2017

GCDAMP Brown Trout Workshop Notes

SEPTEMBER 21-22, 2017

GLEN CANYON DAM ADAPTIVE MANAGEMENT PROGRAM

TEMPE, ARIZONA

Thursday, September 21, 2017

Start Time: 8:30 am
Conducting/Facilitator: Michael C. Runge, Ph.D., Research Ecologist, USGS Patuxent Wildlife Research Center
Recorder: Lauren Johnston, Galileo Project, LLC

Summary Action Items

- GCMRC team follows up with Carlee Brown as needed for assistance in analyzing angler programs as a BT management option.

Meeting Attendees

AZGFD – Arizona Game and Fish Department
CREDA - Colorado River Energy Distributors Association
DOI – Department of the Interior
GCMRC – Grand Canyon Monitoring and Research Center
GLCA – Glen Canyon National Recreation Area
GRCA – Grand Canyon National Park
NPS – National Park Service
SWCA - Steven W. Carothers Associates
USFWS – United States Fish and Wildlife Service
USGS – United States Geological Survey
WAPA – Western Area Power Administration

AMWG Committee Members and Alternates (including proposed*)

Dr. Kerry Christian, Hualapai Tribe
Dawn Hubbs, Hualapai Tribe
Vineetha Kartha, State of Arizona
William Shott, NPS/GLCA
Theresa Pasqual, DOI/OWS
Jan Balsom, NPS/GRCA
Jayne Harkins, State of Nevada
Carlee Brown*, State of Colorado
Jessica Neuworth, Colorado River Board of California
Don Ostler, Upper Colorado River Commission
Brian Sadler*, WAPA
John Hamill, Trout Unlimited
Melinda Ciocco, Navajo Nation
Richard Begay*, Navajo Nation
Eric Bobelu, Pueblo of Zuni
Chris Cantrell, AZGFD
Seth Shanahan, State of Nevada
Leslie James, CREDA
Steve Wolff, State of Wyoming

USGS and GCMRC Staff

Michael Runge, USGS
Scott Vanderkooi, Chief, USGS/GCMRC
Lucas Bair, USGS, GCMRC
Charles Yackulic, USGS/GCMRC
Ted Kennedy, USGS/GCMRC
David Ward, USGS
Mike Moran, USGS/GCMRC

Interested Persons

Jeff Kershner, Hun. Creek Services
Rob Billerbeck, NPS
Brian Healy, NPS/GRCA
Melissa Trammel, NPS
Katrina Grantz, Bureau of Reclamation
Brent Rhees, Bureau of Reclamation
Daniel Picard, Bureau of Reclamation
Kurt Dongoske, Pueblo of Zuni
Shane Capron, WAPA
Ryan Mann, AZGFD
David Braun, Sound Science, LLC
Bill Chadda, Bureau of Reclamation
Richard Valdez, SWCA
Sarah Rinkevich, DOI
Nate Rees, Trout Unlimited/AZ Coordinator
Rabi GyawaliADWR
Scott Garland, Trout Unlimited
John Hayes, Argonne National Laboratory
Bill Persons, Public
Curtis Quam, Pueblo of Zuni
Ken Hyde, GLCA
Helen Fairly, GCMRC
Robert Schelly, GRCA
Marianne Crawford, Bureau of Reclamation
Jessica Gwinn, USFWS
Chris Watt, Bureau of Reclamation
Linda Whetton, Bureau of Reclamation
Grace Ellis, Galileo Project, LLC

Amy Ostdiek, State of Colorado
Craig Ellsworth, Western Area Power Administration
Ben Reeder, Grand Canyon River Guides
Rosemary Sucec, NPS IMR
Mark Anderson, NPS GLCA
Kirk Young, USFWS
Paul Harms, State of New Mexico
Dan Dauwalter, Trout Unlimited
Scott Rogers, AZGFD
Larry Stevens, Grand Canyon Wildlands Council
Peggy Roefer, State of Nevada

Meeting Recorder

Lauren Johnston, Galileo Project LLC, 4700 South McClintock Drive, Suite 100, Tempe, Arizona 85282, (480) 629-4705

Presentations and Discussion

Details of the presentations summarized below, with the exception of the *Pueblo of Zuni Tribal Perspectives*, are included in PowerPoints referenced and posted on the Adaptive Management Working Group meeting webpage (https://www.usbr.gov/uc/rm/amp/amwg/mtgs/17sep20/index.html) with these notes. Further details and specifics on scientific methods are captured in the draft whitepaper titled: *Brown Trout below Glen Canyon Dam: A Preliminary Analysis of Risks and Options*, also posted with these notes. The "Presentation Summaries" later in this document reflect information provided by the presenters both during and after their presentations.

The comments and questions in the "Discussion/Q & A" sections are from the audience and represent the viewpoint of one person or entity, unless otherwise noted. Discussion and comments do not, in general, represent a consensus opinion or agreement.

Meeting Purpose and Objectives

Presenter and Affiliation: Michael C. Runge, Ph.D., Research Ecologist, USGS Patuxent Wildlife Research Center
Referenced Presentation: Brown Trout Workshop Overview PPT

Mike Runge introduced the purpose of the workshop as follows:

- To present the current state of the science to address the questions posed by the AMWG February 2017 Brown Trout Workshop motion
- To initiate discussion of the topic with AMWG and TWG representatives
- To hear and understand Pueblo of Zuni perspectives on fish research and management

The scientific basis of the workshop is the preliminary draft whitepaper developed by the USGS GCMRC and outside researchers at the request of the AMWG.

Pueblo of Zuni Tribal Perspectives

Presenter and Affiliation: Curtis Quam, Pueblo of Zuni

Presentation Summary

Curtis Quam presented a series of murals that explain the origin story and traditions of the Pueblo of Zuni. The Pueblo of Zuni have a deep connection to the Little Colorado River, Colorado River, and the Grand Canyon. Ribbon Falls in the Grand Canyon is the Tribe's ancestral place of origin. Through river trips down the Colorado River, the Pueblo of Zuni find evidence of their ancestors living in the canyon and connect to the stories of their ancestors. Pueblo of Zuni people try to maintain a positive outlook and want what is best for all people.

Curtis indicated the Pueblo of Zuni are willing to work with other governments and agencies to find solutions that meet Pueblo of Zuni cultural needs and US government management goals. The Pueblo of Zuni is actively considering how to respond to changes in their environment with a scientific perspective, and meet Zuni traditions and values as much as possible.

Discussion/Q & A

- Question: Can Pueblo of Zuni eat fish?
    - *Answer: Some Zuni can, but some cannot.*
- Question: Can you expand upon the Zuni perspective of the Hualapai's belief that every action has a consequence, and must be dealt with on a spiritual level.
    - *Answer: Zuni have a similar belief…for example, if we don't provide our offerings, there are certain repercussions. We are guided in communal governance by our elders and religious hierarchies.*
    - *It is not apparent that, as scientists in the canyon deal with their resource problems, they give thought to the cultural ramifications of their research. Please keep those impacts in mind, as those actions that remove undesirable species mechanically and through euthanasia – the Pueblo Zuni bear those consequences. Keep that in mind as scientists with your research ethics.*
    - *Several tribes here, including Hualapai and Navajo, have noted cultural dynamics with how aquatic life is part of larger process than just human beings. There are oral histories with each tribe of how we have a connection to these landmarks and waterways.*

Management Context and Objectives

Presenter and Affiliation: Rob Billerbeck, National Park Service
Referenced Presentation: Brown Trout Workshop – Context and Objectives PPT

Presentation Summary

BT have been in the system for some time, but the new concern is related to increased reproduction in Glen Canyon the AZGFD data show an exponential increase in fish populations. Discussions of BT management must take place within the context of existing laws and management plans. The intent of the workshop is to identify the root causes of the BT increase, risks associated with BT population expansion, pros and cons of experimental management options, research needs to support future decisions, and tribal concerns with management options. The goal of an HFE is to maintain sediment balance. The AMWG motion relates to the HFE and its effect on the BT fishery, but the goal of the motion will be weighed against fishery management objectives and all other resources.

Discussion/Q & A

No questions or discussions followed the presentation.

Scientific Background of Brown Trout

Presenter & Affiliation: Richard (Rich) Valdez, SWCA
Referenced Presentation: Brown Trout Workshop - Scientific Background PPT

Presentation Summary

There are no native trout species in the Grand Canyon; they were introduced to three tributaries for sport fishing. Until recently BT have been primarily confined to tributaries, however fall HFEs could have provided a conduit for BT throughout the system. BT have been recorded in Lees Ferry since 1996, with an apparent population explosion in 2013. Data now indicates presence of a reproductive population in Lees Ferry. BT numbers remain low and variable downstream.

Discussion/Q & A

- NPS clarified BT spawn in the fall. The eggs overwinter and then hatch in the Spring. This means fish spawned during the fall of 2015 would not be collected until 2016 surveys.
- Rich clarified BT do not hybridize with RBT or cutthroat trout. The perceived problem between the BT population increase and the RBT population decrease is competition-predation.
- BT reach sexual maturity at about 12 inches in length (3-5 years old), but this can vary due to habitat restrictions. BT have been known to reach maturity at smaller sizes when in a restricted habitat such as a tributary.
- Juveniles, young of year, and adults have different habitat requirements. Females fan loose debris from gravel and lay their eggs. BT young hatch after 60-90 days. Young require shallow, sheltered, productive shoreline areas.
- Fish population explosions are not new. As conditions change in an ecosystem, a population can expand rapidly. This could be due to an Allee effect, in which a population remains detectable but at low levels, and once a population threshold is reached experiences a disproportionate (density dependent) increase in reproductive success. An increase in the intrinsic growth rate function is a red flag of a population explosion.
- Question: Which tributaries produce the most BT?
    - *Answer: BT are primarily in Bright Angel Creek. They have not survived in Shinumo Creek but have survived in Garden Creek. The Biological Opinion for the 2016 LTEMP EIS established a trigger of capturing 25 brown trout in the JCM reach (RM 60.0-64.5) two years in a row to warrant mechanical BT removal at the LCR. The emphasis is on source control. If the sources of BT are controlled, there will be less need to remove fish from the LCR confluence, in deference to tribal concerns.*

Bright Angel Brown Trout Project Report

Presenter & Affiliation: Brian Healy, NPS
Referenced Presentation: Preliminary Review of Bright Angel Creek Trout Control Operations PPT

Presentation Summary

Healy stressed the potential for a compensatory response from BT if eradication is not strong enough. This could lead to BT reproducing younger and when they are smaller, although a change in age at maturity was not identified. Impacts of electrofishing on other fish species need to be taken into account. Overall the efforts appear to be improving the native fish community.

The main concern is a density dependent response to trout control methods. The science is still under peer review by the science advisors involved in the project.

Discussion/Q & A

No questions followed the presentation.

Root Causes of Brown Trout Increase and Rainbow Trout Decline

Presenter & Affiliation: Ted Kennedy, USGS/GCMRC
Referenced Presentation: Root Causes for the Increase in Brown Trout in the Lees Ferry Reach PPT

Presentation Summary

GCMRC utilized structured decision-making, current studies, scientific literature, and input from experts to develop and rank seven hypotheses that might explain initial increases in BT adults in 2013 and 2014, successful spawning in 2015 and 2016, and a concomitant crash in RBT populations. The final seven hypotheses considered as causes for the phenomena listed above are as follows: Fall HFEs, warmer water, change in prey base, less interference in spawning from RBT, the weir placement at Bright Angel Creek, Whirling Disease in RBT, and change in abundance of RBT prey (see slide #14).

Each hypothesis was weighted by the root-causes sub-team with regard to each individual's interpretation of the ability of the data to support a given hypothesis, as depicted in graphic form on slide #40, *Weights of Different Brown Trout Hypotheses*. The Fall HFE hypothesis had approximately twice the weight of the other individual hypotheses, possibly because the hypothesis could work by either of two mechanisms: the Fall HFE could be triggering migration of ripe BT; and it could be cleaning the gravels used by BT prior to spawning and egg laying.

Ted suggested a combination of warmer water, ripe adults with clean gravels, and abundant prey, which could all be caused by a fall HFE event, can explain the trout observations. The hypotheses are preliminary and more work needs to be done before any hypothesis can be discarded. GCMRC acknowledges a data gap with regards to reproductive specifics for BT in the Grand Canyon.

Discussion/Q & A

- The relationship between dissolved oxygen (DO), redd selection, overall spawning habits, reservoir dynamics, and Fall HFEs could be teased out to better understand if DO could be a factor in increased spawning success.
- Temperature variation could be another factor that might have triggered an increase in BT.
- The Fall HFE hypothesis could have been a trigger for BT to migrate. This could be a possible explanation if there are no data to support evidence of an Allee effect.
- BT population patterns in GRCA are cyclical. The BT population was in decline in 2004 after the 2004 fall HFE, and this could be why BT numbers did not increase after that event.
- There are studies to suggest that waterflow in gravels is important for redd success.
- Pheromonal blooms from a large aggregation of females could attract more males, increasing spawning success.

- Steady releases could have played a part in the BT increase, but the data does not appear to support this suggestion.
- Monitoring studies are potentially inconsistent. Catching smaller fish is more difficult than catching larger fish. This can be considered as a potential factor skewing the BT data. There is also inconsistency in gear types and techniques for catching fish and calculating the population parameters (e.g., catch per unit effort (CPUE) and mark-recapture are very different approaches).
- Overlap in spawning season between BT and RBT could play a role in BT-RBT dynamics.
- Adult BT and juvenile BT eat different foods, and adults can eat foods that RBT cannot, including mud snails and gammarus. It's probable that in past years there has not been enough food to help BT jump from juvenile to adult food sources.
- HFEs effects could last for multiple years and could explain a crash in the RBT population over time due to changes in nutrient dynamics caused by HFE timing.
- Equalization flows in 2011 could play a role in the dynamics we are seeing now. This could be explored further. Other strong levers in the system include dissolved phosphorous, which could explain differences in population results after fall HFE events in previous years.
- Fall HFEs appear to favor conditions for BT success, and spring HFEs appear to favor RBT success.

Risk to Brown Trout Increase

Presenter & Affiliation: Charles Yakulic, USGS
Referenced Presentation: Brown Trout Workshop – Risks, Current and Potential PPT

Presentation Summary

GCMRC used a simplified approach to estimate the current population ratio of BT to RBT and the per capita effect of a single BT on RBT to come up with an imperfect yet informative understanding of how BT and RBT populations interact in the CRE. This could then play into an estimate of how changes in the BT population could directly and indirectly affect HBC. Effects of climate change, capture efficiency, early life stage ecology, and potential for dynamic/non-linear effects on interspecific interactions are not considered in this model. The simplistic model suggests that BT pose minimal to moderate present and future risks to RBT, the immediate risk to HBC is minimal but BT pose a substantially greater future risk to HBC as opposed to RBT. Environmental change has the potential to affect interspecific population dynamics in different ways.

Discussion/Q & A

- Given the present data, the population ratio and per capita effect estimation approach described is the best possible option. Additional studies, data and discussion would be needed to develop a stochastic model.
- Streams with active fish stocking operations were not included in these calculations.
- Whirling disease and variations of its occurrence with changing temperature and seasons could be important to risk calculations, especially in the case of low reservoir years.
- Risk to HBC is measured as the percentage chance of the HBC population falling under an average of 7,000 individuals. This threshold might dilute concern from a risk perspective, and a percentage estimate of decline (e.g., measuring risk of the HBC population numbers

declining by 25% from starting point) might more accurately reflect concern. This would result not in a change of assumption of risk, but would re-characterize the severity of risk impacts.

- There are notable differences in capture efficiency between BT and RBT. BT capture efficiency varies seasonally and larger BT are harder to catch than large RBT for roughly 9 months/yr.
- Question: can large BT affect migration rates of RBT?
    - *Answer: There are examples in the literature of this, but it is an independent effect. There is a negative correlation between abundance of BT vs. RBT in Bright Angel Creek. BT migrate seasonally, which could play into seasonal risk to HBC populations. BT migration drivers are unknown. BT migration could be episodic.*

Comparison of Management Options

Presenter & Affiliation: Lucas Bair, USGS
Referenced Presentation: Comparison of Management Options PPT

Presentation Summary

Current management objectives emphasize options that meet current compliance requirements. The management option costs are considered on a direct basis, and efficacy is evaluated individually. There is still uncertainty surrounding root causes of BT increase, efficacy of management methods, and significance of risk. Complexities and downstream resource impacts still need to be considered in the analysis.

Discussion/Q & A

- It's possible that the mechanisms that resulted in BT increase may not be the methods to use to relieve the problem (e.g., to reduce the population of BT). Fall HFEs may have been important for the increase of BT, but eliminating Fall HFEs might not reduce the population of BT at this time. In this case a sequence or series of actions different than the ones that resulted in the problem will likely be needed to control the BT population and minimize risks to HBC.
- Question: Does economic cost assigned to management actions take into consideration the risk associated with an increase in the BT population?
    - *Answer: risk cost is associated separately and may eventually be included in the economic cost. We want to consider risk, so we don't want to include it as a discount to the cost.*
- Question: does cost include mitigation or consultation?
    - *Answer: No – the costs represent purely the cost of doing the actual work.*
- Question: Were angling restrictions or other angling programs considered?
    - *Answer: Yes, and there is a system and potential partners in place. There is the potential for fishing derbies or other targeted events during seasons of BT vulnerability. This could also address the tribal concern of taking of life.*
    - *Angling ethics in Lees Ferry emphasize catch and release. Incentives could help shift away from that ethic. A concerted education campaign would be needed for angling programs at Lees Ferry. Upstream of Lees Ferry might have better success.*

Intended and unintended consequences to the local economy and community would need to be considered.

- A potential management option for temperature control would be a bypass tube. Temperature control was listed as an option in the LTEMP. The Power Office is looking into the feasibility of generators on bypass tubes at Glen Canyon Dam.
- There is strong resistance to mechanical removal at Lees Ferry. The local community depends on its reputation as a quality fishery. Any mechanical removal effort would require significant public education. This should be considered in discussions about management efficacy. This option should be considered in the context of the overall ecological framework, in the spirit of the ecosystem ethic of the ESA.
- Question: Could the AMWG consider not doing the Fall HFEs as an experiment, and take the next four years off from Fall HFEs? What is the scientific approach to this, and what information would we need now in order to prepare for a hiatus in information collection?
    - *Answer: This is discussed in the whitepaper, however the goal of adaptive management is not to test a hypothesis, it's to find policy options that get you to your resource goal. Turning off all Fall HFES is not a full policy option at this time. The scientific benefit could also be limited and not result in the desired effect.*
- The initial goal of the Fall HFEs was to improve the condition of sediment-related resources in the canyon, but there was an unanticipated increase in BT. The protocol AMWG uses is to implement HFEs when sediment conditions permit and after considering the condition of related resources including nonnative fish like brown trout. We are learning from the system over time. It's difficult to find a hypothesis correct or disprove a hypothesis in a natural system with a myriad of variables and impacts from antecedent conditions. Monitoring multiple variables as different management strategies are implemented and is key to better understanding the system. For next steps it makes sense to consider the monitoring burden for each of these management options.
- A pheromone trap pilot study attempted and failed to capture RBT in Lees Ferry.
- Rotenone-laced baits are aimed as a carp management tool, and are likely not effective against wild fish.

Wrap Up Discussion

Facilitator: Michael C. Runge, Ph.D., Research Ecologist, USGS Patuxent Wildlife Research Center

- Uncertainty in the decision-making process is a constant battle. The group needs to consider at what point it becomes more of a risk to wait and resolve uncertainty rather than act under a precautionary principle. Decision-makers must also weigh potential primacy of objectives. Can the success of one goal outweigh potential costs to another goal?
- It's currently unclear what mechanisms are behind the correlation between HFEs and a BT increase. The potential for learning should be secondary to avoiding acting in a way that could further exacerbate the problem at hand.
- Participants are still concerned that inaction could result in invasion of BT into an entire river system. Waiting for further studies could have drastic impacts on the future of the CRE. It may make the most sense to stem the current population increase and consider the larger mechanistic questions as we continue to learn.

Friday, September 22, 2017

Start Time: 8:30 am
Conducting/Facilitator: Michael C. Runge, Ph.D., Research Ecologist, USGS Patuxent Wildlife Research Center
Recorder: Lauren Johnston, Galileo Project, LLC

Summary Action Items

- Participants send any additional suggestions on the whitepaper to Scott VanderKooi.
- Participants send independent reviewer recommendations to David Braun.

Meeting Attendees

AZGFD – Arizona Game and Fish Department
CREDA - Colorado River Energy Distributors association
DOI – Department of the Interior
GCMRC – Grand Canyon Monitoring and Research Center
GLCA – Glen Canyon National Recreation Area
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Jan Balsom, National Park Service/GRCA
Chris Lehnertz, National Park Service, GRCA
Larry Stevens, Grand Canyon Wildlands Council

U.S. Geological Survey (USGS) and Grand Canyon Monitoring and Research Center's (GCMRC) Staff

David Ward, USGS/GCMRC
Scott VanderKooi, USGS/GCMRC
Helen Fairly, USGS/GCMRC
Michael Moran, USGS/GCMRC
Mike Runge, USGS
Lucas Bair, USGS, GCMRC
Charles Yackulic, USGS/GCMRC
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Interested Persons

David Braun, Sound Science, LLC
Ryan Mann, AZGFD
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Daniel Picard, Bureau of Reclamation
Theresa Pasqual, DOI/OWS
Brian Sadler, Western Area Power Administration

Presentation Review & Further Discussion

September 21, 2017 Discussion Review

Facilitator: Michael C. Runge, Ph.D., Research Ecologist, USGS Patuxent Wildlife Research Center

The workshop's purpose is to elicit revisions to the whitepaper and inform decision-makers of what research/management actions need to be considered in the short and long term. The GCMRC team looked at potential modifications to current operations that could be implemented to achieve HBC objectives. These modifications could interact with other objectives in the LTEMP. This is only a preliminary tradeoff analysis, and the goal of the closing discussion is to decide where to dive deeper into the analysis to better understand options moving forward for managing BT populations within the constraints of other management objectives.

Mike offered these additional questions for consideration during final discussions:

- Is the goal to eliminate BT from the canyon, or to manage the risks associated with a BT increase?
- How do risks change if the BT population continues to grow?
- Are there tactics from other parts of the world that we have not yet explored?
- Is there a series of changes to HFE timing and intensity that could help build resilience in the system as a whole rather than focusing solely on the BT problem at hand?
- What management actions would treat causes of BT abundance and not merely symptoms?
- How do BT management actions interact with other management objectives?
- What is the nature of our concern with BT?
- Which management options are no longer available if a BT population secures a foothold in Lees Ferry?

Humpback Chub Recovery and Section 7 Concerns

- Expansion of BT in the system could slow current HBC recovery efforts. Actions considered in this workshop could also become complicated with ESA Section 7 compliance needs and management actions. The USFWS, with the help of the Recovery Team, is preparing a Species Status Assessment (SSA) to inform the USFWS on the current status of the species and whether a change in status is supported by the scientific data. The future recovery planning process would guide recovery actions. The USFWS AMWG representative confirmed that if HBC populations go below an estimated risk threshold that it would not necessarily preclude down-listing of HBC.

Risk Calculations

- BT are piscivorous under a variety of conditions, and are much more piscivorous than RBT. BT have the potential to impact HBC populations more than estimated in GCMRC's risk calculations.

Agency-led mechanical removal

- Anglers question the efficacy and cost calculation for mechanical fish removal. Mechanical removal is an ongoing process. Impacts to the local community and to tribes have significant costs. Mechanical Removal may keep a population at bay, but may not result in an overall decrease. It could be an interim control measure while AMWG decides on additional, more long-term actions.
- Other actions could be combined with mechanical removal in the short term as well. Both short and long-term actions need to be tied back to the hypotheses.
- While removal efforts in the LCR were effective, the population dynamics at Lees Ferry are different and might not result in an effective population decrease. Seasonal variation in capture efficiency as well as size class of fish that can be captured is of concern.

Angler-Involved Removal Incentives

- There is not and never has been a limit to BT take in Lees Ferry. Incentivizing anglers to take BT would require several components, including education, and the success of such a program would depend on how it is presented to and received by the local and angler community. Any education effort would need to adequately explain how BT presence in Lees Ferry, and not in other tailwaters, is problematic. Involving the community may be the more socially acceptable removal option.
- One potential option is to expand the boundary for incentivizing take beyond Lees Ferry to involve different fishing communities, i.e. bait fishing communities.
- Participants agree that mechanical removal will not in and of itself solve the BT problem.

Life Cycle Perspective

- Fish population survival depends on the success of juveniles. Preventing spawning may not be helpful in reducing the population. It is valuable to consider ways of limiting juvenile survival and slowing the population growth rate. This could have a larger impact than mechanical removal. Slowing the growth rate could provide a trade-off between tribal concerns with taking of life and managing impacts to HBC.

Examples from other fish population control efforts

- Anecdotal experience from other fish removal efforts suggests moving quickly to control population growth is the best option. Lack of action could lead to an interminable BT control effort that could have been prevented with early action.
- Mike Runge cautioned against selection bias in discussing failed management efforts, reiterating that there is not yet scientific consensus of a BT population explosion. Risks and costs associated with a disproportionate management response are just as real as those generated by precaution.

Management Action and Risk

- Current trends are symptoms of long term changes and novel events. The system is stabilized and at the lowest point of ecological variability. This has resulted in a niche shift, which could result in establishment of more invasive species. Niche shift needs to be considered from a research standpoint.

- HBC are a big driver in how the CRE is managed. Given that mechanical removal is not desirable, it makes sense to find a way to keep the population of BT in check until additional tools for management are developed.
- The risk to the HBC is apparent. It's in the group's best interest to take action with the current available science and try and control the problem while the population is small. We need to clearly tie management actions back to hypotheses, for example manipulating dam flow operations in an effort to disrupt any positive effects dam flows might have on BT survival.
- Juvenile BT have been in Lees Ferry for years. While some of the management actions would be unacceptable to the community there, it is an urgent problem. There is not strong evidence of a compensatory response, but there is strong evidence to suggest rapid action. The ecosystem in question is the GRCA, and as such we need to be protective. Taking action and communicating with the interested public is the best precautionary path forward.
- Acting on risk in the face of uncertainty could potentially create more risk. Changing management actions in the face of uncertainty of risk and available time is a challenge.

Baseline Monitoring Programs Currently in the AMWG/GCMRC Budget

The GCMRC research program elements listed below each contain a baseline data monitoring component:

  - Element F5 – shifts in Glen Canyon Prey Base
  - Element G3 – chub / fish monitoring at LCR (spring summer fall)
  - Element H1 – experimental flow assessment of trout recruitment
  - Element H2 – RBT and BT outmigration & recruitment model
  - Element H3 – otolith early life history and growth data to inform management of rainbow trout populations in Glen Canyon (hopefully bycatch)
  - Element H4 – RBT monitoring in Glen Canyon (long term, ongoing, summer and fall)
  - Element I1 – system wide native fish and invasive aquatic monitoring (electrofishing)
- Question: do any of the program elements contain spawning research?
  - *Answer: there are some aspects in H1 that look at redds and early life stages. Study plans and schedules can be adjusted if there is an aspect of monitoring we want to capture in the future that we are not already addressing.*
  - *The NPS's Bright Angel Creek control studies are in peer review by the Bureau of Reclamation.*
    - *NPS/Reclamation has small bodied fish monitoring in place at 57 sites.*
    - *NPS has done a pilot BT telemetry study to capture information on seasonal and daily movement by BT in an effort to identify most vulnerable times for electrofishing.*
    - *Plan to deploy 30 tags over the next spawning period to get a better picture of movement.*
  - *Pit Tag antennas or acoustic tag arrays are in place for razorback sucker and HBC monitoring, two are in the vicinity of the LCR.*
  - *The detection efficiency of the telemetry studies is affected by background noise but has been reliable.*

Workshop Goals - Discussion

The planning team is looking for immediate next steps in fleshing out the draft whitepaper - how much more analysis is needed, and in which areas?

- The group lacks consensus regarding the efficacy of the whitepaper. Some felt it was produced quickly and needs additional work to be useful to the AMP and the NPS EA. Others felt it may be a distraction to continue improving the paper to a final draft and efforts might be better spent trying to manage BT rather than bolstering a whitepaper.
- GCMRC involvement is the result of an AMWG motion. The GCMRC is doing research to support the whitepaper, which would then inform the NPS EA. GCMRC is not working directly with the NPS to develop the EA. Any GCMRC work on the NPS EA would require an AMWG approval and result in research delays.
- Data taken from earlier hydrological events is not explained or taken into consideration in the HFE hypothesis. GCMRC could look at all hydrological patterns (e.g., fall steady flows, equalization flows) for impacts with a longer temporal lens. The hypothesis-weighting process is not clear, and potentially more factors need to be taken into account when weighting hypotheses.
- The AMWG has twenty resource goals. In looking through the budget and considering management options it's worth considering what the impacts of an action are on the other AMWG resource goals. First identify potential management options, then the impacts those options have on other AMWG resource goals, and develop concomitant actions or mitigations to account for those potential impacts. For example, not doing a fall HFE as an action to help control BT could result in lack of sand banks for recreation in the canyon. Are there any mitigation options for minimizing impacts to sand banks?
- The hypotheses and weighting methods in the whitepaper need to be broken out and more thoroughly explained to improve readability. There needs to be a more formal hypothesis rather than proposed pieces that could be combined in a number of ways. Additional details need to be added to the root causes section to better assist decision-makers.
- Economic costs should include explicit details of how costs were calculated.
- Management actions should be described in detail and expressed in clear terms of their potential effects on meeting the objective of protecting HBC.
- There could be a section focused on efforts and implications of removing BT from an ecological perspective. BT is a top predator. The ecosystem is highly altered and resilience is minimal. What are the other potential ecological implications?

The Management team seeks direction on what near-term management actions can be put in place to address the risks. Agencies with a research objective need guidance on how best to utilize current monitoring and research to maximize short term learning opportunities to better inform actions down the road.

- Consider short term management options to address the current danger while continuing to develop a comprehensive whitepaper and the NPS EA.
- Explore ideas of bounties, angler involvement and education. Education would need to start sooner rather than later.
    - This management action is also being considered in the NPS EA.

- Some participants felt decision makers should seriously consider the implications of immediate mechanical removal. They felt the efficacy is overstated and the economic and local social costs might outweigh any potential benefit.
- Utilize BT obtained through incidental take to perform natal origins/otolith studies to better understand population dynamics.
    - Otolith studies are incorporated into the GCMRC project element H3, but do not include microchemistry.
- Weigh the benefits of the BT kill mandate with opportunity cost to research.
- Some participants consider the research presented to bolster the belief that HFEs are largely responsible for the BT increase. It's recommended that a Fall HFE is deferred for this year and the group further discusses a management switch to Spring HFEs. The timing and duration of HFEs needs to be further explored.
- Tribal concerns need to take a prominent role considering management actions and any potential mitigation that might be needed as a result.

Closing Perspectives

The desired outcome of this workshop is perspective on how best to proceed. Questions to consider with final closing perspectives include:

- What is something valuable that we can offer to the program rather than wait for the whitepaper?
- What will the whitepaper mean and be used for? Will it result in change?
- Who is responding to it? What does this mean for circulation and utility of whitepaper?

Participants offered the following closing comments:

- There is a motion from the AMWG to consider the whitepaper and results of this workshop when deciding whether or not to have a fall HFE in 2017. The whitepaper can also be used to inform other agencies management decisions. The conversation of how to consider the whitepaper with future AMWG actions and motions will continue with subsequent AMWG meetings.
- The whitepaper will serve as a good source of the best available science for the brown trout aspects of the NPS's upcoming EA. It feeds into the decision-making process for GLCA and GRCA officials. Both the paper and the forum today are valuable for informing management decisions.
- Tribal concerns from the AMWG motion on Sept. 20, 2017 are not currently reflected in the draft whitepaper. We want to be sure to give tribes an opportunity to contribute. It's a goal of the NPS EA and AMWG to have further tribal involvement through cooperation and formal consultation.
- Final impressions and interpretations from this workshop and whitepaper will be different across individuals and agencies. Feedback from decision-makers after the final whitepaper is released will be invaluable to helping other AMWG participants understand next steps.
- Given that there will always be uncertainty in decision-making, the values of the decision are important. It would be useful to have Mike Runge assist in facilitating discussion of how values and science will weigh into the decision-making process.
- Consider whether identifying root causes is the appropriate question. Instead the GCMRC could research what management actions could rectify the potential BT population problem.

- Develop a process to identify critical uncertainties and explicit mechanisms for addressing the BT problem.
- Publish the whitepaper as an open file USGS report.
- The final workshop report and whitepaper are destined for independent review. Participants can provide suggestions for neutral reviewing parties to assist with the technical review.
- Develop and present more details for economic cost analysis of management options.
    a. Set the costs within a timeframe (i.e. one time, annual, multiyear etc.)
    b. Consider costs to other management objectives
    c. Consider costs to other interested parties, i.e. tribes and other local communities.
- Further analysis into which metrics best inform success of management objectives.
- Provide evidence of other BT management case studies.
- Clearly align economic costs with resource goals in the LTEMP ROD.

Summary Table of Abbreviations

ADWR – Arizona Dept. of Water Resources
AF – Acre Feet
AGFD – Arizona Game and Fish Department
AIF – Agenda Information Form
AMP – Adaptive Management Program
AMWG – Adaptive Management Work Group
AOP – Annual Operating Plan
ARM – Annual Reporting Meeting
ASMR – Age-Structure Mark Recapture
BA – Biological Assessment
BAHG – Budget Ad Hoc Group
BCOM – Biological Conservation Measure
BE – Biological Evaluation
BHBF – Beach/Habitat-Building Flow
BHMF – Beach/Habitat Maintenance Flow
BIA – Bureau of Indian Affairs
BO – Biological Opinion
BOR – Bureau of Reclamation
BWP – Budget and Work Plan
BT – Brown Trout
CAHG – Charter Ad Hoc Group
CAP – Central Arizona Project
GCT – Grand Canyon Trust
CESU – Cooperative Ecosystems Studies Unit
cfs – cubic feet per second
CFMP – Comprehensive Fisheries Management Plan
CMINS – Core Monitoring Information Needs
CMP – Core Monitoring Plan
CPI – Consumer Price Index
CRBC – Colorado River Board of California
CRAHG – Cultural Resources Ad Hoc Group
CRCN – Colorado River Commission of Nevada
CRE – Colorado River Ecosystem
CREDA – Colorado River Energy Distributors Assn.
HBC – Humpback Chub (endangered native fish)
HFE – High Flow Experiment
HMF – Habitat Maintenance Flow
HPP – Historic Preservation Plan
IG – Interim Guidelines
INs – Information Needs
KA – Knowledge Assessment (workshop)
KAS – Kanab Ambersnail (endangered native snail)
LCR – Little Colorado River
LCRMCP – Lower Colorado River Multi-Species Conservation Program
LTEMP – Long-Term Experimental and Management Plan
LTEP – Long Term Experimental Plan
MAF – Million Acre Feet
MA – Management Action
MATA – Multi-Attribute Trade-Off Analysis
MLFF – Modified Low Fluctuating Flow
MO – Management Objective
MRP – Monitoring and Research Plan
NAU – Northern Arizona University (Flagstaff, AZ)
NEPA – National Environmental Policy Act
NHPA – National Historic Preservation Act
NNFC – Non-native Fish Control
NOI – Notice of Intent
NPCA – National Parks Conservation Association
NPS – National Park Service
NRC – National Research Council
O&M – Operations & Maintenance (Reclamation Funding)
PA – Programmatic Agreement
PBR – Paria to Badger Creek Reach
PEP – Protocol Evaluation Panel
POAHG – Public Outreach Ad Hoc Group
Powerplant Capacity = 31,000 cfs
R&D – Research and Development
RBT – Rainbow Trout

CRSP – Colorado River Storage Project
CWCB – Colorado Water Conservation Board
DAHG – Desired Future Conditions Ad Hoc Group
DASA – Data Acquisition, Storage, and Analysis
DBMS – Data Base Management System
DOE – Department of Energy
DOI – Department of the Interior
DOIFF – Department of the Interior Federal Family
EA – Environmental Assessment
EIS – Environmental Impact Statement
ESA – Endangered Species Act
FACA – Federal Advisory Committee Act
FEIS – Final Environmental Impact Statement
FRN – Federal Register Notice
FWS – United States Fish & Wildlife Service
FY – Fiscal Year (October 1 – September 30)
GCD – Glen Canyon Dam
GCES – Glen Canyon Environmental Studies
GCT – Grand Canyon Trust
GCMRC – Grand Canyon Monitoring & Research Center
GCNP – Grand Canyon National Park
GCNRA – Glen Canyon Nat'l Recreation Area
GCPA – Grand Canyon Protection Act
GLCA – Glen Canyon Nat'l Recreation Area
GRCA – Grand Canyon National Park
GCRG – Grand Canyon River Guides
GCWC – Grand Canyon Wildlands Council
GSF – Green Sunfish
RFP – Request for Proposal
RINs – Research Information Needs
ROD Flows – Record of Decision Flows
RPA – Reasonable and Prudent Alternative
SA – Science Advisors
SAEC – Science Advisors Executive Coordinator
Secretary – Secretary of the Interior
SCORE – State of the Colorado River Ecosystem
SHPO – State Historic Preservation Office
SOW – Statement of Work
SPAHG – Strategic Plan Ad Hoc Group
SPG – Science Planning Group
SSQs – Strategic Science Questions
SWCA – Steven W. Carothers Associates
TCD – Temperature Control Device
TCP – Traditional Cultural Property
TEK – Traditional Ecological Knowledge
TES – Threatened and Endangered Species
TMC – Taxa of Management Concern
TMF – Trout Management Flows
TWG – Technical Work Group
UCRC – Upper Colorado River Commission
UDWR – Utah Division of Water Resources
USBR – United States Bureau of Reclamation
USFWS – United States Fish & Wildlife Service
USGS – United States Geological Survey
WAPA – Western Area Power Administration
WY – Water Year