Environmental Benefits of Fish Passage on the Truckee River

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Overview

As part of a large ecosystem restoration and flood risk management project on the Truckee River, the U.S. Army Corps of Engineers (USACE) developed and assessed a range of alternatives for basin-wide fish passage improvement. An assessment of the environmental benefits and costs of alternative restoration strategies was required. USACE scientists identified viable alternatives for bidirectional passage at 17 structures and in coordination with a diverse array of local, state, tribal, and federal partners developed a methodology for quantifying the relative benefits of fish passage improvement alternatives targeting eight native species (two threatened or endangered; see Figure 2).

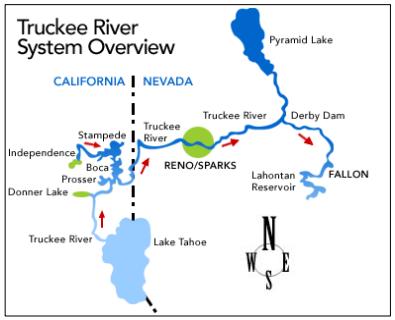


Figure 1. Truckee River (Courtesy of Truckee Meadows Water Authority)

Figure 2. At-risk fishes of the Truckee River (a) endangered cui-ui (Chasmistes cujus) and (b) threatened Lahontan cutthroat trout (Oncorhynchus clarki henshawi). Photos courtesy of USFWS.

Alternative Formulation

The objective of fish passage restoration was *implementation of the most effective measures for fish passage improvement on the Truckee River*. Over 30 structures potentially impede fish passage on the Truckee River. USACE examined each structure, assessed types and degrees of impact, and identified two to four actions to improve fish passage at 17 sites (Table 1).

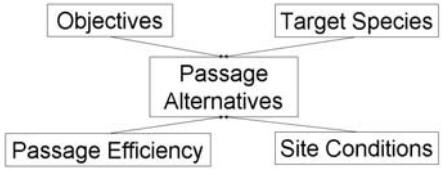


Figure 3. Key factors in fish passage alternative formulation for the Truckee River.

Table 1. Summary of fish passage obstructions on the Truckee River considered in this study.

Structure	River mile (mi)	Relative Diversion Discharge (%)*	Structure Height (ft)
Pyramid Lake	0		
Marble Bluff	4	0.0	35
Numana	12.5	3.1	12
S-S	21.75	0.6	na
Fellnagle	27	0.6	4
Herman	31.5	1.9	2.4
Derby	39.5	25.8	15
Tracy PP	44	3.9	na
Cochran	66	0.8	na
Idlewild Ponds	66.5	0.3	na
Chalk Bluff	69.8	10.7	3
Orr	70	3.3	na
Lake	71.5	1.8	na
Last Chance	73	2.6	na
Washoe-Highlands	76	34.9	8 - 10
Verdi	80.5	40.6	13
Steamboat	83.5	7.0	10
Fleisch	86	44.0	14
Lake Tahoe	121.1		
*Ratio of diversion to river discharge.			

Marble Bluff

Numana

Cochran Ditch

Washoe-Highlands

What passage metrics are available?

- No consensus regarding metrics for bidirectional fish passage
- Existing upstream passage benefits algorithm (WDFW 2000)
- No benefits algorithm for downstream or system-wide passage

Developing a fish passage metric

Pressed to develop an informative, accurate, and defensible benefits methodology in short order, the team modified an existing technique for upstream passage benefits (WDFW 2000) and developed an analogous approach for assessing downstream benefits. Upstream and downstream algorithms were reviewed and vetted with the interagency team.

Given large home ranges in migratory fish, cumulative effects of multiple structures are critical in assessing the benefits of fish passage improvement. It is clear that the benefits of providing improved passage at a given location are a function of the number of fish that reach the site, whether from upstream or down. Thus, "passage efficiency" is a central part of the metric and measures a passage technique's performance expressed as a percentage of the number of fish that successfully pass a structure (Figure 4).

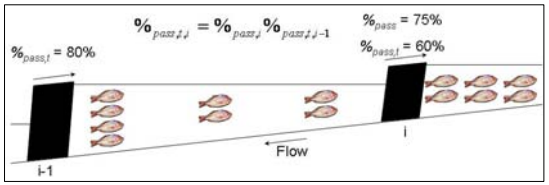
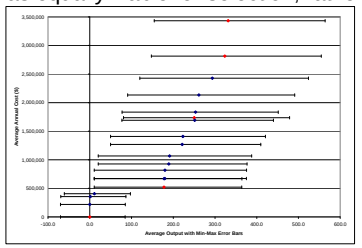


Figure 4. Example of cumulative upstream passage efficiency.

The metric applied considers factors beyond passage efficiency such as the fact that not all species use all areas on the river equally, the biological imperative for movement is not uniform among species, some fish utilize intermediate reaches, and other restoration goals exist beyond fish passage (e.g. passage of sediment and LWD). Using the benefits algorithm and knowledge of the watershed, site specific alternatives were combined into 54 system-wide passage plans.

Plan Comparison

A panel of subject matter experts were asked to assign a range of scores (min, best estimate, and max) for nine benefits parameters which facilitated quantification of benefits, sensitivity testing, and calculation of uncertainty. Plans were compared using cost-effectiveness and incremental cost analyses (CE/ICA) and three predetermined scenarios (worst, expected, and best cases; Figure 5a) as well as randomly combined scenarios (e.g. worst case-structure 1, best case-structure 2; Figure 5b). Given uncertainties in benefits predictions, all cost-effective plans were identified as equally viable for selection, rather than only examining "best buys".



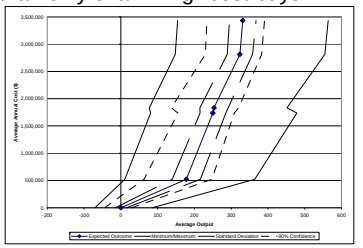


Figure 5. Uncertainty analyses applied in CE/ICA (a) scenario and (b) parametric.

Conclusions

Quantification of dependency and cumulative benefits phenomena is critical to multi-node or multi-action passage projects. For the Truckee River, quantifying dependencies in passage required the project team to develop an appropriate technique for accurately comparing benefits from multiple actions at multiple sites.

Acknowledgements

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References

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