GLEN CANYON DAM ADAPTIVE MANAGEMENT PROGRAM
TECHNICAL WORK GROUP MEETING
APRIL 12-13, 2022
FINAL MEETING MINUTES

Day 1: April 12, 2022
Start Time: 8:33 AM Pacific Daylight Time (PDT)
Conducting: Michelle Garrison, Technical Work Group (TWG) Vice-Chair
Meeting Recorder: Carliane Johnson, SeaJay Environmental LLC

Welcome and Administrative

- **Introductions and Determination of Quorum [Clarence Fullard, Bureau of Reclamation (Reclamation)]** A quorum was reached with 20 members or alternates in attendance.
- **Adoption of Prior Meeting Minutes [Ryan Mann, Arizona Game and Fish Department (AZGFD]** On Page 14, under Emerging Issues, request is made for the following (underlined) addition: "It will be one of the management actions considered." **[Michelle Garrison, Colorado Water Conservation Board (CWCB) and TWG Vice-Chair]** Minutes adopted with that change.
- **Next Meeting Date(s): June 15-16, 2022 [Michelle Garrison, CWCB and TWG Vice-Chair]** This meeting will still be virtual.
- **Ad Hoc Group Membership and Updates [Michelle Garrison, CWCB and TWG Vice-Chair]** Respond to Tara Ashby and Clarence Fullard with any changes to membership.
- **Review Action Items, Motions, and Votes Form [Kelly Burke, Grand Canyon Wildlands Council (GCWC)]** Recommend that GCWC, Lonnie Pilkington, and others could present an update at the June meeting on the Paria Beach restoration **[Michelle Garrison, CWCB and TWG Vice-Chair]** Kerri Pedersen, Reclamation, provided a link to the Southwestern Willow Flycatcher report.
- **Update on Program Funding [Lee Traynham, Reclamation]** The omnibus bill was signed in March, which includes appropriated funds for the program this fiscal year (FY), and not from hydropower revenues.
- **Possible Experimental and Management Actions in the Next 12 Months [Lee Traynham, Reclamation]** A decision is expected this week on implementing the bug flow experiment for 2022, which would begin in May.
- **Update on Activities Impacted Due to COVID-19 Restrictions [Mike Moran, Grand Canyon Monitoring and Research Center (GCMRC)]** GCMRC has not had any impacts to field work since beginning of this fiscal year. Currently at 50% capacity in the office, but should be almost at full capacity by end of May. **[Ryan Mann, AZGFD]** Starting to consider a return to offices but no impact has occurred to work.
- **Stakeholder River Trip July 13-22, 2022 [Clarence Fullard, Reclamation]** The dates are set and a roster is being developed. Contact Lee Traynham and Clarence Fullard if interested.
- **Update on Monitoring and Research Trips to Occur From Today Until Next Meeting [Mike Moran, GCMRC]** Presented a river trip table with the blue color highlighting upcoming trips and the orange color is for upcoming tribal trips. **[Brian Healy, National Park Service – Grand Canyon National Park (NPS-GCNP)]** Have potentially four trips in cooperation with US Fish and Wildlife Service (USFWS) and GCMRC that may involve larval chub collection from the Little Colorado River (LCR), a Havasu

Creek monitoring trip, a Bright Angel Creek hoop monitoring trip, and an inflow monitoring trip near the translocation site of the Colorado River.

Update on Hydrology, Glen Canyon Dam Operations, and Water Quality Conditions in Lake Powell and Below Glen Canyon Dam

[Heather Patno, Reclamation] Starting to see some increase in storage with early snow melt. With current reservoir conditions, Lake Powell is contributing 60% when it is normally at 80% of total storage. Lake Powell elevation is below the critical level of 3,525 feet, but an increase is anticipated with the early snow melt in May. Fall soil moisture conditions have improved from last year, but they remain below normal. The precipitation outlook initially suggested conditions would be cool and dry, but it is now looking to be warm and dry, which will further erode the snowpack. This year might fall into the driest five years based on the conditions. The 24-Month Study is expected to be published this week, which includes Drought Response Operations Agreement (DROA) release volumes and adjustments. The Drought Response Operations Plan is to be finalized in May 2022. The modeling runs for projections in Water Year (WY) 2023, the outage schedule, and the hourly release pattern were also shown.

[Robert Radtke, Reclamation] Temperature trends from March 2021 to March 2022 were provided. The model is being tweaked to run at the lower water levels, and is currently not working so no projections are available.

Q&A and discussion

[Michael Moran, GCMRC] What is minimum power pool in Lake Mead? **[Heather Patno, Reclamation]** Believe that is 950 feet. Will check but water levels will not go below minimum power pool at Lake Mead. **[Charlie Ferrantelli, State of Wyoming]** Is it standard operations and maintenance practice to have two units out at the same time? **[Heather Patno, Reclamation]** That is standard practice. Have discussed the possibility of taking only one unit, but each transformer is a paired unit so try to schedule them together. Can talk to maintenance about taking only one down at a time if that is needed. **[Kelly Burke, GCWC]** Did the Secretary call for lowering the annual release volume? **[Heather Patno, Reclamation]** No decision has been made. The Secretary has sent correspondence to the seven basin states asking for further discussion of decreasing the annual release volume to 7-million-acre feet (maf) in WY22.

[Ryan Mann, AZGFD] How do the inflows last year compare to previous inflows? Could this get larger in future years? **[Robert Radtke, Reclamation]** It depends on what is available. As the reservoir drops, it exposes that sediment primarily in the inflow river. It depends whether the sediment gets washed out during one event or not. If there is a big inflow event in the spring, there is a high probability of it getting to the outflow. If the water levels are higher, then this would make it less likely for sediments to get entrained. Whether the dissolved oxygen (DO) plume gets larger in future years depends on how big the inflow event is and whether the reservoir levels are higher to cover the sediments. Something similar happened two years ago but never made it to the dam.

[Steve Hollenback, Reclamation Technical Services Center (TSC)] This presentation focused on the current monitoring at Lake Powell, forecasting ability, and potential tools for assessing low DO. There is already significant monitoring occurring, but the model could be better calibrated if a vertical profile were available to continuously monitor DO at the penstock. Managing DO is possible at many sites, but

it is not viable at Glen Canyon Dams. Several tools and their attributes are also being considered. A draft of the report should be available around the end of June.

[Clarence Fullard, Reclamation] A motion was made at the February Adaptive Management Work Group (AMWG) meeting for water quality studies at Lake Powell. Reclamation is working with GCMRC to develop a scope of work (SOW), which would include DO modeling efforts.

Q&A and discussion

[Ryan Mann, AZGFD] Does the DO state-of-practice draft report include the risk assessment that was funded? **[Clarence Fullard, Reclamation]** The report will not include the risk assessment work. It will include 1) synthesis of low DO issues at other Reclamation facilities and non-Reclamation facilities, 2) An assessment of current monitoring methodology and infrastructure at Lake Powell, and 3) recommended potential mitigation tools for low DO events at Glen Canyon Dam based on information obtained in steps 1 and 2. **[Bill Davis, Colorado River Energy Distributors Association (CREDA)]** What happened to the extensive competition to develop ways to improve water quality releases? **[Clarence Fullard, Reclamation]** In March 2020, Reclamation contracted with the company, Yet2, to complete a Technology Search to explore innovative water temperature control devices. Reclamation received and reviewed the report 2021, but none of the options were clearly applicable to Glen Canyon Dam. This will be provided to the TSC to determine if it contains anything that could be useful for mitigating DO.

Smallmouth Bass – Lessons Learned from the Upper Basin and Status of Control Efforts

[Kevin Bestgen, Colorado State University (CSU)] that described the history of smallmouth bass and their distribution in the Upper Colorado River Basin. Studies show the predatory nature of smallmouth bass and how their abundance affects management efforts. Only in very high flow years is bass reproduction noticeably decreased, although it is still high. Smallmouth bass impact Colorado pikeminnow and humpback chub populations. Large-scale removal efforts in some reaches are believed to help reduce bass abundance, but they remain resilient. Findings from the spike flow experiment were presented. This experiment occurred in the Green River in 2021 to impact larval stages of bass by increasing water velocity, but preventing colonization is the best management practice that could be employed.

Q&A and discussion

[Brian Healy, NPS-GCNP] Gizzard shad have been seen below Glen Canyon Dam. What is the potential for bass to establish there? What is happening with the plan to re-establish chub in the Green and Yampa rivers? **[Kevin Bestgen, CSU]** It is likely that bass will occur in abundance in the Grand Canyon given the trajectories of temperature with declining flows. Regarding the plan to re-establish chub, no introductions have been attempted to date but a brood stock is being established. The bass population would be a deterrent to any native species. **[Phaedra Budy, Utah State University (USU)]** While there is a compelling argument for flow, is there any evidence of a decrease after mechanical removals? **[Kevin Bestgen, CSU]** They are probably effective enough, but then warm, low flow years override everything. There could also be compensatory spawning after nests have been destroyed, but that was not seen.

[Craig Ellsworth, Western Area Power Administration (WAPA)] How was the distribution of the expected hatching dates developed? **[Kevin Bestgen, CSU]** This is an average distribution based on nine years of data from the Green and Yampa rivers. **[Bill Persons, Fly Fishing International (FFI)/Trout**

Unlimited (TU)] One of the management tools in Grand Canyon is using high flow experiments to move sand to the middle of the channel. Could that be used to bury smallmouth bass nests? **[Kevin Bestgen, CSU]** A couple of flow spikes could be very effective if there is good information about the timing of reproduction and being able to predict this carefully because it is relatively short. This could be effective by flushing young bass from their nests and disturbing the adults. This is a species that is very tied to temperature regimes. There is good data on their thresholds. **[Kelly Burke, GCWC]** Are the lower parts of the canyon already colonized? If not, what is the best tool to prevent it? Is mechanical removal effective? Would the increase in crayfish populations affect the bass populations? **[Kevin Bestgen, CSU]** Where humpback chub can spawn, bass can spawn. Preventing colonization involves keeping fish from moving into the reach and having environmental conditions that prevent reproduction. Bass are very susceptible to electrofishing because of low velocity habitat where it is warm. In the Yampa River where bass ate so many native and non-native fish that not many were left, it is believed that crayfish provided the subsidy that bass needed to make it through those lean years. Refer to Martinez and Johnson on the crayfish studies. **[Ryan Mann, AZGFD]**] Observations of smallmouth bass in 20 years of the long-term monitoring done in Grand Canyon (from Lees Ferry downstream) are rare (observations in 2005, 2006, 2021). However, we do occasionally contact smallmouth bass in our Lees Ferry monitoring (Lees Ferry upstream to Glen Canyon Dam), as far back as 2011 in the sampling, but this is typically one or two individual adults a year. Cold water releases seem to have acted as a buffer for establishment as we do not observe young bass, but changing water temperature is increasing the risk to establishment. **[Kevin Bestgen, CSU]** Bass seem to be very adaptable, and it does not take much to get them established, which will be very difficult to deal with. **[Kirk Young, USFWS]** No bass have been found in the Little Colorado River (LCR), but they are in the LCR headwaters. **[Brian Healy, NPS-GCNP]** Mechanical removal could be effective, but the scale needed would be very difficult versus a flow spike. Also, may not have the equipment to mount a response.

An Update About Non-Native Fish Studies in Lake Powell

[Phaedra Budy, USU] The stimulus for this project was on how the differences in lake elevation would affect fish entrainment at the dam. Historically, warm water occurred far above the penstock. Current temperature conditions and lake levels have resulted in lowering this warm layer to just above the penstock where non-natives could get through the dam. Initial sampling results and next steps were presented.

[Mike Horn, Reclamation] Presented on hydroacoustic fish distribution and how the data are analyzed to obtain size of fish, water depth, location coordinates, etc. Most of the sampling is also done at night when fish are more spread out and actively feeding in the water column. The species cannot be determined but many of them are likely shad. Graphics were presented showing the distribution of fish surrounding the thermocline.

Q&A and discussion

[Clarence Fullard, Reclamation] Are the graphs combined for all sites or just the forebay site? **[Mike Horn, Reclamation]** These slides are the forebay. In the fall, Wahweap had a lot of fish that was in the slide to justify why night sampling is done. Believe a lot of those fish will then move into deeper water and will not be detected.

[Connie Svoboda, Reclamation] PRESENTATION on Glen Canyon Dam fish exclusion options to prevent passage of non-native fish. The focus is on longer-term options, including physical exclusion and behavioral barriers, and how these devices and techniques can be scaled for Glen Canyon Dam. Example case studies were also discussed. A report on the findings will be completed in the fall.

[Bill Persons, FFI/TU] Glen Canyon Dam has Francis Turbines, but the understanding of those is that they are fish friendly. **[Connie Svoboda, Reclamation]** Survival potential is an important piece that still needs to be done to determine how they might limit fish movement. **[Charles Yackulic, GCMRC]** Drew Eppehimer has been doing a literature review on this and can help provide information. **[Jim Strogen, FFI/TU]** Is the greater concern from a larval fish or an adult fish getting through? **[Charles Yackulic, GCMRC]** The literature suggests that smaller fish do not survive the pressure drop while big fish are more likely to hit a turbine. It tends to be the mid-sized fish (100 to 400 millimeters) that are most likely to make it through. **[Melissa Trammell, NPS]** Are the options considering speed of installment in case something is needed very quickly, for instance, a bubble curtain? **[Connie Svoboda, Reclamation]** Have not seen a bubble curtain that can be suspended in the water column. Would be interested to hear if anyone knows of this. **[Charlie Ferrantelli, State of Wyoming]** What kind of maintenance is required for these devices and how long do they last? **[Connie Svoboda, Reclamation]** One net was installed for three years, but there had been noticeable deterioration. The longevity of some other nets might be ten years. They would require quarterly maintenance with divers. **[Jim Strogen, FFI/TU]** Would a bubble curtain affect DO? **[Connie Svoboda, Reclamation]** Don't think it would but will ask that question to the manufacturers. **[Mike Horn, Reclamation]** Hypolimnetic aeration generally is not trying to get a bubble plume to the surface because that would waste oxygen. There is a risk it could cause mixing that might not be wanted from deep in the reservoir. It could also cause nitrogen super-saturation problems downstream of the dam. Some fish such as larger striped bass will swim right through bubble curtains. **[Helen Fairley, GCMRC]** Would the potential for quagga mussel infestation on these devices be factored into the options? **[Connie Svoboda, Reclamation]** That was not considered but it is a very valid point.

Discussion About the Near-Term Threat of Smallmouth Bass Establishment below Glen Canyon Dam and the Team Organized to Better Understand the Threat and Explore Mitigation Opportunities, and a Discussion About the Non-Native Aquatic Species Control Actions Available to the National Park Service

[Kirk Young, USFWS] PRESENTATION on why smallmouth bass are not established in the Grand Canyon, but exist elsewhere. There are 22 records of smallmouth bass in the canyon, the first time in 2003. **[Charles Yackulic, GCMRC]** One of the key questions we are exploring is how reversible a smallmouth bass invasion would be. There are several possible scenarios and how reversible each is depends on how quick the response occurs. A conceptual model was used to understand the entrainment risk and then develop a probability of establishment in Lees Ferry. The model was fit to the March 24-Month Study, which shows a decent probability of smallmouth bass becoming established under the minimum and most probable forecasts. Being able to quickly respond to a small-scale presence of smallmouth bass may buy some time. Some of that depends on where things are going in terms of lake elevations and infrastructure. Prevention is where we need to put our time and effort.

Q&A and discussion

[Rob Billerbeck, NPS-GCNP] What were the assumptions on annual volume and DROA for this summer? What are the costs or efficiencies to flow-based options for lowering temperatures this year versus waiting a couple of years? **[Charles Yackulic, GCMRC]** The assumption for the first hypothetical scenario was an increase of the amount of water in Lake Powell by 1 maf. Don't know the exact costs of the scenarios, but generally for invasive species, a dollar spent early in the process is worth a hundred dollars later in the process. **[Larry Stevens, GCWC]** What is the relative value of more high flows? **[Charles Yackulic, GCMRC]** The high flow option has a lot of other resource benefits, as well. A well-timed spring disturbance, such as around June, could be another management tool, but do not know if it would delay spawning. It is an option to consider further. **[Jim Strogen, FFI/TU]** Do you see controlling flow as a management tool given low lake levels, DROA, and other considerations? [**Clarence Fullard, Reclamation]** This is just starting to be discussed along with the different options.

[Rob Billerbeck, NPS-GCNP] Presented on NPS's rapid response compliance tools that are available for high risk, invasive fish concerns. The efficiencies of the tools were discussed, which can be affected by the condition of the system. If the fish come through and start breeding, a rapid response can be initiated but it needs to be done sooner rather than later. Probably also need to consider multiple tools and not only one rapid response. The tools that NPS can use (including mechanical, physical, biological, and chemical) are in plans that are based on a ranking of risks with the highest species being smallmouth bass (#1), walleye, green sunfish, and striped bass. There is concern about fish passing through, but the populations are not high enough to start a rapid response. However, the need might arise by this summer. A list of rapid response tools was shown but these are not the only ones and funding is needed to carry them out.

[Ryan Mann, AZGFD] Green sunfish of all age classes are contacted, which may suggest fish of all sizes can pass, but don't know what the relative probabilities for survival would be. **[Phaedra Budy, USU]** We are hoping to look at river walleye otoliths for microchemistry or differences in growth ring widths to try and determine origin. **[Ryan Mann, AZGFD]** Our crews typically sample a handful of Walleye each year, typically directly below the dam. We can save otoliths if we aren't already. **[Drew Eppehimer, GCMRC]** There is one study on bluegill survival through Francis turbines that found an average survival of 57% (Bohr J.R., Sundquist M.J. 1991. Fish entrainment and mortality at the French Landing hydroelectric powerhouse. Hydropower '91: International conference on hydropower, Denver, CO). **[Bill Davis, CREDA]** Are smallmouth established below Flaming Gorge Dam where brown trout are plentiful? If not, are brown trout a possible control method below Glen? **[Kevin Bestgen, CSU]** Smallmouth bass are not directly downstream of Flaming Gorge because it is too cold. Yes, brown trout are abundant there and downstream in Lodore Canyon where it is warmer, where smallmouth bass already exist. Trout did not control bass there after bass arrived, nor should they be expected to. Adult bass are not in the body size predation window (too large) and trout and bass likely do not overlap enough in habitat use for trout to have much of an effect; younger bass live in low-velocity backwaters and channel margins where large piscivorous trout do not occur. Further, there are few/no instances in the literature where a bass population was controlled or reduced by another predator, in spite of broad overlap with species such as northern pike and walleye. In fact, in many northern lakes, bass are increasing to the detriment of species such as muskellunge and walleye, in part due to climate-induced warming. **[Brian Healy, NPS-GCNP]** There are also many green sunfish below the dam now. **[Jessica Neuwerth, Colorado River Board of California (CRBC)]** Are green sunfish passing through the dam, or is this an expansion of the existing population? **[Brian Healy, NPS-GCNP]** Many are upstream of the slough by a couple of miles, but it is

unclear where they came from. **[Ryan Mann, AZGFD]** Were the green sunfish detected from the Trout Recruitment and Growth Dynamics (TRGD) sites? **[Charles Yackulic, GCMRC]** All or almost all, are from Brown Trout Early Life Stage (BTELS) and almost all were found upriver from the slough. **[Kim Dibble, GCMRC]** Green sunfish were detected during the last BTELS trip. Usually they catch 1-2 per trip, last trip it was 13 that were largely concentrated in 2 areas. **[Ryan Mann, AZGFD]** AZGFD only detected one in our spring trip, but that trip does not include our targeted non-native sites in the summer and fall. **[Brian Healy, NPS-GCNP]** Twenty-six of 36 green sunfish reported this fall were upstream of river mile -12.

Tabletop Exercise to Explore Information and Management Gaps, Part 1 of 3

Statement of Exercise Purpose: A real possibility exists that future discharges of water from Lake Powell through Glen Canyon Dam could have temperatures, water chemistries (e.g., dissolved oxygen levels), and/or entrained non-native fishes that could affect the aquatic ecosystem below the dam. The purpose of the exercise is to help the Technical Work Group (TWG) identify areas of potential importance to the Adaptive Management Work Group (AMWG), concerning: (a) possible agency responses to such introduced conditions below the dam and (b) possible roles for the AMWG and its TWG in the decision-making process for such responses.

TWG members considered the following scenario and had breakout discussions to discuss their thoughts on how to understand and react.

Scenario: *It's April 12, 2023. AZGFD has captured 12 reproductive-age adult smallmouth bass in Glen Canyon and 25 adult and juvenile green sunfish in the lower slough at RM 12 and observed additional green sunfish in both the upper and lower sloughs. Lake elevation at the dam is 3,510' where it has stood for five weeks; and mid-channel water temperature at Lees Ferry is 10C.*

The tabletop exercise was documented in a separate report and will be available on the TWG site along with these meeting minutes.

Public Comment

No public comment.

Meeting adjourned at 4:04 PM

GLEN CANYON DAM ADAPTIVE MANAGEMENT PROGRAM
TECHNICAL WORK GROUP MEETING
APRIL 12- 13, 2022

Day 2: April 13, 2022
Start Time: 8:30 AM PDT
Conducting: Michelle Garrison, TWG Chair
Meeting Recorder: Carliane Johnson, SeaJay Environmental LLC

Welcome and Administrative

- **Introductions and Determination of Quorum** [**Clarence Fullard, Reclamation**] Quorum was reached with 22 of 25 groups represented.

- **Unresolved Issues from Yesterday's Meeting [Michelle Garrison, CWCB and TWG Vice-Chair]** No unresolved issues.

Tabletop Exercise to Explore Information and Management Gaps, Part 2 of 3

The facilitators for each of the 3 breakout groups provided a summary of the discussions that occurred in each group regarding the scenario. The discussion below was a reaction to those conversations. The tabletop exercise will be formally summarized in a report by the Science Advisor, which will be distributed in the future to the TWG.

Discussion

[Bill Davis, CREDA] There is no law that says rainbow trout needs to be protected in the Lees Ferry area, but there is a law that says humpback chub will be protected under the Endangered Species Act (ESA). Would this be dealt with under the ESA as a priority for humpback chub or is protecting rainbow trout a priority? That needs to be part of the discussions. **[David Braun, Sound Science]** That was included in the discussion. Rob Billerbeck's presentation from yesterday point this out that all the laws need to be addressed. **[Rob Billerbeck, NPS-GCNP]** Would encourage everyone to look at the Comprehensive Fish Management Plan (CFMP) goals and actions, and the expanded non-native plan. As a federal agency, there is planning to get compliance on proposed actions. This river requires interactions with others and there are federal and state interactions. In terms of goals and federal compliance, these are clearly laid out in the process. The only thing is the timeline is probably moving faster than we would like. **[David Braun, Sound Science]** If TWG members would like to be better informed of the legal requirements, this could be a topic of a future presentation. Many of these are also posted on the Glen Canyon Dam Adaptive Management Program (GCDAMP) wiki page. **[Bill Davis, CREDA]** The legal sideboards are the first priorities. **[David Braun, Sound Science]** Recommend reviewing GCDAMP on the governing requirements and the other plans mentioned from the NPS.

[David Braun, Sound Science] Do we endorse prevention as a first priority? **[Clarence Fullard, Reclamation]** That was Group 1's consensus. **[Bill Davis, CREDA]** One thing that was brought up by Kevin Bestgen was cold water. We have the ability with different lake levels to create a cold-water situation below the dam, which is not good for smallmouth bass. This could mitigate the problem if reservoir levels go up. **[Larry Stevens, GCWC]** Regarding the management sideboards, went through this during the high flow experiment last March. That process could be informative and could clarify the constraints. Low flows, perhaps lower than 5,000 cubic feet per second (CFS), which used to be common, could be used to lure smallmouth bass to spawn, then a drop in the flow could be used to desiccate the eggs. **[Charles Yackulic, GCMRC]** This could happen this year, but also would not be surprised if it happens three or more years out. If groups do not have the tools now, there might be time to do it over the next few years. It is good to know the legal sideboards, but it should not define what might happen in future years. **[Ben Reeder, Grand Canyon River Guides (GCRG)]** If flows below 5,000 CFS are being considered, this could have a big impact on river trips, which needs to be known. **[David Braun, Sound Science]** It is important to note there would be a number of tradeoffs with low flows including power generation and water storage management.

[David Braun, Sound Science] What are the big knowledge gaps? **[Larry Stevens, GCWC]** Confidence in the monitoring data because we don't know the impacts of these non-natives on the canyon**. [Shana Rapoport, CRBC]** Would like to understand more about AMWG's role in the decision making, how we

collaborate, and who has the different authorities. **[David Braun, Sound Science**] This came up in some of the groups. How will AMWG be involved in dam operations? **[Michelle Garrison, CWCB and TWG Vice-Chair]** TWG may study the technical aspects with recommendations to AMWG with recommendations to the Secretary, so there is uncertainty about how the TWG sets priorities, how it can be proactive, and how they can interface with all different agency decisions and processes. This is a topic of discussion and no clear resolution. There is a desire to set priorities. What can the TWG do? **[Rob Billerbeck, NPS-GCNP]** The AMWG and TWG fall under the Federal Advisory Committee Act (FACA) rules, so they are not decision-making bodies; they provide recommendations to the Secretary of the Interior. There are also shared responsibilities with the state and a lot of other federal agencies involved. There are consultation steps with the AMWG, but the federal agencies make the decisions in consultation with the tribes. **[Lee Traynham, Reclamation]** One thing to add is that information flows both ways. Interior recognizes we are in extended drought with impacts that might not have been seen in the past. As decision points come up, Interior is making sure to reach out to groups like the AMWG to solicit input on those critical decision points. What is being discussed today is what happens when a concern is seen in the data. These groups help to make sure that the managers and others know a problem may be coming and to help get that information into the planning activities. **[Kelly Burke, GCWC]** It is still unclear how well the TWG is meeting the provisions of the Grand Canyon Protection Act. This is also going on under the group's purview from an advice standpoint under FACA for meeting the goals of the Grand Canyon Protection Act. How is that done under DROA? **[David Braun, Sound Science]** This will be noted as an area that needs more clarity.

[David Braun, Sound Science] How much concern is there about the speed to which decisions need to be made or can be made during an emergency? **[Rob Billerbeck, NPS-GCNP]** NPS is still coordinating but would not envision a timeline of a year. Would anticipate more rapid actions. Those conversations are happening now. **[Brian Healy, NPS-GCNP]** The decision-making process should be rapid; it is the logistics that are limiting. It is important to find a solution. **[David Braun, Sound Science]** Does the NPS have authority now if monitoring crews were to encounter a non-native species that is a threat to humpback chub or green sunfish? **[Rob Billerbeck, NPS-GCNP]** Incidental removal of non-natives is an ongoing action that is included in the CFMP to do a rapid response. **[David Braun, Sound Science]** How fast would it take Reclamation to review Connie Svoboda's findings and make decisions about preventive measures with the dam? **[Clarence Fullard, Reclamation]** It is probably a large infrastructure solution. Part of the work with the TSC is to find out what can be done. Connie's report will provide a ranking of options, which will be available this summer. Some of the ideas could be very expensive and require a lot of compliance. It is hard to speculate.

[David Braun, Sound Science] Do we know the actionable threshold conditions needed to take action? **[Charles Yackulic, GCMRC]** A lot depends on how bad things are at that moment. If there are six to eight captures in a year, then the threshold has been exceeded. If there are three to four captures, then that is more uncertain and may not mean that the threshold has been reached. **[David Braun, Sound Science]** Should the action triggers be defined? **[Ryan Mann, AZGFD]** It is hard to define the thresholds because it depends on the conditions for establishment. Prevention methods include maintaining the conditions from years past (low temperature being the best). Some of the environmental conditions or temperature thresholds should be discussed in how they relate to risk of establishment. **[Pilar Wolters Rinker, USFWS]** There are areas at Lees Ferry that are already suitable for smallmouth bass to spawn. **[Melissa Trammell, NPS]** NPS-GCNP will be installing a thermograph in the slough to monitor

temperature. If there is any kind of young-of-year or sign of reproduction, that would be an immediate trigger for some kind of response that needs to be defined. **[Ryan Mann, AZGFD]** The probability of detection is high with existing monitoring techniques; it is whether there are effective responses. It depends on the scope whether monitoring is enough to meet detection. It could take infinite resources to detect 99% of the fish within one week of establishment. We need to maximize the probability of detection and do that in the time that a rapid response will be effective. **[David Braun, Sound Science]** That argues for a specific design. **[Ryan Mann, AZGFD]** There is targeted monitoring such as at Lees Ferry where conditions are known, but this involves one or two trips per year to specifically target those areas. Don't know if that is enough time to ensure rapid detection and response. Don't have the same level of monitoring downstream and there are many more suitable habitats that exist now for warmwater fish to establish.

[David Braun, Sound Science] What other effects in the ecosystem are of concern in addition to low flow and boating activities and unnecessary taking of life? **[Kurt Dongoske, Pueblo of Zuni]** There are larger historical issues that impact Pueblo of Zuni. One is how science has been used in the past that harmed Zuni's traditional way and the environment such as farming practices and changes to Zuni waterways. It seems that AMWG decisions always prioritize science over Zuni knowledge. Have tried to explain this over the past ten years. It is concerning that we are still not discussing the emotional, psychological, and spiritual effects on a traditional community. What is the ethical responsibility of scientists when those actions have disproportionate effects? The scientists are not unbiased because they are influenced by the laws and this program funds their research. **[Brian Healy, NPS-GCNP]** Don't know the answer to those ethical questions but wish there was a different way to maintain native fish without killing non-natives. Don't know what the solution is and would welcome ideas to prevent extirpation of native fish from Grand Canyon. **[Charles Yackulic, GCMRC]** Have tried to find solutions that do not default to mechanical removal and other taking of life, in part because of the ethical considerations, and also because they are not effective a lot of the time. Translocations are one way to avoid mechanical removal. Part of the reason for working on aquatic vegetation in Lees Ferry is as an alternative to the direct taking of life. One of the things the smallmouth bass task force is thinking about is how to prevent large numbers of smallmouth bass to avoid huge amounts of mechanical removal. **[Helen Fairley, GCMRC]** Consultation is underway on how to deal with these non-natives and prevention is the main thing as well as the idea to maintain conditions that are not conductive to creating habitats. If we are proactive now, that may eliminate lethal means in the future.

Tabletop Exercise to Explore Information and Management Gaps, Part 3 of 3

Discussion topics:

- How can the TWG be a responsive asset and resource to the Glen Canyon Dam Adaptive Management Program in an emergency resulting from introductions of non-native fishes or altered water quality conditions from Lake Powell into the Grand Canyon ecosystem?
- What barriers or inhibitors could prevent the TWG from responding effectively to such an emergency?

Q&A and discussion

[Larry Stevens, GCWC] The GCDAMP process is not able to deal with rapid changes or to respond to crises. **[Leslie James, CREDA]** In the Information and Education Committee, there was a discussion about

how to address immediate or short-term information. It was determined that short turnarounds need to be addressed by the federal agencies. **[Laura Dye, Colorado River Commission of Nevada (CRCN)]** Given the likelihood for this exercise to happen in the near future, what can TWG do to minimize these impacts? Is there a pool of funds for exclusion strategies at the dam or are there certain personnel or groups that have the capacity to handle a solution? Being proactive is going to be worth it in the long run. We can set the stage for this. **[Larry Stevens, GCWC]** Have recently established a subcommittee to learn about changes in the ecosystem on a monthly basis, but the ability to respond is months to years. **[David Braun, Sound Science]** Would the ideas about being proactive or having a more holistic view, involve a framework for stewardship? **[Laura Dye, CRCN]** This means setting the stage and doing the research now and investing in feasible options in a holistic framework. It is hard to do, especially with the current hydrology, but it is an important asset to the program. **[Sinjin Eberle, American Rivers]** The TWG has an opportunity to work with the scientists to emphasize different viewpoints and then synthesize the strategies to advise the AMWG to either mitigate damage or improve the ecosystem. **[David Braun, Sound Science]** The TWG could also support system-wide planning and management. **[Sinjin Eberle, American Rivers]** There are many who are looking at the system with a specific lens and pulling all those elements together. The TWG can help make the connections. **[David Braun, Sound Science]** Would it be helpful to learn more about the Upper Basin to inform decisions? **[Larry Stevens, GCWC]** That program is informative of what to expect downstream, but it also has a lot of experience on how to deal with non-native fish. More information would be great. There is also the downstream story with the Multi-Species Conservation Plan (MSCP) with respect to stocking and fisheries. **[David Braun, Sound Science]** The Colorado River Aquatic Biologists (CRAB) meeting is another. **[Ryan Mann, AZGFD]** We attend the meeting, but it has not happened in a couple of years. **[Kelly Burke, GCWC]** Is there any way to address the timeframes of decisions from the GCDAMP and emerging issues? Can we establish a more accelerated meeting process to make recommendations align with this effort to deal with emerging crises? **[Lee Traynham, Reclamation]** Current noticing requirement for having a formal AMWG meeting is to publish the notice in the Federal Register at least 15 days before the meeting, but that notice has to get Department clearance, which usually takes several weeks and sometimes longer. There is no restriction on information exchange outside of these formal meetings. **[Kelly Burke, GCWC]** Suggest that information dissemination be tracked by the Steering Ad Hoc Group because they meet more frequently.

[David Braun, Sound Science] TWG members will receive a link to a Google form survey about the content of the exercise and about how the exercise was conducted. Will also incorporate the conversations from the breakout sessions and the information in the chat.

Informational Updates

- **Long-Term Experimental and Management Plan Biological Opinion Conservation Measures**

[Kerri Pedersen, Reclamation] Reclamation's letter of sufficient progress update for 2021 to the USFWS was submitted and is on the webpage. GCMRC provides the humpback chub estimates, which were 11,000 adults for 2021, 1,426 for the 3-year average of subadults in the LCR in the spring (which is not below the trigger but may be by next year), and 433 for the 3-year average of subadults in the mainstem along the Juvenile Chub Monitoring (JCM) reach in the fall (which is below the trigger). Runoff seems to be tied to recruitment success. Based on the gauges in the LCR, runoff this year does not look good for spawning success. The USFWS has a river trip next week and conservation actions for this year will be

identified after that trip. **[Charles Yackulic, GCMRC]** There was a flood recently on the LCR. Optimistic this will be enough.

- **Rainbow and Brown Trout Status and Rainbow Trout Management Actions in Lees Ferry**

[Ryan Mann, AZGFD] Presentation on the spring river trip that was conducted from March 8-12, 2022. Seeing comparable numbers from 2021 in which rainbow trout abundance is still at its lowest levels of abundance that have ever been seen. There was a slight increase in brown trout abundance, which now represents about a third of all fish species at Lees Ferry. For non-natives, one green sunfish was caught close to the dam and a common carp was caught in the lower slough area. Also observed a gizzard shad regurgitated from one of the larger brown trout that had been caught. Higher numbers of non-natives are generally seen in the summer and fall. Creel results from January to March 2022 are below the management plan metric for this fishery of one fish per hour. In the angler surveys, more than 95% had heard about the incentivized harvest program and about 50% would be willing to participate. Future projections are concerning for the rainbow trout population from low DO in the fall that would impact the first five miles below the dam, which is one of the most important areas for the fishery. There are concerns about increasing temperatures related to the establishment of non-natives, but it is also impacting the fishery.

[Jim Strogen, FFI/TU] Regarding numbers of brown trout versus rainbow trout, are brown trout making up a third of the trout population right now? **[Ryan Mann, AZGFD]** Brown trout are a third of the trout population [relative abundance]. The higher percentage of species composition is related to the low abundance of rainbow trout. There was also a slight increase in relative abundance from last year. **[Brian Healy, NPS-GCNP]** It is tricky to calculate species compositions. Has the capture probability been looked at? [**Ryan Mann, AZGFD**] There are likely some differences, but the two trout species are comparable. **[Charles Yackulic, GCMRC]** For the biggest size classes, they are relatively similar. Probably more likely to catch rainbow trout than brown trout for the mid-size classes. More likely to catch brown than rainbow for the smallest size class. It depends on the time of year, too. **[Josh Korman, Ecometric]** There are mark-recapture models available for brown trout, and another model from the TRGD reaches, that both show brown trout numbers going up. The TRGD talk addresses catch ratios.

- **Aquatic Vegetation Removal Project Status in Lees Ferry**

[Charles Yackulic, GCMRC] There is evidence that brown trout may be using pond weed (*Potamogeton*). The idea is to remove that habitat to disadvantage brown trout and it does not involve taking of life. Have had preliminary conversation with NPS and will be meeting with AZGFD this week. GCMRC is interested in testing the hypothesis that brown trout catch is strongly linked to particular vegetation types. **[Taryn Preston, NPS-Grand Canyon National Recreation Area (GLCA)]** Have developed a preliminary plan and some initial sampling sites to be targeted. One area has pond weed that would be removed in five acres. Getting cost estimates now. Timing would be February to March 2023 with one control site and one treatment site. Will have more information soon to determine whether to pursue funding.

- **Green Sunfish Status and Incentivized Harvest Program Implementation**

[Brian Healy, NPS-GCNP] There has been an uptick in green sunfish captures in the Lees Ferry reach with 36 in total, 26 of which were found upstream of 12-Mile Slough. The only other recent high-risk non-native capture was a smallmouth bass in Pearce Ferry by AZGFD. **[Taryn Preston, NPS-GLCA]** The Park plans to pump out the slough the last week of April and collect the green sunfish, which will be released

into Lake Powell after a two-week quarantine to allow the pass through of any New Zealand mud snails. For the incentivized harvest program, there were 88 brown trout and 19 successful anglers in January, 100 harvested in February with 22 anglers, and 120 harvested in March with 24 anglers. A video on How to Catch a Brown Trout is on the park's webpage, which is also posted as a QR code at Lees Ferry.

Bug Flows Discussion

[Lee Traynham, Reclamation] Presented on the 2022 Bug Flow process for implementation, for which a Department of the Interior (DOI) decision will be available soon.

[Ted Kennedy, GCMRC] Presentation on the purpose of bug flows is to target Goal 2 of the Long-Term Experimental and Management Plan (LTEMP) to restore ecological patterns and processes. Bug flows is trying to restore one aspect of the pre-dam regime flows during a period when macroinvertebrates are laying eggs. These aquatic insects form the foundation that supports many fish species. High flow experiments have been done over the past 30 years. Low, steady flow experiments that targeted juvenile native fish were found to benefit benthic invertebrates, and this framed the knowledge around bug flows. The research is available in a Bug Flows Synthesis report. Also showed updated results after the cessation of bug flows indicating that insect numbers declined. New monitoring methods are proposed for this year.

Q&A and discussion

[Bill Davis, CREDA] The presentation shows an increase in productivity in the food base, but there has been a decrease in the rainbow trout population. What does that mean? **[Ted Kennedy, GCMRC]** Declines in rainbow trout abundance are probably due to predation from brown trout. In terms of effects of bug flows on individual trout, Josh Korman is preparing a manuscript that looked at growth over a 10-year period. Growth appears to be modest and positive. What is confounding is the three years of bug flows were all during low phosphorus years, which constrain potential biological processes. **[Bill Davis, CREDA]** Where on the river do you see the most caddisfly increases? **[Ted Kennedy, GCMRC]** It seems to be systemwide for caddisflies, in general. *Hydrophysche* increases are from River Mile 199 and down, but the *Microcaddis* are increasing everywhere. Since the bug flow experiments, distance from a tributary no longer has predictive power, which suggests that the increases have been systemwide. **[Craig Ellsworth, WAPA]** How did you determine a 25% decline in caddisfly in 2021? The error bars in the chart overlap the means. Was a statistical analysis done? Why were there so many caddisflies in 2021 when bug flows were not done? **[Ted Kennedy, GCMRC]** It was a calculation from 2021 numbers. It could also be said there was no change. Tried not to explicitly link the numbers to bug flows. There were many things that happened in 2021 with multiple good years of egg laying before then and other benefits. There are other factors that complicates interpretation, such as sediment condition and clear water that occurred in 2018, 2020, and 2021.

Bug Flows Discussion (continued)

[Lee Traynham, Reclamation] The Planning and Implementation (PI) Team has been focused on bug flows and resource conditions since February. The technical report was finalized last week, and we just held a Leadership Team meeting. Reclamation is nearing the end of this process. Stakeholder comments were included. Bug flows would not affect weekly, monthly, or annual release volumes. A number of hydrograph alternatives were considered to minimize impacts to hydropower production. There is still a lot of uncertainty about annual and monthly releases for the remainder of 2022. Other resource

concerns include sediment and non-native fish. **[Ted Kennedy, GCMRC]** Bug flows create a slight increase (5-7% of normal) in suspended sediment transport, which is undesirable; however, overall transport is going to be lower in 2022 than other bug flow years. **[Charles Yackulic, GCMRC]** Factors considered included whether bug flows would impact entrainment (not expected) or the suitability of temperature for smallmouth bass (not much). There could be minor benefits to non-natives, but any effect would be small compared to other drivers and they are not a huge concern.

Q&A and discussion

[Craig Ellsworth, WAPA] How much does the nearshore warm up under low, steady flow, conditions? **[Ted Kennedy, GCMRC]** It is less than 1 degree Centigrade (^{0}C). It is in a fact sheet. **[Charles Yackulic, GCMRC]** If the dam is releasing 18-19 ^{0}C of colder water, then 1 ^{0}C higher seems unlikely to push this over the edge. **[Bill Davis, CREDA]** With lower, steady flows predicted this year, would you expect the downstream warming conditions to progress more quickly upstream? **[Charles Yackulic, GCMRC]** How quickly it warms relates more to volume, but the releases matter at the starting point. If there are no DROA releases, some of the hydrological scenarios show a good chance of 22 ^{0}C water coming out of the dam. There will be some warming from going to lower flows for one day, but lake elevations and temperatures are much larger factors. **[Larry Stevens, GCWC]** With warming temperatures this coming year and subsequent years which may lead to human health issues on the river, how will this group react to an outbreak and the need to cool the river? **[Clarence Fullard, Reclamation]** This was an action item previously. The NPS health officer responded to Jan Balsom that they did not see it as an emerging concern. It could be worth getting an update with the current temperature projections. **[Larry Stevens, GCWC]** The question is not necessarily related to bug flows, but bug flows might exacerbate it, or these human health concerns could change the way the dam is managed and affect the experiments.

Bug Flows Discussion (continued)

[Lee Traynham, Reclamation] Presentation on resource concerns include impacts to hydropower and the basin fund status. WAPA projects declines in the basin fund by $83 million by the end of FY 2022 with projected costs ranging from $1.2 to $1.4 million for the three hydrograph scenarios. These are higher than prior year costs. **[Craig Ellsworth, WAPA]** WAPA gave a presentation last fall on these numbers.

Q&A and discussion

[Jamescita Peshlakai, Reclamation Tribal Liaison] A new bat species from Central America/Southern Arizona has been found in the canyon recently. Has any analysis been done related to human health or if they could affect bug flows? **[Brian Healy, NPS-GCNP]** Heard from River Runners about bug flows and cases of rabies. Will check on that. **[Michael Moran, GCMRC]** On the hydropower costs, Craig mentioned these values were coming from a hydropower model. Are these the central values from the output of that model? Can you show the uncertainty values? **[Craig Ellsworth, WAPA]** When Jerry Wilhite, WAPA, does a modeling run, he pulls cost estimate for a particular set of days in the future. Each day has a cost estimate for peak and non-peak times, which can also change over time depending on what is going on in the system. There is not a good way to come up with uncertainty bounds because those are individual point data on a particular day. One project WAPA has with Argonne is to develop this uncertainty. Backcasting is one method that is being looked at to see how close those estimates were. **[Lucas Bair, GCMRC]** A back-of-the-envelope calculation based on last year's peak prices is not close to these

projected costs. Are these solely economic cost or are there other financial considerations included in the estimates? **[Shane Capron, WAPA]** These are financial numbers based solely on hydropower costs and projected prices. Last year, when the bug flow did not occur, the estimate had gone up because costs had gone up. In looking back over that period, those high prices did not materialize. This is difficult to project. The final costs have still not been completed for 2020, but it looks like it will be substantially higher than estimated. That will be a non-reimbursable cost that WAPA will address with the Treasury. The modeling is very sensitive to some of these changes. WAPA is working with Argonne to better capture some of that uncertainty, but these will not be based on typical biological or physical uncertainties.

Bug Flows Discussion (continued)

[Lee Traynham, Reclamation] Reclamation held an informational webinar on March 30 to receive stakeholder feedback on bug flows. Two comment letters were received – recreational anglers supported the experiment and CREDA was opposed. These letters were included in the packages to leadership in the Technical Recommendation Report, which was not a consensus recommendation. Of the 15 members on the PI Team, ten were in support, one was in opposition, two abstained, and two were absent. The recommendations were to 1) conduct the bug flows in 2022; 2) acknowledge adverse effects on hydropower but defer to leadership whether those effects are "unacceptable;" 3) tackle the operations and resources uncertainty by increasing PI Team coordination during the experiment and having the ability to terminate the experiment, if needed; and 4) consider design improvement.

[Helen Fairley, GCMRC] Understanding the effects on bug flows is being done in the context of unprecedented water levels, temperatures, etc. Is anyone assessing the effects of operating the dam given these environmental considerations such as non-natives through the dam or lower temperatures with lower reservoir? Is anyone talking about foregoing hydropower this summer to build up the reservoir elevation to reduce the possibility of releasing non-natives? Even a steady flow would achieve benefits. How are we factoring in current conditions and all these uncertainties? **[Lee Traynham, Reclamation]** We are trying to provide the best information on all these impacts to resources due to drought, low elevations, high temperatures. A lot of the conversation is on keeping higher water levels in the lake, but that comes with tradeoffs and costs. Holding back releases from Lake Mead also has an impact. It is a complex basin-wide challenge to understand the impacts. The LTEMP goals are meaningful when the resources are there to accomplish them. We are now trying to avoid the worst possible effects to resources. There will be tough conversations about those tradeoffs.

Budget Ad Hoc Group – Initial Findings and Status Report

[Craig Ellsworth, WAPA and BAHG Chair] The BAHG held a series of calls from February to March to discuss the program for FY23. The BAHG recommends the following revisions to the FY23 Budget and Workplan:

1. Continue JCM-West (Project Element G.6),
2. Continue TRGD (Project Element H.2) with two sites instead of one,
3. Begin the Grand Canyon portion of the Water Quality Synthesis (proposal in development),
4. Investigate Aquatic Vegetation Removal Pilot in Lees Ferry to reduce brown trout habitat (proposal in development),
5. Continue Sandbar Vegetation Expansion (Project Element C.1) with two surveys instead of one,

6. Consider Streamflow and Sandbar Modeling to include silt and clay (Project Element B.5).

[Michelle Garrison, CWCB and TWG Vice-Chair] This list will be an agenda item at the June meeting to recommend it to the AMWG.

Discussion About Addressing the Adaptive Management Work Group's Motion Directing the TWG to Pursue Water Quality Studies

[Michelle Garrison, CWCB and TWG Vice-Chair] This is to discuss the motion from the February AMWG directing the TWG to evaluate water quality releases from Glen Canyon by conducting a 1) short-term impacts study and a 2) long-term study on infrastructure modifications. The latter study also shows up as bullet item #3 in the list (above) of BAHG prioritizations.

[Larry Stevens, GCWC] The motion text has changed quite a bit since first proposed because it originally was going to include the bypass tubes, but we will get to that analysis. GCWC is satisfied with the language. **[Bill Davis, CREDA]** The parameters are going to be limited. Will it only include temperature and oxygen? Many parameters affect downstream resources. What will they be looking at? **[Michelle Garrison, CWCB and TWG Vice-Chair]** At this point, the scope might be limited for the first study. **[Charles Yackulic, GCMRC]** Can the SOW be shared? **[Clarence Fullard, Reclamation]** The SOW for the downriver portion has been shared with the BAHG. Reclamation and GCMRC have identified SOWs for Lake Powell water quality synthesis that can affect downstream resources. The downstream SOW is currently being reviewed and ranked by the BAHG. The first study with Lake Powell is outside the GCDAMP's purview. The SOWs have not been shared widely but can do that now. **[Charles Yackulic, GCMRC]** This is not about collecting new data. It is about synthesizing data in a way to understand whether low DO events are likely to increase in the future. On the Lake Powell side, the work is focused on making CE-QUAL-W2 (water quality and hydrodynamic model) work better. We also want to get at whether oxygen is biological or chemical. On the downstream side, been thinking about the implications of low DO events, particularly in Lees Ferry, and supporting the smallmouth bass task force and other non-natives. **[Bill Davis, CREDA]** The GCMRC had originally put together a group of experts to identify water quality monitoring needs. Other than the funding issue, why are we ignoring this work and saying this study will be limited to one or two parameters? There is a need to gather the additional information. Is the TWG going to identify the SOW or are we just accepting what GCMRC identifies? **[Michelle Garrison, CWCB and TWG Vice-Chair]** The June meeting is to get to a SOW for the TWG's consideration. **[Charles Yackulic, GCMRC]** Just to clarify, there is a lot of water quality work already being done as part of the existing budget. This motion was more about predicting future conditions. The thought was to start with temperature and DO because that was possible within the scale of a year, and then think of a broader sweep in future work plans. **[Larry Stevens, GCWC]** That is right. We are facing very different conditions the next few years and what happens under those novel changes was the purpose of this motion. Bacteriological studies are also important in this context to understand warmer water effects on the downstream river and disease issues. **[Bill Davis, CREDA]** Would the studies include sediment and turbidity? We still don't know if caddisfly increases are due to clear water or temperature or something else. There are a few things that would benefit from a full-scale water quality analysis. **[Larry Stevens, GCWC]** Have no doubt that GCMRC would consider insects as indictors of water quality. The issue about caddisflies started before bug flows due to clear water, which may expand under low flow scenarios. **[Mike Moran, GCMRC]** Bill may have been referring to the GCMRC Water Quality Panel in 2017, which was focused on the program in Lake Powell. A lot of the recommendations from that

panel were used to develop the upstream SOW that is being considered now such as improving data collections for nutrients and the CE-QUAL-W2 model. The focus of the downstream part is more on temperature and DO effects from lower reservoir levels on non-native fish survival and establishment. **[Clarence Fullard, Reclamation]** A draft SOW and budget had to be developed to identify funding. This is the TWG's opportunity to determine what to include.

Monitoring Metrics

[Helen Fairley, GCMRC] Have been working on the metrics and discussing them with DOI colleagues. Several meetings were held in February and March. An initial draft will be available for the June TWG meeting. We have achieved consensus around the vegetation riparian metrics. **[Emily Palmquist, GCMRC]** Presentation on Goal 11 for maintaining native vegetation. Flow regime is a major driver in riparian systems. Three metrics are proposed: total plant cover, native plant richness, and native to non-native plant ratio.

[Larry Stevens, GCWC] What species will be used for the habitat evaluation process? There is dead and dying tamarisk that is being taken over by undesirables. How will the habitat evaluation be done? **[Emily Palmquist, GCMRC]** That wildlife component in Goal 11 has not been considered yet. Would welcome input. It would take a different style of monitoring to do. Alternatively, we could work with wildlife biologists to identify plants of particular interest. **[Bill Davis, CREDA]** Where do you go with these numbers? Managers need numbers to operate. We need to reach some final point. **[Emily Palmquist, GCMRC]** We don't have targets yet for vegetation. Right now, just tracking increasing and decreasing numbers. Would welcome input on that. **[Helen Fairley, GCMRC]** We were asked to develop metrics on the goals as they are written, which is very general and sometimes difficult to interpret. It is not the role of the scientists to define the targets, but instead come up with the metrics of what is being aspired. The goal statements tend to be about maintaining conditions or increasing conditions, or in some cases, decreasing certain things. The metrics are designed to track those. **[Rob Billerbeck, NPS-GCNP]** There is a Vegetation Experimental and Mitigation Action written into the LTEMP Record of Decision (ROD). The mitigation is for dam operations and the experimental part is trying to determine the most efficient ways to meet the four goals that were written into that action. **[Jamescita Peshlakai, Reclamation Tribal Liaison]** Is there any work to assess vegetation impacts to wildlife? For example, with the hantavirus, it was tied to rodents that were traced back to a decrease in barn cat population and an explosion of coyotes. **[Emily Palmquist, GCMRC]** GCMRC is limited in its wildlife work although there is a group that is working on bats. But habitat needs for bighorn sheep versus mice are very different. This can be considered for the next work plan. **[Larry Stevens, GCWC]** Will share background information on diet and habitat on almost all vertebrates. GCWC also has a dataset on pollinators. **[Michelle Garrison, CWCB and TWG Vice-Chair]** Anyone who can share similar information should send it to Emily.

Discussion of Emerging or Other Issues, Updates on Items of Interest That Are in Consideration for Implementation Before Next TWG Meeting, and Request for Agenda Items for Next Meeting

[Larry Stevens, GCWC] Still unclear about relationship between GCDAMP and DROA. Would like a presentation on this at the next TWG. **[Lee Traynham, Reclamation]** Rod Smith has presented twice on this. It would be helpful to better target where the issues are still unclear. **[Michelle Garrison, CWCB and TWG Vice-Chair]** This has come up in the Upper Basin, as well. The operations under DROA to

protect critical Lake Powell elevations are trying to fit into the RODs and authorities for each of the units. There is information dissemination that goes on but there is not a formal process that is clear for here or the other upper three units for decision making. **[Larry Stevens, GCWC]** What are the options because scenarios will be very different in June. [**Michelle Garrison, CWCB and TWG Vice-Chair**] The first DROA plan will be out around May 1 with recommendations for all the units including Glen Canyon Dam. That information can be shared at the June meeting. **[Ben Reeder, GCRG]** The state of the beaches are the worst seen in 15 years. Would like to have a presentation on the current state of the beaches by the Adopt a Beach Program. **[Ryan Mann, AZGFD]** With concerns about rising temperature and metabolic costs, would like to have Josh Korman present his results. **[Michelle Garrison, CWCB and TWG Vice-Chair]** Can also give a presentation on the report for the tabletop exercise and another item for Lonnie Pilkington on a vegetation update. Another update would include WAPA's study with Argonne. **[Jim Strogen, FFI/TU]** When will we get notice about the bug flow? **[Lee Traynham, Reclamation]** Once the Decision Memo is issued, that will be sent in a package to everyone and it will also be posted on the website. **[Clarence Fullard, Reclamation]** An update from USU will also be provided about their early June trip. **[Kerri Pedersen, Reclamation]** The razorback sucker expert panel report should be done and an update on the highlights could be provided. **[Jamescita Peshlakai, Reclamation Tribal Liaison]** The annual tribal conference is being scheduled for the first week of August. Between now and June, three of the tribes will be going on river trips. **[Bill Davis, CREDA]** Can Kirk Young, USFWS, speak on the possible introduction of the Colorado pikeminnow? **[Brian Healy, NPS-GCNP]** Received a message from the bat biologist. The Arizona bat species is not necessarily new and poses no new impacts to the environment or human health effects. **[Lee Traynham, Reclamation]** Will be stepping down as the GCDAMP Program Manager and starting a new position.

Public Comment

No public comment.

Meeting adjourned at 3:45 PM PDT

TWG Members and Alternates

Cliff Barrett (UMPA)
William "Bill" Davis (CREDA)
William "Bill" Persons (FFI/TU)
Rob Billerbeck (NPS)
Kelly Burke (GCWC)
Carrie Cannon (Hualapai Tribe)
Kurt Dongoske (Pueblo of Zuni)
Laura Dye (CRCN)
Craig Ellsworth (WAPA)
Mel Fegler (State of Wyoming)
Charlie Ferrantelli (State of Wyoming)
Clarence Fullard (Reclamation)
Michelle Garrison (State of Colorado)
Brian Healy (NPS - Grand Canyon)
Leslie James (CREDA)
Kristen Johnson (ADWR)
Jakob Maase (Hopi Tribe)
Ryan Mann (AZGFD)
Scott McGettigan (Utah)
Betsy Morgan (Utah)
Christina Noftsker (State of New Mexcio)
Emily Omana Smith (NPS-GRCA)
Kerri Pedersen (Reclamation)
Shana Rapoport (CRBC)
Shana Rapoport (CRBC)
Ben Reeder (GCRG)
Erik Stanfield (Navajo Nation)
Larry Stevens (GCWC)
Gary Tallman (Northern Arizona University)
Kirk Young (USFWS)

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Zachary Nelson
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Jamescita Peshlakai
Daniel Picard (Acting Designated Federal Officer)
Robert Radtke
Ernie Rheaume
Dave Speas
Connie Svoboda
Lee Traynham

Interested Persons

Patrick Adams (Arizona Municipal Water Users Association)
Colleen Allen (NPS)
Kevin Bestgen (UA)
David Braun (Sound Science)
Rod Buchanan (FFI/TU)
Phaedra Budy (Utah State University)
Kevin Bulletts (UA-SPC)
Shane Capron (WAPA)
Julie Carter (AZGFD)
Winkie Crook (Hualapai Tribe)
Colleen Cunningham (New Mexico Interstate Stream Commission)
Martina Dawley (Hualapai Tribe)
Alicyn Gitlin (Sierra Club)
Emily Halvorsen (State of Colorado)
Carliane Johnson (SeaJay Environmental)
Josh Korman (Ecometric)
Mark Lamb (USFWS)
Brandon Loomis (Arizona Republic)
Jessica Neuwerth (CRBC)
RJ Neff
Amy Ostdiek (State of Colorado)
Casey Pennock (Utah State University)
Michael Pillow (USFWS)
Taryn Preston (NPS)
Ted Rampton
Peggy Roefer (CRCN)
Scott Rogers (AZGFD)
Robert Schelly (NPS)
Erik Skeie (State of Colorado)
Jim Strogen (FFI/TU)
Gary Tallman (Northern Arizona University)
Melissa Trammell (NPS)
Bob Unnasch (Sound Science)
Christine Wisnewski (Sound Science)
Pilar Wolters-Rinker (USFWS)
Austin Walker (Arizona Municipal Water Users Association)
Emily Zmak (Colorado Water Conservation Board)

Abbreviations

AMWG – Adaptive Management Work Group
BAHG – Budget Ad Hoc Group
CFS – cubic feet per second
CFMP – Comprehensive Fish Management Plan
CRBC - Colorado River Board of California
CREDA – Colorado River Energy Distributors Association
CRCN – Colorado River Commission of Nevada
CSU – Colorado State University
CWCB – Colorado Water Conservation Board
DO - dissolved oxygen
DROA – Drought Response Operations Agreement
DOI – Department of the Interior
ESA – Endangered Species Act
FACA – Federal Advisory Committee Act
FFI – Fly Fishers International
FY – Fiscal Year
GCDAMP - Glen Canyon Dam Adaptive Management Program
GCMRC – Grand Canyon Monitoring & Research Center
GCNP – Grand Canyon National Park
CE-QUAL-W2 – water quality and hydrodynamic model
GCRG - Grand Canyon River Guides
GCWC—Grand Canyon Wildlands Council
GLCA – Glen Canyon National Recreation Area
JCM-West – Juvenile Chub Monitoring-West
LCR – Little Colorado River
LTEMP – Long-Term Experimental and Management Plan
maf – million acre-feet
MSCP – Multi-Species Conservation Plan
NPS – National Park Service
PDT – Pacific Daylight Time
PI Team – Project Implementation Team
Reclamation – Bureau of Reclamation
ROD – Record of Decision
Secretary – Secretary of the Interior
SOW – Statement of Work
TRGD – Trout Recruitment and Growth Dynamics
TSC - Technical Service Center
TU - Trout Unlimited
TWG – GCDAMP Technical Work Group
USFWS – United States Fish & Wildlife Service
USGS – United States Geological Survey
USU – Utah State University
WAPA – Western Area Power Administration
WY – Water Year