April 8, 2022

To: Glen Canyon Leadership Team for Implementation of Experiments under the Long Term Experimental and Management Plan (LTEMP)

From: LTEMP Planning/Implementation Team

Re: Final Recommendation to Implement Experimental Macroinvertebrate Production Flow Releases ("Bug Flows") at Glen Canyon Dam in Water Year 2022

I. Recommendation Summary

The LTEMP Planning/Implementation Team (PI Team) recommends that experimental Macroinvertebrate Production Flows ("Bug Flows") be implemented at Glen Canyon Dam beginning May 1 through August 31, 2022. This recommendation does not reflect consensus: the Western Area Power Administration (WAPA) has substantial concerns with implementing a Bug Flows experiment in 2022 and does not support the recommendation; Arizona and New Mexico abstained; and the U.S. Fish and Wildlife Service and Arizona Game and Fish Department were not present for final deliberations.

The PI Team has determined the Bug Flows experiment has the potential to improve food base productivity and aquatic insect diversity, with consequent benefits to native fish and ecosystem health also likely. The Science Advisors concluded that Bug Flows appeared to have met the experimental objectives described in the LTEMP (i.e., improve food base productivity and insect diversity) and that reducing uncertainties through additional experimentation would inform future design considerations.

The PI Team also identified the potential for adverse effects to the hydropower resource. Using forecasted energy prices obtained in March 2022, the Western Area Power Administration estimates that the expense of a Bug Flows experiment in 2022 would be approximately $1.4M based on current data. The PI Team defers the determination of whether these effects are unacceptable to the Leadership Team and to the Department of the Interior.

In recognition of uncertainty in WY 2022 hydrology, annual and monthly operations, and resource conditions, the PI Team would meet bi-weekly beginning the week of May 1st and continuing throughout implementation of the Bug Flows experiment to evaluate whether new conditions or unanticipated negative impacts have occurred or are likely to occur. Items that may warrant the PI Team to consider recommending termination of implementation include, but are not limited to:

- Detection of juvenile smallmouth bass in Lees Ferry and/or observations that indicate the Bug Flows experiment could benefit smallmouth bass.
- An increase to the estimated cost of the Bug Flows experiment to more than double the current estimated cost (i.e. an increase from $1.4M to $2.8M or more) that may result

from increases in forecasted energy prices relative to the March 2022 estimate or other unforeseen factors.

- A decrease in annual or monthly release volumes from May through August

The Secretary of the Interior or her Designee will consider the recommendations of the PI Team, including those to terminate implementation of an experiment, but retains sole discretion to decide how best to accomplish operations and experiments in any given year pursuant to the ROD and other binding obligations.

Finally, the PI Team recommends further consideration by the GCDAMP to refine hypotheses, specify measures of success, and explore potential design improvements for the Bug Flows experiment. Such consideration would be subject to direction from the Secretary's Designee and pursued in a manner consistent with the operating procedures of the AMWG and the TWG.

The purpose of this memorandum is to transmit these technical recommendations regarding 2022 implementation of the Bug Flows experiment to the Glen Canyon Leadership Team for Implementation of Experiments (Leadership Team) under the LTEMP and to DOI in accordance with the LTEMP Record of Decision (ROD). The PI Team includes technical representatives from National Park Service (NPS), U.S. Fish and Wildlife Service (Service), the Bureau of Indian Affairs (BIA), U.S. Geological Survey (USGS) Grand Canyon Monitoring and Research Center (GCMRC), the Bureau of Reclamation (Reclamation), WAPA, Arizona Game and Fish Department (AZGFD), and one liaison from each of the seven Colorado River Basin States (States) and the Upper Colorado River Commission (UCRC).

In January 2022, the PI Team began meeting regularly to discuss LTEMP flow experiments with the potential for implementation in 2022. Deliberations specific to the Bug Flows experiment took place from mid-February through mid-April, with a recommendation targeted for Friday, April 8. The PI Team evaluated the potential implementation of the experiment, including the latest data from agency experts, and considered multiple issues in making its recommendations, as summarized below. The Secretary of the Interior or her Designee will consider the recommendations of the PI Team but retains sole discretion to decide how best to accomplish operations and experiments in any given year pursuant to the ROD and other binding obligations.

II. Introduction

Bug Flows are a flow experiment that consists of steady, low weekend releases from Glen Canyon Dam and normal fluctuating releases for hydropower during weekdays. The purpose of these experimental flows is to identify whether this type of operation can improve the abundance, diversity, and stability of aquatic insect populations, thereby increasing aquatic insect prey available for endangered humpback chub *(Gila cypha*), other native fishes, and the sportfish rainbow trout (*Oncorhynchus mykiss*), as well as for terrestrial wildlife such as bats, lizards, and birds. Table 4 in Appendix B of the LTEMP ROD summarizes implementation criteria for LTEMP experiments, and an excerpt of the criteria for Bug Flows is provided below (**Table 1**).

Table 1. LTEMP Implementation Criteria for the Bug Flows Experiment

Experimental Treatment	Trigger[a] and Primary Objective	Replicates	Duration	Annual Implementation Considerations[b]	Long-Term Off-Ramp Conditions[c]	Action if Successful
Aquatic Resource-Related Experiments (Cont.)						
Macroinvertebrate production flows	Trigger: None Objective: Improve food base productivity and abundance or diversity of mayflies, stoneflies, and caddisflies	Target two to three replicates	Up to 4 months (May–Aug.)[g]	Potential short-term unacceptable impacts on resources listed in Section 1.3; coordinate planning with other experiments to avoid confounding conditions or results	Steady weekend flows have little or no benefit on food base, trout fishery, or native fish; increase in warmwater nonnative species or trout at the Little Colorado River; or long-term unacceptable adverse impacts on the resources listed in Section 1.3 are observed	Implement as adaptive treatment in target months when conditions allow

a Triggers will be modified as needed during the 20-year LTEMP period in an adaptive manner through processes including ESA consultation and based on the best available science utilizing the experimental framework for each alternative.

b Annual determination by the DOI. Any implementation will consider resource condition assessments and resource concerns using the annual processes described in Sections 1.3 and 1.4.

c Suspension of experiment if the DOI determines effects cannot be mitigated.

g The duration and other characteristics of experimental macroinvertebrate production flows could be adjusted based on the results of initial experiments.

Source: 2016 LTEMP ROD, Appendix B, Table 4 – Implementation Criteria for Experimental Treatments of Alternative D

The Bug Flows experiment was implemented at Glen Canyon Dam from May through August for three consecutive years: 2018, 2019, and 2020. The steady weekend flows of Bug Flows were originally conceived as a means of providing more favorable conditions for aquatic insects to lay eggs along the Colorado River downstream from Glen Canyon Dam. These weekend flows are designed to be similar to daily minimum flows on the weekdays. This flow regime eliminates stage change in the river on the weekends, thus preventing aquatic insect eggs laid along the river margins from drying out. Additional research indicates that the more stable, lower weekend flows provided by Bug Flows also increase gross primary production (GPP) of algae in the river and promote enhanced emergence of adult aquatic insects on weekends. These effects are thought to both increase the food available for aquatic insect larvae and promote increased egg laying during these more favorable low flow conditions. As such, the steady low flow conditions provided on weekends during Bug Flows may have further, synergistic effects on aquatic insect populations beyond their original focus solely on reducing egg mortality.

III. Recent Findings: Synthesis Report and Science Advisors Review

The experiment was initially conceived by GCMRC scientists, as stated in the LTEMP, as targeting two to three consecutive years as a test of the original egg-laying hypothesis. Following these three consecutive years of Bug Flows implementation, the PI Team recommended against implementing Bug Flows in 2021. The recommendation was driven by multiple factors including estimated increases in the cost of the experiment to the hydropower resource relative to prior years and by the stakeholders' desire to have GCMRC synthesize knowledge and learning from the first three replicates of the Bug Flows experiment before undertaking additional experimentation. The PI Team identified several "next step" action items that would support its consideration of Bug Flows in future years.

To inform discussion of potential future implementation of the Bug Flows experiment, the PI Team recommends, by consensus, the following next steps for DOI to consider:

- *The PI Team commits to document its considerations in a memo to DOI and the LTEMP Leadership Team.*
- *Request that GCMRC state resource implications for non-implementation of Bug Flows in water year 2021.*
- *Request that GCMRC complete a report by January 2022 summarizing experimental findings and discuss how the observations of non-implementation compared to the predictions.*
- *Request that WAPA provide additional information regarding purchase power cost estimates, including assumptions and uncertainty, such that effects to hydropower are minimized if Bug Flows are implemented in the future.*
- *Request that the Science Advisors Program establish and convene an independent review panel to evaluate the Bug Flows experiment in achieving its objective and to develop opportunities for further experimentation.*

Each of these actions items has been completed in preparation for 2022 PI Team discussion. GCMRC produced a synthesis report in fall 2021 and workshops were convened through the GCDAMP Science Advisor Program to discuss their findings with a panel of four internationally recognized freshwater science advisors. These workshops took place on October 28 and November 4, 2021 and featured presentations, question-and-answer periods, and discussions that included stakeholders. Key findings from the Bug Flows synthesis report included:

1. Approximately 25% greater emergence of adult aquatic insects (midges) from the Colorado River during steady weekend Bug Flows compared to weekday fluctuating releases (i.e., canyon-wide average of 161 midges/hr for weekdays compared to 207/hr for weekends, a statistically significant difference).
2. The abundance of caddisflies increased by 400% riverwide in two of three years that Bug Flows were conducted. Caddisflies have been rare in Grand Canyon and improving conditions for them was a primary objective of the experiment. These increases are statistically significant (e.g., error bars for these years do not overlap at all with years from pre-Bug Flows baseline) but cannot be definitively attributed to the Bug Flows experiment owing to confounding of these years with low sediment conditions that are also favorable to aquatic insects (see discussion in *Status of Resources*, below, for additional information).
3. Modeling prior to the experiment suggested that a ~30% increase in non-biting midges, a common type of aquatic insect, might be realized riverwide if Bug Flows was successful. However, contrary to predictions, no increases in the abundance of midges were observed during the three-year Bug Flows experiment compared to pre-Bug Flows baselines across multiple long-term datasets (i.e. invertebrate drift data spanning 2008-2020, community science light trap data spanning 2012-2020).

4. Algae production increased by 56% in Marble and Grand Canyon during Bug Flows, resulting in an additional 200 metric tons of algae-carbon per year to sustain food webs.
5. Anglers captured an average of 1.7 more rainbow trout per day during Bug Flows compared to weekday fluctuating flows in a study of volunteer anglers conducted by GCMRC (average of 5.1 trout per angler during weekday flows compared to 6.8 trout per angler during weekend flows, which is a statistically significant difference).

The Science Advisor panel submitted their review of the Bug Flow experiment and synthesis report to Reclamation on January 4, 2022. The Science Advisors provided varied advice on the analyses and monitoring carried out by GCMRC scientists and suggested potential alterations to the design and implementation of Bug Flows moving forward. GCMRC is currently preparing an updated synthesis report based on the recommendations of the Science Advisor panel; see *Section V. Assessment of Resources*, for additional analysis of monitoring data from the experiment. However, throughout this diverse feedback and suggestions for improvements, there was uniform support from the Science Advisors for additional replicates of the Bug Flows experiment. This recommendation by the Science Advisors for additional replicates was grounded in their conclusion that 1) Bug Flows were successful at achieving experimental objectives stated in the LTEMP to "Improve food base productivity and abundance or diversity of mayflies, stoneflies, and caddisflies," and 2) additional replicates would reduce uncertainties concerning treatment effects on aquatic insects and underlying mechanisms.

As noted by the Science Advisors, a fourth replicate of the Bug Flows experiment would help address key uncertainties remaining from the first three years of Bug Flows by further disentangling the effects of hydroclimatic and other physical conditions from experimental flow conditions, particularly as they relate to aquatic insect response. Identifying linkages between Bug Flows and native fish populations is central to the long-term goals of Bug Flows as stated in the LTEMP.

IV. LTEMP Process for Implementing Experiments

The 2016 LTEMP ROD provides the framework for implementing flow experiments at Glen Canyon Dam. The purpose of LTEMP experiments is to leverage adaptive management to better protect, mitigate adverse effects, and improve resources downstream of Glen Canyon Dam, while complying with relevant laws. Ongoing research and monitoring through the Glen Canyon Dam Adaptive Management Program (GCDAMP) ensures the best science and data are available for making decisions related to flow experiments.

Under the LTEMP ROD, the DOI may conduct flow experiments, such as Bug Flows, at Glen Canyon Dam when resource conditions warrant and if it is determined that there will not be unacceptable adverse impacts to other resources.

> *Prior to implementation of any experiment, the relative effects of the experiment on the following resource areas will be evaluated and considered: (1) water quality and water delivery, (2) humpback chub, (3) sediment, (4) riparian ecosystems, (5) historic properties and traditional cultural properties, (6) Tribal concerns, (7) hydropower*

production and WAPA's assessment of the status of the Basin Fund, (8) the rainbow trout fishery, (9) recreation, and (10) other resources.

--P. B-8, Implementation Process for Experiments Under Alternative D, 2016 LTEMP ROD

The process for recommending experiments under the LTEMP, which has been used for past experiments and has been followed here, involves outreach to GCDAMP partners through regular meetings and additional notification to Tribes inviting consultation. The process also involves coordination with the PI Team to plan for the possible experiment, evaluate the status of resources, and make the technical recommendation of whether to conduct an experiment. The PI Team presents its recommendation to the Leadership Team, which makes a recommendation to DOI. The Secretary's Designee to the Adaptive Management Work Group (AMWG) is the chair of the Leadership Team and may make the decision for DOI regarding the experiment, as delegated by the Secretary of the Interior.

V. Hydrologic and Operational Uncertainty

Lake Powell elevation as of March 5, 2022, was 3,523.02 feet, which is below the critical elevation threshold of 3,525 feet outlined in the Drought Response Operations Agreement. Elevation 3,525 feet provides a 35-foot buffer prior to reaching the minimum power pool elevation of 3,490 feet. The April 2022 final inflow forecast of 4,100 thousand acre-feet (kaf) is 64 percent of average and decreased 500 kaf in volume from the forecast provided the prior two weeks. Conditions are expected to worsen over the summer with continued warm and dry conditions and Reclamation's 2-year Colorado River Mid-term Modeling System projections indicate that Lake Powell could drop below 3,490 feet before the end of this calendar year – leading to cessation of all hydropower at Glen Canyon Dam. For these reasons, considerable uncertainty exists regarding operations of the Initial Unit facilities in the Upper Colorado Basin (Flaming Gorge, Blue Mesa, Navajo and Glen Canyon Dams) for the remaining months of water year 2022. For the purposes of this technical assessment, the total annual release volume from Glen Canyon Dam in water year 2022 is assumed to be 7.48 million acre-feet (maf). Operational adjustments may occur at Glen Canyon Dam that require additional coordination and analyses of alternatives by the PI Team to determine if continued implementation makes sense under changing conditions.

VI. Hydrograph Alternatives

By releasing stable and low flows every weekend, Bug Flows are intended to provide two days of ideal egg-laying conditions each week for aquatic insects that lay their eggs along river margins (Kennedy and others, 2016, Miller and others, 2020). From 2018-2020, technical experts at GCMRC and WAPA coordinated the design of the experiment to optimize the benefits for aquatic insects throughout Glen, Marble, and Grand Canyons (the Canyon) while minimizing negative impacts to hydropower. In 2019 and 2020, a Bug Flows hydrograph that incorporated weekend steady low flow releases that were 750 cubic feet per second (cfs) higher than weekday low flow releases in all months (May – August) was implemented (see **Figure 1**). This flow is similar to the Bug Flows hydrograph implemented in 2018, when a 1,000 cfs increase on weekends was implemented. Models of egg-laying developed by GCMRC technical experts indicated that hydrographs featuring this type of weekend offset would optimize insect egg-

laying benefits at sites around the Little Colorado River confluence and sites downstream while a hydrograph without this offset (i.e., H0) would optimize egg-laying benefits in Glen Canyon near the dam and these benefits would diminish in the downstream direction. A hydrograph with a negative offset (H-250) would not optimal benefits at any sites, where optimal is defined as no difference between weekend steady flows and weekday daily minimums.

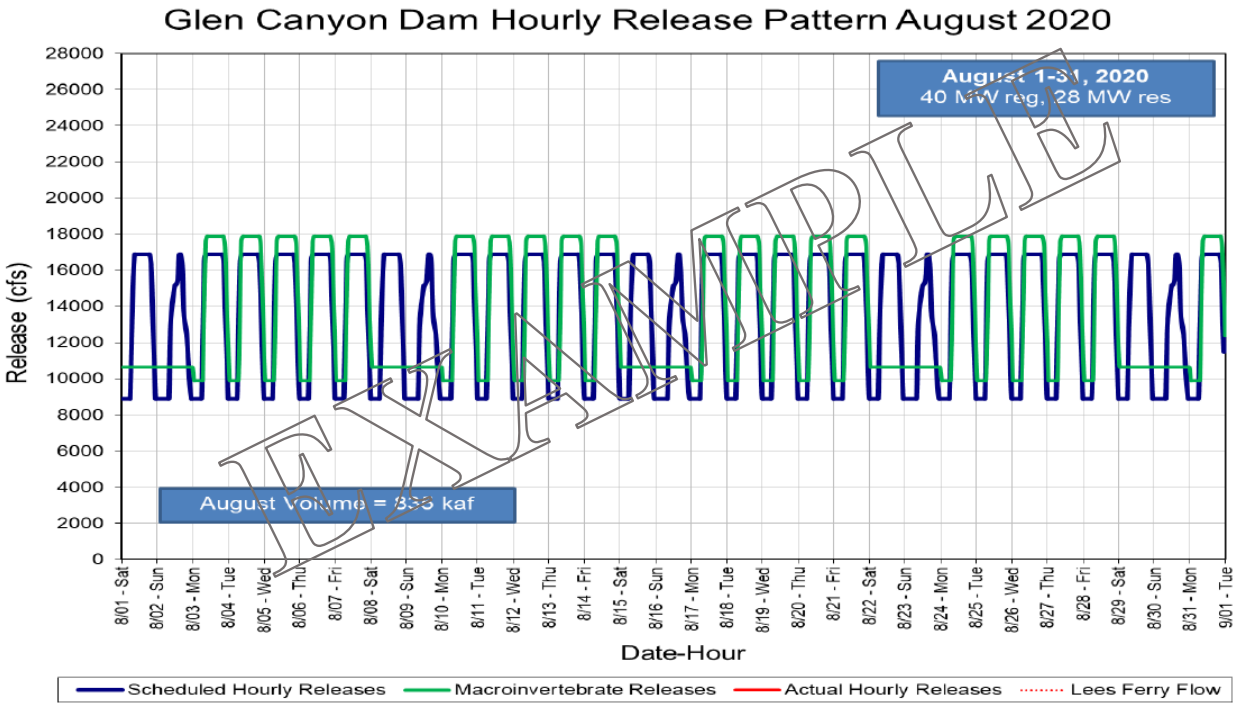

Figure 1. Example hydrograph from August 2020 under base operations (no Bug Flows, dark blue) and Bug Flows (H750, green) scenarios.

In response to concerns regarding the rising cost of the experiment, particularly estimated purchase power costs, GCMRC and WAPA proposed three hydrograph alternatives that had potential to reduce negative impacts to hydropower while still meeting objectives for ecosystem benefits and learning. These alternatives shifted the weekend offset with variations surrounding the base operations scenario for the May through August period (see Figure 2 and Table 2). WAPA provided a cost estimate for each alternative relative to base operations releases during the May through August bug flow implementation window (see **Figure 3**). The H750 alternative provides scientific replication as recommended by the science advisors at an increased cost of approximately $180,000 as compared against the H-250 alternative and $170,000 as compared against the H1 alternative.

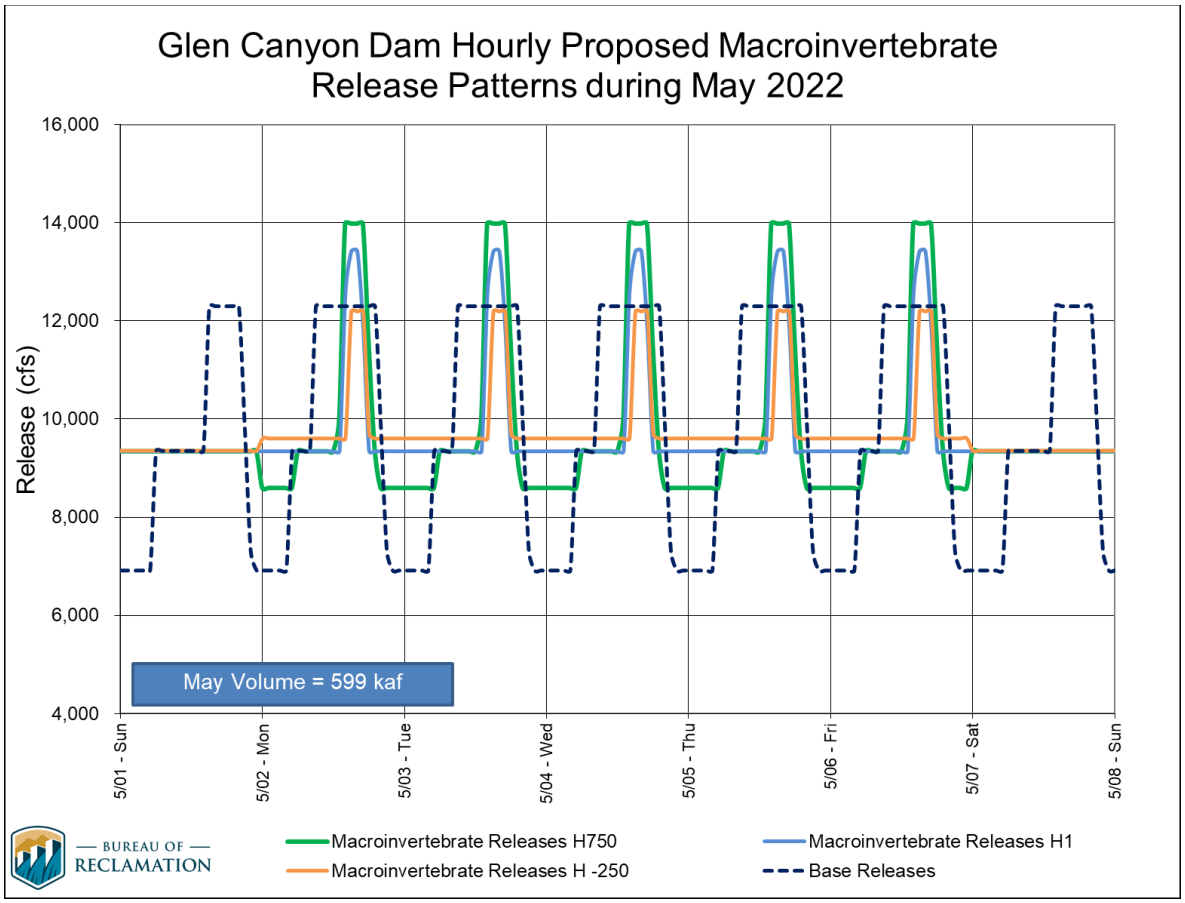

Figure 2. Example hydrograph from May 2022 under base operations (no Bug Flows, dark blue dashes); H750 Bug Flows (green); H1 Bug Flows (light blue); and H -250 Bug Flows (orange) scenarios.

Month	Base Min Release (cfs)	Base Max Release (cfs)	H1 Min Release (cfs)	H1 Max Release (cfs)	H-250 Min Release (cfs)	H-250 Max Release (cfs)	H750 Min Release (cfs)	H750 Max Release (cfs)
May	6,910	12,301	9,350	13,427	9,350	12,196	8,600	13,991
June	7,621	14,401	9,350	16,130	9,350	16,380	8,600	15,380
July	9,037	17,037	9,851	17,851	9,710	17,960	9,585	17,585
August	9,453	17,453	10,119	18,119	9,904	18,540	10,119	18,119

Table 2. Summary of bug flow hydrograph alternatives considered and the minimum and maximum hourly releases under the base operations (no bug flows), H1, H-250, and H750 bug flow alternatives.

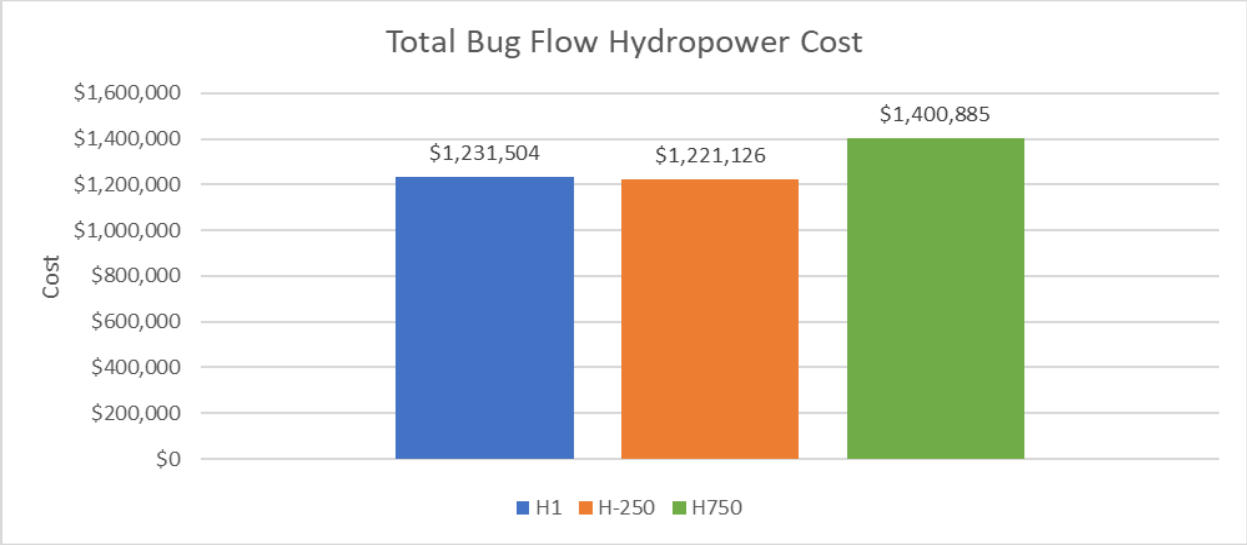

Figure 3. Cost estimate for each Bug Flows hydrograph relative to the base operations scenario for H1 Bug Flows (light blue), H -250 Bug Flows (orange) and H750 Bug Flows (green) in millions of dollars.

VII. Assessment of Resources

This section summarizes the assessment of resources and expected effects of a Bug Flows experiment.

Aquatic foodbase

The objective of the Bug Flows experiment as described in LTEMP is to, "Improve food base productivity and abundance or diversity of mayflies, stoneflies, and caddisflies." The design of the Bug Flow experiment was informed by GCMRC research showing load following operations create a life history bottleneck for aquatic insects through acute mortality of insect eggs. The design of the Bug Flows experiment was also informed by ecological insights and hydropower impacts of prior steady flow experiments in 2000 and 2008-2012. The 2000 experiment involved 120 days of steady flow during summer months, but had a major impact on the hydropower resource. The 2008-2012 experiment involved 60 days of steady flow per year from September-October. This experiment reduced impact to the hydropower resource compared to the 2000 experiment, but benefits to biological resource responses were somewhat constrained because natural processes and biological activity are natural in decline at this time of year. Thus, the Bug Flow experiment sought to mitigate egg mortality caused by daily fluctuations in the least impactful and most cost-effective way possible while still targeting months of high biological activity and rates of natural processes. The purpose of the Bug Flows experiment is to provide favorable egg laying conditions during weekends from May-August, when egg laying activity is highest and hydropower impacts of steady flows are reduced compared to weekdays.

In 2018 and prior to Bug Flows implementation, GCMRC technical experts developed predictions that would be used to evaluate success of a three-year test of the Bug Flows experiment. These included the predictions that, over a three-year experiment, **a)** midges would exhibit modest increases and **b)** caddisflies would exhibit major increases. Contrary to

predictions, midge abundance did not increase during the 3-year experiment (see **Figure 4**) but consistent with predictions, a 400% increase in caddisflies was measured in two of three Bug Flow years compared to the pre-Bug Flow baseline. The large increase in caddisflies was noteworthy and highlighted in GCMRC's synthesis report, because it directly supports the LTEMP objective to "*Improve…abundance or diversity of…caddisflies.*"

Monitoring and modeling from 2018-2019 also demonstrated that water clarity and subsequently the rate of algae production increased during the Bug Flows experiment (COVID-19 prevented this same data collection in 2020); algae is the foundation of aquatic food webs and a primary food for aquatic insects and some native fish. During weekends when Bug Flows were conducted, an increase in rates of algae production of roughly 56% canyon-wide was observed compared to weekday rates. This increase in algae production on clear-water weekends in May and June conservatively translates to an additional 200 metric tons of algae energy available per year to sustain aquatic food webs. This ecosystem benefit is noteworthy and was highlighted in GCMRC's synthesis report.

In 2021 following cessation of Bug Flows, the abundance of midges captured in community science light traps declined by 50% while the abundance of caddisflies declined by 25% relative to the preceding year (note that caddisfly abundance in 2021 remained above the pre-Bug Flows baseline). Multiple environmental (e.g., suspended sediment, water temperature, nutrients, GPP) and flow drivers affect aquatic insect populations and abundance measured in light traps. Suspended sediment concentrations in particular were a major explanatory variable of insect growth rates (timing of emergence) and insect abundance (average catch rate in light traps) from 2012-2020, low suspended sediment and Bug Flow treatments and large increase in caddisflies observed in 2018 and 2020. Thus, with only the data from 2012-2020, it was impossible to fully disentangle the role of low sediment from Bug Flow treatment effects in driving caddisfly increases in these years. In other words, the experimental design matrix was somewhat confounded, where the design matrix refers to the unique combination of environmental conditions that occurs during a given year of the experiment or during "control years" when the experiment is not conducted. Sediment conditions in 2021 were lower than 2018 and 2020 but Bug Flow treatments were ceased, which means that 2021 improved the design matrix and helped disentangle sediment from Bug Flow effects. The decline in midge and caddisfly abundance that were documented in 2021 despite favorable sediment conditions provides additional evidence that the 2018-2020 Bug Flows was likely supporting insect populations. GCMRC technical experts and cooperators at Oregon State University are developing life history model for aquatic insects that will more rigorously quantify these interpretations of light trap data, including quantitatively disentangling the role of environmental drivers (ie. nutrients, GPP, sediment, water temperature) from the effects of Bug Flow treatments in influencing aquatic insect population dynamics.

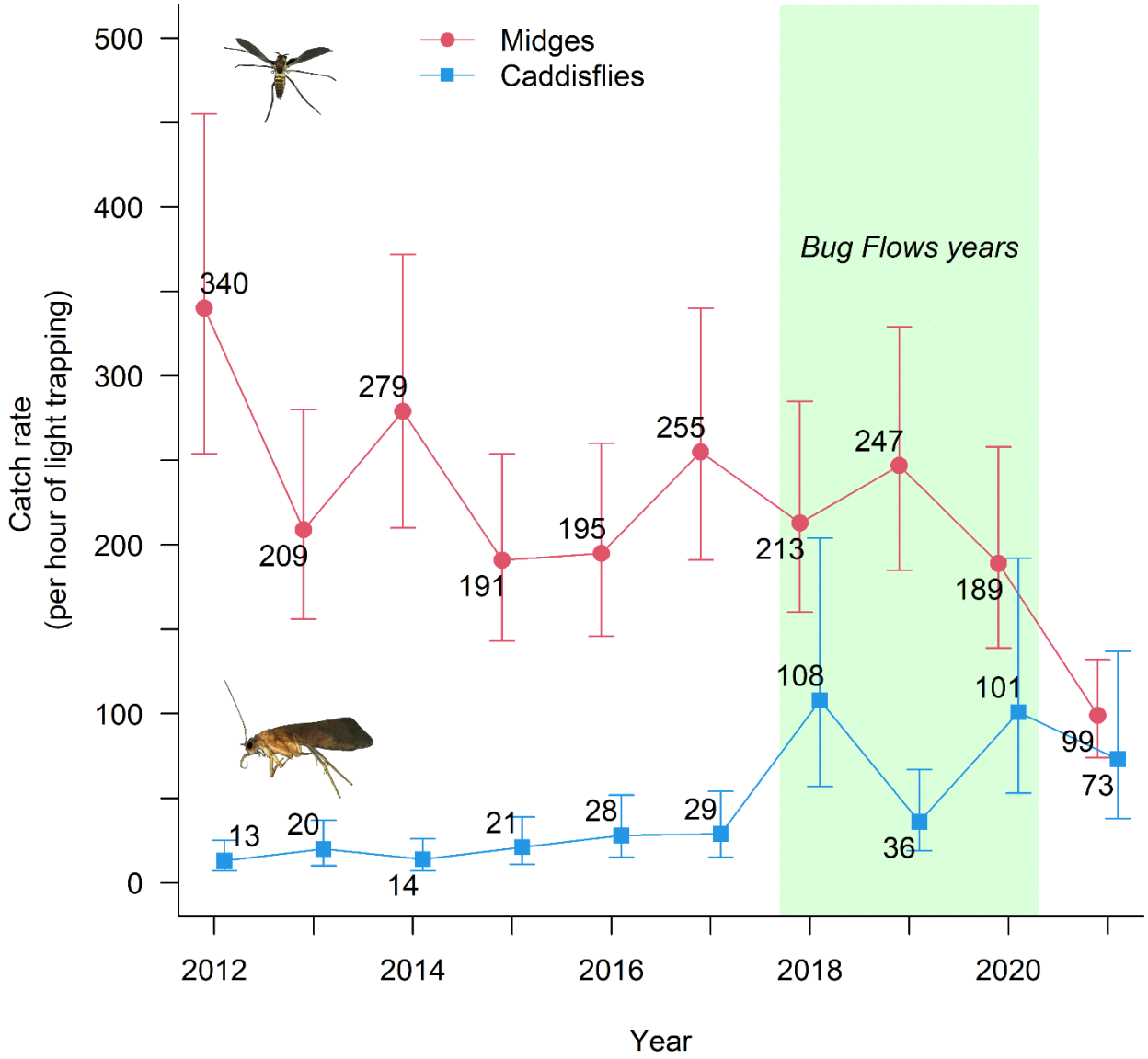

Figure 4. Graph showing abundance of key aquatic insects (midges and caddisflies) captured in community science light traps prior to Bug Flows (2012-2017), during Bug Flows (2018-2020), and one year after discontinuation (2021). During 2018-2020 Bug Flows, caddisfly abundance increased by as much as 400% compared to the pre-Bug Flow baseline while midge abundance remained unchanged. In 2021 following cessation of Bug Flows, midge abundance declined by 50% and caddisfly abundance declined by 25% relative to the prior year, although caddisfly abundance remained above the pre-Bug Flows baseline. Data are based on a mixed effects model of aquatic insect abundances that includes the geomorphic reach, month, and year in which the sample was collected, and error bars are one standard error from the mean. *Provisional data, do not cite.*

Invasive species

Nonnative invasive species were not predicted to benefit from the Bug Flows experiment, but large increases in the abundance of invasive Brown Trout in Glen Canyon starting around 2013 and through 2020 led to a reevaluation of this prediction during 2021 PI Team discussions.

Subsequent analysis of Brown Trout data demonstrated that these Brown Trout increases were unlikely to be arising because of Bug Flows (Yackulic and others, 2021).

Warm-water invasive fish such as smallmouth bass are of great concern to managers. Warm-water invasives have been absent or maintained at low levels within the Colorado River in Glen, Marble, and Grand Canyons largely because of cool water temperatures that are well below optimal for growth and reproduction. However, low elevations in Lake Powell reservoir have increased the likelihood of passage of smallmouth bass and other warm-water invasives to the downstream ecosystem; increased water temperatures have also increased the likelihood of smallmouth bass and other warm-water invasives becoming established in Grand Canyon moving forward.

Expert opinion among multiple fishery biologists on the Smallmouth Bass Task Force is that testing Bug Flows in 2022 would only lead to a small increase in the likelihood of smallmouth bass establishment, with fish passage and water temperatures being the biggest factors determining whether smallmouth bass become established. The predicted increases in GPP and aquatic insect diversity associated with Bug Flows may provide some small benefits to smallmouth bass in the event that passage increases and water temperatures are well-suited, but increases in GPP or aquatic insect diversity arising from Bug Flows are unlikely to be a determinative factor in whether smallmouth bass become established compared to degree of passage and temperature. Additionally, improvements in GPP and insect diversity that are predicted with Bug Flows are expected to benefit native fish populations including humpback chub, whose populations are limited by the low abundance and diversity of aquatic insect food resources in some segments and times of year (Cross and others, 2013).

Endangered humpback chub and other native fish abundance

Although the humpback chub population in the Little Colorado River aggregation is above the Tier-1 threshold of 9,000 adults identified in the Biological Opinion for the LTEMP EIS, the 3-year average of sub-adults has been below the trigger for the last two years. Specifically, the 3-year average (2019-2021) of juvenile humpback chub in the Colorado River mainstem from river mile 63.45-65.2 was estimated at 433, which is well below the 810 necessary to prevent requirements to take additional action. In response to the trigger, 535 humpback chub were translocated above Chute Falls in 2021 where fish generally grow faster and have higher survival rates. Although the translocation action is expected to improve humpback chub survival in the long-term, an immediate impact on the trigger was not expected. The humpback chub population continues to be monitored and additional conservation actions will be planned in the spring once larval recruitment data are available.

A long-term goal of Bug Flows is to have a positive, indirect effect on humpback chub and other native fish through increases in the diversity and production of aquatic insects that are the primary prey for these fish. Year-to-year variation in water temperature, sediment, and nutrients affects native fish growth and should be accounted for before quantifying the marginal effect of Bug Flows. Additional testing of the Bug Flow experiment in 2022 combined with planned studies of native fish diets and feeding habits will help identify whether enhancements to natural processes that have been documented during Bug Flows experimentation (i.e, increased GPP,

increased caddisfly abundance) are contributing to native fish growth and production. Recent modeling shows that Flannelmouth sucker growth is positively related to GPP. The springtime (May and June) increase in GPP due to Bug Flows is estimated to have increased the growth of individual Flannelmouth suckers by about 1.6 mm per month (Hansen, 2021). Further, additional years of Bug Flow experimentation combined with robust mark-recapture studies of native fish vital rates (i.e., Juvenile Chub Monitoring-JCM) will allow GCMRC to quantify the effect of Bug Flows on humpback chub vital rates including growth and survival.

Hydropower production, marketable capacity, and Basin Fund status

WAPA has firm electric power contracts and must meet these contract amounts either with generation from Colorado River Storage Project powerplants or from purchases from the wholesale electrical market. During the Bug Flows experiment, low volume releases from Glen Canyon Dam during the weekend require WAPA to purchase extra electric power to meet contract amounts. Some of these expenses are offset with extra electrical production during the weekdays. Using forecasted energy prices obtained in March 2022, WAPA estimates that the expense of a Bug Flows experiment in 2022 would be about $1,401,000 based on current data. This is roughly four times the amount of prior year cost estimates, as shown in **Table 3**, and is a direct result of the projected high energy prices and the difference between the on and off peak, particularly in July and August. Over the course of the last three years we have seen this trend in energy price increases, as seen in Table 3 as well.

Table 3. Estimated and Actual Purchase Power Costs Associated with the May to August Bug Flows Experiment Relative to Standard Operations at Glen Canyon Dam

Implementation Year	Estimated Cost	Actual Cost
water year 2018	$335,000	$165,000
water year 2019	$332,000	$327,000
water year 2020	$407,000	$1,200,000
water year 2021	$1,021,000	N/A
water year 2022	$1,401,000	N/A

Summer energy prices are uncertain and may be impacted by a reduction in baseload capacity in the West.

WAPA projects that the Upper Colorado River Basin Fund will have a balance of $83M at the end of fiscal year 2022. This projection considers the decrease in funding requirements for BOR, no non-reimbursable funding for environmental programs, and does not include any potential funding from the Bipartisan Infrastructure Law (BIL). The Basin Fund balance does not meet WAPA's target for an end of year balance.

Rainbow Trout fishery

The LTEMP ROD suggests that the Bug Flows experiment may have an indirect effect on the Lees Ferry rainbow trout fishery through increases in the diversity and production of aquatic insects, which are an important prey item for these fish. Formal analysis and modeling of rainbow trout growth and condition data suggest that climatic drivers are having a stronger effect on fish vital rates than Bug Flows over the period of record (2011-2021); Korman unpublished

manuscript). The analysis also shows how Bug Flows are confounded with phosphorus concentrations since all three years where Bug Flows were conducted were low phosphorus years. Preliminary results suggest that Bug Flows have a weak positive effect on rainbow trout growth in length. The effect on growth could be made more certain if Bug Flows were conducted during a year where springtime phosphorus concentrations in Glen Canyon were higher; it is unclear whether 2022 will have low or high phosphorus concentrations.

To assess whether the 2018-2019 Bug Flows experiment had a significant effect on angler catch rates (catch per unit efforts [CPUE] fish/hour), AZGFD analyzed data from boat angler surveys conducted from April to September in 2018 and 2019 to determine if angler CPUE was higher on days with low, steady flows (weekends). Stepwise model selection showed that bug flows explained most of the variance in angler CPUE compared to other significant factors (day of year, guided, year, and interactions) (Rogowski 2018). Angler catch rates were higher on weekends particularly in the early months of the study (i.e. May, June) although this relationship was not observed by August where CPUE was lower on weekends. Although AZGFD's long term monitoring was not designed specifically to investigate whether flow experiments achieve their objectives, creel data suggests Bug Flows influenced the quality of the recreational fishing experience in Lees Ferry. Similar results were obtained in a GCMRC study involving volunteer anglers with higher catch rates observed on weekends compared to weekdays. In AZGFD creel surveys, many anglers commented that they enjoyed fishing more during low, steady flows compared to weekdays. Anglers reported that during weekend low flows (~8,900 cfs) gravel bars were shallow and it was easier to place lures or flies where fish were located. Conversely, guides and anglers expressed that weekday high water levels made it difficult to get fishing gear into habitat where fish were located, and that fishing success declined when the water was rising or falling. Discharges below 8,000 cfs can inhibit or complicate navigation for boat anglers traveling upstream from Lees Ferry as gravel bars become more exposed; however, the proposed hydrograph for 2022 Bug Flows should provide enough discharge as to not impede navigation. Overall, positive effects on recreational fishing are anticipated from a 2022 Bug Flows experiment.

Riparian vegetation

There is no evidence that the Bug Flows experiment significantly impacts riparian vegetation resources. The primary impact is to slightly extend the active channel, which is the zone of daily inundation, upslope on weekdays. This may slightly extend the suitable habitat for obligate wetland herbaceous species that respond positively to inundation, though longer-lived perennial species are unlikely to respond significantly to this short-term increase in inundation (Butterfield and others, 2018). Weekend low flows are also unlikely to have a significant impact, as sufficient water for plant metabolic activity is likely to be retained within sediments for the 2-day duration of the low flows.

Sediment resources

Based on a detailed analysis of prior year data and consistent with predictions in the LTEMP, the Bug Flows experiment exports around 2-7% more sand in a given month relative to normal operations. This increase in sediment transport during Bug Flows arises because hydropower fluctuations are increased during weekdays to make up for less water being released during low weekend Bug Flows, combined with the fact that the relation between sediment transport and

discharge is non-linear. Due to lower release volumes in 2022, it is expected that Bug Flows will have similarly small effects on sediment transport compared to routine operations.

Cultural Resources

Impacts from Bug Flows are anticipated to be minimally beneficial to archaeological site condition and stability, because sand bars may have an opportunity to dry out and windy conditions may allow for the redistribution of sand from the bars to high elevation areas containing archaeological sites. The lower, slower steady weekend flows may also result in oar-power river runners spending more time on the water and less time on shore, reducing the potential for impacting archaeological sites though visitation.

Grand Canyon Whitewater Recreational Rafting

Impacts to the whitewater rafting recreational experience are expected to be negligible. While the weekend steady flows may require boaters to spend slightly more time rowing and less time on shore, the slightly higher low flows on weekends and weekdays may improve the navigability of some rapids. Also, the steady, low weekend flows may allow for a more consistent campsite area during the weekend flow period and minimize the need to move and re-tie boats during the night.

VIII. Monitoring Plan and Hypotheses

If a Bug Flows experiment is implemented in 2022, GCMRC and cooperators will monitor Colorado River food web responses using standardized methods described in the 2021-2023 Triennial Budget and Work Plan. These efforts include a network of dissolved oxygen sensors for Canyon-wide measurements of GPP, Canyon-wide sampling of adult aquatic insects through community science light trapping, an annual aquatic invertebrate benthic (riverbed) sampling river trip targeting larval life stages of insects, and seasonal mark-recapture studies of growth and survival for humpback chub, rainbow trout, and other fish species. These studies and models will provide the GCDAMP with a comprehensive picture of how a 2022 Bug Flows experiment affected natural processes that sustain Colorado River food webs including key fish species.

Starting in 2022, GCMRC will also add non-lethal seasonal diet sampling of native and non-native fishes to assess the potential effect of Bug Flows on native fish feeding habits. Additionally, cooperators at Oregon State University are developing life history models for aquatic insect populations that will help disentangle the role of the Bug Flows experiment from other flow (e.g., annual volume, monthly volume) and environmental drivers (e.g., water temperature, sediment conditions, nutrients, etc.) of aquatic insect populations. Importantly, these models will provide insight into the role of improved egg laying in driving aquatic insect response to Bug Flows compared to potential benefits of steady weekend Bug Flows on other aquatic insect life stages (i.e., larvae/nymph, pupae, adult). Collectively, this monitoring combined with an additional replicate of the Bug Flow experiment in 2022 will inform potential experimental design modifications and considerations that were discussed during Science Advisor review and recent PI Team meetings, including increasing or decreasing the duration of the experiment and altering target months. Note that if the Bug Flows experiment is not implemented in 2022, all of the above monitoring will still occur. See 2021-2023 Triennial Budget and Work Plan for more detail.

Quantifiable hypotheses for the resource outcomes of a Bug Flows experiment in 2022 are based broadly on prior results and our current best understanding of the interactions of environmental conditions, Bug Flows impacts, and organismal ecology. The predictions and hypotheses outlined below are based on an H-level of 750 (i.e., weekend flows are offset 750 cfs higher than weekday minimums) across all four months of the 2022 Bug Flow experiment.

An alternative H-level of 0 (i.e., no offset, weekend minimum identical to weekday minimum) has also been discussed owing to potential to reduce impacts to the hydropower resource. In addition to reducing impacts to hydropower, an H0 design would shift the location of greatest egg-laying benefits to Glen Canyon and Upper Marble Canyon compared to the H1000 and H750 designs that were tested from 2018-2020, which optimizes egg-laying benefits at the Little Colorado River confluence and sites farther downstream; the offset determines which segment of river experiences optimal egg-laying benefits owing to how daily fluctuations propagate and change shape with distance downstream. A hydrograph with a negative offset (H-250) would not provide optimal insect egg laying benefits at any sites, where optimal is defined as no difference between weekend steady flows and weekday daily minimums. Below we outline predictions for a 2022 Bug Flow with an H-level of 750, but we also discuss possible differences in ecological outcomes under an H-level 0:

1. If Bug Flows are tested in 2022, caddisfly abundance is predicted to resemble levels in 2018 and 2020 (the years of highest abundance). Testing Bug Flows this year (2022) will improve the design matrix of the experiment (i.e., the unique combination of environmental conditions that occurs during a given year of the experiment or during "control years" when the experiment is not conducted). Specifically, based on current conditions a test of Bug Flows in 2022 will likely help disentangle the relative influence of sediment loads from experimental Bug Flows effects on caddisfly. Fall/winter conditions in 2021 included high sediment inputs, and this is associated with low caddisfly abundance in the following spring. Thus, a test of Bug Flows in 2022 sets up a unique contrast that will disentangle effects: if sediment inputs are an overarching filter on caddisfly populations, abundances in summer 2022 should be low; alternately, if Bug Flows effects are a stronger driver of caddisfly abundance and population growth, observed abundances in 2022 should be high.

2. If Bug Flows are tested in 2022, midge abundance is predicted to resemble levels observed during Bug Flows from 2018-2020. This prediction is informed by the observation that midge abundance declined by ~50 percent in 2021 following cessation of Bug Flows compared to the 2012-2020 baseline. In other words, Bug Flows may have been supporting higher midge abundance from 2018-2020 than would have otherwise occurred, but owing to the design matrix (i.e., low nutrient concentrations during 2018-2020) this effect was masked and statistically indistinguishable from the 2012-2017 baseline that was available for comparison; adding a Bug Flows experiment for the year 2022 provides a path for learning to address the extent to which the 2021 decline (and potentially the stability of 2018-2020) was indeed due to a positive effect of the experiment on midge abundance.

3. Rainbow trout vital rates in 2022 are predicted to be more influenced by the elevated temperatures predicted in Glen Canyon than by Bug Flows. With an H-level of 0, we expect 2022 Bug Flows to have a greater positive effect on rainbow trout in Glen Canyon than has been observed in previous years, since flows with an H-level of 0 are optimized for egg-laying in Glen Canyon. If springtime phosphorus concentrations are higher in 2022 than in previous Bug Flows years, all of which have been low phosphorus, the additional year of Bug Flows will likely improve understanding of the small but positive effect of Bug Flows on rainbow trout growth rates.

4. Canyon-wide rates of GPP are expected to increase with Bug Flows in 2022, possibly to a greater extent than in previous years. Rates of GPP increase as a function of water temperature, so the predicted warm water releases combined with the planned lower annual flow volumes will contribute to warmer water temperature canyon-wide, resulting in a more pronounced positive effect of Bug Flows on GPP canyon-wide. Elevated tributary sediment inputs during summer months could reduce any positive effect of the Bug Flow experiment on GPP, but we nonetheless still expect large canyon-wide increases in GPP under Bug Flows in May and June before tributary flooding begins. The 200 metric tons of additional algal-carbon reported during 2018 and 2019 Bug Flows testing uses only the months of May and June when these positive bug flow effects on GPP were most likely. The H-level 0 Bug Flows will also present an opportunity to test how a greater degree of weekend shoreline desiccation affects GPP at the weekly time step. Analysis of data from previous Bug Flows years shows no longitudinal trend in the Bug Flow effect, which would be expected if shoreline desiccation was important mechanism driving GPP response.

IX. Coordination During Implementation and Experiment "Offramps"

In recognition of uncertainty in WY 2022 hydrology, annual and monthly operations, and resource conditions, the PI Team will meet bi-weekly beginning the week of May 1st and continuing throughout implementation of the Bug Flows experiment to evaluate whether new conditions or unanticipated negative impacts have occurred or are likely to occur. Items that may warrant the PI Team to consider recommending termination of implementation include, but are not limited to:

- ***Detection of juvenile smallmouth bass in Lees Ferry and/or observations that indicate the Bug Flows experiment could benefit smallmouth bass.***
- ***An increase to the estimated cost of the Bug Flows experiment to more than double the current estimated cost (i.e. an increase from $1.4M to $2.8M or more) that may result from increases in forecasted energy prices relative to the March 2022 estimate or other unforeseen factors.***
- ***A decrease in annual or monthly release volumes from May through August***

The Secretary of the Interior or her Designee will consider the recommendations of the PI Team, including those to terminate implementation of an experiment, but retains sole

discretion to decide how best to accomplish operations and experiments in any given year pursuant to the ROD and other binding obligations.

In addition, members of the PI Team will continue to meet regularly with stakeholders throughout the implementation of the four-month experiment. This will occur through the regularly scheduled monthly Glen Canyon Dam operations coordination calls. Scientists conducting field surveys during the experiment and agency technical experts will report back on data collected and preliminary results to the Department and the GCDAMP at regularly scheduled meetings. Glen Canyon Dam operations will be adjusted accordingly in the event of unexpected impacts from Bug Flows.

X. Safety Considerations

Potential, but minimal effects on public health and safety could occur in conjunction with the Bug Flows experiment, primarily impacting recreational river users. The proposed minimum flows are within the range experienced by recreational users in the past and those currently expected on a monthly basis. Reclamation and NPS coordinate to ensure that safety measures are implemented and will provide public notice about the timing and purpose of the experimental flows. The three affected parks (Glen Canyon—GLCA, Grand Canyon—GRCA, and Lake Mead—LAKE) have coordinated communications plans, medical plans, and resource capabilities for search and rescue responses. Flow and stage change information will be provided via public media, the individual park websites, and by on-site NPS staff at Lees Ferry and Phantom Ranch.

XI. Communications Plan

If a Bug Flows experiment is implemented in 2022, the communications/public affairs aspect of these experimental flows will not include a public/media event at Glen Canyon Dam, and will include communications product development and media coordination.

Reclamation's Upper Colorado Basin – Interior Region 7 Public Affairs Office, in coordination with NPS, USGS, and WAPA public affairs contacts and the Department, will lead communications product development. If the Bug Flows experiment is approved, a detailed news release, for publication on or near the experimental Bug Flows start date, will be sent to convey the intent and timing of the experiment to media representatives and the public. This may be prepared for distribution by the Secretary's Office. Social media outlets will also be used to communicate with the public leading up to and during the event, including to share imagery of the experiment.

XII. Consultation

Reclamation and GCMRC presented much of the information in this report that was available at that time to the AMWG at its regular meetings, and at the GCDAMP Annual Reporting Meetings. An informational webinar and request for input regarding a potential 2022 Bug Flows

experiment was held for GCDAMP stakeholders on March 30, 2022. Written stakeholder comments have been attached to this report (**Attachment B**), for reference.

On March 30, 2022, the required 30-day advance notification and offer for consultation was emailed to the Tribes and parties to the LTEMP cultural Programmatic Agreement of the potential for a Bug Flows experiment beginning May 1, 2022. As of the finalization of this report, no requests for consultation have been received. A follow-up notification will be sent electronically to stakeholders, including Tribes, following DOI decision regarding the implementation of a Bug Flows experiment in 2022.

XIII. Reporting

The PI Team will coordinate to report findings at the 2022 GCDAMP Annual Reporting Meeting in early 2023. In addition, the PI Team will report ongoing findings at meetings of the GCDAMP Technical Work Group (TWG) and Adaptive Management Work Group (AMWG). Reclamation has a commitment to provide an annual monitoring report to the FWS Arizona Ecological Services Office (AESO) in compliance with the 2016 Biological Opinion; this report will also include a summary of the effects of any flow experiments conducted under the LTEMP ROD. GCMRC and Reclamation will use the monitoring information and feedback from AESO and GCDAMP stakeholders to inform monitoring for future experiments, and to design and implement any measures necessary to address any adverse effects that may occur due to these flows.

XIV. Planning for Future Experiments

The three years (2018, 2019, 2020) of Bug Flows experimentation showed promising ecosystem benefits including increases in algae production and greater abundance of sensitive caddisflies. However, the link between caddisfly increases and Bug Flows is not definitive and contrary to predictions, midges have not increased during Bug Flows experimentation. Other noteworthy resource benefits include improved catch rates and higher angler satisfaction during Bug Flows weekends compared to fluctuating weekday flows. Significantly, the negative impact of the Bug Flows experiment on the hydropower resource increased each year owing primarily to increasing purchase power prices.

It is critical to determine if the objective, as stated in the LTEMP ROD, can be met by the Bug Flows experiment and to ensure that there are no unacceptable adverse effects to other resources. PI Team deliberations in 2021 and in 2022 indicate that there may be experimental design alternatives that, with further development and analysis, could better meet these objectives. To inform discussion of potential future implementation of the Bug Flows experiment, ***the PI Team recommends further consideration by the GCDAMP to refine hypotheses, specify measures of success, and explore potential design improvements for the Bug Flows experiment. Such consideration would be subject to direction from the Secretary's Designee and pursued in a manner consistent with the operating procedures of the AMWG and the TWG.***

The PI Team will meet in early 2023 to review the results of any 2022 implementation activities, and to begin coordination on the evaluation of resources and potential experiments that may be

conducted in 2023. In accordance with the LTEMP ROD, the Department may make the decision to conduct future flow-based experiments (High Flow Experiments, Bug Flows, Trout Management Flows, and Low Summer Flows) at Glen Canyon Dam if it is determined that there are no unacceptable adverse impacts on other resource conditions. Information and data from this or other experiments will be considered in future recommendations and decisions.

XV. Conclusion

Determining whether to recommend the Bug Flows experiment required coordination of many details and effective communication among technical staff from multiple agencies. In particular, the PI Team would like to acknowledge the contributions of staff at the GCMRC to support its deliberations regarding Bug Flows. The PI Team recognizes that the development and implementation of a Bug Flows experiment at Glen Canyon Dam requires significant staff time and resources.

The PI Team has thoroughly evaluated the issues discussed above and has taken into consideration the information and analysis included in the LTEMP EIS and ROD. The PI Team has reached a recommendation to proceed with implementation of the Bug Flows experiment in 2022 based on the careful assessment of resources and best available science. This recommendation does not reflect consensus; the Western Area Power Administration (WAPA) has substantial concerns with implementing a Bug Flows experiment in 2022 and does not support the recommendation.

In recognition of uncertainty in WY 2022 hydrology, annual and monthly operations, and resource conditions, the PI Team would meet bi-weekly beginning the week of May 1st and continuing throughout implementation of the Bug Flows experiment to evaluate whether new conditions or unanticipated negative impacts have occurred or are likely to occur.

The PI Team recommends further consideration by the GCDAMP to refine hypotheses, specify measures of success, and explore potential design improvements for the Bug Flows experiment, which will support potential implementation in future years.

Attachments

A. Final Recommendations Regarding Implementation of the Bug Flows Experiment in 2022, LTEMP Planning/Implementation Team, April 8, 2022

B. Stakeholder Comments
    a. Colorado River Energy Distributors Association (CREDA)
    b. Fly Fishers International/Trout Unlimited (FFI/TU) Recreational Fishers

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Attachment A

Final Recommendations Regarding Implementation of the Bug Flows Experiment in 2022, LTEMP Planning/Implementation Team, April 8, 2022

Friday April 8, 2022

LTEMP Planning and Implementation Team
GCD Flow Experiment Deliberations – Bug Flows 2022

Recommendation

The LTEMP Planning/Implementation Team (PI Team) recommends that experimental Macroinvertebrate Production Flows ("Bug Flows") be implemented at Glen Canyon Dam beginning May 1 through August 31, 2022. This recommendation does not reflect consensus: the Western Area Power Administration (WAPA) has substantial concerns with implementing a Bug Flows experiment in 2022 and does not support the recommendation; Arizona and New Mexico abstained; and the U.S. Fish and Wildlife Service and Arizona Game and Fish Department were not present for final deliberations.

The PI Team has determined the Bug Flows experiment has the potential to improve food base productivity and aquatic insect diversity, with consequent benefits to native fish and ecosystem health also likely. The Science Advisors concluded that Bug Flows appeared to have met the experimental objectives described in the LTEMP (i.e., improve food base productivity and insect diversity) and that reducing uncertainties through additional experimentation would inform future design considerations.

The PI Team also identified the potential for adverse effects to the hydropower resource. Using forecasted energy prices obtained in March 2022, the Western Area Power Administration estimates that the expense of a Bug Flows experiment in 2022 would be approximately $1.4M based on current data. The PI Team defers the determination of whether these effects are unacceptable to the Leadership Team and to the Department of the Interior.

In recognition of uncertainty in WY 2022 hydrology, annual and monthly operations, and resource conditions, the PI Team would meet bi-weekly beginning the week of May 1st and continuing throughout implementation of the Bug Flows experiment to evaluate whether new conditions or unanticipated negative impacts have occurred or are likely to occur. Items that may warrant the PI Team to consider recommending termination of implementation include, but are not limited to:

- Detection of juvenile smallmouth bass in Lees Ferry and/or observations that indicate the Bug Flows experiment could benefit smallmouth bass.
- An increase to the estimated cost of the Bug Flows experiment to more than double the current estimated cost (i.e. an increase from $1.4M to $2.8M or more) that may result from increases in forecasted energy prices relative to the March 2022 estimate or other unforeseen factors.
- A decrease in annual or monthly release volumes from May through August

The Secretary of the Interior or her Designee will consider the recommendations of the PI Team, including those to terminate implementation of an experiment, but retains sole

discretion to decide how best to accomplish operations and experiments in any given year pursuant to the ROD and other binding obligations.

Finally, the PI Team recommends further consideration by the GCDAMP to refine hypotheses, specify measures of success, and explore potential design improvements for the Bug Flows experiment. Such consideration would be subject to direction from the Secretary's Designee and pursued in a manner consistent with the operating procedures of the AMWG and the TWG.

Recommendation Support

Support:	BIA, BOR, CA, CO, NV, UT, WY, UCRC, NPS, USGS
Opposed:	WAPA
Abstained:	AZDWR, NM
Absent:	AZGFD, FWS

Planning and Implementation Team Members

- National Park Service (NPS)
- U.S. Fish and Wildlife Service (FWS)
- Bureau of Indian Affairs (BIA)
- U.S. Geological Survey (USGS) Grand Canyon Monitoring and Research Center (GCMRC)
- Bureau of Reclamation (Reclamation)
- Western Area Power Administration (WAPA)
- Arizona Game and Fish Department (AZGFD)
- 7 x Colorado River Basin States (AZ, CA, CO, NM, NV, UT, WY)
- Upper Colorado River Commission (UCRC)

Attachment B: Stakeholder Comments

1. Colorado River Energy Distributors Association
2. Fly Fishers International/Trout Unlimited Recreational Fishers

From:	creda@creda.cc
To:	Fullard, Clarence D; Traynham, Lee E
Cc:	Pullan, Wayne G; cibarre@q.com; kevin@umpa.energy; jbrown@tristategt.org; creda@creda.cc; "Bennett Raley"; "John Bezdek"
Subject:	[EXTERNAL] Bug Flows Webinar - March 30, 2022
Date:	Tuesday, April 5, 2022 12:01:25 AM

CREDA is in receipt of the March 10, 2022, notification to the Parties of the 2017 Programmatic Agreement that bug flows are again being considered for summer, 2022. We appreciate Reclamation's hosting the March 30, 2022, AMWG stakeholder webinar on the same subject. Having reviewed and discussed the information provided on the webinar and the accompanying powerpoint presentation, as well as reviewing comments submitted in October 2021, following is CREDA's response to the webinar's request for input.

Referring to CREDA's comments on the LTEMP DEIS and FEIS, CREDA has consistently urged "that experiments must include a *description of the proposed experiment*, *the time or frequency of implementation of the experiment*, and *the triggers or other conditions that must exist prior to implementation of the experimen*t. Each experiment must also include a description of the *hypotheses that will be tested by the experiment and benchmarks or other identifiable criteria* that will allow the Secretary and interested parties to assess the *success or lack thereof*, *when an experiment or action must be terminated* because of *unacceptable impacts (as specifically defined*).." It does not appear that these parameters are fully fleshed out for an experiment proposed to begin less than a month from now.

CREDA recommends that given the significant annual and monthly uncertainties at this point (identified on slide 19), and in support of the comment made on the webinar regarding the Flow Ad Hoc Group (FLAHG), that the FLAHG be convened/charged with reviewing and considering the science design/hydrograph narrative descriptions identified in slide 15; "new" information contained on slides 10-11; and refine and define the hypotheses, research and monitoring to be included in a potential future bug flow experiment. This process was supported by the AMWG/TWG stakeholders and enabled successful planning, implementation and monitoring the 2021 Spring Disturbance flow.

CREDA requests that the Technical Team and Implementation Team give serious consideration to these comments and concerns. Please don't hesitate to contact me if additional information is required.

Leslie James
Executive Director

From: Jim Strogen
To: Traynham, Lee E; Fullard, Clarence D; Kennedy, Theodore
Cc: Bill Persons TU; Tallman, Gary; Rod Buchanan; John and Carol Jordan; JOHN HAMILL; Jim Strogen
Subject: [EXTERNAL] Bug Flows Comments from Jim Strogen, AMWG Recreational Fishing Representative
Date: Wednesday, April 6, 2022 4:09:19 PM

Lee, Clarence and Ted,

I appreciated the webinar to update all of us on Bug Flows.

I again want to express support for these experimental flows and feel that they are very helpful to the productivity of the river and benefit trout, native fish, and the many birds and animals that may benefit from extra "bugs" in, on, and above the water.

I know that some members of the AMWG and TWG have concerns that in some regards there is not conclusive evidence that the bug flows are accomplishing what they potentially might. From my perspective, there are variables like turbidity, temperature, and nutrients that make it hard to get a clear picture of how much the bug flows are directly responsible for the additional productivity of the river.

Rather than abandon the experiment I believe it is important to continue them, and look for ways to clarify the data. I appreciate the emphasis on the impact to native fish that is being considered for example.

The intuitive nature of these experiments to improve the productivity of the river to me means that given the adverse effects of the dam on the river in so many ways, we must engage in actions that will try to counter those negative impacts whenever we have an opportunity.

The science review comment about the seeming discrepancy of bugs produced and them not showing up in traps or drift, and the possibility that they might be in the stomach of trout, native fish, birds, and bats is a critical question for further study. I think the native fish study aspect will be important information and it would seem that the trout data from the previous angler catch trips would help with that question, but may need a larger sampling size to provide more certainty.

The issue of cost for the Bug Flow experiments has seemed to increase as a factor of concern with changing hydroelectric rate structures and the critical flows in our future from the dam. While it might not be ideal from a data collection perspective, if shifting the timing allows for future studies due to lessening the costs due to impact on energy delivery/water flow issues, then I would suggest considering ways to shift the timeline that would still provide you useful data to help answer questions that you would like to become clearer about.

While I would personally like to see bug flows continue due to their likely value to the system, I understand that cost issues may prohibit that, and like all of the experiments in the TWP process, I believe that most require a defined endpoint when it is clear that no appreciable additional information will be gained and the money can be better spent on some other valuable experiment. To that end, I think it is important to clarify the number of years that you think this experiment should continue, and what you hope to gain by X number of years more of this study. You might include a summary that describes the benefit of one , two,

three, or five more years, and what you would gain from those data set points for example.

I think the likely temperature increases, and lower overall flows will impact the bug life. Studying those impacts from the perspective of the bug flow experiments may be important for us to further understand the impact on the changing conditions on the river system.

One last note/question: Was there any way to incorporate the dam repair flows into the bug flow findings? Or the constant flow for the overflights into the bug flow findings given the extended low flows for both events?

Thank you.

Jim Strogen, Recreational Fishing AMWG Representative