2024
UPPER GALLATIN RIVER WATERSHED
MONITORING REPORT

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The Gallatin River Task Force Community Water Quality Monitoring Program is supported by the Big Sky Resort Area Tax District, the Montana Department of Environmental Quality, Task Force donors, and volunteers. Thank you for investing in the health of the Upper Gallatin Watershed.

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Executive Summary:

In July of 2018, an unprecedented nuisance algae bloom occurred in the Upper Gallatin River. The dominant algae was *Cladophora glomerata* (*Cladophora*), a filamentous algae species native to this drainage. In response, the Gallatin River Task Force (Task Force) partnered with the Montana Department of Environmental Quality (DEQ) on a study to determine possible causes. Similar blooms occurred along the mainstem Upper Gallatin in 2020 and 2022. Factors that influence Cladophora growth include elevated nutrient levels, warm water temperatures, low streamflow, sufficient hardness levels, and abundant sunlight.

From May to October 2024, the Task Force performed seven periodic sampling events on tributaries feeding the Gallatin River including the West Fork, South Fork, Middle Fork, Stormcastle Creek, Swan Creek, Portal Creek, Beaver Creek, Buck Creek, and the Taylor Fork. During this time the DEQ performed sampling events along the mainstem Upper Gallatin from the Yellowstone National Park boundary to the Spanish Creek confluence. In addition, the Task Force collected water samples from Gallatin Lake, the headwaters of the Gallatin River, within Yellowstone National Park. Water chemistry data was collected during every sampling event. Algae biomass and chlorophyll-a data was collected during the sampling events in August and September. The Task Force deployed three continuous dissolved oxygen sensors along the West Fork, South Fork, and Taylor Fork.

There was not a large-scale nuisance algae bloom of *Cladophora* observed on the mainstem of the Gallatin River in 2024. There were widespread blooms observed on the Taylor Fork and Beaver Creek and sections of the West Fork. These sites exceeded the Montana Water Quality Standards (MT WQS) for Ash Free Dry Weight (algal biomass) of 35 g/m².

The MT WQS for nitrogen was exceeded on the South Fork and at one site on the West Fork. Nitrogen concentrations in the lower West Fork were above the historical average. Total phosphorus levels at all sites were below the MT WQS except for Stormcastle and Swan Creeks, where there are known geologic sources. The fluctuation of dissolved oxygen in theWest Fork exceeded the MT WQS.

Streamflow peaked on the Gallatin River and on the West Fork on June 10th. As the summer progressed streamflow levels dropped below average and continued that way into the late summer. Air temperature, water temperature, and sunlight were all comparable to previous years of the current study. Ideal water hardness for *Cladophora* growth was reached at six of the eleven sites.

As the Task Force and the DEQ continue to build upon the data collected since the first large-scale *Cladophora* bloom six years ago, preliminary findings suggest that blooms are caused by a combination of sufficient nutrients, warm water temperatures, low streamflow, and an abundance of sunlight. In response, the Task Force and community partners have prioritized projects that address these factors. Examples of these include stream restoration projects on the

Middle Fork, West Fork, and Gallatin River, advocating for improved wastewater treatment by Big Sky Water and Sewer District, in Gallatin Canyon, and Firelight Meadows subdivision and promoting water conservation throughout the Big Sky community. Together, the community must continue to take tangible action to better the Gallatin River for ourselves and future generations.

Gallatin River Task Force Chief Executive and Science Officer Kristin Gardner photographing algae along the West Fork

Introduction:
The Gallatin River Task Force (Task Force) is a 501(c)3 nonprofit organization whose mission is "to partner with our greater community to lead conservation and inspire stewardship of the Gallatin River Watershed." Since 2000, the Task Force has worked with state, local and federal governments, businesses, community members, and partner organizations towards its vision of a healthy Gallatin River for future generations. With a dataset dating back over 24 years, the Task Force has accumulated enough information to make decisions backed by sound science that are aimed at improving water quality and streamflows in the Upper Gallatin River. The Upper Gallatin River originates in Yellowstone National Park at Gallatin Lake and ends at its confluence with Spanish Creek just north of Gallatin Valley.

The Task Force monitoring program has shifted towards addressing large-scale nuisance algae blooms after the first bloom in 2018. Previously, only tributaries of the Upper Gallatin had exhibited algae blooms including the Taylor Fork, West Fork and South Fork. Large-scale nuisance algae blooms can negatively impact water quality, aquatic insect and fish population health, and recreational experience. Increasing algae growth has been observed in areas with high levels of development, such as Big Sky, as well as areas with relatively little development such as the Taylor Fork. The most common form of algae present is a native species known as *Cladophora*. At healthy levels, *Cladophora* plays an important role in freshwater ecosystems, however there can be detrimental effects when growth becomes prolific. Multiple factors contribute to excess algae growth including elevated levels of nitrogen and/or phosphorus, warm water temperatures, low streamflow, sufficient hardness, and abundant sunlight.

In response to the 2018 algae bloom, the Task Force partnered with the Montana Department of Environmental Quality (DEQ) to increase sampling intensity in an effort to identify the main drivers of algae growth. Repeated large-scale nuisance blooms occurred in 2020 and 2022. In spring 2023, the Upper Gallatin was listed as impaired by the DEQ and the Environmental Protection Agency (EPA). With that designation, sampling efforts along the Gallatin have increased as the state aims to determine the primary factors causing the blooms and then will set a limit to those causal factors. There was not a large-scale nuisance algae bloom in the Upper Gallatin River in 2024, however *Cladophpra* blooms were present in the Taylor Fork, Beaver Creek and sections of the lower West Fork. This report summarizes the findings of the Task Force's 2024 monitoring program.

Nutrient and Algae Assessment:

<u>BACKGROUND:</u>

Algae

At excessive levels, *Cladophora* can deplete oxygen dissolved in water, posing threats to aquatic life. Factors that are known to contribute to the excessive *Cladophora* include 1.) water flowing at 0.4-0.7 m/s, 2.) clear water that allows sunlight to penetrate to the streambed, 3.) sunlight to stimulate photosynthesis, 4.) elevated nitrogen and/or phosphorus levels, 5.) water temperatures between 10 and 25 degrees Celsius, 6.) pH levels greater than 7.0, and 7.) water hardness that is greater than 121 mg/L $CaCO_3$ (MT DEQ, 2019).

Two metrics were taken to characterize algae levels, chlorophyll-A and ash free dry weight (AFDW). Chlorophyll-A is a key facilitator of photosynthesis in algae. AFDW is the mass of organic matter after the collected algae sample has been thoroughly dried. Chlorophyll A and AFDW are compared to thresholds deemed healthy by the state. The state threshold for chlorophyll-A is 125 mg/m^2 and for AFDW is 35 g/m^2. Methods for algae collection are outlined in the Sampling Analysis Plan: Nutrient and Algae Monitoring in the Upper Gallatin Watershed, 2024 (SAP)(MT DEQ, 2024).

Nutrients

The primary nutrients that drive algae growth in the Gallatin River and its tributaries are nitrogen and phosphorus. Three tributaries in the Upper Gallatin watershed are listed as impaired for nitrogen on the Montana 303(d) list- the West Fork, Middle Fork, and South Fork. Human sources of nitrogen include fertilizer, land application of treated wastewater, effluent from private septic systems, pet waste, and stormwater. Sources of excess phosphorus are similar to those for nitrogen with the addition of soil erosion. Two forms of nitrogen were measured: nitrate + nitrite (N+N) and total nitrogen (TN). Two forms of phosphorus were measured: total phosphorus (TP) and orthophosphate. Orthophosphate and N+N are the most readily available forms of nutrients consumed by algae to assist in growth. The Montana state water quality standards (MT WQS) apply from July 1st to September 30th and are 0.3 mg/L for TN and 0.03 mg/L for TP. Levels greater than 0.1 mg/L for N+N are considered elevated (Suplee et al. 2008) and there are no current standards for orthophosphate.

Air and Water Temperature

Warm water creates ideal conditions for *Cladophora* blooms. The growing range for *Cladophora* is between 10 and 25 degrees Celsius (50-77 °F) with an optimal growing range occurring between 13.5 and 17.5 degrees Celsius (56.3-63.5 °F). Air temperature does not have a direct effect on *Cladophora* growth but does impact water temperatures and the timing of spring runoff, that in turn affects *Cladophora*.

Water Hardness

Water hardness is a measure of how much dissolved calcium and magnesium are present in water. Both of these are key components in creating calcium carbonate ($CaCO_3$), an essential building block for aquatic plant life. *Cladophora* thrives at hardness levels greater than or equal to 121 mg/L $CaCO_3$.

Dissolved Oxygen

Dissolved oxygen (DO) is crucial to aquatic macroinvertebrates and fish. Standards for dissolved oxygen were recently adopted by the DEQ to serve as a proxy for possible threats of algae growth to aquatic life. The water quality standard for DO is measured in ΔDO, the difference between the highest and lowest readings of DO during a given day (MT DEQ, 2024). The standard that applies to the Gallatin River is a 7 day moving average greater than 3.5 mg/L ΔDO. The acceptable exceedance rate is 10%. In July, the Task Force deployed three continuous MiniDOT DO sensors at WFGR_Mouth, SFWF_Mouth, and TaylorFk_Mouth.

Sunlight

Sunlight is necessary for algae to undergo photosynthesis. Solar irradiance is the measure of sunlight and high levels in 2018, 2020, and 2022 have correlated with years of widespread nuisance algae blooms. Solar irradiance is the power received per unit area and measured in watts per meter squared (W/m2).

Streamflow

Streamflow is a measure of the quantity of water moving through a system at a given point over a given period of time and is most commonly measured in cubic feet per second (cfs). Lower streamflows facilitate algae growth because less water will heat up more quickly and transmit more sunlight to algae growing on the streambed.

STUDY DESIGN:

In 2024, the Task Force sampled at 11 sites on 9 different tributaries throughout the Upper Gallatin watershed periodically throughout the year. The sites included 6 throughout Gallatin Canyon and 5 sites within the West Fork watershed near Big Sky. The tributaries sampled were: Stormcastle Creek, Swan Creek, Portal Creek, West Fork Gallatin River, South Fork Gallatin River, Middle Fork Gallatin River, Beaver Creek, Buck Creek, and the Taylor Fork (Figure 1 & 2). An individual sampling event occurred in September at Gallatin Lake, the headwaters of the Gallatin River in Yellowstone National Park (Figure 3). Water samples were collected and in situ measurements were taken for air temperature, water temperature, conductivity, dissolved oxygen, pH, and turbidity. Water samples were analyzed for total nitrogen, nitrate+nitrite, total phosphorus, total suspended solids, orthophosphate, calcium, magnesium, and water hardness (Table 1).

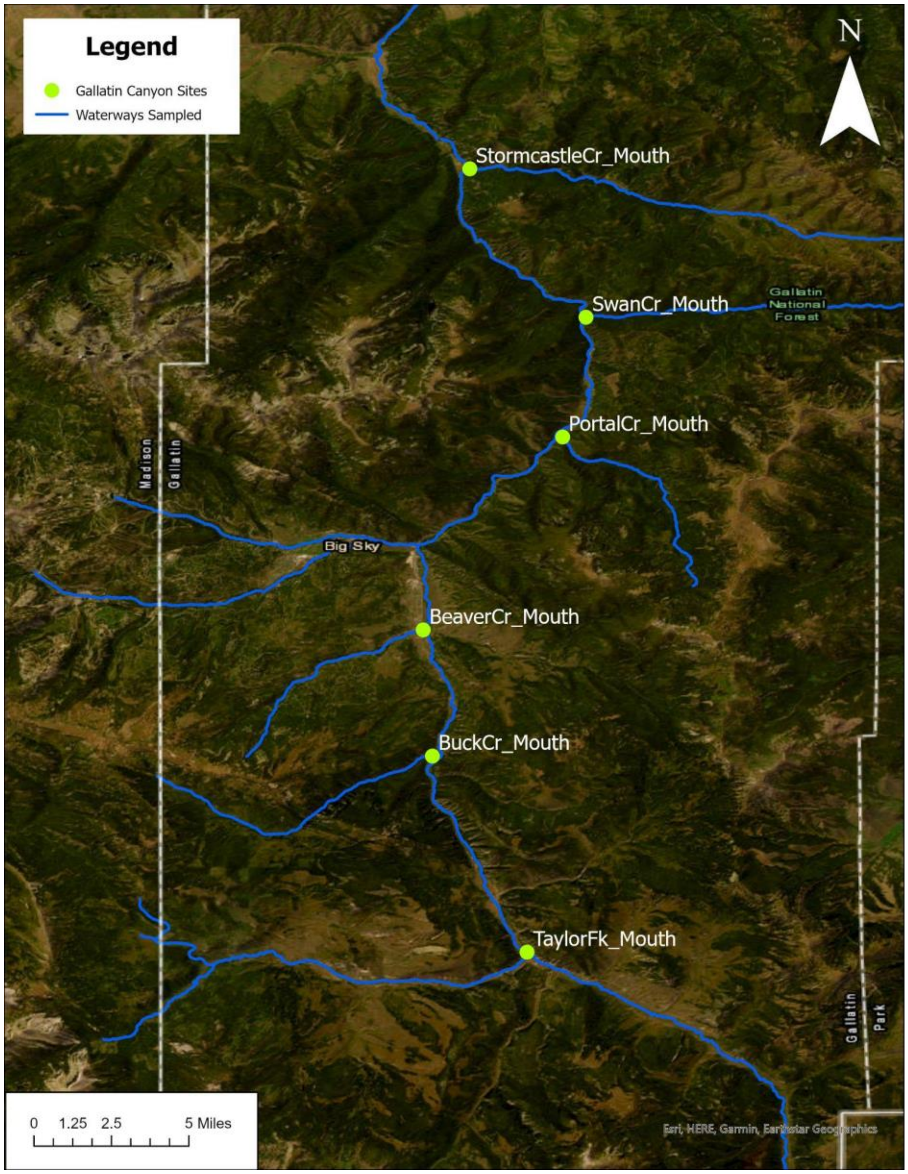

Figure 1: 2024 sampling locations in Gallatin Canyon on tributaries of the Gallatin River

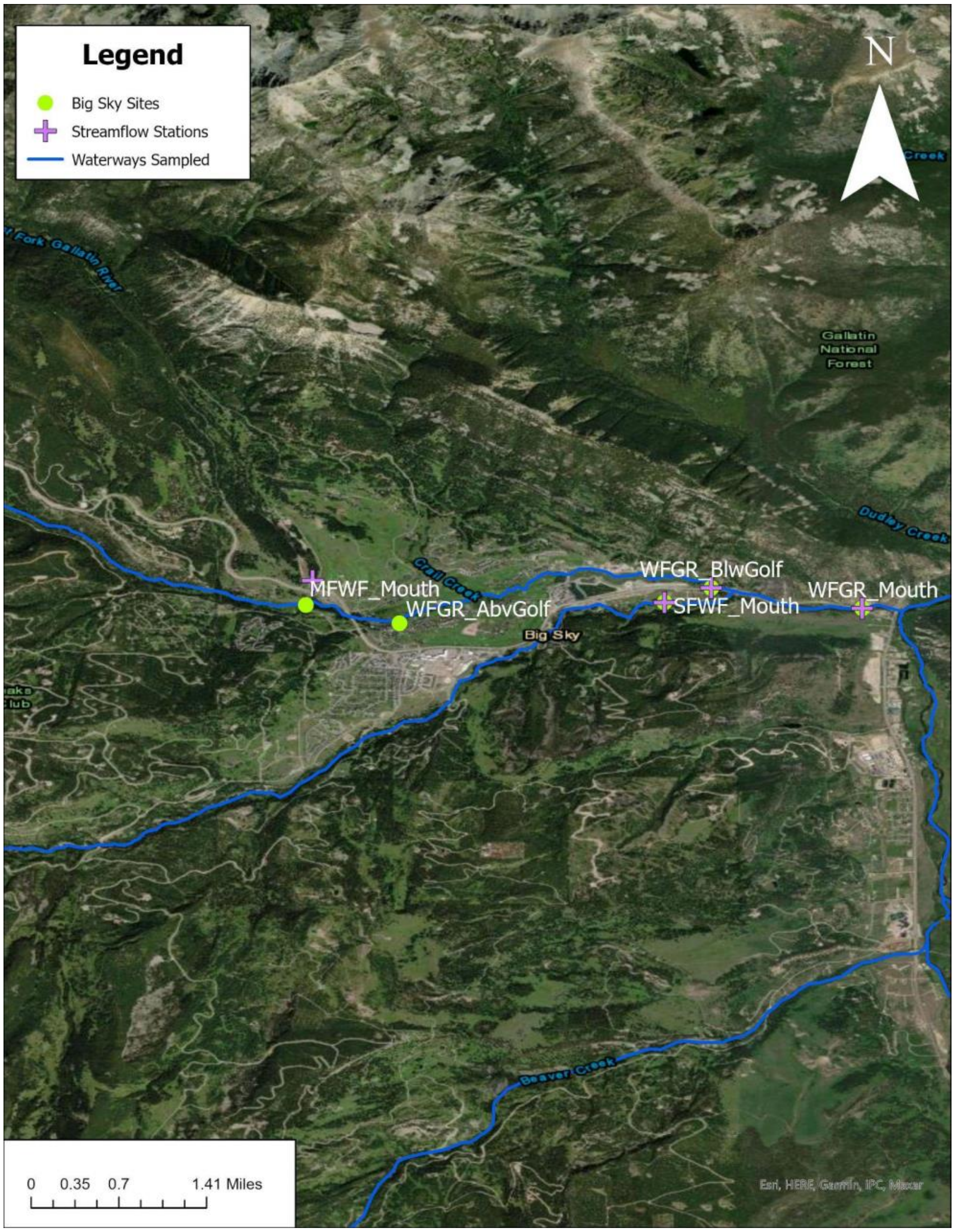

Figure 2: 2024 sampling sites and streamflow gauge stations within the West Fork watershed.

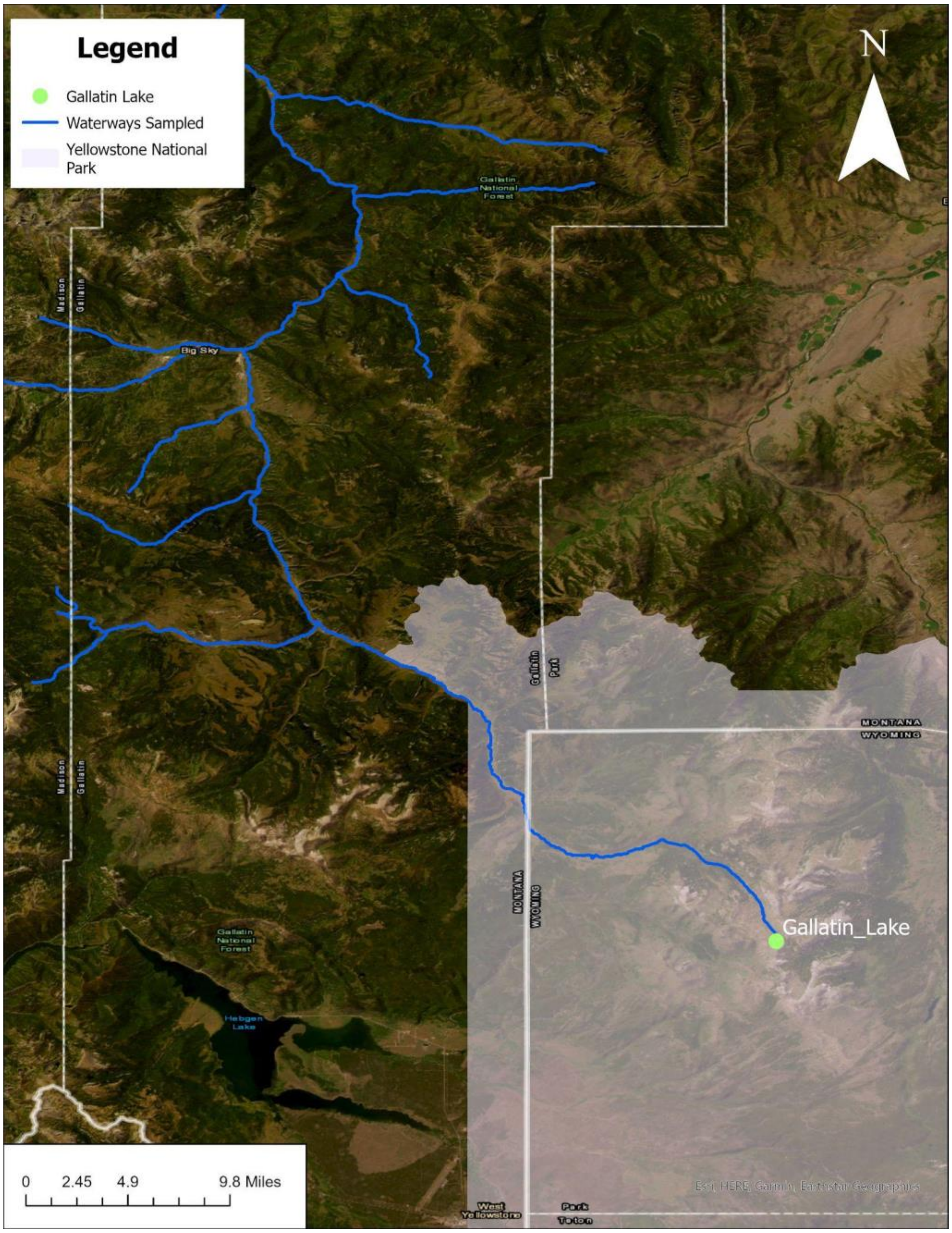

Figure 3: Gallatin Lake sampling site

	March 11	May 6	June 10	July 15	August 20-22	September 16-18	October 14
Air Temperature	x	x	x	x	x	x	x
Water Temperature	x	x	x	x	x	x	x
Conductivity	x	x	x	x	x	x	x
Dissolved Oxygen	x	x	x	x	x	x	x
pH	x	x	x	x	x	x	x
Turbidity	x	x	x	x	x	x	x
Total Suspended Solids		x	x	x	x	x	x
Total Nitrogen	x	x	x	x	x	x	x
Nitrate + Nitrite	x	x	x	x	x	x	x
Total Phosphorus	x	x	x	x	x	x	x
Orthophosphate	x	x	x	x	x	x	x
Calcium	x	x	x	x	x	x	x
Magnesium	x	x	x	x	x	x	x
Hardness	x	x	x	x	x	x	x
AFDW					x	x	
Chlorophyll-A					x	x	

Table 1: Water quality metrics measured at 11 sites throughout the 2024 sampling season

Winter Monitoring
On March 11th, the Task Force sampled four sites in the Upper Gallatin. These sites were SwanCr_Mouth, WFGR_Mouth, BeaverCr_Mouth, and TaylorFk_Mouth. The purpose of this sampling event was to characterize the water chemistry of baseflow, which is primarily fed by groundwater.

Spring, Summer, and Fall Monitoring
Between the months of May and October, in situ measurements and water samples were collected every month at 11 sites along nine tributaries to the Upper Gallatin River. The 11 sites name were StormcastleCr_Mouth, SwanCr_Mouth, PortalCr_Mouth, WFGR_Mouth, WFGR_BlwGolf, WFGR_AbvGolf, MFWF_Mouth, SFWF_Mouth, BeaverCr_Mouth, BuckCr_Mouth, and TaylorFk_Mouth. (Figure 1 & 2). In the months of August and September algae samples were also collected. Streamflow was collected at each site during each sampling event. The Task Force maintained continuous streamflow gauges on the North Fork, South Fork, and two on the West Fork from April through October. A fifth streamflow gauge was installed during the summer on the Middle Fork. These stations also collected water temperature and conductivity data.

Gallatin Lake Monitoring
A sampling event at Gallatin Lake, the headwaters of the Gallatin River, took place on September 24th with express permission from the National Park Service under a scientific collection permit. The purpose of this site visit was to characterize water chemistry at the source. Due to the difficulty of reaching the site, no in situ measurements were collected.

RESULTS:

Winter Monitoring

Total nitrogen levels were highest in the West Fork, with a reading of 0.52 mg/L (Figure 4). Levels at BeaverCr_Mouth, TaylorFk_Mouth, and SwanCr_Mouth were 0.2 mg/L, 0.13 mg/L, and 0.08 mg/L, respectively. N+N levels at BeaverCr_Mouth, TaylorFk_Mouth, and SwanCr_Mouth were 0.163 mg/L, 0.093 mg/L, and 0.067 mg/L, respectively (Figure 5). Because there is limited historic winter total nitrogen data, N+N was used to compare historic nitrogen levels. 2024 levels of N+N were in the upper range of historical data, with the measurement of 0.459 mg/L at WFGR_Mouth (Figure 6). Streamflow during this event was comparable to the historical median for March 11th at the USGS Gallatin Gateway gauge. Due to groundwater's large influence on streamflow during the winter, high levels of nitrogen indicate a groundwater source that is high in nitrogen originating in the West Fork drainage.

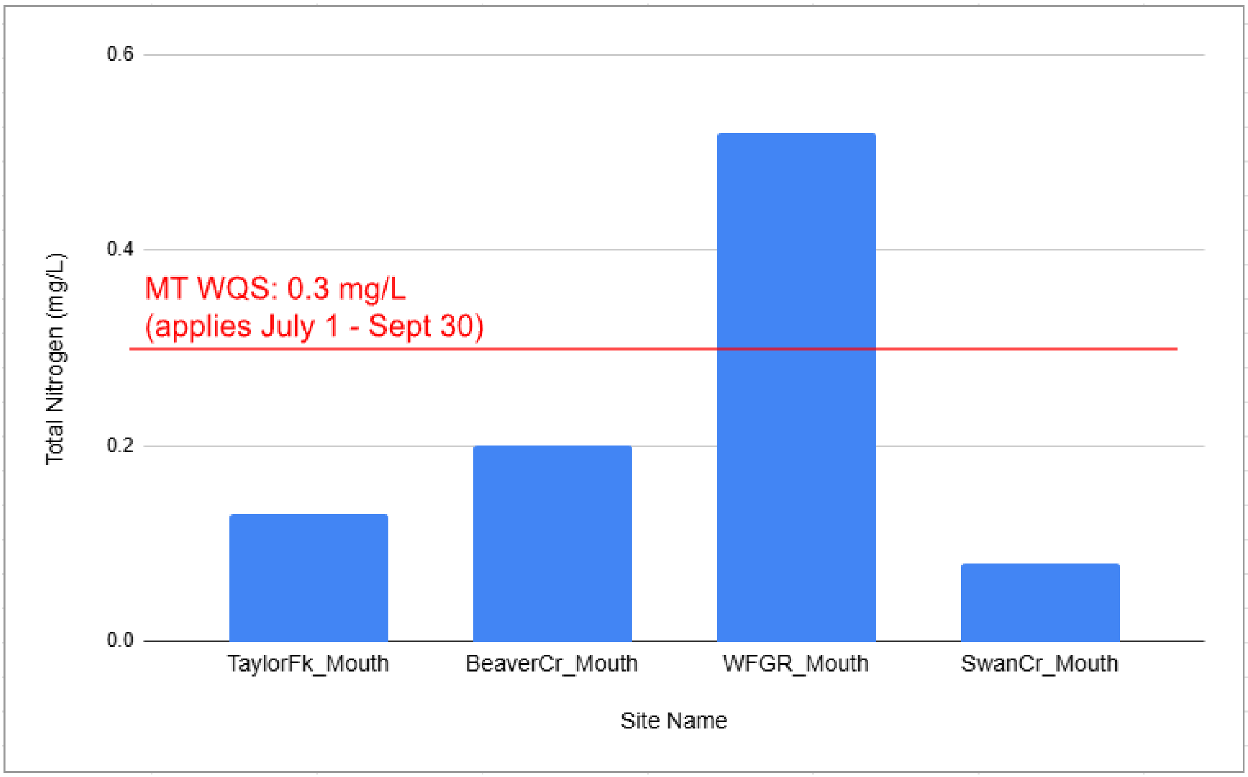

Figure 4: Total nitrogen levels in four tributaries of the Upper Gallatin River on March 11th, 2024. The MT WQS of 0.3 mg/L is not applicable outside of July 1 - September 30th.

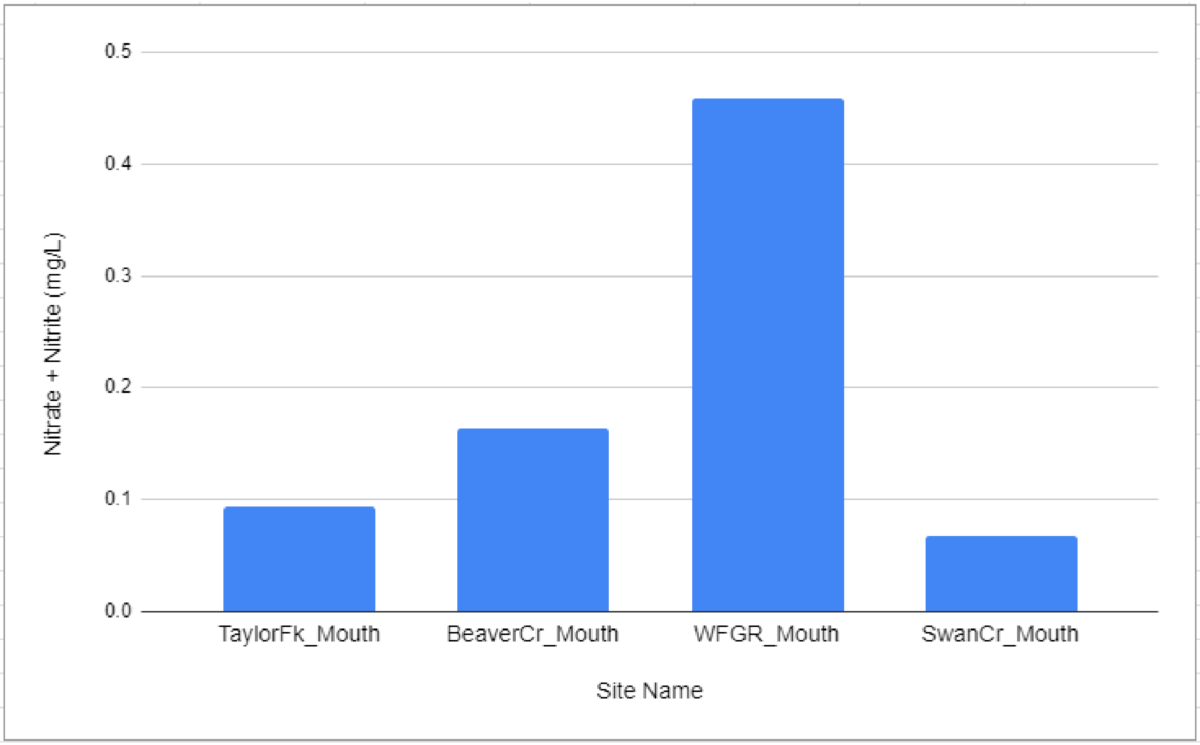

Figure 5: Nitrate+nitrite levels on four tributaries of the Upper Gallatin River on March 11th, 2024

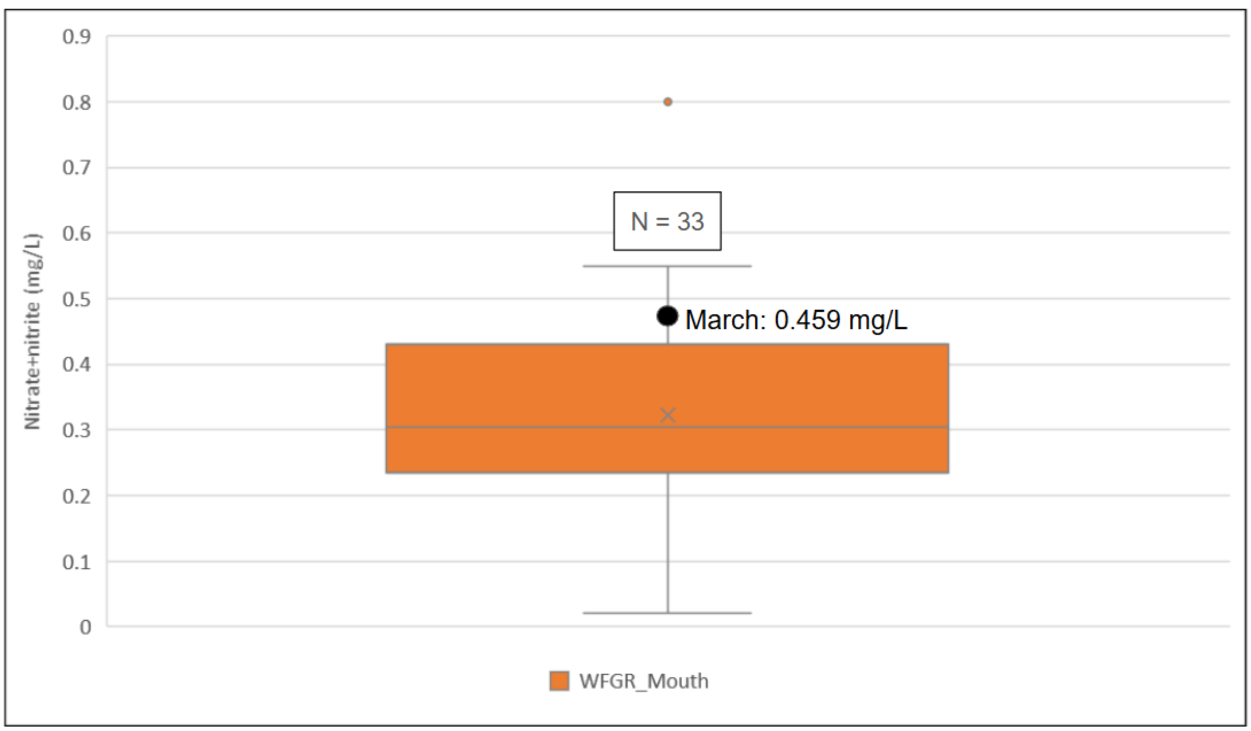

Figure 6: Box plot of historical winter nitrate+nitrite data at WFGR_Mouth from 2000-2024

Total phosphorus levels were highest at SwanCr_Mouth, with a concentration of 0.069 mg/L. TaylorFk_Mouth, BeaverCr_Mouth, and WFGR_Mouth had total phosphorus levels of 0.01 mg/L, 0.009 mg/L, and 0.008 mg/L, respectively (Figure 7). Orthophosphate levels were highest at SwanCr_Mouth with a concentration of 0.072 mg/L[1]. Concentrations at TaylorFk_Mouth, BeaverCr_Mouth, and WFGR_Mouth were 0.007 mg/L, 0.01 mg/L, and 0.002 mg/L, respectively (Figure 8). Elevated levels of phosphorus at SwanCr_Mouth are consistent with historical data and have been documented to be influenced by geology. Swan Creek lies within the Absaroka-Gallatin-Volcanic Level IV region, an area rich in natural sources of phosphorus (MT DEQ, 2013).

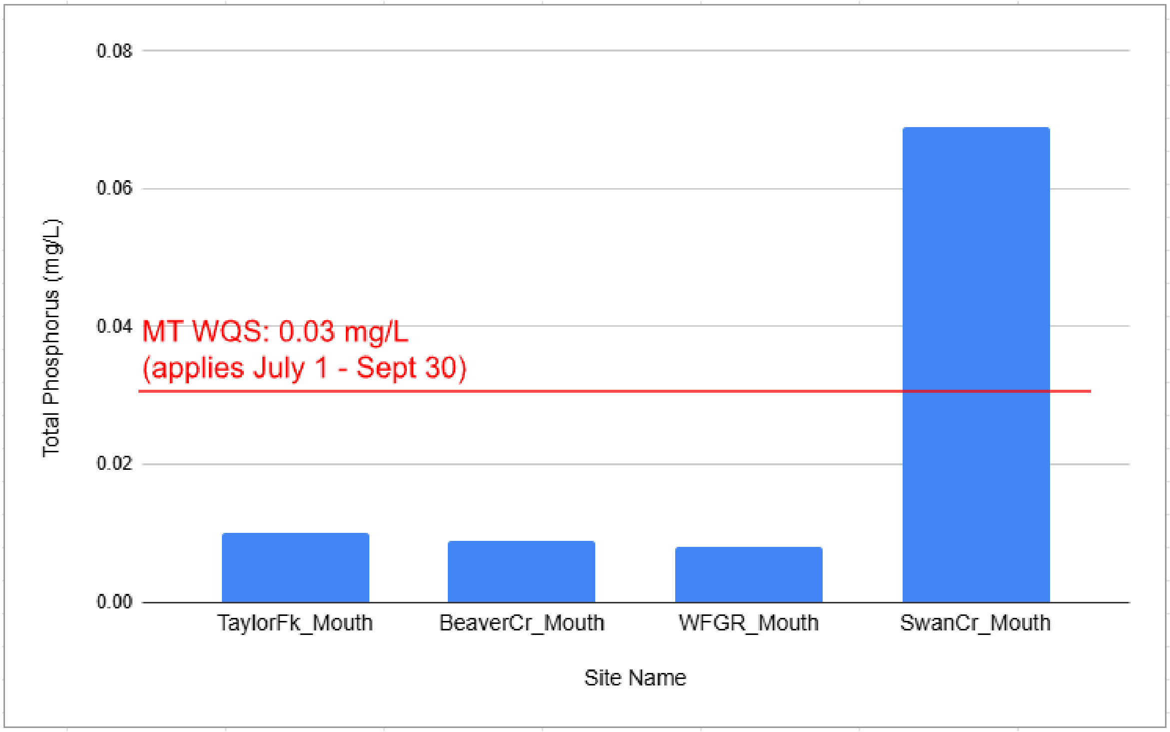

Figure 7: Levels of total phosphorus in four tributaries of the Upper Gallatin River on March 11th, 2024

[1] Orthophosphate readings (0.072 mg/L) at SwanCr_Mouth exceeded total phosphorus levels (0.069 mg/L). This is not possible, however the readings are within the acceptable margin of error for lab analysis.

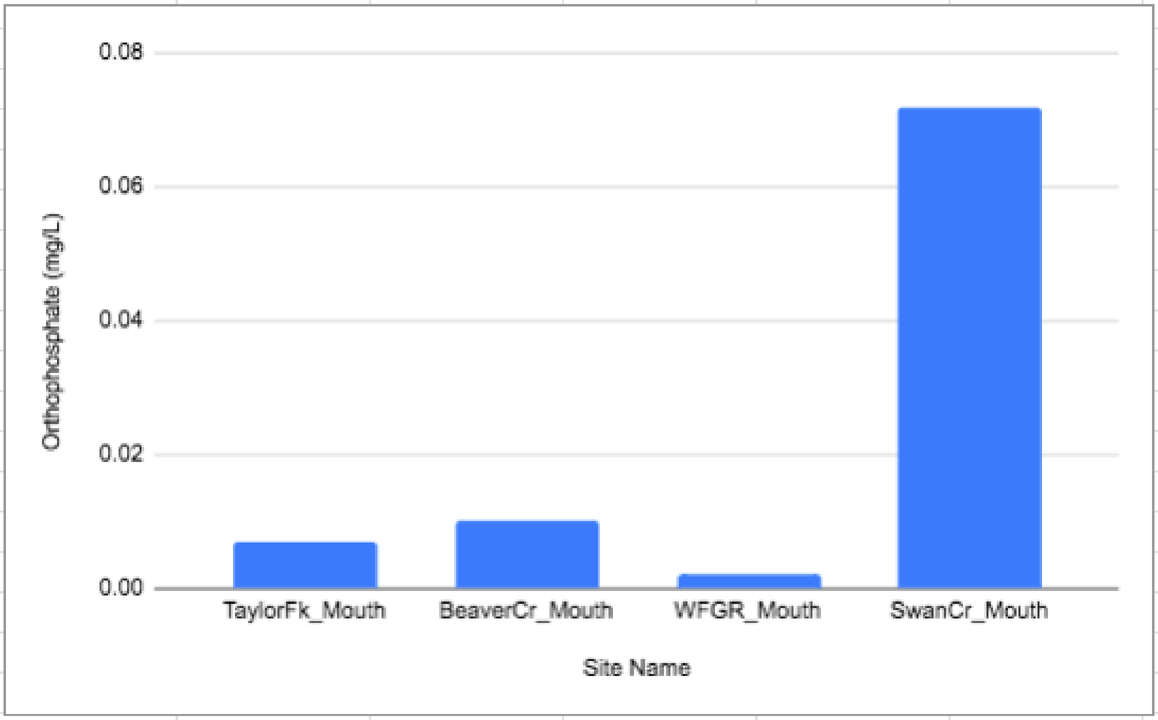

Figure 8: Levels of orthophosphate in four tributaries of the Upper Gallatin River on March 11th, 2024

Spring, Summer, and Fall Monitoring:

<u>Algae</u>

The MT WQS standard of Ash Free Dry Weight (AFDW) of 35 g/m^2 was exceeded in August at PortalCr_Mouth, WFGR_BlwGolf, BeaverCr_Mouth and in August and September at TaylorFk_Mouth (Figure 9). *Cladophora* was the primary algae present in BeaverCr_Mouth and TaylorFk_Mouth, while microalgae was primarily present at PortalCr_Mouth[2] and WFGR_BlwGolf. Chlorophyll-A levels were well below the MT WQS of 125 mg/m^2 for all sites in both August and September (Figure 10).

[2] Visual observations of microalgae at PortalCr_Mouth were all below 40% cover as recorded on Aquatic Plant Visual Assessment Forms during sampling in August

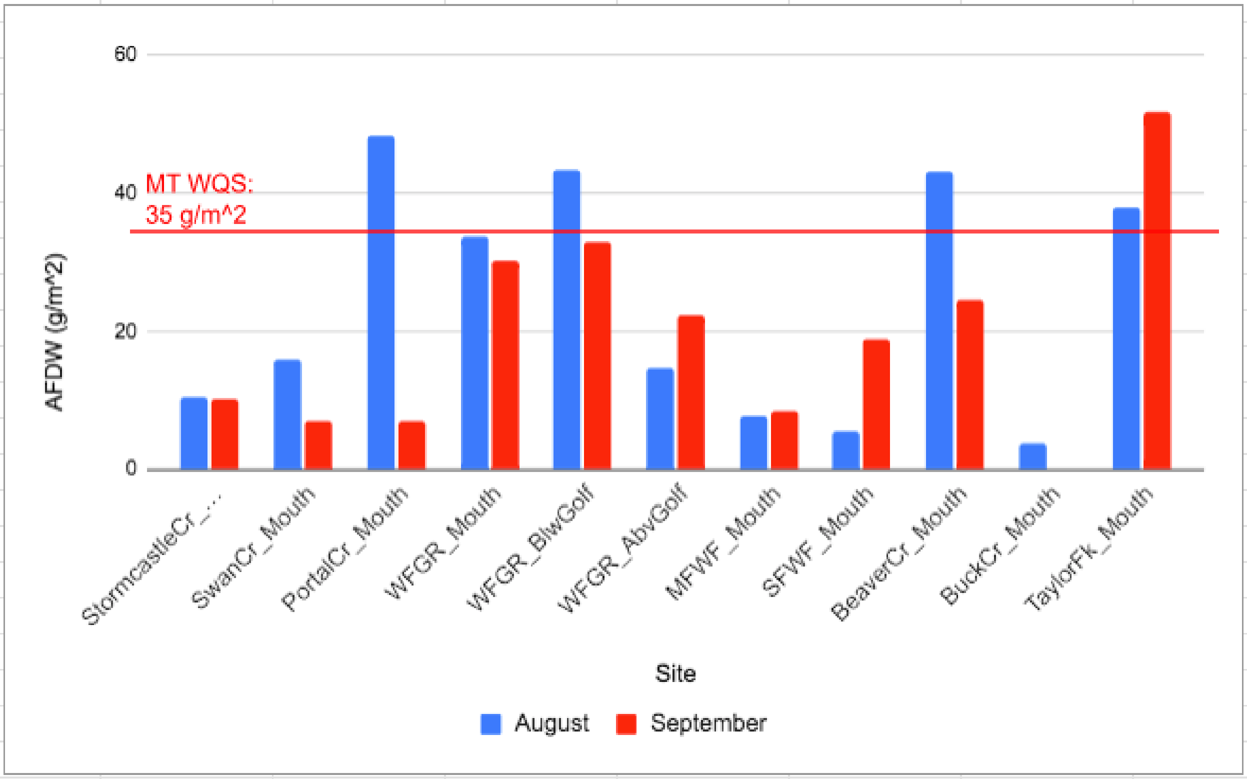

Figure 9: Ash Free Dry Weight (AFDW) in tributaries of the Upper Gallatin River in August and September 2024

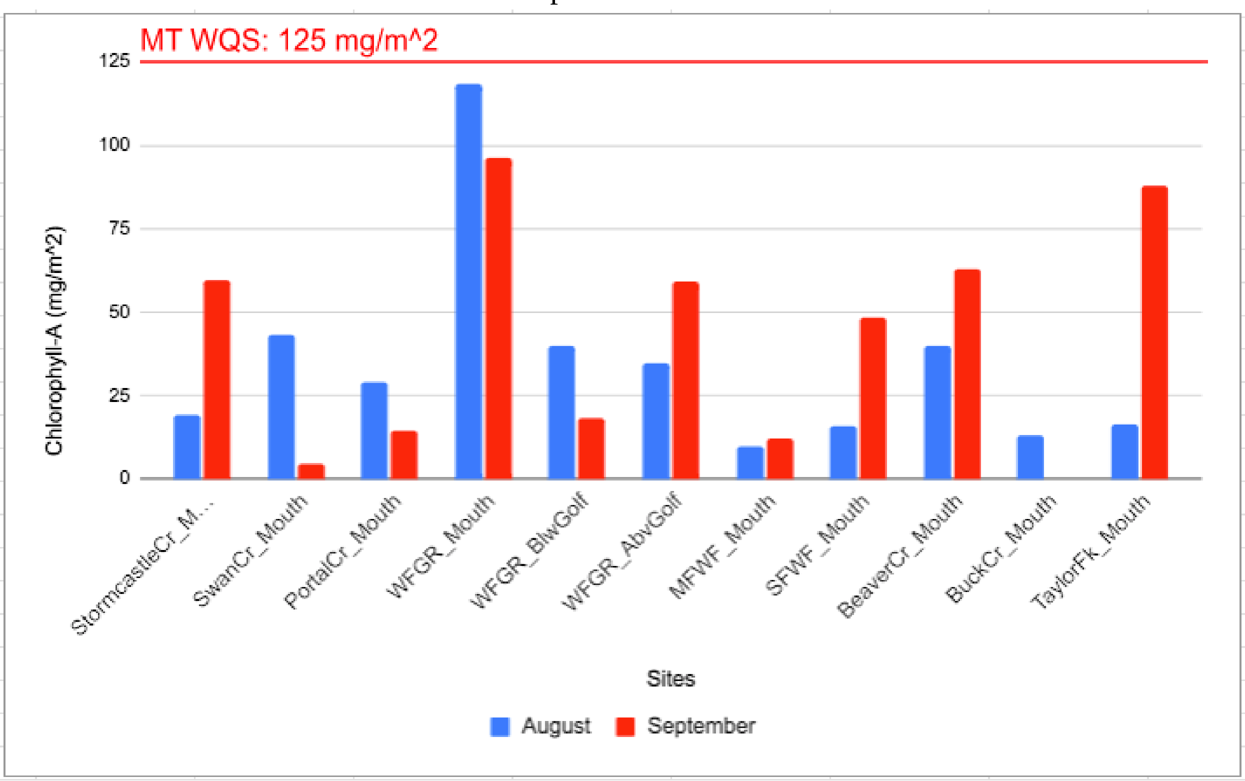

Figure 10: Chlorophyll-A levels in tributaries of the Upper Gallatin River in August and September 2024

Nutrients

The MT WQS for total nitrogen of 0.3 mg/L was exceeded at two sites during the July 1st-September 30th period when the standards apply (Figure 11). WFGR_BlwGolf exceeded the MT WQS in August (0.43 mg/L) and September (0.36 mg/L). There was only one MT WQS exceedance at SFWF_Mouth, which occurred in August, with a reading of 0.31 mg/L. 2024 levels of total nitrogen at WFGR B l w _ Golf were greater than the historical mean in August and September and closer to the upper quartile in July (Figure 12). 2024 levels of total nitrogen at WFGR_Mouth were greater than the historical mean in August, close to the historical mean in September, and near the upper quartile in July. Streamflow levels during all sampling events were below the historical median, likely a contributing factor to higher nutrient concentrations. Total nitrogen loading was highest at all 11 sites in June, during peak runoff (Figure 13). Loading was highest at WFGR_Mouth, SFWF_Mouth, and TaylorFk_Mouth.

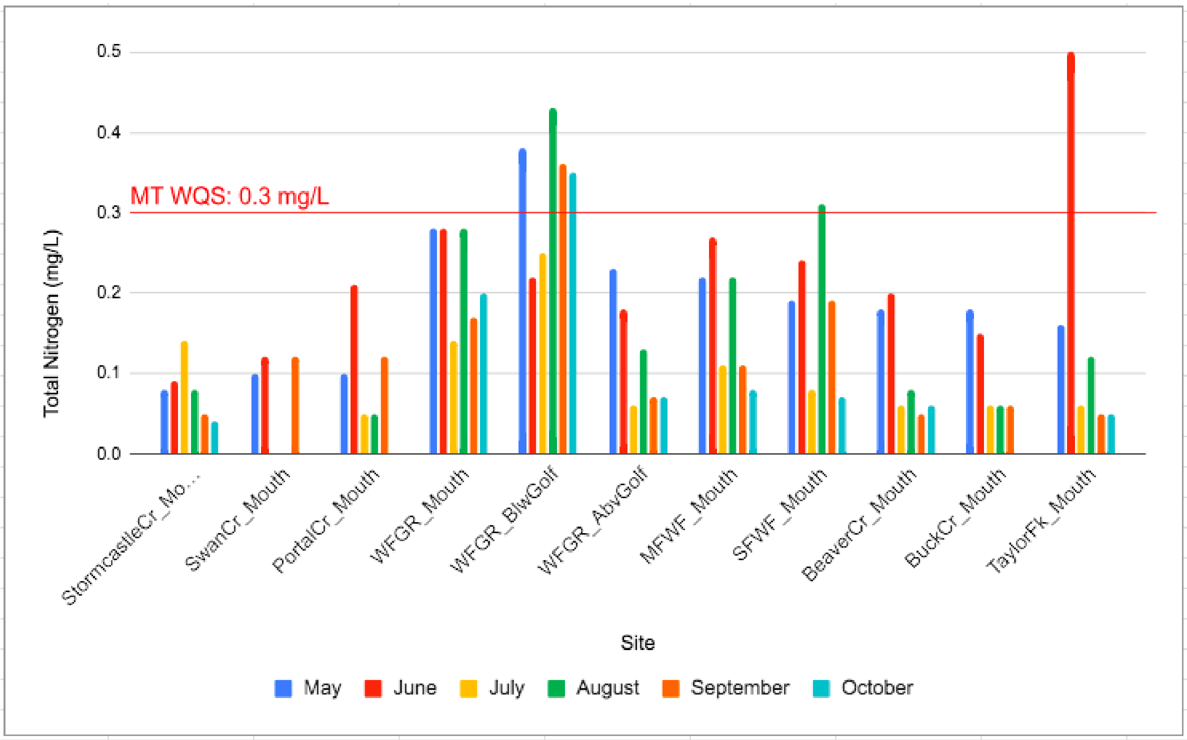

Figure 11: Total nitrogen levels in tributaries of the Upper Gallatin River from May - October 2024

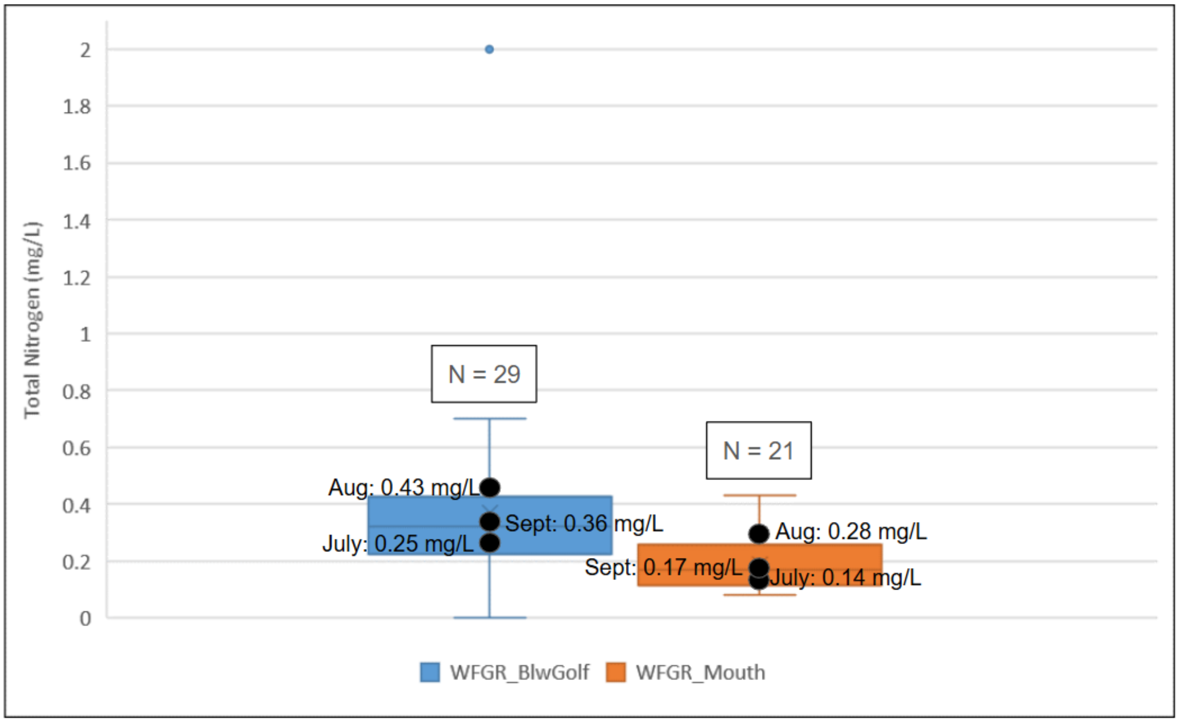

Figure 12: Boxplot of historic summer TN levels at WFGR_Mouth and WFGR_BlwGolf with 2024 readings noted

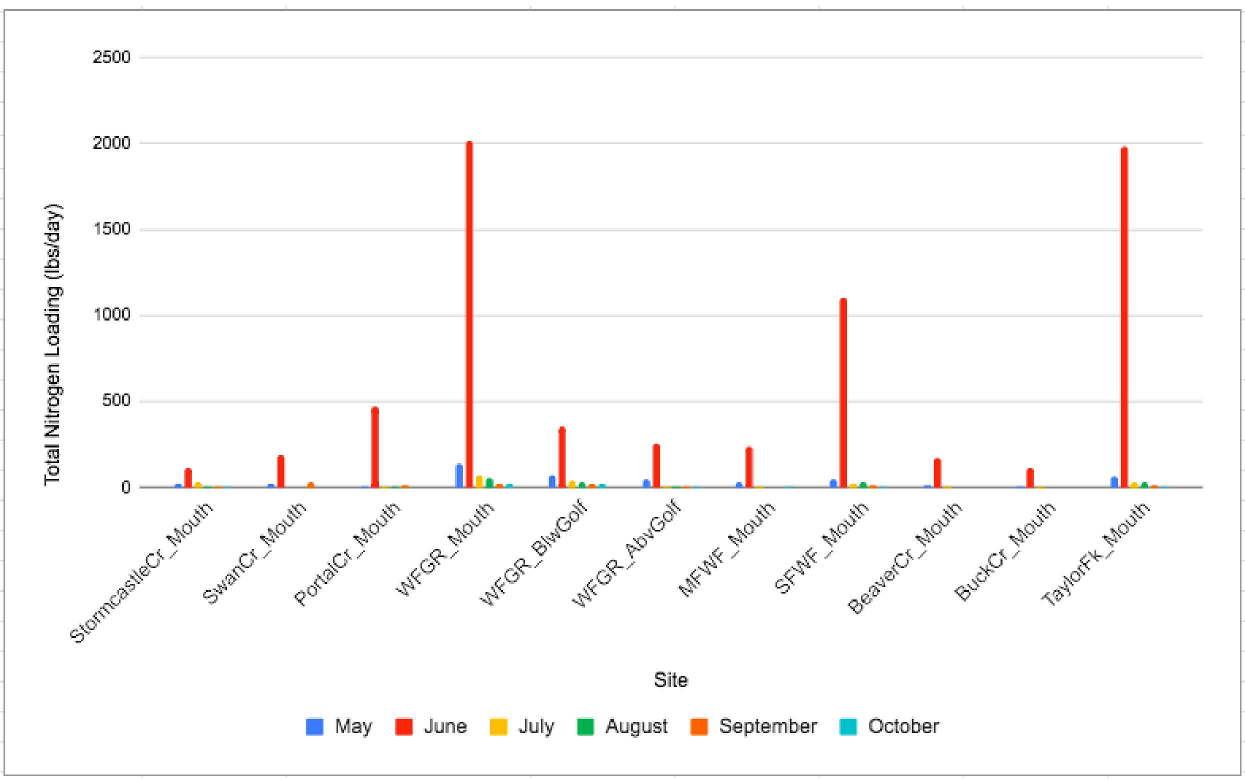

Figure 13: Total nitrogen loading at 11 sites in tributaries of the Upper Gallatin River from May - October 2024

Elevated levels of N+N greater than 0.1 mg/L between July 1st and September 30th occurred at SwanCr_Mouth in September[3]; WFGR_Mouth in August and September; WFGR_BlwGolf in July, August, and September; and SFWF_Mouth in August (Figure 14). N+N levels at WFGR_BlwGolf were above the historical mean in August and September, and just below the historical mean in July (Figure 15). At WFGR_Mouth, 2024 levels of N+N were greater than the historical mean for July, August, and September. Streamflow during all sampling events was below the historical median, likely a contributing factor to higher nutrient concentrations. Over time summer nitrate+nitrite levels have seen a slight increase at both WFGR_Mouth and WFGR_BlwGolf (Figure 16 & 17). WFGR_Mouth has an r^2 value of 0.349 when looking at nitrate+nitrite levels from 2000 to 2024. WFGR_BlwGolf has an r^2 value of 0.072 when looking at nitrate+nitrite levels over time from 2008 to 2024.

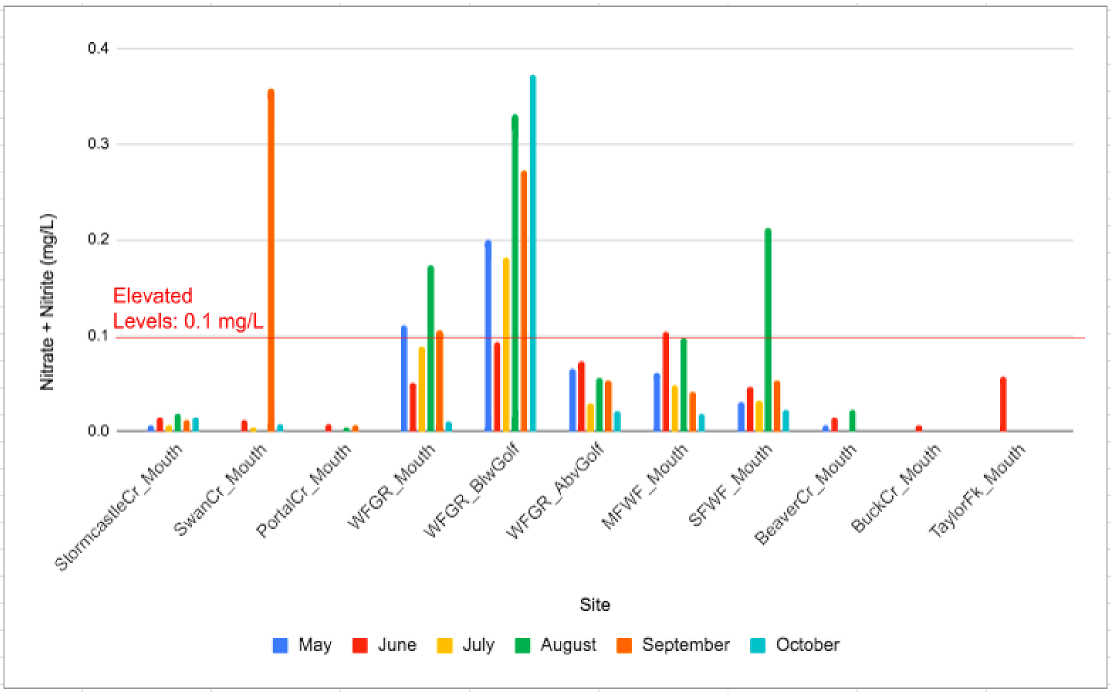

Figure 14: Nitrate + nitrite levels in in tributaries of the Upper Gallatin River from May - October 2024

[3] N+N readings at SwanCr_Mouth in September (0.358 mg/L) were greater than TN readings (0.12 mg/L). Analysis on both samples was conducted again as a quality assurance measure, and the readings were confirmed. This sampling event occurred during a large storm event, and N+N samples are collected in a different bottle than TN samples, meaning the chance for statistical difference is minimal, but possible.

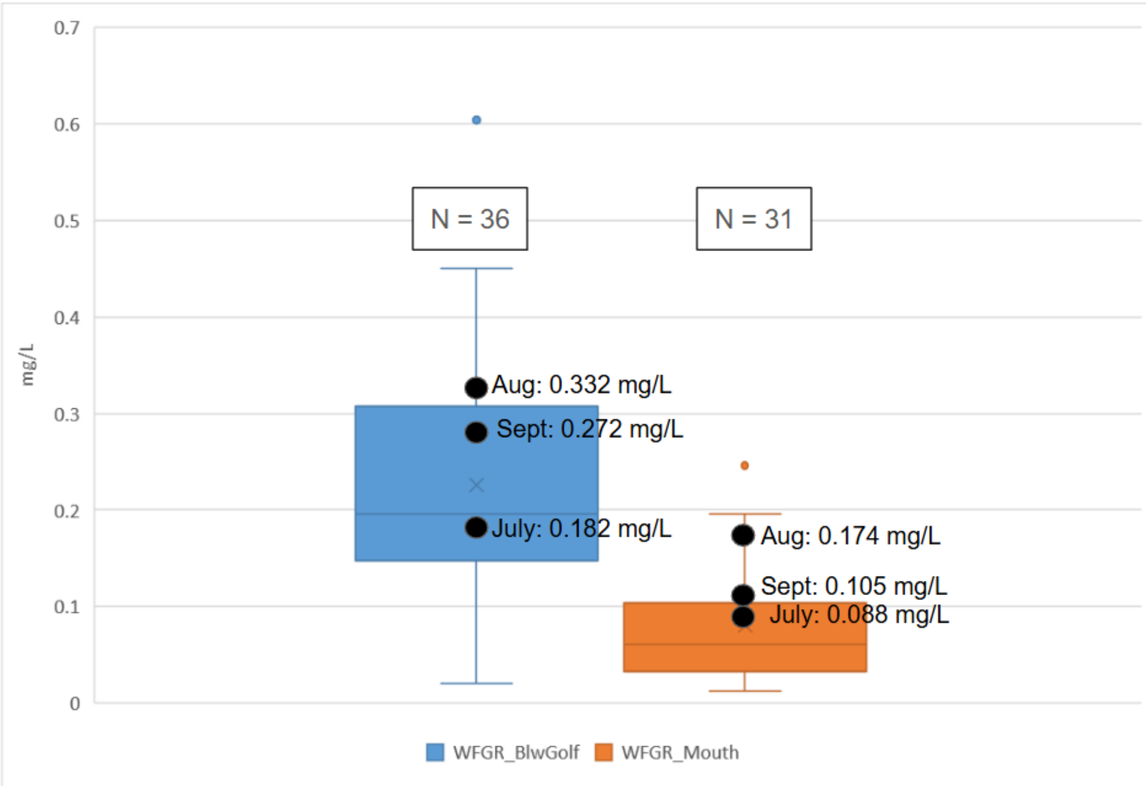

Figure 15: Boxplot of historic summer nitrate+nitrite levels at WFGR_Mouth and WFGR_BlwGolf with 2024 readings noted

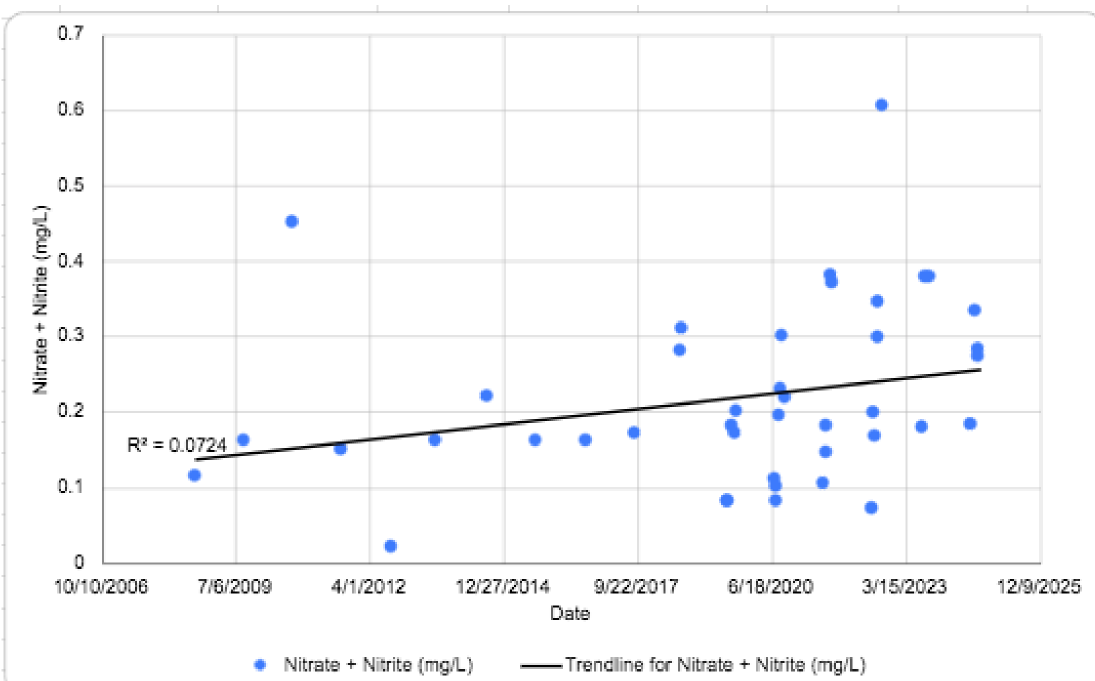

Figure 16: Nitrate + nitrite levels (mg/L) over time at WFGR_BlwGolf from July - September from 2008 - 2024

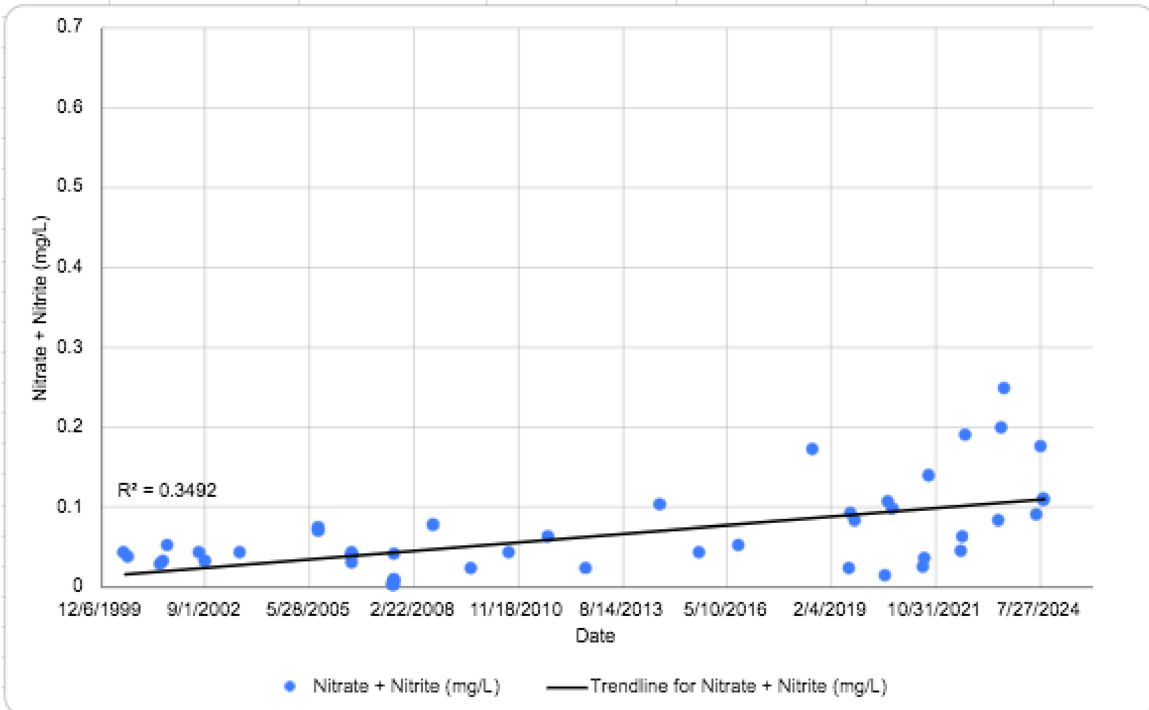

Figure 17: Nitrate + nitrite levels (mg/L) over time at WFGR_Mouth from July - September from 2000 - 2024

The MT WQS of 0.03 mg/L for total phosphorus was exceeded at two sites during the July 1st - September 30th time period (Figure 18). Levels at StormcastleCr_Mouth exceeded state standards in July, August, and September with levels of 0.045 mg/L, 0.075 mg/L, and 0.045 mg/L, respectively[4]. Levels at SwanCr_Mouth were above MT WQS in July, August, and September with readings of 0.072 mg/L, 0.074 mg/L, 0.111 mg/L, respectively. Both of these sites lie within the Absaroka-Gallatin-Volcanic Levels IV Ecoregion which has documented high levels of phosphorus originating from geology. High levels of orthophosphate also correspond with sites originating from that area, with StormcastleCr_Mouth, SwanCr_Mouth, and PortalCr_Mouth having consistently higher levels of orthophosphate than all other sites (Figure 19). Similar to nitrogen loading, the highest levels of phosphorus loading occurred in June during peak runoff (Figure 20). Levels during this event were highest at WFGR_Mouth, SFWF_Mouth, and TaylorFk_Mouth. Later in the summer, as streamflow decreased, StormcastleCr_Mouth, SwanCr_Mouth, and PortalCr_Mouth contributed the highest daily phosphorus loads.

[4] July TP levels at StormcastleCr_Mouth differed from field duplicate collected during the same time (StormcastleCr_Mouth_FD). The levels were 0.03 mg/L and 0.045 mg/L. This difference is greater than the acceptable relative percent difference of 25% outlined in the SAP. Because of this, the higher value was listed and flagged.

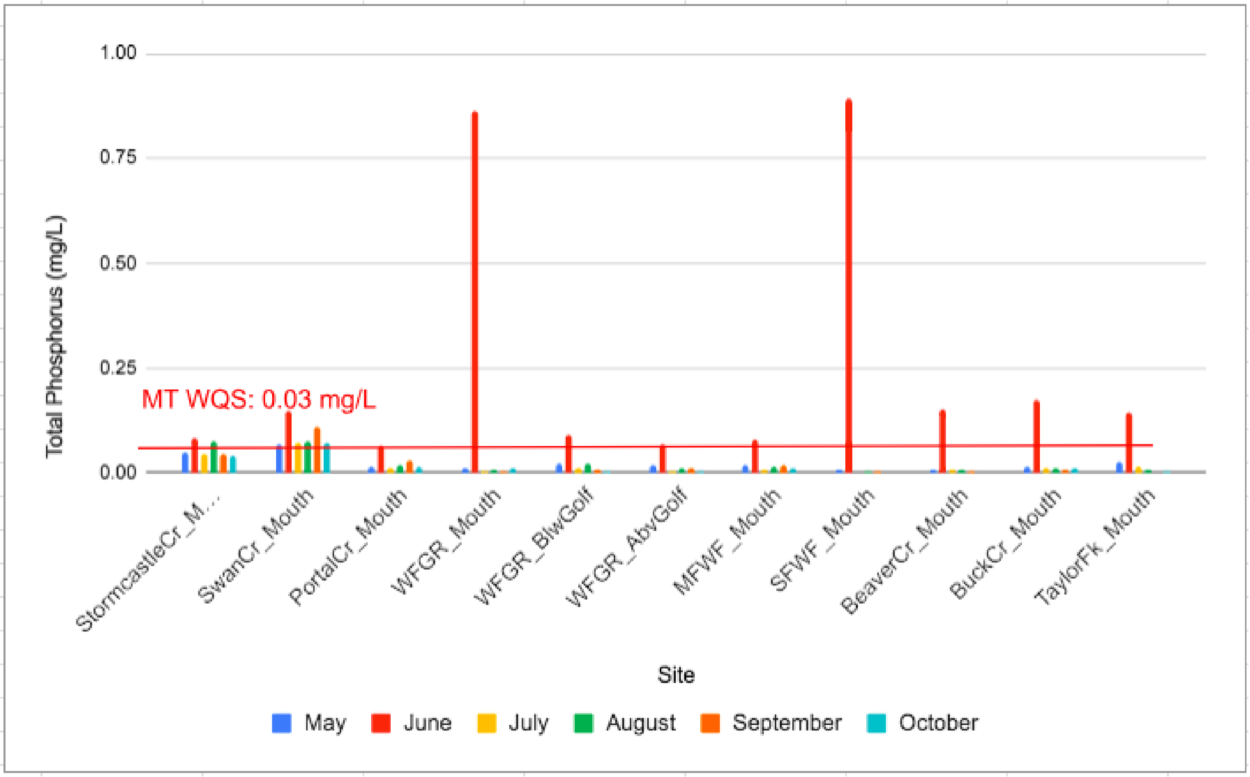

Figure 18: Total phosphorus levels in tributaries of the Upper Gallatin River from May - October 2024

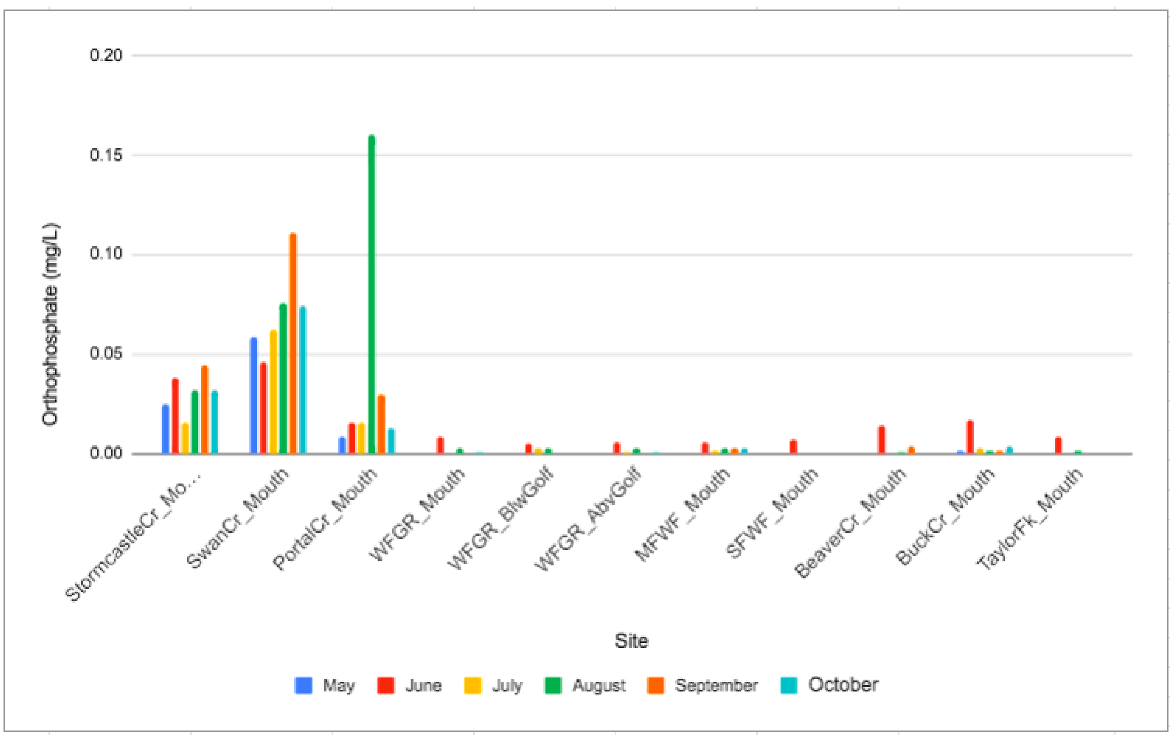

Figure 19: Orthophosphate levels in tributaries of the Upper Gallatin River from May - October 2024

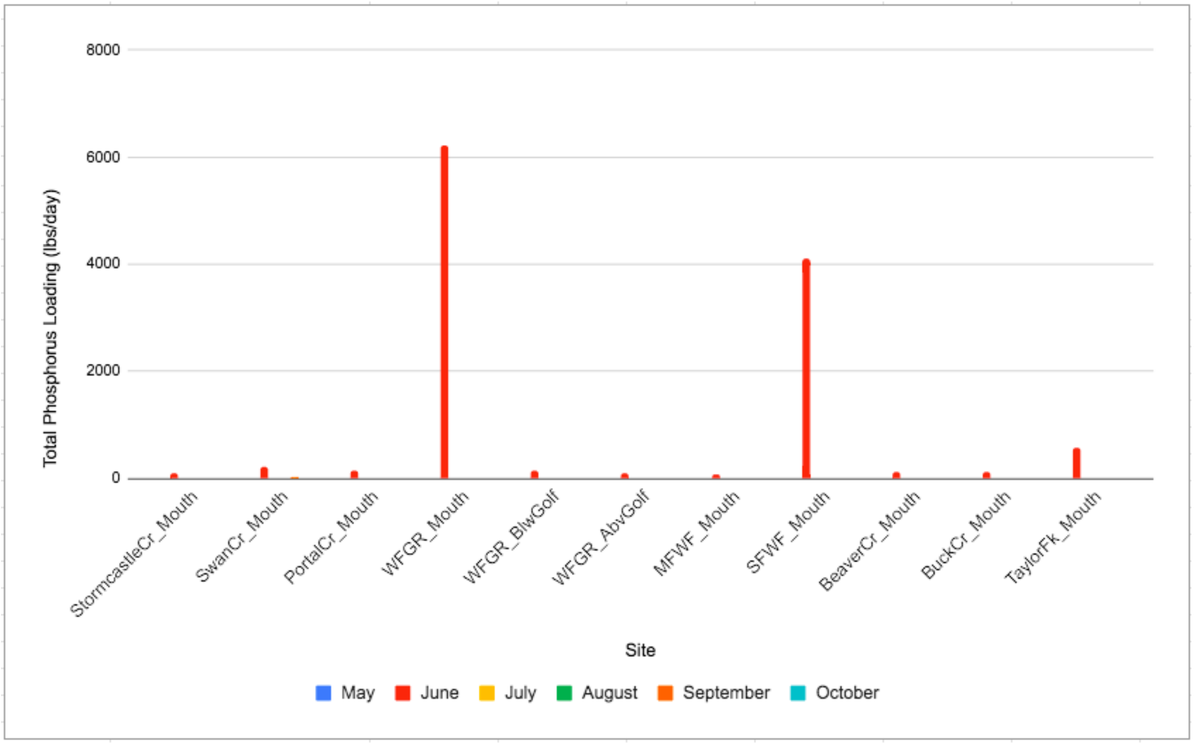

Figure 20: Total phosphorus loading in tributaries of the Upper Gallatin River from May - October 2024

<u>Air Temperature</u>

Average air temperature was highest in July at 15.4 ℃ (59.7 ℉) (Figure 21) falling close to the average July temperatures across 2018 - 2023. Average air temperatures were highest in relation to 2018-2023 averages in June, where average air temperature was 7.62% higher than the 2018 - 2023 average. Average air temperatures in May were 22.5% below the 2018 - 2023 average, average air temperatures in August were 4.92% below the 2018 - 2023 average, and average air temperatures in September were 5.96% above the 2018 - 2023 average. Across May - September, average air temperature in 2024 was 98.4% of the average from 2018 - 2023.

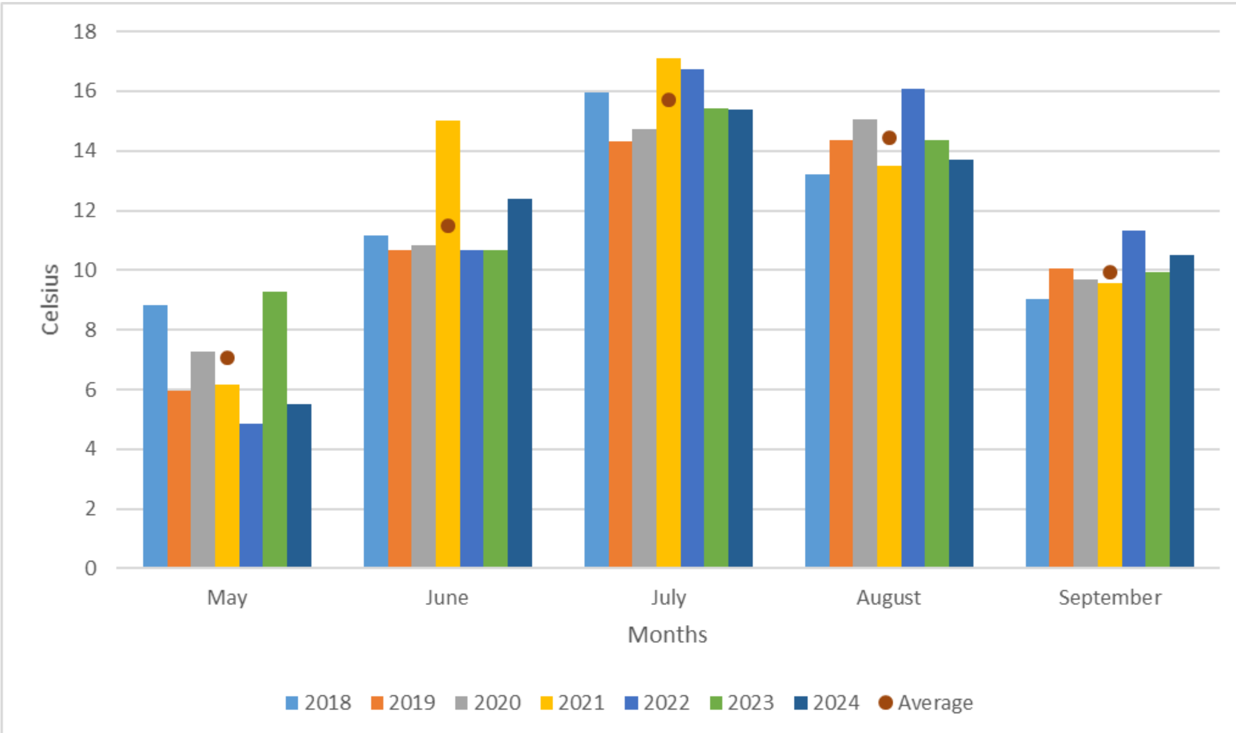

Figure 21: Air temperature from 2018-2024 with average from May - September

Water Temperature

Water temperatures reached 10℃, the temperature at which *Cladophora grows* on the South Fork, Middle Fork and West Fork. The 10℃ threshold was not reached on the North Fork. (Figure 22). That threshold was reached in July and August at the West Fork site; July, August, and September for the Upper West Fork; and August for the South Fork site. Due to technical difficulties of operating the South Fork gauge, water temperature is only available for the months of August and September. Water temperature at the USGS Deer Creek gauge reached the 10℃ threshold in July, August, and September. Water temperatures exceeded 13.5℃, ideal growing conditions for *Cladophora*, in July and August.

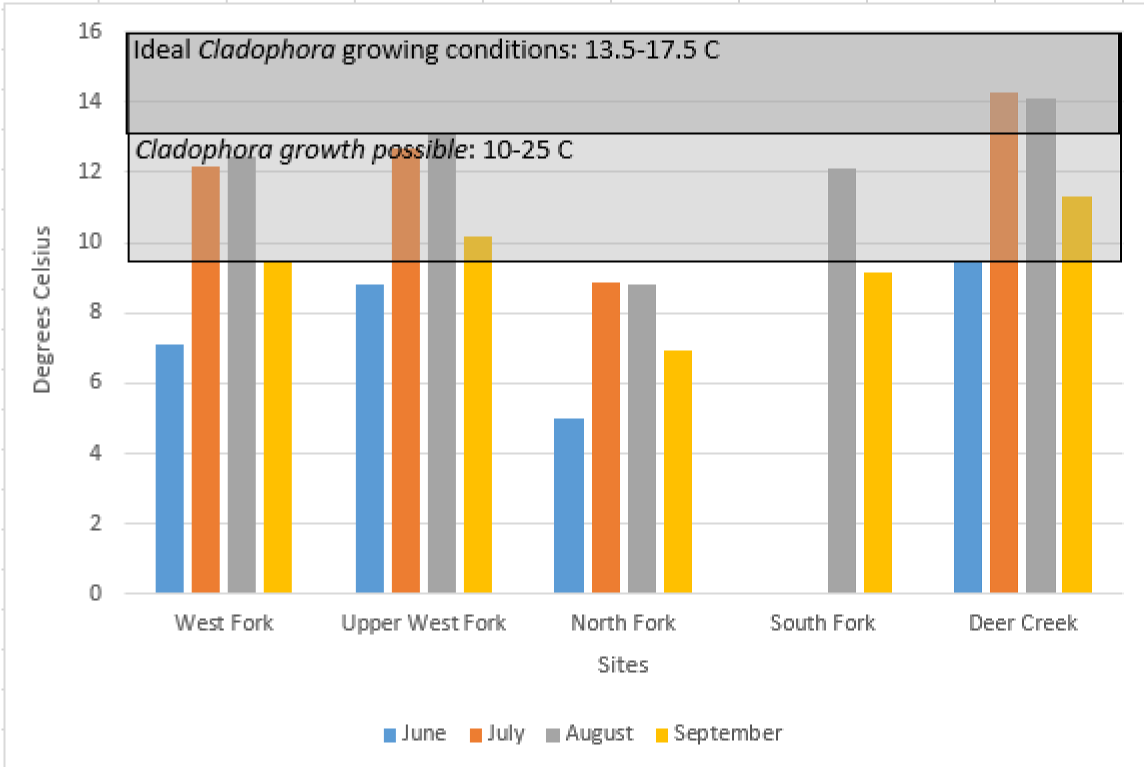

Figure 22: Water temperature at USGS Deer Creek gauge and within the West Fork drainage from June - September 2024

<u>Water Hardness</u>

Water hardness generally increased throughout the summer as streamflow decreased, suggesting increasing groundwater influence (Figure 23). Hardness levels exceeded the 121 mg/L threshold that *Cladophora* thrives in at 6 sites throughout the sampling reach. These sites were: WFGR_Mouth, WFGR_BlwGolf, SFWF_Mouth, BeaverCr_Mouth, BuckCr_Mouth, and TaylorFk_Mouth. Levels were highest at BeaverCr_Mouth.

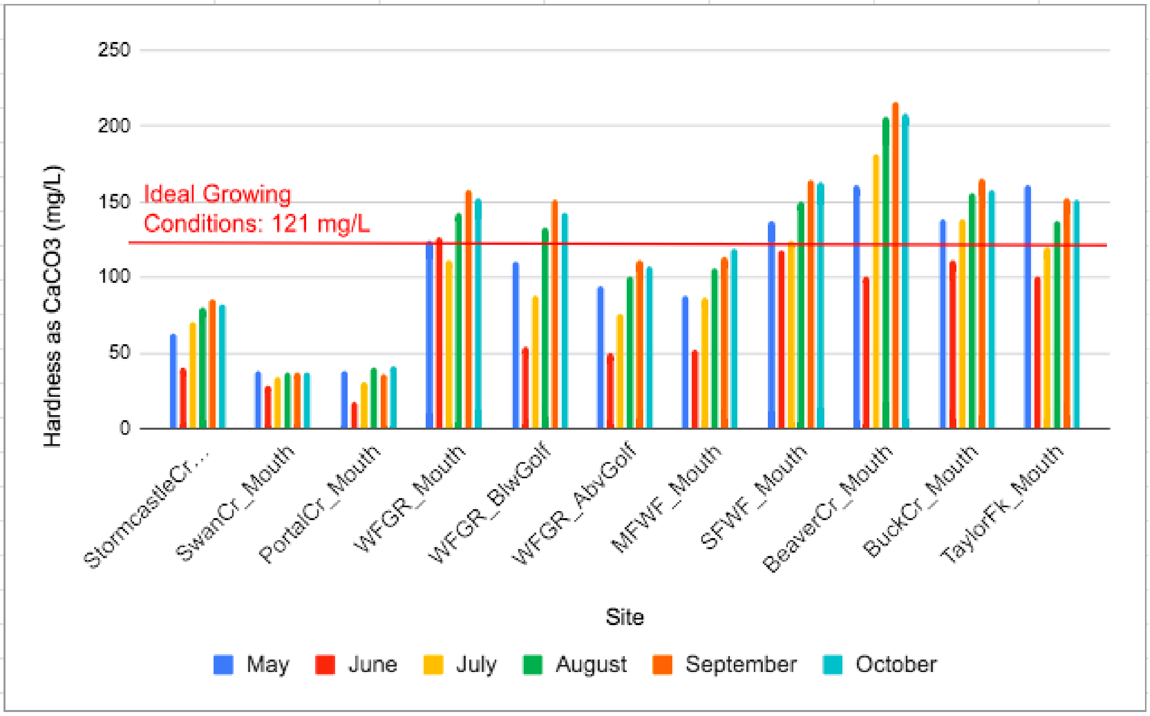

Figure 23: Water hardness levels in in tributaries of the Upper Gallatin River from May - September 2024

<u>Dissolved Oxygen</u>

The ΔDO exceedance rate was 8.2% at SFWF_Mouth (Figure 24). The ΔDO exceedance rate was 0% at TaylorFk_Mouth (Figure 25).[5]Both of these are below the DEQ standard exceedance rate of 10%.

[5] Due to issues that arose from biofouling, the data from the WFGR_Mouth site was an inaccurate representation of actual conditions. This was determined by comparing with DEQ probes deployed at the same site. WFGR_Mouth data has since been removed from this report.

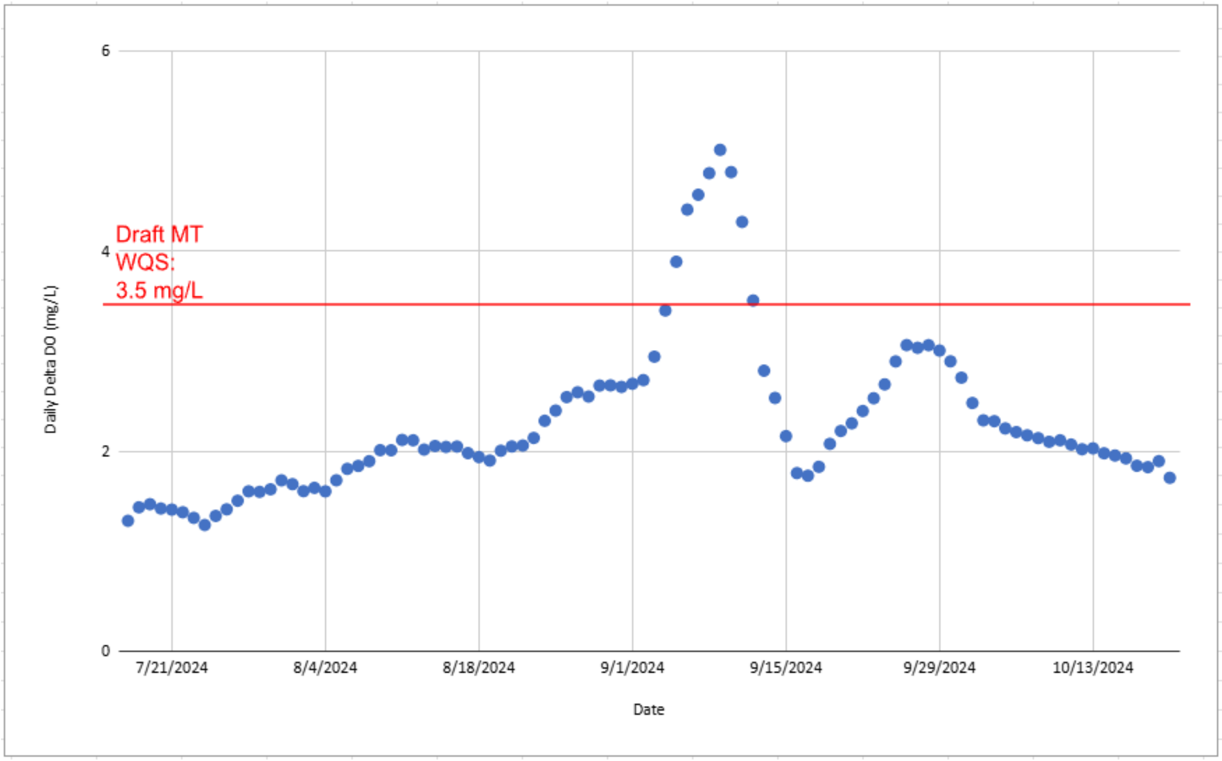

Figure 24: 7-day average of daily delta dissolved oxygen at SFWF_Mouth from July 17th - October 20th, 2024

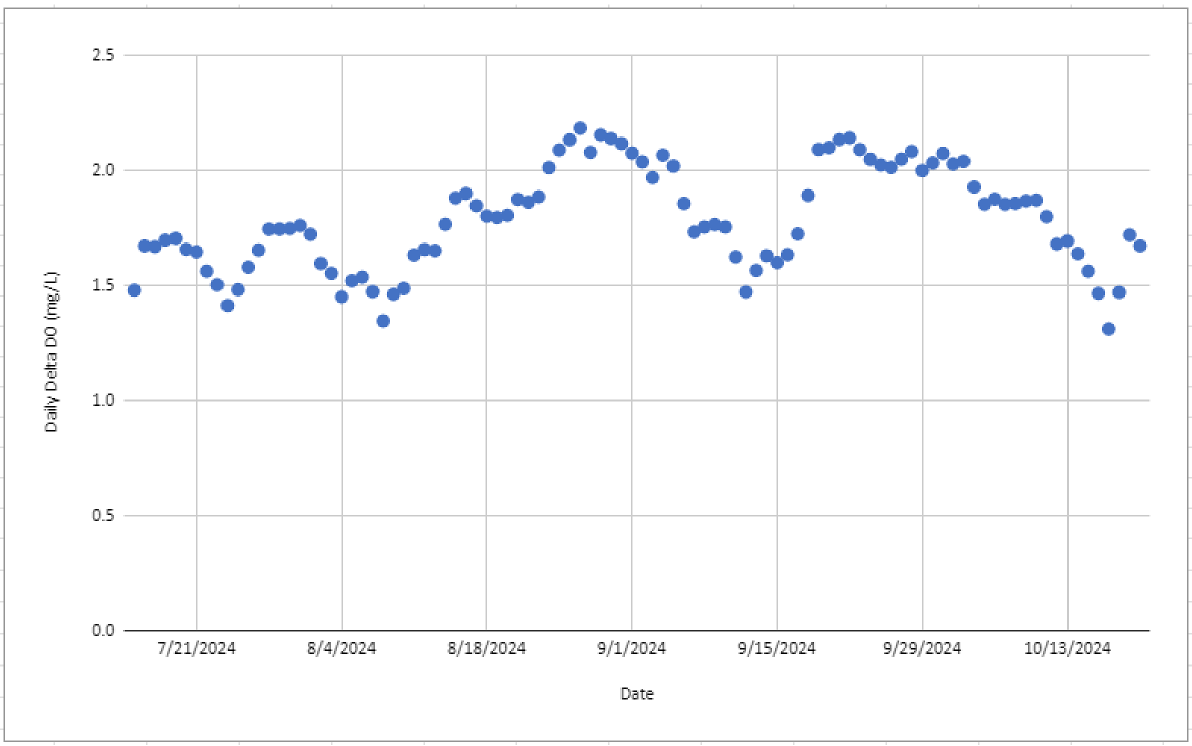

Figure 25: 7-day average of daily delta dissolved oxygen at TaylorFk_Mouth from July 17th - October 20th, 2024

<u>Sunlight</u>

Monthly average sunlight, as measured by solar irradiance (W/m²), was near the average of the 2018 - 2023 time period (Shaw, 2024) (Figure 26). Sunlight data was collected from the Montana State University Optical Remote Sensory Lab Weather Station located on the rooftop of Cobleigh Hall on campus in Bozeman, MT.

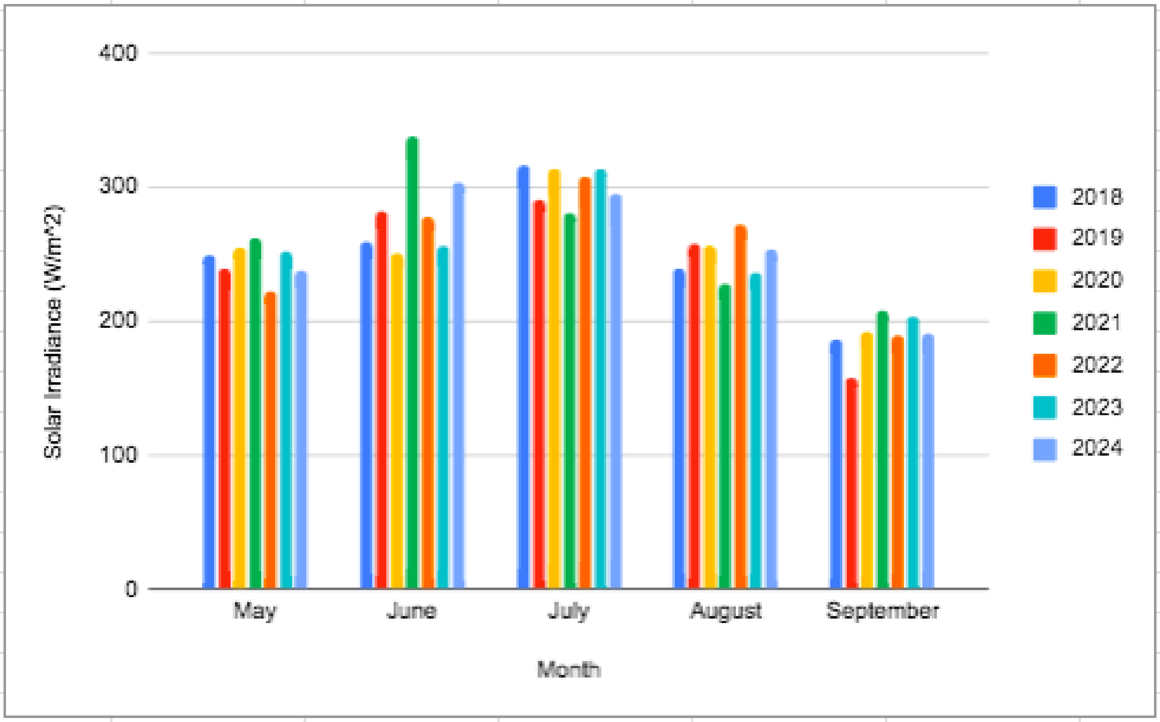

Figure 26: Graph of solar irradiance (W/m^2) in May - September 2024 on roof of Cobleigh Hall in Bozeman, MT

<u>Streamflow</u>

Peak streamflow of 5,710 cfs was reached at the USGS Gallatin Gateway gauge 06043500 on June 10th (Figure 27). This corresponds with the peak of 3,660 cfs at the USGS Gallatin River above Deer Creek gauge 06043120 on June 10th (Figure 28). After peak flow, streamflow dropped below average in the summer and continued that way into September at the USGS Gallatin Gateway gauge. Peak streamflow on the West Fork also occurred on June 10th at 1,884 cfs (Figure 29). At this time, the West Fork was contributing 33% of the total flow reaching the USGS Gallatin Gateway gauge. Peak discharge was reached on June 10th at the Upper West Fork, South Fork, and North Fork gauges as well (Figure 30, 31, & 32). Due to technical difficulties with the South Fork gauge, flow data was extrapolated from the West Fork and Upper West Fork gauge data using a formula that accounted for station error and groundwater inputs.

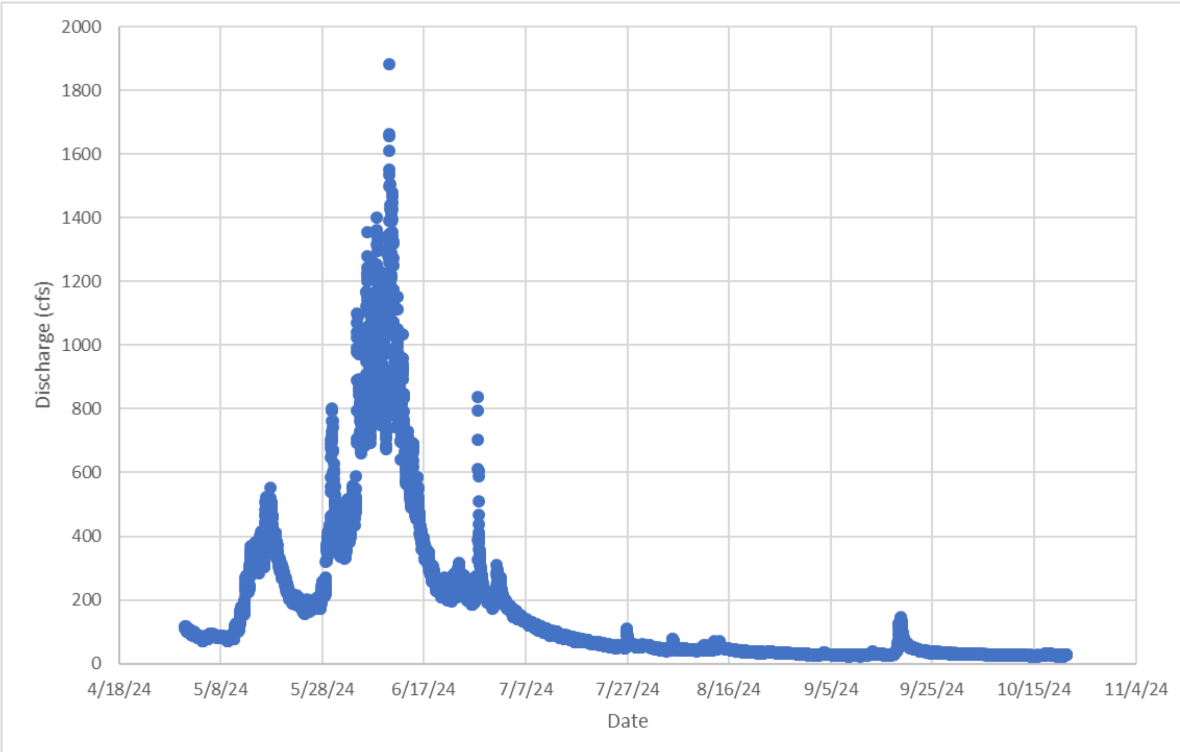

Figure 29: Discharge at West Fork gauge from May 1st - October 15th, 2024

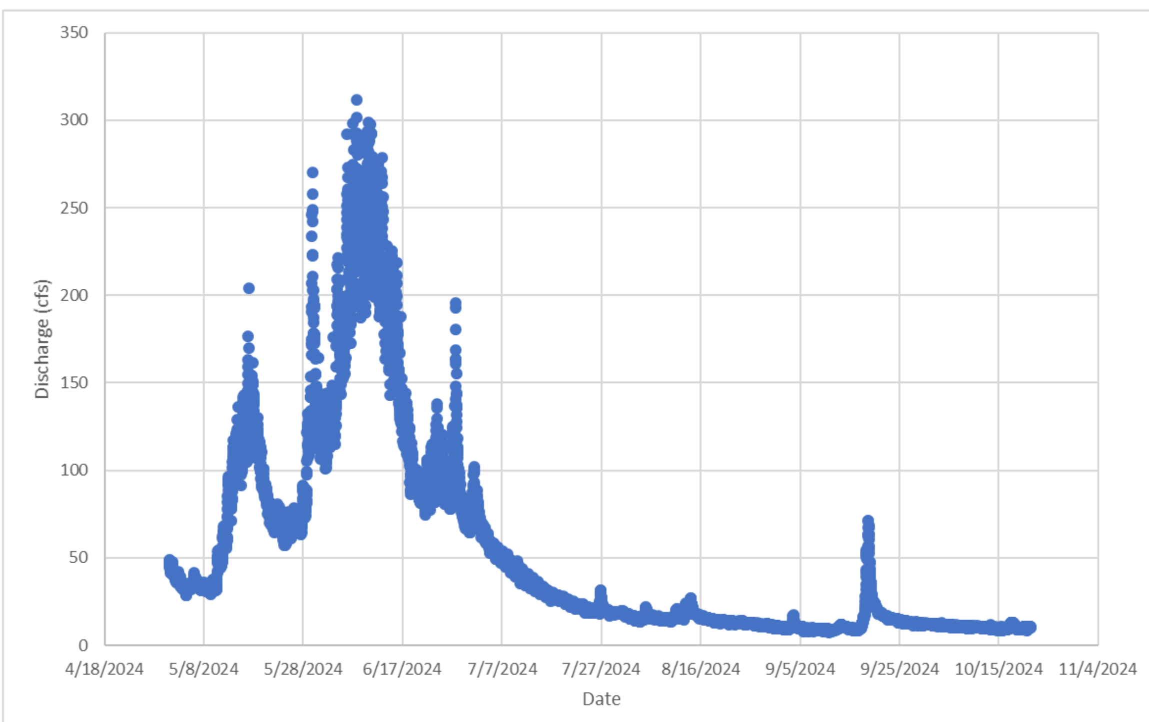

Figure 30: Discharge at the Upper West Fork gauge from May 1st - October 15th, 2024

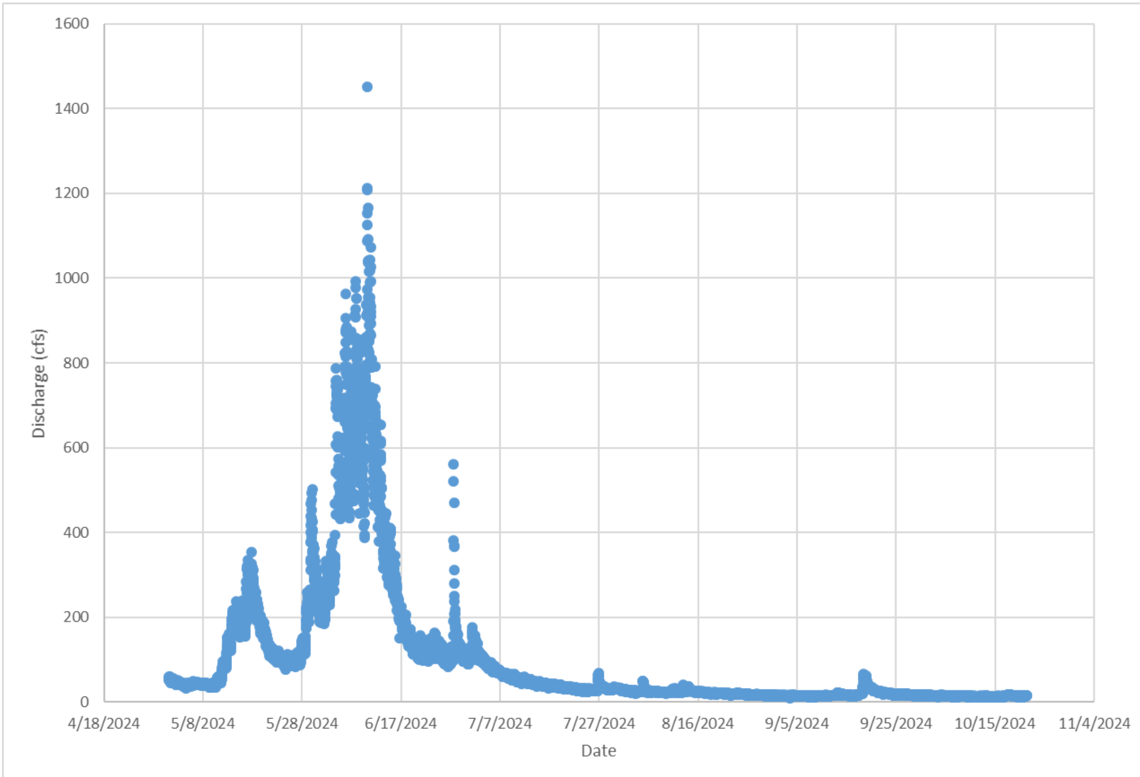

Figure 31: Extrapolated discharge at the South Fork gauge from May 1st - October 15th, 2024

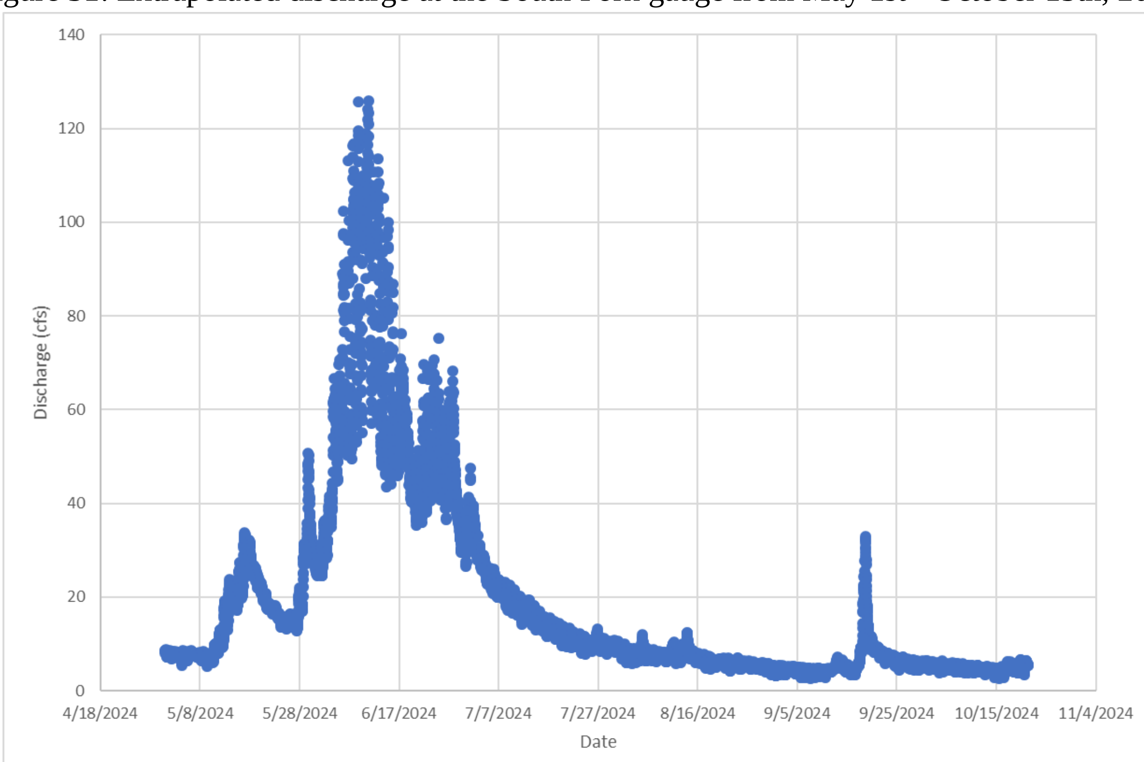

Figure 32: Discharge at North Fork gauge from May 1st - October 15th, 2024

Gallatin Lake Monitoring:

Water chemistry samples were collected at Gallatin Lake on September 24th (Table 2). Total nitrogen concentration was 0.17 mg/L. Nitrate+nitrite was undetectable. Total phosphorus concentration was 0.015 mg/L. Orthophosphate was undetectable. Total suspended solids levels were 7 mg/L. Calcium and magnesium levels were 21 mg/L and 7 mg/L, respectively. Water hardness was 82 mg/L.

	Total Suspended Solids (mg/L)	TN (mg/L)	N+N (mg/L)	TP (mg/L)	Orthophosphate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Hardness (mg/L)
Gallatin Lake	7	0.17	ND	0.015	ND	21	7	82

Table 2: Gallatin Lake sampling results

Nutrient Reduction Strategies
To mitigate future algae blooms in the Upper Gallatin River, the Task Force and community partners have undertaken several projects aimed at reducing nutrient loading into the Upper Gallatin and its tributaries, and at building a resilient water supply. Strategies to reduce nutrients are outlined in the Upper Gallatin Nutrient Assessment and Reduction Plan (Allen and Howell, 2020) and the West Fork Nitrogen Reduction Plan (Blue Water Task Force, 2014).

Projects completed include:

1. A restoration project on the upper West Fork and two on the mainstem Gallatin to reduce nutrient loading and sediment pollution
2. Big Sky Water and Sewer District wastewater treatment plant upgrade
3. Annual Runoff Clean-off event: a community wide annual dog waste pick up
4. Septic system and well outreach and education events during Fix-a-Leak Week
5. Installation of dog waste station and signage across Big Sky community
6. Educational workshops for golf course managers, realtors, and builders
7. Creation of a new water and sewer district in Gallatin Canyon to provide centralized wastewater treatment
8. Listing of the Upper Gallatin on the 303(d) impaired waterways list for nuisance algae

Projects in progress:

1. Artificial wetlands to treat nitrogen high groundwater contributing to the West Fork
2. Restoration projects on the Middle Fork and West Fork to decrease sediment and nutrient loading and increase groundwater infiltration
3. Restoration projects at over thirty five river access sites on the Gallatin River to create sustainable access and repair damage to the native ecosystem
4. Rebates for installation of water fixtures and removal of lawns to conserve water
5. Expansion of the Gallatin Canyon Water and Sewer District
6. Advocate for new development to be hooked installation of septic systems in areas of
7. Advocating for a Wild and Scenic designation for the Upper Gallatin and Taylor Fork through the Montana Headwaters Legacy Act

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