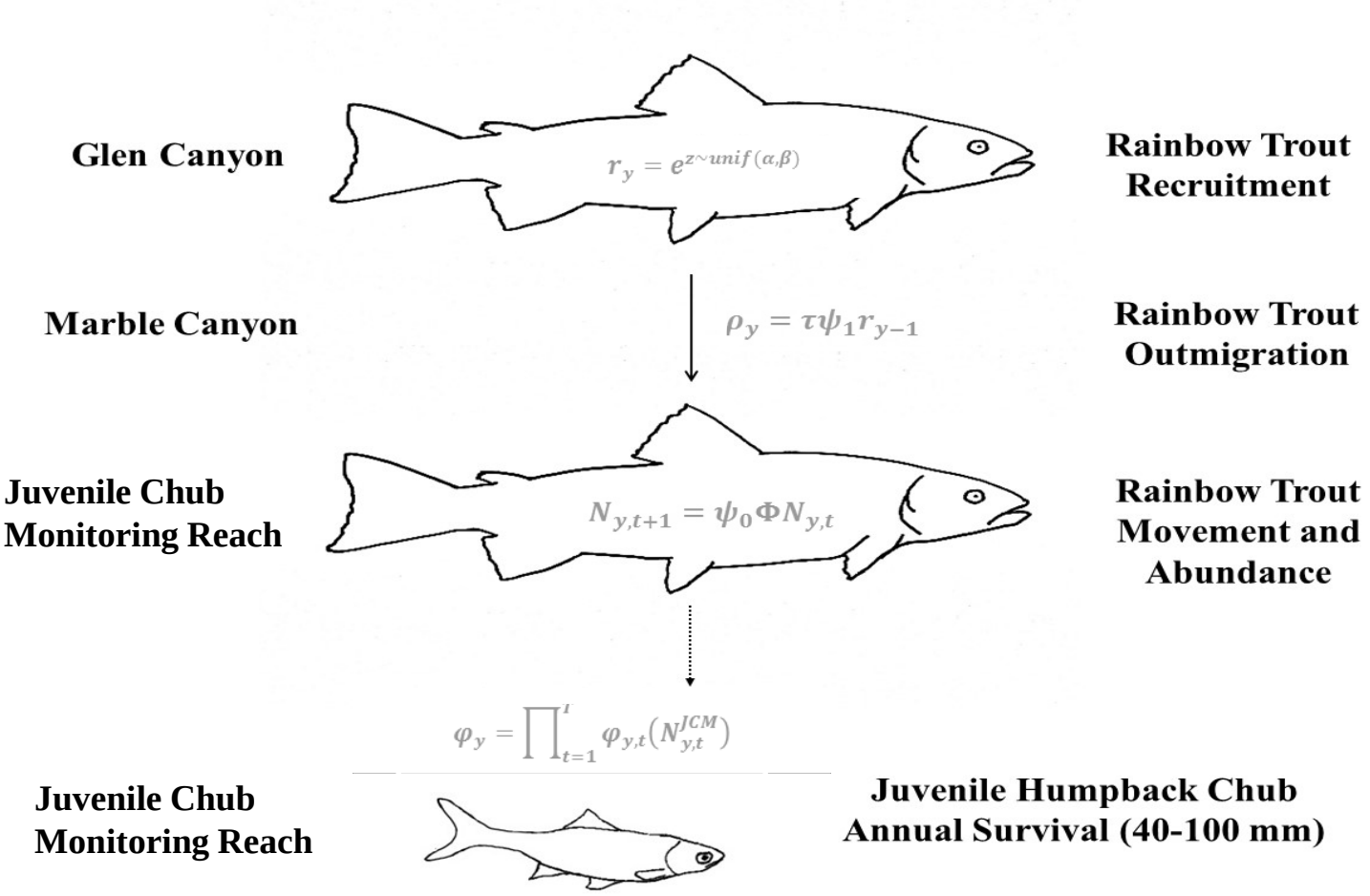
USGS science for a changing world

Presentation Outline

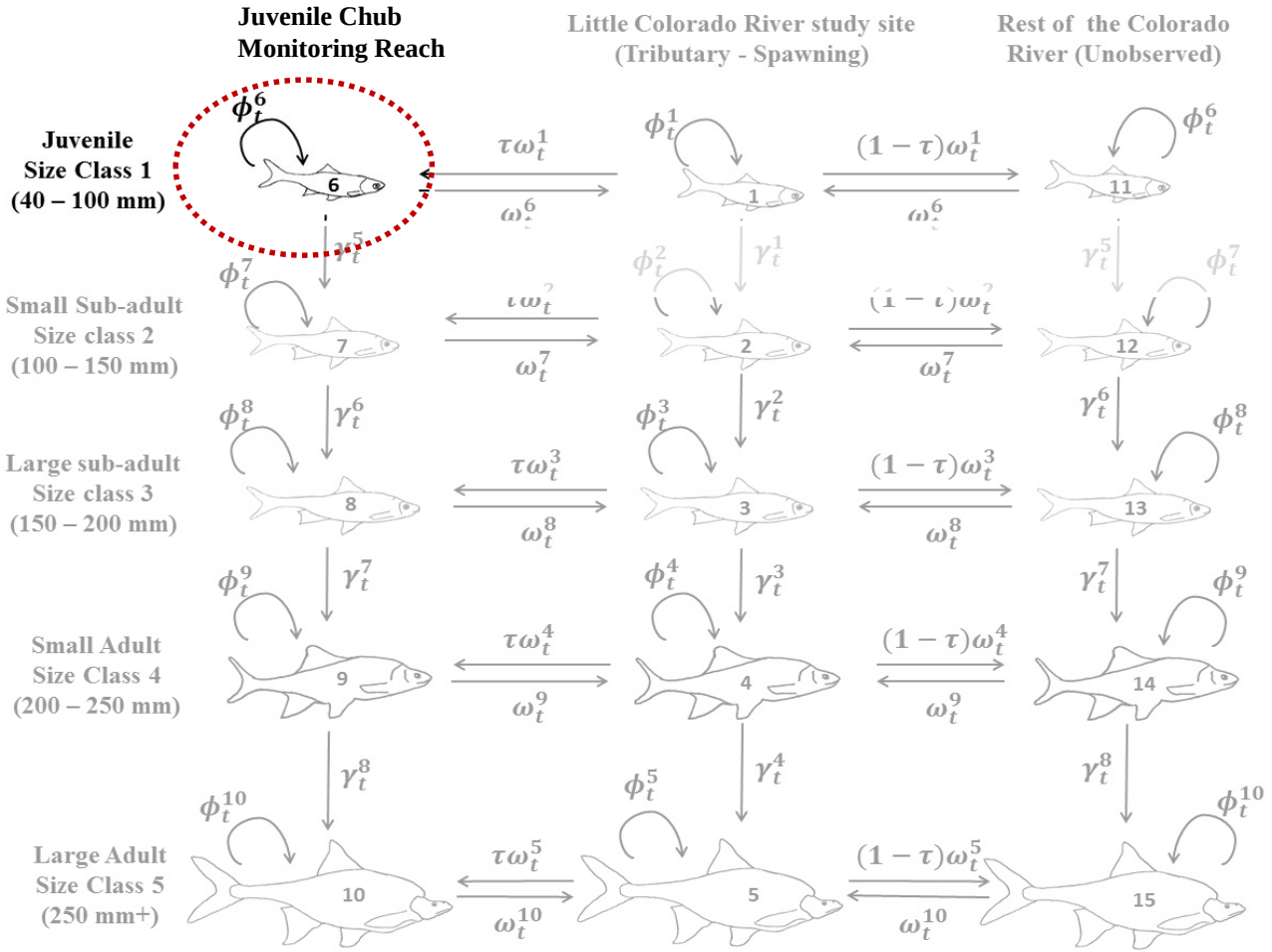
- Importance of cost-effectiveness analysis
- Bioeconomic model with population and management components
- Ongoing and future workplan research

USGS science for a changing world

Population Component



Humpback Chub (Gila cypha)



Summary of model parameters

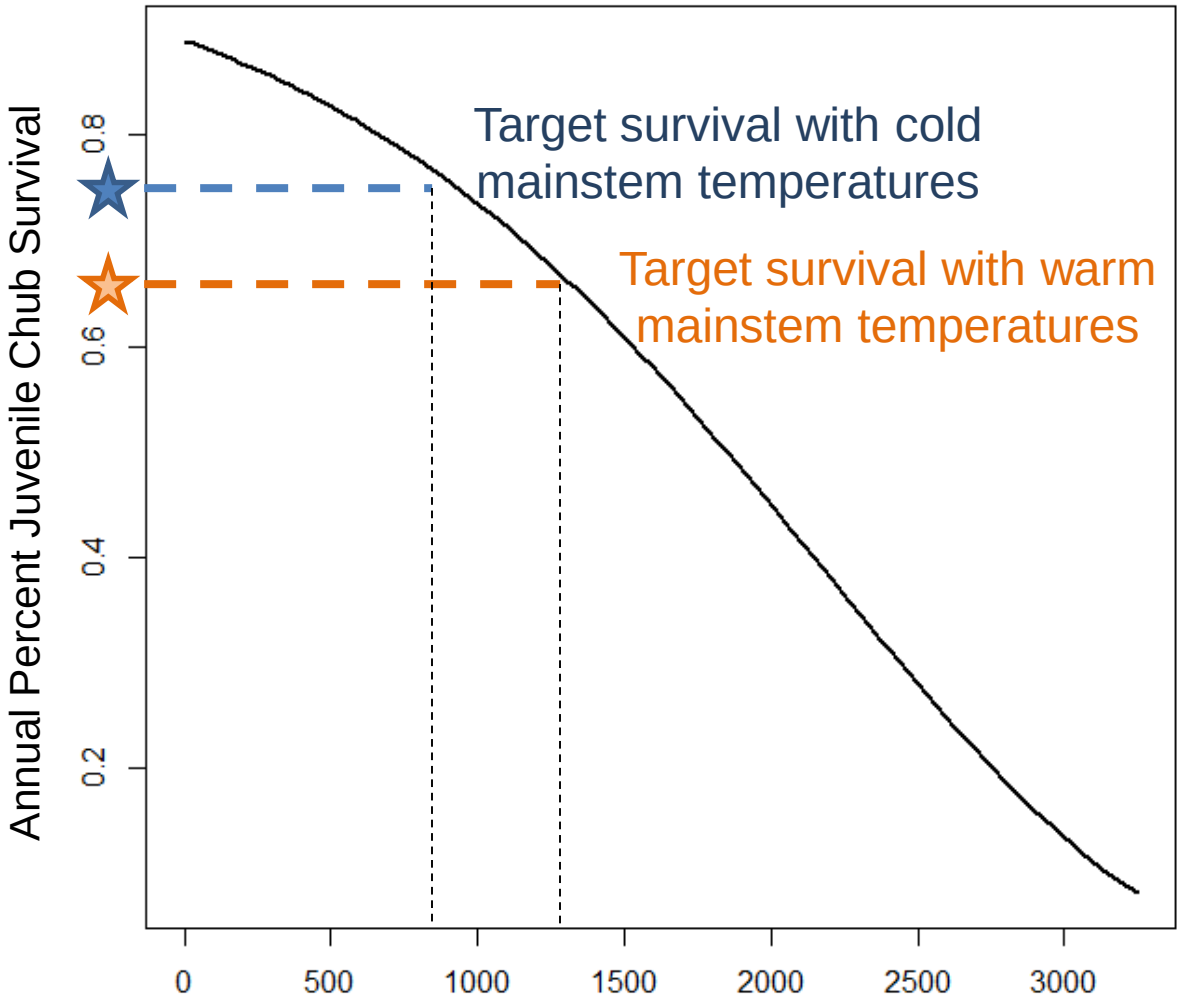
ϕ – survival ω – movement γ – size transition (growth)

τ – proportion of Colorado River fish in Colorado River HBC monitoring site

USGS science for a changing world

Adapted from: Yackulic, C. B., M.D., Yard, J. Korman, and D.R. Van Haverbeke. 2014. A quantitative life history of endangered humpback chub that spawn in the Little Colorado River: variation in movement, growth, and survival. Ecology and Evolution 4(7): 1006-1018.

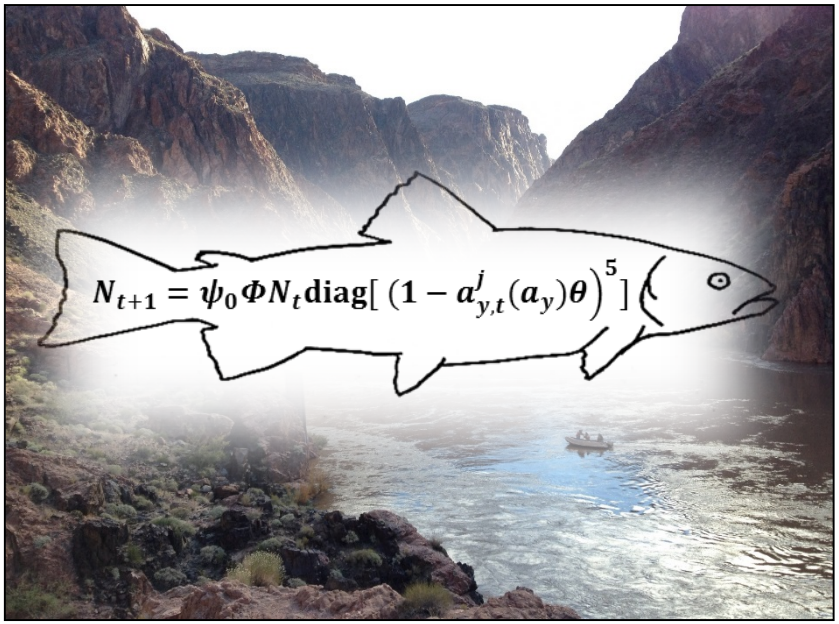
Juvenile Humpback Chub Survival



Preliminary data, do not cite

Management Component

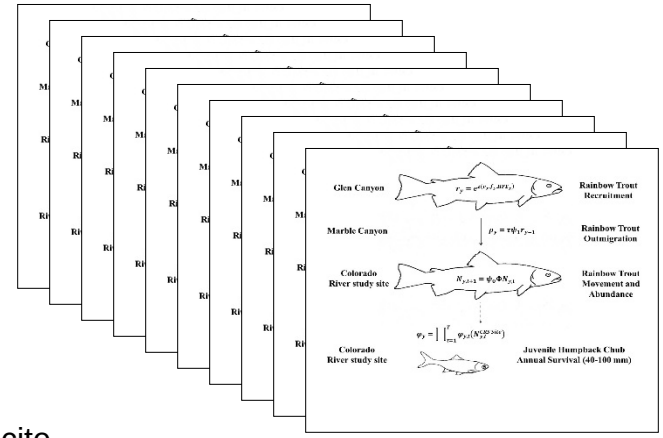
- Mechanical removal
  - Remove rainbow trout in the vicinity of JCM reach
  - Limit of one trip per month and six trips per year
- Minimize costs
  - Number of trips
  - Period of analysis



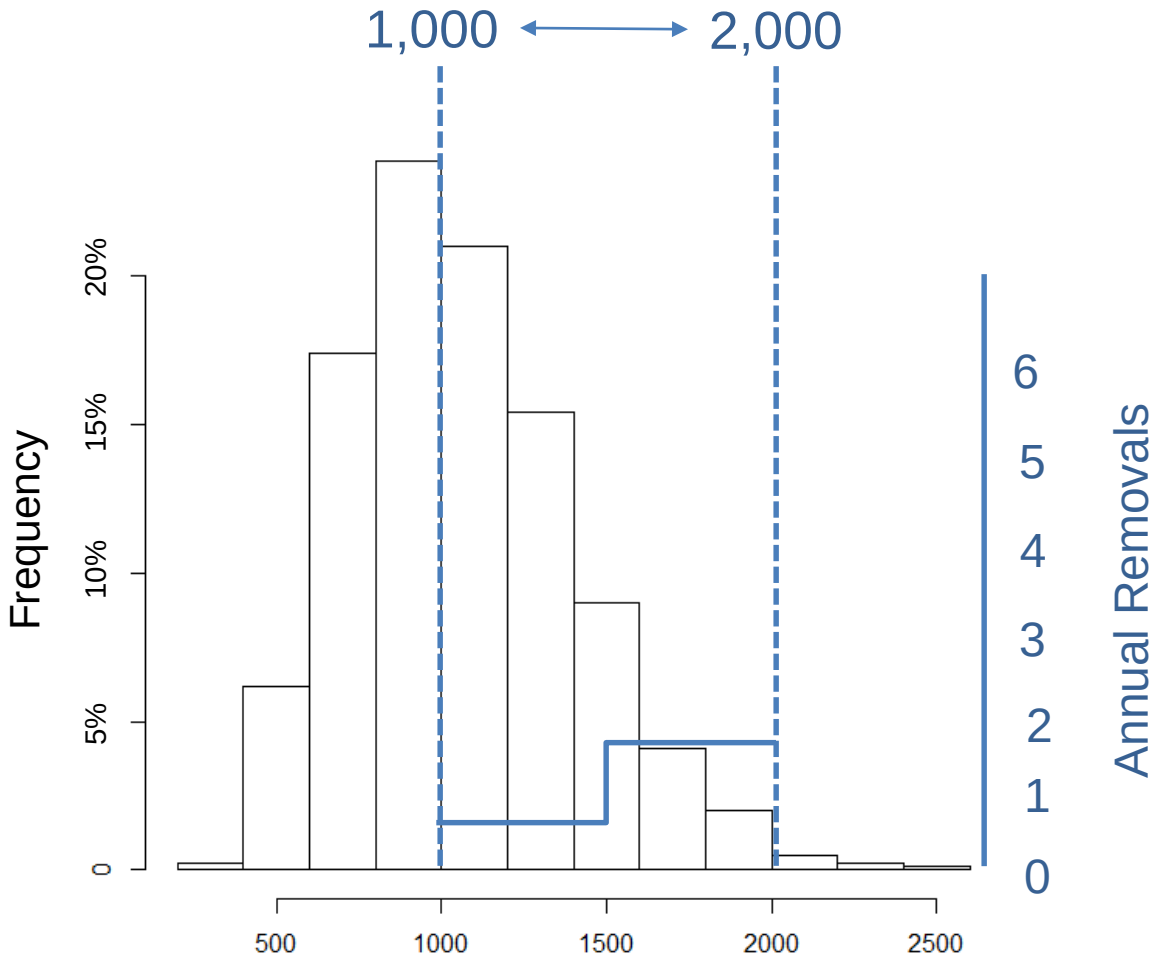
USGS science for a changing world

Bioeconomic Model

- Simulate population component over 20 year period with:
  - Random rainbow trout recruitment at Lees Ferry
  - Fixed policy strategy where removals are triggered by rainbow trout numbers in the juvenile humpback chub monitoring reach



Removal Options



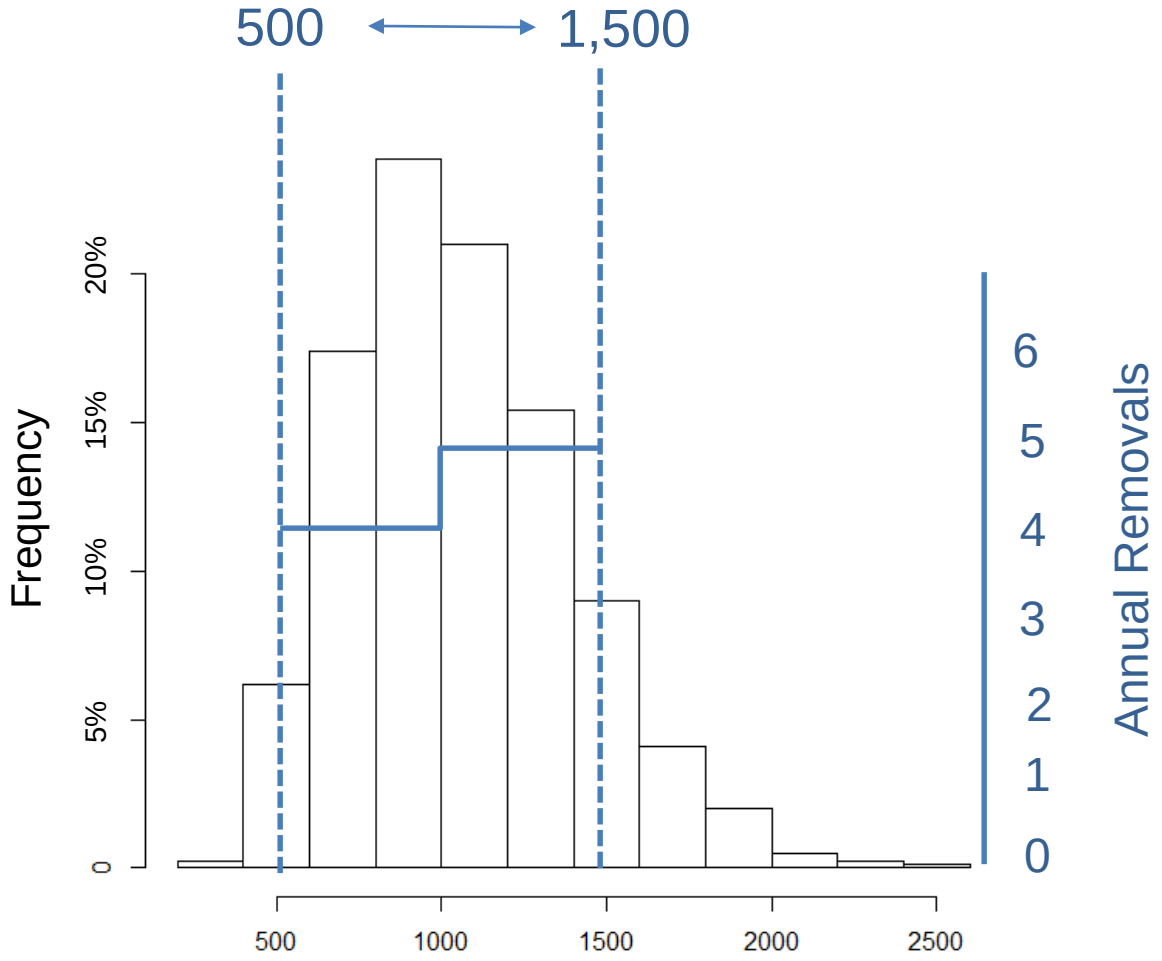
Expected Annual Trout in Juvenile Chub Monitoring Reach

Bioeconomic Model

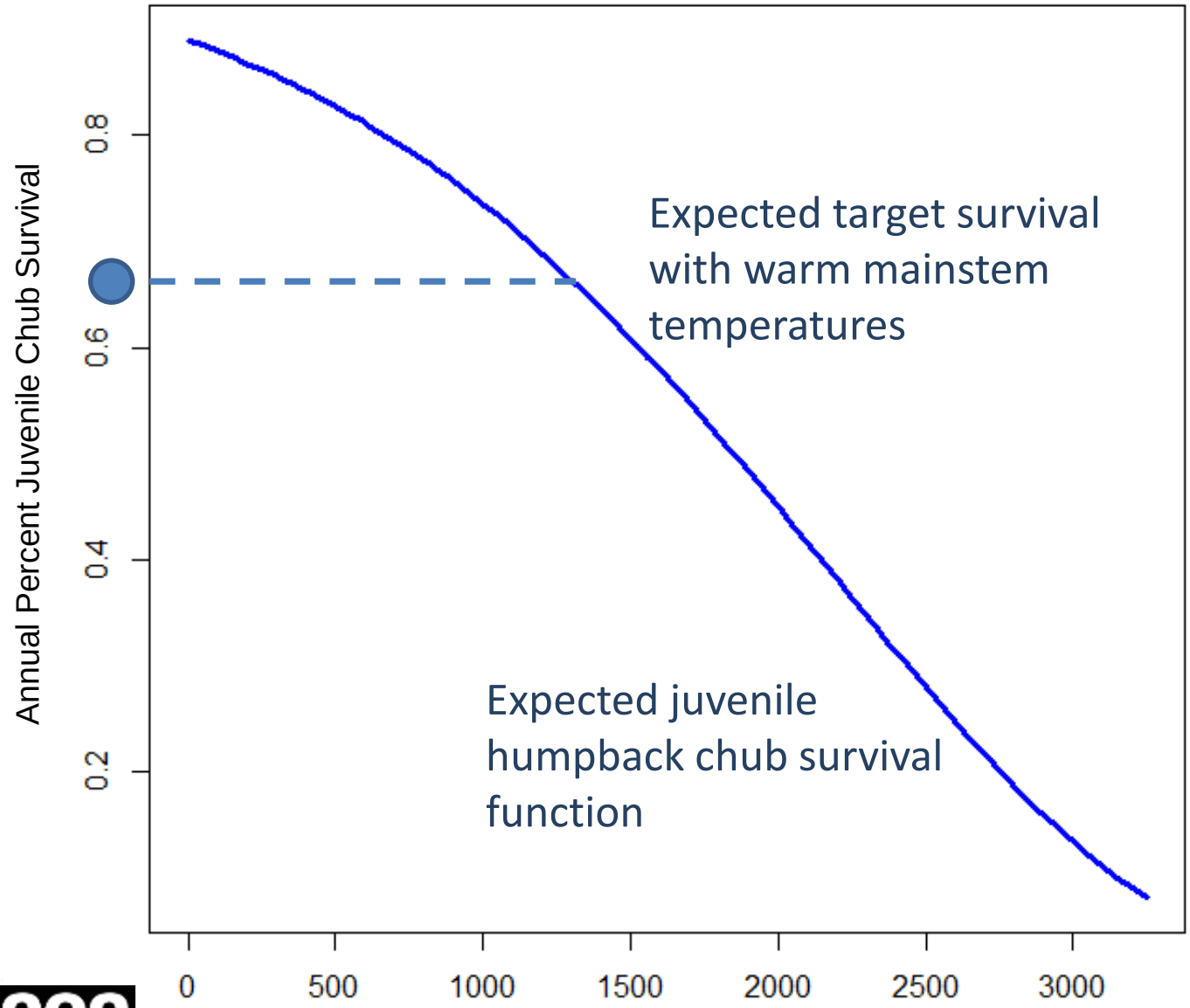
- Simulate population dynamics model over 20 year period with
  - Random rainbow trout recruitment at Lees Ferry
  - Fixed policy strategy where removals are triggered by rainbow trout numbers in the juvenile humpback chub monitoring reach
  - Rerun 1,000 times and identify the probability of meeting target survival and expected costs

USGS science for a changing world

Removal Options



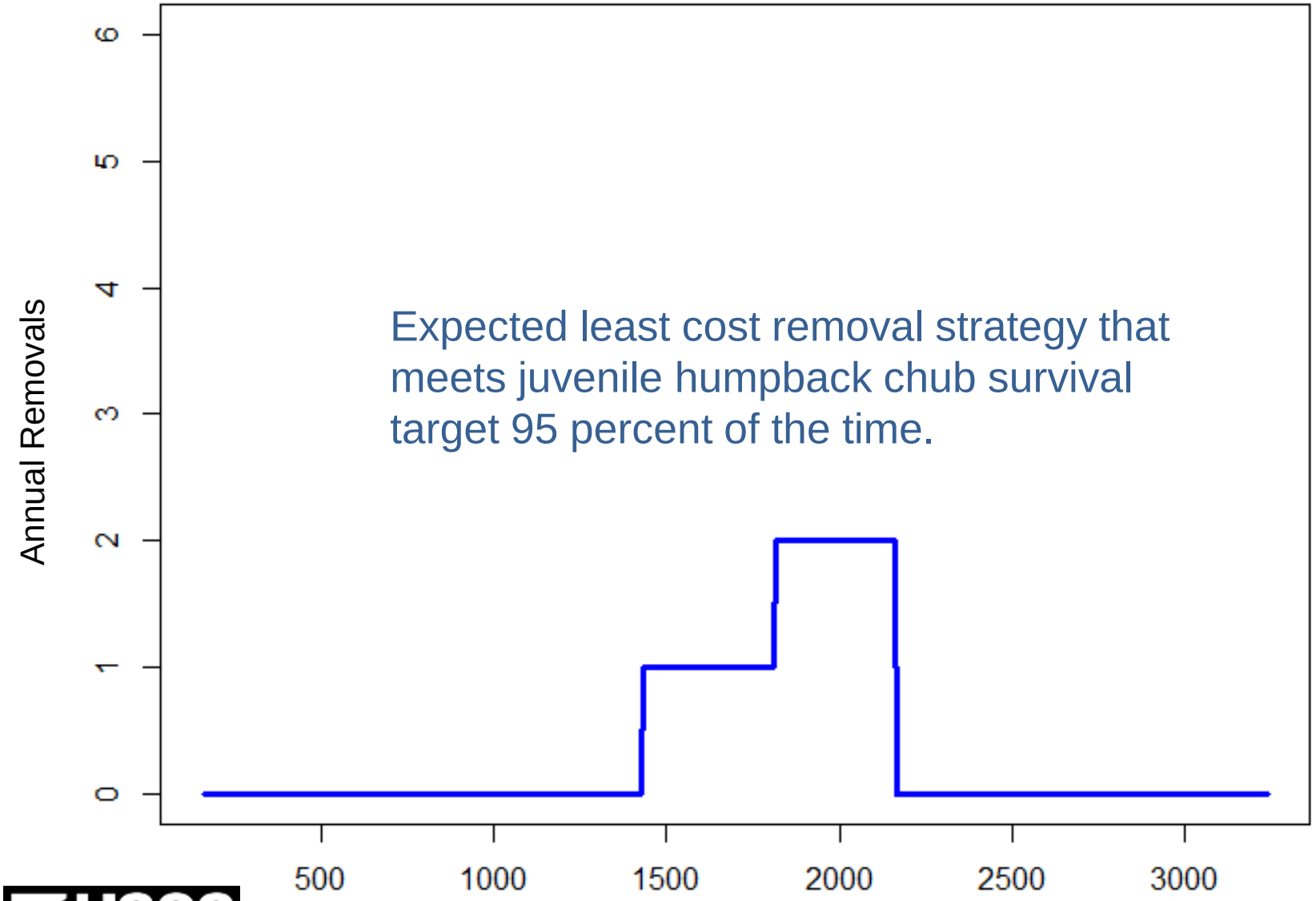
Expected Annual Trout in Juvenile Chub Monitoring Reach



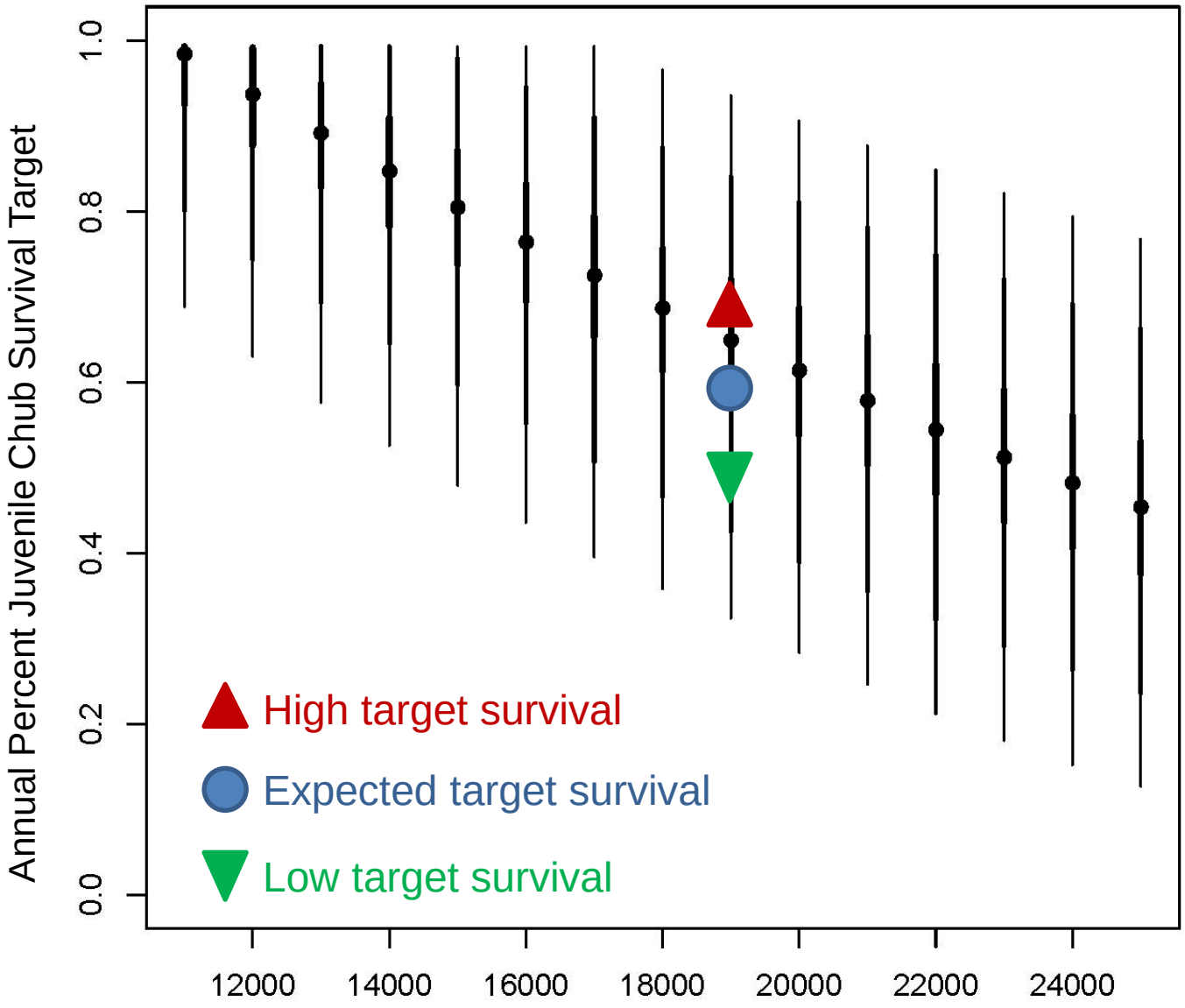
USGS science for a changing world

Trout in Juvenile Chub Monitoring Reach

Preliminary data, do not cite

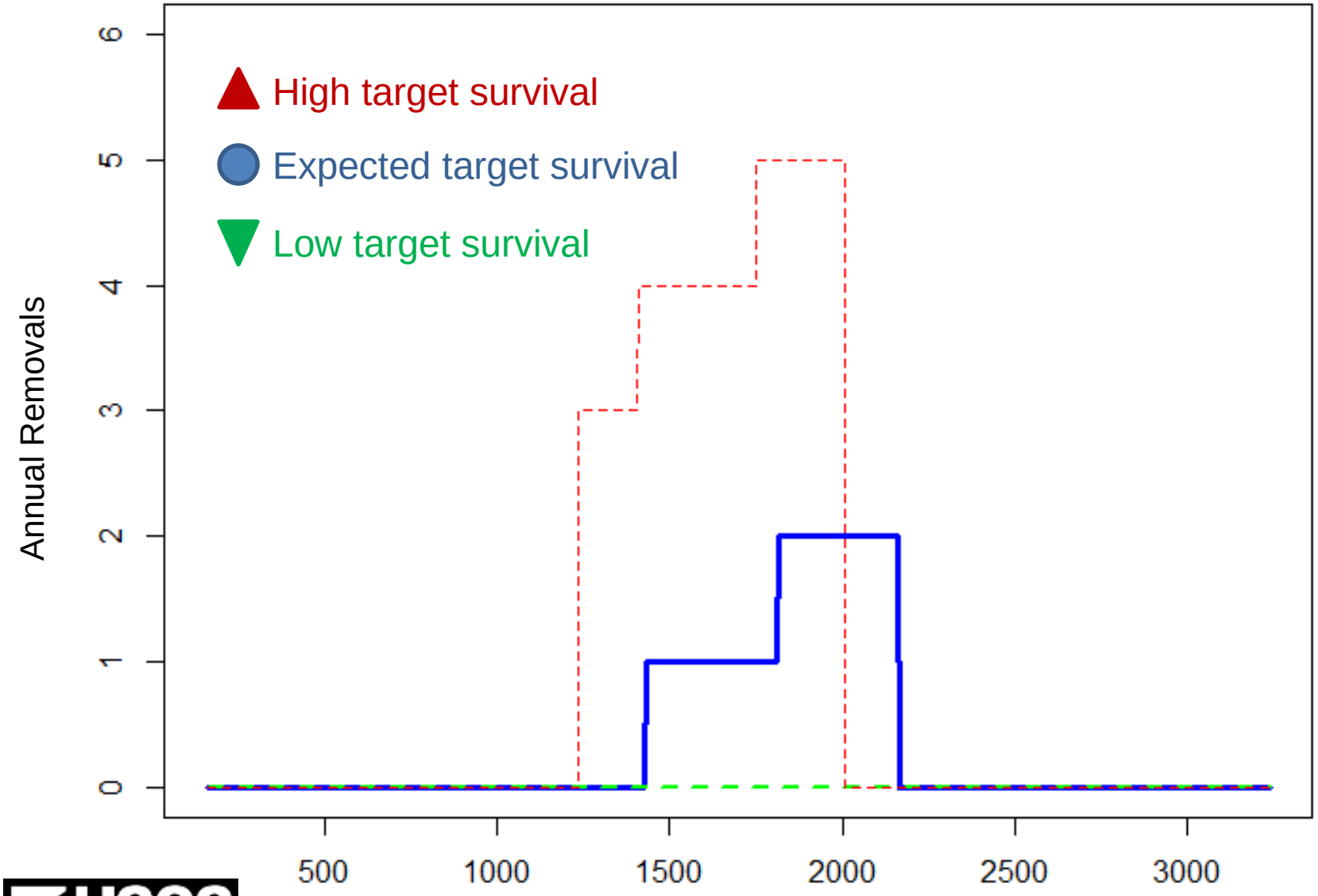


Preliminary data, do not cite



USGS science for a changing world

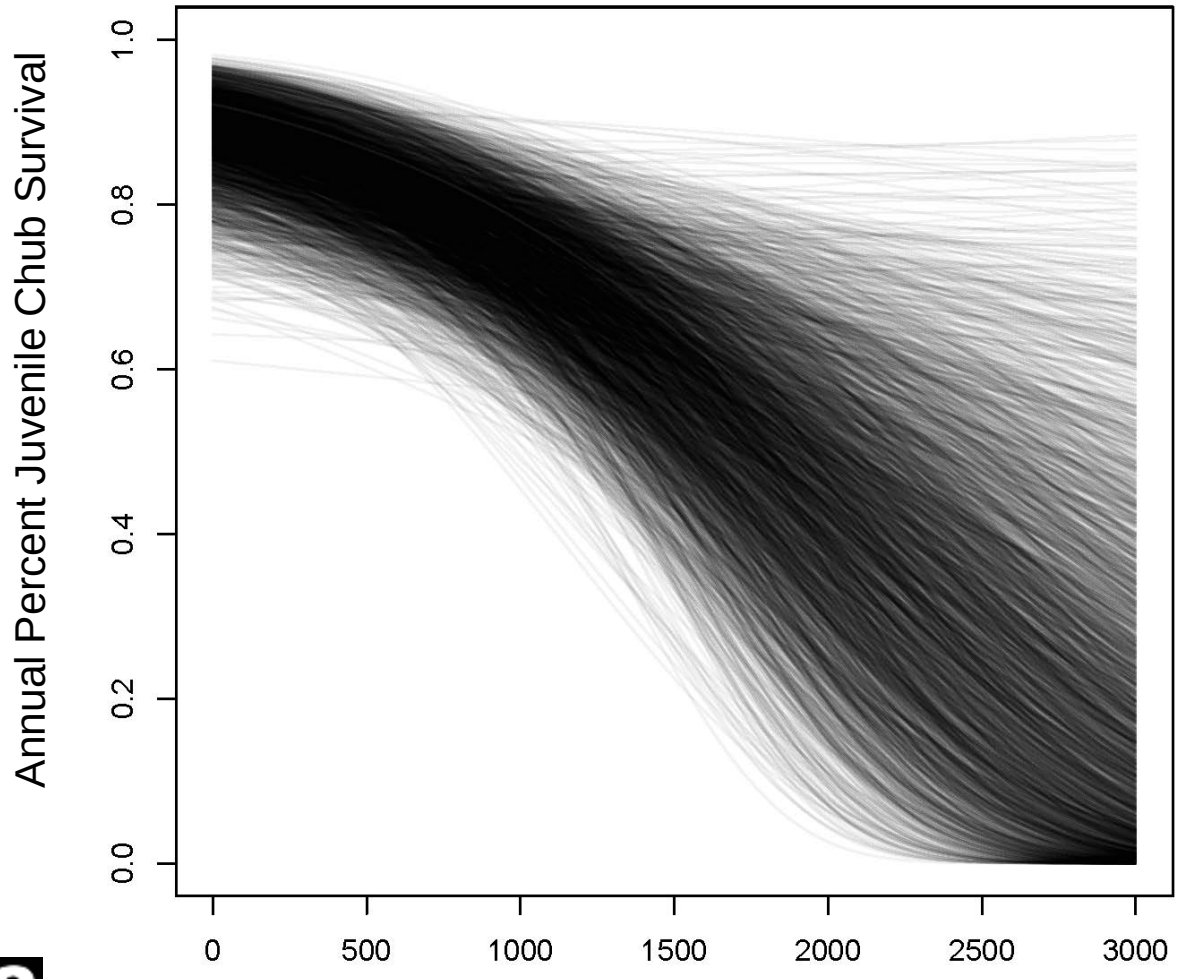
Preliminary data, do not cite



Observed Trout in Juvenile Chub Monitoring Reach

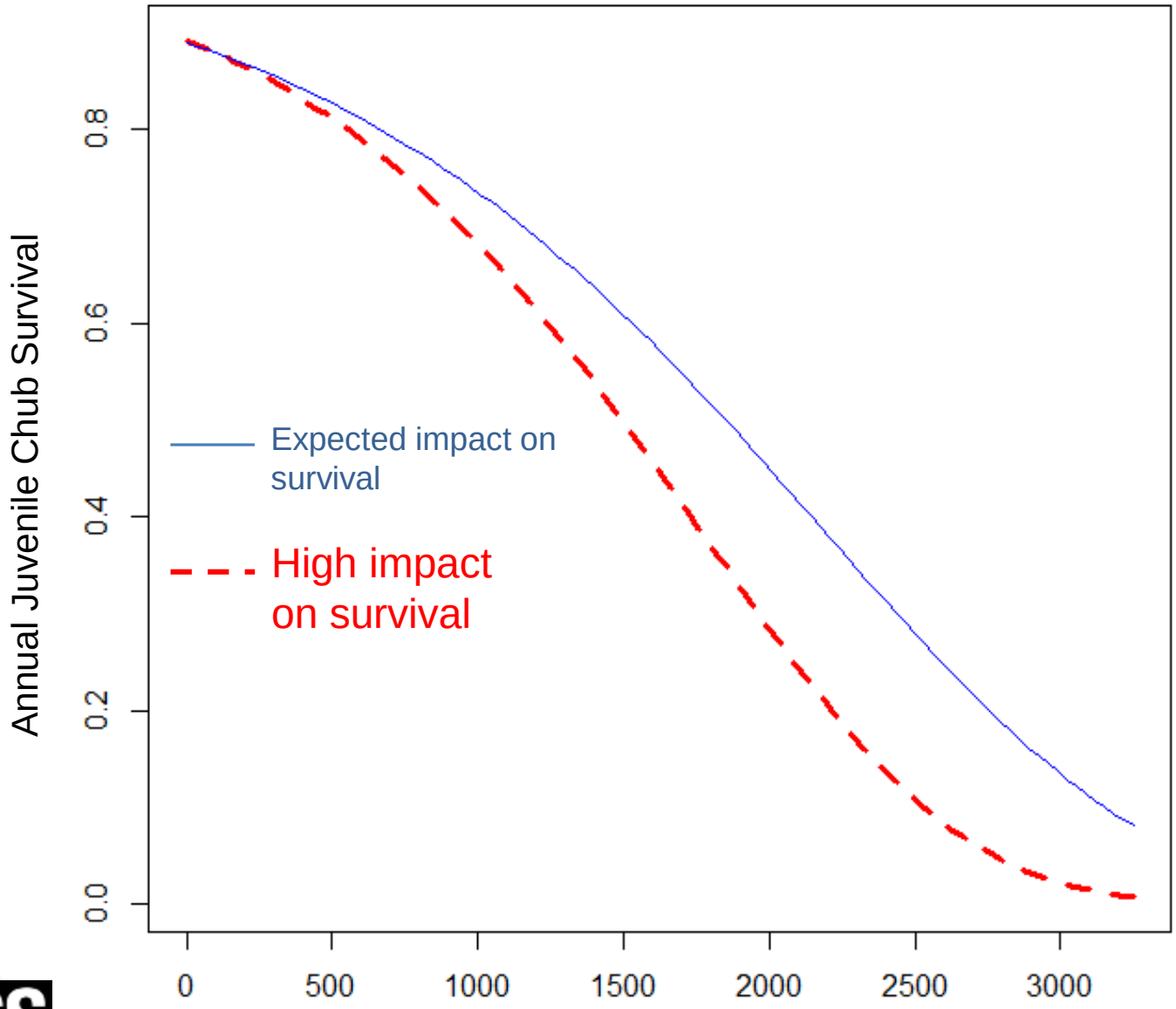
Preliminary data, do not cite

Uncertainty in the Chub-Trout Relationship

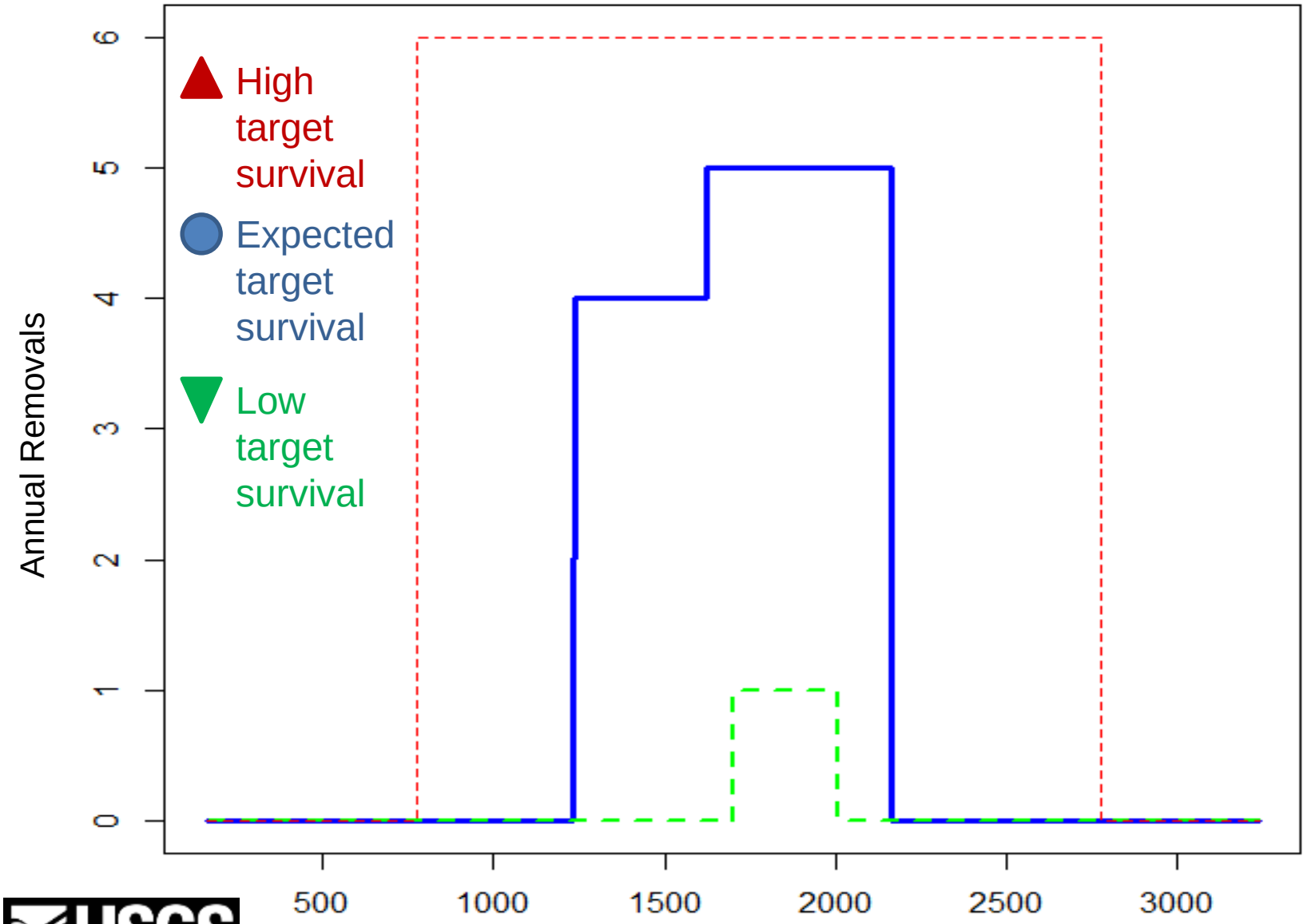


USGS science for a changing world

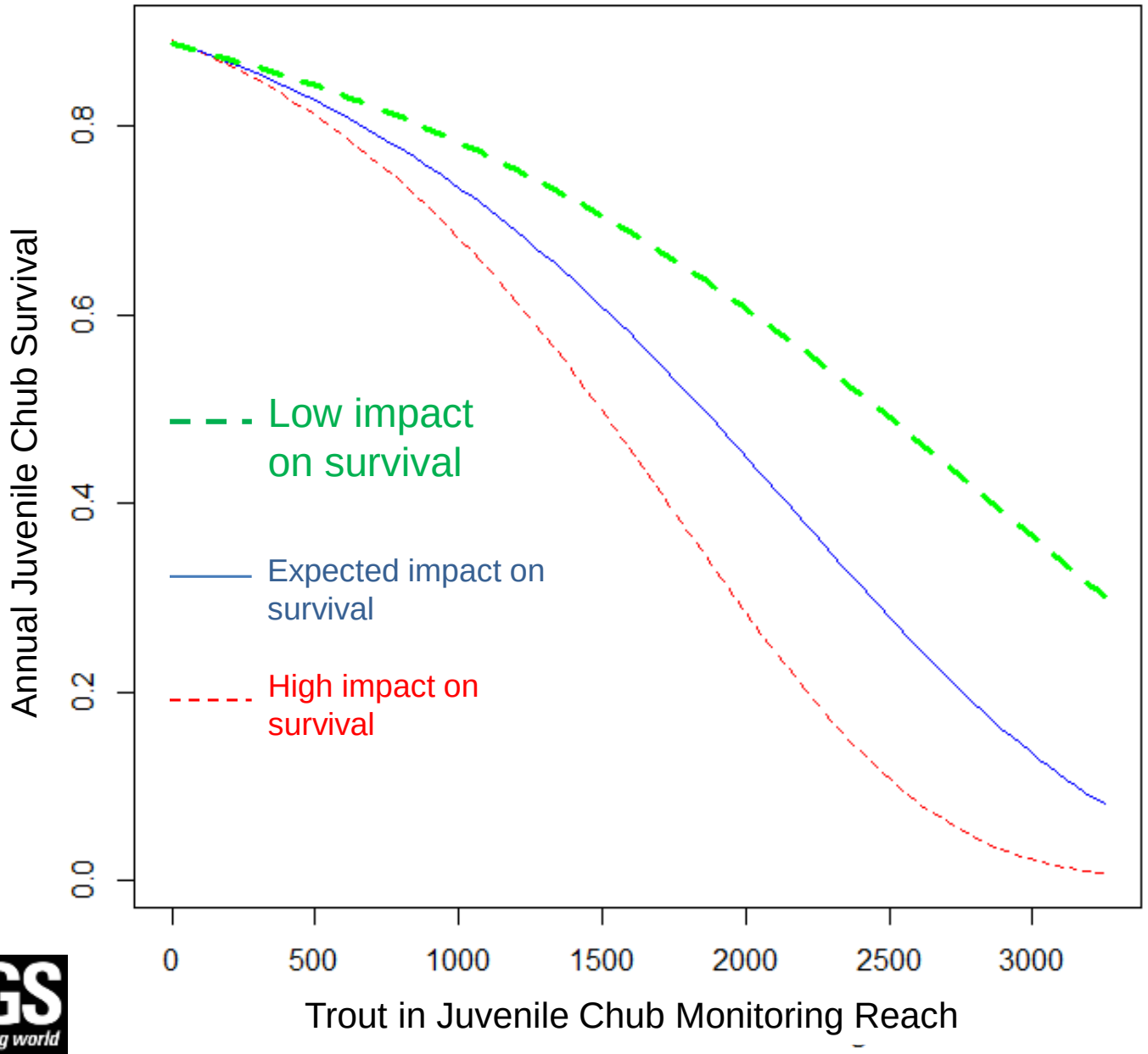
Preliminary data, do not cite



Preliminary data, do not cite



Preliminary data, do not cite



USGS science for a changing world

Preliminary data, do not cite

Presentation Outline

- Importance of cost-effectiveness analysis
- Bioeconomic model with population and management components
- Ongoing and future workplan research

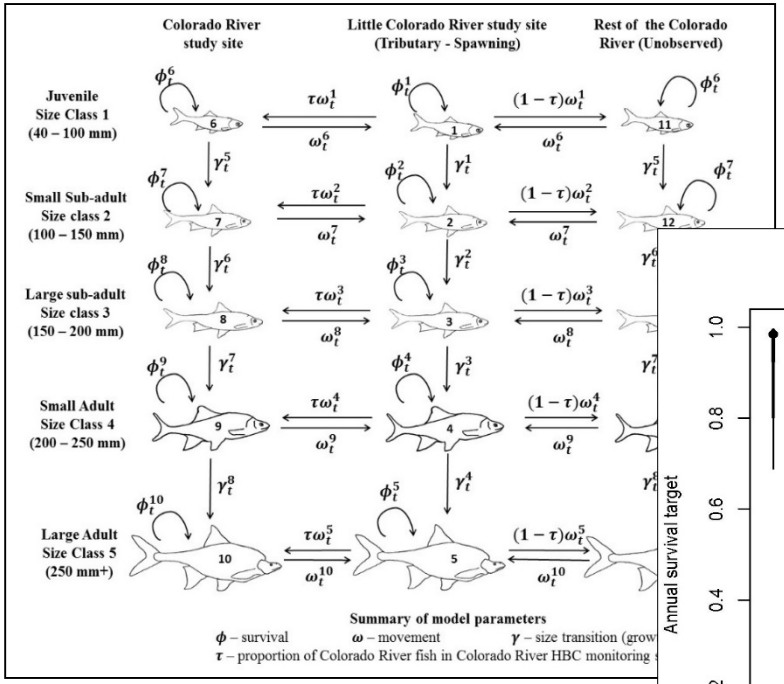
USGS science for a changing world

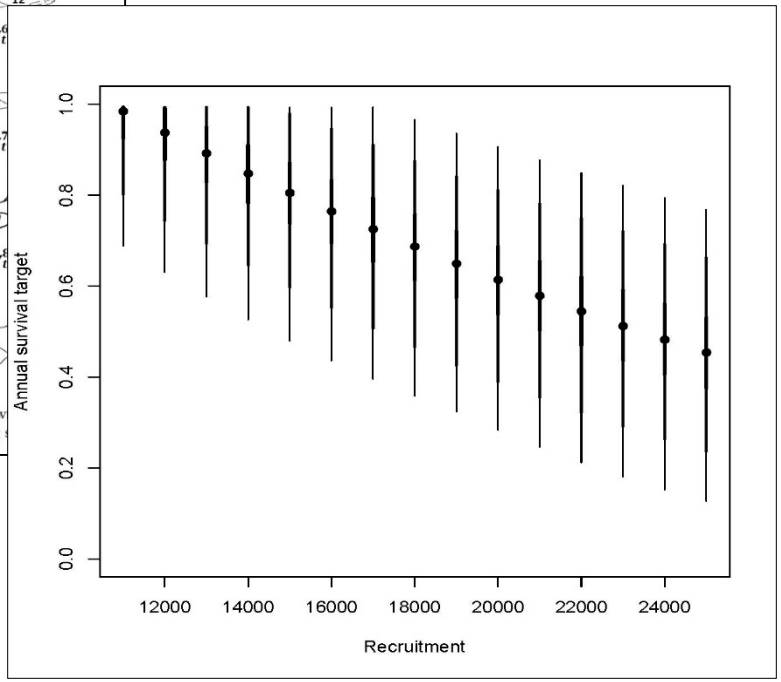
Ongoing Workplan Research

- Humpback chub population parameter uncertainty
  - Identify the importance of parameter uncertainty in prioritization of monitoring and research.
- Trout management flows
  - Incorporate additional management options and associated costs, such as trout management flows at GCD, to improve humpback chub survival.

USGS science for a changing world

Humpback Chub Uncertainty



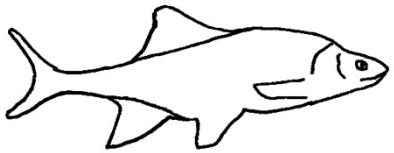


Adapted from: Yackulic, C. B., M.D., Yard, J. Korman, and D.R. Van Haverbeke. 2014. A quantitative life history of endangered humpback chub that spawn in the Little Colorado River: variation in movement, growth, and survival. Ecology and Evolution 4(7): 1006-1018.

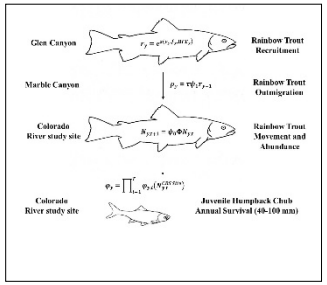
Preliminary data, do not cite

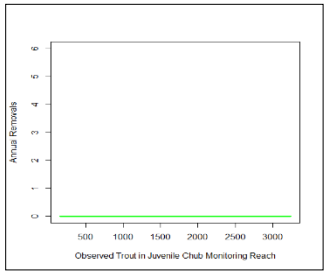
Parameter Uncertainty

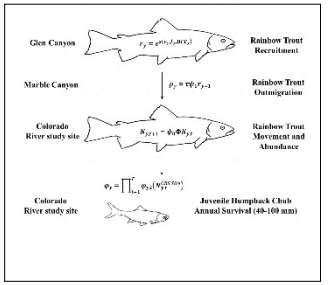
Low
Φ

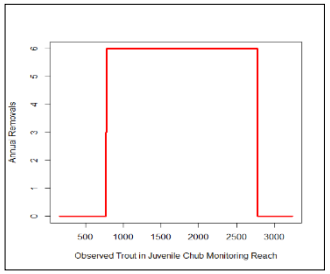


High
Φ



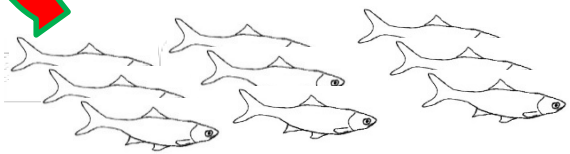




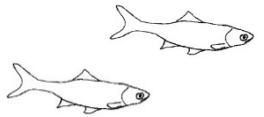


Predictive model

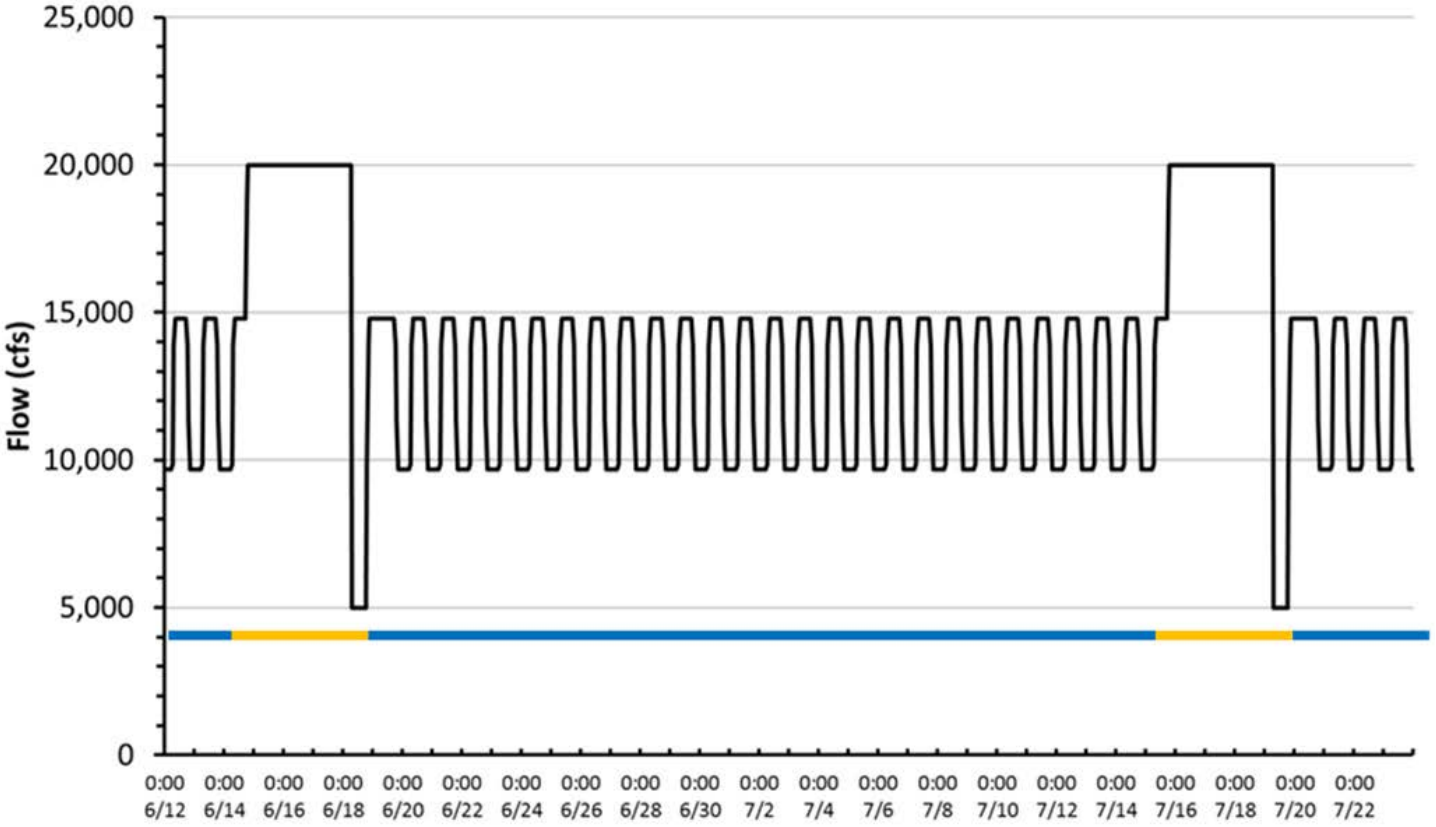
Optimal policy



$\neq$



Trout Management Flows



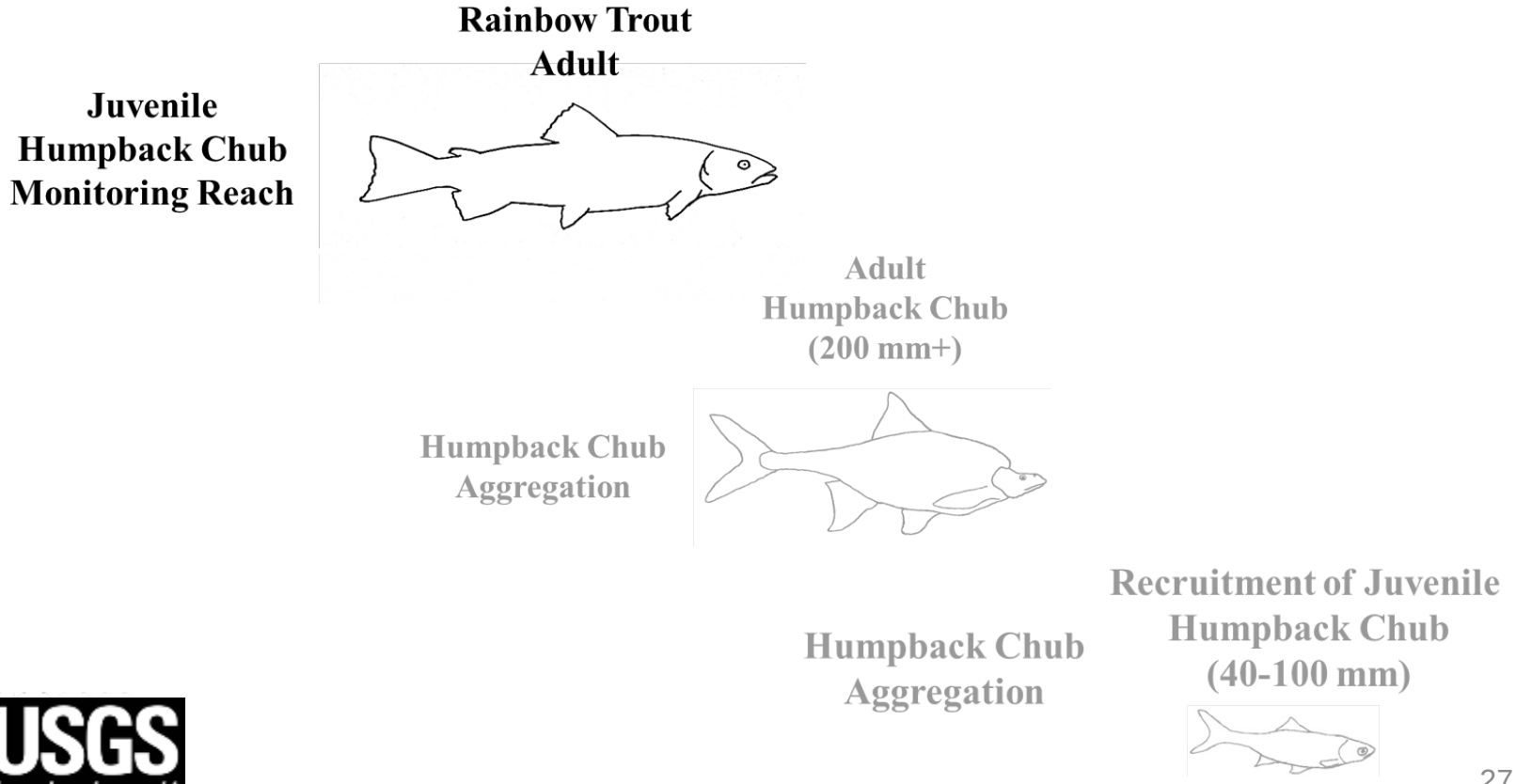
Example implementation of a two-cycle TMF in June and July with resumption of normal fluctuations between cycles and afterward

Adapted from: Glen Canyon Dam Long-Term Experimental and Management Plan December 2015 Draft Environmental Impact Statement http://ltempeis.anl.gov/documents/draft-eis/vol1/Chapter_2-Alternatives.pdf

USGS science for a changing world

Future Workplan Research

- Rainbow trout management triggers



Conclusions

- If trout removals are necessary, they are cost-effective when implemented under moderate trout numbers, not too high, not too low
- A bioeconomic approach is useful for prioritizing research and evaluating experiments (e.g., TMFs) or other management actions (e.g., removal triggers)

USGS science for a changing world