# APPENDIX 1

## Biological Importance of Ephemeral and Intermittent Streams and Non-Adjacent Wetlands in Colorado

Contributors:

Patrick Bachmann - WQCD
Blake Beyea - WQCD
Harry Crockett - CPW
Paul Foutz - CPW
Tina Jackson - CPW
Jenn Logan - CPW
Melynda May- CPW
Kyla Reiner - CPW
Jessica Smith - CPW
Kevin Thompson - CPW
Andrew Treble - CPW
Grant Wilcox- CPW
Boyd Wright - CPW
Raquel Wertsbaugh - CPW

### Executive Summary

The proposed WOTUS rule would remove protections from all ephemeral streams, some intermittent streams, and non-adjacent wetlands. These waters are critical for many Colorado species, either directly by providing habitat, refuge, and breeding grounds, or indirectly through production of food sources (Colvin et al. 2018). Some of the species that utilize waters that could be removed from federal jurisdiction are listed as endangered or threatened under the federal Endangered Species Act (ESA), or have been identified as a Species of Greatest Conservation Need (SGCN) in Colorado (CPW 2015). Species whose conservation status is unknown, and more common species, also rely on these habitats. Removing federal protections from these waters could jeopardize existing conservation efforts, result in additional ESA listings for Colorado species through loss of habitat and/or critical populations, and reduce the overall health of aquatic ecosystems. Examples of species utilizing ephemeral and intermittent streams, and non-adjacent wetlands are provided, but is not an exhaustive list of species utilizing these habitats.

- The fish species Arkansas darter occupies intermittent streams through much of their range in Colorado. This species was a candidate for federal ESA listings, until determined not warranted in 2016. It remains a Tier 1 SGCN.
- Intermittent and isolated waters are vital for other Eastern Plains fish species such as Southern redbelly dace (Tier 1 SGCN), Northern redbelly dace (Tier 1 SGCN; state endangered), and plains topminnow (Tier 1 SGCN; evaluated for ESA).
- Several Tier 1 SGCN fish species spawn in intermittent streams, including roundtail chub, flannelmouth sucker, and bluehead sucker. The larval fish are washed down into perennial waters.
- ESA endangered fish species including razorback sucker, Colorado pikeminnow, and bonytail utilize intermittent streams.
- Boreal toads (Tier 1 SGCN; evaluated for ESA) breed in montane wetlands, including beaver ponds, intermittent streams, wet meadows, and emergent marshes. Toads return to the same breeding spots year-after-year, making them vulnerable to habitat destruction or changes in water quality.
- Plains and Northern leopard frogs (Tier 2 SGCN; evaluated for ESA) utilize ephemeral and intermittent stream habitats and associated wetlands throughout Colorado’s eastern plains.

- Over 250 invertebrate taxa inhabit intermittent streams in Colorado. These organisms are an important food supply to fish and other aquatic organisms as they wash downstream. They also help recolonize downstream populations after floods or other disturbance events.
- Three ESA threatened plants that occur in Colorado are wetland-dependent, including Penland alpine fen mustard, Colorado butterfly plant, and Ute ladies tresses. Additionally, 8 wetland-dependent plant species are Tier 1 SGCN, and 35 are considered rare in Colorado.
- Ten wetland plant-communities in Colorado only occur adjacent to ephemeral streams, intermittent streams, isolated wetlands, or groundwater-fed wetlands. In particular, fens are habitat for rare plant species, and vulnerable to dredge or fill operations.
- ESA endangered mice in Colorado including Preble's meadow jumping mouse and New Mexico jumping mouse depend on riparian vegetation and ephemeral streams. Degradation of riparian vegetation is a primary factor in the population decline of New Mexico Jumping Mouse. Habitat protection and restoration is included in the Preble's mouse recovery plan.

## Introduction

EPA's 2019 definition of waters of the US (WOTUS) would remove the following waters from federal jurisdiction: all ephemeral streams, intermittent streams that do not flow in a typical year, and wetlands that do not have a surface connection to a jurisdictional water. Many species in Colorado rely on habitats that would not be jurisdictional under this proposed rule, including species listed under the federal Endangered Species Act (ESA), and those identified by the state as Species of Greatest Conservation Need (SGCN) (CPW 2015). A high proportion of Colorado wildlife species use wetland and riparian habitats, many of which are imperiled. Of the 295 species of birds, 123 mammals, 47 reptiles, and 18 amphibians that inhabit Colorado at some time during the year, 125 (26%) can be classified as "wetland-dependent species" (Ringelman 1996).

Over 68% of Colorado's stream miles are ephemeral or intermittent (Levick et al. 2008) and several studies have found that USGS maps used for these estimates significantly underestimate the number and length of theses drainage networks (Heine et al. 2004, Mark 1983) (Figure 1).

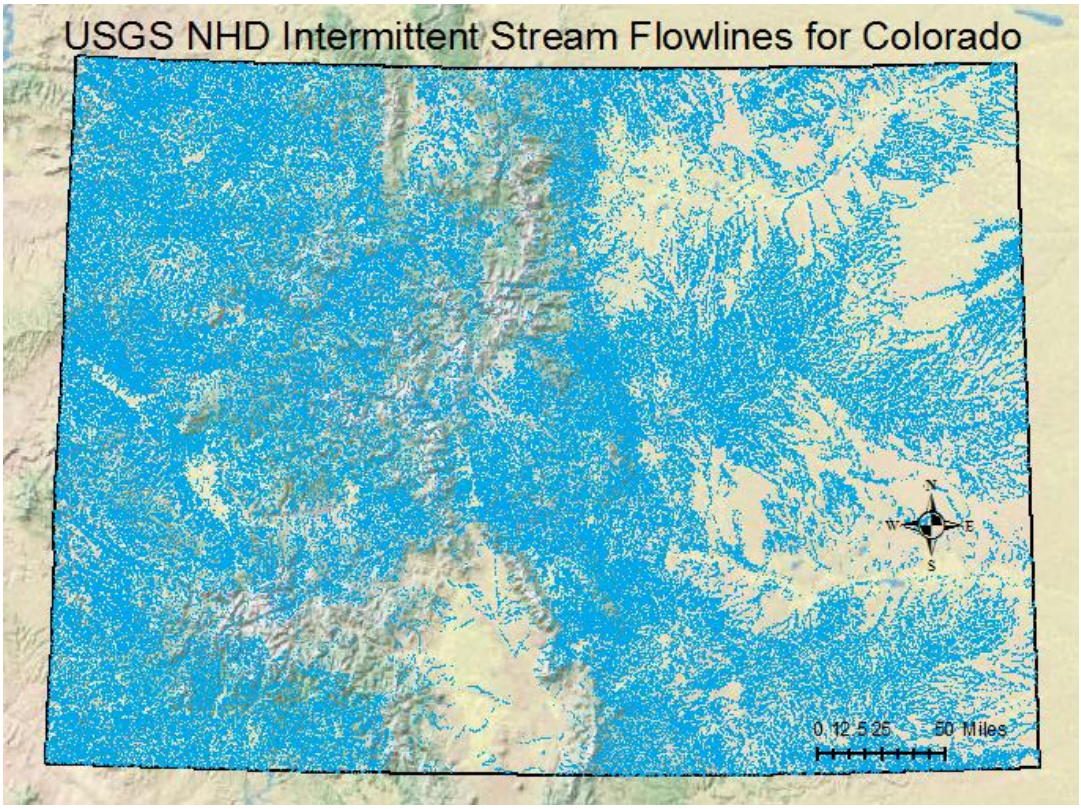

**Figure 1. Intermittent streams in Colorado based on USGS National Hydrography Dataset. Note, this map does not include ephemeral drainages.**

USGS mapping identifies approximately 151,184 miles of intermittent streams in Colorado (USGS 2019). Currently, there are no statewide maps of ephemeral streams.

Ephemeral in intermittent streams are critical to species in Colorado as habitat, refuge, and breeding grounds (Colvin et al. 2018, Blackburn & Mazzacano 2012). They also provide indirect support by regulating the supply of nutrients and sediments to downstream waters (Meyer et al. 2007), improving water quality (Alexander et al. 2007), and as a food source for downstream species occupying perennial waters (Cummins and Wilzbach 2005).

## Fish

**Many CO populations of Arkansas darter depend on intermittent streams**

Arkansas darters occupy intermittent streams through much of their range in Colorado. The species was long a candidate for federal endangered species listing, until determined to be not warranted in 2016. It remains listed as a Tier 1 Species of Greatest Conservation Need (SGCN) in Colorado's 2015 State Wildlife Action Plan (SWAP). Its habitat within Colorado consists mainly of Arkansas River tributaries on the plains of southeast Colorado, many of which exist as a series of partially or entirely isolated pools for much of the year. Arkansas darters are well-adapted to persist in such conditions, being able to tolerate high water temperatures (93 ◦C) and low oxygen levels (.25 ppm; Labbe and Fausch 2000). When these streams reconnect during above-average seasonal flows or flood events, numerous individual darters move within the system, colonizing new habitat and potentially supplementing local genetic diversity. This is a critical life-history strategy for most Arkansas darter populations on Colorado's high plains including those in Big Sandy Creek, Horse Creek, Rush Creek and tributaries, Black Squirrel Creek and Little Fountain Creek, among others. The prevalence of intermittent stream usage by Arkansas darters and its importance are thoroughly documented, e.g., Labbe and Fausch (2000); CDOW (2001); Fitzpatrick et al. (2014)

**Intermittent or isolated waters are vital for other Eastern Plains species**

One of two known aboriginal populations of Southern redbelly dace in Colorado (Tier 1 SGCN, state listed as endangered) persist in a wetland complex near the town of Florence (Bestgen et al. 2013; Foutz, CPW unpublished data; this area is designated swamp/marsh in the National Hydrology Dataset [NHD]). This area appears to be wetted by multiple spring seeps, and potentially in combination with alluvial Arkansas River water. (The area now contains one or more small constructed ponds that the fish appear to utilize, though their presence predates the ponds.) The second known aboriginal population occurs in Low Back Creek, a tributary to Hardscrabble Creek in the Arkansas River drainage (Bestgen et al. 2013; Foutz, CPW unpublished data). The downstream portion of this creek, which appears to sustain this population, is classified as perennial in the NHD (it is classified as intermittent further upstream). However, portions of this nominally perennial reach do in fact go dry, including the location where Southern redbelly dace were originally discovered in the stream.

The only known surviving population of aboriginal Northern redbelly dace (Tier 1 SCGN, state listed as endangered) persist in small ponds adjacent to Garber Creek, tributary to West Plum Creek in the South Platte drainage (Wright, CPW unpublished data). Some of these ponds are entirely spring-fed and disconnected from the creek except at high water, lying in oxbows or abandoned stream channel. (Other ponds have been constructed by impounding the creek or diverting its water, and some of these are also now utilized by Northern redbelly dace).

Plains topminnow, a Tier 1 SGCN that was evaluated for federal listing in 2013, requires slow-moving, shallow, warmwater habitat. Although it is not limited to intermittent waters, important populations occur in such locations. Willow Creek, on the Pawnee National Grassland, is a significant stronghold for this species, and often dries to a series of isolated pools or reaches. Plains topminnow also utilize off-channel alluvial ponds in the St Vrain and likely other drainages (Wright, CPW unpublished data).

In addition to specific examples described above, many of the streams spread across the eastern plains of Colorado are ephemeral or intermittent in nature, and these streams provide critical habitat for a diverse assemblage of fish species that occupy them when water is present. While the natural history of these species isn't completely understood (research on these species is sometimes lacking), their long-term presence within these systems is important to note. Some of these species include, but are not limited to: brassy minnow, central stoneroller, orange spotted sunfish, northern plains killifish, red shiner, and sand shiner (Foutz & Wright, CPW unpublished data).

**Tributary spawning in intermittent streams**
A number of West Slope fish species spawn in tributaries, including intermittent tributaries. CPW researchers have studied tributary use by native roundtail chub, bluehead sucker and flannelmouth sucker (all Tier 1 SGCN, and the focus of a multi-state conservation team of federal, tribal and state agencies including CPW). This research has documented that an intermittent stream can support large spawning runs and thereby play a potentially critical role in sustaining main-stem river populations. In Cottonwood Creek, a tributary of Roubideau Creek in the Gunnison Basin, large numbers of fish migrated into the stream almost immediately after it began to flow, spawned, and migrated back out in a span of 26 - 37 days (Hooley-Underwood et al. 2019). In 2016 researchers handled over 4,400 out-migrating suckers during a 3-day period and over 8,500 over the course of the spawning run. This was only a fraction of the total number of fish present, as they exceeded the researchers' capacity to handle them all. Numbers of fish were even greater in 2017. Fertilized eggs or fish larvae produced in these intensive spawning events then drift downstream to perennial reaches before the spawning areas go dry. CPW's lead researcher on this project observes:

> *It is important to note that these large spawning runs are in a stream that does not flow at the mouth for much of the year. A stream such as this would likely receive little attention or consideration under ordinary circumstances, yet may be heavily used for certain aspects of native fish life history. As such, we ought to view such streams through a new lens, recognizing the possibility that even snowmelt ephemeral (sic, should be "intermittent") streams could be very important to the conservation of native fishes* (Thompson, 2017).

Colorado's West Slope of Colorado features a number of canyon-bound rivers in which long reaches may have relatively little spawning habitat in the mainstem (Fraser et al. 2017) and few perennial tributaries. Intermittent and ephemeral tributaries may be of particular importance in such areas.

## Amphibians

**Many of Colorado's amphibians rely on ephemeral streams, intermittent streams, and non-adjacent wetlands and ponds, particularly for breeding sites.**

Boreal toad is among the better-studied and surveyed amphibian species in Colorado due to its former status as a candidate ESA species. Boreal toads breed in montane wetlands elevations of 8,000-12,000 feet. Although there is some dispersal, most toads return to the same breeding site repeatedly for years, making the persistence of such wetlands critical to populations' persistence. Some of these known breeding sites may lose WOTUS jurisdiction under the proposed rule (Figure 2). Wetland types frequently used for breeding include beaver ponds, intermittent streams, and wet meadows and emergent marshes adjacent to streams, among other habitats.

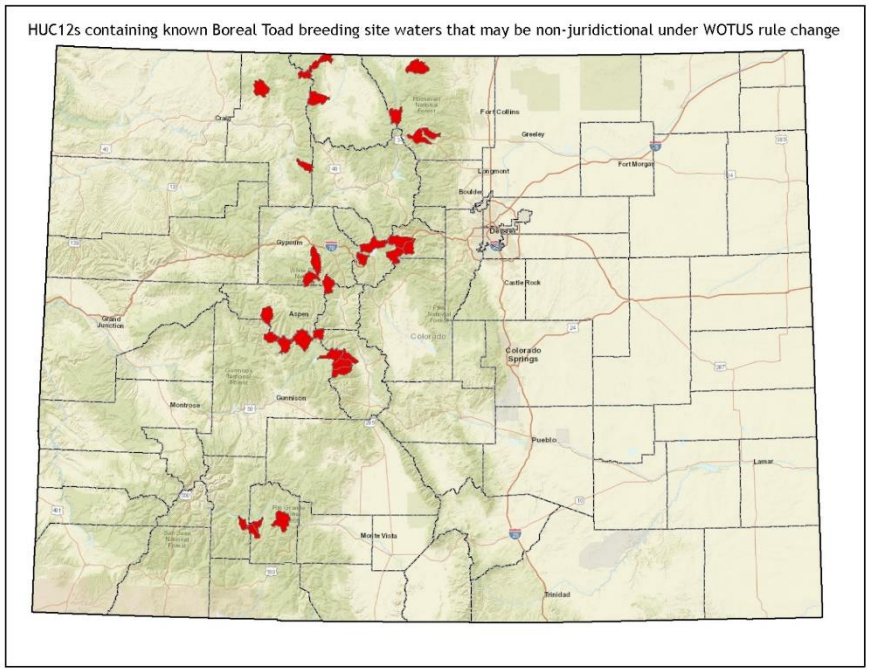


**Figure 2. Map of boreal toad breeding sites likely to lose WOTUS jurisdiction under proposed 2019 rule.**

Great basin spadefoot toads occupy ephemeral and intermittent pools and streams, burrowing in sandy soils during dry periods. Some of these known breeding sites may also lose WOTUS jurisdiction under the proposed rule (Figure 3).

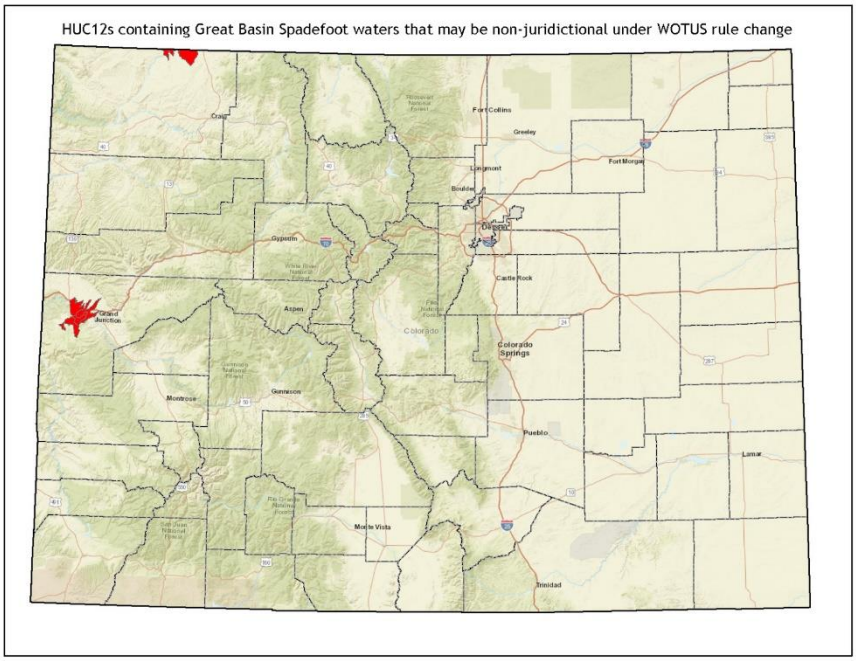


**Figure 3. Map of Great Basin spadefoot breeding sites likely to lose WOTUS jurisdiction under proposed 2019 rule.**

Hammerson (1999) describes the habitat preferences of amphibians in Colorado. Tiger salamanders are common in permanent ponds, semi-permanent ponds,and ephemeral pools. Recently metamorphosed juveniles of Couch's spadefoot use moist cracks between or under plates of drying mud, indicating the use of ephemeral or intermittent waters. The canyon tree frog occurs along intermittent streams in

deep canyons with permanent canyon-bottom pools. In low-land areas, the Western chorus frog remains near ephemeral non-flowing bodies of water such as marshes. Wood frogs are found in glacial poos, subalpine marshes, bogs, pothole ponds, beaver ponds, lakes, stream borders, and wet meadows. Haynes and Aird (1981) expressed concern that the wood frogs breeding areas, which are mostly ephemeral glacier pools are disappearing. They often breed in shallow natural ponds with no inlet or outlet. Plains and northern leopard frog (northern leopard frog was formerly under ESA listing review) utilize ephemeral and intermittent stream habitats and associated wetlands throughout Colorado's eastern plains (CPW unpublished data), and are often observed during stream surveys for native fishes (Foutz, personal comment).

## Macroinvertebrates

Unique and diverse aquatic invertebrates such as insects, snails, worms, crustaceans and other taxa inhabit ephemeral and intermittent systems in Colorado. Intermittent and ephemeral systems are home to a surprising diversity of invertebrates adapted to regular dry periods (Schriever et al. 2015). Headwater streams act as a major source of food for downstream invertebrates as organic matter, microbes, algae are washed downstream. Macroinvertebrates provide critical prey items to fish, particularly smaller juveniles, inhabiting perennial streams (Figure 4). After disturbance events in perennial stream, such as floods, macroinvertebrates drifting down from headwater streams help to re-colonize the habitat.

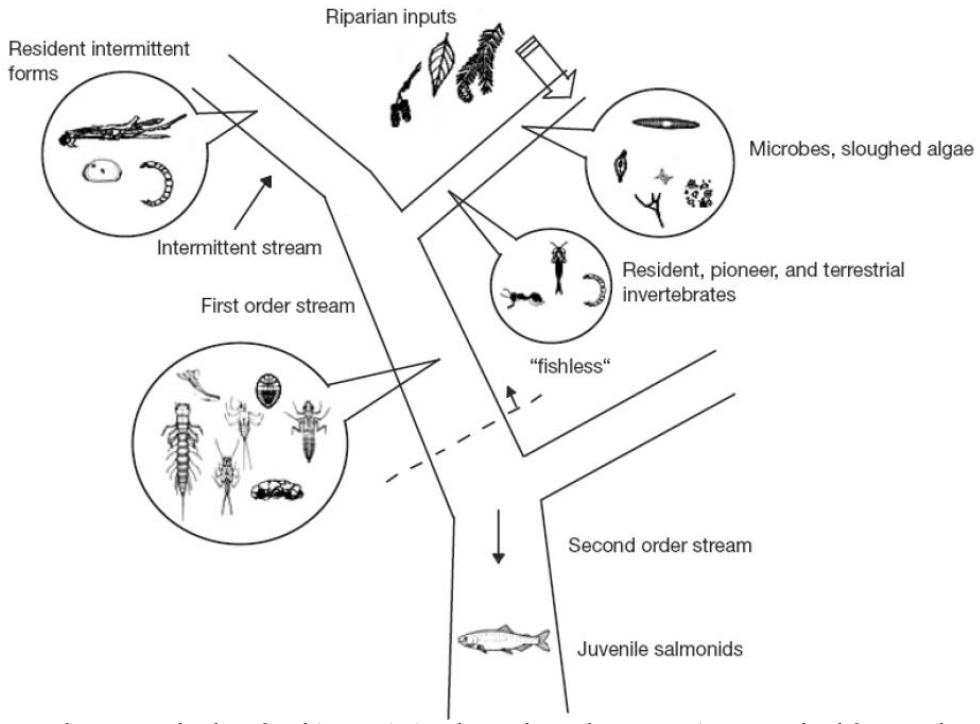


**Figure 4. Invertebrates and other food items (microbes, algae, leaves etc) are washed from ephemeral and intermittent streams, providing an important food source for downstream organisms such as fish (from Cummins and Wilzbach 2005).**

**Findings from the literature on Macroinvertebrate diversity in Western Intermittent Streams**

An extensive study of ephemeral streams in Arizona identified nearly 1,000 taxa (Kingsley 1998) in the wash habitats of the Organ Pipe Cactus National Monument and a study in Oregon found over 200 species of macroinvertebrates inhabiting summer dry streams, 13 of which were previously undescribed to science (Dieterich and Anderson 2000).

Del Rosario and Resh (2000) surveyed invertebrates in the hyporheic zones (the interstitial space beneath and alongside a stream bed) of both intermittent and perennial streams, and found that

intermittent systems had higher species diversity than perennial streams. During a two year study of a 3rd order montane stream in Colorado, multiple taxa (flies, caddisflies, and craneflies) exhibited significant increases in population densities during a drought year resulting in the cessation of surface flow (Canton et al. 1984).

Macroinvertebrates that make their living in these hydrologically disjunct systems have a variety of adaptations to dry conditions such as small body size, diapause (state of dormancy), univoltine life cycles (one generation per year), desiccation resistant eggs/cysts, rapid growth during wet conditions, mobile adult stage, and behavioral adaptations such as burrowing, migration and deposition of eggs in moist soils. (Smith 2001, Williams 2006, Bogan et al. 2013). As documented in further detail by Meyer et al., 2007, headwater intermittent systems are home to unique taxa for multiple reasons ranging from supplying diverse physico-chemical habitats; nursery/spawning habitat; and refuge from predators, competitors, alien and invasive species, and high scouring flows.

**Colorado Macroinvertebrates and Intermittent Streams**

Colorado is home to a large number of streams with taxa identified as "intermittent indicator families." A 2008 study prepared for the Xerces Society for Invertebrate Conservation (Mazzacano & Black 2008) found multiple families of macroinvertebrates whose presence is indicative of stream flow intermittency. Over 400 streams in Colorado are home to these intermittent indicator macroinvertebrate families whose presence is strongly tied to flow intermittency (see Table and Figure 5).

| Intermittent Indicator Family | Common Name | # of Colorado streams surveyed |
|---|---|---|
| *Capniidae* | slender winter stonefly | 181 |
| *Limnephilidae* | Northern caddisfly | 154 |
| *Nemouridae* | forest fly | 38 |
| *Dytiscidae* | predacious diving beetle | 36 |
| *Hydrophilidae* | water scavenging beetle | 17 |
| *Lestidae* | spreadwinged damselflies | 3 |

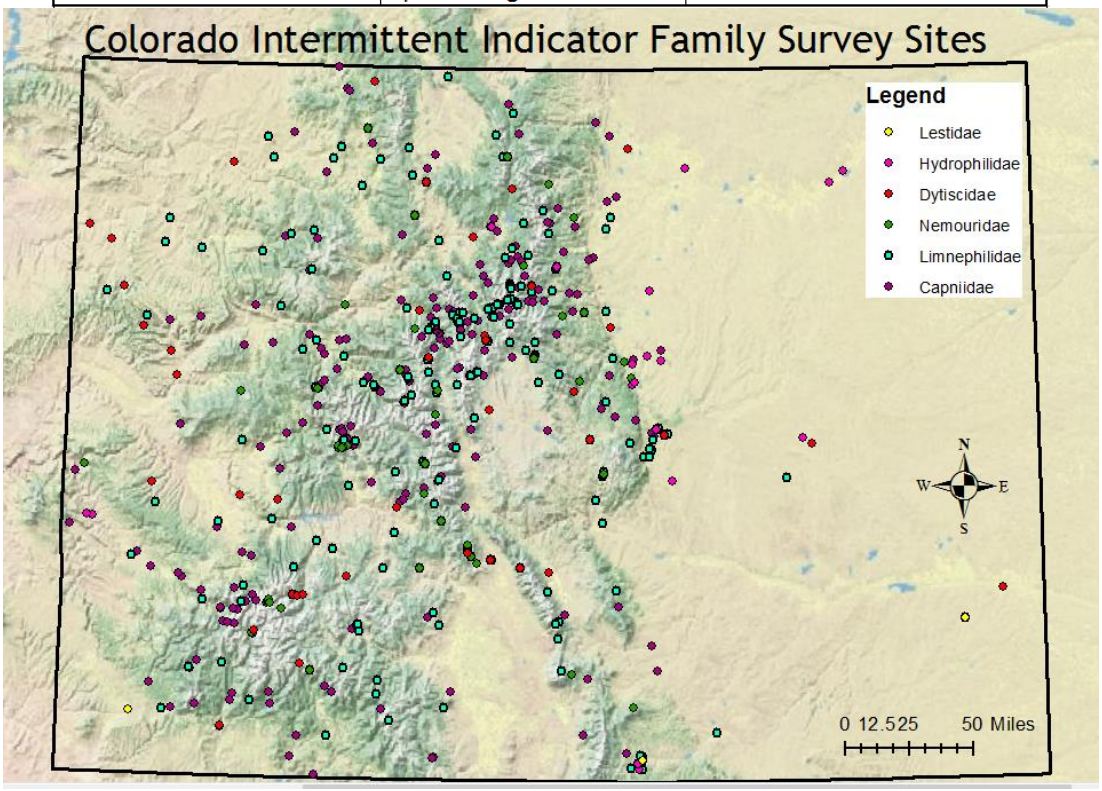

**Figure 5. Map of sampling sites with invertebrates families that are indicators of intermittent flow.**

**How many macroinvertebrates live in intermittent streams in Colorado?**
Colorado's Water Quality Control Division as well as numerous federal/state agencies, watershed groups and interested stakeholders have collected macroinvertebrate samples from over 2200 sites in the state from 1992-2018. (Figure 6)

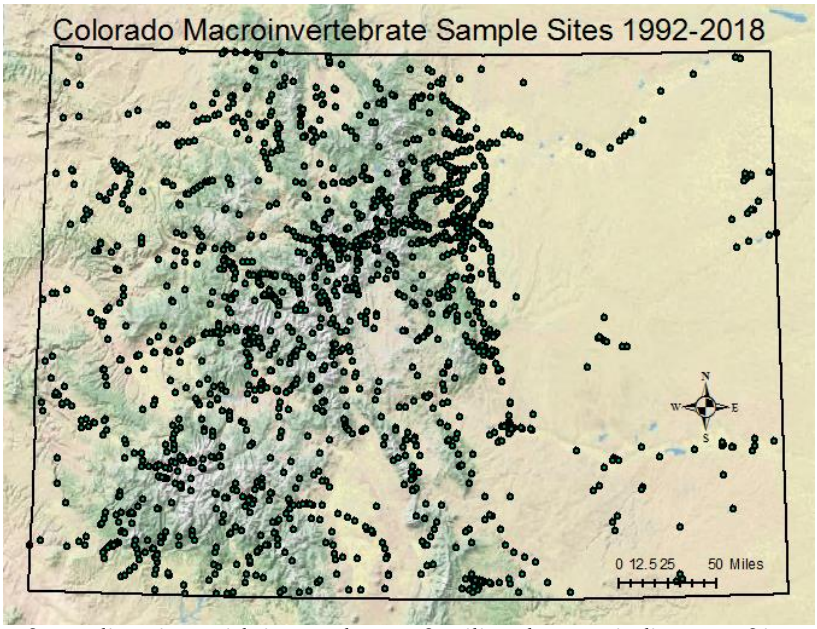


**Figure 6. Map of sampling sites with invertebrates families that are indicators of intermittent flow.**

At least **250 identified taxa inhabit intermittent streams in Colorado** (most organisms identified to genus level). These organisms span multiple phyla and it should be noted that this large number is likely an underestimate, given the methodology of collecting macroinvertebrates with a kicknet typically requires surface flow and does not specifically target organisms in hyporheic and moist soil zones.

## Wetland Plants

- There are over 35 wetland-dependent species of rare plants in Colorado, including 8 that are listed as Plant Species of Greatest Conservation Need in the Colorado Wildlife Action Plan, 3 of which are listed as federally threatened.
- There are at least 10 plant communities in Colorado that are tracked by the Colorado Natural Heritage Program which only occur adjacent to ephemeral streams, intermittent streams, and isolated or groundwater-fed wetlands.
- An example of a significant tracked plant community type that may be affected by the new WOTUS ruling are wetland fens. Fens are groundwater-fed wetlands that can take thousands of years to form and are a high priority for conservation and restoration due to their extremely sensitive nature. Numerous rare plants in Colorado only exist in wetland fen habitats. Many of the species are isolated to these few small wetland habitats and are either endemic to Colorado or are arctic relics, found nowhere else in the lower 48. There are different types of fen habitats including extreme rich fens, which are imperiled both globally and within the state. Examples of rare plant species found in wetland fens include: Porter feathergrass (*Ptilagrostis porterii*) (Tier 2 SGCN), Greenland primrose (*Primula egaliksensis*), pale blue-eyed grass (*Sisrynchium pallidum*), and slender cottongrass (*Eriophorum gracile*). Wetland fens exist on both public and private lands in Colorado, mainly in the Rocky Mountain region of central Colorado. On-site threats to fens include filling and hydrologic alteration due to ditching &

dewatering. Off-site impacts include nearby development that alters hydrology, sediment, and water quality.

## Mammals

**Both federally listed jumping mice in Colorado depend on perennial and ephemeral waters for habitat.**

The federally endangered New Mexico meadow jumping mouse and the federally threatened Preble's meadow jumping mouse are highly dependent on perennial and ephemeral waters. These mice spend all life stages in the riparian areas within ~300 feet of the water's edge - along the southern border of Colorado in the case of the New Mexico meadow jumping mouse and along the Front Range of Colorado in the case of the Preble's meadow jumping mouse. They rely on the wet soils of these areas which are only available with appropriate management of the stream itself. In some areas, downcutting of the stream channel due to changes in water flow or other habitat alterations has destroyed designated critical habitat for both of these mice.

The New Mexico Meadow Jumping Mouse Species Status Assessment (USFWS 2014) states "The jumping mouse requires dense riparian herbaceous vegetation associated with seasonally available or perennial (persistent) flowing water and adjacent uplands that can support the vegetation characteristics needed by foraging, breeding, and hibernating jumping mice". This Assessment also describes the degradation of this habitat as "the primary factor resulting in the loss of historic populations of jumping mice, and it is why populations documented since 2005 are now too small to be resilient".

The Preble's Meadow Jumping Mouse Recovery Plan (USFWS 2018) states "Habitat for the Preble's mouse ranges from large perennial rivers such as the South Platte River to small ephemeral drainages only 3 to 10 feet in width". The recovery plan also describes hydrologic changes to constitute a high threat to Preble's mouse populations. Habitat protection and restoration actions for Preble's meadow jumping mouse as described in the recovery plan all depend on these vital riparian and stream areas.

## References


Alexander, R. B., Boyer, E. W., Smith, R. A., Schwarz, G. E., & Moore, R. B. (2007). The role of headwater streams in downstream water quality. *Journal of the American Water Resources Association*, *43*(1), 41-59. DOl: 10.1111Jj.1752-1688.2007.00005.x.

Bestgen, K. R., H. J. Crockett and H. P. Foutz. (2013). Historical distribution and status of Southern redbelly dace Chrosomus erythrogaster in the Arkansas River Basin, Colorado. *Southwestern Naturalist 58*: 465-469.

Blackburn, M., & Mazzacano, C. (2012). *Using Aquatic Macroinvertebrates As Indicators of Streamflow Duration: Washington and Idaho Indicators.* The Xerces Society, Portland, OR.

Bogan, M. T., K. S. Boersma, and D. A. Lytle. (2013). Flow intermittency alters longitudinal patterns of invertebrate diversity and assemblage composition in an arid-land stream network. *Freshwater Biology 58*:1016–1028.

Canton, S. P., Cline, L. D., Short, R., & Ward, J. V. (1984). The macroinvertebrates and fish of a Colorado stream during a period of fluctuating discharge. *Freshwater Biology 14*(3): 311-316.

Colorado Division of Wildlife (CDOW). (2001). *Arkansas Darter recovery plan.* Colorado Division of Wildlife. Denver, CO. 28 pp.

Colorado Parks and Wildlife (CPW). (2015). *State Wildlife Action Plan*. Colorado Parks and Wildlife. Denver, CO. 865 pp.

Colvin, S. A., Sullivan, S. M. P., Shirey, P. D., Colvin, R. W., Winemiller, K. O., Hughes, R. M., ... & Danehy, R. J. (2018). Headwater streams and wetlands are critical for sustaining fish, fisheries, and ecosystem services. *Fisheries 44*(2):73-91.

Cummins, K.W. and M.A. Wilzbach. (2005). The inadequacy of the fish bearing criterion for stream management. *Aquatic Sciences 67*(4):486 491.

Del Rosario, R.B. and V.H. Resh. (2000). Invertebrates in intermittent and perennial streams: Is the hyporheic zone a refuge from drying? *Journal of the North American Benthological Society 19*(4): 680-696.

Dieterich, M., and N.H. Anderson. (2000). The Invertebrate Fauna of Summer-Dry Streams in Western Oregon. *Archiv fir Hydrobiologie*. *147*:273-295

Fitzpatrick, S. W., H. Crockett and W. C. Funk. (2014). Water availability strongly impacts population genetic patterns of an imperiled Great Plains endemic fish. *Conservation Genetics 15*:771-788.

Fraser, G. S., D. L. Winkelman, K. R. Bestgen and K. G. Thompson. (2017). Tributary use by imperiled flannelmouth and bluehead suckers in the Upper Colorado River Basin. *Transactions of the American Fisheries Society 146*:858-870.

Hammerson, G.A. (1999). *Amphibians and reptiles in Colorado*. Second Ed. University Press of Colorado.

Haynes, C. M., & Aird, S. D. (1981). *The Distribution and Habitat Requirements of the Wood Frog (Ranidae: Rana sylvatica Le Conte) in Colorado* (No. 50). Colorado Division of Wildlife.

Heine, R.A., C.L. Lant, and R.R. Sengupta. (2004). Development and comparison of approaches for automated mapping of stream channel networks. *Annals of the Association of American Geographers 94*(3):477-490.

Hooley-Underwood, Z. E., Stevens, S. B., Salinas, N. R., & Thompson, K. G. (2019). An intermittent stream supports extensive spawning of large-river native fishes. *Transactions of the American Fisheries Society*. DOI: 10.1002/tafs.10141

Kingsley, K.J. (1998). *Invertebrates of Organ Pipe Cactus National Monument, Arizona*. USGS Cooperative Studies Unit, University of Arizona, and National Park Service. Technical Report No. 60, 193 p.

Labbe, T. R. and K. D. Fausch. (2000). Dynamics of intermittent stream habitat regulate persistence of a threatened fish at multiple scales. *Ecological Applications 10*: 1774-1791.

Levick, L.R., Goodrich, D.C., Hernandez, M., Fonseca, J., Semmens, D.J., Stromberg, J.C., Tluczek, M., Leidy, R.A., Scianni, M., Guertin, D.P. and Kepner, W.G. (2008). *The ecological and hydrological significance of ephemeral and intermittent streams in the arid and semi-arid American Southwest*. US Environmental Protection Agency, Office of Research and Development.

Mark, D.M. (1983). Relations between field-surveyed channel networks and map-based geomorphometric measures, Inez, Kentucky. *Annals of the Association of American Geographers* 73(3): 358-372.

Mazzacano, C. & Black, S. H. (2008). Using aquatic macroinvertebrates as indicators of stream flow duration. *The Xerces Society, Portland, OR*.

Meyer, Judy L., David L. Strayer, J. Bruce Wallace, Sue L. Eggert, Gene S. Helfman, and Norman E. Leonard. (2007). The contribution of headwater streams to biodiversity in river networks. *Journal of the American Water Resources Association 43*(1):86-103.

Smith,D.G (2001) *Pennak's Freshwater Invertebrates of the United States: Porifera to Crustacea*, 4th Edition. Wiley & Sons Publishers.

Ringelman, J. (1996). *Wetlands and migratory bird management in Colorado: relationship to species protection and hunting recreation.* Unpublished Colorado Division of Wildlife briefing document.

Schriever, T. A., Bogan, M. T., Boersma, K. S., Cañedo-Argüelles, M., Jaeger, K. L., Olden, J. D., & Lytle, D. A. (2015). Hydrology shapes taxonomic and functional structure of desert stream invertebrate communities. *Freshwater Science*, *34*(2), 399-409.

Thompson, K. G. (2017). *Three-Species Investigations*. Job Progress Report. Colorado Parks and Wildlife. Fort Collins, CO. 62pp.

U.S. Fish and Wildlife Service (USFWS). (2014). *Species Status Assessment Report, New Mexico meadow jumping mouse (Zapus hudsonius luteus)*. Albuquerque, New Mexico. 149 pp.

U.S. Fish and Wildlife Service (USFWS). (2018). *Preble's Meadow Jumping Mouse Recovery Plan, Colorado*. Region 6, Lakewood, Colorado. 148 pp.

U.S. Geological Survey (USGS). (2019). 1:24,000 National Hydrography Dataset. https://prd-tnm.s3.amazonaws.com/StagedProducts/Hydrography/NHD/State/HighResolution/GDB/NHD_H_Colorado_State_GDB.zip.

Williams, D. D. (2006). *The biology of temporary waters*. Oxford University Press, Oxford, UK.

## Appendix A: Selected Colorado Species Utilizing Ephemeral and Intermittent Streams, Non-Adjacent Wetlands.

Note: This list is not exhaustive.

| Selected Colorado Species Utilizing Non-Adjacent Wetlands, Ephemeral Streams, or Intermittent Streams. This list is not exhaustive. | | | | |
|---|---|---|---|---|
| Category | Common Name | Scientific Name | Status | Species of Greatest Conservation Need |
| Fish | Southern redbelly dace | *Phoxinus erythrogaster* | state endangered | Tier 1 |
| Fish | Northern redbelly dace | *Phoxinus eos* | state endangered | Tier 1 |
| Fish | Arkansas darter | *Etheostoma cragini* | state threatened | Tier 1 |
| Fish | brassy minnow | *Hybognathus hankinsoni* | state threatened | Tier 1 |
| Fish | plains topminnow | *Fundulus sciadicus* | | Tier 1 |
| Fish | bluehead sucker | *Catostomus discobolus* | | Tier 1 |
| Fish | flannelmouth sucker | *Catostomus latipinnis* | | Tier 1 |
| Fish | central stoneroller | *Campostoma anomalum* | | |
| Fish | Northern plains killifish | *Fundulus kansae* | | |
| Fish | red shiner | *Cyprinella lutrenis* | | |
| Fish | sand shiner | *Notropis stramineous* | | |

| | | | | |
|---|---|---|---|---|
| Mammal | Preble's Meadow jumping mouse | *Zapus hudosnius preblei* | federal threatened | Tier 1 |
| Mammal | New Mexico meadow jumping mouse | *Zapus hudsonius luteus* | federal endangered | Tier 1 |
| Amphibian | boreal toad | *Anaxyrus boreas boreas* | state endangered | Tier 1 |
| Amphibian | Northern leopard frog | *Lithobates pipiens* | state special concern | Tier 1 |
| Amphibian | plains leopard frog | *Lithobates blairi* | state special concern | Tier 2 |
| Amphibian | wood frog | *Lithobates sylvatica* | state special concern | Tier 2 |
| Amphibian | Couch's spadefoot | *Scaphiopus couchii* | state special concern | Tier 2 |
| Amphibian | canyon tree frog | *Hyla arenicolor* | | Tier 2 |
| Amphibian | western chorus frog | *Pseudacris triseriata* | | Tier 2 |
| Amphibian | tiger salamander | *Ambystoma tigrinum* | | |
| Plants | Arizona Willow | *Salix arizonica* | | Tier 2 |
| Plants | Porter's feathergrass | *Ptilagrostis porteri* | | Tier 2 |
| Plants | Penland Alpine Fen Mustard | *Eutrema penlandii* | Federal threatened | Tier 1 |
| Plants | Colorado Butterfly Plant | *Oenothera coloradoensis* | Federal threatened | Tier 1 |
| Plants | Ute ladies tresses | *Spiranthes diluvialis* | Federal threatened | Tier 1 |
| Plants | Slender spiderflower | *Cleome multicaulus* | | Tier 2 |
| Plants | Parish's alkali grass | *Puccinellia parishii* | | Tier 2 |
| Plants | Northern thelypody | *Thelypodium paniculatum* | | Tier 2 |
| Macroinvertebrates | | *Ablabesmyia* | | |
| Macroinvertebrates | | *Acari* | | |
| Macroinvertebrates | | *Acentrella* | | |
| Macroinvertebrates | | *Acentrella insignificans* | | |
| Macroinvertebrates | | *Aedes* | | |
| Macroinvertebrates | | *Aeshna/Rhionaeschna* | | |
| Macroinvertebrates | | *Agabus* | | |
| Macroinvertebrates | | *Agabus disintegratus* | | |
| Macroinvertebrates | | *Agabus griseipennis* | | |
| Macroinvertebrates | | *Agabus minnesotensis adults* | | |
| Macroinvertebrates | | *Agabus semivittatus* | | |
| Macroinvertebrates | | *Alotanypus* | | |
| Macroinvertebrates | | *Ambrysus* | | |
| Macroinvertebrates | | *Ameletus* | | |
| Macroinvertebrates | | *Ametor scabrosus* | | |
| Macroinvertebrates | | *Amphiagrion abbreviatum* | | |
| Macroinvertebrates | | *Amphicosmoecus canax* | | |
| Macroinvertebrates | | *Amphinemura banksi* | | |
| Macroinvertebrates | | *Amphipoda* | | |
| Macroinvertebrates | | *Anacaena* | | |
| Macroinvertebrates | | *Ancylidae* | | |
| Macroinvertebrates | | *Anisoptera* | | |
| Macroinvertebrates | | *Apedilum* | | |
| Macroinvertebrates | | *Aquarius remigis* | | |
| Macroinvertebrates | | *Arctopsyche grandis* | | |
| Macroinvertebrates | | *Argia* | | |
| Macroinvertebrates | | *Argyra* | | |
| Macroinvertebrates | | *Arrenurus* | | |
| Macroinvertebrates | | *Atractides* | | |
| Macroinvertebrates | | *Atrichopogon* | | |
| Macroinvertebrates | | *Baetidae* | | |
| Macroinvertebrates | | *Baetis* | | |

| | | | | |
|---|---|---|---|---|
| Macroinvertebrates | | *Baetis alius* | | |
| Macroinvertebrates | | *Baetis flavistriga* | | |
| Macroinvertebrates | | *Baetis magnus* | | |
| Macroinvertebrates | | *Baetis tricaudatus* | | |
| Macroinvertebrates | | *Berosus* | | |
| Macroinvertebrates | | *Berosus peregrinus* | | |
| Macroinvertebrates | | *Berosus peregrinus adults* | | |
| Macroinvertebrates | | *Brachycentrus americanus* | | |
| Macroinvertebrates | | *Brillia* | | |
| Macroinvertebrates | | *Brundiniella* | | |
| Macroinvertebrates | | *Caenis* | | |
| Macroinvertebrates | | *Callibaetis* | | |
| Macroinvertebrates | | *Caloparyphus* | | |
| Macroinvertebrates | | *Cambaridae* | | |
| Macroinvertebrates | | *Capniidae* | | |
| Macroinvertebrates | | *Cardiocladius* | | |
| Macroinvertebrates | | *Cenocorixa* | | |
| Macroinvertebrates | | *Centroptilum* | | |
| Macroinvertebrates | | *Ceratopogonidae* | | |
| Macroinvertebrates | | *Ceratopsyche* | | |
| Macroinvertebrates | | *Chaetocladius* | | |
| Macroinvertebrates | | *Chelifera/Metachela* | | |
| Macroinvertebrates | | *Cheumatopsyche* | | |
| Macroinvertebrates | | *Chironomidae* | | |
| Macroinvertebrates | | *Chironominae* | | |
| Macroinvertebrates | | *Chironomini* | | |
| Macroinvertebrates | | *Chironomus* | | |
| Macroinvertebrates | | *Cinygmula* | | |
| Macroinvertebrates | | *Claassenia sabulosa* | | |
| Macroinvertebrates | | *Cladotanytarsus* | | |
| Macroinvertebrates | | *Clinocera* | | |
| Macroinvertebrates | | *Coenagrionidae* | | |
| Macroinvertebrates | | *Collembola* | | |
| Macroinvertebrates | | *Conchapelopia* | | |
| Macroinvertebrates | | *Copelatus chevrolati renovatus* | | |
| Macroinvertebrates | | *Corisella tarsalis* | | |
| Macroinvertebrates | | *Corynoneura* | | |
| Macroinvertebrates | | *Crangonyx* | | |
| Macroinvertebrates | | *Cricotopus* | | |
| Macroinvertebrates | | *Cricotopus (Cricotopus) trifascia* | | |
| Macroinvertebrates | | *Cricotopus (Nostococladius) nostocicola* | | |
| Macroinvertebrates | | *Cricotopus Bicinctus group* | | |
| Macroinvertebrates | | *Cricotopus trifascia group* | | |
| Macroinvertebrates | | *Cricotopus/Orthocladius* | | |
| Macroinvertebrates | | *Cryptochironomus* | | |
| Macroinvertebrates | | *Cymbiodyta* | | |
| Macroinvertebrates | | *Cyphomella* | | |
| Macroinvertebrates | | *Dasyhelea* | | |
| Macroinvertebrates | | *Demicryptochironomus* | | |
| Macroinvertebrates | | *Diamesa* | | |
| Macroinvertebrates | | *Dicranota* | | |
| Macroinvertebrates | | *Dicrotendipes* | | |
| Macroinvertebrates | | *Diphetor hageni* | | |
| Macroinvertebrates | | *Dixa* | | |
| Macroinvertebrates | | *Dixella* | | |
| Macroinvertebrates | | *Dolichopodidae* | | |
| Macroinvertebrates | | *Drunella grandis* | | |

| | | | | |
|---|---|---|---|---|
| Macroinvertebrates | | *Dubiraphia* | | |
| Macroinvertebrates | | *Dugesia* | | |
| Macroinvertebrates | | *Dytiscidae* | | |
| Macroinvertebrates | | *Ecdyonurus criddlei* | | |
| Macroinvertebrates | | *Empididae* | | |
| Macroinvertebrates | | *Enchytraeidae* | | |
| Macroinvertebrates | | *Enochrus pygmaeus adults* | | |
| Macroinvertebrates | | *Ephemerella* | | |
| Macroinvertebrates | | *Ephydridae* | | |
| Macroinvertebrates | | *Erioptera* | | |
| Macroinvertebrates | | *Erpobdella punctata* | | |
| Macroinvertebrates | | *Erpobdellidae* | | |
| Macroinvertebrates | | *Eukiefferiella* | | |
| Macroinvertebrates | | *Euparyphus* | | |
| Macroinvertebrates | | *Fallceon quilleri* | | |
| Macroinvertebrates | | *Ferrissia* | | |
| Macroinvertebrates | | *Forcipomyia* | | |
| Macroinvertebrates | | *Gerridae* | | |
| Macroinvertebrates | | *Gerris gillettei* | | |
| Macroinvertebrates | | *Glossosoma* | | |
| Macroinvertebrates | | *Glyptotendipes* | | |
| Macroinvertebrates | | *Gonomyodes* | | |
| Macroinvertebrates | | *Gymnochthebius* | | |
| Macroinvertebrates | | *Gyrinus* | | |
| Macroinvertebrates | | *Hebrus* | | |
| Macroinvertebrates | | *Heleniella* | | |
| Macroinvertebrates | | *Helichus striatus* | | |
| Macroinvertebrates | | *Helichus striatus adults* | | |
| Macroinvertebrates | | *Helicopsyche* | | |
| Macroinvertebrates | | *Helobdella stagnalis* | | |
| Macroinvertebrates | | *Helophorus* | | |
| Macroinvertebrates | | *Hemerodromia* | | |
| Macroinvertebrates | | *Hemerodromiinae* | | |
| Macroinvertebrates | | *Heptageniidae* | | |
| Macroinvertebrates | | *Hesperoperla pacifica* | | |
| Macroinvertebrates | | *Hesperophylax* | | |
| Macroinvertebrates | | *Hetaerina americana* | | |
| Macroinvertebrates | | *Heterlimnius corpulentus* | | |
| Macroinvertebrates | | *Heterotrissocladius* | | |
| Macroinvertebrates | | *Hexatoma* | | |
| Macroinvertebrates | | *Hyalella azteca* | | |
| Macroinvertebrates | | *Hydra* | | |
| Macroinvertebrates | | *Hydraena* | | |
| Macroinvertebrates | | *Hydrobaenus* | | |
| Macroinvertebrates | | *Hydrophilidae* | | |
| Macroinvertebrates | | *Hydroporinae* | | |
| Macroinvertebrates | | *Hydroporus* | | |
| Macroinvertebrates | | *Hydropsyche* | | |
| Macroinvertebrates | | *Hydropsyche occidentalis* | | |
| Macroinvertebrates | | *Hydropsychidae* | | |
| Macroinvertebrates | | *Hydroptila* | | |
| Macroinvertebrates | | *Hydroptila ajax* | | |
| Macroinvertebrates | | *Hydroptila pecos* | | |
| Macroinvertebrates | | *Hydroptilidae* | | |
| Macroinvertebrates | | *Hygrobates* | | |
| Macroinvertebrates | | *Hygrotus* | | |
| Macroinvertebrates | | *Ilybiosoma cordatum* | | |

| | | | | |
|---|---|---|---|---|
| Macroinvertebrates | | *Ilybiosoma lugens* | | |
| Macroinvertebrates | | *Ilybiosoma seriatum* | | |
| Macroinvertebrates | | *Isoperla* | | |
| Macroinvertebrates | | *Laccobius* | | |
| Macroinvertebrates | | *Laccophilus* | | |
| Macroinvertebrates | | *Laccophilus maculosus* | | |
| Macroinvertebrates | | *Larsia* | | |
| Macroinvertebrates | | *Lebertia* | | |
| Macroinvertebrates | | *Lepidostoma* | | |
| Macroinvertebrates | | *Leptoceridae* | | |
| Macroinvertebrates | | *Leptophlebiidae* | | |
| Macroinvertebrates | | *Leucotrichia pictipes* | | |
| Macroinvertebrates | | *Libellula* | | |
| Macroinvertebrates | | *Limnephilidae* | | |
| Macroinvertebrates | | *Limnephilus* | | |
| Macroinvertebrates | | *Limnophila* | | |
| Macroinvertebrates | | *Limnophyes* | | |
| Macroinvertebrates | | *Limonia* | | |
| Macroinvertebrates | | *Liodessus obscurellus* | | |
| Macroinvertebrates | | *Lispoides aequifrons* | | |
| Macroinvertebrates | | *Lopescladius* | | |
| Macroinvertebrates | | *Lumbricidae* | | |
| Macroinvertebrates | | *Lumbriculidae* | | |
| Macroinvertebrates | | *Lymnaeidae* | | |
| Macroinvertebrates | | *Malenka* | | |
| Macroinvertebrates | | *Maruina* | | |
| Macroinvertebrates | | *Megadrile* | | |
| Macroinvertebrates | | *Meringodixa* | | |
| Macroinvertebrates | | *Metriocnemus* | | |
| Macroinvertebrates | | *Microcylloepus pusillus* | | |
| Macroinvertebrates | | *Micropsectra* | | |
| Macroinvertebrates | | *Micropsectra/Tanytarsus* | | |
| Macroinvertebrates | | *Microvelia* | | |
| Macroinvertebrates | | *Muscidae* | | |
| Macroinvertebrates | | *Naididae* | | |
| Macroinvertebrates | | *Nais spp.* | | |
| Macroinvertebrates | | *Nanocladius* | | |
| Macroinvertebrates | | *Narpus concolor* | | |
| Macroinvertebrates | | *Narpus concolor adults* | | |
| Macroinvertebrates | | *Natarsia* | | |
| Macroinvertebrates | | *Nematocera* | | |
| Macroinvertebrates | | *Nematoda* | | |
| Macroinvertebrates | | *Neocorixa snowi* | | |
| Macroinvertebrates | | *Neoplasta* | | |
| Macroinvertebrates | | *Neotrichia* | | |
| Macroinvertebrates | | *Nilotanypus* | | |
| Macroinvertebrates | | *Notonecta kirbyi* | | |
| Macroinvertebrates | | *Odontomesa* | | |
| Macroinvertebrates | | *Odontomyia* | | |
| Macroinvertebrates | | *Oligochaeta* | | |
| Macroinvertebrates | | *Ophidonais serpentina* | | |
| Macroinvertebrates | | *Ophiogomphus severus* | | |
| Macroinvertebrates | | *Optioservus* | | |
| Macroinvertebrates | | *Orconectes* | | |
| Macroinvertebrates | | *Ormosia* | | |
| Macroinvertebrates | | *Orthocladiinae* | | |
| Macroinvertebrates | | *Orthocladius* | | |

| | | | | |
|---|---|---|---|---|
| Macroinvertebrates | | *Orthocladius (Euorthocladius)* | | |
| Macroinvertebrates | | *Pagastia* | | |
| Macroinvertebrates | | *Pantala* | | |
| Macroinvertebrates | | *Parachaetocladius* | | |
| Macroinvertebrates | | *Paracladopelma* | | |
| Macroinvertebrates | | *Paracymus* | | |
| Macroinvertebrates | | *Parakiefferiella* | | |
| Macroinvertebrates | | *Paraleptophlebia* | | |
| Macroinvertebrates | | *Paramerina* | | |
| Macroinvertebrates | | *Parametriocnemus* | | |
| Macroinvertebrates | | *Paraphaenocladius* | | |
| Macroinvertebrates | | *Paratanytarsus* | | |
| Macroinvertebrates | | *Paratendipes* | | |
| Macroinvertebrates | | *Parochlus* | | |
| Macroinvertebrates | | *Pedicia* | | |
| Macroinvertebrates | | *Pentaneura* | | |
| Macroinvertebrates | | *Pentaneurini* | | |
| Macroinvertebrates | | *Pericoma* | | |
| Macroinvertebrates | | *Pericoma/Telmatoscopus* | | |
| Macroinvertebrates | | *Perlodidae* | | |
| Macroinvertebrates | | *Petrophila* | | |
| Macroinvertebrates | | *Phaenopsectra* | | |
| Macroinvertebrates | | *Physa* | | |
| Macroinvertebrates | | *Physidae* | | |
| Macroinvertebrates | | *Pisidium* | | |
| Macroinvertebrates | | *Polypedilum* | | |
| Macroinvertebrates | | *Pristina* | | |
| Macroinvertebrates | | *Procladius* | | |
| Macroinvertebrates | | *Psectrocladius* | | |
| Macroinvertebrates | | *Pseudochironomus* | | |
| Macroinvertebrates | | *Pseudocloeon* | | |
| Macroinvertebrates | | *Pseudodiamesa* | | |
| Macroinvertebrates | | *Pseudosmittia* | | |
| Macroinvertebrates | | *Psychoda* | | |
| Macroinvertebrates | | *Psychoglypha* | | |
| Macroinvertebrates | | *Psychomyia flavida* | | |
| Macroinvertebrates | | *Ptychoptera* | | |
| Macroinvertebrates | | *Radotanypus* | | |
| Macroinvertebrates | | *Rhagovelia* | | |
| Macroinvertebrates | | *Rhagovelia distincta* | | |
| Macroinvertebrates | | *Rhantus gutticollis* | | |
| Macroinvertebrates | | *Rheocricotopus* | | |
| Macroinvertebrates | | *Rheotanytarsus* | | |
| Macroinvertebrates | | *Rhyacophila alberta group* | | |
| Macroinvertebrates | | *Rhyacophila brunnea group* | | |
| Macroinvertebrates | | *Saetheria* | | |
| Macroinvertebrates | | *Sanfilippodytes* | | |
| Macroinvertebrates | | *Sigara* | | |
| Macroinvertebrates | | *Simuliidae* | | |
| Macroinvertebrates | | *Simulium* | | |
| Macroinvertebrates | | *Skwala americana* | | |
| Macroinvertebrates | | *Sperchon* | | |
| Macroinvertebrates | | *Sphaeriidae* | | |
| Macroinvertebrates | | *Stempellinella* | | |
| Macroinvertebrates | | *Stictochironomus* | | |
| Macroinvertebrates | | *Stictotarsus striatellus* | | |
| Macroinvertebrates | | *Stratiomyidae* | | |

| | | | | |
|---|---|---|---|---|
| Macroinvertebrates | | *Stratiomys* | | |
| Macroinvertebrates | | *Synorthocladius* | | |
| Macroinvertebrates | | *Tabanidae* | | |
| Macroinvertebrates | | *Tabanus* | | |
| Macroinvertebrates | | *Tanypodinae* | | |
| Macroinvertebrates | | *Tanytarsini* | | |
| Macroinvertebrates | | *Tanytarsus* | | |
| Macroinvertebrates | | *Thienemanniella* | | |
| Macroinvertebrates | | *Thienemannimyia group* | | |
| Macroinvertebrates | | *Tipula* | | |
| Macroinvertebrates | | *Tipulidae* | | |
| Macroinvertebrates | | *Tricorythodes* | | |
| Macroinvertebrates | | *Tricorythodes explicatus* | | |
| Macroinvertebrates | | *Tricorythodes minutus* | | |
| Macroinvertebrates | | *Tropisternus* | | |
| Macroinvertebrates | | *Tropisternus affinis* | | |
| Macroinvertebrates | | *Tropisternus ellipticus* | | |
| Macroinvertebrates | | *Tubificidae* | | |
| Macroinvertebrates | | *Tubificidae w/o hair chaetae* | | |
| Macroinvertebrates | | *Tubificidae with hair chaetae* | | |
| Macroinvertebrates | | *Turbellaria* | | |
| Macroinvertebrates | | *Tvetenia* | | |
| Macroinvertebrates | | *Zaitzevia parvula* | | |
| Macroinvertebrates | | *Zapada* | | |
| Macroinvertebrates | | *Zavrelimyia* | | |

# Addendum to "Biological Importance of Ephemeral and Intermittent Streams and Non-Adjacent Wetlands in Colorado"

September 3, 2021

Contributors:
Zachary E. Hooley-Underwood - CPW
Tina Jackson - CPW
Jenn Logan - CPW
Melynda May- CPW

## Fish

### Tributary Spawning in Intermittent Streams

CPW researchers have continued to monitor population stability and intermittent tributary spawning by native suckers (Bluehead and Flannelmouth sucker) and Roundtail chub in the Gunnison River basin. All three species are threatened by the presence of non-native fishes, but the two suckers are particularly at-risk of genetic introgression through hybridization with non-native suckers. In the spring of 2021, approximately 26,000 fish were handled as they immigrated into intermittent Roubideau Creek to spawn. The percentage of these fishes that were native suckers or chub (>90%), was higher than the native percentage typically encountered in the Gunnison River (>80%). These native species disproportionately spawn in intermittent tributaries in this system compared to non-native and hybrid suckers. Intermittent tributary spawning appears to be a natural buffer against hybridization with non-native suckers.

Another major finding of this research has been that federally endangered Razorback Sucker also used Roubideau Creek during the spring spawning season (Hooley-Underwood et al. 2021). In every year since 2015, multiple individual Razorback Sucker implanted with PIT tags (passive integrated transponder tags) have been detected entering Roubideau Creek. These fish are from multiple age classes of fish that have been stocked in the Gunnison River to aid in the recovery of the species. In 2019, a year with exceptionally voluminous spring runoff, 110 individuals were detected in Roubideau Creek, and 7 individuals were encountered in the smaller intermittent Roubideau Creek tributary, Cottonwood Creek. Fish handled in Cottonwood Creek included both males and females expressing gametes, indicating that they may have been accessing the creek to spawn. In 2021, a year with exceptionally poor runoff, CPW researchers detected 76 individual Razorback Suckers entering Roubideau creek during the spawning period. These observations are noteworthy, as Razorback Sucker are largely considered mainstem river spawners. Intermittent waters are routinely used by Razorback Suckers in the Gunnison River, and it may be that as populations of this species rebound, the significance of the role that these waters play in the life histories of these fish becomes more apparent.

## Mammals

### Both federally listed jumping mice in Colorado depend on perennial and ephemeral waters for habitat

The recent publication by Schorr and Mihlbachler (2021) further supports the finding that dense riparian wetland vegetation is required by the federally threatened Preble's meadow jumping mouse (*Zapus hudsonius preblei*). Hydrologic changes to riparian wetlands continue to constitute a high threat to Preble's mouse populations.

## References

Hooley-Underwood, Z. E., Thompson, K. G., & Bestgen, K. R. (2021). Razorback sucker spawning in an intermittent Colorado tributary. *North American Journal of Fisheries Management*. Online. DOI: 10.1002/nafm.10623.

Schorr, R. A., & Mihlbachler, B. S. (2018). Understanding habitat quality for Preble's Meadow Jumping Mouse: How survival responds to vegetation structure and composition. *Journal of Fish and Wildlife Management*, *9*(2), 545-553.

## Appendix A: Colorado Species Utilizing Ephemeral and Intermittent Streams, Non-Adjacent Wetlands.

| Additional Colorado Species Utilizing Non-Adjacent Wetlands, Ephemeral Streams, or Intermittent Streams. | | | | |
|---|---|---|---|---|
| Category | Common Name | Scientific Name | Status | Species of Greatest Conservation Need |
| Fish | Razorback sucker | *Xyrauchen texanus* | federal endangered | Tier 1 |
| Fish | Roundtail chub | *Gila robusta* | state special concern | Tier 1 |