

## Glen Canyon Dam Adaptive Management Work Group Meeting

**February 19, 2014**

**Conducting:** Anne Castle, Secretary's Designee

Start Time: 9:30 a.m.

### **Committee Members/Alternates:**

Charley Bullets, Southern Paiute Consort. (phone)  
Tom Buschatzke, State of Arizona  
Ann Gold, U.S. Bureau of Reclamation  
Jayne Harkins, State of Nevada  
Gerald Hooee, Sr., Pueblo of Zuni  
Leslie James, CREDA  
Sam Jansen, Grand Canyon River Guides  
Tony Joe, Jr., Navajo Nation  
John Jordan, Federation of Fly Fishers  
Lynn Jeka, Western Area Power Administration  
Robert King, State of Utah  
Charles "Chip" Lewis, Bureau of Indian Affairs

Estevan López, State of New Mexico  
John McClow, State of Colorado  
David Nimkin, National Parks Conservation Assoc.  
John Shields, State of Wyoming  
Steve Spangle, U.S. Fish and Wildlife Service  
Larry Stevens, Grand Canyon Wildlands Council  
Bill Stewart, AZ Game and Fish Department  
Dave Uberuaga, National Park Service (GRCA)  
Mike Yeatts, Hopi Tribe  
VACANT, State of California  
VACANT, San Juan Southern Paiute Tribe

### **Committee Members Absent:**

Loretta Jackson-Kelly, Hualapai Tribe  
Leigh Kuwanwisiwma, Hopi Tribe

Ted Rampton, UAMPS  
Frederick H. White, Navajo Nation

### **USGS/Grand Canyon Monitoring and Research Center**

Helen Fairley, Program Manager  
Kyrie Fry, Communications & Outreach Coordinator  
Dave Lytle, SBSC Manager

Ted Melis, Deputy Center Director  
Jack Schmidt, Center Director  
Scott Vanderkooi, Program Director

### **Interested Persons:**

Adam Arellano, WAPA  
Mary Barger, U.S. Bureau of Reclamation  
Peter Bungart, Hualapai Tribe  
Rob Billerbeck, National Park Service  
Shane Capron, WAPA/TWG Vice-Chair  
Lori Caramanian, DOI  
Marianne Crawford, U.S. Bureau of Reclamation  
Kevin Dahl, National Parks Conservation Assoc.  
Evelyn Erlandsen, State of Arizona  
Dr. Dave Garrett, M<sup>3</sup>Research/Science Advisors  
Katrina Grantz, U.S. Bureau of Reclamation  
Martha Hahn, NPS/GRCA  
Chris Harris, State of California  
Beverley Heffernan, U.S. Bureau of Reclamation  
Chris Hughes, NPS/GCNR (via phone)  
Lynn Johnson, DOI/SOL  
John Jordan, TWG Chair  
Vineetha Kartha, AZ Dept. of Water Resources  
Glen Knowles, U.S. Bureau of Reclamation  
Ted Kowalski, State of Colorado  
Eric Kuhn, Colorado River Water Conserv. District

James Lott, Arizona Game & Fish Department  
Jane Lyder, Fish Wildlife and Parks  
Joe Miller, Arizona Trout Unlimited  
Gerald Myers, International Federation of Fly Fishers  
Don Ostler, Upper Colorado River Commission  
Jenika Raub, Salt River Project  
Dr. Sarah Rinkevich, DOI Federal Tribal Liaison  
Mike Runge, USGS  
Kendra Russell, U.S. Bureau of Reclamation  
Seth Shanahan, SNWA  
Kent Simer, K.R. Saline & Associates  
Stacey Smith, U.S. Bureau of Reclamation  
Bob Snow, DOI/SOL  
Justin Tade, DOI/SOL  
Jason Thiriot, State of Nevada  
Tanya Trujillo, State of California  
Larry Walkoviak, U.S. Bureau of Reclamation  
Christi Wedig, Glen Canyon Institute  
John Weisheit, Living Rivers/Colorado River Keeper  
Jeffrey Woner, K.R. Saline & Associates

**Recorder:** Linda Whetton, USBR

**Welcome and Administrative.** Ms. Castle welcomed the members and general public. Introductions were made and a quorum determined.

- Because the Hualapai Tribe's member and alternate were absent, Mr. Peter Bungart represented the Hualapai Tribe.
- Approval of August 8-9, 2013, Meeting Minutes. Motion to approve proposed by John Shields and seconded by Larry Stevens. With one edit, the minutes were approved by consensus.

- Action Item Tracking Report (**Attachment 1**).
- Nominations and Reappointments. Ms. Castle welcomed two new members: John McClow (Colorado) and Dave Nimkin (NPCA). Ms. Kartha was appointed as an alternate for the State of Arizona. There are additional pending appointments and nominations awaiting letters from State governors.
- Facilitation Update. Ms. Ann Gold -due to budget considerations Reclamation has decided to utilize internal staff and others to help in the preparation and facilitation of this meeting. Reclamation will do a post-meeting evaluation to determine the future course of action.
- DOI Personnel Changes; (1) Reclamation Commissioner Mike Conner has been nominated for Deputy Secretary of the Interior--it is pending on the Senate floor. (2) Lowell Pimley will become Acting Reclamation Commissioner. (3) Suzette Kimball Acting Deputy Director of the USGS was nominated to be the director. (4) Rhea Suh from Reclamation Policy, Management and Budget Office been nominated to become the Assistant Secretary for Fish, Wildlife and Parks.

**Basin Hydrology and 2015 Hydrograph (Attachment 2 = AIF and PPT)** – Ms. Katrina Grantz. Under the 2007 Interim Guidelines (IG) Lake Powell is in the mid-elevation release tier for the first time and is releasing 7.48 maf this year. This was determined in August 2013, based on the 24-month study which projected the January 1<sup>st</sup> elevation would be 3,573 feet. Lake Powell was 8 feet above this prediction by January 1, but for planning purposes and IG criteria, the August projection of the January 1<sup>st</sup> elevation locks in the operating tier. The snow map shows more areas of higher snowpack. As of 2/18/14, 114 of 116 sites reported the basinwide SWE is 112% of median (1981-2010). The average forecast for April-July is 7,160 kaf (1981-2010). In November, during a typical 7.48 maf release year, 500 kaf is released but because of the HFE, 680 kaf was released. Water was reallocated to March and May to compensate. The most probable elevation is projected to be in the upper elevation balancing tier. WY 2015 is projected to be a 9 maf release, but the range is 7.48 to 11 maf.

**Maintenance at Lake Powell** –There are eight hydropower units at Glen Canyon Dam (GCD) and maintenance is an ongoing issue. Next year transformers will be replaced to facilitate high releases and meet annual release volumes. In high inflow years there can be issues with releasing enough water.

**2015 Hydrograph Development** -The objective is to improve sand retention for a possible HFE. Releases will be reduced August to October to avoid shifting “extra” water to June (which cools temperatures at the mouth of the LCR), and move water from August to other equal value months for hydropower (Dec/Jan). The average sand inputs are later in the season (Aug-Sep). Based on Jan-Feb 2014 modeling, the 2015 projected annual releases may look like:

- Minimum probable: 7.48 maf release (less likely with improved hydrology)
- Most probable: 9.0 maf release (Upper Elevation balancing, between 8.23 and 9.0 maf)
- Maximum probable: ~11 maf release (with April adjustment to equalization)

Possible 2015 Hydrographs:

- 7.48 maf release (flows are already low, no difference from typical MLFF)
- 8.23 maf release (reduce releases in August and shift over to July, and increase December and January to reallocate some of water in order to bring August down)
- 9.0 maf release (would try to keep August down and reallocate some in July and December and January)
- 11 maf release (lots of water to move: limited flexibility, minimal difference)

**Panel on the Potential Effects of Long-Term Drought on Colorado River Operations** – Ms. Anne Castle. Water managers throughout the Colorado River basin have been working to develop strategies for the long-term implications of climate change for the basin through collaborations such as the recently completed Bureau of Reclamation Colorado River Basin Water Supply and Demand Study. The partners in the Study as well as other stakeholders initiated the “next steps” process that is looking into the potential for municipal conservation, agricultural conservation, transfers, a focus on environmental and ecosystem flows and how those things can be melded together to create a strategy that will address future inflows in the system. That process is underway and reports are expected this summer.

Mr. Rob Billerbeck, NPS - The NPS is interested in the timing and magnitude of flows and how they may change with respect to drought or changes to compensate for the drought. Flows affect fish habitat, sport fisheries, and how vegetation is distributed along stretches of the Colorado River. NPS is also concerned about lake level fluctuations and effects to boat ramp access.

Potential Effects of Long Term Drought on Colorado River Operations (Attachment 3a = AIF & PPT) – Ms. Grantz. Inflows are highly variable year-to-year, the average inflow is going down over time. We can no longer use the past to predict the future. The driest 14-year period in over 100 years of natural flows was 2000-2013. When hydrology is low, reservoirs respond by meeting the water demands. When hydrology is wet, the reservoirs capture the water and fill. Current system storage is at about half full. Lake Powell was at 95% capacity in September 1999, at 33% in April 2005, and at 40% in January 2014. If there are prolonged droughts, there will be more frequent releases of 8.23 maf or lower. Minimum elevation for power generation is approximately 3,490 feet. Below this elevation, releases are made through bypass tubes. Full capacity of bypass tubes is 15,000 cfs. Lower inflows to Lake Powell and lower releases lead to less hydropower generation. Glen Canyon Dam cannot generate power below 3,490 feet. This would result in a significant loss of revenue and could affect hydropower rates. Fortunately when the drought started in 2000 there was a nearly full system. The runoff forecast this water year is better than the past two years but a wide range of future outcomes is possible through 2020. Putting water back into the system through a range of operations improves system resiliency and helps to avoid critical reservoir elevations.

Near Term Risks: Options to Addressing Declining Reservoirs (Attachment 3b) – Mr. Eric Kuhn, Colorado River District. Planning for the continuing dry conditions needs to be done before the intake elevation reaches 3,490 feet. Operating on a year-to-year basis will require higher triggers. Two triggers were considered: (1) the 3,575' trigger corresponds to the IG; (2) a trigger at 3,525 feet but it is unknown where minimum power pool really is. There is a need to “bend the curve,” and reach an agreement on new guidelines. Navajo, Blue Mesa, and Flaming Gorge all have RODS which Reclamation operates under. These RODS have considerable discretion and flexibility. How can the system be operated to reduce the risk of Lake Powell going below 3,525 feet?

There has been a problem since 2000. A Supply (Hydrology) Stress Test, that assumes 1988-2007 hydrology follows 2000-2013 drought and based on current demands indicates that 20% of the months in that period, Lake Powell would be at or below 3500 feet. There are only three ways to slow the decline: 1) reduce system losses, 2) reduce demand, or 3) augment supply. Flaming Gorge is operated within the constraints of the ROD which is flexible. The trigger may have to be higher and start at 3600, not 3575. The most important thing to do in the next couple of years is have a contingency plan in place.

Impacts of Long-term Drought on Colorado River Operations (Attachment 3c) – Ms. Jayne Harkins. The 2007 IG addresses the high end as well as the low end of reservoir operations. There are three critical elevations: 1,075ft, and 1,050ft which result in reductions to Nevada and Arizona, and the 1,025ft which initiates reconsultation. We can't wait until 1,025ft. Under Minute 319, Mexico agreed to share in reductions at those same reservoir elevations. The reductions in the 2007 IG aren't enough to protect powerhead or to protect Southern Nevada's pump intakes. There is one intake and one pump on Lake Mead at 1,050ft. There is a second pump and a second intake at 1,000 ft. SNWA is in the process of tunneling from the lake side, underneath the lake and putting an intake at the 860 level. SNWA has a third pump intake designed but it isn't in the current construction. The 860ft elevation level will be connected by a connector tunnel up to the 1,000 ft elevation pump and the 1050 ft elevation pump. This design helps water quality because the pump stations can pump the colder water at the lower levels of Lake Mead and reduce the cost of water treatment but it doesn't help lake elevations. At 1050 ft one pump is lost. Ninety percent of the water brought into Southern Nevada is with one pump. There are long-term plans to include a third pumping station. Construction of the third intake is about 60% complete. The intake structure is in the middle of the lake. The connector tunnel for intake one and two to the third intake was completed last year.

The 24-month study currently shows 7.48 maf release in 2014 and a 9 maf release from Glen to Powell in 2050. The reality is that there is a number of things that could happen. The worst case is having a great snowfall but then having it tank in March, April, and May with no more snow. Because of the extreme drought in California, the Metropolitan Water District needs to take water this year because they're in a crisis. The District has to take water out of Lake Mead to get dry intervening inflows. Southern Nevada Water Authority has acquired groundwater rights in Northern Nevada. Getting the water is 10-15 years out and there are currently lawsuits over water rights. The construction project will take 10-50 years. There's no quick fix. There's groundwater in the Las Vegas Valley because SNWA stores Colorado River water in the aquifer but it's not a big aquifer and the water can't be taken out all at once.

One of the good things from the 2007 IG is it intentionally created surplus. To conserve water stored in the lake, Nevada has over 500,000 acre-feet, California has about 580,000 acre-feet, Arizona about 103,000 acre-feet for a total of about 1.2 maf in 2012. That brings Lake Mead up 13 feet. In 2013 it will come up again because Nevada and California have conserved more. Mexico, under Minute 318, has been storing water in reservoirs. Their total at the end of 2012 is about 176,000 acre-feet and more in 2013. The lake level has risen as discussed in contingency planning but more needs to be done. If water isn't coming from Lake Powell, then Lake Mead releases have to be reduced.

Hydropower production is somewhat better at Hoover Dam than at GCD because water through the turbines can be taken at a much lower lake level. There are 17 turbine generators (2 at 62 MW; 15 at 130 MW) 2,074 MW at full lake capacity. It's currently at 1745 MW at the 1,108ft lake elevation. At 1050, it is 1372 MW estimated capacity; at 1,000 ft, 1046 MW; and at 950 ft, at 696 MW. Power customers at Hoover pay for the operations and maintenance at the dam plus Western's costs for marketing. When lake levels go down, power generating is less, and the power rate goes up unless Reclamation and Western cut their costs. There's also funding at Hoover that goes for the Salinity Forum and that part of the issue also comes into play.

GCMRC Perspective – Dr. Jack Schmidt. As the Colorado River exits across the southern Colorado plateau, it flows through a series of canyons, Cataract, Glen, Marble, and Grand. As the basin confronts and deals with drought, there are implications to these canyons. Big fluctuations in Lake Powell determine and control the characteristics of the lower end of Cataract Canyon and the upper end of Glen Canyon. The fluctuations in Lake Mead have fundamental impacts on the riverine section as well as the flow that goes through lowermost Glen, Marble, and Grand canyons. The Grand Canyon is never going to have a drought. Fundamental changes in the flow regime through Grand Canyon include floods, an increase in the magnitude of base flows and the introduction of daily tides. These are human decisions that will be made in response to drought and the question is going to be how do operations change. This is illustrated by looking at the releases in Glen Canyon Dam. In two years, it has had controlled floods. The background is what the natural hydrology through Grand Canyon would've been in the absence of Lake Powell. It's really all about operational decisions. The same thing is happening at Mead and now we have razorback suckers that are maintaining a population at the head of the riverine section of Lake Mead. We also have Southwest Willow Flycatchers establishing themselves there.

Operational decisions are going to drive the characteristic of the ecosystem. Climate change is out of human control and will determine what happens with tributary flows. The Little Colorado River (LCR), as a contributor of water and sediment to the Grand Canyon, is most at risk. LCR has already been significantly affected by trans-basin diversions. These have greatly reduced flow into the system and significantly affected the ecosystem such that now the Paria River is the biggest sediment contributor. The flood regime is caused primarily by summer and fall rains and the question is, how will drought change the North American monsoon? There's a lot of speculation that the sediment influx from the Paria may not change.

Ms. Castle -The Department, through its various bureaus, is following these discussions very closely. It is important to Interior that the CRSP System operates efficiently, that large cities don't run out of drinking

water supplied through the Colorado River, that there aren't huge disruptions to the agricultural economy in the Southwest, and that power generation isn't lost at Lake Powell which would result in lost revenue that supports recovery and other programs. We want to be prepared to address any contingency that arises.

Comments:

- *The State of Colorado is looking at all CRSP reservoirs as a possible source, not just Flaming Gorge. It is also looking at expanding existing efforts.*
- *Arizona has 11 maf of storage in the ground but will go through that in a short period of time if faced with catastrophic shortages similar to 2000-03 years. Question: Does Arizona really have 11 maf of water stored in the ground right now? That seems pretty high.<sup>1</sup>*
- *Climate changes will increase upper basin consumptive use as crop requirements go up.*
- *Governor Brown declared a drought emergency last month and the state water project allocations are zero this year. There will be no water available for contractors who typically rely on millions of acre-feet of water and California is struggling to figure out how to react to that very unprecedented situation. Historically California has been using water that was not used by Arizona and Nevada and over the last 10 years has been successful in reducing their consumptive use of water by about 900 kaf per year.*
- *WAPA will be a very collaborative partner with both the upper and the lower basins. If there is a substantial blackout in the southwest, Hoover Dam and Glen Canyon Dam play a very important part in essentially jump-starting the grid, including the big nuclear plant at Palo Verde.*

**Technical Work Group Chair Report (Attachment 4a)** – Mr. John Jordan. In considering budget and workplan issues the TWG is mindful of the LTEMP EIS and how that final document may impact or alter current decisions. Concerns previously raised about holding in-person meetings vs. webinars resulted in the TWG passing the following motion: “The TWG requests that DOI approve up to 4 in-person meetings, as necessary per year for the TWG in order to maintain relationships, develop budget and workplans, and have full and meaningful interaction with GCMRC and its cooperators. The TWG believes that the current 2014 limit of only 2 in-person meetings per year is detrimental to a successful GCDAMP.”

**Administrative History Ad Hoc Group Update (Attachment 4b)** – Mr. Jason Thiriot. The “Dashboard” feature was presented which enables web users to the GCDAMP *wiki* site find specific information. The Group is hopeful in the next budget cycle to address key components of the Administrative History Prospectus including oral histories, interviews, and looking at the program’s institutional knowledge.

**Socioeconomics Ad Hoc Group Update** – Dr. Dave Garrett. The SEAHG was formed to look at market and non-market assessments of every major resource category the GCDAMP feels is important: cultural resources, water, power, recreation, and environmental resources. All these resources were addressed

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<sup>1</sup> The Arizona Water Banking Authority (AWBA) has stored nearly 4 MAF underground since its inception in 1996. This storage has resulted in 3.82 MAF of long-term storage credits after subtracting losses and a 5% cut to the aquifer. The AWBA has stored Colorado River water (CAP water) to develop these long-term storage credits. These credits are to be recovered during times of shortage on the Colorado River to firm municipal supplies for entities within the tri-county CAP service area, to firm Indian water rights settlements and for on-river municipal users. Additionally, 600,651 AF of these long-term storage credits were stored on behalf of Nevada.

The remainder of the 11 MAF is long-term storage credits developed by other entities in the state, largely municipalities, Indian tribes and the CAWCD. These credits were developed through recharge in the AMAs at underground storage facilities and groundwater savings facilities through the storage of CAP water and reclaimed water.

The following numbers were compiled in November 2013 and represent the most recent Long-term Storage Credits calculation. The 6.2 MAF (non-AWBA) available includes cut-to-aquifer, annual and LTS recovery and other debits removed already.

Long-term Storage Credits

INCLUDING THE AWBA:

Total water stored through 2010 = 10,492,652 AF

Total water remaining in storage as of 2010 = 7,346,637 AF

NOT INCLUDING the AWBA:

Total water stored through 2010 = 8,395,982 AF

Total water remaining in storage as of 2010 = 6,186,353 AF

but the AMWG also asked for analysis of the LTEMP EIS process needs for FY 2015-16. The SEAHG critical issues include:

- Market aspects in the CRE of recreation – sports fishery, boating, private/commercial camping, hiking, etc. The SEAHG worked with GCMRC's new economist, Lucas Bair, and Jack Schmidt to develop a project which is proposed to start this year using FY13-14 funds through FY15-16. The project will utilize the survey instruments that NPS was going to use on market assessments but were unable to continue.
- A proposed workshop to be done in late FY14-FY15 on non-market assessment methodology.
- The development of structural decision making tools that would be customized to the needs of the TWG and AMWG and include socioeconomic and biophysical assessments, and tradeoff analysis.

Ms. Castle - funding is a little better in FY14 since DOI is not subject to the same level of sequester as the past year. However, budgets are still constrained and the federal agencies are strongly encouraged to conduct meetings via teleconference/webinar to reduce in-person meetings and travel costs.

Comments:

- *During 2-year budget cycles, more in-person meetings are needed because the issues are complicated and require additional discussion.*
- *Concern about federal agencies as non-voting members and not attending meetings.*
- *Coming out of the LTEMP EIS process will require more analysis and it will be critical to have more TWG meetings for doing the science and management activity planning.*
- *NPS is under considerable pressure to reduce attendance at meetings.*
- *The TWG should be thorough in determining why an in-person is needed.*
- *Travel dollars might be better spent in improving/enhancing use of webinar technology.*
- *Utilize a combination whereby updates are handled via webinars but have key people in room with experts on the phone.*

Mr. Knowles and Mr. Jordan will work together to identify the critical in-person TWG meetings for the coming year and develop a plan for what work should be accomplished in the next two years.

**Tribal Liaison Report (Attachment 5)** – Ms. Sarah Rinkevich:

- At the September 2013 meeting, a decision was made to hold quarterly tribal meetings.
- She and other DOI staff met with the Havasupai Tribal Council at Supai Village on Nov. 8, 2013. The Havasupai Tribe was invited to participate in the GCDAMP. No decision has been made about their involvement and may need to be vetted with the newly-elected Council.
- More coordination needs to be done with GCMRC prior to next AR meeting so tribal reps are prepared to answer questions on specific work projects.
- The following additions were made to the Tribal Consultation Plan: (1) Updated DOI policy information, (2) Information regarding joint Tribal Liaison duties and responsibilities, and (3) General information regarding Traditional Ecological Knowledge. Based on internal discussions and minor work, the Plan should be distributed within the next few weeks.
- It's extremely difficult to put some tribal values into a performance metric. A webinar may be set up with the tribes to go through some swing-weighting exercises.

Status on Tribal Liaison Position – Ms. Lori Caramanian. Progress is being made on identifying the tribal liaison person and hopefully that position will be filled by August 2014.

**Updates on the 2013 High Flow Experiment (Attachment 6a)** – Mr. Glen Knowles. HFEs can be done for a duration of four days from 31,500 cfs to 45,000 cfs depending on the GCD maintenance schedule. For the 2013 HFE, the lower boundary of sand inputs was used in order to prevent an overestimate of sand in the system. The purpose of the Protocol is to run the largest HFE that doesn't result in a negative sand mass balance at the end of the period. The large amount of sand from the Paria last September allowed the largest possible HFE (37,000 cfs) for 96 hours, still leaving about 800,000 metric tons on the bed. As part of that decision making process, in August, the Resource Status Assessment was used to determine if a 2013 HFE would be conducted, considering sediment, biological and cultural resources. The information was provided to the DOI Leadership Team and they approved an HFE in mid-November. Seven units were considered to be available at GCD allowing a release of about 37,200 cfs. One unit wasn't available however, resulting in a maximum of six units operational during the HFE and an estimated release of 35,000 cfs from November 11-16, 2013. However, BOR instrumentation has been

underestimating high releases, and so the actual release was actually 37,000, this is due to error in the estimation of water going through the bypass tubes. GCMRC now has repeat digital photography of flows all through Grand Canyon for both the 2013 and 2014 HFEs. The Protocol appears to be working, in the long-term sediment is building from previous HFE successes, and in the short-term there have not been adverse affects to cultural resources. High releases don't allow hydropower to be marketed as effectively. An estimated cost for the 2013 HFE was \$1.74 million. A spring HFE won't be conducted until 2015 but if it could happen this spring, it would require 110,000 tons of sand to trigger the smallest HFE. Next fall, approximately 200,000 tons will trigger the smallest HFE.

Preliminary HFE Findings (Attachment 6b) – Dr. Jack Schmidt. The following results were presented from the HFE conducted in November 2013:

Between July 1 – Nov 17, 2012	Between July 1 – Nov 10, 2013	Between July 1 – Nov 10, 2013
617,000 – 769,000 mt entered Colorado River from the Paria River	~1,800,000 mt entered Colorado River from the Paria River	
550,000-770,000 mt accumulated in upper Marble Canyon	140,000 mt were transported past the RM 30 gage	Between 1,300,000 and 2,300,000 mt accumulated in upper Marble Canyon
~46,000 mt accumulated in lower Marble Canyon	110,000 mt were transported past the RM 60 gage	64,000 mt accumulated in lower Marble Canyon
~170,000 mt accumulated in east-central Grand Canyon	390,000 mt were transported past the RM 87 gage	120,000 mt accumulated in east-central Grand Canyon
~14,000 mt accumulated in west-central Grand Canyon	570,000 mt were transported past the RM 166 gage	160,000 mt accumulated in west-central Grand Canyon
~27,000 mt accumulated in eastern Grand Canyon	520,000 mt were transported past the RM 225 gage	22,000 mt was eroded from eastern Grand Canyon
~450,000 mt accumulated in western Grand Canyon and Lake Mead	240,000 mt entered Colorado River from the Little Colorado River	540,000 mt accumulated in western Grand Canyon and Lake Mead

- The 2012 HFE did not fully mobilize the sand available for redistribution.
- A small amount of the sand delivered during the 2012 fall season remained in Marble Canyon at the beginning of the 2013 accounting season.
- The primary input came in floods in mid-September 2013.
- Sandbar response to sediment-rich high flows November 2013 HFE:
  - Images from remote cameras;
    - 53% (21 out of 40): noticeable gain
    - 30% (12 out of 40): no substantial change
    - 18% (7 out of 40): noticeable loss
- The 2013 HFE mobilized a small part of the supply that was available for redistribution.
- Sand on the bed has accumulated in upper Marble Canyon since July 1, 2012. We are not fully mobilizing the sand available for redistribution.
- Rainbow trout are above the removal trigger in the LCR, although Humpback chub are stable or increasing.
- Trout populations are declining in Glen and Marble Canyons.
- There's no evidence of trout being flushed downstream.

Update from the GCDAMP Annual Reporting Meeting (Attachment 7a) – Mr. Scott VanderKooi. The Annual Reporting Meeting was held on January 28-29, 2014. Projects reported on:

- The RBT Natal Origins Study determined the movement of trout downstream from Lees Ferry. The study determined that there are not significant downstream movements of trout.
- Biological Opinion Triggers –Triggers from the biological opinion, if met, would require management actions including non-native fish removal. The ASMR estimate for adult chubs indicates the population is stable but this will continue to be monitored.
- Aquatic Foodbase – Midges and blackflies are important sources of food, especially up in Glen Canyon, and are the only aquatic insects in the system available to trout. This is an unhealthy situation because the food web is unstable. The trout population is robust but based on an unstable food source.
- Humpback Chub – Dr. Yackulic has developed a model that indicates HBC survival and growth between the mainstem Colorado River and the Little Colorado River are different. The previous method assumed all chub were the same. Monthly survival is generally higher in the Colorado River, but growth rates are much faster in the LCR.

Dr. Schmidt encouraged the AMWG to attend the poster session following today's meeting as many of the scientists will be available to discuss their work. He passed out copies of a list describing the posters (**Attachment 7b**). The PPT presentations can be found on the January TWG meeting web page (<http://www.usbr.gov/uc/rm/amp/twg/mtgs/14jan30/index.html>). He reported on the following projects:

- Riparian Vegetation – Joel Sankey and Barbara Ralston are finishing a manuscript quantifying the increase in riparian vegetation throughout the river corridor, using remote sensing.
- Vegetation Changes at Campsites - Dan Hadley and Paul Grams are working on a project initially started by Helen Fairley. Dan has looked at 504 campsites in the canyon and identified that vegetation is growing in the vicinity of most of these campsites. Comparisons of the sizes of the sand deposits in the campsites, indicate the majority of campsite change is caused by erosion of sand not by increases in riparian vegetation.
- Cultural Resources Monitoring – Brian Collins- Erosion now paces deposition by 2 to 1 at the sites that have been measured and most of the change is due to overland flow of gulleys and hillslope runoff going through the areas.

**Public comments:** None

**Adjourned:** 4:05 p.m.

Poster Session on Patio: 4:30 – 6 p.m.



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Rob Billerbeck, National Park Service  
Shane Capron, WAPA  
Lori Caramanian, DOI  
Marianne Crawford, U.S. Bureau of Reclamation  
Kevin Dahl, National Parks Conservation Assoc.  
Jim deVos, Arizona Game & Fish Department  
Evelyn Erlandsen, State of Arizona  
Dr. Dave Garrett, M<sup>3</sup>Research/Science Advisors  
Katrina Grantz, U.S. Bureau of Reclamation  
Martha Hahn, NPS/GRCA  
Chris Harris, State of California  
Beverley Heffernan, U.S. Bureau of Reclamation  
Chris Hughes, NPS/GCNRA (via phone)  
Vineetha Kartha, AZ Dept. of Water Resources  
Glen Knowles, U.S. Bureau of Reclamation  
Ted Kowalski, State of Colorado  
Eric Kuhn, Colorado River Water Conserv. District

Kirk LaGory, Argonne National Lab  
James Lott, Arizona Game & Fish Department  
Joe Miller, Arizona Trout Unlimited  
Eric Millis, State of Utah  
Gerald Myers, Federation of Fly Fishers  
Don Ostler, Upper Colorado River Commission  
Jenika Raub, Salt River Project  
Dr. Sarah Rinkevich, DOI Federal Tribal Liaison  
Mike Runge, USGS  
Kendra Russell, U.S. Bureau of Reclamation  
Seth Shanahan, SNWA  
Stacey Smith, U.S. Bureau of Reclamation  
Bob Snow, DOI/SOL  
Justin Tade, DOI/SOL  
Jason Thiriot, State of Nevada  
Tanya Trujillo, State of California  
Larry Walkoviak, U.S. Bureau of Reclamation  
Christi Wedig, Glen Canyon Institute  
John Weisheit, Living Rivers/Colorado River Keeper  
Jeffrey Woner, W.R. Saline & Associates

**Recorder:** Linda Whetton, USBR

**Welcome and Administrative** – Ms. Castle welcomed the members and public. She thanked GCRMC for providing the impressive poster session.

- Ms. Gold informed the group that Nick Williams, who has done a lot of the sediment modeling for the LTEMP EIS, will be transferring to the Washington Office to serve as the UC Regional Liaison.

- Mr. Sam Jansen read and distributed copies of “Benedicto” by Edward Abbey (**Attachment 8**).
- Ms. Amy Heuslein retired on February 6 after 35 years with BIA. A retirement party is being held for her on March 21. Details will be provided in a future e-mail.
- Mr. Shields will be retiring after 30 years of service with the State of Wyoming. He has served as chair of the Engineering Committee for the Upper Colorado River Commission and been a tireless advocate for the Upper Colorado Recovery Implementation Program in addition to serving on the AMWG. Ms. Castle thanked him for his service and also welcomed him as a new Bureau of Reclamation employee in the Lower Colorado Region.

**National Historic Preservation Act Update (**Attachment 9**)** – Ms. Ann Gold. In January 2013 NPS and BOR met in Washington DC and agreed the new Programmatic Agreement would supersede the 1994 PA but not until a new one is in place. The new PA will include accomplishments to date, a process for concerns related to the treatment plan, how interaction with the tribes will be handled and necessary monitoring. The new PA will be broad and flexible enough to incorporate LTEMP EIS concerns. Ms. Gold met with Mr. Uberuaga and both feel they have a good path moving forward. A draft should be available in the next few weeks.

**GCDAMP FY2015-16 Budget and Work Plan (**Attachment 10a**)** – Ms. Castle. The 2014 Omnibus Appropriations Bill was adopted last month so the FY14 and FY15 budgets are known. The program won't be subject to sequestration because the budget figures for 2014 didn't trigger sequestration; however, there still needs to be constraint in developing budgets. In 2010, the program went to a 2-year budget process cycle and is currently at the end of that 2-year cycle and the beginning a new 2-year cycle for FY15-16. Ms. Castle reminded the group its function is to give policy direction and not get mired in the minutia of monetary details. There is always room for improvement in the budget process and she asked staff from the DOI agencies that provide funding and GCMRC to bring potential solutions to the TWG and AMWG for further discussion.

**Work Plan and Overview of Reclamation FY15-16 Budget Considerations (**Attachment 10b**)** – Mr. Glen Knowles. Reclamation has responsibility for the administrative portion of the budget. The line items remain fairly static. He reviewed the following line items:

- Facilitation Contract – Reclamation needs to evaluate what facilitation is needed and develop an accurate scope of work, if that's something the AMWG wants to pursue in FY15-16.
- TWG Meetings – Need for further discussion on how many in-person meetings are needed.
- Experimental Fund and Native Fish Carryover Fund – These budgets were zeroed out to accomplish the cut in the sequester budget. In the non-sequester budget, they were both kept whole.
- Integrated Tribal Resource Monitoring – In the FY15-16 budget, this will be moved to the cultural program.
- Cultural Program – This includes work to mitigate the effects of dam operations on tribal cultural properties.

**GCMRC Budget (**Attachment 10c**)** – Dr. Jack Schmidt. GCMRC is the science provider to the AMP, DOI, and other sister agencies. He presented a pie chart illustrating the various GCMRC budget categories for budgeted items in FY13 versus actual expenses. More details can be found in the GCMRC Annual Report (**Attachment 10d**). The allocation of the pieces of the pie are similar to the previous budget. About \$200K more will be required for monitoring fish in FY14. Lucas Bair has identified some SEAHG work to be done. One big issue is how to go forward in relationship to the uncertainty of the LTEMP and at what point it becomes appropriate for GCMRC to propose a science plan that implements the preferred alternative of LTEMP. At this point in time, GCMRC will go forward with scheduled projects. The FY15-16 workplan is being started and the irony is that they haven't begun year two of the field season for FY13-14. The following steps are involved in developing the FY15-16 Biennial Work Plan:

- Winter 2014: Received stakeholder input based on AR meeting; work with AMWG/TWG to develop the preliminary FY15-16 work plan
- Spring 2014: BWG development in collaboration with TWG and TWG/BAHG
- Summer 2014: Refinement of BWP; consideration by AMWG (August)
- Fall/Winter 2014: Budget/contract finalization

Dr. Schmidt emphasized the importance of:

- USGS working with sister agencies to efficiently monitor fish populations and eliminate redundancies
- Increase work of the GCMRC economist

- Shift contracts for independent peer review from GCMRC to Reclamation

Ms. Castle said the Department intends to release a draft LTEMP EIS in early fall. Consequently, some last minute adjustments to the FY15-16 budget and work plan may be needed to conform with that EIS.

TWG Budget Report – Mr. Capron. The TWG held a meeting on January 30 to discuss and develop issues of concern for the FY15-16 budget. The previous budget process included initial recommendations on a budget to GCMRC and Reclamation and response to Information Needs. The BAHG held a conference call last week in which they had 45 items up for discussion but only got halfway through that process. He concluded that the real power of the AMP is having the wide range of input from the TWG to provide for a good adaptive management program.

Comments:

- *GCMRC staff work on projects funded by the agreements of the AMP. If staff are working on other projects, then funding needs to come from a different source.*
- *Concern for how larger issues in the basin will be considered broadly and integrated with the necessary science given there are limited budgets.*
- *AMP funds are restricted to science that relates to the operations of Glen Canyon Dam.*
- *If we'd had an ecosystem conceptual model that embraced both the flow through aspects of the river and landscape 20 years ago, the interaction of linkages between aquatic and terrestrial could've been filled in.*
- *It would be helpful to see where the actual power revenues and appropriations are in the AMP budget.*
- *Hope that collecting all this data and knowledge will lead to management and mission decisions.*

Long-Term Experimental Management Plan EIS Update (Attachment 11a = AIF) – Ms. Castle. Interior is committed to working with all of the stakeholders to reach a consensus alternative. We are continuing the Structured Decision Analysis process both to engage stakeholders who do not have cooperating agency status, and to provide input for the co-lead agencies to consider. The Department remains committed to the SDA process and is hopeful that everyone will participate.

Since the SDM workshop, Mr. Knowles said they've have completed critical uncertainties which led to refinement of the resource goals, performance metrics, and models. GCMRC is doing the model peer review and some of that work is nearing completion. They're in the process of reanalyzing the alternatives with the refined models for use in the next steps.

- Update on Process and Schedule (Attachment 11b) – Mr. Rob Billerback. After the swing-weighting exercise, solid answers out of the SDM process will be available to help with the key questions. This additional analyses will be completed during the last phases and will include socioeconomic metrics, empirical data review, and qualitative analysis. It's expected that a preferred alternative will not be in the draft but further discussion will occur moving toward a consensus alternative. Additional steps in finalizing the public draft EIS:
  - June 2014 – Preparation of preliminary draft EIS
  - July 2014 – Preliminary draft EIS circulated for Cooperating Agency review
  - August 2014 – Public Science Meeting
  - September 2014 – Public Draft EIS
  - Fall 2014 – Draft EIS, public meetings and comment period
- Description of the Draft Alternatives – Mr. Kirk LaGory. The eight alternatives modeled in August were presented, but two have been dropped from consideration: (1) Modified Low Fluctuating Flows with Extended Protocols, and (2) Seasonal Fluctuations with Summer Flows. The following six alternatives are going forward:
  1. No-Action Alternative
  2. Balance Resource Alternative (with modification)
  3. Condition-Dependent Adaptive Strategy (with modifications)
  4. Resource Targeted Condition-Dependent Alternative (with modification)
  5. Seasonally Adjusted Steady Flows (with modifications)
  6. Year-Round Steady Flows (with modification)

Note: The alternatives are subject to change as the NEPA process unfolds. There are 15 alternative/long-term strategies to be evaluated and those were explained in more detail (refer to PPT presentation).

Comments:

- *When we have an opportunity to comment on the individual alternatives, it will be helpful to have the flexibility to incorporate knowledge as it evolves over that period of time. It would be helpful if an assessment of the extent new knowledge that was incorporated into each alternative. There are constants which will not vary the amount of water, but will effect the power that would be generated. It would be helpful under the different scenarios of flows for an evaluation of what the annual power revenues would be under each one of those flows, what would be the cost of each alternative.*
- *The NAME is WRONG. This is a public process and people will completely ignore it because of the name. Using the "LTEMP" may actually be a violation of public trust. It should be place-based name, i.e., Grand Canyon or Glen Canyon Dam.*
- *We have trained the river to a 45,000 cfs stage, HFE process. If we had conditions similar to 1983 within the next 20 years, what more could we learn, and how would we start learning about higher flows when they become quickly available? A decision might be required in a very short time frame.*

Mr. LaGory stated there are 12 resource goals and 33 performance metrics. With the next round of modeling, they may wind up compressing the list of metrics. It may be that a number of the metrics are highly correlated and there won't be much advantage for carrying them forward. They actually hope to decrease the number of performance metrics. They are doing 21 traces which represents every fifth of the 105-year period of record. They will get a full range of hydrologic conditions represented in the modeling. They will use existing models wherever possible and have some new models that were developed specifically for the LTEMP. The resource goals have all elements of tribal values but they do not have corresponding performance metrics. This will be evaluated in the EIS.

- An Update on the LTEMP Decision Analysis (Attachment 11c) – Mr. Mike Runge. Structured Decision Analysis (SDA) is meant to be a framework and a platform for exploring the policy science interface and providing a way of knowing how scientific information can be used in a policy context to make management decisions. The other component the analysis provides is structured input from the stakeholders about the value side of things and how they see the importance of the different values and how to weigh that in this EIS. A swing-weighting webinar will be held on March 18 to introduce the exercise, a workshop in late March to share the modeling results, followed by a 10-day working period to complete the swing-weighting. He identified the long-term strategies which help prioritize the questions to build into an experimental design. Using a value-of-information analysis will essentially pull the best ideas from all the alternatives and put them together in an adaptive and experimental design. All the analyses will actually motivate more creative thought about how to craft an alternative

Comments:

- *Having the ability to complete the swing-weighting exercise as homework and review with other agencies would be helpful.*
- *Participation in the SDA is already unwieldy but AMWG or other LTEMP participants could consult with other organizations or stakeholder groups. This is the time to start that process.*
- *Caution should be exercised in reducing the number of performance metrics to one per resource goal. Recreation has six different metrics and reducing those could be a dangerous shortcut.*
- *It's important to stay focused on the result. The SDM is going to be a useful tool but is only one source of the input.*
- *There may be conflicting elements in the riparian vegetation metric, the concentration of non-native species vs. native species. Use of pre-riparian literature and more analysis should be used to develop that metric.*

Participants in the LTEMP process can contact Mr. Runge for assistance in understanding the SDA process. A webinar may be scheduled to prepare people for the next swing-weighting exercise.

**Quagga Mussels – Impacts and Solutions for Hydropower Facilities (Attachment 12)** – Mr. Leonard Willard. Most of the quagga mussels research is being done in the Lower Colorado River because that's where the quagga mussels have fully colonized. Adult quagga mussels were first found in January 2007 in Lake Mead. Facility vulnerability assessment templates can be found at <http://www.usgr.gov/mussels>.

Just because larvae are present doesn't mean that quagga mussels have infested the water line. It takes just the right water quality and environment for the mussels to actually become adults and become reproducing and colonizing mussels. Structures are considered infested when the quagga mussels become adults. There is a normally a 3-week life cycle from free-floating swimmers and almost 90% of them die off naturally making them very easy to control. Once they start forming a shell in the Pediveliger state, they need to attach. In this state they are much harder to deal with and higher doses of chemicals are needed to control them. Reproduction occurs at 50° F or higher. In the Colorado River at Parker Dam, they reproduce 6-7 times. The mussels don't attach to copper tubes, but to the end plate plugs on copper tubes. This restricts water circulation. The challenge is to keep them out of the heat exchangers. A big problem at Hoover Dam is mussels plug up the drains. They've identified projects over a 10-year budget for Hoover Dam at approximately \$1 million each fiscal year to install quagga mussel control systems. Bio-Boxes have been installed to give them an idea of mussel growth inside pipes. There's also been some success in using a silicone based cooling panel, but silicone is very soft so it's not very durable. There are reports on Reclamation's website (<http://www.usbr.gov/mussels/history/related.html>) and the Renata Claudi (RNT Consulting) website (<http://www.rntconsulting.net/Publications/Articles.aspx>).

**NPS Comprehensive Fisheries Management Plan (Attachment 13)** – Ms. Martha Hahn. Due to existing and potential threats, the NPS Fisheries Management Plan was completed in 2013 for fisheries in the Colorado River and its tributaries between Glen Canyon Dam and Lake Mead. The Park Service Plan includes; meet or exceed population and demographic goals for existing fish species, maintain or enhance viable populations of existing native fish, restore self-sustaining populations of extirpated fish where possible and appropriate, foster meaningful tribal relations and integrate tribal knowledge, and prevent further introductions of nonnative (exotic) aquatic species. A tagged HBC that was translocated from the LCR into Shinumo was discovered back at the LCR a year later. When put into the side streams, the fish have enough food and the type of food that allows growth at a very significant rate. Even though they're leaving the tributary system, they're leaving at a size that in that allows them to avoid predation the mainstem. The main focus in Glen Canyon is to maintain a highly valued recreational trout fishery but not moving downstream and causing havoc with the native species. The Park Service has partnered with AGFD, USFWS, and tribal governments to preserve and protect native species found in national parks. The Park Service is also working with Reclamation to implement conservation measures required by the USFWS to offset or mitigate impacts from Glen Canyon Dam.

To view the environmental assessment, FONSI, and scoping materials for the comprehensive fish management plan, go to: <http://parkplanning.nps.gov/projectHome.cfm?parkID=65&projectID=35150>.

**Public Comment:** Mr. John Weisheit (Living Rivers) – There haven't been any new postings to the LTEMP website (<http://ltempeis.anl.gov>) since July 2012.

Argonne is responsible for that website and will be notified to update it as needed.

**Wrap-Up and Adjourn:** Ms. Anne Castle - This set of meetings has been primarily informative and will lay the groundwork for reviewing and approving the FY2015-16 workplan at the August meeting. Secretary Jewell greatly appreciates the value of this advisory committee. This is the way an advisory committee is supposed to work. We're supposed to be getting input from diverse interests and considering input and recommendations for the management and policy decisions that are being made within our Department. Secretary Jewell has learned very quickly the value of the work being done by the AMWG and how its members come together to discuss solutions to problems. She complimented the AMWG on its ability to find a common path that honors so many different responsibilities in a way that has kept the issues largely out of the political arena and devolving into litigation. She thanked the members and the public for their attention during the 2-day meeting and emphasized the importance of the work being done.

**Adjourned:** 2:25 p.m.

**Next AMWG Meeting:** Thursday, May 27, 2014 - via WebEx/Conference Call

Respectfully submitted,

Linda Whetton  
Bureau of Reclamation  
Upper Colorado Region

## 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
AGFD – 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	KAS – Kanab Ambersnail (endangered native snail)
ASMR – Age-Structure Mark Recapture	LCR – Little Colorado River
BA – Biological Assessment	LCRMCP – Lower Colorado River Multi-Species Conservation Program
BAHG – Budget Ad Hoc Group	LTEMP – Long-Term Experimental and Management Plan
BCOM – Biological Conservation Measure	LTEP – Long Term Experimental Plan
BE – Biological Evaluation	MAF – Million Acre Feet
BHBF – Beach/Habitat-Building Flow	MA – Management Action
BHMF – Beach/Habitat Maintenance Flow	MATA – Multi-Attribute Trade-Off Analysis
BHTF – Beach/Habitat Test Flow	MLFF – Modified Low Fluctuating Flow
BIA – Bureau of Indian Affairs	MO – Management Objective
BO – Biological Opinion	MRP – Monitoring and Research Plan
BOR – Bureau of Reclamation	NAU – Northern Arizona University (Flagstaff, AZ)
BWP – Budget and Work Plan	NEPA – National Environmental Policy Act
CAHG – Charter Ad Hoc Group	NHPA – National Historic Preservation Act
CAP – Central Arizona Project	NNFC – Non-native Fish Control
GCT – Grand Canyon Trust	NOI – Notice of Intent
CESU – Cooperative Ecosystems Studies Unit	NPCA – National Parks Conservation Association
cfs – cubic feet per second	NPS – National Park Service
CFMP – Comprehensive Fisheries Management Plan	NRC – National Research Council
CMINS – Core Monitoring Information Needs	O&M – Operations & Maintenance (USBR Funding)
CMP – Core Monitoring Plan	PA – Programmatic Agreement
CPI – Consumer Price Index	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	Secretary – Secretary of the Interior
DOI – Department of the Interior	SCORE – State of the Colorado River Ecosystem
DOIFF – Department of the Interior Federal Family	SHPO – State Historic Preservation Office
EA – Environmental Assessment	SOW – Statement of Work
EIS – Environmental Impact Statement	SPAHG – Strategic Plan Ad Hoc Group
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	TWG – Technical Work Group
GCMRC – Grand Canyon Monitoring & Research Center	UCRC – Upper Colorado River Commission
GCNP – Grand Canyon National Park	UDWR – Utah Division of Water Resources
GCNRA – Glen Canyon Nat'l Recreation Area	USBR – United States Bureau of Reclamation
GCPA – Grand Canyon Protection Act	USFWS – United States Fish & Wildlife Service
GLCA – Glen Canyon Nat'l Recreation Area	USGS – United States Geological Survey
GRCA – Grand Canyon National Park	WAPA – Western Area Power Administration
GCRG – Grand Canyon River Guides	WY – Water Year
GCWC – Grand Canyon Wildlands Council	
HBC – Humpback Chub (endangered native fish)	