Upper Colorado River Basin 2026 Salmonfly Assessment



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THE SALMONFLY PROJECT

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Data Accessibility

A master compiled dataset can be made available upon request.

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Executive Summary

The giant salmonfly (*Pteronarcys californica*) is one of the most iconic aquatic insects in the western United States and an important indicator of cold, clean, well-functioning rivers. In Colorado, salmonflies are widely distributed among the larger mountain river basins throughout the state. However, only a few main stem rivers are known for populations large enough for anglers to target their emergence. In 2025, Colorado Parks and Wildlife designated the species as a Species of Greatest Conservation Need (SGCN) as long-term trends are poorly understood

This report, which focuses on the Upper Colorado River Basin, is the first step in a longer-term effort to evaluate status and trends of salmonflies across Colorado. A foundational step in this process is compiling available public data into a single, accessible source that can support management and stakeholder decision-making. Results from this project have been incorporated into an interactive map, available at: https://salmonflyproject.org/reports/.

Within the Upper Colorado River Basin, we compiled and integrated salmonfly records dating from the 1980s (Erickson, 1983; Nehring et al. (2010, 2011)) through the present. Based on historical sites in the resulting dataset, we selected targeted sites to resample salmonflies in summer 2026. Differences in salmonfly density and presence/absence were analyzed. Together, our results provide a comprehensive assessment of long-term salmonfly trends across the Upper Colorado River Basin and help identify where populations remain strong, where they have declined, and where additional monitoring or conservation action is warranted.

Results indicate substantial but spatially variable declines. The strongest remaining salmonfly populations occur immediately below Byers Canyon, where they appear stable, and below Gore Canyon, where we found salmonflies to be in decline by 98% over the last 17 years. Several other historically productive reaches have also experienced salmonfly reductions. Near Kremmling, contemporary monitoring efforts and targeted 2026 sampling failed to detect salmonflies in reaches where they were historically present, suggesting a potential local extirpation. At Kemp Breeze, contemporary densities are less than 8% of historical averages. Upstream of Byers Canyon, densities have continued to decline from an average of over 300 individuals/m² in the 1980s to approximately 60 individuals/m² in the 2010s to a modern baseline of only 2 individuals/m². Salmonflies persist at moderate densities during our resampling efforts in Fraser Canyon, although they appear to be in decline at this site. Salmonflies were not detected in Willow Creek during targeted 2026 surveys.

While this project highlights an important concern over salmonfly persistence in the Colorado River Basin, future research should thoroughly assess the drivers of observed patterns to direct management and restoration efforts for this newly designated SGCN species. The recently completed Colorado River Connectivity Channel (CRCC) creates a significant opportunity for salmonfly recovery by restoring a continuous river corridor around the former Windy Gap Reservoir, below which salmonfly populations have historically been dramatically reduced. Salmonflies were not yet detected within the new channel in 2026. Continued monitoring will be essential for determining whether improved connectivity translates into measurable biological recovery.

The Upper Colorado is well positioned for long-term salmonfly monitoring because the Upper Colorado Wild & Scenic Alternative Management Plan, Learning By Doing, and Northern Water already maintain extensive annual macroinvertebrate datasets. We recommend adding monitoring sites within the CRCC and near the mouth of Fraser Canyon and establishing a coordinated *"Salmonfly Watch"* partnership to integrate these existing datasets into recurring basin-wide assessments to track future salmonfly trends.

Introduction

Aquatic insects are the core of healthy rivers. They feed trout, create the hatches that fly fishers target which enhances local fishing economies, and sustain freshwater food webs across the Western U.S. Because many species are highly sensitive to changes in water quality, flow, temperature, sediment, and other environmental stressors, aquatic insects are also widely used as indicators of river health.

The giant salmonfly (*Pteronarcys californica*) is an ecologically sensitive stonefly and is one of the largest and most iconic aquatic insects in western North America. The species occupies medium to large rivers and is most strongly associated with cool, well-oxygenated streams containing coarse, unconsolidated cobbles and relatively little fine sediment (Brusven & Prather, 1974; Stewart & Oswood, 2006; Huff, 2006). Among fly anglers, its annual emergence produces some of the most anticipated hatches of the year, drawing anglers to rivers throughout the Rocky Mountain West.

The ecological importance of salmonflies extends well beyond their value to anglers. As large-bodied shredders, salmonfly nymphs consume and process substantial quantities of leaves and other coarse organic material, converting them into fine particulate matter that becomes available to other stream organisms (Short & Maslin, 1977; Poole, 1981; Perry et al., 1987). Salmonflies are also an important prey resource for trout and, during emergences, transfer large quantities of aquatic production to terrestrial food webs. In high-abundance rivers, salmonfly emergences can represent a major pulse of energy to fish, birds, spiders, and other terrestrial consumers and can exceed the terrestrial carbon export of all other emerging aquatic insects combined (Walters et al., 2018). Consequently, the loss of a salmonfly population represents more than the disappearance of a famous species or ‘hatch’; it can alter food-web structure, nutrient processing, and the transfer of energy between rivers and surrounding terrestrial ecosystems.

Understanding how, where, and to what extent salmonflies are declining is of particular importance, as the species is known to be an indicator of high-water quality and its abundance, or lack thereof, can provide information about the broader ecosystem condition (Fore et al., 1996; Huff, 2006; Richards et al., 2013; Kowalski & Richer, 2020; Heinold et al., 2020). Their life cycle typically spans four to five years, including a prolonged egg-diapause stage followed by an approximate three-to-four-year aquatic nymphal phase (DeWalt & Stewart, 1995; Townsend & Pritchard, 1998, 2000). Individuals must therefore persist through multiple years, increasing the potential for exposure to unfavorable temperatures, flows, sediment levels, oxygen availability, and water chemistry.

Evidence of salmonfly declines is apparent across the region and the species has declined or been extirpated from at least 10 well-known fisheries in Montana and Utah, including the Madison, Clark Fork, Yellowstone, Provo, Logan, Blacksmith Fork, and Ogden Rivers (Stagliano, 2010; Anderson et al., 2019; Vinson, 2008; Birrell et al., 2019; Williamson, 2021; Birrell & Cox, 2026; Birrell & Kowalski, 2026). Recent analyses by The Salmonfly Project have quantified substantial statewide declines, including an estimated 84% decline in Utah since 2000 (Birrell et al., 2024) and declines of at least 50% in Montana since the mid-1960s (Frakes et al., in prep.).

Large reliable salmonfly hatches are only known to occur in relatively few watersheds in Colorado, including the Upper Colorado, Gunnison, San Miguel, and Rio Grande Rivers. Even within these remaining strongholds, anglers and biologists have raised concerns about apparent declines in abundance. Salmonflies have declined or become locally extirpated in at least some reaches of the Colorado, Gunnison, and Arkansas Rivers (Colborn, 1985; Nehring et al., 2011; Kowalski & Richer, 2020), and Colorado Parks and Wildlife (CPW) recently designated the giant salmonfly as a Colorado Species of Greatest Conservation Need (SGCN). This designation, however, was made proactively and without a formal statewide status and trends analysis. Because patterns in salmonfly abundance, both within Colorado and across their broader range, show signs of decline,

understanding their status and trends at the watershed level is increasingly important to promote proactive management of the species.

The Upper Colorado River supports one of Colorado's most important remaining salmonfly populations and one of the state's best-known salmonfly hatches. The river is unique in that it has been well monitored since the 1980s, when Erickson and Nehring (1983) cataloged salmonfly densities across the upper watershed. In 2010, Nehring and colleagues evaluated salmonfly trends below the Windy Gap Dam following its construction and documented salmonfly declines within the 10 miles reach below the dam (Nehring et al., 2010). In recent years, additional macroinvertebrate monitoring programs have been implemented across the river by several watershed groups, primarily to track water quality. The collective value of these datasets for evaluating long-term salmonfly trends, however, has remained unexploited until now.

Here, we compile and integrate quantitative benthic macroinvertebrate records to produce an evaluation of salmonfly trends across the Upper Colorado River Basin. During summer 2026, we strategically resampled historical monitoring sites along the Upper Colorado River from Pumphouse to the mouth of the Fraser River Canyon and compared these new, spatially replicated observations with available historical density records. This approach allowed us to directly compare contemporary salmonfly densities with conditions documented decades earlier and to evaluate trends across multiple reaches of the river. In addition, we evaluated the range extent, density, and, where possible, declines of salmonflies by sampling in the Colorado River headwaters and in several tributaries (Fraser River and Willow Creek). Together, this report provides a clear assessment of long-term salmonfly trends in the Upper Colorado River Basin, identifies where populations remain strong, and examines how patterns vary longitudinally throughout the Basin. These results provide CPW and river stakeholders with quantitative evidence relevant to the recent SGCN designation and establish a stronger scientific foundation for future monitoring and conservation of the iconic giant salmonfly.

Methods

Data Compilation and Site Selection

To assess long-term salmonfly trends and inform selection of sites for contemporary resampling in the Upper Colorado River Basin, we compiled and integrated as many publicly available benthic macroinvertebrate datasets as possible that included *P. californica*. Data were obtained from:

1. **National public repositories**
    a. National Water Quality Monitoring Council (NWQMC), URL: https://www.epa.gov/awma/national-water-quality-monitoring-council (EPA, 2026)
    b. National Aquatic Monitoring Center (NAMC) Aquatic Invertebrate Database, URL: https://qanr.usu.edu/research/namc/database (NAMC, 2026)
2. **Ongoing benthic macroinvertebrate monitoring programs**
    a. Grand County Learning By Doing (2018–2025). *Macroinvertebrate monitoring reports* [Annual monitoring reports]. URL: https://www.grandcountylearningbydoing.org/monitoring-reports.html (LBD, 2018-2025)
    b. Upper Colorado Wild & Scenic Alternative Management Plan macroinvertebrate monitoring reports (2018–2025), produced by Timberline Aquatics/Spheros. URL: https://www.upcowildandscenic.com/documents--links.html (UCWSAMP, 2018-2025)
    c. Northern Water monitoring program, Upper Colorado River. URL: https://www.northernwater.org/data (NW, 2018-2025)
3. **Historical datasets**
    a. Historical Colorado Parks and Wildlife data (Nehring et al., 2010; Nehring et al., 2011)
    b. Historical data collected by consultant Robert C. Erickson (Erickson, 1983)

4. **New data**
    a. Salmonfly Project data collected during summer 2026 (Appendix I).

In most cases, historical data were manually transcribed from scanned PDFs or online reports into CSV files and subsequently compiled and standardized in R. Sampling methods differed somewhat among data sources but were included if they employed quantitative sampling data (i.e., measurements of macroinvertebrate density from a discrete, known area of the benthos). Erickson, 1983 used a Hess sampler, whereas Nehring, 2011 used a specialized 1-m² Surber sampler. Contemporary benthic macroinvertebrate monitoring programs on the Upper Colorado River primarily use quantitative Hess-net sampling (UCWSAMP, 2018-2025; LBD, 2018-2025; NW,2018-2015). Following Nehring et al. (2010), salmonfly abundances from all quantitative samples were standardized to density (individuals/m²) to facilitate comparisons among sampling methods and datasets. Although this standardization allows for comparisons across monitoring programs, differences in field collection methods, sampling effort, and laboratory processing procedures may introduce some variability in density estimates. These differences are particularly relevant when comparing historical and contemporary datasets, as sampling methods may vary in their efficiency at capturing salmonfly nymphs. Table 1 summarizes the collection methods, sampling effort, and laboratory processing procedures associated with each dataset. Potential influences of methodological differences on observed population trends are considered in the Discussion.

Table 1. Summary of sampling methodology for historic and modern-day macroinvertebrate surveys.

Comparison of Sampling Methods					
Data Source	**Net Type**	**Benthic Sampling Area (square meters)**	**Replicates per site**	**Sampling Season**	**Laboratory Processing**
Erickson 1983	Modified Hess	0.25	4	Fall	Subsampled > 25% of all samples
Nehring 2010 & 11	Substrate Sampler	1	between 2 and 5	Spring & Fall	Subsampled 50% or 100% of all samples
The Salmonfly Project 2026	Surber on a stick	0.25	6	Summer	samples fully enumerated, no subsampling
Learning By doing	Hess	0.093	3	Fall	samples fully enumerated, no subsampling
Upper Colorado Wild and Scenic Alternative	Hess	0.093	3	Fall	samples fully enumerated, no subsampling
Northern Waters	Hess	0.093	3	Fall	samples fully enumerated, no subsampling

Because monitoring sites collected by different sources were rarely positioned at identical coordinates, nearby sampling records were grouped into common site clusters. A 0.5-mile (0.8-km) buffer was applied around each sampling location, and records with overlapping buffers were assigned to the same cluster and given a unique cluster ID. The 0.5-mile distance was selected to balance uncertainty in historical site coordinates and minor differences in sampling location with the need to avoid combining clearly distinct river reaches. Clusters therefore represent groups of historical and contemporary samples considered sufficiently close to support temporal comparison at a given sampling site. Cluster IDs (hereafter, ‘sites’) were used as unique identifiers for mapping and statistical analysis and do not infer river distance, stream order, or any other ecological characteristic.

We also identified five distinct river segments of the Upper Colorado River shown by black ovals in Map 1: 1) between State Bridge and Pumphouse (below Gore Canyon), 2) between the Troublesome Creek and Blue River

confluences, 3) between the Williams Fork and Troublesome Creek confluences, 4) between the mouth of Byers Canyon and the Williams Fork confluence, and 5) from Windy Gap to the upper end of Byers Canyon. These Segments represent larger longitudinal sections of the Upper Colorado, differentiated by tributary confluences or habitat characteristics (above or below canyons) and were used to describe and summarize spatial patterns in the River Segment Analysis section below.

Following compilation, clustering and segmenting the historical data, one historical site from each distinct river segment (see Map 1) was selected for contemporary resampling based on the duration of the historical record, frequency of repeated sampling, availability of quantitative density estimates, and public access for resampling. Emphasis was placed on sites with repeated historical observations because these offered the strongest basis for evaluating trends. Final sampling sites were distributed at approximately even intervals along the Upper Colorado River to capture conditions across the watershed (Map 1).

Macroinvertebrate Sampling

Salmonfly Density Sampling (Sites 1-7)

Density samples were collected at seven sampling sites, sites 1-5 were historically sampled sites on the Upper Colorado River, site 6 is a new sampling location from within the Colorado River Connectivity Channel where, and site 7 was a historically resampled site on the Fraser River (Map 1).

At most sites (Sites 1 and 3–7), six replicate 0.25 m² Surber samples were collected from riffle habitats dominated by large cobbles, as Nehring et al. (2010) identified this microhabitat as supporting the highest salmonfly nymphal densities. A 0.25 m² Surber net was selected because it is a commonly used, commercially available quantitative sampling device that can effectively sample the large cobble substrate that support abundant salmonfly populations (Kowalski & Richer, 2020). We selected this relatively large-area sampling device, rather than a smaller Hess sampler used by several ongoing macroinvertebrate monitoring programs on the Upper Colorado River, to maximize the likelihood of detecting salmonflies when densities were low. At Site 2 above Kremmling, a Surber sampler was deemed inadequate, however, due to low flows and the absence of riffles. Instead, density was assessed semi-quantitatively using four kick screen samples, each from roughly 0.5 m^2.

For each sample (i.e., Surber and kick screen), cobbles were dislodged and scrubbed by hand so that attached macroinvertebrates were washed into the net. After all cobbles larger than a baseball had been removed and scrubbed, the remaining substrate within the frame was vigorously agitated with a garden rake to dislodge remaining macroinvertebrates.

Samples were elutriated in the field and preserved in 99% isopropyl alcohol for laboratory identification. Only giant salmonflies (*Pteronarcys californica*) were counted from these samples, and each sample was processed in full without subsampling. Nymphs were identified using the taxonomic keys of Merritt et al. (2008) and Myers and Kondratieff (2017).

Headwaters and Tributaries: Salmonfly Presence/Absence Sampling (Sites 8-12)

To assess the upstream and tributary range extent of salmonflies, we collected 10 semi-quantitative kick-net samples from five sites: one on the Fraser River upstream of Fraser Canyon (Site 8), one on the Colorado River between Windy Gap Reservoir and Granby Dam (Site 9), and three on Willow Creek (Sites 10–12). At each site, samples were taken from habitats considered most suitable for salmonfly nymphs, including riffles with large, unconsolidated cobbles (Kowalski & Richer, 2020).

The contents of each kick-net sample were carefully inspected for salmonfly nymphs in the field within a white plastic tub by a trained entomologist. Following inspection, all macroinvertebrates were returned alive to the stream. If no salmonflies were detected after 10 targeted kick-net samples, the site was classified as salmonfly-absent under this sampling protocol.

Trend Statistical Analysis

Temporal trends in salmonfly density were evaluated using two complementary analyses. First, trends were analyzed independently at the six 2026 resampling sites (Figures 1–6), allowing contemporary salmonfly densities to be compared directly with historical observations at the same general locations. Second, a broader river-segment analysis was conducted by pooling sites within the five distinct sections of the Colorado River (See map 1).

For the site-specific analysis, observations with missing salmonfly density or sampling-year values were excluded. At each site, we fitted a simple linear regression in R, with salmonfly density as the response variable and sampling year as a continuous predictor (R Core Team, 2026). For each model, we report the estimated slope, 95% confidence interval, and *p*-value. The direction of the slope was used to characterize temporal trends in salmonfly density, with $p < 0.05$ indicating statistical significance.

To evaluate the potential influence of differences in historical sampling methodologies on site-specific density estimates and temporal trends, we conducted a sensitivity analysis using a multiplicative correction factor applied to observations from Nehring et al. (2010, 2011). These studies employed a 1-m² substrate sampler, substantially larger than the sampling devices used in other studies. This larger sampling area may have produced higher salmonfly density estimates by more effectively sampling large cobble substrates, which can provide important habitat for salmonfly nymphs but may be underrepresented by smaller sampling devices.

The correction factor was derived by comparing median salmonfly densities reported by two historical data sources, Erickson (1983), who used a 0.25-m² modified Hess sampler, and Nehring et al. (2010, 2011), who used a 1-m² substrate sampler. Comparisons were restricted to observations collected before 2000 at the Kemp Breeze sampling location, where data from both sources were available. Median salmonfly densities were 25.2 and 111 individuals/m² for Erickson and Nehring et al., respectively, yielding a correction factor of 0.227 (25.2/111). This factor was applied to all Nehring-derived density estimates across sampling years and repeated sampling locations, and the site-specific regression analyses were repeated using the adjusted values. These corrected analyses were treated as a sensitivity analysis rather than a definitive standardization of sampling methods, allowing us to assess the robustness of estimated population trends to potential methodological differences among historical datasets.

For the river-segment analysis, the same linear regression framework was applied after combining observations from pooled sites within the five distinct segments of the Colorado River. This analysis was intended to evaluate broader temporal patterns across river segments while incorporating information from multiple nearby monitoring sites. Sites within each river segment are color-coded in the scatterplots shown in Map 1, allowing observations from the contributing sampling sites to be distinguished within each pooled analysis.

To assess the influence of sampling season on estimated salmonfly density trends, we repeated site-specific linear regressions with sampling year and season (spring, summer, fall, winter) as predictors. Season was treated as a categorical covariate, and its significance was evaluated using F-tests ($\alpha = 0.05$). Sites with observations from only one season were analyzed using year alone.

2026 Sampling Results

Summary

Based on analyses of the raw data, we detected statistically significant salmonfly declines at five of the six density-based resampling sites, including Pumphouse (Site 1), above Kremmling (Site 2), Kemp Breeze (Site 3), Sheriff Ranch (Site 5), and at the mouth of the Fraser River Canyon (Site 7). This includes a potential extirpation above Kremmling (Site 2). After applying the methodology correction factor, all regression trends estimates remained in the same direction, but the decline at Pumphouse became non-significant. Sampling season was not a significant predictor of salmonfly density at any of the four sites where multiple seasons were represented (all $p \geq 0.130$).

Colorado River Density and Trends

Pumphouse (Site 1)

Pumphouse Boat Launch had a relatively high density of salmonflies in 2026 (mean = 62 individuals/m²). Despite their abundance, we found evidence of a strong decline since 2009 [estimate = -27.4, CI = (-40.4, -14.4), P = 0.0003] (Fig. 1), with an estimated loss of −27.4 individuals/m²/year. Model-predicted density shows that salmonfly densities have decreased from approximately 477 to 10 individuals/m². This is equivalent to a 98% decline over 17 years. Following the application of a 0.227 multiplicative correction factor to Nehring et al.'s density estimates, the temporal trend at this site remained negative but was no longer statistically significant [estimate = −5.01, CI = (−14.0, 3.93) , P = 0.254].

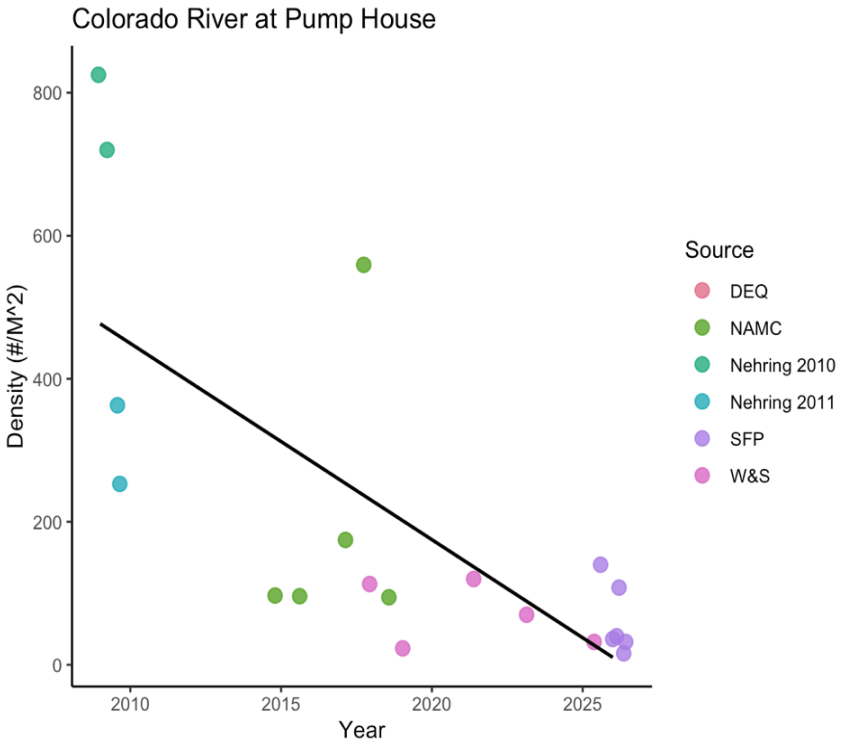


Figure 1. Scatterplot of salmonfly nymph density across available years of compiled data at Pumphouse boat launch, SW of Kremmling, CO. Colored points represent different data sources.

Above Kremmling (Site 2)

No salmonflies were detected during 2026 resampling at the site above Kremmling (Fig. 2). Nehring et al. (2011) reported an average density of 13 individuals/m² at this site in 2010, suggesting that this reach has undergone a local extirpation in the last 16 years.

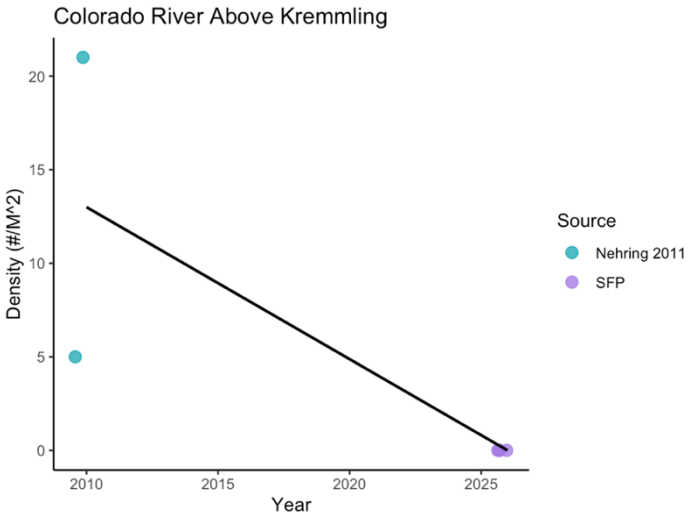


Figure 2. Scatterplot of salmonfly nymph density across available years of compiled data upstream of Kremmling, CO. Colored points represent different data sources.

Below Byers Canyon (Site 4)

Among all sites, Below Byers Canyon supported the highest mean density of salmonflies in 2026, at 84.66 individuals/m². (Fig. 4). At this site, density was stable, with no evidence of a temporal trend in density [Estimate = + 0.983, 95% CI = (-3.68, 5.64); P = 0.66].

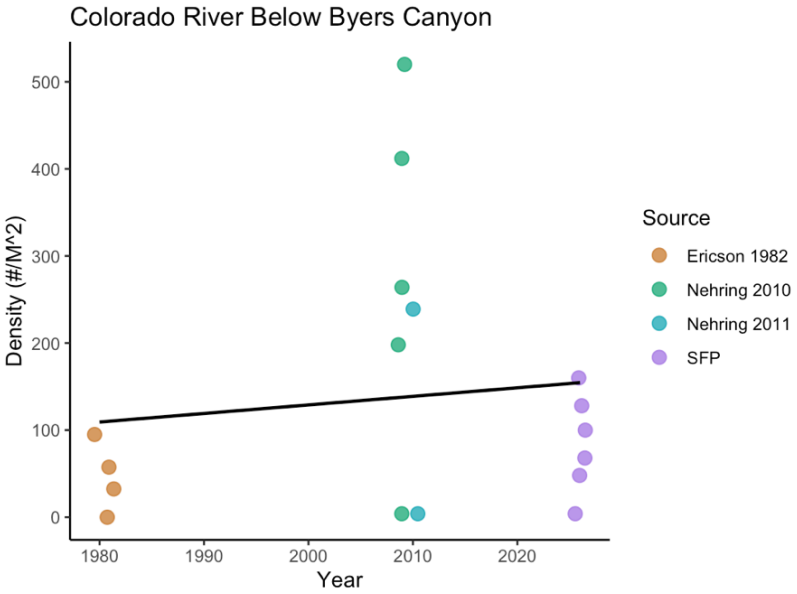


Figure 4. Scatterplot of Salmonfly nymph density across available years of compiled data Below Byers Canyon, SW of Hot Sulphur Springs, CO. Colored points represent different data sources.

Kemp Breeze (Site 3)

At Kemp Breeze, mean salmonfly density was 11.33 individuals/m² in 2026 and declined significantly from 1980-2026 [Estimate = -4.23 individuals/m² per year, 95% CI = (-6.19, -2.28), p <0.0001] an estimated decline of 94.5% over 46 years (Fig. 3). When the analysis was restricted to the more recent 2009–2026 period (n = 25), density showed no statistically detectable trend [Estimate = + 0.43 individuals/m² per year, 95% CI = (−0.01, 0.87), P = 0.055]. This suggests that the major decline at Kemp Breeze occurred at some point between the 1990's and early 2000s and that salmonfly density has since remained relatively stable at a substantially reduced level.

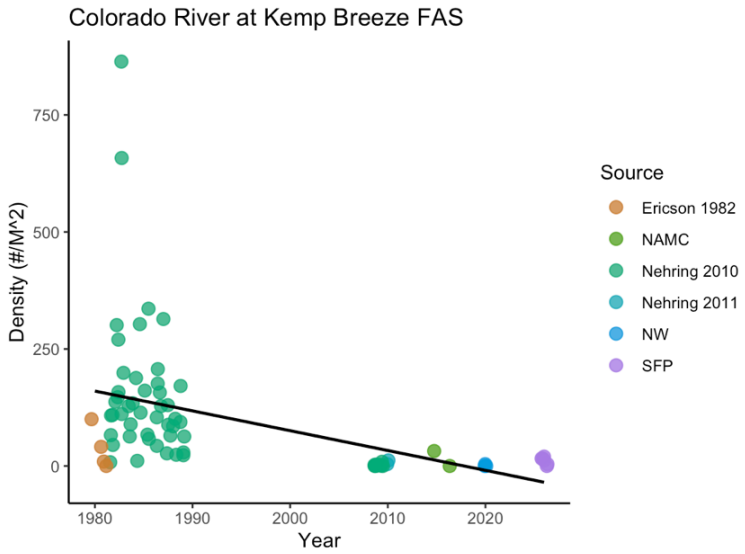


Figure 3. Scatterplot of Salmonfly nymph density across available years of compiled data at Kemp Breeze FAS near Parshall, CO. Colored points represent different data sources.

Sheriff Ranch (Site 5)

In 2026, Sheriff Ranch had very low average salmonfly density of 2 individuals/m². Density declined significantly from 1982-2026 (Estimate = −8.11 individuals/ m²/year, 95% CI = (−14.9, −1.35), P = 0.019) (Fig. 5) by an estimated 90%.

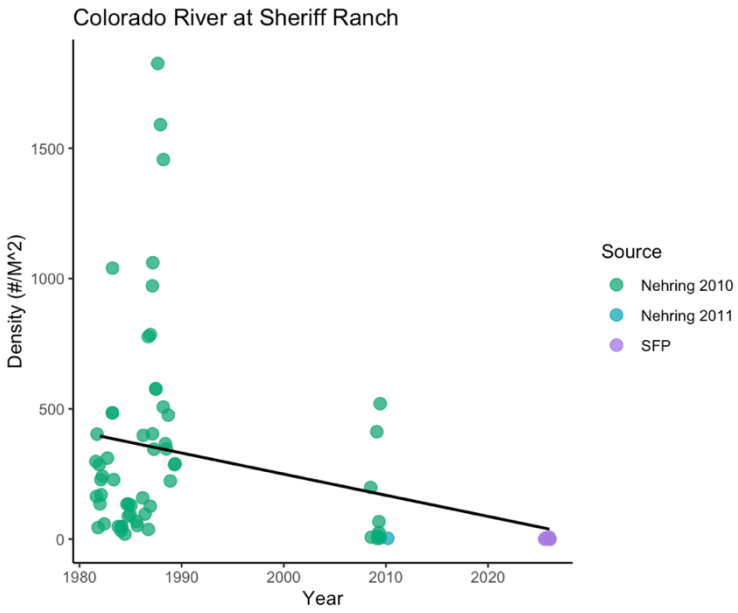


Figure 5. Scatterplot of Salmonfly nymph density across available years of compiled data at Sheriff Ranch (HWY 40 Bridge) near Hot Sulphur Springs, CO. Colored points represent different data sources.

Fraser River Density and Trends

BLM land Below Fraser Canyon (Site 7)

At the mouth of the Fraser River Canyon, mean salmonfly density was 17.33 individuals/m^2 in 2026. However, densities declined significantly from 2010–2026 [Estimate = - 2.35 individuals/m² per year, 95% CI = (−3.92, −0.79), P = 0.012] (Fig. 6) by approximately 55 individuals/m² in 2010 (Nehring, 2011) to 17 individuals/m² in 2026. This corresponds to an estimated 69% decline over the last 16 years.

Colorado River Connectivity Channel (CRCC) (Site 6)

No salmonfly nymphs were found in any 2026 samples in the CRCC, suggesting a density of 0 individuals/m^2. Substrate within the channel appeared largely free of fine sediment. The 2026 macroinvertebrate assemblage was dominated by heptageniid mayflies and brachycentrid caddisflies, indicating that colonization by other rheophilic aquatic insects was already underway.

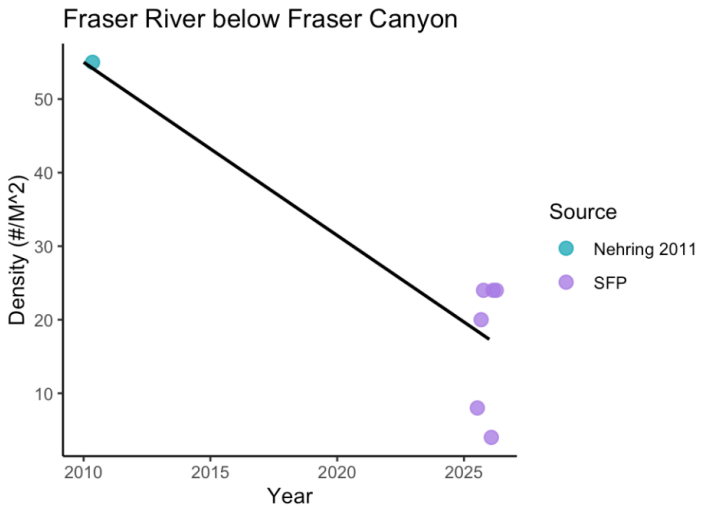
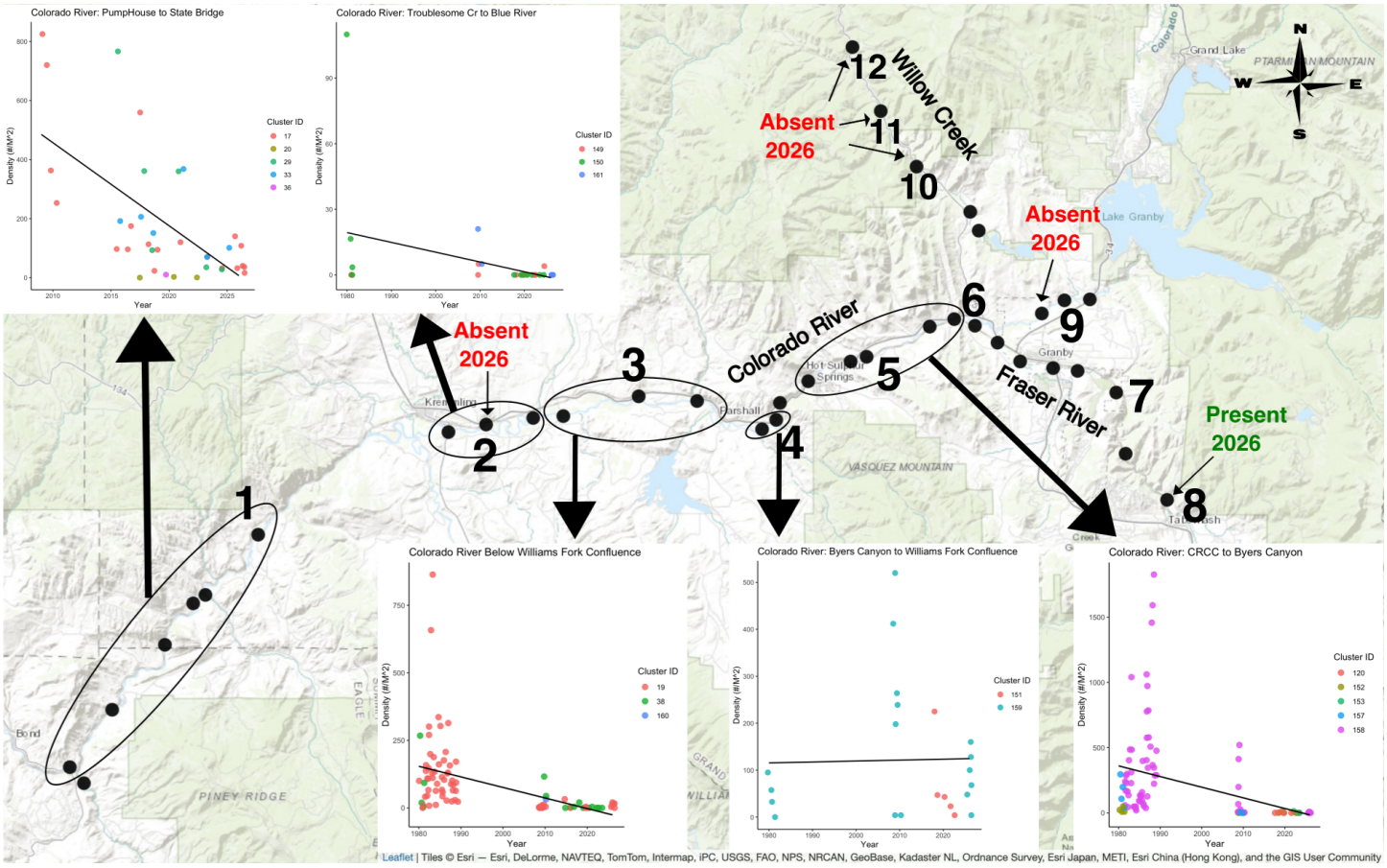


Figure 6. Scatterplot of Salmonfly nymph density across available years of compiled data on the Fraser River below the Fraser Canyon, near Granby Ranch Golf Course, Granby, CO. Colored points represent different data sources.

Headwaters and Tributary Presence/Absence (Sites 8-12)

Targeted presence/absence sampling revealed limited salmonfly occurrence in the upper Colorado River watershed and tributaries. Above Fraser Canyon, one salmonfly nymph was detected among 10 targeted kick-net samples, confirming salmonfly presence but relative rarity. No salmonflies were detected in 10 targeted samples from the Colorado River upstream of Windy Gap Reservoir (Site 9), and the site was therefore classified as unoccupied under our sampling protocol. This result is consistent with two nearby upstream samples collected by Nehring et al. in 2009, which also failed to detect salmonflies in this reach. Similarly, no salmonflies were detected among 30 targeted kick-net samples collected across three Willow Creek sites. Historical records indicate that salmonflies were previously present at very low densities in this area. Nehring detected one salmonfly nymph at our middle sampling site in 2010. A single salmonfly nymph was collected in a kick-net sample just downstream of our study reach in 2002 (NAMC, 2026). The apparent absence of salmonflies in our contemporary survey suggests there may be high annual variability in habitat availability for

salmonfly nymphs or could suggest a possible local extirpation or population decline, but this should be confirmed with further surveys.



Map 1. Summary map of the Colorado River Basin, showing compiled historical sampling sites and segment-level groupings used in the river segment analysis. Numbers 1–7 correspond to 2026 resampling sites used to evaluate density, while numbers 8–12 indicate 2026 presence/absence sampling sites. Black points represent all sites within the mapped area. Cluste ID's represent grouped sited by a 0.5 mile radius. Groups of circled sites indicate distinct Colorado River segments, ordered from downstream to upstream: 1) between State Bridge and Pumphouse (below Gore Canyon), 2) between the Troublesome Creek and Blue River confluences, 3) between the Williams Fork and Troublesome Creek confluences, 4) between the mouth of Byers Canyon and the Williams Fork confluence, 5) and from Windy Gap to the upper end of Byers Canyon. The point directly south of segment 1 was excluded because it was located on a tributary. The site between the two upstream segments was excluded because it was located within Byers Canyon and may not be representative of either adjacent segment due to strong differences in hydrology and geomorphology.

River Segment Analysis

Summary

Analysis of distinct Colorado river segments show that salmonfly densities have declined in four of the five river segments analyzed. Salmonflies are now extremely rare or potentially locally extirpated between Troublesome Creek and the Blue River, they remain greatly reduced between the Williams Fork and Troublesome Creek and have continued to decline to very low densities between Windy Gap and Byers

Canyon. The most robust populations remain between Byers Canyon and the Williams Fork confluence where densities are stable and from Pumphouse downstream to State Bridge, where densities appear to be in decline since 2010.

Gore Canyon to State Bridge (Segment 1)

Salmonfly densities from Pumphouse, below Gore Canyon, downstream to State Bridge have declined substantially from historical conditions, although this reach continues to support one of the strongest remaining populations in the upper Colorado River. Historical sampling reported densities exceeding 500 individuals/m² in this area (Nehring et al., 2011). More recent monitoring has documented considerably lower abundances, with a mean density of approximately 130 individuals/m² since 2016 (USEPA, 2026; NAMC, 2026; UCWSAMP, 2025) and an average of approximately 71.6 individuals/m² in annual monitoring conducted by the Upper Colorado Wild & Scenic Alternative Management Plan since 2018 (UCWSAMP, 2025). In 2026, our sampling at State Bridge produced a mean density of 62 individuals/m². Collectively, these data indicate a substantial long-term decline in salmonfly abundance, despite this reach remaining an important contemporary stronghold. The multiplicative correction factor to Nehring et al. data was not applied throughout the river segment analysis.

Troublesome Creek to the Blue River (Segment 2)

Between the confluences of Troublesome Creek and the Blue River, salmonflies appear to have been extirpated or reduced to extremely low abundances. Historical records from Erickson (1983) documented a mean density of approximately 32.5 individuals/m² in this reach. Nehring et al. (2011) sampled the segment in 2001 and 2009 and reported a mean density of approximately 5.2 individuals/m². Learning By Doing has monitored the same general area annually since 2018, but only one salmonfly has been collected across eight years of sampling. In 2026, we were unable to detect salmonflies using targeted kick-screen sampling. Together, these observations indicate a substantial long-term reduction in salmonfly abundance and suggest possible local extirpation.

Williams Fork to Troublesome Creek (Segment 3)

Salmonflies reappear below the Williams Fork confluence, although at densities substantially lower than those documented historically. At Kemp Breeze, mean salmonfly density in 2026 was 11.33 individuals/m². In comparison, Nehring collected 49 samples at this site between 1980 and 1990, with an average density of 143.1 individuals/m². Contemporary densities therefore represent less than 8% of the historical average. Erickson's 1980's sampling in this segment also documented substantially greater abundance, with a mean density of 95.4 individuals/m² (Erickson, 1983). Learning By Doing has monitored this reach annually since 2017 and has reported a mean density of approximately 3.5 individuals/m², with no salmonflies detected in its Hess samples since 2021. Multiple independent datasets therefore indicate a major long-term reduction in salmonfly abundance on the Colorado River between the Williams Fork and Troublesome Creek.

Byers Canyon to the Williams Fork (Segment 4)

The Colorado River between Byers Canyon and the Williams Fork confluence remains an important salmonfly stronghold, and in contrast to all other river segments analyzed, densities remaining apparently stable over time. Modern salmonfly densities are comparable to observations from the 1980s and 2010, with a mean density over time of approximately 68 individuals/m². This reach is currently monitored annually by Northern Water using quantitative Hess samples.

Windy Gap to Byers Canyon (Segment 5)

Upstream of Byers Canyon to Windy Gap, salmonfly densities show evidence of a severe long-term decline. Historical sampling from 1989–1990 documented mean densities exceeding 300 individuals/m² (Erickson,

1983). By 2010, mean density had declined to about 66 individuals/m². During the past decade, average density has declined further to approximately 2.2 individuals/m². Relative to the average from the 1980's, this represents a decline of roughly 99%. Salmonfly declines have been previously reported on this segment; In 2010, Nehring et al.(2011) concluded that salmonflies had been nearly extirpated from the six-mile reach immediately downstream of Windy Gap Dam. In 2026, we collected three salmonfly nymphs within this segment (at Sheriff Ranch), all of which were small females ranging from 16–28 mm in length. This confirms that salmonflies still persist within the reach, despite their extremely low abundance.

Discussion

Taken together, our findings indicate that salmonflies remain widely distributed across numerous Colorado watersheds (Appendix II), although the available data are insufficient to evaluate population trends statistically in watersheds outside the Colorado River Basin. Within the Colorado River Basin, declines appear widespread but vary in magnitude across locations. Of the five distinct Colorado River segments evaluated, four showed evidence of declining density or possible local extirpation. Likewise, we found fewer salmonflies at five of the six resampling sites in 2026, compared to historical surveys. The Colorado River between Byers Canyon and the Williams Fork confluence was the only segment (including Site 4, below Byers Canyon) where contemporary salmonfly densities remained comparable to historical levels.

Decline severity varied substantially among reaches. the Colorado River between Troublesome Creek and the Blue River appear to have experienced a localized salmonfly extirpation. Severe declines were also evident from Pumphouse through State Bridge, where densities have decreased by approximately 98% from historical levels despite this reach continuing to support comparatively high salmonfly abundance today. Similarly large declines occurred near Kemp Breeze and from Byers Canyon upstream toward Windy Gap, where present-day densities are substantially lower than historical observations. Together, these results indicate that the majority of the upper Colorado river watershed has endured significant salmonfly decline although at differing severities.

The persistence of relatively strong salmonfly populations between Byers Canyon and the Williams Fork confluence may be particularly important for future recovery because reaches immediately upstream and downstream have experienced severe declines. This population may provide a source of drifting nymphs or dispersing adults for recolonization of neighboring reaches. Just as importantly, comparing environmental conditions within this segment to those of reaches with decreasing salmonfly densities may help identify the factors associated with their persistence and declines. Differences in temperature, sediment, flow regime, substrate condition, water quality, and other habitat characteristics should therefore be evaluated as potential drivers of observed spatial patterns in density and declines.

The Fraser River may provide an additional important source population for recovery. Salmonflies remain present in and near Fraser Canyon and could contribute to recolonization of the upper watershed if habitat conditions improve. Continued monitoring will be important for tracking population trends and evaluating whether recent restoration efforts influence salmonfly abundance and distribution over time.

The Colorado River Connectivity Channel (CRCC) also creates a unique opportunity to evaluate salmonfly recovery following restoration of longitudinal connectivity around the former Windy Gap Reservoir. Salmonflies appear to have not yet colonized the newly constructed CRCC as we did not detect any nymphs from our six replicate Surber samples in 2026. However, long-term monitoring should be established within the CRCC to document salmonfly colonization and broader development of the macroinvertebrate community.

Overall, these findings suggest that salmonfly conservation in the Upper Colorado should focus not only on continued monitoring of population change, but also on understanding why some river segments continue to support relatively strong populations while neighboring reaches have experienced severe declines or apparent

extirpation. Identifying the environmental factors responsible for these differences will be critical for directing future restoration and management efforts (see Next Steps, below).

Considerations and Limitations

Sampling methods and seasons varied among the historical and contemporary datasets included in this analysis, introducing potential sources of variation in estimated salmonfly densities. To improve comparability, only quantitative samples were included in density analyses; qualitative sampling methods, such as kick-net sampling, were excluded. All quantitative observations were standardized to a common density unit (individuals/m²), following Nehring et al. (2010). Although this standardization facilitates comparisons among datasets, differences in sampling equipment, frame size, substrate characteristics, and collection and laboratory processing protocols can influence density estimates (Chiasson, 2009; Gibbs et al., 2023). Particular consideration is warranted when comparing density estimates from Nehring et al. (2010, 2011) with those from other historical surveys, as their larger sampling frame encompassed a greater area of substrate (1 m²) than the smaller devices used in other monitoring programs (e.g., 0.25 m^2). This difference may be particularly relevant for salmonflies, which are often associated with large cobble substrates that may be difficult to adequately sample using smaller frames (Kowalski & Richer 2020). Nevertheless, Nehring et al. (2010, 2011) also compared density estimates with historical data collected by Erickson (1983) using a 0.25 m² sampling device, providing precedent for comparisons using different methods. However, the extent to which differences in sampling frame size influence salmonfly capture efficiency and density results remains uncertain.

Seasonal effects may be less pronounced for salmonflies than for many shorter-lived aquatic insects because they have an approximately three- to four-year nymphal life cycle, resulting in multiple overlapping year classes occupying the benthos throughout the year. Although emergence removes the oldest cohort from the aquatic population annually, younger cohorts remain present, with recruitment of nymphs from newly oviposited eggs following shortly after. Seasonal changes in nymphal size, habitat use, and capture efficiency may also influence density estimates, particularly if smaller age classes are less effectively sampled or detected. Additionally, mature nymphs migrate toward near-bank habitats prior to emergence, which often coincides with periods of elevated spring runoff. These changes in nymphal distribution and flow conditions may further influence capture probability during benthic sampling.

Finally, variation in antecedent streamflow and sampling timing may also influence estimated salmonfly population trends. Zuellig and Carlisle (2019) demonstrated that accounting for these factors altered the magnitude of biological trend estimates by an average of 21% and changed their interpretation in approximately one-third of the cases evaluated. These findings suggest that differences in hydrologic conditions preceding sampling may contribute additional variability to the historical and contemporary salmonfly density estimates compiled here.

Collectively, differences in sampling methods, laboratory processing, and seasonality introduce uncertainty when comparing historical and contemporary density estimates. These factors are summarized for compiled dataset in Table 1 and should be considered when interpreting long-term population trends. However, the extended juvenile development and overlapping cohorts of salmonflies, along with summer-time sampling of surveys in this analysis, suggest that seasonal and methodological differences alone are unlikely to explain the large, persistent, and spatially coherent declines in salmonfly density observed across much of the watershed. Indeed, integrating a methodological correction in our analysis, did not change the direction of regression trend estimates at any site, and seasonality did not have a statistically significant effect in any of our density trend models.

Next Steps

In addition to continued monitoring, a basin-wide assessment of the environmental factors associated with salmonfly loss is urgently needed. Evaluating relationships between salmonfly density and environmental conditions, e.g., temperature, flow, and sedimentation, will help managers identify the factors most strongly associated with declines and determine which habitat conditions and management actions are most important for supporting recovery.

We also recommend establishing a coordinated *Colorado Basin Salmonfly Watch*. Fortunately, the Upper Colorado already has a strong network of annual macroinvertebrate monitoring sites maintained by the Upper Colorado Wild & Scenic Alternative Management Plan, Learning by Doing, and Northern Water. These programs provide an existing foundation for collaboration, particularly because their samples are processed through a common taxonomic laboratory: *Spheros,* in Fort Collins, Colorado. Rather than building an entirely new monitoring network, these existing programs can be used to track salmonfly trends across the watershed annually. This partnership would create a centralized basin-wide salmonfly dataset, allow trends to be evaluated across the watershed rather than within individual monitoring programs, thereby increasing the scientific value of existing monitoring investments without duplicating sampling effort.

We recommend adding two high-priority sampling sites not currently covered by other monitoring programs: one within the CRCC and another near the mouth of Fraser Canyon (Map 2). The CRCC site would track colonization of the newly constructed river channel, while the Fraser site would monitor one of the furthest-upstream salmonfly strongholds and a potential source population for downstream recovery. Additionally, monitoring within Byers canyon and Gore Canyon may provide important information as important salmonfly refugia in the Upper Colorado River Basin.

To more rigorously evaluate the influence of differing sampling methodologies on assessments of salmonfly trends, we recommend conducting a one-year study comparing the three sampling methods historically employed on the Colorado River: hess nets, large surber samplers, and 1-m^2 substrate samplers. We propose selecting three to four sites across the upper Colorado River where historical monitoring has employed these methods and collecting eight replicate samples per method at each site during both a spring and fall sampling event. This standardized study design would allow for direct comparisons of sampling efficiency and density estimates among methods, helping to identify and quantify methodological biases and develop more robust correction factors for comparing historical datasets. Beyond improving the reliability of long-term trend assessments on the Colorado River, the findings would help resource managers establish standardized, effective salmonfly monitoring protocols across Colorado to inform conservation and management decisions following the species' recent designation as a Species of Greatest Conservation Need (SGCN).

Our findings also have implications beyond the Upper Colorado. Salmonflies occur in several other Colorado watersheds, but most lack enough repeated historical and contemporary sampling to evaluate long-term trends. Developing comparable datasets elsewhere would help clarify whether the declines documented here are primarily a local issue or part of a broader statewide pattern. As salmonflies are now recognized as a Species of Greatest Conservation Need in Colorado, understanding their status, trends, and drivers of declines across the entire state is now of heightened importance.



Map 2. Map of the Upper Colorado River Basin showing ongoing annual benthic macroinvertebrate monitoring sites maintained by Learning by Doing (green), Northern Water (orange), and the Upper Colorado Wild & Scenic Alternative Management Plan (purple). Black stars indicate two proposed annual monitoring sites: the Colorado River Connectivity Channel and the mouth of Fraser Canyon.

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Appendix I - Data from The Salmonfly Project's 2026 field collections.

Site Name	River	Date	Rep	Method	Latitude	Longitude	Count	Density(#/M^2)
Above Hot Sulpher Springs	Colorado River	6/24/26	3	Surber	40.084682	-106.07766	0	0
Above Hot Sulpher Springs	Colorado River	6/24/26	5	Surber	40.084682	-106.07766	0	0
Above Hot Sulpher Springs	Colorado River	6/24/26	6	Surber	40.084682	-106.07766	0	0
Above Hot Sulpher Springs	Colorado River	6/24/26	2	Surber	40.084682	-106.07766	2	8
Above Hot Sulpher Springs	Colorado River	6/24/26	1	Surber	40.084682	-106.07766	0	0
Above Hot Sulpher Springs	Colorado River	6/24/26	4	Surber	40.084682	-106.07766	1	4
Pumphouse	Colorado River	6/23/26	2	Surber	39.989929	-106.50848	9	36
Pumphouse	Colorado River	6/23/26	5	Surber	39.989929	-106.50848	10	40
Pumphouse	Colorado River	6/23/26	1	Surber	39.989929	-106.50848	4	16
Pumphouse	Colorado River	6/23/26	4	Surber	39.989929	-106.50848	27	108
Pumphouse	Colorado River	6/23/26	3	Surber	39.989929	-106.50848	35	140
Pumphouse	Colorado River	6/23/26	6	Surber	39.989929	-106.50848	8	32
Below Fraser Canyon	Fraser River	6/24/26	3	Surber	40.06658	-105.88444	1	4
Below Fraser Canyon	Fraser River	6/24/26	2	Surber	40.06658	-105.88444	2	8
Below Fraser Canyon	Fraser River	6/24/26	1	Surber	40.06658	-105.88444	6	24
Below Fraser Canyon	Fraser River	6/24/26	5	Surber	40.06658	-105.88444	6	24
Below Fraser Canyon	Fraser River	6/24/26	4	Surber	40.06658	-105.88444	5	20
Below Fraser Canyon	Fraser River	6/24/26	6	Surber	40.06658	-105.88444	6	24
Below Byers Canyon	Colorado River	6/23/26	1	Surber	40.05199	-106.1322	12	48

Below Byers Canyon	**Colorado River**	**6/23/26**	**6**	**Surber**	**40.05199**	**-106.1322**	**32**	**128**
Below Byers Canyon	**Colorado River**	**6/23/26**	**3**	**Surber**	**40.05199**	**-106.1322**	**40**	**160**
Below Byers Canyon	**Colorado River**	**6/23/26**	**4**	**Surber**	**40.05199**	**-106.1322**	**1**	**4**
Below Byers Canyon	**Colorado River**	**6/23/26**	**2**	**Surber**	**40.05199**	**-106.1322**	**17**	**68**
Below Byers Canyon	**Colorado River**	**6/23/26**	**5**	**Surber**	**40.05199**	**-106.1322**	**25**	**100**
Kemp Breese	**Colorado River**	**6/23/26**	**4**	**Surber**	**40.063083**	**-106.18494**	**1**	**4**
Kemp Breese	**Colorado River**	**6/23/26**	**6**	**Surber**	**40.063083**	**-106.18494**	**5**	**20**
Kemp Breese	**Colorado River**	**6/23/26**	**3**	**Surber**	**40.063083**	**-106.18494**	**0**	**0**
Kemp Breese	**Colorado River**	**6/23/26**	**5**	**Surber**	**40.063083**	**-106.18494**	**3**	**12**
Kemp Breese	**Colorado River**	**6/23/26**	**1**	**Surber**	**40.063083**	**-106.18494**	**4**	**16**
Kemp Breese	**Colorado River**	**6/23/26**	**2**	**Surber**	**40.063083**	**-106.18494**	**4**	**16**
CRCC	**Colorado River**	**6/26/26**	**5**	**Surber**	**40.1047989**	**-105.98794**	**0**	**0**
CRCC	**Colorado River**	**6/26/26**	**2**	**Surber**	**40.1047989**	**-105.98794**	**0**	**0**
CRCC	**Colorado River**	**6/26/26**	**3**	**Surber**	**40.1047989**	**-105.98794**	**0**	**0**
CRCC	**Colorado River**	**6/26/26**	**1**	**Surber**	**40.1047989**	**-105.98794**	**0**	**0**
CRCC	**Colorado River**	**6/26/26**	**4**	**Surber**	**40.1047989**	**-105.98794**	**0**	**0**
CRCC	**Colorado River**	**6/26/26**	**6**	**Surber**	**40.1047989**	**-105.98794**	**0**	**0**
Above Kremmling	**Colorado River**	**6/23/26**	**1**	**Kick Screen**	**40.0498272**	**-106.34443**	**0**	**0**
Willow Creek 1	**Willow Creek**	**6/26/26**	**1**	**Kick Net**	**40.19381**	**-106.03016**	**0**	**NA**
Willow Creek 2	**Willow Creek**	**6/26/26**	**1**	**Kick Net**	**40.22663**	**-106.05732**	**0**	**NA**
Willow Creek 3	**Willow Creek**	**6/26/26**	**1**	**Kick Net**	**40.26024**	**-106.07696**	**0**	**NA**
Above Fraser Canyon	**Fraser River**	**6/26/26**	**1**	**Kick Net**	**40.007781**	**-105.84801**	**1**	**NA**
Below Granby Dam	**Colorado River**	**6/26/26**	**1**	**Kick Net**	**40.111879**	**-105.93924**	**0**	**NA**

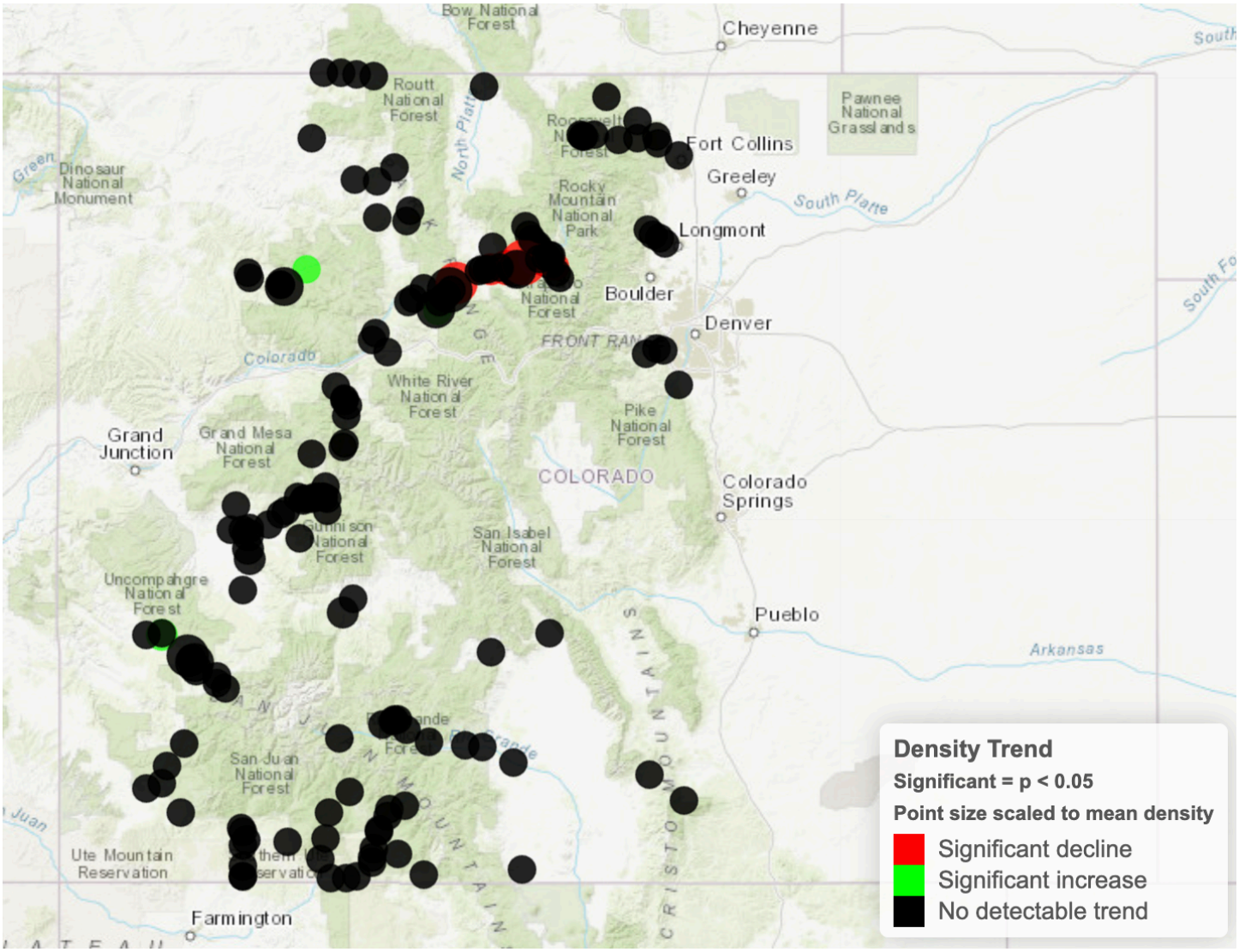
Appendix II – Interactive Salmonfly Map

Sampling sites were summarized and mapped in R using the dplyr**,** leaflet, and scales packages. For each site, we calculated the total number of samples, number of unique sampling years, first and most recent sampling year, mean salmonfly density, and mean relative abundance. To evaluate temporal trends at each site, we fit a simple linear regression of salmonfly density against sampling year. The slope of the year coefficient was used to describe the direction of change, and its associated p-value was used to determine whether the trend was statistically significant. Sites with a significantly negative slope ($p < 0.05$) were classified as significant declines and plotted in red, while sites with a significantly positive slope ($p < 0.05$) were classified as significant increases and plotted in green. All remaining sites were classified as having no detectable trend and plotted in black.

Point sizes were displayed as proportional circle markers using the leaflet package, such that marker size was scaled according to mean salmonfly density at each site, with observed densities linearly rescaled to points ranging from 4 to 18 pixels.

The map was displayed over the Esri World Topographic Map basemap. Interactive pop-up windows were added to each sampling site and reported the site identification number (Cluster ID), total number of samples, number and range of sampling years, mean salmonfly density, mean relative abundance, estimated density-trend classification, regression slope, and p-value. Together, marker size and color provide a spatial summary of both average salmonfly abundance and statistically supported long-term changes in density across monitored sites.

Below is a screenshot from the interactive map displaying sampling sites compiled from available data sources across Colorado. The present study detected statistically significant salmonfly density trends at resampling sites within the Colorado River drainage. However, most mapped sites do not include repeated annual monitoring data, which limits the ability to estimate temporal trends at those locations. Continued monitoring at other targeted sites would improve the ability to evaluate long-term changes in salmonfly distribution and abundance across the state. The interactive map itself is publicly available at https://salmonflyproject.org/reports/ and is associated with this report.


Bow National Forest
Cheyenne
Routt National Forest
Pawnee National Grasslands
Fort Collins
Dinosaur National Monument
Greeley
Rocky Mountain National Park
Longmont
Boulder
Denver
Colorado
White River National Forest
Pike National Forest
Grand Junction
Grand Mesa National Forest
COLORADO
Colorado Springs
Gunnison National Forest
San Isabel National Forest
Uncompahgre National Forest
Pueblo
Arkansas
San Juan National Forest
Ute Mountain Reservation
Farmington
Density Trend
Significant = p < 0.05
Point size scaled to mean density
Significant decline
Significant increase
No detectable trend