



# Example Metrics for the Long-Term Experimental and Management Plan

## Technical Work Group Meeting

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# Introduction

- LTEMP defines 11 goals
  - How do we know if goals are being achieved?
  - Need to define performance metrics!
- Section 6.1(c) of the LTEMP ROD\* states:

“The DOI, in consultation with the AMWG, will develop monitoring metrics for the goals and objectives using those in Appendix C as a starting point.”

(Note: Appendix C = performance metrics developed by Runge et al. (2016) to help select the preferred LTEMP alternative.)
- FY 21-23 TWP, Reclamation Project C.12

\* Department of Interior, 2016, Record of Decision for the Glen Canyon Dam Long Term Experimental and Management Plan Final Environmental Impact Statement, December 2016. Bureau of Reclamation, Upper Colorado River Region, Salt Lake City, Utah and National Park Service, Intermountain Region, Lakewood, Colorado.

# Metrics Project Objectives

- Determine technically feasible, sustainable metrics to provide objective measures of progress towards attaining the 11 LTEMP resource goals.
- Use metrics to periodically evaluate and report status of the 11 LTEMP resource goals relative to pre-LTEMP (pre-2016) condition and LTEMP projections.
  - Improve annual/cyclical reporting by distilling large amounts of scientific information into a set of standardized metrics that can be communicated to DOI managers and GCDAMP stakeholders via standardized methods and graphics on a regular (annual?) basis.
  - Inform other planning efforts (e.g., specify knowledge gaps in the context of resource goals).

# Draft Criteria for Selecting Metrics

- Reflects the expected performance outcome of each LTEMP goal or measures a performance outcome that triggers a compliance action or experiment
- Quantifiable (metric = measurable)
- Technically and financially feasible to measure
- Compatible with the metrics used to select LTEMP preferred alternative

# Metrics Description

- Metric Type: (direct observation, estimate based on model, etc.)
- Relevant Criteria: relationship to established criteria
- Data required: data needed to produce the metric
- Metric calculation: How will metric be calculated?
- Frequency: How often will the metric be measured?
- Presentation: How will the metric be presented graphically?
- Interpretation: How will the metric be interpreted (historic range, trend, thresholds?)
- Limitations and uncertainties of the metric

# Project Timeline: FY22

- October 2021 TWG:
  - GCMRC presents draft LTEMP performance metrics (sample)
  - TWG provides input during meeting; discussion of how best to graphically represent metrics to meet stakeholder needs.
  - Input from TWG (due end of October: Friday, 10/29/21)
- December 2021:
  - GCMRC pilots a sample of metrics in the FY2021 Annual Report, including sample graphics
- January 2022:
  - GCMRC solicits feedback from the TWG regarding sample reporting of metrics in the FY2021 Annual Report.
- February 2022:
  - GCMRC solicits feedback from the AMWG and DOI regarding the sample of reported metrics in the FY2021 Annual Report.

# Example Metrics for the Long-Term Experimental and Management Plan: Hydropower and Energy

# Hydropower and Energy

- **\*Resource Goal:** Maintain or increase Glen Canyon Dam electric energy generation, load following capability, and ramp rate capability, and minimize emissions and costs to the greatest extent practicable, consistent with improvement and long-term sustainability of downstream resources.
- Maximize the economic value of hydropower.

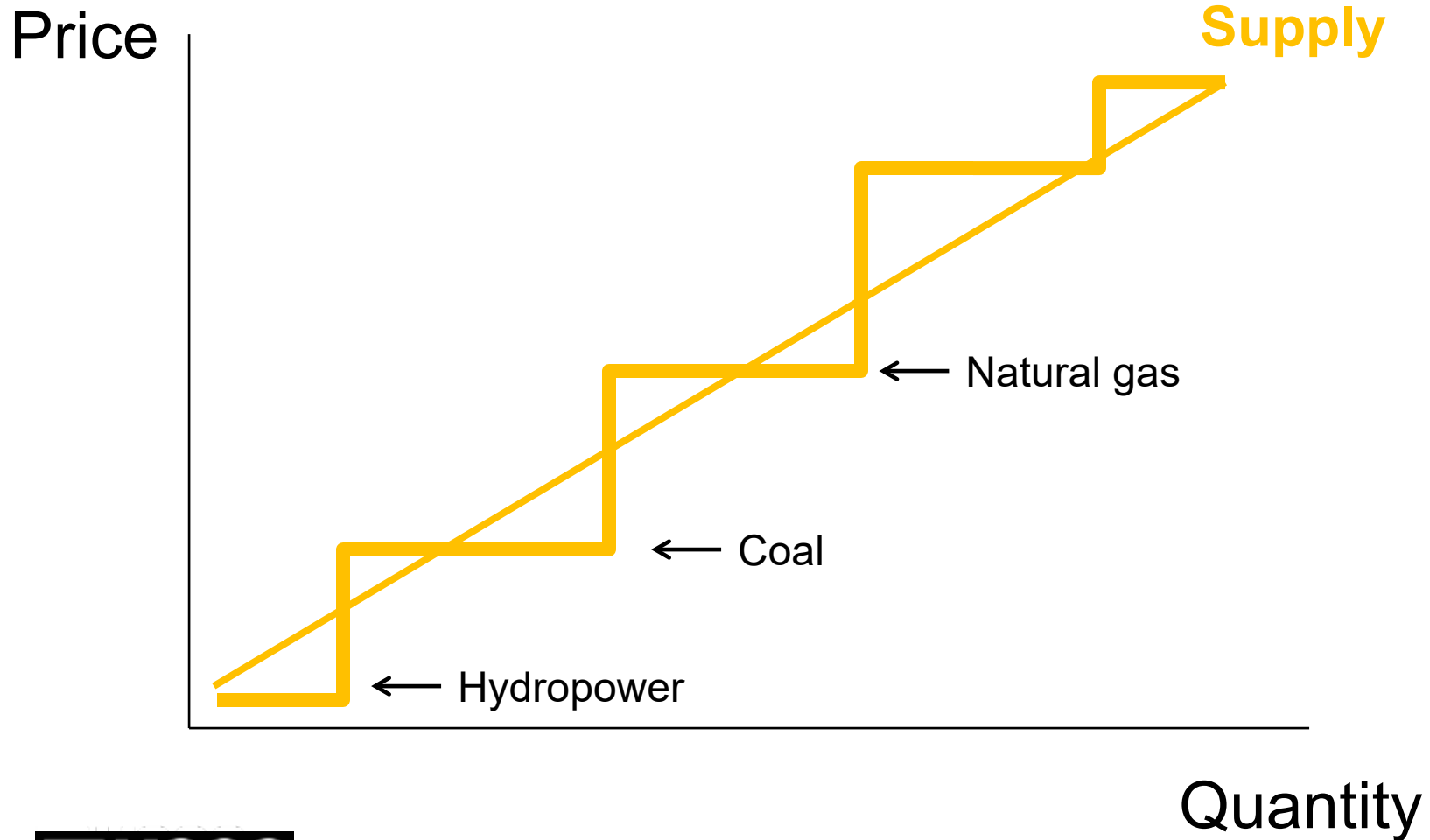


# Hydropower and Energy Metrics\*

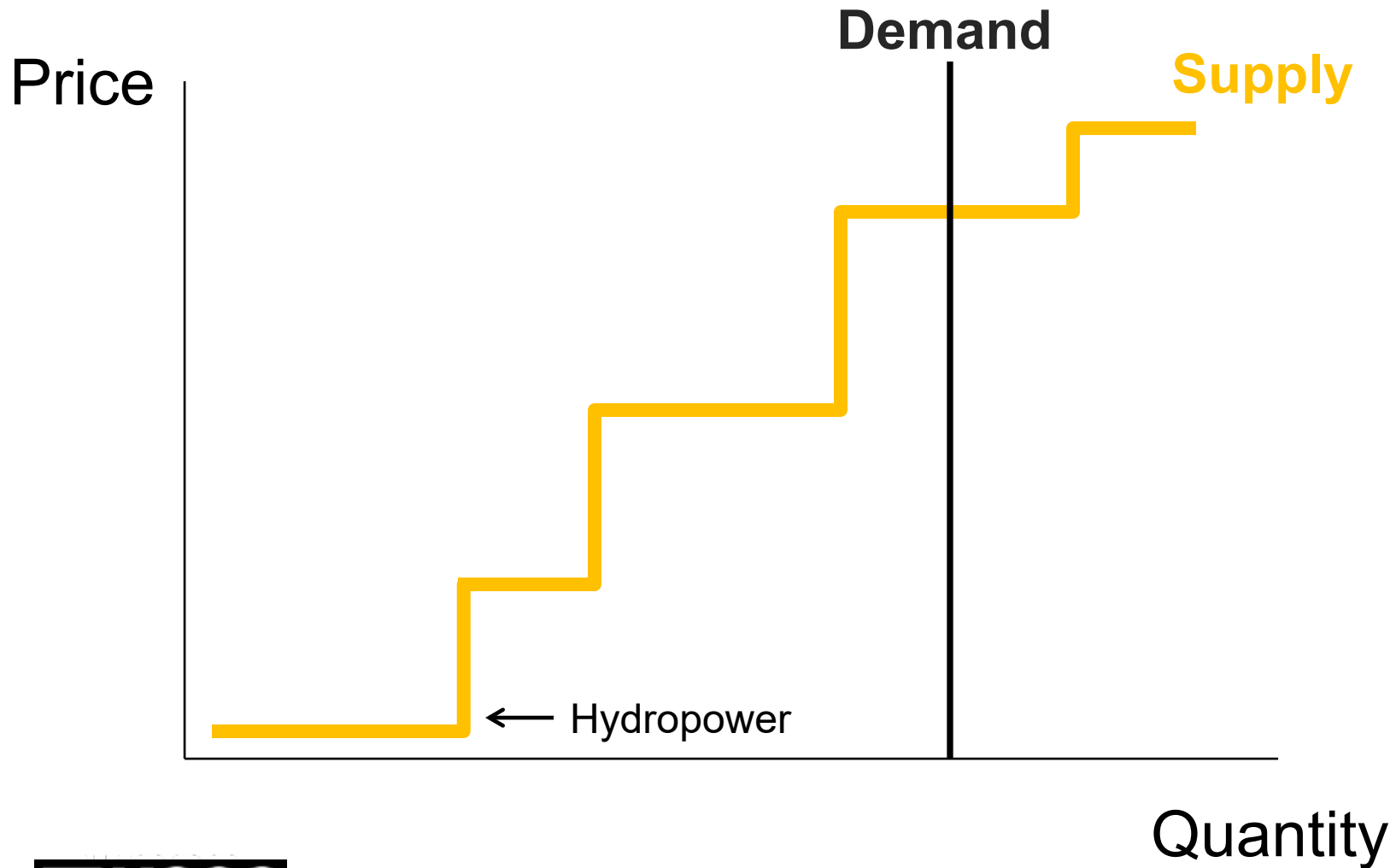
- Economic value of energy generation
  - Estimated using optimization model of GCD release and energy generation (e.g., GTMax)
- Economic value of generation capacity
  - Estimated using system model of the larger electricity sector and power system expansion costs

\* Runge, M.C., LaGory, K.E., Russell, Kendra, Balsom, J.R., Butler, R.A., Coggins, L.G., Jr., Grantz, K.A., Hayse, John, Hlohowskyj, Ihor, Korman, Josh, May, J.E., O'Rourke, D.J., Poch, L.A., Prairie, J.R., VanKuiken, J.C., Van Lonkhuyzen, R.A., Varyu, D.R., Verhaaren, B.T., Vesekla, T.D., Williams, N.T., Wuthrich, K.K., Yackulic, C.B., Billerbeck, R.P., and Knowles, G.W., 2015, Decision analysis to support development of the Glen Canyon Dam Long-Term Experimental and Management Plan: U.S. Geological Survey Scientific Investigations Report 2015–5176, 64 p., <http://dx.doi.org/10.3133/sir20155176>.

# Economic Value of Energy

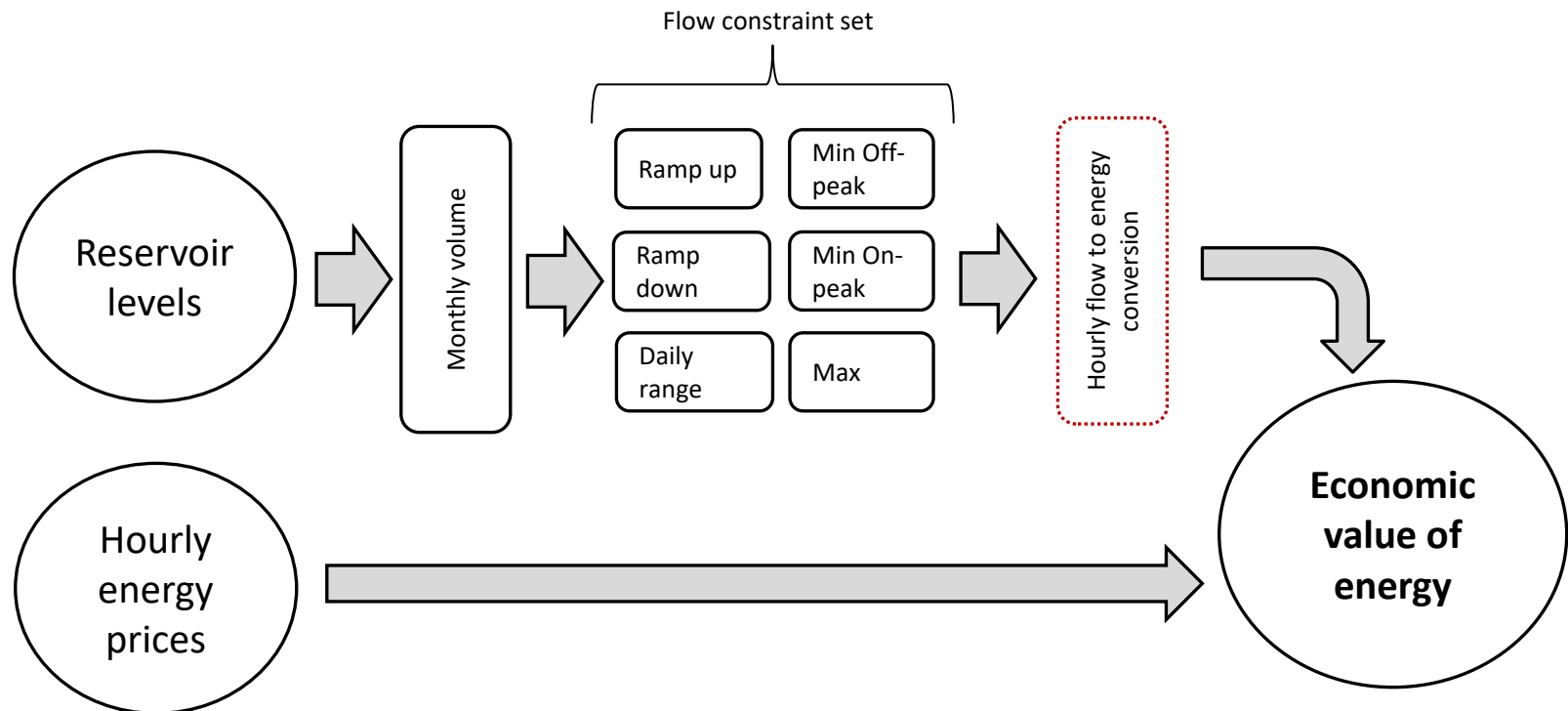


# Economic Value of Energy

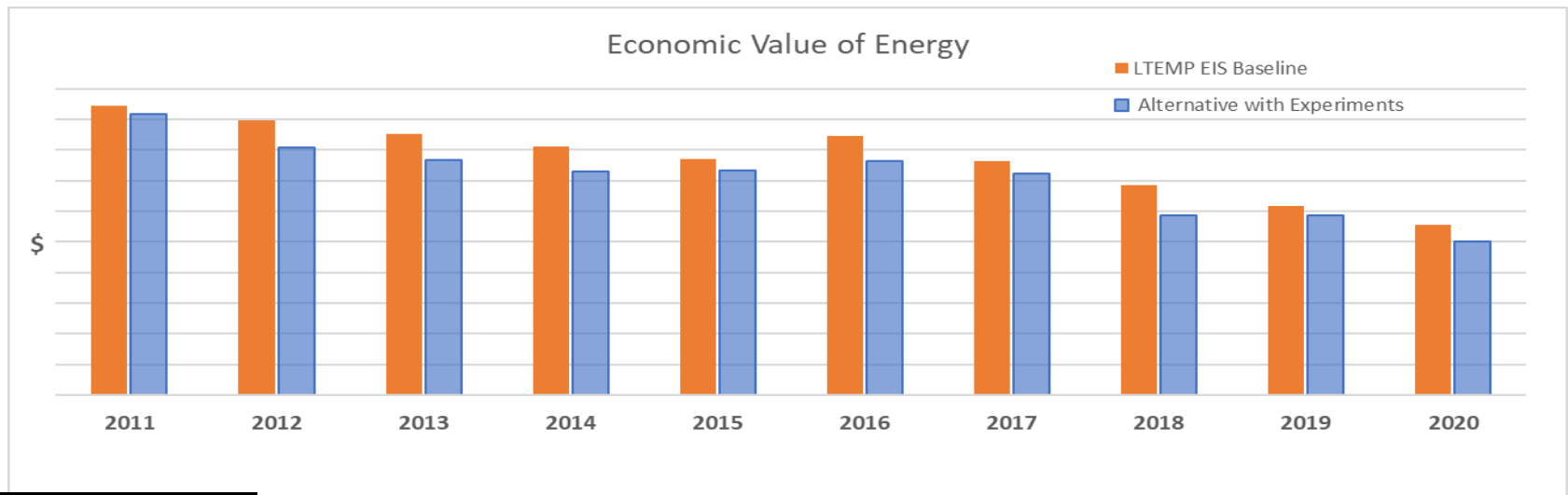
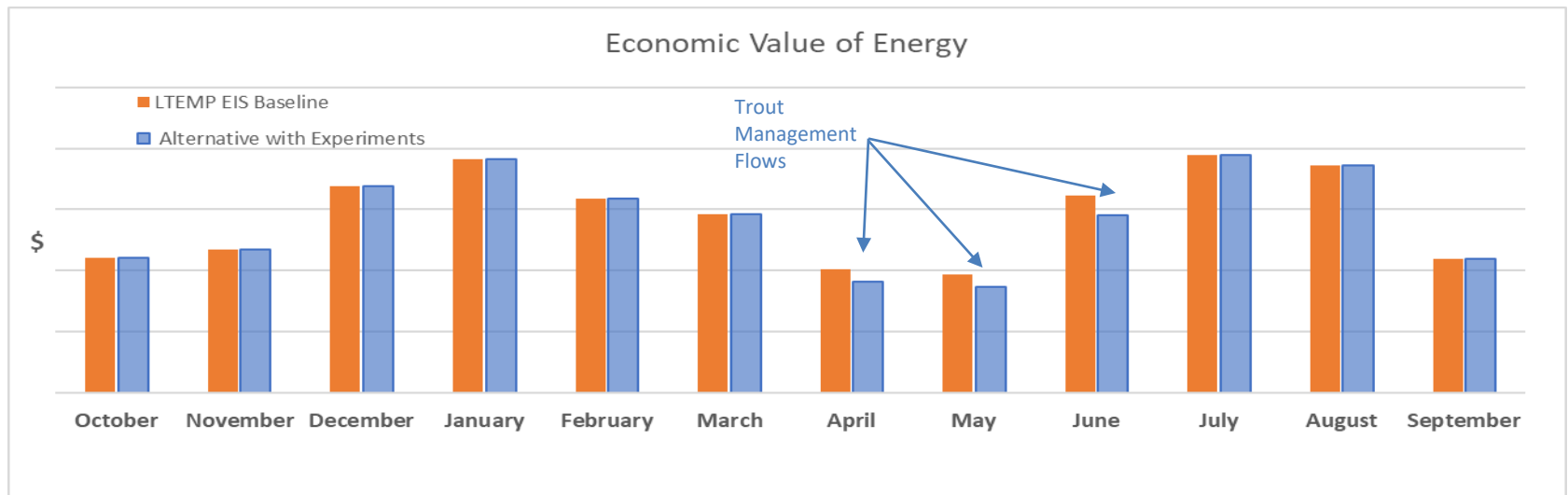


# Hydropower Objective

- Maximize the economic value of hydropower over time subject to operational constraints.



# Example Metric Presentation





# Example Metrics for the Long-Term Experimental and Management Plan: Recreational Experience



# Recreational Experience

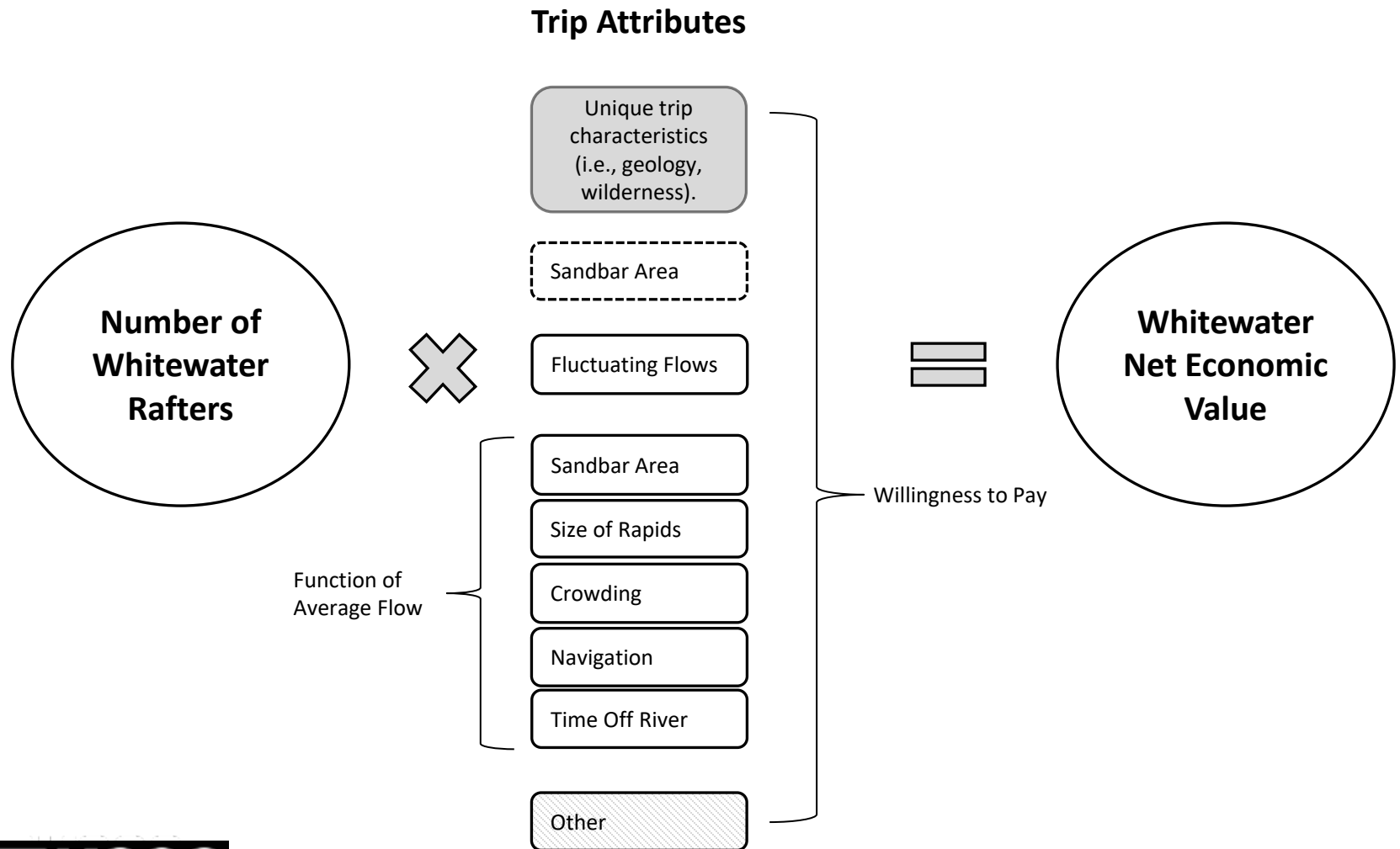
- **Resource Goal:** Maintain and improve the quality of recreational experiences for the users of the Colorado River ecosystem.







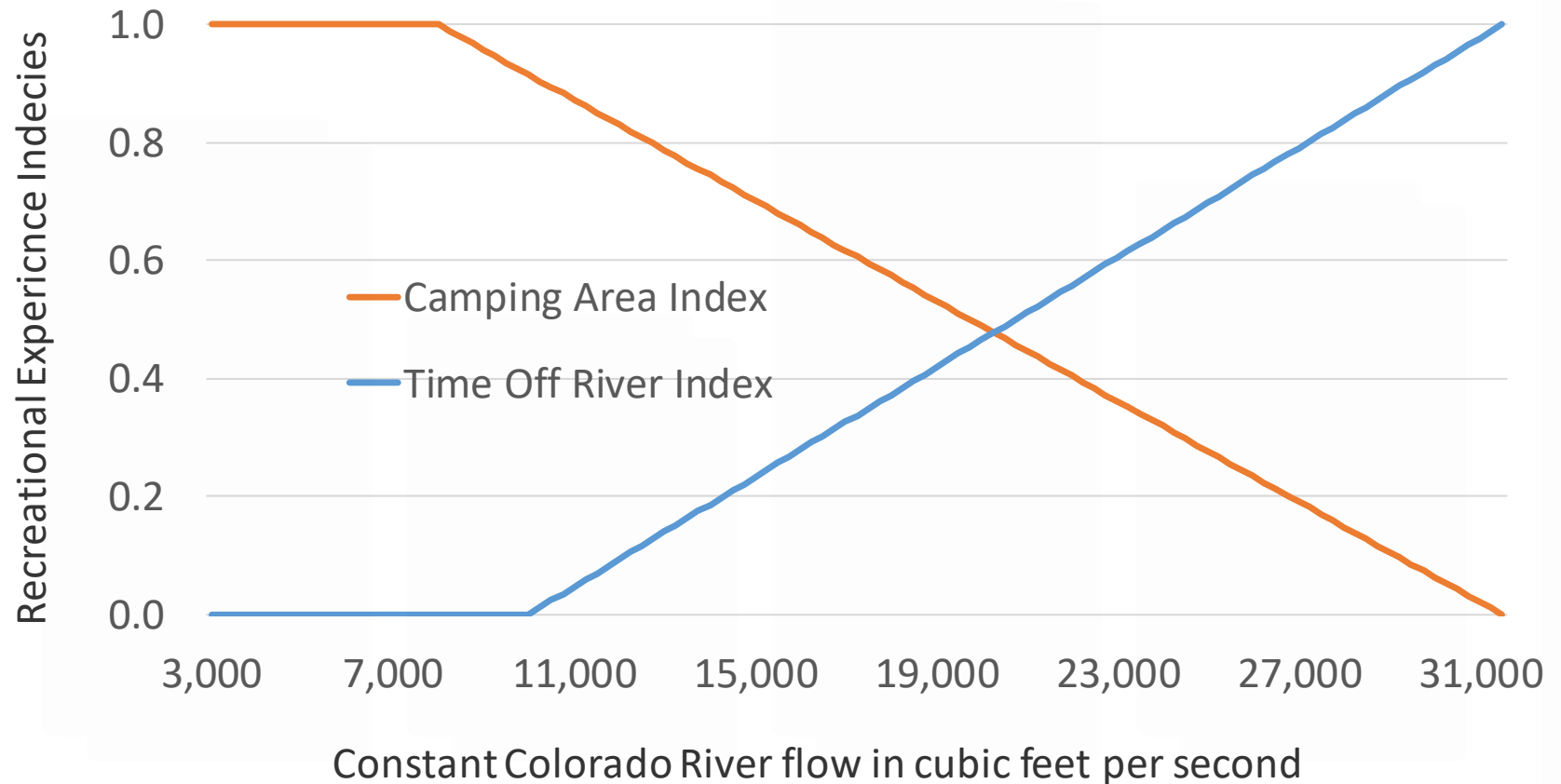
# Whitewater Conceptual Model

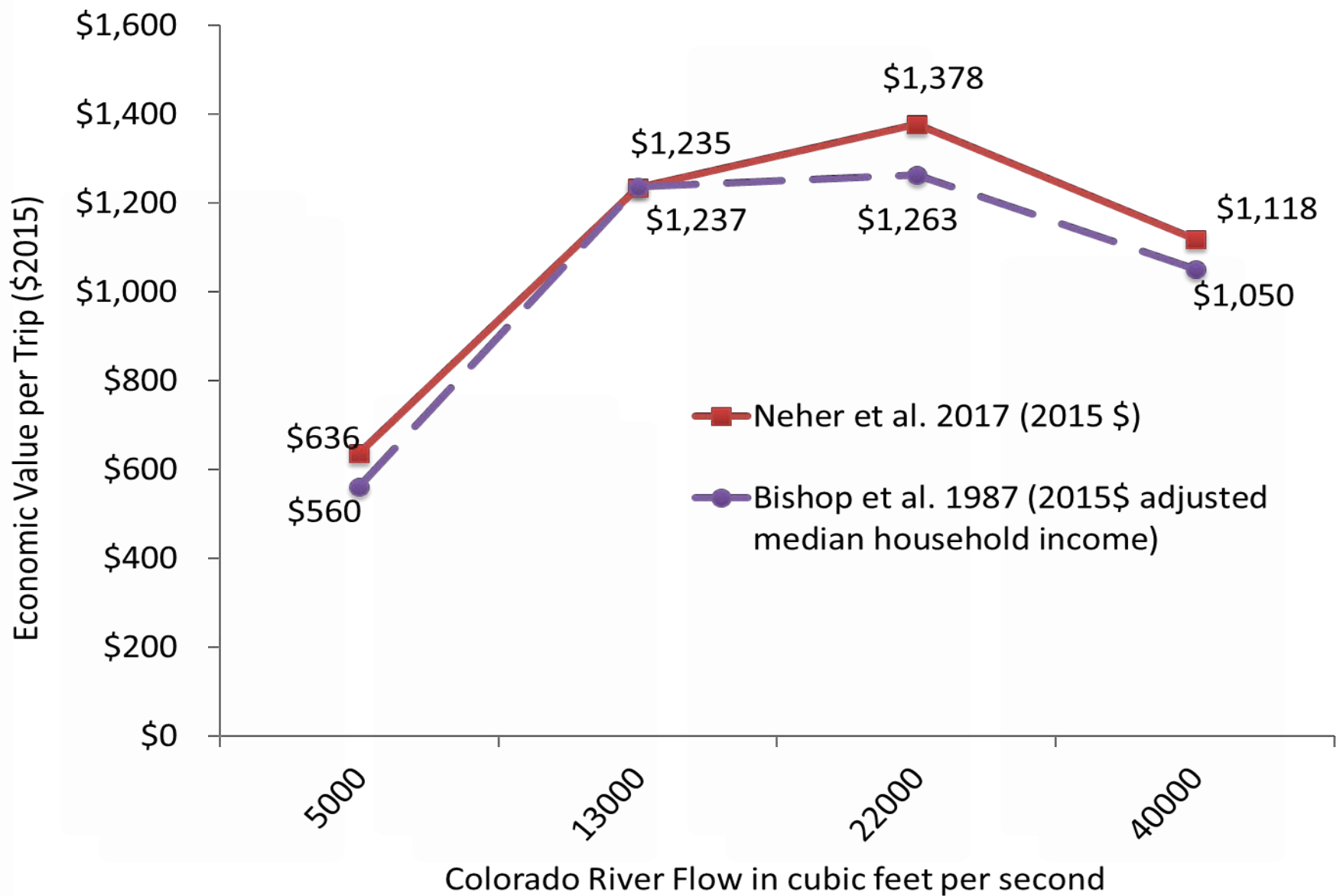


# LTEMP Performance Metrics

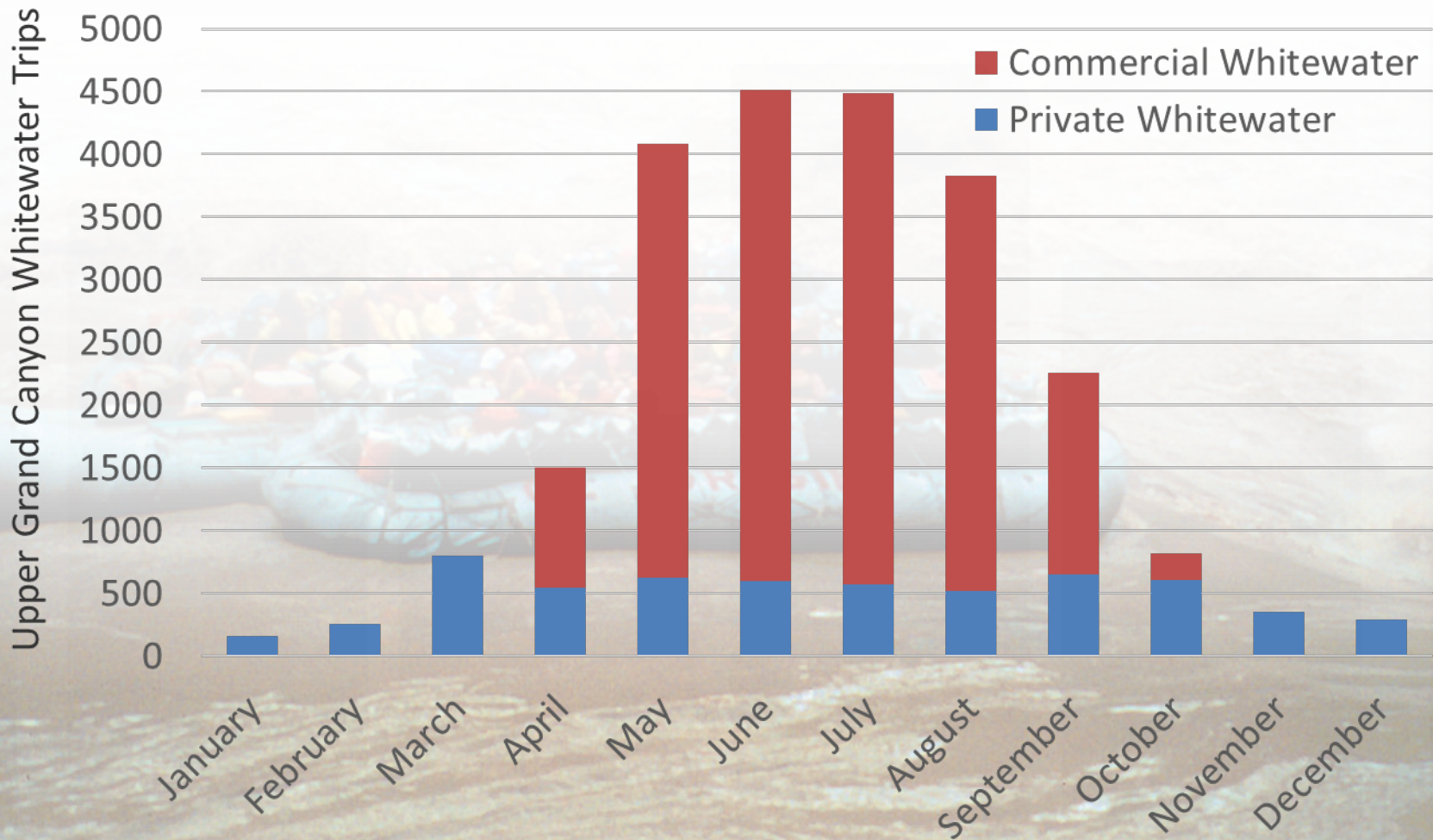
- **Camping Area Index:** Accounts for optimal campsite area building and maintenance flows and sediment load.
- **Navigational Risk Index:** Measure of navigation difficulty based on the number of days during which the daily minimum flow was less than 8,000 cfs.
- **Fluctuation Index:** Measures the degree to which combinations of flows and fluctuations are within a range identified as preferable by experienced boat guides.
- **Time Off River Index:** Relates the level of flows to visitors being able to spend time ashore visiting attractions.

# LTEMP Performance Metrics

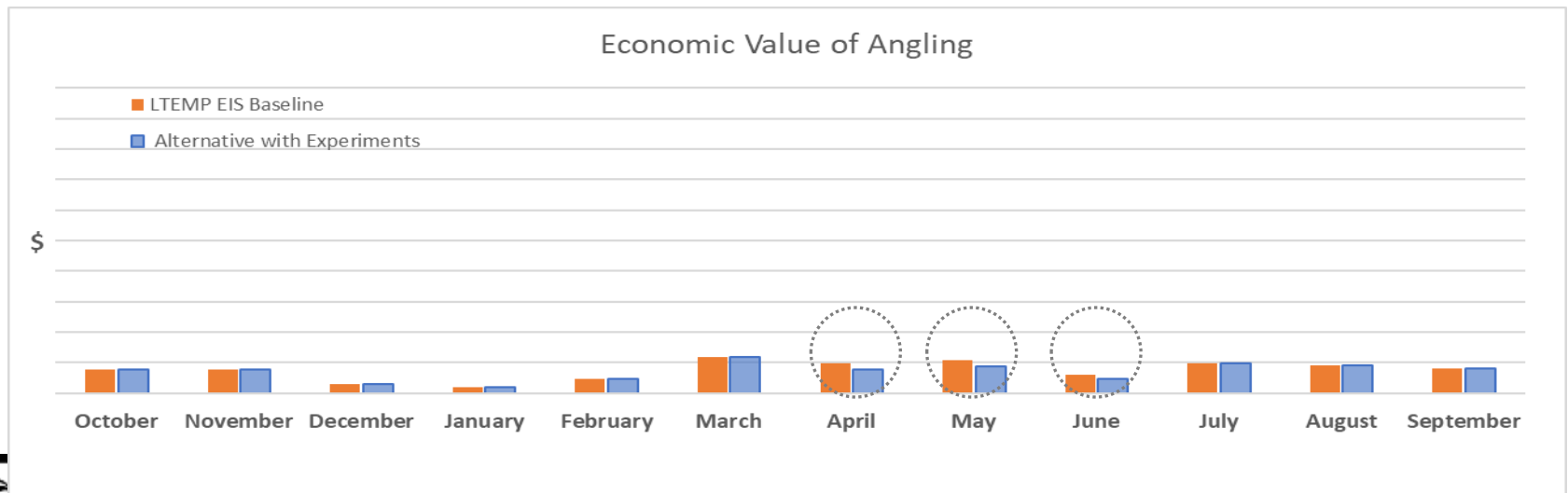
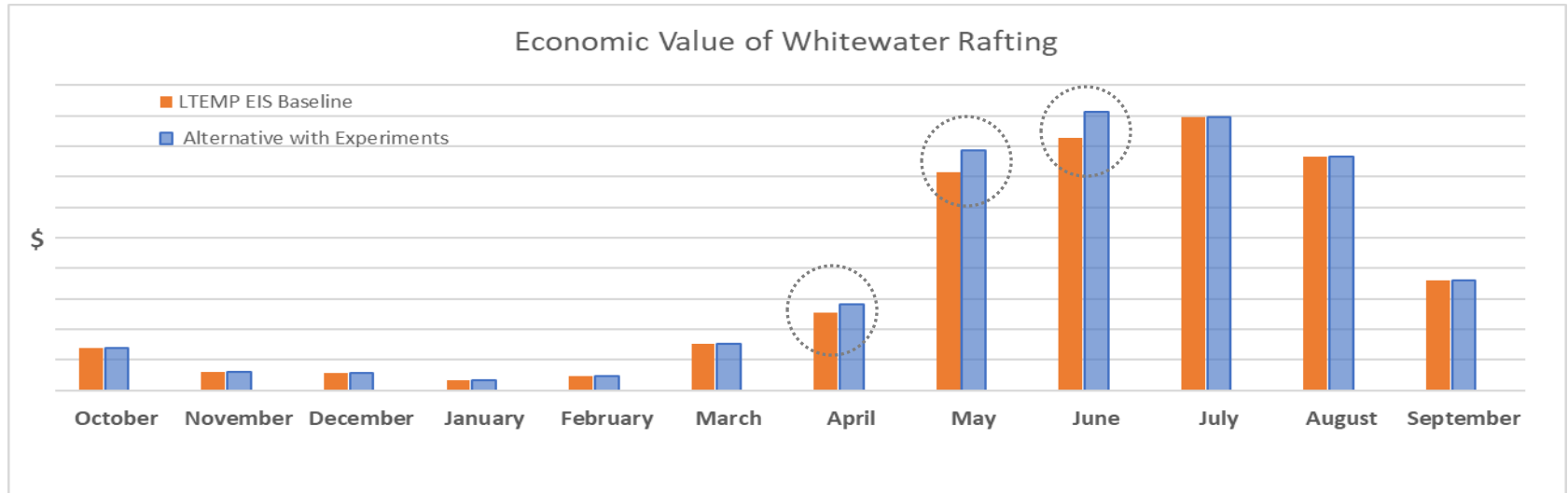




# Upper Grand Canyon Whitewater

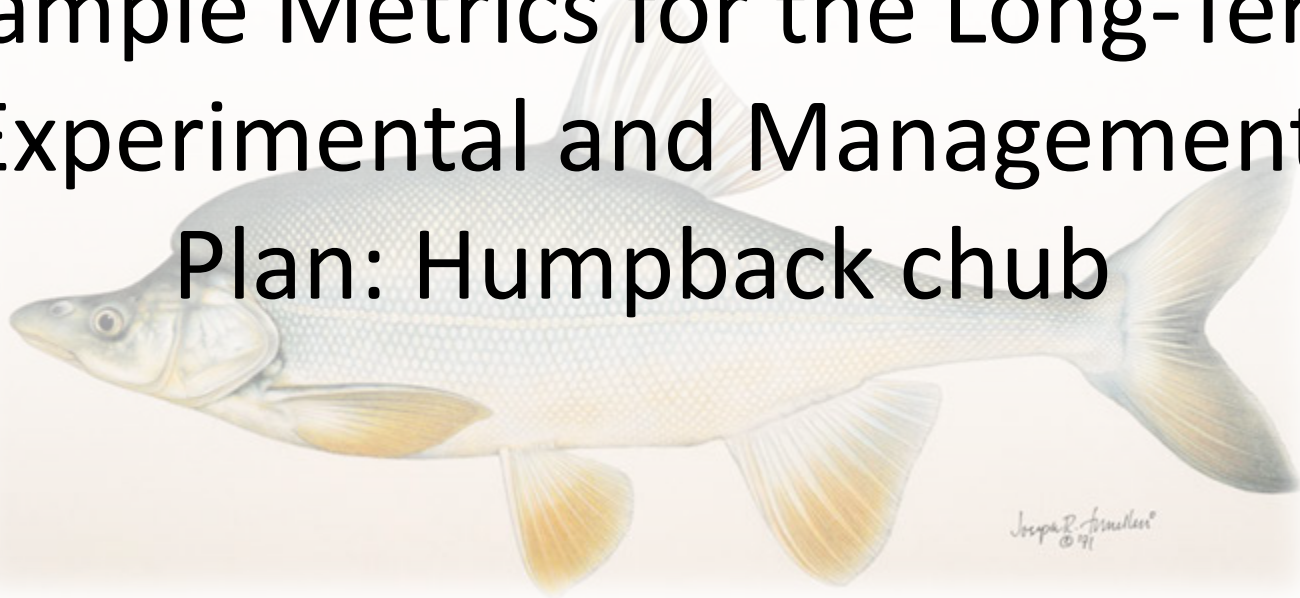


# Example Metric Presentation





# Example Metrics for the Long-Term Experimental and Management Plan: Humpback chub



# Humpback chub

- **Resource Goal:** Meet humpback chub recovery goals, including maintaining a self-sustaining population, spawning habitat, and aggregations in the Colorado River and its tributaries below the Glen Canyon Dam.



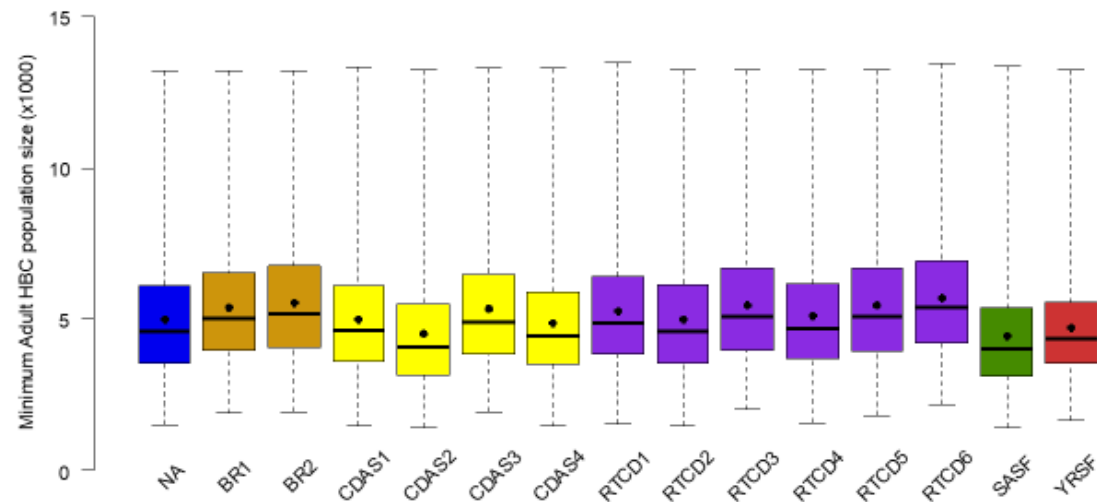
\* Department of Interior, 2016, Record of Decision for the Glen Canyon Dam Long Term Experimental and Management Plan Final Environmental Impact Statement, December 2016. Bureau of Reclamation, Upper Colorado River Region, Salt Lake City, Utah and National Park Service, Intermountain Region, Lakewood, Colorado.

# Humpback chub

- **Performance metric 1:** Expected minimum number of adult HBC in the Little Colorado River population during the LTEMP planning period (20 years).

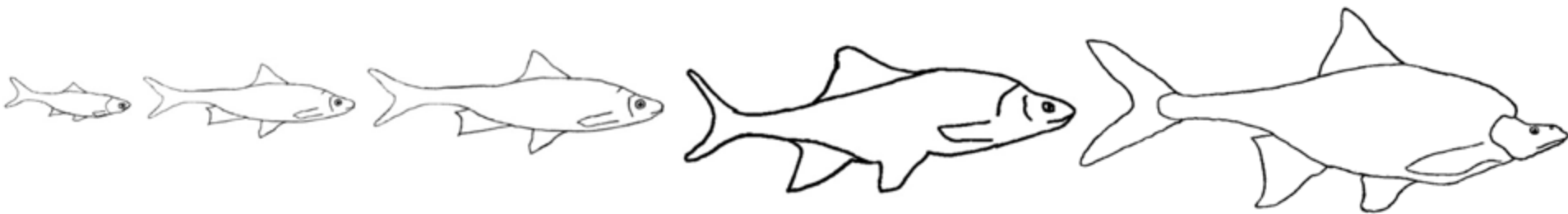


**Lowest Adult HBC pop. (x1,000)**



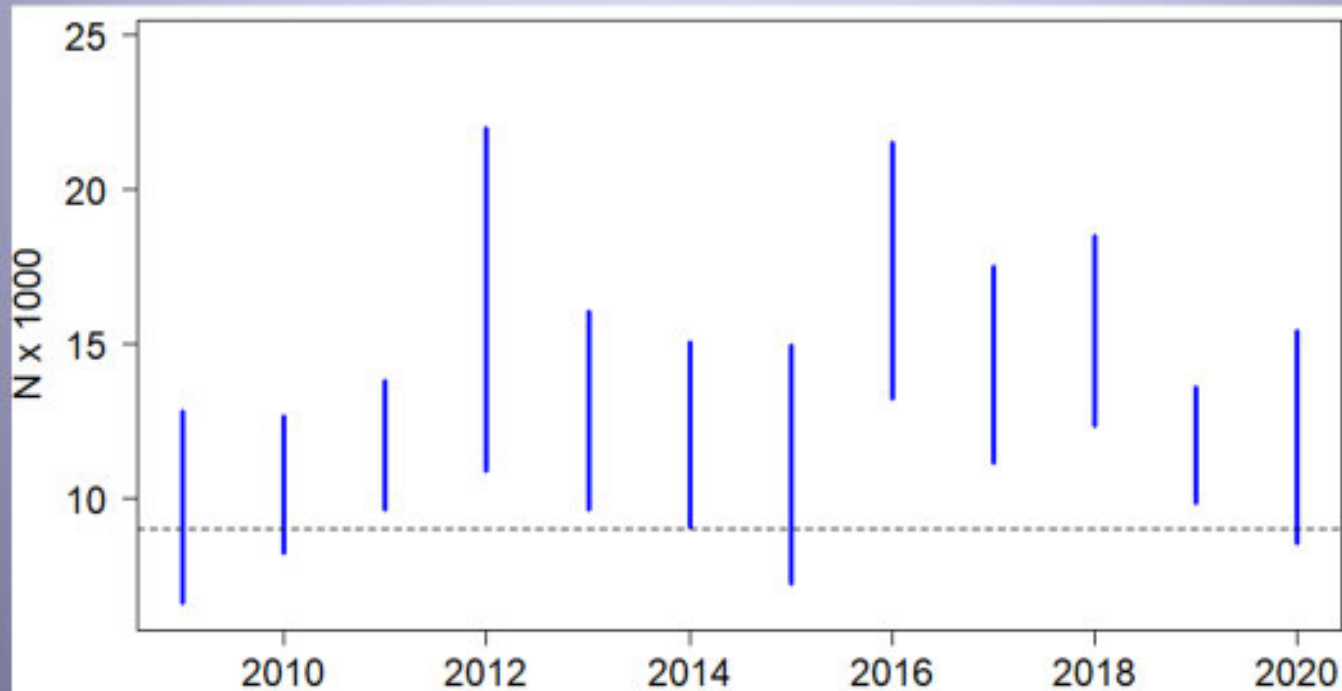
# Humpback chub

- **Performance metric 1:** Adult HBC abundance in the Little Colorado River population.
- Metric Type: Estimated
- Data required: Sampling in the LCR and mainstem CR
- Metric calculation: Multistate mark-recapture model
- Frequency: Annually



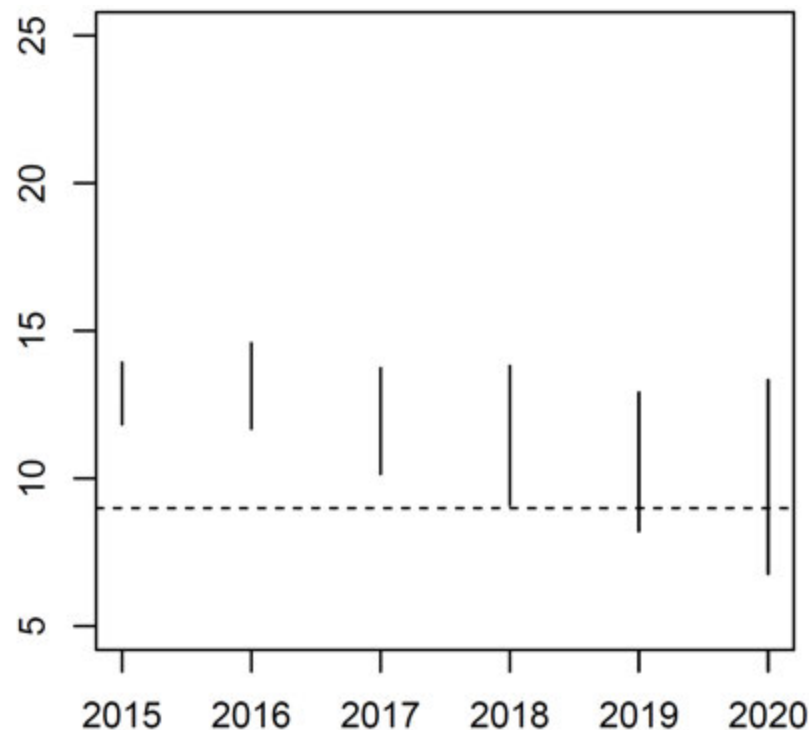
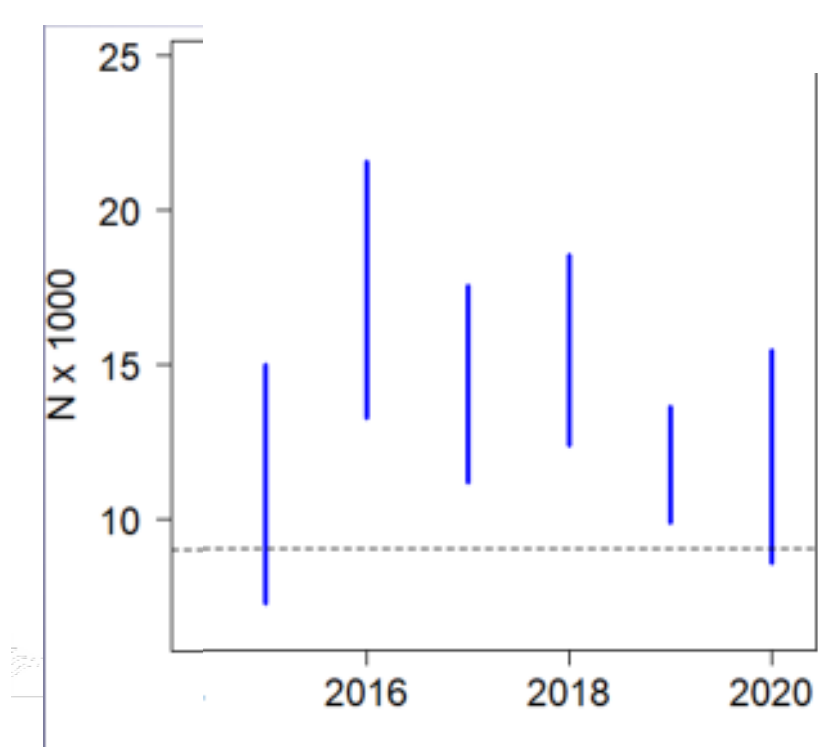
# Presentation

## Fall abundances of adult humpback chub in the LCR aggregation (>199mm TL)



# Interpretation

- Relative to Biological opinion triggers (along with other metrics derived from multistate model)
- Relative to LTEMP predictions under similar conditions



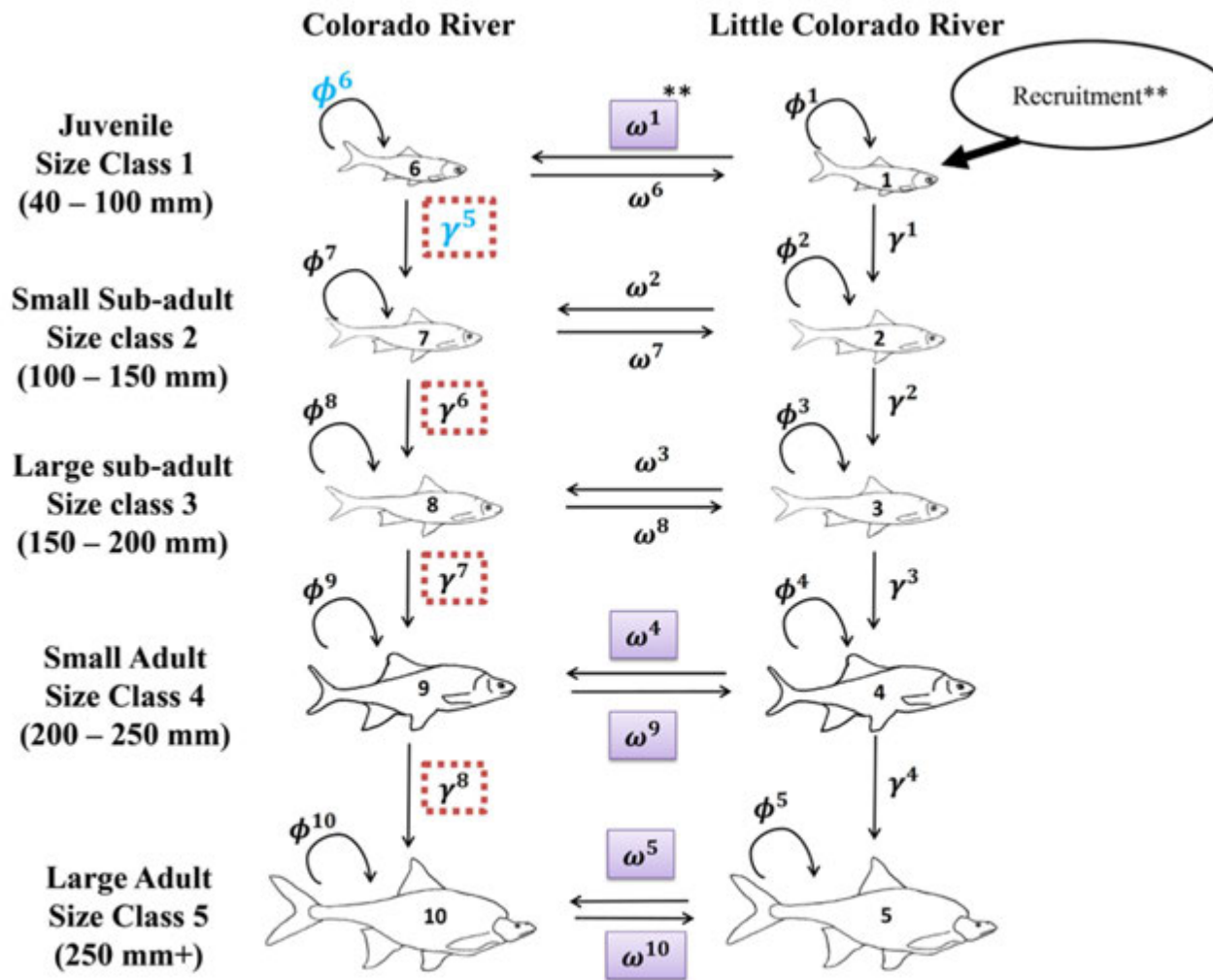
Preliminary, do not cite



# Limitations/Uncertainties

- Estimation adult abundance:
  - Capture probability heterogeneity, long-term behavioral responses, assumptions about partially sampled mainstem.
- Forecasting adult abundance
  - Future foodbase conditions.
  - Impacts of temperatures above 16-ish.
  - **Brown trout\***, catfish, and any new nonnatives
  - Climate change and juvenile production in the LCR
  - (see appendix F for more details.)

# Conceptual models

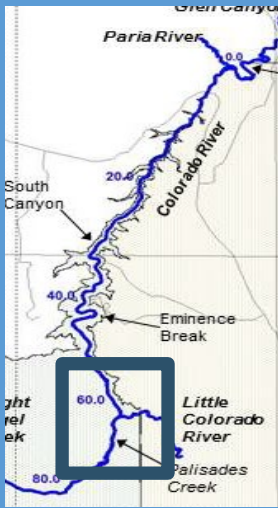


### Summary of model parameters

$\phi$  – survival

$\omega$  – movement

$\gamma$  – size transition (growth)



# Colorado River

outmigration

skipped spawning

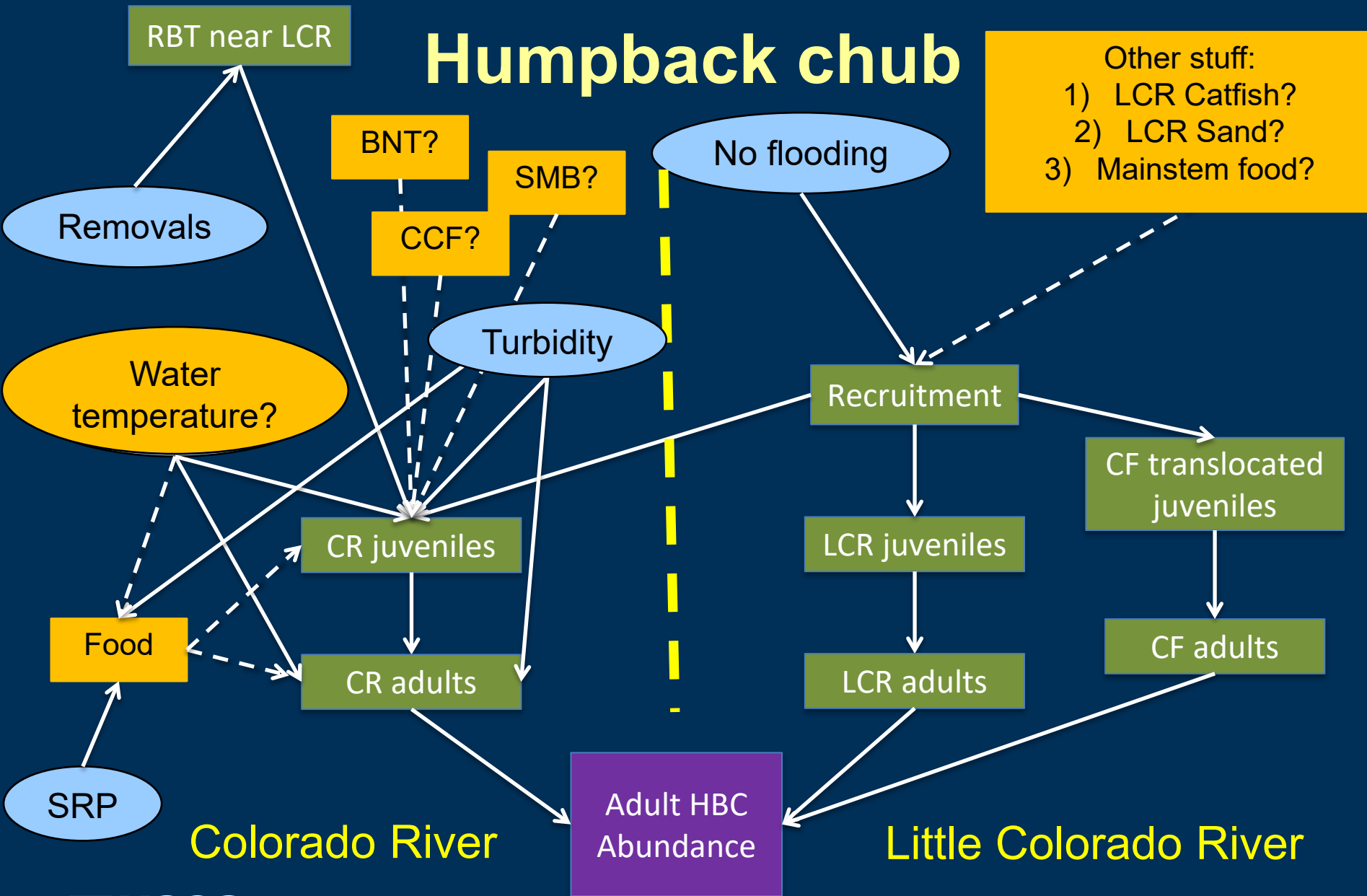
spring spawning migration

resident

# Little Colorado River

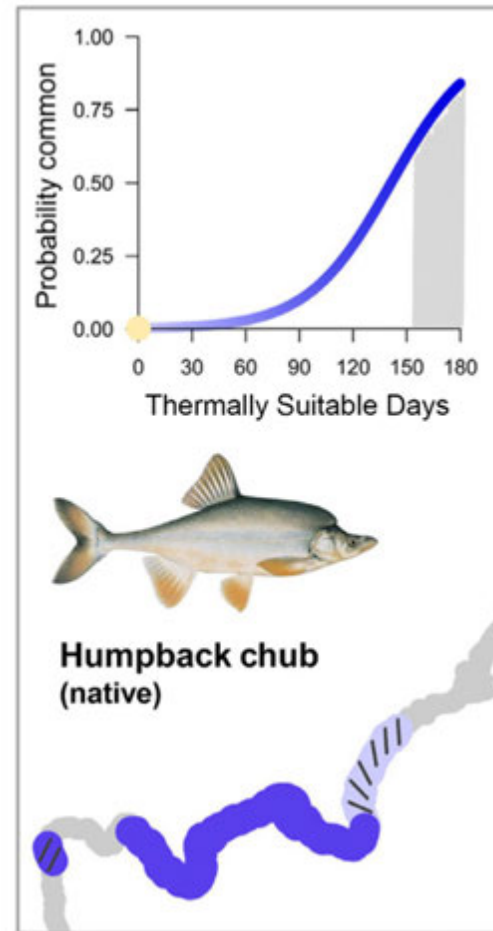
Preliminary, do not cite

# Humpback chub



# Humpback chub

- **Performance metric 2:** Average temperature suitability for HBC at RM 157 and RM 213.
- Dibble et al. (2021) provides an improved version.
- But in near future, would like to move towards actual abundance estimates for western GC.



# Questions

