BENTHIC MACROINVERTEBRATES OF THE WOOD RIVER BASIN, IDAHO – A 2024 BASELINE SURVEY

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THE SALMONFLY PROJECT

SUGGESTED CITATION

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TABLE OF CONTENTS:

EXECUTIVE SUMMARY:

Purpose

The purpose of this report is to describe the year-one findings of a newly initiated macroinvertebrate and habitat monitoring project throughout the Wood River Basin, Idaho. The project was initiated by Project Big Wood and designed, carried out, and led by The Salmonfly Project. Monitoring began in September, 2024 and is ongoing. Here, we summarize necessary background information and describe initial findings, conservation implications, and recommendations to guide monitoring efforts in future years. This report is not intended to be exhaustive, but to briefly summarize macroinvertebrate survey results and act as a tool for evaluating and improving the design and execution of the monitoring project during its early phases.

Key takeaways

1. At the Basin level, macroinvertebrate communities are relatively abundant, biodiverse, and dominated by mayflies, stoneflies and caddisflies. Conditions at most sites reflect high water quality and ecosystem integrity, though some differences in macroinvertebrate communities exist between the mainstem and tributaries.

2. Macroinvertebrate data from some sites, including Lower Trail Creek, Upper Trail Creek, and Stanton Crossing, indicate relatively low water quality and ecosystem integrity compared to other sites. Trail Creek and the Big Wood River near Stanton Crossing may require more immediate conservation attention than other sites.

3. Conditions at Lower Trail Creek appeared to be particularly poor. Because Trail Creek is not currently listed as impaired by IDEQ, we recommend additional sampling be performed to formally evaluate whether it merits listing under the State 303(d) impairment list.

4. The lack of long-term historical macroinvertebrate data throughout the Basin currently makes quantifying declines or shifts in macroinvertebrates and ecosystem integrity impossible. Continuing this and other contemporary monitoring programs will thus be necessary to track population shifts over time and identify threats and solutions.

A *Baetis tricaudatus* adult (Blue-Winged Olive) – one of the most abundant aquatic insects in the Big Wood Basin. Photo Credit: Jason Neuswanger, TroutNut.com

INTRODUCTION

Why Monitor Macroinvertebrates

Aquatic insects – and other 'large' invertebrates (i.e., macroinvertebrates) – are critical components of streams and rivers, worldwide. They comprise over 70% of all aquatic biodiversity and often represent the majority of in-stream animal biomass (Dijkstra et al. 2013). Aquatic insects also make up the core of aquatic food webs – they feed a wide array of fish species, including trout, along with insectivorous birds, bats, and terrestrial invertebrates (Allan & Castillo 2007; Merritt et al. 2008l; Shipley et al. 2022). They control the production and decomposition of plants by feeding on algae, macrophytes, and detritus. During adult emergences (hatches), aquatic insects transfer massive amounts of nutrients to riparian ecosystems, supporting the terrestrial plants and animals that live on the riverbanks (Walters et al. 2018). They also support recreational economies by creating renowned angling opportunities (Macadam & Stockam 2015). Without abundant and diverse aquatic insects, freshwater ecosystems – and the trout populations and fishing industries they support – would quickly collapse.

Aquatic insects, along with other macroinvertebrates, are also important because of their widespread use as indicators of water quality and ecosystem health (Barbour et al. 1999). This is possible because each species has a different sensitivity to environmental disturbances, and conditions must be conducive across each species' lifetime - usually one year - if it is to survive at any location. The abundance and composition of aquatic insects and other macroinvertebrates at a single point in time and space therefore represents the integration of annual conditions at that location. Because monitoring aquatic macroinvertebrates is relatively fast and inexpensive, it is frequently preferred over monitoring the physical environment itself, which must be done many times throughout the year and include a wide array of conditions (e.g., temperature, sediment, pollutants, etc.).

Despite their ecological, economic, and practical importance, aquatic insects – including sensitive species of stoneflies, mayflies, and caddisflies – have declined across the US, with recent examples highlighted by both scientists and anglers (e.g., DeWalt et al. 2005; Sánchez-Bayo et al. 2019; Stepanian et al. 2020, Sautner 2023; Bonavist 2023). Indeed, since the early 1990's, the abundance of aquatic insects in streams and rivers has declined by a staggering 23% nationwide (Rumschlag et al. 2023). Aquatic insect biodiversity is also decreasing, especially among mayflies and stoneflies, which tend to be the most sensitive to environmental disturbances (e.g., DeWalt et al. 2005; Giersch et al. 2017; Stepanian et al. 2020; Rumschalg et al. 2023; Birrell et al. 2024). At a global level, such declines are often attributed to a wide array of factors, including dewatering, warming temperatures, organic pollution, pesticides, and others (Sánchez-Bayo et al. 2019; Didham et al. 2020; Wagner et al. 2021).

Local solutions are difficult to implement, however, because little is known about the extent and causes of insect declines in specific rivers and streams. Indeed, aquatic insects are rarely included in federal and state conservation plans because of a lack of information about specific regional threats and vulnerabilities (e.g., Montana FWP 2015; USDA 2011). This knowledge gap hinders effective management of wild fisheries and the biodiversity, economies, and fishing opportunities that aquatic insects support. Generating new information to solve the insect conservation challenge – both at local and national levels – will thus require implementing widespread, systematic monitoring programs to track the status, trends, and causes of insect declines and identify conservation strategies. Only afterwards can strategic and targeted solutions finally be implemented to conserve fisheries.

The Big Wood River

Implementing monitoring programs on economically and ecologically important fisheries should be most heavily prioritized, especially those with little data on local insect populations, such as the Big Wood River, Idaho. The Big Wood River is well-known for its wild scenery, abundant trout, and diverse insect hatches, which draw anglers from around the world. Anglers on the Big Wood, however, have also reported changes in the strength and timing of insect hatches, along with reduced flows, increased sediment, and warmer water temperatures, which they suspect contribute to their observed reduction in insect abundance and biodiversity (Bauman 2024, personal communication). Often, locals attribute problems to the rapid increase in population growth and human development around the Big Wood River valley, along with climate change and impacts from agriculture (Bauman 2024, personal communication). Indeed, the Wood River Basin has several stream reaches listed as impaired by the Idaho Department of Environmental Quality (IDEQ) for surpassing threshold limits related to river flows, temperature, sediment, and nutrient levels (see *State impairments*, below). Unfortunately, however, historic scientific data on the Big Wood River's aquatic insects are sparse, and there have been few systematic insect monitoring programs to validate claims or determine where, why, and the degree to which insect populations may be shifting throughout the Basin. One good exception is the macroinvertebrate monitoring program recently initiated by the Wood River Last Trust (WRLT), which began annually monitoring at six sites in 2022 (Marshall 2025). Our monitoring program is intended to be synergistic with WRLT, as sampling occurs at a different time of year, at several different sites, and includes surveying of various habitat factors relevant to ecosystem health.

Initiating Additional Monitoring

To help improve the conservation of aquatic insects and water/habitat quality in the Wood River Basin, we initiated an annual macroinvertebrate and habitat monitoring program across four mainstem and six tributary sites. The primary goals of the monitoring project are: i) establishing more extensive baseline data on macroinvertebrate communities and habitat conditions throughout the Wood River Basin, ii) tracking spatial and temporal trends in both insect health and habitat quality, iii) detecting likely causes of insect trends, iv) identifying whether stream conditions meet state and federal water quality standards, and v), ultimately, inform and guide local conservation decisions to preserve the Wood River Basin.

Below, we report results for the first year of macroinvertebrate sampling, performed in September, 2024, and discuss potential ways to improve the program in future years. Data outputs here, and in future years, will be distributed to local managers and stakeholders to help identify the status and trends of aquatic insects and threats that should be mitigated. Ultimately, these efforts will facilitate more compressive conservation efforts throughout the Wood River Basin.

METHODS

State Impairments

Within the Wood River Basin, most state and federally acknowledged impairments tend to be associated with the arid hills surrounding the central Wood River Valley (near Hailey and Bellevue, ID) or in lower rangelands and agricultural valleys. According to IDEQ, the most significant impacts on the Wood River Basin include suburban development in the Central Valley and irrigation, sedimentation, and nutrient pollution associated with agriculture in the lower watershed (IDEQ 2017). Together, these impacts, combined with recent poor water years in an already arid system, have shifted portions of the Basin from a steady state (unimpaired) to impaired, according to IDEQ's threshold metrics. In fact, it is now common to see several tributaries, and even the mainstem of the Big Wood River (between bridge at W. Glendale Rd and Stanton Crossing) run dry in late summer.

As a part of the State's efforts to monitor reductions in water quality, stream reaches that exceed State published thresholds for any water quality parameter (e.g., macroinvertebrate-based metrics, nutrients, temperature, flow, etc.) are included in the IDEQ's State 303(d) impairment list. For listed reaches, Total Maximum Daily Loads (TMDLs) are derived to describe the maximum pollutant load that listed reaches can tolerate so that appropriate actions can be taken to later achieve water quality standards.

The first management plan describing impaired reaches with Total Maximum Daily Loads (TMDLs) in the Wood River Basin was written in 2002, with updates published in 2011, 2013, and 2017. Separate plans regarding agricultural impacts have also been provided in 2006, 2014, and 2020 (2025a and 2025b). TMDLS are currently associated with three of the four rivers monitored in this study (see *Monitoring Sites,* below), including the Big Wood River from Seaman's Creek (near Hailey, ID) to Magic Reservoir and the headwaters of Warms Springs and East Fork Creeks (Table 1) (IDEQ 2017). Specific impairments include excessive total phosphorous (Big Wood, Warm Springs, East Fork) and high sedimentation, low flow, and high *E. coli* levels (Big Wood, only). Other tributaries within the Basin also have associated TMDLs, but these are not summarized because they are outside the scope of the present monitoring program.

Table 1. Table describing current TMDLs on the Big Wood River and its tributaries in which macroinvertebrate and habitat monitoring occurred in 2024.

River	TMDLs	Associated sites	Location description
Big Wood River	Total Phosphorous Sedimentation Flow E. coli	Stanton	Seaman's Creek to Magic Reservoir. Includes 2024 sampling site at Stanton. Bullion sampling site is above the TMDL by ~0.75 mi.
Warm Springs Crk	Total Phosphorous	None	Source to and including Thompson Creek. Upper and Lower sites well-below TMDL by ~ 11 mi
Trail Crk	None	NA	NA - No TMDLs associated with Trail Creek.
East Fork Crk	Total Phosphorous	None	Source to Hydman Creek. Upper site below TMDL by ~ 0.5 mi.

Monitoring Sites
We collected aquatic macroinvertebrates and measured fine sediment and embeddedness levels at four sites on the Big Wood River, Idaho between Easley Springs and Stanton Crossing and two sites each on three of the Big Wood River's major tributaries – Warm Springs, Trail Creek, and East Fork Creek (10 sites, total) (Fig. 1).

To align with standards of the Idaho Department of Environmental Quality (IDEQ), sampling was conducted during summer base-flow conditions on September 9-18th, 2024 and targeted riffled reaches with cobble-dominated substrate (IDEQ 2011). Specific sites were strategically selected to capture a range of disturbance levels throughout the watershed. Sites higher up in the watershed (e.g., Easley and the upper tributary sites) were assumed to be less disturbed because they are above sources of major human development. Samples were not taken below Magic Reservoir in year-one of sampling but may be prioritized in future years.

Macroinvertebrate and Habitat Sampling
All macroinvertebrate samples were made with a 1 ft^2 (0.093 m^2) Hess sampler (WildCo) with 500 micron mesh, the same equipment used in surveys conducted by IDEQ, throughout the State (IDEQ 2011). At each site, one sample was taken along each of three evenly spaced transects of a 30m section of riffle (three samples per site). Replicate samples were not composited (i.e., pooled into a single sample), as performed by IDEQ, to increase statistical power for analyzing insect trends – a primary goal of the monitoring program. At each transect, a sampling location

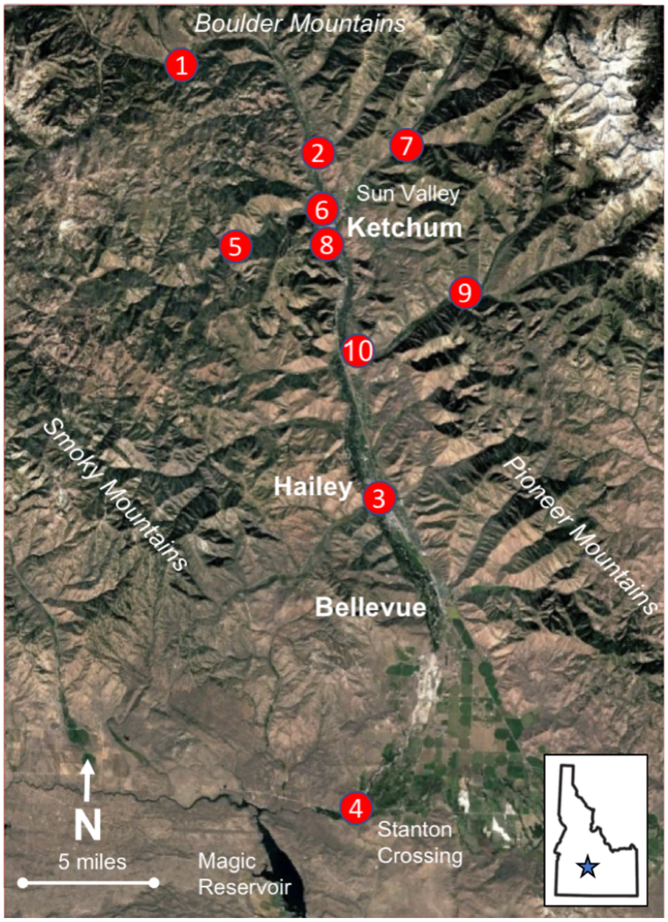

Fig. 1: Map of insect and habitat monitoring sites. GPS locations of monitoring sites are as follows: Site 1 – Easley Springs: 43.77902, -114.53567; Site 2 – Hulen: 43.71793, -114.37885; Site 3 – Bullion: 43.51655, -114.32126; Site 4 – Stanton Crossing: 43.33050, -114.31747; Site 5 – Upper Warm Springs 43.66780, -114.44011; Site 6 – Lower Warm Springs: 43.68720, -114.38077; Site 7 – Upper Trail Creek: 43.73088, -114.30994; Site 8 – Lower Trail Creek: 43.66878, -114.36346; Site 9: Upper East Fork: 43.64263, -114.25282; Lower East Fork: 43.60401, -114.34317.

was chosen by walking a randomly chosen number of paces from shore and driving the Hess sampler into a representative cluster of cobbles until a seal was made between the sampler and stream substate. If no seal could be made, a sample was taken in a nearby location.

Macroinvertebrates were then collected by disturbing the substrate contained within the Hess sampler, thereby washing all individuals into the attached net. This was achieved by first removing the larger substrate (> 10 cm) from the streambed and scrubbing it with a brush. The smaller substrate was then vigorously agitated with a metal gardening claw to a depth of ~7cm for one minute or until all fine sediment had been washed away. Once the substrate was completely disturbed, the contents of the net were brought to shore and washed into a 5-gallon bucket. Organic material was separated from substrate within each sample by repeatedly rinsing the bucket with clean stream water and pouring the buoyant contents (i.e., macroinvertebrates) through a 500 micro sieve. Sample contents were then washed from the sieve into labeled, 1-L polyurethane bottles and stored in 99% isopropyl ethanol. Rocks left in the bucket were inspected to ensure no macroinvertebrates were missed.

Substrate Surveys

Substrate surveys were performed at each site, following macroinvertebrate surveys. Fine sediment levels were measured with a sampling frame method similar to that of Bunte & Abt (2001). Measurements were made by throwing a 0.5m diameter steel hoop in twelve random locations throughout the riffle and observing the presence of fine sediment (dominant particle < 0.2mm in diameter; sand, silt, or clay) directly below 36 sampling points along two steel bars (i.e., 19 tick marks spaced at even intervals, per bar) welded along the vertical and horizontal axes of the hoop (Kowalski & Richer 2019). Observations were made visually with an underwater viewer (Fieldmaster, Aquaview Underwater Viewer) and by feel. The number of fine-sediment-dominated points were expressed as the percentage of the sampling area containing fine sediment (i.e., number of fine sediment observations / 36 total sampling points). Following the methods of Platts et al. (1982), the embeddedness of substrate by fine sediment was also visually estimated from within the steel hoop each time it was thrown and expressed on an ordinal scale (1: 0-5% embedded, 2: 5-25 embedded, 3: 25-50% embedded, 4: 50-75% embedded, and 5: 75-100% embedded). Following the methods of Wolman (1954), a Wolman pebble count was also performed by randomly measuring the intermediate axes of 100 randomly selected rocks spread throughout the 30 m study length of the riffle. Fine sediment measurements and embeddedness estimates were averaged, and the median intermediate axis of the substrate was calculated from the Wolman pebble measurements for each site, and these values will be used in future analyses.

Other Habitat Sampling

Temperature loggers (HOBO, Pendant) were deployed in September, 2024 at eight sites (Sites 1-7, & 9) and are currently monitoring temperatures at 15-minute intervals. Temperature data will be summarized and incorporated into analyses once at least one year of data has been collected. *Project Big Wood* also began taking monthly water quality gab samples in July, 2024, using the methodologies and lab services provided by *Science on the Fly* to measure levels of total nitrogen, phosphate, and ammonia at all sites. Temperature, nutrient, and sediment data, along with flows measured at USGS gauges across the watershed, will be summarized and incorporated into analyses once at least one year of data has been collected for all habitat factors.

All field efforts were aided by volunteers, including the staff of *Project Big Wood*. All volunteers were carefully trained prior to field work, and their actions were closely overseen by the authors in the field.

Macroinvertebrate Sorting, Taxonomy, and Metric Calculation
In the lab, macroinvertebrates from each sample were subsampled, with each subsample containing at least 500 individuals (IDEQ 2011). The number of each target species were enumerated per sample by dividing by the subsampling proportion (often 0.25), and density was calculated per 1 ft^2. Commonly used macroinvertebrate-based water quality metrics were then calculated for each sample, following instructions of IDEQ (2011) (e.g., Hilsenhoff Biotic Index [HBI], taxa richness, Shannon diversity, EPT richness, % Ephemeroptera-Plecoptera-Trichoptera [EPT], % midges, and % non-insects), along with multi-metric indices developed by IDEQ (2011) and McGuire (1993) (see Table 2, below for descriptions of metrics and multi-metric indices). These metrics, along with densities the entire macroinvertebrate community were used as response variables in the analyses described below. All macroinvertebrate sorting and taxonomy were performed by a state and federally accredited taxonomy lab, *Montana Biological Survey*.

Statistical Analysis
Summarization and analyses for the effects of environmental covariates on macroinvertebrate densities and metrics were performed in R (R Core Team, 2023). Differences in metrics and index values between different groupings of sites (i.e., mainstem versus tributaries) were analyzed using either t-tests or linear mixed effects models (R package: lme4; function: lme). For mixed effects models, site location was included as a random effect because multiple macroinvertebrate samples were taken at each site.

INTERPRETING METRICS AND MULTI-METRIC INDICES

Notes for Interpreting Results
Environmental degradation is generally a function of a wide array of environmental stressors exerting pressure on biotic communities. In addition, because organisms – from individual species to broad species groups (e.g., Orders) – have different sensitivities to combinations of stressors, biotic communities often respond to stress in complex ways. Despite this complexity, a wide array of metrics have been developed over the past several decades to assess water quality and ecosystem integrity from macroinvertebrate community data (Barbour et al. 1999). Interpretations of metrics rely on the fact that some species (or species groups) tend to be more sensitive to environmental degradation than others and that healthy communities generally support higher species diversity (e.g., number of species). For instance, mayflies, stoneflies, and caddisflies (i.e., Ephemeroptera, Plecoptera, and Trichoptera; EPT) tend to be sensitive, while true flies and non-insects tend to be tolerant. Thus, ecosystems represented by many species, and especially by many species of generally sensitive taxa, are generally considered to be healthier. In reality, however, variation in sensitivity also exists within each major macroinvertebrate group (including within EPT), and it is possible to find unhealthy streams that are nonetheless dominated by EPT (typically mayflies and/or caddisflies), but by only a few tolerant species.

Because of this complexity, it is essential to use a broad range of metrics to interpret macroinvertebrate data. In Table 2, we describe some of the most common macroinvertebrate-based metrics used to infer water quality and ecosystem health. For each metric, we also describe the expected response of each to anthropogenic disturbance, along with subjective thresholds denoting impairment, based on the authors' experience. We also describe two multi-metric indices, which incorporate several metrics into a single biointegrity value, including the primary index used by IDEQ to infer general water quality impairments in streams throughout Idaho (Idaho Mountain Stream Benthic Macroinvertebrate Multi-Metric Index). The Maguire (1993) index was also used, which was developed detect general water quality impairments, along with nutrient and heavy metal pollution, in the Clark Fork River of western Montana. Although our methods broadly aligned with IDEQ methods, they differed in that replicate samples at each site were not composited; they were also processed by a different laboratory and did not follow the same quality control procedures. This means that all interpretations of the IDEQ index values should be treated as preliminary – they do not represent nor are they comparable to actual IDEQ data. In the Results and Discussion, below, these metrics and indices are used to interpret our 2024 macroinvertebrate community data, infer which areas are most heavily disturbed, and recommend changes or additions to monitoring practices in future years.

Table 2: Table defining macroinvertebrate-based metrics and multi-metric indices used to assess water quality and ecosystem health, along with expected responses to disturbance, impairment thresholds, and metric definitions. *Subjective impairment thresholds for metrics are based on the authors' experience and do not represent legal thresholds in Idaho. **Established impairment thresholds for multi-metric indices indicate severe impairment in Idaho (IDEQ index) and on the Clark Ford River in Montana (McGuire index). Interpretation of Maguire index: < 50%: severe, 50-70%: moderate; 70-90%: slight; 90-100%: no impariment. Interpretation of IDEQ index: < 52%: severe; 52-70%: moderate; 70-100%: little to no impairment. Comparisons of our data with IDEQ thresholds should be treated as preliminary, as we did not follow all IDEQ protocols (see *Macroinvertebrate and Habitat Sampling* and *Notes for Interpreting Results,* above).

Metric	Expected response to disturbance	Subjective threshold*	Metric description
Hilsenhoff Biotic Index (HBI)	Increase	> 4	Index of organic pollution based on abundances of taxa with differing tolerances of organic pollution
Taxa Richness	Decrease	< 34	Total number of taxa (i.e., "species")
Shannon Diversity	Decrease	< 3	Quantification of diversity, which accounts for both both taxonimic richness and relative abundance
EPT Richness	Decrease	< 15	Number of mayfly, stonefly, and caddisfly taxa ("species") (i.e., Ephemeroptera, Plecoptera, Trichoptera; EPT)
% EPT	Decrease	< 40%	% of individuals represented by mayflies, stoneflies, and caddisflies (i.e., Ephemeroptera, Plecoptera, Trichoptera; EPT)
% Midges	Increase	> 45%	% of individuals represented by midges (i.e., Chironomidae)
% Non-insects	Increase	> 15%	% of individuals represented by non-insects (e.g., snails, skuds, worms)
Multi-metric index	**Expected response to disturbance**	**Established threshold****	**Multi-metric description**
IDEQ – Mountain Stream Index	Decrease	< 52%	A multi-metric index produced by IDEQ ranging from 0-100%, based on several metrics, including taxa richness, HBI, and others.
McGuire (1993) - General Index	Decrase	< 50%	A multi-metric index produced by McGuire (1993) for western Montana ranging from 0-100%, based on several metrics, including taxa richness, Shannon diveristy, and others.

RESULTS & DISCUSSION

Below, we report on findings from 2024 macroinvertebrate sampling. We summarize the status of macroinvertebrate populations and community composition at the Basin level and describe differences between the mainstem and the tributaries. We also rank the water quality and ecosystem health at each site, using a variety of macroinvertebrate-based metrics and multi-metric indices, and assess whether any sites may merit new impairment listings based on our data. We then discuss the results within the context of historical data regarding known areas of degradation and make recommendations for improving monitoring efforts in future monitoring years. The results and interpretations provided below are not meant to be exhaustive. Instead, they provide a broad level of discussion meant to guide the next several years of monitoring within the Basin. More exhaustive analyses will be performed, once multiple years of macroinvertebrate and habitat data are accumulated.

Macroinvertebrate Densities and Community Composition

Basin-wide Patterns

In 2024, we collected and identified 237 unique taxa (i.e., usually species or genera) of macroinvertebrates. These include 45 mayflies, 23 stoneflies, 42 caddisflies, 17 beetles, 74 true flies (including 53 midge species), 27 non-insects, along with 2 moth, 3 true bug and 4 dragonfly or damselfly species.

Throughout the Basin, the majority of taxa had relatively low densities or were encountered infrequently. Others, however, tended to be very abundant at the majority of sites. These often included species that produce well-known hatches targeted by anglers (e.g., Blue-Winged Olives, Western March Browns, and Spotted Sedges), though some are more discrete or do not hatch from the water at all (e.g., riffle beetles) (Table 3). Species indicating poor water quality (HBI score > 4.5) or that do not produce hatches (e.g., non-insects) were quite rare. Indeed, average Basin-wide HBI scores equaled 3.1, indicative of excellent water quality and little evidence of organic pollution, with non-insects representing < 2% of all individuals. Mayflies, stoneflies, and caddisflies on the other hand represented 62.9% of all individuals. This is moderately high for western trout streams, and higher than those recently reported on the Henry's Fork River, ID (mean ~ 50% across all sites and years) (Van Kirk 2025). Sites with few mayflies, stoneflies, and caddisflies, however, (i.e., Upper and Lower Trail Creek) did exist, but these were the minority, being dominated instead by tolerant species, like midges.

Average macroinvertebrate densities also were within apparently normal, healthy levels, with sites supporting an average of 1697.1 macroinvertebrate individuals per ft^2 across the Basin. These values are comparable to other well-known trout streams in the Rockies. For example, in 2024, the Madison River, MT supported an average of 1085.1 indi./ft^2 at five sites along the Upper and Lower River, while the Henry's Fork River, ID supported about 3,000 indi./ft^2 across five sites from Flat Rock to Saint Anthony's (Birrell & Frakes unpublished data; Van Kirk 2025). This suggests that – while the total biomass and, the apparent strength of hatches may not be equivalent to the Madison or Henry's Fork – the production per unit area is similar.

Table 3: Table of densities (individuals per ft^2) of the top-five most abundant taxa at each sampling site.

Rank abundance	Site Name	Taxon	Common Name	Order	Density (indi/ft2)
1	Easley	Simulium sp.	Black Fly	True Fly	1452
2	Easley	Rhithrogena sp.	Western March Brown sp.	Mayfly	772
3	Easley	Caudatella heterocaudata	Caudatella Mayfly	Mayfly	545
4	Easley	Arctopsyche grandis	Great Gray Spotted Sedge	Caddisfly	363
5	Easley	Baetis tricaudatus	Blue-Winged Olive	Mayfly	157
1	Hulen	Baetis tricaudatus	Blue-Winged Olive	Mayfly	679
2	Hulen	Arctopsyche grandis	Great Gray Spotted Sedge	Caddisfly	636
3	Hulen	Glossosoma sp.	Little Brown Short-Horned Sedge	Caddisfly	391
4	Hulen	Rhyacophila coloradensis gp.	Green Sedge	Caddisfly	256
5	Hulen	Ephemerella excrucians	Pale Morning Dun	Mayfly	210
1	Boullian	Lepidostoma sp.	Lepidostoma sp.	Caddisfly	1736
2	Boullian	Hydropsyche oslari	Hydropsyche oslari	Caddisfly	844
3	Boullian	Optioservus quadrimaculatus	Riffle Beetle	Beetle	640
4	Boullian	Hydropsyche morosa gr.	Spotted Sedge	Caddisfly	440
5	Boullian	Baetis tricaudatus	Blue-Winged Olive	Mayfly	412
1	Stanton	Hydropsyche oslari	Spotted Sedge	Caddisfly	4256
2	Stanton	Micropsectra sp.	Midge	True Fly	312
3	Stanton	Paraleptophlebia sp.	Mahogany Dun	Mayfly	276
4	Stanton	Hydropsyche occidentalis	Spotted Sedge	Caddisfly	236
5	Stanton	Hydropsyche morosa gr.	Spotted Sedge	Caddisfly	228
1	Upper Warm	Lepidostoma sp.	Little Brown Sedge	Caddisfly	2238
2	Upper Warm	Optioservus quadrimaculatus	Riffle Beetle	Beetle	404
3	Upper Warm	Paraleptophlebia sp.	Mahogany Dun	Mayfly	342
4	Upper Warm	Hydropsyche slossonae	Spotted Sedge	Caddisfly	220
5	Upper Warm	Baetis tricaudatus	Blue-Winged Olive	Mayfly	214
1	Lower Warm	Lepidostoma sp.	Little Brown Sedge	Caddisfly	1304
2	Lower Warm	Hydropsyche oslari	Spotted Sedge	Caddisfly	1128
3	Lower Warm	Baetis tricaudatus	Blue-Winged Olive	Mayfly	1064
4	Lower Warm	Optioservus quadrimaculatus	Riffle Beetle	Beetle	880
5	Lower Warm	Eukiefferiella sp.	Midge	True Fly	384
1	Upper Trail	Rhithrogena sp.	Western March Brown sp.	Mayfly	804
2	Upper Trail	Simulium sp.	Black Fly	True Fly	670
3	Upper Trail	Glossosoma sp.	Little Brown Short-Horned Sedge	Caddisfly	322
4	Upper Trail	Epeorus albertae	Pink Albert	Mayfly	120
5	Upper Trail	Arctopsyche grandis	Great Gray Spotted Sedge	Caddisfly	119
1	Lower Trail	Simulium sp.	Black Fly	True Fly	2016
2	Lower Trail	Optioservus quadrimaculatus	Riffle Beetle	Beetle	364
3	Lower Trail	Micropsectra sp.	Midge	True Fly	272
4	Lower Trail	Pagastia sp.	Midge	True Fly	268
5	Lower Trail	Parakiefferiella	Midge	True Fly	196
1	Upper East Fork	Rhithrogena sp.	Western March Brown sp.	Mayfly	190
2	Upper East Fork	Caudatella heterocaudata	Caudatella Mayfly	Mayfly	184
3	Upper East Fork	Heterlimnius corpulentus	Riffle Beetle	Beetle	158
4	Upper East Fork	Optioservus quadrimaculatus	Riffle Beetle	Beetle	154
5	Upper East Fork	Ephemerella excrucians	Pale Morning Dun	Mayfly	144
1	Lower East Fork	Optioservus quadrimaculatus	Riffle Beetle	Beetle	278
2	Lower East Fork	Pericoma sp.	Moth Fly	Moth	198
3	Lower East Fork	Rhithrogena sp.	Western March Brown sp.	Mayfly	191
4	Lower East Fork	Baetis tricaudatus	Blue-Winged Olive	Mayfly	164
5	Lower East Fork	Sweltsa sp.	Sallfly	Stonefly	164

Overall, these results should reassure resource users that – while macroinvertebrate communities may have shifted in recent decades due to environmental disturbances – they are still largely dominated by sensitive and abundant insects that produce fishable hatches, providing a strong foundation for future conservation programs. Unfortunately, quantifying trends of aquatic insects, either in terms of community composition or density, is currently impossible due to a lack of historical timeseries monitoring data. Documenting insect declines, their causes, and potential conservation solutions will thus require relying on continued macroinvertebrate and habitat monitoring into the future (see *Changes Over Time,* below).

Mainstem and Tributaries Patterns

There are several clear differences between the macroinvertebrate communities in the mainstem of the Big Wood River and its tributaries. On average, the mainstem supported higher densities of macroinvertebrates (mean = 1964.3 indi./ft^2) than the tributaries 1429.9 indi./ft^2) (P = 0.071), a common occurrence for trout streams in other basins as well. Higher densities of insects in the mainstem likely reflects a variety of factors, including warmer water temperatures and higher nutrient levels, which increase primary production (i.e., algal and plant growth) and, ultimately, numbers of macroinvertebrates. This hypothesis is supported by a significant (P = 0.008) positive correlation between BMI (an index of nutrient pollution) and macroinvertebrate density across all sites. Indeed, *some* nutrient inputs are important for sustaining abundant aquatic life, and frequently low BMI scores in the mainstem and tributaries (mean = 3.11 and 3.21, respectively) suggests that nutrient loading has not risen to harmful levels at most sites. If this had occurred, we would likely see higher densities of macroinvertebrates and communities dominated by more pollution-tolerant taxa (i.e., higher HBI scores). Future analyses will incorporate data on nutrient levels directly, which will strengthen inferences.

In addition, the mainstem of the Big Wood supported a macroinvertebrate communities than those of the tributaries. Samples from the mainstem, for instance, were represented by a larger proportion (mean = 72.3) and more species (mean = 21.7) of mayflies, stoneflies, and caddisflies than the tributaries (mean = 53.4% and 19.1, respectively) (P = 0.005 and P = 0.062, respectively), along with lower proportions of beetles (P = 0.002) and non-midge true flies, such as blackflies (P = 0.085). These differences may reflect poorer water quality in the tributaries, especially at the lower sites nearer to urban development. However, no statistically significant differences existed for total taxa richness, EPT richness, or HBI between the mainstem and the tributaries, suggesting that despite differences in community composition and higher abundance of some sensitive groups, average water quality may be similar (see *Water Quality and Ecosystem Integrity*, below). Differences in macroinvertebrate communities between the mainstream and the tributaries are likely caused by a variety of subtle factors, which may be identified in the future, once habitat monitoring data is incorporated into the analyses.

Site Patterns

An extensive description of differences in macroinvertebrate densities and community composition among sites is beyond the scope of this report, though we do display the data for the primary metric for each site in Fig. 2 and Fig. 3. More detail will be provided in future years, once additional macroinvertebrate and habitat data is accumulated.

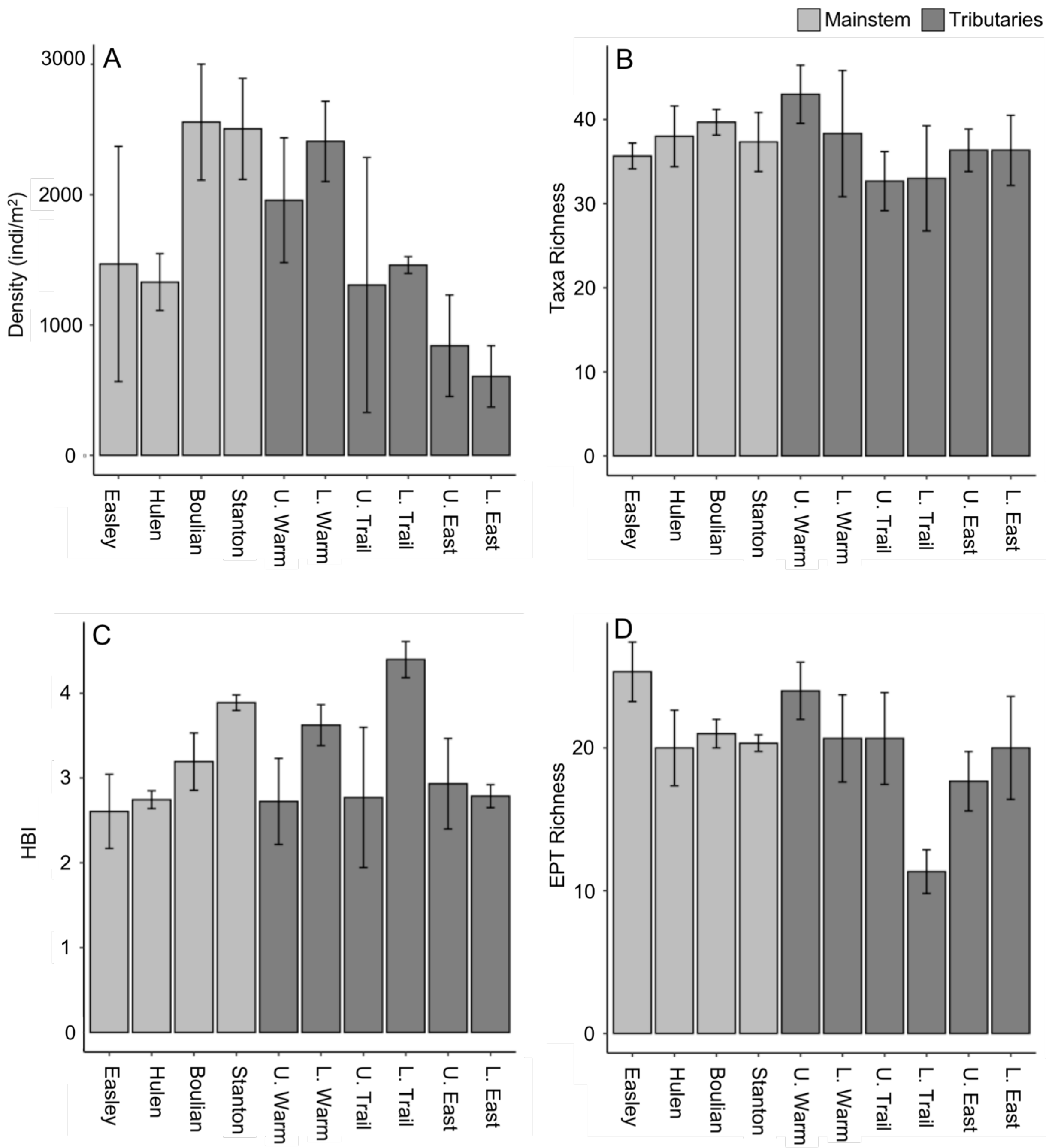

Fig 2: Barplots of primary metrics, including macroinvertebrate density (A), taxa richness (B), HBI (C), and EPT Richness (D), with error bars (mean +/- standard deviation), for each site.

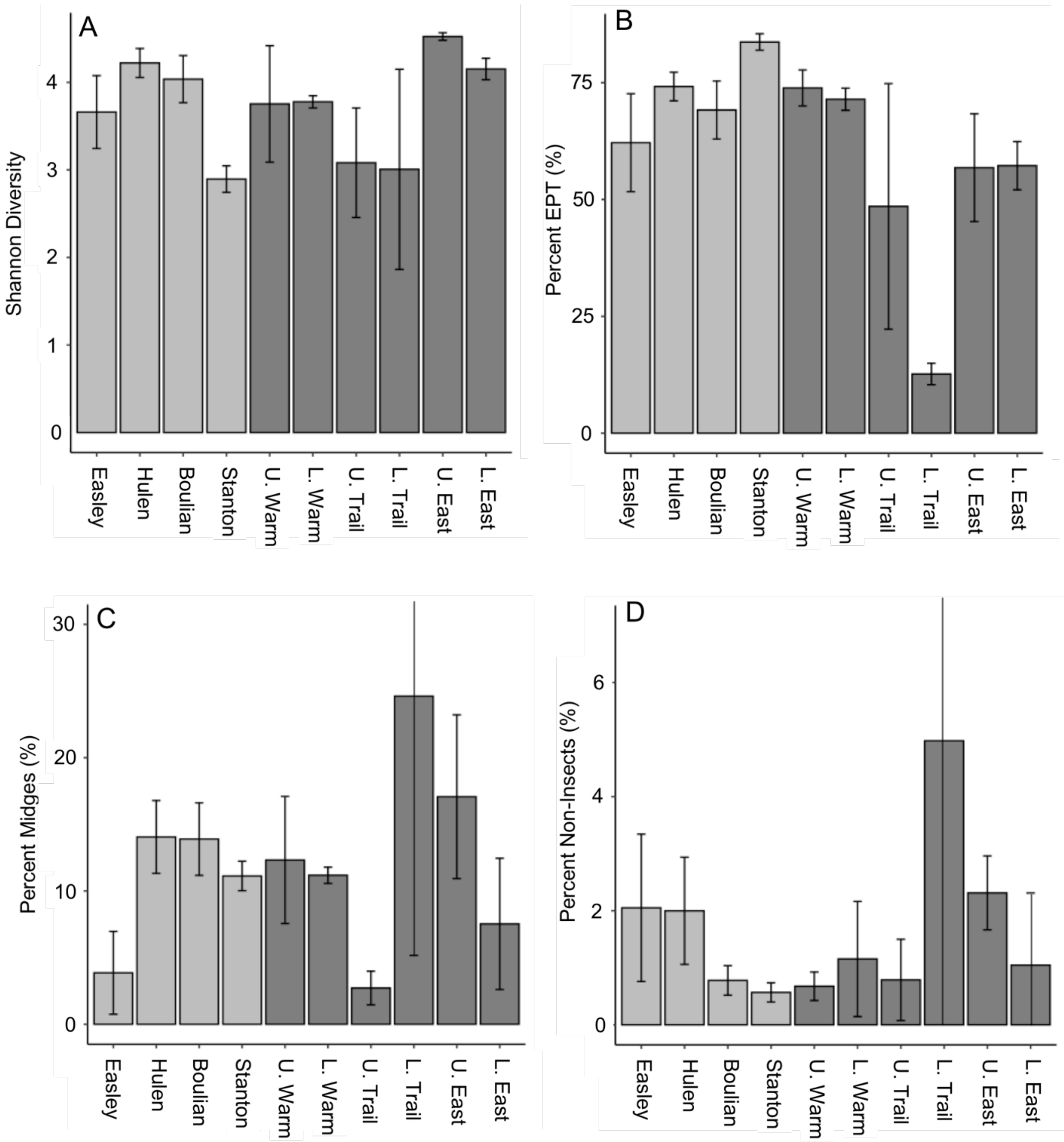

Fig 3: Barplots of primary metrics, including Shannon diversity (A), percent EPT (B), percent midges (C), and percent non-insects (D), with error bars (mean +/- standard deviation), for each site.

Water Quality and Ecosystem Integrity

Site Patterns

As discussed above, metrics derived from macroinvertebrate data denote that the Wood River Basin – as a whole and at the tributary and mainstem scales – has relatively abundant and diverse aquatic insect communities that, on average, indicate high water quality and ecosystem integrity. However, significant variation did appear to exist among individual sites, with some supporting vastly more true flies and other taxa that indicate lower ecosystem health (Table 3). Indeed, one of the primary goals of this report is to identify sites that may merit special conservation attention or State impairment listings. To do so, comparisons of macroinvertebrate communities from different sites must be as systematic as possible, and, ideally, response variables should be compared to well-known thresholds that denote different levels of impairment. Below, we compare macroinvertebrate metrics and multi-metric index scores from each site with a variety of thresholds derived by the authors, IDEQ, and McGuire (1993) to identify potentially impaired reaches. We also rank sites with the best to worst water quality to evaluate where conservation efforts may be best invested going forward.

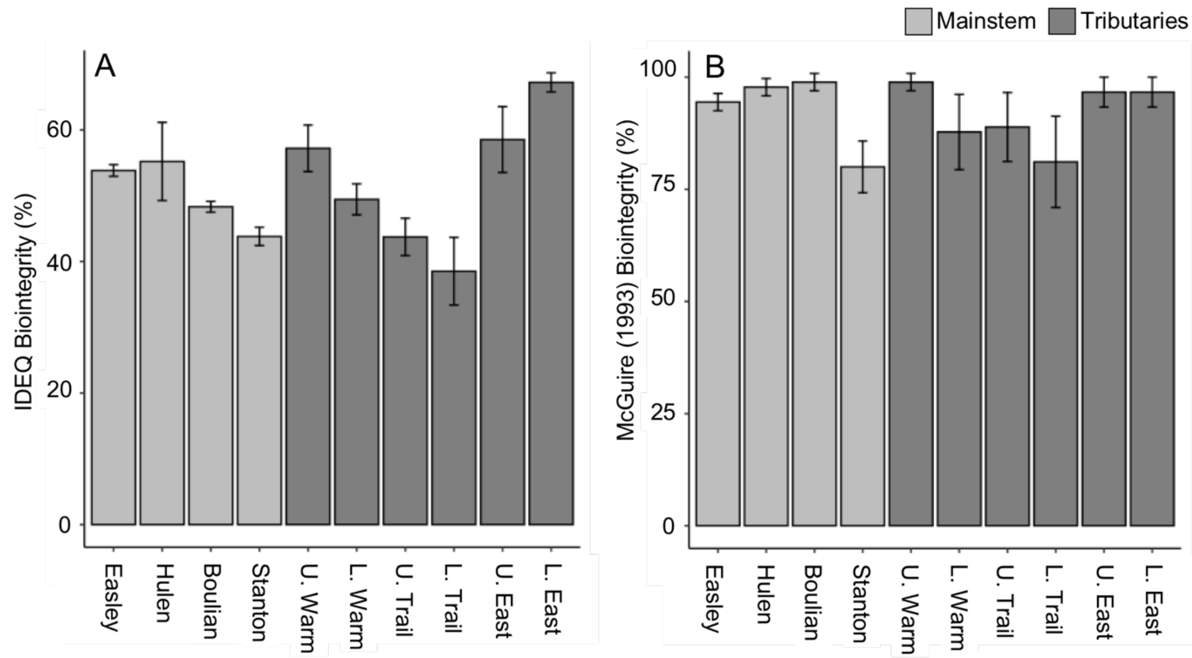

Fig. 4: Barplots of percent biointegrity derived from IDEQ (A) and McGuire (1993) (B), with error bars (mean +/- standard deviation), for each site. Interpretation of Maguire index: < 50%: severe impairment, 50-70%: moderate impairment; 70-90%: slight impairment; 90-100%: no impairment. Interpretation of IDEQ index: < 52%: severe impairment; 52-70%: moderate impairment; 70-100%: little to no impairment. Note: Comparisons of our data with IDEQ thresholds should be treated as preliminary, as we did not follow all IDEQ protocols (see *Notes for Interpreting Results,* above).

Comparisons of the seven primary metrics considered in this report with water quality impairment thresholds derived by the author (Table 2) raise considerable concern regarding at least one metric at three sites: Stanton Crossing (low Shannon diversity), Upper Trail Creek (low taxa richness), and Lower Trail Creek (low Shannon diversity, taxa richness, EPT richness and % EPT). Conclusions that these sites are the most disturbed in the Basin are further strengthened by referencing values from multi-metric indices from IDEQ and McGuire (1993), which generally show decreasing biointegrity from upstream to downstream in each river (Fig. 4). Values from both indices show that Upper Trail Creek, Stanton Crossing, and Lower Trail Creek had the lowest ecosystem integrity among all 10 surveyed sites (Table 4). This suggests that future restoration and remediation would likely be most impactful at these sites.

Low biointegrity at Stanton Crossing is perhaps not surprising, as this site lies below a great deal of human development, accumulating impacts from sedimentation, nutrient pollution, dewatering, and warming associated with upstream human practices. Indeed, this site is already associated with an official 303(d) impairment listing from IDEQ (Table 1). However, the poor condition of Upper and Lower Trail Creek is more surprising, as no State impairments are currently listed on this stream. In addition, visual assessments of site quality were similar for these sites compared to other tributaries, and Upper Trail Creek is located above most sources of major human development. We suspect that Trail Creek is possibly being stressed from indirect effects of anthropogenic disturbances, including low flows, warm temperatures, and drought associated with climate change in the headwaters. Indeed, 303(d) impairment listings exist for several remote, headwater streams throughout the Basin (Table 1), and some currently run dry in mid-summer even though little to no water extraction occurs from surface water diversions (Bauman 2024, personal communication). Similar impacts could be associated with Upper Trail Creek. If this is true, we hypothesize that the already stressed condition of Trail Creek worsens as it nears areas of human development near Ketchum, ID, resulting in additional sedimentation, nutrient pollution, and other impacts that cause the low taxa richness, biodiversity, %EPT, and biointegrity values we measured. Including thorough measurements of habitat factors into future analyses will be key to testing this hypothesis and identifying specific impacts and solutions for future conservation projects on Trail Creek, along with Stanton Crossing.

Interpreting how poor conditions are at our monitoring sites, and whether they merit impairment listings, remains challenging, however, as actual biointegrity values (0-100%) were remarkably different between the two quantitative indices. The IDEQ index, for example, suggests that all sites within the Basin are moderately to severely impaired. Alternatively, the McGuire (1993) index suggests that disturbance ranges from no impairment to slight impairment. Differences in biointegrity between indices are likely due in part to the different applications for which each were designed. The IDEQ index, for example, was created to evaluate the ecosystem quality of (ideally pristine) small mountain streams in Idaho, whereas the McGuire (1993) index was derived to evaluate river-sites near or recovering from acute mining and agricultural disturbance in the Clark Fork River in Montana. Although the McGuire (1993) index is likely not the best fit for evaluating water quality among streams in the Wood River Basin, it was included in this study in an attempt to validate the results from the IDEQ index. This was successful in that the relative ranking of sites are consistent between each index, even if the final biointegrity value remained different. The McGuire (1993) index is also useful in that it employs subset indices to identify whether impairment is likely related to nutrient or heavy metal pollution. Index scores of these subsets show that Trail Creek and Stanton Crossing are again the most disturbed, with slight nutrient and heavy metal pollution at Lower Trail Creek and slight nutrient pollution, only, at Stanton Crossing (Table 5).

Table 4: Table of percent biointegrity of sites within the Wood River Basin, calculated via multi-metric indices from the IDEQ and McGuire (1993) used to integrate and assess multiple aspects of water quality. Biointegrities of sites were ranked relative to one another to determine those with the worst (rank = 10) to best (rank = 1) biointegrity in the Basin, based on each metric. Note: Comparisons of our data with IDEQ thresholds should be treated as preliminary, as we did not follow all IDEQ protocols (see *Notes for Interpreting Results,* above).

Site Name	Multi-Metric Index	Biointegrity (%)	Impairment Classification	Site Rank	MMI-averaged Rank
Upper Warm	IDEQ	57.21%	Moderate	3rd	2
	McGuire	98.89%	Non-impaired	1st	
Lower East Fork	IDEQ	67.22%	Moderate	1st	3
	McGuire	96.67%	Non-impaired	5th	
Hulen	IDEQ	55.20%	Moderate	4th	3.5
	McGuire	97.78%	Non-impaired	3rd	
Upper East Fork	IDEQ	58.53%	Moderate	2nd	3
	McGuire	96.67%	Non-impaired	4th	
Boullian	IDEQ	48.32%	Severe	7th	4.5
	McGuire	98.89%	Non-impaired	2nd	
Easley	IDEQ	53.83%	Moderate	5th	5.5
	McGuire	94.44%	Non-impaired	6th	
Lower Warm	IDEQ	49.44%	Severe	6th	7
	McGuire	87.78%	Slight	8th	
Upper Trail	IDEQ	43.73%	Severe	9th	8
	McGuire	88.89%	Slight	7th	
Stanton	IDEQ	43.81%	Severe	8th	9
	McGuire	80.00%	Slight	10th	
Lower Trail	IDEQ	38.51%	Severe	10th	9.5
	McGuire	81.11%	Slight	9th	

Biointegrity values derived from the IDEQ multi-metric index may also be somewhat unreliable, however, because the index is specific to samples collected using IDEQ protocols. Indeed, our field survey and laboratory methods, while designed to be similar to IDEQ, are not identical (see *Notes for Interpreting Results,* above). Current methods meet IDEQ Tier 2 standards for data comparability, meaning that data can be referenced in reports by IDEQ but cannot be used in lieu of IDEQ data to establish new impairments or TMDLs. This is likely justified, as subtle differences in macroinvertebrate sampling, subsampling, and taxonomy procedures can have significant effects on final results (e.g., Vinson & Hawkins 1996). Thus, we are confident about the relative ranking of the 10 sites surveyed in 2024, but acknowledge that using the present data to confidently identify reaches that merit state 303(d) impairment listing may not be prudent. However, it's also possible that the 2024 data may have *overestimated* biointegrity based on the IDEQ index, as the WRLT data shows that 2024 generally supported the most biodiverse and healthy macroinvertebrate communities since they started sampling in 2022 (Marshall 2025). We thus recommend altering methods slightly in 2025 to fully align with IDEQ Tier 1 methods, allowing us to generate IDEQ-approved impairment assessments at each site (IDEQ 2016). This would include an additional composite samples at each site and using IDEQ-approved quality control and quality assurance protocols.

Documenting Future Impairments

Poor ecosystem quality is expected to be reflected in the macroinvertebrate communities found within reaches with 303(d) listings and TMDLs. Indeed, macroinvertebrate-based water quality metrics and multi-metric indices were among the lowest at Stanton Crossing, which has TMDLs for total phosphorous, sedimentation, and flow. The lack of TMDLs on Trail Creek, however, should be noted, as both the Upper and Lower Trail Creek sites had among the lowest water quality, based on both multi-metric indices. We recommend that future sampling – of both macroinvertebrates and pertinent habitat parameters (e.g.,. sedimentation, temperature, etc.) – be performed on Upper and Lower Trail Creek in alignment with IDEQ Tier 1 methodology (IDEQ 2016), so any necessary 303(d) impairment listings and TMDLs can be established. Likewise, we also recommend additional sampling sites be established within the long TMDL reach between Bullion and Stanton to better document (expectedly poor) baseline macroinvertebrate community composition at this location and to track future trends in populations and water quality metrics. Additionally, we suggest adding a monitoring site below Magic Reservoir to establish the baseline macroinvertebrate community there.

Table 5: Table of percent biointegrity of sites within the Wood River Basin, calculated via multi-metric indices from McGuire (1993) used to assess organic and heavy metal pollution.

Site Name	Multi-Metric Index	Biointegrity (%)	Impariment Classification
Hulen	Organic Pollution	100.00%	Non-impaired
Lower East Fork	Organic Pollution	100.00%	Non-impaired
Upper East Fork	Organic Pollution	100.00%	Non-impaired
Easley	Organic Pollution	96.30%	Non-impaired
Upper Warm	Organic Pollution	96.30%	Non-impaired
Boullian	Organic Pollution	92.59%	Non-impaired
Lower Warm	Organic Pollution	92.59%	Non-impaired
Upper Trail	Organic Pollution	92.59%	Non-impaired
Lower Trail	Organic Pollution	79.63%	Slight
Stanton	Organic Pollution	70.37%	Slight
Easley	Heavy Metals	100.00%	Non-impaired
Upper Warm	Heavy Metals	100.00%	Non-impaired
Boullian	Heavy Metals	96.30%	Non-impaired
Lower Warm	Heavy Metals	96.30%	Non-impaired
Hulen	Heavy Metals	94.44%	Non-impaired
Stanton	Heavy Metals	94.44%	Non-impaired
Upper Trail	Heavy Metals	94.44%	Non-impaired
Lower East Fork	Heavy Metals	88.89%	Non-impaired
Upper East Fork	Heavy Metals	87.04%	Non-impaired
Lower Trail	Heavy Metals	77.78%	Slight

Changes Over Time

Community composition, macroinvertebrate densities, and water quality are expected to vary naturally over time. Indeed, recent monitoring data across six Wood River Basin sites from WRLT shows that 2024 produced the most abundant and generally healthy insect communities since the program began in 2022 (Marhsall 2025). Such results are likely a natural response to short-term shifts in annual weather and hydrological patterns. However, long-term declines in ecosystem quality, including the loss of sensitive species, are often caused by anthropogenic disturbances and are very possible, and perhaps likely, in the Wood River Basin. Indeed, anglers and other resource users have described altering hatch timing and declines of some stonefly, mayfly, and caddisfly species based on their own anecdotal records.

Long-term, annual monitoring data is, however, rare to nonexistent from the Wood River Basin, making some interpretations of our 2024 data difficult. Do values presented in this report reflect historical macroinvertebrate populations? Have declines of sensitive taxa occurred? How severe have declines been? Unfortunately, answering these questions is currently impossible. With the lack of abundant historical data, scientifically quantifying shifts will require continuing current monitoring programs. Combining future data with that of the WRLT will be particularly powerful and key to accurately tracking future trends and identifying threats and solutions. WRLT and PBW are currently communicating how to further align the goals and efforts of their respective programs to accurately survey macroinvertebrates in as many sites as possible each year.

CONCLUSIONS

The first season of the Project Big Wood monitoring program was an overwhelming success, and analysis of year-one data led to several important findings. First, we found that macroinvertebrate communities are generally abundant, diverse, and dominated by mayflies, stoneflies, and caddisflies, at the Basin level. This generally reflects high water quality and ecosystem integrity at most sites, though some variation in quality did exist between the mainstream and tributaries and at individual sites. This is good news and shows that although problems exist – including the possibility of declines of some insects groups – the watershed still supports abundant aquatic insects that produce fishable hatches. Second, despite healthy conditions, on average, our data suggests that Lower Trail Creek, Upper Trail Creek, Stanton Crossing are experiencing at least some degree of impairment. We recommend reaches associated with these sites be a focal point for future restoration and remediation projects. Identifying causes of impairments, and solutions, is a key priority for future monitoring years. This will require thoroughly monitoring habitat conditions, such as temperature, sedimentation, and nutrient pollution, and incorporating these into future analyses. Third, conditions at Lower Trail Creek appear particularly poor, and because Trail Creek is not currently listed as impaired by IDEQ, additional sampling using IDEQ Tier 1 protocols is recommended to determine if it should be considered for inclusion on the State 303(d) impairment list. We also recommend additional sampling sites between Bullion and Stanton Crossing to better document baseline macroinvertebrate community composition and to track future trends in populations and water quality metrics. Finally, the absence of long-term widespread macroinvertebrate data across the Basin limits our current ability to quantify historical trends in insect species or ecosystem integrity. Continuing contemporary monitoring programs is thus critical for tracking future changes, identifying emerging threats, and developing effective management strategies. We recommend continuing to collaborate with WRLT, along with IDEQ and other state and federal partners, to further synergize our collective conservation efforts.

DATA ACCESSIBILITY

For raw macroinvertebrate sampling data used in this report, see Appendix I, below. For other data inquires, including R-scripts used in analyses, contact The Salmonfly Project at conservation@salmonflyproject.org.

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