Glen Canyon Dam Adaptive Management Program
Technical Work Group: Budget Ad Hoc Group

Conference Call #1, March 7, 2017 – Meeting Notes

ATTENDEES

The following people identified themselves as being on the call.

Cliff Barrett, UAMPS
Carlee Brown, Colorado
Chris Budwig, Anglers
Shane Capron, WAPA and BAHG Chair
Marianne Crawford, Reclamation
Craig Ellsworth, WAPA
Helen Fairley, GCMRC
Paul Harms, New Mexico
Leslie James, CREDA
John Jordan, Anglers
Vineetha Kartha, Arizona
Ryan Mann, AGFD
Michael Moran, GCMRC
Jessica Neuwerth, California
Clayton Palmer, WAPA
Jenny Rebenack, NPS
Ben Reeder, GCRG
Peggy Roefer, Nevada
Seth Shanahan, TWG Chair
Mike Yeatts, Hopi
Kirk Young, USFWS

The following were not on the call:

Melinda Arviso-Ciocco, Navajo
Janet Balsom, NPS
Kathleen Callister, Reclamation
Kerry Christensen, Hualapai
Kurt Dongoske, Zuni
Katrina Grantz, Reclamation
Christopher Harris, California
Brian Healy, NPS
Don Ostler, New Mexico and Wyoming
Dave Rogowski, AGFD
Chris Schill, GCMRC
Randy Seaholm, Colorado
Larry Stevens, GCWC
Rosemary Sucec, NPS
Scott VanderKooi, GCMRC

Mary Orton of The Mary Orton Company, LLC attended as facilitator.

REVIEW THE AGENDA

Shane Capron opened the meeting and welcomed everyone.

He said that Mary Orton (facilitator) and Craig Ellsworth (WAPA) would help with meeting minutes. During calls, Mary would help manage the queue if several people wanted to speak at the same time. He encouraged attendees to speak up, ask questions, and have a robust discussion, even as he acknowledged it is sometimes difficult to do this on the telephone. He emphasized that he wanted everyone to have the opportunity to speak and offer input into the FY18-20 AMP budget.

He reviewed the agenda and asked for any additions or questions. There was none.

He noted that everyone was sent that morning the Triennial Work Plan (TWP) process as recommended to AMWG by TWG, and a spreadsheet developed by Craig with input from others that included all the FY15-17 projects, some additional projects that might be required by the LTEMP EIS and ROD, and links to source documents. He said he re-

ordered the projects based on the resource areas in the ROD, and provided a crosswalk to current FY15-17 budget project numbers for clarity.

REVIEW OF THE GCDAMP BUDGET PROCESS AND TIMELINE

Shane said that they would use the TWG-recommended budget process. He reviewed Table 1 from that process, and specifically the February, March, and April tasks. (See Table 1, attached.)

He said that now through the April 20-21 TWG meeting, the BAHG would work on input to the budget, and would see the draft budget from GCMRC and Reclamation by April 10. Any input after that would be integrated into the next draft budget, and then a final draft would go to the TWG in June for a recommendation to AMWG. He proposed that the BAHG work through the resource areas, line by line, getting comments from BAHG and getting input on a future recommendation, for example, this is important new project to add, this should continue, this should be eliminated or reduced or have a modified scope. GCMRC and Reclamation will be on the conference calls so they would also receive input along the way and have an opportunity to discuss projects and answer questions.

In response to a question, Shane clarified that deadline for mailing to the TWG, and thus the deadline for having the draft budget from Reclamation and GCMRC, was April 10. The next draft would be developed between the April meeting and the June meeting. He clarified that the first draft was envisioned to be a series of project proposals in abstract form; enough detail to understand scope and funding needs, and probably more projects than funding available. The second draft would add detail, some projects might not be included, and there may be some additions and more detail from the scientists as they flesh out their proposals. He acknowledged that the TWG and GCMRC are a little out of phase, and that the agencies would be getting input along the way from the BAHG regarding the next draft. Mike said that the scientists have finished their extended abstracts, and he encouraged them to work on full drafts and start putting budget numbers on their proposals. He noted there is not much time after the April meeting and the draft needs to be reviewed by the Science Advisors before the June TWG meeting. He asked for and received validation that the draft that goes to the June TWG meeting is close to a final draft. Shane encouraged communication between the agencies and the TWG.

Seth noted that Scott VanderKooi (GCMRC) and Katrina Grantz (Reclamation) met the day before to discuss schedule and deliverables. Seth said as soon as they further clarified their timelines, he would share it with the group.

Other comments included:

- The draft budget needs to be reviewed by DOI before coming to the BAHG or TWG.
- Request that project summaries include details, as possible, such as sample locations, frequency, and data to be collected.
    - Mike Moran said some of them have this detail, and some do not.

BUDGET DEVELOPMENT

Roles
Shane said that the TWP is complicated and a lot of work, so he asked for support from the AMP facilitator, Mary Orton, and received quite a few hours for her from Reclamation. She is reimbursed on a "firm fixed price" basis, which means she is paid a flat rate regardless of how many hours she works, so he intends to use all the hours she is budgeted for. If BAHG calls need her assistance, she'll help with those; if BAHG calls are easy, he might hold off to have her at a face-to-face meeting later. She will also provide draft and final minutes to all calls and meetings.

A BAHG member asked that any face-to-face meetings be scheduled soon.

Guidelines for Discussion
Shane noted that the TWP Process provides guidelines about discussion and on what the work plan should be based. Katrina would like to add the new Record of Decision (ROD) to that guidance. We will probably receive input from DOI at some point, and it might change the way we look at projects. We'll need to ask questions about projects such as, does it relate to issues about which AMWG can make recommendations to Secretary? Does it help implement the ROD? He also referenced the presentation from solicitor Rod Smith from the last TWG meeting, and said he would send out that presentation as soon as Rod gave permission.

He noted the link for the Wiki BAHG page had been sent to members. He said members would find there meeting notes, upcoming meetings, and documents to review.

OBJECTIVES OF THE BAHG CALLS

Shane noted there were three BAHG calls scheduled between now and the April TWG meeting. After that TWG meeting, he said he would be out of the office for almost two weeks, and that others might chair one or more BAHG calls. He said he would be working with GCMRC and Reclamation to figure out how best to proceed.

He said that at the next meeting, they would begin the substantive review, resource area by resource area. Some areas might have more discussion than others. The spreadsheet that Craig put together shows where each of the projects comes from: the FY15-17 budget, conservation measures, or the dot-ranking exercise from the last TWG meeting. Project numbers are for this spreadsheet only and may change. He encouraged feedback on the spreadsheet and how to make it more useful.

He requested initial comments on projects and spreadsheet format by 3:00 pm MT on Thursday, including input from the Trout Ad Hoc Group (AHG), Cultural Resources AHG, and the Socioeconomics AHG. He invited input in columns K (narrative) and L (add, continue, eliminate, reduce).

Craig gave more detail about how the spreadsheet was organized. Socioeconomics projects are sorted by resource area. "Hot topics" included were only those that received two or more dots during the dot-ranking exercise. Craig said he had to shorten the description of

some of those new projects so he requested members let him know if he didn't get it right. Some projects on the spreadsheet may be funded outside the AMP.

He and Shane encouraged feedback on how to improve the spreadsheet. Shane asked about the spreadsheet, and there appeared to be general agreement to use it. Comments included:

A member said he didn't get the impression that the TWG was prioritizing projects with the dot-ranking exercise, so some may have been left off that are important. Shane encouraged members to add back in projects that were not included when they make their comments. All the projects from that exercise are on the Wiki and the link is in the spreadsheet.

Additional Meeting Date and Meeting Plans

Shane asked if the group wanted to work through the table, project by project, at a medium level of detail. He said he wanted discussion on what are the important projects and what might be able to be cut. The latter is important because we know we will have tight budget with higher overhead rates and new mandates from the LTEMP EIS and ROD.

Some members noted that it would take a long time to discuss every line in the spreadsheet. Others said they were interested in some projects but not others. Another clarified that the LTEMP columns were probably going to be necessary to include.

Because of a Programmatic Agreement meeting on Friday that conflicts with the next BAHG meeting, Shane suggested—and the group agreed—to start with the Humpback Chub resource area at that meeting, then Other Native Species, and then Rainbow Trout.

The group agreed to add a BAHG meeting on March 20, 2-4 pm MT. They also agreed to let Shane know if they were unable to make a meeting and would prefer the group not discuss a particular resource area while they were absent.

Action Items

- Comments on BAHG spreadsheet due Thursday by 3 pm MT to Linda Whetton, Shane, and Mary.
- Mary will send the new meeting schedule, Rod Smith's presentation, and list of action items out to everyone soon after the meeting.
- At the next meeting, everyone should be ready to discuss and make recommendations (add, continue, eliminate, reduce) on resource areas Humpback Chub, Other Native Species, and Rainbow Trout on BAHG #2, discussion and recommendations

The meeting adjourned.

Attachment: Triennial Budget Development Process as Recommended by TWG

Table 1. Approximate timelines for the development and implementation of the TWP. Dates shown are estimated targets. Dates are shown which implement the 2018-20 TWP for reference.

Month	Year-1 (2017) (development of TWP)	Year-2 (2018)
December (year prior)	GCMRC and Reclamation produces annual project reports document for GCDAMP review.	
January	Annual reporting meeting and information synthesis (2 days) followed by 1-day TWG meeting to review budget and provide initial guidance to GCMRC and Reclamation. TWG reviews progress in addressing Information Needs and research accomplishments.	Annual reporting meeting (1-2 days) followed by 1-day TWG meeting with a primary emphasis on reporting results/findings/scientific advances on previous work plan.
February	GCMRC meets with tribes and DOI agencies. GCMRC follow-up with BAHG on priorities and areas of emphasis on TWP. GCMRC meets with cooperators to develop projects. AMWG meeting to discuss initial priorities. DOI and Federal family input.	
March	GCMRC and Reclamation will develop an initial TWP based on DOI priorities and input from scientists, the TWG, and DOI/DOE family. Initial TWP presented to DOI and Secretary's Designee.	
April	GCMRC meets with tribes and DOI agencies. April TWG meeting to consider draft TWP, including anticipated funding sources. Unresolved issues or conflicting priorities will be resolved by DOI in consultation with the DOI Family. GCMRC begins development of second draft TWP.	BAHG and TWG considers potential changes to the Fiscal Year 2 TWP based on criteria in section 2.7.
May	GCMRC and Reclamation provide a second draft TWP to the BAHG, Science Advisors, DOI agencies, and tribes for their review and comment. GCMRC meets with tribes, BAHG, to get input on TWP. GCMRC develops third draft of TWP.	
June	GCMRC and Reclamation finish third draft for review. TWG meets to provide input on the draft GCMRC and Reclamation TWP and provide a recommendation to the AMWG.	TWG recommends Fiscal Year 2 (2019) budget of TWP to AMWG.
July	GCMRC and Reclamation provide a final draft TWP to the AMWG for their review.	

Month	Year-1 (2017) (development of TWP)	Year-2 (2018)
August	AMWG meets to provide input on the GCMRC and Reclamation draft TWP and provide a recommendation to the SOI.	AMWG recommends Fiscal Year 2 (2019) budget of TWP to SOI.
September	SOI reviews the budget and work plan recommendation from AMWG.	
October 1	Fiscal Year 1 begins under the TWP guidance.	Fiscal Year 2 begins under the TWP guidance.
November 1	Consumer Price Index becomes available.	
Late November	Science and management meeting with DOI and cooperators.	Science and management meeting with DOI and cooperators.
December	Budget is finalized. USGS produces GCMRC annual project reports document for prior year work.	GCMRC produces annual project reports document.

Glen Canyon Dam Adaptive Management Program
Technical Work Group: Budget Ad Hoc Group

Conference Call #2, March 10, 2017 – Meeting Notes

ATTENDEES

The following people identified themselves as being on the call.

Cliff Barrett, UAMPS
Carlee Brown, Colorado
Shane Capron, WAPA and BAHG chair
Marianne Crawford, Reclamation
Craig Ellsworth, WAPA
Helen Fairley, GCMRC
Paul Harms, New Mexico
Christopher Harris, California
John Jordan, Anglers
Vineetha Kartha, Arizona
Ryan Mann, AGFD
Michael Moran, GCMRC
Clayton Palmer, WAPA
Jenny Rebenack, NPS
Peggy Roefer, Nevada
Scott Vanderkooi, GCMRC

The following were not on the call:

Melinda Arviso-Ciocco, Navajo
Janet Balsom, NPS
Chris Budwig, Anglers
Kathleen Callister, Reclamation
Kerry Christensen, Hualapai
Kurt Dongoske, Zuni
Katrina Grantz, Reclamation
Brian Healy, NPS
Leslie James, CREDA
Jessica Neuwerth, California
Don Ostler, New Mexico and Wyoming
Ben Reeder, GCRG
Dave Rogowski, AFGD
Chris Schill, USGS
Randy Seaholm, Colorado
Seth Shanahan, TWG Chair
Larry Stevens, GCWC
Rosemary Sucec, NPS
Mike Yeatts, Hopi
Kirk Young, USFWS

Mary Orton of The Mary Orton Company, LLC attended as facilitator.

Shane thanked everyone who provided comments on the draft spreadsheet. He noted that everyone had received an updated version that morning that included all comments received, and thanked Craig and Mary for putting the comments together. He asked about comments from the three Ad Hoc Groups. Vineetha said the Socioeconomics AHG planned to have its comments submitted by March 16.

Shane gave an overview of the budget development process as he saw it unfolding, and as had been discussed at the last meeting. The BAHG would start discussing the budget at a high level. On April 10 the TWG would see the draft budget from Reclamation and GCMRC. The spreadsheet that Craig created and that now includes all received comments was a tool to have everything in one place: current projects, LTEMP projects, "hot topics" from the last TWG meeting, conservation measures from the Biological Opinion (BO), LTEMP required actions, etc. It could also include everyone's comments and ideas.

He noted he was also trying to make sure TWG is ready to make a recommendation to AMWG by June: staying at a high level now, having discussions that GCMRC can absorb, then seeing their draft budget on April 10. He reminded the group that they have three more BAHG meetings after this one, scheduled through March 23.

He also said the group has options. It doesn't need to use all the meetings that are currently scheduled. The group could continue soliciting input on the spreadsheet, have short conference calls, and send the spreadsheet with all the comments to GCMRC and Reclamation for them to consider as they are finalizing their budgets. Then at the TWG meeting in April, everyone can sit together and walk through the budgets in some fashion.

How much time should we spend, and what is our objective? Should we just provide written comments to GCMRC and Reclamation by March 23? Shane asked for input and asked for Scott to begin.

Scott said he was surprised at the level of detail in the spreadsheet, and that it might have been good to have had more discussion earlier about expectations. He said he asked his staff to think about what work and what support is needed to implement LTEMP, based on the LTEMP ROD, the objectives and resources, the goals, the resource areas to evaluate before experiments, and the BO. He said he asked them to think about writing Information Needs (INs) in support of LTEMP implementation. This spreadsheet took the last work plan and walked it over, and it seems premature to be at that stage. He said he wanted discussion on key resources, level of information needed, and focal areas stakeholders are interested in; and then move from that high level to a more detailed level. The spreadsheet seems much more detailed than what is needed now.

Shane explained that the process and the spreadsheet were developed to give Reclamation and GCMRC timely advice from the BAHG and TWG. He thought that many projects would need to continue from the current work plan, based on GCMRC's science plan; and the spreadsheet included conservation measures and other items from the LTEMP FEIS, ROD, and BO. And because the budget might have as much as $1 million less for science because of increased overhead, he thought it would be important to start thinking about what is required and what may be more discretionary.

Scott agreed, and said he didn't want the scientists to feel any entitlements with their previous projects. He did not want them to assume all would be continued or budget levels would be the same. He wanted them to focus on implementation and monitoring of experimental actions in LTEMP.

He thought it might be good to have a discussion with BAHG on objectives and resource goals, resources that need to be evaluated before experiments, tying that into the science plan, then narrowing down what needs to be done.

Some members said they liked the spreadsheet because it gave so much information and helped them understand the budget and work plan. It helped them understand what might need to be added and what might need to be replaced. One said the spreadsheet should be useful to GCMRC if all BAHG comments were in one place, and it might save time later. Another asked if GCMRC was planning to give the BAHG something similar to work from. Scott said he saw the value of having a spreadsheet like this, and agreed that at some point they would need to go through something like this.

Scott said that having recommendations to delete certain projects, before any discussion, concerned him and he didn't find it helpful. Some pointed out that with the budget shrinking, it might be useful to him to see where individual BAHG members saw opportunities to cut the budget, and that today was intended to be the start of the discussion. Others said that they agreed it was premature to have "delete" in the spreadsheet. Still others said that if an individual thought a line could be deleted, it did not mean others agreed or that it should be taken seriously at this point in the process. Another said long-term monitoring is not included in the projects, but it provides information on many project elements.

Scott reiterated that he would prefer to have a higher-level discussion first. Mary and Shane offered a number of options:

- Scott could lead the group in the discussion he wanted.
- The group could talk about Humpback Chub as they had planned and Scott could offer input on that subject.
- The call could end and the DOI agencies discuss and agree how to engage the stakeholders in the process.
- The call could end and the TWG leadership (Seth, Vineetha, Shane) could meet with Scott and Katrina and discuss a way forward.

After a brief talk from Scott on Humpback chub, BAHG members suggested that the meeting end and the leadership get together to agree on a process moving forward.

Mary apologized to the group and assured them a better way forward would be planned.

Several members praised the spreadsheet and all of Shane and Craig's efforts and said it had helped them understand the budget and be prepared for the budget process.

The meeting adjourned.

Glen Canyon Dam Adaptive Management Program
Technical Work Group: Budget Ad Hoc Group

Conference Call #3, March 16, 2017 – Meeting Notes

ATTENDEES

The following people identified themselves as being on the call.

Cliff Barrett, UAMPS
David Braun, Sound Science
Carlee Brown, Colorado
Shane Capron, WAPA and BAHG chair
Marianne Crawford, Reclamation
Laura Durning, GCMRC
Craig Ellsworth, WAPA
Helen Fairley, GCMRC
Paul Harms, New Mexico
Christopher Harris, California
Leslie James, CREDA
John Jordan, Anglers
Vineetha Kartha, Arizona
Ryan Mann, AGFD
Mike Moran, GCMRC
Clayton Palmer, WAPA
Emily Palmquist, GCMRC
Peggy Roefer, Nevada
Seth Shanahan, TWG Chair
David Ward, GCMRC
Mike Yard, GCMRC
Mike Yeatts, Hopi

The following were not on the call:
Melinda Arviso-Ciocco, Navajo Nation
Janet Balsom, NPS
Chris Budwig, Anglers
Kathleen Callister, Reclamation
Kerry Christensen, Hualapai
Kurt Dongoske, Zuni
Helen Fairley, GCMRC
Katrina Grantz, Reclamation
Brian Healy, NPS
Jessica Neuwerth, California
Don Ostler, New Mexico and Wyoming
Jenny Rebenack, NPS
Ben Reeder, GCRG
Dave Rogowski, AFGD
Chris Schill, USGS
Randy Seaholm, Colorado
Larry Stevens, GCWC
Rosemary Sucec, NPS
Scott Vanderkooi, GCMRC
Kirk Young, USFWS

Mary Orton of The Mary Orton Company, LLC attended as facilitator.

Chairman Shane welcomed everyone to the Budget Ad Hoc Group (BAHG) meeting. He said he intended to keep the current meeting schedule. He assumed Technical Work Group (TWG) members would receive the Reclamation and Grand Canyon Monitoring and Research Center (GCMRC) draft budgets on April 10, in time for adequate review in advance of the April 20-21 TWG meeting and to use as a focal point of discussion at that meeting. He reminded the members to be sure to set aside time to review the budget before the TWG meeting.

He said today is the BAHG's chance to hear from Reclamation and GCMRC on their budget ideas in three resource areas: Other Native Fish Species (other than humpback chub [HBC]), Rainbow Trout (RBT) Fishery, and Non-native Invasive Species. After presentations, the BAHG members would be invited to discuss the budget at a high level. He wanted to make sure the members start to understand critical information needs (INs) in these project areas. He hoped they could ask questions, learn from each other, and have the

scientists understand the members' ideas, concerns, and input. He said he didn't think today would be the time to make recommendations, but rather to learn and exchange ideas.

He said he asked Mary Orton to help facilitate today, to help the group stay away from the details and to stay at a high level, mostly at the INs level with only a little project-level detail. He invited others to do the same.

OTHER NATIVE FISH SPECIES (OTHER THAN HBC)

David Ward noted that there were no proposed projects in the area of Other Native Fish Species, and that this subject is tied in with routine ongoing monitoring. Shane noted that the resource areas used by the BAHG are organized as was the Long-Term Experimental and Management Plan (LTEMP) Record of Decision (ROD), and that the group was interested in monitoring as well as projects.

In discussion, members noted that the Triennial Budget and Work Plan (TWP) might not be organized in the same way as the ROD. Craig, who developed the budget table for the BAHG, said the LTEMP has identified "other native fish species" as an important resource the program should be working on, and according to the table, there are some projects regarding these other native species, mostly geared toward razorback sucker. There was not a lot of work on other such species even though it was identified as resource area in the ROD.

David Ward said GCMRC funds Arizona Game and Fish Department (AGFD) for ongoing monitoring from Lees Ferry to Lake Mead, so they can note trends in native and non-native fish populations. They are proposing to do more monitoring for other native fish near the upper end of Lake Mead that used to be lake and is now river. It is a continuation of existing monitoring, just extending further because the river now extends further.

Marianne said that the San Juan Recovery program, in an effort to determine the extent of razorback reproduction upstream, is monitoring small-bodied fish. They are picking up small razorback and larvae at the outflow so they moved into the lower Grand Canyon where they are also picking up HBC and other species. Reclamation receives this information through the SJRIP reports that are also shared with GCMRC, NPS and others. She said they have discussed continuing this work in the GCDAMP, continuing further upriver and for more species. It may be that Reclamation would direct some funding towards this monitoring in this work plan.

Mike Yard said that during the HBC aggregation trip, they catch other native fish which can inform the program of their abundance. Also, while AGFD does system-wide electrofishing geared to RBT, the secondary catch includes native and non-native fish. This is informative over time to assess native fish populations. He noted that hoop netting tends to do a better job catching native fish. Also, for the juvenile chub monitoring project, Charles Yackulic is proposing to establish a site in lower western Grand Canyon focused on chub and other native fish monitoring similar to the Little Colorado River (LCR) reach juvenile chub monitoring (JCM) project.

A member asked about the Biological Opinion (BO) for the LTEMP Environmental Impact Statement (EIS), and the requirement that the program assess the triggers for potential removal of RBT, brown trout (BNT), and other species that put predation pressure on HBC.

Is the existing monitoring adequate, given that BNT are difficult to monitor? David Ward said that monitoring for those trigger requirements is accomplished through routine monitoring and HBC monitoring at the LCR confluence. They had not considered separate monitoring activities; rather, that the data needs for the triggers would be filled through ongoing monitoring. Mike Yard said the main purpose of the juvenile chub monitoring project is to determine abundance of HBC and abundance estimates of trout in the LCR area. The methodology used allows them to quantify RBT numbers. They have been unable to provide population estimates of brown trout (BNT) because captures have been too low. However, if there were a change in BNT numbers, GCMRC believes it could be detected.

David Ward said all the fish projects are interwoven. It is hard to discuss them in discrete pieces because they all provide information to others. Mike Yard said the trips were primarily driven by logistics and efforts to be cost-effective. They partition the trips based on their focus, but there is also incidental information gained on every trip.

RAINBOW TROUT FISHERY

Mike Yard said that the salmonid monitoring and research projects involve RBT and BNT; however, when other native or non-native fish are caught, they capture those data to inform the managers. The main purpose of this area of work is to determine the effects of flows identified in the ROD on trout. There are two general components:

1. Overall ongoing monitoring elements. This includes:
    a. The AGFD system-wide electrofishing, from Lees Ferry downstream. While this is principally electrofishing, AGFD is starting to use additional gear like hoop nets to obtain more information on native fish.
    b. Glen Canyon monitoring, which gives us a good idea of the relative abundance and distribution of trout and other fish.
    c. The Lees Ferry creel survey. This is public outreach effort where we interact with anglers to get an idea of their catch.
2. New proposed research: evaluating the LTEMP EIS flows and addressing cause and effect relationships. There are four objectives:
    a. Understanding the effects of Trout Management Flows (TMF) on age-0 trout recruitment and dispersal.
    b. Understanding the effect of stable flows, equalization or other, on trout recruitment and dispersal.
    c. Understanding the effect of fall high flows on juvenile survival or reduced egg deposition driven by decrease in growth.
    d. Understanding the effect of spring high flows on recruitment, growth, and dispersal.

    These four research elements are designed to assess impacts of flows on RBT and BNT. GCMRC is currently focused on RBT because they are dominant; however, they recognize that BNT have started to spawn and they are becoming more common in Glen Canyon, so they want to be able to address how both species are changing in relationship to flow.

In the past, monitoring of early life state RBT survival was included. That is not included here; the protocols need to be restructured so they capture recruitment events as well as become more quantitative. This realignment will be the most useful tool in understanding

whether flows change recruitment. So they are changing the spatial design and integrating it into the mark-recapture design. This is similar to the natal origins project, but it will not be from the dam to Lees Ferry. It will give an overall idea of what is going on with young fish and how they recruit into juvenile and adult fish.

RBT recruitment project: A number of factors influence recruitment of trout. GCMRC needs a model that could predict the years when there would be high or low recruitment. This project would assess data collected as part of long-term monitoring, and data collected in the natal origins project, as well as the ongoing proposal of experimental flow assessment.

They are uncertain whether there will be actions controlling BNT in Glen Canyon. If there are, they will take the opportunity to use otoliths to back-calculate hatch dates, spawning dates, and general grown patterns.

Other research ties into the creel survey and would measure angler catchability. Of their catch, what proportion was smaller or larger? AGFD has proposed a citizen science project in which they would pay guides to measure the length of fish of their customers to determine length and size distribution of the catch over time, to give an idea of the quality of catch, not just the numbers.

The call was opened to questions and comments by BAHG members.

- There is a need for a science plan. The LTEMP EIS says TMF will be needed to reach the trout goals, and it models one type of TMF. It may be that experimenting with different TMF starts with that type. It will require field experiments to know whether a flow regime has the desired effect on trout. We are interested in having a rigorous and significant science plan that is drawn up using standard scientific methods, examines the flow regime, gives quick feedback on whether it has the desired effects, and permits changes that allow for managing trout without destroying the Lees Ferry fishery.
    - Mike Yard: The experimental flow assessment project proposal is the type of qualitative framework that will assess flow effects. It will be reach-based and work with actual abundance, so we can compare the different effects of flows based on habitat types. It should quantify how well a TMF strands fish and also look at the long-term effect. A TMF could remove half of the recruits in a year, but fish compensate for losses by changes in density. So it might end up having a short-term effect but no long-term effect. Mark-recapture will allow us to track survival through time as the age-0 cohort recruits into the adult population. For the experimental flow assessment the RBT early life stage survival (RTELSS) will be restructured to a multi-reach mark-recapture. The original RTELSS project erred on large recruitment events and changes in survival, so we are restructuring it to make it more quantitative and more precise.

- Is the multi-reach mark-recapture the same as before?
    - Yes, except for the location. Instead of the dam downstream, there will be three sites. The sites will have low and high elevation shoreline characteristics, and will be where we know there is high reproduction and where young trout use the bars for habitat. In Glen Canyon, there are three reaches with low-elevation bars. If

the TMF are effective, we can determine to what degree there was stranding there. The natal origin concept is used as framework to put RTELSS in. Sampling trips would allow us to compare and contrast the fall high flows effect on recruitment, or changes in condition to adult fish that negates reproduction later through the spring. Guides have expressed concerns that high flows negatively affect the trout fishery, so we want to address multiple questions.

- What about the bioenergetics or condition of the trout fishery?
  - There will be many metrics collected. To do the mark-recapture, we will PIT tag a lot of fish and track growth and condition. We are working on a bioenergetics model.

- Is what we are hearing here what we will see in the budget?
  - We've been asked to give you a verbal description of the different projects. We have also been working on a generalized extended abstracts. Those abstracts are general; they don't get into the details. Eventually, we will give you more detailed abstracts as we have in the past.

NONNATIVE INVASIVE SPECIES

David Ward said that the priority in the LTEMP EIS and Biological Assessment (BA) was to decrease the impact, presence, and expansion of invasive aquatic species. There are three areas of focus for the TWP:

1. Increase early detection efficiency and surveillance, especially in three areas: Lees Ferry, in the LCR, and near the Lake Mead inflow.
   a. Lees Ferry: The proposal is to do additional monitoring in the summer on a monthly basis, and identify locations where invasives pass through the dam. The idea is to address them early before they become established.
   b. Little Colorado River: The concern is new species coming to where the HBC live, so there will be surveillance on the watershed. The FWS is doing that this year. The proposal is more monitoring between Blue Springs and Grand Falls. When the LCR floods, lots of invasives come downstream and stay in pools in that area, where there is an opportunity for them to spawn. The goal is to prevent a few smallmouth bass to turn into hundreds, and then come downstream during flooding. The project would proactively keep fish from entering the Grand Canyon. This preemptive approach is more cost-effective in small isolated areas, before the species spreads into the LCR.
   c. Lower end of the Colorado River: The goal is to detect invasive species coming out of Lake Mead and going upstream with water samples and eDNA analysis. They are hoping to employ this within the LCR for smallmouth bass and in the lower river for flathead catfish.

2. Assess and quantify the risk warmwater invasive fish pose to HBC. GCMRC has assessed the risk of RBT and BNT on HBC, and how temperatures affect risk. Now, they want to quantify warmwater species predation impacts on HBC in a laboratory setting, including common carp, smallmouth bass, flathead catfish, channel catfish, and small bodied invasives like killifish and flathead minnow.

3. Develop action plans with evaluations of existing management strategies. If there are established invasive species, there is little anyone can do about it. This would be an exploration of emerging technologies that can be used to control them. For example, a new technology being used for invasive brook trout is to treat juvenile brook trout, cause them to have YY (not XY) chromosomes, and release them. When they breed, they produce sterile males in the population and can cause the population to crash. GCMRC is not proposing this, but wants to evaluate the utility of the approach. How might they be employed in this system? In this TWP, there would be an evaluation of options for their potential.

Shane asked BAHG members for questions and discussion.

- For the action plan, are you also looking at emerging technology to manage chub; that is, to improve native species or not just decrease non-native fish?
    - We have some ideas about that. That would be in the HBC section of the work plan.
- What would be the spatial design in the LCR?
    - The initial thought would be Grand Falls to Blue Springs. This year, FWS will do surveillance on the entire upper LCR watershed. Depending on what is found, the proposed spatial scope might change.
- For early detection, will you be doing actual fish sampling in addition to eDNA? If yes, how will that relate to the fish sampling by AGFD system-wide?
    - Simultaneously, AGFD will employ hoop nets at the lower end of river, mostly to look for new HBC and native fish; this could also turn up invasive species. We hope eDNA would give us more power to detect rare species; hoop netting could capture and detect new invasives as well.
- There are other requirements in the BO regarding non-native fish that are not included in these three elements, such as investigating the possibility of treating Bright Angel Creek and Shinumo Creek with piscicide and other tools. Who will address those? How do we get those requirements fulfilled?
    - Marianne: Those are not yet decided. The Bright Angel Creek action would have to have additional NEPA. We have to decide whether it is feasible. Also, is it a management action or research?
- Will the conservation measures be in the TWP or funded outside the program?
    - Marianne: Reclamation funds conservation measures through a different fund. If someone else does the work, it would not be in the TWP.
    - David: We would be eager to work on a chemical renovation of tributaries.
- BAHG should make sure program funds are focused on the Programmatic Agreement, BO requirements, and LTEMP experiments.
- It needs to be clear where those requirements are being addressed, so we don't have to search for them.

RIPARIAN VEGETATION

Emily Palmquist said she invited Laura Durning to the call because she has a large role in the riparian vegetation program. Riparian vegetation has two ongoing complementary monitoring components: ground-based and image-based.

In the ground-based component (10.1), they look at smaller plants on an annual time scale. The image-based component (element 2 in the previous workplan and the upcoming workplan) looks at woody vegetation and change over longer timeframes. The latter is great at assessing slower-growing vegetation like tamarisk. Those two components complement each other: one on an annual and the other on a 5-20 year timescale.

They have proposed four additional components. The first is to revisit Stevens et al. (1995) which examined how marsh vegetation changed since the dam was built. The Stevens study, published before the 1996 ROD, showed that the large fluctuations in flows from the dam had increased marsh vegetation. This was useful for many other resources, produced increased complexity, and was deemed a benefit of dam operations. That research was important in the western regulated river scene as it showed positive outcomes of a dam. Since 1996, flows have changed and there has been significant change in marshes, but this has not been quantified. It would be good to do so before the flows change again. They have received some positive feedback from NPS on this idea and some tribes might be interested. That project would have ground- and imagery-based components.

In the second proposed element, they want to model how LTEMP flows would impact riparian vegetation.

The third proposal would address experimental vegetation mitigation and removal that Grand Canyon and Glen Canyon are implementing. GCMRC has talked with NPS about their intentions: removing dead tamarisks, removing other non-native species of interest, and planting strategically-placed native species in certain areas. GCMRC could help in the design of the project by modeling where they might be most successful as well as best practices to increase successful outcomes. This would include monitoring results.

The fourth proposal is to expand the photo matches, which have proven to be useful throughout the Southwest when looking at longer time scales and vegetation. It provides a better understanding of pre-dam conditions.

All this work would be done on the mainstem in Glen and Grand canyons. All the projects are tied to the LTEMP ROD and determining how the new flows would impact riparian vegetation distribution and composition, tied to the management goal of maintaining native vegetation and wildlife habitat. The experimental vegetation removal and planting is also dictated in one of the ROD documents.

Laura Durning said they were proposing another overflight May 2020. As they did for the 2013 overflight, the plan is to set aside some funding each fiscal year so the budgetary impact is not significant in any one year. The resulting high-resolution imagery is used in almost every other project. She offered to give more detail as requested.

The floor was opened to members for questions and discussion.

- For the photo-matching project, is there was an opportunity to draw from the Webb work and other photo matching that is already done? Is that useful for vegetation work?

- Helen: Yes, that dataset exists and will be used. The point here is to create a baseline record for the next 20 years of LTEMP, and there are great resources already available. By doing it now, the baseline visual record at the start of ROD will be available so we can compare the changes 20 years from now.

- In the Knowledge Assessment spreadsheet, you noted the possibility of looking at Cataract Canyon as potential reference site. Is that going to be included? Also, have you defined functional guilds or does that yet need to be done?
  - Emily: We referenced Cataract because that is the most similar area we know of for riparian vegetation. If we were to start work in Cataract, it would be in collaboration with an Inventory and Monitoring group there and would be funded separately. Tributaries in Grand Canyon, while interesting and unique, are probably not the best references for the mainstem: they are smaller, have more vegetation than the mainstem, and have a dissimilar flow regime. Regarding the guild work, we have not had a riparian ecologist for 18 months, so we have been trying to get it done elsewhere with a person in Ft Collins. That paper is not yet published though the manuscript is in prep. Regarding guilds, we will use them in other efforts, e.g., to identify successful areas for rehabilitation work. We want to use guilds to model how these different LTEMP flows will impact different groups of vegetation. They could also be used to identify species to use in restoration. We are still working on integrating guilds into what we are doing.

- Is the model in the LTEMP the model you are proposing to work on?
  - Emily: The State and Transition Model is great, but coarse. We'd like to use statistical modeling—a hierarchical Bayesian model or other model—to statistically model change over time, and we are exploring which would be best. We want to use statistical models for prediction, and then improve the State and Transition Model using the statistical models and ground-based monitoring.

- Regarding the mapping project, is there already a similar database created by Barb Ralston?
  - Laura: Yes, there is a wonderful existing database from the 2002 dataset that we want to build on. That is a snapshot in time, from 2002, and we will have that again for 2013. The latter is in process; we are building that database for woody plants. Our proposal is to do another overflight in 2020 for another time snapshot, all of which would build on that Ralston dataset.

- The overflight project was not included in the last work plan because of concerns about utility and expense. We were waiting to see an evaluation of the 2013 overflight. Are we still looking at utility?
  - Laura: The 2013 results have been published and are available. I can email it to you and we can talk about that more in detail. When the overflight system was set up, it was recommended to repeat every four years. We said we didn't need to do it in 2017 because of the cost in money and time. However, we do think it is important and valuable to periodically get these high-resolution datasets, and we think the time is right.

- Emily: Many products are developed off this imagery. It is also our best way to look at tamarisk defoliation and death over time. The ground-based component gives of some of that information, but that is only a sample. Some pockets of tamarisks are defoliating and others are not. So because it is discontinuous, imagery will do a better job of seeing how they are dying over time than would ground-based monitoring.
- Laura: The one-meter resolution digital elevation model developed from overflights is used in flow models, channel bathymetry, models from the bottom of river to terraces, and the surface model. It helps with a lot of information we are interested in.

BUDGET DEVELOPMENT PROCESS

There being no further questions or discussion, the discussion turned to the budget development process. Shane said that there would be two more BAHG calls, both of which would involve hearing from GCMRC. It might be best for the ad hoc groups (cultural, socioeconomic, and trout) to consider their deliberations after seeing the April 10 draft, and come to TWG with some discussion about that draft. He noted this is evolving process.

He also noted that GCMRC is getting feedback on the work plan through this informal process of dialogue with GCMRC and Reclamation staff: we hear from them, we ask questions, we give them some initial input. At this point, people are getting up to speed about the various budget components and figuring out how all the pieces come together. The table is helpful in some areas and maybe not others. We are having good discussions now, leading up to an important discussion at the April TWG meeting. From there, we need to have input on the second draft document: we will be leaving out projects that don't make the cut, focusing on where we are over budget, and getting the next level of project detail. We'll need enough detail early enough so we can make a BAHG recommendation before the June TWG meeting, when the TWG will make a recommendation to AMWG.

Comments and questions from BAHG members:

- There are two big differences now: LTEMP, and a desire to have the TWP detail the science plan for experiments under LTEMP.
- Is the dialogue between BAHG and GCMRC all verbal?
  - Shane: We will have meeting notes and share them with GCMRC. The back and forth discussion has been effective. We have always worked on a kind of handshake deal with GCMRC, asking them to consider our ideas. We cannot task the GCMRC to do anything. If we have a disagreement, we will raise it with Katrina and try to work it out.
- This is a great opportunity for BAHG to voice their issues and bring up areas of concern with the principal investigators. Don't lose this opportunity to state your opinions about what you have heard.
- We need to organize the work plan so we can see that all the important requirements are addressed.

Mike Moran noted this was his first budget process. He was concerned that there was not much time between the April and June TWG meetings. He has encouraged the GCMRC staff to start working on their extended abstracts now. Marianne said she would talk to Linda

about rescheduling the TWG meeting for later in the month, and said that it can be difficult to find the needed facilities.

The meeting adjourned.

Glen Canyon Dam Adaptive Management Program
Technical Work Group: Budget Ad Hoc Group

Conference Call #4, March 20, 2017 – Meeting Notes

ATTENDEES

The following people identified themselves as being on the call.

Cliff Barrett, UAMPS
Shane Capron, WAPA and BAHG chair
Marianne Crawford, Reclamation
Bridget Deemer, GCMRC
Craig Ellsworth, WAPA
Helen Fairley, GCMRC
Katrina Grantz, Reclamation
Paul Harms, New Mexico
Christopher Harris, California
John Jordan, Anglers
Ted Kennedy, GCMRC
Michael Moran, GCMRC
Jessica Neuwerth, California
Clayton Palmer, WAPA
Peggy Roefer, Nevada
Randy Seaholm, Colorado
David Ward, GCMRC
Scott Vanderkooi, GCMRC
Charles Yackulic, GCMRC

The following were not on the call:

Melinda Arviso-Ciocco, Navajo Nation
Janet Balsom, NPS
Carlee Brown, Colorado
Chris Budwig, Anglers
Kathleen Callister, Reclamation
Kerry Christensen, Hualapai
Kurt Dongoske, Zuni
Brian Healy, NPS
Leslie James, CREDA
Vineetha Kartha, Arizona
Ryan Mann, AGFD
Don Ostler, New Mexico and Wyoming
Jenny Rebenack, NPS
Ben Reeder, GCRG
Dave Rogowski, AFGD
Seth Shanahan, TWG Chair
Chris Schill, USGS
Larry Stevens, GCWC
Rosemary Sucec, NPS
Mike Yeatts, Hopi
Kirk Young, USFWS

Mary Orton of The Mary Orton Company, LLC attended as facilitator and note-taker.

Shane noted that today's subjects for presentations from GCMRC staff are Nutrients, Humpback Chub (HBC), and Foodbase. He asked Katrina if she would like to present on the Reclamation budget, and she asked to present at the next meeting.

NUTRIENTS

Bridget Deemer said they had an extended abstract that describes an ecosystem-based system: nutrients and temperatures operate together in food web dynamics, primary production, macroinvertebrates, and fish. They are proposing to take a number of different approaches:

- A background characterization of the river, looking at the dam vs. tributaries in terms of overall nutrient budgeting.
- Continuing some previous work on modeling primary production: how nutrients and temperatures influence the rate at which plants can produce biomass for the rest of the food web.

- How Lake Powell influences nutrients in river, which they believe is the most important.

Charles Yackulic said they have been working on an improved temperatures model because the past model under-predicts temperatures downstream by about 2 degrees on average. They think they are developing an improved model. That would be worked on early in the work plan. Other areas include:

- Inexpensive work on aquatic vegetation composition that Mike Yard has been working on. This involves how to monitor vegetation composition over time, particularly in Lees Ferry.
- Moving modeling toward an ecosystem approach, working more with temperatures and nutrients and how they affect lower trophic levels. It is important to make predictions about how the Colorado River Ecosystem (CRE) responds to reservoir conditions, such as temperatures regularly above 16 degrees.
- How quagga mussels might affect nutrients, with a focus on phosphorus and temperatures as key levers.
- Using mesocosms, where they replicate a smaller version of the river in fiberglass raceways. They will use Colorado River water to see how vegetation and bugs respond to different phosphorus levels and EPTs[1] and looking at higher trophic levels. They would take rocks, algae, and plants from the CRE, put them in raceways, and then see what is favored if temperatures increase, or phosphorus is doubled, or other changes are introduced. This could show where the system could go in the next 10-20 years. They will also look at nutrient stoichiometry: they could drip in nutrients, paying attention to how much as well as how much in relation to other nutrients.

Shane invited questions and discussion from attendees.

- Is the temperature model like the one used by Robert Radtke at Reclamation?
    - This model is not for the reservoir; rather, it is about predicting temperatures downstream. The current one doesn't do well in the hot months far downstream from the dam. It consistently under-predicts in hottest months by 2 degrees C, so we think we can have an improved model.

- I like the idea of mesocosms. Are you bringing in invertebrates or letting them colonize themselves?
    - We might transplant mudsnails and gammarus from the river. We will need to count them out. We might, for example, add 100 of each type to each stream, and control for the numbers, so can make inferences about growth rates and abundances under different conditions.

- As you gather this information, which would be very helpful for determining importance of a TCD, can you tie it into how that information would help adjust dam operations to improve the situation? This would give us an idea of how the ecosystem works and also the potential for adjusting dam operations

[1] Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).

- We are always motivated by those questions of dam operations here. It is possible that some things we ascribed to flows in the past are more driven by nutrients. For example, we think equalization flows affected RBT, but that year phosphorus was high in the system. I don't know what you might do to control that. There is some discussion of putting turbines on lower outtakes to control for different nutrients. Our current understanding of flows is affected by our ability to control for other factors that might be more important. It's not that flows are not important; sometimes they are very important. However, other impacts that we thought were due to flows might be due to nutrients. Equalization always happens with big inflows into Lake Powell, and we think those are connected with phosphorus. The idea of TCDs and the ability to affect nutrients is fascinating. We hope to understand the mechanisms better with the Lake Powell work. Previous work done shows, in both Lake Powell and other reservoirs, if you spill water from lower in the water column, it changes nutrient levels.

- Please suggest ideas for alternative reservoir operations that should be investigated.
  - A lot of our work is based on how to operate the dam to improve things.

- Are you addressing improving our understanding of what comes in as nutrients from tributaries such as the Paria, and how to take advantage of that with dam operations?
  - A lot of carbon from tributaries is older carbon, which is not as useful. We find as we move downstream, there is more and more terrestrial detritus in food web, but ultimately it is driven by algae production. Our working hypothesis is that output from Powell is dominant, but we are also looking at Paria and Little Colorado River (LCR) inputs. Maybe during monsoons, the LCR could be significant source of nutrients, but there is none during low flows. We need to look at storm events. The Paria watershed doesn't have the same source of land use you associate with higher phosphorus input.
  - At the Annual Reporting Meeting (ARM), we said it looked like the dynamics at the LCR were driven by dam operations; however, during floods, both LCR and Paria can provide significant amounts of nutrients. How long do they stay in the system? If it leaves quickly, it may not be able to be used for more than a few weeks. These are all hypotheses.
  - Ted Kennedy: We are developing nutrient budget in the work plan. This will be a simple tool for looking at what is coming out of dam, and will put the tributaries floods into context. Nutrients might spike during a flood but move quickly out of system, is my guess. Year over year, what is coming from the dam is what is important for affecting fish populations. We want to better understand nutrients and how affecting food web dynamics.

HUMPBACK CHUB

Charles Yackulic said that, motivated by the Long-Term Experimental and Management Plan (LTEMP) Environmental Impact Statement (EIS) and Biological Opinion (BO), they were probably going to propose three main groups of activities.

1. Ongoing long-term studies.
   Charles said they are proposing here to continue population modeling with added improvements. Specifically they will integrate new forms of portable remote antennae. In

the mainstem, this would improve their ability to estimate the population of larger adult HBC by allowing their detection at greater depth. They can count five times more fish than when using hoop nets. They will also integrate LCR antennae work into their models. At end of work plan, they will analyze the fish translocation data in the population model with rest of population model, and quantify the impact of translocation. They will continue to look at impacts of the environment on spawning probability. The Fish and Wildlife Service (FWS) leads monitoring on the LCR in the spring and fall. They are considering changing the fall trip by adding a second gear type and avoiding floods. This could reduce trips from two to one and improve cost effectiveness. Juvenile chub monitoring in the mainstem will continue, and will probably decrease from four to three trips. They will focus on the times of year during which they are most effective in capturing them: April, July, and October. That is starting this year; they are waiting to hear if they will be permitted. They also plan to slightly increase the spatial study to decrease trips. The current system of PIT tag arrays is degrading, and they want to pilot shore-based antennae, which could costs to 25% of the current expense and potentially have a smaller footprint on the LCR. They will continue sampling at the aggregation sites.

2. New research.
    a. Charles said that they are looking into establishing juvenile chub monitoring (JCM) in western Grand Canyon. They learned a lot at the LCR, and something is now happening in western Grand Canyon. They want to find the drivers. The BO said to find the drivers of the aggregations. The natal origins project did the first part of the trip, and JCM the rest. Now they propose to do JCM in first part, and then JCM in western Grand Canyon in the second half. These trips will be six to seven days each, and include Parashant and Pumpkin Springs, among other places, to determine which is best.
    b. Also they will do otolith microchemistry work in western Grand Canyon for incidental takes, which was recommended by the fisheries Protocol Evaluation Panel (PEP).
    c. David Ward said another new element is to use drift nets to measure larval HBC movement from the LCR and Havasu Creek, to determine how many exist in those creeks and the timing of the out-migrations. If the numbers of larval HBC vary highly from year to year, the next step is to evaluate the impacts of dam operations or of trout on abundance. Drift nets are commonly used to answer questions of quantity and timing.
    d. Another project will use thermal imaging to evaluate warm springs in the mainstem. They had a graduate student using ultrasound to look at eggs in HBC, and found that most females in the mainstem had ripe eggs. This was surprising given the water temperature, so they are postulating that those fish are finding warmer water somewhere. They want to use thermal imaging to find those warm springs. They used a handheld device and found some, and think they would be able to find more. They would work with a graduate student to map the thermal warm springs in conjunction with where HBC are found. In response to a question about why these springs were not found earlier, David said that they think they are subsurface, under the mainstem, and so easy to miss. Scott added that this is a new development. HBC females don't release their eggs, so they

didn't know the status of their sexual maturity. They learned from this study that there are more ripe females in the mainstem then they knew.

e. The final new element would be data mining to identify environmental conditions where ripe HBC are found, in order to link habitat to spawning grounds (which are currently unknown). They would look at existing data showing where when they are caught and analyze those data in a spatial framework. They would identify the spawning locations in the LCR and those habitat characteristics.

3. Translocations and research.
    a. David Ward said that continued translocations are called for above Chute Falls and the mainstem this year. This is led by Kirk Young at FWS. The fish are from the LCR, reared at Dexter, and going into the lower end of the mainstem in several locations this year. FWS is also conducting a feasibility analysis for translocation above Beaver Falls. This will require consultation with tribes and coordination with them, if possible.
    b. They are also proposing an investigation into imprinting in HBC. They have done translocations without understanding imprinting. Most of the other Colorado River fish imprint, but there is no information on imprinting for HBC. This would be laboratory work, linking spikes in thyroid hormone levels with olfactory imprinting. If that is what occurs, and fish are translocated, they won't stay there; they will return to the LCR. Downlisting requires new aggregations, so there is a need to know what and when imprinting happens.

Shane asked for questions and discussion from attendees.

- How much work is done on predation before translocations?
    - Translocated fish are adults, so they will not be eaten except by large bass or catfish. So we think there is a low predation rate. This will be the first time that we have translocated to the mainstem.

- Will sonic tags be used this year or next year?
    - That will be this year in the current work plan. FWS has said we should translocate with sonic tags so the fish can be tracked. We are still working out the details for the next work plan. If it shows promise and is effective, it might make sense to continue sonic tags. We currently have a placeholder for that decision. The context is that the FWS BO calls for mainstem translocations if the tier 1 trigger is met; that is, if the fish fall below a certain abundance for subadults and adults. This could become a management action; it could be that we are to do some groundwork now to make sure it will be effective strategy.

- Please clarify: translocations this year are in western Grand Canyon and the conservation measures are to be near the LCR. If you are refining techniques, why are you doing that away from the LCR?
    - David Ward said that research needs to be done at the LCR. It is proposed to have translocations above Chute Falls, away from predators, and this needs to be evaluated, as well.

- Regarding Chute Falls, the conservation measures call for not only evaluating growth, but also measuring survival or contribution to adult populations. What are your thoughts for that?
    - It's my hope that we will get at those things with this analysis. The evidence that growth is better above Chute Falls is convincing, and it could be that survival is similar. We need to see how many adult fish are adding to the population and compare rates in the LCR to above Chute Falls. We need to quantify the difference in survival and population.

- Another BO item is population modeling and estimates for mainstem fish in the mainstem aggregation. What are your plans for that?
    - Charles said that mainstem fish are in the estimate of the multistate model. We keep track of fish size and location; the tricky part is defining the "rest of the Colorado." How far does it extend? If you include fish marked 100 miles downstream, that is problematic. We need to keep looking at that. We are already making abundance estimates for fish spawning in the LCR.
- The LCR population estimates are inclusive of LCR and mainstem aggregations.
    - Charles said they are inclusive of the adult population that spawns in the LCR. We think all fish in JCM spawn in LCR, plus we have fish in the LCR.
    - Scott said we have to look at the specific language. We have been struggling with this. In the previous BO, we had a lot of back and forth on this with FWS. They wanted a means of estimating abundance in the mainstem and the aggregations. We tried a couple of different ways. The report was rejected in peer review because the methodology was suspect. Some in FWS are interested in an inclusive estimate that includes the entire Colorado River ecosystem in Grand Canyon; but with the isolated populations of aggregations, this is challenging because of the small sizes. One concern is potential negative impacts on the aggregations because of the amount of handling. We'll continue to work on it.
    - Charles added that JCM west and the portable antennae could potentially help us with this.

- Are we being prudent in doing translocations without knowing about imprinting?
    - David Ward said this was his argument. We need to understand imprinting before too many more management actions. We are overdue in answering this question.
    - Charles said one could argue that Chute Falls shows improved growth and survival, and whether they spawn there or not is not so important. At Havasu, there are no fish there anyway, so could be positive. But for the mainstem, we need to know.
    - Scott added that we have a little information. A handful of translocated fish have returned to the LCR. They are PIT tagged so we know some are moving back.

- Even though a small number have returned to the LCR, there are many more that have stayed in the reach where they were translocated and are contributing to that aggregation.
    - We know they stayed, but we don't know if they are contributing to the population. Maybe they will stay, but if we understand imprinting, that will

change how we translocate. Maybe we translocate pre-spawn adults so the larval fish imprint on the tributary.

- The fish in Shinumo Creek that never matured: was that due to imprinting?
  - There is a lot we don't understand. Even salmonids can stray to a different stream; it is all part of the population dynamics. We just need to answer the questions about imprinting.
  - Scott added that the example of Shinumo had unfortunate timing because of the fire and flood. We are guessing, but we think they were just getting to where they might have matured and started actively spawning.

- Will doing JCM in western Grand Canyon be cost effective? What will it get us?
  - In the past, we did a second trip, but the return was minimal when you look at the amount of effort: two or three nights of hoop netting. With JCM, we use multiple gear: we do electrofishing, we are on shore. There is an art to doing this. We need the right boatman and Mike Yard to get them into nearshore environment. We are also incorporating seining in Grand Canyon west. JCM west may not work; I wonder how much of the resurgence is one big year class vs. a number of year classes. We will learn more with the pilots.
  - Ted Kennedy added that this intrigued him. In the foodbase work, we see chub growth with higher water temperatures, even though the foodbase is poorer than the LCR. Estimates of growth rates from downstream will resolve some questions about temperatures and foodbase.
  - Scott added this was different from what has been done in the past: marking small fish. JCM has been so successful that we want to try it in another location and use it to better understand what is going on in western Grand Canyon. One of the most interesting developments in recent years is the expansion of chub there.

- Is the translocation of adults into western Grand Canyon starting next year?
  - That is in the current work plan for 2017. FWS is leading the project with help from GCMRC. In new work plan, FWS may do some follow up in the mainstem, contingent on how things go this year.

FOODBASE

Ted Kennedy said the foodbase proposal was divided into three categories.

1. Continuation of existing foodbase monitoring programs.
   The long-term drift monitoring in Lees Ferry has been ongoing for 10 years. The proposal is to continue the citizen-science light trapping, which is in its sixth year; and the sticky traps in Glen Canyon, which is in its fourth year. These provide important baseline data on the status of the foodbase and evaluate how the foodbase is responding to changes in management or in water temperatures.
2. Foodbase monitoring and support of HBC and invasive species range expansions.
   a. They are proposing to do some foodbase monitoring and monitoring drift wherever the JCM West happens and at the existing JCM monitoring site near the LCR confluence. They propose to compare and contrast foodbase conditions at these two

locations, along with growth rates and temperatures, to better understand what role food plays in expansions of HBC populations in downstream sites.

b. They are also proposing some new small-scale drift and emergent foodbase work downstream of Diamond Creek, where little is known about foodbase and where HBC and RZB are growing.
c. Finally, they propose to continue foodbase monitoring in the LCR in collaboration with the FWS, and initiate new foodbase research in tributaries like Bright Angle Creek and Shinumo Creek, among others. They will describe foodbase conditions and study invertebrates to understand how mayflies and caddisflies colonize in the mainstem. Also, they are trying to understand if changes in foodbase in Lees Ferry are contributing to the increase in the BNT population. They think BNT prefer mudsnails and gammarus. They are also tracking quagga mussels from the Glen Canyon Dam to Grand Canyon, by putting down artificial substrates in the spring and retrieving them in the fall. This is commonly used to monitor quaggas: they let them incubate and then compare growth rates and population densities as a function of distance downstream.

3. New monitoring and research in anticipation of new flow experiments proposed in the LTEMP.

   The experiments are macroinvertebrate flows (bug flows), trout management flows (TMF), and changes in HFE timing. If bug flows are tested, they will do targeted monitoring and research at different locations in Grand Canyon, proximate to tributaries, that might support EPT taxa that might colonize the mainstem. Also, they will attempt to determine whether habitat substrate quality is affecting foodbase production, and perhaps serving as a constraint on EPT. The idea here is that if cobble bars are clogged with algae invasives, they may not be suitable for aquatic insects to colonize. So they plan to test mechanically scrubbing rocks to see how habitat quality affects foodbase production. They evaluate macrophytes (aquatic plants) and see how they affect the quality of benthic substrates and what kind of invertebrates they support. They also plan research in the tailwaters of Colorado River basin, at Parker, Davis, and Hoover Dam. Despite big daily changes in discharge (load following) at these dams, there are caddisflies there, contradicting the findings of GCMRC's paper that posited that daily fluctuations are bad for EPT species. This will build on one year of investigation funded by Western Area Power Administration two years ago.

Shane asked for questions and discussion.

- How much of the information below Parker and Davis could you get from the Multi-Species Conservation Project (MSCP)? Do you need to actually go there, or is there information available?
    - Ted: I don't think anyone is studying these insects. I have heard a rumor that MSCP might hire an entomologist. We have also tried to get funding from MSCP for this work but they are on a three-year funding cycle and I don't know if they will fund us for a year or two.
- MSCP is on an annual funding cycle. Have you looked at the work on flannelmouth sucker below Davis?

    - Ted: I am not familiar with that. We want to look at the caddisfly populations.
- Lots of work has been done down there on foodbase and native fish.
    - Ted: We will look into that.

- Is any work done on EPT in Flaming Gorge?
    - Ted: Maybe, but the habitat is closer to Grand Canyon when you go downstream than when you go upstream.
- Water temperatures are colder upstream and warmer downstream.
    - Ted: We have natural-looking temperatures in Colorado River downstream. We don't see caddisflies, so we think it is the load following. That is why we find that downstream situation so interesting.

- What methods will you use to monitor the effects of flow experiments and bug flows?
    - Ted: We have very valuable long-term monitoring in place like the 10-year record of drift at Lees Ferry and six years of adult insect citizen science. If we knew what flow experiments were coming, then we could develop the details. We have a consensus here about the logical sequence of flow experiments. We are open to engage here and with Reclamation and others to see if we can come to consensus on what should be tested in the next three years.
- How planning to evaluate bug flows: light trapping, drift netting?
    - Ted: All those metrics will be used to track ecosystem response to bug flows: invertebrate drift, light trapping, sticky trapping. We also propose some continuation of the egg laying work we started. We think bug flows will lead to higher survival of eggs. So we want to do more research on eggs around tributaries with EPT populations. In terms of analysis, and before and after comparisons: we have the record of drift from Lees Ferry. If bug flows benefit some type of insect, we should see an increase of drift in those species. We also have a five-year record of light traps that is spatially intensive. We should see a higher catch rate for midges and others.

- According to the LTEMP ROD, we can do bug flows in 2018, right?
    - Katrina: That is correct.
- Do we also have the potential for a TMF?
    - Katrina: Yes, pending the projected trout numbers, which is tied to hydrology.
- When should we start those discussions of 2018 experiments—at the TWG meeting in April?
    - Katrina: That is a great question. We also need to talk about fall HFE. Maybe at the TWG meeting, may not be prepared, or spring early summer.

- Are you proposing any work with emergent substrates and the effect on invertebrates' biomass? That is, looking at rocks and natural substrates, or experiments with unnatural substrates.
    - Ted: We just did some pilots on egg laying last summer, and the results were intriguing. We are planning to do more studies this spring or summer during the egg-laying season. It is hard to say where they will go. We've seen in Lees Ferry that emergent substrates are important. We put black pipes along different shoreline types and millions of eggs were laid on them. This was near large

emergent rocks. On a microscopic level, the natural substrates were clogged with algae and muck and it was harder to see the eggs.

- It is important to keep looking at this.
    - Ted: Right, we are interested to see how bug flows works. If it pressure washes the cobble bar, simulating a big flood, what kind of bugs will we see on different quality substrates? We are thinking of experiments beyond flows.

- Would the mesocosm experiments be at the dam or at Lees Ferry?
    - We have different options, and we want to talk with Reclamation about them.
    - We've also discussed partnering with high school science classes in Page when we use artificial streams for experiments. The kids could help maintain the experiment, and this could lead to summer internships. In this case, having it at the dam would make sense.

- It appears there is a loss of foodbase with fall HFEs. Are you trying to figure out if this is occurring?
    - We can switch the timing of HFEs or turn them off, not running them for a sequence of years. We know what will happen to sandbars if you don't run HFEs. If you want sandbars, then test spring HFEs. We saw positive foodbase response to the 2008 spring HFE.

- We've had some years with fall HFEs and some years without. What type of information do you have to separate out the effects?
    - In the foodbase KA, we say fall floods have a neutral to negative affect on foodbase. Given enough time without disturbance, the foodbase will become dominated by mudsnails. When there was a four-year gap since the last HFE, the system was overrun with mudsnails. It was a degraded foodbase. So it is hard to see if fall HFEs have made it any worse. But if you compare the foodbase response to the 2008 HFE, the highest midge and blackfly abundance are from 2008. Next highest is 2009. There were enormous increases of 500%. Spring HFEs seem to be very positive.

- There is a short-term impact on foodbase, month to month, after a fall HFE. Have you looked at a finer timescale yet?
    - No. This could tell us if fall floods are neutral or negative on foodbase. We need to run the foodbase numbers through the bioenergetic model, but it is more complicated than that. If you want to manage for insects, emergent life stage for birds and bats, then do spring HFES. If you want mudsnails, fall floods are good way to get them.

Shane noted the next call would include presentations on cultural resources, socioeconomics, sediment, and Reclamation projects. The meeting adjourned.

Glen Canyon Dam Adaptive Management Program
Technical Work Group: Budget Ad Hoc Group

Conference Call #5, March 23, 2017 – Meeting Notes

ATTENDEES

The following people identified themselves as being on the call.

Lucas Bair, GCMRC
Janet Balsom, NPS
Shane Capron, WAPA and BAHG chair
Kerry Christensen, Hualapai
Marianne Crawford, Reclamation
Craig Ellsworth, WAPA
Helen Fairley, GCMRC
Paul Grams, GCMRC
Katrina Grantz, Reclamation
Paul Harms, New Mexico
Brian Healy, NPS
Dawn Hubbs, Hualapai
Leslie James, CREDA
Vineetha Kartha, Arizona
Ted Kennedy, GCMRC
Ryan Mann, AGFD
Michael Moran, GCMRC
Jessica Neuwerth, California
Joel Sankey, GCMRC
Randy Seaholm, Colorado
Dave Topping, GCMRC
Scott Vanderkooi, GCMRC
Mike Yeatts, Hopi

The following people were not on the call:

Melinda Arviso-Ciocco, Navajo Nation
Cliff Barrett, UAMPS
Carlee Brown, Colorado
Chris Budwig, Anglers
Kathleen Callister, Reclamation
Kurt Dongoske, Zuni
Christopher Harris, California
John Jordan, Anglers
Don Ostler, New Mexico and Wyoming
Clayton Palmer, WAPA
Jenny Rebenack, NPS
Ben Reeder, GCRG
Peggy Roefer, Nevada
Dave Rogowski, AFGD
Seth Shanahan, TWG Chair
Chris Schill, USGS
Larry Stevens, GCWC
Rosemary Sucec, NPS
Kirk Young, USFWS

Mary Orton of The Mary Orton Company, LLC attended as facilitator and note-taker.

Shane reminded the group that at this meeting, they would hear presentations from Grand Canyon Monitoring and Research Center (GCMRC) on sediment, socioeconomics, and cultural resources, and from Reclamation on their budget. Ted Kennedy would also spend some time to revisit the funding question on the foodbase project.

CULTURAL RESOURCES

Joel Sankey gave an overview of the research and monitoring in what was Project 4 in the last work plan. They will evaluate how flow and non-flow resources affect cultural resources on archeological sites. He said there would be a focus on the effects of dam operations on Holocene terraces throughout Grand Canyon. Another focus will be on the effects of vegetation management required by the Long Term Experimental Management Plan (LTEMP) Record of Decision (ROD).

They plan to continue monitoring topographic geomorphic changes of individual dune fields and archeological sites through LIDAR, surveys, and topographic surveys with drones (if permitted). While they will apply the classification system to archeological sites, that work will not be updated during this work plan.

For vegetation management, they are interested in using the tools noted above, especially remote sensing, to identify sites where would make sense for National Park Service (NPS) to target vegetation removal to free up sand to be moved by aeolian processes to cover archeological sites. They will rank potential sites in terms of their relative potential or importance. They also plan to use survey and change detection methods, and other new methods, to monitor and evaluate the outcome or effectiveness of the vegetation removal, by collecting data before and after the treatment. They will work in close collaboration with NPS and tribes.

Another element will be to update the analysis of dam-related geomorphic changes of channel and terrace banks in the Glen Canyon National Recreation Area (NRA), for the most part using existing remote sensing channel mapping data. They plan to update the paper Paul Grams published in 2007.

The tribes expressed an interest to work with GCMRC on dam effects and long-term erosion rates, and the erosion potential from all geomorphic processes, on Holocene terraces throughout the system.

Another element is based on Alan Kasprak's work that was reported at the Annual Reporting Meeting (ARM). He used the channel mapping and remote sensing data of sand on channel beds and above in aeolian dune fields, and used historical data of hydrograph and remote sensing of vegetation, to analyze how vegetation encroachment and changes in the flow regime affected the availability of sand for aeolian transport. He completed this for Lower Marble Canyon and he will do this for other reaches where there are similar classifications.

Finally, they plan to develop web mapping from a new geomorphic change detection tool. They will use survey data, per river reach, to attribute geomorphic processes to those changes. They think it would be useful and plan to turn it into a web-mapping framework for the GCMRC webpage.

They will also be doing outreach under the auspices of the riparian vegetation monitoring and research under the ROD, as well as for cultural resources. Outreach efforts will include the tribes and members of the Grand Canyon National Park and Glen Canyon archeological staff.

Shane opened up the meeting for questions and discussion.

- Is the primary purpose of the vegetation removal for aeolian transport or for the benefit of camping beaches?
    - Joel: There are four purposes of vegetation removal noted in the ROD:
        1. Vegetation encroachment at campsites.

2. Replacing non-native species with native species (planting).
3. Freeing up sand for aeolian transport for the benefit of cultural areas.
4. Addressing arrowweed.

The project I described is #3. However, there are sites where we could address several goals with one action.

- How are the projects you are coordinating with the tribes different from those you are coordinating with NPS?
    - Joel: Vegetation management is a non-flow action conducted by the land management agency, which is NPS or tribes. We are offering to monitor before and after in order to measure the effectiveness of the treatment. We might also recommend promising sites, and we have existing baseline data to show how topography or the sediment budget changes over time. In addition, Glen Canyon NRA and the tribes have expressed interest in having a better understanding of how dam operations affect the erosion of Holocene terraces. We are equipped to study, analyze, and collect data, and inform you on these issues.

- Please describe how important aeolian transport is for preserving cultural sites. It seems there were just a few sites in one study that were affected by aeolian transport.
    - Joel: That is not the appropriate study from which to extrapolate to all sites. The researcher focused on only a small number of sites, some of which were affected by wind processes. Thirty of the 356 sites in the wind classification are in the category of best-case scenario to receive windblown sand. There are dozens more with vegetation that precludes transport. We are focusing here because this vegetation management work is noted in the ROD, and because there are many sites where targeted removal could make a difference.
- So the point of the work is to determine how vegetation removal could increase sites receiving sand?
    - Joel: Yes. Also, the work will be accomplished under the ROD, so we would evaluate its effectiveness.
    - Helen: More vegetation will be removed with the tamarisk beetle, which could change the dynamics for many sites that receive sand from wind processes. The question is: to what extent do dam operations limit the availability of sand to be transported to sites?
- Hopi is pushing for this broader understanding of the relationship between sand availability and dam operations. Our focus is on archeological sites on Holocene terraces, which is a small sample of the ecosystem. Looking more broadly, and independent from archeological sites, this will help us understand how dam effects can affect erosion rates. Looking at archeological compliance, we will measure changes and see if high flows have any effect at all.

- Have you thought about how to determine what actually can be affected by dam operations, and do we need to separate the research between the Colorado River Ecosystem (CRE) and the rest of the canyon? Also, regarding the aeolian transport of sand, do we know whether operations at the dam can create the sandbars valued by recreation? My thought is that much could be done before getting so far into this project that you cannot discern what operation is affecting what resources.

- Joel: With regard to your first question, we are very conscientious and careful about focusing research and monitoring on the effects of dam operations. A linkage has been clearly shown between the transport of sediment from sandbars rebuilt from certain flows and downwind dune fields. What we know about the erosion of terraces relative to dam operations is in Glen Canyon, where we've shown with our LIDAR work that those terraces will erode immediately following controlled floods if there is a quick drop of water level. We can use this landscape-scale remote sensing to identify other cut-banks and terraces throughout the canyon that might be similarly affected by those processes.

  With regard to your second question, I imagine NPS would do this work at a small number of sites when it is first implemented in year one. Based on all the data we've collected and the analysis we have done, we can recommend 10 to 30 sites where it would make sense to try the vegetation removal. We know sandbars there have responded to floods and that large vegetation barriers exist.

- Have you talked with recreational interests? How does this fit in with pattern of sandbars they want to see for river trips? Have you looked at the overlap with these sites?
  - Joel: To date we have talked with NPS and the tribes. We would need to approach vegetation research and monitoring from the point of view of the four reasons for vegetation management under the ROD. We need to have some kind of workshop or work group to identify where we can get double or triple benefit for the various resources: campsites, cultural sites, aeolian dune fields, tamarisk removal sites, and maybe even planting native species.

- Do the tribal representatives feel they are getting a good balance between mitigation and identification required under Section 106 on the one hand, and work on aeolian sand transport on the other?
  - Mike Yeatts: The question about whether aeolian processes are happening under current dam operations is important. The current situation cannot be viewed as a comprehensive method for mitigation of erosion at archeological sites under the Programmatic Agreement (PA). It's possible vegetation management will help. Beyond that, with the finalization of the PA and discussions on the Triennial Work Plan (TWP), I think we will get back to monitoring work that has lapsed at archeological sites and determining whether there are impacts. We can also get back to the mitigation of adverse effects we have identified over the last 15 to 20 years. We've been lacking on some of the compliance mitigation aspects, but this is not the fault of GCMRC; they are not the responsible agency.

- Joel: Can you explain the table of potential project ideas the tribes sent us yesterday?
  - Mike Yeatts: The impetus was the BAHG discussions. Looking at the table that Shane distributed, we realized that the tribal representatives hadn't discussed our overall vision for the cultural program. We developed a list of brainstormed projects among tribal representatives and others. We haven't yet discussed it with the broader group. I sent it out yesterday to the PA group to get feedback before sending it to the Cultural Resources Ad Hoc Group. Some of the things Joel reported on were from these discussions.

- Kerry: Hualapai mostly agrees with what Mike said. We didn't think the aeolian transport project was important, but with the potential for vegetation management it might become important process. We don't agree that GCMRC is not responsible for Section 106 compliance. GCDAMP is responsible for compliance for ESA, and the whole program is partly responsible for Section 106 compliance.
- Katrina: As the agency that takes action under LTEMP and funds GCMRC, Reclamation's main goal is to ensure compliance with Section 106, including actions by GCMRC, through the PA and the eventual Historic Preservation Plan.
- Scott: GCMRC is committed to compliance with Section 106. Reclamation is the action agency and we work with them through interagency agreements.

FOODBASE PROJECT FUNDING

Ted Kennedy reminded the group that he had presented on the new foodbase project at the last BAHG meeting. This was in follow-up to GCMRC work Western Area Power Administration (WAPA) funded on invertebrate assemblages in the lower Colorado River, below Davis and Parker dams. Dam operations there could be characterized as extreme load following; however, there are robust caddisfly populations—almost to a nuisance level where they are considering removal efforts. This was counter to GCMRC's earlier findings in which they identified hydropower production in general and load following specifically as the primary cause of the poor health of invertebrate assemblages. He said they are looking for funding to continue this work, including from the AMP, Multi-Species Conservation Program (MSCP), and other sources, as studying these populations of caddisflies could benefit the managers. Understanding their life histories could inform the management of those populations, also inform the program on invertebrate assemblages for Grand Canyon.

Shane invited questions and discussion.

- I'm glad you are talking with MSCP about funding; I believe you should be coordinating with them. A joint proposal would be helpful, from my perspective. Regardless of funding, are you looking at trying to take caddisflies and move them to Glen Canyon reach? That is, would the funding be for reintroduction of extirpated species? We would not be in favor of that idea.
    - Ted: WAPA funded some studies on this subject in the upper and lower basins. One objective was to identify potential candidates for reintroduction, and this might be a good candidate. I would hesitate moving insects around without more information. These are a native species, but relocation is a big step. That is something on our radar, but we are far from developing a proposal advocating that. That would be coordinated with NPS.

- If this is funded, there needs to be consultation with Colorado River Indian Tribes and the Mohave Tribe, along with AMP tribes.
- I appreciate you thinking about this, even though it challenges your earlier paper.
- You might want to also talk with Bullhead City and Arizona Game and Fish Department for funding.

SOCIOECONOMICS

Lucas Bair presented on socioeconomics monitoring and research. He said that he had developed two categories of proposed work with the help of the Socioeconomics Ad Hoc Group (SEAHG).

1. Social and economic survey research.
   Two activities in the proposed TWP are important due to the proposed experiments in the LTEMP ROD.
   a. Commercial whitewater guide survey. Based on conversations with stakeholders, GCMRC proposes to interview guides about their recreational experience, including what attributes are important to them under different flow regimes. This will add insight into how dam operations influence recreation activities, and refine understanding of dam operations and attributes important to this group.
   b. An extension of Project 13.2, initiated this fiscal year, which is an evaluation and assessment of tribal preferences for resources downstream of the dam. GCMRC is developing surveys through workshops with tribes that would evaluate their preferences for and values of downstream resources. This qualitative information will give the program a better understanding of tribal perspectives for these resources.

   There are other lower-priority projects, including non-market economic surveys of commercial whitewater boaters, backpackers, and day users. These are groups the AMP and SEAHG have identified as accessing the river and having preferences about their experience. They learned by surveying anglers that their preferences are stable over time. Dam operations don't impact some of these groups' preferences, so they are a lower tier of importance. This may come up later if conditions change.

2. Applied decision scenario analysis.
   a. Build on and use what GCMRC learned in the recreation surveys of boaters and anglers to update Reclamation's model to evaluate experiments proposed in the LTEMP and understand how seasonal timing affects anglers and boaters.
   b. Update information on how anglers and boaters spend money in the region. The flow experiments can impact angler participation and spending. There is an opportunity to learn from those in the area who commercially benefit from the anglers about the regional economic impact of how LTEMP experiments occur, including their timing and how they are organized.
   c. Build on the bio-economic modeling and scenario analysis work GCMRC is currently doing. This model, reported on at the last ARM, was used to evaluate rainbow trout (RBT) management strategies in relation to humpback chub (HBC) goals. GCMRC proposes to build on this model to evaluate the most efficient way to learn about HBC populations, including aspects like survival and recruitment, and to minimize the need to manage RBT at the Little Colorado River (LCR). GCMRC is building that model to evaluate tradeoffs, efficacy, and costs compared to RBT removals at the LCR. This also supports evaluating and assessing LTEMP experiments and thinking more systematically about translocations.

d. Modeling regarding the RBT removal trigger, and how to increase efficiency and effectiveness of management actions like trout management flows and other experiments.
e. Building on existing modeling that GCMRC, NPS, Argonne, and others are doing based on recent work by the University of Oklahoma and including what was done in the LTEMP EIS. GCMRC proposes to formally look at the conceptual model to identify research priorities and how they can better standardize and identify how things would fit together, looking at LTEMP experiments. He emphasized that this work is focused on building on existing studies and work, updating information, while focusing on LTEMP experiments.

Shane invited questions and discussion.

- As you go through these evaluations, can you differentiate between previous dam operations and new experiments? Can you separate impacts of the dam and focus solely on the impacts of experiments?
    - Lucas: Yes, I feel confident that is possible with our modeling. With survey research and more formal modeling, the focus is to refine and pay attention to operations specifically including LTEMP proposed experiments.

- If the anglers' survey shows that their opinions tend to be stable, why are we supporting additional survey work?
    - Lucas: Because some of the data used to support the LTEMP assumptions is dated, so we thought it would be important to include more current survey work.

SEDIMENT

Dave Topping said he was proposing to continue the ongoing monitoring with a few minor changes. The focus will be more on evaluation of LTEMP flows and the interpretive products will be different. This project collects basic measurements of stage, water elevation, discharge, water quality, and sediment transport data in the CRE at a number of sites along Colorado River and tributaries. It also develops the sand budget for six different reaches. He works closely with Reclamation on triggering and design of high flow experiments (HFEs) each year, and gathers the data in the sand budgets to evaluate HFEs as they occur. The monitoring has shown that there have been some differences in response to the HFEs over the last few years.

The AMP funds are largely used to gather basic monitoring data that are used by all the other projects funded through the AMP. A small component of the AMP funding is used for interpretive work. He noted that AMP funds provided for the monitoring stations cover only 70% the network costs; other funding sources are Bureau of Land Management, USGS, and the State of Arizona.

This year, there are three elements to the project.

1. Stream gaging to measure river stage and discharge in the river and tributaries.
2. Water quality measurements, every 15 minutes, of dissolved oxygen, temperature, and other metrics at six mainstem sites. GCMRC also supplies logistical support for

water chemistry measurements, including nutrients, paid for by other sources in places such as Diamond Creek and Lees Ferry.

3. Sediment transport and budgeting, the biggest element of the project, collects and analyzes sediment transport measurements. The data are used to help determine when triggers are met for HFEs and for constructing the mass balance sand budget that informs scientists and managers of the effects of dam operations on the CRE. These mass balance budgets are useful because when increases indicate there is more sand, more sand is available for deposition during HFEs. He noted there have been sustained losses of sand as a function of dam operations.

This monitoring is designed to evaluate the effects of any dam operations, so they are not proposing any major changes. As LTEMP flows occur, they will break out those flows individually and be able to give updates about those flows and impacts on sediment.

- Should we identify in the TWP how much outside funding is part of your project?
    - Dave: This will be included in the TWP. We are also taking advantage of data collected by other agencies for stream gaging and water quality.

- Help me understand, now that DOI has made decisions on dam operations for 20 years through LTEMP, what recommendations this program might make to the Secretary on dam operation. Are there opportunities where decisions have been made and some data gathering may not be so important? Have these LTEMP decisions given us opportunity to refocus funds, or does everything have to go forward?
    - Dave: If you want to know the impacts of LTEMP flows, then you do need to collect these data. You won't get it from a model. It's a balancing act between what you are willing to pay for and the information you want to have. We try to keep this project to the point where you can evaluate all the operations. The project has gotten less expensive, even though the costs haven't changed. The net costs have decreased because less overhead has been applied to the project.

Paul Grams reported on an extension of Project 3 from the previous work plan, which is annual sandbar monitoring with remote cameras for daily analysis. They are proposing some changes in research elements along with some phasing from research to implementation or dropping some elements. They have made progress on how to analyze the data in an automated way. This year or next, they will be reporting on some sandbars monthly from remote cameras; how many will depend on the quality of the images. They have also rebuilt the database that supports sandbar monitoring data on the Web, and they continue to make advances there.

The other monitoring component is long-term sediment storage monitoring, also known as the channel mapping project. They repeatedly collect maps of river segments between Lees Ferry and Phantom Ranch, which provides a long-term perspective on sand storage in a spatially explicit way, which is not possible with sediment transport monitoring. When Dave talks about sand loss in eastern Grand Canyon and National Canyon to Diamond Creek, the next question is, what does that mean for sandbars? What are the implications for long-term operations? By doing the repeat maps, they can evaluate where changes in storage have occurred and use those data to better provide managers and stakeholders with information

on how change in sediment storage will affect future high flows and the ability to build sandbars.

What will we want to know in 20 years when LTEMP is winding down? If we want to know the effect on sand resources and storage in Grand Canyon, this project will provide that information. We proposed over the three years to conduct repeat maps in lower Marble Canyon and eastern Grand Canyon, and expand the time period to 10 years. These were originally done in 2010 and 2011. They will have 3-5 years interval between maps. They are also discussing mapping Diamond Creek to Pearce Ferry; NPS is interested in this reach because of dropping lake levels and erosion. The Hualapai are also interested in navigation here. GCMRC can include modeling how potential management actions might affect that river segment.

The other project elements are as follows:

- Continue development of modeling tools for predictive response of sandbars. A publication is coming regarding grouping sandbar sites, examining the relationship between site characteristics, site behavior, and riparian vegetation expansion. This would be useful to the riparian vegetation project and would involve empirical and statistical sandbar modeling.
- Pilot flume studies looking at sandbar response. These would be lab experiments to evaluate how different flow regimes, hydrograph shapes, and downramp rates result in different sandbar characteristics that affect longevity and shape.
- Workshops planned in the near term:
    - Workshop with the Hualapai Tribe on Diamond Creek work.
    - Workshop with stakeholders and/or scientists on LTEMP flow experimental actions. There is almost unlimited research that could be done to evaluate those experiments, and GCMRC wants to consider what is best to do and how. They might want to include some contingency funding for this.

Shane invited questions and discussion.

- You mentioned the potential need for contingency funding. If we do an extended duration fall HFE, we will need to monitor, in real time, the efficacy of the extended times to ensure we are getting continued deposition on beaches and locations with the longer duration.
    - Paul: We are not used to making decisions during an event. Are you suggesting that we turn the water off if we are not getting certain results?
- No, it would be monitoring to see if we get continued deposition or if we have net erosion.
    - Dave: My project could used to modify the releases on the fly, but it would probably be too difficult from a dam management point of view.

Dave Topping said that with regard to ramping rates, depending on what happens in HFEs and daily operations, GCMRC has the ability to measure sand transport at 15-minute intervals, so they can test different ramping rates and see the impacts. It would not cost anything extra to collect those data.

Paul added that they have had some success experimenting with sonar to measure sand thickness. There are some limitations, and they cannot use it everywhere, but it does work in many places. This will help them improve estimates of total sand storage during this work plan.

RECLAMATION

Katrina gave a high level overview of the Reclamation budget, and noted it would have the same general elements as before:

- AMWG management, travel, facilitation.
- Public outreach.
    - This includes public affairs, overall website maintenance, and publications.
    - This is proposed to be a similar amount as before.
- TWG will have similar costs for travel and chair reimbursement or facilitation
- Reclamation administrative costs include
    - NPS permitting
    - Contract administration
    - Science Advisors Program contract
        - This will probably increase.
    - Experimental fund
        - They are considering collaboration on experiments to make sure there is enough funding for additional monitoring, the experimental fund, and the native fish contingency fund.
    - New conservation measures under the LTEMP Biological Opinion (BO)
        - Over the next three years there are required new actions under the BO, including new technology for fish passage and a Temperature Control Device for warming or cooling.
    - Cultural resources
        - Reclamation's highest priority here is to ensure Section 106 compliance, including monitoring, reporting, and getting the Historic Preservation Program in place.

Katrina offered to meet with the BAHG again to give more detail on the Reclamation budget. The group agreed that questions could be brought up at the TWG meeting.

The meeting adjourned.