COLORADO
Parks and Wildlife
Department of Natural Resources

Enclosure D1
Agenda Item 10.d
CWCB Board Meeting
May 21-22, 2025

May 6, 2025

Director Lauren Ris
Colorado Water Conservation Board
1313 Sherman Street, 7th Floor
Denver, CO 80203

Subject: Colorado Parks and Wildlife Recommendation on the Proposed Acquisition of an Interest in the Shoshone Hydroelectric Power Plant Water Rights

Dear Ms. Ris,

Colorado Parks and Wildlife (CPW) offers the following evaluation of the proposed instream flow (ISF) acquisition of water rights associated with the Shoshone Hydroelectric Power Plant, which are currently owned and operated by Public Service Company (PSCo), a subsidiary of Xcel Energy. The Colorado River District (CRD) is in the process of acquiring the Shoshone water rights and has proposed adding ISF as a beneficial use and making that water available to the Colorado Water Conservation Board (CWCB or Board) for the benefit of the aquatic ecosystem in the Colorado River. The CWCB will review this proposal and may accept an interest in the water rights through a two-board meeting administrative approval process, currently scheduled to commence in May. As required under CWCB's Instream Flow and Natural Lake Level Program Rules, CWCB has requested that CPW evaluate the aquatic benefits and provide recommendations on the proposed acquisition. CPW's perspective is offered under the mandate of our mission to perpetuate the wildlife resources of the state and provide enjoyable and sustainable outdoor recreation opportunities that educate and inspire current and future generations to serve as active stewards of Colorado's natural resources.

The Shoshone water rights include a 1250 cfs senior right with a 1905 priority date and a 158 cfs junior right with a 1940 priority date for a total decreed flow rate of 1408 cfs. The CRD is in the process of acquiring the Shoshone water rights from PSCo under procedures described in their Purchase and Sales Agreement executed in December 2023. If the CWCB votes to approve the acquisition by accepting an interest in the water rights, PSCo, CRD, and the CWCB will file a joint water court application to add ISF as a decreed beneficial use to the Shoshone water rights. Once a decree is obtained, the Shoshone water rights can be dedicated to CWCB to exercise ISF use

when the rights are not used to generate hydropower. Furthermore, should the power plant be decommissioned, ISF use will become the sole beneficial use for the water rights. The reach defined for ISF use extends from the point of diversion for the hydroelectric plant at the Shoshone Dam approximately 2.4 miles downstream to the outfall of the power plant discharge outlets. This reach, referred to as the Shoshone Reach, will benefit from a donation of the full water right (up to 1408 cfs) when in priority and as dictated by the water court change case.

The Shoshone water rights have a significant influence on administration of the Colorado River due to their seniority, magnitude, and location. An administrative call of the Shoshone water rights has historically served as an important legal mechanism for water right curtailment on the upper Colorado River mainstem and its tributaries, with broad implications for flow management throughout the Upper Colorado River watershed. Given the age of the power plant and operational challenges, permanent preservation of the Shoshone water rights has been contemplated for decades and prioritized in numerous planning efforts. As entirely non-consumptive water rights, partnering with the CWCB to utilize the state's ISF acquisition tool and dedicating the rights to ISF use was identified as an appropriate legal mechanism to protect the rights in perpetuity.

In response to CWCB's request, CPW's offers the attached report which details our assessment, professional opinions, and recommendations on the proposal. The report includes details about several factors the Board must consider in evaluating the appropriateness of the acquisition, specifically the natural environment and whether that natural environment will be preserved and/or improved to a reasonable degree by the water available from the proposed acquisition. The Shoshone Reach of the Colorado River is a high-gradient, dangerous segment of river, so no fishery and habitat studies existed in the reach prior to 2023. CPW staff conducted fishery surveys to fill this data gap and coordinated with CRD and CWCB staff to assess flow-habitat relationships using two-dimensional hydraulic habitat modeling.

Based on these assessments, CPW concludes there is a flow-dependent natural environment that can be preserved and improved by the proposed acquisition. The water right preserves the historical flow regime in the Colorado River upstream while improving flows in the Shoshone Reach by adding additional wetted area and suitable fish habitat to a historically dewatered section of the Colorado River. The best use of this water is to preserve and improve the natural environment at any flow rate up to 1408 cfs, the amount decreed for the subject water rights. Additionally, hydraulic-habitat modeling shows that fish habitat improves in the Shoshone Reach at flows up to at least 3000 cfs. However, this upper threshold of 3000 cfs is based on the upper limit of the hydraulic-habitat model. It is also our professional opinion that flows

greater than 3000 cfs provide improvements to fish habitat, specifically by supporting important geomorphic functions and habitat maintenance. Based on professional expertise, flows greater than 3000 cfs maintain an aquatic food base, provide additional thermal refuge areas, and support fish passage. Given the anticipated biological benefits, CPW staff believes this acquisition will preserve and improve the natural environment to a reasonable degree and recommends the CWCB accept the interest in the acquired water. CPW staff will be available at the May CWCB meeting to address the benefits provided by the proposal and to answer any questions about the fishery and associated flow benefits of dedicating the Shoshone water rights to ISF use.

Sincerely,

Jeff Davis

Director of Colorado Parks and Wildlife

Biological Evaluation of the Shoshone Water Rights Instream Flow Acquisition

Colorado Parks and Wildlife

May 6, 2025

Contents

1. Introduction

Built in the early 1900s, the Shoshone Hydroelectric Power Plant sits on the north bank of the Colorado River in the middle of Glenwood Canyon. Currently owned and operated by Public Service Company (PSCo), a subsidiary of Xcel Energy, the power plant and associated direct flow water rights are used to generate hydroelectric power by diverting flow from the Colorado River through two hydropower turbines. The water rights consist of a relatively senior water right with a 1905 priority date for 1250 cfs and a junior right with a 1940 priority date for 158 cfs. The combined total of 1408 cfs is decreed for non-consumptive beneficial use of power generation.

The seniority, magnitude and decreed use of these water rights, when combined with a call on the water right(s), have historically commanded water administration on the Colorado River. When a valid call is placed and administered at the Shoshone power plant, junior appropriators upstream are directed to curtail surface diversions or provide augmentation water to replace out of priority depletions to the calling right. Additionally, a Shoshone call dictates reservoir releases that supplement baseflows in the Upper Colorado River. During periods of low flows in the river, which can extend from the conclusion of spring runoff through the winter, the diversion is legally required to sweep, or divert the entirety of the river to place a call on the hydropower right. This administrative requirement results in the river channel being significantly dewatered for 2.4-miles between the Shoshone Dam and power plant outfall. Without the Shoshone call in place, junior appropriators are entitled to exercise their water rights, depleting streamflows throughout the Upper Colorado Basin and impacting many water rights, including instream flow (ISF) water rights held by the Colorado Water Conservation Board (CWCB).

The Colorado River District (CRD) is in the process of acquiring the Shoshone water rights from PSCo. In partnership with the CWCB, the CRD has proposed adding an ISF beneficial use to the water rights by filing a joint water court change case application. Once a decree is obtained, the Shoshone water rights can be dedicated to CWCB to exercise ISF use when the rights are not used or only partially used to generate hydropower. Furthermore, should the power plant be decommissioned, ISF use will become the sole beneficial use for the water rights. The reach defined for ISF use extends from the point of diversion for the hydropower plant at Shoshone Dam approximately 2.4 miles downstream to the power plant outfall (Map 1). This reach is referred to as the Shoshone Reach and is described in detail below.

CPW supports CWCB's ISF Program by providing biological and technical expertise and assists CWCB staff in making a determination of whether the natural environment will be preserved and/or improved to a reasonable degree by the water made available under the proposed acquisition. CPW staff use professional judgement and best available data to make that determination and in some instances collect additional biological data where little exists. The

Shoshone Reach of the Colorado River is a high-gradient, dangerous segment of river, so limited biological information existed in the reach prior to 2023. CPW reviewed existing data, collected additional data, and worked with CWCB, CRD, and consultants to develop additional studies for the proposed acquisition. The following report is CPW's evaluation of the proposed acquisition and CPW's recommendations to the Board pursuant to C.R.S.37-92-102(3).

2. Natural Environment & Biological Data

2.1 Natural Environment Overview

The Shoshone Reach of the Colorado River runs through the central portion of Glenwood Canyon, a confined canyon where the river over time carved a deep gorge that runs nearly 15-miles between 2,500 feet high walls of sedimentary rock. The canyon is a heavily trafficked corridor and the river and its floodplain are confined by Interstate 70, a streamside recreational path, and railroad. The river is heavily used by whitewater enthusiasts and floatboaters. In the Shoshone Reach, steep riverbed drops create renowned rapids for expert whitewater kayakers. Downstream of the outlet of Shoshone Power Plant, the Shoshone Rapids are targeted by private and commercial whitewater boaters spring through fall as flows allow. Immediately below the rapids, year-round casual and angler floatboating occurs from Grizzly Creek to Glenwood Springs. Throughout Glenwood Canyon, there are diverse outdoor recreational opportunities beyond river whitewater and floatboating including coldwater sportfishing, hiking, rock climbing, streamside bike and pedestrian trail use, vapor caves, and hot springs. These recreational opportunities provide the foundation of the local tourism-based economy.

The infrastructure and operation of the Shoshone water rights creates significant hydrological alteration to the Colorado River. The dam was constructed to impound and divert water for hydropower generation and creates a barrier to downstream sediment transport and upstream river connectivity for aquatic organisms, especially fish. For a Shoshone call to be administered the structure much divert the called priority water. This can result in the legal diversion of the entirety of the Colorado River when flows are less than 1408 cfs, which leaves the Shoshone Reach in a dewatered state. During seasonally low flows, the Colorado River flows are comprised of seepage from the dam (Photo 1), groundwater, and tributary inputs. Under these diminished flow conditions, aquatic habitat persists mainly in deep pools and glides that are isolated by steep boulder drops or shallow riffles that present passage challenges for fish. Aquatic organisms are impacted by habitat fragmentation and limited occupiable wetted habitat. Through the reach, there are many insurmountable drops created by the river gradient and large boulder constrictions. While the Shoshone water rights call may have specific localized impacts to the Shoshone Reach, there are broad benefits provided by the call in the form of flow supplementation to the Colorado River mainstem and its tributaries.

Despite the anthropogenic alteration of the Colorado River through Glenwood Canyon, the Shoshone Reach continues to support a variety of native and sport fisheries and some limited

riparian areas. Wildlife commonly encountered include bighorn sheep, river otters, beaver, Mule Deer, elk, Peregrine Falcons, and eagles. Riparian and upland plant communities generally consist of cottonwood and alder in the riparian areas, and oak, pine, spruce, fir, and aspen trees in the uplands. The unique canyon geology includes caves, springs, and geothermal outputs. The discrete and diffuse geothermal springs occur at the eastern and western ends of Glenwood Canyon, including one of the largest hot springs in the state of Colorado, Glenwood Hot Springs and in the popular Yampah Vapor Caves. These and other extraordinary values of the Colorado River between Gore Canyon and Glenwood Canyon qualify it as eligible for a federal Wild and Scenic Rivers designation.

2.2 Colorado River Fish Community

2.2.1 Fish Community Overview

The Colorado River hosts a diversity of native river fishes and abundant coldwater sportfishes. The native fish community inhabiting the Colorado River in proximity to and through the Shoshone Reach includes multiple cold and cool water species, including small-bodied sculpin and dace, and larger-bodied Bluehead Suckers, Flannelmouth Suckers, and Roundtail Chub, which are naturally adapted to a wide range of mainstem river habitats and water quality conditions. A variety of coldwater salmonid species, both native and introduced, comprise the sportfish community, including (in order of abundance): Brown Trout, Rainbow Trout, Mountain Whitefish, and Cutthroat Trout. The coldwater sportfish thrive in colder temperatures and clearer waters than Colorado River mainstem native fish, but are able to withstand some seasonal perturbations including warmer summer water temperatures and occasional sediment flows from monsoonal rains. CPW manages the Colorado River from its headwaters downstream to Rifle for coldwater sportfish, including the Shoshone Reach. Near Rifle, warmer river temperatures develop as well as increased turbidity. Critical Habitat begins at the Highway 13 bridge in Rifle for the federally listed Threatened and Endangered river fishes, Colorado Pikeminnow and Razorback Sucker, and farther downstream near the Utah Border for Bonytail Chub and Humpback Chub. The diversity of Colorado River fishes and their life history characteristics are sustained by the variety of habitats and dramatic landscapes that characterize the river corridor in Western Colorado.

The current State Wildlife Action Plan (SWAP) identifies wildlife conservation priorities of CPW and recognizes the Bluehead Sucker, Flannelmouth Sucker, and Roundtail Chub (collectively known as the "Three Species") as Tier 1 Species of Greatest Conservation Need. In the Colorado River and its tributaries, the Three Species persist from higher elevation waters around 8,000 feet downstream to the western desert and canyon reaches where they overlap with the Colorado River Threatened and Endangered fishes. As documented in the 2019 Rangewide Three Species Conservation Agreement and Strategy ("2019 Conservation Strategy"), the Three Species have become increasingly rare with significantly reduced occupancy in less than 50 percent of their historic range. The dramatic decline of the Three Species in mainstem rivers is attributed to habitat degradation due to hydrologic alterations and reduced water availability because of water diversions, fragmentation and passage

impediments from dams and diversions, and the widespread invasion of nonnative fishes that either hybridize with (in the case of native suckers), compete with, or predate upon native fishes. The ability of the Three Species to exploit ephemeral and intermittent tributary habitats and the seasonal movements (some greater than 100 miles) performed by native suckers, allows for their long-term persistence in the Colorado River.

The Upper Colorado River is well suited to coldwater fishes in its cooler high-elevation climate sustained by winter snowpack that provides cold waters that surge seasonally as runoff or upwells through springs. The widespread introduction of several trout species, Brown Trout, Rainbow Trout, and Brook Trout, and their salmonid relative, Mountain Whitefish, began in the late 1800s in the Colorado River basin. In the 1940s, Colorado wildlife officials introduced the Mountain Whitefish, another Colorado native fish, from its indigenous waters in the Yampa River to the Roaring Fork River to increase diversity in angling opportunities. Expansion of whitefish into the Colorado River above Glenwood Canyon is limited by Shoshone Dam, as it provides a substantial barrier to upstream fish passage. Once the only trout in the Colorado River, native Colorado River Cutthroat Trout continue to use the Colorado River mainstem periodically, but primarily sustain their populations in cold tributary streams where they are better suited to high elevation and isolated habitats than the introduced trout species. Coldwater sportfish and sculpin are best suited to the coldwater reaches of the Colorado River where high seasonal flows and higher stream gradients maintain hydraulic conditions for the maintenance of preferred habitats for reproduction, growth, and forage.

Rainbow Trout and Brown Trout are the two most popular sportfish targeted by anglers in Colorado (2020 Colorado Angler Survey Summary Report). Prioritized for Wild Sportfish Management, CPW categorizes the Colorado River as “302 - Salmonid Recreation Stream” which specifies that the fishery consists of mostly wild-produced trout, with some stocking of Whirling Disease (WD) resistant Rainbow Trout fingerlings to overcome losses from the WD parasite. Increasingly successful, the current fishery management strategy allows CPW to designate the Colorado River in Glenwood Canyon as a Quality Trout Water, as it is considered a productive, quality fishery where anglers are likely to catch quality-sized trout (greater than 14 inches). Fishing the Colorado River is an enticing recreational opportunity that attracts visitors and residents to the area and generates millions of dollars for local economies annually. Small native fish (sculpin and dace) serve as a nutritious food source along with a healthy macroinvertebrate community to support the sport fishery, and the rare native fishes occasionally encountered by anglers while fishing for sportfish add unexpected and unique encounters.

2.2.2 Fish Survey Results

Recent CPW fish surveys in the Shoshone Reach of the Colorado River (November 2023 and October 2024) revealed a notably high abundance of desirable fish species. These efforts were the first documented fish surveys by CPW in this section of river. The sampling included both opportunistic capture surveys for presence detection (spot electrofishing) and a population

survey to estimate relative fish abundance and biomass. The November 2023 survey occurred during an extended period of time when the Shoshone power plant was inoperable (February 2023-August 2024), allowing more natural flow conditions. Due to flow conditions, the 2023 survey was limited to electrofishing along the banks and wadeable river margins. Spot electrofishing in 2023 detected the presence of Brown Trout and Rainbow Trout, confirming trout will migrate into and use the Shoshone Reach following a period of restored flows.

In October 2024, extensive spot surveys were conducted in the dewatered river channel after the power plant came back online. The 2024 spot electrofishing surveys demonstrated the extent of Brown Trout, Rainbow Trout, dace, sculpin, Mountain Whitefish, and Longnose Sucker (in order of relative abundance) and confirmed their presence throughout the 2.4-mile Shoshone Reach. In October 2024, CPW staff also conducted a depletion estimate to survey the population for the first time in order to assess fish abundance, biomass, and size class structure of the fishery (Photo 2). Fish captured during the survey include in descending order of abundance: dace, Brown Trout (Photo 3), Rainbow Trout (Photo 4), Mountain Whitefish, Longnose Sucker, Bluehead Sucker (Photo 5), and sculpin. Table 1 summarizes the Abundance (fish/acre), Biomass (pounds/acre), and Total Fish Length from tip of nose to tip of tail in inches calculated for each fish species encountered.

Table 1: Summary of Abundance (fish per acre), Biomass (pounds per acre), and the average and range of Fish Total Lengths (inches) for an October 23, 2024 survey in a dewatered Colorado River reach between Shoshone Dam and Shoshone Hydropower Plant near Flag Buttress.

Fish Species	**Abundance** fish/acre	**Biomass** pounds/acre	**Fish Total Length Mean (Min-Max)** inches
Brown Trout	205	205.1	11.3 (3.9 – 21.9)
Rainbow Trout	157	125.6	13.0 (8.2 – 15.6)
Mountain Whitefish	20	10.2	10.6 (5.6 – 12.3)
Sculpin *spp.*	6	--	3.4 (3.2 – 3.6)
Dace *spp*.	260	--	3.8 (1.9 – 5.2)
Bluehead Sucker	8	2.3	8.3 (7.7 – 8.9)
Longnose Sucker	14	7.1	10.7 (10.0 – 11.3)

2.2.3 Fishery Discussion & Conclusion

Low flows in October 2024 in the Shoshone Reach provided CPW an opportunity to thoroughly evaluate the fishery in the high-gradient, boulder-lined river channel that would otherwise be

inaccessible. Though significantly depleted from its natural flow condition, the residual stream was sustained by a minimal flow of water bypassing the dam, perennial tributary flow, and spring flows that maintained pools, riffles, and runs to harbor a notable abundance of fishes. The presence of sub-adult Bluehead Suckers and a variety of age-classes of trout suggests that some spawning occurs in this reach in either mainstem or proximal tributary habitats. Juvenile and adult fish are able to find refuge from aquatic and terrestrial predators in the channel's limited wetted area, specifically in small habitat features created by large boulders and in runs and pools that hold residual depth. Furthermore, the persistence of large trout supports quality angling opportunities in the canyon-bound river that benefits local communities that are sustained by tourism-based economies.

The adaptability of the Three Species to intermittent and seasonally dynamic river conditions allows for their persistence in an altered river system. CPW researchers have documented the use of small tributary habitat in the Colorado River basin (Thompson and Hooley-Underwood 2019), where naturally ephemeral and intermittent stream conditions are similar to those in the Shoshone Reach under current hydropower diversion operations. Within proximity to Glenwood Canyon, fishery monitoring reaches at Lyons Gulch (6 miles upstream), No Name (lower Glenwood Canyon), South Canyon (6 miles downstream), and New Castle (13 miles downstream) have detected the presence of at least one of the Three Species during each sampling occasion between 2008 and 2024, and CPW considers the Colorado River to be occupied Three Species habitat throughout Glenwood Canyon.

The recent population survey of the Shoshone Reach in October 2024 documented the presence of juvenile Bluehead Suckers. Bluehead Sucker are more likely to exploit the local canyon reaches, as they are more often found in higher gradient, swifter velocity habitats compared to the Flannelmouth Sucker and Roundtail Chub (Thompson and Hooley-Underwood 2019). In particular, juvenile Bluehead Sucker primarily consume macroinvertebrates as a food source (2019 Conservation Strategy), thus they are likely to exploit the Shoshone Reach year-round based on the 2024 CPW macroinvertebrate and fish surveys. Flannelmouth Sucker are confirmed to use the Shoshone Reach, as a CPW PIT-tagged fish from the Eagle River was detected by a PIT-tag antenna in Debeque Canyon approximately 90 miles downstream, requiring the fish to migrate downstream through the Shoshone Reach, including the power plant diversion infrastructure. Despite their rarity, Roundtail Chub are regularly detected in approximately 50 percent of surveys at three locations surrounding Glenwood Canyon – Lyons Gulch, South Canyon, and New Castle – all of which exhibit habitat characteristics (low gradient, more turbid water) preferable to Roundtail compared to high-gradient canyon reaches (2019 Conservation Strategy). All Three Species use Glenwood Canyon at least briefly to access or find refuge given the dynamic conditions that offer seasonally and spatially variable resources. Ensuring the permanency of historical flows available through the Shoshone water right and restoring instream flow to dewatered Shoshone Reach will support the continued persistence of the Three Species in the Upper Colorado River.

The Shoshone Reach of the Colorado River in Glenwood Canyon supports a high-quality fishery, even in its seasonally dewatered state with limited wetted habitat. During the

October 2024 survey, the Shoshone Reach had very low flow, as the majority of the natural river flow above Shoshone Dam was diverted into the hydropower plant. The reduced channel, despite appearing from a distance to be flowing at a mere trickle, provides enough holding habitat in deep pools and glides and offers large cover features to harbor both small and large river fishes produced in the full spectrum of waters and resources lower in Glenwood Canyon. As the water recedes from the Shoshone Reach with declining seasonal flows, smaller fish find habitats with favorable velocities and small pools to occupy between large boulders. Microhabitats that support small-bodied fish like dace persist between small substrates and also support macroinvertebrate and algae food sources. Large predatory trout will find desirable slower velocities in deep, boulder-lined runs and pools where they successfully use these habitats to make a living through the winter – finding cover from their predators and hunting for their own prey. As encountered in the fish survey, an abundance of small-bodied prey, including sculpin, dace, and juvenile trout and suckers will sustain larger predatory trout. Rainbow Trout can subsist on the abundance of macroinvertebrates, a preferred prey item, that concentrate into the reduced wetted channel. Few competitors will invade their occupied habitat, especially for the adult fishes, as large drops in the river channel once connected by water become insurmountable (Photo 6). The presence of a variety of age classes of fish indicate that some supplemental reproduction for Colorado River native and sportfish populations occurs in the Shoshone Reach, particularly following a period of restored flows.

2.3 Biocriteria & the Macroinvertebrate Community

2.3.1 Biocriteria Overview

Macroinvertebrate data can be used to evaluate the overall health of a waterbody and to analyze stressors to an aquatic ecosystem using "biocriteria" or aquatic life metrics. Water quality samples only represent a singular moment in time and provide limited information on the combination of pollutants and stressors affecting a biological community. In contrast, macroinvertebrates are the best single assemblage for bioassessment due to their generally short life spans of approximately a year, limited migration patterns, representation in most Colorado habitats, and ease of collection. Although the Colorado Department of Health and Environment (CDPHE) has macroinvertebrate data for the COUCUC03 segment of the Colorado River from the outlet of Lake Granby to below the confluence with the Roaring Fork River, no sampling stations exist in Glenwood Canyon. To fill this data gap and assess biocriteria for the Shoshone Reach, CPW staff collected macroinvertebrate samples in the Colorado River at a location below Devils Hole Creek (CRblwDH) on November 5, 2024. During the sampling event, flows were very low (approximately 50 cfs) as the Shoshone power plant was operating (Photo 8). LRE Water performed laboratory identification of the samples and ran a standard 300-count sub-sample of the macroinvertebrate data through Colorado's Ecological Data Application System (EDAS) program. Based on the analysis, CRblwDH meets the state thresholds for macroinvertebrate health and biodiversity.

2.3.2 Macroinvertebrate Survey Results

The summary tables below reports the macroinvertebrate community metrics that the state considers when assessing a stream's macroinvertebrate community and potential impairment. Macroinvertebrate metrics and thresholds are described in CDPHE Policy 10-1. Colorado's multi-metric index (MMI) is a combination of macroinvertebrate metrics used to score sites from 0 to 100. The MMI score for CRblwDH is 64.3 which exceeds the state's threshold (greater than 45) and meets the threshold for a "High Scoring Water" (greater than 56). The two auxiliary metrics used by CDPHE are the Hilsenhoff Biotic Index (HBI) and Shannon Diversity Index (SDI). HBI is an indicator of how many pollution-tolerant insects occupy the site where higher scores indicate a pollutant-tolerant community. The HBI score for CRblwDH, 4.44, is below the state threshold of 5.8 and considered typical. The SDI metric quantifies community biodiversity, with high scores indicating a greater variety of species present in a range from 0 to 5. The SDI score for this site is 2.17, narrowly meeting the state's threshold of greater than 2.1.

Table 2: Macroinvertebrate metrics (MMI, HBI and SDI) for CPW's macroinvertebrate survey site (CRblwDH) in the Shoshone Reach

Station ID	Waterbody Name	Location	Latitude	Longitude	Collection Date	Biotype	MMI	Hilsenhoff Biotic Index (HBI)	Shannon Diversity Index
WQCC Policy 10-1						1 (Transition)	> 45	< 5.8	> 2.1
CRblwDH	Colorado River	Below Devil's Hole	39.57608	-107.20968	05-Nov-24	1	64.3	4.44	2.17

Additional metrics analyzed by CPW staff evaluate the presence of sensitive macroinvertebrate species belonging to the mayfly (*Ephemeroptera*), stonefly (*Plecoptera*), or caddisfly (*Trichoptera*) orders, also known as "EPT" taxa. The metric "% EPT non-*Baetidae*" indicates how many insects belong to the EPT orders excluding the *Baetidae* family. *Baetidae* are mayfly species that are pollution-tolerant, so they are intentionally excluded from this metric. At the CRblwDH site, approximately 90% of the individuals collected in the sample belong to EPT orders while only 25% of those species belong to the EPT category which excludes *Baetidae*, indicating that a vast majority of EPT individuals at this site were pollution-tolerant *Baetidae* species. The "% Intolerant taxa" category assesses the percentage of the sample with pollution-intolerant species. At the CRblwDH site, despite a high presence of *Baetidae* species, there is a strong presence of pollution-intolerant taxa with 39.1% of the sample belonging to that category. This sample had 23 total taxa present, which demonstrates the macroinvertebrate community is species-rich, thus considered to have relatively high biodiversity. Of the 23 taxa present, 11 taxa were EPT species. The final metric assessed by CPW is sediment Tolerance Index Value (TIV) to characterize the sediment tolerance of the macroinvertebrate community on a ranking of 1 to 10. The sediment TIV score for this site is 5.62, meeting the threshold of less than 7.2 for this region. The relatively high abundance of sediment-sensitive macroinvertebrate species indicates that fine sediments are relatively low in the Shoshone Reach, which is expected in a high-gradient transport reach with an upstream on-channel dam.

Table 3: Additional macroinvertebrate metrics assessed for CPW's macroinvertebrate survey site (CRblwDH) in the Shoshone Reach

Station ID	Waterbody Name	Location	EPT % non Baetidae	% EPT	% Intolerant Taxa	Total Taxa	EPT Taxa	Sediment TIV
CRblwDH	Colorado River	Below Devil's Hole	24.7	90.5	39.1	23	11	5.62

2.3.3 Macroinvertebrate Community Discussion & Conclusion

All indices demonstrate Aquatic Life Use attainment at this site for the macroinvertebrate community despite dewatered conditions leading up to and during the sampling event. Approximately three months of extended dewatering occurred prior to sample collection. The sample was collected in a portion of a riffle where perennial water in a low-flow channel likely persists year-round despite the diversions into the power plant (Photo 9). Even under these low flow conditions, CRblwDH is meeting and even surpassing select thresholds for macroinvertebrate health and biodiversity in the low-flow channel. This indicates both good habitat and water quality are maintained in the consistently wetted portions of the channel. When Shoshone is operational and diverting, insects entrained in the river bed outside of the low-flow channel may perish as the channel dries. Several macroinvertebrate families within the orders of stonefly (6 families) and caddisfly (5 families) are present in the Colorado River upstream of Shoshone at a survey site sampled by Timberline Aquatics near Sweetwater, but are missing in the river below Shoshone Dam (GEI, 2025). Both stoneflies and caddisflies make limited movements and live attached to or under rocks. As the waters recede, they will become stranded. This is one explanation for the low SDI score and low percentage of EPT non-*Baetidae*. The missing families would likely occupy this segment of the Colorado River if there were consistent flow throughout the channel, and they may recolonize if consistent flows return.

With an overall diverse population of macroinvertebrates in the low-flow channel, the macroinvertebrate community in the Shoshone Reach has potential to improve. The current resident community of insects serves as a population center that would expand as the wetted channel area increases with additional flow. Particularly during the winter, additional flows will result in less anchor ice within the canyon, which will likely improve the macroinvertebrate community diversity. With fluctuating river flows, fish can move in to the Shoshone Reach when flow increases, but food may be limited in rewetted habitat if the majority of insects persist in the perennial low-flow channel. A healthy and diverse macroinvertebrate community is a crucial component of the ecosystem and indicates potential for healthy fish populations.

3. Instream Flow Evaluation & Flow-Habitat Relationships

3.1 Instream Flow Evaluation Overview

CPW supports CWCB's ISF Program by providing biological and technical expertise and assists the CWCB in making a determination of whether the natural environment will be preserved and/or improved to a reasonable degree by the water made available under the proposed acquisition. CPW staff use professional judgement and best available data to make that determination and in some instances may collect additional biological data to fill data gaps. No fishery or habitat studies existed in the Shoshone Reach prior to 2023 because its gradient and occasional high flows often make it inaccessible and dangerous. In addition to fisheries sampling conducted in 2023 and 2024, CPW staff recommended collecting data necessary for an instream flow evaluation using the Instream Flow Incremental Methodology (IFIM). IFIM is a widely accepted method used to quantify how hydraulic habitat attributes relevant to fish vary with flow over a representative reach. The two-part modeling approach uses habitat suitability criteria (HSC) indices and hydraulic modeling to evaluate habitat suitability as a function of discharge for specific aquatic species. IFIM has been widely used in Colorado for instream flow evaluations on large and complex rivers, namely the Dolores River, San Miguel River, Cache La Poudre River, Blue River, and Colorado River between Kremmling and Dotsero. The IFIM methodology uses a hydraulic model, paired with HSC for fish species and life stages of interest. Habitat suitability for hydraulic variables of depth and velocity, and sometimes substrate and cover, are combined into a composite score which can be summed over the representative study reach to calculate the area of suitable habitat, also known as weighted usable area (WUA). WUA is a measure of suitable fish habitat that varies as depth and velocity change with discharge.

3.1.1 Overview Freshwater Consulting Habitat Modeling – 2023-24

In November 2023, CRD contracted with two consulting firms, River Restoration and Freshwater Consulting, to evaluate hydraulic habitat-flow relationships in the Shoshone Reach using IFIM.

Two-dimensional (2D) hydraulic modeling was performed by River Restoration using SRH-2D on a representative reach of the Colorado River. The study reach, referred to as Site 1, measured 1850 feet long with an upper terminus approximately 0.5-mile downstream of the Shoshone Dam. Site 1 includes two large pools divided by riffle. Freshwater Consulting conducted habitat suitability analysis using a spreadsheet-based model and output from the 2D hydraulic model. Suitable habitat area was modeled for flows between 50 and 3000 cfs for four focal species in their adult life stage – Brown Trout, Rainbow Trout, Mountain Whitefish, and Flannelmouth Sucker. The seven selected flow rates modeled were 50, 250, 700, 1020, 1250, 1400, and 3000 cfs.

CPW reviewed and participated in the initial model scoping and selection of appropriate focal species and associated HSC. Site-specific HSC are derived from direct observations of actual

fish locations within river habitats. In the Shoshone Reach, deriving site-specific HSC was not possible due largely to safety concerns given dangerous river hydraulics, as well as time limitations. It is standard and accepted practice to use existing HSC from literature or comparable studies based on professional judgement when site-specific HSC is not possible. For the Shoshone Reach, HSC used previously for the Colorado River Wild and Scenic reach were adapted to include fish habitat preferences that are unique to a high-gradient, canyon study area such as the Shoshone Reach, namely deep pools. Adult life stages were selected because the characteristics of the canyon generally favor these larger-bodied, mature species.

3.1.2 Results Freshwater Consulting Habitat Modeling – 2023-24

Results summarized below are from the September 30, 2024 Freshwater Consulting Report. Results show that suitable habitat area (or WUA) increases rapidly between 50 to 700 cfs for all species. For the salmonid species (Brown Trout, Rainbow Trout, and Mountain Whitefish), WUA continues to increase precipitously up to 1020 cfs. Maximum WUA occurs at 1020 cfs for Brown Trout, 1400 cfs for Rainbow Trout, 1250 to 1400 cfs for Mountain Whitefish, and 700 cfs for Flannelmouth Sucker. Habitat suitability for Flannelmouth Sucker is lower than the other species overall and declines at flows greater than 700 cfs. This is because the preferred depth of Flannelmouth Sucker ranges between 1 to 4 feet with declining suitability at depths greater than 4 feet. Alternatively, HSC for salmonid species are high for depths 10 feet and greater. Given the abundance of deep water in the pool and run habitats that dominate Site 1, these flow-habitat relationships are explained.

Overall WUA, calculated by averaging the results of the four fish species, is maximized at 1250 cfs with modest declines at flows in the 1400 to 3000 cfs range. The decline in WUA at flows greater than 1400 cfs is driven in large part by high water velocities that are less suitable for all species. The initial results for Site 1 show the highest habitat availability for Brown Trout and Rainbow Trout, Mountain Whitefish, and Flannelmouth Sucker at flows in the range of 700 to 1400 cfs. The results show modest declines in suitable habitat between 1400 and 3000 cfs, although there is still suitable habitat available for fish species at higher flows. As incremental flows between 1400 and 3000 cfs were not assessed by Freshwater Consulting, it is difficult to directly evaluate the relationship between these higher flows and WUA.

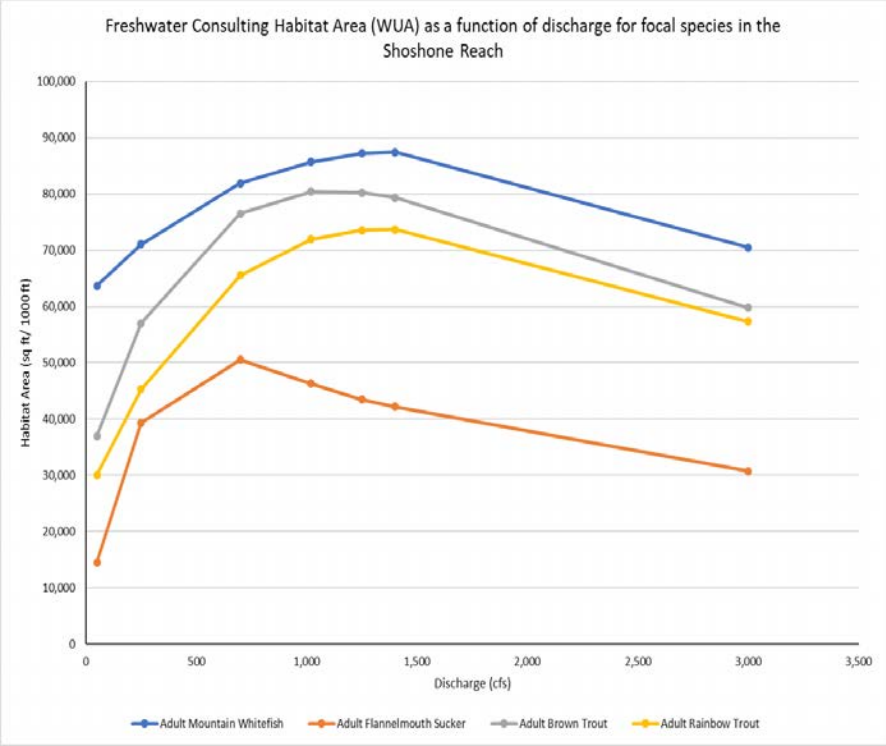


Figure 1: Freshwater Consulting assessment of Weighted Usable Area (WUA, square-feet per 1000 linear-feet of stream) across a range of river flows (cubic feet per second, CFS) for Site 1 in the Shoshone Reach of the Colorado River for four focal fish species.

3.2 Hydraulic Habitat Model Limitations

The Shoshone Reach is a high-gradient confined canyon with highly variable streambed roughness, water depths, and velocities (GEI, 2025). Within Colorado, there are multiple examples of canyon reaches like the Shoshone Reach supporting dynamic and high quality habitats for coldwater sportfish such as Brown Trout and Rainbow Trout, including the No Name Reach on the Colorado River, Gunnison Gorge on the Gunnison River, and Cheesman Canyon on the South Platte River. This is evidenced in abundance and biomass metrics documented in CPW fish surveys. Like the Shoshone Reach, many portions of these river reaches have hydraulic conditions that limit surveying efforts or make them impossible due to safety concerns. Complex hydraulics in canyon reaches like the Shoshone Reach also present nuanced fish habitat use that can be over-simplified by hydraulic habitat modeling.

The Freshwater Consulting results were developed from a single site with somewhat homogenous habitat features and a relatively coarse spatial resolution with a grid size of approximately 4 x 4 feet. While this grid size is appropriate for IFIM, it is unable to represent all microhabitat refugia used by fish. Site 1 is a pool dominated reach with two large pools divided by a boulder and cobble riffle. The reach was bound on the downstream end by a rapid created by an alluvial fan from Devils Hole Creek. This reach was selected for the survey because of surveyor safety concerns given hydraulic conditions at the time of the

survey. The limited hydraulic habitat perspective did not account for more complex habitat features present in the Shoshone Reach that are exploited by fish.

Much of the usable fish habitat in the Shoshone Reach, especially at higher flows, is in the form of velocity refuges created by variable bed substrate, large boulders, and the boundary layer of the streambed. 2D models simulate hydraulics in lateral and longitudinal directions, producing depth-average values for water velocity that moderate the variability in velocity throughout the water column. The use of depth-average velocity to calculate habitat suitability underestimates the amount of suitable habitat available in streambeds, particularly in rivers with high roughness like the Shoshone Reach of the Colorado River. Microhabitats and near-bed features used by fish are not captured with the depth-average velocities produced by the hydraulic model. Water velocities are typically lowest along the stream bed, and the variability in channels with high roughness will be even more pronounced. In channels with high roughness, actual velocities along the stream bed can be 40 to 60% lower than the depth-average velocity. Therefore, habitat suitability models which rely on depth-average velocity do not account for fish-favorable velocities in roughness features. In the Shoshone Reach, this likely resulted in an underestimate of suitable fish habitat.

3.2.1 Overview Ecosystem Sciences Habitat Modeling – 2024-25

During fall 2024, CRD contracted River Restoration and Ecosystem Sciences, an Idaho consulting firm, for additional modeling to better understand the relationship between fish habitat and flows in the Shoshone Reach. During the fall and winter of 2024-25, River Restoration and Ecosystem Sciences performed fieldwork to assess a second study site (Site 2) and address the limitations in the initial analysis. The addition of Site 2 increased the spatial coverage of the hydraulic habitat model and introduced increased channel complexity and habitat features into the model. The upper terminus of Study Site 2 is immediately downstream of Site 1 and the reach is approximately 1830 feet long. Site 2 is lower gradient and less constrained with a greater variety of habitat features, including a split-channel island, more variety in the bed composition, and complex riffle, run, and pool habitats. Adding Site 2 increased the total spatial representation of habitat evaluated to include approximately 29% of the Shoshone Reach. Lastly, five additional higher flow rates were also modeled for both sites to develop a better understanding of the habitat-flow relationships between 1500 and 3000 cfs. For the 2024-25 modeling effort, habitat suitability was evaluated at flows of 50, 250, 700, 1020, 1250, 1400, 1500, 1750, 2000, 2250, 2500, and 3000 cfs.

3.2.2 Results Ecosystem Sciences Habitat Modeling – 2024-25

Results summarized below are from the April 22, 2025 Ecosystem Sciences report. Results for Site 1 assessed by Ecosystem Sciences (Figure 2) demonstrate a similar trend to the Freshwater Consulting results (Figure 1) with steep increases in WUA for each species between 50 and 700 cfs. For Brown Trout and Rainbow Trout, WUA continues to increase sharply until 1020 cfs. Maximum WUA occurs at 2250 cfs for Brown Trout and Rainbow Trout,

2000 cfs for Mountain Whitefish, and 1500 cfs for Flannelmouth Sucker. Overall WUA is maximized at 2250 cfs. Above 2250 cfs, WUA generally plateaus and slightly declines between 2500 and 3000 cfs. This differs from the Freshwater Consulting Site 1 evaluation, but it is difficult to compare the two because incremental flows between 1400 and 3000 cfs were not evaluated by Freshwater Consulting.

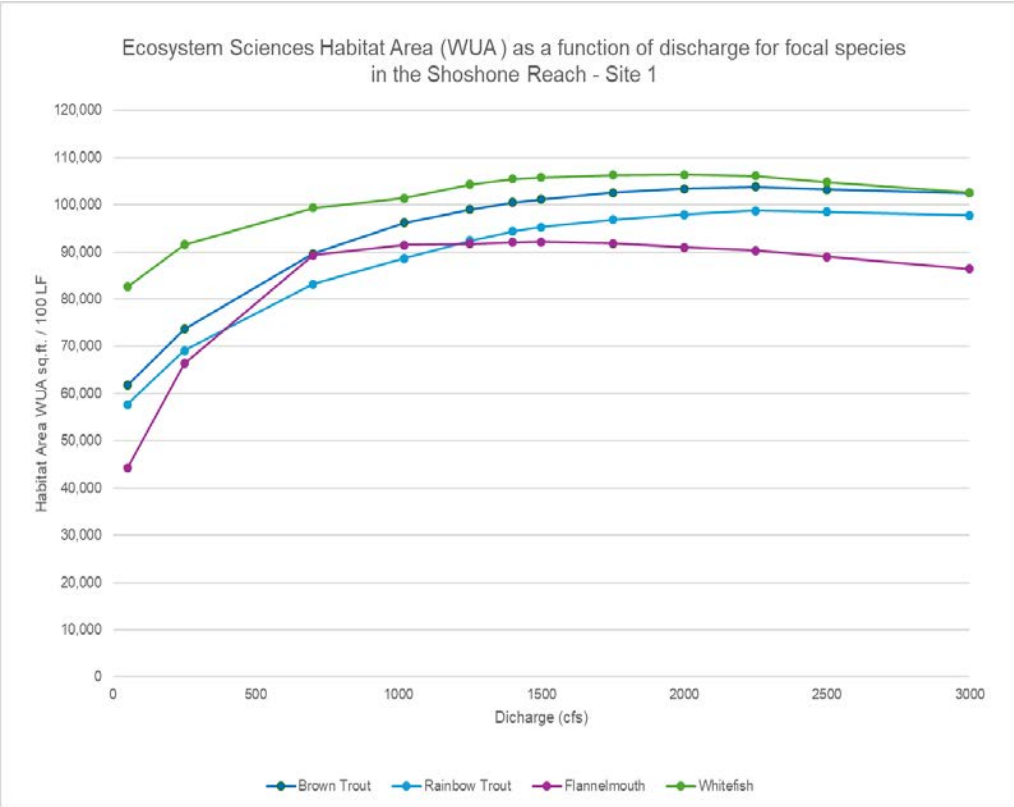


Figure 2: Ecosystem Sciences assessment of Weighted Usable Area (WUA, square-feet per 1000 linear-feet of stream), across a range of river flows (cubic feet per second, CFS) for Site 1 in the Shoshone Reach of the Colorado River for four resident fish species.

Results for Site 2 (Figure 3) demonstrate a trend of gradual and consistent increases in WUA for all four species as flows increase (as compared to the dramatic increase followed by a plateau in Site 1). Site 2 has a less constrained channel and floodplain compared to Site 1. Site 2 has more habitat complexity and depositional features that create a mid-channel island that splits the river at lower flows. Site 2 also contains deep pool and shallow riffle features similar to Site 1. For the four species evaluated, maximum WUA occurs at relatively high flows with a maximum WUA at 3000 cfs for the salmonid species and 2000 and 3000 cfs for Flannelmouth Sucker. Benefiting from the hydraulic complexity within Site 2 and supporting their lower depth and velocity preferences, WUA for Flannelmouth Sucker is greatest at Site 2. As flows increase in Site 2, portions of the islands inundate, and the split channels expand and connect, increasing the variety of depth and velocity conditions suitable for Flannelmouth Sucker. Conversely, for adult salmonids, WUA is lower at Site 2 than Site 1, though Site 2 still contains important habitats.

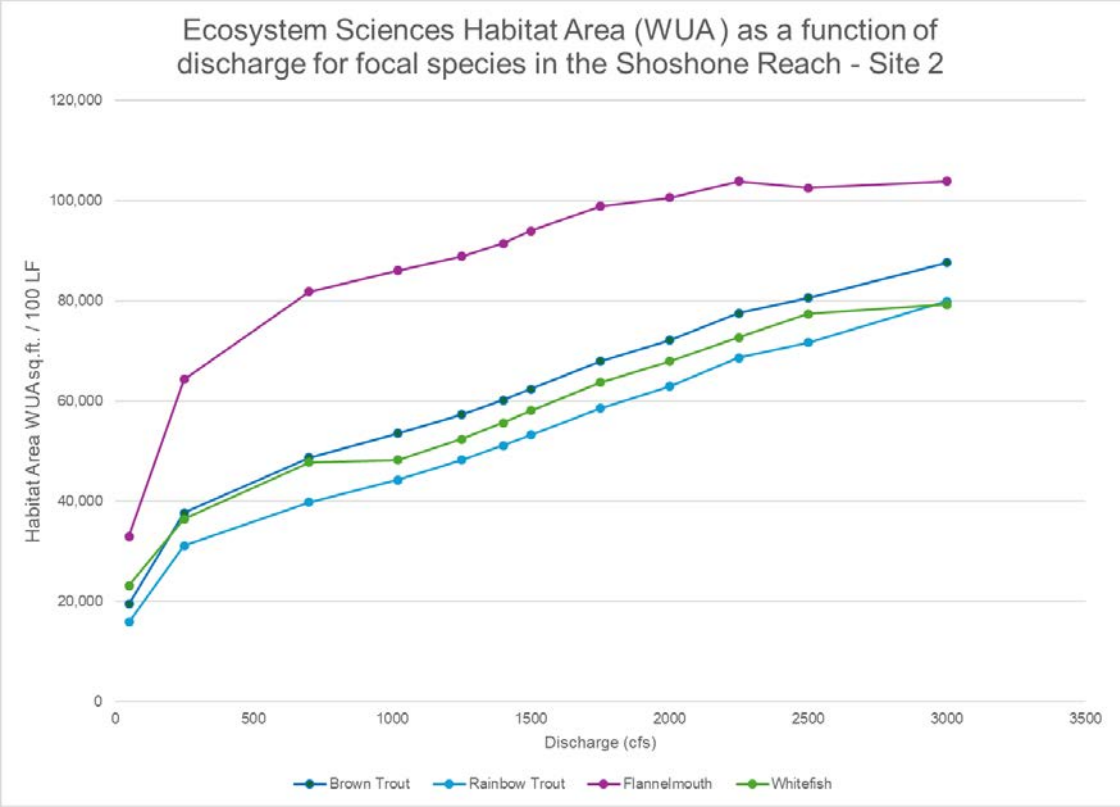


Figure 3: Ecosystem Sciences assessment of Weighted Usable Area (WUA, square-feet per 1000 linear-feet of stream), across a range of river flows (cubic feet per second, CFS) for Site 2 in the Shoshone Reach of the Colorado River in Glenwood Canyon for four resident fish species.

Adult life stage species were the focus of the habitat modeling because of complex hydraulic conditions in the Shoshone Reach. While not specifically modeled, juvenile trout will benefit from the same lower velocity, shallow habitats that benefit Flannelmouth Suckers. These conditions provide suitable rearing conditions for juvenile trout. Spawning habitat was not explicitly modeled but gravel bars provide spawning habitat for fish including Bluehead Suckers and Flannelmouth Suckers at a wide range of flows. Gravel bar deposits are present around the island features at Site 2 and is where Brown Trout redds were observed in late Fall 2024 (Photo 7).

3.2.3 Addressing Modeling Limitations

The Shoshone Reach is a high-gradient river with highly variable streambed roughness, water depths, and velocities which contributed to high velocities represented by the hydraulic model that under-represented actual suitable fish habitat availability. To address this issue, Ecosystem Sciences used an additive model to estimate the composite habitat suitability by adding depth and velocity suitability for each cell from the hydraulic model. Conversely, Freshwater Consulting used computations that multiplied depth and velocity suitability to estimate the composite habitat suitability score for each cell. The limitation of the multiplicative approach for composite suitability is that high depth-average velocities will result in low or zero habitat suitability scores for areas where suitable velocities are actually

present along the rough streambed. In Freshwater Consulting's computations, velocity suitability scores of zero will drive the overall habitat suitability to be deemed unsuitable. This misrepresents velocity refuges used by fish and underestimates suitable habitat because in reality suitable velocities exist along the streambed in roughness features. In fact, a substantial amount of these roughness features exist in the Shoshone Reach due to the highly variable substrate, velocities, and depths (GEI, 2025). Therefore, suitable habitat is under-represented by traditional IFIM modeling computations in steep canyon reaches like the Shoshone Reach. When using an additive model to estimate habitat suitability to account for a high degree of roughness in the channel, WUA results account for microhabitat features that provide important fish habitat.

3.3 Discussion and Conclusions on Flow-Habitat Relationships

Given the limitations and uncertainties discussed above, it is helpful to review the results from the Freshwater Consulting and Ecosystem Sciences reports in conjunction with one another. Freshwater Consulting used a more traditional approach for IFIM that multiplied depth and velocity suitability to estimate the composite habitat suitability and associated WUA. As previously discussed, this approach likely underestimated suitable habitat used by fish in the Shoshone Reach due to the use of depth-average velocity, particularly at higher flows. The Freshwater Consulting results indicate that overall WUA was highest between 1250 to 1400 cfs at Site 1 when averaged across the four fish species. Overall WUA increased steeply from 50 to 700 cfs before plateauing between 1020 and 1400 cfs and then declining from 1400 to 3000 cfs. As no flow values were evaluated between 1400 and 3000 cfs, it is not clear how WUA changed in between these values.

The Ecosystem Sciences report analyzed WUA at two sites within the Shoshone Reach, including the same site evaluated by Freshwater Consulting (Site 1), using an additive approach for estimating composite habitat suitability from modeled water depths and velocities. This approach was intended to address the aforementioned limitation of using depth-average velocity to calculate the composite habitat suitability. When averaged across all species, WUA peaked at 2250 cfs at Site 1. Similar to the Freshwater Consulting results, WUA increased sharply for all species between 50 and 700 cfs. WUA then increased gradually between 700 and 2000 cfs, and declined slightly between 2250 and 3000 cfs. At Site 2, there was a very steep increase in WUA between 50 and 250 cfs and a more moderated increase between 250 and 700 cfs when averaged across species. WUA then increased steadily from 1020 to 3000 cfs with no evidence of a distinct plateau.

When considered together, the habitat suitability studies by Ecosystem Sciences and Freshwater Consulting indicate that using the Shoshone water rights of 1250 and 158 cfs for a total of 1408 cfs would benefit fish habitat, as WUA consistently increased at both sites from 50 to 1400 cfs on average. However, the two reports differ in what happens to WUA above 1400 cfs. The Freshwater Consulting report indicates the WUA declines at 3000 cfs. In contrast, the Ecosystem Sciences report indicates that WUA continues to increase (Site 2) or remain relatively stable (Site 1) for flows greater than 1400 cfs. Given the limitations of

using depth-average velocity to estimate the total amount of suitable habitat in the Shoshone Reach, which provides complex and dynamic conditions that support fish, it is likely that habitat suitability does not decrease significantly as flows increase up to 3000 cfs due to the presence of lower velocities near roughness features.

3.3.1 Other Considerations in Assessing Flow-Habitat Relationships

With regard to suitable habitat, the importance of deep pools in habitat suitability models is often underestimated and modifications for the presumed importance of deep pools in the Shoshone Reach are substantiated by CPW research. Recent CPW research shows that residual pool depth is the most important physical habitat variable driving Brown Trout population biomass. Additionally, this research shows that Quality Brown Trout were only present in pools with depths of 3 feet or greater and total fish biomass increased with increasing residual pool depth (Kondratieff and Richer 2022). In addition to this research, many other studies from Colorado rivers have shown the value of deep pools in providing important habitat functions for native Cutthroat Trout and Mountain Whitefish, such as depth cover, overwinter and low-flow refugia (Harig et al. 2000, Behnke 2002, Beinstadt et al. 2004). Important pool habitat exists in the Shoshone Reach even under dewatered conditions. Additional water provided by the instream flow acquisition will support refreshening flows to maintain these pool habitats.

High flows provide important geomorphic and ecological functions related to sediment transport and habitat for benthic macroinvertebrates. Flushing fine sediment is critical to maintain habitat for fish and macroinvertebrates, especially in locations that receive episodic sediment inputs, which has been a recurring issue in Glenwood Canyon following recent wildfires. As wetted area increases with discharge, there is more habitat available for macroinvertebrates, the primary prey resource for the fishery. Higher flows may also activate new pathways through high-gradient rapids and steep drops, which could improve conditions for fish movement in some locations, providing access to a more optimal refuge habitat. The combination of increasing WUA and improved geomorphic and ecological functions indicates that using the Shoshone water rights for instream flow would be beneficial for the fishery in the study reach.

Instream flows in the Shoshone Reach will increase suitable habitat for coldwater sportfish and native species. Recent habitat suitability studies have demonstrated that when greater flows are present, the amount of usable habitat for Rainbow Trout, Brown Trout, and Mountain Whitefish increases substantially up to 1400 cfs (Freshwater Ecosystems 2024 and Ecosystem Sciences 2025) and will improve or maintain habitat to flows approaching 3000 cfs (Ecosystem Sciences 2025). Restored instream flows in the Shoshone Reach will increase wetted habitat area for fish and macroinvertebrates and will maintain pool depths that provide important cover and refugia in the Shoshone Reach, which, based on these corroborating studies, will promote increased fish abundance and enhanced angling opportunities for Quality Trout.

4. Colorado River System Assessment

In addition to benefitting the natural environment within the Shoshone Reach, the proposed acquisition will provide benefits throughout the Upper Colorado River by providing a call that maintains the historic flow regime and will continue to support the quality of fisheries. The following sections describe the benefits provided by the Shoshone water rights beyond the benefits to the Shoshone Reach.

4.1 Upper Colorado River Wild and Scenic Reach

Four segments of the Colorado River from Kremmling to No Name Creek in Glenwood Canyon (Map 2) were identified by the Bureau of Land Management (BLM) and U.S. Forest Service White River National Forest (WRNF) as eligible for inclusion in the Wild and Scenic Rivers system due to their Outstandingly Remarkable Values (ORVs). ORVs are unique or exemplary river-related values highlighted for protection for future generations. Within the Colorado River, the specific values include fishing, boating, scenic viewing, hiking, and geological features. The Wild and Scenic designation comes with protections from significant future channel and streamside development and can include federally-held water rights. Due to competing water needs and development in the Colorado River, a stakeholder group was formed to develop a plan to protect and enhance these values in lieu of a federal Wild and Scenic designation. The Upper Colorado River Wild and Scenic Stakeholder Group (SG) includes both east and west-slope water providers, local interests, environmental groups, and state agencies. The SG adopted a Wild and Scenic alternative management plan with the goal of protecting the ORV's without limitations imposed by the federal designation and water right. CPW is a cooperating agency in the SG Plan and participates in large part because the fishery in the Colorado River between Kremmling and Glenwood Springs is an important recreational asset with a high number of Quality Trout markers, high biomass, and high usage, the foundation of the Fishing ORV. CPW's fishery management goals include managing for desirable species of Brown Trout, Rainbow Trout, Mountain Whitefish, Bluehead Suckers, Flannelmouth Suckers, Roundtail Chub, sculpin, Speckled Dace, and Cutthroat Trout. Long-term fishery monitoring sites were established by CPW in 2008 throughout the Upper Colorado River Wild and Scenic reach to monitor fish population metrics and ensure that the Fishing ORV is protected (Map 3).

A key component of the SG Plan is "Long-Term Protection Measures" identified by the SG to provide for significant protection of the ORVs. The SG Plan specifically identifies the Shoshone water rights as critical to maintaining streamflows and protecting the ORVs in the Colorado River by calling water through the upstream Wild and Scenic segments to the power plant. According to the SG Plan, "this administrative call generally results in stream flow through the subject stream segments in amounts greater than would exist in the absence of the administrative call." Securing ISF water rights decreed to the CWCB was another key component to protecting ORVs on the Colorado River between Kremmling and Dotsero. In 2013, three ISF reaches were appropriated by CWCB on the Colorado River between the Blue River and the Eagle River confluence. CPW was involved in the quantification of these ISF segments and their associated flow rates. In addition to helping maintain flow-related ORVs,

the senior call by the Shoshone water rights helps to satisfy the CWCB's ISF rights, which are junior in priority. Maintaining adequate streamflows is crucial for supporting streamflow-influenced ORVs, specifically recreational fishing, floatboating, wildlife, botanical, and scenic qualities.

Table 4: Decreed ISF rights in the Wild and Scenic reach of the Colorado River

Segment	Decreed flow rates (cfs)	Priority Date
Colorado River between Blue River and Piney River	750 cfs (8/1 – 9/15) 500 cfs (9/16 – 5/14) 600 cfs (5/14 – 7/31)	07/12/2011
Colorado River between Piney River and Cabin Creek	800 cfs (8/1 – 9/15) 525 cfs (9/16 – 5/14) 650 cfs (5/15 – 7/31)	07/12/2011
Colorado River between Cabin Creek and Eagle River	900 cfs (5/15 – 6/15) 800 cfs (6/16 – 9/15) 650 cfs (9/16 – 5/14)	07/12/2011

4.2 Temperature Exceedances

Maintaining adequate seasonal streamflows is not only crucial for preserving ORVs but also plays a significant role in regulating water temperature. The Upper Colorado River's water temperature is influenced by seasonal precipitation, ambient air temperature, and flow conditions. The river flowing downstream from higher to lower elevation climates influences the natural warming trend from Kremmling to Glenwood Springs, with peak runoff periods temporarily moderating temperature differences along the stream gradient with high snowmelt flow volumes. During late summer and early fall, heat accumulation becomes more pronounced, particularly during low flow periods and when upstream reservoir releases are minimized. According to data reported annually by the SG, acute temperature standard exceedances did not occur between 2021 and 2025, as measured by the Daily Maximum (DM) temperature. However, chronic temperature standards exceedances (maximum weekly average temperature, MWAT) are a recurring issue across wet, dry, and average year-types during summer months. In 2023, an average water year, exceedances of the chronic temperature standard occurred upstream near Catamount and Red Dirt Creek beginning in early August and chronic temperature exceedances in Glenwood Canyon persisted for 3 to 4 weeks. In 2024, a wet water year, chronic temperature standard exceedances returned at Catamount and extended downstream through Glenwood Canyon from July through August, enduring for 2 to 3 weeks between Catamount and Red Dirt Creek and extending nearly 6 weeks from Dotsero to Glenwood Springs. Chronic temperature exceedances indicate repeated and extensive thermal stress is occurring in coldwater fishes during the summer months. Additional stresses such as hooking and handling stress from anglers or sediment

caused by monsoonal rain events, can create compounding impacts to fish health and mortality.

In 2010, CDPHE identified a reach of the Upper Colorado River from Kremmling to the Roaring Fork River on Colorado's Section 303(d) List of Impaired Waters due to repeated temperature exceedances that impair Aquatic Life Use (CDPHE Regulation #93). CDPHE identifies this segment at the lowest level of attainment, #5 - Impaired without a Total Maximum Daily Load (TMDL) plan, thus it has been a High Priority for TMDL development. In December 2024, CDPHE finalized Regulation #33 to create distinct water quality standards for the Upper Colorado River Basin. Regulation #33 specifies that temperature should maintain normal diurnal and seasonal fluctuations with no abrupt changes and not increase temperature at a magnitude, rate, and duration deemed deleterious to the resident aquatic life. The regulation sets temperature standards for the segment of the Colorado River between its confluence with the Blue River and the Roaring Fork River that are an amalgamation of Coldwater Stream temperature standards similar to those developed for Tier 1 species (Brook Trout & Cutthroat Trout) and Tier 2 species (other coldwater fishes) species depending on season.

Since the temperature impairment listing, stressful summer water temperatures above 70°F for coldwater sportfish in the Colorado River have become increasingly frequent. Seasonally high water temperatures resulting from low flows and hot ambient air temperatures can cause stress that impacts fish health, spawning success, and increases disease and mortality. Sediment flows from summer monsoonal rains can amplify physical stress on fish directly through tissue abrasions on skin and gills, and indirectly by enhancing solar radiation on the turbid waters. During sustained periods when daily water temperatures peak above 70°F and fish stress, disease, or mortality is observed in areas of moderate to high angling pressure, CPW implements voluntary fishing closures informing anglers not to fish in affected river reaches to protect local coldwater sportfisheries. Mountain Whitefish appear to be the most sensitive to summer stressors as mortalities with high temperatures, handling stress, and sediment events are documented more frequently than other fishes. Furthermore, their once notable spawning runs are significantly diminished in Grizzly Creek and No Name Creek in Glenwood Canyon. These same factors affect Rainbow Trout and Brown Trout where CPW has documented disease outbreaks and physiological stress from low water and high temperatures cause ubiquitous lesions and fungal infections on unusual numbers of trout and furunculosis outbreaks in the Eagle River, a tributary in close proximity to Glenwood Canyon.

Adequate and reliable river flows associated with the Shoshone call can help maintain water temperatures for popular coldwater sportfish. When ambient air temperatures are high in the late summer, additional flows can help mitigate excessive river warming. Greater flows not only moderates temperature effects directly, but it can also increase available wetted habitat, alleviate fish crowding, which reduces stress and disease transmission, and improves river connectivity to allow fish to move to more optimal habitat conditions elsewhere. In addition to Long-Term Protection Measures identified by the SG to protect the ORVs, the SG has identified Tier 2 "Cooperative Measures" which are voluntary actions to improve stream

conditions to protect the ORVs. Strategic releases from upstream reservoirs have been implemented in recent years to supplement low flows and mitigate harmful temperatures in the Colorado River.

4.3 Anchor ice and winter temperature issues

Low flows can also affect aquatic organisms in the winter. During periods of low flow, cold temperatures can impact fish in the Colorado River. When temperatures drop well below freezing, depleted baseflows can lead to the formation of anchor ice and ice dams that impound floating ice and water and deplete downstream reaches. Anchor ice can eliminate occupiable habitat for macroinvertebrates and fish. During freeze-thaw cycles, the ice dams can break, releasing a wave downstream that scours the riverbed causing localized mortality to macroinvertebrates and fish and flushes organisms downstream. The breaking of ice dams can also pose hazards for people and infrastructure near the river. In December 2010, an ice blockage on the Shoshone power plant intake prevented diversion to the penstocks and with the dam gates frozen closed, river flows were functionally shut off in the Colorado River between Shoshone Dam and Roaring Fork River from December 14 to 16, with the exception a few tributary inputs and springs. During the extensive dewatering of lower Glenwood Canyon, a fish kill occurred at the canyon mouth near hot spring inputs, leading to documented mortalities of trout and native sculpin due to high water temperatures. Additional streamflows from the proposed acquisition will mitigate incidences like this, as well as anchor ice formation. The proposed acquisition will also supplement baseflows providing additional useable overwintering habitat for fish and macroinvertebrates.

4.4 Lower Glenwood Canyon Fishery Resources

The Colorado River downstream of the Shoshone Reach supports a thriving coldwater sport fishery comprised of Brown Trout, Rainbow Trout, and Mountain Whitefish, as well as the Three Species. Return flows from the Shoshone power plant create and maintain a diversity of habitat features that support reproduction, recruitment, and seasonal needs of resident fishes. With more consistent flows below the power plant outfall, wetted habitat fluctuates more naturally with a less altered hydrograph, and habitat is maintained and connected by gradual seasonal changes in flow. CPW fish surveys from 2021, 2023, and 2024 consistently recorded high trout numbers, particularly quality-sized trout, reaffirming that lower Glenwood Canyon is a premier fishery. Traditional riverine riffle-pool sequences support a productive macroinvertebrate and fish community where sediment transport functions are maintained. These flows sustain a resilient aquatic ecosystem that is essential for both sport fishing and native fish conservation. Two large tributaries located downstream of the power plant, Grizzly Creek and No Name Creek, provide critical spawning habitat for Rainbow Trout, Brown Trout, and Mountain Whitefish. Reproductive habitat is generally limited by the fluvial geomorphology in the mainstem river in Glenwood Canyon, so connection to tributary habitats is important. These tributaries also contribute coldwater inputs as their headwaters originate at elevations well over 10,000 feet in the Flat Tops that encompass the northern portion of Glenwood Canyon. Self-sustaining trout and whitefish populations in the Colorado River are maintained by reproduction and recruitment from coldwater tributaries. Similarly, warm and

cool-water perennial, intermittent, and ephemeral tributaries play an important role in spawning for the native Three Species. Fishing regulations implemented by CPW recommend annual spawning closures for the Colorado River in and around the tributaries of Elk Creek, Canyon Creek in Garfield County, No Name Creek, and Grizzly Creek, as the aggregations of large river fish amassing in relatively small tributary streams are easy targets for anglers. Additional flows provided by the Shoshone water rights help ensure these tributary habitats are accessible, providing critical reproductive habitat and seasonally variable river resources for resident fish. Connectivity within mainstem habitats and accessibility to tributaries are both imperative to sustaining Colorado's outstanding sportfishing opportunities and long-term persistence of native fishes.

4.5 Quality Trout and Gold Medal Fisheries

CPW manages the Colorado River for Quality Trout fishing opportunities including Gold Medal Waters. A Quality Trout is defined as a trout that exceeds 14 inches in length, contributing to a high-quality fishing experience for anglers. Designated Gold Medal Trout fisheries exhibit a high density of Quality Trout (greater than 12 trout over 14 inches per acre) and high trout biomass (greater than 60 pounds per acre) that provide the highest quality fishing experiences. The fishery in the Colorado River provides increased opportunities to capture Quality Trout and reaches that meet Gold Medal criteria are designated Gold Medal Waters. The Colorado River is designated Gold Medal in two reaches upstream of the Shoshone Reach: Fraser to Troublesome Creek and Canyon Creek in Grand County to Rock Creek. Additionally, two tributaries to the Colorado River also contain Gold Metal Waters, the Blue River and Gore Creek. The historical flow regime provided by the Shoshone call and recent efforts to introduce whirling disease-resistant Rainbow Trout support fishery enhancements that strive to meet Gold Medal metrics in Glenwood Canyon. A more recent identification of the Colorado River as a Quality Trout Water from Rock Creek downstream to Rifle signals to anglers the increased opportunity and accessibility to catch large Quality Trout in the Colorado River, including through Glenwood Canyon. Maintaining the historical flow regime in the Colorado River is essential to sustaining the existing high-quality fishery and could facilitate the return of abundant wild Rainbow Trout and push the segment between Glenwood Canyon and Rifle towards a Gold Medal designation.

4.6 Maintaining and Restoring River Connectivity

The Upper Colorado River, including the Shoshone Reach, lies in an ecoregion termed the Colorado Plateau-Wyoming Basin of the Colorado Plateau and is a specified high priority habitat in the SWAP. These larger-order rivers contain habitat features that are unavailable in smaller streams, particularly deep pools and runs, and large backwaters and floodplain areas that are inundated during high flow events. As a result, they comprise the core habitat for several native big-river fish species, though these species are also occasionally found in smaller streams (e.g., the Three Species, Bluehead Sucker, Flannelmouth Sucker, Roundtail Chub, and the federally-listed river species: Colorado Pikeminnow, Razorback Sucker, Bonytail Chub, Humpback Chub). River conditions are considered moderately or highly

impacted in many river reaches due to dams and diversions that have altered the natural hydrograph to varying degrees as snowmelt-driven peak flows are greatly reduced, as are baseflows in many cases. Additionally, dams and diversion structures function as barriers preventing upstream movement of fishes that are highly migratory species which require many miles of connected habitat to move between spawning and rearing, foraging, and overwintering habitats. These hydrological alterations, combined with channelization, bank hardening, introduction of invasive species, and other anthropogenic and climatic stressors, have degraded the condition of associated in-channel and riparian habitats. Colorado's SWAP emphasizes the protection of resources, habitat, and natural processes in these rivers. Specifically, high priority conservation actions include the securing instream flow rights, restoration and maintenance of suitable hydrological regimes, and control of invasive nonnative fish.

The Shoshone Dam disrupts the hydrologic function and river connectivity of the Colorado River, significantly impacting aquatic habitat and fish populations. Immediately upstream of the dam, the river is pooled with a flat gradient and low water velocities, leading to excessive sediment deposition and the loss of essential riffle-run sequences that characterize a healthy river. This habitat degradation diminishes macroinvertebrate productivity, reduces native sculpin habitat, and eliminates crucial refugia for juvenile fish, ultimately limiting food availability and lowering fish productivity. This lentic, highly sedimented habitat favors only the invasive White Sucker that CPW actively removes in the Colorado Basin to prevent hybridization with native Flannelmouth and Bluehead Suckers. Additionally, the dam acts as a physical barrier to upstream and downstream fish movement when diversions are occurring, and an upstream velocity barrier when closed and spilling or when bottom release gates are open. Restricting the upstream movement of fish fragments their populations and reduces access to critical spawning and rearing habitats and optimal river resources that are essential to their persistence. By altering the Colorado River's flow regime and limiting sediment transport and fish passage, the Shoshone Dam severely impacts the ecological integrity of the Colorado River surrounding Glenwood Canyon.

Within the Shoshone Reach, restoring and maintaining a more natural hydrological regime will improve fish passage. With increased water volume, drop heights will be reduced at cascades and boulder drops and downstream pool depths will be increased which increases fish passage probability. Higher flows provide increased cross-sectional habitat connectivity and wetted channel complexity, which provides alternative pathways along the channel margins when velocities in the main channel are unfavorable. Reestablishing river flows will facilitate movement for resident fish species, including desirable sportfish and the Three Species. The Three Species are endemic to the Colorado River Basin and are an important assemblage of fish for the greater Colorado River ecosystem and significant to the natural heritage of the state. Trout, whitefish, and the native Three Species will make large movements to exploit seasonally variable resources and often return to the same places to spawn. Connecting long expanses of river systems allows for nutrient cycling, fish population resiliency, and preserves genetic diversity, which is especially important within declining native species populations like those of the Three Species.

Returning natural flow conditions directly upstream of the Shoshone Dam and through the Shoshone Reach would also enhance macroinvertebrate communities and strengthen the aquatic food web that supports trout and native species populations. Macroinvertebrate surveys upstream of Glenwood Canyon indicate a stable, diverse macroinvertebrate community dominated by mayflies, caddisflies, and other pollution-sensitive taxa, signaling good water quality and nutrient cycling. Perennial flows in the Shoshone Reach could sustain a similar diverse community, ensuring a steady supply of high-quality forage for sport and native fishes alike. Furthermore, with limited riparian communities that would otherwise harbor abundant terrestrial insect food inputs for fish, aquatic macroinvertebrate drift is an essential food resource from upstream (GEI, 2025). Connected river reaches and reliable baseflows would support a thriving ecosystem, promoting fish health and population stability in the Colorado River system as a whole.

4.7 Benefits to Existing Instream Flow Reaches

The continued operation of the Shoshone call results in upstream administration that helps maintain streamflows in the upper Colorado River and many of its major tributaries. When Shoshone is calling, junior water rights are curtailed and/or reservoir replacements are made resulting in increased flows to the Colorado River headwaters and major tributaries like the Fraser, Blue, and Eagle Rivers and their tributaries. Benefits are also realized to many decreed ISF reaches held by the CWCB in the upper Colorado River Basin. The CWCB holds 350 decreed instream flow water rights upstream of the Shoshone Power Plant (CRD, 2025). In their analysis of the Shoshone water rights' impact on existing ISF reaches, CRD analyzed differences in streamflow on two ISF reaches with and without the Shoshone call using the 2024 Colorado River StateMod model. Two ISF reaches were evaluated – the Colorado River between Kremmling and State Bridge and the Eagle River between Lake Creek and Brush Creek.

Based on this analysis, there is a clear trend for both ISF reaches, which experience reduced flows absent the Shoshone call, particularly during dry years and months of August through October. The analysis showed more days when the ISF was satisfied with the Shoshone call in place. Based on CRD's analysis, the Eagle River ISF, decreed for 45 cfs in the winter and 110 cfs in the summer, would see reduced flows by 5 cfs (all years) and 7 cfs (dry years) on average absent the Shoshone call. Impacts on flows in the Colorado River at Kremmling were particularly pronounced due to compounding upstream reductions. In dry years during the months of August through October, flows at Kremmling would be reduced by 80 cfs on average if the Shoshone Water Rights were not exercised and approximately 50 cfs across all years. Under current demands absent the Shoshone call, the amount of days when the ISF reach would be met is reduced by 31% in August through October for dry years and by 19% across all months in dry years. The findings of this analysis are significant, particularly as it relates to the Colorado River near Kremmling, which has been identified by CPW as a Quality Trout Water. The Eagle River has also been identified by CPW as a Quality Trout water.

5. Conclusion & CPW Recommendation

Securing the Shoshone water rights in perpetuity is a concept that has been contemplated for decades. This proposal has broad support from a wide variety of Western Slope constituents spanning irrigation, municipal, recreational, and environmental interests. Many of these interests have also contributed financially to support the project. Permanent protection of the Shoshone water rights has been identified in a number of state-funded planning documents, including the Colorado Basin Round Table's Basin Implementation Plan(s), the Upper Colorado Wild and Scenic Alternative SG Management Plan, and the Middle Colorado River Integrated Water Management Plan. The acquisition of this non-consumptive water right aligns with CPW conservation priorities as specified in the Colorado SWAP. Overall, the corroborating studies conducted within the Shoshone Reach and knowledge-based experience of CPW's aquatic experts demonstrate that the Shoshone water right supports baseflows, habitat connectivity and habitat maintenance, and attenuates seasonally stressful conditions for important sportfish and native fishes. More consistent use of the Shoshone water rights in the Shoshone Reach for ISF purposes will provide significant preservation and improvements to natural ecological processes that support fish and macroinvertebrate communities.

It is the opinion of CPW staff that the best use of this water is to preserve and improve the natural environment at any flow rate up to 1408 cfs (the amount decreed in the senior and junior water rights). Based on hydraulic-habitat modeling, fish habitat also improves in the Shoshone Reach at flows up to at least 3000 cfs. This upper threshold is based on the upper limit of modeled flows in the hydraulic-habitat model. It is our professional opinion that flows greater than 3000 cfs also provide improvements to fish habitat by supporting geomorphic functions (e.g. moving fine sediments required for clean spawning gravels and scour and maintenance of holding habitats), supporting the aquatic food web, supporting thermal refuge areas, and creating additional fish passage pathways. Because the Shoshone Reach has been historically dewatered when the plant is operating, we believe the offered water would establish flows necessary to both preserve and improve the natural environment. Furthermore, the water right preserves the historical flow regime in the Colorado River while improving flows in the Shoshone Reach by adding additional wetted area and suitable fish habitat to a historically dewatered section of the Colorado River.

Given the demonstrated biological benefits within the Shoshone Reach, to the Colorado River headwaters and tributaries, and to the mainstem Colorado River below the power plant, CPW staff believes this acquisition will preserve and improve the natural environment and recommends the CWCB accept the interest in the acquired water. CPW believes the best use of the acquired water rights is to preserve and improve the natural environment in the Shoshone Reach of the Colorado River at any rate up to full decreed amount of 1408 cfs. Fish habitat will also be improved in the Shoshone Reach at streamflows up to at least 3000 cfs.

Photos

Photo 1: Shoshone Dam leakage during November 5, 2025 macroinvertebrate sampling event by CPW staff

Photo 2: CPW fisheries crew surveys the dewatered Shoshone Reach of the Colorado in Glenwood Canyon on October 23, 2024. (Photo Credit: K. Bakich)

Photo 3: CPW aquatic staff prepares to weigh and measure a large Brown Trout captured in an October 23, 2024 fishery survey in the dewatered Shoshone Reach on the Colorado River. (Photo Credit: K. Bakich)

Photo 4: CPW aquatic staff shows off a Rainbow Trout captured during a fishery survey on October 23, 2024 in the dewatered Shoshone Reach on the Colorado River. (Photo Credit: K. Bakich)

Photo 5: Bluehead Sucker collected October 23, 2024 during a novel fishery survey in the dewatered Shoshone Reach on the Colorado River. (Photo Credit: K. Bakich)

Photo 6: Boulder constriction in the dewatered stream in the Shoshone Reach creates a >4-foot pour-over of stream water onto a flat boulder face is insurmountable to fish moving upstream. A small constricted side channel on the left of the photo has high-velocity laminar flows that also restrict upstream fish movement. (Photo Credit: K. Bakich)

Photo 7: The red arrow points to bright, clean gravels in the Shoshone Reach of the Colorado River that are indicative of a trout redd likely created by the spawning activities of local Brown Trout during a site visit in the late fall of 2024.

Photo 8: Low flow channel during November 5, 2024 macroinvertebrate sampling event. (Photo credit: M. May)

Photo 9: CPW staff collected macroinvertebrate data in the low flow channel. 11-5-2024 (Photo credit: M. May)

References

Colorado Parks and Wildlife. 2015. State Wildlife Action Plan: A Strategy for Conserving Wildlife in Colorado. Available at cpw.state.co.us/conservation-plans (4/17/2025).

Three Species Rangewide Conservation Team. 2019. Range-wide Conservation Agreement and Strategy for the Roundtail Chub Gila robusta, Bluehead Sucker Catostomus discobolus, and Flannelouth Sucker Catostomus latipinnis. Prepared by Utah Department of Natural Resources, Publication Number 06-18, September 2006, Revised 2019.

Thompson, K. G., and Z. E. Hooley-Underwood. 2019. Present Distribution of Three Colorado River Basin Native Non-game Fishes, and Their Use of Tributary Streams. Colorado Parks and Wildlife Technical Publication 52.

Kondratieff, M.C. and E.E. Richer. 2022 Stream Habitat Investigations and AssistanceProject Summary Annual Report. Colorado Parks and Wildlife, Aquatic Research Section. Fort Collins,Colorado. Pp110

Behnke, R.J. 2002. Trout and salmon of North America. The Free Press, New York.

Deinstadt, J. et al. 2004. "Survey of Fish Populations in Streams of the East Fork Carson River Drainage, California." California Department of Fish and Game. Administrative Report 2004 - 8. 252pp

CDPHE. August 10, 2020. Policy Statement 10-1. Aquatic Life Use Attainment Methodology to Determine Use Attainment for Rivers and Streams.

Freshwater Consulting. September 30, 2024. Shoshone Reach Instream Flow Habitat Data Analysis, Habitat Simulations and Habitat Evaluation of the Colorado River from the Shoshone Diversion to the Shoshone Power Plant Outfall.

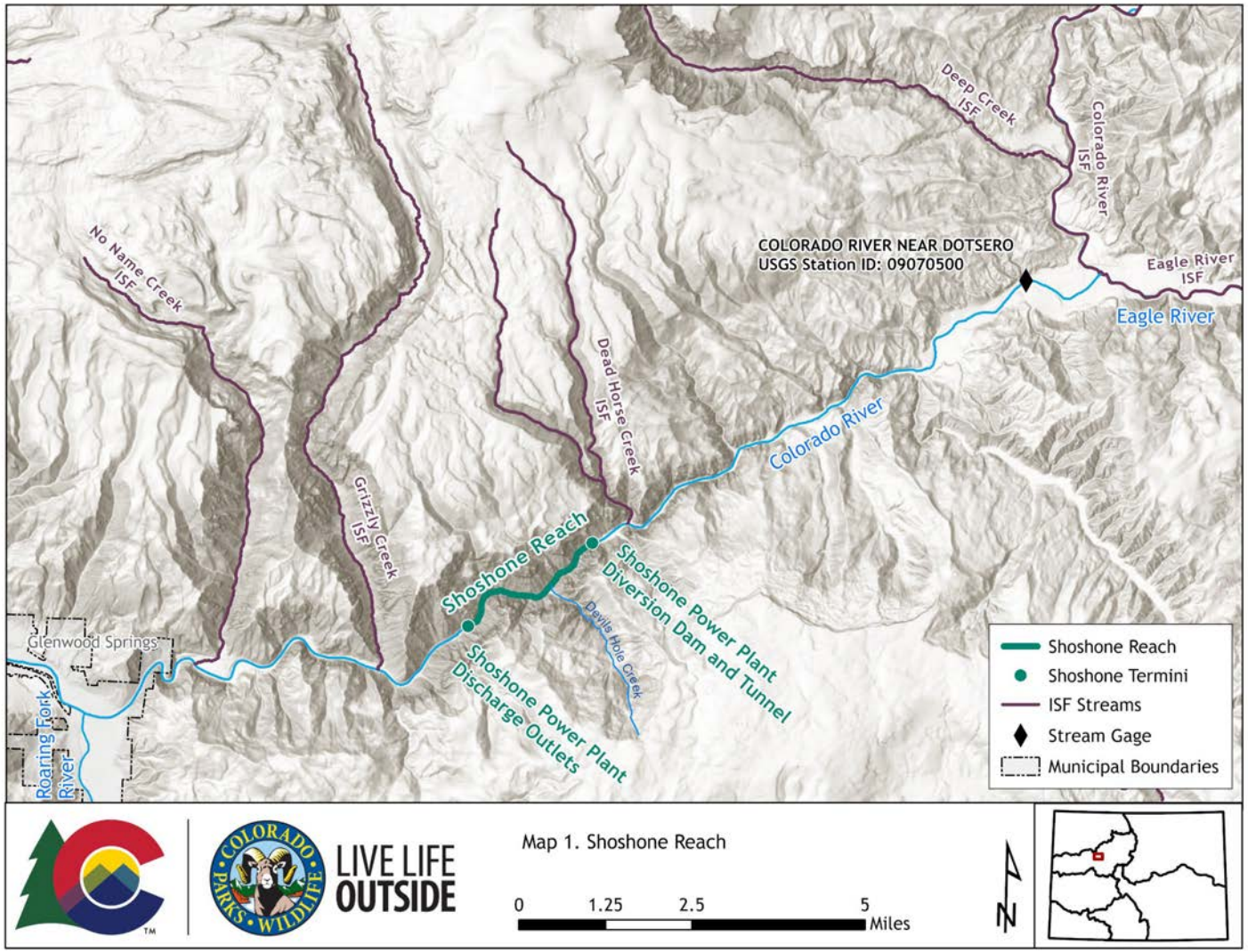
Ecosystem Sciences. April 22, 2025. Shoshone Reach Instream Flow Beneficial Use and Hydraulic Habitat Suitability Assessment.

GEI. April 2025. Review of the Effects of Flow on Biology and Stream Processes, Glenwood Canyon. Submitted to: Colorado Water Conservation Board.

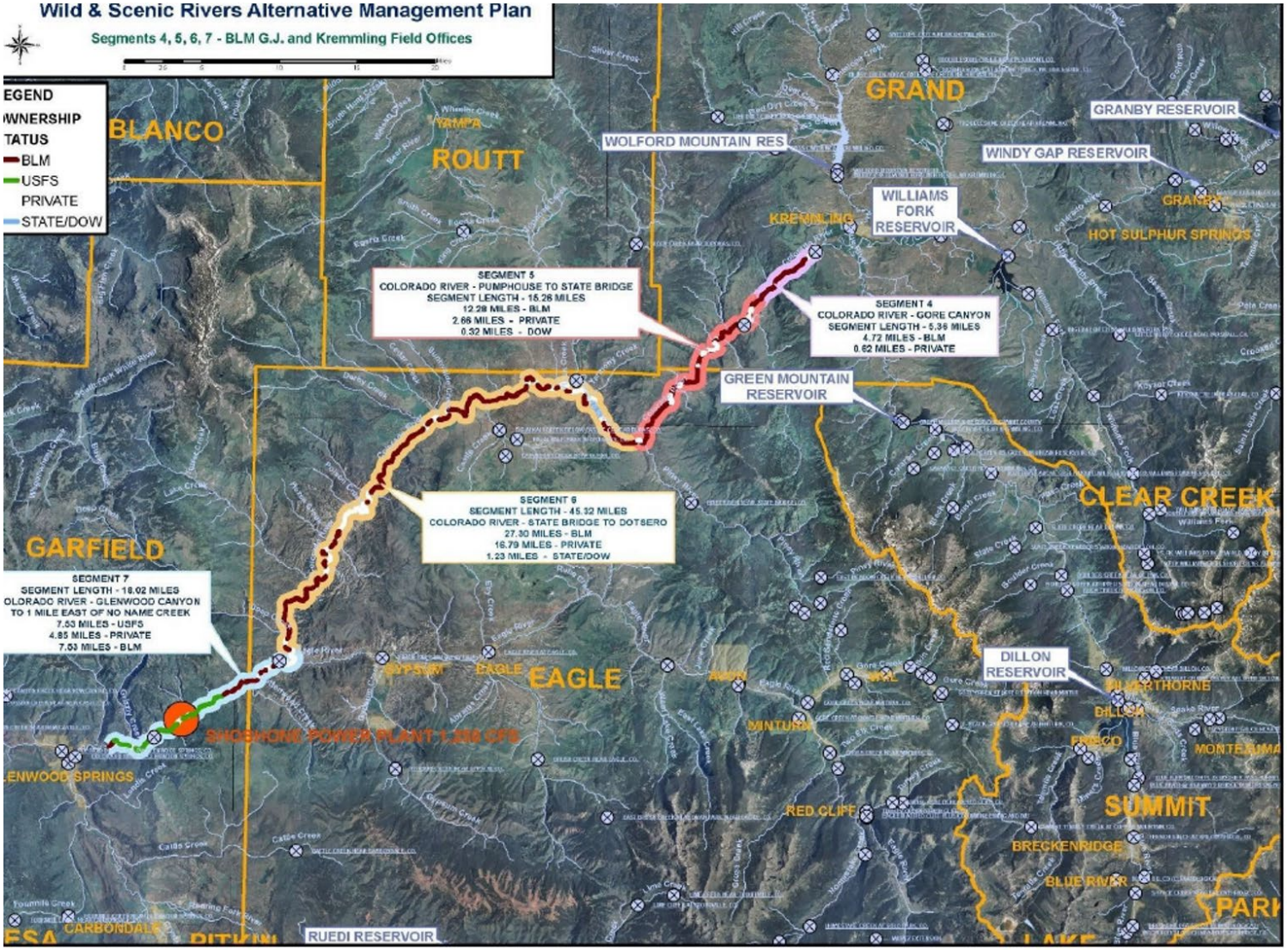
Amended and Restated Upper Colorado River Wild and Scenic Stakeholder Group Management Plan Adopted January 2012, Amended and Restated June 2020

Flinker, R. and B. Langenhuizen. 2025. Shoshone Water Rights Analysis on Decreed Instream Flow Reaches in the Colorado River Watershed. Colorado River District. 4-30-2025 Final Report.

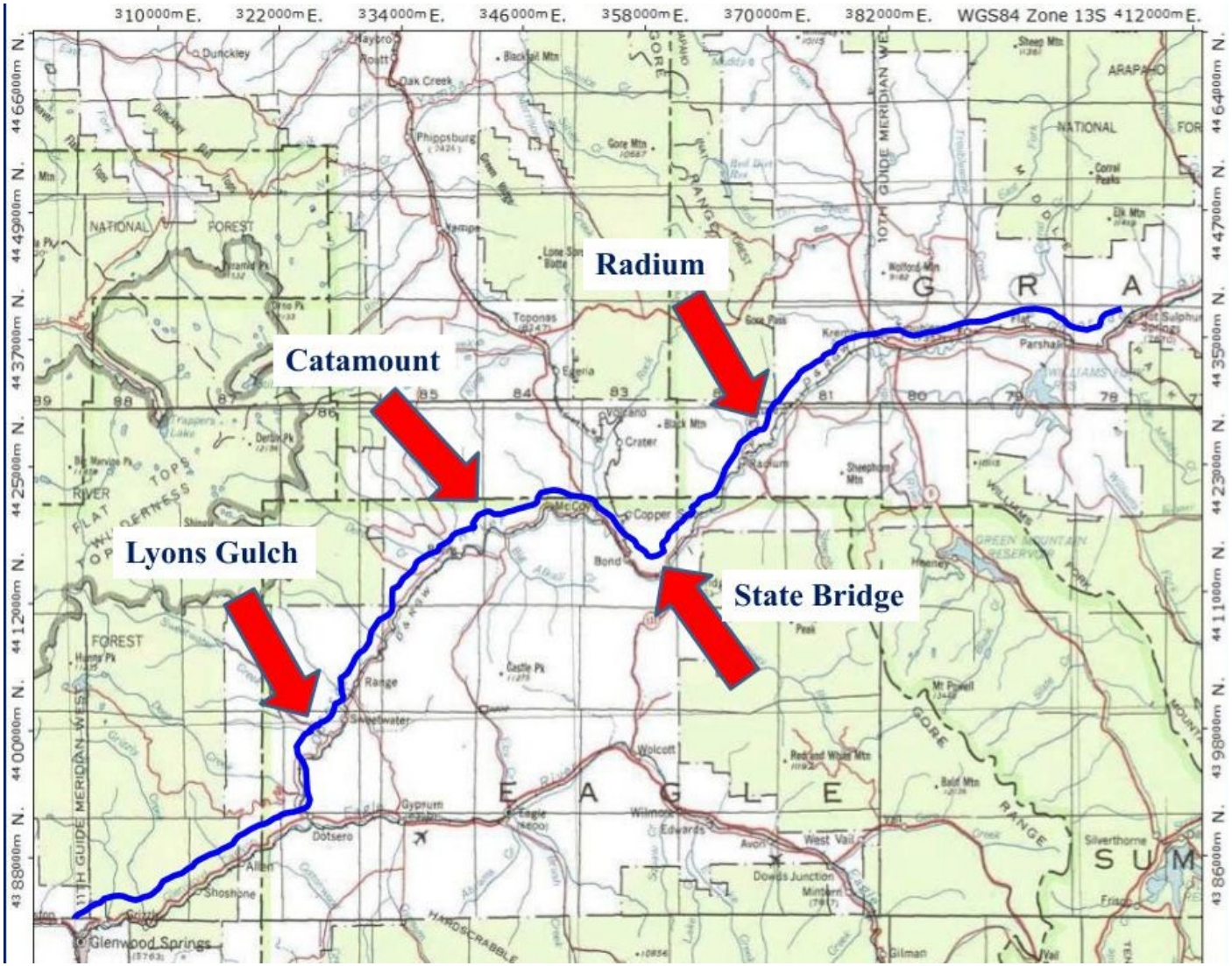
Platis, N. and G. J. Schilser. 2020. 2020 Colorado Angler Survey Summary Report. Prepared by Colorado Parks and Wildlife Aquatic Research Section, July 31, 2021.



Map 1. Proposed instream flow reach, the Shoshone Reach, where the Shoshone water rights will be dedicated for ISF use.



Map 2. Upper Colorado River Wild and Scenic Rivers segments (source: Amended and Restated Upper Colorado River Wild and Scenic Stakeholder Group Management Plan)



Map 3. CPW fishery monitoring sites in the Upper Colorado River Wild and Scenic stretch.

Gary Wockner, PhD
2525 Arapahoe Ave., E4, #260
Boulder, CO 80302
970-218-8310
gary@savetheworldsrivers.org

Education:
1997, PhD in Environmental Geography, University of Colorado-Boulder. Dissertation in wildlife resource management

1989, MA in Education, University of Colorado-Boulder
1987, BA in social sciences, Western Illinois University

Relevant Work Experience:

2022 – present, Executive Director, Tell The Dam Truth
2010 – present, Executive Director, Save The World's Rivers (formerly named Save The Colorado)
2005 – present, Executive Director, Save The Poudre

2005 – present, Author of two books, a dozen magazine articles, and over a hundred newspaper columns supporting river protection in Colorado, the western U.S., and globally.

Other Work Experience:
1999 – 2010, Research Associate in Wildlife Ecology/GIS, Colorado State University
1998, Math Instructor, University of Wisconsin – Madison
1997, Research Associate in Forestry/GIS, University of Wisconsin-Madison
1996, Research Associate in GIS, Great Lakes Indian Fish and Wildlife Commission

Full Bio see: GaryWockner.com