Evaluating the Relative Benefits of Water Reuse, Recycling, and Environmental Flows

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CSU WATER Conference
April 13, 2023
California’s Water Crisis

• California is water limited and demand for water is increasing
  ➢ Agricultural, municipal, recreational, hydropower production, fisheries, etc.

• Climate change is further stressing water supply and ecosystems
  ➢ Changing rainfall patterns and increasing temperature
  ➢ Extended duration and severity of droughts

• Overallocation of water resources puts a strain on water supply infrastructure and the environment
Numerous Policy Drivers that Demand Solutions

- CA Water Action Plan, CA Recycled Water Policy, CA Cannabis Policy, FERC Relicensing, water quality control plans, FloodMAR, Sustainable Groundwater Management Act (SGMA), etc.
CA’s Recycled Water Policy

• Established in 2018 by State Water Resources Control Board
• Encourages safe use of recycled water from wastewater sources while protecting public health and the environment

https://www.waterboards.ca.gov/water_issues/programs/recycled_water/policy.html
Water Recycling and Reuse is Critical Part of the Solution

Diversify local water supplies and replenish over-drafted groundwater resources
Reuse Can Create Conflicts with Protection of Aquatic Life and Recreational Beneficial Uses
Framework For Solutions

- California Environmental Flows Framework (CEFF) developed with statewide partners:
  - Science-based approach for guiding decisions
  - Determines environmental flows that balance water for humans and the environment
  - Assesses impact of changing flow conditions
  - Explores tradeoffs associated with various management actions
  - Based on a *Functional Flows Approach*

https://ceff.ucdavis.edu/
Functional Flows

Salmon spawning
Floodplain rearing
Cottonwood germination
Salmon migration
pools flush
gravel mobile
channel bars wetted
deep scour

modified from Yarnell et al. 2010, 2015 *BioScience*
Functional Flow Metrics

Metrics quantify flow components

<table>
<thead>
<tr>
<th>Flow Component</th>
<th>Flow Metrics</th>
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<tbody>
<tr>
<td>Fall pulse flow</td>
<td>Magnitude (cfs) Timing (date)</td>
</tr>
<tr>
<td>Wet-season base flow</td>
<td>Magnitude (cfs) Timing (date)</td>
</tr>
<tr>
<td>Wet-season peak flow</td>
<td>Magnitude (cfs) Timing (date)</td>
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<tr>
<td>Spring recession flow</td>
<td>Magnitude (cfs) Timing (date)</td>
</tr>
<tr>
<td>Dry-season base flow</td>
<td>Magnitude (cfs) Timing (date)</td>
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California Environmental Flows Framework (CEFF)

https://ceff.ucdavis.edu/
CEFF Adopted by State Agencies

- Instream Flow Program
- CA Water Action Plan
- Cannabis Cultivation Policy
- CA Recycled Water Policy
Tools for Ecological Tradeoffs

- Evaluate tradeoffs between water management actions and instream flows needed to support ecology
Need Tools and Approaches to Assess Economic and Socio-Cultural Tradeoffs

• Most environmental flow studies lack non-biophysical considerations

• Need tools to help managers balance ecological, economic, and socio-cultural tradeoffs for more holistic water resource management
CSU WATER / SCCWRP Collaboration

• Shed light on how to integrate social-cultural, economic, and environmental factors to balance water for human uses and the environment
  ➢ Develop tools that consider economic and socio-cultural tradeoffs
  ➢ Create approach that seeks to balance tradeoffs for more stable and resilient water supply
  ➢ Illustrate the use of the toolkit within CEFF in a real-world example
SCCWRP’s Conceptual Model for Ecohydrology Research

- Δ Climate
- Δ Water Use
- Δ Land Use

Δ Hydrology
Contemporary Future

Δ Physical Habitat
- Sediment flux
- Channel morphology
- Habitat complexity/connectivity
- Hydraulics

Δ Water Quality
- Stream temperature
- Turbidity
- Salinity
- Ionic concentrations
- Other constituents

Δ Biology
Across trophic levels

Management Applications
- What should we do where?
- Are management actions effective today and will it be in the future?

Socio-Economic Considerations
- Environmental Justice
- Recreation/Aesthetics
- Economic Tradeoffs
SCCWRP’s Conceptual Model for Ecohydrology Research Provides Opportunities for Collaboration

- Δ Climate
- Δ Water Use
- Δ Land Use

Δ Hydrology
Contemporary Future

Δ Physical Habitat
Sediment flux
Channel morphology
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Δ Water Quality
Stream temperature
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Management Applications
What should we do where?
Are management actions effective today and will it be in the future?

- Climate/Flood Forecasting
- Groundwater – Surface Water Interactions
- Socio-Economic Considerations
  - Environmental Justice
  - Recreation/Aesthetics
  - Economic Tradeoffs

Socio-Economics
We Look Forward to Working Together

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EXTRA SLIDES
CEFF Applications Focus on Ecological Tradeoffs

Primary focus on ecological tradeoffs, with limited effort on economic and social tradeoffs of allocating flows for other uses.
Process for Determining Flow Ranges

(a) Habitat suitability relationship

(b) Adult/Depth: Probability according to Q

Flow Models

Based on MEDIUM probability

Based on HIGH probability
Measuring Economic Benefits from Changes in LA River Flows

Total Economic Value (TEV)

Use Value
- Direct use value (e.g. outdoor recreational uses such as walking, biking, fishing, kayaking, wading, photography, etc.)
- Indirect use value (e.g. ecosystem benefits such as riparian habitat improvement, pollination, water cycling, fish migration, groundwater recharge etc.)

Non-use value
- Altruism or bequest value. Existence value.

Source: Adapted from Boyer and Polasky (2004)
Other Considerations for Tradeoff Analysis

Ecological

Socio-Cultural

Economic

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