

FINAL

Yampa River Scorecard Project Upper Yampa Segment Results and Scoring

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Prepared for:



Friends of the Yampa
Steamboat Springs, Colorado

Prepared by:



Alba Watershed Consulting
Boulder, Colorado

Colorado State University
Fort Collins, Colorado



**YAMPA RIVER
SCORECARD
PROJECT**

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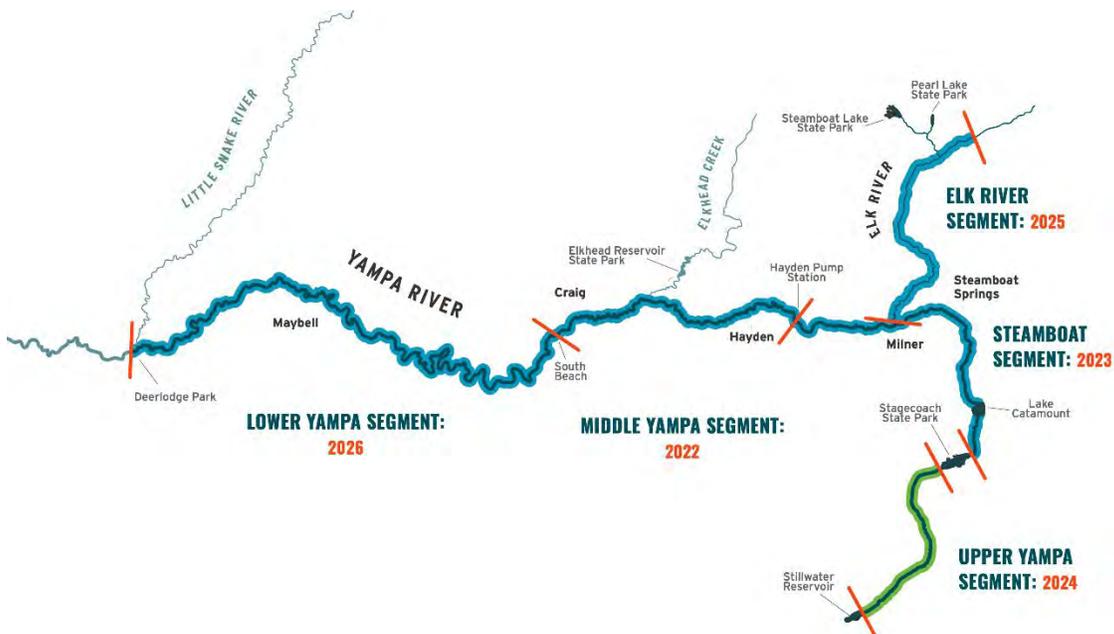
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1.0 INTRODUCTION

Friends of the Yampa is leading a community-based process to implement a long-term river health monitoring and evaluation program for the Yampa Basin that rates the overall condition of different segments of the Yampa River and articulates results through a *Yampa River Scorecard*. This third iteration of the Yampa River Scorecard Project (YRSP) is focused on the Upper Yampa segment of the Yampa River main stem (including the Bear River in the headwaters region), a 31-mile segment from Stillwater Reservoir to Stagecoach Reservoir. Figure 1-1 shows all five segments of the Yampa River Scorecard Project, as well as the schedule for completing assessments for each segment (Middle Yampa, 2022; Steamboat, 2023; Upper Yampa, 2024; Elk River, 2025; Lower Yampa, 2026). The Upper Yampa segment begins at the tailwaters of Stillwater Reservoir just downgradient of the Flat Tops Wilderness Area and ends at the inlet to the Upper Yampa Water Conservancy District's Stagecoach Reservoir. The segment follows the Bear River through the Medicine Bow-Routt National Forest, past Bear Reservoir and Yamcolo Reservoir to the Town of Yampa, where it joins Phillips Creek to become the Yampa River. The Yampa River in this segment then flows through private lands to the Town of Phippsburg, CPW's public fishing access on the SKCK Ranch, and several other private ranches until it reaches Stagecoach Reservoir. YRSP analyses do not include Stillwater, Bear, Yamcolo, or Stagecoach Reservoirs.

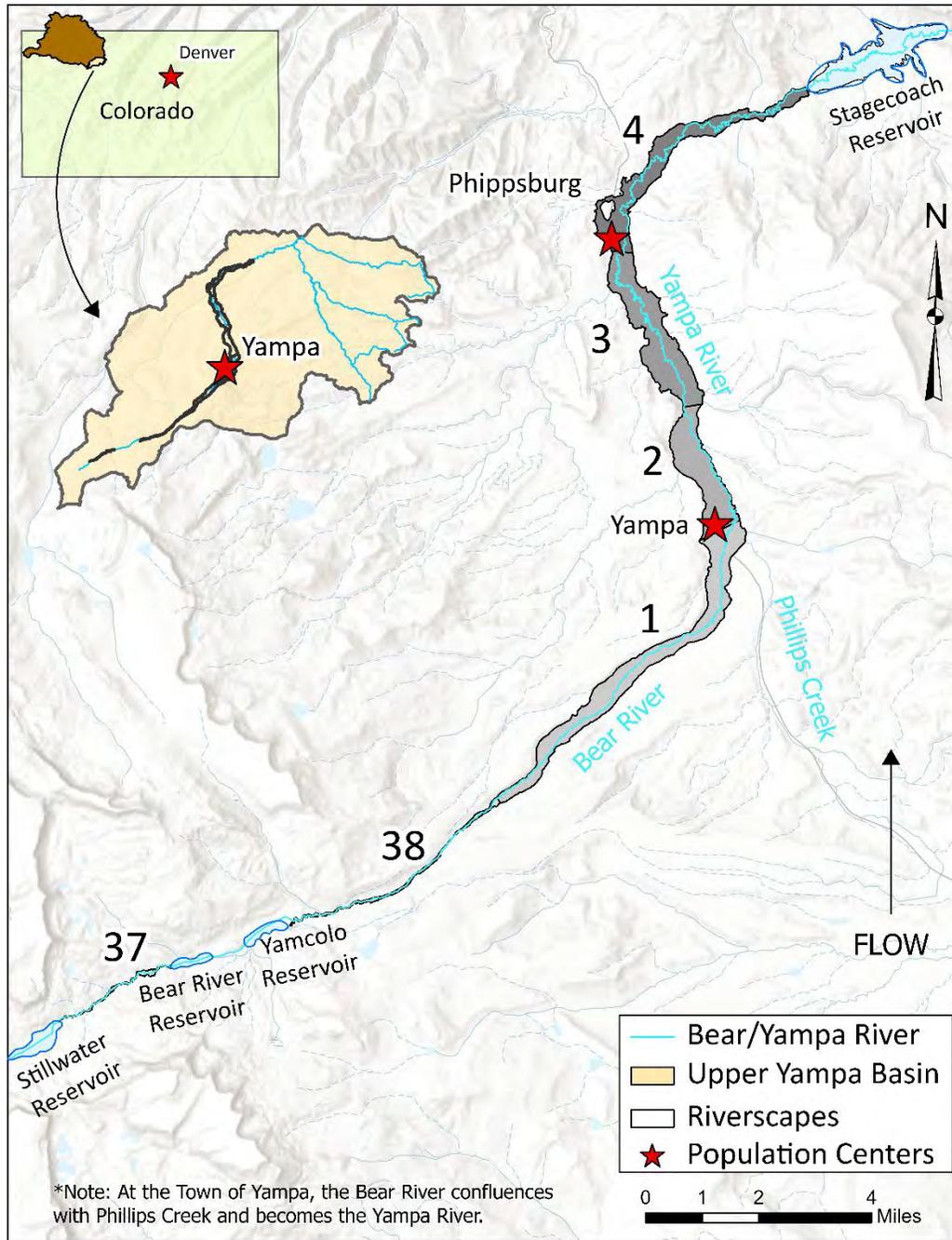
Figure 1-1. Yampa River Scorecard Project Segments and Timeline



The Upper Yampa segment includes 6 riverscapes: 4 riverscapes identified in the Yampa Integrated Water Management Plan (IWMP) remote assessment (Yampa IWMP 2021), and two additional riverscapes upstream of Yamcolo Reservoir that were not included in the IWMP but are included in the Scorecard's geographic scope (Figure 1-2). A score for each indicator is developed for each riverscape, and then averaged for an overall riverscape score (refer to Section 11 for

more information). A weighted average across the six riverscapes is then calculated to generate an overall ecological health and function score for the Upper Yampa segment.

Figure 1-2. Upper Yampa Segment Riverscapes



More information about the Yampa River Scorecard Project goals; background on determination of the five study segments and their planned timeframes; information related to the three stakeholder-identified attribute areas that are evaluated as part of the Scorecard effort (river uses and management, people and community benefits, and ecological health and function); and

details specific to the categories, indicators, monitoring methods, and scoring criteria used to assess the ecological health and function attribute area are provided in the Yampa River Scorecard Project Indicators and Methods Report (FOTY/Alba Watershed Consulting 2021). To encourage community-wide engagement and contribution to tracking river health, the monitoring and evaluation process is communicated using concise, clear, and visually appealing methods; visit <https://yampascorecard.org/> for the YRSP public interface.

This document details the results and rationale behind scoring of the ecological health and function attribute area for the Scorecard's Upper Yampa segment. The YRSP Technical Committee agreed on a set of categories to evaluate river health and function, largely based on the Functional Assessment of Colorado Streams (FACStream, Beardsley et al. 2015), a reach-scale assessment tool developed for the US EPA and State of Colorado that rates stream health according to the degree of impairment of several ecological variables, and the Colorado Stream Health Assessment Framework (COSHAF), a stream health assessment framework based on the FACStream variables used in many stream management plans (SMP) across Colorado, including an SMP completed by the City of Steamboat Springs covering a 12-mile section of the Yampa River through the City (City of Steamboat Springs 2018). COSHAF uses 11 variables to: evaluate the key factors that determine the health and resilience of a stream reach, ensure that all relevant aspects of stream health are considered, and serve as a guide for determining which monitoring parameters are most relevant. Other river-related report card efforts, particularly the Eco Health Report Cards undertaken by the University of Maryland Center for Environmental Science and its partners, were consulted as well. Based on these existing scorecards and ongoing input from the Technical Committee, the following categories were identified for evaluation:

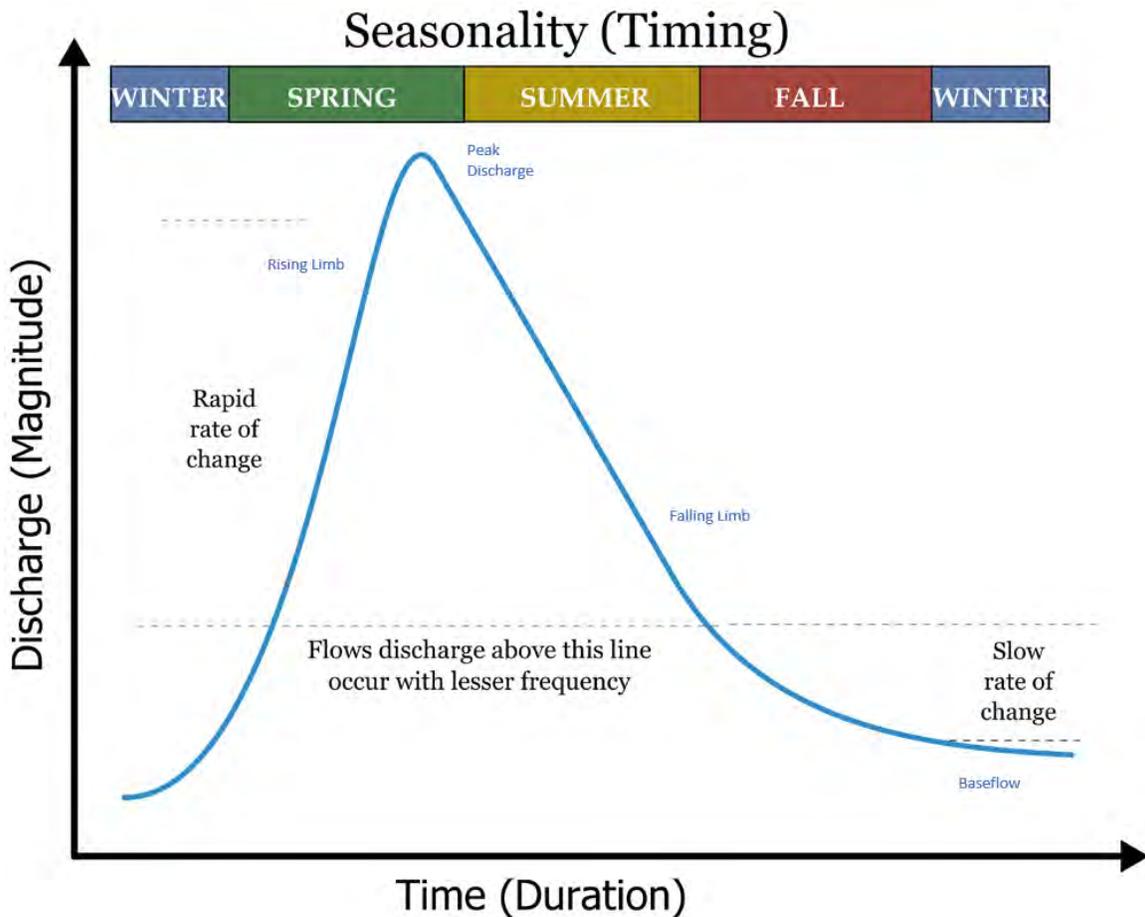
- Flow Regime (amount and timing of water supply);
- Sediment Regime (amount, timing, and type of sediment supply);
- Water Quality (physicochemical properties of water);
- Habitat Connectivity (aquatic and terrestrial habitat connectivity);
- Riverscape Connectivity (extent of riverscape/floodplain saturation or inundation);
- Riparian Condition (riparian habitat condition, including vegetation structure, diversity, and invasive species);
- River Form (channel morphology including planform, dimension, and profile);
- Structural Complexity (physical habitat including water depth, velocity, structural components, and substrate); and
- Biotic Community (community and trophic structure of the organisms in the reach).

The remainder of this document describes the suite of categories and indicators that, when evaluated, provide a comprehensive understanding of river health and function across the Upper Yampa segment. Each sub-section discusses one of the nine categories listed above, with further subdivisions by indicator. The discussion of each indicator contains a description of the indicator, the data sources and methods used to evaluate the indicator, the scoring criteria that are applied, the results and rationale for scoring, and associated scores. Existing data are used to the extent possible, supplemented by additional data analysis and field data collection where specified. In the Upper Yampa segment, every riverscape was visited on foot for field observations, except for approximately 20% of riverscapes 37 and 38, 10% of riverscape 1, and 70% of riverscape 2, mainly due to private property access considerations.

2.0 FLOW REGIME

Flow regime is defined as the characteristic pattern by which water is supplied to a river segment from its contributing watershed. It is often represented by a hydrograph, and is dictated by precipitation, inter- and intra-annual weather patterns, watershed characteristics, and human influences. Flow regime is a primary determinant of a river’s structure and function. In particular, the magnitude, duration, frequency, and timing of river flow interact with the landscape to determine the functions that the river performs. The Yampa River Scorecard evaluates two indicators within the flow regime category: the overall **hydrograph** and the annual **snowpack**. Figure 2-1 provides a schematic diagram of an annual hydrograph, illustrating important concepts such as peak discharge, base flow, and rising and falling limbs. The final flow regime score is calculated as 90% hydrograph indicator score and 10% snowpack indicator score. The Technical Committee decided on this uneven split to avoid double counting and consider the fact that snowpack is a driver of flow regime and exerts a major influence on the elements of the hydrograph indicator.

Figure 2-1. Hydrograph Schematic Diagram



2.1 HYDROGRAPH INDICATOR

The hydrograph indicator considers the following components of the Yampa River's flow regime:

- Magnitude, timing, and duration of **peak flows**. Adequate peak flows are essential to river health and function. In particular, the magnitude of a high flow event controls how much of the floodplain is inundated, and for how long, and is therefore of substantial importance for maintaining riparian vegetation health, distributing sediment through and across the river corridor, building structural complexity, and enabling connectivity between in-channel and floodplain habitat. Snowmelt-driven peak flows during spring runoff are also important for numerous watershed services, such as fishery support, riparian habitat quality, sediment flushing, water quality maintenance, recreation, aesthetics, and groundwater connection and recharge.
- Magnitude, timing, and duration of **base flows**. Base flows are the low flows that occur after snowpack melt, during the dry season, usually from late summer to early spring. They provide critical support of aquatic habitat and riparian connectivity when the stream needs it most after peak flows have receded. Low flows help to maintain essential aquatic habitat, riparian vegetation, and a healthy fishery, and also influence water quality and sediment transport. Sources of base flows are rainfall events and slowly percolating groundwater, and they can be augmented by reservoir releases and irrigation return flows in managed systems.
- **Total annual flow volume**, or the amount of water delivered to the riverscape from its contributing watershed, is an important overall metric describing flow regime in the Yampa River basin both from a human use perspective and as it relates to water delivery across the riverscapes.
- Magnitude and variability of **flow rates of change**, or the rate at which flow changes (for example, how quickly flows rise during spring snowmelt), are important for various ecological aspects of the river, including habitat connectivity, aquatic habitat, riparian condition (particularly seedling establishment), and sediment transport. The speed at which flows change can be driven by rainfall, snowmelt, dam releases, diversion operations, and various other natural dynamics and human actions. Though there are some differences in their ecological and physical importance, here we evaluate both rising and falling rates together as one by considering the overall average change from natural to current conditions.

This analysis also considers timing of peak flow, which can be used as a proxy for changing climatic conditions that impact streamflow. Together, the various sub-indicators are given the following weights to determine a total score for the hydrograph indicator: 30% peak annual flow, 30% annual 7-day minimum flow, 20% annual flow volume, 15% flow rate of change, and 5% peak flow timing.

2.1.1 *Data Sources and Evaluation Methods*

Development of scores for this indicator relies heavily on existing USGS stream gauge data, modeled natural and existing streamflows, and local knowledge. As a holistic indicator, this

variable uses expert judgement and review and analysis of available data to generate a single score for the hydrograph indicator.

In the Upper Yampa segment, three small reservoirs (with storage capacities of less than 10,000 acre-feet) are located near the headwaters of the Bear River: Stillwater, Bear, and Yamcolo (Figure 1-2). These reservoirs store water that is primarily used for irrigation, but also recreational and municipal purposes (Day 2021). The Upper Yampa segment ends at the inlet of Stagecoach Reservoir (Figure 1-2). The stream gauges within the Upper Yampa segment of the Bear and Yampa Rivers are as follows:

- USGS 09236000 BEAR RIVER NEAR TOPONAS, CO – This is an inactive USGS gauge located just below Bear River Reservoir (1952-1986).
- USGS 09236500 BEAR RIVER NEAR YAMPA, CO – This is an inactive USGS gauge located approximately 5 kilometers downstream of Yamcolo Reservoir (1939-1944).
- USGS 09237450 YAMPA RIVER ABOVE STAGECOACH RESERVOIR, CO – This is an active USGS gauge located just above Stagecoach Reservoir (1988-2024).
- CO DWR BEAR RIVER BELOW BEAR LAKE (BERBBLCO) – This is an active gauge operated and maintained by CO DWR located just below Bear Lake Reservoir (2012-2024).
- CO DWR BEAR RIVER AT BOX K RANCH (BERBXKCO) – This is an active gauge operated and maintained by the CO DWR located approximately 7 kilometers downstream of Yamcolo Reservoir (2022-2024).
- CO DWR BEAR RIVER AT CR7 NEAR YAMPA, CO (BERCR7CO) – This is an active gauge operated and maintained by CO DWR located approximately 4 kilometers upstream of the Town of Yampa (2018-2024).

The Wilson Water Group (WWG) conducted hydrology modeling for the Basin Implementation Plan Phase 3 (WWG 2018), where these and other stream gauge nodes within the Yampa Basin were used to explore the potential benefits and impacts of Yampa-White-Green Basin Roundtable projects under different hydrologic scenarios, including natural streamflows, baseline (existing) streamflows, and future scenario streamflows. The modeled natural flow regime is derived by removing the influence of human activities from current recorded streamflow to estimate natural, undisturbed flows at locations on the Yampa River. Disturbance activities that can be accounted for include diversions, irrigated agriculture and return flows, storage and releases, and water rights administration. Existing streamflow conditions, referred to as baseline conditions, represent recorded diversions, current consumptive demands, administration, instream flow and recreational in-channel diversions (RICD), existing infrastructure, and reservoir operations, and include modifications based on water-user interviews. While the WWG modeling did not include pre-measurement changes to hydrology or paleohydrology in establishing “natural” streamflows, the authors of this report acknowledge the relative recency of the USGS and CO DWR stream gauge data.

The Yampa IWMP remote assessment’s Data Synthesis Report (Yampa IWMP 2022) applied these data to percent departure of baseline conditions from natural conditions for two metrics: (1) percent departure of high flows and (2) percent departure of low flows. The two metrics were used in the remote assessment to provide a high-level, holistic indication of flow regime alteration within the Yampa basin. However, a more detailed hydrologic analysis of more than 107 metrics is presented in the Yampa River Hydrologic Review and Needs Assessment Report (Lotic 2021) and associated [interactive online storyboard application](#) (Mason 2021). Additional metrics from this report and an associated storyboard are changes in annual flow volume and rise and fall rates of the hydrograph from natural to human-altered conditions.

To rate the hydrograph indicator, streamflow data from the active USGS gauge listed above, as well as additional streamflow nodes within the 31-mile Upper Yampa segment that are used in the detailed hydrologic analysis (Lotic 2021, Mason 2021), were used to determine the departure of existing flow regime from modeled natural flow conditions, as well as to compare the baseline hydrograph to the modeled natural hydrograph over the period of record. In particular, daily flow data for modeled baseline (modeled existing) and modeled natural flows for all gauges/nodes covering the years 1975-2013 are compared. Riverscapes that lack modeling nodes are assumed to score similarly to the riverscape immediately upstream for metric(s) calculated from modeled data, except where significant withdrawals and/or tributaries exist within the riverscape that lacks nodes. Future iterations of the Yampa River Scorecard Project will explore acquiring similar modeled data that extends to more recent years (i.e., beyond 2013).

Additional data sources used to augment this review of historical modeled hydrographs are current local knowledge of dry-up points or significantly reduced flow locations that are not reflected in the existing stream gauge records, as well as a recent USGS publication investigating streamflow and water quality in the upper Yampa River Basin from 1992-2018 (Day 2021). This publication also conducts a streamflow trend analysis on the main stem Yampa River over a much longer time period (since 1910).

2.1.2 Scoring Criteria

The descriptive and semi-quantitative scoring criteria outlined in Table 2-1 are used to rate the hydrograph indicator. Each sub-indicator (e.g., 1-day maximum flow) is given a score and then sub-indicator scores are compiled to yield an overall score.

Table 2-1. Hydrograph Indicator Scoring Criteria

Grade	Description
A	Baseline hydrograph characteristics resemble the natural hydrograph. Magnitude and duration of annual discharge peaks and base flows closely resemble natural hydrograph. Percent of natural median 1-day maximum and 7-day minimum discharge estimated to be greater than or equal to 90% and lack of observable temporal downward trends in the gauge record exists. Net percent of natural flow greater than 90% of the total annual volume. Flow rates of change closely resemble natural hydrograph; average rise and fall rates greater than 90% of natural rates.
B	Hydrograph has a near natural seasonal pattern, but peaks are attenuated, elevated, extended, or shortened, with 75-90% of natural median 1-day maximum flow magnitude. Seasonal 7-day minimum discharge approximately 75-90% of

	natural flow. One-day maximum and 7-day minimum flows lack statistically significant downward trends over time, though some observable trends may be present. Net percent of natural flow between 80-90% of total annual volume. Rate of change for flows are 80-90% of natural rates.
C	Hydrograph has a natural seasonal pattern, but peaks are attenuated, elevated, extended, or shortened, with 50-75% of natural median 1-day maximum flow magnitude. Periods of biologically critical low flows occur occasionally, and seasonal 7-day minimum discharge is approximately 50-75% of natural flow. One-day maximum and 7-day minimum flows display statistically significant downward trends for a given time period (e.g., April flows) but not at the overall annual scale. Net percent of natural flow between 65-80% of total annual volume. Rate of change for flows are 60-80% of natural rates.
D	Disrupted seasonal hydrograph patterns and/or similarity to natural median 1-day maximum flow magnitude less than approximately 50%. Periods of biologically critical low flows are frequent, with less than 50% of natural seasonal 7-day minimum discharge. One-day maximum and 7-day minimum flows display statistically significant downward trends for several given time periods (e.g., spring month flows) but not at the overall annual scale. Net change percent of natural flow between 50-65% of the total annual volume. Rates of change for flows are 50-60% of natural rates.
F	Disrupted seasonal hydrograph patterns and/or similarity to natural median 1-day maximum flow magnitude substantially less than approximately 50%. Frequent and extended periods of biologically critical low flows and/or periods of no flow occur, with less than 50% of natural seasonal 7-day minimum discharge. One-day maximum and 7-day minimum flows display statistically significant downward trends for a majority of given time periods (e.g., all but winter flows) and at the overall annual scale. Net percent of natural flow less than 50% of total annual flow volume. Rates of change for flows are less than 50% of natural rates.

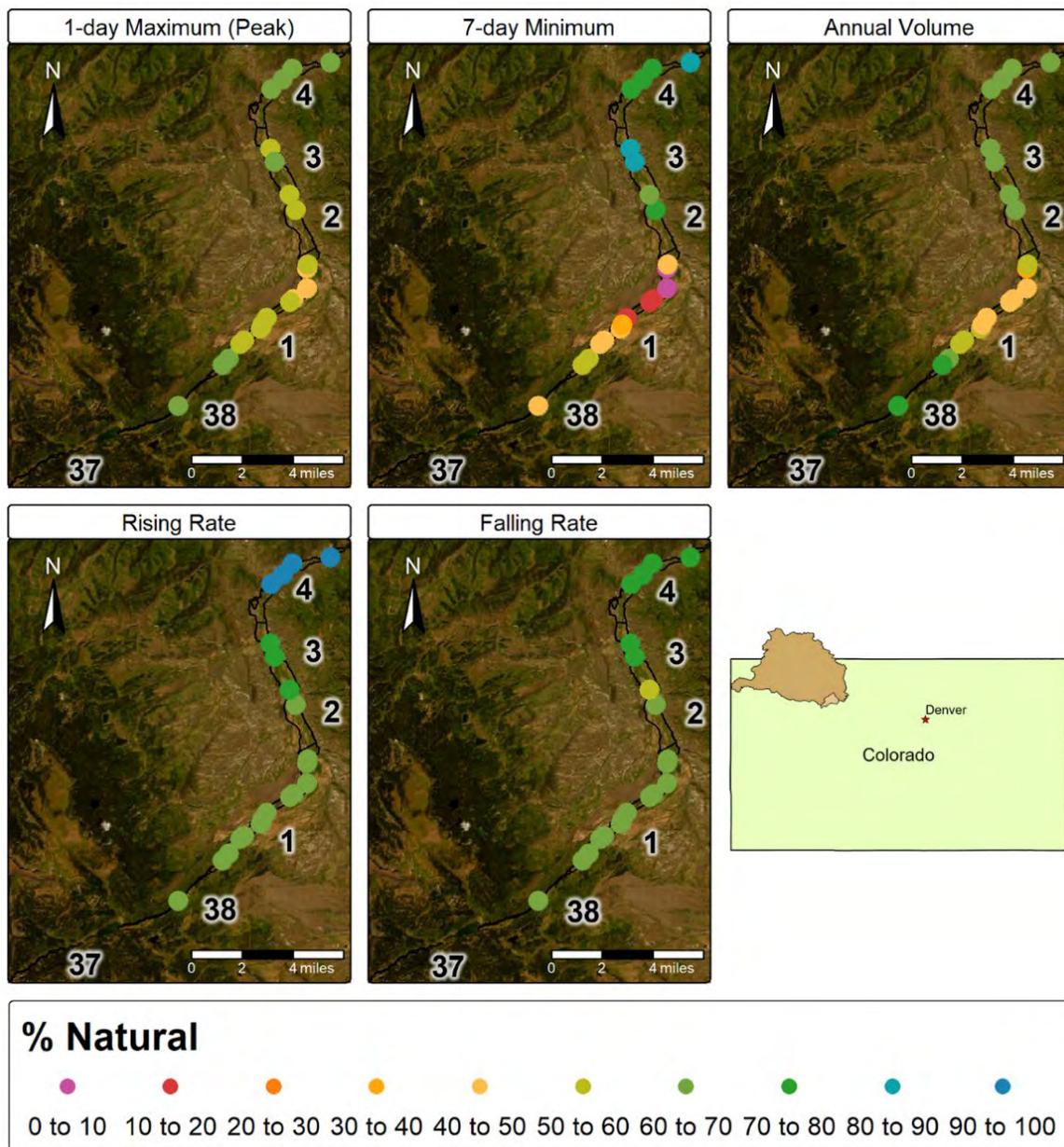
2.1.3 Results

Results and findings of previous reports regarding the health of the hydrologic regime on the Yampa River (Wilson Water Group 2018, Lotic 2021, Mason 2021) have been refined and synthesized to integrate into the Scorecard framework. Analysis focuses primarily on peak flows, minimum flows, total flow volume, and rates of flow rise and fall, as these correspond strongly with natural function. Additional consideration is given to the timing of peak flows.

The existence of three reservoirs in the upstream reaches of the Upper Yampa segment, as well as the large quantity of diversions in the upper watershed, result in changes to natural hydrology. The Bear River reaches involve a complex system of water rights administration. Stillwater Reservoir is owned and managed by the Bear River Reservoir Company, and operated by the Upper Yampa Water Conservancy District (UYWCD). Yamcolo Reservoir is managed by UYWCD, and consists of multiple water rights with varying seniority levels. Yamcolo meets minimum bypass requirements year-round and passes natural streamflow during spring runoff in coordination with the Colorado Department of Water Resources (CDWR) in accordance with the prior appropriation system. Bear Lake is owned by CPW and passes flow through from the inlet to the outlet without attempting to fill (Lowell pers. comm. 2024).

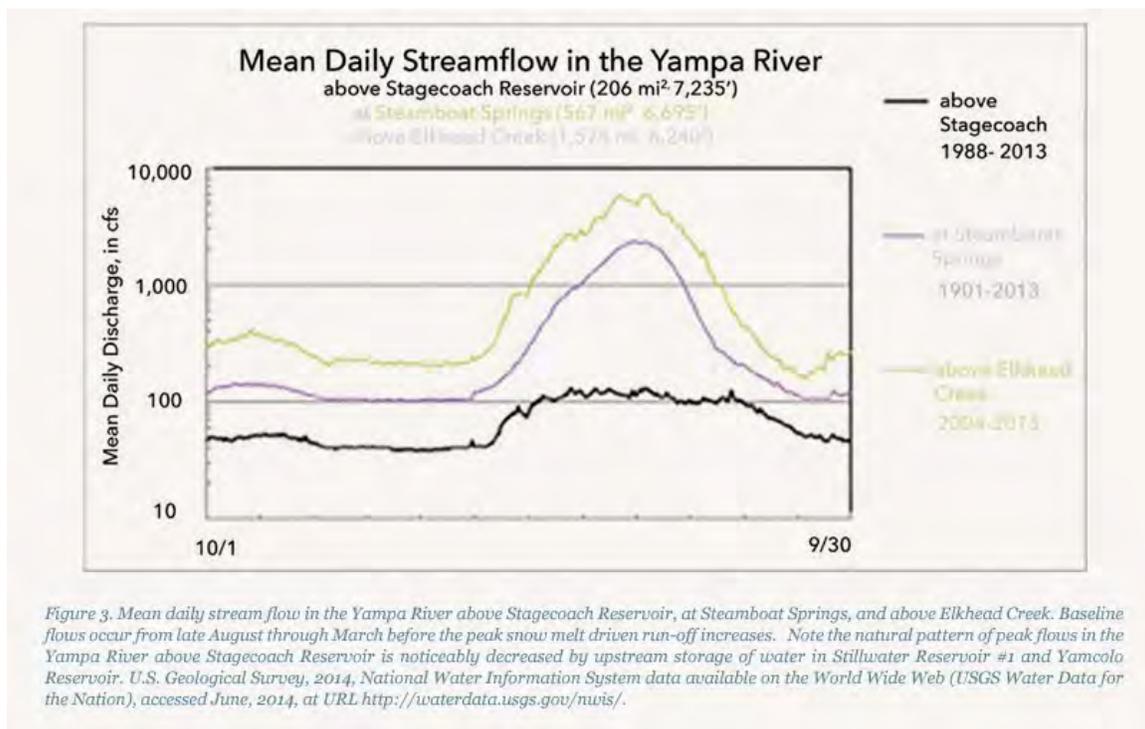
Percent of natural annual 1-day maximum flows is a metric that reflects the degree to which the magnitude of high flow events has changed from modeled natural flows during the period of record studied (1975-2013, Lotic 2021, Mason 2021). In all riverscapes in which analysis was possible (riverscapes 38, 1-4), modeled results indicate that average percent of natural conditions for the 1-day maximum flow per riverscape ranged from 54 to 67% of modeled natural flows (Figure 2-2). The departure from modeled natural high flows indicates a high density of diversions and instream infrastructure, regulated reservoirs, or other anthropogenic influences (Yampa IWMP 2022). No modeling results are reported for riverscape 37 due to the lack of modeling nodes (i.e., the points of the river at which flows are simulated) in these riverscapes.

Figure 2-2. Percent of Natural Flow Characteristics for Hydrograph Sub-Indicators at Upper Yampa Modeling Nodes



As previously mentioned, modeling results were unavailable for riverscapes 37 and only one node was present in riverscape 38. Subsequently, a review of discharge data from upstream CO DWR gauges (BERCR7CO (2018-2024), BERBXXCO (2022-2024), and BERBBLCO (2012-2024)), which are either directly downstream or near headwater reservoirs (Stillwater, Bear, and Yamcolo Reservoirs), was performed despite the shorter term periods of record to supplement the hydrograph analysis and scoring. While discharge data at the gauge below Bear Lake retains the shape of a more natural hydrograph (with spring flows generally peaking at around 130 cfs), discharge at the gauge below Yamcolo shows much lower peak flows during spring and early summer (generally 30-60 cfs). The reservoir releases, primarily for irrigation, are responsible for consistent discharge in the upper reaches of the Bear River that include attenuated peak flows during the runoff season. Figure 2-3 shows a plot from the Upper Yampa Watershed Group's 2014 State of the Watershed Report that illustrates this phenomenon (UYWG 2014). The presence of beaver found in riverscape 37 just upstream of Bear River Reservoir could positively influence discharge by naturally maintaining minimum flows through floodplain attenuation.

Figure 2-3. Mean Daily Streamflow Hydrographs Across the Yampa Basin (from UYWG 2014)



The metric assessing the percent departure in median annual 7-day minimum flow quantifies the extent to which low flows are similar to modeled natural conditions. Riverscapes 2, 3, and 4 had flows that were 74%, 78%, and 79% of natural modeled flows, respectively. These are less pronounced deviations in 7-day minimum flows from their natural state compared to riverscapes 38 and 1, which had flows that were 46% and 31% of natural modeled flows, respectively. Large departures in low flows in riverscapes 38 and 1 (on the Bear River) suggest influence from dam-related storage of winter and spring runoff and augmentation of summer water supplies (Day 2021). Furthermore, correspondence with local Routt County personnel indicates that the Bear River regularly “dries up” throughout the irrigation season (June through October) due to multiple

diversions (e.g., Bird Ditch, Nickell Ditch, Fix Ditch) located in riverscape 1, drastically impacting the river's flow regime. More specifically, dry-up points are areas where the river's flow is substantially reduced due to water diversions, leaving baseflows heavily altered. Overall, impacts from diversions, in-stream infrastructure, and regulated reservoirs were mostly seen in the Upper Yampa segment in riverscapes 38 and 1 through modeled departures in high and low flows. Inputs that help to compensate for decreased instream flows in riverscape 1 include the perennial Coal Creek, groundwater contributions, beaver activity, and regular releases from upstream reservoirs. The Bear River is the most highly administered system in the Yampa River basin, with a unique and complex flow regime (Clyncke pers. comm. 2024). The flow regime is complicated by calls for water diversions by senior water right holders utilizing the priority system of "first in time, first in right." When calls are in place (typically June through October), releases from Yamcolo Reservoir must occur to help maintain baseflows (Clyncke pers. comm. 2024). Despite these releases, the minimum flows on the Bear River are severely impacted in riverscape 1 from water diversions and therefore riverscape 1 receives an F for the baseflow score (Table 2-2).

At USGS 09237450, significant downward trends in 7-day minimum streamflow were observed in January and February, and on an overall annual basis (Day 2021). Additionally, the annual downward trend of 7-day minimum streamflows decreased by 35% over the 27-year period of analysis (Day 2021). Downward trends in minimum streamflows are likely influenced by upstream reservoir management (Figure 1-2), changes in water use, or climate-related changes in the basin (Day 2021). Riverscape scores for the baseflow component of the hydrograph indicator are presented in Table 2-2.

Modeling of total flow volume shows that flow volume is substantially decreased compared to natural in all riverscapes of the Upper Yampa where modeling results are available, ranging from a low of 71% of modeled natural in riverscape 38 to the relatively lower proportions of 53%, 64%, 67%, and 64% in riverscapes 1-4, respectively. Total flow volume scores thus are between C and D for all riverscapes.

In terms of flow rates, rising flow rates are approximately 67% of natural for riverscapes 38, 1, and 2, 7% of natural for riverscape 3, and 100% of natural for riverscape 4. Falling rates are also 67% of natural for each of riverscapes 38 and 1-3, and 75% of natural for riverscape 4. These more gradual rises and falls are consistent with changes in flow due to dam-related operations and demonstrate that dam operations alter natural flow dynamics in a multitude of ways.

Additionally, a subtle yet noteworthy shift in the date of peak flow towards earlier in the year has been identified, supported by a marginally significant p-value of 0.06 (Lotic 2021). These observed trends in the Yampa River Basin, characterized by earlier peak flow events and a decline in annual streamflow, are consistent with the broader trends observed across the Colorado River Basin. They can be attributed to changing temperature patterns, particularly warming, which have led to reduced winter snowpack, reduced soil moisture, and an earlier onset of snowmelt during the spring. The impact of these changes on the riverscape is reflected in the riverscape scores for the overall hydrograph indicator using a shifting peak analysis, as detailed in Table 2-2.

Overall, the available evidence suggests that changes to the natural hydrograph are substantial throughout the Upper Yampa, with an indicator score of D for riverscape 1, and scores in the C range for the remaining riverscapes (Table 2-2). These relatively lower scores likely reflect the

impact of the several reservoirs and many diversions located within the Upper Yampa segment on the natural flow regime.

Table 2-2. Hydrograph Indicator Scores by Riverscape

Riverscape	Peak Flow Score	Base Flow Score	Total Flow Volume Score	Flow Rates of Change Score	Shifting Peak Score*	Hydrograph Score
Riverscape 37	D	B	-	-	C	C
Riverscape 38	C	D	C	C		C-
Riverscape 1	C	F	D	C		D
Riverscape 2	C	C	D	C		C
Riverscape 3	C	B	C	C		C+
Riverscape 4	C	B	D	B+		C+

* Analysis of the timing of peak flow was done for USGS 09237450. The shifting peak analysis was incorporated holistically into overall scores for all riverscapes.

2.2 SNOWPACK INDICATOR

Much of the Yampa Basin is currently a snowmelt-driven system, meaning that the majority of river flows are derived from a melting snowpack in the springtime as opposed to rainfall or groundwater. In a snowmelt-driven system, snowpack characteristics have a direct effect on the basin's overall flow regime. This indicator considers maximum snowpack depth and associated maximum snow-water equivalent volume, timing of maximum snowpack, and timing from maximum snowpack to peak runoff.

2.2.1 Data Sources and Evaluation Methods

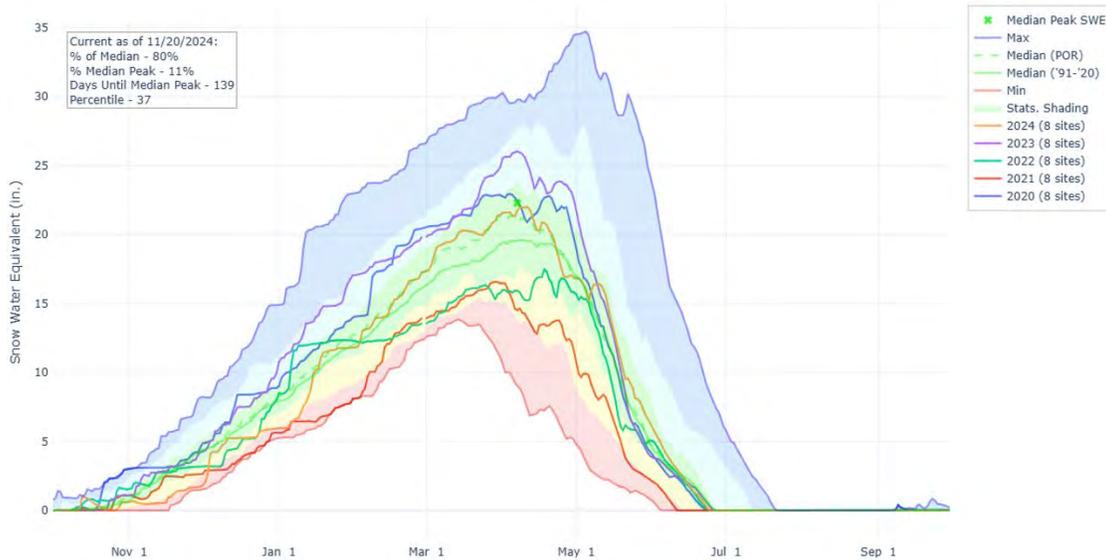
Snowpack data (in the form of snow water equivalent, or SWE) is collected and shared by the Natural Resources Conservation Service (NRCS) collectively for the Yampa, White, and Little Snake River Basins. The NRCS typically compares SWE amounts and timing to the 30-year average and median curves (Figure 2-4). However, in using the NRCS dataset, the Yampa River Scorecard Project obtained data for the entire period of record instead of limiting the analysis to the most recent 30-year average. It also reviewed the locations of SNOTEL sites that generate the SWE data to ensure they are located in the contributing watershed for the current focal segment.

This indicator is evaluated as follows:

- (1) Calculate the mean, 95% confidence interval, and standard deviation for maximum SWE (inches) for the period of record;
- (2) Calculate the mean, 95% confidence interval, and standard deviation for timing of maximum snowpack (Julian date) for the period of record;
- (3) Calculate the date of peak runoff for the USGS 09239500 YAMPA RIVER STEAMBOAT SPRINGS, CO, stream gauge for each year since 1989, and calculate the number of days from maximum snowpack to peak runoff;

- (4) Calculate the mean, 95% confidence interval, and standard deviation for maximum snowpack to peak runoff (number of days) for the period of record; and
- (5) Review these statistics in light of scoring criteria to rate this indicator for the most recent 5-year period for which data are available (2020-2024).

Figure 2-4. Yampa Basin Snowpack Summary for the 2023-24 Water Year



2.2.2 Scoring Criteria

The semi-quantitative scoring criteria outlined in Table 2-3 are used to rate the snowpack indicator. Current conditions are considered to be the last five years of data, and the entire period of record for each SNOTEL site used in the analysis is provided in Table 2-4.

Table 2-3. Snowpack Indicator Scoring Criteria

Grade	Description
A	Current snowpack is within the range of historical conditions. Maximum snow-water equivalent (SWE) volume is within the 95% confidence interval (CI) of the period of record. Timing of maximum SWE is within the 95% CI of the period of record. Timing from maximum SWE to peak runoff is within the 95% CI of the period of record.
C	Current SWE volume is within one standard deviation of the period of record. Timing of maximum SWE is within one standard deviation of the period of record. Timing from maximum SWE to peak runoff is within one standard deviation of the period of record.
F	Current SWE volume is greater than one standard deviation from the period of record. Timing of maximum SWE is greater than one standard deviation from the period of record. Timing from maximum SWE to peak runoff is greater than one standard deviation from the period of record.

2.2.3 Results

Two SNOTEL sites, Bear River and Crosho, generate SWE data and are located within the contributing watershed for the Upper Yampa segment (Figure 2-5). The periods of record at the Bear River and Crosho sites are 19 years and 39 years, respectively (Table 2-4).

Table 2-4. Upper Yampa Segment Contributing Watershed SNOTEL Site Details

Station	Start Year*	End Year	Elevation (ft)
Bear River	2004	2024	9,113
Crosho	1985	2024	8,975

*Data begins with first snow of the denoted start year (generally in October).

Figure 2-5. Locations of Upper Yampa Segment Contributing Watershed SNOTEL Sites

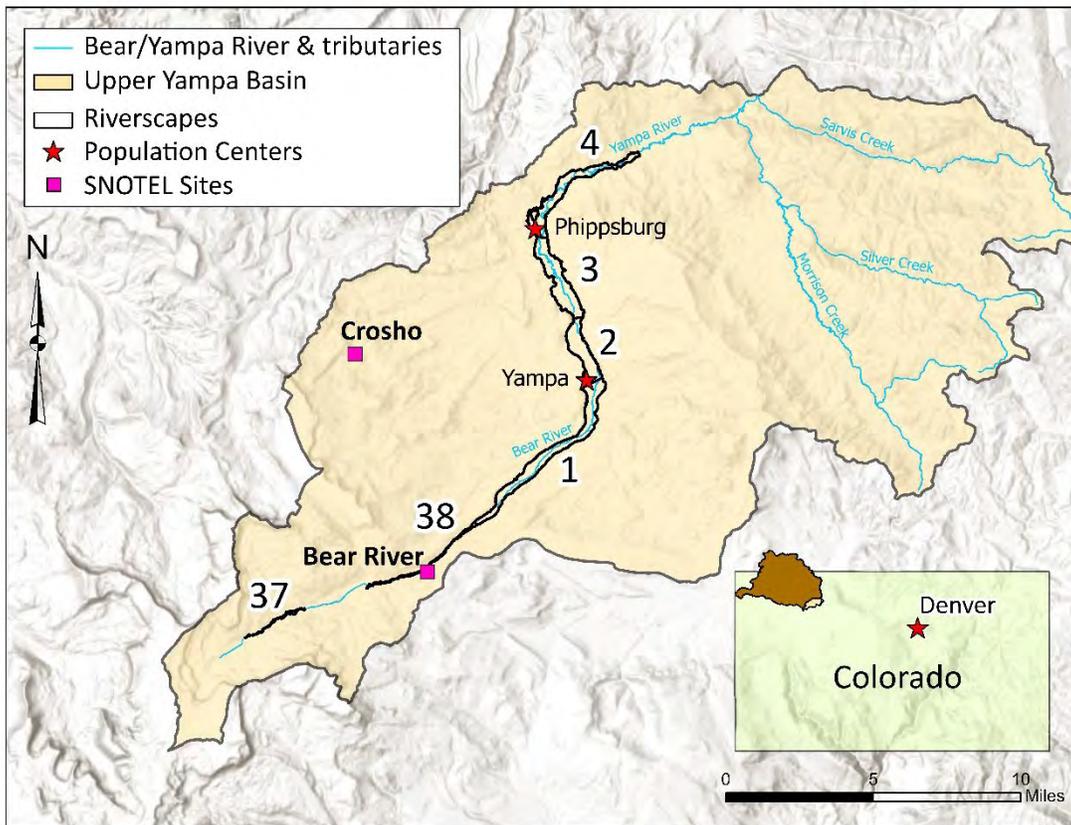


Figure 2-6 compares the maximum annual SWE volume for the past 5 years of data (2020-2024) to the long-term mean (dashed line), 95% confidence interval (dark gray), and standard deviation (medium gray) generated from the period of record data. Maximum SWE volume over the last five years is generally within a single standard deviation of the period of record mean (Figure 2-6). For the current water year (2023-2024), the maximum annual SWE lies closely to the mean value for each of the SNOTEL stations, within the 95% confidence interval (Figure 2-6). In 2021 and 2022, SWE volume is significantly below the mean (i.e., outside the 95% confidence interval) at each SNOTEL station, though still within a single standard deviation of the mean at the Crosho station (2022 at Bear River is the exception). At Crosho, the maximum annual SWE was

significantly higher than the mean and greater than one standard deviation from the mean (Figure 2-6), implying a direct beneficial impact to the Yampa River. Compared to the winter of 2023, however, the winter of 2024 presented less SWE with insignificant differences from the historical mean for each SNOTEL station (Figure 2-5). Scores for maximum SWE for the 5-year period of record are found in Table 2-4.

Figure 2-6. Maximum Annual SWE Volume (2020-2024) Compared to Long-Term Data

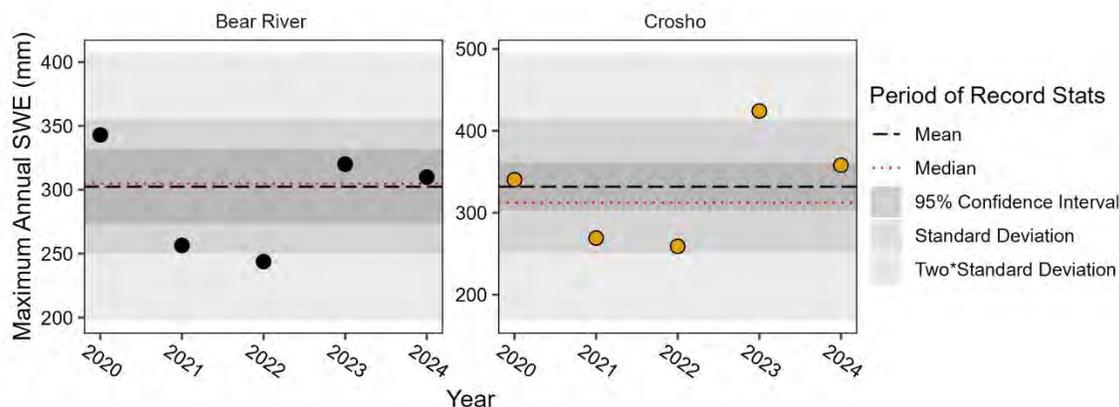


Figure 2-7 shows the timing of maximum annual SWE volume (day of year) for the past five years of data compared to the long-term mean (dashed line), 95% confidence interval (dark gray), and standard deviation (medium gray) generated from the period of record data. All datapoints analyzed indicated that maximum annual SWE occurred earlier than the historical mean, except during the winter of 2020 at the Bear River SNOTEL site. At each SNOTEL site, the timing of maximum annual SWE is within a single standard deviation of the mean for all years (Figure 2-7). During the winter of 2024, the Crosho site experienced a similar timing of maximum annual SWE to the historical mean, at approximately 90 Julian Days (March 31, Figure 2-7). The maximum annual SWE came significantly sooner than the historical mean at the Bear River site during the winter of 2024, but the timing still fell within one standard deviation (Figure 2-7). Timing scores are reported in Table 2-5.

Finally, the length of time (i.e., offset) between the timing of peak SWE from the Crosho and Bear River SNOTEL stations and the timing of peak streamflow from the USGS Yampa River Above Stagecoach station are shown in Figure 2-8. In general, the two SNOTEL stations had similar trends in offset, likely because the SNOTEL stations are situated approximately 10 miles from one another and have similar timings for peak SWE over the last five years. At the Bear River station, however, offset was negative in 2020 and 2021 which indicates the length of time between peak snowpack and peak streamflow was shorter than the mean length of time between these two events (Figure 2-8). The offset was highest in 2022 for both SNOTEL stations, when peak streamflow occurred 121 days after peak SWE for Crosho and 91 days after peak SWE for Bear River (Figure 2-8). These values were both significantly higher than the long-term mean for each station, and likely signifies an earlier than usual snowmelt onset coupled with a delayed peak river discharge. The year 2022 also had lower than average maximum annual SWE (Figure 2-6) suggesting lower-than-usual snow accumulation. The long-term mean for offset suggests peak streamflow normally occurs around 30 or 40 days after peak SWE for the Bear River and Crosho stations, respectively (Figure 2-8). Although the maximum annual SWE was slightly higher than the long-term mean in 2024 (Figure 2-6), the offset is significantly low at both SNOTEL stations, suggesting the peak SWE and peak streamflow occurred at relatively similar timings. The

combined effect of reduced snowpack and early snowmelt can disrupt the usual hydrological dynamics. Scores for this indicator are found in Table 2-5.

Figure 2-7. Timing of Maximum Annual SWE Volume (2020-2024) Compared to Long-Term Data

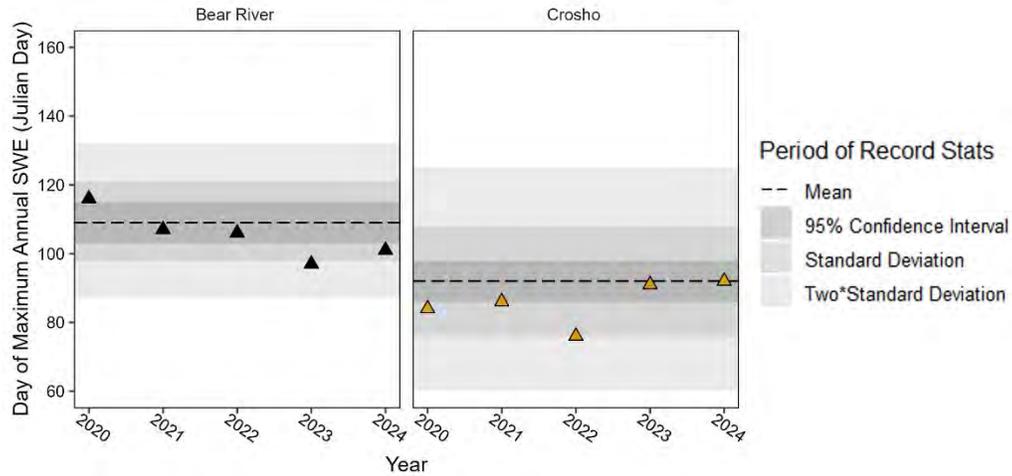
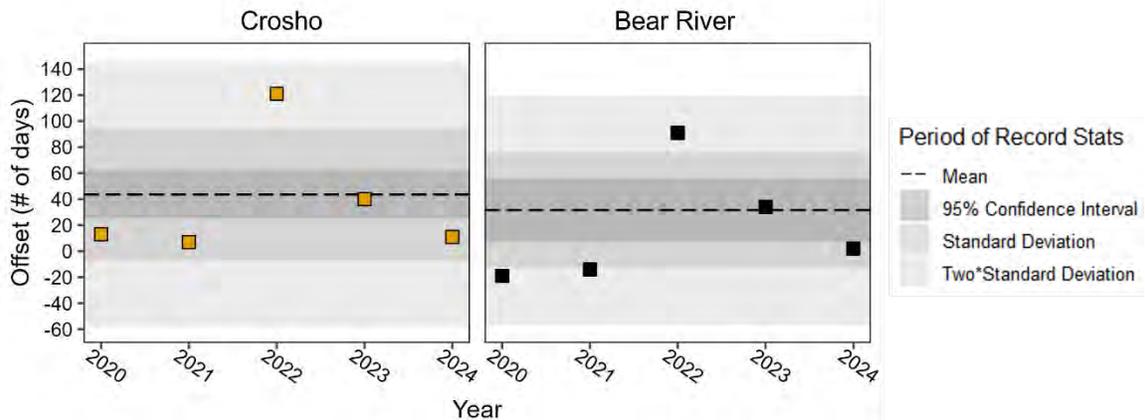


Figure 2-8. Offset of Maximum Annual SWE Volume and Peak River Discharge (2020-2024) Compared to Long-Term Data



The SNOTEL stations scored a C for the average overall score; as a result, the snowpack indicator overall receives a score of C for all riverscapes in the Upper Yampa River segment (Table 2-5).

Table 2-5. Snowpack Indicator Scores by SNOTEL Station

Station	Max Score	Timing Score	Offset Score	Overall Score
Bear River	C	C	D-	C-
Crosho	B-	C	C	C+
Upper Yampa Segment (All Riverscapes)	C			

3.0 SEDIMENT REGIME

Sediment regime is defined as the amount and timing of sediment that all sources, including land erosion in the contributing watershed and upstream channel erosion, supply to a reach, as well as patterns of sediment transport along and out of a reach. The production, transport, and deposition of sediment largely determines channel form and dynamics. Like changes to flow regime, an altered sediment regime can cause significant impacts to stream form and function, including aquatic habitat quality and long-term channel stability, and can damage infrastructure. The Yampa River Scorecard evaluates the system's sediment regime holistically, using a single indicator referred to as **sediment transport and continuity**.

3.1 SEDIMENT TRANSPORT AND CONTINUITY INDICATOR

The sediment transport and continuity indicator considers the ability of the system to maintain natural transport of sediment from its upstream and upgradient sources. For the Yampa River Scorecard Project, this indicator is scored holistically and qualitatively. While sediment transport capacity is predominantly controlled by stream discharge and slope, the number and size of natural and unnatural impediments to sediment transport and the proportion of the reach and watershed from which sediment transport is limited or blocked have a significant impact.

3.1.1 *Data Sources and Evaluation Methods*

This indicator is scored using expert interpretation of stressors affecting sediment transport, which may be the same stresses affecting other natural processes. Scoring is based on field observations (Appendix A), aerial imagery, and GIS spatial data. Signs of sediment aggradation or degradation outside of natural or expected patterns include disproportionate bar formation, increased bar stabilization, embeddedness by fine-grained material, disproportionate erosion, rapid meander migration, an incised channel with collapsing banks, and/or development of an inset floodplain. Field assessments are completed where appropriate to gain information about streambed substrate composition, stream power, sedimentation, embeddedness, and armoring. The Scorecard public interface explains in layperson terms that erosion and deposition are natural processes that are both critical to maintaining a healthy system, using examples of cottonwood and willow riparian galleries relying on bank erosion and its associated bar and substrate deposition, and bank stabilization practices to limit erosion that just propagate the impact downstream. The Scorecard also presents river stability as a continuum that can be affected by sediment loads, which may lead to either erosion or deposition, but may not necessarily make the river an "unhealthy" one.

3.1.2 *Scoring Criteria*

Table 3-1 includes the narrative criteria used to rate the sediment transport and continuity indicator. The criteria relate primarily to impediments to sediment transport, signs of sediment balance (or imbalance), and also to the presence of stressors and level of maintenance required to maintain functional river processes.

Table 3-1. Sediment Transport and Continuity Indicator Scoring Criteria

Grade	Description
A	The amount of sediment transported through the reach is optimized to maintain self-sustainable balance with no management or maintenance required. There are only limited, if any, impediments to sediment delivery or transport throughout the reach. Minimal signs of sediment imbalance or disequilibrium are evident.
B	Impediments to sediment transport may exist, but they are either insignificant or they impact sediment balance from only a small portion of the overall contributing area. Minor stressors are present and minimal management or maintenance is required to maintain functionality. Limited signs of sediment imbalance or disequilibrium are evident.
C	Impediments to sediment transport through the reach are notable and are impacting the sediment balance through a moderate portion of the reach. Maintenance and management are required to maintain functionality. Moderate signs of sediment imbalance or disequilibrium are evident.
D	Major impediments to sediment transport exist, yet these impediments either pass a portion of the sediment downstream or block sediment from less than half of the reach. Stressors significantly alter the natural sediment balance, and extensive or consistent active management and maintenance are required. Ample signs of sediment imbalance or disequilibrium are evident.
F	Severe impediments to sediment transport are present and impact most or all of the reach. The sediment balance through the reach is severely altered to a level that results in an inability to support functional processes. Signs of sediment imbalance or disequilibrium are ubiquitous.

3.1.3 Results

The sediment transport and continuity indicator is evaluated through field observations and remote sensing analysis using aerial imagery and GIS spatial data. Review of additional documents, specifically a 2021 USGS report of water quality in the Upper Yampa Basin (Day 2021) and the Yampa River Basin Remote Assessment (Yampa IWMP 2022), was also completed to further augment the analysis.

A USGS investigation of suspended sediment data at the Yampa River Above Stagecoach Reservoir gauge indicates the highest estimated median annual concentration from 2010 to 2018 was 14 mg/L, the highest concentration in the Upper Yampa River Basin analysis (Day 2021). Sediment concentrations were generally highest during spring runoff (May and June), and lowest during base flow (September through February) (Day 2021). In the downstream direction of the Yampa mainstem, annual suspended sediment loads generally increased (Day 2021). Although agricultural land use was classified as light in the Upper Yampa segment (IWMP 2022), the Upper Yampa River subbasin contains the highest percentage of hay fields and pastureland in the Yampa River Basin (Day 2021). Agricultural land-use adjacent to the river (e.g., grazing practices) may disrupt sediment continuity, exacerbate erosion, and cause sediment imbalances (Day 2021; IWMP 2022). Overall, the USGS investigation (Day 2021) and the Yampa IWMP (2022) suggest that the sediment regime through the Upper Yampa segment is relatively healthy based on the lack of any generalizable temporal trends; however, suspended sediment concentrations may be elevated due to land use.

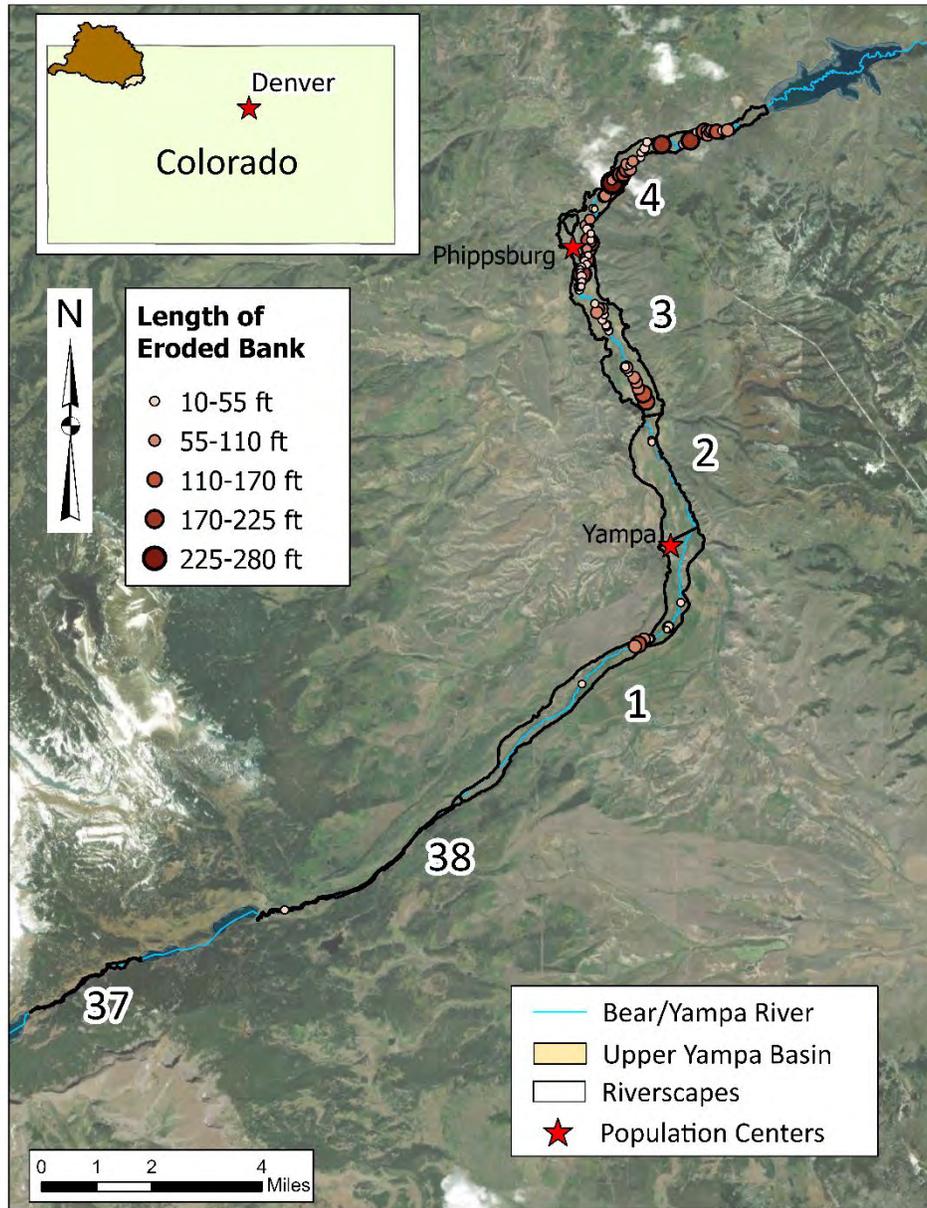
Examination of field-collected data reveals that bank erosion increases downstream, with minimal erosion in riverscapes 37 and 38, and a much higher degree of erosion in riverscape 4 (Figure 3-1). Bank erosion is more commonly found in the downstream riverscapes (1-4) because the channel is more sinuous and meander bend cutbanks are capable of eroding. Although this could be a possible sediment imbalance in the downstream riverscapes, cutbank erosion is a natural and expected pattern in a healthy river system.

In riverscape 37, no bank erosion data points were recorded (Figure 3-1). However, the entire riverscape was not readily accessible by foot or craft and so erosion data could be lacking. There are large beaver complexes in riverscape 37 (Appendix A, Photos A-1 and A-2), which would indicate a more complex sediment regime, such that erosional and depositional processes are altered. Generally, beavers contribute to a more dynamic and resilient river system, but their influence can also result in less downstream sediment deposition where beaver dams are present. Beaver dams act as sediment sinks that help increase local sediment storage. When dams are breached, accumulated sediments mobilize and influence downstream channel morphology. In riverscape 38, only one eroded area was recorded near a tributary input and measured approximately 35 feet long (Appendix A, Photo A-3). A lack of erosion directly downstream of multiple reservoirs, however, is not expected. Typically, downstream of large dams and reservoirs, rivers can be starved of sediment, incised, and have armored beds, due to the altered flow regime and lack of sediment input. These extent of beaver activity and active complexes in the riverscapes in the Upper Yampa may mitigate some of the negative impacts that the dams would otherwise have on sediment transport and continuity in the absence of sustained beaver activity. Although signs of bank erosion were not generally present, some evidence of incision is found in riverscape 38. These headwater riverscapes are steep, confined, have low sinuosity with minimal floodplain extents, and are expected to have higher velocities with narrower channel widths. Nonetheless, bank erosion and incision is minimal, most likely due to local factors such as lithology, riparian vegetation, the confined nature of the river, and mitigating beaver activity. The river's naturally coarse bed and bank substrate and in some cases, local bedrock, help resist degradation despite reduced sediment supply. Riparian vegetation also helps to stabilize banks and reduce erosion, and in these headwater riverscapes, riparian forests are abundant. In general, a relatively stable channel form has developed despite sediment starvation given the natural channel and landscape conditions. Furthermore, the absence of developed bars (Figure 3-2) could indicate an environment dominated by transport processes rather than depositional processes, and is supported by the steep, confined, and forested nature of these headwater riverscapes. Ultimately, while scores for the sediment regime indicator in riverscapes 37 and 38 consider the above factors, these riverscapes are also impacted by the existence of large adjacent dams, yielding C- scores for these riverscapes (Table 3-2).

In riverscape 1, bank erosion is concentrated primarily on the cutbanks of meander bends. The cutbanks generally lack vegetation and in some locations bank undercutting and collapse are evident (Appendix A, Photos A-4 and A-5). Prominent longitudinal barriers (Figure 5-1, Table 5-2) and diversions exist in this riverscape (e.g., Nickell Ditch, Bird Ditch), which influence both the flow and sediment regimes. Diverting water reduces streamflow downstream, lowers the energy available to transport sediment, and can lead to increased downstream sediment deposition and accumulation of fine-grained sediments. This is supported by the embeddedness data where embeddedness increases in the downstream direction (Figure 9-4). Scores for the sediment transport and continuity indicator are impacted by the local impediments within riverscape 1 that

may alter the downstream movement of sediment (Table 3-2). Based on these considerations, riverscape 1 receives a score of C (Table 3-2).

Figure 3-1. Distribution and Amount of Bank Erosion in the Upper Yampa Segment

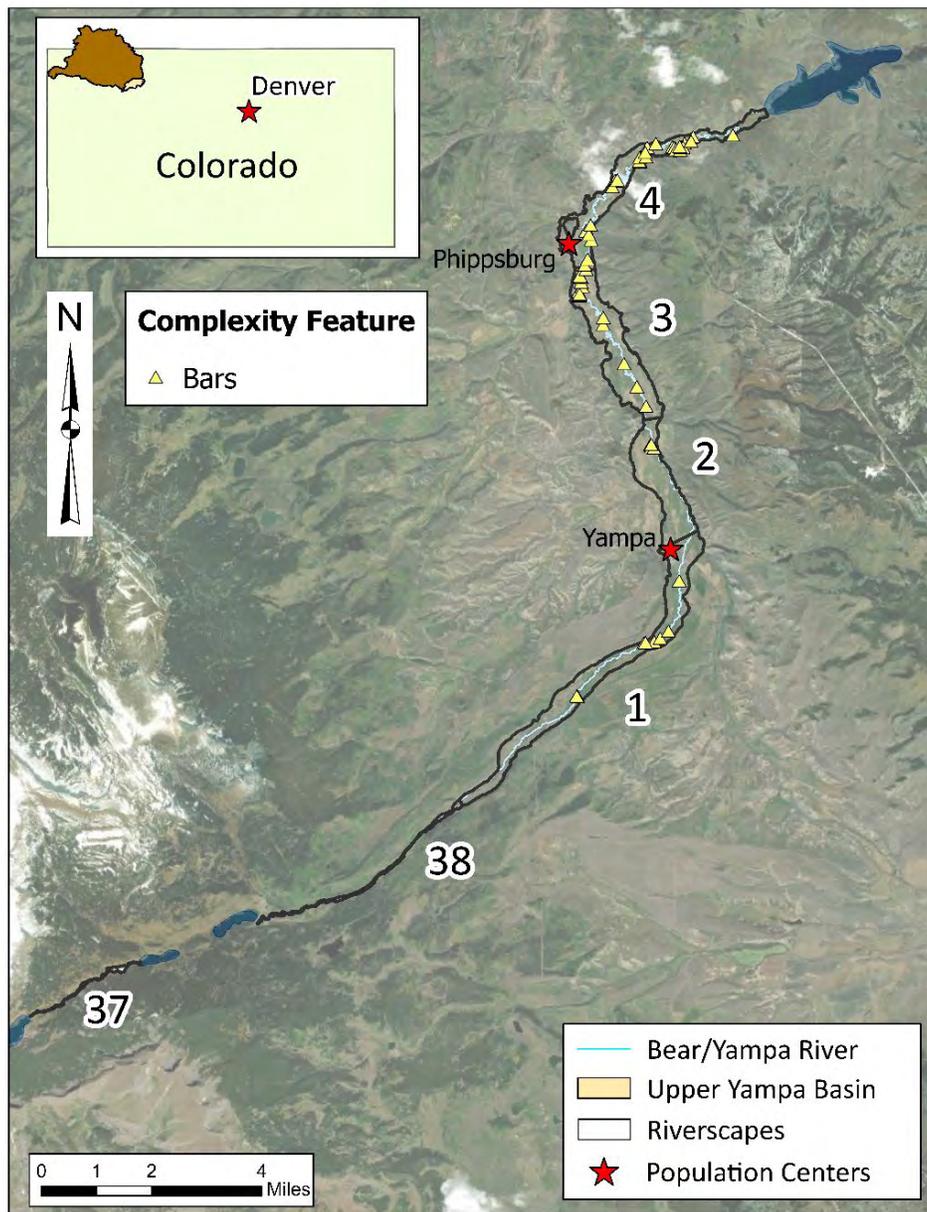


* Note: Each riverscape was visited on foot for field observations, except for approximately 20% of riverscapes 37 and 38, 10% of riverscape 1, and 70% of riverscape 2, mainly due to private property access considerations. Therefore, this graphic may not show the full extent of bank erosion, particularly in riverscape 2.

In riverscape 2, although several upstream reservoirs are present, the confluence of Phillips Creek and the Bear River forms the Yampa River, and sediment contributions from Phillips Creek may help to reestablish and improve the sediment regime. While field data in riverscape 2 are lacking, aerial imagery analyses reveal a moderate riparian forest that may help stabilize the river channel.

Additionally, sinuosity in this riverscape is high (Table 8-2), and evidence of erosion is present on pronounced cutbanks where bank vegetation is minimal (from aerial imagery). Field-based data on bars are also lacking, but prominent point bars are seen in aerial imagery opposite of meander cutbanks. Only three major irrigation ditches are present (CWCB/DNR 2024), but longitudinal barriers strongly influence habitat connectivity (Figure 5-1, Table 5-2) and likely sediment continuity as well. In the downstream portion of the riverscape, bank armoring to stabilize the river when intersecting Colorado State Highway 131, the railroad, and private properties (Figure 9-1), simplifies the river system and alters sediment continuity. Nonetheless, signs of deposition and transport, indicative of a healthy dynamic river system, are prevalent and generally ample space is available for these processes to be maintained. Based on these considerations, riverscape 2 earns a score of B+ (Table 3-2).

Figure 3-2. Locations of Bar Features by Riverscape



* Note: Each riverscape was visited on foot for field observations, except for approximately 20% of riverscapes 37 and 38, 10% of riverscape 1, and 70% of riverscape 2, mainly due to private property access considerations. Therefore, this graphic may not show the full extent of bar features, particularly in riverscape 2.

Riverscapes 3 and 4 had the highest concentrations of bank erosion points compared to the other riverscapes (Figure 3-1). This finding may suggest an erosional imbalance; however, with a wider floodplain and relatively large meanders (Table 8-2), the opportunity for cutbank erosion is higher. The lack of riparian vegetation in riverscapes 3 and 4 may strongly influence bank erosion such that cutbanks can erode more easily where vegetation is absent. Banks in riverscape 4 are more armored than riverscape 3, however, which would indicate that relatively less sediment is removed from the system (Figure 9-1). Coarse-grained (i.e., coarse sand and gravel) bars were commonly found in both riverscapes 3 and 4 (Figure 3-2) and are suggestive of a healthy sediment regime. However, longitudinal barriers are prevalent throughout both riverscapes (Figure 5-1, Table 5-2) and likely impede downstream movement of sediment. Based on the available data, riverscapes 3 and 4 receive scores of B and B-, respectively (Table 3-2).

Deposition and erosion are natural processes that play a key role in shaping rivers and maintaining their health, and a balance of these processes is crucial to creating and sustaining various habitats and features including meanders, bars, pools, riffles, and floodplains. In excess, however, erosion can lead to rapid bank collapse, channel incision, and loss of floodplain connectivity. Generally, where bank erosion was most present (riverscapes 1-4), these phenomena were not observed. Suspended sediment concentrations were elevated, however, compared to USGS gauges downstream of Stagecoach Reservoir (Day 2021), and degree of embeddedness increased in a downstream direction (Figure 9-4). These observations could be attributed to increased sediment erosion from local grazing practices. Sediment transport and continuity scores for all riverscapes are provided in Table 3-2.

Table 3-2. Sediment Transport and Continuity Indicator Scores by Riverscape

Riverscape	Sediment Transport/Continuity Score
Riverscape 37	C-
Riverscape 38	C-
Riverscape 1	C
Riverscape 2	B+
Riverscape 3	B
Riverscape 4	B-

4.0 WATER QUALITY

Water quality is defined as the physico-chemical characteristics of water in a river segment, and it is influenced by natural geological weathering, biogeochemical processes, and human activities (upstream land and water uses). Suitable water quality in streams supports recreational uses, ensures public health, and supports wildlife and fish habitat. The Yampa River Scorecard uses several indicators to evaluate water quality. The list of indicators is based on feedback from the Technical Committee and contains parameters that are relatively easy to measure and/or for which data already exist. The six water quality indicators are **temperature, dissolved oxygen, pH, macroinvertebrates, nutrients, and metals**. The final water quality score is calculated as an average of the six indicator scores.

Water quality measurements that can be important for assessing stream health include parameters that fall into the following categories: (1) standard physical parameters that can be measured *in situ* with a handheld water quality instrument that provides instantaneous results (e.g., temperature, pH, conductivity, dissolved oxygen, oxidation-reduction potential, turbidity); (2) analytes that require water samples to be collected and sent to a laboratory for analysis (e.g., total and dissolved metals, nutrients); and (3) biological indicators of water quality (e.g., macroinvertebrates). Locations of surface water quality and macroinvertebrate community samples collected in the field, as well as temperature sensors and gauges used in the analysis, are summarized in Figure 4-1. Water quality data are compared to CDPHE standards for scoring criteria. If water quality samples frequently exceed these standards, the stream segment is placed on the State's 303(d) or M&E (monitoring and evaluation) list for that particular constituent. This section provides more detail on the six indicators included in the Yampa River Scorecard.

Instantaneous data from water quality sampling are considered in addition to USGS water quality data due to the lack of available USGS monitoring locations. Water quality sampling took place in riverscape 38 on USFS land along the Bear River and riverscape 2 on private property (Herbert residence) along the mainstem Yampa River on two occasions during high flow (June) and low flow (August) periods to cover a range of flow conditions (Table 4-1). In-situ and laboratory-derived results are summarized in Table 4-1.

Table 4-1. Summary of 2024 Water Quality Sampling Results for Constituents of Interest

Constituent ^A	Sample ID ^B	Riverscape	High Flow Result ^C	Low Flow Result ^C	CDPHE Standard ^D
TKN	Bear-USFS-SW1	38	<0.2	<0.2	1.25
TP	Bear-USFS-SW1	38	0.031	0.015	0.11
pH	Bear-USFS-1	38	8.41	8.31	6.5-9
DO	Bear-USFS-1	38	8.97	7.59	6
TKN	Yampa-Herbert-SW1	2	0.78	0.26	1.25
TP	Yampa-Herbert-SW1	2	0.131	0.048	0.11
pH	Yampa-Herbert-1	2	8.19	8.54	6.5-9
DO	Yampa-Herbert-1	2	7.96	7.75	6

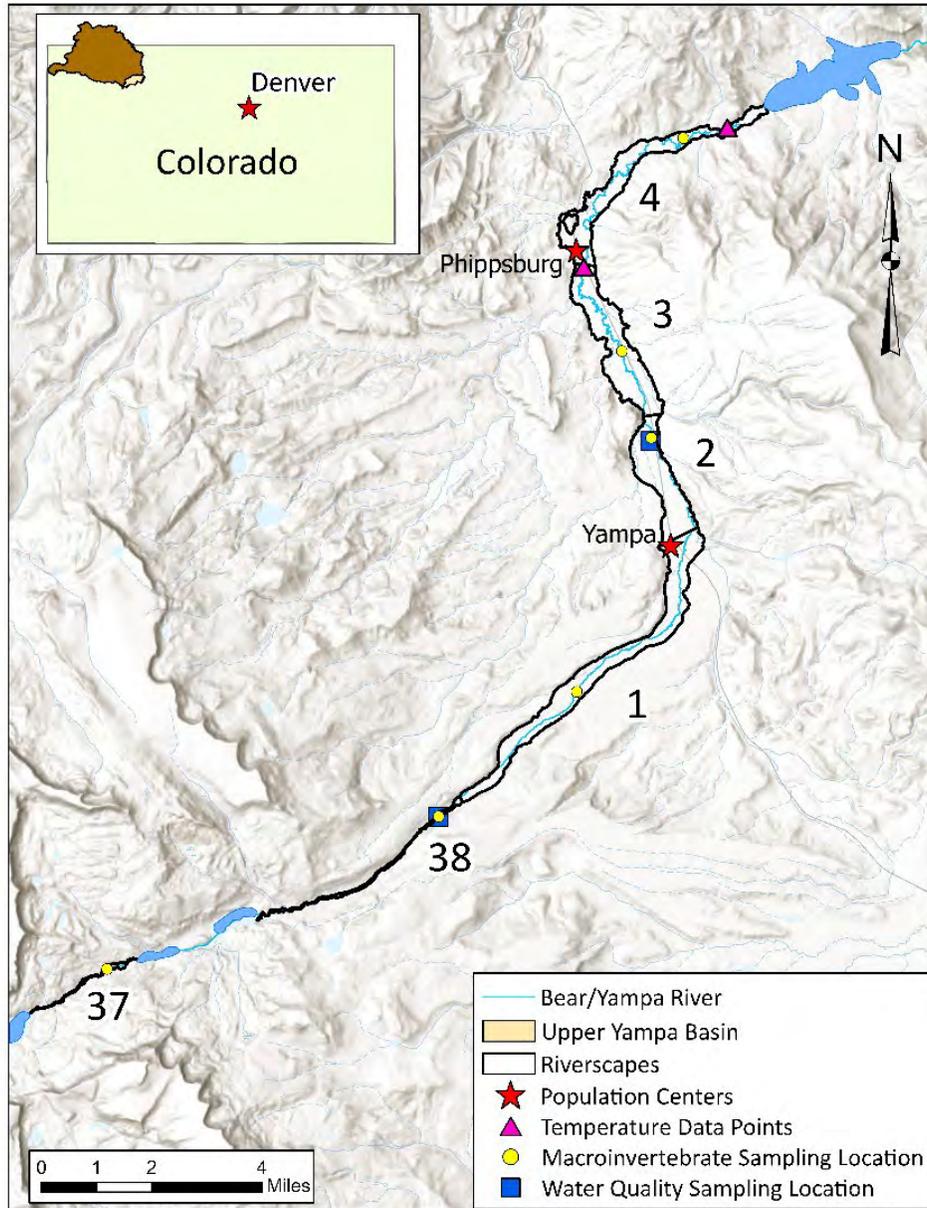
^A TKN = Total Kjeldahl Nitrogen; TP = Total Phosphorus; DO = Dissolved Oxygen

^B Results from surface water samples that were sent to the lab are labeled "SW." Otherwise, results are from in-situ measurements recorded in the field.

^c High flow and low flow sampling events occurred in mid-June and late August, respectively.

^d More information on Colorado Department of Public Health and Environment (CDPHE) standards are found in subsequent indicator sections.

Figure 4-1. Locations of 2024 Temperature Data Points (Sensor and Gauge), Water Quality Samples, and Macroinvertebrate Community Samples Included in Data Analysis



4.1 TEMPERATURE INDICATOR

Water temperature is measured using a standard water quality meter, a thermometer, or a HOBO temperature data logger. The ranges of many aquatic species are limited by temperature, so this parameter is an important measure of habitat quality. Shading from the riparian canopy, good

hyporheic exchange, and seepage from spring-fed tributaries (in some cases) contribute to lower temperatures that support the cool- and cold-water fish species present in many Colorado streams and rivers. The CDPHE Stream Classifications for Aquatic Life with the Upper Yampa segment are as follows:

- Bear River to Yampa River (Confluence with Phillips Creek; Bear River Segment COUCYA03): Aquatic Life Cold Water 1 and Cold Stream Tier I¹ (CS-I) temperature standards.
- Yampa River to Stagecoach Reservoir (Segment COUCYA02a): Aquatic Life Cold Water 1 and Cold Stream Tier I (CS-I) temperature standards.

The Aquatic Life Cold Water 1 classification applies to all six riverscapes in the Upper Yampa segment. These stream segment classifications are further subject to specific water quality standards set by CDPHE, including water temperature standards (Table 4-2).

Table 4-2. Temperature Water Quality Standards in Yampa River Segments 02a and 03

Month	CS-I Temperature Standards	
	Acute Standard (deg C)	Chronic Standard (deg C)
January	13.0	9.0
February	13.0	9.0
March	13.0	9.0
April	13.0	9.0
May	13.0	9.0
June	21.7	17.0
July	21.7	17.0
August	21.7	17.0
September	21.7	17.0
October	13.0	9.0
November	13.0	9.0
December	13.0	9.0

4.1.1 Data Sources and Evaluation Methods

Instantaneous temperature was measured by FOTY during the collection of water quality samples in the Upper Yampa segment (Figure 4-1). However, instantaneous measurements of water quality taken manually have limited value when considering optimal conditions for resident aquatic species. Continuous temperature data loggers that collect temperature measurements at regular intervals provide a greater understanding of the conditions impacting aquatic habitat and allow for comparison with water quality temperature standards. These are relatively inexpensive but can be tricky to install in a system like the Yampa River Basin that sees large fluctuations in flows, freezing during winter months, visitation by curious individuals or animals, and other challenging conditions for field monitoring.

¹ WQCC Regulation 31, page 52: “Cold Stream Tier I temperature criteria apply where cutthroat trout and brook trout are expected to occur.”

Continuous temperature measurements are collected by USGS every 15 minutes at stream gauge 09237450 (Yampa River above Stagecoach Reservoir), and every 30 minutes at a HOBO temperature logger deployed by FOTY between September 5, 2023 and October 16, 2024 (Figure 4-1). Temperature data loggers deployed as part of the Scorecard effort follow the same protocols for equipment installation and retrieval as the City of Steamboat Springs to maintain consistency across the Yampa basin; additional details are provided in the Yampa River Scorecard Project Indicators and Methods Report (FOTY/Alba Watershed Consulting 2021).

4.1.2 Scoring Criteria

The temperature indicator scoring criteria outlined in Table 4-3 are based on regulatory standards outlined in CO Regulation 33 (CDPHE 2023). These criteria are not quantitative; rather, they rely on consulting current regulatory standards.

Table 4-3. Temperature Indicator Scoring Criteria

Grade	Description
A	Temperature regime is natural and appropriate for a well-functioning river in its process domain.
B	Temperature regime is within the range of natural variability. Natural aquatic biota may be minimally impaired. Regulatory standards are not exceeded.
C	Temperature regime is altered to a degree that could significantly affect natural aquatic biota. Regulatory standards are occasionally exceeded. CDPHE Monitoring and Evaluation (M&E) listed reaches fall in this category.
D	Temperature regime is altered to a degree that is known to affect natural aquatic biota. Regulatory standards are frequently exceeded. CDPHE 303(d) listed reaches fall in this category.
F	The temperature regime is fundamentally altered. Natural biota are severely impaired. Regulatory standards are chronically exceeded.

4.1.3 Results

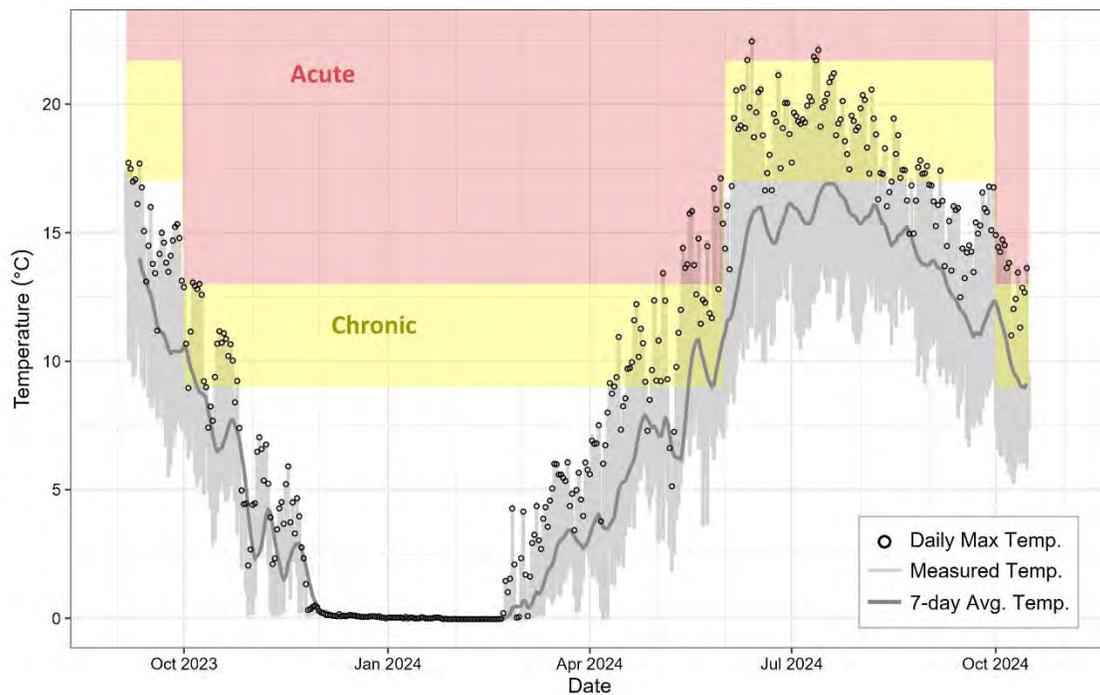
Riverscapes downstream of the Upper Yampa segment (below Stagecoach Reservoir) are designated on the State's 303(d) list of impaired waterbodies for stream temperature, indicating concerns about the impact of temperature on aquatic life throughout the year. The riverscapes in the Upper Yampa segment, however, are not listed as impaired.

The temperature indicator for the Upper Yampa segment is evaluated through an approximately year-long analysis of temperature data recorded from a HOBO temperature logger deployed near the town of Phippsburg, and a USGS stream gauge (09237450) that records continuous temperature data. The HOBO logger was deployed by FOTY and collects data at 30-minute intervals. The USGS gauge is located just upstream of Stagecoach Reservoir and collects data at 15-minute intervals. Results were evaluated against current regulatory standards, primarily the daily maximum (DM) temperature or acute standard, which regulates the maximum temperature that can occur over a 24-hr period, and the maximum weekly average temperature (MWAT) or chronic standard, which sets the maximum allowable temperature for the rolling 7-day mean of daily average temperature (CDPHE 2023).

At the upstream end of riverscape 4, temperature sensor data collected near Phippsburg revealed that in 2023, the daily maximum temperature exceeded the acute DM regulatory standard of 13°C only twice in early October (Figure 4-2). The MWAT was briefly exceeded in early October as well, as shown by the 7-day average temperature (Figure 4-2). In late May of 2024, daily maximum temperatures exceed the acute DM standard by up to 4°C, and the chronic MWAT is also exceeded (Figure 4-2). Beginning in June, the acute and chronic standard temperatures increase (Table 4-1), but five occurrences of daily maximum temperature exceedances occurred in June and July (Figure 4-2). From June to September, although daily maximum temperatures lie within the chronic standard exceedance range, the weekly average temperature did not exceed the MWAT (Figure 4-2). The weekly average temperature, however, does exceed the MWAT during the month of October (until the period of record ended on October 15), and daily maximums exceeded the acute DM standard nine out of the 15 days of monitoring record.

From October 2023 to October 2024, USGS temperature gauge data from above Stagecoach reservoir revealed the daily maximum temperature exceeded the acute DM standard eight times in May, three times in June, and four times in July (Figure 4-3). The weekly average temperature exceeded the chronic MWAT standard for most of the period of record, except for the winter months (November 2023 to late March 2024; Figure 4-3). Additionally, the weekly average temperature did not exceed the MWAT during the month of September 2024 (Figure 4-3).

Figure 4-2. Temperature Data from HOBO Logger Near Phippsburg



Based on the data analyzed and in accordance with the scoring criteria, riverscapes 3 and 4 earned a score of C+ (Table 4-4). Regulatory standards were occasionally exceeded, but the riverscapes are not located within a river reach on the CDPHE Monitoring and Evaluation list. Riverscapes 37, 38, and 1 are located upstream of the Town of Yampa on the Bear River, and riverscape 2 is located on the Yampa River between Yampa and Phippsburg. These riverscapes were given a score

of A based on field-collected water quality samples (collected at both low and high flows) that indicated stream temperatures did not exceed regulatory standards (Table 4-4). These results suggest the temperature regime is natural and appropriate for the Bear River and upper Yampa River. However, these scores are based on very limited instantaneous measurements. It is recommended that continuous monitoring equipment be deployed in riverscape 1 or 2 to more accurately pinpoint the geographic range of potential regulatory exceedances. Increased water diversions on the Yampa main stem suggest reduced streamflow and shallower depths, which can elevate water temperatures. The potential impacts of increasing ambient air temperatures related to climate change and increasing development pressure also suggests future challenges in maintaining suitable water temperatures for aquatic biota. Installation of temperature sensors located in upstream riverscapes will be considered to improve future analyses.

Figure 4-3. Temperature Data from USGS Gauge Above Stagecoach Reservoir

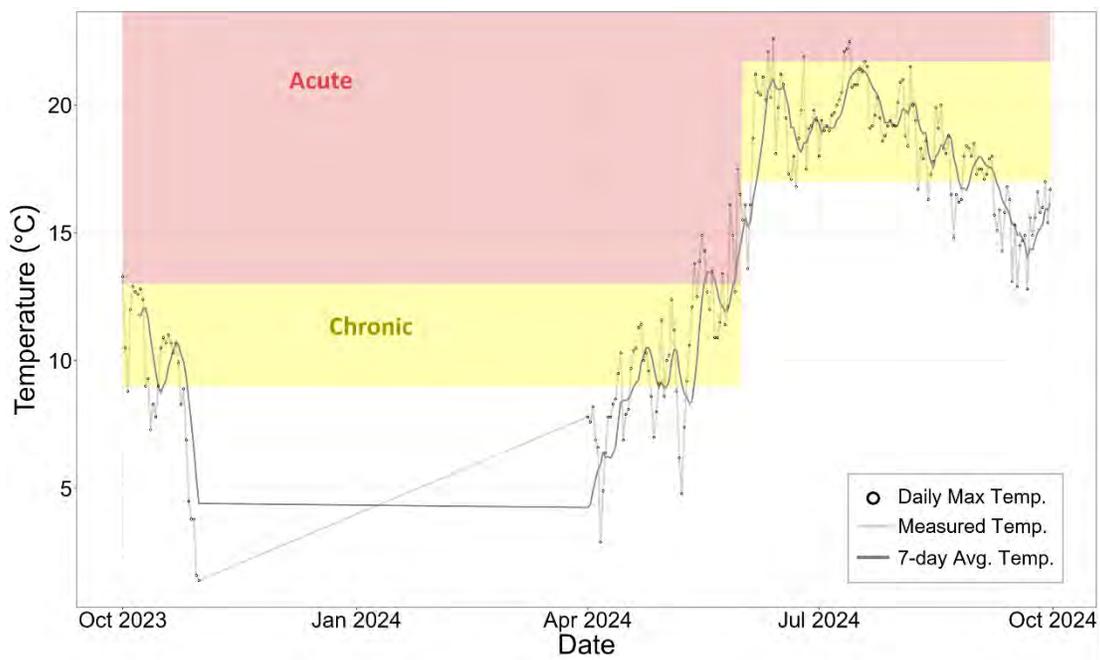


Table 4-4. Temperature Indicator Scores by Riverscape

Riverscape	Temperature Score
Riverscape 37	A
Riverscape 38	A
Riverscape 1	A
Riverscape 2	A
Riverscape 3	C+
Riverscape 4	C+

4.2 DISSOLVED OXYGEN INDICATOR

Dissolved oxygen (DO) is the amount of free oxygen present in the water column and is important for the survival of fish and other aquatic species. To ensure accurate readings when using a water quality meter to record DO, the meter must be suspended in the water column and out of direct contact with the stream bed, which is sometimes difficult in shallow streams.

4.2.1 Data Sources and Evaluation Methods

Field-based water quality parameters including dissolved oxygen are measured quarterly by USGS as part of the Upper Yampa River Basin Water Quality Monitoring Program. One location in the Upper Yampa Scorecard focal segment is part of this monitoring program: Yampa River above Stagecoach Reservoir. Data were downloaded from nwis.waterdata.usgs.gov. Additionally, in-situ DO was measured by FOTY during the collection of water quality samples in the Upper Yampa segment (Table 4-1, Figure 4-1) and considered in these analyses.

4.2.2 Scoring Criteria

Similar to temperature, the dissolved oxygen scoring criteria outlined in Table 4-5 are based on regulatory standards.

Table 4-5. Dissolved Oxygen Indicator Scoring Criteria

Grade	Description
A	Dissolved oxygen concentrations are natural and appropriate for a well-functioning river in its process domain.
B	Dissolved oxygen concentrations are within the range of natural variability. Natural aquatic biota may be minimally impaired. Regulatory standards are not exceeded.
C	Dissolved oxygen concentrations are altered to a degree that could significantly affect natural aquatic biota. Regulatory standards (6.0 mg/L or 5.0 mg/L) are occasionally exceeded. CDPHE Monitoring and Evaluation (M&E) listed reaches fall in this category.
D	Dissolved oxygen concentrations are altered to a degree that is known to affect natural aquatic biota. Regulatory standards (6.0 mg/L or 5.0 mg/L) are frequently exceeded. CDPHE 303(d) listed reaches fall in this category.
F	Dissolved oxygen concentrations are fundamentally altered. Natural biota are severely impaired. Regulatory standards are chronically exceeded.

4.2.3 Results

The dissolved oxygen indicator is evaluated through review of USGS Water Quality Monitoring Program data at the Yampa River above Stagecoach Reservoir located in riverscape 4. Additional instantaneous data from water quality sampling are also considered due to the lack of available USGS monitoring locations. Because rivers integrate upstream inputs, data from the one USGS station in the focal segment are used to score riverscape 3, and data from instantaneous water quality sampling in riverscapes 38 and 2 are used to score riverscapes 37 and 1, respectively.

Dissolved oxygen concentrations at the Yampa River above Stagecoach Reservoir are well above the standard for aquatic life for each year between 2010 and 2023 (Figure 4-4). Based on these

data, riverscapes 3 and 4 are within healthy standards and are functional for this parameter and receive an A score (Table 4-6). Instantaneous DO measurements from water quality sampling in riverscapes 38 and 2 also indicate DO levels higher than the standard, suggesting these riverscapes support a well-functioning river for this parameter (Table 4-6).

Figure 4-4. Dissolved Oxygen Concentrations from Quarterly Water Sampling at USGS Gauge Yampa Above Stagecoach (2010-2024)

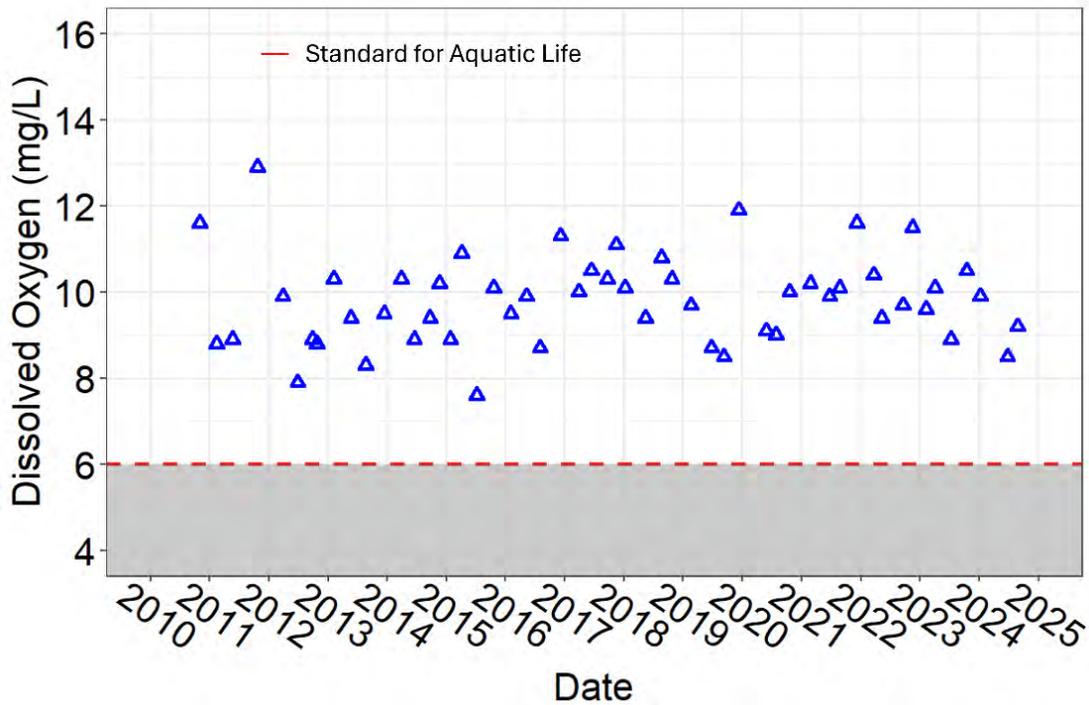


Table 4-6. Dissolved Oxygen Indicator Scores by Riverscape

Riverscape	Dissolved Oxygen Score
Riverscape 37	A
Riverscape 38	A
Riverscape 1	A
Riverscape 2	A
Riverscape 3	A
Riverscape 4	A

4.3 pH INDICATOR

pH is a measure of water acidity that runs on a scale from 0 to 14, where lower numbers indicate high acidity, pH 7 is neutral, and higher numbers indicate water that is more basic. The ranges of many aquatic species are limited by pH. The pH of a water quality sample can be affected by biological activity in a stream, geology, precipitation, and human activities (Bauch et al. 2012).

4.3.1 Data Sources and Evaluation Methods

Field-based water quality parameters including pH are measured quarterly by USGS as part of the Upper Yampa River Basin Water Quality Monitoring Program. One location in the Upper Yampa segment is part of this monitoring program: Yampa River above Stagecoach Reservoir. Data were downloaded from nwis.waterdata.usgs.gov. Additionally, in-situ temperature was measured by FOTY during the collection of water quality samples in the Upper Yampa segment (Table 4-1, Figure 4-1) and considered in these analyses.

4.3.2 Scoring Criteria

Similar to temperature and dissolved oxygen, the scoring criteria for pH outlined in Table 4-7 are based on adherence to regulatory standards.

Table 4-7. pH Indicator Scoring Criteria

Grade	Description
A	pH values are natural and appropriate for a well-functioning river in its process domain.
B	pH values are within the range of natural variability. Natural aquatic biota may be minimally impaired. Regulatory standards are met.
C	pH is altered to a degree that could significantly affect natural aquatic biota. pH values occasionally fall outside the range of regulatory standards (6.5 - 9.0). CDPHE Monitoring and Evaluation (M&E) listed reaches fall in this category.
D	pH is altered to a degree that is known to affect natural aquatic biota. pH values frequently fall outside the range of regulatory standards (6.5 - 9.0). CDPHE 303(d) listed reaches fall in this category.
F	pH is fundamentally altered. Natural biota are severely impaired. pH values chronically fall outside the range of regulatory standards.

4.3.3 Results

The pH indicator is evaluated through review of USGS Water Quality Monitoring Program data at the Yampa River above Stagecoach Reservoir. Additional instantaneous data from water quality sampling are also considered due to the lack of available USGS monitoring locations. Because rivers integrate upstream inputs, data from the one USGS station in the focal segment are used to score riverscape 3, and data from instantaneous water quality sampling in riverscapes 38 and 2 are used to score riverscapes 37 and 1, respectively.

pH values less than 4 and greater than 10 can lead to mortality of aquatic life if the condition persists (Bauch et al. 2012). Standards for aquatic life (6.5 - 9) set by the CDPHE were used to

score the pH indicator (Table 4-7). pH values do not fall outside the range of regulatory standards for aquatic life (Figure 4-5). Regulatory standards are regularly and consistently met. Values of pH across the Upper Yampa segment indicate slightly alkaline conditions, with pH values generally ranging from 7.5 to 9 from 2010 to 2024 (Figure 4-5). Instantaneous pH measurements taken in riverscapes 38 and 2 (Table 4-1) also fall within the range of regulatory standards. All riverscapes received an A score (Table 4-8).

Figure 4-5. pH Values from Quarterly Water Sampling at USGS Gauge Yampa Above Stagecoach (2010-2024)

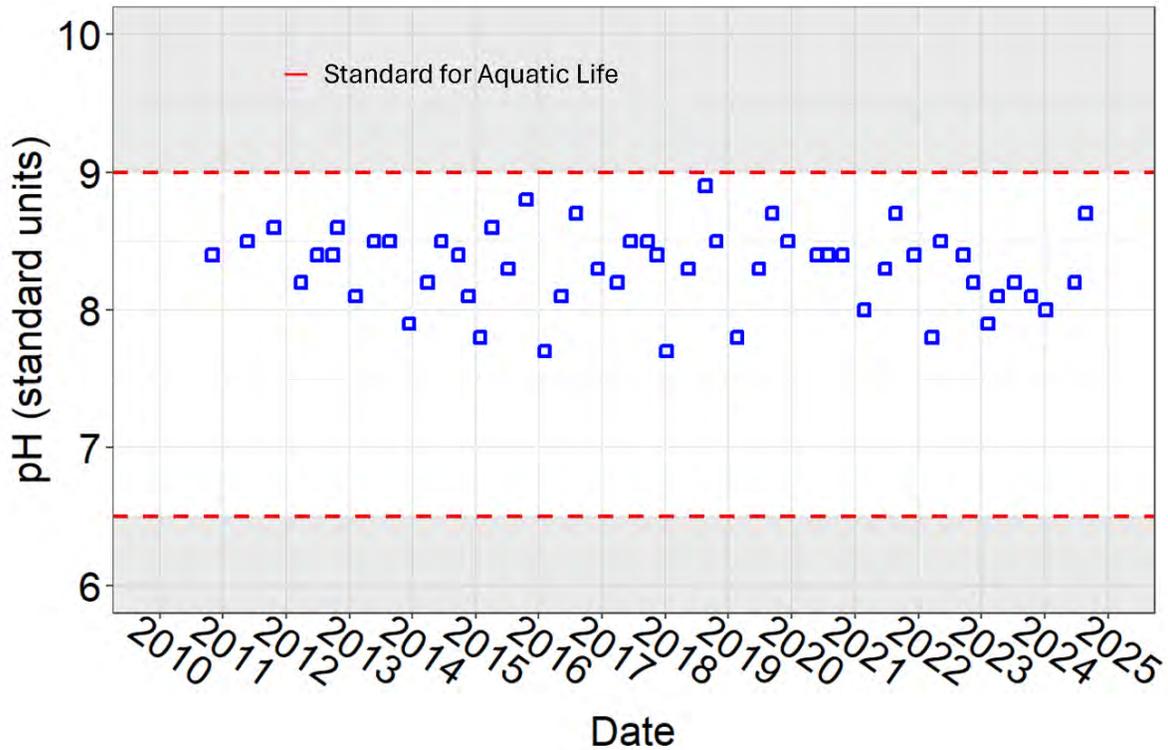


Table 4-8. pH Indicator Scores by Riverscape

Riverscape	pH Score
Riverscape 37	A
Riverscape 38	A
Riverscape 1	A
Riverscape 2	A
Riverscape 3	A
Riverscape 4	A

4.4 MACROINVERTEBRATES INDICATOR

Benthic macroinvertebrates are excellent indicators of the condition of lotic aquatic systems because macroinvertebrates are found in almost all freshwater environments, have a small home range, are relatively easy to sample and identify, and the different taxonomic groups show varying degrees of sensitivity to pollution and other stressors (CDPHE 2016a, Barbour et al. 1999). Benthic macroinvertebrate community monitoring is a useful tool for river health monitoring, particularly if baseline data are available.

Many comparative metrics may be used to assess the health of the benthic community, including the number of individuals; total number of taxa; total number of pollution-sensitive Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa; percentage of EPT taxa; ratios of different functional feeding groups or taxonomic groups; Shannon-Wiener Diversity Index (SDI); Hilsenhoff Biotic Index (HBI); and many others. The SDI is a mathematical measure of species diversity within a given community. For benthic macroinvertebrates, values range from 0-5, and higher values indicate higher species diversity (MacArthur 1965). The HBI reveals the relative abundance of pollution-tolerant species. Scores range from 0-10, where a higher value indicates more pollution-tolerant species are present (Hilsenhoff 1987).

The Colorado Department of Public Health and Environment (CDPHE) monitors streams throughout the state for assessment and protection of water resource quality. Their principal indicator is a multi-metric index (MMI) based on direct benthic macroinvertebrate sample data. By using five to six equally weighted metrics, the MMI combines measures of diversity, abundance, pollution tolerance, community structure, and other factors to generate a normalized score of 0-100 for each sample. Scores may then be compared to reference threshold scores for one of three generalized Colorado biotypes (mountains, transition, plains). In “grey” areas where the MMI alone is not sufficient, CDPHE also compares SDI and HBI results to attainment and impairment threshold values.

4.4.1 *Data Sources and Evaluation Methods*

Historical benthic macroinvertebrate data are scarce for the Upper Yampa segment. Given the paucity of existing data, the relative ease of collecting and analyzing macroinvertebrate data, and the useful information that can be gleaned from these data, the Scorecard project provides a prime opportunity for evaluating the macroinvertebrate community and tracking changes over time.

Six benthic macroinvertebrate community samples were collected in the Upper Yampa segment for the Scorecard project effort: one in each riverscape. Macroinvertebrate monitoring occurred during the low-flow period in late August 2024, and followed the SOP used by CDPHE for benthic macroinvertebrate sampling (CDPHE 2016). Detailed procedures for sample collection, processing, and preservation are provided in the SOP. Samples were collected by project partners using River Watch protocols and sent to Timberline Aquatics for taxonomic identification and data analysis.

4.4.2 Scoring Criteria

The scoring criteria outlined in Table 4-9 are based on adherence to regulatory standards set by CDPHE for the relevant biotype (biotype 2/mountain for riverscapes 37 and 38, and biotype 1/transition for riverscapes 1-4) using mainly MMI scores and CDPHE-designated attainment and impairment thresholds. Because component metrics incorporated into the MMI are designed to detect water quality impairments and are less sensitive to changes in habitat, results of other comparative metrics are also considered during the scoring process.

Table 4-9. Benthic Macroinvertebrate Indicator Scoring Criteria

Grade	Description
A	The reach is considered to be representative of the expected condition for aquatic insect communities and aquatic life use for a well-functioning river in its process domain. No management is needed other than protection of existing conditions. MMI score is 80-100 and the reach is in attainment for aquatic life use (CDPHE 2016).
B	Some detectable stressors are evident with minor alterations to aquatic insect communities. The ecological system retains its overall structure and supports a high level of function. Some management may be required to sustain or improve this condition. MMI score is in the 60-79 range, other metrics are generally indicative of a diverse and functional macroinvertebrate community, and the reach is in attainment for aquatic life use (CDPHE 2016).
C	The reach supports and maintains essential components of the unimpaired aquatic insect community, but exhibits measurable signs of degradation and less than optimal community parameters. Management is required (or recommended) to maintain and improve this condition. MMI score is in the 46-59 range and meets the CDPHE (2016) attainment threshold for aquatic life use, but other metrics are generally indicative of an impaired or unbalanced macroinvertebrate community.
D	Detectable alterations or degradation of aquatic life use are present, but the system still supports a fundamental aquatic insect community structure and function. Active management is required (or recommended) to maintain and improve characteristic functional support. MMI score is 34-45 and is considered to be in the “gray area” between aquatic life use attainment and impairment (CDPHE 2016).
F	Clear impairment to the aquatic insect community and aquatic life is present. This level of alteration generally results in an inability to support characteristic aquatic organisms, or makes the stream segment biologically unsuitable. MMI score is < 34 and aquatic life use is thus considered “impaired” (CDPHE 2016).

4.4.3 Results

The macroinvertebrates indicator is evaluated through analysis of data collected via the Scorecard project at benthic community monitoring locations within the Upper Yampa segment (Figure 4-1). All samples collected within the Upper Yampa segment exhibited moderately healthy macroinvertebrate communities. In particular, total taxa ranged between 31-44 taxonomic groups, species diversity scores were relatively high at all locations, and all locations exhibited a well-balanced array of functional feeding groups. In addition, MMI scores ranged from 51 to 71,

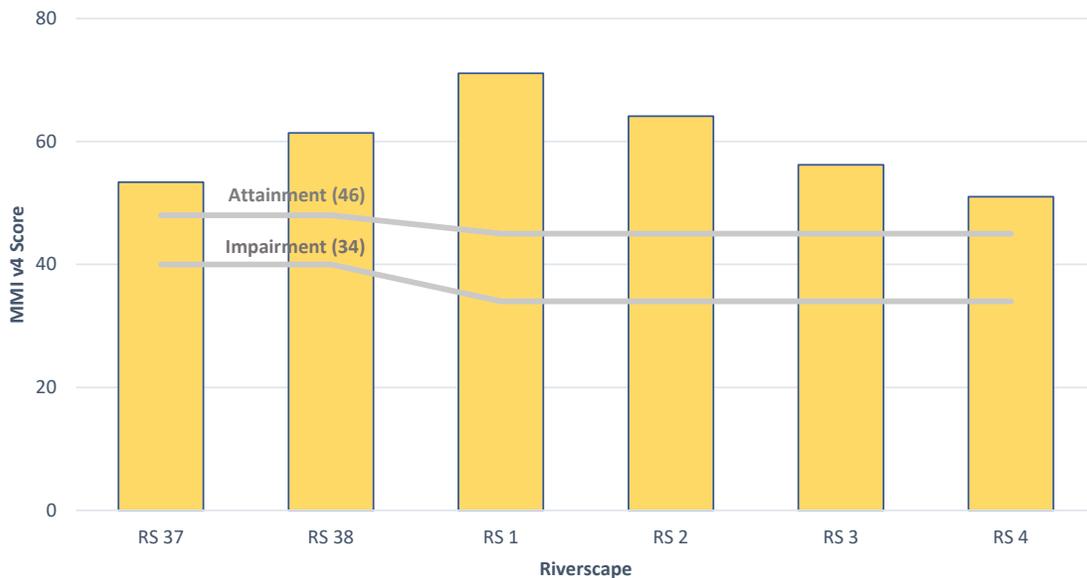
well above the CDPHE aquatic life use “attainment” threshold of 45 and 48 for biotype 1 and biotype 2 samples, respectively (Table 4-10, Figure 4-6).

Table 4-10. Select Macroinvertebrate Metrics by Riverscape

Riverscape/ Metric	RS 37	RS 38	RS 1	RS 2	RS 3	RS 4
MMI v4	53.4	61.4	71.1	64.1	56.2	51.0
Diversity	3.77	3.68	3.83	3.16	3.20	3.75
Evenness	0.718	0.692	0.725	0.638	0.587	0.714
HBI	4.80	2.46	4.07	3.81	4.30	5.43
EPT	18	18	15	14	21	16
% EPT	25.0%	73.0%	23.6%	54.2%	49.3%	39.0%
Total Taxa	38	40	39	31	44	38
% Chironomids	56.3%	6.7%	27.2%	7.6%	10.9%	36.4%

Although riverscape 37 has a relatively low MMI score and percent of pollution-intolerant taxa (EPT) score, it still has a comparatively high number of EPT taxa, suggesting that those sensitive taxa are still present, albeit in lower numbers. The relatively high percentage of chironomids is likely associated with the surrounding lentic waters (both reservoirs and beaver ponds). Chironomids are the most common macroinvertebrates in rivers and streams, and are a major food source for trout species. These organisms tend to do well in areas accumulations of fine sediment, and numbers are likely high because the sampling location, while in a riffle, is surrounded by slower-moving habitat areas.

Figure 4-6. Macroinvertebrate MMI Scores by Riverscape



The statistics from riverscape 4 illustrate some of the impacts that agriculture can have on macroinvertebrate communities. The HBI score is the only one that is higher than the HBI threshold of 4.9, indicating that the proportion of nutrient-tolerant individuals is elevated. This site also has the lowest MMI score, as well as a relatively low number of EPT taxa. The proportion

of functional feeding groups is also slightly skewed, with a reduced proportion of scraper taxa compared to other sites (Table 4-11). Scraper taxa typically do not tolerate locations where filamentous algae is abundant, and the reduction in scrapers may be evidence of impacts generally associated with agricultural operations such as grazing and fertilization.

Table 4-11. Macroinvertebrate Functional Feeding Group Percent Composition by Riverscape

Riverscape/ Functional Feeding Group	RS 37	RS 38	RS 1	RS 2	RS 3	RS 4
Collector-Gatherer	80%	35%	45%	34%	39%	63%
Collector-Filterer	4.5%	1.7%	4.7%	25%	31%	28%
Shredder	0.4%	27%	6.1%	0.3%	0.9%	0.2%
Scraper	3.7%	23%	38%	37%	28%	6.9%
Predator	8.6%	9.5%	6.3%	3.8%	1.2%	2.0%
Omnivore	3.0%	3.6%	0.2%	0.0%	0.0%	0.0%

Overall, Upper Yampa segment riverscapes received scores between B and C for the macroinvertebrate indicator (Table 4-12). While the riverscapes with lower scores are still in attainment of the aquatic life use per CDPHE guidelines, there is room for improvement for these benthic populations to become more robust and healthier in the future and opportunities for limited management, particularly related to grazing and fertilizer application, to help improve conditions at these locations.

Table 4-12. Macroinvertebrate Indicator Scores by Riverscape

Riverscape	Macroinvertebrate Score
Riverscape 37	C+
Riverscape 38	B-
Riverscape 1	B
Riverscape 2	B-
Riverscape 3	C+
Riverscape 4	C

4.5 NUTRIENTS INDICATOR

Nutrients in stream water are essential for plants and animals. They occur naturally due to processes such as weathering and erosion, breakdown of organic material, and atmospheric deposition, but high nutrient levels are not good for stream health. Elevated nutrient levels in surface waters can result from human activities such as fertilizer application, runoff from agricultural and urban areas, effluent from wastewater treatment, seepage from septic systems, detergent, animal waste, and fuel combustion. Elevated nutrient levels can also cause algal blooms. In the last decade, concerns about cyanobacteria and associated cyanotoxins have been expressed by stakeholders in the Yampa Basin as algal blooms have been reported in local lakes

and reservoirs, so this indicator is of public interest and therefore important to evaluate for the Scorecard.

4.5.1 Data Sources and Evaluation Methods

Nutrients, including total nitrogen and phosphorus, are measured quarterly by USGS as part of the Upper Yampa River Basin Water Quality Monitoring Program. One location in the Upper Yampa segment is part of this monitoring program: Yampa River above Stagecoach Reservoir. Data were downloaded from nwis.waterdata.usgs.gov. Additionally, FOTY collected two water quality samples in the Upper Yampa segment (Figure 4-1) and considered the data in these analyses.

4.5.2 Scoring Criteria

The scoring criteria outlined in Table 4-13 based on adherence to interim regulatory standards set by CDPHE for nitrogen and phosphorus are used to rate the nutrients indicator.

Table 4-13. Nutrients Indicator Scoring Criteria

Grade	Description
A	Nutrient levels are natural and appropriate for a well-functioning river in its process domain.
B	Nutrient levels are within the range of natural variability. Natural aquatic biota may be minimally impaired. Interim regulatory standards are not exceeded.
C	Nutrient levels are altered to a degree that could significantly affect natural aquatic biota. Interim regulatory standards (0.11 mg/L (cold) and 0.17 mg/L (warm) for total phosphorus; 1.25 mg/L (cold) and 2.01 mg/L (warm) for total nitrogen) are occasionally exceeded. CDPHE Monitoring and Evaluation (M&E) listed reaches fall in this category.
D	Nutrient levels are altered to a degree that is known to affect natural aquatic biota. Interim regulatory standards (0.11 mg/L (cold) and 0.17 mg/L (warm) for total phosphorus; 1.25 mg/L (cold) and 2.01 mg/L (warm) for total nitrogen) are frequently exceeded. CDPHE 303(d) listed reaches fall in this category.
F	Unnaturally eutrophic or oligotrophic conditions clearly affect the distribution and abundance of characteristic aquatic life. Interim regulatory standards have been exceeded consistently.

4.5.3 Results

The nutrients indicator is evaluated through review of USGS Water Quality Monitoring Program data at the Yampa River above Stagecoach Reservoir monitoring locations, where total phosphorus (TP), total Kjeldahl (organic) nitrogen (TKN), and total nitrogen T(N) have been measured quarterly since 2010. Because rivers integrate upstream inputs, data from the Yampa River above Stagecoach Reservoir station (located in riverscape 4) are used to score riverscapes 3 and 4, and data from water quality sampling in riverscapes 38 and 2 (Figure 4-1) are used to score riverscapes 37 and 1, respectively. A USGS analysis of nutrient data (both concentrations and loads) in the Upper Yampa Basin for the 1992-2018 period was completed in 2021; more specifically, this report analyzed nutrient data at the Yampa River above Stagecoach Reservoir

station from 1992-2018 (Table 4-14). Scoring is based upon that analysis, the findings of which have been synthesized for the purpose of the Scorecard and are presented below (Day 2021), as well as additional examination of the data after the period covered in the USGS report (2019-2024). Details of the methodology used in the nutrient analysis that yielded the summarized results below can be found in the body of the referenced USGS report (Day 2021).

Total nitrogen (inorganic + organic nitrogen; TN) is measured quarterly by USGS at the site mentioned above, as is Kjeldahl nitrogen (TKN). In the USGS report, daily concentrations of constituents are estimated from quarterly samples using linear regression models fit with R-LOADEST, a USGS-developed statistical program designed to calculate nutrient loads from periodic sampling data (see equation 1 of Day [2021] for mathematical explanation). Daily estimations of TN are not able to be made due to lack of the requisite number of samples; therefore, daily estimations of TKN are used as a surrogate for TN. Notably, daily estimations do not include quarterly sampling data from 2019-2024; rather, only the discrete data for this latter period were analyzed for the purposes of the Scorecard.

Table 4-14. Modeled Median Kjeldahl Nitrogen and Total Phosphorous Concentrations for Each Water Year and the Overall Period of Analysis, 2010-2018 (adapted from Day [2021])

Station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2010-18
Modeled Median Kjeldahl Nitrogen concentration (mg/L)										
Yampa River above Stagecoach Reservoir	0.55	0.32	0.3	0.31	0.31	0.31	0.30	0.31	0.29	0.32
Modeled Median Total Phosphorous Concentration (mg/L)										
Yampa River above Stagecoach Reservoir	0.088	0.059	0.050	0.050	0.056	0.054	0.049	0.051	0.043	0.054

Note: All years are water year (October-September) rather than calendar year

Estimated median annual TKN was well below the interim regulatory standard of 1.25 mg/L for cold water rivers for all evaluated water years at the gauging station in the focal segment (Table 4-14). Modeled monthly median concentrations for TKN were also well below the regulatory standard for all days across the analysis period at each site (Figure 4-7).

TKN was typically the highest during the summer months of May, June, and July (Figure 4-7). Day (2021) mentions concentrations of water-quality constituents were typically highest in the spring months during early snowmelt runoff period for USGS gauging stations downstream of Stagecoach Reservoir, suggesting different factors control nitrogen input at the Yampa River Above Stagecoach station. Above Stagecoach Reservoir, the Yampa River subbasin contains the highest percentage of hay fields and pasturelands in the Upper Yampa River Basin (Day 2021), so grazing practices may be influencing soil erosion and ultimately the amount of nitrogen that ends up in streams. Similar to model results, discrete TKN and TN concentrations (Figure 4-8) remained below the interim regulatory standard for all quarterly samples. Lastly, results from water quality samples collected in riverscapes 38 and 2 showed TKN concentrations less than the 1.25 mg/L

standard (Table 4-1). Based on the available data, all riverscapes earn a score of A with respect to nitrogen.

Figure 4-7. Modeled Monthly Median Kjeldahl Nitrogen and Total Phosphorus at Yampa River Above Stagecoach USGS Station from 2010-2018 (Adapted from Day [2021])

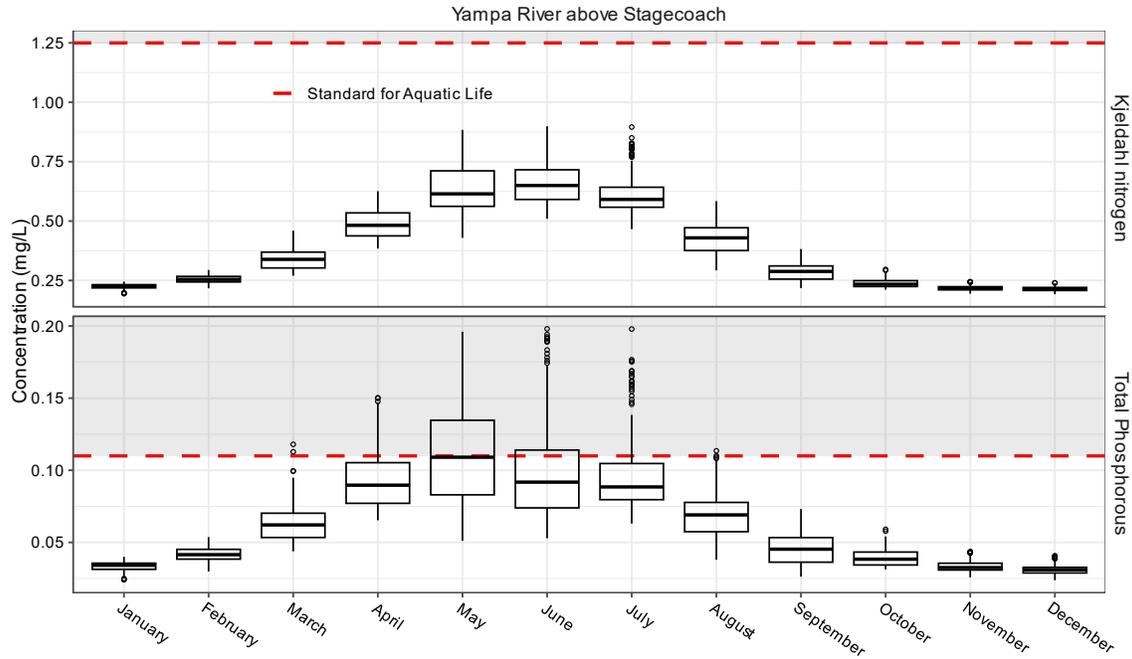
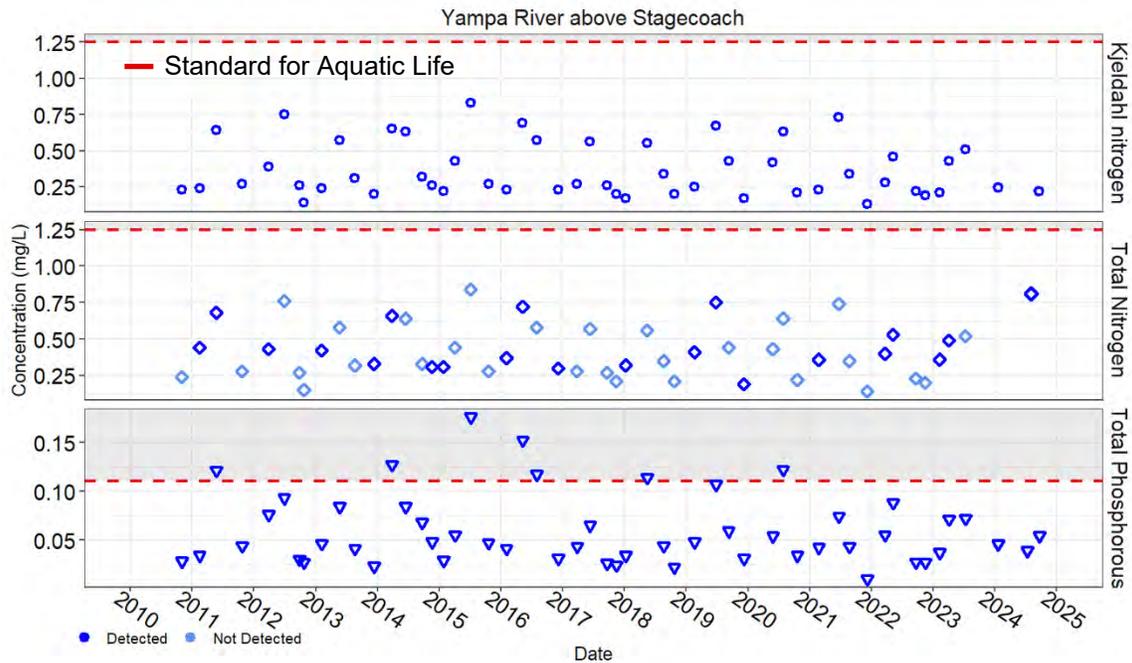


Figure 4-8. Measured (Discrete) Kjeldahl Nitrogen, Total Nitrogen, and Total Phosphorus at Yampa River Above Stagecoach USGS Station (2010-2024)



Like nitrogen, total phosphorous (TP) is measured quarterly at the Yampa River Above Stagecoach Reservoir station, and these quarterly samples were used to estimate daily TP concentrations. Estimated median annual total phosphorous (TP) was below the interim regulatory standard of 0.11 mg/L for cold water rivers at the Yampa River Above Stagecoach station for all years (Table 4-14). However, summarizing the data at the annual scale obscures some trends; at closer examination, estimated daily concentrations exceeded the standard frequently during the summer months (Figure 4-7). More specifically, median monthly values of TP for the period analyzed exceed the standard March through August (Figure 4-7). Additional information is provided by examining the modeled data on the daily scale. The median number of days over the period of record in which the interim water quality standard is exceeded are 2, 16, 27, 19, 5, and 2 days for the months of March through August, respectively. Discrete phosphorous concentrations also showed exceedances of the interim regulatory standard seven times from March-August between 2010 and 2023 (Figure 4-8). Water quality samples collected in Riverscapes 38 and 2 showed TP concentrations less than the 0.11 mg/L standard during low flow conditions in the month of August, but during high flow conditions in June, TP was measured as 0.131 mg/L at the sampling location in riverscape 2 (Figure 4-1). The TP measured below the standard during June at the sampling location in riverscape 38 (Figure 4-1). Riverscapes 37 and 38 thus receive A scores and riverscapes other than 37 and 38 each receive C scores regarding TP given their exceedance of interim regulatory standards. Combined nutrient indicator scores are provided in Table 4-15.

Table 4-15. Nutrients Indicator Scores by Riverscape

Riverscape	Nitrogen Score	Phosphorus Score	Nutrients Score
Riverscape 37	A	A	A
Riverscape 38	A	A	A
Riverscape 1	A	C	B
Riverscape 2	A	C	B
Riverscape 3	A	C	B
Riverscape 4	A	C	B

4.6 METALS INDICATOR

Metals generally occur at low concentrations in surface waters, and a number of them are essential nutrients to aquatic biota, but they are toxic at higher concentrations. CDPHE sets regulatory standards for most metals based on the uses identified for each stream segment (e.g., water supply, agriculture, recreation, aquatic life protection); if water quality samples frequently exceed these standards, the stream segment is placed on the State's 303(d) or M&E (monitoring and evaluation) list for that particular constituent.

4.6.1 Data Sources and Evaluation Methods

Select trace metals (total iron and manganese; dissolved cadmium, copper, lead, manganese, selenium, silver, and zinc) are measured quarterly by USGS as part of the Upper Yampa River Basin Water Quality Monitoring Program. One location in the Upper Yampa segment is part of this monitoring program: Yampa River above Stagecoach Reservoir. Data were downloaded from nwis.waterdata.usgs.gov. Additionally, FOTY also collected two water quality samples in the Upper Yampa segment (Table 4-1, Figure 4-1) and considered the data in these analyses.

4.6.2 Scoring Criteria

The scoring criteria outlined in Table 4-16 based on adherence to regulatory standards set by CDPHE are used to rate the metals indicator.

Table 4-16. Metals Indicator Scoring Criteria

Grade	Description
A	Chemical conditions are within ranges that are natural and appropriate for a well-functioning river in its process domain.
B	Chemical conditions are within the range of natural variability. Natural aquatic biota may be minimally impaired even though background concentrations of certain metals may be elevated. Regulatory standards are not exceeded (except for metals with elevated background concentrations).
C	Chemical conditions are altered to a degree that could potentially limit natural aquatic biota. Stressors are present which create conditions that may warrant inclusion on State impaired waters lists. CDPHE Monitoring and Evaluation (M&E) listed reaches fall in this category.
D	Chemical conditions are altered to a degree that is known to be lethal or limiting to natural aquatic biota. Regulatory standards are frequently exceeded. CDPHE 303(d) listed reaches fall in this category.
F	The chemical environment is fundamentally altered. Natural biota are severely impaired. Regulatory standards have been exceeded consistently.

4.6.3 Results

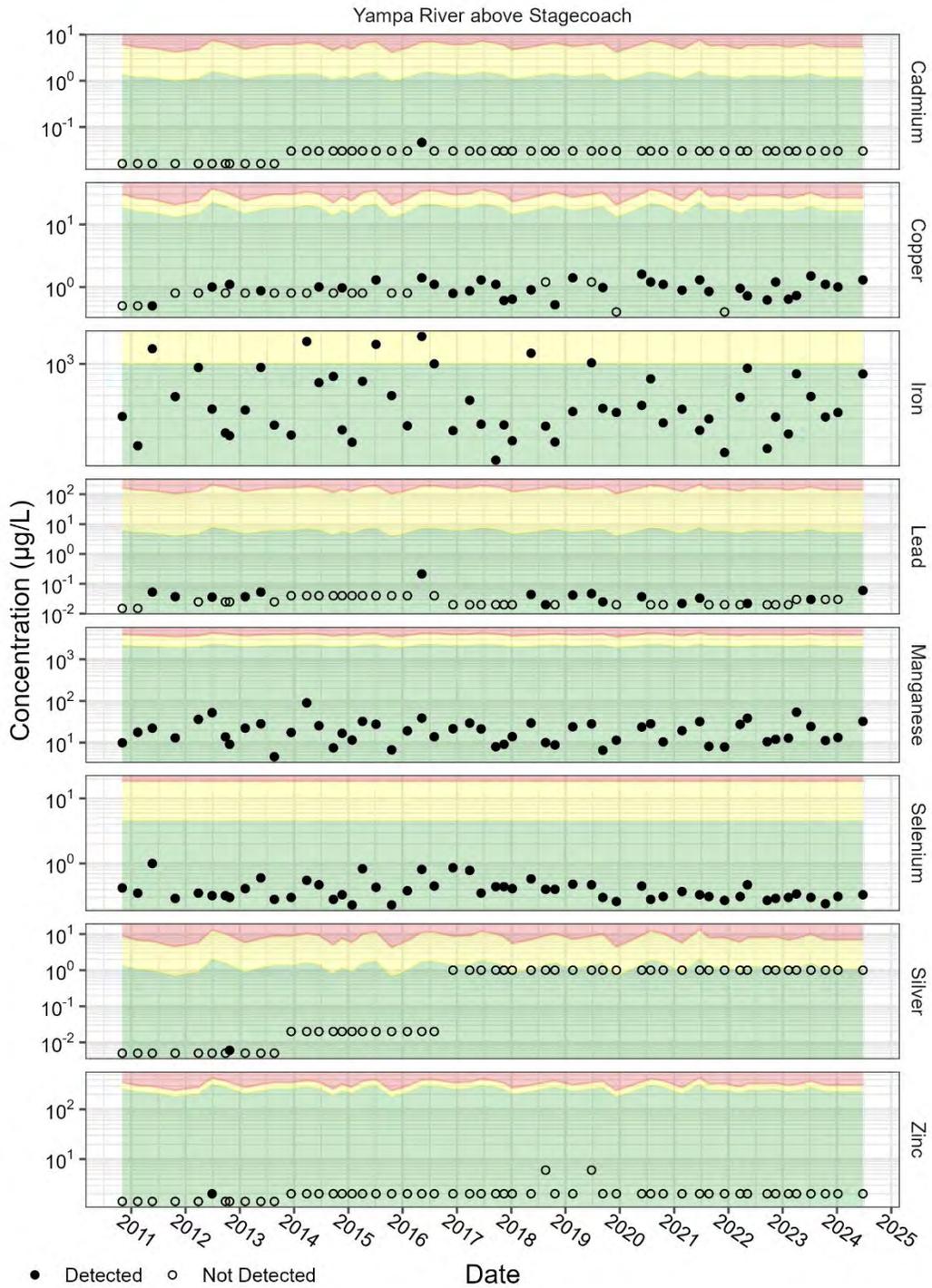
The metals indicator is evaluated through review of USGS Water Quality Monitoring Program data at the Yampa River Above Stagecoach Reservoir monitoring location, where total iron, total and dissolved manganese, dissolved cadmium, dissolved copper, dissolved lead, dissolved selenium, dissolved silver, and dissolved zinc are measured quarterly. As was done with other water quality indicators, because rivers integrate upstream inputs, data from the Yampa River Above Stagecoach Reservoir station (located in riverscape 4) are used to score riverscape 3, and data from water quality sampling in riverscapes 38 and 2 (Figure 4-1) are used to score riverscapes 37 and 1, respectively. A USGS analysis of metals and other water quality data for the Upper Yampa Basin for the 1979-2009 period was completed in 2012; portions of this report that contain analysis and interpretation of data for the Upper Yampa focal segment were examined for additional context (Bauch et al. 2012).

Figure 4-9 summarizes the total iron and dissolved metals concentrations from quarterly sampling at the Yampa River above Stagecoach Reservoir station. Open circles indicate that concentration was below the level of the position of the point (e.g., an open circle at 1 mg/L for silver suggests that silver concentration for that sample was < 1 mg/L; Figure 4-9). Red shading corresponds to the respective metal's acute contamination standard, the yellow shading for the chronic standard, and the green shading represents the acceptable the range for aquatic life (Figure 4-9). Of the metal constituents analyzed, all except iron were consistently below CDPHE regulatory standards (though the detection limit of the method used to calculate silver concentrations post-2015 precludes stating this with certainty; Figure 4-9). Elevated iron levels are likely lithologically driven; the sedimentary and igneous rocks in the Yampa Basin contain iron and iron-bearing minerals in relatively high concentrations (Bauch et al. 2012). Likely because of the high natural iron content in the surrounding rocks and because of the relatively few exceedances of the regulatory standard, the CDPHE monitoring sections of the Yampa River contained within the Upper Yampa segment riverscapes are not listed as M&E or 303(d) for metals. Low iron levels (<0.3 mg/L) were also seen in water quality sampling results at both sampling locations for both high and low flow events. Overall, the relatively low concentrations of metals in the analyzed riverscapes aligns with the recent cessation or overall lack of activities that generally enhance in-stream concentrations of metallic species (e.g., industrial production, mining of precious metals). Every riverscape therefore scores an A for the metals indicator (Table 4-17).

Table 4-17. Metals Indicator Scores by Riverscape

Riverscape	Metals Score
Riverscape 37	A
Riverscape 38	A
Riverscape 1	A
Riverscape 2	A
Riverscape 3	A
Riverscape 4	A

Figure 4-9. Total (Iron) and Dissolved Metals Concentrations from Quarterly Water Sampling at Yampa River Above Stagecoach USGS Station (2010-2024)



5.0 HABITAT CONNECTIVITY

Habitat connectivity is defined as the interaction and interconnectedness between a river segment and its surrounding landscape, including pathways for movement of biological organisms and organic matter through the riparian corridor. This category includes connectivity of both terrestrial and aquatic communities and considers both longitudinal (upstream/downstream) and lateral (channel/floodplain/upland) directions. The Yampa River Scorecard evaluates two indicators within the habitat connectivity category: **aquatic connectivity** and **terrestrial connectivity**. The final habitat connectivity score is calculated as an average of the aquatic connectivity and terrestrial connectivity indicator scores.

5.1 AQUATIC CONNECTIVITY INDICATOR

The aquatic connectivity indicator addresses the ability for aquatic organisms to migrate and disperse in both longitudinal (upstream/downstream) and lateral (between the channel and floodplain, e.g., side channels) directions. This indicator looks at the presence or absence of barriers to aquatic movement, as well as the presence and relative abundance of connected lateral aquatic habitats.

5.1.1 *Data Sources and Evaluation Methods*

Data used to score this indicator are collected by hiking as much of the Upper Yampa segment as possible given private property and accessibility constraints and identifying (and marking with GPS) any in-channel structures and barriers to aquatic species movement, as well as connected lateral aquatic habitats. This fieldwork was completed in summer of 2024 coordinated in partnership with local landowners (Appendix A). To the extent possible, observers assessed the height of channel-spanning structures and the amount of time of the year and associated flow conditions where that structure poses a barrier to aquatic species movement (e.g., only passable during spring runoff, impassable during all flow conditions, etc.). Other in-channel structures, such as cross-vanes, weirs, and boulder features were also noted.

Field hiking during summer 2024 also identified the following features that are important to aquatic species migrating laterally for spawning and cover:

- Permanently inundated side channels;
- Seasonally inundated side channels;
- Backwater areas; and
- Split flows (i.e., two narrow channels versus one wide channel).

Fieldwork is augmented by review of historical aerial imagery to reflect the complexity and evolution of the riverscapes in terms of aquatic connectivity.

5.1.2 *Scoring Criteria*

The scoring criteria outlined in Table 5-1 based on presence and extent of barriers to aquatic species movement and abundance of connected lateral aquatic habitats are used to rate the aquatic habitat connectivity indicator.

Table 5-1. Aquatic Connectivity Indicator Scoring Criteria

Grade	Description
A	No significant barriers exist that prevent migration or dispersal of aquatic organisms within the entire ecoregion and upstream headwaters.
B	Impermeable migration/dispersal barriers are at least 10 miles apart and/or there are minor migration/dispersal impediments on the reach or adjacent reaches. Mild loss of side channel and/or backwater area access may impact spawning and cover for certain species.
C	Impermeable migration/dispersal barriers are approximately 5 miles apart and/or there are multiple migration/dispersal impediments on the reach or adjacent reaches. Moderate loss of side channel and/or backwater area access may impact spawning and cover for certain species.
D	Impermeable migration/dispersal barriers are approximately 2 miles apart and/or migration/dispersal is severely impeded on the reach or adjacent reaches. Substantial loss of side channel and/or backwater area access may impact spawning and cover for certain species.
F	The reach is effectively isolated. Impermeable migration/dispersal barriers are approximately 1 mile apart or less and/or migration/dispersal is completely impeded on the reach or adjacent reaches. Access to side channel and/or backwater areas for spawning and cover is unavailable.

5.1.3 Results

The results of aquatic connectivity scoring are composed of two parts that together yield an overall score for this indicator: barriers to longitudinal connectivity (e.g., channel-spanning structures such as dams) and pathways for lateral connectivity (e.g., side channels).

The Upper Yampa segment identified in the Yampa IWMP encompasses riverscapes 1-4 (Yampa IWMP 2022). These riverscapes had some of the highest diversion infrastructure density compared to lower segments of the Yampa River, around 5 diversion structures per square mile (Yampa IWMP 2022). This finding supports the heavy agriculture land use intensity near the Town of Yampa and the primary use of the Bear River reservoirs as irrigation. In the Middle and Lower Yampa segments where riverscapes are more unconfined, “push-up”-style diversions are frequently used (Yampa IWMP 2022). However, in the Upper Yampa (riverscapes 37, 38, and 1-4) where riverscapes are more confined, it appears that more traditional channel-spanning barriers such as concrete dams and diversion structures are utilized (Appendix A, Photos A-6 through A-8). These structures are primarily intended for bank stabilization/protection and flow direction, but they negatively impact aquatic life by limiting the longitudinal connectivity. Cross-vane structures are also commonly found in the Upper Yampa segment (in all riverscapes except riverscape 37) and have been found to interrupt natural sediment, flood, and habitat-development processes, but do not significantly hinder aquatic organism passage (Appendix A, Photo A-9).

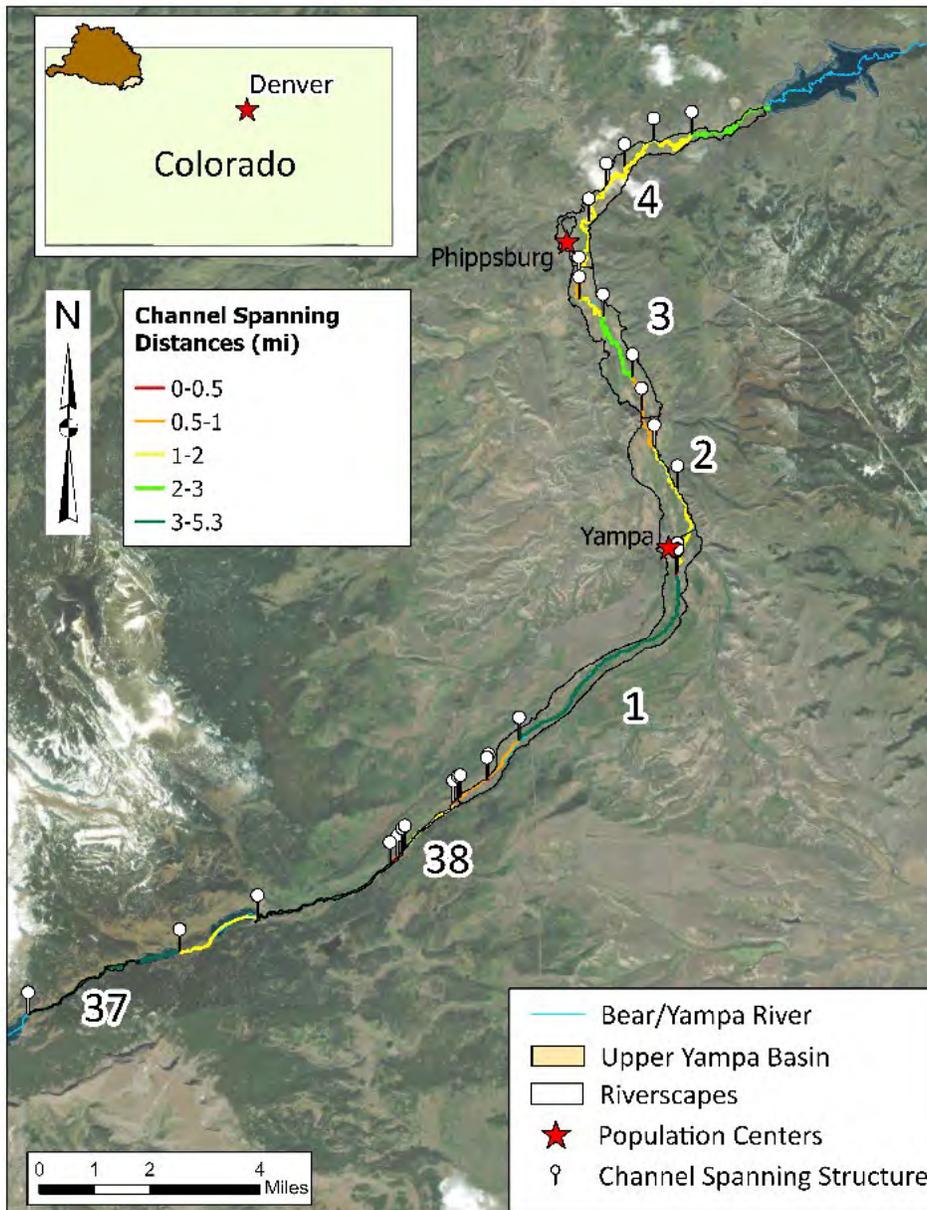
Greater demands for irrigation and diversions exist high in the watershed along the Bear River, as evidenced by the relatively high number of channel-spanning structures in riverscape 38 and the upstream portion of riverscape 1 (Figure 5-1). These riverscapes along the Bear River had the most channel-spanning structures recorded, but the downstream portion of riverscape 1 also had the

longest distance between structures at approximately 5 miles (Figure 5-1). Riverscapes 37 and 38 are directly downstream of large dams (Figure 1-2) that essentially isolate the river and prevent aquatic connectivity through altered flow and sediment regimes. In addition, the Colorado Water Conservation Board (CWCB)/Department of Water Resources (DWR) reports a total of twenty-two diversions listed on the Bear River, some of which are not associated with a channel-spanning structure (CWCB/DNR 2024). For these reasons, riverscapes 37 and 38 receive the lowest barrier scores (Table 5-2). Although riverscape 1 had the longest distance between structures, the riverscape also scores low for the barriers score (Table 5-2) because of the unique concentration of barriers, and because these barriers (e.g., Nickell Ditch) severely impede aquatic connectivity. Along the main stem Yampa (riverscapes 2, 3, and 4), channel-spanning structures were more evenly distributed and generally spaced 1-2 miles apart (Figure 5-1). The entire riverscape 2 was not accessible for field observations due to lack of access permissions, and so only two channel-spanning structures were observed in the field (Figure 5-1). However, the CWCB/DWR's online GIS mapping shows four diversions within riverscape 2, suggesting that more barriers to longitudinal connectivity may exist (CWCB/DNR 2024). The heights and composition of structures varied, but generally concrete structures are used more readily along the Bear River compared to boulders along the main stem Yampa (the height of structures was not directly measured in the field, but rather estimated visually). Scores for channel barriers are found in Table 5-2.

Pathways for lateral movement (e.g., side channels) are commonly found along the Yampa throughout the study area. The presence of such features enables aquatic organisms to extricate themselves from the higher energy of the main channel into relatively sheltered and quiescent waters (Appendix A, Photos A-10 and A-11). Lateral connectivity pathways are important for spawning and rearing of several species of fish, as well as for other organisms that may move frequently between the main river channel and the neighboring floodplain (e.g., beaver). Lateral pathways scores were determined by (1) calculating the number of such features observed in the field and on imagery per river mile, and then (2) evaluating that number relative to what may be expected of a natural river in its process domain using the following rubric, which dovetails with the scoring criteria described in Section 5.1.2: No loss of side channel access (>4/mile); mild loss of side channel access (<4/mile); moderate loss of side channel access (<3/mile); substantial loss of side channel access (<2/mile); and full loss of side channel access (<1/mile). Field-based estimates of lateral pathways represent minimum values, as we were unable to measure all pathways in certain "hotspot" areas where beaver complexes are located. These complexes were particularly challenging to access and traverse due to their dense vegetation and complex structures.

Lateral pathways were most frequent and widespread in riverscapes 4 (24/mile) and 3 (14/mile) (Figure 5-2). Despite the valley confinement, Riverscape 37 also had frequent lateral pathways (9/mile), where in-channel boulders and wood jams could create island features, or in areas of high beaver activity. True secondary habitat is likely lacking in some of the narrower channel reaches, but in the wider reaches with floodplain pockets, active beaver support increased lateral connectivity and preserve floodplain functions and ecosystems (Appendix A, Photo A-12). The same is true for other beaver "hotspots" where abundant lateral pathways are created that help preserve floodplain ecosystems and riparian forests (discussed further in Section 9.1). Riverscape 38 is also rather confined in the headwater region of the Bear River, and had less frequent lateral pathways per mile (5.4/mile) than the nearby riverscape 37. Because a portion of channel in this riverscape was only accessible from the road, aerial imagery was used to identify noticeable split flows and secondary channels.

Figure 5-1. In-Channel Barriers to Longitudinal Movement as Observed in the Field

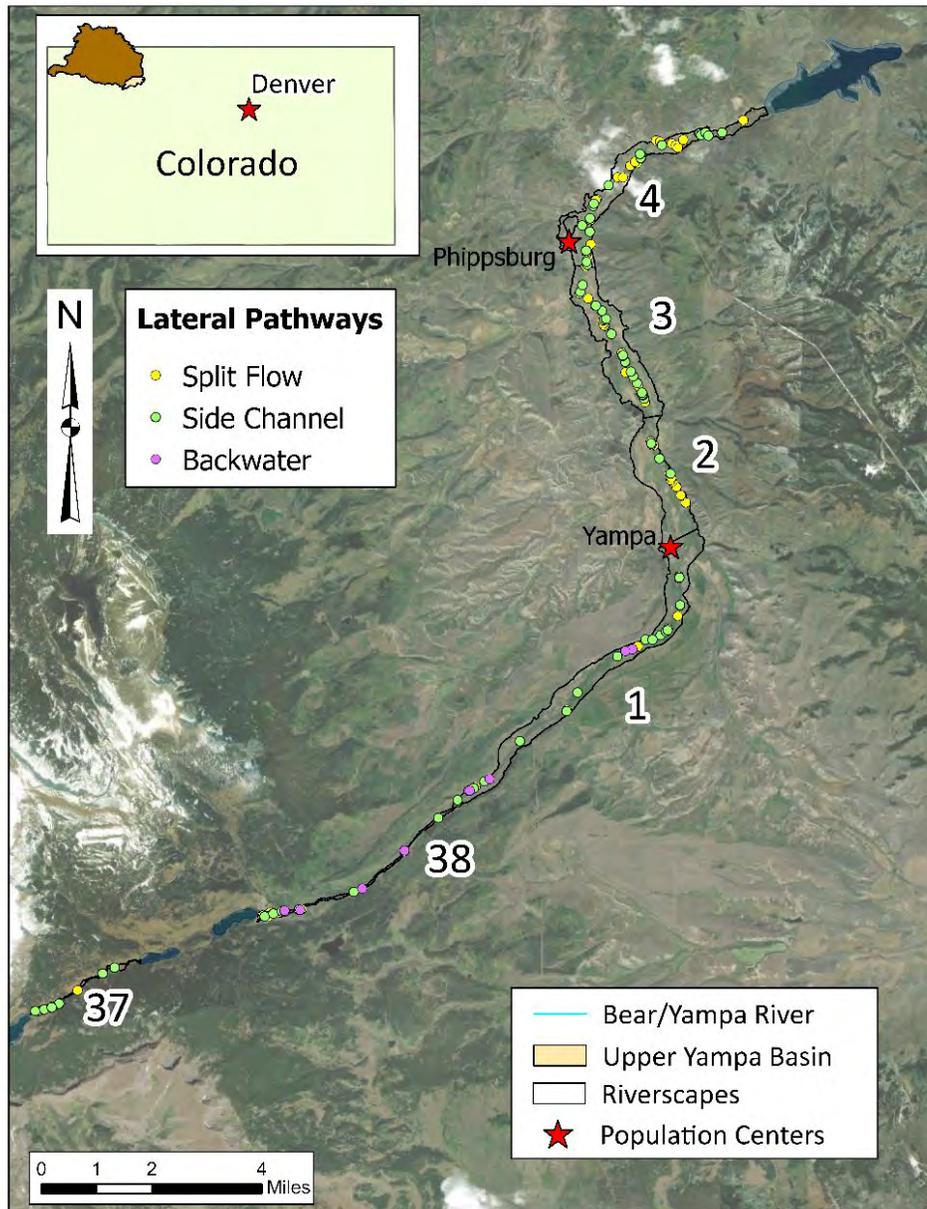


There were approximately 3.2 lateral pathways per mile in riverscape 1 (Figure 5-2). As previously mentioned, however, baseflows are highly altered on a daily basis for almost half the year particularly in riverscape 1 due to calls for water diversions. With less water in the channel, the assumption can be made that lateral pathways will also be affected. Although riverscape 1 has a mild loss of side channel access based on the number of pathways per mile, riverscape 1 receives a C for the lateral pathways score due to the likely substantial loss of pathways from severe changes in baseflow (Table 5-2).

Riverscape 2 had the lowest number of side channel access per mile (2.4/mile); however, the entire length of the riverscape was not accessible for field observations. The few side channel and split flow data points gathered in the field in the downstream portion of riverscape 2 were

associated with active beaver activity. In locations where field data are lacking, noticeable split flows around mid-channel islands and smaller secondary channels were identified using aerial imagery to supplement the analysis. This approach yielded an estimated number of lateral pathways for riverscape 2 of approximately 3-5/mile as is used for the lateral pathway scoring (Table 5-2). Additional split flows, side channels, and backwater areas would likely be observed during field work.

Figure 5-2. Locations of Pathways for Lateral Movement as Observed in the Field



* Note: Each riverscape was visited on foot for field observations, except for approximately 20% of riverscapes 37 and 38, 10% of riverscape 1, and 70% of riverscape 2, mainly due to private property access considerations. Therefore, this graphic may not show the full extent of lateral pathways, particularly in riverscape 2.

Table 5-2. Aquatic Connectivity Indicator Scores by Riverscape

Riverscape	Barriers Score	Lateral Pathways Score	Aquatic Connectivity Score
Riverscape 37	F	A	C
Riverscape 38	F	A	C
Riverscape 1	D	C	C-
Riverscape 2	D	B+	C
Riverscape 3	C+	A	B
Riverscape 4	D	A	C+

5.2 TERRESTRIAL CONNECTIVITY INDICATOR

The terrestrial connectivity indicator addresses the ability of terrestrial organisms to move both longitudinally (upstream/downstream) and laterally (between the channel and riparian zone, between riparian zone and upland areas). This indicator considers habitat fragmentation, including barriers created by roads, railroads, trails, bridges, fences, and other impediments.

5.2.1 *Data Sources and Evaluation Methods*

The Scorecard relies on floodplain fragmentation metric results from the Yampa IWMP remote assessment that was conducted as part of the riparian condition evaluation (Yampa IWMP 2021). For context, the Yampa IWMP remote assessment evaluated riparian condition across the basin using the Riparian Condition Assessment Tool (RCAT) developed by Utah State University (MacFarlane et al. 2018). RCAT provides a holistic proxy measure of riparian condition by assessing and integrating three key metrics of riparian functions: (1) riparian vegetation departure from historical conditions, (2) land use intensity within valley bottoms, and (3) floodplain fragmentation by infrastructure (roads, railroads, levees, etc.). The floodplain fragmentation metric calculates the proportion of accessible versus inaccessible floodplain within a reach due to roads, railroads, levees, or other infrastructure. Scores range from one (fully accessible) to zero (inaccessible). The floodplain fragmentation statistic calculated for each riverscape (encompassing the lateral extent of the entire valley bottom) is coupled with review of aerial imagery to rate the terrestrial connectivity indicator. For consistency, riverscapes not included in the geographic scope of the Yampa IWMP were evaluated in 2023 using the same methodology.

5.2.2 *Scoring Criteria*

The terrestrial connectivity indicator scoring criteria outlined in Table 5-3 are based on floodplain fragmentation and severity and proximity of migration barriers to terrestrial species movement.

Table 5-3. Terrestrial Connectivity Indicator Scoring Criteria

Grade	Description
A	Negligible fragmentation of the floodplain by infrastructure and development, with a floodplain fragmentation score of > 91%. No significant barriers to migration or dispersal of terrestrial organisms.
B	Minor fragmentation of the floodplain by infrastructure and development, with a floodplain fragmentation score between 71-90%. Impermeable barriers affect a minor portion of surrounding habitat, but permeable barriers such as gravel roads, minor berms, ditches, or barbed wire fences may be present.
C	Moderate fragmentation of the floodplain by infrastructure and development, with a floodplain fragmentation score between 41-70%. Impermeable barriers affect a moderate portion of surrounding habitat, and semi-permeable barriers such as two-lane paved roads, rail lines, or widely scattered residential development may be present.
D	Significant fragmentation of the floodplain by infrastructure and development, with a floodplain fragmentation score between 21-40%. Impermeable barriers and/or permeable barriers affect a substantial portion of surrounding habitat.
F	Severe fragmentation of the floodplain by infrastructure and development, with a floodplain fragmentation score of < 20%. Impermeable barriers and/or permeable barriers affect almost all of the surrounding habitat.

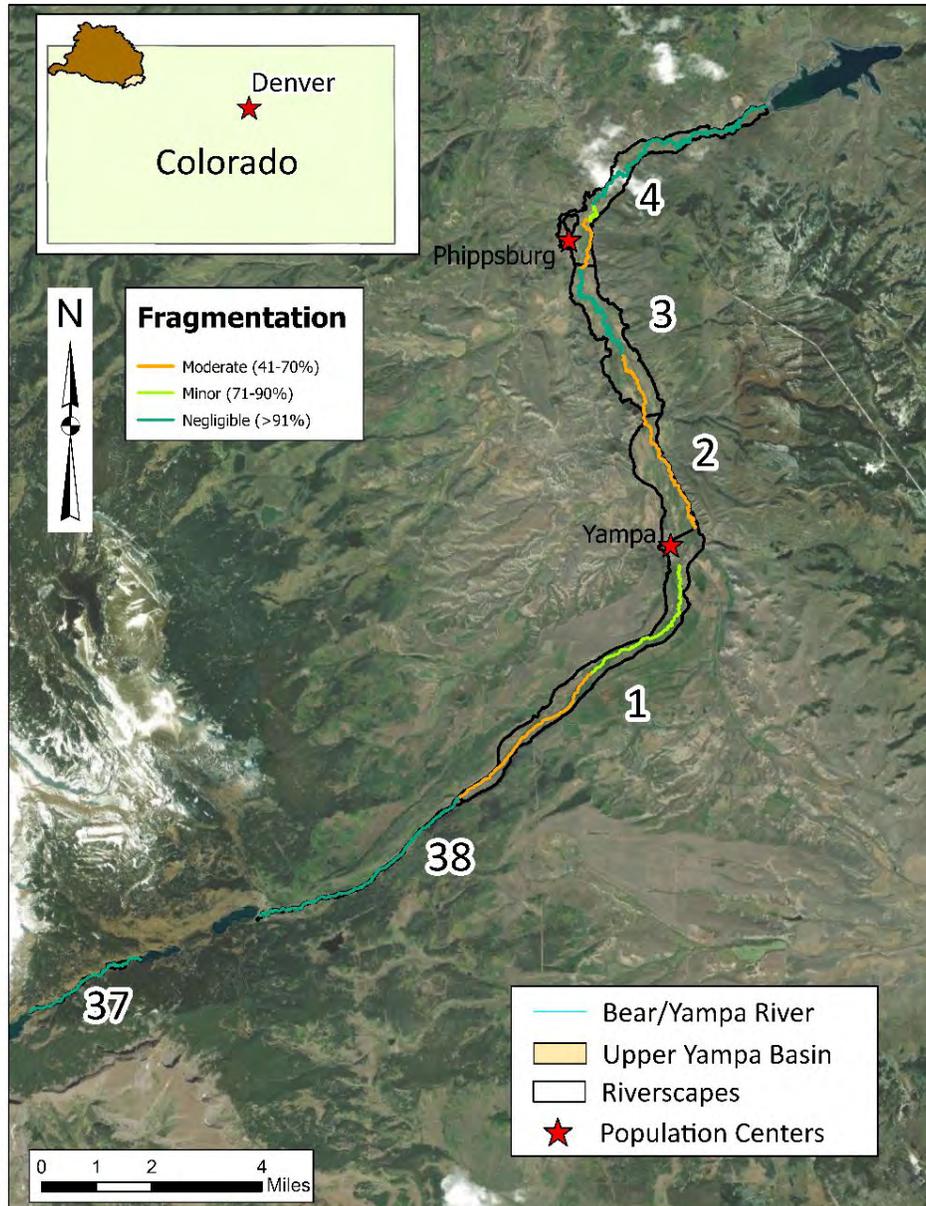
5.2.3 Results

This indicator is scored through review of IWMP remote assessment results and confirmation from aerial imagery. Briefly, the Yampa River Remote Assessment delineated the floodplain along the Yampa River using a variety of data sources, and then overlaid various infrastructure layers (roads, levees, railroads, etc.) to calculate the fraction of the floodplain that was isolated by that infrastructure. Refer to Section 6.2.1.1.3 in the Yampa River Remote Assessment Data Synthesis Report for further details on the methodology (Yampa IWMP 2022). Riverscapes 37 and 38, which were not included in the geographic scope of the Yampa IWMP, were evaluated in 2023 using the same methodology.

In riverscapes 37 and 38, terrestrial habitat fragmentation is essentially negligible (Table 5-4, Figure 5-3). These areas are located mostly on US Forest Service land and thus benefit from a relative lack of significant anthropogenic disturbances, contributing to an environment with higher habitat connectivity. The confined nature of riverscapes 37 and 38 also likely aids in favorable percentages. Floodplain fragmentation is also relatively low in riverscape 4 where the population center of Phippsburg is located (Table 5-4). Phippsburg is situated on the western side of Colorado State Highway 131 approximately 0.3 miles on average from the channel, and although substantial infrastructure and development around the town exist, the river primarily flows on the eastern portion of the riverscape. Despite much of the population center of the Town of Yampa being in riverscape 1, floodplain fragmentation from infrastructure and development is relatively low in this riverscape as well (Table 5-4). The Bear River flows through a small southeastern portion of the town (Figure 5-3) as opposed to the entire length of the town, and roads and rail lines briefly intersect the channel in the downstream portion of riverscape 1. For these reasons, the interactions between the river channel and the population center are generally

minimal. Nevertheless, impermeable and permeable barriers that fragment the floodplain and alter ecological habitat exist.

Figure 5-3. Floodplain Fragmentation (Representing Terrestrial Connectivity) by Riverscape



Floodplain fragmentation is moderate in riverscape 3 (Table 5-4), likely due to the presence of Highway 131 and the rail line that both run on the eastern side of the river for the entire length of the riverscape. Lastly, floodplain fragmentation is the highest in riverscape 2, but still moderately fragmented (Table 5-4). Highway 131 and the rail line are located on the western side of the river in this riverscape, intersect the channel near the downstream end, and then are found on the eastern side of the river (Figure 5-3). Because the floodplain fragmentation data are based on major roads, highways, and railroads, fragmentation is relatively high in riverscape 2. This indicator does not include floodplain connectivity, riparian condition, or longitudinal connectivity;

rather, it is solely a measure of riverscape fractionation due to infrastructure and terrestrial impediments.

Table 5-4. Floodplain Fragmentation Percent by Riverscape

Riverscape	Floodplain Fragmentation
37	100%
38	94%
1	75%
2	55%
3	70%
4	86%

* Adapted from the Yampa River Remote Assessment Data Synthesis Report (Yampa IWMP 2021) and appended with 2023 data for missing riverscapes; higher percentages correspond to minimal fragmentation and lower percentages correspond to greater fragmentation of the landscape.

Table 5-5. Terrestrial Indicator Scores by Riverscape

Riverscape	Terrestrial Connectivity Score
Riverscape 37	A
Riverscape 38	A
Riverscape 1	B-
Riverscape 2	C
Riverscape 3	B-
Riverscape 4	B+

6.0 RIVERSCAPE CONNECTIVITY

Riverscape connectivity is defined as the degree to which water can access and hydrate the surrounding riverscape (channel and floodplain). In particular, riverscape connectivity reflects the ability of the valley bottom to be actively and routinely engaged by fluvial processes. Connectivity varies naturally based on geology, topography, and hydrology. It also reflects impediments due to hydromodifications, channel modifications (e.g., enlargement, entrenchment, channelization/stabilization), and/or anthropogenic land uses within the floodplain (e.g., levees, drainage ditches, development, fill), which limit hydrogeomorphic processes, dynamism of channel/floodplain interaction, and biological interactions between the channel and its floodplain. The Yampa River Scorecard evaluates riverscape connectivity using a single indicator referred to as **riverscape connectivity**.

6.1 RIVERSCAPE CONNECTIVITY

Riverscape connectivity for the Scorecard project is defined as the ratio of the active floodplain to the maximum possible floodplain extent, as was done for the Yampa IWMP remote assessment. The Yampa IWMP remotely evaluated a Floodplain Connectivity indicator across the entire basin, described as the ratio of the accessible extent of the active floodplain to the maximum potential accessible floodplain (Yampa IWMP 2021). The floodplain connectivity ratio is a proxy measure of the extent and frequency with which flows interact with the channel and adjacent floodplain. This interaction is critical for creating and maintaining a healthy stream corridor by helping establish and maintain riparian vegetation throughout the floodplain, which in turn extends inundation residence times by attenuating and slowing flows through the system.

For the Yampa IWMP remote assessment, floodplain connectivity was assessed across the entire basin, and reassessed using higher resolution data in 6 priority riverscapes, to characterize the capacity of water to inundate and activate the adjacent riparian corridor. The higher resolution data used for a portion of the Middle Yampa and Elk River segments allowed for better identifying and mapping fluvial features and more accurately delineating floodplain extents, and those analyses yielded the generation of a set multipliers to better approximate floodplain connectivity for riverscapes with moderate resolution data. It is important to note that a critical component of accurate floodplain and geomorphic delineations is field verification. While the remote assessment provides a good foundation, the Scorecard effort provides ground-truthing, field verification, and refinement of those results to the extent possible using all available information (described more in Section 6.1.5).

The active floodplain is defined as the extent to which flows can access the land adjacent to the river over frequent to moderate recurrence intervals. The active floodplain delineates the areas where inundation duration and frequency can maintain riparian vegetation and active fluvial processes. To determine the area occupied by active floodplain via remote sensing, two lines of evidence were used: (1) floodplain fragmentation by development and transportation infrastructure, which have disconnected low-lying areas from the active floodplain, and (2) topographic datasets to identify low-lying areas that have the potential to be inundated at frequent to moderate recurrence intervals. Integration of the floodplain fragmentation and the potentially active floodplain layers were used to delineate the active floodplain. The active floodplain is defined as land that is within the potentially active floodplain that has not been

disconnected by development or transportation networks. Figure 6-1 shows some of the steps taken to determine the floodplain connectivity ratios for the Yampa IWMP remote assessment from an example riverscape in the Middle Yampa segment (Yampa IWMP 2021).

Figure 6-1. Yampa IWMP Remote Assessment Floodplain Connectivity Metrics Example

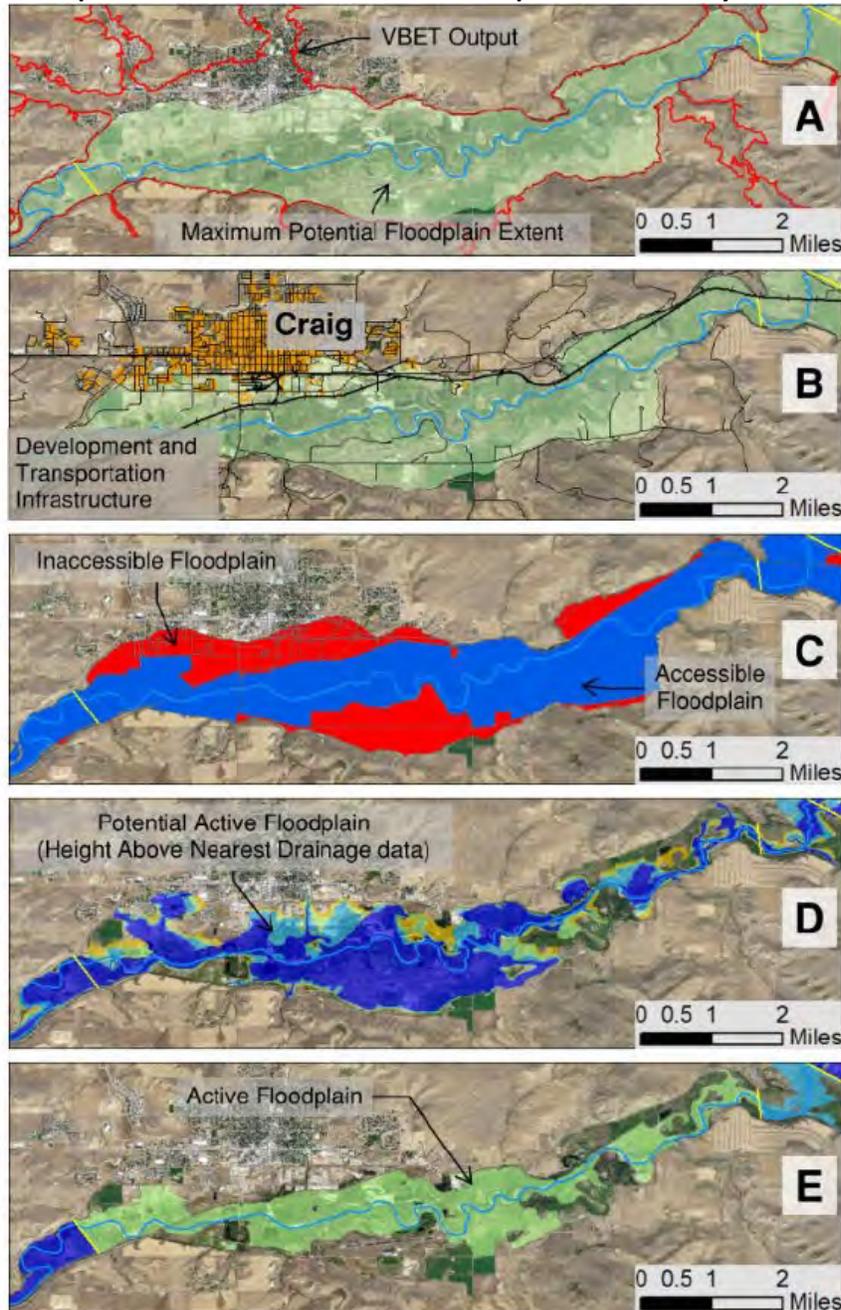


Figure 6-1. Example floodplain connectivity metrics for Riverscape 23 (see Figure 2-4 for context). A) VBET outputs and manually modified valley bottom representing the maximum potential floodplain extent. B) Development and transportation infrastructure overlain on valley bottom polygon. C) Floodplain fragmentation by development and transportation network. D) Potential active floodplain based on Height Above Nearest Drainage. E) Active floodplain.

6.1.1 Data Sources and Evaluation Methods

The Scorecard uses the results of the Yampa IWMP remote assessment floodplain connectivity evaluation to score the riverscape extent indicator and duplicates this methodology for riverscapes not covered in the Yampa IWMP geographic scope (riverscapes 37 and 38). However, the remote assessments did not include a field verification component. For the Scorecard, the floodplain connectivity ratios for the six riverscapes in the Upper Yampa segment were ground-truthed to the extent possible, particularly in unconfined reaches where remote assessment may have overestimated the maximum potential floodplain extent, through site visits in areas with landowner access permissions. Select sites were visited for field verification in October 2024 following review of available aerial imagery and topography data. Where discrepancies were identified, the Scorecard alters the IWMP evaluation as necessary based on the field verification exercise and uses an updated score for evaluation per the scoring criteria described in Section 6.1.3.

6.1.2 Scoring Criteria

The scoring criteria outlined in Table 6-1 based on Yampa IWMP remote assessment floodplain connectivity ratios are used rate the riverscape connectivity indicator.

Table 6-1. Riverscape Connectivity Scoring Criteria

Grade	Description
A	Natural pattern of floodplain activation over frequent to moderate recurrence intervals, with a floodplain connectivity ratio of > 90%.
B	Majority of riverscape extent is available for activation over frequent to moderate recurrence intervals, with a floodplain connectivity ratio of 75-90%.
C	Moderate amount of riverscape extent is available for activation over frequent to moderate recurrence intervals, with a floodplain connectivity ratio of 50-74%.
D	Small amount of riverscape extent is available for activation over frequent to moderate recurrence intervals, with a floodplain connectivity ratio of 25-49%.
F	Riverscape activation over frequent to moderate recurrence intervals is extremely limited, with a floodplain connectivity ratio of < 25%.

6.1.3 Results

This indicator is scored using a combination of review of IWMP remote assessment results and data collected during site visits with Scorecard partners. Edits to the active floodplain polygon generated by the IWMP were made using ground truthing, 1-m topographic data, and aerial photograph inspection for all riverscapes. Maximum floodplain extents are the same as those delineated in the IWMP report. Additionally, the floodplain connectivity multipliers determined by the IWMP assessment by comparison of floodplain mapping results in areas with high resolution elevation (1-m) data to those in areas with moderate resolution elevation (10-m) data were used here as well. The floodplain connectivity percentage reported in Table 6-2 is a ratio of the active floodplain extent and the maximum floodplain potential and is determined using the Scorecard (edited) active floodplain polygon data.

Overall, riverscape connectivity scores were low for all riverscapes in the Upper Yampa segment. The highest floodplain connectivity score was found in riverscape 37, where 57% of the floodplain is readily accessible by relatively frequent flows (Table 6-2, Figure 6-2). The relatively high score for this riverscape is most likely due to the overall confined nature of the Bear River in this stretch, where the maximum potential floodplain and active floodplain largely overlap. However, confined rivers, especially those in steep headwater reaches, typically have lower connectivity to their floodplain because lateral movement is limited, and floods generally remain within the channel or the immediate vicinity. In the wider reaches of riverscape 37 where beaver are actively present, broad floodplains foster a more frequent and greater exchange of water (and sediment and organic matter), increasing floodplain connectivity.

Table 6-2. Confinement and Floodplain Connectivity Percentages by Riverscape

River-scape	Confinement	Max. Potential Floodplain (mi ²)	Active Floodplain IWMP (mi ²)	Active Floodplain YRSP (mi ²)	Floodplain Connectivity	Multiplier	Adjusted Floodplain Connectivity (%)
37	Confined	0.07	-	0.04	57%	1.0	57%
38	P. Confined	0.16	-	0.07	44%	1.0	44%
1	Confined	2.21	0.32	0.35	16%	2.5	40%
2	P. Confined	1.16	0.17	0.13	11%	2.5	28%
3	P. Confined	1.54	0.26	0.31	20%	2.5	50%
4	P. Confined	1.45	0.42	0.52	36%	1.3	47%

The next highest scores are for riverscapes 3 and 4, which are near 50% connected (Table 6-2, Figure 6-2). In these riverscapes, the river is partially confined to bedrock and alluvial fans, limiting the maximum potential floodplain extent. Their maximum potential floodplain areas are similar, but riverscape 4 has a larger active floodplain (Table 6-2). The adjusted floodplain connectivity values for these riverscapes suggest a moderate level of connectivity and that while flows can reach a large floodplain area, frequent interactions are more limited to closer parts of the floodplain. This is evident by much of the Town of Phippsburg being included in the maximum potential floodplain extent in riverscape 4, but likely it is not inundated during frequent floods (Figure 6-2).

Riverscape 38 is just downstream of Yamcolo Reservoir and is partially confined by bedrock and terraces (Figure 6-2). The natural confinement of the river in this riverscape likely impedes floodplain interaction and results in the lower floodplain connectivity percentage (Table 6-2). Prior to the multiplier adjustment, riverscape 1 had a floodplain connectivity of just 16% (Table 6-2), suggesting that the river's regular connectivity with its floodplain is very limited. Although there is a broad floodplain area, only a small portion is engaged by frequent to moderate flows (Figure 6-2). Post-adjustment, the floodplain connectivity ratio for riverscape 1 was 40% (Table 6-2), the second to lowest percentage of the six analyzed riverscapes. A high degree of development (the Town of Yampa, Highway 131, and the railroad) is also in the downstream portion of riverscape 1, and likely isolate the river from its floodplain through bank stabilization, levee construction, and floodplain manipulation. Additionally, the relief is steep in riverscapes 38 and 1 and the rapid movement of water through these areas reduces the potential for floodplain inundation and associated hydrologic connectivity.

Lastly, riverscape 2 had the lowest adjusted floodplain connectivity of 28% (Table 6-2). Much of riverscape 2 is agriculturally developed, and the maximum potential floodplain extent remains wide (approximately 0.5 miles wide on average) and relatively unobstructed throughout the entire riverscape length (Figure 6-2). For the majority of the riverscape length, however, the active floodplain of the Yampa main stem only occupies a narrow (approximately 0.05 miles wide on average) portion of the eastern side of the riverscape (Figure 6-2), resulting in a low floodplain connectivity ratio. Scores for the riverscape connectivity indicator are presented in Table 6-3.

Figure 6-2. Riverscape Connectivity Scores for the Upper Yampa Segment

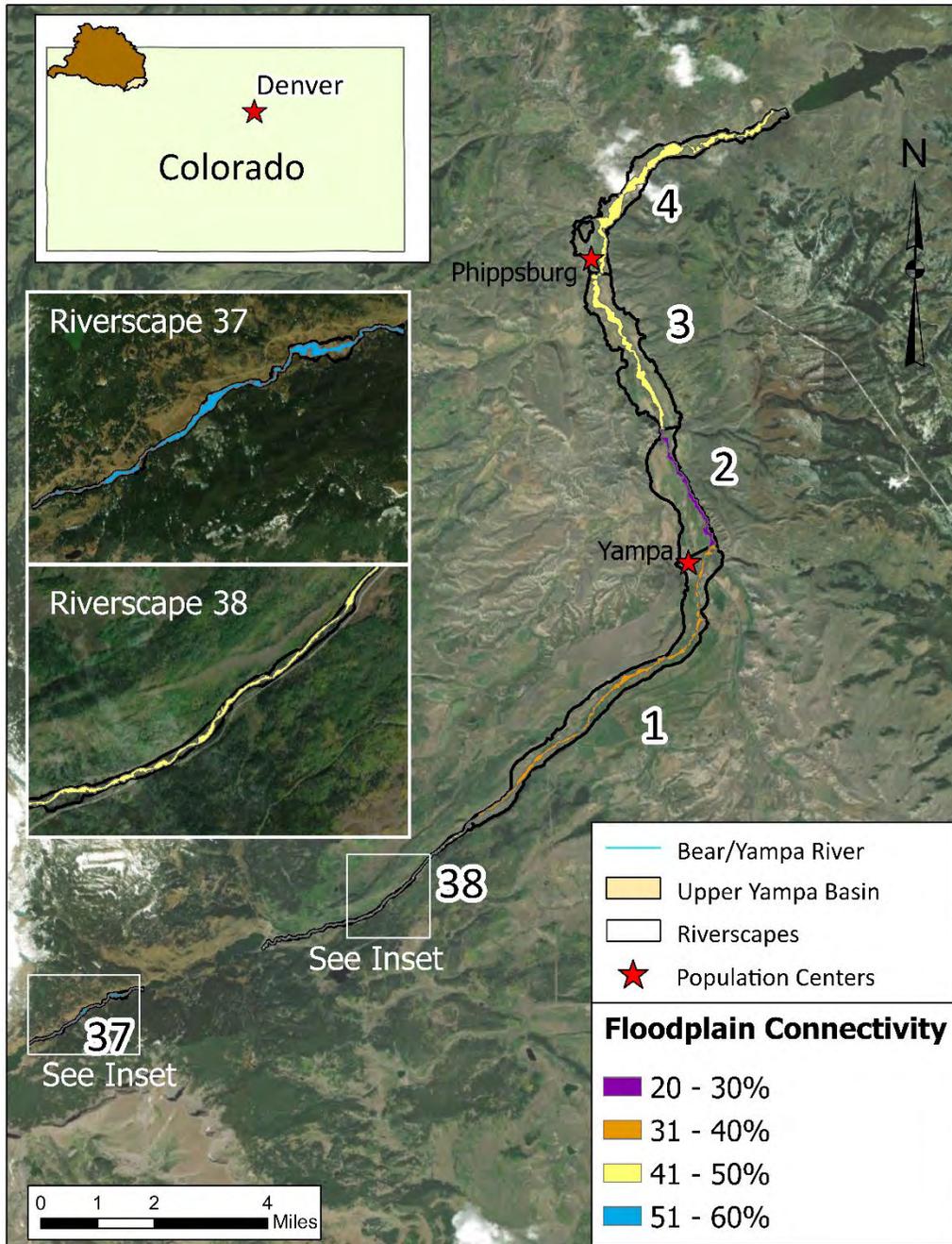


Table 6-3. Riverscape Connectivity Indicator Scores by Riverscape

Riverscape	Riverscape Connectivity Score
Riverscape 37	C
Riverscape 38	D+
Riverscape 1	D+
Riverscape 2	D-
Riverscape 3	C-
Riverscape 4	D+

7.0 RIPARIAN CONDITION

Riparian areas, or lands that occur along and are influenced by watercourses, are a critical part of a healthy and resilient stream ecosystem, providing physical roughness that slows water velocities and mitigates the impacts of flood flows; bank stability through root system cohesiveness; habitat for a diversity of riparian plants, animals, and microbes; water quality improvement; shade for the stream corridor to maintain a healthy thermal regime; large wood to stream channels, which creates beneficial habitat complexity; organic matter to the water column; and off-channel habitats like backwaters, wetlands, and side channels that act as refugia for fish and other aquatic species. Well-established and connected riparian areas also link stream corridor and upland ecological processes. Riparian condition is defined as the degree to which riparian areas support river health and critical functions. The Yampa River Scorecard evaluates two indicators within the riparian condition category: **vegetation structure and complexity** and **invasive species**. The final riparian condition score is calculated as 90% vegetation structure and complexity indicator score and 10% invasive species indicator score.

7.1 VEGETATION STRUCTURE AND COMPLEXITY INDICATOR

The vegetation structure and complexity indicator describes riparian vegetation and its ability to support characteristic riparian functions. Healthy riparian zones are characterized by a high level of vertical and horizontal complexity, including a mosaic of habitat types and multiple vegetation layers. Included in these considerations are structure, height, cover, species diversity, complexity, age, and patchiness/interspersion of riparian vegetation. The character and complexity of riparian vegetation are primarily driven by above ground saturation and the associated disturbance caused by seasonal flooding, alluvial groundwater, and erosional and depositional changes that create bars and distribute overbank fine sediment. Complex riparian corridors in turn influence a spectrum of physical functions in the river ecosystem while providing critical wildlife habitat.

Riparian condition is evaluated within a limited portion of the maximum potential floodplain as defined in the riverscape connectivity category. In particular, it is evaluated out to a maximum of 100 meters from each channel bank. The maximum potential floodplain – and therefore potential extent of riparian vegetation – is sometimes considerably wider than 200 meters on the Yampa River, which is the case for portions of several of the riverscapes within the Upper Yampa segment. The limited scope of the riparian condition category represents a compromise between data acquisition and available resources. The condition and extent of riparian vegetation is evaluated near the channel where it exerts the greatest control on river health, but the condition of riparian vegetation in the wider riverscape is not assessed. Future assessments will seek to expand the breadth of riparian vegetation mapping within the maximum potential floodplain in order to chart riverscape-scale changes in land cover and land use.

7.1.1 *Data Sources and Evaluation Methods*

Vegetation structure and complexity are evaluated using the same remote polygon methodology applied in the City of Steamboat Springs SMP's river health assessment (City of Steamboat Springs 2018), with the lateral extent of the riparian zone defined as the edge of the natural floodplain or 100 meters from each river bank (200 meters total terrestrial width), whichever is narrower. This methodology was applied to riparian condition assessments of the two previous iterations of the

Yampa River Scorecard Project evaluations: the Middle Yampa segment and the Steamboat segment. The approach entails the following steps:

- (1) Create and classify polygons within the riparian zone by land cover (e.g., cottonwood/canopy forest, sub-canopy forest, sub-alpine forest, montane forest, scrub-shrub, herbaceous, wetland, developed, bare ground, open water) and land use (e.g., ranch lands, light agriculture, wildlands, rural development, infrastructure, park lands, naturalized open space, disturbed open space, transportation corridor);
- (2) conduct initial desktop grading on polygons created in step 1;
- (3) field verify and refine initial polygons, particularly for polygons with natural-looking riparian vegetation;
- (4) perform a calibrated grading based on information from field verification step 3;
- (5) grade each cover type polygon based on Table 7-1, below; and
- (6) calculate an area-weighted average of all polygon scores within each riverscape to produce a single vegetation structure and complexity indicator score for each riverscape.

More details regarding the methodology for this approach are provided in Appendix B.

7.1.2 Scoring Criteria

The scoring criteria outlined in Table 7-1 based on the ability of the riparian corridor to support river health functional attributes are used to rate the vegetation structure and complexity indicator.

Table 7-1. Vegetation Structure and Complexity Indicator Scoring Criteria

Grade	Description
A	Native riparian conditions exist that appear natural and appropriate for the Yampa River. Woody vegetation is present and commonly dominant, but patches and ribbons of meadow are typical. Vegetation is characteristically patchy, with strong interspersions of patches and overall good vertical structure driven by connection to the river. No evident effects of stressors – many stressors ameliorated by frequent flooding. Examples include cottonwood forest on well-connected surfaces such as vegetated point bars; young, characteristically willow-dominated, vegetation on recently formed surfaces; low, in-channel benches protected from human manipulation, typically scrub-shrub. Full support of river health.
B	Riparian habitat resembles native conditions but with detectable changes or mild, evident stressors. Vegetation appears self-sustaining and requiring little or no maintenance to preserve characteristic structural diversity. Habitat maintains a high degree of patchiness and interspersions, with little homogenization or loss of vertical structure. Small habitat patches can be relatively homogenous but contribute to the local mosaic of habitats. Common examples include river-connected cottonwood canopy and subcanopy forest with impacts such as grazing and primitive roadways. Minor reduction in the support of river health attributes.
C	Vegetated but with substantial departure from native conditions. Most commonly, alterations result in a loss of structural complexity, and/or homogenization of vertical structure, patchiness, and/or interspersions. Examples include cleared pastures that contain scattered trees and shrubs; fallow floodplain hayfields and

	cottonwood forests with substantial understory alteration; and palustrine emergent wetlands associated with ditches and sloughs. Riparian condition contributes to the degradation of one or more river health processes.
D	Dramatic loss of structural complexity, and/or homogenization of vertical structure, patchiness, and interspersions. Habitat commonly isolated from the river. Bare ground or impervious surfaces commonly makes up a significant portion of land cover. Vegetation tends to be very disturbed or actively cultivated. Examples include actively cultivated hay fields, old gravel mines, primitive roadways, and golf courses. Riparian land use contributes to river dysfunction.
F	Riparian area is developed or wholly converted with predominantly bare ground, impervious surfaces, or otherwise lacking in vegetation as a result of land use and management actions. Riparian habitat function is essentially extinguished, and land use contributes substantially to river dysfunction.

7.1.3 Results

The remote polygon desktop exercise with field verification was completed in summer/fall 2024. Refer to Appendix B for a technical memorandum describing methods and results in more detail. A summary of the results is provided below.

The riparian zone for the Upper Yampa segment was divided into 735 polygons based first on land cover and then land use. Of the 11 cover types designated, herbaceous cover was by far the most common, accounting for almost 1,000 acres. Herbaceous areas were mostly hayfield and pasture lands. Scrub-shrub, subcanopy forest, and canopy/cottonwood forest were the next three most common cover types, which illustrates the rural nature of the landscape. The next most common cover type was developed areas, highlighting the rural and residential infrastructure associated with the local communities of Yampa and Phippsburg. The cover types with the best mean condition were those in closest association with the river, including sub-alpine forest, montane forest, and scrub-shrub habitats. These areas are continually disturbed by natural processes and recover rapidly, so in most cases signs of human disturbance are quickly erased. Subcanopy forests and cottonwood forests are next in terms of condition, and excellent examples of both land cover types still exist on features shielded from intensive human use. As expected, developed polygons were assigned the lowest scores.

Following the pattern in land cover, rangeland and agricultural land uses are the most prevalent land uses in the Upper Yampa segment. It should be noted that there is little distinction between these two land uses, and they often overlap spatially or temporally. The agricultural land use implies that the polygon is under active cultivation, usually for hay. It is acknowledged that fields are continually taken in and out of production, and it is not always possible to determine whether and area is being actively hayed, used as pasture, or simply has abundant herbaceous cover. Wildlands, particularly the public lands in the Routt National Forest in the vicinity of Stillwater, Bear, and Yamcolo Reservoirs, covered the next largest area in the Upper Yampa segment. With rangelands encompassing several different land cover types, scores have a wide range (between A and F), as they did in the other segments evaluated (Middle Yampa and Steamboat segments). Rangelands hold many of the Yampa Valley's finest examples of riparian habitat, and the average score for rangelands in the Middle Yampa and Steamboat segments was a B. However, the overall average score for these habitats in the Upper Yampa segment is a C+. The rangelands in the Bear

and Upper Yampa Rivers hold a high proportion of expansive, productive hayfields that help to maintain open habitat in the riparian zone, but this has come at the expense of the diversity of cover types such as forest and shrubland patches that are more typical of ranchland habitats in the Yampa River riverscapes further downstream.

Riparian condition scores based on land cover and land use were weighted by area to compute an overall riparian condition score for each of the six riverscapes in the Upper Yampa segment. Examples of the fine-scale riparian mapping that was completed for this assessment are provided in Appendix B, and final weighted averages by riverscape are shown in Table 7-2. The riverscapes that encompassed public lands (i.e., those in or very near the Routt National Forest) scored in the A/A- range, while the riverscapes in closer proximity to rural development and agriculture scored lower, in the C/D range.

Table 7-2. Vegetation Structure and Complexity Scores by Riverscape

Riverscape	Riparian Condition Score
Riverscape 37	A
Riverscape 38	A-
Riverscape 1	C
Riverscape 2	C-
Riverscape 3	D+
Riverscape 4	C-

7.2 INVASIVE PLANT SPECIES INDICATOR

The invasive species indicator provides a measure of the presence and relative proportion of several invasive plant species that are common in the Yampa Valley, including leafy spurge, Russian olive, and tamarisk.

Leafy spurge is a Colorado List B noxious weed species. It is a deep-rooted perennial that spreads explosively by seed and has extensive, creeping roots. Leafy spurge is adapted to a wide range of habitats and is very competitive with other plant species, crowding out nearly all other vegetation when it becomes established in rangeland, pasture, and riparian sites. Its white, milky sap is extremely toxic to cattle and horses, and damaging to sensitive human skin and eyes. The Yampa River Leafy Spurge Project (YRLSP) has been working to map and manage the infestation of leafy spurge in riparian areas in the valley since 2015.

Russian olive, another Colorado List B species, is a perennial tree or shrub that reproduces by seed or root suckers. Once thought to be a beneficial windbreak tree, Russian olive is detrimental to riparian zones because it outcompetes native plants, interferes with natural plant succession and nutrient cycling, and disadvantages several native animal species relative to native vegetation.

Tamarisk, or saltcedar, is also a Colorado List B noxious weed. It was introduced for ornamental purposes and streambank stabilization but is now widespread in the US and crowds out native stands of riparian and wetland vegetation. Tamarisk increases the salinity of surface soils, rendering them inhospitable to native plant species.

7.2.1 Data Sources and Evaluation Methods

The Yampa River Leafy Spurge Project (YRLSP) conducted field mapping of leafy spurge along the Yampa River from Hayden, CO, to Cross Mountain in 2019-2021. This field data was used by a University of Wyoming graduate student to build a remote sensing model of current leafy spurge infestation in the Yampa Valley. Based on identified attributes of highly infested areas, a predictive model was developed to identify areas at risk for future invasion as well. A presentation describing this project and explaining modeling results is available at (<https://www.yampariverleafyspurgeproject.com/chloemattilio>) on the YRLSP website. The remote sensing project yielded > 83% confidence that leafy spurge is correctly detected by remote sensing methods, and the final remote sensing maps and risk model have been used as a primary data source for scoring the invasive species indicator.

Data to score this indicator are also collected by walking most of the Upper Yampa segment and noting instances of Russian olive and tamarisk. These observations are documented via photographs and notes, and observations of Russian olive and tamarisk are scored based on presence/absence of either species. In particular, a score of 0 is assigned if no Russian olive or tamarisk is observed on either bank within a riverscape, and 1 point is assigned if at least one individual is observed on either the left or right bank for either species. For example, if Russian olive is observed on one of the two banks in a riverscape, but tamarisk is not observed, the score is 1. If both Russian olive and tamarisk are observed on one bank, the score is 2. If both species are observed on both banks, the score is 4. Scores for these invasives range from 0 to 4 points.

7.2.2 Scoring Criteria

The scoring criteria outlined in Table 7-3 based on YRLSP leafy spurge mapping and qualitative field observations of Russian olive and tamarisk are used to rate the invasive species indicator. Scoring is mainly driven by leafy spurge data.

Table 7-3. Invasive Plant Species Indicator Scoring Criteria

Grade	Description
A	No or only trace amounts (<1%) of leafy spurge present in the riparian area. No observations of Russian olive and/or tamarisk noted (invasives score of 0).
B	Low coverage (1-5%) of leafy spurge present in the riparian area. Infrequent observations of Russian olive and/or tamarisk noted (invasives score of 0-1).
C	Moderate coverage (6-25%) of leafy spurge present in the riparian area. Moderate number of observations of Russian olive and/or tamarisk noted (invasives score of 0-3).
D	High coverage (26-50%) of leafy spurge present in the riparian area. Frequent observations of Russian olive and/or tamarisk noted (invasives score of 2-4).

F	Very high coverage (51-100%) of leafy spurge present in the riparian area. Consistent to constant observations of Russian olive and/or tamarisk noted (invasives score of 4).
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7.2.3 Results

Field observations did not reveal the presence of target invasive plant species, including tamarisk, Russian olive, or leafy spurge, throughout the entirety of the accessible portion of the Upper Yampa segment². Furthermore, the YRLSP identified only one small (0.03 square miles) region as lower risk to leafy spurge invasion (Figure 7-1). Several regions were identified in the vicinity of Stagecoach Reservoir as either higher risk or lower risk and are shown in Figure 7-1 due to their proximity to riverscape 4, but these regions are not technically within the Upper Yampa segment and thus are not included in the indicator score. Leafy spurge risk data are summarized in Table 7-4. The remainder of the entire Upper Yampa segment is classified as least risk to leafy spurge invasion. These field-based and remotely sensed findings suggest an absence of leafy spurge and a low concern for future leafy spurge invasion. Further communication with the YRLSP team indicates that there are minor populations of leafy spurge beginning to establish in the uplands above Stagecoach Reservoir, but the valley bottom has not been impacted yet. Biological controls, in the form of co-adapted flea beetles in the genus *Aphthona*, as well as a stem-boring beetle (*Oberea erythrocephala*), have been released in the Yampa River valley to manage the spread of this invasive weed. These control releases have not been performed near the Upper Yampa segment. Invasive species indicator scores by riverscape are summarized in Table 7-5.

Table 7-4. Leafy Spurge Risk by Riverscape in the Upper Yampa Segment

Riverscape	Lower Risk Percent by Area (%)
Riverscape 37	0
Riverscape 38	0
Riverscape 1	0
Riverscape 2	0
Riverscape 3	0
Riverscape 4	0.02

² While not specifically listed as an invasive species in Colorado, tall buttercup (*Ranunculus acris*) was observed in many locations across the riparian landscape, particularly in pastures and meadows, where it can be problematic because it is toxic to livestock and can outcompete native plants.

Figure 7-1. Remotely-Sensed Leafy Spurge Risk Across the Upper Yampa Segment

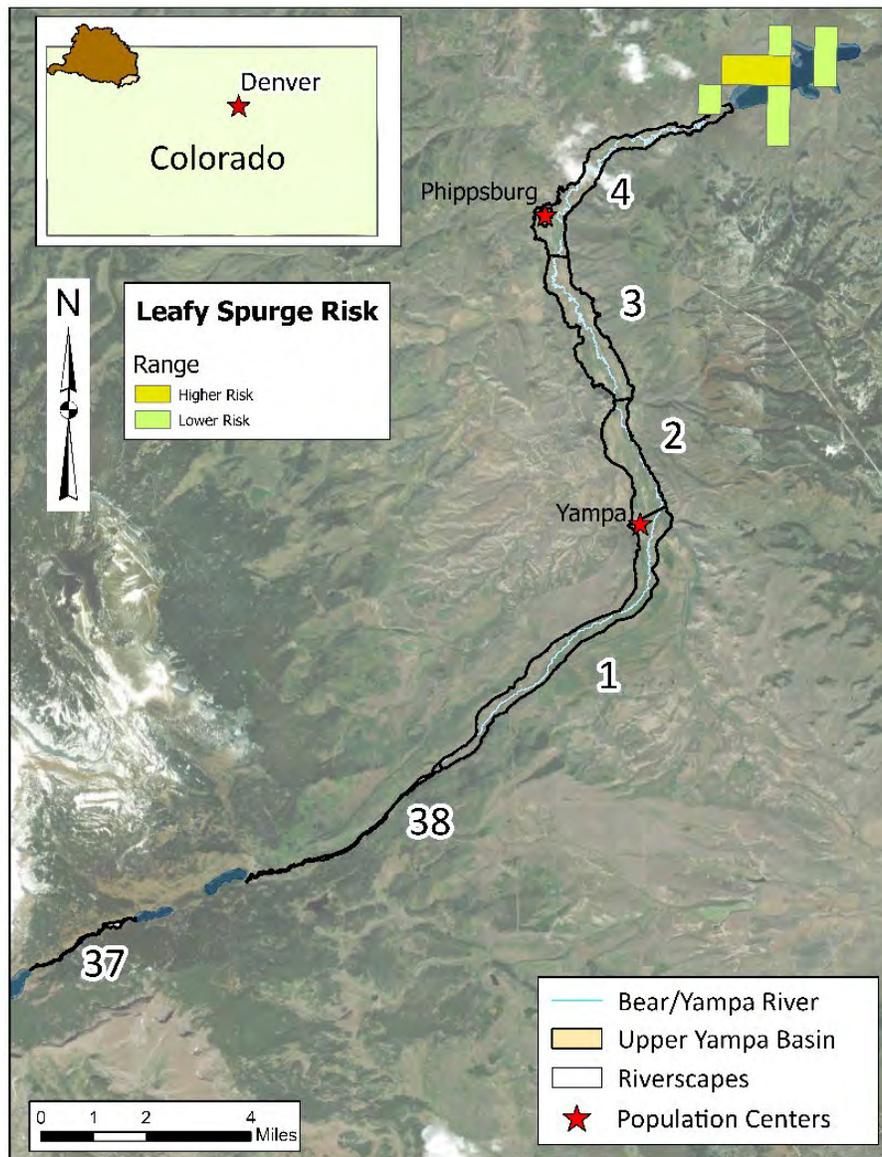


Table 7-5. Invasive Plant Species Indicator Scores by Riverscape

Riverscape	Tamarisk/Russian Olive Score	Leafy Spurge Score	Invasive Species Score
Riverscape 37	A	A	A
Riverscape 38	A	A	A
Riverscape 1	A	A	A
Riverscape 2	A	A	A
Riverscape 3	A	A	A
Riverscape 4	A	A	A

8.0 RIVER FORM

River form is defined as the river channel shape and geometry. It is directly influenced by the physical attributes of the watershed (e.g., geology, topography, hydrology), channel hydraulics, sediment transport, and local hillslope and floodplain uses (e.g., adjacent roadways, grazing). Biological drivers (e.g., riparian vegetation, large woody material, beaver activity, aquatic vegetation) influence river form as well, by altering hydraulics and erosional patterns. The Yampa River Scorecard evaluates river form holistically, using a single indicator referred to as **channel morphology**.

8.1 CHANNEL MORPHOLOGY INDICATOR

The channel morphology indicator is scored holistically and qualitatively considering planform shape (aerial shape), dimension (cross-sectional shape/size), and profile (slope). In some cases, quantitative measurements are used to inform qualitative scoring.

8.1.1 *Data Sources and Evaluation Methods*

A combination of remote sensing, quantitative measurements, and field observations are used to score the channel morphology indicator. Planform shape can be evaluated through remote measurement of valley confinement and parameters such as sinuosity. Comparison of historical and current aerial imagery can also be helpful. A stressor-based approach is also employed to evaluate channel morphology, with a component of the fieldwork that includes taking note of low-head dams, diversions, and bank- and in-channel treatments that may impact grade (Appendix A).

The Scorecard effort acknowledges that channel morphology assessments that employ traditional metrics have been conducted on river systems that have been impacted by controls that reduce complexity, leading to the narrow view of rivers as channels having easily measured forms. For the Scorecard, these metrics are used in the context of a progression from the past to the present, as well as evaluating where they fall on a continuum of stability. In this manner, the channel form that falls outside of the natural continuum to be expected of a healthy river can be evaluated as indicative of a river that may be impacted by unnatural influences. The Scorecard public interface explains these differences.

This indicator is scored using best professional judgement supported by the observations and measurements described above. Expert opinion is based on data collected and observed in the field, aerial imagery, and GIS spatial data to generate a single score for the channel morphology indicator.

8.1.2 *Scoring Criteria*

The descriptive, qualitative scoring criteria outlined in Table 8-1 are used to rate the channel morphology indicator. The criteria relate primarily to the presence of stressors and level of maintenance required to maintain functional river processes.

Table 8-1. Channel Morphology Indicator Scoring Criteria

Grade	Description
A	Planform, sinuosity, meander-wavelength to bankfull-width ratios, and variations are appropriate for a well-functioning river of this flow/sediment regime and landscape setting. There are no significant constraints to river planform or significant artificial changes in slope (e.g., dams, channelization, grade control structures). Channel geometry is within a range that is natural and appropriate for a well-functioning river in its process domain. The channel geometry is self-sustaining under natural channel processes and requires no maintenance.
B	Planform, sinuosity, meander-wavelength to bankfull-width ratios, and variations are within a range that is natural and suitable for a river of this flow/sediment regime and landscape position. Stressors are detectable but minimal management is needed to maintain functionality. Minor localized impacts exist that minimally affect channel entrenchment, capacity, or width-depth ratios.
C	Stressors on the river planform and/or sinuosity and/or wavelength-width ratios impact localized portions of the channel. Examples include reaches with short lengths of bank armoring (decreased sinuosity) or reaches that have been slightly straightened (decreased wavelength-to-width ratios). Stressors are common along the reach and management is likely required to maintain functionality. Moderate impacts exist that significantly affect channel entrenchment, capacity, or ratios.
D	Widespread stressors impact the river planform, such as floodplain encroachment, hardened banks, or planform straightening. Major bank armoring and/or significant changes to sinuosity or meander wavelength are present, such as reaches with large (>3 feet) grade control structures and moderate planform changes. Active management and maintenance are required to maintain functionality. Widespread impacts exist that severely affect channel entrenchment, capacity, or width-depth ratios.
F	Widespread stressors cause severe impacts or changes to the planform and slope. Examples include anastomosed or meandering streams that were straightened or channelized, rivers with severe floodplain encroachment or armoring of banks, and streams with very large (>6 ft) grade control structures. Stressors are extensive throughout the reach and the level of impairment results in an inability to maintain characteristic function. Profound impacts exist with near-complete alteration of channel entrenchment, capacity, or width-depth ratios. Intensive or consistent active management and maintenance are required. Severe changes to slope are evident.

8.1.3 Results

The channel morphology indicator is evaluated through remote sensing analysis using aerial imagery and GIS spatial data, as well as qualitative field observations. Various morphological calculations were made to evaluate planform in the context of what would be expected for a river in the process domain of the Upper Yampa segment, including sinuosity and meander wavelength to channel width ratios (l/w). Fieldwork completed for the Scorecard project included stressor-based observations that are relevant for channel morphology.

The highest relative scores for the channel morphology indicator in the Upper Yampa segment are in riverscapes 3 and 4 (Table 8-3). Sinuosity was highest in these partly confined riverscapes, with very high values of 2.7 and 1.85, respectively, and the l/w ratios are moderate with values around 13 (Table 8-2). The l/w ratios are within the range of natural variability for freely meandering, unconfined channels (Nicoll and Hickin 2010). These riverscapes are generally moderately connected to the available floodplain, despite moderate terrestrial habitat fragmentation (Table 5-4) and high infrastructure density (IWMP 2022). The adjusted floodplain connectivity values (Table 6-2) for these riverscapes suggest a moderate level of connectivity and that while flows can reach a large floodplain area, frequent interactions are more limited to closer parts of the floodplain. Inhibitions to natural channel processes, including armoring and limitations by road and railroad infrastructure, are present in these riverscapes, but these inhibitions are minimal (Figure 5-1). Complexity features such as prolific evidence of lateral mobility, wood accumulation, and beaver activity are indicative of a moderately well-functioning river system, and sinuosity values and l/w ratios (Table 8-2) observed in both riverscapes 3 and 4 are within the natural range of variability for a mixed-load river (Nicoll and Hickin 2010). Furthermore, these riverscapes have a meandering planform expected from the stream evolution triangle (Castro and Thorne 2019). These two riverscapes therefore earn a channel morphology score of A (Table 8-3).

Table 8-2. Confinement, Sinuosity, and Meander Wavelength to Bankfull Width Ratios (l/w) by Riverscape

Riverscape	Confinement	Sinuosity	l/w
37	Confined	1.08	7.66
38	Partly Confined	1.07	23.36
1	Confined/Canyon	1.18	20.66
2	Partly Confined	1.72	15.53
3	Partly Confined	2.7	13.74
4	Partly Confined	1.85	13.62

Riverscapes 37 and 38 each had the lowest sinuosity values of 1.08 and 1.07, respectively (Table 8-2). Riverscape 37 also had an expected low l/w ratio, but riverscape 38 had an unexpectedly high l/w ratio of 23.36 (Table 8-2). In these riverscapes, the Bear River is generally confined, and the river has limited space to meander which restricts sinuosity. A low sinuosity would likely be associated with a low l/w due to tighter and more frequent meander bends; however, the high l/w of riverscape 38 highlight very narrow bankfull widths. The lack of movement in a confined, low-sinuosity channel in riverscapes 37 and 38 suggest limited interaction with the floodplain, and this finding is corroborated by the relatively low floodplain connectivity seen in the Upper Yampa segment of the IWMP (2022) and the adjusted floodplain connectivity values (Table 6-2). Aside from the dams, stressors are minimal in these headwater riverscapes and channel geometry are within a natural range for a well-functioning river in these confined domains. Sinuosity values for both riverscapes are expected. The channel in riverscape 38 reflects a confined path with long, subtle meanders that stretch over a considerable distance relative to the narrow width of the channel. This riverscape is likely stable due to confinement and appears to still exhibit the physical variability that supports diverse aquatic and riparian habitats. The channel morphology score for these riverscapes are found in Table 8-3.

In the upstream portion of riverscape 2, the Yampa River begins where the Bear River confluences with Phillips Creek (Figure 1-2). Although the river is partly confined by Pleistocene terraces, this riverscape has a major highway and railroad that run north-south to the west of the river, and the Town of Yampa is located just west of the river in the upstream portion of the riverscape, a relatively wide floodplain exists with moderately-developed meanders. The channel is found hugging the eastern side of the riverscape (Figure 6-2), flanking adjacent bedrock in some stretches. Sinuosity is high in this riverscape at 1.72, the second highest of all riverscapes (Table 8-2). The l/w ratio was moderately high, indicating that the river's meanders are relatively large compared to its bankfull width. Localized stressors exist but are not widespread in the riverscape; however, fragmentation is high compared to other riverscapes (Table 5-4). Bank armoring and localized stressors associated with Highway 131 and the railroad are primarily in the downstream portion of the riverscape where the channel and highway/railroad intersect. In addition, channel straightening and bank armoring may occur where private property exists. In these areas, channel morphology is altered, and river functionality is impaired. This riverscape therefore earns a channel morphology score of B (Table 8-3).

Lastly, riverscape 1 had a relatively low sinuosity and high l/w ratio (Table 8-2). This riverscape is mostly confined, however, and so the l/w ratio was expected to be slightly lower (Nicoll and Hickin 2010). Lower bankfull widths are likely responsible for the higher l/w ratio. Despite the moderate degree of armoring in riverscape 1, abundant backwater areas, side channels, and wood are present (Section 9.1). These findings suggest that this riverscape generally falls within suitable ranges of variation for channel morphology and therefore earns a score of B- (Table 8-3).

Table 8-3. Channel Morphology Indicator Scores by Riverscape

Riverscape	Channel Morphology Score
Riverscape 37	A
Riverscape 38	A-
Riverscape 1	B-
Riverscape 2	B
Riverscape 3	A
Riverscape 4	A

9.0 STRUCTURAL COMPLEXITY

Structural complexity is defined as the degree of heterogeneity and physical composition of a stream that results from interactions between flow regime, sediment dynamics, and other factors. The more complex and heterogeneous the physical structure of a stream, the more enhanced the habitat for resident aquatic species. Structural complexity considers hydraulic characteristics (water depth and velocity patterns), bed and bank features, and substrate material. In scoring the indicators in this category, a concerted effort is made to integrate quantifiable records and observations from fieldwork conducted by educational partners. Two indicators are included in the structural complexity category: **macrohabitat** and **microhabitat**. The final structural complexity score is calculated as 75% macrohabitat and 25% microhabitat indicator scores.

9.1 MACROHABITAT INDICATOR

The macrohabitat indicator considers physical habitat relevant to fish and larger animals, including distribution and diversity of water depth, velocity, and physical cover, shape of bed and bank features, heterogeneity of habitat, and other large physical structure provided by rock, wood, vegetation, etc. Macrohabitat includes cobble/sand bars, undercut banks, presence/absence of secondary channels/backwaters, and presence, extent, and quality of large wood.

9.1.1 *Data Sources and Evaluation Methods*

The following features that are important for heterogeneity and complexity within the channel are evaluated in the field, usually from a boat:

- Bedforms including riffles, runs, pools, and glides;
- Split flows (i.e., two narrow channels versus one wide channel);
- Secondary channels (count, GPS, presence of water yes/no);
- Point bars (characteristics: vegetated, cobble, gravel, sand; size);
- Signs of beaver activity (chews, dams, side channel dams, bank dens);
- Presence, size, and quality of large wood;
- Reinforced bank length and type (GPS start and end of reinforced banks on both sides of channel and indicate material (concrete, car bodies, riprap, etc.);
- Undercut bank length; and
- Backwater areas.

Fieldwork to inform this indicator was completed during the summer of 2024, in partnership with local landowners. Data was collected by foot and supplemented with aerial imagery. To the extent possible, these features were enumerated, representative photos are taken, and measurements are quantified and marked with a GPS device (Appendix A). These quantitative measurements feed into the scoring described in detail in Table 9-1.

9.1.2 Scoring Criteria

The scoring criteria outlined in Table 9-1 for the macrohabitat indicator is based on the presence of complexity features and physical structure of the reach, estimates of diversity of depth/velocity combinations, and topographic complexity of beds and banks.

Table 9-1. Macrohabitat Indicator Scoring Criteria

Grade	Description
A	Macro-scale structural heterogeneity is natural and appropriate for a well-functioning river in its process-domain. All velocity-depth combinations and structural components (features formed by wood, rock, vegetation, debris dams/jams, and beaver activity) are present in characteristic distribution.
B	Most typical velocity-depth combinations are present, but distribution of structural components (features formed by wood, rock, vegetation, debris dams/jams, and beaver activity) is slightly skewed due to dispersed stressors or minimal direct impacts. Pools provide adequate cover for fish and other aquatic organisms.
C	Some typical velocity-depth combinations or characteristic structural elements (features formed by wood, rock, vegetation, debris dams/jams, and beaver activity) are absent or limited. Pools provide some cover for fish and other aquatic organisms. Examples include reaches with increased pool/run habitat, lack of off-channel habitat, or skewed riffle-pool ratio. Reaches with artificial structure or hardened/revetted banks also fall into this category.
D	Some typical velocity-depth combinations or characteristic structural elements (features formed by wood, rock, vegetation, debris dams/jams, and beaver activity) are absent, making the reach uncharacteristically homogeneous. Pools may provide minimal cover for fish and other aquatic organisms. Examples include reaches with graded or heavily armored banks, or with features that are frequently limited by inundation or low flow.
F	Homogeneous form with uniform velocity-depth pattern, lack of physical structure, and lack of pools. Examples include reaches with severely homogenized physical characteristics such as unnatural plane-bed morphology.

9.1.3 Results

Macrohabitat was scored by the consideration of the variables outlined in the scoring scheme above, several of which comprise criteria considered for additional indicators herein. Rather than an indicator of redundancy, this instead illustrates the broad, integrative nature of the river landscape in setting the habitat template. Data evaluated here was gathered from field hikes of the riverscapes in consideration and informed by review of current and historical aerial imagery.

Bank armoring contributes to reach homogenization and increased resistance to the drivers of river complexity, mainly channel migration and the formation of secondary channels. Therefore, bank armoring (e.g., Figure 9-1; Appendix A, Photos A13 through A16) is likely the most consistently detrimental factor regarding relatively diminished structural heterogeneity and thus macrohabitat. Diversion structures, or hard points such as stairs and bridge pilings, also decrease levels of complexity and potential for channel migration, although their impact is minimal compared to traditional armoring due to shear differences in length/impacted area.

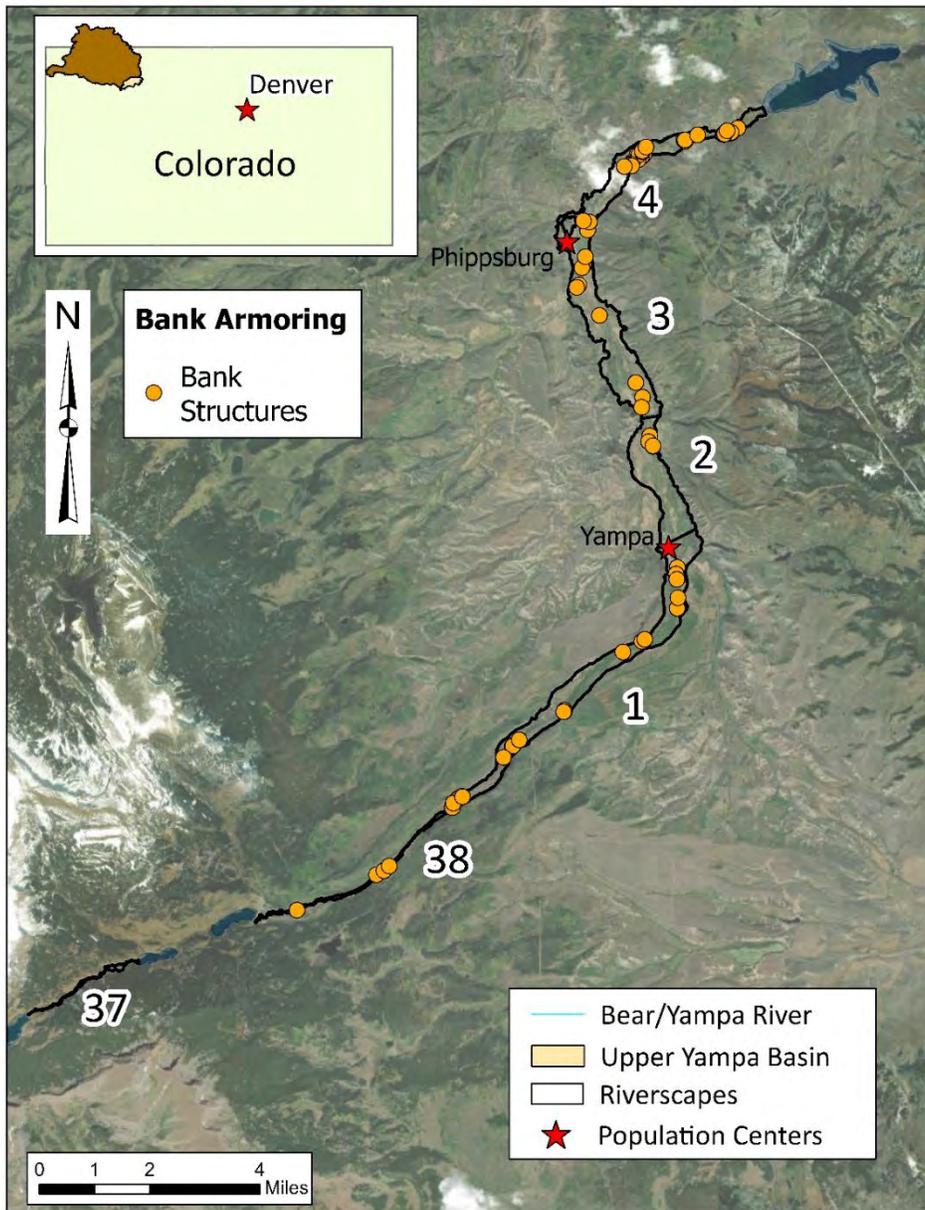
Moderate bank armoring exists in all riverscapes except riverscape 37 (Figure 9-1). Riverscape 37 is located at the upstream end of the Upper Yampa segment on USFS land and so bank armoring is essentially nonexistent aside from the grey infrastructure associated with the outlet of Stillwater Reservoir. Just downstream, riverscape 38 has minimal armoring, mostly in locations where diversion structures are present and at the outlet of Yamcolo Reservoir. Throughout the Upper Yampa segment, higher frequencies of diversion-related structures are generally found rather than development-related hard points, due to abundant agricultural land uses (Figure 9-1). In riverscapes 1-4, the channel is reinforced via a variety of mechanisms: traditional riprap using large rocks, placement of a mélange of concrete debris, or, on occasion, “Detroit riprap” – the lining of riverbanks with old automobiles and appliances (Appendix A, Photo A-13). Additionally, restoration-related bank structures were seen in riverscape 4. Restoration actions taken to improve bank stability and fish habitat utilized boulders to create hardened banks but in turn limit lateral mobility (Appendix A, Photo A-16). As previously mentioned, the upstream portion of riverscape 2 was inaccessible, so armoring data are not available for this portion of the river.

Although riverscapes 1, 3, and 4 have moderate armoring, they also have extensive occurrences of features indicative of complexity such as backwater areas and side channels/split flows (Figure 5-3; Appendix A, Photo A-18). This may result from the additional “freedom” of the river to migrate across the floodplain in locations where bank armoring is not present.

Large wood also contributes to channel and floodplain heterogeneity and complexity that is important for aquatic habitat. Wood is found extensively throughout all riverscapes (Appendix A, Photos A19 through A21) but is somewhat sparse in several reaches of riverscape 1 (Figure 9-2). Higher frequencies of large wood are found in riverscapes 3 and 4, and generally these higher density areas correlate to increased habitat connectivity (Figure 5-3), the presence of bars (Figure 3-2), and beaver activity (Figure 9-3). Bars play a crucial role in riverine macrohabitats, providing habitat and refuge for fish, support riparian vegetation, and variability in the river’s natural dynamics that help to create pools, riffles, and other structures critical to fish. Sand and gravel bars were primarily found in the downstream riverscapes 3 and 4 (Figure 3-2; Appendix A, Photos A22, A23). The lack of bar formation in the upstream riverscapes possibly suggests an inadequate supply of sediment, likely due to the steep nature of the landscape and/or dams from nearby reservoirs (Figure 1-2) and have implications for macrohabitat availability.

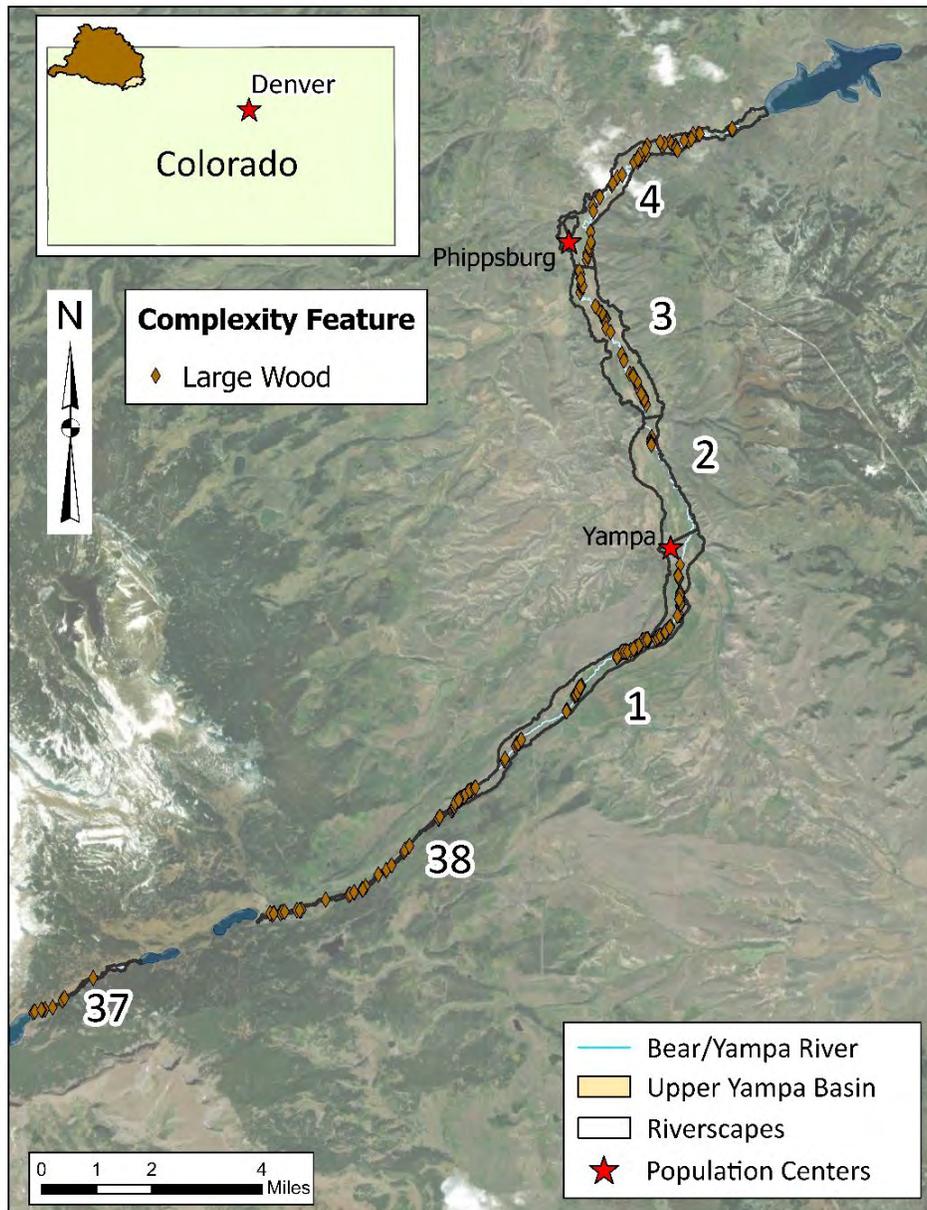
Signs of beaver activity are frequently found throughout all riverscapes but are minimal in riverscapes 2 and 3 (Figure 9-3). Signs of beaver activity ranged from beaver chew on the floodplain, beaver dams in the channel, lodges, and “hotspots” of channel complexity (Appendix A, Photos A24 through A27). Beaver activity in the upper riverscapes (riverscapes 37 and 38) is crucial to macrohabitat development because otherwise these riverscapes are limited in bars (Figure 3-2) and lateral pathways (Figure 5-3), and generally experience localized erosion on major cutbanks. Beavers enhance macrohabitats by altering the physical conditions of riparian ecosystems. Their presence leads to the creation of pools, increased complexity and floodplain connectivity, sediment and nutrient retention, support for riparian vegetation, and increased biodiversity. Riverscapes with more frequent signs of beaver activity therefore receive better scores than others. As previously mentioned, however, much of the upstream portion of riverscape 2 was not accessible and so data for this area are lacking.

Figure 9-1. Bank Armoring Across the Upper Yampa Segment by Riverscape



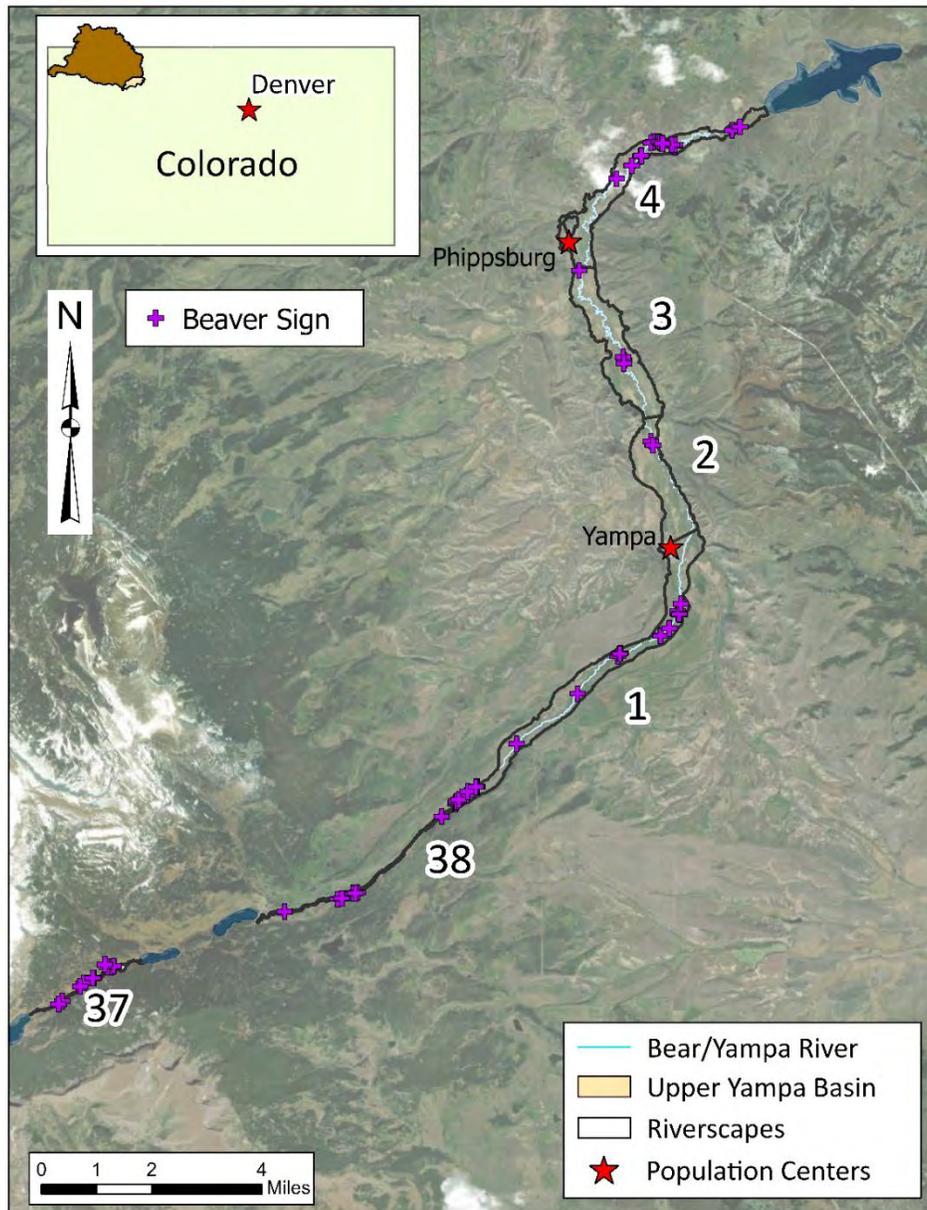
* Note: Each riverscape was visited on foot for field observations, except for approximately 20% of riverscapes 37 and 38, 10% of riverscape 1, and 70% of riverscape 2, mainly due to private property access considerations. Therefore, this graphic may not show the full extent of bank armoring, particularly in riverscape 2.

Figure 9-2. Locations of Woody Material by Riverscape



* Note: Each riverscape was visited on foot for field observations, except for approximately 20% of riverscapes 37 and 38, 10% of riverscape 1, and 70% of riverscape 2, mainly due to private property access considerations. Therefore, this graphic may not show the full extent of large wood, particularly in riverscape 2.

Figure 9-3. Beaver Sign by Riverscape



* Note: Each riverscape was visited on foot for field observations, except for approximately 20% of riverscapes 37 and 38, 10% of riverscape 1, and 70% of riverscape 2, mainly due to private property access considerations. Therefore, this graphic may not show the full extent of beaver sign, particularly in riverscape 2.

Table 9-2. Macrohabitat Scores by Riverscape

Riverscape	Macrohabitat Score
Riverscape 37	A-
Riverscape 38	A-
Riverscape 1	B-
Riverscape 2	B-
Riverscape 3	C+
Riverscape 4	B

9.2 MICROHABITAT INDICATOR

The microhabitat indicator considers physical habitat relevant to small aquatic species such as benthic macroinvertebrates and larval fish, particularly the availability of interstitial spaces among the river bed substrate, degree of embeddedness, armoring, proportion of fine sediment, algae cover, and patches of organic material or detritus accumulations.

9.2.1 Data Sources and Evaluation Methods

The microhabitat indicator is scored in the field through measurements of embeddedness and visual observations of presence/absence of algae cover. Embeddedness measures the degree to which gravel and cobble substrates are surrounded by fine sediment. It relates directly to the suitability of the stream substrate as habitat for macroinvertebrates, fish spawning, and egg incubation. Embeddedness measurements occur in riffles only. Embeddedness is measured by picking up particles of gravel or cobble with the evaluator's fingertips at the fine sediment level. The particle is pulled out of the bed and the percent of that particle that was buried by sediment is estimated (NRCS 2017). All measures of percent embeddedness within each riverscape are averaged for a final embeddedness percentage by riverscape.

9.2.2 Scoring Criteria

The scoring criteria outlined in Table 9-3 based on field observations of interstitial space availability, bed armoring, embeddedness, and algae in riffles are used to rate the microhabitat indicator.

Table 9-3. Microhabitat Indicator Scoring Criteria

Grade	Description
A	Micro-scale structural heterogeneity is natural and appropriate for a well-functioning river in its process-domain. Interstitial spaces appropriate for natural geographic conditions.
B	All aspects of micro-scale structural diversity are present, but distribution of features is skewed due to dispersed stressors or minimal direct impacts. Examples include reaches with mild fine sediment deposition or slightly decreased interstitial

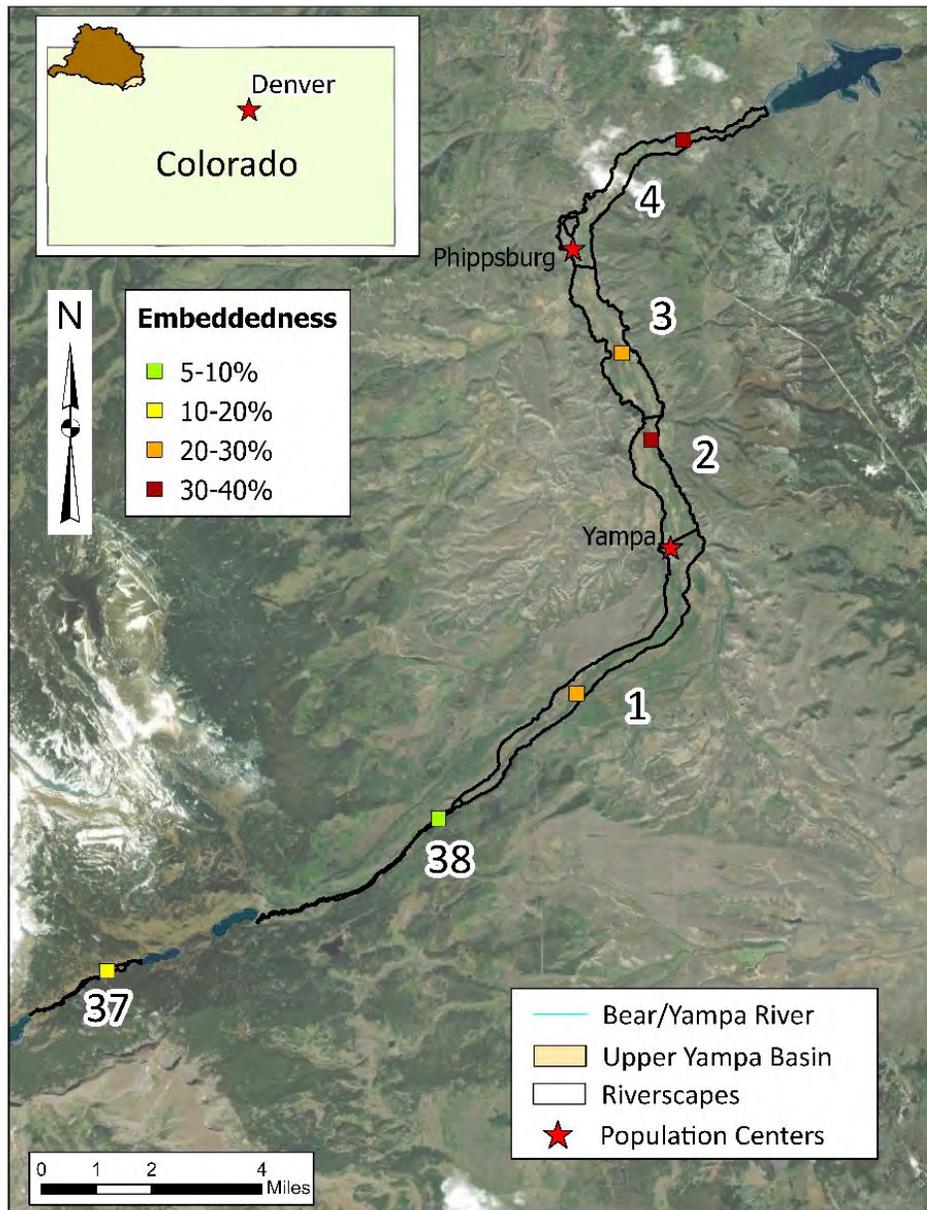
	space (mild embeddedness, 10-20%) for either cobble- or gravel-bed reaches, depending on natural geographic conditions.
C	Some aspects of micro-scale structural diversity are lacking or limited. Examples include reaches with altered bed material distribution, patches of armoring, increased cover of persistent algae/aquatic vegetation, decreased detritus/organic accumulation patches, or moderate embeddedness (20-30%) for either cobble- or gravel-bed reaches, depending on natural geographic conditions.
D	Some aspects of micro-scale structural diversity are lacking or severely limited, making the reach uncharacteristically homogeneous. Examples include reaches with widespread armoring, persistent algae/aquatic vegetation in riffles, lack of any detritus/organic accumulation patches, or severe embeddedness (30-40%) for either cobble- or gravel-bed reaches, depending on natural geographic conditions.
F	Completely static or homogeneous armored micro-scale physical structure. Examples include gravel- or cobble-bed streams that are aggrading with fine material (embeddedness >40%) or choked with algae, alluvial streams unnecessarily scoured to bedrock, or grouted/hardened artificial streambeds.

9.2.3 Results

Data to score this indicator were collected via field visits to illustrative locations with reliable access in each riverscape and observing presence/absence of algae cover, as well as evaluating embeddedness at riffles co-located with macroinvertebrate monitoring locations. Embeddedness is evaluated following the methodology described above.

Embeddedness was lowest (5-10%) at measured riffles in riverscape 38, and next lowest (10-20%) in riverscape 37 (Figure 9-4). Low values of embeddedness in these Bear River headwater reaches track with the proximity of these reaches to Stillwater, Bear, and Yamcolo Reservoirs, which serve as an impediment to natural sediment transport through these reaches. Higher valley confinement and higher velocities through riverscapes 37 and 38 also limit finer particles from settling and embedding, leading to coarser bed material overall. Riverscapes 1 and 3 had 20-30% embeddedness, and riverscapes 2 and 4 had the highest embeddedness ranges at 30-40% (Figure 9-4). Higher embeddedness suggests more fine sediment deposition, and possible causes could include inadequate flushing flows or grazing impacts. Fine sediment deposition often has negative implications for habitat quality (reduced oxygen availability, spawning challenges, reduced interstitial spaces for macroinvertebrates, etc.). Algal cover was not significant at any of the sampled locations, or generally observed throughout the Upper Yampa segment during 2024 fieldwork across a range of flow conditions.

Figure 9-4. Embeddedness Locations and Ranges by Riverscape



Overall, values of embeddedness were within the range of expected variability (from mild to severe), and these percentages indicate an impacted relationship between deposition and transport through some of the lower reaches of the Upper Yampa segment. Scores for the microhabitat indicator are presented in Table 9-4.

Table 9-4. Microhabitat Scores by Riverscape

Riverscape	Microhabitat Score
Riverscape 37	B+
Riverscape 38	A-
Riverscape 1	C+
Riverscape 2	D+
Riverscape 3	C+
Riverscape 4	D+

10.0 BIOTIC COMMUNITY

Biotic community is defined as the health of resident aquatic biota including microbes, periphyton (attached algae), macrophytes (aquatic plants), macroinvertebrates (aquatic insects), fish, amphibians, and any other organism that is part of the aquatic biological community for all or part of its life history. There are two indicators within the biotic community category: **macroinvertebrates** and **native fish**. The final biotic community score is calculated as an average of the macroinvertebrates and native fish indicator scores. Information about sport fish is covered in the River Uses and Management attribute of the Scorecard.

10.1 MACROINVERTEBRATES INDICATOR

Benthic macroinvertebrates can be used as indicators of both water quality and the health of the biotic community. Refer to Section 4.4 for details and scores related to this indicator.

10.2 NATIVE FISH INDICATOR

Fish population monitoring, typically conducted via electrofishing surveys, is used to determine fish species composition (including relative abundances of species), density estimates, age or size class distribution, and other metrics related to the health of the fishery. Due to the paucity of comprehensive data in the Upper Yampa segment, the native fish indicator is focused on percent native fish and presence of Mountain Whitefish. It is important to note that after 2000, the geographic ranges of native coldwater fishes in the Upper Yampa (including native Mountain Whitefish and Colorado River Cutthroat Trout) decreased markedly (Yampa IWMP 2021). This section is completed mainly as a tool for comparison between riverscapes and to contrast with other Scorecard segments. While Friends of the Yampa is engaging in efforts to conduct fishery population monitoring in additional locations in this segment, the historical data (and even current data) are extremely limited and so any conclusions that are made based on available data in this section are associated with some uncertainty.

10.2.1 Data Sources and Evaluation Methods

Many of the fish electroshocking efforts in this region, particularly in the vicinity of Stagecoach Reservoir, have been motivated by invasive species removal (for species such as Northern Pike, Walleye, and White Sucker). While some level of historical data exist for the riverscapes in the Upper Yampa segment, it is important to consider that these data are often more focused on non-native fish removal efforts, and are therefore biased to record those species more frequently instead of providing some estimation of species abundance and diversity.

According to CPW's database of aquatic data collected across the state, fish population data have still been collected at each riverscape in the Upper Yampa segment except riverscape 2 between one and five times over the years 1978 to 2020. Due to the paucity of fish population data in the Upper Yampa segment, electrofishing surveys to determine species presence/absence and relative abundance were conducted as part of the Scorecard effort at two sites on August 29, 2024: one in riverscape 38 and one in riverscape 2. Because limited data were available for review in the entirety of the Upper Yampa segment, some uncertainty is associated with fishery scores from all riverscapes.

10.2.2 Scoring Criteria

The scoring criteria outlined in Table 10-1 based on presence and proportions of native species are used to rate the native fish indicator. This scoring scheme is based on the fisheries evaluation conducted for the Yampa IWMP remote assessment (Yampa IWMP 2021). It acknowledges that nearly all of the Yampa's riverscapes contain impacted fisheries; any riverscapes that earn a score of A are still highly modified compared to historical conditions. However, the goal of this scoring system is to differentiate between riverscapes on a relative scale. Had the historical condition of robust, native fisheries been used for a score of A, no differentiation would be possible, because all riverscapes would have low scores. The use of an altered baseline condition allows the prioritization of riverscapes and the opportunity to select individual riverscapes for future adaptive management and research activities (Yampa IWMP 2021).

Table 10-1. Native Fish Indicator Scoring Criteria

Grade	Description
A	The reach supports all of the expected native species for the given watershed location. In coldwater riverscapes, Colorado River Cutthroat Trout, Mountain Whitefish, native Sculpin ³ , and Mountain Sucker are expected. In warmwater riverscapes, The Three Species (Bluehead Sucker, Flannelmouth Sucker, and Roundtail Chub), Mountain Sucker, Colorado Pikeminnow, and Speckled Dace are expected. Nonnative species such as Northern Pike, Smallmouth Bass, and White Sucker are not common. The percentage of native species is generally greater than 50%.
B	The reach supports a majority of the expected native species for the given watershed location. In coldwater riverscapes, Colorado River Cutthroat Trout, Mountain Whitefish, native Sculpin, and Mountain Sucker could be expected. In warmwater riverscapes, The Three Species (Bluehead Sucker, Flannelmouth Sucker, and Roundtail Chub), Mountain Sucker, Colorado Pikeminnow, and Speckled Dace are expected. Nonnative species such as Northern Pike, Smallmouth Bass, and White Sucker are present but not common. The percentage of native species is generally greater than 20%.
C	The reach supports some expected native species for the given watershed location. In coldwater riverscapes, some or all of the native salmonids may have been replaced with Brook Trout, Brown Trout, and/or Rainbow Trout, but the naturalized populations are robust. Native Sculpin are expected. In warmwater riverscapes, some of the native warmwater species listed above are present. Native Sculpin and Speckled Dace are also expected. Nonnative species are common, and native species comprise 10-20% of the fish community.
D	The reach supports few or no native fish, or the fishery exhibits a highly degraded condition. In coldwater systems, salmonids are expected, but in low densities. Native Sculpin or Speckled Dace may be present. In warmwater riverscapes, The Three Species (Bluehead Sucker, Flannelmouth Sucker, and Roundtail Chub), Mountain Sucker, and Colorado Pikeminnow are largely or entirely absent. Speckled Dace may be the only native warmwater species present. Nonnative

³ The CPW database lists native sculpin as Mottled Sculpin, but sculpin taxonomy has been updated in recent years and we refer to them in this and future Scorecard reports as "native sculpin."

	species are common and abundant. Native species comprise less than 10% of the fish community.
F	The reach does not support native fish, and/or the fishery exhibits a highly degraded condition. In coldwater systems, salmonids are absent or present in low densities, and native Sculpin and Speckled Dace are absent. In warmwater riverscapes, The Three Species (Bluehead Sucker, Flannelmouth Sucker, and Roundtail Chub), Mountain Sucker, and Colorado Pikeminnow are absent. Nonnative species dominate, and native species comprise less than 5% of the fish community.

10.2.3 Results

Results for the native fish indicator are provided in Table 10-2 and described here. It is important to note that CPW keeps stocking data records, and that reports of hundreds of thousands of trout (many different species, including, but not limited to, Rainbow, Brown, Brook, Cutthroat, and Colorado River Cutthroat Trout) have been stocked in Stillwater Reservoir, Bear Lake, Yamcolo Reservoir, Stagecoach Reservoir, along the Bear and Yampa Rivers, and in surrounding tributaries. Since 2007, only varieties of Rainbow and Cutthroat Trout have been stocked in these areas (and Brook and Brown Trout have not been stocked since 2006). CPW stocking records show consistent stocking in these locations from the early 1970s to the present time (2024). In addition, the database may not include stocking on private ranches, which also adds significant numbers of trout to these water bodies. This widespread stocking makes it difficult to draw conclusions about the presence of self-sustaining populations of any species.

Riverscape 37 between Stillwater Reservoir and Bear Lake has limited data, with information available from 1976, 2007, and 2008. In those years, Brook Trout, Brown Trout, and Colorado River Cutthroat Trout (possibly stocked in 1976 and the early 2000s, but possibly self-sustaining more recently) were the sport fish observed, and Mountain Whitefish and native Sculpin were also reported, but in comparatively low numbers. The presence of beaver activity in this riverscape may be mitigating some of the deleterious effects of the upstream and downstream dams, with positive outcomes for the fishery. Based on the limited available data, riverscape 37 earns a score of C-.

In riverscape 38 between Yamcolo Reservoir and the USFS land boundary, data availability is even more limited. Reports from 1976 show observations of Rainbow Trout, Brook Trout, and Mountain Whitefish. Recent electrofishing efforts for the Scorecard project in summer 2024 to increase data availability and understand the current state of the fishery revealed observations of native Sculpin in comparatively large numbers, as well as Brook Trout, Brown Trout, and Rainbow Trout. The 2024 monitoring event showed presence of many native Sculpin, and that trout populations are diverse and have good size class distributions. The native Cutthroat Trout have been replaced by other salmonids, which is arguably a function of historical fishery management decisions as opposed to poor river health, and these salmonid populations appear to be robust and self-sustaining. No native salmonids (e.g., Mountain Whitefish, Colorado River Cutthroat Trout) were observed in 2024. The percent of native species observed increased from 29% to 44% between 1976 and 2024. Based on these data, riverscape 38 earns a score of B-.

Riverscape 1, extending from the USFS land boundary to the Town of Yampa, was sampled only twice: in 1976 and 1993. Species observed in 1976 included several Brown Trout and one White

Crappie. Since this is a warmwater fish species and an approximately 50-year old record, it may not be accurate. The species found in 1993 included only sportfish (Brook, Brown, and Rainbow Trout). No native species were identified. Based on these very limited data, this riverscape earns a score of D. However, the next iteration of this segment of the Scorecard may want to shift the electrofishing focus to this riverscape so more current fish species data are available.

Riverscape 2 consists of the southern (upstream) portion of the Yampa River between Phippsburg and Yampa. No data exist in the CPW database for this reach, but recent electrofishing efforts for the Scorecard project in summer 2024 to increase data availability and understand the current state of the fishery revealed observations of Sculpin, Brown Trout, and Mountain Whitefish, with the native fish (predominantly Sculpin) accounting for almost 90% of the catch. However, capture probabilities were naturally limited at the time of sampling due to fast and turbid waters; therefore, some large trout as well as trout of other age classes were missed, so the 90% native fish estimate may be misleading. Numbers of Brown Trout and Mountain Whitefish caught were approximately the same, and no native trout were captured. As a result, riverscape 2 earns a score of B.

The northern (downstream) portion of the Yampa River between Phippsburg and Yampa is represented by riverscape 3. Comparatively robust datasets from 1994 and 2020 provide promising information about the fishery through this reach. Observations of 5 species were made in 1994, including nonnative White Sucker, Redside Shiner, and Brown Trout, but also relatively large numbers of native Mountain Whitefish and native Sculpin. In 2020, 12 different species were observed, including native Mountain Whitefish, Speckled Dace, and native Sculpin, and nonnative, Brown Trout, Rainbow Trout, Cutthroat/Rainbow hybrid Trout, Brook Trout, White Sucker, Fathead Minnow, Creek Chub, White/Blue Sucker hybrid, and Northern Pike. Relative abundances of native versus nonnative fish species, although relatively high, declined between the two sampling events, with nonnative fish of varying species becoming much more common. The presence of so many warmwater fish species (likely swimming up from Stagecoach Reservoir) negatively affects the score in this riverscape because these species would not typically be present in a coldwater system. Based on this limited information, riverscape 3 earns a score of B-.

Riverscape 4, spanning the Yampa River between the Town of Phippsburg and Stagecoach Reservoir, and including the CPW fishing access/easement on the SKCK ranch as well as several other private ranches, had the most data available in the CPW database, with samples from 1993, 1995, 1998, 2012, and 2020. However, both the 2012 and 2020 efforts focused on non-native species removal, particularly of Walleye at the Stagecoach inlet. The sampling events in the 1990s that were more focused on population information than nonnative species removal had 8-10 species observed, including several nonnatives but also Mountain Whitefish, native Sculpin, and Speckled Dace. Percentages of native fish were low in 1995 (2%) but higher in the intermediate years (39% in 1993 and 24% in 1998). Similar to riverscape 3, riverscape 4 also supports a diversity of warmwater nonnative species, likely coming from Stagecoach Reservoir. Based on these available data, riverscape 4 receives a score of C. Considering that all recent electrofishing efforts seem to be geared toward nonnative species removal, the next iteration of this segment of the Scorecard may want to shift the electrofishing focus to this riverscape so more current fish species data are available.

It is possible that scores for some of the riverscapes would improve slightly with data collection efforts tailored toward community characterization; however, the fishery in these riverscapes is

significantly impaired due to an overabundance of nonnative species. While scores in the B range assigned to riverscapes 38, 2, and 3 appears high, it denotes a very degraded condition as a result of the use of an “altered baseline condition” for this Scorecard effort to allow for the prioritization of riverscapes and the opportunity to select individual riverscapes for future adaptive management and research activities. However, these three riverscapes appear to be the most successful in the Upper Yampa segment at supporting populations of native fish. From a future data collection perspective, it would be informative to focus on community or population estimates at these locations again to limit some of the uncertainty around the state of the fishery through this segment. It could also be wise to visit some of the other riverscapes for information about current species presence/absence and relative abundance because the majority of the existing data are not current.

Table 10-2. Native Fish Indicator Scores by Riverscape

Riverscape	Native Fish Score
Riverscape 37	C-
Riverscape 38	B-
Riverscape 1	D
Riverscape 2	B
Riverscape 3	B-
Riverscape 4	C

11.0 OVERALL RIVER HEALTH AND FUNCTION SCORE

Upon assigning scores for each indicator and category to each riverscape within the Scorecard focal segment, the individual category scores are integrated to derive a final river health and function score for each of the 6 riverscapes within the 31-mile Upper Yampa segment of the Bear and Yampa Rivers. The percent contributions of each river health and function category are provided in Table 11-1. A weighted average by riverscape area is then calculated to yield a final segment score for the River Health and Function attribute area.

Table 11-1. Percent Contribution to Overall River Health and Function Score by Category

Category	Percent
Flow Regime	20
Sediment Regime	5
Water Quality	15
Habitat Connectivity	5
Riverscape Connectivity	10
Riparian Condition	20
River Form	5
Structural Complexity	15
Biotic Community	5

The final river health and function scores for the Upper Yampa River segment are provided in Table 11-2, organized by indicator and riverscape. **Weighting the cumulative scores for each riverscape by river length yields an overall ecological health and function score of C+ for the entire Upper Yampa segment.**

This assessment highlights both the strengths of the Upper Yampa segment and opportunities to enhance its resilience in the face of ongoing environmental and societal pressures. Across the Upper Yampa segment, channel morphology is largely intact, and features that add complexity and heterogeneity across the channel and floodplain are abundant. Invasive plant species have limited negative impacts on the riparian zone, and water quality across the segment is generally good.

The Upper Yampa segment relies on a snowmelt-driven flow regime, which supports diverse ecological functions. However, alterations to minimum and peak flow patterns that result from reservoir management and diversions highlight the importance of balancing water use with ecological needs. Similarly, the sediment regime remains largely stable, but riverscapes are influenced by headwater reservoirs and the degree to which the sediment regime is altered from dams and diversions is still unclear. The Upper Yampa segment shows compliance with most regulatory standards for water quality parameters, but periodic exceedances of temperature

thresholds in downstream riverscapes could stress native aquatic species. Aquatic and terrestrial connectivity scores indicate a functioning but fragmented habitat, with barriers and infrastructure limiting connectivity. The riparian zone shows limited invasive plant species and higher vegetation complexity in the upper riverscapes (37 and 38). These upper riverscapes benefit from minimal direct human alterations with limited bank armoring but are ultimately heavily affected by large upstream dams. The channel is confined and steep in the upper riverscapes but in locations where a wide valley floor is present, beaver activity has helped connect the channel to an expansive and diverse floodplain. In contrast, the downstream riverscapes (1-4) face greater flow modifications from diversions and habitat fragmentation but have consistently broad floodplains, sinuous channels, and increased potential for lateral floodplain connectivity and healthy riparian corridors. Despite these differences, a common thread across all riverscapes is the need to balance natural processes with human demands. This is particularly highlighted in riverscape 1 where “dry up” points from water diversions severely alter the flow regime, underscoring the challenges of managing water resources to support both ecological integrity and human water use within the confines of existing Colorado water laws.

Patterns across riverscapes in the Upper Yampa segment reveal that areas with minimal alterations to the floodplain generally exhibit better river health (Table 11-2). Protecting and enhancing flow and sediment regimes, bolstering habitat connectivity, and expanding monitoring efforts to capture local and emerging climate impacts will be key to preserving the river’s ecological health. One particular area where these ideas could be proactively explored is in beaver coexistence. The beaver “hotspots” described and often lauded in this report are not limited to the Bear River headwaters (riverscape 37); rather, areas of historical and active beaver activity are also present in riverscapes 38, 1, and 2, and to a lesser extent in riverscapes 3 and 4. Sometimes, these beaver activity areas present challenges to landowners and land managers in the form of complicating diversions, consuming vegetation, blocking culverts, and flooding fields. However, with targeted beaver coexistence strategies, these challenges can be overcome and the benefits to river health provided by the presence of beaver could be realized for riverscape and floodplain connectivity, structural complexity and aquatic habitat, and riparian vegetation health. Improvements in these indicators could have cascading effects on biotic community structure and function as well.

Another timely consideration for improving riverscape health is to replace aging diversion infrastructure with contemporary designs such as ecological rock ramp structures or constructed riffles (Appendix A, Photo A-9) instead of channel-spanning concrete structures. These types of projects would also reduce maintenance activities, pass sediment, ensure water delivery to the adjacent agricultural landscape, and promote connectivity, both for aquatic species in the channel and for riverscape connection across the floodplain.

Overall, results from the Bear River and Yampa River headwaters segment illustrate that the Yampa remains a relatively healthy river and still holds the potential to become a flagship for riverine health across the western US. The Yampa River Scorecard Project website at <https://yampascorecard.org/> is a resource for understanding the nuanced strengths and challenges that make up the current state of the river. Engaging with the website and with Friends of the Yampa can provide pathways for becoming actively involved in the preservation and restoration of the Yampa River toward a promising future.

Table 11-2. Upper Yampa Segment Ecological Health and Function Scores by Indicator and Riverscape

		Segment	Upper Yampa River Segment						
		Riverscape	37	38	1	2	3	4	Overall
		Length (miles)	2.8	4.89	6.73	2.99	5.26	7.78	30.5
		Riverscape Area (square miles)	0.07	0.16	2.21	1.16	1.54	1.45	6.6
Category	Indicator	Scoring Weight							
Flow Regime	Hydrograph		C	C-	D	C	C+	C+	C
	Snowpack		C	C	C	C	C	C	C
	Flow Regime	20%	C-	C-	D	B-	B-	B-	C
Sediment Regime	Sediment Transport and Continuity	5%	C-	C-	C	B+	B	B-	C+
Water Quality	Temperature		A	A	A	A	C+	C+	B+
	Dissolved Oxygen		A	A	A	A	A	A	A
	pH		A	A	A	A	A	A	A
	Macroinvertebrates		C+	B-	B	B-	C+	C	C+
	Nutrients		A	A	B	B	B	B	B+
	Metals		A	A	A	A	A	A	A
	Water Quality	15%	A-	A	A-	A-	B+	B+	A-
Habitat Connectivity	Aquatic Habitat Connectivity		C	C	C-	C	B	C+	C
	Terrestrial Habitat Connectivity		A	A	B-	C	B-	B+	B
	Habitat Connectivity	5%	B	B	C+	C	B	B	B-
Riverscape Connectivity	Riverscape Connectivity	10%	C	D+	D+	D-	C-	D+	D+
Riparian Condition	Vegetation Structure and Complexity		A	A-	C	C	D+	C-	C+
	Invasive Species		A	A	A	A	A	A	A
	Riparian Condition	20%	A	A-	C	C	D+	C-	C+
River Form	Channel Morphology	5%	A	A-	B-	B	A	A	A-
Structural Complexity	Macrohabitat		A-	A-	B-	B-	C+	B	B
	Microhabitat		B+	A-	C+	D+	C+	D+	C+
	Structural Complexity	15%	A-	A-	B-	C+	C+	B-	B-
Biotic Community	Macroinvertebrates		C+	B-	B	B-	C+	C	C+
	Native Fish		C-	B-	D	B	B-	C	C
	Biotic Community	5%	C	B-	C	B	B-	C	C+
	Weighted River Health Score	100%	B	B	C	C+	C+	C+	C+

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APPENDIX A
PHOTO COMPILATION



Figure A-1. Large beaver complex in riverscape 37.



Figure A-2. Beaver complex in riverscape 37.



Figure A-3. Eroding bank near tributary on river left in riverscape 38.



Figure A-4. Bank erosion in riverscape 1.



Figure A-5. Bank erosion in riverscape 1.



Figure A-6. Diversion structure in riverscape 1 (Nickell Ditch).



Figure A-7. Diversion structure example in riverscape 4.



Figure A-8. Diversion structure example in riverscape 1.



Figure A-9. Example of the recently reconstructed South Side diversion structure with a ecological rock ramp feature in riverscape 4 that allows for fish and sediment passage while ensuring the decreed amount of water to the ditch (photo from October 2023 courtesy of Flywater Inc).



Figure A-10. Backwater area in riverscape 3.



Figure A-11. Split channel flow in riverscape 3.



Figure A-12. Beaver-influenced channel complexity (increased lateral pathways) in riverscape 37.



Figure A-13. Bank armoring with old automobiles in riverscape 4.



Figure A-14. Bank armoring with old tires in riverscape 4.



Figure A-15. Bank armoring with concrete rip rap in riverscape 4.



Figure A-16. Bank armoring with large boulders in riverscape 4.



Figure A-17. Side channel in riverscape 3.



Figure A-18. Example of complexity features (channels and backwater areas) in riverscape 3.



Figure A-19. Wood accumulation in channel in riverscape 3.



Figure A-20. Channel-spanning log jam in riverscape 1.



Figure A-21. Wood accumulation in middle of channel in riverscape 4.



Figure A-22. Cobble bar in riverscape 4.



Figure A-23. Cobble bar in riverscape 3.



Figure A-24. Beaver chew in riverscape 38.



Figure A-25. Breached beaver dam in riverscape 38.

APPENDIX B

TECHNICAL MEMORANDUM: YAMPA SCORECARD UPPER YAMPA SEGMENT RIPARIAN MAPPING METHODS AND RESULTS (OCTOBER 30, 2024)

FINAL

Yampa River Scorecard Project

River Uses & Management and People & Community Benefits

Upper Yampa Results and Scoring

August 2025



Prepared by:

Friends of the Yampa
Steamboat Springs, CO



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1.0 INTRODUCTION

The Yampa River Scorecard Project (YRSP) focuses on three attribute areas: Ecological Health and Function, River Uses and Management, and People and Community Benefits. While the project's primary focus is on Ecological Health and Function, the community-based attribute areas are also important. Focusing on these attributes helps with outreach and education by piquing peoples' interest and highlighting the many ways in which people personally connect to and derive benefit from the river. By focusing on these three attribute areas, the YRSP can increase community understanding of the ecosystem services provided by the river, including [regulating, provisioning, and cultural services](#). A healthy river provides regulating services including flood control, balanced erosion and deposition of sediment, and maintenance of water quality. Examples of provisioning services include clean drinking water and irrigation water. Cultural services may include emotional well-being, a sense of place, river recreation, and birding. These attribute areas were decided upon after engaging stakeholders over a 7-month period during the planning of the Scorecard. We asked: *what matters to you when you think of the Yampa River, how do you use the river, what do you think the community will be interested in, how do you value these interests, and what is an ideal when considering them (i.e., what would receive an "A" score)?* At any given time during the 7-month planning period, there were upwards of 30 participating stakeholders meeting monthly using the Zoom platform. Stakeholders represented many different interests and included community members that recreate on or near the river, run agricultural operations near the Yampa, own land on the Yampa, own river-related businesses in the valley, are concerned with the environment, are concerned with the economic growth or economic sustainability of the community, and much more.

The River Uses and Management and People and Community Benefits Attributes: Methods and Scoring Report is a living document that evolves as each river segment is studied. Several indicators are still in the development stage. We want to make sure our methods reflect diverse stakeholder interests, are implementable, and provide useful information. These methods will continue to be refined as we enter the 2026 season.

A note on scoring: Many indicators in this report rely on a 5-point ranking system as a measure of “user satisfaction,” where users rank their experience on a scale of 1-5. In all instances where a 1–5-point system is used for scoring, the conversion system in Table 1 is used to assign a letter score.

Table 1: Scoring System Reference

1-5 Point Assignment	Average Score	Letter Score Equivalent
5	5.0	A+
	4.7-4.9	A
	4.6	A-
4	4.4-4.5	B+
	3.8-4.3	B
	3.6-3.7	B-
3	3.4-3.5	C+
	2.8-3.3	C
	2.6-2.7	C-
2	1.6-2.5	D
1	1-1.5	F

2.0 RIVER USES AND MANAGEMENT

This attribute reflects how the river is directly used or managed by the various recreational river users, river managers, water and irrigation districts, agricultural producers, and non-governmental organizations.

2.1 RECREATION CATEGORY

The recreation category seeks to measure river-related or connected recreation in which either the river is used or the river is directly correlated with quality of experience. For instance, although birding can be experienced on or off the river, the river has a direct correlation with the quality of the experience and has a direct impact on birding populations and abundance.

2.1.1 Boating Indicator

The Boating indicator is meant to reflect the overall quality of the recreational boating experience in the focal segment. The Boating indicator is not applicable (na) for the Upper Yampa segment because the small size of the river channel and low-volume flow regime do not support any safe or quality boating through these riverscapes.

2.1.2 Fishing Indicator

The fishing indicator focuses on the sport fishing experience, specifically trout, and does not focus on native fish species. (The native fishery is addressed in the Ecological Health and Function attribute area.) While rainbow trout, brown trout, and brook trout are not native to the Yampa, their populations are managed (e.g., via stocking) by CPW because of their value to the recreational sport fishing industry and local economies. Additionally, many private ranches also stock their river reaches and in some cases this private stocking is not mediated by CPW. Other species of non-native fish (e.g., Northern pike) are considered undesirable because they are in direct conflict with native endangered fish. CPW engages in active mitigation against Northern pike.

The fishing indicator evaluates the fishing experience for each riverscape within the Upper Yampa segment based off a combination of:

- 1) user satisfaction,
- 2) intended species and number of fish caught, and
- 3) accessibility for wading and boating

2.1.2.1 *Data Sources and Evaluation Methods*

User satisfaction and species and number of fish caught data are collected via online intercept surveys, specifically the “2022 to 2026 YRSP- Boating and Fishing Intercept Survey,” distributed by Friends of the Yampa and available through a Google Form that recreationists can fill out throughout the year, for any segment floated or fished. Surveys are shared by local guides and

outfitters, via FOTY’s social media outlets, and with QR codes and signage at public access points. The intercept survey asks users to rate their satisfaction from 1-5, 1 being very unsatisfied to 5 very satisfied (Table 1). User satisfaction responses are filtered by riverscape, and the average is calculated. If a user floated more than one riverscape, their response is used for each riverscape in which they floated. Intercept surveys include questions related to both fishing and recreational boating to maximize efficiency and reach the highest possible number of river users. Fishing does not always depend on the floatability of a river segment; wading can also offer a high-quality experience. Intercept surveys can be completed for outings that occur during the entire period when the river is not frozen. ([Click for link to intercept survey](#)).

Access data is collected through analysis of each riverscape using Google Earth, public fishing knowledge, and visits to public access locations according to the criteria set forth in the “Fishing scoring matrix” (Table 2). An excellent fishing experience can be had with one or the other, and both are not necessary for a riverscape to offer great fishing access. Considering this, the access portion of the overall “Fishing” score is whichever is higher, wadable access or boat access. For the Upper Yampa segment, only wadable access is considered because there is no river access for boats.

2.1.2.2 Scoring Criteria

Each riverscape is scored using an evaluation matrix that counts user satisfaction for 35%, species and number of fish caught for 35%, and accessibility for wading and boating for 30% of the riverscape score (Table 2). The segment’s overall score is based on the combined weighted score of each riverscape. A scale of 1-5 is used in the intercept surveys for users to rate their overall experience. The 1-5 scoring conversion scale can be found in Table 3.

Table 2: Fishing scoring matrix

Category	Subcategory	Weight	Evaluation
Fish Catch	Intended species	10%	<i>Species type does not matter unless it does to the angler. (The question asked is if they caught their intended species):</i> Caught intended species (5); caught fish but not intended species (3); did not catch anything (1)
	Gamefish catch total	25%	Within trip: Caught more than 1 game fish (5), Caught at least 1 game fish (3), did not catch a fish (1)
Access (only the higher of the two scores is used)	Wadable access	30%	Yes, there is public wadable access within a riverscape (5), Yes but only guided private (3), No public or guided wading access (1)
	Boat access	30%	OR Yes, there is a boat ramp with parking within RS (5), Yes, there is convenient nearby boat ramp w/ parking (4), Only limited carry-in access AND nearest boat ramp inconveniently located (3), No boat access but boats may float through from distant access (2), No

			boat access or float-through ability (1)
User Satisfaction		35%	5-point scale; convertible to letter scores A-F

Table 3: Fish Scoring Scale

Letter Score	Number Score	Description
A+	5	The combined weighted scores of access, user satisfaction, and fish catch info collected is between 4.6 and 5.0 (≥92%)
A	4.7-4.9	
A-	4.6	
B+	4.4-4.5	The combined weighted scores of access, user satisfaction, and fish catch info collected is between 3.6 and 4.5 (72-91%)
B	3.8-4.3	
B-	3.6-3.7	
C+	3.4-3.5	The combined weighted scores of access, user satisfaction, and fish catch info collected is between 2.6 and 3.5 (52-71%)
C	2.8-3.3	
C-	2.6-2.7	
D	1.6-2.5	The combined weighted scores of access, user satisfaction, and fish catch info collected is between 1.6 and 2.5 (32-51%)
F	1-1.5	The combined weighted scores of access, user satisfaction, and fish catch info collected is less than or equal to 1.5 (≤31%)

2.1.2.3 Results

Fishing for the Upper Yampa Segment received an overall score of B.

Table 4: Fishing Indicator Scores by Riverscape

Riverscape	Fishing Indicator Score	Fish		Access		User Satisfaction
Overall:	B	Intended Species	Game fish	Boating	Wading	User Satisfaction

			<i>Catch Total</i>			
RS 37	A+	<i>A+</i>	<i>A+</i>	<i>na</i>	<i>A+</i>	<i>A+</i>
RS 38	A+	<i>A+</i>	<i>A+</i>	<i>na</i>	<i>A+</i>	<i>A+</i>
RS 1	C	<i>na</i>	<i>na</i>	<i>na</i>	<i>C</i>	<i>na</i>
RS 2	C	<i>na</i>	<i>na</i>	<i>na</i>	<i>C</i>	<i>na</i>
RS 3	C	<i>na</i>	<i>na</i>	<i>na</i>	<i>C</i>	<i>na</i>
RS 4	A+	<i>na</i>	<i>na</i>	<i>na</i>	<i>A+</i>	<i>na</i>

Riverscapes 37 and 38 scored “A+”: These riverscapes offer excellent fishing opportunities in Routt National Forest and are situated on public land that is fully accessible by wading. The small size of the river channel and low-volume flow regime do not support any safe or quality boating in these riverscapes. The intended species, catch total, and user satisfaction scores for RS 37 and 38 are based on a single user satisfaction survey. Additional user satisfaction survey responses are needed to obtain more robust data and improve the accuracy of the resulting scores.

RS 1, 2, 3 scored “C”: Lack of public access for fishing creates these riverscapes lower scores. These riverscapes are only accessible via private fishing easements and support little to no public river access. The small size of the river channel and low-volume flow regime do not support any safe or quality boating in these riverscapes. No “Boating and Fishing Intercept Surveys” were returned for these sections. Intended species, game fish catch total, boating, and user satisfaction were consequently scored “na” and fishing indicator scores for these riverscapes are based solely on the quality of wading access.

RS 4 scored “A+”: Public access for fishing creates this riverscape’s high score. Riverscape 4 includes Colorado Parks and Wildlife’s SKCK State Wildlife Area Fishing Easement, which provides over 2.4 miles of public walk-in fishing access. Because entry is restricted to anglers, disturbances to fish habitat are minimized and the section provides excellent fishing opportunities. The small size of the river channel and relatively low-volume flow regime do not support any safe or quality boating in these riverscapes. No “Boating and Fishing Intercept Surveys” were returned for these sections. Intended species, game fish catch total, boating, and user satisfaction were consequently scored “na” and the fishing indicator score for RS 4 is based solely on the quality of wading access.

Of note:

- *Riverscapes with a low wading score are not a destination for anglers looking for wade-fishing opportunities open to the public. Conversely, there are numerous wade-fishing opportunities available through private fishing guides in these riverscapes. Guided services hold special access agreements or leases on otherwise restricted sections.*
- *Scores for fishing user satisfaction and fish catch total are based on survey responses to FOTY’s annual Boating and Fishing Intercept Survey. Only a single response to this survey*

was collected for the entire Upper Yampa segment, making that single response overly impactful to the overall score. Future efforts will focus on increasing survey participation among river users to develop a more robust data set.

2.1.3 Birding Indicator

The birding indicator is approached from a recreational perspective, as birding is an important form of recreation along the Yampa River, and the health of the river directly impacts the quality of the birding experience. The health of the birding populations and bird habitat are components of the overall score, which also includes accessibility. This indicator is scored completely by our expert partners at Audubon of the Rockies. Audubon of the Rockies is a Yampa River Scorecard Project partner and brings extensive knowledge and expertise to the scoring for the birding indicator.

The birding indicator is scored based on elements related to three component areas:

- Birds (diversity, nests, species of interest and seasonality)
- Access (trails and parking)
- Threats to birds (invasive bird species and habitat degradation)

2.1.3.1 Data Sources and Evaluation Methods

This indicator is scored in full by an expert partner from Audubon Rockies. Audubon awards points for each subcomponent for a total maximum possible points earned of 100. This point tally is then scored on a traditional 100% grading scale. See Tables 5 and 6 for more information.

Data are collected through a combination of field surveys done on foot, float surveys, and eBird. In June of 2024, Audubon staff collected field data with the Scorecard team, downloaded their observations to eBird, and used those data to score both the “Birds” and “Threats to Birds” components of the birding indicator. The “Access” component of the birding indicator was scored by Audubon for each riverscape according to the criteria presented in Table 6.

Table 5 Birding Scoring Scale

Percentage/ Points Earned out of 100	Letter Score Equivalent
98-100	A+
92-97	A
90-91	A-
88-89	B+
82-87	B
80-81	B-
78-79	C+
72-77	C

70-71	C-
60-69	D
≤59	F

2.1.3.2 Scoring Criteria

The birding indicator score is a combination of bird diversity and population data (70%), riverscape accessibility to recreational birders (15%), and threats to birds (15%). There are several subcomponents that make up each component of the birding indicator. See Table 6 for more information. Each riverscape is scored according to the criteria described, and the Upper Yampa segment's overall score is based on the combined weighted score of each riverscape (derived by weighting each riverscape score according to its mileage as a percentage of the entire segment).

Table 6: Birding Scoring Criteria

Component	Subcomponent	Percentage Points	Evaluation
Birds	Species Diversity	45%	Species diversity can be critical to a birder if regional specialties or species of greatest interest are not found.
	Raptor Nests	10%	Raptor nests and rookeries create charismatic bird viewing opportunities for birders and nature enthusiasts.
	Species of Interest	10%	Regional specialties can draw birders to a given area if the likelihood of observing that species is high.
	Seasonality	5%	Seasonal changes affect the diversity and abundance of local birds.
Access	Trail	10%	Infrastructure, i.e. trails and footpaths, allowing for physical activity and increased bird detectability improves the birding experience.
	Parking	5%	Is there parking available?
Threats to Birds	Invasive Species	5%	The presence of invasive bird species can affect diversity, abundance, and birding quality.
	Environmental Impact	10%	Disturbances such as habitat disturbance, litter, light

			pollution, and feral cat colonies impact bird habitat, abundance, and diversity. Disturbance also impacts river health and wellness.
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2.1.3.3 Results

The overall birding indicator score for the Upper Yampa segment is a C

Table 7: Birding Scores by Riverscape

Riverscape	Species Diversity	Nests	Species of Interest	Seasonality	Trail	Parking	Environmental Impact	Invasive Species	Total Score	Letter Score
Overall Score: C										
Max Possible	45	10	10	5	10	5	10	5	100	
RS 37	45	0	10	5	10	5	10	5	95	A
RS 38	45	0	10	5	5	5	10	5	90	A-
RS 1	45	10	10	5	0	0	3	3	76	C
RS 2	45	5	5	5	0	0	3	3	66	D
RS 3	45	0	5	5	0	0	3	3	61	D
RS 4	45	5	10	5	3	5	3	3	79	C+

RS 37 scored “A”: This riverscape scores highly due to its public access, high diversity, quality habitat (relative), and its lack of avian and major plant invasives. The birding along this riverscape is premium montane birding and the public land access in the area adds to the value. Highlight species for this riverscape include Broad-tailed Hummingbird, Williamson's Sapsucker, Dusky Flycatcher, Violet-green Swallow, Cassin's Finch, and Pine Siskin.

RS 38 scored “A”: Access is high in this riverscape, however, decreased walkability lowers its score slightly from RS 37. This is not necessarily negative, as too much infrastructure and overemphasizing recreation can create habitat issues. Highlight species for this riverscape include Warbling Vireo, MacGillivray's Warbler, and Hermit Thrush.

RS 1 scored “C”: Lack of public land creates this riverscape's low score. Hayfield encroachment and/or agricultural development into riparian areas can attract invasives and lower habitat quality. This area still has fair stretches of quality habitat (relative). Highlight species for this riverscape include American Dipper, Bullock's Oriole, Fox Sparrow, Lesser Goldfinch, Red Crossbill, Willow Flycatcher, and Red-naped Sapsucker.

RS 2 scored “D”: Lack of public land creates this riverscape's low score. Hayfield encroachment and/or agricultural development into riparian areas can attract invasives and lower habitat quality. This area still has fair stretches of quality habitat (relative). Highlight birds in this riverscape include White-throated Swift, Broad-tailed Hummingbird, Swainson's Hawk, Willow Flycatcher, and Western Flycatcher.

RS 3 scored “F”: Lack of public land creates this riverscape's low score. Hayfield encroachment and/or agricultural development into riparian areas can attract invasives and lower habitat quality. This area still has fair stretches of quality habitat (relative). Highlight birds in this riverscape include the Broad-tailed Hummingbird, Willow Flycatcher, and Say's Phoebe.

RS 4 scored “C+”: Public access in this riverscape is intended for anglers only. While there is no supporting infrastructure, public access via the SKCK State Wildlife Area Fishing Easement increases this score. Highlight birds for this riverscape include Broad-tailed Hummingbird, Sandhill Crane, Swainson's Hawk, Red-tailed Hawk, Red-naped Sapsucker, Willow Flycatcher, Western Flycatcher, Say's Phoebe, Gray Catbird, Lesser Goldfinch, Bullock's Oriole, and Black-headed Grosbeak.

Of note: Scores are calculated based on a formula that includes categories related to species diversity and categories related to accessibility. This segment scored exceptionally well in terms of the diversity of species present. The lower scores in some riverscapes can be attributed to a lack of public access and walkability and/or public amenities like parking.

2.2 AGRICULTURE CATEGORY

The agriculture category seeks to both capture the health of agriculture in our region and the value that agriculture derives from the river and its provisioning ecosystem services in the form of water for irrigation. The Scorecard has actively sought input from multiple agricultural stakeholders regarding this category, including Community Agriculture Alliance, Division of Water Resources staff, and agricultural landowners, but has not yet been able to determine an appropriate and meaningful metric to quantify this attribute. We are actively continuing the conversation and will include a metric in the Scorecard report when we begin our second cycle in the Middle Yampa in 2027.

2.3 RIVER MANAGEMENT CATEGORY

The river management category is intended to evaluate the efficacy of the tools used to manage the water in the river. Broadly, these tools include reservoir storage and releases, calls on the river, river infrastructure, and administration of non-consumptive water use rights. River management in the Upper Yampa segment in 2024 considers non-consumptive use water rights and diversion infrastructure.

2.3.1 Non-Consumptive Use Water Rights

Non-consumptive water use occurs when all the water being diverted returns to the stream after use, or when the use itself is instream, and no diversion occurs at all. In other words, a non-consumptive use water right is a water right that has a 100% return rate to the stream of origin. These rights include in-stream flow rights (ISFs), recreational in-channel diversions (RICDs),

hydropower rights, and other environmental flow deliveries through leases such as releases for endangered fish flow targets or downstream temperature mitigation. The underlying assumption for the scoring of this indicator is that the river and the community benefit when non-consumptive water use right flow targets exist and are consistently met.

2.3.1.1 Data Sources and Evaluation Methods

All non-consumptive use water rights within the segment of interest are identified, confirmed through conversations with water commissioners and other CO DWR staff, and then compared to existing USGS or DWR gauge data showing daily mean discharge (in cfs) to see if flow targets are being met during the time period(s) specified in the decree for the water right. Non-consumptive water use rights are first identified using Colorado Water Conservation Board's (CWCB) instream flow data¹. Flow data is obtained from the Colorado's Decision Support Systems website and USGS.

There are three non-consumptive use water rights on the Bear River, all with a priority date of September 23, 1977 and all intended to preserve the natural environment to a reasonable degree. The first ISF has a water district identifier (WDID) of 5801367 and is found upstream of riverscape 37 on the Bear River above Stillwater Reservoir. The amount of water claimed for this water right is 5 cubic feet per second (cfs) between January 1st and December 31st, as seen in Table 8. *This ISF is outside of the established geography of the YRSP.*

The second non-consumptive use water right is identified as WDID 5802404 and is found immediately downstream of Stillwater Reservoir, extending approximately 2 miles to the inflow for Bear Lake. The amount of water claimed for this water right is 5 cfs between January 1st and December 31st.

The third non-consumptive use water right is identified as WDID 5802202. This instream flow begins at the outflow of Upper Stillwater Reservoir, also known as Bear Lake, and extends 11 miles to the confluence of the Bear River with Phillips (Chimney) Creek. The amount of water claimed for this water right is 12 cfs between January 1st and December 31st.

Table 8: Decreed Minimum Flow Targets for Bear River instream flows:

WDID	Flow Rates	Location on the Bear River
5801367	5 cfs (1/1-12/31)	Above Stillwater Reservoir (not included in YRSP)
5802404	5 cfs (1/1-12/31)	Between Stillwater Reservoir and Bear Lake
5802202	12 cfs (1/1-12/31)	From Bear Lake to Phillips Creek confluence

¹<https://data.colorado.gov/Water/CWCB-Instream-Flow-and-Natural-Lake-Level-Data/kztsx-agy6>

2.3.1.2 Scoring Criteria

The score for the non-consumptive use water right indicator for the Upper Yampa segment is based on two assessment questions:

- 1) Is there a non-consumptive use water right for the riverscape?
- 2) Are the non-consumptive use water right minimum flow targets being met during the most recent 5 water-year period?

Details for whether the 2 non-consumptive use water rights on the Bear River in the Upper Yampa segment are being met can be seen in Table 9 and Table 10.

Table 9: WDID 5802404 Stillwater Reservoir to Bear Lake

Water Year:	Decreed minimum flow target: 5 cfs at Bear River below Bear Lake (BERBBLCO)
Oct 1, 2019-September 30, 2020	Data "na" Oct-May; Met June-Sept
Oct 1, 2020-September 30, 2021	Data "na" Oct-May; Met June-Sept
Oct 1, 2021-September 30, 2022	Data "na" Oct-May; Met June-Sept
Oct 1, 2022-September 30, 2023	Data "na" Oct-May; Met June-Sept
Oct 1, 2023-September 30, 2024	Data "na" Oct-May; Met June-Sept

Table 10: WDID 5802202 Bear Lake to Phillips Creek

Water Year:	Decreed minimum flow target: 12 cfs at Bear River at Box K Ranch (BERBXKCO)	Decreed minimum flow target: 12 cfs at Bear River at CR7 near Yampa, CO (BERCR7CO)	Decreed minimum flow target: 12 cfs at Bear River near Nickel & Bird Ditches- no gage
Oct 1, 2019-September 30, 2020	na	10/6/19, 1/1/20, 5/20-24/20, 8/5-25/20 not met	Anecdotal data- daily dry-ups during irrigation season
Oct 1, 2020-September 30, 2021	na	Consistently not met (ice affected Oct-Apr)	Anecdotal data- daily dry-ups during irrigation season
Oct 1, 2021-September 30, 2022	na	Not met 10/1-12/18; 3/9-5/22; 8/4-9/30	Anecdotal data- daily dry-ups during irrigation season
Oct 1, 2022-September 30, 2023	na	Not met 10/1-10/31; 8/30-9/30 Data "na" 11/1-5/1	Anecdotal data- daily dry-ups during irrigation season

Oct 1, 2023- September 30, 2024	na	Not met 10/15-11/27; 5/23-6/2 Data "na" 12/1-4/23	Anecdotal data- daily dry-ups during irrigation season
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The data in Tables 9 and 10 are sourced from: <https://dwr.state.co.us/tools/stations>

Scoring criteria can be found in Table 11. Conditions for each riverscape are compared to the scoring criteria and a score is assigned. Weighted riverscape scores are combined to determine a score for the Steamboat segment.

Table 11: Non-Consumptive Use Scoring Criteria

Score	Number value	Description
A	5	RS has an in-stream flow right or in-channel diversion (non-consumptive use) and flow requirements are being met consistently.
B	4	RS has a non-consumptive use water right but flow requirements are met inconsistently (determined if 3 or more years out of 5, targets are not being met.)
C	3	RS does not have an in-stream flow right or in-channel diversion but benefits from water that is shepherded through riverscape to meet a non-consumptive water use right downriver OR RS does have a non-consumptive use water right that is sporadically met (2 out of 5 years).
D	2	RS does not have a non-consumptive use water right but one is being discussed or planned OR RS does have a non-consumptive use water right that is consistently not met (1 or less out of 5 years).
F	1	RS does not have a non-consumptive use water right and a non-consumptive water use right is not being planned and RS does not benefit from a downstream non-consumptive right.

2.3.1.3 Results

The overall non-consumptive use water right indicator score for the Upper Yampa segment is a D.

For a breakdown of the non-consumptive use water right indicator by riverscape, refer to Table 12.

Table 12: Non-consumptive Use Riverscape Scores

Riverscape	Non-consumptive Use Water Right?	Is the water use right being met?	Score
		OVERALL SEGMENT SCORE	D
37	WDID 5802404 (Stillwater Reservoir to Bear Lake)	RS has a non-consumptive water right and flow requirements are being met consistently.	A
38	WDID 5802202 (Bear Lake to Phillips Creek)	RS has a non-consumptive water right that is consistently not met.	D
1	WDID 5802202 (Bear Lake to Phillips Creek)	RS has a non-consumptive water right that is consistently not met.	D
2	no	RS does not have a non-consumptive water right.	F
3	no	RS does not have a non-consumptive water right.	F
4	no	RS does not have a non-consumptive water right.	F

2.3.2 River Infrastructure Indicator

Generally speaking, the term “river infrastructure” as used in this report refers to manmade structures on a river constructed to divert water from the river, address erosion, protect adjacent land infrastructure, and/or allow for crossing of the river.

River infrastructure can include but is not limited to:

- Push up dams
- Dams
- Diversion structures and headgates
- Road crossings (e.g., bridges, culverts, or low water crossings)
- Pump structures
- Bank hardening or erosion control efforts (e.g., riprap or other armoring)
- In-channel river training structures (e.g., cross vanes, j-hooks)
- Jetty jacks

The river infrastructure indicator for the Upper Yampa segment is focused solely on the condition, performance, and river impacts of diversion infrastructure and headgates.

2.3.2.1 Data Sources and Evaluation Methods

For general information on diversion structures in the Bear and Upper Yampa, users can visit the Colorado Decision Support System “structures” search tool found here <https://dwr.state.co.us/tools/Structures>. Users can filter structures by water district, water source, stream mile, and/or diversion structure type. The Upper Yampa is in water district 58.

Upper Yampa segment infrastructure scores are derived from findings in the “[Diversion Infrastructure Assessment Final Report for the Yampa River Basin Integrated Water Management Plan](#),” prepared by Wilson Water Group and JUB Engineers and submitted in December 2020. The final report can be found on the Yampa White Green Basin Roundtable’s Integrated Water Management Plan (IWMP) website, under “Assess Conditions.” The final report identifies infrastructure locations where infrastructure improvements could provide multiple benefits to both the Yampa River and its water users. Potential benefits occurring from future infrastructure improvements include benefits to the structure owners, improved fish passage, increased passability for recreational boating, and improved river health. Assessments were conducted during the summers of 2019 and 2020 on 45 structures, 36 of which the owners “opted in” and the results are publicly available. Of those 36 structures, 5 are located in the Upper Yampa segment.

2.3.2.2 Scoring Criteria

Only structures included in the IWMP’s irrigation infrastructure assessment are included in the scoring. For the Upper Yampa segment, which includes the Bear River, only five structures were assessed and had owners who “opted in” to having the results shared. The number of structures included in the assessment is very limited compared to the number of structures in the Upper Yampa segment, and this is a recognized limitation of this category’s scoring. We hope to be able to include more structures during the Scorecard’s second cycle, which will begin in the Middle Yampa segment in 2027. River infrastructure is assigned an “opportunity score” on a scale of 1-5 where a score of “5” represents the highest opportunity for improvement of a given characteristic, with a maximum possible structure score of 20. The four characteristics or opportunity areas include:

- 1) Opportunities for Improvement to Benefit Agriculture, Municipal, or Industrial Use;
- 2) Opportunities for Improvement to Benefit Fish Passage
- 3) Opportunities for Improvement to Benefit Recreational Boating;
- 4) Opportunities for Improvement to Benefit River Health.

The assessment goal is to identify opportunity areas for river infrastructure upgrades and to track changes in infrastructure condition and function over time.

According to the scoring matrix used by JUB Engineers and Wilson Water Group, the lowest possible score is a “4” and the highest possible score is a “20”. See Table 13 for the criteria used to score the river infrastructure indicator.

Table 13: River Infrastructure Scoring Matrix

Score	Aggregate Points	Description
A	4-5	No to low opportunity for infrastructure improvements across all opportunity areas.
B	6-7	Some opportunity for infrastructure improvements in some opportunity areas.
C	8-10	Medium opportunity for infrastructure improvements in most opportunity areas.
D	11-14	Strong opportunity for infrastructure improvements in most opportunity areas.
F	15-20	Strong opportunity for infrastructure improvements in all opportunity areas.

2.3.2.3 Results

The overall score for the river infrastructure indicator in the Upper Yampa segment is an “A”.

Table 14: River Infrastructure Results

Riverscape	Total number of ditch structures	Number of scored Structures	Score	Weighted Score
RS 37	0	0	na	na
RS 38	5	0	na	na
RS 1	18	5	5.2	na
RS 2	3	0	na	na
RS 3	6	0	na	na
RS 4	15	0	na	na
Overall Upper Yampa segment score= 5.2				na

The Upper Yampa segment contains 47 ditch structures along with their associated infrastructure like headgates. Of those structures, 5 are included in scoring based on information available from the [“Diversion Infrastructure Assessment Final Report for the Yampa River Basin Integrated Water Management Plan,”](#) prepared by Wilson Water Group and JUB Engineers and submitted in December 2020 to the Yampa White Green Basin Roundtable as part of the Integrated Water Management Plan. All of the assessed structures are in Riverscape 1, so the Upper Yampa segment score is based off of information from one riverscape only.

3.0 PEOPLE AND COMMUNITY BENEFITS

This attribute area seeks to quantify and/or highlight the connections between the Yampa River and its people and communities in terms of economic vitality, river engagement (government, education, and volunteer), and community connection to the river.

3.1 ECONOMIC BENEFIT CATEGORY

The economic benefit category measures the extent to which the communities along the Yampa River possess local economic vitality, a healthy business environment, and good entrepreneurship. Due to the coal-fired [power plants planned shutdown date in 2028](#) in Moffat and Routt Counties, there is a concern that both counties, but especially Moffat County, will have challenges creating high- to middle-income jobs after those jobs are no longer available through the power and mining sectors.

3.1.1 Employment, Wages, and Establishment Indicator

The employment, wages, and establishment indicator does not seek to draw a connection to the river's influence on the economic health of the Upper Yampa segment, but rather to track trends that show either growth or decline of economic vitality over time. The underlying assumption is that economic diversification through enhanced commitment to river-related recreation and visitation can potentially spur river-related job growth or be a quality-of-life appeal for new industries in the area.

3.1.1.1 *Date Sources and Evaluation Methods*

Employment, wages, and establishment data is obtained from the Colorado Department of Labor and Employment, Labor Market Information (LMI) Gateway. The metric assessed for employment, wages, and establishments is "change in 5-year average." This is calculated for both the state of Colorado and Routt County. This "change in 5-year average" metric is derived by taking the "5-year average" number for each sub-indicator (employment, wages, and establishments) obtained in the most recent year and comparing it to the "5-year average" number from the previous year. The Upper Yampa segment falls entirely within Routt County and its score is a comparison between Colorado's economic data and Routt County's economic data. The Colorado LMI Gateway website can be found at www.colmigateway.com.

3.1.1.2 *Scoring Criteria*

The Upper Yampa segment receives one blanket score for economic benefit, as the entire Upper Yampa segment falls within Routt County lines (except for riverscape 37, which is part of Garfield County and not included); individual riverscapes are not scored. The economic growth of Routt County is evaluated based on how county growth compares to state growth. The change in 5-year average for each of 3 sub-indicators for Routt County is compared to the change in 5-year average for each of 3 sub-indicators for the state of Colorado. See Table 15 for scoring criteria. The scoring criteria is set up so that economic growth, in general, results in a score as high as an "A", but not below a "C". If the county sees no growth but also no decline, the score would be a "C". If the

economy shrinks instead of grows, it will receive a score of C, D, or F, depending on the extent of decline.

Table 15: Economic Indicator Scoring Criteria

Score	Description
A	The change in 5-year average for the segment is between 70 and 100% of the change in 5-year average for the State.
B	The change in 5-year average for the segment is between 30 and 69% of the change in 5-year average for the State.
C	The change in 5-year average for the segment is between -10 and 29% of the change in 5-year average for the State.
D	The change in 5-year average for the segment is between -50 and -11% of the change in 5-year average for the State.
F	The change in 5-year average for the segment is between -100 and -51% of the change in 5-year average for the State.

3.1.1.3 Results

The overall employment, wages, and establishment indicator score for the Upper Yampa segment is an A.

Table 16: Economic Indicator Results

Indicator	Routt County change in 5-year average	Colorado change in 5-year average	% comparison	Letter Score Equivalent
Overall Score:				A
Routt Employment	1.35%	1.32%	102% of growth seen by CO	A
Routt Wages	5.83%	4.41%	132% of growth seen by CO	A
Routt Establishment	2.65%	3.41%	78% of growth seen by CO	A

“Routt Employment” scored “A”: The change in 5-year average for employment in Routt County for 2024 was 1.35%. During the same period, the state of CO saw 1.32% growth in employment. Routt County’s employment growth was 102% of the growth seen by the state. The

employment growth in Routt County exceeded the employment growth for the state of CO for this period.

“Routt Wages” scored “A”: The change in 5-year average for wages in Routt County for 2024 was 5.83%. During the same period, the state of CO saw 4.41% growth in wages. Routt County’s wage growth was 132% of the wage growth seen by the state. The wage growth in Routt County exceeded the wage growth for the state of CO for this period.

“Routt Establishments” scored “A”: The change in 5-year average for establishments in Routt County for 2024 was 2.65%. During the same period, the state of CO saw a 3.41% increase in the number of establishments. Routt County’s increase in the number of establishments was 78% of the establishment decrease seen by the state. Although the county growth was less than the state’s growth in employment for this period, the county’s 5-year change in establishments was positive and is consistent statewide trends, yielding a score of “A” per the scoring criteria.

3.2 ENGAGEMENT CATEGORY

The Engagement Category seeks to quantify or highlight the ways in which local governments are invested in the river, the educational opportunities available for community members to expand their river knowledge, and the river-related volunteer opportunities available in Routt and Moffat County.

3.2.1 Government Engagement Indicator

The government engagement indicator measures local, county, and regional planning and/or investment related to the river from government entities.

3.2.1.1 *Data Sources and Evaluation Methods*

The Government Engagement indicator is a qualitative assessment, and data is collected from government master plans and other relevant planning documents, annual budgets, and interviews with key personnel. Each of the government entities’ contribution to the score is weighted depending on the geographic extent of the city or county in each riverscape.

Interviews are conducted with government representatives and officials to help find the relevant data and inform us about past and future planned projects, inclusion of river-related spending and grants in annual budgets, and considerations made during planning to assess best management practices. Master plans and other planning documents (e.g., the Routt County Unified Development Code) are reviewed for any river related terms including tributaries and assessed for mention of BMPs or environmental considerations.

The Government Engagement Scoring Matrix (Table 17) considers three categories as follows:

1. Master Plan: Master plans and other applicable planning documents (related to the Yampa River, Parks and Open Space, and other environmental and recreational issues) are collected for each governmental entity. All planning documents are

reviewed for mentions of the river and its tributaries, specifically any aspects relating to environmental or community access concerns or goals. For the Upper Yampa segment, this review includes planning documents from both Routt County and the Town of Yampa. Based on this review, one score is assigned to Routt County, and another score is assigned to the Town of Yampa.

2. **Funding:** Interviews with key staff are arranged for each governmental entity. For example, for the Town of Yampa, we interviewed the Town Planner, and for Routt County, we interviewed the Planning Director, the Floodplain Administrator, and the Director of Environmental Health. During interviews, staff are asked whether funding is allocated to the river and whether that funding is used for addressing access and infrastructure improvement, outreach, communications, maintenance, trash removal, or for only adjacently-related projects like park maintenance. Responses are recorded and each governmental entity receives a score according to Table 17.
3. **BMPs:** Also, during interviews, key staff are asked if the government entity uses a set of established, up-to-date BMPs or process-based restoration techniques to maintain or improve river health. Responses are recorded and each governmental entity receives a score according to Table 17.

Scores are weighted based on governmental jurisdiction and riverscape overlap. For each riverscape in the Upper Yampa segment, for each of the three categories (Master Plan, Funding, and BMPs), individual scores are computed based on the percentage of the riverscape that is contained within Routt County's jurisdiction versus within the Town of Yampa's city limits. For example, roughly 50% of Riverscape 1 is in the Town of Yampa and the other 50% is in Routt County — its composite score is derived by averaging Yampa's jurisdictional score with Routt County's jurisdictional score. An overall score for the focal segment is computed from the weighted riverscape scores, with the three categories each contributing 33% toward the final score. Riverscape 37 is located on US Forest Service land in Garfield County and was assigned an "na" score because both Garfield County and the federally managed USFS is outside the sphere of influence for the Scorecard Project.

3.2.1.2 *Scoring Criteria*

Each of the governmental jurisdictions that the focal segment passes through are scored in three categories: master plan, funding, and BMPs. Then, a score is computed for each riverscape based on the scoring matrix (Table 17), and which government entities are included in each riverscape (Table 19). For example, most riverscapes fall completely within Routt County, and master plan, funding, and BMPs scores are therefore weighted 100% from Routt County scores. However, Riverscape 1 falls partly within Routt County and partly within the Town of Yampa; its score is an average of Routt County and Town of Yampa scores.

Letter scores for each riverscape are computed according to Table 18. All riverscapes are weighted and combined to calculate the overall score of the focal segment.

Table 17: Government Engagement Scoring Matrix

Category	Subcategory	Weight
Master Plan	River addressed within Master Plan including environmental and community access (5), River addressed but only as a management piece and only environmental or community access is considered, not both (3), River is not addressed in Master Plan (1)	33%
Funding	River related funding addressing access and infrastructure improvements using BMPs (5), River related funding only addresses outreach, communications, or maintenance (4), There is river related funding for only adjacently related projects, such as maintenance of city park space or trash removal (3), There is no river related funding (1)	33%
BMPs	Currently known BMPs are being utilized to maintain water quality, ecosystem services, habitat connectivity, and process based restoration techniques are planned or used (5), BMPs are being used but may not be sufficiently addressing needs for all stakeholders or river health, or they may be outdated (3), no BMPs are being used (1)	33%

Table 18: Government Engagement Scoring Criteria

Letter Score	Number Score	Description
A+	5	The government engagement score is between 4.6 and 5.0 (≥92%)
A	4.7-4.9	
A-	4.6	
B+	4.4-4.5	The government engagement score is between 3.6 and 4.5 (72-91%)
B	3.8-4.3	
B-	3.6-3.7	
C+	3.4-3.5	The government engagement score is between 2.6 and 3.5 (52-71%)
C	2.8-3.3	
C-	2.6-2.7	

D	1.6-2.5	The government engagement score is between 1.6 and 2.5 (32-51%)
F	1-1.5	The government engagement score is less than or equal to 1.5 (≤31%)

Table 19: Weighting of Riverscapes Based on Geography

Riverscape	% within Routt County	% within Yampa
37	100	0
38	100	0
1	50.0	50.0
2	100	0
3	100	0
4	100	0
Total Focal Segment	91.67	8.33

3.2.1.3 Results

The overall government engagement indicator score for the Upper Yampa segment is A-.

Table 20: Government Engagement Scores by Riverscape

Riverscape	Government Engagement Score	Planning	Funding	BMPs
Overall:	A-	A+	B	A
RS 37	na	na	na	na
RS 38	A	A+	B	A+
RS 1	B	A+	B	B
RS 2	A	A+	B	A+
RS 3	A	A+	B	A+
RS 4	A	A+	B	A+

RS 37 scored “na”: Riverscape 37 is in Garfield County and is managed by the U.S. Forest Service. Because it is under federal management rather than local jurisdiction, it was marked as ‘na’ because the government engagement indicator evaluates local governmental commitment to the river.

RS 38, RS 1, RS 2, RS 3, and RS 4 are in Routt County. RS 1 includes the Town of Yampa.

Routt County scored “A”:

- Planning Documents: The [2022 Routt County Master Plan](#) contains explicit policy directives aimed at preserving river health through habitat protection, floodplain development regulation, water conservation, and the enhancement of forest and riparian ecosystems. Additionally, it addresses the growing demand for responsible river recreation. The [2024 Routt County Unified Development Code](#) establishes environmental safeguards on development. It contains specific and detailed development regulations to protect water quality, quantity, and scenic resources through required studies, setbacks, mitigation measures, monitoring, and operational controls. The [Routt County Climate Action Plan](#) identifies land-use strategies and actions that protect and enhance river health.
- Funding: Routt County has partnered with the USGS and other local entities for quarterly water quality monitoring on the Yampa and its tributaries since 2011. The county also contributes \$25,000 annually to the Yampa River Fund, contingent upon budgetary approval. Routt County has historically supported the development and implementation of river management plans, including the Yampa River Stream Management Plan. Continued support for these initiatives is generally expected, although future funding remains subject to approval by the Board of County Commissioners during the annual budgeting process.
- Best Management Practices (BMPs): The [2024 Routt County Unified Development Code](#) utilizes updated BMPs to regulate development in riverine environments and address water quality.

Town of Yampa scored “B”:

- Planning documents: The Town of Yampa’s [Comprehensive Plan](#) emphasizes the protection of river and wildlife habitat through enforceable setbacks, riparian buffer zones, and low-impact development practices. It includes a commitment to “no net loss” of wetlands and discourages construction in ecologically sensitive riparian corridors. The plan also outlines the addition of restroom and pavilion facilities to River Park, and the creation of a minimally invasive trail network along rivers and ditches.
- Funding: Project-based annual funding supports infrastructure projects that improve river health and community access. The budget lacks dedicated river-related funds. As a small governmental entity, Yampa tends to take gradual, carefully considered steps in their approach to projects and land stewardship, reflecting their limited capacity and resources.
- Best Management Practices: The [Yampa Land Development](#) code implements several BMPs such as setbacks and erosion controls for all new development. Yampa’s BMPs came from a body of professional work and standards are incorporated into the town codes in general form.

3.2.2 Educational Engagement Indicator

The educational engagement indicator consists of opportunities provided to the community to learn about the Yampa River's health and function as well as its ecosystem services. Opportunities to learn about the river can be articles in the local newspaper, K-12 curriculum, interpretive materials, nonprofit outreach, special events, etc.

The Stakeholder group felt that this was a worthwhile indicator to include but could not determine what an ideal score would be or a comprehensive way to measure it. Therefore, this indicator is included but only provides interpretive materials and resources to teach website visitors about where education is provided and resources to find out more. This indicator is not measured or scored and does not affect the scores presented in the Scorecard report.

Please visit www.yampascorecard.org for useful information related to educational engagement opportunities within the Steamboat segment.

3.2.3 Volunteer Engagement Indicator

The volunteer engagement indicator is a measurement of the time, measured in hours, that people engage in stewardship efforts for the river and/or the adjacent lands that are directly connected to the Yampa River to improve public access or improve river health and function.

The Stakeholder group felt that this was a worthwhile indicator to include but could not determine what an ideal score would be. They were also unsure if we would be able to get consistent data because this largely depends on the ability of each volunteer management entity to keep good records. The goal of this indicator is to track hours and inspire people to engage in river related stewardship. This indicator is not scored and does not affect the scores presented in the scorecard report.

Please visit www.yampascorecard.org for useful information related to volunteer engagement opportunities within the Steamboat segment.

3.3 COMMUNITY CONNECTION CATEGORY

The Community Connection Category seeks to quantify and highlight the degree to which members of the community are physically, emotionally, spiritually, and intellectually connected to the river. Ideally this category would approach community connection to the river holistically by looking at a variety of ways in which the community connects to the river, for example opportunities to sit by, swim in, or walk along the river for mental health, connection with nature, and spiritual replenishment. For the Upper Yampa segment, the approach is limited to opportunities for physical connection via an assessment of public river access locations.

3.3.1 Public Access Indicator

This indicator measures the ability for the community to access the river for personal connection and includes parks; access points; amenities; and river-adjacent public lands available for walking, swimming, or just enjoying the river. This indicator does not specifically address recreational access for birding, recreational fishing, or rafting, paddleboarding and kayaking (which are all included in the Recreation Category), but can address tubing.

3.3.1.1 Data Sources and Evaluation Methods

For the Public Access Indicator, all public access points within a riverscape are evaluated. All publicly owned locations are visited in the field and the Public Access Scoring Matrix (see Table 21) is completed. If there is no public land ownership or public access within a riverscape, that riverscape receives a score of “na”. This indicator is a qualitative assessment that is evaluated using local knowledge of the area and site visits throughout the year.

3.3.1.2 Scoring Criteria

Each riverscape that contains public lands adjacent to the river is assessed using the scoring matrix in Table 21.

Table 21: Public Access Indicator Scoring Matrix

Category	Subcategory	Weight
Parking	Parking sufficient in size and structure for all user types (5), Parking exists but not sufficient or too far to walk (3), no parking (1)	20%
Bathrooms	Bathrooms within riverscape sufficient and maintained (5), Bathrooms within riverscape, but inadequate and/or poorly maintained (3), No bathrooms within riverscape (1)	20%
Receptacles	Adequate trash and/or recycling receptacles within riverscape and maintained (5), Receptacles exist but not maintained or pack it in pack it out signage only (3), no receptacles (1)	20%
Park space, swimming access, or trails to walk	Public lands/river access has recreational amenities adjacent to river for public to picnic, recreate, swim, enjoy scenery (5), public lands and river are accessible via primitive trails (3); land is public but river inaccessible (1)	20%
Interpretive signs	Information about the river, park/river access, and rules interpretive signs exist at access, parking area, or along trails (5), Only some of the previous exists, more interp. needed (3), no signs or information (1)	20%

Table 22: Public Access Scoring Scale

Letter Score	Number Score	Description
A+	5	The public access indicator score is between 4.6 and 5.0 ($\geq 92\%$)
A	4.7-4.9	
A-	4.6	
B+	4.4-4.5	The public access indicator score is between 3.6 and 4.5 (72-91%)
B	3.8-4.3	
B-	3.6-3.7	
C+	3.4-3.5	The public access indicator score is between 2.6 and 3.5 (52-71%)
C	2.8-3.3	
C-	2.6-2.7	
D	1.6-2.5	The public access indicator score is between 1.6 and 2.5 (32-51%)
F	1-1.5	The public access indicator score is less than or equal to 1.5 ($\leq 31\%$)

3.3.1.3 Results

The overall public access indicator score for the Upper Yampa segment is a C.

Table 23: Public Access Indicator Results

Riverscape	Parking	Bathrooms	Receptacles	Access	Interpretive Signs	Letter Score
OVERALL						C
RS 37	5	5	3	3	5	B
RS 38	5	5	3	3	5	B
RS 1	3	1	1	2	2	D
RS 2	na	na	na	na	na	na
RS 3	na	na	na	na	na	na
RS 4	5	1	1	3	5	C+

RS 2 and 3 scored “na”: These riverscapes do not include any public land and were not scored.

RS 37 and 38 scored “B”: Riverscapes 37 and 38 are comprised of publicly accessible U.S. Forest Service land. Both riverscapes offer high quality opportunities to connect with the river via primitive trails along FS Road 900. Interpretive signage is present in multiple areas along both riverscapes, and permanent bathrooms are maintained at multiple USFS campsites along the river. No trash receptacles are present, but standard USFS waste protocols are in effect.

RS 1 scored “D”: Riverscape 1 offers limited opportunities for public access and community connection. The only publicly accessible reach is 25 meters of open riverbank within the Yampa Town Park. The Yampa Town Park has a small parking area and does not contain public bathrooms or trash receptacles. Signage is present but does not include information about the river. Improved access to the Bear River for Yampa residents is an opportunity area identified in this report.

RS 4 scored “C+”: Riverscape 4 includes the Colorado Parks and Wildlife SKCK State Wildlife Area Fishing Easement, which provides public fishing access along 2.4 miles of the river. The SKCK fishing access has a sufficient parking area and contains standard CPW signage. No bathrooms or trash receptacles are present. The SKCK easement is expected to be used for fishing only and therefore does not technically offer access to the public beyond anglers. It is the only publicly accessible reach within RS 4. That any access at all exists in this riverscape is due entirely to the generosity and public service of the landowners (with management and support from CPW) who have created a fishing easement so that more people may enjoy the river.