Reservoir Reoperation for Enhancing Ecosystem Services

A Cost/Benefit Framework using ResSIM, HEC-RAS, geoRAS, & EFM

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Conceptual approach

Convincing owners of water supply reservoirs to use conservation space for ecosystem purposes can be challenging in regions where water is scarce. This project takes a different approach by modeling the trade-offs associated with levels of encroachment in the flood pool. Less flood space increases hydropower revenues, water supply reliability, and flexibility for ecosystem releases. Less flood space also increases the risk of flood damage associated with high reservoir releases. USACE software is used to analyze these trade-offs. A strong emphasis is placed on understanding the history of the river and floodplain interaction as well as developing an explicit accounting system for the cost benefit analysis.

The way things were...

The Mokelumne River flows west from the Sierra Nevada Mountains across the Central Valley and into the Sacramento-San Joaquin Delta. The river’s annual flow averaged 720 taf with distinct rain peaks in winter and long spring snowmelt that continued through mid-Summer. Historical floodplain:

- 22.5 km² (above Lodi, CA) 46% riparian vegetation (based on 2 yr flood inundations) 2-yr event: 5,780 cfs 10-yr event: 19,200 cfs 50-yr event: 43,400 cfs 100-yr event: 57,250 cfs

The Mokelumne supported a Chinook salmon tail-run as well as steelhead and other inland fisheries. Valley oak, elderberry and blackberry bushes, and cottonwood trees were common along unregulated Central Valley rivers.

What changed?

1) Increasing river regulation by both PG&E and EBMUD had muting effects on the river flow regime: Pardee (built in 1929), Salt Springs (1931), Lower Bear (1952), and Camanche (1963). 809 cfs modeled flow.

2) Landuse conversion to agriculture has reduced riparian vegetation to <15% of the original floodplain.

3) Major Abstractions:
   - EBMUD upto 364 taf/yr
   - Vino Farms upto 60 taf/yr

What can be done?

1) Encroachment into flood space can increase release flexibility for adult salmon attraction flows, high flow spring pulses, and other water quality related flows. 2) Floodplain landuse changes can reduce flood damage and increase ecosystem benefits.

Preliminary Results

Hydropower results:

- Extra storage volumes raise operating head and increases hydropower generation opportunities. Revenue gains of up to $100,000/yr are realized at Camanche under aggressive reservoir operations. Pardee reservoir operates as a peaking facility and has greater potential gains.

Water supply results:

- Increased reliability against mandatory conservation measures provides a quantifiable benefit for water utilities. A reliability approach using refill target volumes and dates will analyze effects of increased storage.

- East Bay Muni Utility District takes water from Pardee Reservoir resulting in a direct conflict with increased instream flows. This trade-off will be explored further.

Flood damage results:

- Positive benefits from hydropower, water supply reliability and ecosystem services cannot off-set the costs of urban flood damage. High flow events need to be attenuated before they reach the urban Lodi, CA area.

- Agricultural landuse changes coupled with set-back levees reduce the risk of flood damage for agriculture. Areas that flood often (<1 in 3 years) should convert to seasonal crops or riparian wetlands to avoid the damage associated with permanent tree crops. A net present value economic approach will help decide the landuse conversion question for each parcel.

Future Work

1) Quantify ecosystem values in terms of dollars
2) Perform reliability analysis of water supply and risk analysis for flooding based on changes of guide curve through reservoir re-operations.
3) Finalize the overall accounting method to be used to integrate all components.

References


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