

GLEN CANYON DAM ADAPTIVE MANAGEMENT PROGRAM
TECHNICAL WORK GROUP MEETING
JUNE 16-17, 2022

Day 1: June 16, 2022

Start Time: 8:34 AM Pacific Daylight Time (PDT)

Conducting: Seth Shanahan, Southern Nevada Water Authority (SNWA) and Technical Work Group (TWG) Chair]

Meeting Recorder: Carliane Johnson, SeaJay Environmental LLC

Welcome and Administrative

- **Introductions and Determination of Quorum** [Clarence Fullard, Bureau of Reclamation] A quorum of 16 members or alternates was reached.
- **Adoption of Prior Meeting Minutes** [Ryan Mann, Arizona Game and Fish Department (AZGFD)] The reference on page 11 to the CRAB meeting should be the Colorado River Aquatic Biologists meeting. [Seth Shanahan, SNWA and TWG Chair] Minutes adopted with that change.
- **Next Meeting Date(s): October 12-13, 2022** [Seth Shanahan, SNWA and TWG Chair] This will be virtual with the January meeting possibly in person. [Clarence Fullard, Reclamation] The Adaptive Management Work Group (AMWG) meeting in August will be virtual.
- **Ad Hoc Group Membership and Updates** [Seth Shanahan, SNWA and TWG Chair] Everyone should review the list and make sure membership information is correct.
- **Update on Program Funding** [Clarence Fullard, Reclamation] The Glen Canyon Dam Adaptive Management Program (GCDAMP) is being funded by appropriated dollars rather than hydropower revenues, as it had been in the past.
- **Possible Experimental and Management Actions in the Next 12 Months** [Clarence Fullard, Reclamation] The bug flows experiment is currently in the middle of its fourth year. The Planning and Implementation (PI) Team has been meeting biweekly since May to determine whether off-ramping of that experiment is warranted. The PI Team is hearing about any changes in hydrology or operations, new updates from the Western Area Power Administration (WAPA), the basin fund and experiments, and any reports about encounters with non-native species. The fall accounting period will kick off on July 1. [Seth Shanahan, SNWA and TWG Chair] This meeting was to include a conversation about the TMF white paper, which will occur at a later meeting. Is there a webinar date to get TWG input on discussions for a fall HFE? [Clarence Fullard, Reclamation] **ACTION:** Reclamation will set up a TWG/AMWG webinar to share about the deliberations of the PI Team and to solicit feedback. [Larry Stevens, Grand Canyon Wildlands Council (GCWC)] There remains a need to use HFEs to manage beaches and sediment, and to set up well-informed dam management for the future.
- **Stakeholder River Trip July 13-22, 2022** [Clarence Fullard, Reclamation] Confirmations were sent to trip attendees.
- **Update on Monitoring and Research Trips** [Mike Moran, GCMRC] See table of trips that have occurred this year and will be occurring through October 2023.
- **Other Items** [Larry Stevens, GCWC] A group from the non-federal side have been discussing issues about the GCDAMP. The group has concerns about four items that happened over the past year that were described in a letter sent to the Secretary: 1) Reclamation is not integrating

tribal perspectives, 2) a need for springtime HFEs, 3) climate change and increasing water temperature need to be more fully considered in the PI Team process, 4) the relationship between GCDAMP and DROA is still not understood. **[Kelly Burke, GCWC]** There is a need for AMWG to formally engage in the DROA. It might need to be subject to the National Environmental Policy Act (NEPA) and GCDAMP needs to include climate change into the program. The Grand Canyon Protection Act is central to all of this. **[Seth Shanahan, SNWA and TWG Chair]** **ACTION:** Request made to Craig Ellsworth to post the letter to the [GCDAMP wiki page](#). **[Rod Smith, Solicitor's Office]** Agree with the need for continuous improvements and welcome constructive feedback. There are a lot of things in the letter that DOI takes issue with, in particular with the allegations regarding compliance. A response is in progress.

TWG Chairperson and Vice-Chairperson Election

[Clarence Fullard, Reclamation] Seth Shanahan and Michelle Garrison have stated their willingness to serve another year as chair and vice-chair, respectively. **[Larry Stevens, GCWC]** Motion made to nominate Seth Shanahan for TWG chair and Michelle Garrison for TWG co-chair for 2023. **[Shana Rapoport, Colorado River Board of California (CRBC)]** Seconds the motion on the nominations. **[Clarence Fullard, Reclamation]** With no further discussion or objections heard, the following proposed motion is passed: *The TWG appoints Seth Shanahan to the position of Chairperson and Michelle Garrison to the position of Vice-Chairperson of the Glen Canyon Dam Technical Work Group for Fiscal Year 2023.*

Report Out and Recommendation from the Budget Ad Hoc Group for the Fiscal Year 2023 Budget and Work Plan

[Mike Moran, GCMRC] PRESENTATION on the GCMRC Fiscal Year (FY) 2023 Budget Overview. Not expecting any deviation from the funding requested for FY23. The shortage is expected to be available from FY22 end-of-year funds. Also discussed the budget for the Lake Powell Water Quality project that was directed from an AMWG motion in February, and the BAHG recommendations.

Q&A and Discussion

[Seth Shanahan, SNWA and TWG Chair] Do the projects on the slide for the FY23 GCMRC Budget Request from the Triennial Work Plan reflect the “budget worksheet” that is the topic of the next agenda item? **[Mike Moran, GCMRC]** Yes, this is what GCMRC would be doing with anticipated GCDAMP funding. The other items mentioned, particularly the BAHG list, are all end-of-year funding.

[Rob Billerbeck, National Park Service – Glen Canyon National Recreation Area (NPS-GLCA)] Given the smallmouth bass invasion, NPS has been trying to figure out how to respond. Have not considered a carry-over funds for rapid response. Smallmouth bass are a big problem that may drastically alter the system. Not spending much on the management of that issue. Are we being nimble enough to respond to an imminent situation that will change the fishery?

[Clarence Fullard, Reclamation] PRESENTATION on the GCDAMP FY23 Budget and Work Plan for Reclamation. Of the total, 80% goes to GCMRC's budget, as discussed above. Not seeing any changes or revisions on the Reclamation side. With funding now coming from appropriations rather than hydropower revenues, it will be difficult to build up the Native Fish Conservation Contingency Fund with carryover funds. Will discuss this later in the agenda. Some projects are also seeing cost increases that may need more funds. Emerging issues include trigger responses to the humpback chub Biological

Opinion (BiOp), support to GCMRC on the water quality study through non-GCDAMP funds, and non-native fish risk and detection.

[Seth Shanahan, SNWA and TWG Chair] Is it correct that the table showing the FY23 Budget: Reclamation projects represent the projects on the “budget worksheet” that will be considered later in the proposed motion? **[Clarence Fullard, Reclamation]** Yes, that is correct.

[Craig Ellsworth, WAPA and BAHG Chair] The BAHG has met several times this year to discuss the FY23 budget. The BAHG also spoke with the project investigators and contractors. These notes have been posted to the [GCDAMP wiki page](#). See Table 1 on how the BAHG ranked the projects to prioritize if end-of-year funding is available.

Development of Budget Recommendation to the AMWG

[Seth Shanahan, SNWA and TWG Chair] Discuss the proposed language is to accept the BAHG’s recommendation. Final language is available on the TWG site.

Q&A and Discussion

[Erik Stanfield, Navajo Nation] Is this a place to consider tribal resources? The tribal resources budget has not been increased in 30 years. When can that be discussed? **[Clarence Fullard, Reclamation]** Those were not discussed during the BAHG. **[Kathy Callister, Reclamation]** That is outside the TWG budget process, but Tara Ashby can schedule those meetings to discuss. The participation funds are different from the funds in the Triennial Work Plan. **[Seth Shanahan, SNWA and TWG Chair]** Were the participation funds in the Reclamation budget presentation? See Item D.15. This is funded elsewhere but it is important for the group to get the work done in the GCDAMP but would not be part of the recommendations that TWG would make to AMWG. **[Kelly Burke, GCWC]** Are there any tradeoffs related to the amount for tribal participation versus what goes into the program? **[Kathy Callister, Reclamation]** The tribal participation funding comes from the Assistant Secretary for Water and Science. The fund also supports tribal river trips. Reclamation is open to meeting with the tribes if they feel the amount needs to be increased. The amount has not changed in many years and there are specific uses for it. Project D funds (except for tribal participation) have increased quite a bit. Also have not received an increase in GCDAMP program funds in 4-5 years. **[Seth Shanahan, SNWA and TWG Chair]** Should this be something that the TWG should look into? **[Kathy Callister, Reclamation]** A few years ago, Reclamation did an analysis of the data and submitted it to the Secretary’s Designee, which made the decision to not increase the funding. It would probably need to be a request by AMWG to the Secretary for the BAHG to look into it. It would have to be increased at the DOI level. It is not included in Reclamation’s annual budget request.

[Mike Moran, GCMRC] There were no consumer price index (CPI) increase in the last work plan. This is significant in years when inflation is high.

[Kelly Burke, GCWC] Supports efforts to increase tribal participation funding and increasing their involvement. Would support looking into this again. Regarding the motion, can a reference be added to the budget about the emerging need related to non-natives? **[Seth Shanahan, SNWA and TWG Chair]** Maybe this could come from left over funds or the Native Fish Conservation Contingency Fund. Is there flexibility to respond? **[Clarence Fullard, Reclamation]** There is also the problem of having partners in the program to get the work done and whether there is flexibility to spend funds. There is uncertainty

around this, and what the priority uses would be of those funds. **[Kelly Burke, GCWC]** Should we have a placeholder for these leftover funds? The priorities might be different if we already knew these things. How big is this pool of money and can it handle the issues that might be considered? **[Clarence Fullard, Reclamation]** The Tier 1 and Tier 2 triggers for humpback chub might be one thing to consider for those funds. **[Rob Billerbeck, NPS-GLCA]** Now is the time to consider this an emergency if smallmouth bass were to get established and affect humpback chub. This should not be constrained only by the Native Fish Contingency Fund. If smallmouth bass aggregations are found this summer, funding is not available to respond rapidly to it. **[Seth Shanahan, SNWA and TWG Chair]** Is it a level of magnitude of the response that is not available with existing funding? **[Rob Billerbeck, NPS-GLCA]** If aggregations are found in late July or August, for example, there is one person to be able to do more monitoring, but that would be more difficult farther down the canyon. There is also a limited amount of equipment. Maybe the best that can be done is to ramp up for next season. If money is available, maybe solutions can be found more quickly. Response would depend on the location. **[Melissa Trammell, NPS]** Currently, there is no way to respond to something happening in Grand Canyon. The monitoring is in place, but there is a lack of staff and boats to respond and no funding to launch a trip. **[Larry Stevens, GCWC]** The river community is willing to help. It is not just federal agency partners.

[Kelly Burke, GCWC] Can we start with the premise that there will be smallmouth bass seen this summer to figure out what we need to do now? How can we recognize that to shift priorities, funds, and resources? **[Seth Shanahan, SNWA and TWG Chair]** The TWG has struggled with this emergency funding issue for a long time and to develop the steps to be prepared if something does happen.

[Ben Reeder, Grand Canyon River Guides (GCRG)] What is the preferred method of catching smallmouth bass? Can they be targeted on commercial river trips? **[Rob Billerbeck, NPS-GLCA]** Angling can be used. **[Ryan Mann, AZGFD]** With the current abundance, it would be difficult to catch. Angling is not likely to be an effective method of control but reporting those sightings would be important. **[Larry Stevens, GCWC]** A flyer would be good to get this information to others on the river and would also recommend taking a picture of the fish. **[Ryan Mann, AZGFD]** There are still concerns about what to do once those fish are found and having an appropriate level of funding. Would be concerned about reallocating things in the work plan. **[Seth Shanahan, SNWA and TWG Chair]** If there is an emergency, then it would mean that some things could not be done. Is that not feasible? **[Ryan Mann, AZGFD]** Agree with that. It is problematic to hear that the Native Fish Conservation Contingency Fund might not be available until a response to the triggers is needed for humpback chub. Non-native rapid response is important to consider for that funding.

[Craig Ellsworth, WAPA and BAHG Chair] If this issue is of such important, why are we not doing everything inhospitable to this fish as possible? Why are we in the middle of a bug flows experiment? **[Clarence Fullard, Reclamation]** There is an agenda item and a directive to develop those ideas. There could be compliance requirements, too. The switch from 7.48-million-acre-feet (maf) to 7.0 maf and the drought actions alleviated much of the higher risks and probabilities of establishment to next year. Reclamation is doing what it can in the timeframe it has been presented. As to why we are in the middle of bug flows, the Technical Team recommended the experiment and did not see it being problematic.

[Seth Shanahan, SNWA and TWG Chair] 1. Is there an action on the proposed motion? 2. The difficulty to work this out can be the TWG's report back to the AMWG and to also encourage the agencies to figure it out. 3. There will also be a discussion of a new ad hoc group, which could be the forum that

could work through this issue of funding. At least Parts 1 and 2 the TWG can lead. Is anyone willing to propose the motion for adoption or amend it? **[Kelly Burke, GCMRC]** Supports it. **[Larry Stevens, GCWC]** Supports it. **[Erik Skeie, Colorado]** Supports it. **[Shana Rappaport]** Supports it but is struggling as to why this was missed during the BAHG process. It is an emerging need that has been coming for some time. How do we improve the BAHG process in the future to make sure this is being considered? **[Seth Shanahan, SNWA and TWG Chair]** There could be an additional consideration in which issues proposed for funding could be initially heard by the SCAHG. Perhaps Kelly Burke can propose this.

Key Elements of the 2022 Drought Response Operations Plan and Reducing Glen Canyon Dam Releases to 7.0 Million Acre-Feet in Water Year 2022

[Rod Smith, DOI Solicitor's Office] Refer to [the video link](#) of the Commissioner's testimony in the Senate Committee on the drought across the west and the Colorado River Basin. Reclamation set an annual release volume of 7.48 maf for Water Year (WY) 2022 in August 2021 under the 24-month study. DROA is one of the elements of the Drought Contingency Plan across the Upper and Lower basins. These were ratified by Congress for additional tools to deal with drought. DROA works by looking at the upstream units from Glen Canyon Dam to see whether additional water can be released. The caveat is that the water released under DROA needs to be consistent with the agreements on the facility's operations requirements (water rights, contracts, fish, flow, NEPA provision, etc.). There must be flexibility in the system that could be potentially available for DROA if Lake Powell target elevations are below 3,525 feet, which is the buffer for the 3,490-foot level when power cannot be generated. Protecting power is one reason, but the other reason is for infrastructure protection – vortices can occur at lower levels that can damage equipment. The first trigger under DROA is when the 24-month study forecasts water levels dropping below 3,525 feet. In 2021, when water was released, these were under DROA's emergency provisions and not the full bore of DROA, which was implemented and ongoing since at least fall 2021. When the DROA triggers were met, Lake Powell monthly volumes were considered in January, February, and March 2022 to hold back 350 maf. On May 3, a letter from Assistant Secretary Trujillo outlined the release from 7.48 maf to 7.0 maf.

Q&A and Discussion

[Larry Stevens, GCWC] What happens in a third year of dire conditions? **[Rod Smith, DOI Solicitor's Office]** One of the issues with DROA is that it is tool, but not one that is a permanent solution. Water has to be moved within the parameters set for that facility. Other tools will be needed to address these conditions.

[Bill Persons, Fly Fishers International (FFI)/Trout Unlimited (TU)] Are there efforts to be made for consumption in the longer term? **[Rod Smith, DOI Solicitor's Office]** We do not control the supply lever. Usage must be part of this. The guidelines expire in 2026. A scoping process is starting to kick off on those guidelines.

[Larry Stevens, GCWC] What is the seniority status of trans-basin diversion waterways on the Upper Colorado River Basin? **[Rod Smith, DOI Solicitor's Office]** It depends on the state, but almost all of the uses are outside of the basin. Tribal rights have also not been settled in terms of other uses of the system. **[Larry Stevens, GCWC]** Is anyone keeping track how much water is stored in the Navajo sandstone aquifer at Lake Powell? **[Rod Smith, DOI Solicitor]** Two important locations of flow

measurements are the releases at the dam and the Lees Ferry gauge. Don't know whether water is being tracked from the sandstone, but it would be picked up from the Lees Ferry gauge.

[Larry Stevens, GCWC] What is the relationship between DROA and GCDAMP? **[Rod Smith, DOI Solicitor's Office]** The 350 maf needs to be put back and that was discussed at the AMWG February meeting, but that discussion ended because the May 3 letter came out and overtook it.

Status of Non-Native Fish in Lake Powell

[Barrett Friesen, Utah State University (USU)] Presentation on the fish assemblage of the Lake Powell forebay to help evaluate escapement of non-native fish into the lower Colorado River. Risk is low when Lake Powell elevations are high. At the current level (3,535 feet) fish could become entrained through the penstock. The forebay is now at 18-19 degrees Celsius. Suspect that fish are coming from Wahweap. Smallmouth bass, common carp, and channel catfish are all being caught in the forebay.. Catch per unit effort (CPUE) of these non-native fish has increased by seven times between March and June sampling.

Q&A and Discussion

[Seth Shanahan, SNWA and TWG Chair] What are the depths of the intakes at the penstock? How deep could the epilimnion go to? **[Barrett Friesen, USU]** Centerline of the penstock is at 3,470 feet and the water is now at 3,535 feet (about 20 meters higher). The nets can sample down to 24 meters. As the epilimnion continues to build, the fish are likely to move deeper with the warm water and to the penstock level, but they are not that deep right now. The November profile shows the epilimnion depth at roughly 20 meters. It is likely that all warm water species would be seen at the bottom of this layer.

[Ryan Mann, AZGFD] Is there information in the literature about pressure tolerance of the species that are most concerning? **[Barrett Friesen, USU]** Survival seems high or at least higher than we like. It could be as high as 30-40% or higher.

[Larry Stevens, GCWC] These young fish are probably moving along the shorelines. Is that likely?

[Barrett Friesen, USS] There is littoral habitat in the forebay where smallmouth bass are caught, and also catching them in areas that would not be considered "bass habitat." Could not rule them out from moving along the vertical dam face.

[Melissa Trammell, NPS] How deep are the minnow traps set? And what were you catching? **[Barrett Friesen, USU]** A string of them were set with the first ones quite shallow, then 6-7 meters with the deeper traps. Have never caught anything but green sunfish.

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

[Heather Patno, Reclamation] The Colorado Basin runoff is almost finished with some increases still being seen. Flaming Gorge storage is at 75% and will be releasing an additional smallmouth bass flow spike beginning June 21. The June end-of-month forecast at Lake Powell is expected to be at 3,528 feet. The 2022 plan includes additional releases from Flaming Gorge. The Yampa River is included in the Flaming Gorge operations. Near normal temperatures are expected but precipitation is mixed. These change daily. The most probable June forecast for Lake Powell unregulated inflows is 58% of average for WY22, which is less than a 30% chance of getting average conditions. Two Upper Basin Drought Response Actions were announced on May 3. Benefits of Lake Powell operations can be seen with the

additional releases from Flaming Gorge along with the DROA operations. Lake Powell is in a lower elevation balancing tier. These releases are placeholder schedules for modeling purposes. There will be updates on the lower elevation balancing tiers for 2023 after further discussions with the basin states. The bug flow releases (May through October) increase the base from what would have been scheduled. There will be increasing temperatures through the summer with a minimum probable reaching 21 degrees Celsius in September. For the Colorado River water temperature projections graph, River Mile (RM) 0 is Lees Ferry, RM 61 is Little Colorado River, and RM 226 is Diamond Creek.

Q&A and Discussion

[Melissa Trammell, NPS] Is there a way to estimate whether water is flowing more slowly from Lake Powell because of bank storage? **[Heather Patno, Reclamation]** Storage is included in the total volume of the 24-Month Study. Whether the physical reservoir storage is decreasing more slowly because of bank storage is not included. That would be seen in observed storage values. In terms of an actual calculation, that has not been looked at that in detail. **[Larry Stevens, GCWC]** This could be reflected in the noise between total inflow and what is actually measured at the dam. **[Heather Patno, Reclamation]** There are multiple pieces in the unregulated inflow in the storage values including evaporation and bank storage. All that would need to be included.

[Kelly Burke, GCWC] Is there a way to anticipate the water coming in if there was a monsoon similar to last year? **[Heather Patno, Reclamation]** Those are hard to forecast. **[Seth Shanahan, SNWA and TWG Chair]** How would Reclamation anticipate how much side flow a monsoon could produce? **[Heather Patno, Reclamation]** With monsoons, those are generally a southern event and would see that more in the Little Colorado and Lake Mead. Sometimes the moisture would increase up to Lake Powell, which is what happened last October with increased precipitation, which would then need to be prepared for changes in dissolved oxygen and sediment load. Monsoonal events are not seen in the upper reservoir, so it would be a localized event. There is influence of monsoonal events for Lake Mead, which can be seen in the record. But with the uncertainty to forecast those (i.e., they are convective and not strongly linked like runoff is to snowpack), the side inflows to Glen Canyon include the last five-year average, which decreases the amount of noise. It dampens these flashy impacts.

Status of Harmful Non-Native Fish Below Glen Canyon Dam, Incentivized Harvest, and Smallmouth Bass Task Force

[Kirk Young, USFWS] The Smallmouth Bass Task Force has not been meeting regularly since April. Since then, the models continue to be refined with new learnings and other assumptions. There was information that suggested young life stages could be susceptible to cold shock. Some fry were obtained to conduct two different experiments to see if a 10-degree shock treatment could be a possible option, but it did not have an effect. It is probably the adults that are affected by cold temperatures either during spawning or nest abandonment.

[Larry Stevens, GCWC] Are there olfactory or sonic ways of deterring fish movement? **[Kirk Young, USFWS]** One subgroup took this on and brainstormed ways to filter invasive species from coming through the dam. Reclamation has compiled the information.

[Seth Shanahan, SNWA and TWG Chair] Are there plans for the Task Force to meet? **[Kirk Young, USFWS]** There are no plans for more meetings. These have been subsumed by the Secretary's direction.

[Larry Stevens, GCWC] What about a large release of Colorado pikeminnow as a natural predator of non-native fish? **[Kirk Young, USFWS]** Great idea, but it would take 6-7 years to get large enough Colorado pikeminnows to make a difference. Predators were included for invasive control ideas, but they would still be around the margins of effectiveness against the bigger concerns of establishment and recruitment.

[Melissa Trammell, NPS] Nobody has reported smallmouth bass. One walleye was found below the dam, which is not unusual. One dead striped bass and one crappie was caught in the Little Colorado River, and there was a steady stream of green sunfish above the sloughs that are believed to be coming through the dam. Common carp reproduced in the slough, and we might have missed the window to remove those fish. No carp were found in the upper slough.

Secretary's Designee Direction From the May 18, 2022 AMWG Meeting

[Wayne Pullan, Secretary's Designee to the AMWG] Temperatures at Phantom Ranch last week were 114 degrees Fahrenheit. The stakes are high now and there is a temptation to dig in because of that, but results have greater power when consensus is reached by the TWG. If consensus does not happen, decisionmakers have to decide what is the best science and this is a failure of the process. An action was requested for the TWG to tell the AMWG how to avoid establishment of smallmouth bass or other aggressive, non-native species downstream of Glen Canyon Dam. It is understood there will be things that can be implemented more easily because they have environmental compliance and then there are other things that might need to be delayed because they do not yet have environmental compliance.

Q&A and Discussion

[Seth Shanahan, SNWA and TWG Chair] One way to address this came from the SCAHG to create a new ad hoc group that allows quicker discussion and flexibility. The new ad hoc group has started to discuss the different components and focus on the immediate term issues. It is understood that other conversations are happening outside the TWG including the Smallmouth Bass Task Force, NPS rapid responses, and Reclamation-led efforts to evaluate barriers and a report coming out in the next month or so.

[Wayne Pullan, Secretary's Designee to the AMWG] The ad hoc group is encouraged, particularly if it creates additional accountability. Progress is not made unless there is a small group that owns the issue and leads the process. There is urgency but also concern that there were solutions being proposed that were looking for a justification, or that might be duplication of effort, or did not have the necessary justifications to commit the public's funds. Any conclusions from other sources need to be reviewed and assessed, and that the actions are justified and have science behind them. The smallmouth bass efforts need to have the weight of AMWG and the TWG behind them. AMWG must also have funding. If this is a key issue, then efforts need to be reprioritized.

[Seth Shanahan, SNWA and TWG Chair] The group struggled about who to lean on for these activities. GCMRC will be part of the group, but it is less clear about the strategy document and who will write that. There was also great interest in the ad hoc group so the "small team" might not be so small.

[Wayne Pullan, Secretary's Designee to the AMWG] Will there be sufficient results for meaningful discussion by the AMWG in August? **[Seth Shanahan, SNWA and TWG Chair]** It is reasonable the group

can provide operational alternatives and what that level of support is by August. An ad hoc group will also be able to have much more frequent conversations.

[Kelly Burke, GCWC] Would like to highlight Wayne's comments about shifting priorities. **[Seth Shanahan, SNWA and TWG Chair]** Reprioritization might be another component to charge the ad hoc and to consider the resources that might be needed. **[Leslie James, CREDA]** Would not want to do away with SEAHG until there is more understanding about the commitment on Project N. This ties into prioritization. Is there an opportunity to look within the existing budget to be used toward this effort? **[Michael Moran, GCMRC]** Could look at Project N. Could also look at end-of-year funds especially with reprogramming some of the priorities the BAHG had mentioned. It is not so much about funds but about capacity. Under bullet two of the request, a draft document on the operational efforts could be easily completed because much of this was done with the Smallmouth Bass Task Force. But the first bullet point is a big job. There is not the capacity to do that in GCMRC even with available funding. **[Leslie James, CREDA]** If there is an opportunity under bullet two with the hydrograph work, please include WAPA. What would be the first rapid response action (completely setting aside the money question)? **[Seth Shanahan, SNWA and TWG Chair]** That is what we need the ad hoc group to accomplish. Was Project N not discussed or was it missed in the BAHG conversions? **[Leslie James, CREDA]** BAHG did not relook at things that were already in there. **[Lucas Bair, GCMRC]** Project N is not a lot of money, but GCMRC continues to work with WAPA, Clayton, and Argonne on the topic of hydrographic modeling and experimental flows. These efforts are informing Project J and how that fits into managing humpback chub and rainbow trout. GCMRC is also moving forward on new modeling for hydrographic flows. There are other efforts, and some of that will be focused on bullet two. **[Leslie James, CREDA]** **ACTION:** Would appreciate the TWG receiving a report on this rather than having the SEAHG in the middle.

[Melissa Trammell, NPS] What to do if smallmouth bass are found downstream is a good question. The first thing is prevention and making the river as inhospitable as possible. If smallmouth bass are found below the dam, the fastest way to control them is to control their reproduction. Cold water shows the most promise on that. There are two different NPS comprehensive non-native fish management response plans that guide rapid response, mechanical, barriers, etc. The details are not available because that partially depends on where they are found and how many are found. There are many options available, but they require people, money, and equipment, as well as additional consultations with the tribes. Plans are in place, but not the money.

Monitoring Metrics

[Helen Fairley, GCMRC] The draft report with example metrics of eight of the 11 LTEMP goals was distributed on June 8. This is not a comprehensive monitoring plan but a focus on one aspect of monitoring, which is assessing the performance of these goals. None of these resource goals are exclusively a product of dam actions or of other management actions within LTEMP. The program is affected by many external factors that it does not have any control over. One of the challenges is to focus on metrics that are under control by LTEMP. Only feedback received was from tribal representatives who had concerns about measurable metrics to assess tribal resource values. **ACTION:** TWG members need to review the draft metrics report and submit written comments by July 1.

Q&A and Discussion

[Seth Shanahan, SNWA and TWG Chair] Consider this in terms of AMWG’s next step to adopt these metrics to identify targets for the program to achieve. **[Kelly Burke, GCWC]** Instead of targets, there is also a need to consider the specific questions relative to these goals and which of those questions have modeling in place to evaluate the metrics.

Public Comment

No public comment.

[Seth Shanahan, SNWA and TWG Chair] The budget item will need to be addressed first thing in the morning. Kelly Burke has also provided additional text related to budget priorities, which will be added to the proposed motion for discussion.

Meeting adjourned at 5:09 PST

**GLEN CANYON DAM ADAPTIVE MANAGEMENT PROGRAM
TECHNICAL WORK GROUP MEETING
JUNE 16-17, 2022**

Day 2: June 17, 2022

Start Time: 8:32 AM PDT

Conducting: Seth Shanahan, SNWA and TWG Chair

Meeting Recorder: Carliane Johnson, SeaJay Environmental LLC

Welcome and Administrative

- **Introductions and Determination of Quorum** **[Seth Shanahan, SNWA and TWG Chair]** Quorum was reached with 22 of 25 groups represented.
- **Unresolved Issues from Yesterday’s Meeting** **[Seth Shanahan, SNWA and TWG Chair]** Kelly Burke and Larry Stevens provided additional text to the motion. Shane Capron provided additional text changes to address the issue of non-native fish in the budget as a priority item in that list.

Final Budget Motion Language:

The Technical Work Group recommends that the Adaptive Management Work Group (AMWG) recommend for approval to the Secretary of Interior, the Fiscal Year 2023 budget as shown on the budget worksheets presented to the Technical Work Group (TWG) on June 15, 2022; furthermore, as funds become available, the Technical Work Group recommends those funds are used to fund the work items listed below in priority order:

Priority 1 – Given the historic release temperatures from Glen Canyon Dam and the possibility of invasive fish establishment in the Colorado River ecosystem (CRE) with the potential to harm Endangered Species Act listed fish and the rainbow trout fishery, the Department of Interior should prioritize funds, including the use of the Reclamation C.6 Native Fish Conservation Contingency Fund and the C.5 Experimental Management Fund, and prioritize activities such as evaluation of operational alternatives or other CRE management and monitoring, to address this concern. These activities might require budgetary adjustments. Such actions will be coordinated with the TWG and AMWG. The Glen Canyon Dam Adaptive Management Program sees the potential establishment of nonnative fish as an emergency situation that warrants swift and decisive mitigation action.

- Priority 2 – Continue Project Element G.6, Juvenile Chub Monitoring-West*
- Priority 3 – Continue sampling at two sub-reaches for Project Element H.2, Experimental Flow Assessment of Trout Recruitment*
- Priority 4 – Begin the Grand Canyon portion of the water quality synthesis requested by the Adaptive Management Work Group at their February 9-10, 2022 meeting*
- Priority 5 – Investigate an aquatic vegetation removal pilot project in Lees Ferry to reduce brown trout habitat*
- Priority 6 – Continue two monitoring trips for Project Element C.1, Ground-based Riparian Vegetation Monitoring*
- Priority 7 – Continue Project Element B.5, Streamflow and Sandbar Modeling*

In addition, should an emergency arise that would require budgetary adjustment, the TWG is notifying the AMWG that we may make necessary budgetary recommendations at a later date.

*Motion made by Kelly Burke, GCWC,
Seconded by Erik Stanfield, Navajo Nation,
To adopt the motion as written above on 6/16/2022.
The motion was approved by consensus.*

Tabletop Exercise Summary of Findings

[Michelle Garrison, Colorado Water Conservation Board (CWCB) and TWG Vice-Chair] Presentation on high level findings from the [tabletop exercise](#). This exercise was to help the TWG identify areas of potential importance to the AMWG concerning agency responses to emerging issues. There have been concerns about being quicker and nimbler. Emergency actions are different from the experimental action described in LTEMP. The intent is to use this as a planning tool to identify roles and responsibilities. Also received great feedback from the Post Exercise Survey, some with unanimous responses from all the parties and others that were more mixed.

Q&A and Discussion

[Jakob Maase, Hopi Tribe] It was a great exercise and there were many things that need to be connected between the agencies. It would be helpful to do these workshops on other topics in the future. Maybe keep the survey questionnaire to collect data but allow for open questions, too.

[Seth Shanahan, SWNA and TWG Chair] Is there a date to get feedback on this report? **[Clarence Fullard, Reclamation]** **ACTION:** Will accept feedback by July 1 that will be compiled and sent to the Science Advisor, but there will not be a revised report.

[Craig Ellsworth, WAPA] It was extremely hard to do the tabletop remotely. This would have been a great exercise and more effective when we are able to meet in person.

Informational Updates About Activities Related to the Long-Term Experimental and Management Plan Programmatic Agreement

[Jamescita Peshlakai, Reclamation] One of the first things to do after being hired in January was to start conducting quarterly meetings with the five tribes. The LTEMP Programmatic Agreement (PA) Annual Meeting will be held on August 4 with a strong likelihood there will be a second day added on August 5, which will allow for both virtual and in person attendees. By September 30, the tribes need to have new

five-year participation agreements in place. Regarding the request to increase the Tribal Participation Funding, all but one of the tribes has a balance and some are quite high.

Q&A and Discussion

[Kurt Dongoske, Pueblo of Zuni] The previous programmatic agreement in 1994 was not completely complied with, so some stipulations related to tribal properties in the canyon that were never sufficiently recognized or addressed. When the current PA was negotiated, and the Historic Preservation Plan was developed the tribes were assured that Reclamation would adhere to the stipulations in the current PA. In the past five years, there has not been an Annual Meeting about the PA and there has been minimal progress by Reclamation to address the stipulations in the current PA. Dr. Nelson has begun work on the Non-Native Fish Memorandum of Agreement as part of the PA, but there is trepidation that the same avenue is happening with the 1994. There are only two hours for the Annual Meeting devoted to the PA. This is going to obfuscate what the tribes are concerned about and what Reclamation has agreed to. **[Jamescita Peshlakai, Reclamation]** The concern about only have two hours on the agenda is why a second day is being added.

Informational Updates

- **Feasibility Study for Reintroducing Colorado River Pikeminnow: Kirk Young, Fish and Wildlife Service**

[Kirk Young, USFWS] The USFWS led the science part of compiling a comparison on habitats needed and what is in the canyon. There are attributes that could provide some recovery potential for the species and others that are missing. This document was forwarded to the TWG for review and comment. Changes were made and responses to commenters were also prepared. The paper was submitted to the Journal of Wildlife Management. As funding is available, questions related to the effects to humpback chub, prey base, and energetics will be explored. Humpback chub does not appear to be a preferential diet item when given a choice between them and flannelmouth suckers. There are no immediate plans for releases or experiments in Grand Canyon. The TWG would hear about those ideas way before they would occur to ensure there are no unintended consequences.

[Shane Capron, WAPA] Supports recovery, and for there to be some certainty for hydropower to deal with potential take from dam operations **[Kirk Young, USFWS]** USFWS has been open to this idea. Would need funding before a proposal for research is ready. **[Seth Shanahan, SWNA and TWG Chair]** Would you seek the TWG's recommendation on that proposal? **[Kirk Young, USFWS]** It is probably not a TWG action, but it would be foolish not to get this group's feedback on such a proposal. **Water Quality and Public Health Items**

[Ronan King, NPS] There have been 116 reports of gastrointestinal (GI) outbreaks from river rafting trips that started in April that culminated in five outbreaks in one day in mid-May. Went to Phantom Ranch and Lees Ferry to investigate the river water and supplies of potable water. This was to eliminate these sources as the root cause. There is a case study with both sick and well participants of these rafting trips. The survey went to everyone. These were commercial, park, and private trips. The majority of cases get sick in latter half (from Phantom Ranch downward) that eliminates sick individuals from coming on the trips to bad water. Now trying to eliminate environmental factors to this norovirus.

Q&A and Discussion

[Shana Rapoport, CRBC] Is there coordination with EPA of water quality monitoring for microbes?

[Ronan King, NPS] It depends on whether this refers to water quality in the river or the potable water provided to the users. Park water distribution and delivery is overseen by the U.S. Public Health Service and others, but the quality water in the Arizona River is not typically assessed because it is not considered a swim beach. There is a park science team that looks at harmful algal blooms or elevated diseases in the water, but they are not routinely monitoring it like a swim beach or recreational area. Part of this is the flow volume of the river. There is less risk of disease-causing microorganisms when there is flowing water, but there many eddies or pools that might need to be targeted for comprehensive environmental sampling.

[Ben Reeder, GCRG] What about outbreaks from food sources? Could swabbing of door handles on bathrooms be done at Lees Ferry or Phantom Ranch? **[Ronan King, NPS]** Have not eliminated anything in the investigation yet. Some people getting sick prior to Phantom Ranch or earlier in the trip. The issue is the wide distribution of disease onset. Food source cannot be eliminated, but the evidence right now is circumstantial. As to door swabbing, the samples are extensive, and most labs are not too willing to analyze them if there isn't any direction on what the culprit is. Some noroviruses can last on surfaces for up to three weeks but reduced with UV light. Right now, this is the data information and collection phase, not at the environmental sampling phase yet.

[Kelly Burke, GCWC] Anecdotally, many other people who do not work on the river were experiencing gastrointestinal infections around the same time. What has been learned whether they are spreading this? Is it clear it is norovirus? **[Ronan King, NPS]** There is norovirus in the feces of those who were sick. There was also norovirus detected in the groovers. Individual samples are needed to know whether this is causing the sickness. It might be giardia or other illnesses. Filtration should get the larger parasites while disinfection gets smaller organisms. If individual samples are received, will ask the labs to provide a more comprehensive analysis to see if there is anything else. Can't eliminate anything because the data are a not available yet. Regarding others who have gotten sick, GI is being seen more frequently around the country. As to the Grand Canyon, it is manifesting within 12-36 hours with people experiencing more fatigue with a shorter duration (24 hours) of sickness. The full impact may be greater.

- **Razorback Sucker Augmentation Activities in Grand Canyon**

[Seth Shanahan, SNWA and TWG Chair] There are efforts to introduce razorback suckers into the canyon. This will be a presentation at a later meeting. **[Shane Capron, WAPA]** Would like to know what incidental take requirements there would be from dam operations if razorback suckers are introduced? Would this be an informal consultation? Would take be allowed? **[Kirk Young, USFWS]** ACTION: Will get back to the TWG on this question. It is believed this was a formal part of the BiOp. USFWS will need to work through this. **[Melissa Trammel, NPS]** Razorbacks are being proposed for downlisting to threatened along with a proposed 4D rule. It includes incidental take coverage for activities such as augmentation.

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

[Ryan Mann, AZGFD] Next monitoring trip is scheduled for July 11-15. Have not had a trip since April. Preliminary results include observations of higher catch rates this year than last year (.64 fish per hour for walk-ins and .71 fish per hour for boat anglers). These are still below goal of 1 fish per hour in the Lees Ferry Management Plan. Overall satisfaction from anglers is quite high from last year probably

because of increased catch rate. The overwhelming majority of anglers are targeting brown trout, which may be because of incentivized harvest program, but about 93% of fish caught are rainbow trout versus 6.2% of brown trout. This is related to the low relative abundance of brown trout. Hearing that the anglers that are contributing to the Incentivized Harvest Project are catching around 50% of brown trout. There is low relative abundance of rainbow trout. The increase temperature projections are concerning.

- **Bug Flows Experiment [Ted Kennedy, GCMRC]**

The monitoring is going as planned. The backbone is the citizen science monitoring of the light trap samples. A gross primary productivity monitoring network was deployed in February. Those units are being serviced regularly. Also doing intensive sampling in Lees Ferry (Friday, Saturday, Sunday, and Monday), which will continue through the experiment. A new piece of the study includes feeding habits of native fish downstream using fecal e-DNA collections and isotope analysis of fin clips. No life is being taken for this sampling. The diet sampling is a seasonal comparison.

Drought Related Changes in Water Quality Surpass Experimental Flow Effects on Growth of Rainbow Trout in Glen Canyon

[Josh Korman, Ecometric] This work was funded by GCMRC as Project H. Modelling was used to determine the dominant drivers of rainbow trout growth rates and compare the relative effects of bug flows and HFEs with the effects of water quality. Higher temperatures will stunt growth, reduce survival, and decrease fecundity. The model predicts variation in growth rate. One example of a confounding trend is when phosphorous levels were much higher than average in spring and summer, but much lower than average when Bug Flows were implemented. There were also high levels of competition during first part of the study, which was also when the first three HFEs were conducted. The model shows very limited effect from Bug Flows or from fall HFEs on lifetime growth. A nutrient-enhanced condition (increased phosphorous) is nearly three times higher relative to Bug Flows. Higher water temperatures predict a very large negative effect under 2022 drought conditions. **[Bridget Deemer, GCMRC]** Presentation of water quality of Glen Canyon Dam releases under drought. Lake Powell stratification continues to bring warmer water lower in the penstock. With higher temperatures, more dissolved oxygen is needed to get the same benefit. The largest effect on trout from low dissolved oxygen will occur near the dam although sediment remobilization might provide another source of phosphorous to the system. The evidence suggests the population is on the edge of a collapse.

Discussion and Q&A

[Ryan Mann, AZGFD] How quickly is phosphorous increase seen in macroinvertebrate biomass or fish biomass? Have only brown trout primarily benefited from fall HFEs all these years? **[Josh Korman, Ecometric]** Fall HFEs did not affect rainbow trout growth. It is speculative whether HFEs benefit brown trout. **[Bridget Deemer, GCMRC]** Higher phosphorous concentrations are seen at the bypass tubes at Lees Ferry but it is relatively short to have an effect on the foodbase. **[Josh Korman, Ecometric]** The most certain drivers on growth are temperature and dissolved oxygen effects. Temperature would be the first thing to be done to aid rainbow trout; phosphorous would be a secondary priority. **[Ryan Mann, AZGFD]** AZGFD is supportive of modeling to understand low dissolved oxygen, extent, and timing. **[Kelly Burke, GCWC]** Explain the statement, “under current circumstances these are not “enhancement” actions”? **[Josh Korman, Ecometric]** Rainbow trout enhancement has not been done under GCDAMP. In

the current circumstance, this is about stopping collapse; it is not “enhancement” with respect to NPS policy. **[Dave Rogowski, AZGFD]** If there is a new normal, at what point would the conditions be that they would not survive? **[Josh Korman, Ecometric]** The drop could happen in one or two years. **[Bill Persons, FFI/TU]** The rainbow trout fishery is just getting harder. There was an idea to stock sterile triploid rainbow trout to stock the fishery if it does collapse. **[Ryan Mann, AZGFD]** Stocking is one of the management actions being discussed. Also just completed consultations for stocking and updated the permitting compliance.

Trout Management Flows White Paper

[Kerri Pedersen, Reclamation] This is one of the flow experiments in LTEMP. The trigger is high trout recruitment. The purpose of the white paper is to review the current state of science regarding the design, implementation, and effectiveness of implementing a TMF experiment as a tool for managing rainbow trout. It is not a decision document. Focus is on rainbow trout but the hydrograph could be adapted to incorporate brown trout. **ACTION:** Provide comments to kpedersen@usbr.gov by September 15.

Discussion and Q&A

[Bill Davis, CREDA] With the potential collapse of the rainbow trout population at Lees Ferry due to temperatures, etc., there is a need for future TMF planning efforts. **[Kerri Pedersen, Reclamation]** There is a broad mention in the report that environmental conditions should be considered for TMFs.

An Update on the Grand Canyon River Guides’ Adopt-a-Beach Program

[Ben Reeder, GCRG] Presentation on the Adopt-a-Beach Program, which tracks the condition of 44 beaches. The lower the fluctuation of flow, the longer the beaches last. Spring HFEs are needed.

[Seth Shanahan, SNWA and TWG Chair] In the photo from Paul Grams that showed the benefits of a spring disturbance flow, is there a sense for which beaches benefited? Are there some flows in some locations that are more helpful? **[Ben Reeder, GCRG]** The camping beaches were in great shape last summer. This spring, it was the worst ever seen. The spring disturbance flow had a positive impact. A lot of people say Marble Canyon gets stripped during these flow events. It appears that some areas pop up after the spring disturbance flow and after every HFE, but some beaches stay the same. It appears to be an overall benefit but have not seen the river immediately after an HFE (it has always been the following season).

[Clarence Fullard, Reclamation] Is the degradation happening in enough places so there is more competition to find good beaches? **[Ben Reeder, GCRG]** Maybe part of the competition is due to increased launches because of COVID in 2020. Some beaches are not really camps. Guides might be forced to go another hour beyond what is expected.

[Bill Davis, CREDA] Has there been any interest in seeing what effects camping and beach use by campers has on the erosion of sand from the same beaches? The beaches are used repeatedly by one tour after another and may have an impact on beach erosion. **[Ben Reeder, GCRG]** There will be movement from walking, but water (particularly monsoons) is much more conducive to erosion than from people. **[Helen Fairley, GCMRC]** This question was studied in the 70s when beach studies started. There were concerns about it and there is an effect when beaches are steep. Relative to Glen Canyon Dam operations, it was concluded it was a minor issue.

[Kelly Burke, GCWC] With safety during monsoon events, and eroded beaches combined by not having an HFE, does it become more difficult to find camping beaches that are not in the middle of a wash or farther from a drainage? **[Ben Reeder, GCRG]** That was a concern especially after Tatahatso Wash from last year's monsoon season. Will expect more monsoons. It does impact where to pull out. Tatahatso Wash was not a big wash and would not have been a concern by the guides to stop there. There are also places where rockfall might be a concern. It changes the way to think about the camp if it is a monsoon type of day. It is an added stress to make sure people are safe and to travel farther to find a place.

Items for Next Meeting

[Seth Shanahan, SNWA and TWG Chair]

- Stand up the new Smallmouth Bass Ad Hoc Group (SBAHG); the member list is on the [website](#).
- Request for review of the monitoring metrics document by July 1 and to provide feedback on the tabletop report although there will not be a revision to the document.
- Is there a razorback augmentation effort that would occur before October? Kirk Young confirmed there was an analysis of effects and a take statement in the BiOp.
- Comments on the TMF paper are due by September 15. Document will be posted to the website under the June meeting materials.
- Ben Reeder will make available his report on the Grand Canyon River Guides' Adopt-a-Beach Program.
- Questions to Rod Smith about the volume of water that will be released. **ACTION:** Clarence Fullard will follow up on those questions.

[Jim Strogen, FFI/TU] When will the in-person meetings return? **[Seth Shanahan, SNWA and TWG Chair]** Maybe January for the TWG. **[Clarence Fullard, Reclamation]** The August AMWG will be virtual, and it is likely that the October TWG meeting will be virtual, too. The Programmatic Agreement meeting in August can be in person. The issue is when there will be more than 50 people in attendance. **[Tara Ashby, Reclamation]** However, if COVID rates are high, Reclamation cannot have in-person meetings.

[Leslie James, CREDA] Seeing a lot of communication in the utility industry about grid reliability this summer. **[Seth Shanahan, SNWA and TWG Chair]** **ACTION:** Leslie James had also requested a conversation on Project N.

[Helen Fairley, GCMRC] **ACTION:** Depending on comments received, there might be a need to discuss comments received on the monitoring metrics.

Public Comment

No public comment.

Meeting adjourned at 3:11 PM PST

TWG Members and Alternates

Cliff Barrett, UMPA

Rob Billerbeck, NPS-GLCA

David Brown, GCRG

Daniel Bullets, Southern Paiute Consortium

Ryan Mann, AZGFD

Scott Mcgettigan, State of Utah

Betsy Morgan, State of Utah

Jessica Neuwerth, CRBC

Kelly Burke, GCWC
Shane Capron, WAPA
Colleen Cunningham, NMISC
William "Bill" Davis, CREDA
Laura Dye, CRCN
Kurt Dongoske, Pueblo of Zuni
Sinjin Eberle, American Rivers
Craig Ellsworth, WAPA
Mel Fegler, State of Wyoming
Clarence Fullard, Reclamation
Michelle Garrison, State of Colorado
Emily Higuera, AZDWR
Leslie James, CREDA
Jakob Maase, Hopi Tribe

Emily Omana Smith, NPS-GRCA
Kerri Pedersen, Reclamation
William "Bill" Persons, FFI/TU
Shana Rapoport, CRBC
Ben Reeder, GCRG
Peggy Roefer, CRCN
David Rogowski, AZGFD
Seth Shanahan, SNWA
Erik Skeie, State of Colorado
Larry Stevens, GCWC
Erik Stanfield, Navajo Nation
Gary Tallman, FFI/TU
Kirk Young, USFWS

AMWG Members, Alternates, and Leadership

Richard Begay, Navajo Nation
Julie Carter, AZGFD
John Jordan, FFI/TU

Daniel Picard, Acting DFO, Reclamation
Wayne Pullan, DOI
Jim Strogon, FFI/TU

USGS/GCMRC Staff

Lucas Bair
Bridget Deemer
Helen Fairley
Ted Kennedy
Teo Melis

Michael Moran
Joel Sankey
Scott VanderKooi
Charles Yackulic

Reclamation Staff

Tara Ashby
Kathy Callister
Dale Hamilton
Dave Isleman

Dagmar Llewellyn
Heather Patno
Jamescita Peshlakai
Zachary Nelson

Interested Persons

David Braun, Sound Science LLC
Kevin Bullets, Southern Paiute Consortium
Brooke Damon, NAU
Martina Dawley, Hualapai Tribe
Bud Fazio, NPS
Barrett Friesen, USU
Carlinae Johnson, SeaJay Environmental
Ronan King, NPS
Josh Korman, Ecometric
Karen Kwon, CO River Sustainability Campaign

Kevin McAbee, USFWS
David McIntyre, SeaJay Environmental
Mckenna Murray, State of Utah
Michael Pillow, USFWS
Ted Rampton
David Rheinheimer, CRBC
Pilar Wolters Rinker, USFWS
Gene Seagle, NPS
Rod Smith, DOI Solicitor's Office
Melissa Trammell, NPS

Abbreviations

af – acre-feet
AMWG – Adaptive Management Work Group
AZDWR – Arizona Department of Water Resources
AZGFD – Arizona Game and Fish Department
BAHG – Budget Ad Hoc Group
BiOp – Biological Opinion
CPUE – catch per unit effort
CRAB – Colorado River Aquatic Biologists
CRBC – Colorado River Board of California
CRCN – Colorado River Commission of Nevada
CREDA – Colorado River Energy Distributors Association
CWCB – Colorado Water Conservation Board
DOI – Department of the Interior
DROA – Drought Response Operations Agreement
e-DNA – environmental DNA
EPA – (United States) Environmental Protection Agency
FFI – Fly Fishers International
FY – Fiscal Year
GCDAMP – Glen Canyon Dam Adaptive Management Program
GCMRC – Grand Canyon Monitoring & Research Center
GCRG – Grand Canyon River Guides
GCWC – Grand Canyon Wildlands Council
GI – gastrointestinal
HFE – High Flow Experiment
JCM-West – Juvenile Chub Monitoring-West
LTEMP – Long-Term Experimental and Management Plan
maf – million acre-feet
MOA – Memorandum of Agreement
NEPA – National Environmental Policy Act
NMISC – New Mexico Interstate Stream Commission
NPS – National Park Service
NPS-GLCA – Glen Canyon National Recreation Area
NPS-GRCA – Grand Canyon National Park
PA – Programmatic Agreement.
PDT – Pacific Daylight Time
PI Team – Project Implementation Team
Reclamation – Bureau of Reclamation
RM – river mile
SBAHG – Smallmouth Bass Ad Hoc Group
SCAHG – Steering Committee Ad Hoc Group
SEAHG – Socioeconomics Ad Hoc Group
SNWA – Southern Nevada Water Authority

TMF – Trout Management Flows
TU – Trout Unlimited
TWG – GCDAMP Technical Work Group
USFWS – United States Fish & Wildlife Service
USGS – United States Geological Survey
USU – Utah State University
UV – ultraviolet
WAPA – Western Area Power Administration
WY – Water Year