# Coldwater Stream Ecology Investigations

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Aquatic Research Section

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# COLDWATER STREAM ECOLOGY INVESTIGATIONS
# PROJECT SUMMARY

Period Covered: July 1, 2024 to June 30, 2025

## PROJECT OBJECTIVE

Improve aquatic habitat conditions and angling recreation in Colorado by investigating biological and ecological factors affecting sport fish populations in coldwater streams and rivers in Colorado.

## RESEARCH PRIORITY

Colorado River Ecology and Water Project Mitigation Investigations

## OBJECTIVE

Investigate the ecological impacts of stream flow alterations on aquatic invertebrates and fish of the Colorado River and evaluate the mitigation efforts associated with Windy Gap Firming project.

## INTRODUCTION

Dams are known to drastically alter the habitat of rivers and have a multitude of effects on fish and aquatic invertebrates (Ward and Stanford 1979). On the upper Colorado River near Granby, CO, dams have not only altered the temperature and flow regime of the river, but transbasin water diversions have reduced the average annual flow of the river 52% below historical levels and peak flows by 81% (Richer 2013). Colorado Parks and Wildlife aquatic research projects have previously identified major ecological impacts of streamflow reductions and a mainstem reservoir on the invertebrates and fish of the river (Nehring et al. 2011). The health of the invertebrate community declined after the construction of Windy Gap Reservoir, with a 38% reduction in the diversity of aquatic invertebrates from 1980 to 2011. A total of 19 species of mayflies, four species of stoneflies, and eight species of caddisflies are rare or extirpated in stream reaches below Windy Gap Reservoir (Erickson 1983; Nehring et al. 2011).

In addition to impacts on the aquatic invertebrate community, Windy Gap Reservoir and associated changes in flow and sediment regimes have altered the fish community of the upper Colorado River. Native sculpin, once common, are now rare or extirpated immediately below Windy Gap Reservoir (Dames and Moore 1977; Nehring et al. 2011). These fish currently recognized as Mottled Sculpin *Cottus bairdii* are likely different species, the Colorado Sculpin *C. punctulatus* or Eagle River Sculpin *C. annae* (Young et al. 2022). Due to the taxonomic uncertainty and ongoing work to properly describe these fish, in this report we will refer to both

species simply as “sculpin.” It is most likely that the fish are primarily Colorado Sculpin *C. puntulatus*, with lower numbers of *C. annae* in the upper Colorado River. Stream reaches below several dams and water projects in Middle Park have reduced density and range of native sculpin (Nehring et al. 2011). The decline in sculpin distribution appears both temporally and spatially related to the reservoirs or their operations (Kowalski 2014).

The Windy Gap Firming Project will increase trans-basin water diversions from the upper Colorado River and may further reduce streamflow in the river. Several large-scale mitigation projects have been completed to reduce the impacts of the Firming Project (Northern Water Conservancy District 2011). A large component of the mitigation plan was the construction of a bypass channel around the reservoir from 2022-2023, the Colorado River Connectivity Channel (CRCC). In October of 2023, the majority of the flow of the Colorado River was routed into the new channel and the upper Colorado River was re-connected for the first time in 40 years.

The goal of this project is to investigate the ecological impacts of stream flow alterations on aquatic invertebrates and fish of the Colorado River and evaluate the mitigation efforts associated with Windy Gap Firming project. The specific research objectives are to examine changes in the aquatic invertebrate and native fish community of the river associated with the CRCC.

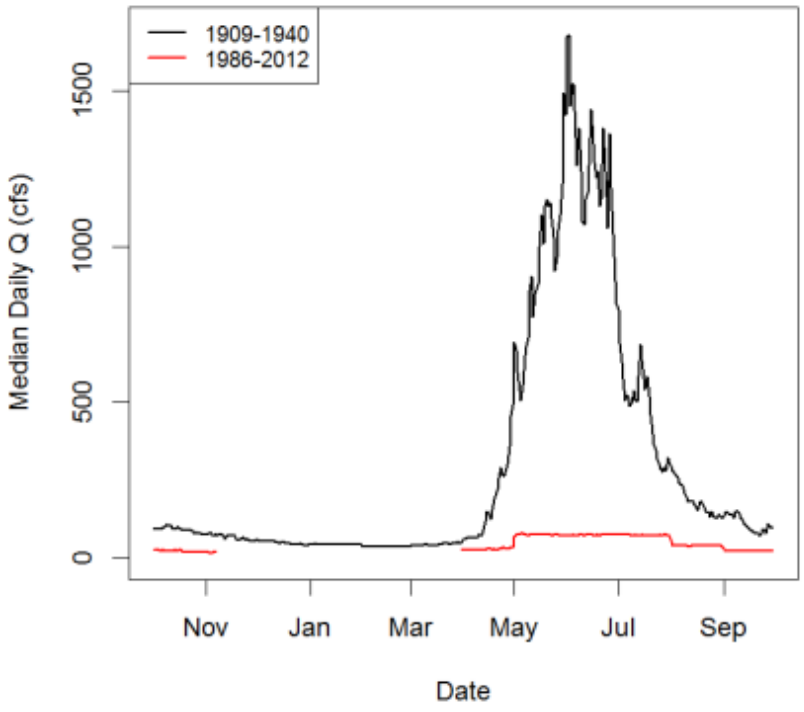


**Figure 1.** Pre-impoundment and post-impoundment hydrograph patterns of the Colorado River near Granby.

## METHODS

Invertebrate samples were collected by two different protocols, a quantitative Hess sampling method common to the USGS and Colorado State University (Clements 1994; Moulton et al. 2000) and the MMI method used by Water Quality Control Division of the Colorado Department of Public Health and Environment (CDPHE 2020). The Hess method involved taking five replicate samples at each site with a 0.086 $m^2$ Hess sampler with a 500 µm mesh net. The MMI method is a semi-quantitative kick-net protocol that takes a single one square meter (approximate) sample of streambed for 60 seconds with a rectangular framed kick net (0.46 m wide, 0.20 m tall, and 0.91 m long with 500 µm mesh.). All samples were elutriated in the field with five-gallon buckets, preserved in 80% ETOH, and sent to the National Aquatic Monitoring Center at Utah State University. Sampled were taken at seven sites from the Fraser River-Colorado River confluence downstream to the Hot Sulphur Springs State Wildlife Area (Table 1; Figure 2).

The objective of the fish sampling was to monitor the composition of the small-bodied fish community of the Colorado River and specifically to estimate the range and density of native sculpin. Fish sampling consisted of single or multiple pass electrofishing with three Smith Root 20B or LR24 backpack electrofishers and a crew of five people. A 30.5 m (100 ft) reach of stream was sampled along a randomly selected bank and approximately 1/3 the entire stream channel was covered with three backpack electrofishers (mean width 6.5 m) depending on the depth and visibility. If sculpin were found in the first 30.5 m of sampling then three-pass removal sampling was completed to estimate sculpin density. If no sculpin were found in the first 31 m, the sampling continued upstream for a minimum of 91.4 m (300 ft). The objective was to cover enough typical habitat to determine if sculpin were present and to estimate their density.

All fish were identified, counted, and a subset was measured to the nearest millimeter. At sites where sculpin were found, three pass density estimates were made with the Huggins Closed Capture model in Program Mark (Huggins 1989; White and Burnham 1999). Four models were built estimating capture probabilities by length, time, time + length, as well as a constant capture probability for all fish and all three passes. Model selection was conducted with AICc, population and parameter estimates were made by model averaging across all four models with AICc weights (Burnham and Anderson 2002).

**Table 1.** Aquatic invertebrate and sculpin sampling sites on the Colorado River 2025.

| Site Code | Site Name | Latitude | Longitude |
|---|---|---|---|
| CR1 | Confluence | 40.10062 | -105.97427 |
| CR10 | CRCC | 40.10127 | -105.97815 |
| CR11 | Windy Gap Ranch | 40.10655 | -105.99198 |
| CR2 | Hitching Post | 40.10897 | -106.00181 |
| CR3 | Chimney Rock | 40.10249 | -106.02411 |
| CR5 | Pioneer Park | 40.07468 | -106.10812 |
| CR6 | Gerrans SWA | 40.05228 | -106.13274 |

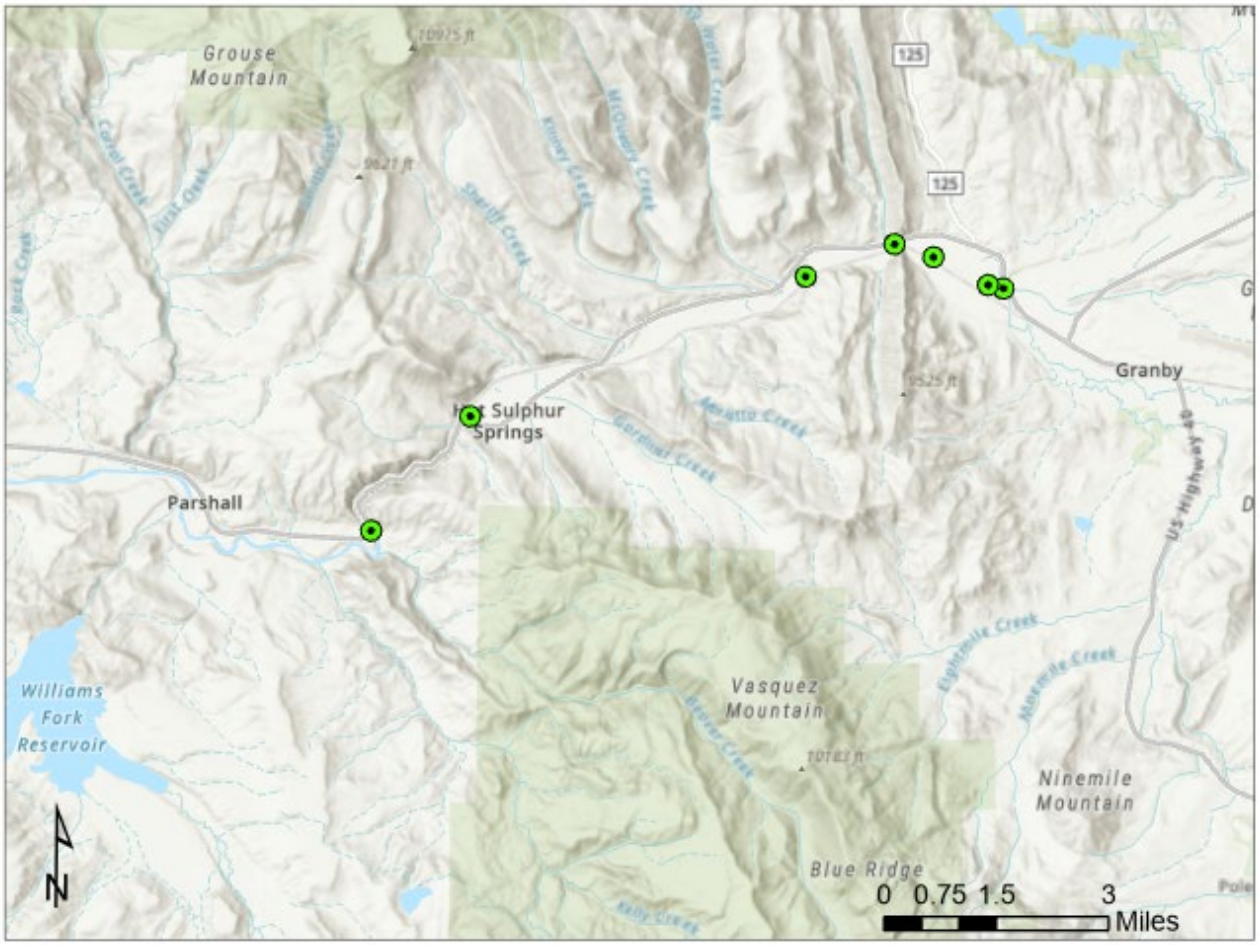


**Figure 2.** Map of the benthic macroinvertebrate and sculpin sampling sites on the Colorado River in 2025.

## RESULTS

Invertebrate samples were taken with both protocols from a single riffle at all seven sites (five historically sampled sites and two new ones) on September 29-30, 2025 (Table 1; Figure 2). Processing and identification of those samples is ongoing with results expected in 2026. Fish sampling occurred on September 16-17, 2025.

In 2025, sampling documented native sculpin in good numbers above Windy Gap Reservoir at site CR1 as well as in the connectivity channel at site CR10, but not at the five lower sites. At site CR1 the estimated density of sculpin was 0.08 $m^2$ (95% C.I. 0.07-0.10 $m^2$). Within the CRCC, the estimated density of sculpin was actually higher than the river above, 0.21 $m^2$ (0.16-0.26). Sculpin were first documented in the CRCC in 2024 when 11 young of the year fish were found (36-48 mm) and one 119 mm adult fish was sampled in three passes of the 100 ft sampling reach (Figure 4). In 2025, all of the fish sampled in the CRCC were larger adult fish 78-100 mm (Figure 3). Despite sampling 1,893 $m^2$ of streambed at five sites below the CRCC in 2025 and handling 557 other small-bodied fish, no sculpin were observed (Table 2). In 2024 a single young of the year fish was found below the CRCC (Figure 5).

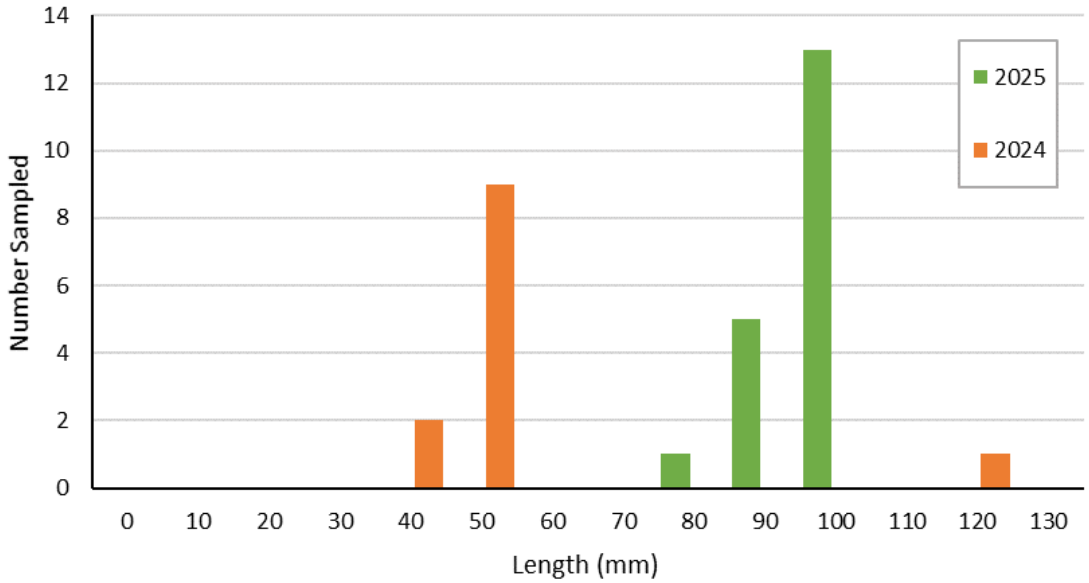


**Figure 3.** Length frequency histogram of sculpin sampled in the Colorado River Connectivity Channel 2024-2025.

**Figure 4.** Adult and juvenile sculpin sampled in the Colorado River Connectivity Channel in the fall of 2024.


**Figure 5.** Colorado Parks and Wildlife technician Josie Eccher with the first sculpin sampled in the Colorado below Windy Gap Reservoir since the connectivity channel became operational.

**Table 2.** Results of small-bodied fish sampling on the Colorado River 2025.

| | CR1 Confluence | CR10 CRCC | CR11 W.G. Ranch | CR2 Hitching Post | CR3 Chimney Rock | CR5 Pioneer Park | CR6 Gerrans SWA |
|---|---|---|---|---|---|---|---|
| Area Sampled $m^2$ | 212.3 | 104.4 | 295.4 | 292.6 | 313.5 | 735.5 | 255.6 |
| Sculpin | 16 | 19 | | | | | |
| Brown Trout | 17 | 13 | 20 | 9 | 5 | 12 | 25 |
| Rainbow Trout | 5 | 39 | 4 | 15 | 24 | | 20 |
| Speckled Dace | 30 | 22 | 86 | 64 | 29 | 95 | 61 |
| Iowa Darter | | 1 | 4 | | | | |
| White Sucker | | 6 | | 7 | | 18 | 52 |
| Longnose Sucker | 3 | 2 | | 2 | | 4 | |
| Fathead Minnow | 4 | | | | | 1 | |

## DISCUSSION

Native sculpin are migrating downstream into the CRCC and establishing themselves in the newly created habitat faster than anticipated and some of the expected benefits of reconnecting the Colorado River are now being realized. Densities of sculpin in the CRCC in 2025 actually exceeded density in the control site above the CRCC. As of 2025, large numbers of sculpin have not been documented below the CRCC, with a single young of the year fish being found in 2024. However, as more of adult sized fish become established in the channel, more downstream dispersal of young sculpin is likely to occur. Because habitat limitations were likely the main driver of the reduction of sculpin range in the Colorado River, reestablishing them throughout the river may be a slow process and be dependent on flow-driven changes of the instream habitat and not simply a function of fish passage and immigration. It appears that the primary mechanism of recolonization is downstream dispersal of young of the year fish that are not sexually mature. Therefore, establishing multiple age classes of fish will likely take serval years. While the large-scale ecological benefits of the CRCC may take years to be fully realized, the 2025 sampling results are promising and are important milestones in the efforts to improve habitat conditions and native fish populations in the upper Colorado River. Sampling for both native fish and aquatic invertebrates will continue and future efforts will concentrate below the CRCC to focus on areas that will most likely to be colonized first.

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## RESEARCH PRIORITY

Habitat Preferences of the Stonefly *Pteronarcys californica* and Factors Related to Declines in Range

Coauthor: Jackson Birrell, Graduate Research Associate, University of Montana, Missoula, Montana.

## OBJECTIVE

Investigate the habitat use of the salmonfly *Pteronarcys californica* in Colorado rivers and explore the factors related to their decline.

## INTRODUCTION

Giant Salmonflies, *Pteronarcys californica*, are among the largest of all stoneflies (Insecta: Plecoptera) and are endemic to Western North America. Salmonflies frequently occur in high densities (> 400 $m^2$) in mid-sized mountain streams and are often a major component of in-stream biomass (Nehring et al. 2011). They play a key role in nutrient cycling as shredders of leaf material (DeWalt and Kondratieff 2019; Vannote et al. 1980), provide an important food resource for trout populations (Nehring 1987), and transfer massive amounts of carbon to terrestrial systems during their large, synchronous emergences (Walters et al. 2014). Giant Salmonflies are sensitive to human disturbances and are used as bioindicators of river health (Barbour et al. 1999). They are also recreationally important to anglers because of the quality of the fishing during their emergence. Despite their ecological and cultural importance, reduction in the range and density of *P. californica* populations have been observed across the western United States.

Salmonfly declines have been reported in at least 10 rivers in the western U.S. They have been lost from >550 km of river in Montana, including reaches on the Madison, Smith, Big Hole and Clark Fork Rivers (Stagliano 2010). In Colorado, *P. californica* has been extirpated from the Arkansas River (Benzel 2016), and from several reaches of the Colorado (Nehring et al. 2011) and the upper Gunnison River (Elder and Gaufin 1973; Wiltzius 1976; Colborn 1985). In Utah, they have also been lost from the Logan River (Vinson 2011) and much of the Provo (Birrell et al. 2019) and Ogden Rivers. The factors influencing the declines of *P. californica* are not well understood. Changes in physical habitat, stream temperature, and oxygen levels may play a role (Anderson et al. 2019; Birrell et al. 2019; Kowalski and Richer 2020). In the Gunnison River, when temperature is not limiting, fine sediment deposition and cobble embeddedness may be driving Salmonfly range and density (Kowalski and Richer 2020). However, Giant Salmonfly disappearances in Utah do not appear to be correlated with high levels of fine sediments. Although abiotic factors, such as temperature, oxygen, and sedimentation, may play a role in *P. californica* declines, little work has been done to assess the importance of biotic interactions, such as diet and food availability. The interactions of abiotic and biotic factors likely influence

the range and distribution of this stonefly, and more work is needed to explore these factors in the Gunnison and other rivers.

In the Gunnison River specifically, Salmonflies have declined in range after the completion of the Aspinall project both above Blue Mesa Reservoir and immediately below Crystal Reservoir (Elder and Gaufin 1973; Wiltzius 1976). Currently, there is a thriving population of Salmonflies approximately five miles below the lowest of the three hydroelectric dams in the lower part of the Black Canyon National Park and downstream throughout the Gunnison Gorge NCA. The density and distribution of larval Salmonflies declines closer to Crystal Dam, likely due to temperature and physical habitat limitations related to the large ecological impacts of regulated flow and altered temperature regime caused by the large bottom release impoundment.

The objective of this study is to explore the abiotic (temperature and physical habitat) and biotic (diet) factors that may be influencing Salmonfly density and range and to explain their disappearance from specific rivers, specifically below regulated impoundments.

## METHODS

Fifteen sites on the Gunnison River were sampled from Almont to Austin, Colorado in 2022 for Salmonfly density and abiotic habitat factors (Table 3). At eight sites that contained Salmonflies, 3-10 individual larvae were collected and frozen for diet analysis to be completed by collaborators and N.C. State University. Abiotic habitat sampling involved measuring dominant particle size (D50) of riffles with a pebbled count, fine sediment with a visual grid method, cobbled embeddedness with the Bain visual method as well as a an estimate of force to move cobble particles. Temperature was monitored with Hobo Pendant temperature logger and dissolved oxygen was monitored with a PME MiniDOT meter. Flow was estimated using USGS gage data and discharge models. Three of these sites in BCNP were also sampled for aquatic invertebrate community structure because little invertebrate work has been done in this part of the river historically. Invertebrate sampling was done following the state of Colorado standard MMI method for invertebrate community health.

## PROGRESS

Sampling has concluded for this study and data analysis and final report writing is ongoing, including a draft manuscript to be submitted in 2026.

*Salmonfly Density Estimates*

Salmonfly density estimates varied by site, but generally followed expected patterns previously observed (Figure 6). There were no Salmonflies observed upstream of Blue Mesa Reservoir or immediately downstream of Crystal Reservoir. Approximately five miles below Crystal Reservoir, Salmonflies were found at Gunnison Point. Densities increased downstream with the highest densities observed in Ute Park in the Gunnison Gorge NCA. Salmonfly densities generally decline below Ute Park and they were present in low densities at Smiths Mountain and

absent from Drysdales site near Austin, Colorado, approximately eight miles below the confluence with the North Fork of the Gunnison.

*Aquatic Invertebrate Community*

Results of the MMI sampling revealed interesting, but not unexpected results. Downstream of Crystal Reservoir the invertebrate community has low diversity but high density of select taxa (Tables 4-5). All three sites were dominated by tolerant, coldwater species like midges, blackflies, and scuds. This pattern has been reported before and is typical of invertebrate communities downstream of large bottom-release reservoirs (Ward and Stanford 1979; Vinson 2001).

The East Portal site was dominated by *Gammarus lacustris* (30.6%), and 33.4% *Baetis tricaudatus*, with only one stonefly species present *Hesperoperla pacifica*. The Gunnison Point site was dominated by oligochaete worms in the genus *Nais* (38.0%) and Chironomidae (37.1%), mostly genus Tvetenia. Two stonefly species were also present (*H. pacifica* and *P. californica)*. This is farthest upstream (closest to Crystal Dam) that Salmonflies have been documented as larvae. The Red Rocks site was dominated by Simulidae (67.9%) and also had two stonefly species *H. pacifica* and *P. californica*. The densities of Salmonflies were higher at the Red Rocks site than Gunnison Point. The diversity of the invertebrate communities and the MMI scores was low at all sites but increased going downstream (Table 4).

**Table 3.** Gunnison River Salmonfly sampling sites.

| Site Code | Site | UTM (NAD83, Z13) | Sampling Completed |
|---|---|---|---|
| GR1 | Almont Campground | 338493, 4280034 | Benthic, Temp, DO, Habitat |
| GR2 | Garlic Mikes | 332499, 4271989 | Benthic, Habitat |
| GR3 | Gunnison Whitewater | 329747, 4266462 | Benthic, Temp, Habitat |
| GR4 | East Portal | 269116, 4267719 | Benthic, Temp, DO, Habitat, MMI |
| GR5 | Gunnison Point | 266346, 4271222 | Benthic, Diet, Temp, DO, Habitat, MMI |
| GR6 | Red Rocks | 257277, 4275405 | Benthic, Diet, Temp, Habitat, MMI |
| GR7 | Chukar Trail | 253421, 4278775 | Benthic, Habitat |
| GR8 | Bobcat | 251353, 4280344 | Benthic, Diet, Temp, Habitat |
| GR9 | Ute Park | 252376, 4284894 | Benthic, Diet, Temp, Habitat |
| GR10 | Smith Fork | 253338, 4291889 | Benthic, Temp, DO, Habitat |
| GR11 | Goldmine | 253728, 4295747 | Benthic, Diet, Temp, Habitat |
| GR12 | Cottonwood | 252129, 4295940 | Benthic, Diet, Temp, Habitat |
| GR13 | Orchard Boat Ramp | 247947, 4295297 | Benthic, Diet, Temp, DO, Habitat |
| GR14 | Smith's Mountain | 246534, 4295614 | Benthic, Diet, Temp, Habitat |
| GR15 | Drysdales | 245053, 4296502 | Benthic, Temp, DO, Habitat |

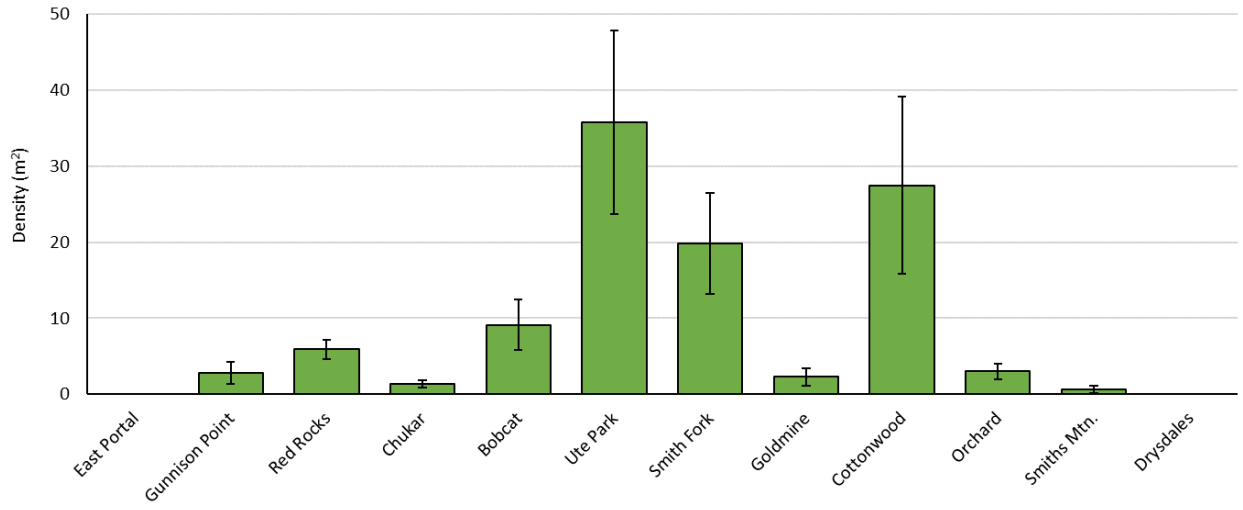


**Figure 6.** Salmonfly larvae density and 95% confidence intervals at Gunnison River sites below the Aspinall Unit reservoirs in 2022. No Salmonflies were sampled at Gunnison Whitewater, Garlic Mikes, Almont Campground above the dams or East Portal, or Drysdales sites below.

**Table 4.** Community metrics and index scores for invertebrate sampling in Black Canyon of the Gunnison National Park in 2022.

| Community Metrics | East Portal | Gunnison Point | Red Rocks |
|---|---|---|---|
| Total Taxa Richness | 20 | 26 | 29 |
| EPT Taxa Richness | 3 | 6 | 8 |
| Plecoptera Richness | 1 | 2 | 2 |
| SDI | 2.62 | 2.55 | 1.65 |
| MMI | 12.9 | 15.9 | 37.0 |

**Table 5.** Relative abundance invertebrate orders in Black Canyon of the Gunnison National Park in 2022.

| Order | East Portal | Gunnison Point | Red Rocks |
|---|---|---|---|
| Nematoda | 0 | 0 | 0.1 |
| Oligochaeta | 22.7 | 41.4 | 2.8 |
| Amphipoda | 30.6 | 0.4 | 0.2 |
| Ephemeroptera | 33.6 | 17.5 | 17.7 |
| Plecoptera | 0.1 | 0.1 | 0.4 |
| Trichoptera | 0.0 | 0.1 | 0.7 |
| Coleoptera | 1.4 | 0.9 | 2.9 |
| Diptera | 11.6 | 39.4 | 74.6 |
| Gastropoda | 0 | 0.1 | 0.1 |
| Bivalvia | 0 | 0 | 0.4 |

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## RESEARCH PRIORITY

Sculpin Phylogeny, Diversity, and Morphology in Colorado

## OBJECTIVE

Use molecular techniques to identify sculpin from Colorado to evaluate diversity within and between species, document their distribution, and to assess their phylogenetic relatedness to other lineages of sculpin. Compare morphological and meristic characters of sculpin in Colorado to identify distinctive characters and evaluate the physical differences among sculpin in Colorado.

## INTRODUCTION

Sculpin are members of a diverse family fish (Cottidae) that occur in a variety of marine and freshwater habitats throughout the northern hemisphere. In western North America, sculpin commonly inhabit coldwater streams with good quality habitat that is not excessively impacted by sedimentation or pollution (Adams and Schmetterling 2007). They are important ecologically in stream communities and can be better bioindicators of coldwater stream habitat than the salmonid species that they usually co-occur with (Adams and Schmetterling 2007).

There has long been taxonomic uncertainty about the identity of lineages of sculpins in Colorado (Woodling 1985; Adams and Schmetterling 2007). Sculpin are among the most difficult freshwater fishes to identify based on morphological characteristics (Jenkins and Burkhead 1994), a difficulty compounded by geographic variation in phenotypically diagnostic characters within individual species (Maughan 1978; McPhail 2007). Currently there are two recognized species of sculpin in Colorado, the Mottled Sculpin *Cottus bairdii* and the Paiute Sculpin *C. beldingii,* but the morphological characteristics of those two species do not differentiate them in Colorado and are not diagnostic for identification. Colorado Parks and Wildlife biologists and researchers have long suspected that sculpin in Colorado do not morphologically align with the described type specimens of Mottled Sculpin and Paiute Sculpin and recent publications have supported that hypothesis.

Gill (1862) first described a sculpin from the Colorado River basin as *Potamocottus punctulatus*, which was collected between Bridger Pass and Fort Bridger, Wyoming, likely from the Little Snake or Green River basins. Subsequently, sculpins of this lineage from the Colorado River basin were assigned a variety of generic, species, and subspecies names, and are presently recognized as Mottled Sculpin *C. bairdii*. Neely (2001) argued that *C. bairdii* should be restricted to sculpins from a portion of the Ohio River basin, and that the former members of this taxon in western North America constituted a mixed of named and unrecognized species. He proposed that those from the Colorado River basin be recognized as *C. punctulatus*, the Colorado Sculpin. Those conclusions were based on both molecular and morphological data, he found difference in mitochondrial DNA and morphological characteristics, including higher lateral line pore counts among western forms. Other researches have come to the same conclusions that the

fish recognized as the Mottled Sculpin in Colorado (and throughout the basin) are not *C. bairdii* (McPhail 2007; Young et al. 2013; Young et al. 2022).

The second species of sculpin recognized from Colorado, *C. annae*, was originally described from individuals collected from the Eagle River near Gypsum, Colorado (Jordan 1896). With little justification, Bailey and Bond (1963) synonymized this species with the Paiute Sculpin *C. beldingii*, which was originally described from Lake Tahoe, Nevada.

The objective of this study was to use DNA barcoding and other molecular techniques to identify specimens of *Cottus* from Colorado, to evaluate divergence within and among lineages, and to assess their phylogenetic relatedness to other lineages of sculpin, especially *C. beldingii* and *C. bairdii* from near their type locations. The secondary objective was to compare lineages of sculpin in Colorado to explore any morphological or meristic difference between them.

The first phase of this project was completed in 2020 (Young et al. 2020; Young et al. 2022). The second phase of this project began in 2022 and will continue through 2027. Phase two of the project is a cooperative study with Colorado State University and will involve exploring the morphological differences between our two sculpin species.

In the first phase of the project, Colorado Parks and Wildlife biologists and researchers sampled 262 specimens from 93 waters around the western slope of Colorado. These specimens were sent to the U.S. Forest Service National Genomics Center for Wildlife and Fish Conservation as part of a larger study of *Cottus* species across the west (Young et al. 2022). The results here are summarized from Young et al. (2020).

Phylogenetic analyses based on DNA barcoding placed the Colorado specimens in two primary lineages. One lineage (referred to here as *C. punctulatus*) is currently called Mottled Sculpin *C. bairdii* but is notably divergent from that taxon. Mottled Sculpin from eastern North America was a highly supported lineage that differed substantially (mean pairwise distance, 2.1%) from a primarily western group found in the Great Basin, Colorado, and Columbia River. Pairwise distances of this size are generally indicative of differences between full species (Ward 2009). The second lineage in Colorado (referred to here as *C. annae*) was unambiguously affiliated with the *C. beldingii* species complex, particularly those in Nevada, Idaho, Utah, and Wyoming, but was divergent from *C. beldingii*. The Colorado member of the Paiute Sculpin group was found to be geographically discrete, genetically divergent, and monophyletic and is likely and unique species endemic to Colorado.

Specimens of *C. punctulatus* were more widely distributed than *C. annae* in Colorado. The fish previously referred to as Mottled Sculpin, now thought to be *C. punctulatus*, were found in every river basin in western Colorado that was a tributary to the Colorado River. In contrast, *C. annae* was not found in samples from the San Juan and Green River basins in Northern Colorado, implying that the extent of its range was the Colorado River basin above the mouth of the Dolores River. It is currently unknown if the range extends to parts of the Dolores River basin in

Utah on the eastern side of the La Sal Mountains, but *C. punctulatus* was present in La Sal Creek near Paradox, Colorado.

The two sculpin lineages were found to be sympatric in the main-stem Dolores River, Dallas Creek (Gunnison River basin), the Eagle River, and the Crystal River. The co-occurrence of these taxa has been reported before; Jordan (1896) noted that *C. bairdii punctulatus* was abundant at the type location for *C. annae*. More recently, Shiozawa et al. (2010) detected both groups in samples from the Frying Pan River.

Interestingly, the distribution of *C. annae* is equivalent to that of the "Uncompahgre" lineage of Colorado River cutthroat trout *Oncorhynchus clarki pleuriticus* and the range *C. punctulatus* is the same as "Green River" lineage of Colorado River cutthroat trout (Bestgen et al. 2019). Because these species complexes share similar ranges, their distribution implies that *C. annae* and "Uncompahgre" lineage cutthroats may have established in Colorado at a similar place and time, in a way that differed from *C. punctulatus* and "Green River" lineage cutthroats.

Results from the first phase of the study demonstrate that there are two distinct lineages of sculpin in Colorado and that they are different species from their current classification. This important conclusion indicates that two of the 13 fish species native to the upper Colorado River basin in Colorado may be misclassified. These results also emphasize the need to describe the physical characteristics of the fish properly and will ultimately help inform decisions on re-naming the fish and potentially support resurrecting the name Eagle River Sculpin *C. annae*.

**PROGRESS**

The second phase of this project began in July of 2023 and field collections continued through November 2024. This phase is a collaboration between CPW and Kevin Bestgen and graduate research assistant Ben Applegate of the Larval Fish Laboratory at Colorado State University. The objective is to provide a morphological description of two provisional sculpin species in Colorado. A primary outcome of the study will be an improved understanding of morphological differences between the two taxa, and whether they are useful to differentiate taxa, is required to aid effective management and conservation efforts.

In 2023, 10 sampling sites were visited and 100 individual sculpin specimens were taken and preserved in 10% formalin solution (Figure 7). Paired genetic samples were taken from each individual specimen, preserved on chromatography paper, and sent to the U.S. Forest Service National Genomics Center for Wildlife and Fish Conservation. In 2024, 24 sites were sampled and 240 individual sculpin specimens were taken and preserved. Field collections are now complete, analysis of the samples is ongoing an expected to be complete in 2027.

The 340 sculpin specimens sent to CSU have all received morpho-meristic analysis composed of 15 meristic, 14 nominal, 37 morphometric, and 6 descriptions of features. Multiple correspondence analysis (MCA), principal component analysis (PCA), and factor analysis of

mixed data (FAMD) tests have been conducted to identify patterns in the morphological and meristic data. Preliminary analysis of meristic data (MCA) shows strong clustering into two groups, while morphological data (PCA) shows weak clustering with a blending between the clusters. Preliminary analysis of combined morphological and meristic data (FAMD) displays strong clustering into two groups, as well as variability in each cluster. Genetic data are needed to first match up with morphological identifications of species, which will then allow for discriminant analysis to determine if the clustering shown is congruent with presumptive taxa. Results of the genetic analysis of these specimens were delayed by the federal government shutdown in 2025 but all of the 2023 samples have been genotypes and complete results are expected in early 2026.

Characteristics appearing most promising to identify presumptive taxa are presence or absence of palatine teeth, number of preopercle spines, size and shape of the head, caudal peduncle length and depth, and presence or absence of lateral line canal pores on the caudal peduncle. These characteristics and their utility to distinguish taxa are preliminary and require confirmation with genetic information.


**Figure 7.** Sculpin sampling locations 2023-2024. Thirty-four sites in all major river basins on the western slope of Colorado were sampled.

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## RESEARCH PRIORITY

Investigate the influence of streamflow patterns, reservoir operations, and fish stocking on the population dynamics of the trout fishery of the Uncompahgre River tailwater in Southwest Colorado.

## OBJECTIVE

The objective of this project is to investigate the biotic and abiotic factors affecting the sport and native fisheries of the Uncompahgre River and Cow Creek and explore how fish populations are effected by stream flows, reservoir operations, and fish management activities.

## INTRODUCTION

Dams are known to drastically alter the habitat of rivers and have a multitude of effects on fish and aquatic invertebrates (Ward and Stanford 1979). Dams affect river ecosystems in a variety of ways including altering the natural pattern of water flow, transforming the biological and physical characteristics of river channels and floodplains, and fragmenting the continuity of rivers (Poff et al. 1997). How reservoirs are operated directly influences the flow and temperature of rivers and can dictate the diversity of aquatic invertebrate communities in rivers as well as the quantity and quality of fish habitat (Vinson 2001; Olden and Naiman 2010). Despite the many negative ecological effects, dams often benefit a subset of species. For instance, modified tailwater sections of river immediately downstream of dams can provide ideal conditions to support economically and recreationally important salmonid fisheries (Dodrill et al. 2016). Rainbow Trout (*Oncorhynchus mykiss*) and Brown Trout (*Salmo trutta*), two popular sport fish, thrive in tailwaters rivers throughout the Western U.S. because of the cool and clear water, stable flows, optimal water temperatures, and high production of algal and invertebrate resources.

Many of Colorado's best trout fisheries are in tailwater rivers so dam operations have a direct and strong influence on many the state's best and most highly used fisheries. Wild trout populations in Colorado are frequently driven by the strength of annual recruitment because spawning and adult habitat are generally abundant in most rivers and streams (Nehring and Anderson 1993; Latterell et al. 1998). Young of the year trout recruitment is heavily influenced by the rivers' hydrograph pattern with the timing of spring runoff as a major influence on trout recruitment success and the subsequent year class strength (Nehring and Anderson 1993). Therefore, the flow and temperature patterns below dams are driving both the biotic and abiotic factors that dictate the character and quality of many important trout streams in Colorado.

The Uncompahgre River is a tailwater trout fishery in Ridgway State Park between south of Montrose in southwest Colorado. At the USGS gage below the dam, the river has a drainage area of 265 square miles, an average daily flow of 195 cfs, a minimum daily flow 28 cfs, and a maximum daily flow 1,400 cfs. The river is the outflow from Ridgway Reservoir, a 1,030-acre (84,591 AF) flood control and water supply reservoir that is a "participating project" of the

Colorado River Storage Project. The Dallas Creek Project was authorized by the Colorado River Basin Project Act of 1968 was constructed on the Uncompahgre River in 1987 to increase water supplies for irrigation, provide water for municipal and industrial purposes, and to provide flood control. Recreational fishing was not a primary purpose of the project but is an ancillary benefit from it. The Uncompahgre tailwater supports a highly used coldwater sport fishery that, while it is well publicized and popular, suffers from habitat and flow limitations that may limit the quality of the fishery available to anglers (Kowalski 2009; Dillingham 2018). The river is heavily used by anglers and is a major draw for Ridgway State Park (CPW Creel data 2007, 2022).

The river is managed by CPW as a category 507 coldwater mixed stocking stream with intensive sportfish management strategies, meaning it can receive supplemental stocking of both subcatchable and catchable sized trout to provide angling recreation in lower productivity waters. However, this management strategy is inconsistent with CPW's policies, (Administrative Directive OW-8) that state:

> "Colorado Parks and Wildlife will consider the use of stocked fish in those water management categories where population augmentation is needed to either support fish species recovery and conservation, or to provide fishing recreation opportunity in waters not capable of sustaining natural reproduction or suitable fish growth due to habitat limitations. Stocking of catchable-sized trout will be used in waters that are not capable of natural reproduction or substantial growth, based on natural productivity or water conditions but have sufficient water quality to harbor trout until they are caught. Catchable trout may only be stocked in lakes and streams where there is sufficient harvest of stocked fish (50% or greater) and demonstrated lack of capability of the waters to support angling pressure through natural fish recruitment."

The section of river in Ridgway State Park has special fishing regulations that mandate the use artificial flies and lures only and all trout must be returned to water immediately (catch and release, flies and lures only) and is recognized on CPW's Quality Waters list. The mandatory catch and release regulations dictate zero return to creel for the stocked catchable trout unless they emigrate downstream outside of the special regulations water.

The specific factors that most influence the fishery are dynamic and have changed over time, but fish habitat limitations, gas super saturation, and low wintertime stream flows have been identified as factors affecting the fishery at various times in recent years (Kowalski 2009). Fish populations in the river were studied intensively in the late 1990's through middle 2000's by CPW biologists, researchers, instream flow coordinators, as well as scientists from the Bureau of Reclamation. More recently, two proposed water projects could substantially alter the flow regime of the river and have emphasized the need for more updated information. The first proposed project is Rams Horn Reservoir, a new reservoir project with a conditional water right first proposed in the 1950's as part of the original Dallas Creek Project. It would create a new 235 surface acre 25,000 acre-foot reservoir on Cow Creek near the U.S.F.S. Uncompahgre Wilderness Area. Cow Creek is known to support native Colorado River Cutthroat Trout (*Oncorhynchus clarki pleuriticus*) as well as a robust population of native Eagle River Sculpin

(*Cottus annae*) and low to moderate numbers of native Bluehead Suckers (*Catostomus discobolus*) in its lower end. The Rams Horn project would drastically alter the flow and sediment regime of Cow Creek and could influence how water is released from Ridgway Reservoir due to water exchanges and a proposed pipeline to the reservoir (Sackett 2021).

The second proposed project that could change flow patterns on the Uncompahgre River below Ridgway Reservoir is the Project 7 Regional Water Resiliency Program Water Supply Project. This is a plan for municipal suppliers to use water out of Ridgway Reservoir to diversify its water supply for the communities of Montrose, Olathe, and Delta Colorado. Together with Ramshorn Revoir, the future flow patterns in the Uncompahgre River could change dramatically and more information was needed on how the flow patterns and temperature regimes in the Uncompahgre River below Ridgway affect trout populations in the river.

The specific research objectives of this project are to explore how temperature, flow, and hydrograph pattern affect trout populations of the Uncompahgre River tailwater and how fish management activities such as stocking and habitat improvement projects can be used to improve the fishery. Specific goals to accomplish this objective are to:

1. Estimate growth, survival, diet composition, immigration, and emigration of trout in the Uncompahgre River to evaluate biological and environmental factors that limit the trout population.
2. Investigate instream flow needs of sport and native fish in the Uncompahgre River and Cow Creek.
3. Suggest mitigation efforts, management strategies, and reservoir operations to improve the sport fishery in the Uncompahgre River.
4. Document the biological and environmental baselines of Cow Creek fish populations and habitat to inform mitigation efforts of the planned future water project.

Management implications of this study will be an improved insight into the biology and ecology of the native and sport fisheries of Cow Creek and the Uncompahgre River to inform biologists and managers on the best fish management strategies for this river and assist commenting on upcoming large-scale water projects.

## METHODS

Fish populations are sampled in the Uncompahgre River two times a year (November and April) with mark recapture electrofishing using a portable barge and Smith Root 2.5GPP electrofisher. All fish are weighed to nearest gram, measured to the nearest millimeter, and individually tagged with 12.5 mm full duplex Biomark GPT12 passive integrated transponder (PIT) tags. The study area is in Ridgway State Park, is 944 m (3,096 ft) long, and extends from approximately the footbridge downstream to the confluence of Cow Creek. The Robust Design model in Program Mark will be used to estimate population size, capture probabilities, and survival of different size classes and types of fish for both winter and summer time periods (White and Burnham 1999). The Robust Design method takes advantage of the strengths of both closed population models

and open population models to best meet model assumptions and give accurate population estimates during the closed periods as well as survival estimates between those periods (Pollock 1982). Short-term periods occur each spring and fall where mark-recapture electrofishing is conducted 48 hours apart (closed population modeling) and seasonal survival, immigration, and emigration is modeled between the seasonal sampling periods (open population models similar to the basic Cormack-Jolly-Seber approach). Instream flow modeling as well as foraging-bioenergetics food web modeling similar to methods in Dodrill et al. (2016) will be used to investigate the influence of stream flows and available prey resources on the trout population. These modeling approaches will be used to test specific hypotheses about how flow, temperature, available habitat, and fish management activities like stocking influence fish population dynamics of brown and rainbow Trout in the Uncompahgre River Tailwater.

**PROGRESS**

Fish population estimates have been made in the Uncompahgre River two times a year (November and April) with mark recapture electrofishing since fall of 2023. There have been five seasonal closed capture periods, 10 total capture events, and 2,447 individually tagged fish as of November 2025 with 4,022 total captures of those fish. Data analysis and population modeling in Program Mark is ongoing. In November of 2025, an array of Biomark PIT Tag Antennas was installed at the bottom of the study reach to monitor fish movements, assess model assumptions, and better estimate long-term fish survival (Figure 8).

**Figure 8.** Biomark PIT Tag antenna in the Uncompahgre River at the downstream end of the study section.

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## RESEARCH PRIORITY

Technical Assistance

## OBJECTIVE

Provide technical assistance to biologists, managers, researchers, and other internal and external stakeholders as needed in a variety of coldwater ecology applications.

## INTRODUCTION

Fishery managers, hatchery personnel, administrators, and CPW Field Operations personnel often need fishery ecology information or technical consulting on specific projects. Effective communication between researchers, fishery managers and other internal and external stakeholders is essential to the management coldwater stream fisheries in Colorado. Technical assistance projects are often unplanned and are addressed on an as-needed basis.

## ACCOMPLISHMENTS

Technical assistance was provided to filmmakers from Fin and Fur Films on the biology and ecology of the Giant Salmonfly *Pteronarcys californica*. Several field visits and float trips were made to collect specimens and assist with the filming of the annual emergence on the Colorado River near Gore Canyon. The film was released in 2025 is currently available on various streaming platforms. The movie is called "The American South West," an adventurous journey down the Colorado River that explores the region's extraordinary wildlife, cultural history, and uncertain future. Approximately 10 minutes of the film is about the Giant Salmonfly emergence and it includes high definition high-speed footage of the emergence and trout and terrestrial predation on adult stoneflies. Streaming services link to watch full-length film: https://theamericansouthwest.film/watch

A collaborative effort with Dr. Yoichiro Kanno and Helen Acosta from Colorado State University continued on sculpin populations of the Eagle, Blue, and Colorado rivers. This project aims to compare growth, diet, reproduction, and ecology of sculpin in regulated and freestone rivers. Each river system was sampled in the summer to collect population density estimates and 50 sculpin specimens were taken in spring, summer, and fall for age and growth analysis (150 fish total for each river). Aquatic invertebrate samples were taken at each site and temperature was monitored throughout the ice-free season.

A technical assistance project is ongoing with USGS scientists from Arizona and Colorado. A large data request was received from USGS scientists in 2022 for fish population data on many of Colorado's premier tailwater trout fisheries. Responding to that request began a collaboration to improve the project, aid in selection of sampling sites, and to improve the understanding of CPW fish data. This project will benefit the state of Colorado with an improved understanding of

how flow and temperature influence tailwater trout fisheries, give specific information on the diet habitats of trout in the tailwater fisheries and how it relates to available drifting invertebrates, and how future climate change may affect the temperature regime of these fisheries. The objective of this study is to investigate the diet habits of Rainbow Trout (*Oncorhynchus mykiss*) and Brown Trout in tailwater fisheries and predict how they will respond to climate change and future water storage decisions. By providing insights into how flow and temperatures influence trout populations, our approach will be useful in evaluating current dam operations, ongoing drought impacts, and mitigating the future impact of climate change on important tailwater fisheries in Colorado. Data collection and analysis is complete for this project and two manuscripts have been submitted, one is in review and one is in press in the journal Food Webs.

## COMMUNICATION AND INFORMATION TRANSFER

One report was produced to summarize and disseminate information from the coldwater stream ecology research projects:

Kowalski, D. A. 2024. Coldwater stream ecology investigations progress report. Colorado Parks and Wildlife, Aquatic Wildlife Research Section. Fort Collins, Colorado.

One manuscript was published in 2025:

Richer, E. E., B. Friesen, A. E. Brubaker, D. A. Kowalski, M. C. Kondratieff, and T. A. Barnes. 2025. Making Waves: The Effects of Whitewater Parks on Fish Passage in Colorado. River Research and Applications 1–16. https://doi.org/10.1002/rra.70069

One manuscript is in press:

Scholl, E. A., T. A. Kennedy, M. J. Dodrill, M. A. Ford, R. E. Zuellig, D. M. Carlisle, D. Nelson, J. P. Pomeranz, D. A. Kowalski, C. B. Yackulic. *In Press*. Effects of temperature on ectothermic predators are modulated by warming-induced changes to prey. Food Webs.

One manuscript in in review:

Scholl, E. A., T. A. Kennedy, M. J. Dodrill, M. A. Ford, R. E. Zuellig, D. M. Carlisle, D. A. Kowalski, C. B. Yackulic. *In review.* Rainbow Trout growth across western U.S. tailwaters is determined by temperature and prey: implications for future management. Canadian Journal of Fisheries and Aquatic Sciences.

One manuscript is in preparation to be submitted in 2026:

Avila, B. W., E. R. Fetherman, M. Kondratieff, E. Richer, D. Kowalski, M. Baerwald, A. Goodbla, and J. Spohn. *In preparation*. The influence of population structure and life history on spotting pattern of Brown Trout in the South Platte River, Colorado.

Three book chapters were previously completed for the Fishes of Colorado Book. In 2025, proofs were reviewed and are currently with the publisher:

Kowalski, D. A. *In press*. Brown Trout. In Treble, A. J., G. J. Schisler, J. Woodling, editors. Fishes of Colorado. Fort Collins, CO.

Woodling, J., D. A. Kowalski, A. J. Treble. *In press*. Eagle River Sculpin. In Treble, A. J., G. J. Schisler, J. Woodling, editors. Fishes of Colorado. Fort Collins, CO.

Woodling, J., Kowalski, D. A., A. J. Treble. *In press*. Colorado Sculpin. In Treble, A. J., G. J. Schisler, J. Woodling, editors. Fishes of Colorado. Fort Collins, CO.

Two internal presentations were given:

Kowalski, D. A. 2025. Temperature based angling closures. Colorado Parks and Wildlife Aquatic Section Meeting. Nathrop, Colorado. February 4, 2025.

Kowalski, D. A. 2025. Muddled sculpins: diversity and phylogeny of Colorado's native cottids. Colorado Parks and Wildlife Area 7 Meeting. December 2, 2025.

One internal research summary was written:

Firestone, T. B. R. and D. A. Kowalski. 2025. Research results supporting BKD stocking regulations. Colorado Parks and Wildlife Aquatic Research. Fort Collins, Colorado.