

Glen Canyon Dam Technical Work Group Meeting

January 24, 2013

Conducting: John Jordan, Chairperson
Facilitator: Chris Page with Triangle Associates, Inc.

Convened: 8:20 a.m.

Committee Members/Alternates Present:

Jan Balsom, NPS/GRCA
Cliff Barrett, UAMPS
Charley Bullets, So. Paiute Consortium
Shane Capron, WAPA
Todd Chaudhry, NPS
Kerry Christensen, Hualapai Tribe
Jerry Lee Cox, Grand Canyon River Guides
Bill Davis, CREDA
Kurt Dongoske, Pueblo of Zuni
Paul Harms, State of New Mexico
Amy Heuslein, BIA
Chris Hughes, NPS/GLCA
Tony Joe, Jr. Navajo Nation

Vineetha Kartha, State of Arizona
Robert King, State of Utah
Glen Knowles, Bureau of Reclamation
Marianne Crawford, Bureau of Reclamation
Ted Kowalski, Colo River Cons. Board
Nikolai Lash, Grand Canyon Trust
Gerald Myers, Federation of Fly Fishers
Larry Stevens, GCWC
Bill Stewart, AGFD
Jason Thiriot, State of Nevada
Michael Yeatts, Hopi Tribe

Committee Members Absent:

Chris Harris, State of California

Don Ostler, Upper Colorado River Commission

Grand Canyon Monitoring and Research Center:

Helen Fairley, USGS/GCMRC
Jack Schmidt, USGS/GCMRC
Scott Vanderkooi, USGS/GCMRC

Interested Persons:

Mike Anderson, AGFD
Mary Barger, Bureau of Reclamation
Peter Bungart, Hualapai Tribe
Marianne Crawford, Bureau of Reclamation
Kevin Dahl, GCT
Craig Ellsworth, WAPA
Lesley Fitzpatrick, USFWS
Dave Garrett, M³Research/Science Advisors
John Hamill, Federation of Fly Fishers
Loretta Jackson-Kelly
Leslie James, CREDA

Bill McDonald, Triangle Associates
Lisa Meyer, WAPA
Scott Miller, ADWR
Chris Page, Triangle Associates, Inc.
Sarah Rinkevich, FWS
Mark Van Vlade, CRB of California
Bob Wheeler, Triangle Associates
Jerry Wilhite
Kirk Young, FWS

Meeting Recorder: Linda Whetton

Welcome and Administrative. Welcome by John Jordan.

1. Approval of June 20-21, 2012, Meeting Minutes – Without objection, the minutes were approved.
2. Approval of October 24-25, 2012, Meeting Minutes – Pending one correction, the minutes were approved.
3. Introduction of Triangle Associates. Chris Page introduced Bob Wheeler, President of Triangle Associates, who will be serving as the facilitator for AMWG meetings. Bob provided background information on himself and the company. He won't be attending every TWG meeting but assured the group that he and Chris will work together in addressing AMWG/TWG issues. Bob introduced Bill McDonald. He has extensive experience in the Colorado Basin, in water resource management as

director of the Colorado Water Conservation Board for 11 years (1980-1990) and as Colorado's representative on the Compact and the Governor's appointee on the Seven State Operational Committees. He has been involved in Colorado River issues since 1981. He has worked with the Colorado Water Conservation Board for the last two years writing a history of the Colorado Water Conservation Board. He doesn't feel there is any conflict of interest between that role and serving as an advisor with Triangle Associates.

4. Review of TWG Ground Rules. Chris Page reviewed the ground rules and the TWG agreed to follow them.
5. Review of Action Items (Attachment 1).
 - Status of the core monitoring plan
 - o Dr. Schmidt said GCMRC has been tasked to work on this plan for the LTEMP EIS and the TWG need not continue to develop the plan until the LTEMP EIS is completed.
 - o Reading from the August 2012 minutes, Glen Knowles said there is some latitude, the TWG can continue to work with and provide recommendations to GCMRC.
6. Old Business
 - Ad Hoc Group Updates (Attachment 2).
 - o BAHG - Robert asked if the TWG should advise the AMWG to have a standing budget subcommittee. Shane said in conversations he has had with Anne and Lori, they believe reviewing the budget is a primary TWG task.
 - o CRAHG – The group is waiting for further direction from the TWG.
 - o Core Monitoring AHG – A revised charge will be developed during today's discussion.
 - o SEAHG – An update will be included in today's presentation.
 - o Operating Procedures AHG – An update will be included in today's presentation.
 - o Administrative History – An update will be included in today's presentation.
 - o Steering Committee AHG – Members interested in participating should contact Linda.
 - o Species of Management Concern AHG – A charge will be developed and a group established at the next TWG meeting.

Updates on the two EAs and LTEMP EIS

- o LTEMP EIS - Glen said he and Rob Billerback (NPS) had a call in December to update DOI leadership on the EIS. The message from DOI was, a draft should be completed in calendar year 2013. The co-lead agencies are working on a revised schedule. Preliminary modeling and assessments are being done to refine the list of draft alternatives. DOI is interested in involving the AMWG and TWG in the EIS process and will provide more information in the coming weeks. The tribes are concerned with cultural and tribal values. A meeting is scheduled for tomorrow with them to get specific input from tribal perspectives on the resource criteria and metrics being used to preliminarily assess the performance of the alternatives. The co-leads have a meeting with the Basin States on February 8 to review the alternative the States provided.
- o Cultural Program Update. Mary Barger reported that a PA was initially developed for the 1995 EIS. That PA should be renewed or a new one written. Meetings were held between the federal preservation officers, BOR, and NPS and the advisory council to discuss this issue and it was decided to develop a new PA. Reclamation will provide a draft that addresses generic actions for dam operations in the Grand Canyon. It won't be ready for at least two months.

BOR Hydrology. Glen reported that the April-July most probable forecast is for inflow of 4.4 maf. The minimum probable is 1.3 maf and the maximum probable is 7.7 maf. They all lead to the same release year of 8.23 maf even though there has been more snow in parts of the basin.

7. New Business

- o NPS Fishery Management Plan Update- Jan Balsom reported that the USFWS is reviewing the BA and NPS will be revising it based on comments. A draft should be ready for public review in late Feb/early March.
- o Refuge and hatchery planning for humpback chub (Attachment 3)- Kirk Young reported that the desired number of fish in the refuge population at Southwest Native Aquatic Resources and

Recovery Center (SNARRC), formerly Dexter Fish Hatchery, has been achieved. There are 1,000 HBC in captivity. They are a refuge, not brood stock. There are an additional 500 in the system for future translocations. Depending on the outcome of the EA, the fish will continue to be translocated into Shinumo and Havasu.

- Protection of Indian Sacred Sites MOU Update (**Attachment 4**). Mary reported that DOI is going to provide some guidance on how each of the agencies should respond to the memo. She suggested tabling this item until that time.
- BOR Basin Study. A pre-production copy of the Executive Summary (**Attachment 5**) was distributed. Glen reported this document was released in December (www.usbr.gov/lc/region/programs/crbstudy/finalreport/index.html). By 2060, there could be an imbalance between supply and demand of about 3.2 maf. There are a number of ways to fix that problem before it hits and he encouraged everyone to read the report. Robert added that people need to review the scenarios that were developed. This report is an opportunity to have a public dialogue about what the future will be like and consider potential solutions. Carly Jerla will be making a presentation at the next AMWG meeting on future scenarios and necessary funding over a wide variety of conditions. Ted noted that it's not a predictive study and in terms of how dire the situation is, and that 3.2 maf is available in the lower basin. The upper basin asserts that there is additional water to develop and it intends to develop it. Hydrology studies indicate that there is a potential in 2014 to see a 7.48 maf release. Jack said LTEMP is anticipated by many to determine the future, but actually it will be the Basin Study. **ACTION ITEM**: Linda will check into adding a link to the BOR Basin Study before the TWG meeting page.
- Next TWG Meeting: April 3-4, 2012 in Phoenix. **UPDATE: This meeting will be a webinar as a result of budget cuts.**

HFE Updates. Glen gave a PPT (**Attachment 6a**) on the lessons learned from the HFE. He described the HFE decision-making process, (1) planning and budgeting, (2) modeling, and (3) decision and implementation. He reviewed the parameters involved in planning for an HFE. Although the model allows for flexibility, a memo from Anne Castle dated Nov. 7, 2012 stated "it would be inappropriate to adjust the model output in a way that would increase the amount of water to be released or increase power costs associated with an HFE release." GCMRC recommended a slower downramp rate, resulting in a savings of about 29,000 acre-feet of water and about \$164,000 of hydropower revenue. He said the following issues came up during the HFE planning process:

- Need to request input from stakeholders sooner
- The hydrograph should be modified based on the model output
- Examine the effect of the HFE on the spread of Whirling Disease
- Determine the impacts of the background operation of 5,000 to 8,000 cfs on:
 - Foodbase and Lees Ferry rainbow trout fishery
 - Whitewater rafting safety concerns
- Determine the extent and techniques of sandbar monitoring
- Determine effects to archaeological sites
- Determine hydropower costs and impacts to ratepayers

Discussion resulted in the following concerns raised:

- It is difficult to assess the impacts on Lees Ferry trout and the foodbase; explore the potential of a partnership with NPS for monitoring impacts in future events
- Need an assessment of impacts to Hualapai Reservation
- Use of historical data as part of the decision-making process
- Consider postponing an HFE event in order to complete analysis work on the results of the previous HFE

Early HFE Results. Dr. Jack Schmidt presented a PPT (**Attachment 6b**): Background on HFE Releases and Assessment of Success.

Concerns expressed:

- The HFE protocol potentially minimizes the time period between HFE events. Will more effort be needed for monitoring in order to capture the integrated impacts of multiple HFEs?
- Will the HFE effects be adequately conveyed to Zuni.
 - Reclamation will go to Zuni to consult, Glen will work with Kurt on setting a date this summer.

Will the sand model depicting a slower downramp be looked at as the “ah ha” moment? Jack responded that Topping and Wright are working on that now, though gaging the cumulative effects of multiple events would be an involved analysis. The program documents and science plans indicate that not every spike needs to be examined. There are many things to learn about floods, however consideration should be given to the stress the recent HFE put on GCMRC and Reclamation staff as well as others. The TWG should evaluate how much time to spend on “ah ha” moments relative to the benefit they provide to the system.

- The HFE EA provided NEPA coverage for 10 years in order to allow for HFEs when resource conditions are optimal, however without having the results from the previous HFE it is difficult to determine effects of cumulative HFEs.

ACTION ITEM: Stakeholders interested in talking with Dr. Schmidt and/or his staff on any of the AR meeting presentations should contact him ASAP.

Nearshore Ecology Update and Recent Temperature Findings from LTEMP. Mr. Scott Vanderkooi - The NSE project was designed to assess two key fundamental research questions related to knowledge of HBC population ecology: (1) Do steadier flows during late summer and early fall increase survival, abundance, and/or growth rates of juvenile native and non-native fish? (2) Do juvenile HBC select specific habitat types and if so, does this selection change under different river flow regimes? He distributed copies of a 3-page summary (**Attachment 7a**) prepared by Dr. Bill Pine and said more detailed information can be found in previous annual reports and in three University of Florida Master's theses available at <http://floridarivers.ifas.ufl.edu/NSE.htm>.

Results of the NSE project showed that juvenile humpback chub apparent annual survival, habitat selection, and daily movements did not differ between fluctuating and steady flow treatments applied during summer and fall 2009-2011. An unexpected finding was that growth of these fish declined slightly during fall steady flows. It's unclear why this occurred, but differences in food availability (i.e., drifting insects) between flow regimes may be responsible. It is likely that more extreme flow treatments (higher or lower discharges, longer duration) are required before changes in these metrics would be observed. This data demonstrates the apparent flexibility of juvenile HBC to habitat selection regardless of flows and provides new information on growth, survival, and persistence of juveniles in the mainstem Colorado River. This is a valuable addition to the body of knowledge for managing both the Colorado River and regulated rivers globally. GCMRC is currently preparing results for submission to peer reviewed journals in cooperation with agency partners.

Results of Early Temperature Analyses of the LTEMP EIS. Glen Knowles, PPT (**Attachment 7b**). Dr. Pine and others suggested an examination of native fish in relation to temperature as part of the LTEMP EIS work. Temperatures in the Colorado River at the LCR have been significantly warmer since 2003, than the previous 13 years. This may be a reason for the improvement in native fish, HBC recruitment, and an increase in HBC in the mainstem. The most consistent trend exceeds 12 degrees C in the mainstem at the Little Colorado River, and more specifically exceeds 12 degrees C in the months of July, August, and September when small fish are leaving the Little Colorado River and need conditions that support growth in the mainstem. Temperature requirements of HBC appear to be lower than the literature suggests. This may be a “sweet spot” providing critical conditions for HBC without providing benefits to

warm water nonnative fishes. These data are part of an analysis of historical Colorado River water temperatures to determine the temperatures that have resulted in improvement of native fish populations by Argonne for the LTEMP EIS.

Comments:

- Suggestion to look at winter temperatures. HBC may be abandoning the tributaries and the backwaters in the mainstream during the winter months because the main route serves as a thermal refuge during the winter.
- Consider evaluating a TCD as part of the LTEMP EIS.
- HBC do well when temperatures are 12 C or more in the mainstem, but temperatures may actually be higher where the fish are in the river if they are in more shallow water, 12 C may not be what the fish are actually experiencing.
- Consider relaxing work on trout removal in the future and re-focus on temperature issues.

Potential Budget Considerations from the Annual Reporting Meeting. The following documents were provided as background materials for today's discussion:

- **Attachment 8a.** GCDAMP Biennial Budget and Work Plan – Fiscal Years 2013-14
- **Attachment 8b.** GCDAMP Biennial Budget Process Approved by the AMWG on May 6, 2010
- **Attachment 8c.** Memo from Secretary's Designee Anne Castle to AMWG Dated May 4, 2011, Re: TWG and AMWG Suggested Roles
- **Attachment 8d.** Streamlined GCMRC Biennial Work Planning Process dated March 20, 2011

Shane said the program is currently in year one of a biennial budget cycle. The next step is for the BAHG, in the month of May, to provide input on the USGS and BOR draft biennial workplan. In June the TWG will consider a recommendation and provide final input on the second year of the workplan. Technical issues go from the TWG to Interior and only policy issues are forwarded to the AMWG. Any potential second year budget changes will likely be discussed in detail at the TWG level and it is unlikely that there will be changes.

Jack - this is the first time this schedule has been implemented and there might still be some glitches to be worked out. The FY13-14 budget was a radical change from the previous workplan and completely changed the structure of the projects and how GCMRC would justify science to the TWG. GCMRC has no proposed changes at this time.

Concerns:

- TWG should discuss how to run equalization flows that are more supportive of sand and other resources in the river system. This would be a policy issue for AMWG to send to SOI.
- Discuss whether additional resources are needed to alleviate pressure on GCMRC staff reporting requirements.
- Set up a webinar for Ted Kennedy to complete foodbase presentation.
- Need concise list of concerns for BAHG to discuss

Shane presented the following list of questions related to the budget from the Annual Reporting meeting.

The BIG ONES

1. Do we know what is driving humpback chub population dynamics (up/down)? Why are they trending up now?
2. Is the LCR reaching carrying capacity for humpback chub, are their opportunities in the mainstem to expand the population, are the aggregations at capacity?

3. If population trends for RBT and HBC are going up, what does that mean for the relationship of trout to humpback chub?
4. Why do Lees Ferry and Marble Canyon retain rainbow trout? This question related to the graph of Lees Ferry and Marble Canyon with inverse numbers of RBT at different ages – how to explain that?
5. Is there significant trout spawning below Lees Ferry that contribute to abundance?
6. Are there dam operations that would benefit the ecosystem, post-Tamarisk decline?
7. Will food base research help us better understand the relationship of steady/fluctuation flows vs. food availability for fish?
8. Long-term sand mass budget is affected by intervening operations, and that affects the HFEs. Are there considerations or lessons learned going forward in future HFEs?
9. What is the trend of sand input from major tributaries?
10. Is Phragmites an important species to look at?
11. Implications of equalization flows on physical and biological resources?

Bill Davis - these are good, but are they questions to be addressed in the next year from for the science plan? Shane said he didn't want to lose what the TWG had previously discussed so he brought them forward for the TWG to consider

Bill McDonald (Triangle) - the two year budget is unique and implies a commitment that the Department is going to continue funding beyond the FY14 budget cycle. In three weeks, when the President's budget comes out, it may not comport with the AMP's two-year budget. If there are issues for FY14, they will be within the sums shown in the two-year plan. If there are adjustments that the TWG recommends in FY14, it won't be total dollars up or down, it will be a shift within the budget. TWG will need to work with GCMRC to think through all the practical problems of disrupting multi-year research, etc. These questions may be more pertinent to FY15. The Bureau executive leadership is in the process of contemplating what will be proposed and submitted to their respective assistant secretaries towards the end of May for the FY15 budget.

Jack said that in January 2013 (FY14) he will be working with his staff on the big questions, next questions, and new projects. By next fall he will be seeking comments from the TWG on which projects need to be tackled. In the meantime, he will only be making minor changes such as correcting numbers.

ACTION ITEM: Linda will send a reminder to the TWG with the "Roundtable Questions." TWG members should submit suggestions for the BAHG to consider for Year Two adjustments to the budget/workplan. They should provide issues and why it makes sense to reconsider. Due Date: Friday, Feb. 8, 2013.

Socioeconomics AHG Report (Attachment 9). Dr. Garrett reviewed the charge given to the SEAHG to work with TWG, AMWG, GCMRC, and DOI agencies to support timely development of improved socioeconomic values for CRE resources. They also need to identify information needs and research priorities that are not being addressed through the LTEMP process so that GCMRC can refine and develop a work plan. He reported that Dr. Dave Harpman (BOR) will be doing some market and non-market assessment activities. Their intent is to bring back some fairly concise delineation of what is being accomplished in the LTEMP process and therefore what information needs the TWG has specified and

how to address those. There will also be involvement by other entities to do market and non-market assessments in the area of hydropower and water.

Update on Economist Position. Jack and SBSC director Dave Lytle are in the process of reviewing the list of candidates and determining which individuals to interview.

Administrative History AHG Update. Jason Thiriot showed new additions to the GCDAMP “wiki” website. He was asked how to add information to the website. His IT department provided an interface to upload documents. The site has been set up for two years and the intent is to have it function as a collaborative product so other people can participate. If anyone adds to the site, he receives an e-mail letting him know. Larry Stevens noted that in order to obtain historical information, it might require additional funding considerations. It is important to get critical interviews with older people before we lose the ability to talk with them.

ACTION ITEM: Linda will check into adding a link from AMWG and TWG meeting pages to the new GCDAMP “wiki” website.

Operating Procedures AHG Update (**Attachment 10**). Shane noted the following concerns from the group:

- The TWG Vice-Chair position was a big issue with the ad hoc group. Shane crafted language to the OP that is inclusive of the different options expressed by the group.
- The GCMRC role (and the tasks assigned to them in the OP) was questioned since it is also defined in the Strategic Plan. However, the SP is an old draft and may not be utilized by the program. Shane removed the GCMRC language from this version.
- Other sections need to be trimmed down.

Shane would like to meet with the ad hoc group to finalize the issues. Glen wasn’t able to attend the last meeting and Reclamations’ input is critical. TWG members should provide comments on the draft OP to Shane, and a final draft should be available for the next TWG meeting.

Comments:

- A TWG vice-chair could better facilitate TWG chair elections.
- The same objectives could be met without adding another layer to the structure.
- Item #13 - Need for further discussion on how to engage the public in attending TWG meetings.

Suggestions for April agenda.

- Lidar work in the canyon Species of Management Concern
- Effect of equalization flows on sediment resources
- Effects of quagga mussels in the Grand Canyon. (Refer also to Ted Kennedy report, “A Dreissena Risk Assessment for the Colorado River Ecosystem” (**Attachment 11**) or could ask Mark Anderson to make a presentation.)

ACTION ITEM: Linda will put AMWG & TWG meeting dates and details on the bottom of future meeting agendas.

Attachment 12: Final Products of the 2011 Hydropower Knowledge Assessment and GTMax Model Review Workshop Date January 14, 2012

Attachment 13: Analysis of the Potential Implementation of a Rapid Response High Flow Experiment Dated October 15, 2012 Prepared by Western Area Power Administration

Public Comment: None

Adjourned: 2:35P

Respectfully submitted,

Linda Whetton
Upper Colorado Regional Office
Bureau of Reclamation

Key to Glen Canyon Dam Adaptive Management Program Acronyms

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

