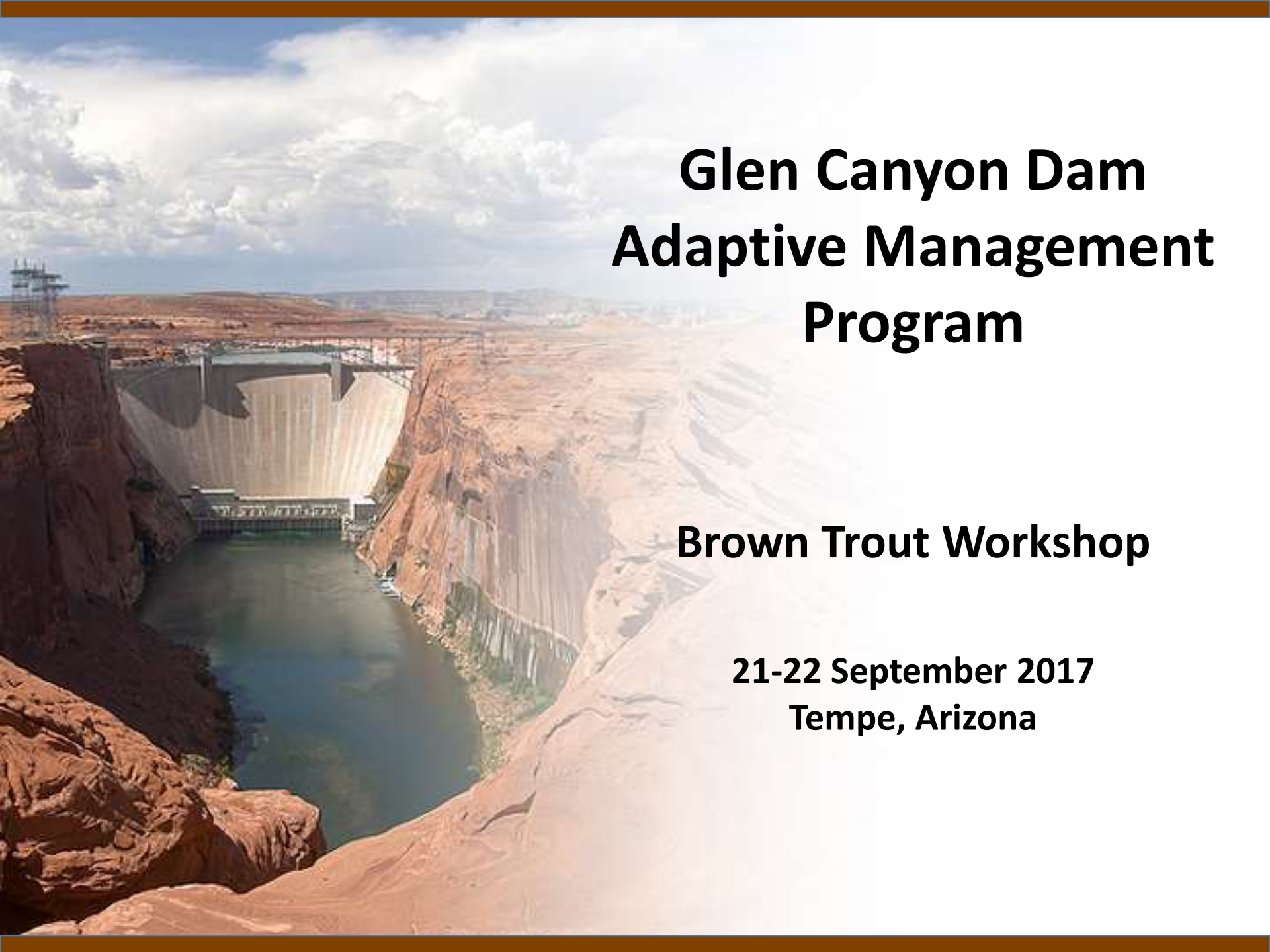

Glen Canyon Dam Adaptive Management Program

Brown Trout Workshop

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Tempe, Arizona

Comparison of Management Options

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Section objectives

- Identify management and experimental actions that are relevant to brown trout management in the Colorado River below Glen Canyon Dam.
- Evaluate each action's efficacy, outcome regarding management objectives, impact to other downstream resources, and consistency with stakeholder (e.g., Tribal) values.
- Characterize uncertainty, risk, and additional factors that could affect results of implementation of options, including environmental compliance.

Management objectives

- The evaluation of management options related to brown trout considers existing management activities and management objectives, as defined in Section 3.
- No quantitative management objectives have been set specifically for brown trout.
- Management and experimental actions are expected to reduce brown trout densities to a level that is consistent with management objectives designed to allow for the recovery of humpback chub.

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

Management options

- Management options are organized in accordance to their ability to directly or indirectly influence brown trout abundance in the mainstream or if they directly address hypotheses in Section 4.
- Management actions:
  - Mechanical removal
  - Trout management flows
  - YY brown trout stocking
  - Angling regulations
- Experimental actions:
  - High-flow experiments
  - Rainbow trout stocking
  - Temperature control device

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Management actions

- Management actions are options that specifically address brown trout abundance by direct or indirect manipulation of the population.
- Management actions could be used to reduce brown trout abundance in the Lees Ferry or Little Colorado River reach of the mainstem to meet objectives identified in Section 3.
- There is significant uncertainty in the efficacy of many of the proposed management actions and several actions do not have appropriate environmental compliance and permitting.

Brown trout mechanical removal

- Significant reductions in densities and recruitment of salmonids have been obtained with mechanical removal. However, populations can rebound in as little as two years.
- The efficacy of mechanical removal of brown trout is less uncertain than other management options with effectiveness corresponding to effort.
- The economic cost of removing brown trout at Lees Ferry, to maintain abundance at existing levels, is estimated to be $500,000 per year (Yard M., 2017, Pers. comm.).

Brown trout mechanical removal

- Mechanical removal is species specific and could be accomplished with relative precision and may have limited impact to the rainbow trout fishery, Sand Load Index or other resources of concern.
- Mechanical removal of brown trout in the Lees Ferry or Little Colorado reaches of the mainstem would have a significant impact on the 'Tribal concerns with the taking of life' objective.

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Brown trout angling regulations

- Angling regulations may be an effective tool for management of brown trout populations. The efficacy of angling regulations in reducing brown trout is unknown but may help to educate the public and encourage buy-in from anglers for nonnative species control measures.
- Angling regulations are not expected to have an effect on downstream resources.
  - Tribal concerns may be less with these methods because all fish taken in this way are likely to be consumed by humans.
  - Trout removal in Lees Ferry may have a negative impact on the angling community.

Brown trout management flows

- Brown trout TMFs would target either young-of-year in February through April or target spawning to dry out redds in December or January. TMFs that target brown trout could mimic the design of LTEMP rainbow trout TMFs.
- The efficacy of TMFs is uncertain. The economic cost (i.e., foregone hydropower value) of brown trout TMFs would likely be comparable to the costs of TMFs in the LTEMP (e.g., $400,000 – 1 million per experiment).

Brown trout management flows

- Brown trout TMFs have the potential to negatively affect the condition of the rainbow trout fishery. TMFs could also have a negative interaction with HFEs and minimum flows limits may be needed to minimize the impact on the foodbase.
- Brown trout TMFs would have a significant impact on the 'Tribal concerns with the taking of life' objective.
- If brown trout TMFs are proposed outside of the time specified and considered under the LTEMP EIS and BO, further consultation may be needed.

Brown trout stocking

- Experimental stocking with YY male brown trout in Lees Ferry is potentially an effective tool for management of brown trout populations. This management action would result in brown trout offspring that are all male XY male.
- Brown trout stocking is experimental and the efficacy is highly uncertain. The economic cost of brown trout stocking would likely be comparable to other low cost management action to control abundance.
- This method of management focuses on multi-generational declines, and in the short-run increased brown trout abundance may cause outmigration of brown trout into Marble Canyon.

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Experimental actions

- Experimental management actions are options that are potentially an effective tool for management of brown trout populations and specifically address one or more of the hypotheses identified in Section 2.
- These experimental options potentially have a higher level of uncertainty in both efficacy and impact on other downstream resources. Not all the experimental actions have appropriate environmental compliance and permitting.

High-flow experiments

- Fall-timed HFEs cleanse spawning gravels immediately prior to brown trout spawning thereby improving egg survival and recruitment. Fall-timed HFEs may cue migration of ripe brown trout into Glen Canyon thereby augmenting the number of spawners.
- Options under existing compliance include experimental short-term suspension of fall HFEs or altered timing or duration of fall HFEs. A change in timing or sediment accounting outside of the LTEMP EIS protocol would require appropriate environmental compliance and permits.

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Suspension or alteration of fall high-flow experiments

- Suspension or altered timing of fall HFEs may affect brown trout recruitment to an extent that compliance with the ESA is feasible, reducing abundance of brown trout below the predator index defined in the LTEMP.
- The efficacy of altered HFE protocol is uncertain. A short-term suspension of fall HFEs of a sufficient interval to test hypotheses about the increased brown trout abundance would likely have a negative effect on the Sand Index and a positive effect on the condition of the rainbow trout fishery.

Sediment triggered spring high-flow experiments

- Spring HFEs possibly disadvantage brown trout recruitment and shift the food base in favor of rainbow trout.
- Spring HFEs might also improve the health of rainbow trout populations by greatly reducing the abundance of sludge worms (Tubifex tubifex) which are the vector for whirling disease affecting rainbow trout populations .
- The efficacy of an altered HFE protocol is uncertain. Spring HFEs could have neutral-to-negative effects on the Sand Index but a positive effect on the condition of the rainbow trout fishery.

Annual spring high-flow experiments

- Annual spring HFEs would be implemented independent of sediment triggers. Spring HFEs could have a similar impact on brown trout as the sediment-triggered spring HFEs.
- The efficacy of an altered HFE protocol is uncertain. Annual spring HFEs could result in negative impacts to the value of hydropower generation and the Sand Index, and potentially a positive impact to the condition of the rainbow trout fishery.

Rainbow trout stocking

- Stocking the rainbow trout fishery with individuals that potentially could out-compete brown trout or are less vulnerable to whirling disease may put downward pressure on the brown trout population in Lees Ferry.
- This action is experimental and the efficacy of stocking is highly uncertain. The economic cost of rainbow trout stocking would likely be comparable to other low cost management action to control abundance.
- It is not anticipated that rainbow trout stocking would have impacts on downstream resources except possibly for humpback chub.

Temperature control device

- It is hypothesized that recent warm water temperatures may have facilitated expansion of brown trout populations by increasing egg survival, growth rates, and other vital rates for brown trout, and these growth requirements were not being met by previous cold-water temperatures.
- Installation of a temperature control device would allow resource managers to control the withdrawal depth of water from Lake Powell to assist in the control of temperature in the mainstem.

Temperature control device

- The efficacy of altering temperature in the mainstem is uncertain. The cost of a temperature control device could range from $15-150 million, in 2006 dollars (Bureau of Reclamation, 1999).
- The rainbow trout fishery, humpback chub, and other native and nonnative species could be affected by changes in mainstem temperature for the management of brown trout populations.
- Installation of a TCD would need appropriate environmental compliance and permitting.

Photo credit: Lucas Bair, USGS

Comparison of Management Actions

- To compare management actions each individual management and experimental action is evaluated based on:
  - Efficacy
  - Economic cost
  - Management objectives
  - Other resource impacts
  - Ease of implementation

Efficacy

- The efficacy of both management and experimental actions is relatively unknown. The outcomes of mechanical removal actions have been demonstrated in previous work and are generally viewed as more certain than the potential outcomes of habitat management and experimental flow, temperature manipulation, and trout stocking.
- While mechanical removal actions may increase the likelihood of brown trout removal, it is uncertain if the outcome associated with mechanical removal would improve compliance with the ESA; reducing the abundance of brown trout near the LCR below the predator index as defined in the LTEMP.

Economic costs

- The potential economic cost of actions range from personnel and logistics costs of mechanical removal to foregone hydropower revenue involved with flow actions, to cost associated with the construction of a temperature control device.
  - Low cost are anticipated to be <$500,000 per year,
  - Moderate costs between $500K and $1.5 million per year, and
  - High costs greater than $1.5 million per year

Rainbow trout and high-flow experiments

- The condition of the rainbow trout fishery
  - The condition of the rainbow trout fishery may be negatively affected by any mechanical or other removal efforts in the Lees Ferry reach of the mainstem, although such removal passes might be similar to or even less intensive than recent electrofishing projects targeting rainbow trout in that reach.
- Potential interactions with high-flow experiments
  - Experimental flow actions would affect sediment delivery in the mainstem. Brown trout TMFs may have a negative effect on the delivery of fine sediment while suspension of fall HFEs and annual spring HFEs would likely have a definitive negative effect on the delivery of fine sediment.

Tribal concerns with the taking of life

- As identified in the “Management Objectives” section, the Pueblo of Zuni, Hopi Tribe, and Navajo Nation, have expressed concern for the removal of fish, including nonnative trout, if such removal constitutes what they believe is an unwarranted or unnecessary taking of life.
- What are the preferences of the Pueblo of Zuni, Hopi Tribe, Navajo Nation, Hualapai Tribe, and the Southern Paiute Consortium regarding proposed management and experimental actions proposed?

Comparison of individual brown trout management actions

Management and experimental actions	Relative efficacy	Economic cost	The condition of the rainbow trout fishery	Potential interactions with high-flow experiments	Tribal concerns with the taking of life
Brown trout removal at Lees Ferry	Moderate	Low	0	NA	Need input from tribes
Brown trout removal at the Little Colorado River	Moderate	Low	0	NA	Need input from tribes
Brown trout angling regulations	Not yet analyzed	Low	0	NA	Need input from tribes
Brown trout management flows	Not yet analyzed	Low	0	-	Need input from tribes
Brown trout YY stocking in Lees Ferry	Not yet analyzed	Low	0	NA	Need input from tribes

Notes: NA (not applicable), + (positive outcome), - (negative outcome), 0 (neutral outcome)

Comparison of individual brown trout experimental actions

Management and experimental actions	Relative efficacy	Economic cost	The condition of the rainbow trout fishery	Potential interactions with high-flow experiments	Tribal concerns with the taking of life
Suspension of fall high-flow experiments	Not yet analyzed	Moderate	+	-	Need input from tribes
Sediment triggered spring high-flow experiments	Not yet analyzed	Low	+	0/-	Need input from tribes
Annual spring high-flow experiments	Not yet analyzed	Moderate	+	-	Need input from tribes
Rainbow trout stocking in Lees Ferry	Not yet analyzed	Low	+	NA	Need input from tribes
Temperature control device	Not yet analyzed	High	+	0	Need input from tribes

Notes: NA (not applicable), + (positive outcome), - (negative outcome), 0 (neutral outcome)

Other objectives

- Other resources
  - There are a number of objectives identified in the LTEMP resource goals that could potentially be affected by actions directed at brown trout management, including changes in hydropower production, effects on other native fish, and effects on recreation (especially, boating and rafting).
- Ease of implementation
  - The speed at which management options could be implemented largely depends on appropriate environmental compliance and permitting.

Other considerations

- No action
  - The brown trout population may continue increasing in abundance in a No Action scenario. Impacts on the rainbow trout fishery and humpback chub downstream may increase as the abundance of brown trout increase.
- Multiple management and experimental actions
  - Multiple management options or a sequence of multiple management actions and experiments may be more effective and possibly efficient at managing brown trout populations.

Next steps

- Did we consider the full set of hypotheses and objectives to evaluate the management and experimental actions?
- Did we identify the right set of management and experimental actions to effectively manage brown trout populations while considering impacts to downstream resources?
- What is the level of additional analysis needed to make an initial decision about the preferred management or experimental action

Questions

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