

**Glen Canyon Dam Adaptive Management Program
Technical Work Group (TWG) Meeting
April 23–24, 2018**

Date: April 23, 2018

Start Time: 9:30 a.m.

Conducting: Seth Shanahan, TWG Chair
Vineetha Kartha, TWG Vice-Chair

Committee Members/Alternates Present:

Melinda Arviso-Ciocco, Navajo Nation (phone)
Cliff Barrett, USAMPS (phone)
Carlee Brown, State of Colorado
Kerry Christensen, Hualapai Tribe
Marianne Crawford, U.S. Bureau of Reclamation
Kevin Dahl, National Parks Conservation Assn.
Bill Davis, CREDA
Kurt Dongoske, Pueblo of Zuni
Craig Ellsworth, WAPA
Paul Harms, State of New Mexico
Brian Healy, NPS/GRCA

Ken Hyde, NPS/GLNRA
Ryan Mann, Arizona Game & Fish Department
Jessica Neuwerth, State of California
Don Oster, State of Wyoming
Ben Reeder, Grand Canyon River Guides
Peggy Roefer, CRC/Nevada (phone)
Larry Stevens, Grand Canyon Wildlands Council
Jim Strogon, Federation of Fly Fishers/TU
Michael Yeatts, the Hopi Tribe (phone)
Kirk Young, U.S. Fish and Wildlife Service

Committee Members Absent:

Jan Balsom, NPS/GRCA
Charley Bullets, Southern Paiute Consortium
Shane Capron, WAPA
Robert King, State of Utah

Katrina Grantz, U.S. Bureau of Reclamation
Chip Lewis, Bureau of Indian Affairs
Steve Wolff, State of Wyoming

USGS/Grand Canyon Monitoring and Research Center:

Helen Fairley, Program Manager
Mike Moran, Deputy Center Director

Scott VanderKooi, Center Director

Interested Persons

Kevin McAbee, U.S. Fish and Wildlife Service
Peter Bungart, Hualapai Tribe
Rob Billerbeck, NPS
David Braun, Sound Science LLC (phone)
Kathy Callister, U.S. Bureau of Reclamation
Paul Davidson, U.S. Bureau of Reclamation (phone)
James DeVos, Arizona Game and Fish Department
Brent Esslin, Arizona Dept. of Water Resources
Ed Gerak, Arizona Power Authority
Jessica Gwinn, U.S. Fish and Wildlife Service
Leslie James, CREDA
Nicole Jimenez, U.S. Fish & Wildlife Service

John Jordan, Federation of Fly Fishers/TU
Kirk LaGory, NPS (phone)
Don Ostler, Upper Colorado River Commission
Clayton Palmer, Western Area Power Administration
Theresa Pasqual, DOI Joint Tribal Liaison
Bill Persons, FFF/Trout Unlimited
Sarah Rinkevich, DOI Joint Tribal Liaison
Dave Rogowski, Arizona Game & Fish Department
Mike Runge, U.S. Geological Survey
Steve Spangle, U.S. Fish and Wildlife Service
Melissa Trammell, NPS (phone)
Lee Traynham, U.S. Bureau of Reclamation

Meeting Recorder: Linda Whetton

Welcome and Administrative: Ms. Kartha welcomed the members and the public. Introductions were made and a quorum determined.

- Approval of January 25, 2018, Meeting Minutes. Pending a few edits, the minutes were approved by consensus.
- Next Meeting Dates: June 25-26; October 10 -11. Both meetings will be held at ADWR.
- Ad Hoc Group Updates. The list was circulated for updates and finalized ([Attachment 1](#)).
 - SEAHG Update – Mr. Reeder. The group met for lunch during the last TWG meeting held in Flagstaff and discussed concerns about Project N. He's following up on questions raised.
- Update on Monitoring and Research Trips ([Attachment 2](#))
- Update on Brown Trout Workshop Report – Mr. VanderKooi. The report was e-mailed last Friday and can be found [here](#) (or at: <https://doi.org/10.3133/ofr20181069>). He thanked those who provided input. Mike Runge felt it was a very professional document.

- **Action Item:** The TWG will recommend that the AMWG discuss the BT Report at the August 2018 meeting and determine what further action is needed.
- Update on Funding Tribal Contracts – Ms. Traynham. Delays in getting contracts approved is a problem occurring throughout the Department. The Assistant Secretary for Water and his deputy, Andrea Travnicek, have reached out to Reclamation staff requesting a timeline to better understand how they can expedite the outstanding agreements and improve the contracting process.
- Science Advisors' Program Update – Mr. Braun. An e-mail was sent on April 17, 2018, asking the GCDAMP community to complete a survey focused on providing advice to Reclamation and the Science Advisors Program. The SAP is looking for suggestions on (1) Identifying topics that the SAP potentially could address through external independent review panel over the course of FY 2018-2020, and (2) Based on these specialized topics and the current research and monitoring priorities of the GCDAMP, identifying the disciplinary areas that need to be represented among the members of the expert panel for 2018-2020. Responses should be sent to Christine Wisnewski (christine@sound-science.org) by May 1.
- Bright Angel Creek Translocation and the SCP review – Mr. Healy. The NPS has been working to control non-native BT and RBT from BAC since the early 2000's but more intensively since 2012. As part of their CFMP, Reclamation coordinated with the SAP to conduct a peer review of the 5-year monitoring report. The recommendation from the panel was to move forward with an experimental HBC translocation to BAC. Suppression of trout is at a sufficient level for the native fish to rebound there. NPS is working with USFWS and BOR to coordinate that effort and are shooting for May 14 to release about 150 year 2+ HBC in BAC. As part of the monitoring effort, BOR has coordinated the installation of a PIT tag antennae at the base of BAC and the project will involve monitoring similar to other translocation projects that have been conducted.

The inclusion of the Total Value of Hydropower into Information and Decision Making in the Grand Canyon Adaptive Management Program (Attachment 3a) – Hank Jenkins-Smith. Non-market value is a major component of the total value of the change that's associated with any major program. Non-market values are handled very poorly in frameworks that require formal benefit cost analysis. Jenkin-Smiths' group has been trying to come up with a protocol for understanding how value changes occur. Values that concern people must be included in order to measure them. If the TWG is working on the technical issues associated with the operation of GCD without consideration of the full array of potential non-use values that are involved, then there could be areas not receiving the right attention. A total market value approach should be used in order to design a research program that actually informs what matters, rather than assume it is known which value can be excluded or omitted based on a priority judgment.

The Total Value of Hydropower (Attachment 3b) – Clayton Palmer. This research can be used for information sharing, production of reports, decision-making and developing recommendations to the Secretary of the Interior. For hydropower, the research implies that the measurement of a hydropower effect by changing the operation of GCD is not quantitatively adequate if you use market values. Further analysis is needed. No changes to GCMRC's budget are necessary and this is not Project N. Project N is the improvement of hydropower values through experimentation and other means. According to the research explained by Dr. Jenkins-Smith, hydropower is a bundled product. The dimensions of value with respect to hydropower are more than electricity and one needs to include all the dimensions of value when assessing the impact to hydropower of operational changes.

Discussion / Q&A

- *The Grand Canyon is the most revered national park or landscape in the world. Is there a way to sort out those data to understand which kinds of landscapes are being addressed by the public? (Stevens)*
Yes, but keep in mind we're looking for the variety of origins for value propositions and arguments that are out there. Some of them may not be of relevance to an operational change. There are two steps that are relevant to your question, one is making sure that we're not omitting things that may matter to people, and the second is putting it in the context of a geographic, historical, cultural change such as the GCD.
- *How do you calculate the emotional and the psychological costs that is inflicted upon an indigenous group? You also talked about willingness to pay and that obviates the Native American perspective because the Pueblo of Zuni's*

relationship to the GRCA is not valued in terms of a monetary system. The Zuni would say they've been paying for over 500 years with colonial oppression. (Dongoske)

We work within a framework that's been defined for the making of federal decision. The whole basis of benefit cost analysis comes from utilitarian models that assume value rests in the benefits and costs as people recognize them in a market-based economy. To the extent that we are trying to recognize this sort of tradition of western values in benefits and costs in a benefit framework, we're doing so with due care to the array of value systems that are out there. Ultimately, we're going to have to do a much better job of putting benefit cost analysis and monetizing of values as a piece of a broader and more effective framework. (Jenkins-Smith)

- *I think there are some people who are involved in traditional cultures where values haven't changed for centuries and not thousands of years. The Zuni, Hualapai, and other tribes' values will not change. I think the people doing the surveys have a bias. Hydropower interests have paid for a survey to show that there are even more values than hydropower. (Dahl)
WAPA partnered with the University of Oklahoma. The University paid for the survey, WAPA did not. (Palmer)*
- *All the indigenous people in this area have centuries of practice of conserving what they have, of not being wasteful, and realize they live with limited resources. In your research, are you addressing people's values and practices about conservation or even controlling for instance their perceptions of climate change and living in an area where we have explosive population growth and relatively fine resources. (Bungart)*

Update on Potential Rainbow Trout Stocking in Glen Canyon ([Attachment 4](#)) – James deVos. The Arizona Game and Fish Department is a state agency and operates under the direction of the Arizona Game and Fish Commission which is a policy-setting body. The NPS/AGFD shared fishery goals are: (1) Maintaining a quality recreational RBT fishery in Lees Ferry, and (2) Maintaining healthy populations of all native fish (including HBC and RBS) populations in the lower Colorado River. To increase fish numbers to the catch rate goal one fish per hour, the AGFD believes more stocking will help. The AGFD plans to stock 16,000 triploid RBT between April 1 – Oct 15 in 2018 and 2019, which should yield about 32,000 fish. A 2-year research project will be conducted to evaluate out-migration into other reaches and will include federal partners and related needs. Approximately 5,000 fish per month will be stocked in the walk-in fishery. Stocked fish have a high mortality, the average rate will be 95%. The number of fish expected to reach the LCR is very small. Conservation measures and AGFD's implementation approach were reviewed.

Discussion / Q&A

- *Regarding the slide with 35% decline in angling, there was a graph that was a little confusing. In 2011-12 there is a huge boom in fish, but it seems like even before that the trend was already declining in the angler use. Can you answer that? (Reeder)
When fishing is hot, there are more anglers. The quality of fish in 2012 had declined substantially in body condition which probably led to the decline so the interest in angling started declining. It has fallen off the table currently. (deVos)*
- *Regarding Section 106 Consultation, who is going to be contacting the tribes? And do you have any concerns about whirling diseases or other diseases with these triploid fish? (Christensen)
The FWS sent letters to the affected tribes approximately 6 weeks ago. The fish initially will be coming from one of two facilities, one of them is our vendor facility which follows AFS Blue Book standards, whirling disease free, some will come from the Canyon Creek hatchery which we have a really good record of fish health at that facility. With the whirling disease being in the system itself, these are catchable fish so we don't suspect that would be a problem to those fish at all. (Cantrell)*
- *We ought to be addressing the foodbase problem. What's your budget and how much is re-subsidizing the trout fishing? (Reeder)
About half of the Department's license sales come from anglers so we're actually doing an entrepreneurial model where we're generating more resources to the Department than we spend for our trout fishery. We're not subsidizing the angling community, we're in the business of having opportunity and again about \$20 million/year in fish license. (deVos)*
- *Collectively we have almost 25 years of information on trout population dynamics in that reach. We have a huge*

dataset, great time series, good tracking of pretty much all the factors that could be responsible there. Why don't we have a predictive model yet that will tell us how to better manage for trout? (Stevens)

We have a pretty good sense of some of the drivers. We could probably get good models from Charles Yackulic and Josh Korman, but we have a fairly good sense of what's going on. Going forward we'll have a better understanding of the dynamics of nutrients and that seems to be moving us into a better direction in trying to understand the complexity between reservoir elevation and nutrients and flows. Part of the problem is trying to piece together causative factors for correlations. (VanderKooi)

Q: *However, with the accumulation of so much information, we have the opportunity to build a pilot model and shouldn't that be a priority for this program?*

Update on Compliance Status for Rainbow Trout Stocking in Glen Canyon (Attachment 5) – Nicole Jimenez, Jessica Gwinn. The FWS Wildlife and Sport Fish Restoration Program (WSFR) collects a tax on fishing equipment, boats, engine, fuel, etc. and deposits the money into an aquatic resource trust fund. These funds can only be granted to State fish and wildlife agencies that have the authority to manage wildlife. Thus, the only agency in Arizona that's eligible to receive funds out of this account is the AGFD. The program doesn't consider what work should or shouldn't be done and leaves that to the expertise of the game and fish agencies, but only looks at eligibility. In March 2018, AGFD requested funding to stock Rainbow Trout at Lees Ferry. AGFD will be required to complete Intra-Service Section 7 Consultation between WSFR and the Ecological Services office. NHPA 106 compliance has been initiated. The WSFR office sent invitations for government-to-government consultation with the tribes and continue to consult with the SHPO, the ACHPO, and the ACHP.

Discussion / Q&A

- *Would you explain the thought process as to how you came to a categorical exclusion when the Zuni's expressed concern that you may have an adverse effect under 106 which prevent a categorical exclusion. (Dongoske)*
Well, having an effect on 106 doesn't necessarily kick it out of the Cad Ex. In this case we're looking at that because controversy for a NEPA is looked at as being controversy scientifically about the outcomes, not that there is opposition to the project. (Jimenez)
- *But you have to consider the human environment relationship and I think it's appropriate and necessary to fully consider alternative perceptions, interactions with the environment, other than just a western science perspective and that's what Zuni would be offering you. (Dongoske)*
We have just barely kicked off the 106 process and currently are gathering data. Once it goes through the process, we'll know what further work needs to be done. (Jimenez)

Update on Hydrology and Operations (Attachment 6) – Paul Davidson. The amount of snow this year has been tracking equal to the historic low year of 2002. The April to July 2018 forecasted inflow to Lake Powell is 3,300 kaf or 46% of average. The minimum and maximum probable hydrological forecasts are also below average. For Water Year 2018, Lake Powell is operating in the Upper Elevation Balancing Tier. There will be an April adjustment to Balancing, with releases from GCD not to exceed 9.0 maf and not less than 8.23 maf in the water year. The projected water year release volumes for 2019 are between 8.80 maf and 9.0 maf. Maintenance requirements at the powerplant caused some adjustments to the LTEMP release volume last year. In November 2018, all units will be available for a potential High Flow Experiment, pending any unforeseen maintenance.

As approved by the Asst. Secretary for Water and Science on April 13, the Bug Flow experiment will run May through August with steady weekend flows, normal hydropower production flows during week days, no monthly or weekly volumes flow changes, and week day fluctuating flows that will follow LTEMP guidelines.

Evaluation of Temperature Control Methods at Glen Canyon Dam (Reclamation Project C.9) – Project Overview and Status Update – Connie Svoboda is a hydraulic engineer with the Denver Technical Service Center that conducts physical and numerical modeling of hydraulic structures related

to temperature control of dams. The TSC has been involved in design and testing of selective withdrawal systems and temperature curtains. A white paper is being prepared that will include a literature review, interviews with BOR operators/engineers and current operations that help better achieve temperature goals. This paper will be completed in FY18. The information will be provided to the Research and Development Office to determine whether a prize competition may provide new solutions to this problem. This effort should provide some basis for the GCDAMP's investigation into the best alternatives for Glen Canyon.

Action Item: TWG should send any comments or suggestions to Lee Traynham with next two weeks and she'll forward to Connie.

Update on the Status of Developing the Expanded Non-native Aquatic Species Management Plan Environmental Assessment (Attachment 7) – Rob Billerbeck.

Comments received from scoping sessions indicate NPS should share some refined alternatives and start talking about some triggers and tiers. NPS has some compliance for non-natives through the existing 2013 CFMP and Reclamation has compliance through the 2016 LTEMP, but changes in the system have produced more BT, GSF, and Quagga mussels. NPS wants to ensure there are sufficient tools in the toolbox to manage the non-natives, retain the recreational trout fishery in Lees Ferry and the endangered and native fish downstream. The EA needs to be adaptable so that new information can be incorporated easily.

Next steps:

- Materials will be provided to TWG for an opportunity to comment on draft alternatives, tiers and triggers, and risk of rating species (April)
- Release scoping report and comments (April)
- Meeting with AGFD regarding incentivized harvest and other concerns
- Consultation with tribes as needed
- Refine and finalize alternatives, tiers and triggers (May)
- Conduct analysis (May/June)
- Work with cooperating agencies on administrative draft of EA (May/June)
- Release EA for public comment (July)

Discussion / Q&A

- *Change "consultation with tribes as needed" to "consultation with tribes as required by law."* (Dongoske)
- *Have you included fish parasites in your non-native species list?* (Stevens)
We have included some parasites. We're looking at invertebrates rather than taking it down to pathogens. We have to cut it off somewhere. (Billerbeck)
- *There's a lengthy list of non-native fish parasites in the system, some of which are now in some of the native fish and strategies for dealing with those might be important.* (Stevens)
We will provide the list of how we ranked some of them. Again, we are not including pathogens – viruses, bacteria, but we are including invertebrate parasites. (Billerbeck)
- *From the perspective of trying to protect the RBT fishery, those numbers are important to us. Who determined what those numbers are and what would lead to another tier?* (Strogen)
We're thinking that this tier 4 version of electrofishing would look very much like what they scoped out for the white paper which my understanding is it would be something like 8 trips between November and the end of January. (Billerbeck)
Charles Yackulic modeled that and provided it to us. Those are complete passes and there was an aspect of the type of shocking that would be done. It would be at this particular speed that the AGFD generally does their work. (Trammell)
- *Trying to wrap my head around the YY stocking and one of my reservations is while technology is (astute or stupid) treatment and has been around an aqua culture for decades, in the wild it's only been applied to small streams. Are we gaining something other than adding adult male fish to the system? If you're removing them, why do we need to add this extra population when it's going to end up creating a second generation of all males?* (Brown)
There are things we really need to explore probably mathematically before we actually try to implement this. The modeling shows that if you were just introducing the YY males that it takes 10-20 years to have the effect that you're trying to have. If you couple that with some sort of removal action at the same time,

you can shorten the time period, but it is a question of the balance of how many fish you have in the system and how many YY males are available to stock. The broodstock isn't even going to be available for a number of years so I'm hoping that during that time people doing the research can refine this technique and maybe actually test it and reveal a little bit more before a final decision is made on whether we would implement this or not. (Trammell)

Update on Humpback Chub Species Status Assessment (SSA) ([Attachment 8](#)) – Kevin McAbee.

The USFWS is using a new species status assessment program to increase collaboration, transparency, and consistency in making scientific determinations for species. There is a clear distinction and separation between the scientific analysis and the decision analysis. The USFWS is required to review the status of each federally listed species every five years. The key statutory difference between a threatened species and an endangered species is the timing of when a species may be in danger of extinction, either now (endangered species) or in the foreseeable future (threatened species).

The SSA and 5-year Review for the Humpback Chub were published in March 2018. The 5-year Review found that the humpback chub does not meet the definition of an endangered species, but the species could become endangered within the foreseeable future. Thus, the USFWS concluded that the humpback chub meets the definition of a threatened species.

Discussion / Q&A

- *In the past, to downlist a species like HBC which has populations in the upper and lower basin, each individual population had to be reviewed for the three R's. Now it appears as though you're lumping the entire Colorado River Basin under one umbrella as the entire species. How much of this has depends on what's happening in the Grand Canyon. (Davis)*
We are looking at it on a species co-level because that's how we have to make our decision, but we have broken it between the upper and lower basin and honored the differences when we consider the viability. We still honor the difference between the upper and lower basin, but I do think you're correct in that these resource conditions and this strong viability provide a really strong foundation for the safety of the species and allows us to accept some of the risks between the different scenarios in the upper basin. If this is the reality that plays out, then the HBC would reach recovery. It is not viable in the upper basin as scenario 1 plays out but today we have four sustaining populations in the upper basin and they are paired genetically. Even if one of those goes away, we're maintaining genetic diversity. We feel that even with the Dinosaur National Monument population becoming extirpated, it's more tenuous, but we have redundant, resilient and representative populations in the upper basin. They're just not as high quality. (McAbee)
- *Does the threatened status and the policy look out 50 or 60 years, was that something established just for the chub or is there a benchmark for that in other decisions? (Ostler?)*
Using the 16-year biologically meaningful timeframe was not adequate for the Service's foreseeable future, so the Service requested we look out farther into the future. Foreseeable future applies to the Service's ability to foresee the future not only for the species but for threats and the condition of the species. We look as far into the future as we can reasonably foresee.
- *Follow-up: Specifically I was trying to get at whether that time period could be 25, 35, or 40 years. Who picks the number and then when you're getting out 40 years for projections, whether you're forecasting the rate of growth of your kids and any other thing, we're not very good at it. Really going out there a long ways to projection seems to be questionable whether it has much meaning at all.*
You're right. We need to stop with foreseeable future where we have comfortable understanding. We could have a different concept for foreseeable future for non-native fish than we do for water availability than we do for habitat conditions. We have to look as far into the future as we can reasonably foresee. This is a Service comfort level based on what they know. It's a complex topic and it's not prescriptive. Our policies are shaped by solicitor's memos. (McAbee)
- *As a member of the public and somebody that pays attention to this fish, my rough estimate is that we've spent ½ billion dollars on this species. And for that ½ billion dollars we've certainly learned about the ecology. But, as far as I can tell, we have basically no idea why they are now successful in the lower basin. It's great to have a planning process but it would be very nice to see a better explanation of why, from a scientific standpoint, the fish are doing*

better now in the lower basin in this last 15 years when they weren't 15 years before that. (Stevens)

Annual Reporting Meeting (ARM) Discussion (Attachment 9) – Seth Shanahan. Because the ARM and the TWG meeting weren't held together, the TWG missed the opportunity to ask questions at the ARM. In the OP and in the TWP budget process documents, there is text that outlines the kinds of conversations they should have. The ARM's purpose is to review the progress of the funded work with the emphasis on results, findings, and scientific advances. Questions to start the discussion:

- Which results/findings/scientific advances stood out as impactful?
 - *FWS wasn't at the ARM and missed the HBC discussion. Possibly a webinar should be held to get a reporting of Service projects done last year? Mr. VanderKooi - there was a conflict with Kirk and the FWS staff and he supports having a webinar. Mr. Young concurred and FWS could do that. Suggestion by Mr. Ellsworth to do a webinar before the June TWG meeting.*
 - *Questions on the aquatic foodbase indicate it's not clean on what's going on.*
- Were there major omissions or projects lacking suitable progress?
 - *There was a lot of concern about aquatic foodbase and if the BT controversy will continue*
 - *Status of funding for tribal participation.*
 - *When we think we've figured something out we get a curve ball. LTEMP is just completed and now are starting to think about spring HFEs. It's difficult to understand this system.*
 - *It would be helpful to have a packet of information on the presentations to facilitate taking notes.*
 - *More time is necessary to ask questions. Can we submit something in writing and have the presenter respond so everyone will know the question and a response?*
 - *Exciting to see GCMRC involving nutrients and how the ecosystem works as a whole.*
 - *The TWG should be able to provide feedback on a prepared report before it is finalized and becomes a publication.*
 - *There's confusion in this program on how things fit together. The Science Advisors are supposed to review GCMRC's science as independent reviewers. They're a program within our program and they don't do policy. GCMRC doesn't do policy so it's a conundrum on how everything fits together. We need to explore the levels of review and action from preparation to final reporting.*
 - *Thanks to Mike Moran for organization of the ARM.*
 - *These subjects are in the SA Survey. People need to get that done.*

Mr. Shanahan noted the major topics of concern from the discussion: aquatic foodbase, modeling to test our understanding and potential management actions, BT and Spring HFEs.

Possible LTEMP Experimental and Management Actions for 2018 (Attachment 10) – Lee Traynham, Scott VanderKooi. The 2016 LTEMP Record of Decision outlined the specific process for planning and implementing experiments and the Department's commitment to consult with the tribes as requested.

Macroinvertebrate Production Flows (Bug Flows) are scheduled for May-August 2018. The experiment impacts hourly and daily releases, but does not impact the weekly, monthly or annual release volume from GCD. The cost is estimated at \$335,000 and is not expected to have a substantial impact on the Basin Fund. WAPA has not yet established a target for the end of year balance, but they know it's above \$112M and that Bug flows won't have a consequential effect on WAPA's ability to meet obligations.

Other potential 2018 experiments include a Fall High Flow Experiment \leq 96 hours (Oct-Nov 2018) and an Extended Duration Fall HFE up to 192 hours (Oct-Nov 2018), but both of these are dependent on July-Nov sediment inputs.

Public Comment: None
Adjourn: 4:53 pm.

**Glen Canyon Dam Adaptive Management Program
Technical Work Group (TWG) Meeting
April 23–24, 2018**

Date: April 24, 2018

Start Time: 9:30 a.m.

Conducting: Seth Shanahan, TWG Chair
Vineetha Kartha, TWG Vice-Chair

Committee Members/Alternates Present:

Melinda Arviso-Ciocco, Navajo Nation (phone)
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USGS/Grand Canyon Monitoring and Research Center:

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Mike Runge, U.S. Geological Survey
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Lee Traynham, U.S. Bureau of Reclamation

Meeting Recorder: Linda Whetton

Welcome and Administrative: Mr. Shanahan welcomed the members and the public. Introductions were made and a quorum determined.

Unresolved issues from yesterday:

1. Mr. VanderKooi - a list of the field work in the Grand Canyon between now through June was e-mailed to the TWG this morning.
2. Mr. Young - Clarification of the TCD process.

State of the Budget and Work Plan and Consideration of Potential Changes to the Fiscal Year 2 Triennial Work Plan Based on Criteria in Section 2.7 of the Budget and Work Plan Process

([Attachment 11a](#)) – Seth Shanahan, Scott VanderKooi. The Triennial Budget and Work Plan Process table shows the next steps for the BAHG and the TWG. Today's action is to consider potential changes to the second year of the TWP. In the June meeting the TWG will develop a recommendation on FY2019 to the AMWG. Carlee Brown will co-chair the Budget Ad Hoc Group (BAHG) with Shane Capron.

Next Steps in April:

- TWG to receive general status update from GCMRC and Reclamation
- TWG to provide preliminary direction to the BAHG
- TWG to send proposed revisions to Linda by May 8

Upcoming BAHG Calls

- May 18 (10-12) MDT
- May 31 (1030-12) MDT

Discussion / Q&A

- *The nature of this program often requires unplanned changes. There needs to be flexibility for unplanned events. The [PPT](#) presentation given by Lynn Jeka at August 2016 meeting helps understand how the basin fund works. (James)*
- *Who should the tribes talk to about funding? The Hopi tribe had to cancel their routine monitoring trips and others are in dire straits for funding. (Bungart)*
The outstanding agreements have been approved at the Washington Office level. The three outstanding agreements for tribal participation are in the region and there's a collective effort between the tribes and our regional acquisitions teams to get those completed and sent out as soon as possible. I appreciate your involvement in spite of the contracting delays. (Traynham)
- *The CRAHG should not be listed on the Ad Hoc Group list, it is no longer needed. A group of people will be convened on a case by case basis to address issues relative to cultural resources that affect this group. Most issues dealing with cultural resources seem to be covered under the PA at this point.*
The CRAHG is suspended for now and if we need a subset of people involved in the process, we can activate it or convene a group of people to address some issues. (Shanahan)

FY 18-20 Budget Update ([Attachment 11b](#)) – Lee Traynham. The FY18 budget increased slightly from what was in the TWP due to the change in the CPI from 1% to 2.2%. The total budget is \$11,156,00 with BOR receiving \$2,231,000 and GCMRC at \$8,925,000. FY19 and FY20 have an assumed 1%.

Discussion / Q&A

- *On D10, there is \$29K for 2018, \$30K for 2019, and \$30K for 2020. In 2019, you added a \$1,000 to the budget and it stays constant into 2020. Are you adding \$30K to the \$29K in 2019? Should it be \$59K in total? (Dongoske)*
Yes. If we weren't utilizing those funds, we would show a cumulative balance in 2019 of \$59K.
- *If money doesn't get spent in 2018 and moved into 2019 and 2020, at the end of these three years what happens to those funds. (Pasqual)*
They would be a carryover into the following years.
Post-meeting Correction: *Funds that are not spent in FY18 can be carried over into FY19 and FY20, provided there is reasonable justification. However, funds not used within the three-year triennial work plan horizon (FY18-20) will be reallocated within the Adaptive Management Program budget. The Contingency fund for NHPA section 106 compliance (D10) is an exception; these funds can be carried over for an extended period beyond the TWP planning horizon.*
- *What happened to funding in the prior workplan budget that didn't get spent? Did it get allocated, reassigned or did we lose it? (Pasqual)*
My understanding is that was rolled over into carryover in 2018. I'm happy to go back and get an answer to you.
Post-meeting Correction: *Funds that were not used within the three-year triennial work plan horizon (FY15-17) were reallocated within the Adaptive Management Program budget.*

GCMRC FY 2018 budget update ([Attachment 11c](#)) – Scott VanderKooi - presented a summary of the 2018 budget from the work plan in September 2017. GCMRC budgeted for \$9,021,000 but expected \$8,820,000. To make up for that difference of \$200K, they used funds from the Native Fish Fund and carryover from FY17. Carryover from FY18-19 will balance the budget. Not shown in the total, is the work at Lake Powell (\$150,000 power revenues) that is not funded by GCDAMP. \$150K will come from the Experimental Fund to cover bug flows, the BT report (Mike Runge) and updating the sand routing model. With the adjusted CPI it is \$9,587,000. The new budget for FY19 is \$9,215,000 and anticipate carrying over \$106K to FY2020. Currently there is no funding for Lake Powell. The funding agreements expired at the end of 2017. BOR is currently in the process of setting up a new agreement with GCMRC.

The building overhead rate will be determined by July 2019. The pass-through rate should stay at 3.0%. The latest word on the new building is GSA is looking to sign a contract with the City of Flagstaff as early as next month. GCMRC occupation may be in December, the overhead rates will increase after 2019.

Discussion / Q&A

- *Project F - focus on recommendations to improve the foodbase and nutrients. Maybe a little tweak in that budget. We need a conversation on phosphorus input. Decisions would have to be deferred to the management agencies. Drivers and their influence lead to management actions and that goes to the management agencies. We recommended bug flows and that will take place this year. (VanderKooi)*
- *This is the first year of a 20-year experimental program and pathways of where we're going are not clear. Can the LTEMP models be improved, having a road map for the next 20 years? How do we get to a better management system? (Stevens)*
The issue of developing criteria for resource goals and objectives shows how complicated it is to try and meet all the program's objectives. BOR is talking internally about advancing the objectives. Maybe in June we will have BOR talk about their thoughts on that process. (Shanahan)
- *Would like to encourage consideration of a trout predictive model to help inform what can be done in the Glen Canyon Reach. (Stevens)*
Charles Yackulic developed a model based on current numbers of trout and nutrients.. The model was for LTEMP and could be applied up to Glen Canyon. My question is the utility for how it would be used and applied? (VanderKooi)
- *Would like to explore more as it relates to the proposed AGFD stocking plan and what was used to inform the planning document. There might be features that might be helpful for AGFD goals. (Shanahan).*
- *The idea of the model is great. Based on the number of fish and nutrients we should be able to predict how many fish the system can sustain. If we ask GCMRC to put a model together will AzGF use it to inform stocking? (Crawford)*
Stocking is a short-term solution to the fishery not meeting the metrics identified with the hatchery management plan. It's useful information for us to have a model to predict and explain some of the variation and inform management. We're trying to set up a plan for management of that fishery including a self-sustaining population. (Mann)
- *Why are we so focused on TMFs when the modeling says that flows aren't the best way to manage fish populations? Fish population can be managed more effectively with nutrients. We've been working at Flaming Gorge to model some of the relief and upgrade for use at Glen Canyon. (Ellsworth)*
- *The model for LTEMP indicated that TMFs were a good way to manage fish. Maybe BT modeling is a different situation. (Billerbeck)*
- *We've need to go into historical data that could provide more information. (Stevens)*

Temperature Control Device – Kirk Young. Connie Svoboda's work is a great idea and needs to be balanced that with the urgency. There are certain events that could reset everything and one of those things is a really low level at Lake Powell, and warm water input from a low power pool. There are opportunities with this administration to structure a bill, and get Congress to do something about a temperature ability lever. Is there a way for us to move on the cold-water piece? Are there other partners that abilities for movement parallel to Connie's effort?

Mr. Shanahan – TWG needs to provide comments to Connie.

Mr. Mann requested that the BAHG consider reinstating the monitoring trip at Lees Ferry. It's a really an important that assesses conditions of fish in the spring. It's also one of their first opportunities for detection of BT. Logic costs are about \$8,000. There is still a summer and fall, this would be the first year of not having a spring trip.

Mr. Shanahan recapped items for the BAHG to discuss:

1. Getting ready for TMFs – some additional field work and laying the groundwork for potential work
2. TCDs – what the efficacy study should look like
3. Potential usage of approved trout model for management actions like stocking or other types of activities in Glen Canyon Reach that fits into the broader discussion of how we use models in this whole program to help us achieve the direction we think we need to give to
4. AZGFD Spring sampling in the Lees Ferry Reach

Evaluating the Frequency of Triggered Spring High Flow Experiments (HFE's) Assumed in the Long-Term Experimental and Management Plan (Attachment 12) – Paul Grams. HFEs utilize tributary sand inputs on the bed of the river. The HFE re-suspend the sand and deposits it at higher elevations. HFEs transfer sand from channel and low elevations to sandbars along channel margins but they also erode sand from beaches. The goal of an HFE is to build sandbars with the sand in the system, the higher the flow the more sand you export. The calculation includes sand inputs from the Paria River passing the gage over time. The time period must be specified to make this equation balance. It can be accomplished with long-term sand accounting or a relative short-term accounting (how much you put vs. what you take out). The starting point is unknown for long-term accounting consequently short-term accounting is used to plan for HFEs. Most inputs come in July – September. The accounting period starts on July 1 and the flows are balanced (HFEs and other flows) so the export matches the input from the Paria River. All releases above powerplant capacity count towards the HFE duration, slower downramp reduces the duration of peak and sand concentrations. A meaningful experiment might be to follow a “regular” 96-hour HFE with slow downramp as part of extended duration HFE test.

Discussion / Q&A

- *In previous HFEs there was a 56% gain on the beaches but within 3 months there was only a 15% gain. Would there be more sand in the system to do HFEs if we did Spring HFEs? (Reeder)*
If you're doing a river trip in June, you would see bigger sandbars if the HFE had happened in April than if it had happened in November. The people on the river in the summer would experience bigger sandbars. (Grams)
- *There is some published information about how spring flows can disadvantage recruitment of trout. We're a-further away from understanding when BT emergence and when those floods would be timed. (Healy)*
Suppressing BT recruitment is based on the water temp in the winter because it affects the incubation period. A spring HFE would have to be a earlier, like Feb or March, in order to have an effect on suppressing BT recruitment because that's about when they hatch out and they're only vulnerable for a few weeks. After that, they're big enough to withstand the kind of flood that we're talking about here. And that's in the white paper to some extent. (Trammell)
- *Can we move from prescribed triggering periods and a prescribed schedule to an experimental mode? When we have good sediment input in the fall, defer from a fall HFE and hold off until Mar or Apr for an HFE that will minimize the impacts on recreation and maximize negative impacts on BT. Can we treat this as an experiment in this program and just plan on it? And if so, what do we need to actually accomplish so we're ready when that sediment trigger is reached during a fall period? (Stevens)*
I think there would be value in taking a step farther and looking at the average timing of the inputs of these events because there's a disconnect between the two accounting periods identified, and the decision making process. In the fall, for example, we're looking at the accounting period Jul – Dec, but decisions are starting to be made generally in Sep which is probably okay for most sediment input occurring prior in that time. The spring HFE time frame, flows in Feb or Mar or April, but decisions are starting to be made a month or 45 days before then, meaning inputs that are occurring from Jan – Feb are being evaluated. We need to have a better understanding of when inputs actually occur. (Fairley)

For summer inputs it basically works but the winter ones are few and far between and we need a better understanding for that period. Data from 1964 to present doesn't help to predict when they're likely to occur. (Grams)

Mr. Shanahan reminded the TWG that the questions being asked are policy in nature and that the TWG needs to focus on what do we know about these HFEs, what are ways potentially that could modify them to achieve the objectives that we have for this program, and begin that dialogue.

- *Discussions on the inclusion of Project N in the TWP, designing future HFEs, should factor into the design, ways to help improve the hydropower resources as well as research on the fluctuation levels and ramp rates, and things like that. This is a perfect opportunity to start getting that resource into the mix of discussions. Is Lucas in those discussions? (James)*
We're not really having discussions about changing HFE designs. There's been a lot of discussions about the trigger window. We'll include Lucas. (Grams)
- *Anytime you do an HFE, the majority of the sand ends up on Hualapai land. More frequent and longer duration HFEs have more of a financial impact on Hualapai tourism. Hualapai proposed mitigation in the LTEMP EIS for those economic impacts to the Hualapai Tribe and especially wanted to mention that to Reclamation. (Christensen)*

Mr. Shanahan requested the TWG submit questions or proposed changes to Linda by May 8.

The Twenty-First Century Colorado River Hot Drought and Implications for the Future ([Attachment 13](#)) – Brad Udall (Colorado State University). Dr. Udall presented information on drought conditions occurring now and the Grand Canyon in the 1950s. Temperatures have risen in the lower basin 2-4°F or in some cases 6-8°F above normal. It's called anthropogenic greenhouse gas warming and it's not going to go away. The north central mountains of Colorado have stayed wet and even the South Platte has stayed wet. That leads to a low snowpack, 0% in Arizona, reasonably good in the wind rivers, and awful in Utah. According to the NWS Forecast Center, as of April 16, Lake Powell was 46% of average. This is one of the sixth worst years on record. Arizona's mountain watersheds in 2018 has been the driest winter ever. In March, Colorado was the warmest in 123 years of records. It was 8.8 F warmer than normal. May 2015 was the country's wettest May since records began 121 years ago. In fact, it was the wettest month every recorded.

- Record Colorado River flow reductions averaged 19.3% per year during 2000-2014. One-third or more of the decline was likely due to warming.
- Unabated greenhouse gas emissions will lead to continued substantial warming, translating to 21st flow reductions of 35% or more and that's just on the temperature side.
- More precipitation can reduce the flow loss, but the lack of an increase to date and a large megadrought threat, reinforces risk of large flow loss.

There has been unusual 21st Century hydrology with: (1) two 5-year periods of below average flow, (2) only 4 years with above average flow, and (3) ~ 19% flow loss relative to 20th Century. Reclamation's natural flow record of two-year running averages were evaluated up to 18-year running averages: 100 years of flow, and 99 traces of 2-year averages, 98 traces of 3-year, etc. The combined contents for the two largest reservoirs (Lake Mead and Lake Powell) were 90% full in 2000 but ~40% in 2015. In Lake Mead this was due to structural deficit (overuse) and in Lake Powell it was due to drought. This is the most serious drought since records have been kept. An interdisciplinary team reconciled the future of the Colorado River and concluded that warming alone will drive Colorado River flow declines of -6.5% +/- -3.5% per °C. He offered the following conclusions:

- Temperature is impacting Colorado river Flows
- Have already lost ~7%
- Could lose 20% by 2050, 35% by 2100
- Increases in precipitation could reduce these temperature-induced losses (but many reasons to doubt this will occur)

- Need to deal with greenhouse gasses → they must all go away, the sooner the better and it's everyone's responsibility

Discussion / Q&A:

- *The president's cabinet seems to be disbelievers. Is there any hope in terms of the present context to navigate these very troubled waters? Reclamation has assessed these risks. What risk are we at losing the focus? (Stevens)*
I don't know the answer to that. Most climate sites really struggle to deal on this political sphere and figure out exactly how to make a difference and how to get the facts out and where they can be acted on. The rest of the world isn't doing what it should be doing either. Recently there was a report on the IBBC Paris Treaty Goals and nobody's really getting it done. If you want to see something optimistic, local action is taking place right now. Mayor Bloomberg is stepping up. In the 1970s environmental legislation happened because people got involved and that's what is going to be needed again. (Udall)
- *There are social implications of climate change and warming and the drought in the southwest because water is going to get scarce and there's going to be competition for what water is available. Generally in those scenarios, tribal people don't fare too well. They get overrun by capitalist ventures. The societal pressures from global warming if they continue in the trend they are going will be much worse than we've ever imagined in terms of people being displaced and moving to places where they're not wanted. (Dongoske)*
This is happening right now. If you're paying attention to external water fault it's underway in this State and has been for over a year. This entity and the facilities we're using right now, the largest deliverer of Colorado River water and that dispute involves many things that are very difficult questions. It's unfortunate but it's also a case in point of what you're describing. The Indians that have water rights, which aren't all of them in this state, are in a powerful place and they're part of the debate and dispute over who frankly has power of this water. They have a very important seat at the table and seem willing to help. (Udall)
- *How does the dust implications play into temperature and the precipitation? (Katha)*
There are many papers on dust. Painter's original paper said that 5% of loss in flow is due to additional dust and 3-week earlier runoff. The earlier runoff may be more important than the flow reduction. Jeff Deems published on super dusty conditions, they didn't reduce the flow much. It went from 5% to 6% loss but increased the timing of runoff. Dust mostly does its harm in wet conditions. In dry years, dust can't absorb the moisture for solar insulation for very long and so it washes out. (Udall)
- *Have you worked with any researchers that are looking through the lens of agricultural and maybe another lens that is very western specific? (Brown)*
The agricultural connection is fascinating on multiple levels. The U.S. Agriculture Dept is 10% of U.S. greenhouse gas emissions. (Udall)
- *Relative to greater flow or lesser flow, as things get drier, is there more incentive to hold water off the land building conservation systems? (Fairley)*
No. There is a connection between soil parchement and the moisture holding capacity of soils. When land is plowed soil carbon is lost. Carbon oxidizes resulting in less water holding capacity. There are multiple benefits and water has a benefit, fuels that have more root systems will hold more water. (Udall)

Taking of Life Inventory ([Attachment 14](#)) – Mike Moran. GCMRC has been asked to take an inventory of the life they take because of their work. This is the first attempt to provide results. Data from biologists from 2017 includes GCMRC and partners in the AMP. Take of fish includes GCMRC, USFWS, and AGFD. The majority of RBT taken were fish that are >150 millimeters in length. About 200 smaller RBT, averaging <80 millimeters, were also taken. The HBC taken were mostly under 80 millimeters. The table includes both incidental take and required (under permitting). Required take is shown in the shaded rows on the graph. Insects and plants are also included.

Ms. Pasqual cautioned Mr. Moran that the slide referring to insect take should not refer to the mass of insects taken relative to mass of other objects. The intent by the program is to value the significance of life as perceived by the tribes. Mr. Moran said he would investigate providing information on the number of fish that weren't killed. Mr. Dongoske said he would like to share the slides with the Zuni religious leaders and Mr. Moran said he'd provide the information to him.

Cultural Resources Update – Mr. Chada - provided information on the Historic Preservation Plan (HPP):

- A component of the 2017 Programmatic Agreement is to assure Reclamation's compliance with 106 of the NHPA.
- The HPP is a step-by-step guidance for the Cultural Resources Program to be followed on all actions under the LTEMP.
- The HPP has a completion date of Sep 6, 2018. A draft for review and modifications is anticipated, May 13, 2018.
- The components of the HPP will consist of an introduction which identifies what the HPP is and what the requirements are under the Cultural Resources Program. The regulatory framework will be identified that guides the process to achieve compliance.
- There is a section on goals and that focuses on compliance and other related cultural resources.
- Historic context of the canyon over time includes both the tribal perspective and the western science perspective. The recorded historic properties that have been identified will be described. These consist of physical remains of past activities which are discussed in another section.
- A review of the history of work over the past 20 years will be broken down by GLCA and GRCA and by Navajo and Hualapai lands.
- Research designs and questions for the future and an update on current monitoring programs will be included. Past work will be reviewed and goals identified.
- A Remedial or treatment action plan will develop procedures for independent discoveries on any cultural resources that have been identified in the canyon.
- A provision for future project activities will be provided.
- Information on dissemination to the public will be included.

Mr. Chada - A challenge in the CR program is limited funding, the required research can be costly. The HPP should be completed by the next meeting. The tribes and others who were involved in developing the HPP. Mr. Christensen reported that the Hualapai Tribe and most of the other tribes have been working diligently to provide a description of the historical relationship between their tribes and the canyon via their past monitoring efforts, potential treatment actions that may have occurred and good efforts to completing the HPP.

Mr. Stevens offered the Museum of Arizona as a venue for tribal presentations on values associated with the river. The Museum has opened a hall of Native American art and encouraged people to tour it the next time they're in Flagstaff.

Discussion of Emerging Issues and Request for Agenda Items for Next Meeting – Seth Shanahan.

Future agenda items identified:

- Action item - recommend a budget to the AMWG in August.
- Action item - Linda was sending things out.
- Ad Hoc Group List
- Experiments for the year
- Any information from the bug flow experiment for the June meeting → GCMRC can even provide anecdotal information.
- Elections for TWG Chair and Vice TWG Chair.
- TCD efficacy studies
- What's the next step for the Brown Trout Report? What action is needed? → Reclamation
- Pending AMWG appointments.
- Need for the GCDAMP to equitably consider and integrate tribal knowledge into this program.
- The 20-year plan for the program.

Mr. Ellsworth requested a webinar be scheduled before the June TWG meeting to receive an update on USFWS projects.

Public Comment: None.

Adjourn: 2:58 p.m.

Respectfully submitted,

Linda Whetton
Upper Colorado Region
Bureau of Reclamation

Key to Glen Canyon Dam Adaptive Management Program Acronyms

ADWR – Arizona Dept. of Water Resources	HFE – High Flow Experiment
AF – Acre Feet	HMF – Habitat Maintenance Flow
AZGFD – Arizona Game and Fish Department	HPP – Historic Preservation Plan
AIF – Agenda Information Form	IG – Interim Guidelines
AMP – Adaptive Management Program	INs – Information Needs
AMWG – Adaptive Management Work Group	KA – Knowledge Assessment (workshop)
AOP – Annual Operating Plan	LCR – Little Colorado River
ARM – Annual Reporting Meeting	LCRMCP – Lower Colorado River Multi-Species Conservation Program
ASMR – Age-Structure Mark Recapture	LTEMP – Long-Term Experimental and Management Plan
BA – Biological Assessment	LTEP – Long Term Experimental Plan
BAHG – Budget Ad Hoc Group	MAF – Million Acre Feet
BCOM – Biological Conservation Measure	MA – Management Action
BE – Biological Evaluation	MATA – Multi-Attribute Trade-Off Analysis
BHBF – Beach/Habitat-Building Flow	MLFF – Modified Low Fluctuating Flow
BHMF – Beach/Habitat Maintenance Flow	MO – Management Objective
BIA – Bureau of Indian Affairs	MRP – Monitoring and Research Plan
BO – Biological Opinion	NAU – Northern Arizona University (Flagstaff, AZ)
BOR – Bureau of Reclamation	NEPA – National Environmental Policy Act
BWP – Budget and Work Plan	NHPA – National Historic Preservation Act
BT – Brown Trout	NNFC – Non-native Fish Control
CAHG – Charter Ad Hoc Group	NOI – Notice of Intent
CAP – Central Arizona Project	NPCA – National Parks Conservation Association
CESU – Cooperative Ecosystems Studies Unit	NPS – National Park Service
cfs – cubic feet per second	NRC – National Research Council
CFMP – Comprehensive Fisheries Management Plan	O&M – Operations & Maintenance (Reclamation Funding)
CMINS – Core Monitoring Information Needs	PA – Programmatic Agreement
CMP – Core Monitoring Plan	PBR – Paria to Badger Creek Reach
CRBC – Colorado River Board of California	PEP – Protocol Evaluation Panel
CRAHG – Cultural Resources Ad Hoc Group	POAHG – Public Outreach Ad Hoc Group
CRCN – Colorado River Commission of Nevada	Powerplant Capacity = 31,000 cfs
CRE – Colorado River Ecosystem	R&D – Research and Development
CREDA – Colorado River Energy Distributors Assn.	RBT – Rainbow Trout
CRSP – Colorado River Storage Project	RFP – Request for Proposal
CWCB – Colorado Water Conservation Board	RINs – Research Information Needs
DAHG – Desired Future Conditions Ad Hoc Group	ROD Flows – Record of Decision Flows
DASA – Data Acquisition, Storage, and Analysis	RPA – Reasonable and Prudent Alternative
DBMS – Data Base Management System	SA – Science Advisors
DOE – Department of Energy	SAEC – Science Advisors – Executive Coordinator
DOI – Department of the Interior	Secretary – Secretary of the Interior
DOIFF – Department of the Interior Federal Family	SCORE – State of the Colorado River Ecosystem
EA – Environmental Assessment	SHPO – State Historic Preservation Office
EIS – Environmental Impact Statement	SOW – Statement of Work
ESA – Endangered Species Act	SPG – Science Planning Group
FACA – Federal Advisory Committee Act	SSQs – Strategic Science Questions
FEIS – Final Environmental Impact Statement	SWCA – Steven W. Carothers Associates
FRN – Federal Register Notice	TCD – Temperature Control Device
FWS – United States Fish & Wildlife Service	TCP – Traditional Cultural Property
FY – Fiscal Year (October 1 – September 30)	TEK – Traditional Ecological Knowledge
GCD – Glen Canyon Dam	TES – Threatened and Endangered Species
GCES – Glen Canyon Environmental Studies	TMC – Taxa of Management Concern
GCT – Grand Canyon Trust	TMF – Trout Management Flows
GCMRC – Grand Canyon Monitoring & Research Center	TWG – Technical Work Group
GCNP – Grand Canyon National Park	UCRC – Upper Colorado River Commission
GCNRA – Glen Canyon Nat'l Recreation Area	UDWR – Utah Division of Water Resources
GCPA – Grand Canyon Protection Act	USBR – United States Bureau of Reclamation
GLCA – Glen Canyon Nat'l Recreation Area	USFWS – United States Fish & Wildlife Service
GRCA – Grand Canyon National Park	USGS – United States Geological Survey
GCRG – Grand Canyon River Guides	WAPA – Western Area Power Administration
GCWC – Grand Canyon Wildlands Council	WY – Water Year
GSF – Green Sunfish	
HBC – Humpback Chub (endangered native fish)	

