**Project Title**
General Hydrology Support

**Bureau of Reclamation Agreement Number:**
R18PG40023

**Project/Grant Period:**
Start date: 10/1/2017
End date: 9/30/2022
Reporting period end date: 12/31/2022
Is this the final report? Yes __x__ No __

**Principal Investigator:**
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**Abstract:**

The Service's hydrologist provides basic hydrology support to Recovery Program operators and researchers. Accomplishments during FY 2022 include: (1) with significant assistance from the Program Data Coordinator, collecting and posting temperature data for sites on the Colorado, Green, Yampa, and Gunnison rivers; (2) providing technical hydrology support for a wide range of Recovery Program activities; (3) coordinating and collaborating with a wide range of stakeholders to protect and augment instream flows for threatened and endangered fish; and (4) supporting the Recovery Program in basic data collection and monitoring of project efforts relating to hydrology and related habitat conditions**.**

**Study Schedule:**
1990-Ongoing

**Relationship to RIPRAP:**
General Recovery Program Support Action Plan:
I.A.4.b. Conduct needed Geomorphology research and monitoring.

Green River Action Plan: Mainstream
I.A.3. Deliver identified flows.

Colorado River Action Plan: Mainstream
I.E. Evaluate and revise as needed flow regimes to benefit endangered fish populations.

Colorado River Action Plan: Gunnison River
I.D. Evaluate and revise as needed flow regimes to benefit endangered fish populations.

Yampa River Action Plan:
I.B.2 Provide augmentation of low flows.

Duchesne River Action Plan:
1.D Coordinate reservoir operation

**Accomplishment of FY 2022 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:**

The Recovery Program Director's Office (PDO) provides basic hydrology support to Recovery Program researchers and undertakes tasks that support the Recovery Program with basic data collection, monitoring, partner coordination, flow augmentation, data analysis, report reviews, and data summaries and reporting. The work provided is, in large part, supportive of other research projects or collaborative activities such as flow delivery, flow quantification, and habitat restoration, all of which have a direct impact on the recovery of the Colorado River endangered fish.

Stream Temperature Data Collection

One Recovery Program task is the collection of water temperature data in various river reaches of the Upper Basin. Temperature monitoring duties are divided between the PDO staff, researchers at Colorado State University in Fort Collins, and the Fish and Wildlife Conservation Office field station in Grand Junction (FWCO-GJ)[1]. PDO and CSU staff currently collect data from seven locations on the Yampa and Green Rivers, as described below. FWCO-GJ currently collects water temperature data from four sites on the mainstem Colorado River, four sites on the Gunnison River and one site on the Uncompahgre River, as described in the separate Project 19b annual report. Changes in locations and distributions of the temperature sensors are described in that report. These data are downloaded semi-annually, quality-checked, and assembled into an Excel temperature database for use by Recovery Program researchers and others, following the format used by USGS in their Water Resources Data yearbooks. The PDO web enables and links them to the webpage: Upper Colorado River Basin Data Repository - U.S. Fish and Wildlife Service (fws.gov). GPS locations for each thermograph are available by request; for security purposes exact locations are not provided on the web page.

FY2022 temperature data for all sites on the Green and Yampa rivers were downloaded during July by Ed Kluender (CSU) and Jim Renne (FWS retired). Due to fall storms only the more readily accessible sites were downloaded again in October. For the CO, Gunnison, and Uncompahgre rivers, data were downloaded summer and fall 2022 by Benjamin Schleicher of FWCO-GJ. The one-hour interval readings from the previous year (FY21) as well as for FY22 were converted to daily means, and site-specific daily-mean tables completed. Data from all sites monitoring in FY 2022 will be processed and uploaded to the FWS link referenced above in spring of 2023 and will migrate to the new web site when that site is fully operational.

The data collection on the Green River from the above- and below- Yampa locations (Ladore and Mitten Park) yielded good data for the period, adding to the long term record for those locations. A preliminary

[1] Temperature data collection on the Colorado River by FWCO-GJ was consolidated in this Scope of Work beginning in FY99 and a separate budget table is included for this work. See annual report 19b General Hydrology Support (CRFP-Grand Junction contribution). Principal Investigators for 19b were Ben Schliecher and Dale Ryden.

look at these thermographs shows water temps to be higher than most prior years, and the experimental flows released from Flaming Gorage in late May for LTSP and late June for the smallmouth bass flow spike show the decreases in river temperature that correlated to those releases.

The PDO maintains a summary table of site information for all known long-term stream temperature monitoring locations in the upper Colorado River basin, including those managed by cooperating entities such as USGS, Colorado State University, and the State of Utah. The purpose is to have a centralized inventory of this information to help address such questions as to where temperature data are collected, why those sites were selected, and how the data are used by the Program.

Hydrology Support for Program Implementation and Monitoring

**Water Supply – Upper Co Basin 2022 Streamflow Summary**

Late fall and early winter 2021 snow accumulation in the upper Co River basin was above average by Jan. 1, 2022, and initial forecasts for Lake Powell inflows (including San Juan and Upper Colorado/ Green Rivers) were near 100% of average. However, precipitation January through May was well below average throughout the upper basin, resulting in sub-basin snow water equivalent peaking between 80-90%, with a few basins close to the 30 year median (e.g., Roaring Fork). However, similar to 2021 the snowpack did not directly translate into streamflow, and April – July runoff in Upper Colorado River sub-basins were generally 50-80% of the 30-year medians for those gages (Figure 1). April-July inflow to Lake Powell was only 61% of the 30-yr median (3.75 MAF). Total 2022 Water Year inflows to Lake Powell were 6.08 MAF, which were aided by decent monsoon inflows from August through October (82% of the long-term mean) and by the addition of ~400,000 AF of releases from Flaming Gorge for Drought Response Operations (DROA) intended to maintain a minimal power pool at Lake Powell.

Lake Powell storage and elevations for the last three water years are shown below in Table 1 and Figure 2, reflecting total changes in Lake Powell storage between October 2020 and 2022, relative to full pool storage and water surface elevations. Protecting a critical elevation in Lake Powell of 3525 ft (35 ft of freeboard over minimum power pool intake elevations) is a focus of Reclamation's management of the CO River Storage Project Act reservoirs in the Upper Colorado Basin. Lake Powell's elevation was 3524.75 ft on 12/31/2022

Table 1. Lake Powell Storage Changes: 10/1/20 thru 10/1/2022 – Water Years 2021 and 2022

| | Storage (MAF) | % Total (26.2 MAF) | Pool Elevation (ft) |
|---|---|---|---|
| **October 1, 2020** | 11.34 | 43% | 3595.83 |
| **October 1, 2021** | 7.18 | 27% | 3545.29 |
| **October 1, 2022** | 5.83 | 23% | 3529.92 |
| **CHANGE: 2021 - 2022** | **-1.35** | **-4%** | **- 15.4 ft** |

Full Pool = 26.2 Million AF
Full Pool Elevation = 3700 ft

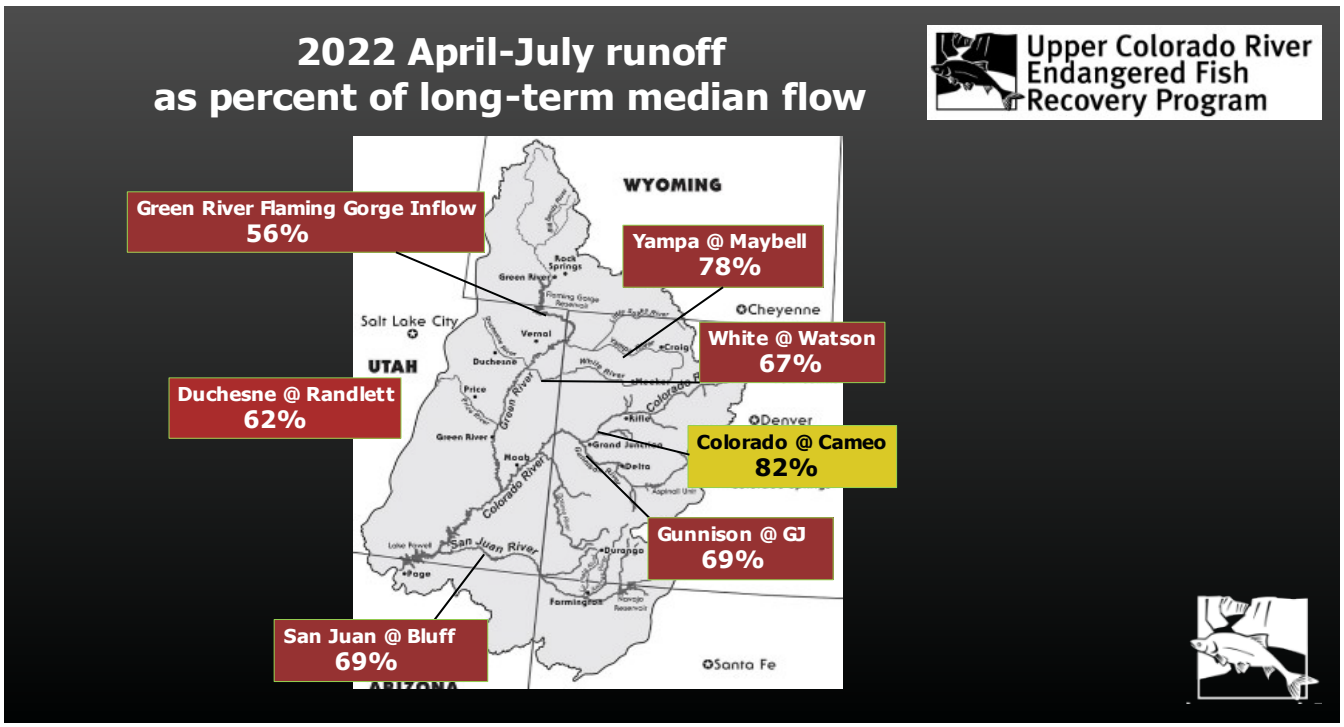


Figure 1. 2022 April-through-July runoff as a percent of long-term average at seven representative Upper Basin gage locations.

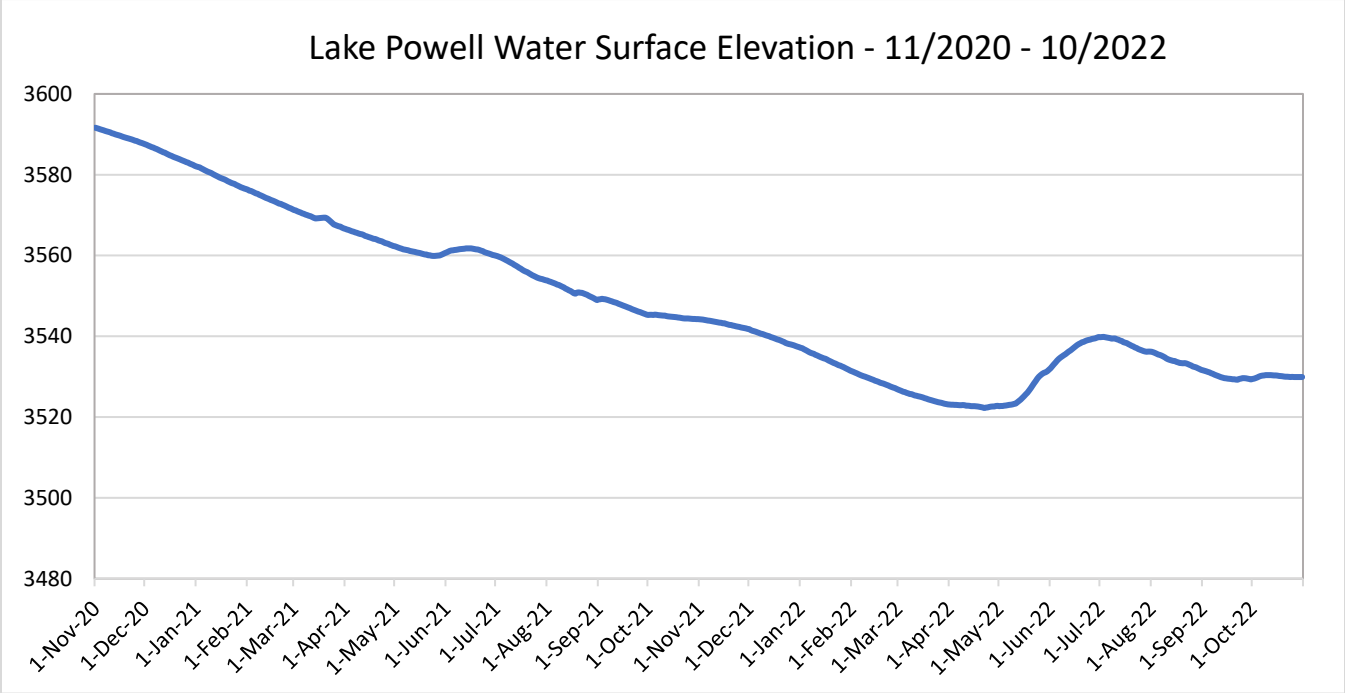


Figure 2. Water surface elevations at Lake Powell, November 1, 2020 thru October 31, 2022.

**Peak mean daily flows**

Peak daily flows (daily averages) observed at key gaging locations in the upper Colorado River basin are summarized in Table 2 below. Peak flows at Jensen on the Green River were the only peaks that exceeded average peak flows, due specifically to the release of ~9000 cfs from Flaming Gorge Reservoir from May 27 – June 2 in accordance with Larval Transport Study Plan (LTSP) experimental flow releases (LaGory et al., 2019). The LTSP experiment coordinates high flow releases from Flaming Gorge to correspond with the presence of razorback larvae drift in the river. In 2022, these releases were also aided by Drought Response Operations, which directed Reclamation to release an additional volume of water to protect storage elevation in Lake Powell. Peak flows at Jensen slightly exceeded hydrologic targets, which allowed for entrainment of larval razorback sucker from the Green River into adjacent floodplain wetlands. Other than peak flows at Jensen, peak flows in the Upper Colorado River were below the long-term average peaks, though the Yampa River peak was near-average, and included multiple smaller peaks in June after the May 20 peak flow. Other notable qualifiers about the 2022 peak flows are included here:

- Colorado River at Palisade/ head of 15 Mile Reach (15 MR): No Coordinated Reservoir Operations (CROS) operations occurred in 2022.
- Gunnison River at Whitewater: Reclamation operated Flaming Gorge releases in accordance with the ROD (2012) and moderately-dry peak flow targets described therein.
- Duchense River at Randlett: Starvation Reservoir did not spill water, and no peak flows of note were released or passed through the reservoir. The highest flow recorded in WY2022 was 300 cfs July 2 in response to a monsoon event.
- San Juan River at Bluff: a modest peak was obtained during spring runoff, but peak flows over 4000 cfs occurred at other non-snowmelt periods in response to monsoons five times from late June through September, including an instantaneous peak of 7,760 cfs September 23.

Table 2. 2022 spring peak flow magnitudes compared to mean daily annual peak flow magnitudes at seven representative Upper Basin gage locations.

| River / Location[1] | Mean Daily Peak (cfs) | 2022 Peak (cfs) | % of Avg Peak |
|---|---|---|---|
| Yampa @ Deerlodge | 12,500 | 12,000 | 96% |
| Green @ Jensen* | 16,500 | 17,000 | 103% |
| White @ Watson | 2,400 | 1,890 | 79% |
| Duchesne @ Randlett** | 2,142 | 111 | 5.2% |
| Gunnison @ Whitewater | 8,000 | 6,050 | 76% |
| Colorado @ Palisade | 16,454 | 10,200 | 62% |
| San Juan @ Bluff*** | 10,500 | 2,370 | 23% |

[1] Peak flows for the Green, Yampa, and Colorado Rivers are noted at Jensen, Deerlodge, and Palisade, respectively.
* Peak flows at Jensen were aided by release of ~9000 cfs from Flaming Gorge for LTSP flow experiment (5/27 – 6/2).
** Peak flow during a monsoon event July 2 was 300 cfs.

*** Post-snowmelt peak flows were 5070 cfs June 30 and 6250 cfs September 23 in response to monsoon events.

Additional Support Provided by the Program Hydrologist in FY2022:

*Mainstem Colorado River*

- Participated in the weekly 15 MR coordination calls during the 'April Hole' or 'irrigation start-up' period and throughout the summer and fall irrigation season (~ July – October). Approximately 1010 AF of the carryover water in the Historic Users Pool ('HUP' compensatory storage pool) from 2021 was used to improve flow deficits in the 15 MR during April 2022. The 'hole' in the 15 MR develops when water users in the lower river valleys (mainly the Grand Valley) open large canal headgates without lower-tributary runoff and before the bulk of mountain snowmelt begins, which was occurring during the onset of irrigation in 2022. Over 22,000 acre-feet remained in Green Mountain Reservoir at the end of WY2022 as carryover ('HUP Surplus') for possible delivery in 2023, prior to Reclamation's 'declaration of fill', which usually occurs the first week in May.

- The ISF Coordinator managed delivery of the augmentation sources (both Recovery Program pools and storage leased by other entities) to minimize low-flow impacts to listed fish in the 15 MR. The ISF Coordinator coordinates releases of the augmentation sources designated in Ruedi, Granby, and Wolford Mountain Reservoirs to support April and summer base flows in the 15 MR. In WY2022, partners who had existing storage contracts or access to storage also played a large role in leveraging the water supplies operated by the Recovery Program for 15 MR flows. During the 2022 irrigation season, 30,795 AF were released between July 19 and October 23, 2022 for delivery to the 15 MR. Benefits to flows in the 15 MR are illustrated in Figure 3.

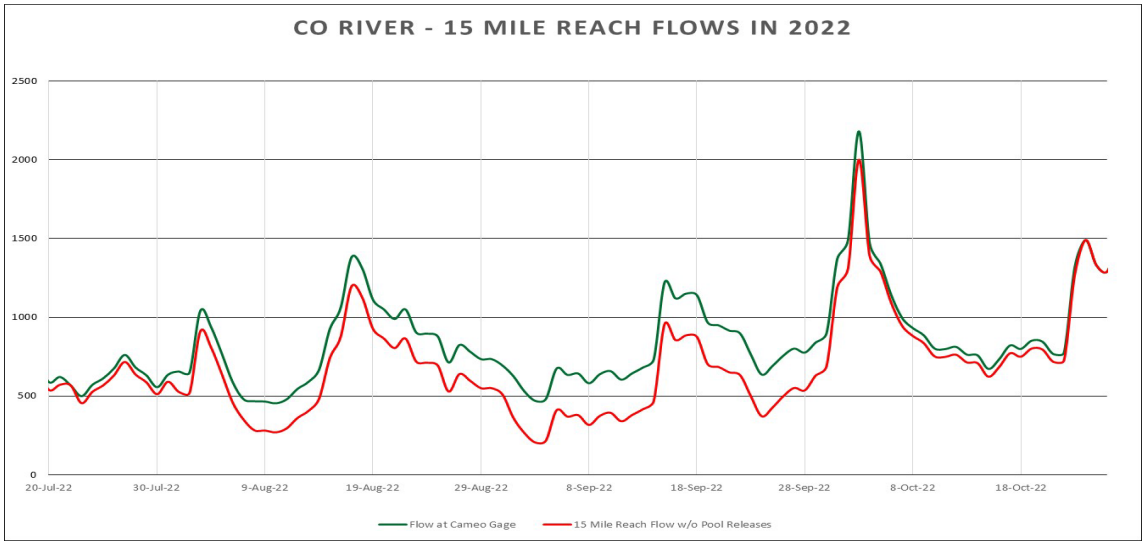


Figure 3. July-through-October 2022 flows in the Colorado River at the Palisade gage location below the GVIC diversion (USGS #09106150), with and without augmentation flow releases from the collected Recovery Program and lease pool sources.

- Lease and donation partners in 2021 included: Colorado Water Conservation Board, Colorado River District, Ute Water Conservancy District, Garfield County, Colorado Water Trust, and Caerus Energy. **These partners voluntarily provided an additional 9350 AF of water** available for benefits to listed fishes in the 1 -MR.

- Despite the efforts to supplement streamflow in the 15 MR to better meet the minimum baseflow target of 810 cfs, there were still 83 days (of 213 days total) during April 1 thru Oct 31 that did not meet the 810 cfs target. However, flow releases and a decent monsoon plume did result in average monthly average flows in August, September, and October of 800 cfs, 770 cfs, and 1105 cfs, respectively.

- In late November, the PDO and ISF Coordinator initiated an important effort revisiting the 15 MR flow targets, as requested by Ecological Services in their spring 2022 response to the 15 MR PBO Review. The first step in this 5-year effort is to develop a strategy to simultaneously investigate ecological, geomorphic, and biological questions that need to be updated relative to the initial PBO investigations in the 1990s. Included in these assessments are an effort to better understand water supply challenges (despite flow pools and CROS operations), and the potential future effects of climate change that will affect the Program's ability to deliver sustainable flows for listed fish.

*Yampa River*

- The ISF coordinator convened weekly Yampa Flow Coordination calls beginning July 20, 2022, requesting coordination of releases from the CWCB/ Recovery Program Elkhead Reservoir pools for the benefit of endangered fish, integrated with an understanding of how upstream releases or other factors were affecting the river. Releases from Elkhead Reservoir to improve the frequency of meeting listed fish flow targets were made from August 16 through October 3 and totaled 5,960 AF (Figure 4). Daily mean flow at the Yampa-Maybell gage fell below 93 cfs (the dry-year target) for 15 days; however, these releases significantly improved flows over what would have been near-zero discharge had the flow releases from Elkhead Reservoir not occurred (Figure 5).

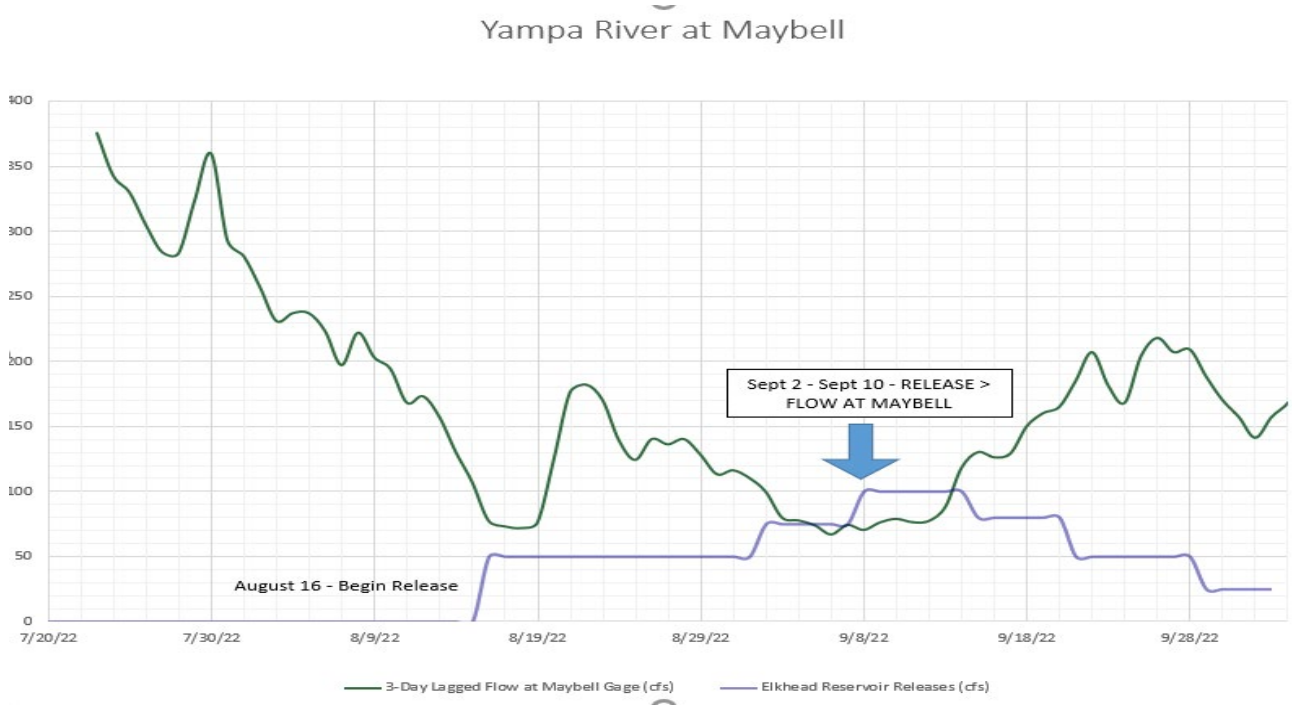


Figure 4. Flow releases from Elkhead Reservoir in summer, 2022, and resulting flows at the Maybell gage.

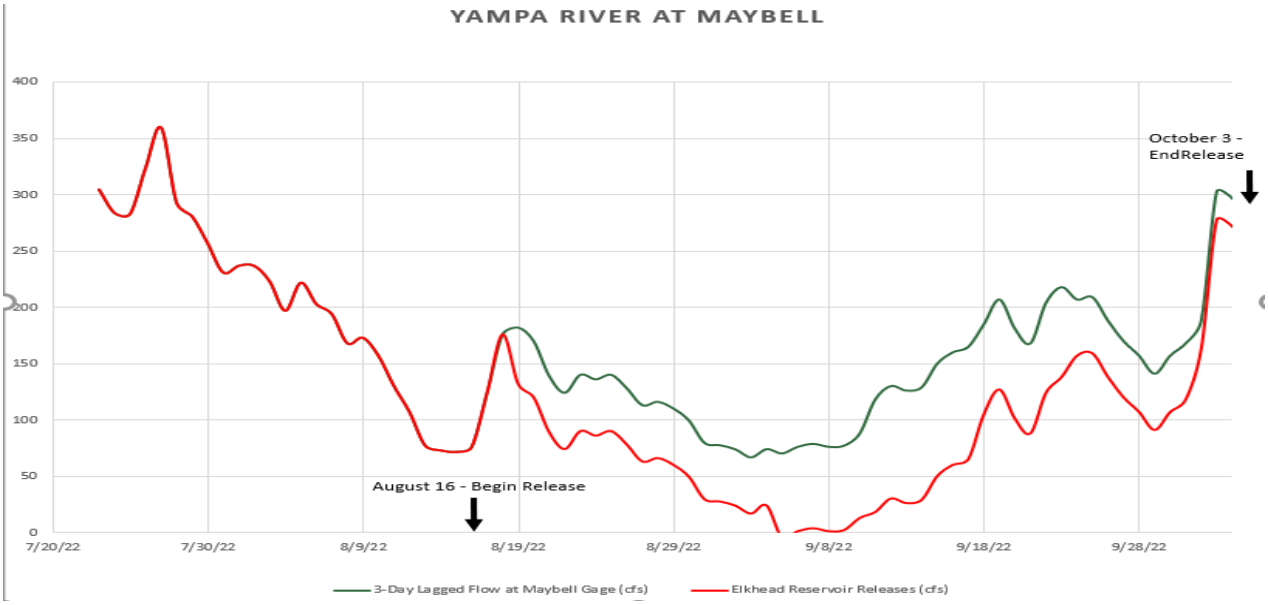


Figure 5. July-through-October 2022 flows in the Yampa River at the Maybell gage with and without Recovery Program's augmentation flow releases from Elkhead Reservoir

- Participated in the Yampa River Fund's Advisory Technical Review Committee to help review and make recommendations on their third round of grant proposals.

- Participated in the Yampa River Integrated Water Management Planning process (IWMP) to recognize and integrate the needs of listed species and specifically, flow targets for listed fish, into goals for the Yampa IWMP project.

*Green River*

- Participated in discussions with NPS regarding the collection and use of data for the Green River physical monitoring plan for 2022 and following years.

*Price River*

- Continued tracking State of Utah, Carbon Canal Company, and TNC efforts to enhance Price River base flows and habitats to benefit native fish (see Annual Report for Project 171).

*White River*

- The PDO/ Instream Flow Coordinator completed a DRAFT White River Management Plan (WRMP), distributed to the White River Planning Team (WRPT) for comments (provided by the WRPT in early January), in coordination with CWCB and Recovery Program Partners. The WRMP, when finalized (anticipated late spring- early summer 2023) may provide the basis for a PBO, which would provide ESA compliance for an increment of future depletions in CO, UT, and Ute Tribal Lands within the White River basin. If the WRPT does not choose to pursue PBO development at this time, the WRMP contains a list of potential management activities that could be incorporated into the Program's RIPRAP in subsequent years. If a PBO is pursued, completion of the WRMP would be followed by a Biological Assessment, completion of additional NEPA requirements, and a Cooperative Agreement amongst White River entities that affirms implementation of the Plan. These materials become the basis of the PBO, written and authorized by FWS Ecological Services, which would authorize that the depletions detailed in the plan would be offset by implementation of the management activities described therein. See also Project 168, 'White River Management Plan' and PBO development.

*Other/General*

- Participated in Duschesne River IBAT/DRWG spring planning meeting & fall review meetings via webinar.
- Seminars and Webinars relevant to Upper Co River Basin water management as appropriate (CWC; Utah Water Users Assoc; Ruth Hutchins Powell CMU Water Center, CRWUA; …)

**Additional noteworthy observations:**

Ongoing activities independent of the Recovery Program that could provide instream flow and/or other habitat benefits for endangered fish in coming years include: individual projects funded by the Yampa River Fund; TNC's proposal to improve the Maybell Irrigation District diversion dam and passage on the Yampa River; ongoing river flow enhancement efforts championed by the Colorado Water Trust on the Colorado and Yampa rivers; completion of the Integrated Water Management Plan in the Yampa River basin (spearheaded by the Yampa-White-Green Basin Roundtable); the efforts of the White River Integrated Water Initiative and White River Partnership; and implementation of various water and stream management plans developed or in development on the Colorado River and its major tributaries (e.g., Blue, Eagle, Roaring Fork). Continued participation and outreach to these groups re: the flow needs for endangered and threatened fish are critical components of a basin-wide approach that invites

the engagement and participation of individuals and entities that may be affected by regulatory actions under the ESA.

**Recommendations:**
We recommend continuation of the current data collection administered under this Project, and to also continue participation and coordination of the managed flow activities in the Yampa and Colorado basins that result in improved flow conditions for listed fish. The ISF Coordinator should continue outreach with water user groups and active basin water forums, coordinate and implement the production of useful information germane to Recovery Program management activities, and promote the PBO compliance efforts for the Recovery Program in the White and other western Colorado river basins.

**Project Status:**
Ongoing and on-track.

**FY 2022 Budget Status**
Funds Budgeted/Provided: $184,138
Funds Expended: $184,138
Difference: -0-

Status of Data Submission
N/A

**Signed:**
David Graf
Principal Investigator
April 18, 2023