Water Year 2025 Technical Report

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April 1, 2026

Summary

1. **Climate.** Mean temperature was 3rd warmest in the 37-year record both for the water year as a whole and for the April–September period. Precipitation ended up at 84% of average for the water year and 66% for April–September, the latter being the lowest in the record. Peak snow water equivalent in 2025 was 92% of average and occurred on April 5, 7 days earlier than average. Drought conditions worsened over the year from “abnormally dry” to moderate/severe drought.
2. **Water Supply.** Natural flow for water year 2025 was 79% of average, ranking 41st out of the last 48 water years. In the 96-year record for natural flow between Henry’s Lake and Ashton, water year 2025 came in at 80% of average, ranking 87th. Natural flow peaked earlier than average in 2025 and rapidly receded from its springtime peak to around 75% of average for most of the summer. Long-term downward trends continued: the 2001–2025 average is 16% lower than the 1978–2000 average.
3. **Irrigation Management**. Henry’s Fork watershed diversion was 7th lowest since 1978 and 97% of the modern (2001-2024) average. Diversion was above average from April through June but below average after that due to poor water-rights priorities. Delivery to the Teton River through the Crosscut Canal was 70% of the modern average, compensated in part by exchange-well pumping that was 150% of average. Over the period of Island Park Reservoir draft, streamflow downstream of all diversions was 419 cfs on the Henry’s Fork and 45 cfs on the South Fork Teton. Variability in streamflow at these lower-watershed outflow points was among the lowest on record. Low but consistent lower-watershed streamflow contributed to carryover in Island Park Reservoir that exceeded expectations by 21,353 ac-ft, despite delivery of 10,610 ac-ft of water to American Falls Reservoir in late summer.
4. **Island Park Reservoir Management**. Winter outflow from Island Park Reservoir in water year 2025 was 288 cfs, below the 1978–2024 average of 354 cfs but higher than expected based on water supply. Reservoir draft began on June 13, 19 days earlier than average, and ended on August 27, 15 days earlier than average. Minimum reservoir volume was 43,948 ac-ft (32.5% full), compared with the 1978–2025 average of 60,697 ac-ft (44.9% full). Since precision water management infrastructure and operations were first implemented in 2018 by Fremont-Madison Irrigation District, HFF, U.S. Bureau of Reclamation, and water users, minimum reservoir volume has exceeded expectations based on water supply by an average of 23,530 ac-ft, a 78% improvement. Since precision management was first implemented, winter outflow from Island Park Dam has exceeded expectations based on water supply by 100 cfs, a 36% improvement.
5. **Streamflow Gaging**. Mean relative error of the six streamflow measurements HFF made at Island Park compared to USGS adjusted flow was 9.9%, with HFF measurements biased low by 4.5%. HFF made six measurements at Ashton, with a mean error of 2.9% relative to USGS data and a bias of 0.50%.

6. **Performance of Predictive Models**. Our April-1 predictions overestimated natural flow by 13% at the watershed scale, a little higher than the average absolute error of 10.2% over the past nine years. The April-1 predictions also estimated that runoff timing, as measured by center of mass, would be two days later than actually occurred. The primary reason for overestimation of water supply and runoff timing was spring and summer weather that was among the warmest and driest on record. Even at that, all relevant hydrologic parameters fell within the range of statistical uncertainty for the majority of the summer. Most importantly, the April-1 model predicted that Island Park Reservoir would end the water year at 48,106 ac-ft, and the observed value was 45,569 ac-ft.
7. **Water Quality**. Higher water temperatures, lower dissolved oxygen, and higher occurrence of harmful algal blooms have degraded water quality in Island Park Reservoir, producing high turbidity and water temperatures downstream. With another year of data in hand, watershed-wide natural streamflow is the single best predictor of turbidity at Island Park Dam, which was highest in our 12-year record in 2025. Summer water temperature is best predicted by reservoir drawdown and air temperature. At the watershed scale, turbidity is increasing at around 4% per year, and summer water temperature is increasing at 1.6°F per decade, but dissolved oxygen concentrations are high and showing no change.
8. **Aquatic Invertebrates**. Based on 11 years of sampling at six different locations, invertebrate communities in the Henry's Fork are abundant, diverse, and dominated by mayflies, stoneflies and caddisflies (EPT taxa); are as good or better than on other western trout streams; and are as good or better than they were on the Henry's Fork decades ago. The Hilsenhoff Biotic Index (HBI) indicates good to excellent water quality from headwaters to St. Anthony, with little evidence of pollutants. Most of the invertebrate community metrics we assessed were best explained by location on the river, with little to no dependence on streamflow or water quality. Total invertebrate abundance and Pale Morning Dun abundance have decreased significantly since 2015, but HBI, %EPT, and EPT taxa richness have all improved significantly since 2015, indicating improvement in water quality and aquatic habitat and replacement of non-insects with more desirable EPT species. Decreased dry-fly fishing quality at Last Chance/upper Ranch over the past decade is likely due to a combination of lower trout populations, increased turbidity, and altered mayfly emergence behavior due to warmer temperatures, not to decreased insect numbers. There is no evidence that trout populations are limited by invertebrate numbers. In addition to our annual sampling in 2025, we conducted an online survey for anglers. We received 104 hatch observations from 47 individuals between March 20 and October 9. Of these, 72% occurred in May and June, with over half of the observations coming from Ashton Dam to Chester Dam and from the north boundary of Harriman State Park to Riverside. Across the 104 river visits, there were 288 total observations submitted, including observations of no hatch. Blue Winged Olive and Pale Morning Dun mayflies and Mother's Day and Spotted Sedge caddisflies were the most frequently observed species, and diversity of observed species increased with distance downstream, as predicted by the River Continuum Concept and observed in our benthic samples.
9. **Buffalo River Fish Ladder**. In 2025, HFF conducted the 20th year of monitoring fish passage through the reconstructed Buffalo River fish ladder. Annual March 1–June 15 passage of spawning-sized (11.8 inches or greater) Rainbow Trout ranged from 88 to 748 fish, with an average of 247. Median migration date ranged from April 13 to May 20, but most years clustered between mid-April and early May. Rainbow Trout dominated captures throughout the record, although Brook Trout and several other species were also recorded. The number of spawning-sized Rainbow Trout depended strongly on a Box Canyon winter flow index that integrates the effect of winter flow on trout recruitment over all preceding years that contributed cohorts of spawners. The fitted regression model explained 59.7% of the interannual variation in annual spawner abundance. The monitoring record indicates that the Buffalo River fishway provides functional upstream passage but that annual variation in spring spawners is consistent with a population that is limited by winter flow in Box Canyon.

Document Guide

Statistical summaries of water year 2025 (October 1, 2024 – September 30, 2025) and irrigation year 2025 (November 1, 2024 – October 31, 2025), as well as 11-year trends from our water-quality and invertebrate monitoring are presented and interpreted in nine thematic sections:

1. Climate
2. Natural Flow
3. Irrigation Management
4. Island Park Reservoir Management
5. Streamflow Gaging
6. Performance of Predictive Models
7. Water Quality
8. Aquatic Invertebrates
9. Buffalo River Fish Ladder: 20-year Review

Data are subject to change upon review and final approval by government agencies and Henry's Fork Foundation (HFF). All primary and calculated statistics in this document are based on data available on and current through March 24, 2026. Details on data sources, periods of record, and terminology are given in the daily water report glossary and station guide.

Periods of record for hydrologic comparisons are:

- Climate: water years 1989–2025
- Streamflow and reservoir volume: water years 1978–2025 (lower Teton River forks 2004–2025)
- Irrigation diversion and related: irrigation years 2001–2025 for averages; 1978–2025 for ranks
- Water quality: irrigation years 2014–2025 at Flatrock, Island Park Dam, Pinehaven, and Marysville; irrigation years 2015–2025 at Ashton Dam and St. Anthony, 2016–2025 at other locations.

Statistics are compared with the period-of-record averages through 2024, so that the average is not influenced by the current year. Rank statistics include the current year in the record and are ordered from highest to lowest. For example, natural flow for water year 2025 is compared with the 1978–2024 average, and the rank is reported out of the full 1978–2025 record. Also note that, 75% *of* average is equivalent to 25% *below* average, and a rank of 41/47 indicates the 6th *lowest* value in the 47-year record.

1. Climate

Temperature

On the whole, water year 2025 was warm and dry. Mean temperature for the water year was 1.8 degrees F above average, ranking 3rd warmest in the 37-year record (Table 1), behind 2015 at 2.4 degrees above average and 2007 at 1.9 degrees above average. Water year 2000 came in at 4th place, just 0.02 degree cooler than 2025. While among the warmest water years for most of the spring and summer, 2016 dropped to 5th place, at 1.5 degrees above average. For the April–September period, water year 2025 also came in at 3rd warmest, a full 2 degrees warmer than average. The warmest spring/summer period on record belongs to 2007, at 3.3 degrees above average, while 2012 came in second, at 2.3 degrees above average. Fourth and fifth places belong to 2021 and 2016, at 1.9 and 1.6 degrees above average, respectively.

Table 1*. Climate statistics. Ranks for SWE, precipitation and temperature are ordered from highest to lowest (1 = highest on record). Temperature statistics are the mean of the 12 stations in the watershed. Ranks for date of peak SWE are ordered chronologically (1 = earliest).*

	Water year 2025		Water year 2024		1989-2024
	Value	1989-2025 rank	Value	1989-2025 rank	Average
Peak SWE (inches)	26.0	19/37	25.5	21/37	28.3
Date of peak SWE	April 5	12/37	March 31	8 (tie)/37	April 12
Total precipitation (inches)	30.3	29/37	34.8	18/37	36.0
Mean temperature (°F)	39.4	3/37	39.2	6/37	37.6
April-Sep. temperature (°F)	52.8	3/37	51.8	13/37	50.7

We experienced only two periods of very cold weather, one in mid-January and the other in early February (Figure 1). The only other period with temperatures well below average occurred in late June. Otherwise, temperatures were consistently above average, with the greatest departures on the warm side occurring in October, December, late May/early June, and all of August and September.

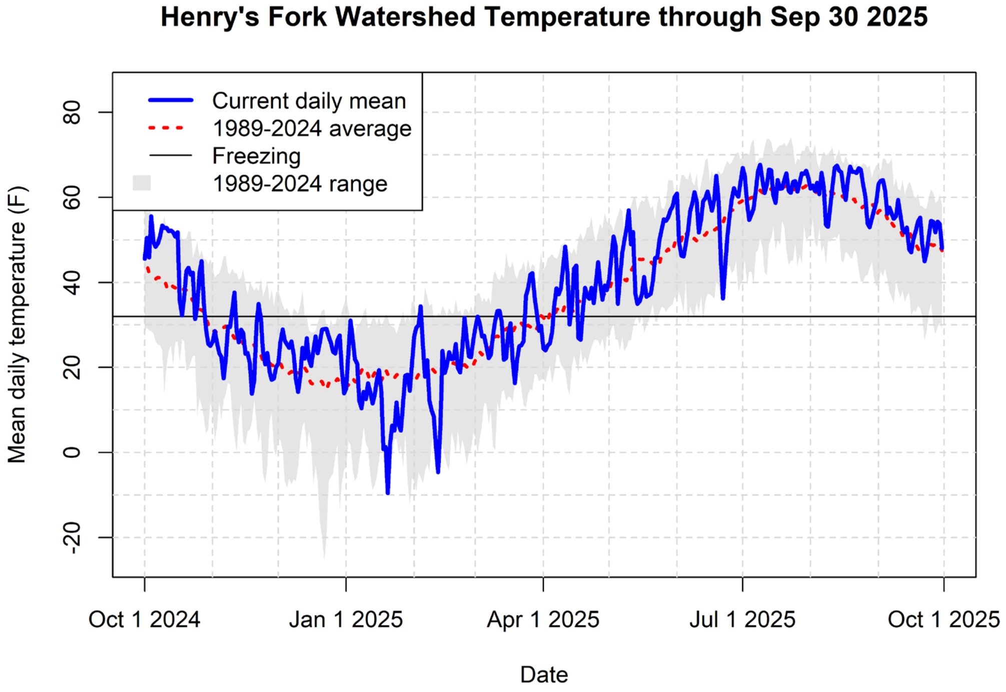


Figure 1*. Water year 2025 mean temperature, compared with 1989–2024 average and range.*

Fortunately for water temperatures, air temperatures in late June and July were much closer to average than they were earlier in the spring and later in the summer. Even with that, the strong increasing trend in June–August air temperatures we have observed over the past four decades continued this year, with the 2025 data point falling right on the trend line (Figure 2). June–August temperatures are increasing at

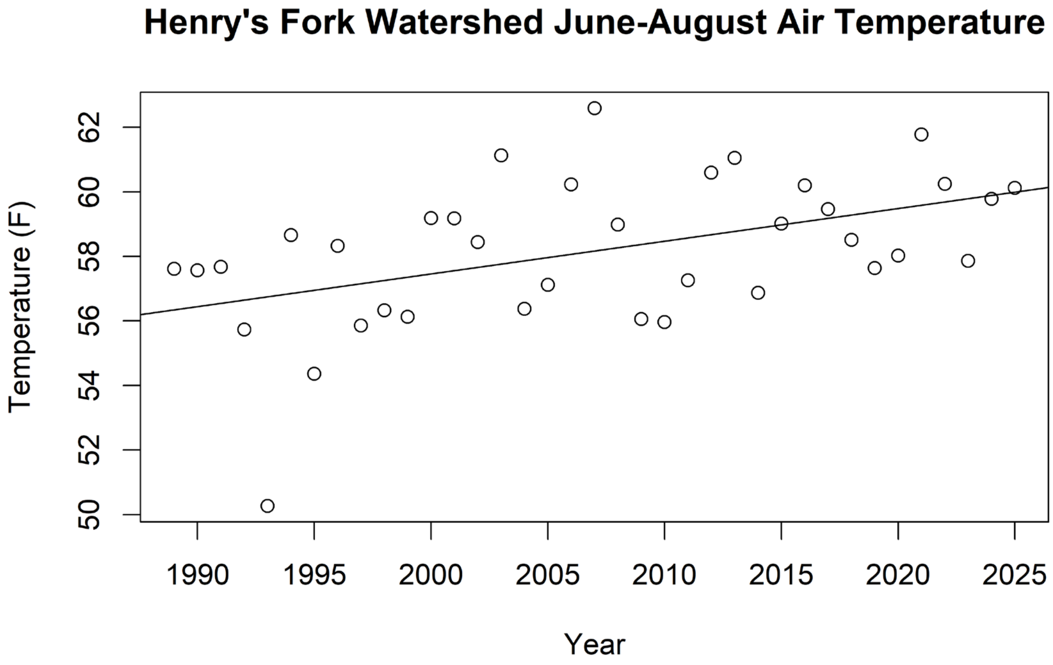


***Figure 2**. Long-term trend in mean June-August air temperature in the Henry's Fork watershed.*

1 degree F per decade, and that trend is statistically significant. However, temperatures at other times of the year are not showing a systematic increase, so annual temperature is not showing any significant trend one way or the other.

Precipitation

Because of a dry September, water-year precipitation dropped from 86% of average at the end of August—when we had our only appreciable summer rain—to 84% of average by the end of the water year (Figure 3): 89% in Teton headwaters, 87% in Fall River, 82% in upper Henry's Fork, and 75% in the valleys. The watershed-wide value ranked 29th in the 37-year record (Table 1). For the April–September period, precipitation was 66% of average and lowest in the record by 0.35 inch behind 2007. The spring/summer periods of 2003, 2016, and 1989 rounded out the bottom five. By far, the three years in the record that were both warm and dry over the whole year and the spring/summer period were 2007, 2025, and 2016.

Snow

The wettest months of water year 2025 relative to average turned out to be December, February and March, producing a snowpack that was not nearly as far below average as total precipitation was. Peak snow water equivalent (SWE) was 92% of average and occurred on April 5, one week earlier than average (Table 1, Figure 4). By subwatershed, peak SWE was 96% of average in the Fall River subwatershed, 94% of average in the Teton subwatershed, and 87% of average in the upper Henry's Fork. As a result of near-average snowpack but very low precipitation both last fall and this summer, 86% of the precipitation we received in 2025 was accumulated in the peak snowpack, compared with an average of 78%. This year's

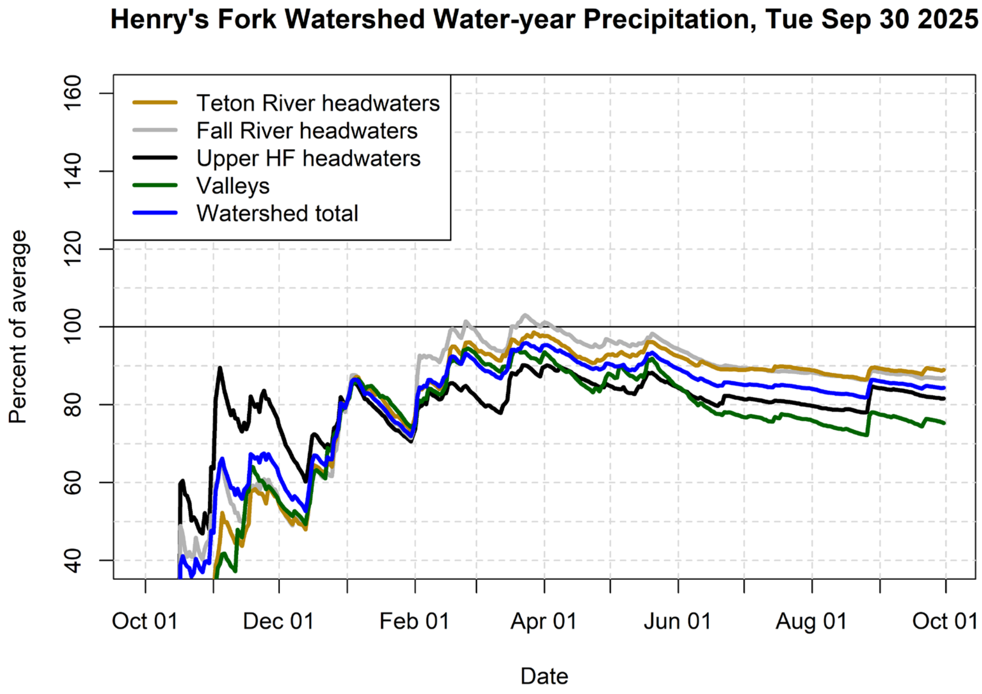


Figure 3. *Water year 2024 precipitation as a percent of the 1989–2023 average.*

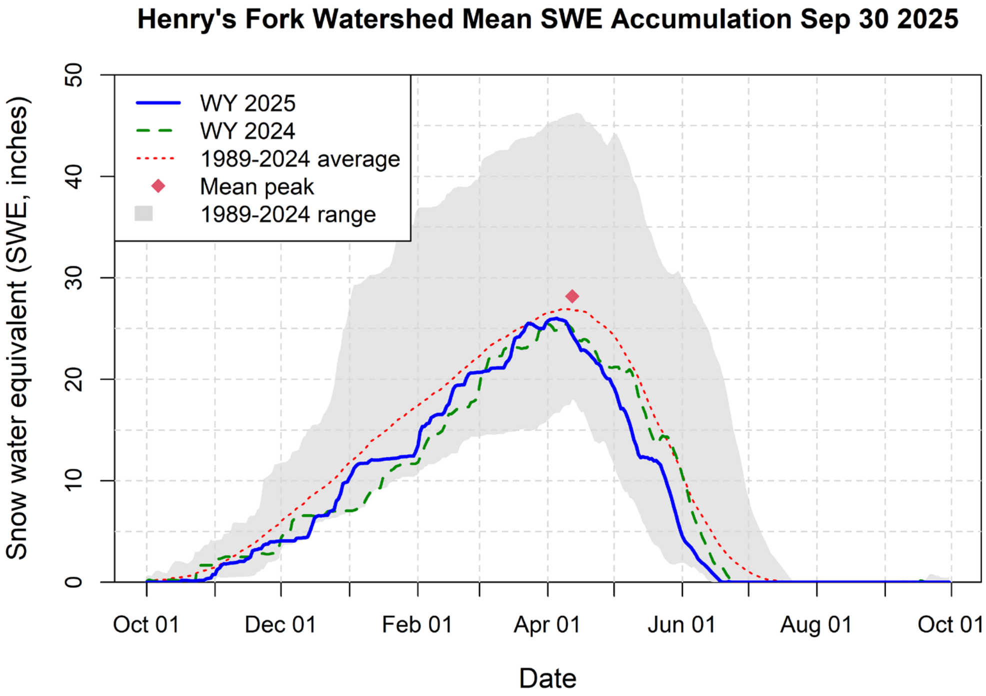


Figure 4. *Mean snow water equivalent (SWE) over the nine SnoTel stations in the watershed, compared with 2024, the 1989–2024 average, and the 1989–2024 range.*

snow fraction was the highest since 2018, reversing a recent trend toward lower snow fractions. Like annual temperature, no statistically significant trend one way or the other is apparent in either annual precipitation or in the fraction of annual precipitation occurring as snow.

Drought trends

Hydrologic conditions deteriorated over water year 2025. My short-term drought indicator—the cumulative one-year difference between precipitation and evapotranspiration—decreased from 1.5 inches below average to 8 inches below average over the course of the year (Figure 5). My medium-term indicator—three-year average precipitation—dropped from average to 1.8 inches below average over the year (Figure 6). Similarly, drought designation from the U.S. Drought Monitor went from abnormally dry over most of the Henry's Fork watershed in October of 2024 to moderate drought in the upper Henry's Fork subwatershed and severe drought in the Teton River and Fall River subwatersheds at the end of September 2025.

2. Natural Flow (Water Supply)

Natural flow is defined as the amount of water that would flow down the Henry's Fork and its tributaries in absence of reservoir storage and delivery, irrigation diversion, and return flows. In other words, natural flow is the supply of water provided by the watershed that is available for all uses, including agriculture, fisheries, aquatic ecosystem function, and hydroelectric power generation.

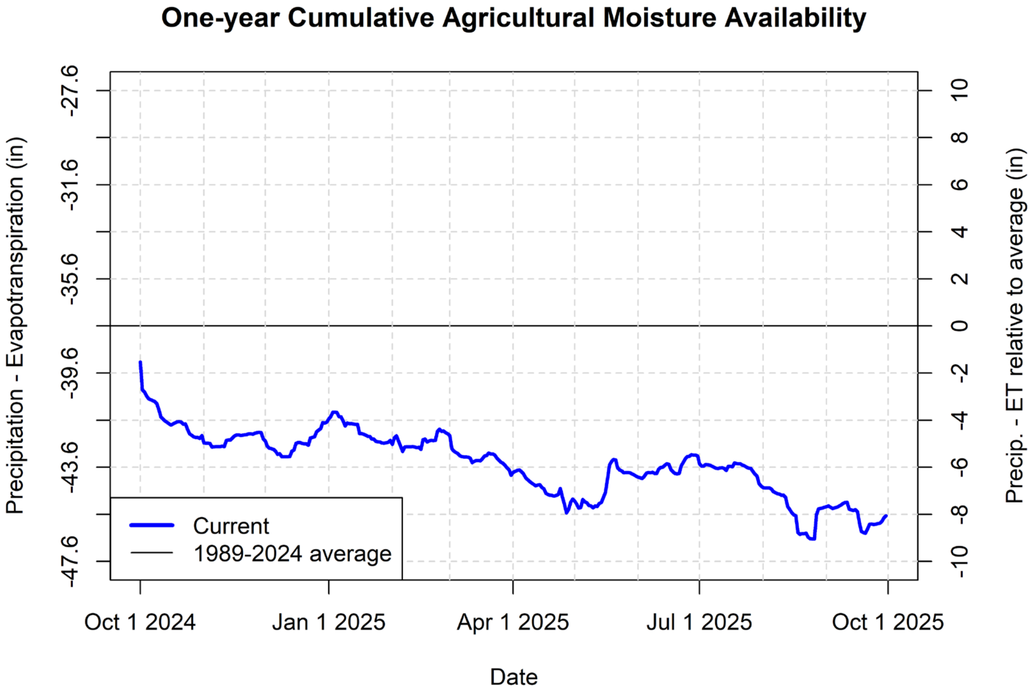


***Figure 5**. One-year average difference between precipitation and evaporation.*

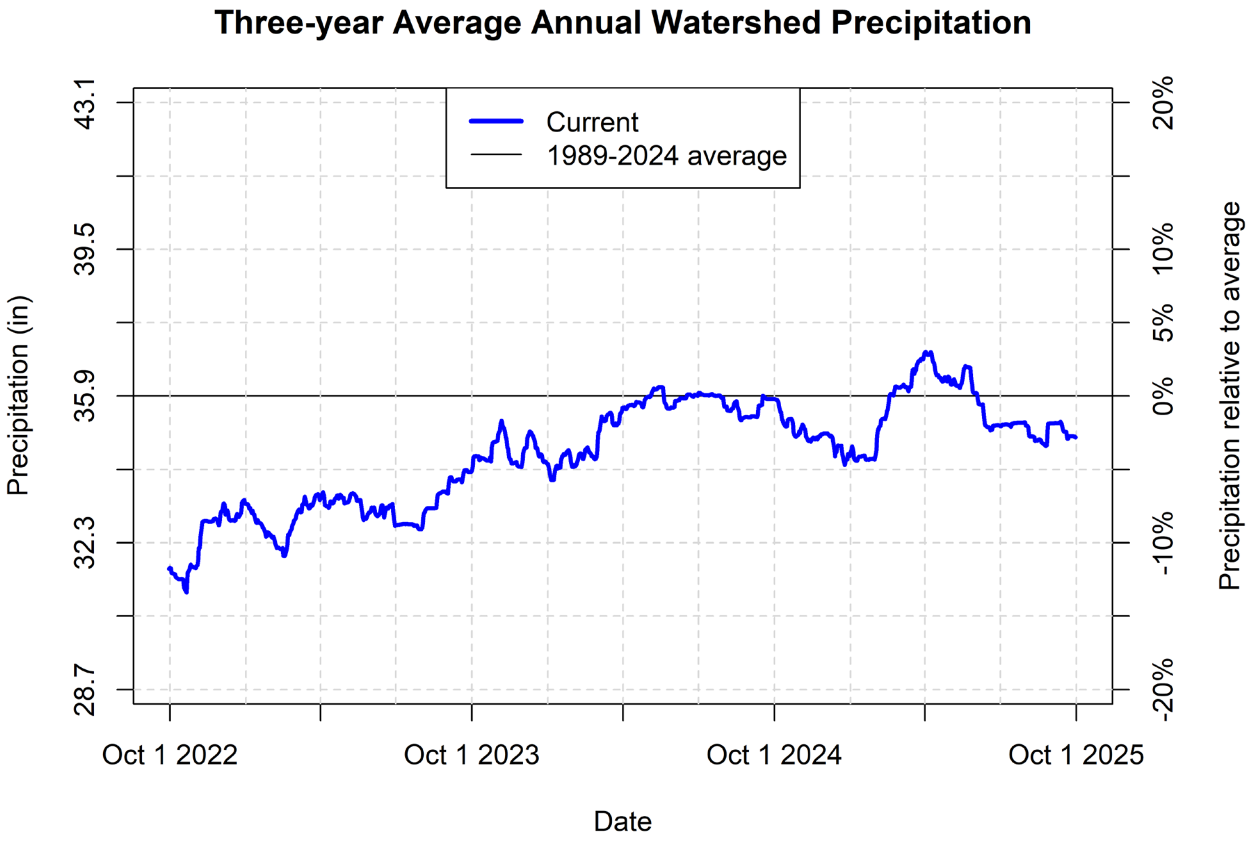


Figure 6. *Three-year average annual precipitation across the watershed, Oct. 2022 to Oct. 2025.*

Natural flow

Natural flow was very easy to describe for water year 2025: baseflow last winter was slightly below average, snowmelt runoff was low and early, and summer baseflow was well below average. We received only a few bumps in natural flow due to spring and summer rain, and those that we received were short in duration and low in magnitude, occurring in late June/early July, late August, and mid-September (Figure 7).

For the water year as a whole, natural flow was 79% of average: 76% in upper Henry's Fork, 82% in Fall River, and 82% in Teton River (Table 2). Out of the 48 water years in the record, these ranked 41st for the watershed, 45th for upper Henry's Fork, 36th for Fall River, and 34th for Teton River. Subwatershed natural flow was in proportion to total water-year precipitation—82% of average in upper Henry's Fork, 87% in Fall River, and 89% in Teton River, as reported above. In the longest period of reliable natural flow estimates we have—the Henry's Lake to Ashton record that dates back to 1930—natural flow in 2025 was 80% of average, ranking 87th in the 96-year record (Figure 8). Of the nine years with lower natural flow than we had in 2025, six occurred in the 1930s and 1940s, while the other three were 2015, 2016, and 2022.

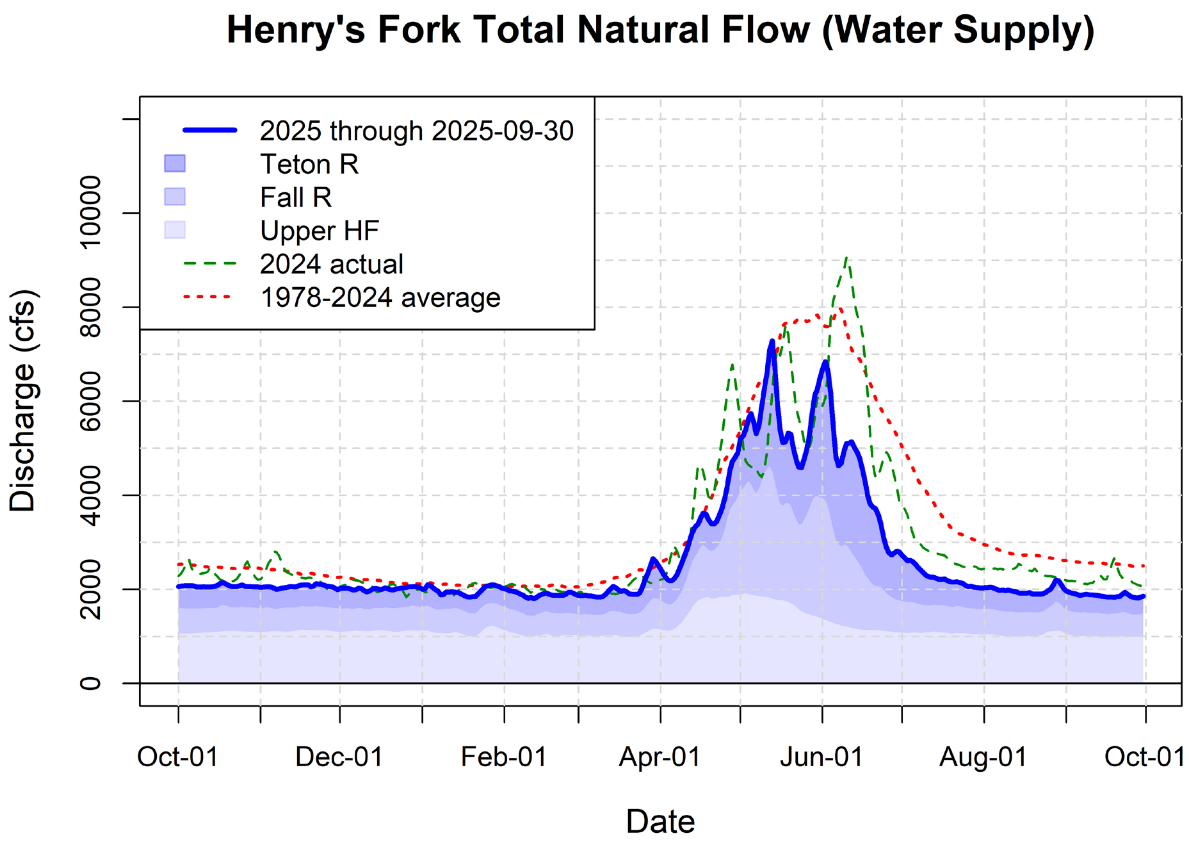


***Figure 7**. Natural flow hydrograph for water year 2025, compared with water year 2024 and the 1978–2024 average.*

***Table 2**. Water-year natural flow statistics. The ranks are from largest to smallest (1 = wettest on record; 48 = driest on record).*

	Water year 2025		Water year 2024		1978-2024
	Mean natural flow (cfs)	1978-2025 rank	Mean natural flow (cfs)	1978-2025 rank	Average annual natural flow (cfs)
Upper Henry's Fork	1,178	45/48	1,317	38/48	1,559
Fall River	786	36/48	852	29/48	958
Teton River	675	34/48	858	18/48	824
Watershed total	2,640	41/48	3,027	29/48	3,341

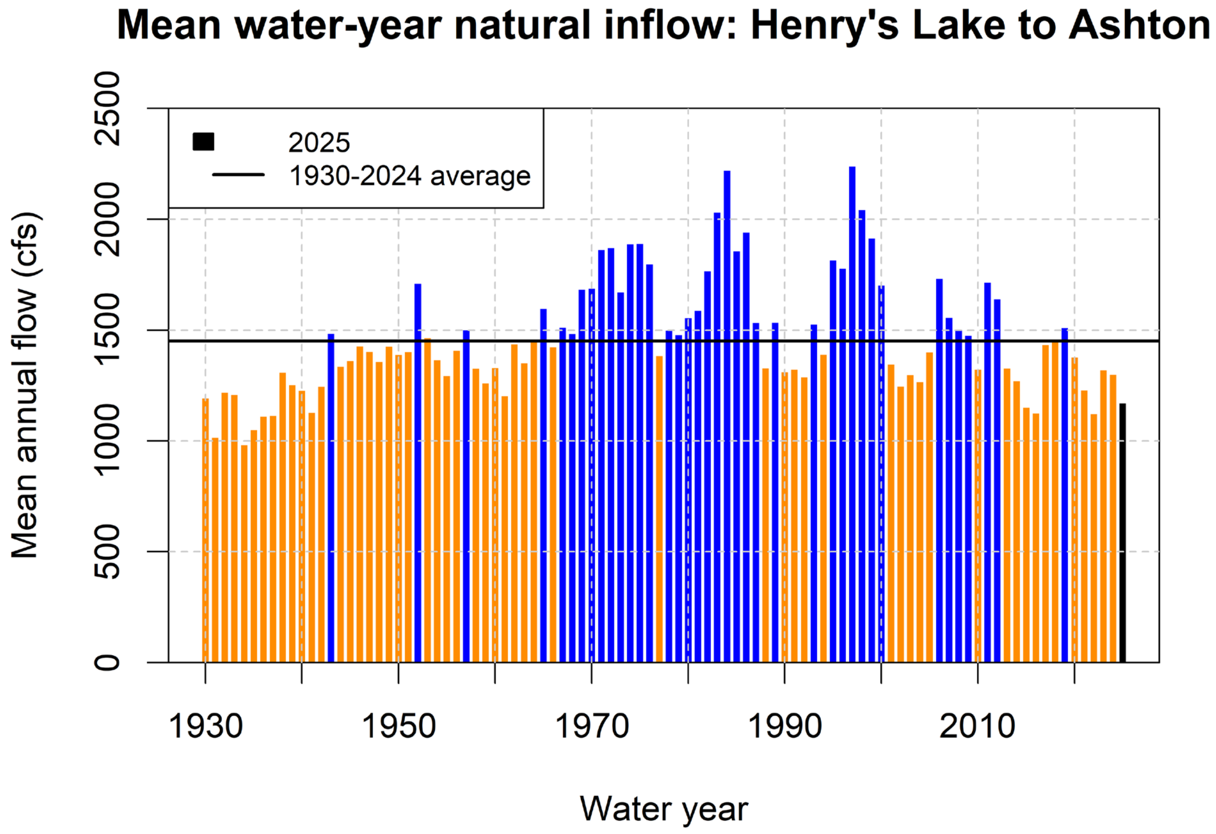


***Figure 8**. Mean annual natural streamflow between Henry's Lake and Ashton, 1930-2025.*

As is always the case, peaks in natural flow occurred during periods of warm weather in the spring, which happened at the watershed scale on May 5, May 13, June 2, and June 12. Watershed-total natural flow peaked at 6,849 cfs on June 2. On average, peak natural flow is 10,265 cfs and occurs in early June, when Fall River is dropping from its peak and Teton River is rising toward its peak. As mentioned yesterday, peak snow water equivalent occurred one week earlier than average, and this was reflected in the center of mass of the spring/summer hydrographs. The center of mass is the "balance point" of the streamflow graph and measures how late into the summer the effect of snowmelt lasts. For the watershed as a whole, the center of mass was June 15, 3 days earlier than average (Table 3). By subwatershed, the centers of mass were June 21 in upper Henry's Fork (1 day earlier than average), June 9 in Fall River (7 days earlier than average), and June 13 in Teton River (4 days earlier than average).

***Table 3**. Observed and predicted center-of-mass of April-September streamflow.*

Subwatershed	2025 prediction	2025 observed	2024 observed	1978–2024 average
Upper Henry's Fork	June 23	June 21	June 21	June 22
Fall River	June 13	June 9	June 14	June 16
Teton River	June 13	June 13	June 13	June 17
WATERSHED TOTAL	**June 17**	**June 15**	**June 16**	**June 18**

Once the last snowmelt-driven peak had passed in mid-June, natural flow dropped rapidly to summer baseflows that were generally in the range of 70–80% of average. Rain events in late June, early July, late August, and mid-September created very small increases in natural flow, but none of these were large enough or lasted long enough to make any appreciable difference in water supply. The only weather change that did make a difference was a transition from a period of well above average temperatures and evapotranspiration in May and early June to values much closer to average from late June through July. That transition, which occurred during a period of cold, wet weather around June 22, increased natural flow in the watershed upstream of Island Park Reservoir from 50% of average (second lowest in the long record) in mid-May through mid-June to around 75% of average, where it spent most of the rest of the summer.

Long-term trends in natural flow

As for long-term trends, water year 2025 certainly did not do anything to counter those; water supply has been consistently lower since 2000 than it was prior, and this continues to be driven primarily by low water supply in the upper Henry's Fork subwatershed. While recent precipitation patterns appear to be shorting the upper Henry's Fork relative to the other two subwatersheds, the upper Henry's Fork is more susceptible to the effects of increased temperatures and evapotranspiration because of its relatively low elevation, flat topography, and more extensive vegetative cover, regardless of precipitation. Thus, while natural flow has decreased by 16% relative to the 1978–2000 time period at the watershed scale (Figure 9), it has decreased by 23% in the subwatershed upstream of Island Park Dam (Figure 10).

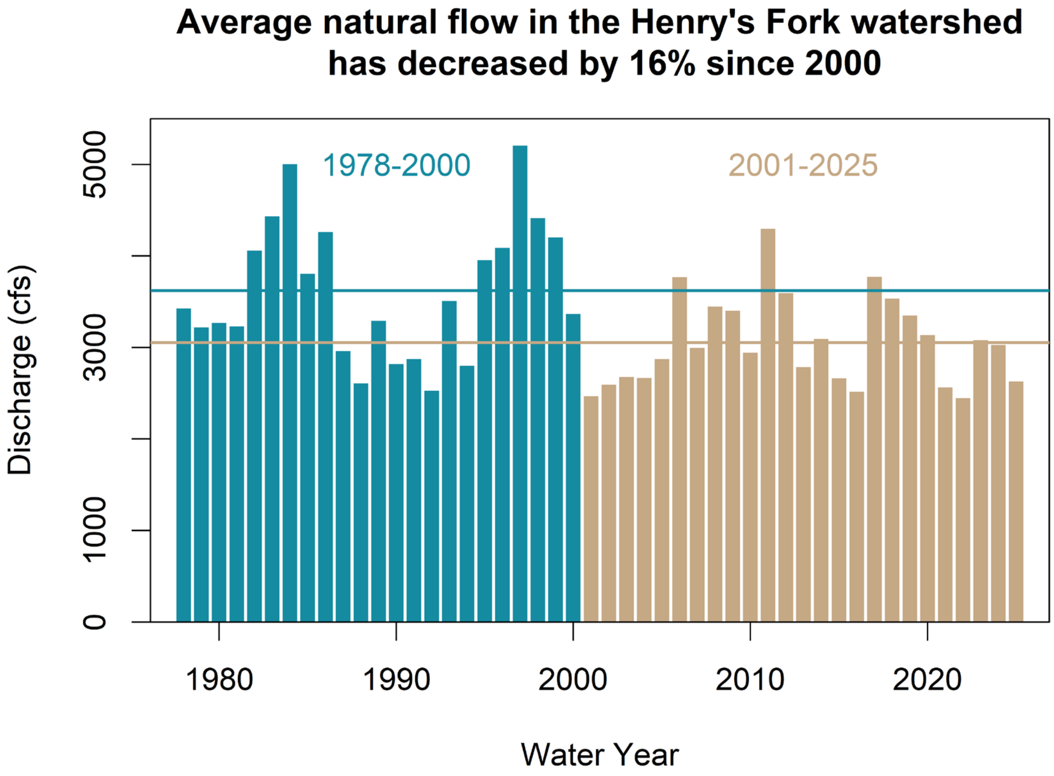


***Figure 9**. Annual natural flow (water supply) in the Henry's Fork watershed, 1978–2025. Blue line is the 1978–2000 period average, and the orange line is the 2001–2025 period average.*

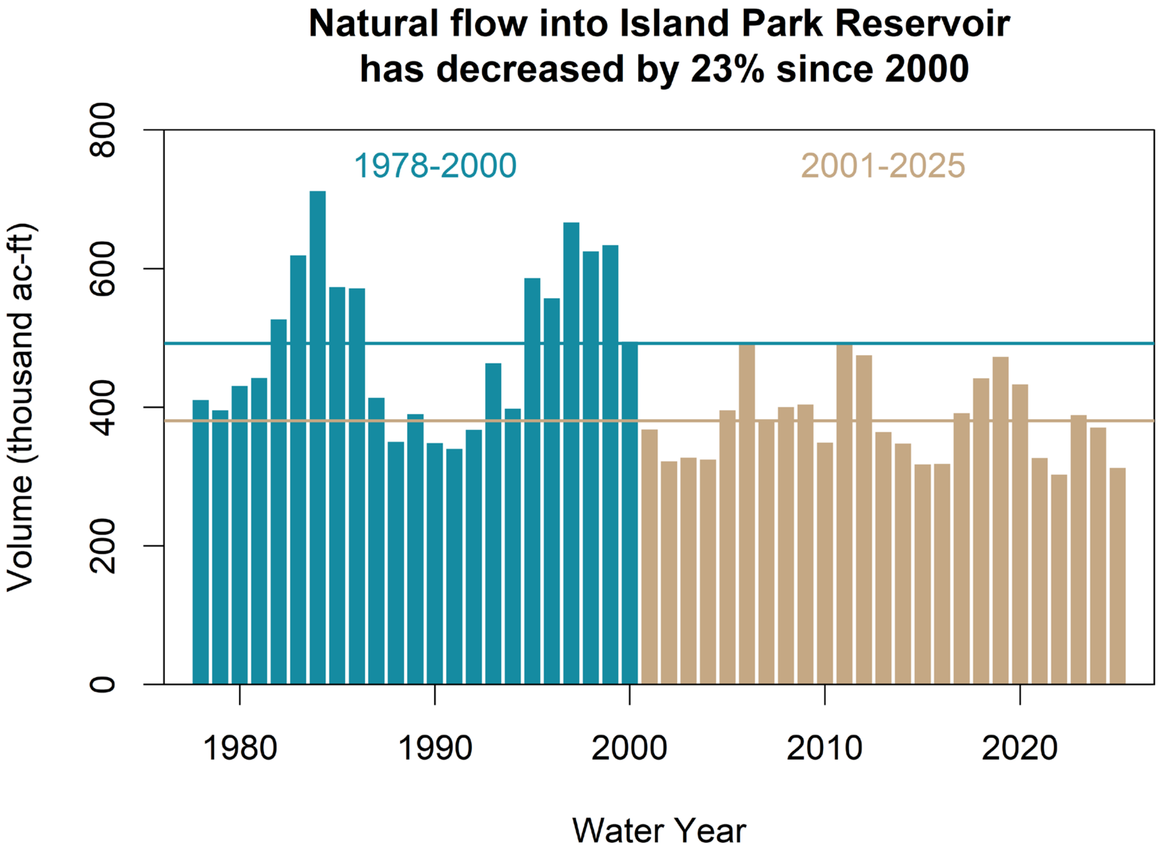


***Figure 10**. Annual natural flow (water supply) in the Henry's Fork at Island Park Dam, 1978–2025. Blue line is the 1978–2000 period average, and the orange line is the 2001–2025 period average.*

The 23% reduction in natural flow in the Henry's Fork at Island Park is equivalent to 80% of the capacity of Island Park Reservoir. In only four years between 1978 and 2000 was natural flow lower than the 2001–2025 *average*, and there have been *no years* since 2001 when natural flow at Island Park exceeded the 1978–2000 average. While irrigation demand at the watershed scale depends on water supply across the whole watershed, the effect of that demand on Island Park Reservoir draft is primarily determined by water supply at Island Park Dam. Further, that water supply has direct effect on nearly aspect of the fishery between Island Park Dam and Riverside campground, including the trout abundance and water quality.

3. Irrigation Management

Because of one of the hottest and driest summers on record throughout the upper Snake River basin and very low natural-flow availability, irrigation management on the Henry's Fork during irrigation year 2025 was driven by weather over the first half of the irrigation season and by water-rights limitations over the second half.

Administrative water availability

Despite above-average basin-wide reservoir carryover at the end of the 2024 irrigation season, high demand early in the 2025 irrigation season, coupled with natural flow that was well below what was expected based on snowpack, the reservoir system as a whole came up short on both physical and paper fill. The reservoir system peaked physically at 90% full in early June, and storage water rights allocations were only slightly better, at 91% of full allocation. Storage water allocations in Henry's Lake, Island Park Reservoir, and Grassy Lake were somewhat higher but still short of full. Had natural-flow availability been higher, the relatively small shortfall in storage would not have had much of an effect on irrigation management.

However, natural flow turned out to be far below what was predicted in April, due primarily to much lower streamflow yield per unit of snowpack than expected. As a reminder, HFF and its colleagues have been studying this decrease in what is called "runoff efficiency" and published a paper in early 2024 documenting a statistically significant decrease in this critical hydrologic measure in the Henry's Fork watershed over the past few decades. While not as apparent over the whole Snake River basin, low runoff efficiency caught everyone's attention in 2025. As a result of low natural flow, water-rights priorities dropped rapidly in June, falling below the relatively senior 1893 priority date by July 6, over two weeks earlier than average (Figure 11).

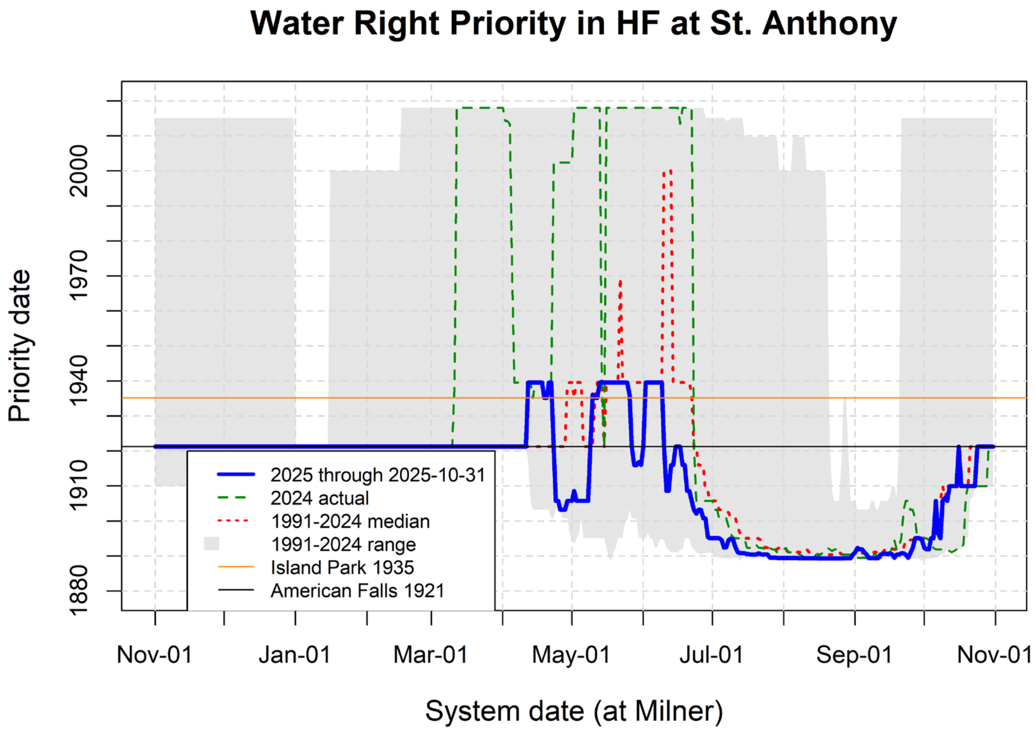


Figure 11. *Water right priority in the Henry's Fork at St. Anthony for irrigation year 2025.*

Irrigation diversion

Because of hot and dry weather in the spring, diversion was above average from April through June. Diversion peaked at 3,496 cfs on July 3—very close in magnitude to average but about one week earlier. Once water-rights priorities dropped below 1893 a few days later, diversion dropped substantially and was below average for the remainder of the irrigation season. Two other notable drops in diversion occurred later in the summer, one following the only significant rain event of the summer in late August and another following widespread precipitation at the beginning of October (Figure 12).

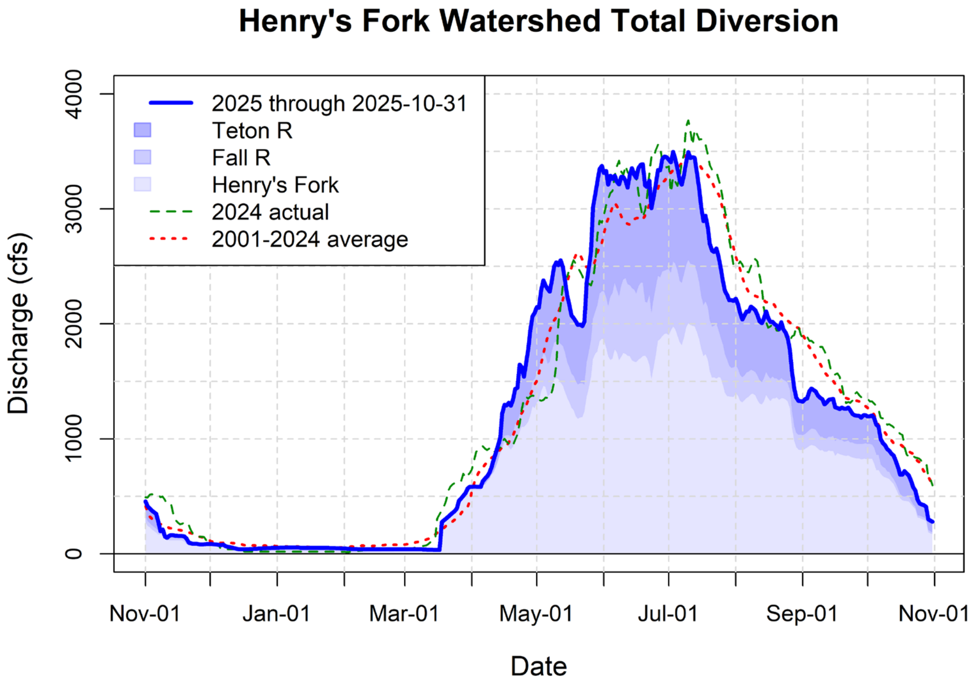


Figure 12*. Total diversion for irrigation year 2025, by subwatershed.*

Total diversion for the irrigation year was a little under 870,000 ac-ft, ranking 42nd out of the last 48 years and around 97% of the 2001–2024 average (Table 4). Return flow to the lower Henry's Fork and Teton River—what is termed *reach gain* by water managers—was negative for the water year as a whole. Seepage of water from the river to the aquifer outweighed gains from the aquifer back to the river by over 19,000 ac-ft. This was the 4th lowest reach gain on record and was well below even the 2001–2024 average gain of +16,967 ac-ft. Mean annual diversion since 2001 is 250,000 ac-ft (23%) lower than it was between 1978 and 2000 due to widespread conversion from flood to sprinkler irrigation throughout the 1980s and 1990s, and mean annual reach gain is lower by about that same amount.

Table 4*. Irrigation-year statistics. Coefficient of variation is defined as standard deviation divided by mean. With the exception of coefficient of variation, ranks are defined from highest to lowest (1 = highest).*

	Irrigation year 2024		Irrigation year 2023		2001–2023
	Value	Rank	Value	Rank	Average
Total diversion (ac-ft)	869,621	42/48	924,056	28/48	895,308
Crosscut Canal diversion to Teton (ac-ft)[1]	26,940	36/38	27,587	34/38	38,271
Teton exchange well injection (ac-ft)	20,554	12/48	277	41/48	13,705
Lower-watershed river reach gain (ac-ft)	-19,210	45/48	10,239	37/48	16,967
HF at Parker summer flow (cfs)[2]	419	38/48	429	36/48	681
HF at Parker coefficient of variation[2]	28%	37/48	21%	42/48	37%
SF Teton River summer flow (cfs)[3]	45	22/22	92	14/22	201
SF Teton coefficient of variation[3]	50%	20/22	44%	21/22	87%

1. Water-rights accounting data for Crosscut to Teton diversion has 1988–2024 period of record.
2. Calculated over period of Island Park Reservoir draft
3. South Fork Teton River gage has 2004–2024 period of record.

Since 2001, neither diversion nor reach gain have shown any trend one way or the other, and the typical situation over the water year is that the river loses water to the aquifer during the fall, winter and spring and gains water only during the middle of the summer. This year's reach gain hydrograph generally followed the modern average but showed greater losses last winter and a shorter period of gain over the summer (Figure 13). Interestingly, one measure that has not changed at all since at least the late 1970s is the net withdrawal of surface water from the watershed, which is defined as total diversion minus return flow. That figure has been constant at around 850,000 ac-ft/year as far back as we have reliable data (Figure 14). In the 1980s, that 850,000 ac-ft net withdrawal would have been attained by diversion of over 1,000,000 ac-ft and return of around 200,000 back to the river via shallow groundwater flow. In the modern period, diversion averages around 870,000 ac-ft, of which only 20,000 ac-ft or so returns to the river. Despite no long-term trends in net withdrawal, outflow from the watershed, as measured by streamflow in the Henry's Fork at Rexburg, has declined because inflow has declined (Figure 14).

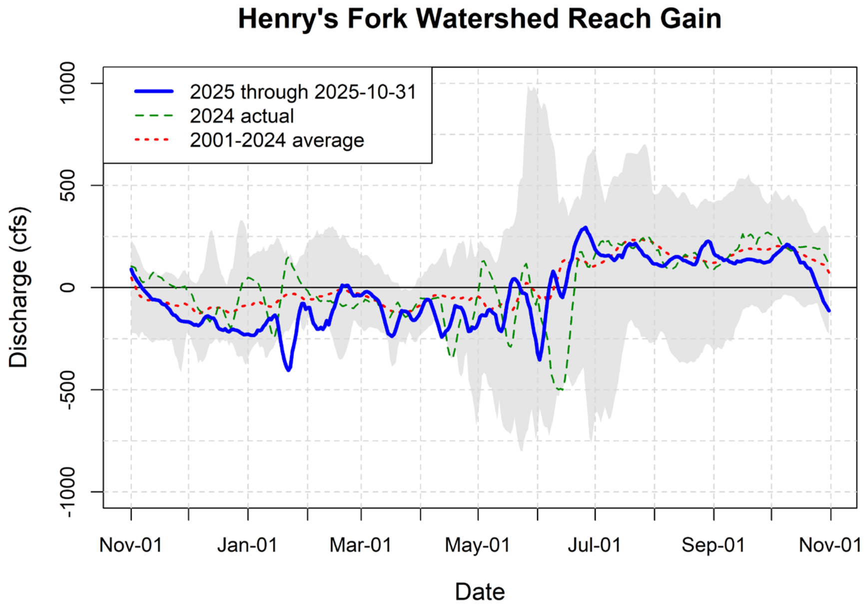


Figure 13. *River reach gains in the lower Henry's Fork and lower Teton River.*

Teton River administration

Streamflow shortage in the Henry's Fork watershed after natural flow drops from its snowmelt-fed peak is greatest in the Teton River, which necessitates greater need for supplementation of streamflow there to meet demand. This water is supplied by two sources: 1) delivery of water diverted from the Henry's Fork to the Teton River through the Crosscut Canal and 2) water injected into the Teton River from so-called "exchange wells." These wells pump groundwater into the river and were drilled following the Teton Dam failure as a mechanism by which to offset pumping from the river by irrigators along the rim of Teton Canyon. These irrigators held storage rights in Teton Reservoir and would have pumped this water directly from the reservoir. In most years, the administrative aspect of this diversion can be met with FMID storage and other sources such as Palisades storage and rental water. The physical water is provided by Crosscut Canal injection as needed, with pumping of exchange wells reserved only for the very driest years.

In 2025, the total amount of Teton River supplementation was 47,494 ac-ft, which is 91% of the modern-period average. Delivery through the Crosscut Canal was 26,940 ac-ft, about 70% of average, while exchange well injection into the Teton River totaled 20,554 ac-ft, about 150% of average (Table 4). While above average, this year's exchange pumping was similar to that in recent dry years such as 2015, 2021, and 2022 but well below that in 2016 and 2007, the two years most similar to 2025 in the combination of water supply, temperature, and spring/summer precipitation.

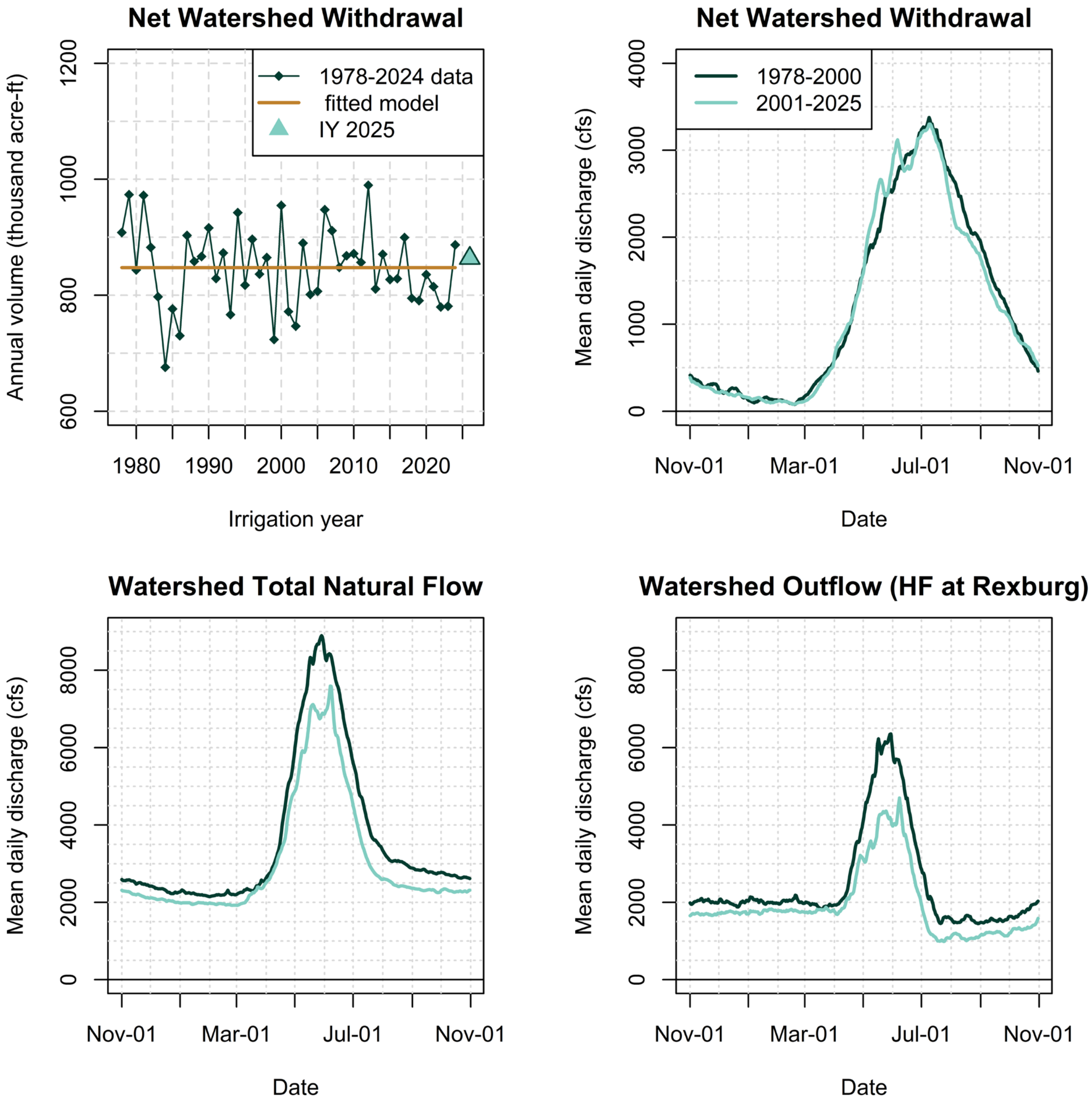


***Figure 14**. Net watershed withdrawal (diversion minus return flow; top two panels), watershed natural flow (lower left), and watershed outflow (lower right).*

Lower watershed streamflow

In most years the Henry’s Fork irrigation system can be managed to meet physical irrigation demand only within the watershed, subject of course to basin-wide water rights. In this case, the amount of water added to the lower-watershed irrigation system from the exchange wells and the watershed’s three storage reservoirs (Grassy Lake, Henry’s Lake, and Island Park Reservoir) must meet within-watershed diversion and leave enough in the river to provide adequate river stage (“depth”) at the downstream-most points of diversion and maintain basic aquatic ecosystem function in the lower Henry’s Fork.

My “600-cfs” rule of thumb serves as a reliable indicator of the need for Island Park Reservoir draft based on the balance of natural-flow supply and irrigation demand. That rule states than when natural-flow supply drops within 600 cfs of diversion, draft of Island Park Reservoir will be needed to meet irrigation demand and the lower-watershed streamflow targets. In 2025, reservoir draft started five days earlier than indicated by the 600-cfs rule because natural flow on the upper Henry’s Fork and Fall River dropped faster and earlier than that on the Teton River, so reservoir draft was needed to meet demand on the lower Henry’s Fork before it was needed on the Teton River, which usually triggers the need for storage draft. At the other end of the season, the difference between supply and demand climbed back up to 600 cfs on August 27, and reservoir draft ended that day (Figure 15).

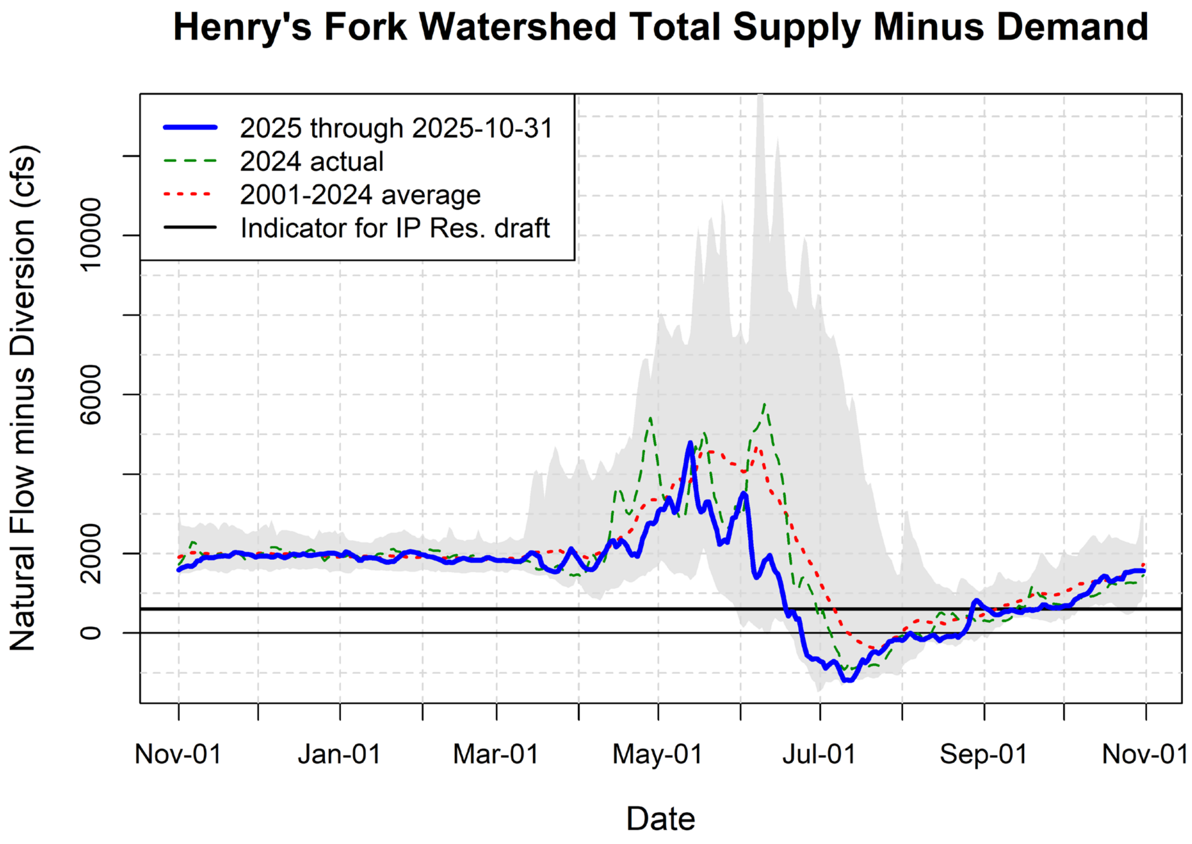


Figure 15. *Difference between supply (natural flow) and demand (irrigation diversion).*

Surface water can leave the Henry’s Fork irrigation system through three pathways: the South Fork Teton River, North Fork Teton River, and mainstem Henry’s Fork. Higher streamflow in any one of these stream channels increases the amount available locally for fish and aquatic ecosystems but comes at the costs of higher exchange well pumping and higher draft of the reservoir system. The latter, in turn, has negative consequences for fisheries and aquatic ecosystem function upstream of, in, and immediately downstream of Island Park Reservoir. On the other hand, too little streamflow at the bottom of the irrigation system can lead to lower fish habitat and a shortage of water available for the downstream-most diversions, which are Rexburg Irrigation Canal on the South Fork Teton, Teton Island Feeder Canal on the North Fork Teton, and Consolidated Farmers Canal on the Henry's Fork. The general management strategy to balance these factors within administrative constraints is to:

1. set flow in the North Fork Teton to 0 downstream of Teton Island Feeder when administrative storage is being used,
2. maintain flow in the South Fork Teton just high enough to absorb daily fluctuation in diversion at Rexburg Irrigation (~50–100 cfs),
3. fix an irrigation-season streamflow target flow in the lower Henry's Fork,
4. minimize flow variability in the South Fork Teton and lower Henry's Fork.

The first of these components ensures that only the amount of water needed by the Teton Island Feeder water users is delivered to the North Fork Teton during the period when storage is being used. Any water in excess of this amount is charged to storage users, even if they can't or don't divert it all. There are several small diversions on the lower North Fork Teton, but they are entitled to only natural flow that emerges as groundwater inputs and return flows to the river downstream of Teton Island Feeder. Once the North Fork Teton constraint applies, a set of headgates at the North Fork-South Fork split (called the "splitter") is operated to send the appropriate amount of water down the North Fork, with the remainder flowing down the South Fork. The total flow reaching the splitter is controlled by how much Henry's Fork water is diverted and delivered through the Crosscut Canal.

On the Henry's Fork, water is delivered from the reservoir system to meet the Crosscut Canal need and meet diversion on the Henry's Fork downstream of the Crosscut plus the lower-Henry's Fork streamflow target. In previous years, that target was set at the St. Anthony streamflow gage and was usually around 1,000 cfs. However, that target does not consider diversion downstream of St. Anthony and generally resulted in very low flows downstream of Consolidated Farmers Canal in July, higher releases than necessary from Island Park Reservoir later in the season and into the beginning of reservoir fill season in the fall, and generally higher variation in streamflow all summer. To remedy these shortcomings, the Henry's Fork Drought Management Planning Committee set the target at 350 cfs immediately downstream of the Consolidated Farmers diversion starting in 2020. This flow is calculated by subtracting diversion from the four canals downstream of St. Anthony from flow at the St. Anthony gage and nominally represents the flow in the river at the Parker-Salem Highway (aka Red Road) bridge.

Implementing this strategy is much easier said than done, given daily changes in diversion at over 100 pumps and canals in the watershed, stream and canal losses to and gains from groundwater, and streamflow travel times of around 20 hours from Island Park Reservoir to the Crosscut Canal diversion (Chester Dam), several more hours to reach the Teton River, and another hour or two to pass the splitter and reach the Rexburg Irrigation and Teton Island Feeder diversions. Fortunately, remote-controlled headgates at the Crosscut diversion and splitter installed in 2020 now allow FMID managers to make small adjustments at any time of day, saving water and reducing travel and time costs. New stream and canal gages and calculations provide real-time data to inform operation of the new remote-controlled headgates.

In 2025, streamflow at Parker during the period of Island Park Reservoir draft (June 13 to August 27) averaged 419 cfs, 11th lowest since 1978 and 62% of the modern average (Table 4; Figure 16). Streamflow in the South Fork Teton River downstream of all diversions averaged 45 cfs during the period of Island Park Reservoir draft, lowest in the 22 years over which that reach of river has been gaged. While these flow values were low, they were also very stable. The coefficient of variation (standard deviation divided by the mean) in streamflow during the period of reservoir draft was 28% in the Henry's Fork at Parker and 50% in the South Fork Teton River, both lower than the modern averages of 37% and 87%, respectively. The low average streamflow values contributed greatly to savings in Island Park Reservoir, while the low coefficients of variation minimized the negative effects of low flows on fish and other aquatic life in the lower watershed. As a result, minimum reservoir volume in 2025 was 21,353 ac-ft higher than expected based on water supply, contributing to an 8-year average end-of-season reservoir volume that is 23,530 ac-ft (78%) higher than expected based on water supply.

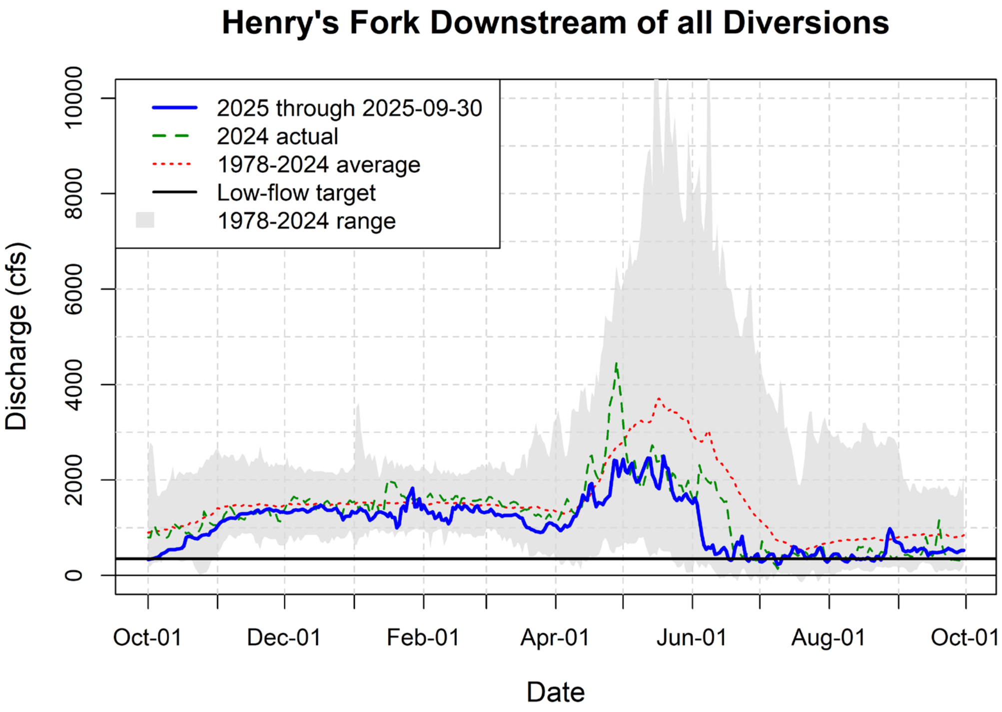


Figure 16. *Streamflow in Henry's Fork at Parker, downstream of all diversions.*

Irrigation year 2025 was one of the few years in which physical water from the Henry's Fork watershed was delivered to meet demand farther down on the Snake River. The last such year was 2022. In 2025, water above what was needed to meet within-watershed diversion and streamflow targets was delivered out of the watershed between August 28 and October 4 to help keep American Falls Reservoir from draining completely. As it was, American Falls Reservoir reached 3% full. Over that time period, streamflow at Parker averaged 560 cfs, compared with the 419 cfs average between June 13 and August 27. While Island Park Reservoir did not drop between August 28 and October 4, the difference between 560 and 419 cfs represented about 10,610 ac-ft of water sent out of the Henry's Fork watershed that could have been stored in Island Park over that period. Under normal circumstances, 10,610 ac-ft from the Henry's Fork would be nearly unnoticeable at American Falls, but in 2025 that represented 21% of the contents of American Falls when it reached its minimum on October 1. At Island Park, that 10,610 ac-ft is equivalent to about 55 cfs of mid-winter outflow but would have come at a cost of lower streamflow downstream of Island Park Dam between August 28 and October 4, when it was already lower than desirable for late-summer and early-fall fishing.

4. Island Park Reservoir Management

As with natural flow, management of Island Park Reservoir in 2025 was easily characterized and held few surprises. The reservoir was filled to the ice-off constraint by mid-April, topped off during the first two weeks of May, held constant until draft was needed in mid-June, drafted rapidly until late August, and then held roughly constant over the remainder of the water year and into the beginning of October.

Winter flow

Because of aggressive fill during the second half of September 2024—which came at the expense of good fishing conditions in late September and early October—the reservoir started water year 2025 at 50% full, quite a bit higher than the average of 44% full (Figure 17). Outflow was kept at an average of 168 cfs throughout October and November to maximize fill rate (Figure 18). Unfortunately, due to a very warm, dry fall and higher evaporation loss than normal over that time (Figure 19), reservoir fill came up several thousand ac-ft short of projections by the end of November, and the subsequent increase in outflow for the winter was around 75 cfs lower than initially expected (Figure 20). Including a two-week period of increased outflow during cold weather during late January, average December–February winter outflow ended up at 288 cfs, well below the 1978–2024 average of 354 cfs (Table 5) but not far from the average of 293 cfs observed over the entire 87-year history of the reservoir. Winter outflow exceeded statistical expectations based on water supply for the 7th consecutive year, since precision water management programs were first implemented in water year 2018 by Fremont-Madison Irrigation District, U.S. Bureau of Reclamation, and individual farmers and canal companies. The average increase in winter flow relative to water supply over that time is 100 cfs (Figure 21).

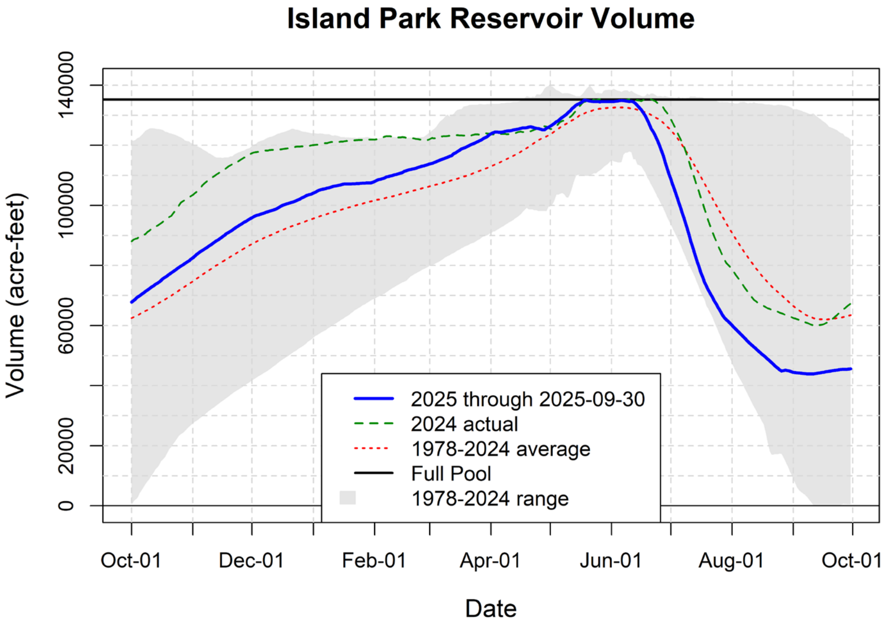


***Figure 17**. Island Park Reservoir volume for water year 2025.*

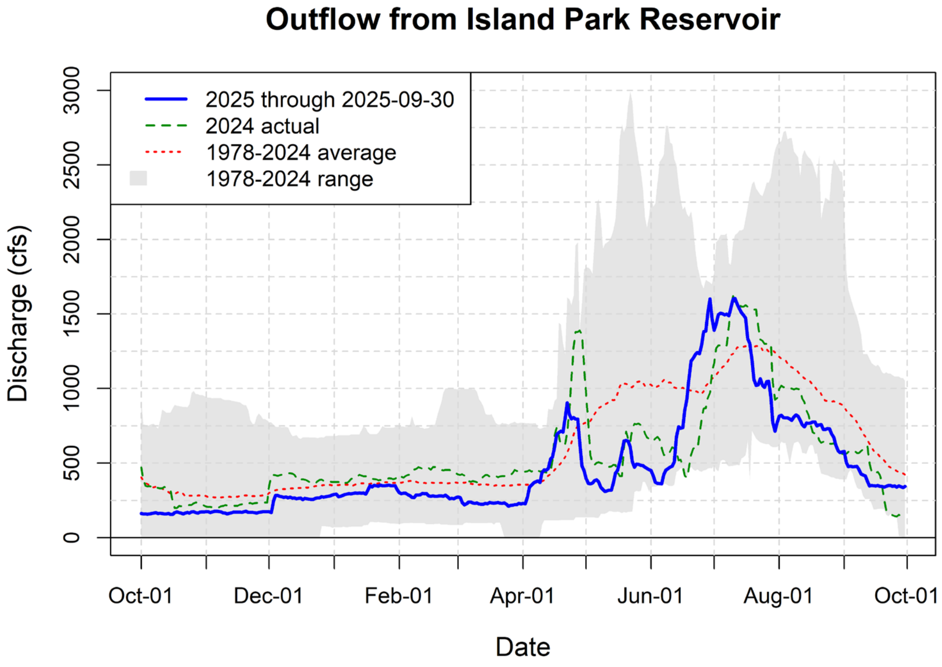


***Figure 18**. Island Park Reservoir outflow for water year 2025.*

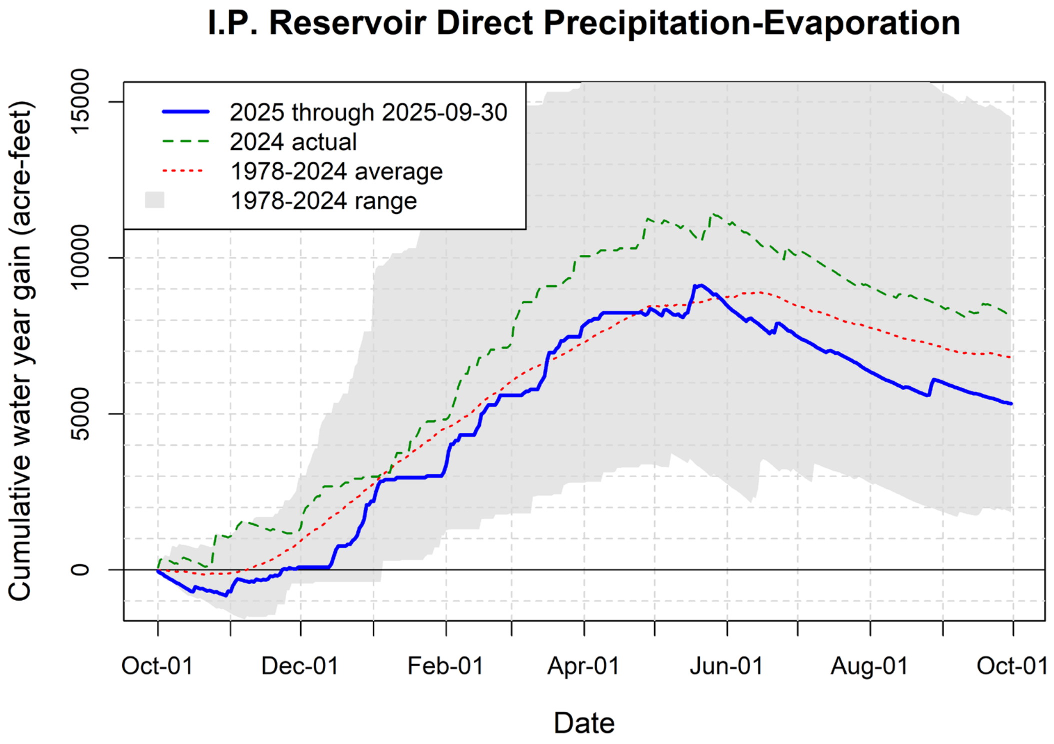


***Figure 19**. Net gain to/loss from Island Park Reservoir from precipitation/evaporation on the reservoir surface.*

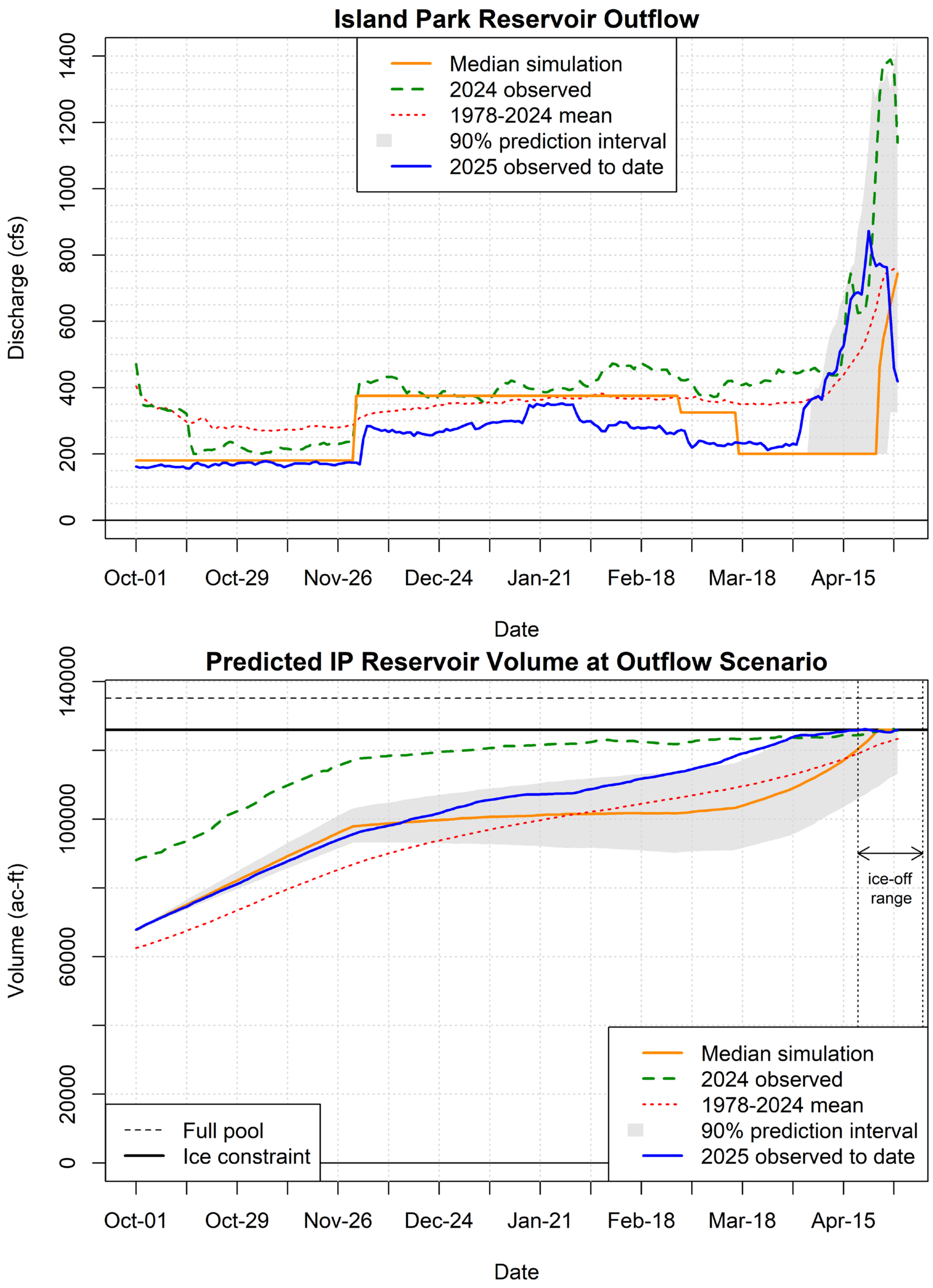


***Figure 20**. Predicted and observed outflow (top) and reservoir volume (bottom) during winter 2024/2025.*

***Table 5**. Island Park Reservoir statistics. Flow and volume statistics are ranked from highest to lowest (1 = highest flow or highest reservoir volume). Date statistics are ranked from earliest to latest. Volumes are reported in acre-feet, with percent of reservoir capacity in parentheses.*

	Water year 2025		Water year 2024		1978-2024
	Value	1978-2025 rank	Value	1978-2025 rank	Average
Dec-Feb. IP outflow (cfs)*	288	28/48	411	17/48	355
Start of reservoir draft	June 13	8 (tie)/48	June 22	23/48	July 2
End of reservoir draft	August 27	9/48	Sept. 12	21 (tie)/48	Sept. 11
Min. volume (ac-ft, % full)	43,958 (33%)	33/48	59,989 (44%)	24/48	60,697 (45%)
Sept. 30 vol. (ac-ft, % full)	45,569 (34%)	33/48	67,291 (50%)	23/48	63,515 (47%)

*This is "winter" flow out of Island Park Dam for months 3–5 of the water year and so primarily reflects conditions at the end of the previous irrigation season. For example, winter flow for water year 2025 is the mean for December 1, 2024 through February 28, 2025, reflecting summer 2024 conditions.

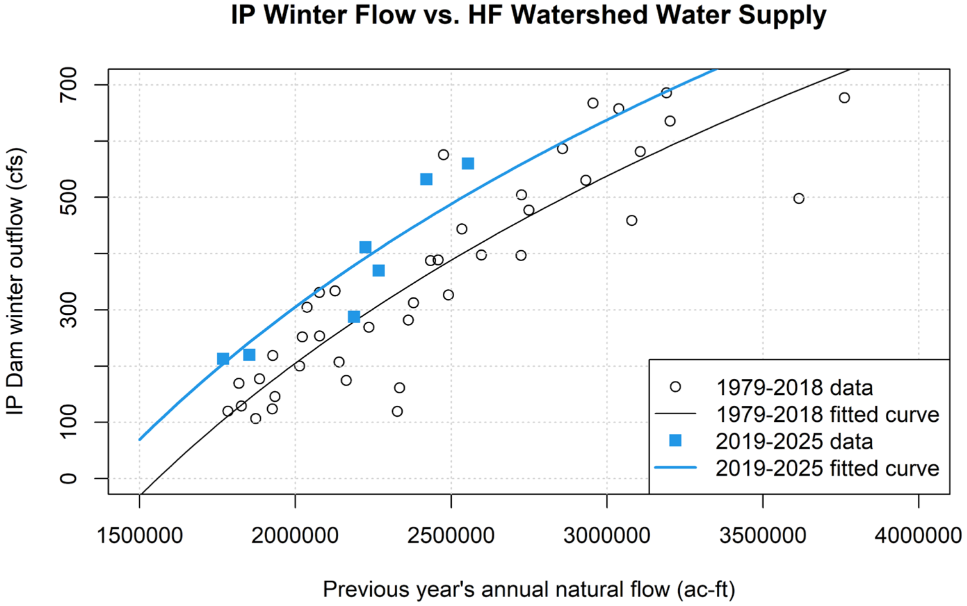


***Figure 21**. December 1 through February 28 outflow from Island Park Dam as a function of the previous water year's natural flow (water supply). The vertical distance between the blue points and the black curve is the amount of additional winter flow attained since 2018 from improved water management. The vertical distance between the blue and black curves is the average increase in winter flow.*

Springtime management

Outflow was lowered slightly from March 3 to April 3 to bring the reservoir close to the ice-off target of 126,000 ac-ft (93% full) and then gradually increased until it matched inflow in late April before ice was completely melted from around the spillway. While ecological ice-off occurred on April 25, it wasn't until April 28 that outflow from the reservoir was decreased to top off the reservoir. Unfortunately, peak inflow to the reservoir occurred on April 23, so the last foot of the reservoir (around 8,000 ac-ft of volume) had to be filled while inflow was decreasing. This resulted in a period of relatively low outflow from early May to early June. Outflow from May 1 to June 8 averaged 435 cfs, ranking 5th lowest in the reservoir's 87-

year history. Reservoir level was held at full pool from mid-May until draft started on June 13, 19 days prior to the average draft start date of July 2. The earliest draft in the 1978–2025 period was May 27 in 2007. This year's draft start date was in a three-way tie with 1988 and 2016 for 8th earliest. All three of these years—2007, 1988, and 2016—were similar to 2025 in water supply and spring/summer weather.

Irrigation-season management

The reservoir dropped rapidly from late June through late July, as irrigation demand was high, natural flow was low, and weather was generally hot and dry. Outflow reached a one-day peak of 1604 cfs on July 11, which is the average date of highest irrigation demand in the watershed. Outflow was reduced incrementally to around 800 cfs by August 1 and remained between 700 and 800 cfs until the only heavy rain of the summer fell in late August. Reservoir draft ended on August 27, during that rain event, due to a combination of increased stream inflow, volume gained directly from rain on the reservoir surface, and decreased outflow. The draft end date was 15 days earlier than average. The earliest end to draft in the modern record occurred was August 14, in 2021.

Late Summer/Fall Management

After the August 27 rain, outflow was then incrementally reduced to around 345 cfs, where it stayed for over two weeks in late September and early October. During that time, outflow was equal to the river's natural flow, as the combined storage in Henry's Lake and Island Park did not change. While the reservoirs did not lose any volume during this late-summer/early fall period, over 10,000 ac-ft of water that could have been stored during this time was delivered out of the watershed to American Falls, thereby delaying reservoir fill until early October. This operation was in contrast to that of the fall of 2024, when outflow was lowered substantially in mid-September to store as much water as possible in the reservoir prior to winter. When water is short, which is nearly every year now, late-summer and fall operations require a tradeoff between maximizing winter flow and maintaining decent flows for late-summer and early-autumn fishing. In 2024, September flows were very low, which allowed slightly higher winter flow in the 2024/2025 winter, but at the expense of good fishing conditions. In 2025, September flows were higher due to the need to send water to American Falls, providing better fishing conditions but cutting into subsequent winter flow.

Minimum reservoir volume in 2025 was 43,948 ac-ft (32.5% full), compared with the 1978–2025 average of 60,697 ac-ft (44.9% full) and the 87-year average of 58,158 (43.0% full) over the reservoir's full history. While the lowest reservoir volume we have observed since 2016, this year's value was well ahead of that in 1988, 2016, and 2007, the three years mentioned above as being similar in draft start date, overall water supply, and summer weather. As mentioned above, water supply in the upper Henry's Fork subwatershed in 2025 was in the bottom 10 of the last 96 years, while minimum volume in Island Park Reservoir ranked higher than 28 other years in the 87-year history of the reservoir.

To be more precise, this year's minimum reservoir volume, which we refer to as "physical carryover", exceeded the statistically expected value based on water supply and other watershed-wide factors by 21,353 ac-ft. This is the 8th consecutive year that reservoir carryover has exceeded expectations based on water supply and other watershed-wide factors (Figure 22). This improvement relative to pre-precision management operations is statistically significant at $P = 0.0002$, meaning that the probability of observing this much improvement over eight consecutive years by random chance is 0.02%. The average improvement in reservoir carryover due to precision water management infrastructure and operations over the past eight years is 23,530 ac-ft. To put that in perspective, that is 17% of the reservoir's capacity and a 78% improvement. In fact, the *savings* in reservoir volume in the eight years of precision management to date is greater than the actual *carryover* itself in 16 years in the full history of the reservoir, including 2015, 2103, 2016, and 2007, all years of similar water supply.

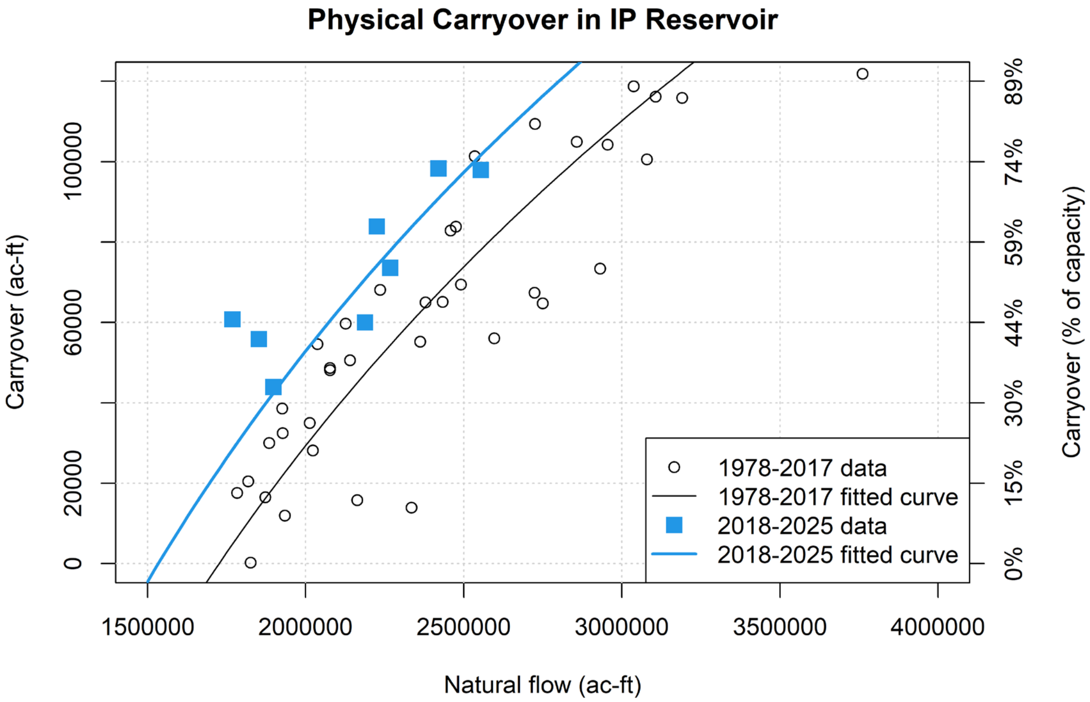


Figure 22. *Minimum volume in Island Park Reservoir as a function of the previous water year's natural flow (water supply). The vertical distance between the blue points and the black curve is the amount of savings in the reservoir attained since 2018 from improved water management. The vertical distance between the blue and black curves is the average increase in physical reservoir carryover.*

5. Streamflow Gaging

For the seventh consecutive year, HFF measured streamflow in the Henry's Fork at Island Park regularly during the summer and fall, when the relationship between river depth and streamflow ("stage-discharge" or "gage rating") changes most rapidly ("shifts") due to growth and decay of aquatic vegetation (called "macrophytes"). As vegetation grows during early summer, it displaces water, leading to higher depth at a given flow. The opposite happens in late summer and fall as vegetation decays. The U.S. Geological Survey (USGS) measures streamflow to update the rating curve every 2–8 weeks, depending on season of the year, but during periods of rapid shift, the actual streamflow indicated on the real-time USGS gage can be higher or lower than the actual flow by the time several weeks have passed since the last adjustment. We use our regular measurements to calculate an approximate rating shift in between the official USGS adjustments so that water managers and river users can have more accurate flow data on a day-to-day basis. In 2019, we were just learning how to use the Acoustic Doppler Current Profiler (ADCP) unit FMID has loaned us for this purpose. Not only were we learning how to use the unit and its software, but we were also learning how to row a drift boat across the river with the ADCP tethered from the front of the boat and adhere to standard measurement protocols. Those include two pairs of measurements in each direction across the river, three-minute duration of each pass across the river, and a total measurement error of around 4% or less. We were able to consistently meet those criteria in years 2020 through 2025.

We made fewer measurements at Island Park Dam in 2025 than in previous years (Table 6) because USGS made more frequent measurements. Our relative error in 2024 was 9.9%, our highest error since the trial year of 2019. Bias was -4.5%, meaning that on average, we underestimated flow. This was the first year our bias was negative. Underestimation was greatest in the three measurements we made at flows higher than 600 cfs; our measurements were very accurate at flows lower than 600 cfs (Figure 23). Nonetheless, our measurements were closer to actual flow than USGS gaged flow was during the late summer and fall, when USGS measurements were less frequent.

We have also been measuring streamflow at Ashton since 2019, and made six measurements there during 2025 (Figure 24). Maintaining frequent rating adjustments there during the summer and fall is critical to making accurate estimates of natural streamflow in the upper Henry's Fork subwatershed, which are, in turn, critical for assessing ongoing water supply trends and for predicting fall and winter water availability. Our Ashton measurements had a mean error of 2.9% relative to USGS data, the lowest we have yet achieved at Ashton, and a bias of 0.50%.

Table 6*. HFF measurements of streamflow at Island Park Dam and error measures relative to shift-adjusted USGS streamflow data.*

Year	No. HFF measurements	Mean absolute error	Mean relative error	Bias
2020	24	23.5 cfs	7.9%	+3.4%
2021	20	20.6 cfs	8.3%	+6.4%
2022	14	28.6 cfs	4.9%	+3.0%
2023	14	29.0 cfs	5.6%	+0.9%
2024	11	24.5 cfs	5.0%	+0.8%
2025	6	45.8 cfs	9.9%	-4.5%

In addition to measuring streamflow at Island Park and Ashton for the purposes of estimating gage shift in between USGS measurements, HFF also measures streamflow regularly in the Buffalo River at Highway 20, Henry's Fork at Marysville (inflow to Ashton Reservoir), Henry's Fork at the Parker-Salem highway, and Teton River at Harrop's Bridge. We maintain stream gages at these three locations, year-round in the Buffalo River and at Marysville and seasonally at the other two locations. Streamflow data at these locations is useful in monitoring long-term hydrologic trends, specifically natural groundwater-fed headwater inflow in the case of the Buffalo River and gains from irrigation return flow and/or managed aquifer recharge in the case of the lower Henry's Fork and the Teton River. The streamflow data collected at these four locations are available at https://henrysforkdata.shinyapps.io/WaterQuantity/.

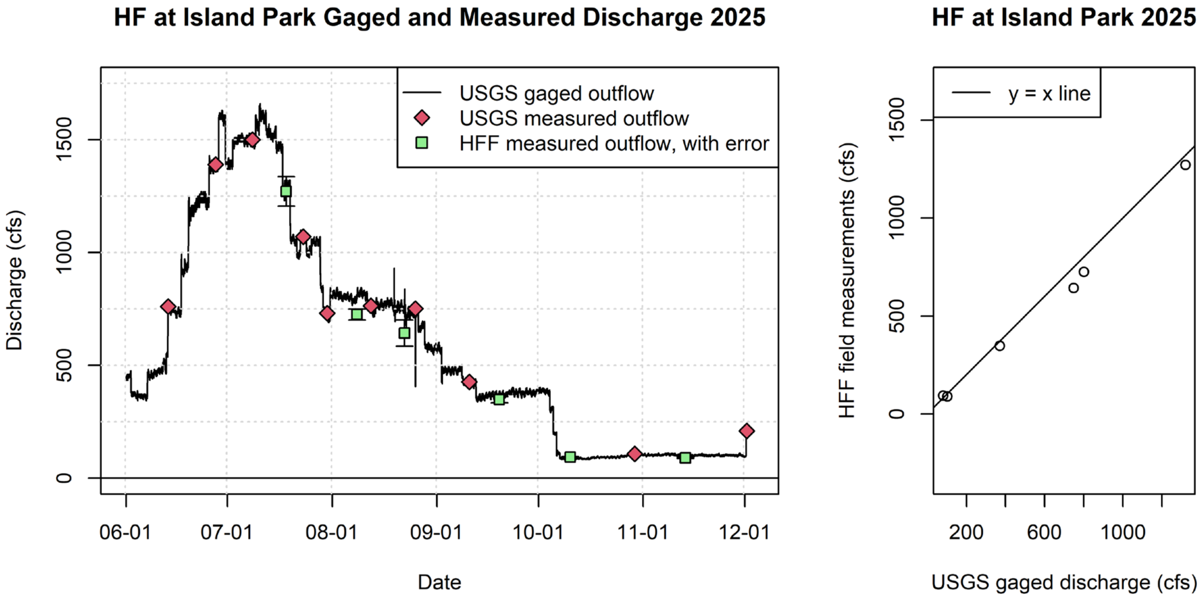


Figure 23*. Official USGS record of 15-minute discharge in the Henry's Fork at Island Park from June through early December 2025, showing all USGS and HFF measurements (left panel). The right panel shows HFF measurements vs. USGS gaged discharge.*

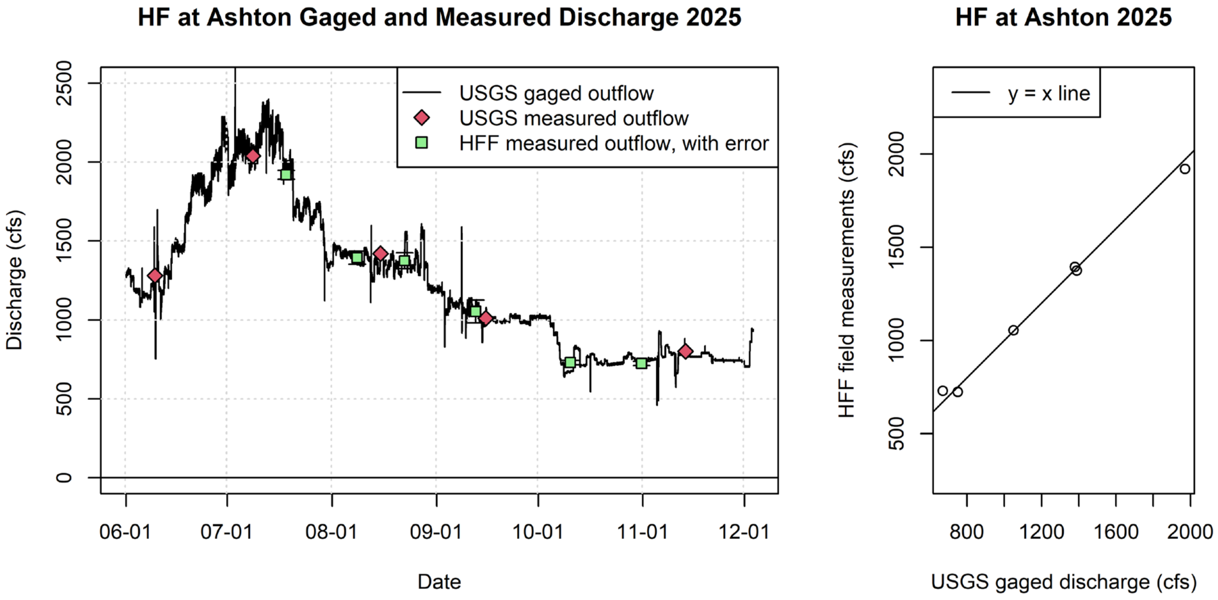


Figure 23*. Official USGS record of 15-minute discharge in the Henry's Fork at Ashton from June through early December 2025, showing all USGS and HFF measurements (left panel). The right panel shows HFF measurements vs. USGS gaged discharge.*

6. Performance of Predictive Models

We first developed predictive models for all aspects of water supply and irrigation-system management during water year 2017 and have continued to refine and apply these models every year since then. We quantify their performance each year to assess their utility in informing seasonal-scale predictions.

Winter flow and reservoir operation

By far the most precise quantity we predict ahead of time is streamflow during the October 1 to March 31 “winter” period. During that time, natural flow consists primarily of what we call “base flow”, the flow sustained by inputs from groundwater. In turn, that flow nearly completely reflects water supply during the preceding summer, which is why it is predictable on October 1. My October 1, 2024 prediction of October-March natural flow in the watershed between Henry’s Lake and Island Park Reservoir overestimated actual flow by 6% (Figure 24). This natural flow provides the majority of inflow to Island Park Reservoir during the winter, with much smaller amounts (less than 10% of the total) provided by outflow from Henry’s Lake and by precipitation directly on the reservoir surface. Thus, with a good prediction of inflow to Island Park Reservoir on October 1, we can predict the outcomes of winter management of Island Park reservoir with a reasonable degree of certainty. Based on October-1 conditions, I predicted that a winter outflow of 350 cfs would be possible, if outflow was set at 180 cfs during October and November. However, as mentioned above, October and November were very dry, and reservoir fill was behind expectations at the end of November, requiring a winter target outflow of 275 cfs instead of 350 cfs (Figure 20). Due to a temporary increase to around 300 cfs during the January cold spell, the winter averaged ended up at 288 cfs, 18% lower than my October-1 prediction. Nonetheless, the October-1 predictions provided accurate guidance for reservoir fill.

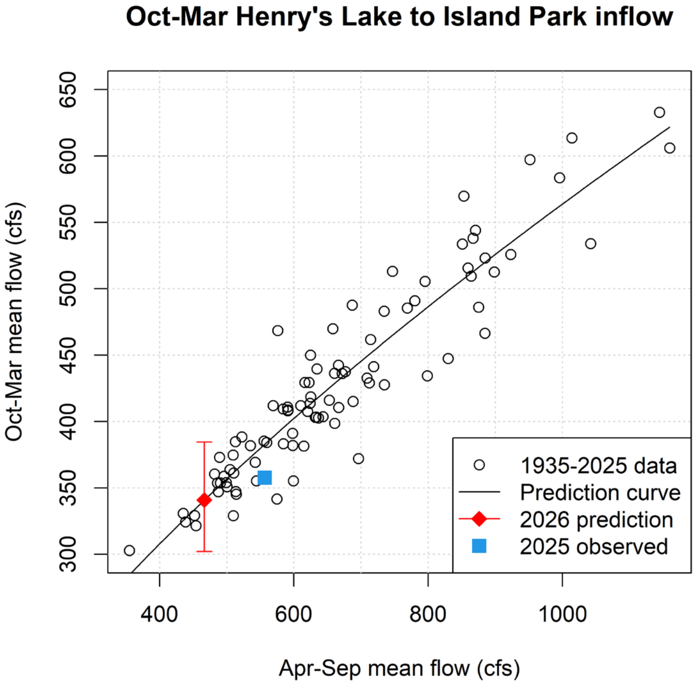


***Figure 24**. Dependence of October–March natural streamflow between Henry’s Lake and Island Park on preceding April–September streamflow. The observed value for 2025 and prediction for 2026 are shown.*

April–September natural flow

Unfortunately, predicting streamflow between April 1 and September 30 on April 1 is not nearly as easy as predicting October through March streamflow on October 1. Temperatures and precipitation during the spring and summer have a large effect on streamflow volume and an even larger effect on timing of runoff, which is critical in predicting need for reservoir draft and other irrigation-system operations.

Water year 2025 was the ninth year in which I issued predictions of streamflow, irrigation demand, water management and reservoir levels on April 1. The predictions cover the April–September period and are based only on information available on April 1. They are designed to give river users and water managers information ahead of the spring and summer fishing and irrigation season on streamflow, reservoir levels, and water quality. This section will just cover hydrology. I will report on my predictions of water quality in the water quality section below.

My April-1 predictions overestimated natural streamflow by 13.0% at the watershed scale: 6.6% in upper Henry's Fork, 12.7% in Fall River, and 15.3% in Teton River (Table 7). Over the first nine years of these predictions, the average absolute error in estimating watershed-total natural flow is 10.2%, so this year's error was a little above average. Over those nine years, the models underestimated natural flow in 2017 and 2022 and have overestimated it in all other years. I incorporated some changes to the models this year to reduce the chance of overestimation, and those proved helpful in the upper Henry's Fork, where overestimation errors have typically been in the range of 10–20%. Given that the April-1 predictions incorporate the full range of potential weather that could occur over the subsequent 6 months, they will always overestimate streamflow—especially in the Fall River and Teton River subwatersheds—if weather is warmer and drier than average. That was indeed the case in 2025.

***Table 7**. April 1–September 30 natural flow statistics, including predictions made on April 1. Prediction error is 100*(predicted – observed)/observed and so is positive if the prediction was too high and negative if the prediction was too low.*

	Mean April 1 – September 30 natural flow						
	2025 prediction		2025 observed		Prediction error (%)	2024 observed	
Subwatershed	cfs	% of ave.	cfs	% of ave.		cfs	% of ave.
Upper Henry's Fork	1,354	73%	1,270	68%	6.6%	1,500	81%
Fall River	1,190	87%	1,056	77%	12.7%	1,156	84%
Teton River	1,055	88%	915	76%	15.3%	1,273	106%
WATERSHED TOTAL*	**3,663**	**83%**	**3,241**	**73%**	**13.0%**	**3,928**	**89%**

*The watershed total prediction is made independently of the three subwatersheds, so the subwatershed figures do not necessarily add to the watershed total.

For the same reason, the April-1 models predicted runoff timing to be later than actually occurred. The models predicted that the hydrograph center of mass would occur on June 17 at the watershed scale: June 23 in upper Henry's Fork and June 13 in each of Fall and Teton rivers (Table 3). Observed values were June 15 for the watershed, and June 21, June 9, and June 13 for upper Henry's, Fall, and Teton, respectively. These all turned out to be earlier than average, by a full week in the case of Fall River, due to warm springtime temperatures.

Early runoff caused the greatest deviations between observed and predicted natural flow hydrographs (Figure 25). In all subwatersheds, the observed values were lower than predicted early in the summer, in some cases falling outside of the 90% prediction interval, meaning that the observed flows had less than a 10% chance of being that far away from the predicted values, given the snowpack and other conditions present on April 1. By mid-summer, the effect of early runoff had disappeared, and natural streamflow—while lower than predicted—fell within the statistical prediction intervals in all subwatersheds. This indicates that the predictive models were successful at capturing overall hydrologic conditions across the watershed based only on April-1 information and that the majority of error early in the summer was due to early runoff.

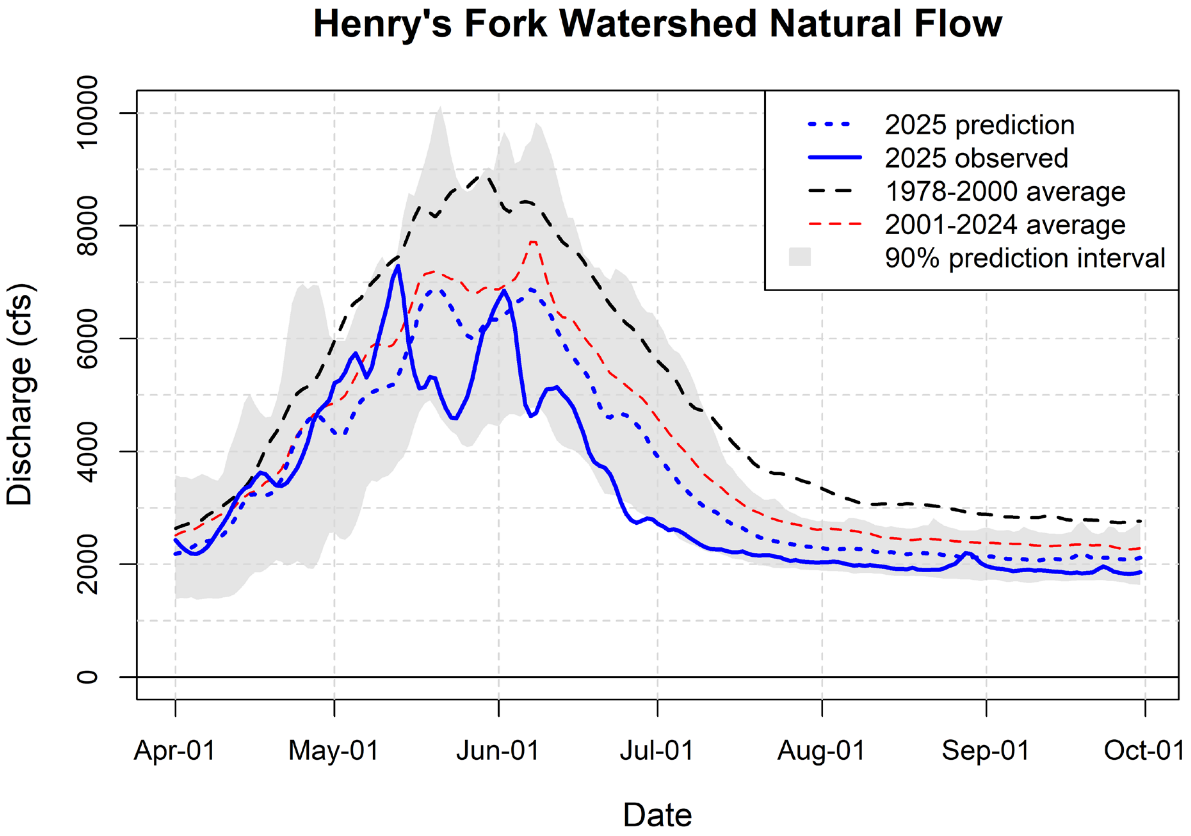


***Figure 25**. Predicted and observed April-1 through September-30 natural streamflow in the Henry's Fork watershed for water year 2025, with the 1978–2000 and 2001–2024 averages shown for reference.*

April–September reservoir operations and regulated flow

As a consequence of early runoff, streamflow in the lower Henry's Fork dropped to near irrigation-season targets by mid-June (Figure 26), requiring and early start to draft of Island Park Reservoir (Figure 27). As mentioned above, reservoir draft started on June 13, compared with an average date of July 2. The April-1 predictions gave only a 10% chance that reservoir draft would start that early. As a result of early draft and low natural flow, the reservoir dropped much faster than predicted during late June and early July and was nearly 25,000 ac-ft below the predicted value by the middle of July. However, reservoir draft from then until the August-27 rain was slower than predicted, and by the end of the water year, reservoir volume was only 2,500 ac-ft less than predicted, a deviation of less than 6%. Similarly, September-30 reservoir levels in Henry's Lake (Figure 28) and Grassy Lake (Figure 29) were within a few percent of predicted values. The April-1 models correctly predicted maximum outflow from Island Park Dam of around 1500–1600 cfs but predicted that the outflow peak would occur in mid-to late-July instead of late-June to mid-July as actually occurred (Figure 30).

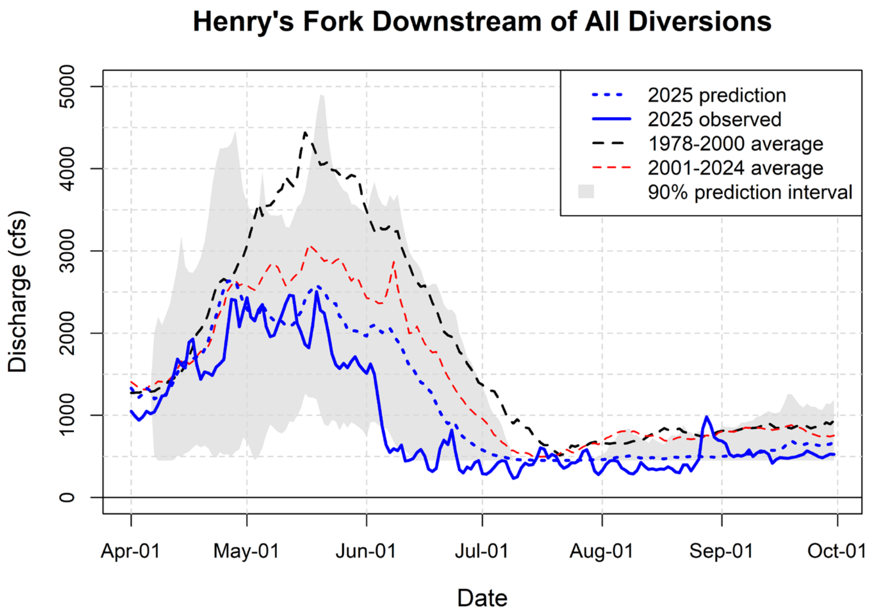


Figure 26. *Predicted and observed April-1 through September-30 regulated streamflow in the Henry's Fork at Parker for water year 2025, with the 1978–2000 and 2001–2024 averages shown for reference.*

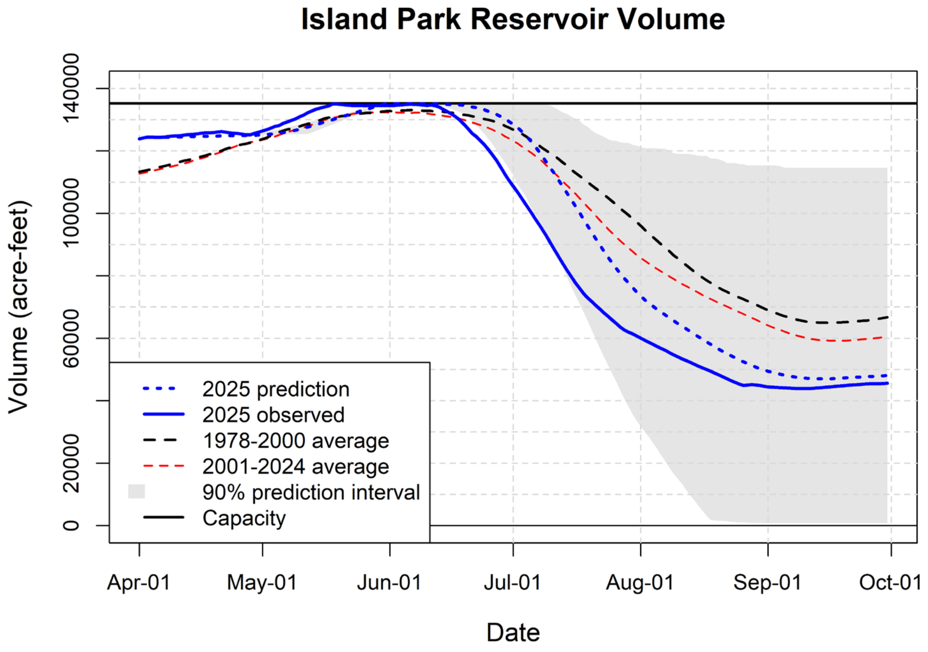


Figure 27. *Predicted and observed April-1 through September-30 volume in Island Park Reservoir for water year 2025, with the 1978–2000 and 2001–2024 averages shown for reference.*

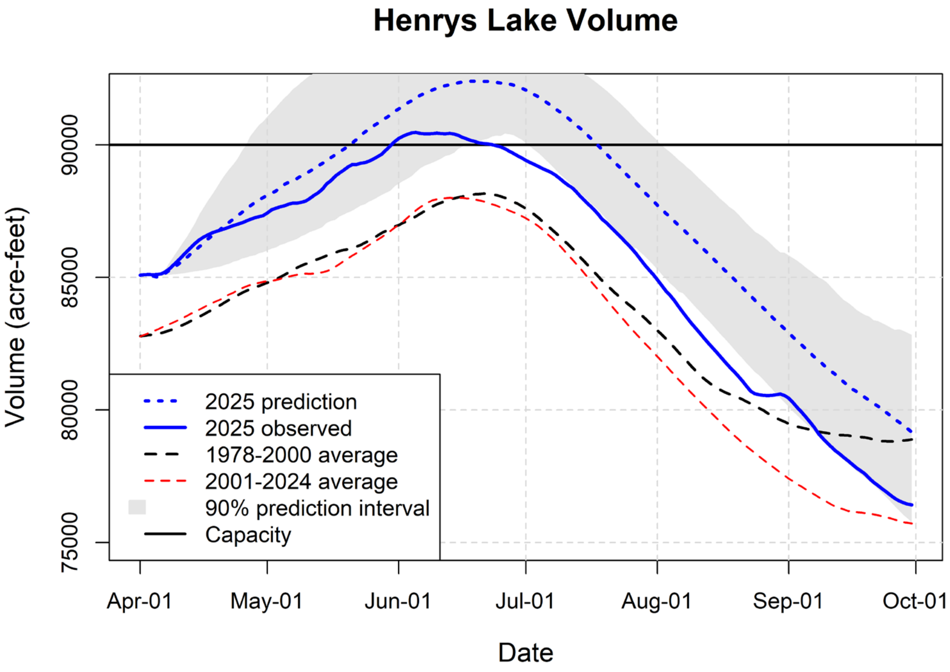


Figure 28. *Predicted and observed April-1 through September-30 volume in Henrys Lake for water year 2025, with the 1978–2000 and 2001–2024 averages shown for reference.*

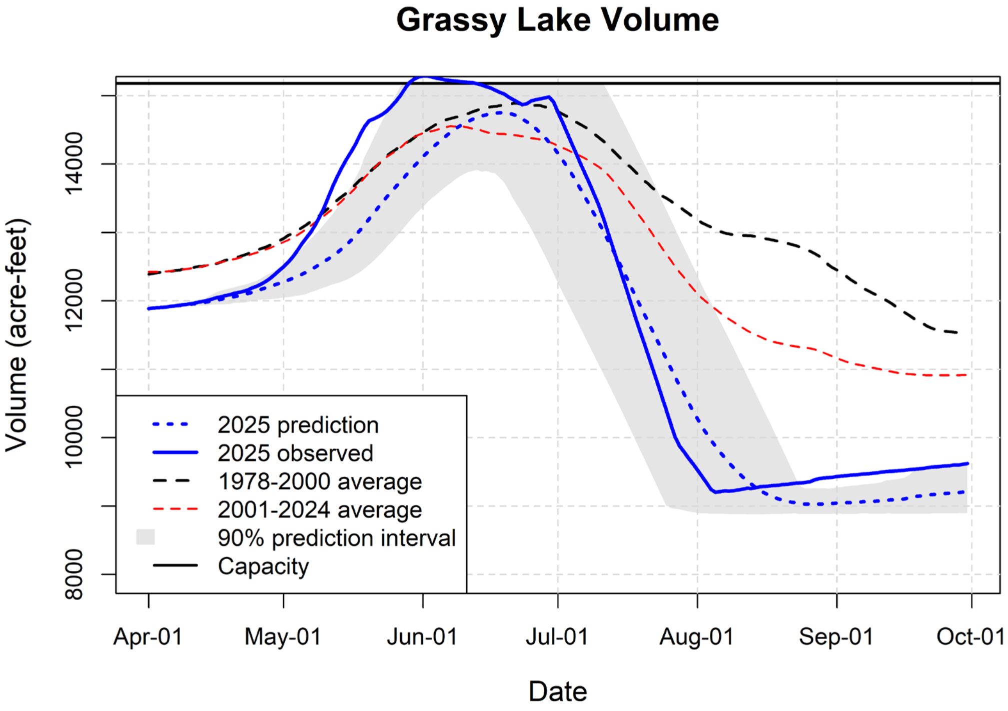


Figure 29. *Predicted and observed April-1 through September-30 volume in Grassy Lake for water year 2025, with the 1978–2000 and 2001–2024 averages shown for reference.*

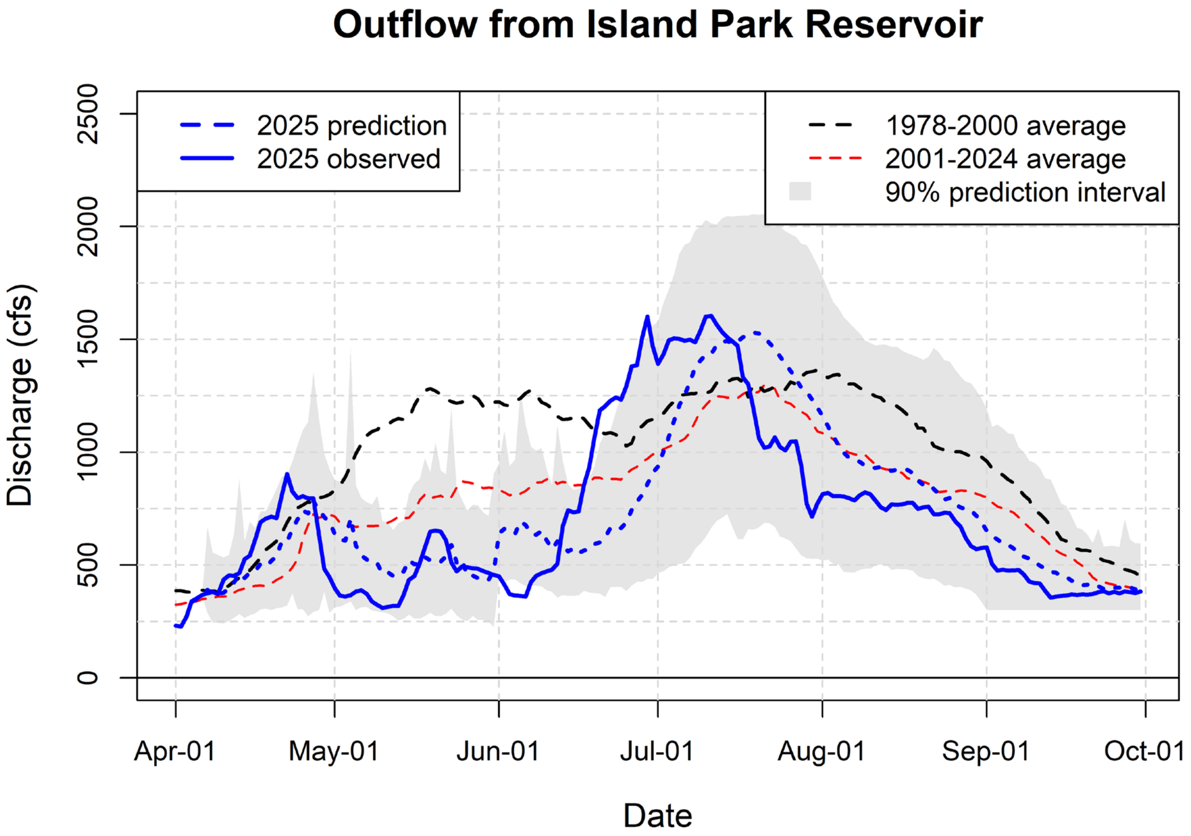


***Figure 30**. Predicted and observed April-1 through September-30 outflow from Island Park Reservoir for water year 2024, with the 1978–2000 and 2001–2024 averages shown for reference.*

First need for Crosscut Canal delivery to the Teton River was correctly predicted at around June 23 (Figure 31). Observed and predicted Crosscut delivery aligned fairly well from then through mid-July. After that, higher-than-expected use of the exchange wells (Figure 32) to meet demand in the Teton River resulted in lower-than-expected Crosscut delivery, thereby reducing Island Park Reservoir draft during the second half of the summer.

Given that the April-1 predictions are based on conditions known at the time and on historical relationships among weather, water supply, and water-management decisions, this year's predictions performed very well, especially where they counted the most—in predicting end-of-year reservoir levels.

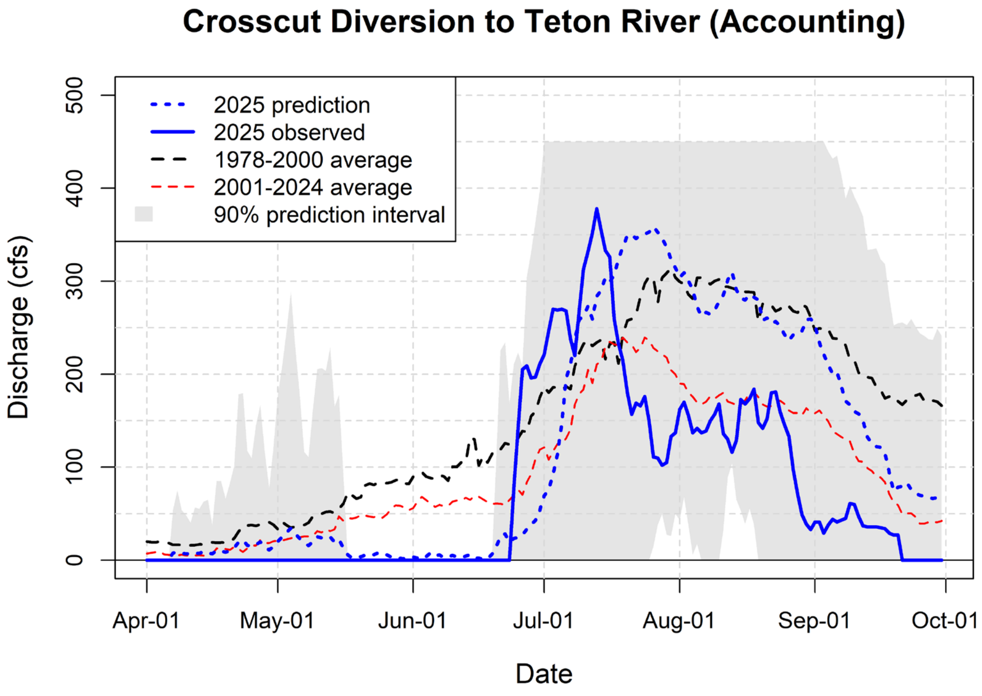


Figure 31. *Predicted and observed April-1 through September-30 diversion into the Crosscut Canal for water year 2024, with the 1978–2000 and 2001–2024 averages shown for reference.*

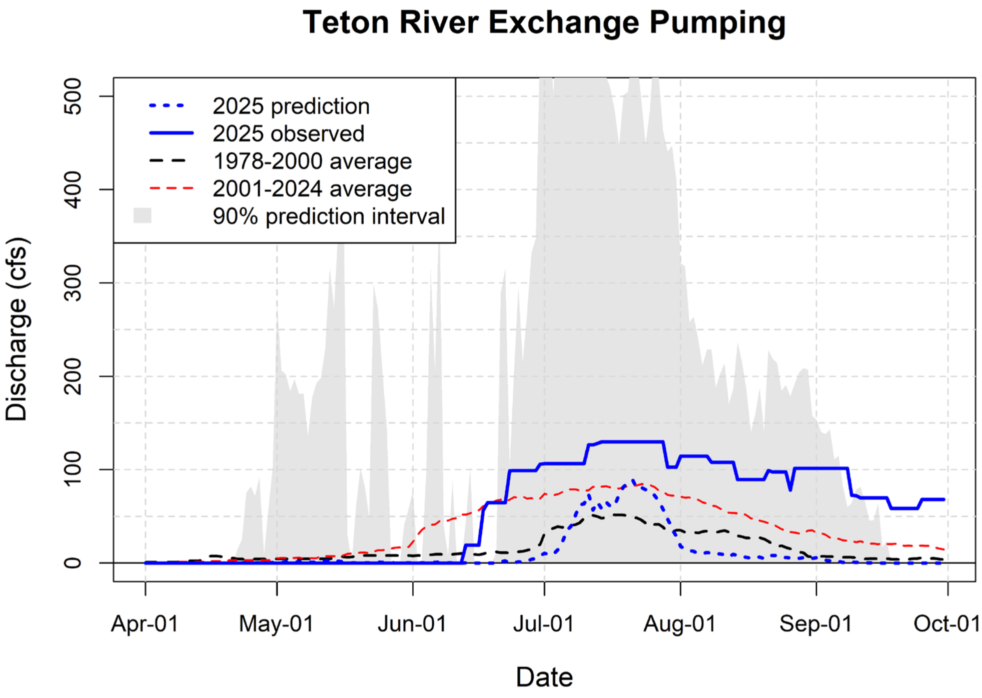


Figure 32. *Predicted and observed April-1 through September-30 exchange well pumping for water year 2025, with the 1978–2000 and 2001–2024 averages shown for reference.*

7. Water Quality

Water quality is the key limiter of fish habitat and fish populations in Island Park Reservoir and hence the limiting factor in populations of trout and kokanee that migrate upstream into the upper Henry's Fork and other reservoir tributaries. Further, water quality in Island Park Reservoir also affects fish behavior, aquatic insect behavior, and thereby the fishing experience in the Henry's Fork downstream, in some cases all the way to Ashton Dam. High water temperatures, harmful algal blooms (HABs), high turbidity, and low dissolved oxygen are key water quality problems in Island Park Reservoir that affect fisheries and aesthetic resources in the Henry's Fork Watershed. Even outside of the sphere of influence of Island Park Reservoir, warmer water temperatures have likely already contributed to changes in trout abundance and species composition and changes in invertebrate communities and hatch timing. Generally, water quality in 2025 was the worst since we first installed continuous-recording water-quality sondes in the summer of 2014, contributing to ongoing, watershed-wide increases in water temperature and turbidity.

Water quality in Island Park Reservoir

Because the 2024 technical report contained an extensive section covering details of water quality in the reservoir, this report will present only key observations from the spring and summer of 2025. Physical, chemical, and biological processes in the reservoir that determine water quality get underway each year when ice melts from the reservoir surface. Full ice formation on the reservoir in the fall of 2024 occurred on November 26, 11 days later than the 10-year average. Complete melt occurred in 2025 on April 25, 5 days earlier than average, for a total ice-covered period of 150 days, 16 days shorter than average. That shorter period of ice cover, combined with warm spring temperatures, set the reservoir on a path toward warm water temperatures, excessive algae growth, and high turbidity that was later exacerbated by warm summer and fall temperatures, dry weather, and early and rapid reservoir draft.

The cool pool of water on the reservoir bottom was evacuated from the reservoir by early July, resulting in very warm temperatures throughout the water column from then until September (Figure 33). Surface temperatures exceeded 70 degrees Fahrenheit for several weeks in July. As a result, the window between the usual algae growth that happens as a result of reservoir turnover after ice-off and the onset of mid-summer blooms lasted only about 6 weeks. Algae growth, as indicated by chlorophyll concentrations in the upper layers of the reservoir, started in early July and persisted through the remainder of the summer and fall (Figure 34). Particularly high concentrations were present continuously from late July through early October. Dead algae cells sink to the bottom of the reservoir, where oxygen is consumed as part of the decay process. Thus, dissolved oxygen (DO) concentrations at the power plant intake fell below the plant's 6 mg/L criterion in mid-July and did not recover until early October (Figure 35). Critically for trout and kokanee, dissolved oxygen in much of the water column was below their tolerance limit of 5 mg/L from late July through late September, and the upper layers of the reservoir that had high enough DO to support trout and kokanee during that time were too warm. That prompted older trout and kokanee to migrate upstream into the river early in the summer, while younger fish were likely forced into small refuge areas of the reservoir where they were susceptible to predation and other mortality factors. While high water temperatures and low dissolved oxygen concentrations affected fish in the reservoir, the bigger effects downstream resulted from high turbidity generated by algae growth and decay, wind waves, motorboats, and density currents. The latter played a lower role than usual because we experienced only a couple of cold fronts that were strong enough to form density currents. Nonetheless, turbidity at the dam gates was high all summer (Figure 36) and exceeded 5 Nephelometric Turbidity Units (NTU) at the power plant intake from late July through early October (Figure 37).

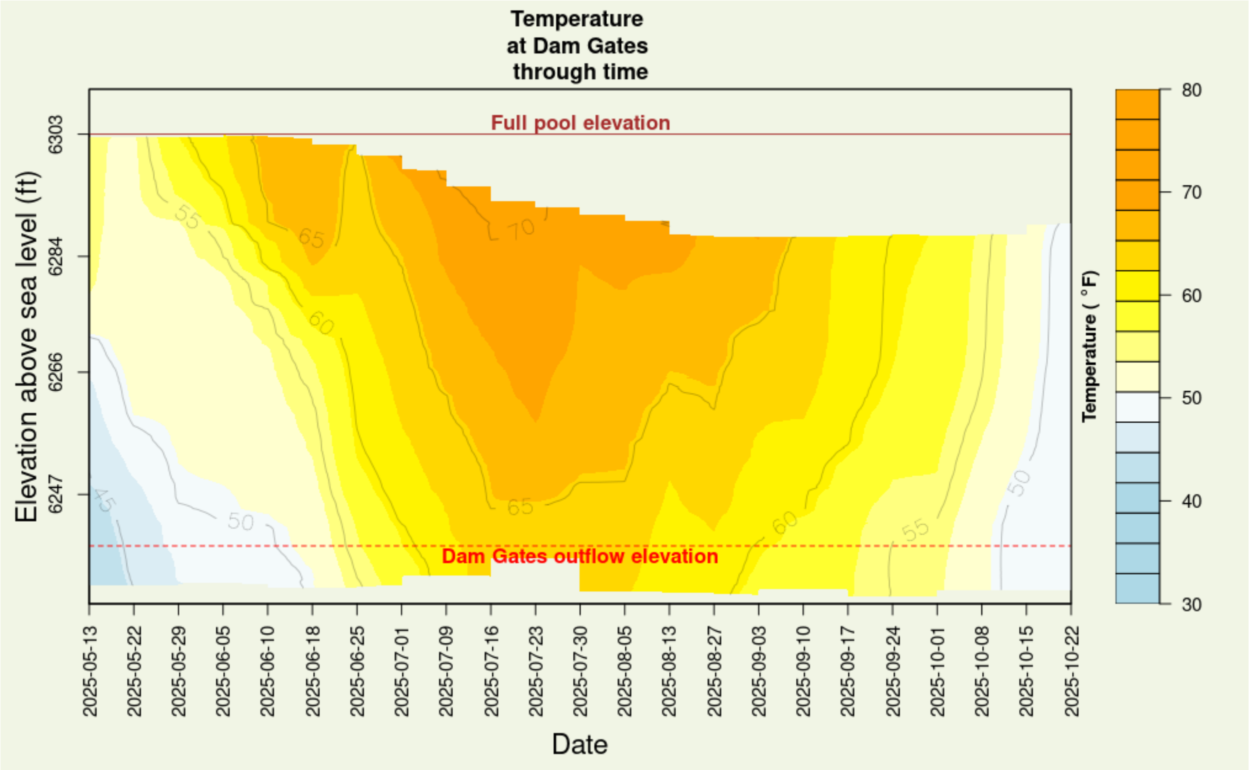


***Figure 33**. Water temperature in Island Park Reservoir at the dam gates, May-October 2025.*

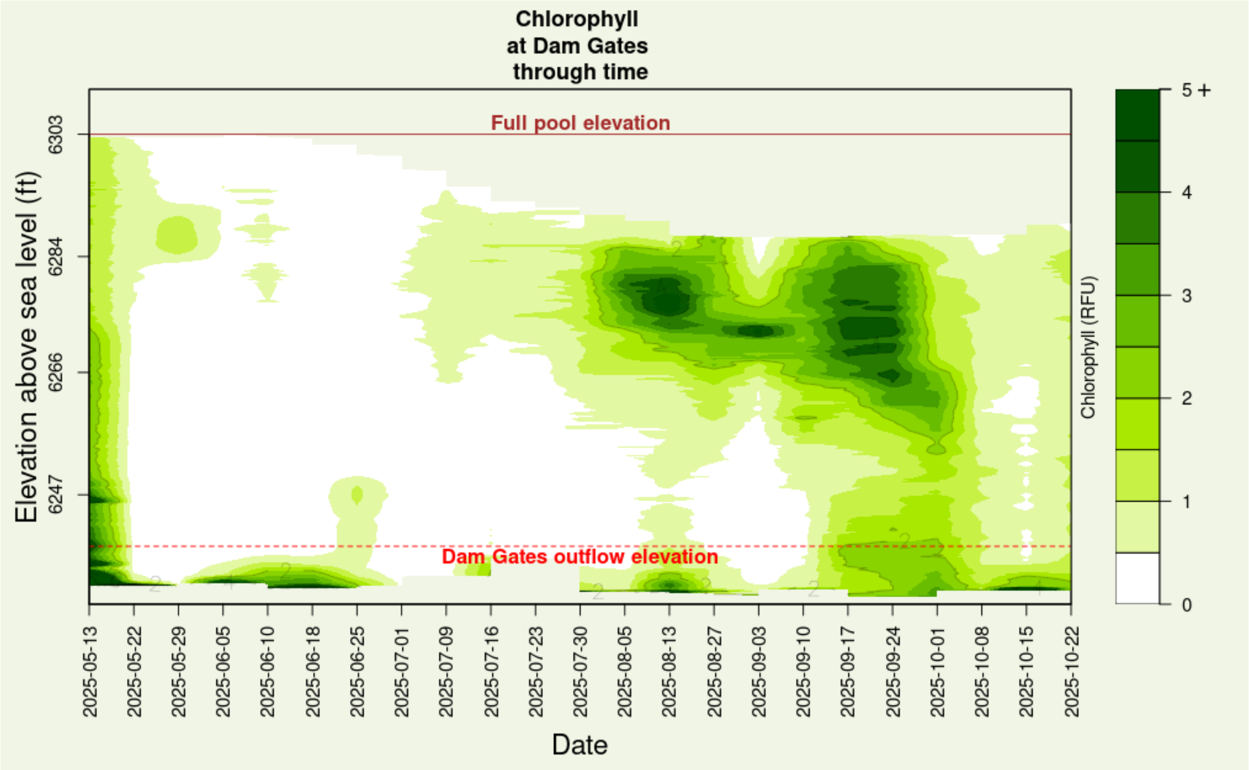


***Figure 34**. Chlorophyll concentration in Island Park Reservoir at the dam gates, May-October 2025.*

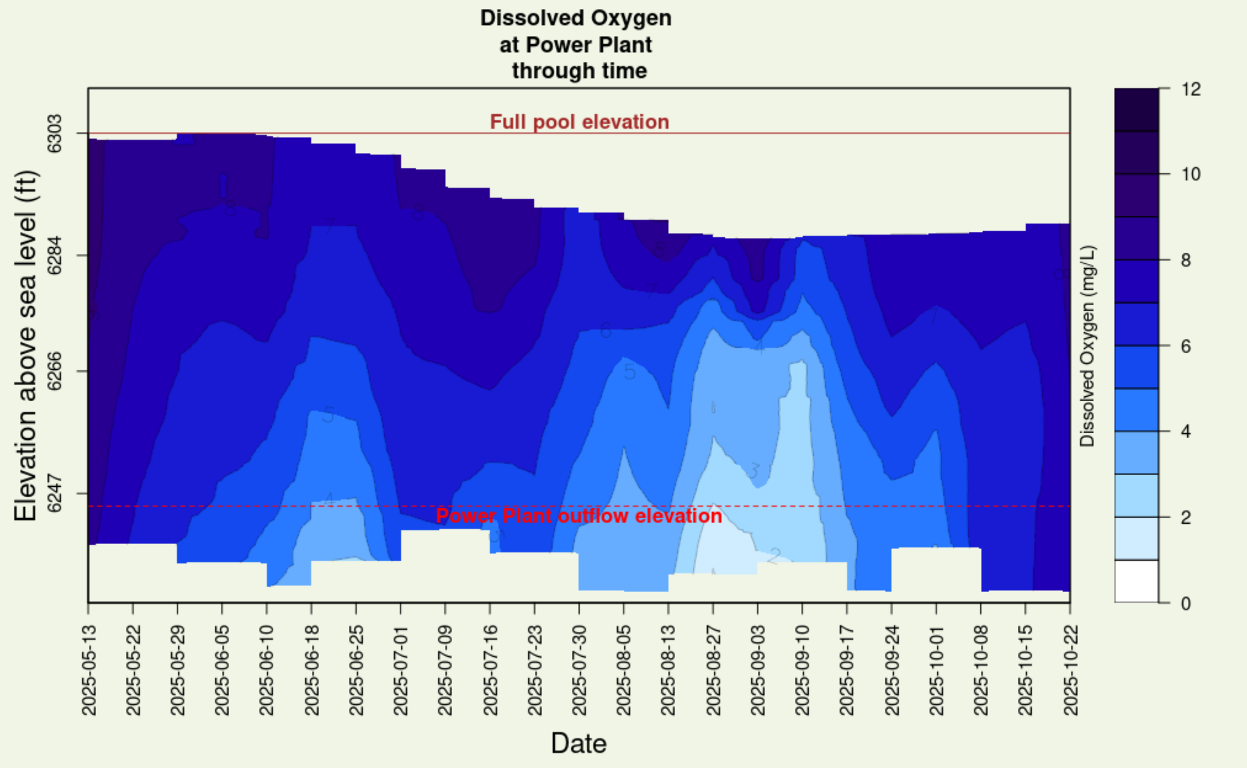


***Figure 35**. Dissolved oxygen concentration in Island Park Reservoir at the power plant, May-October 2025.*

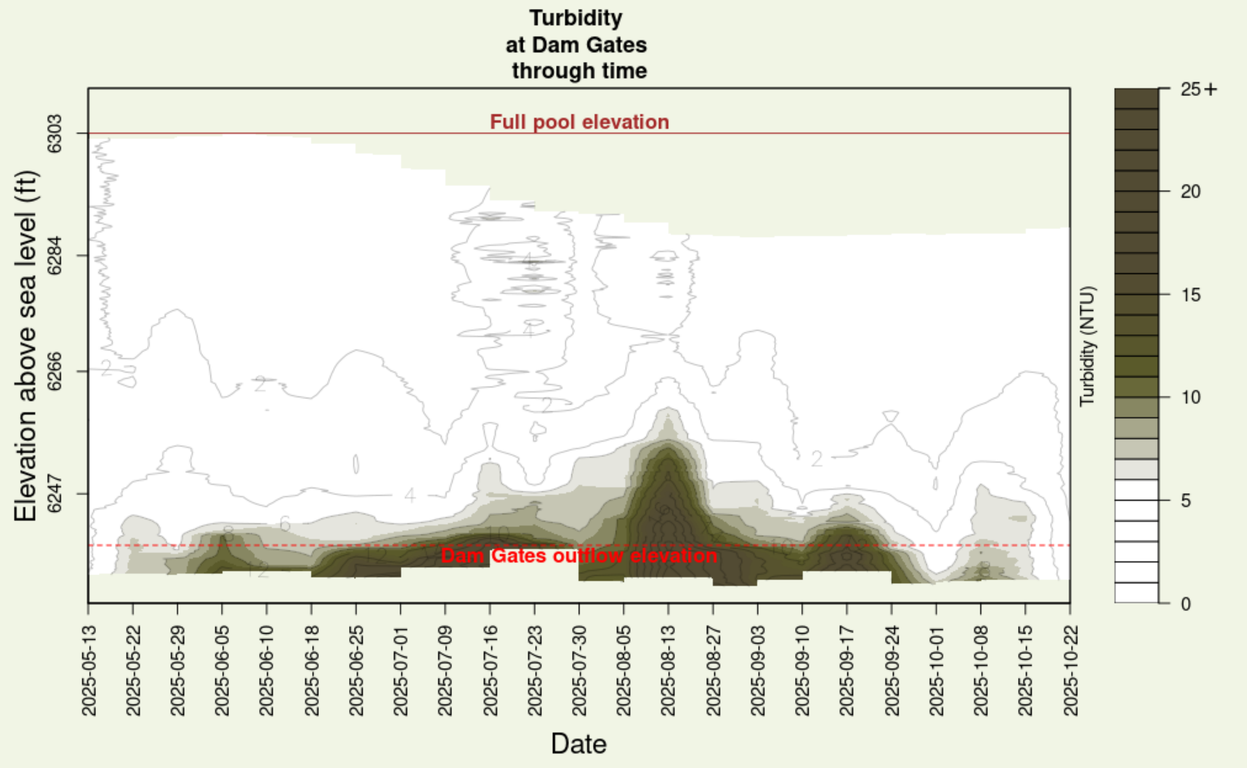


***Figure 36**. Turbidity in Island Park Reservoir at the dam gates, May-October 2025.*

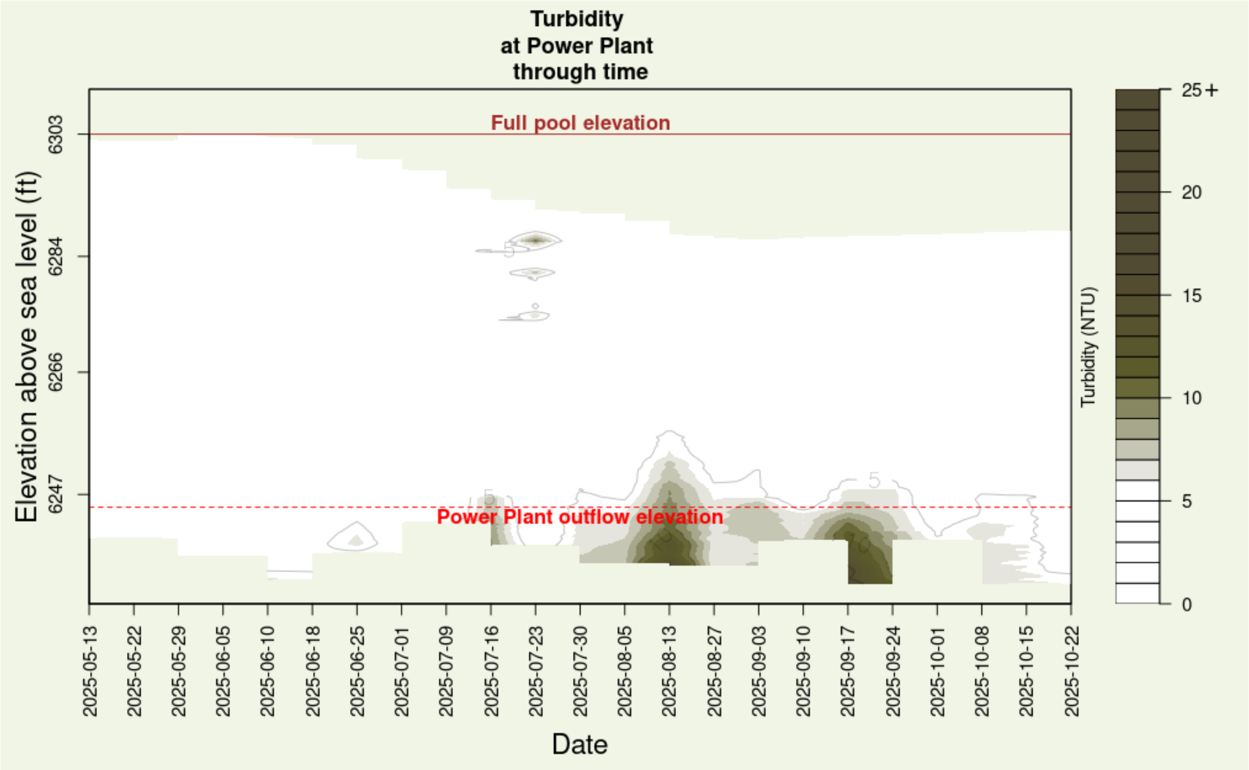


***Figure 37**. Turbidity in Island Park Reservoir at the dam gates, May-October 2025.*

In addition to collecting and analyzing our own reservoir water quality, we contributed field data and samples to the efforts of two consulting firms that produced reports on the reservoir during 2025. The first of these reports was produced by Annear Water Resources, with funding from Idaho Department of Environmental Quality, and documented construction of water-temperature models for Island Park Reservoir and the Henry's Fork downstream from the dam to the Thurmon Creek confluence in Harriman State Park. While primarily a model construction and calibration exercise, Annear's work tested a few climate and management scenarios. Those results showed that some cooling of water temperatures in the reservoir outflow early in the summer might be possible by manipulating the elevation from which water is delivered out of the reservoir during the spring. Specifically, if reservoir surface water could be released in the spring when it is still in the optimal range for trout, the pool of cold water on the reservoir bottom could be preserved longer into the summer, for release in early to mid-summer when the reservoir surface water gets too warm. Further, the temperature model clearly showed that water temperatures in the reservoir outflow and in the river respond to air temperatures; roughly a 3.6°F change in air temperature would change mid-summer water temperatures in the reservoir outflow and in the river downstream by around 1.1°F. As mentioned in the climate section, mean June-August air temperature in the watershed has been increasing at around 1°F per decade for the past 40 years. According to the Annear temperature model, this change in air temperature alone, aside from its indirect effects on water supply, is responsible for an increase of over 1°F in water temperatures over that time.

The second of the two reports we received in 2025 was an assessment conducted by Hazen and Sawyer of dissolved oxygen in the reservoir and the potential for direct oxygenation of the lower layers of the reservoir to increase it. Based on extensive water samples we collected in 2025, Hazen and Sawyer concluded that Island Park Reservoir is hypereutrophic, meaning that it has extremely high nutrient levels and is susceptible to routine and excessive algae blooms, high turbidity, and low dissolved oxygen. Along with previous studies, the Hazen and Sawyer report documents another step in the continuous progression from mesotrophic conditions (moderate nutrient levels, near-optimal for trout growth and survival) in the 1970s to eutrophic conditions (excessive nutrient levels) by 2000 to hypereutrophic conditions now. A time series of remotely sensed data published by U.S. Geological Survey illustrates this progression (Figure 38) but also shows that the trophic status of the reservoir varies from year to year. The year-to-year variability is explained by a number of factors, including water supply and temperature, but in general, the probability that the reservoir will experience high nutrient levels is lowest when water supply is high (mid- to late-1990s, 2006, 2011, 2017, 2018) and highest when water supply is low (1992, 2010, 2015, 2016, 2020). The general trend toward a more eutrophic reservoir is coincident with general trends toward lower water supply and increased temperatures.

While the Hazen and Sawyer report recommended some oxygenation methods that could increase oxygen concentrations in the reservoir enough to benefit fish and power-plant operations, the report concluded that fully addressing all of the water quality issues in the reservoir would require a multi-faceted effort that includes direct treatments (oxygenation, algaecide), infrastructure modification (variable-elevation outflow), reducing negative effects of recreational activities such as wake surfing, and assessing and reducing nutrient inputs from various land uses and development around the reservoir, including septic tanks. The Hazen and Sawyer study was funded with a grant from the Reservoir Fish Habitat Partnership, administered by the U.S. Fish and Wildlife Service. Over the next year or so, HFF will fund additional studies of an oxygenation system and some of the other assessments recommend by Hazen and Sawyer with grants from the U.S. Bureau Reclamation, as part of our long-term DIRTT (Developing Infrastructure to Reduce Temperature and Turbidity) plan.

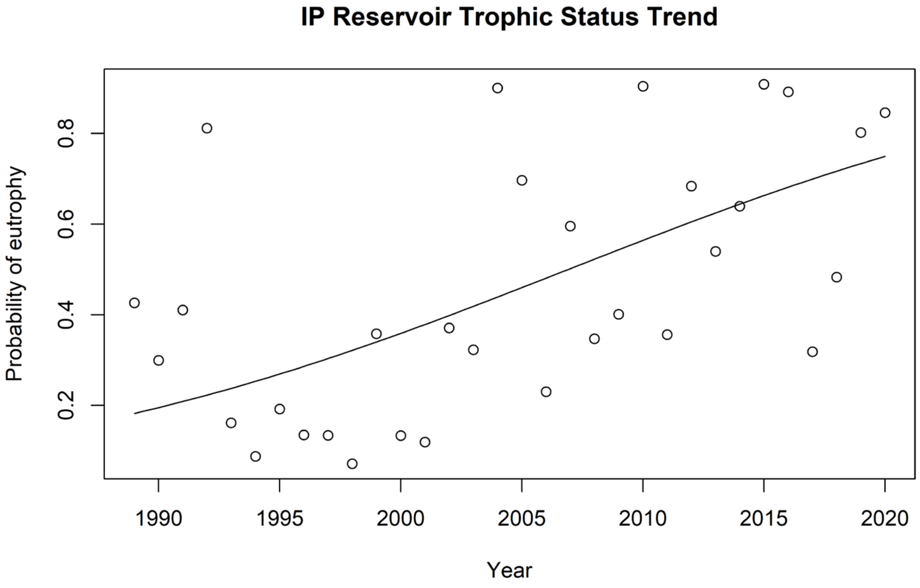


***Figure 38**. Probability of eutrophy in Island Park Reservoir, 1989–2020, from U.S. Geological Survey.*

Water quality in the Henry's Fork and tributaries

We monitor water quality in the river and its tributaries at 14 sonde installations: Big Springs, Henry's Lake Outlet, Flat Rock, Island Park Dam West (gates), Island Park Dam East (power plant), Buffalo River (at Highway 20), Pinehaven, Warm River (at Warm River campground), Marysville (upstream of Ashton Reservoir), Ashton Dam (near the Ora Bridge boat launch, downstream of Ashton Reservoir), Fall River (near Chester), St. Anthony, Parker, and Teton River at Harrops Bridge. The Henry's Lake Outlet, Fall River, and Teton River locations were added in the summer of 2025, the latter in cooperation with Idaho Department of Environmental Quality. You can see a map of these sites and view and download complete data from any of those sites at our water quality website. In addition to temperature, turbidity, dissolved oxygen and conductivity—which are recorded continuously by the sondes—we analyze weekly water samples for turbidity, which we use to ground-truth the sondes and adjust turbidity records weekly, between full sonde calibrations. We also analyze water samples for suspended sediment, phosphorus, and nitrogen concentrations. We have collected those data nearly every week of every year since the fall of 2013 at Flat Rock, Island Park (center of the river downstream of the mixing point of gates and power plant outflow), and Pinehaven. At most of the other locations, we collected the full suite of sediment and nutrient data in 2016 and then again in 2024.

Here, we will present a brief summary of the three most important water-quality parameters measured by the sondes—temperature, turbidity, and dissolved oxygen—at the six locations of most relevance to anglers: Flat Rock, Island Park East, Pinehaven, Marysville, Ashton Dam, and St. Anthony. Additional data will be provided for the Island Park location, to complement the information in the previous section and clearly show how the processes *in* the reservoir described above translate into water quality *downstream* of the reservoir. Lastly, we will present results of temporal trends in the three parameters listed above.

Water Temperature

As always, water temperatures at all locations except Island Park Dam were highly variable from day to day over the course of the spring and summer as driven by weather. In general, water temperatures in 2025 were above average for most of the spring, early summer, and late summer, corresponding to the times of warmest air temperatures (Figures 39 and 40). As mentioned in the climate section, air temperatures in late June and July—while above average—were not as far above average as they were at other times during the spring and summer. That is the period of highest solar radiation and hence highest potential water temperatures. Thus, water temperatures during this period in 2025 were close to average and generally cooler than over the same time period in 2024. There was only one day in 2025 when water temperature at Pinehaven reached up into the stressful level for trout, versus numerous days in 2024. That said, mean temperature over the entire April-October aquatic growing season was the highest in our record (10-12 years) at all six of these sites except Marysville. By the end of October, fish and other aquatic organisms had experienced the equivalent of 10-20 additional days of growth over the course of the spring and summer. As long as daily maximum temperatures stay below stressful levels, this additional growth potential is actually a benefit to fish and other aquatic organisms, providing additional body condition prior to winter.

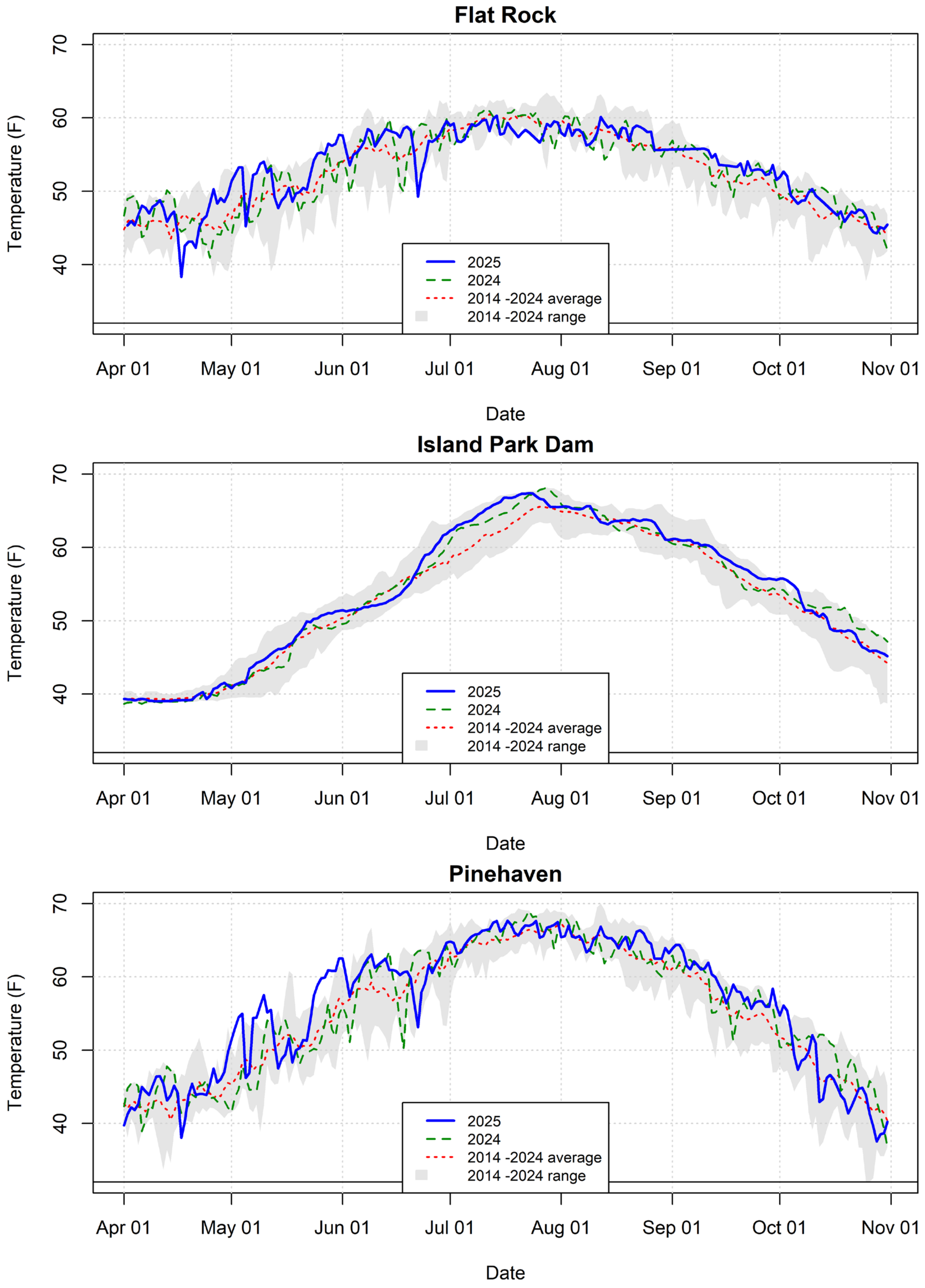


Figure 39. *Water temperature in degrees Fahrenheit at three sites in the Upper Henry’s Fork watershed: Flat Rock, Island Park Dam, and Pinehaven.*

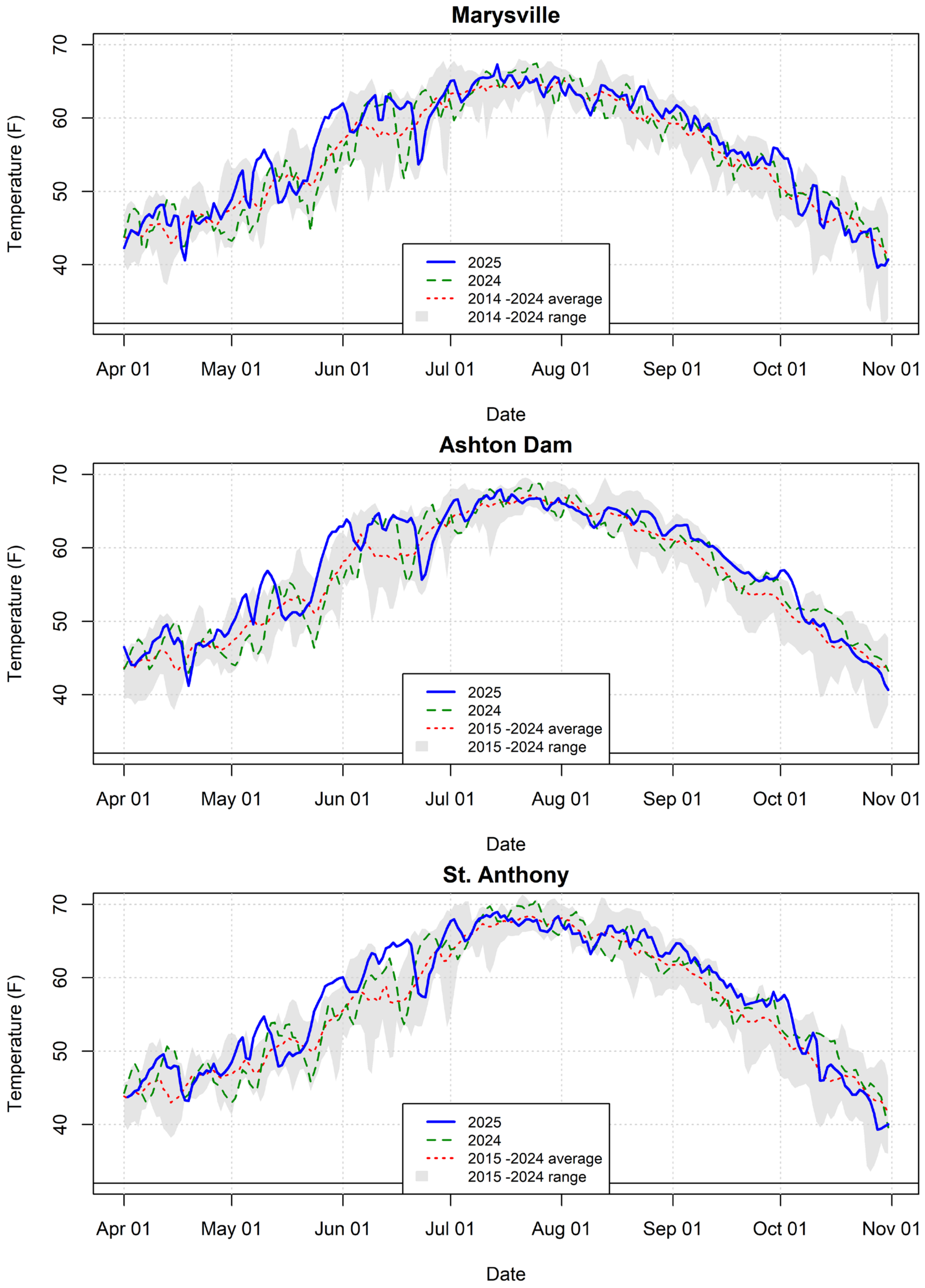


Figure 40. *Water temperature in degrees Fahrenheit at three sites in the Lower Henry's Fork watershed: Marysville, Ashton Dam, St. Anthony.*

Turbidity

At locations not directly affected by Island Park Reservoir (Flat Rock, Ashton Dam, and St. Anthony) turbidity was generally near average over the course of the growing season, with predictable seasonal variation (Figures 41 and 42),. Turbidity at Island Park Dam, Pinehaven, and Marysville reflected high turbidity in Island Park Reservoir outflow from mid-July through early October, directly correlated with the periods of high turbidity observed in the reservoir (Figures 36 and 37). In 2025, most of the turbidity in the reservoir and hence in the river downstream was caused by cycles of algae growth and decay in the reservoir and not to specific density-current events as we have seen in the past. Although it is impossible to say what fraction of turbidity in 2025 was produced by wake-surfing boats and other reservoir recreation, that activity has likely increased turbidity to some degree over the past few years. As always, turbidity in the river downstream of Island Park Dam is higher when a greater fraction of total outflow is delivered through the dam gates rather than through the power plant. Prior to mid-August, the power plant delivered all outflow, up to its capacity of 960 cfs, which means that the gates delivered outflow in excess of that from mid-June to late July. After a brief period in early August when the power plant delivered all outflow and turbidity dropped, the power plant's aeration equipment was no longer able to meet the DO requirement due to warm water temperatures and low DO at the power plant intake. At that point in the summer, all outflow was transferred back to the gates and stayed there for the remainder of the summer and fall. Thus, turbidity was higher than it would have been had the power plant been able to operate. However, turbidity still exceeded the visual detection threshold of 5 NTU at the power plant intake throughout the late summer and early fall, so even had the power plant operated that entire time, turbidity would still have been higher than desired by anglers, albeit 3-5 NTU lower than what we actually observed. Turbidity stayed above 5 NTU from mid-July until early November at the dam and nearly the entire summer at Pinehaven. Turbidity final dropped below 5 NTU there when flow was reduced in early September, allowing turbidity to settle out in aquatic vegetation between the dam and the upper Ranch.

Over irrigation year 2025, 891 tons of sediment were exported out of the Island Park to Pinehaven river reach (Figure 43), the third lowest amount of export since we started measuring this parameter in 2016. The two years of lower net export were 2016, at 667 tons, and 2019, at 815 tons. Average over the 10-year record is a net export of 1,182 tons. Below-average export occurs in years with some combination of high reservoir outflow during the summer, high sediment loads out of the reservoir, low springtime flows, and heavy growth of aquatic vegetation in the stream channel. The years of highest export are those with a high springtime freshet flow out of the dam, low macrophyte growth, and low export from the reservoir. Due to the managed springtime freshet in 2023, export that year was highest in the 10-year record, at 2,141 tons. In 2025, the primary factors that led to low net export were low springtime flows, high reservoir outflow during the summer, and high export of sediment from the reservoir. The period of highest retention of sediment in the reach, depicted as negative export in Figure 43, was coincident with the period of highest turbidity at Island Park Dam, namely mid-July through the end of October. During the 1992 reservoir drawdown, 50,000–100,000 tons of sediment were deposited in the river, most of that between the dam and Pinehaven. At an average export rate of around 1,200 tons per year, 40–80 years will be required to fully mobilize and transport all of that sediment from that reach of river, meaning that we are not even halfway there yet. A few years ago we had estimated higher export rates, but recent dry years and a much larger data set to relate sonde-measured turbidity to suspended sediment concentration have reduced our estimate of the average annual export, thereby extending the expected time frame until all of the 1992 sediment will have been removed.

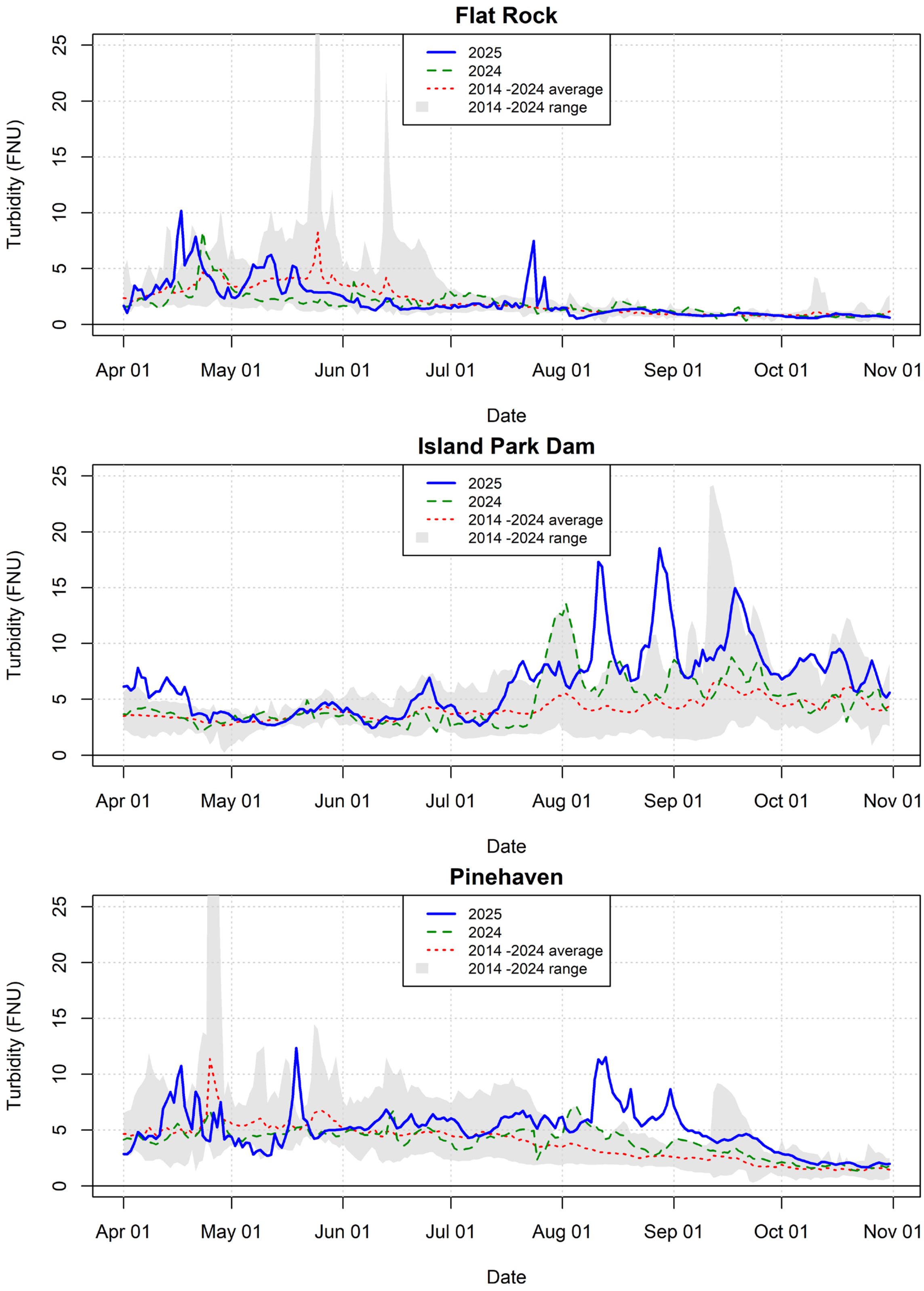


Figure 41. *Turbidity (FNU) at three sites in the Upper Henry's Fork watershed: Flat Rock, Island Park Dam, Pinehaven.*

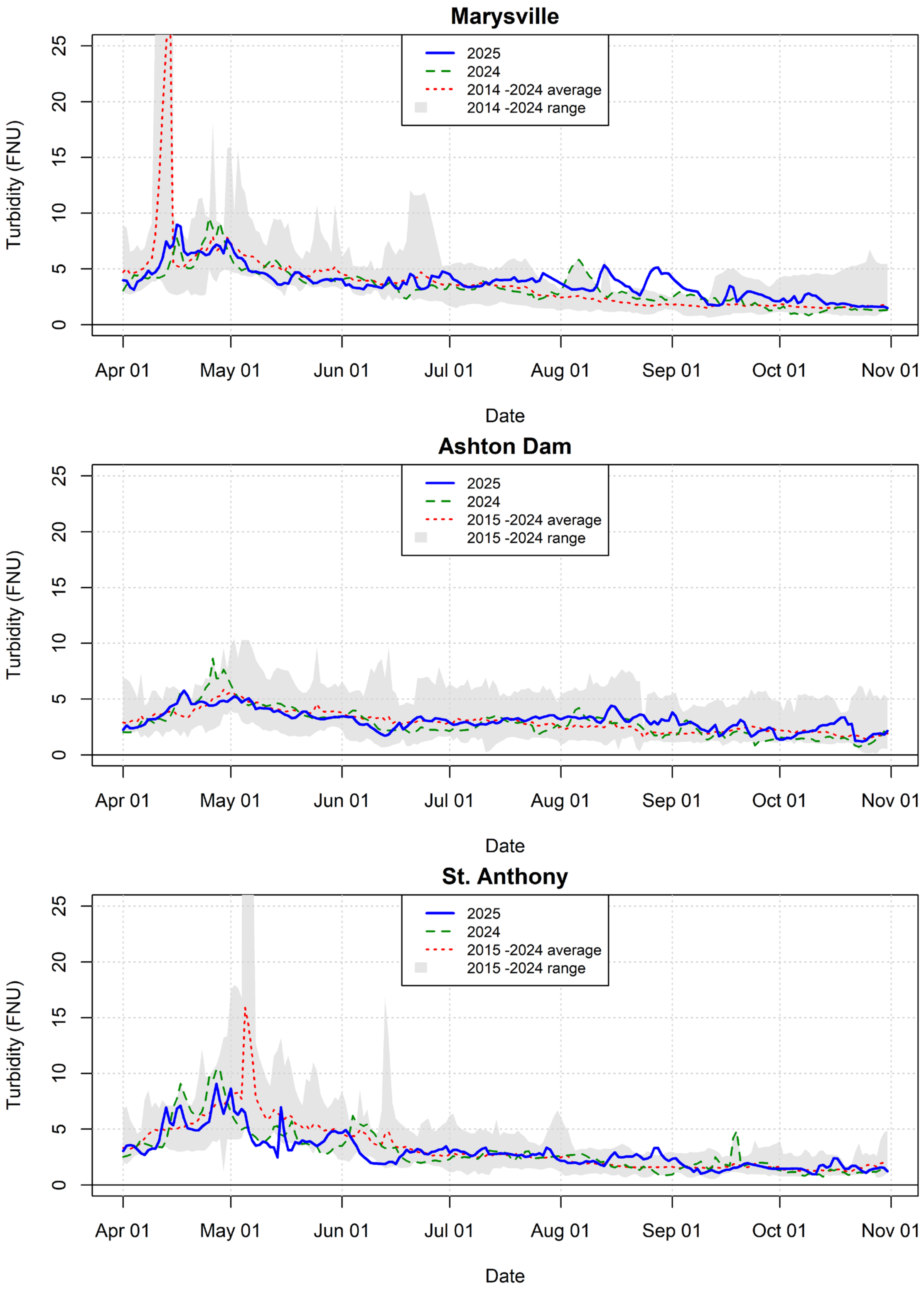


Figure 42. *Turbidity (FNU) at three sites in the Lower Henry’s Fork watershed: Marysville, Ashton Dam, St. Anthony.*

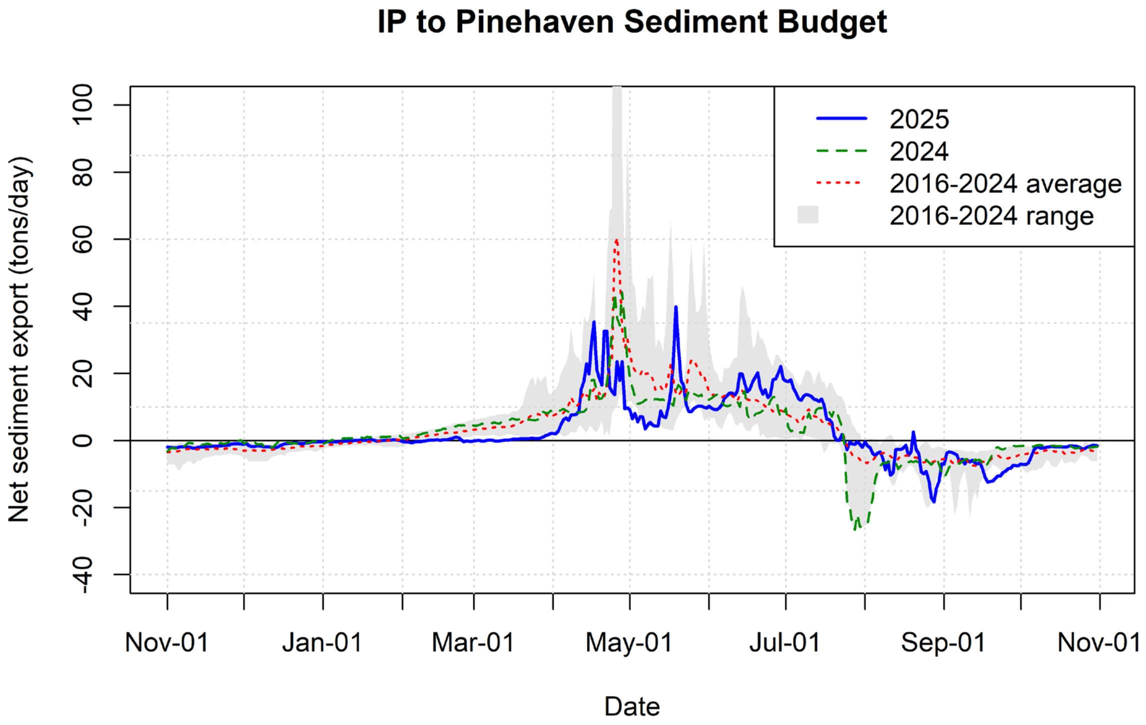


Figure 43. *Net sediment export from Island Park Dam to Pinehaven in tons/day.*

Dissolved Oxygen

Of the three water-quality parameters reported here, dissolved oxygen has the greatest potential to cause a fish kill or other acute degradation of aquatic ecosystem function. At the levels we observe in the Henry's Fork, high water temperature and turbidity values primarily affect short-term fish and insect behavior and negatively impact the mid-summer fishing experience but do not pose any threat to trout survival. It is possible that warming temperatures have changed invertebrate species composition over the past several decades, but we have no evidence that water temperature, turbidity, or suspended sediment concentrations are negatively affecting trout or invertebrate populations over the short term.

As discussed in the previous section, low dissolved oxygen in Island Park Reservoir limits the amount of habitat available to trout and kokanee and also contributes to processes that degrade water quality. Fortunately, we see no evidence of low dissolved oxygen in the river. Even with warm water temperatures, photosynthesis by rooted aquatic vegetation maintains high dissolved oxygen concentrations throughout the Henry's Fork and its tributaries all summer. At all locations except Island Park Dam, where dissolved oxygen is affected by the oxygenation system at the power plant, dissolved oxygen concentrations averaged 7 mg/L or better all summer, with most locations staying above 8 mg/L (Figures 44 and 25). For reference, trout become stressed when dissolved oxygen drops below 5 mg/L. Generally, the lowest dissolved oxygen concentrations occur very late at night or early in the morning, before aquatic vegetation begins photosynthesizing for the day, and even then, we observed only one day when dissolved oxygen dropped below 5 mg/L. That occurred at Pinehaven early on the morning of June 1, when dissolved oxygen dropped to 4.9 mg/L for less than 30 minutes. At all other locations, dissolved oxygen stayed above 5.5 mg/L at all times of day for the entire summer, above the stressful range for trout.

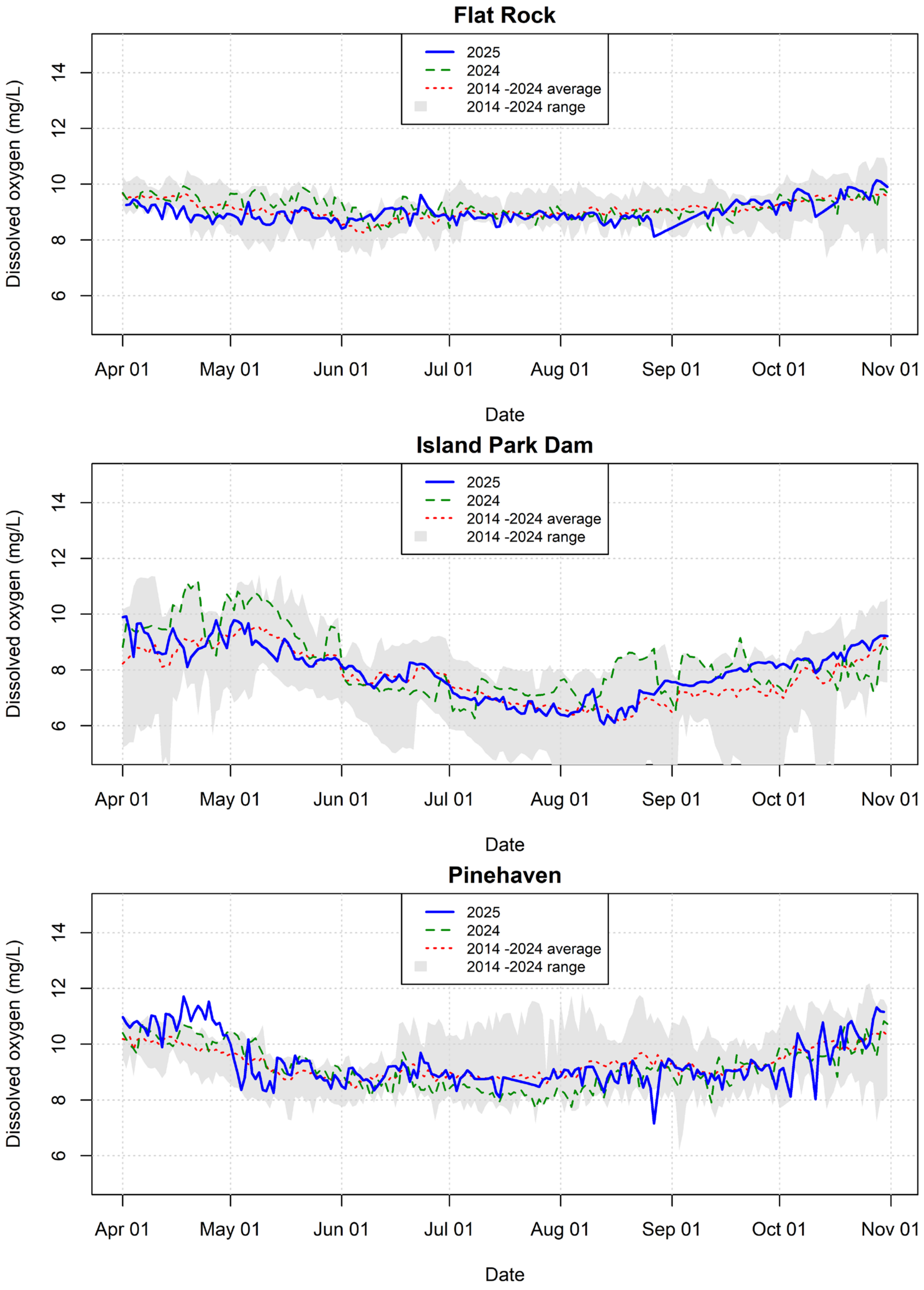


Figure 44. *Dissolved oxygen (mg/L) at three sites in the Upper Henry's Fork: Flat Rock, Island Park Dam, Pinehaven.*

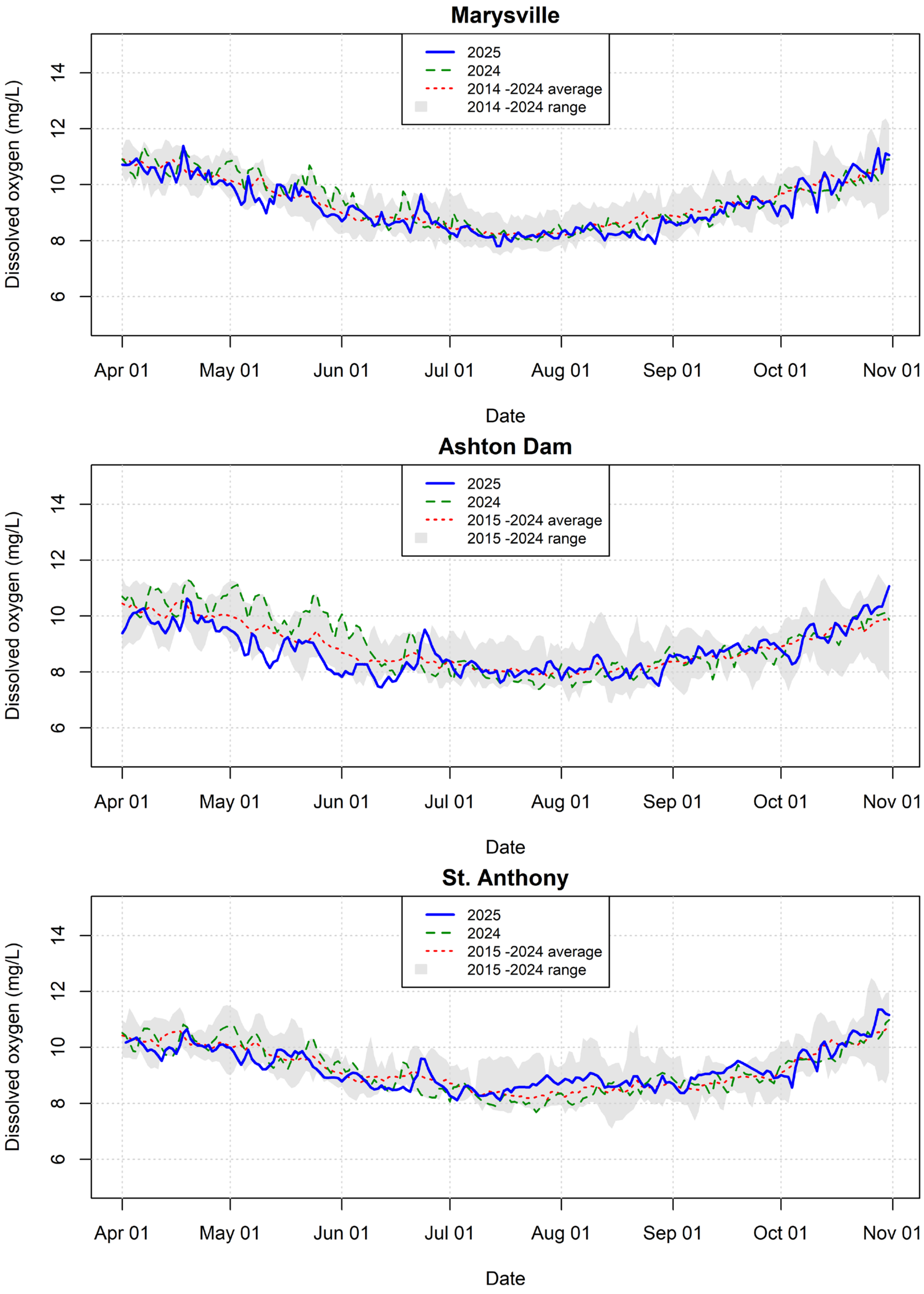


Figure 45. *Dissolved oxygen (mg/L) at three sites in the Lower Henry's Fork: Marysville, Island Park Dam, St. Anthony.*

Predictors of Water Quality Downstream of Island Park Reservoir

Adding another year of data continued to tighten statistical relationships between water quality downstream of Island Park Reservoir and causative factors. Starting with July-August water temperature, our 12-year sonde record augments data from 1996–2009 collected by Fall River Rural Electric, providing a 26-year data set. Statistically, July-August water temperature at Island Park Dam is significantly and negatively dependent on peak snow water equivalent in the upper Henry's Fork subwatershed, Henry's Fork watershed-total natural flow, Island Park Reservoir inflow, and August 31 reservoir volume. The negative dependence means that water temperature is higher when these water-supply variables are lower. Water temperature depends positively on Island Park Reservoir outflow and July-August air temperature in Island Park. Many of these predictors are either highly correlated with one another (for example, watershed-total natural flow and Island Park inflow) or are combinations of one another (reservoir volume reflects the difference between outflow and inflow). Thus, the best multi-variable model that predicts reservoir outflow water temperature includes only two of these variables, namely August-31 reservoir volume and July-August air temperature (Figure 46). The predictor variables explain 75% of the year-to-year variability in water temperature, with reservoir volume responsible for 47% of the explanatory power and air temperature responsible for the remaining 28%. This is the same predictive model that Jack McLaren found in his master's thesis research, which included data only up through 2017, but addition of more data improved the R^2 value from 0.63 to 0.75.

The highest summertime water temperature in the 26-year record was observed in 2007 due to high reservoir draft and warm air temperatures. The coolest temperature in the record occurred in 2009. Temperature in 2025 came in at 6th warmest. On average, the 23,500 ac-ft improvement in reservoir carryover resulting from more precise water management since 2018 has decreased July–August water temperature by around 0.5°F.

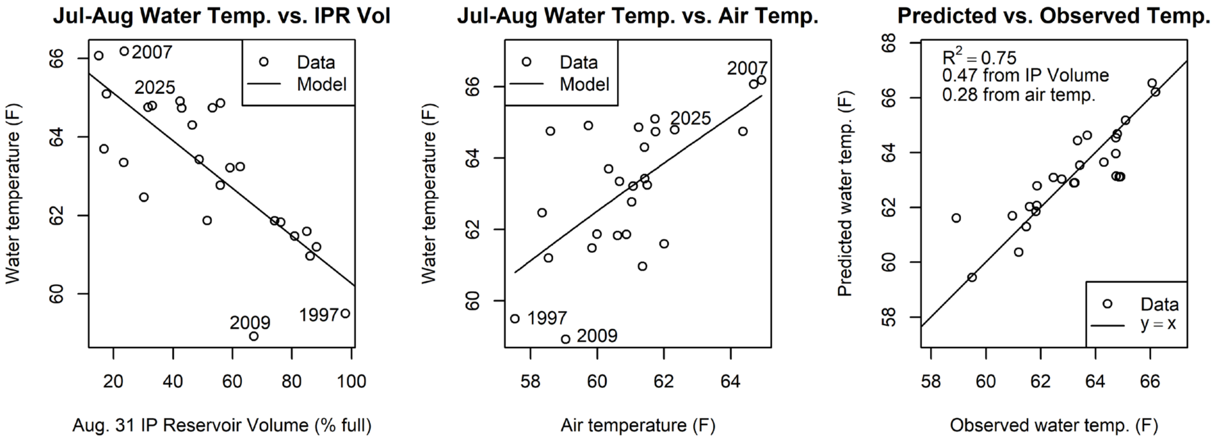


Figure 46. *Water temperature downstream of Island Park Dam vs. reservoir volume and air temperature (left two panels), model performance when water temperature is predicted by both variables (far right).*

Adding a 12th year of data to the turbidity dataset produced a much better statistical model than we had after the summer of 2024. June 15–September 30 Turbidity depended positively on Island Park Reservoir outflow and negatively on both end-of-season reservoir volume and watershed-wide natural flow. As it turned out, the best statistical model included only watershed-wide natural flow as a predictor (Figure 47). Watershed-wide natural flow is a master variable that is correlated with inflow to Island Park

Reservoir, the amount of water needed to be released from the reservoir to meet irrigation demand, and summertime weather. Higher natural flow is associated with both increased reservoir inflow and decreased reservoir draft, as well as lower nutrient concentrations and shorter residence time of water in the reservoir. This model explained 63% of the year-to-year variability in summertime turbidity in the outflow from Island Park Reservoir and clearly demonstrates that turbidity is much lower in years of higher water supply. Turbidity in 2025 was the highest in our 12-year record by a wide margin. Based on the decreasing trend in watershed natural flow (Figure 9), we estimate that summertime turbidity has increased by around 2 NTU over the past 48 years, from an average of around 3 NTU to its current average of around 5 NTU.

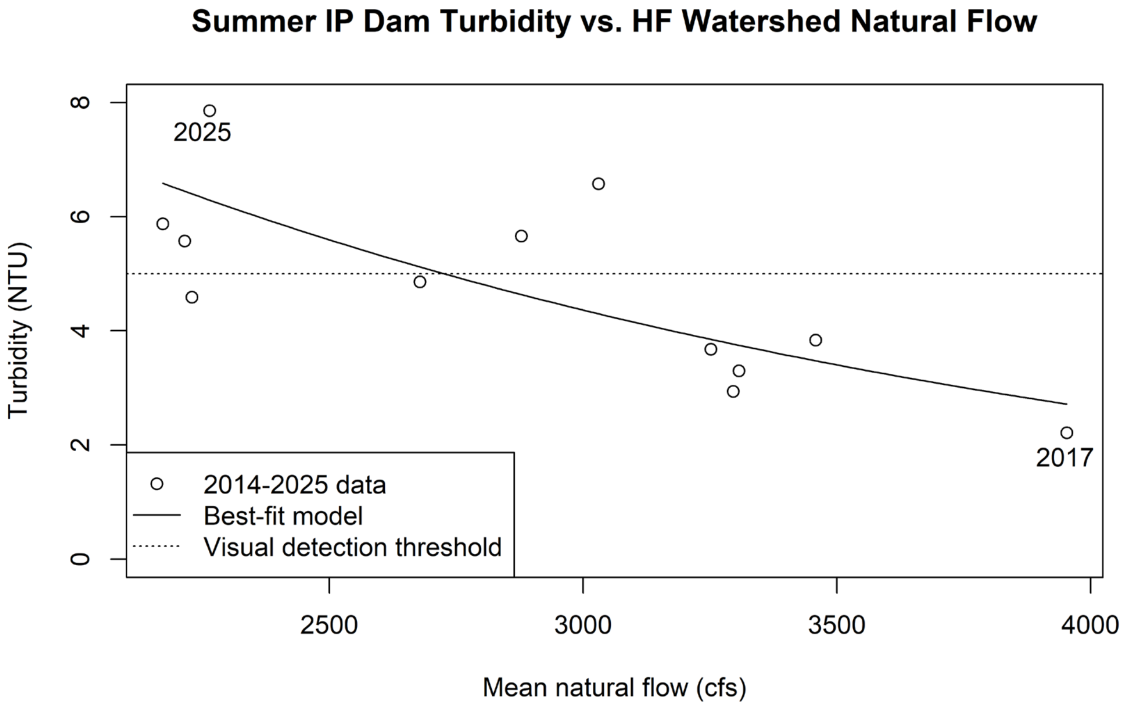


Figure 47. *Turbidity in Island Park Dam outflow vs. watershed natural flow.*

The best statistical model for June 15–September 30 sediment load at Island Park Dam did not change with the addition of another year of data. Because sediment concentration is proportional to turbidity, it was negatively dependent on watershed-wide natural flow and end-of-season reservoir volume. However, sediment load is concentration multiplied by flow, and outflow from the reservoir varies more from year to year than concentration. Thus, the best predictor of sediment load was simply total outflow from the dam (Figure 48). This model explained 60% of the variability in sediment load. The 23,500 ac-ft increase in reservoir carryover since first implementation of precision water management in 2018 is equivalent to a decrease in summertime outflow at Island Park Dam of around 78 cfs, which has resulted in a 17% reduction in sediment load over what would have been expected without the water savings.

Accuracy of water quality predictions in 2025

Using water-quality models fit to data through 2024 and our April-1 predictions of water-supply and streamflow, we under-estimated Island Park Reservoir outflow water temperature, turbidity and

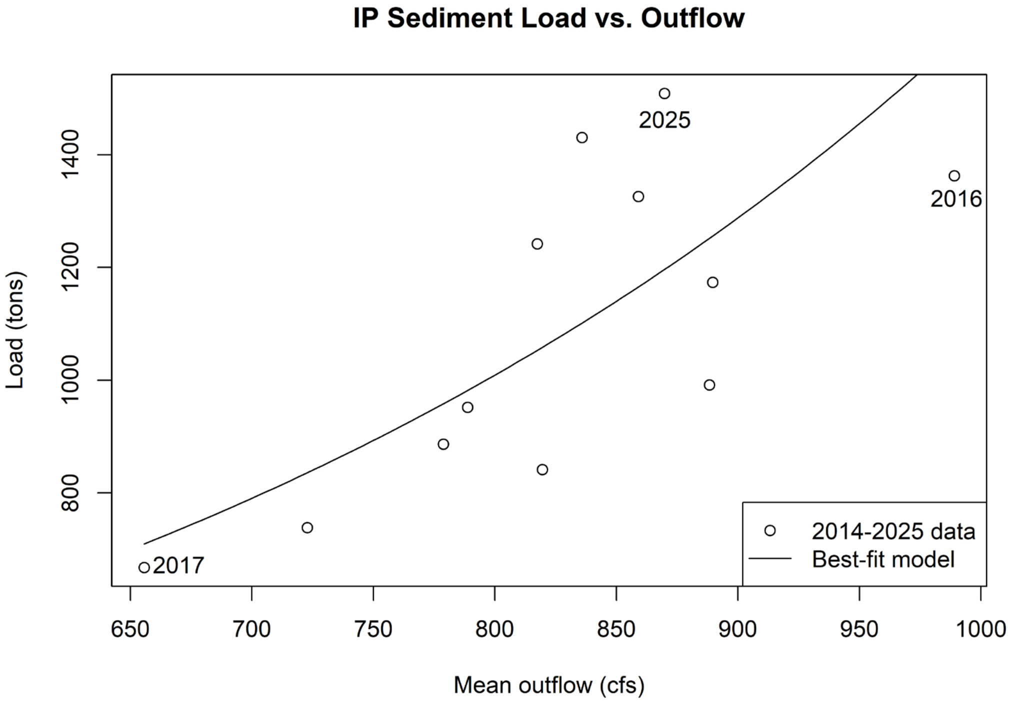


Figure 48. *Sediment load at Island Park Dam vs. reservoir outflow.*

suspended sediment load (Table 8). These underestimates were the result of the summer turning out to be among the warmest and driest on record, as mentioned earlier in the section on water-supply predictions. However, all observed values fell within the 95% prediction intervals. With the more precise models fit to data through 2025, we anticipate better performance in predictions of water quality in 2026.

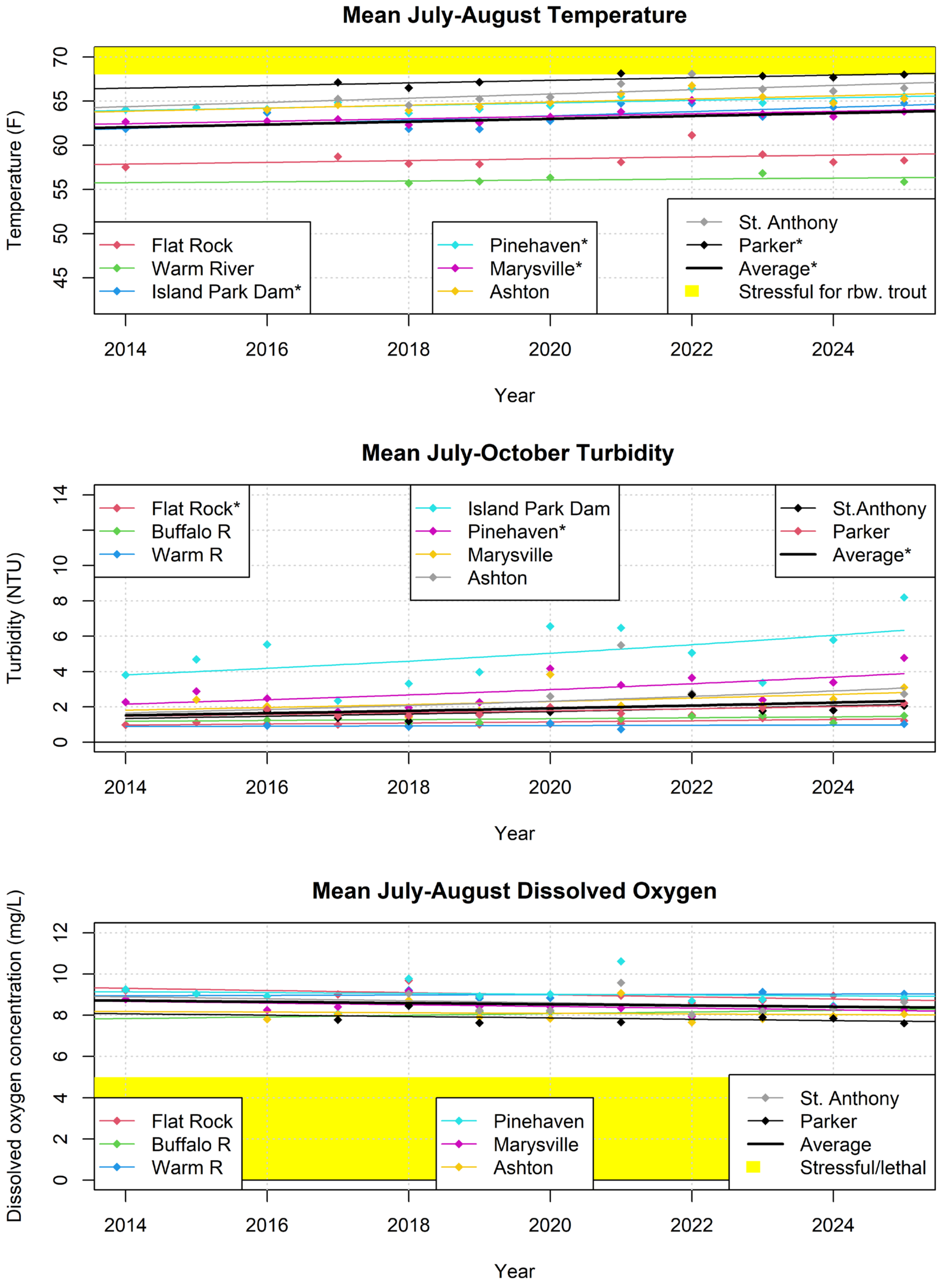
Table 8*. Predicted and observed values for June 15–September 15 water quality in the outflow from Island Park Reservoir.*

Parameter	Prediction	95% prediction interval	Observation
Average temperature (°F)	61.5	59.6–63.3	62.8
Average turbidity (NTU)	4.6	2.5–8.2	7.4
Suspended sediment load (tons)	1,450	800–2200	1,727

Water quality trends

We have observed statistically significant increases in temperature and turbidity at the watershed scale since we started our sonde program in 2014 but no trend one way or the other in dissolved oxygen (Figure 49).

Mean July-August water temperature has increased by 1.6°F per decade since 2014 across eight sonde locations on the mainstem Henry's Fork and Warm River. We did not include Buffalo River in this analysis because the sonde was moved to a new location in 2022 that may not be comparable in temperature. Temperatures at Flat Rock and Warm River are below the eight-site average, while those at Parker, St. Anthony, Ashton, and Pinehaven are below the average. Temperatures at Island Park and Marysville are very close to the average. Not surprisingly, mean temperature at Warm River is coldest, while that at


Mean July-August Temperature

Mean July-October Turbidity

Mean July-August Dissolved Oxygen

Figure 49. *Summertime water quality parameters on the Henry's Fork (Water Year 2014–2025). Asterisks indicate that the trend is statistically significant.*

Parker, near the bottom of the watershed is the warmest, around 9°F warmer than Warm River. Trends were positive at all locations and statistically significant at four of the eight locations when considered independently of the other locations. However, the fact that summertime water temperature is increasing nearly universally at all locations provides strong evidence for warming at the watershed scale; hence the statistical significance for the average across the eight locations. This increase in summertime water temperatures in our 12-year sonde record is concurrent with the longer-term increasing trend in summertime air temperatures mentioned in the climate section. Mean summertime water temperature has stayed below the stressful threshold for rainbow trout for the past decade everywhere except St. Anthony and Parker. Brown trout dominate the trout population at both of those sites, most likely because of warm temperatures.

Turbidity also showed a statistically significant increase at the watershed scale, in this case around 4% per year. Turbidity was lowest at Warm River and highest at Island Park Dam, with values at Island Park being 5 times higher than at Warm River, due nearly exclusively to processes in the Island Park Reservoir. Turbidity at Warm River, Flat Rock, and Buffalo River—all at or near headwater springs—are below the 9-site average, while that at Island Park Dam, Pinehaven, Marysville and Ashton Dam are above the average. St. Anthony and Parker are very close to the watershed average. The only sites with statistically significant increasing trends on their own were Flat Rock and Pinehaven, but as with temperature, the fact that all locations are experiencing some degree of increase provided strong statistical evidence that turbidity is increasing at the watershed scale and not just at and downstream of Island Park Dam.

For the dissolved oxygen analysis, we omitted Island Park Dam, because oxygen concentrations there are maintained according to the Federal Energy Regulatory Commission license for the power plant and so do not necessarily reflect environmental conditions. Further, the dissolved oxygen requirement there was changed in 2018 to require higher dissolved oxygen during the rainbow trout spawning and rearing period but require lower concentration in the summer to allow the power plant to more easily meet the requirement and hence operate a greater fraction of the time. Across the other eight locations, dissolved oxygen concentration showed no trend one way or the other over the past decade and little variability across sites. Mean summertime dissolved oxygen concentrations were highest at Flat Rock, Warm River and Pinehaven, due to cooler water temperatures at Flat Rock and Warm and River and to high rates of photosynthesis by aquatic vegetation at Pinehaven. Dissolved oxygen was lowest at Parker due to warmer water temperatures and the lowest aquatic vegetation abundance of any of our sonde locations. Given that dissolved oxygen has the greatest potential to threaten short-term trout survival and degrade the aquatic ecosystem—including aquatic insects—very high and stable oxygen concentrations are a strong indicator of healthy ecosystem function and high resilience to warming.

8. Aquatic Invertebrates

Spatial and Temporal Patterns in Invertebrate Communities

To address angler concerns about decreased hatches, particularly at Last Chance and the upper Ranch, and holistically assess ecological function throughout the mainstem Henry’s Fork, we implemented a statistically rigorous, quantitative study of aquatic invertebrates in 2015. This followed implementation of a watershed-wide water-quality monitoring program in 2014 and prompted subsequent expansion of stream gaging. The result is a set of 56 independent observations of macroinvertebrates collected at six different sites on the river over an 11-year period, each accompanied by a full suite of water-quality and streamflow variables. In this section, we include only a summary, but you can download the full report, which contains full details of methods, statistical analyses, and results.

Our sampling sites—Flat Rock, Last Chance, Osborne Bridge, Marysville, Ashton Dam, and St. Anthony—represent conditions over the 80 miles of river most popular among anglers. We analyzed invertebrate abundance, five standard community metrics—Shannon's diversity, EPT taxa richness (the number of mayfly, stonefly, and caddisfly species), Hilsenhoff Biotic Index (HBI), percent non-insects, and percent EPT—as well as the abundance of Pale Morning Duns (*Ephemerella* sp.), *Drunella* mayflies (Flavs + Green Drakes), and Spotted Sedge caddis (Hydropsychidae). For each of these response variables, we tested for dependence on distance downstream from Big Springs as predicted by the River Continuum Concept, difference across sites independent of the river continuum, and dependence on seven streamflow and water-quality variables: annual streamflow, 3-day maximum streamflow, 21-day minimum streamflow, annual flow variability, suspended sediment concentration, conductivity, 7-day maximum water temperature, and total phosphorus. Primary results are:

1. Invertebrate communities in the Henry's Fork are abundant, diverse, and dominated by mayflies, stoneflies and caddisflies; are as good or better than on other western trout streams; and are as good or better than they were on the Henry's Fork decades ago. HBI indicates good to excellent water quality from headwaters to St. Anthony, with little evidence of pollutants.
2. Abundance and %non-insects showed no variability across location along the river and no dependence on any of the streamflow or water quality variables.
3. The other seven responses were best explained by location on the river, with little to no dependence on streamflow or water quality, after accounting for location.
4. Total invertebrate abundance and Pale Morning Dun abundance have decreased significantly since 2015, with marginal evidence for decreases in %non-insects and community diversity.
5. However, HBI, %EPT, and EPT taxa richness have all improved significantly since 2015, indicating overall improvement in water quality and aquatic habitat and possible replacement of non-insect and other degradation-tolerant species with more sensitive and desirable EPT species.
6. There is no evidence that trout populations are limited by invertebrate numbers (Figure 50).
7. It is possible that large changes in PMD abundance and community metrics occurred at Last Chance prior to this study, as a result of increasing temperatures relative to previous decades.
8. However, decreased dry-fly fishing quality at Last Chance/upper Ranch over the past decade is likely due to a combination of lower trout populations, increased turbidity, and altered mayfly emergence behavior due to warmer temperatures, not to decreased insect numbers.

2025 Hatch Observation Survey

Introduction

Aquatic insect hatches are a fundamental component of the Henry's Fork fly fishing experience. Since 2015, the Henry's Fork Foundation has collected benthic aquatic invertebrate data at multiple locations along the Henry's Fork river as a measure of water quality. However, these surveys collect information on insect density and diversity on the river bottom and do not capture the day-to-day behavior of emerging adult insects of interest to anglers and important to the Henry's Fork fly fishing experience.

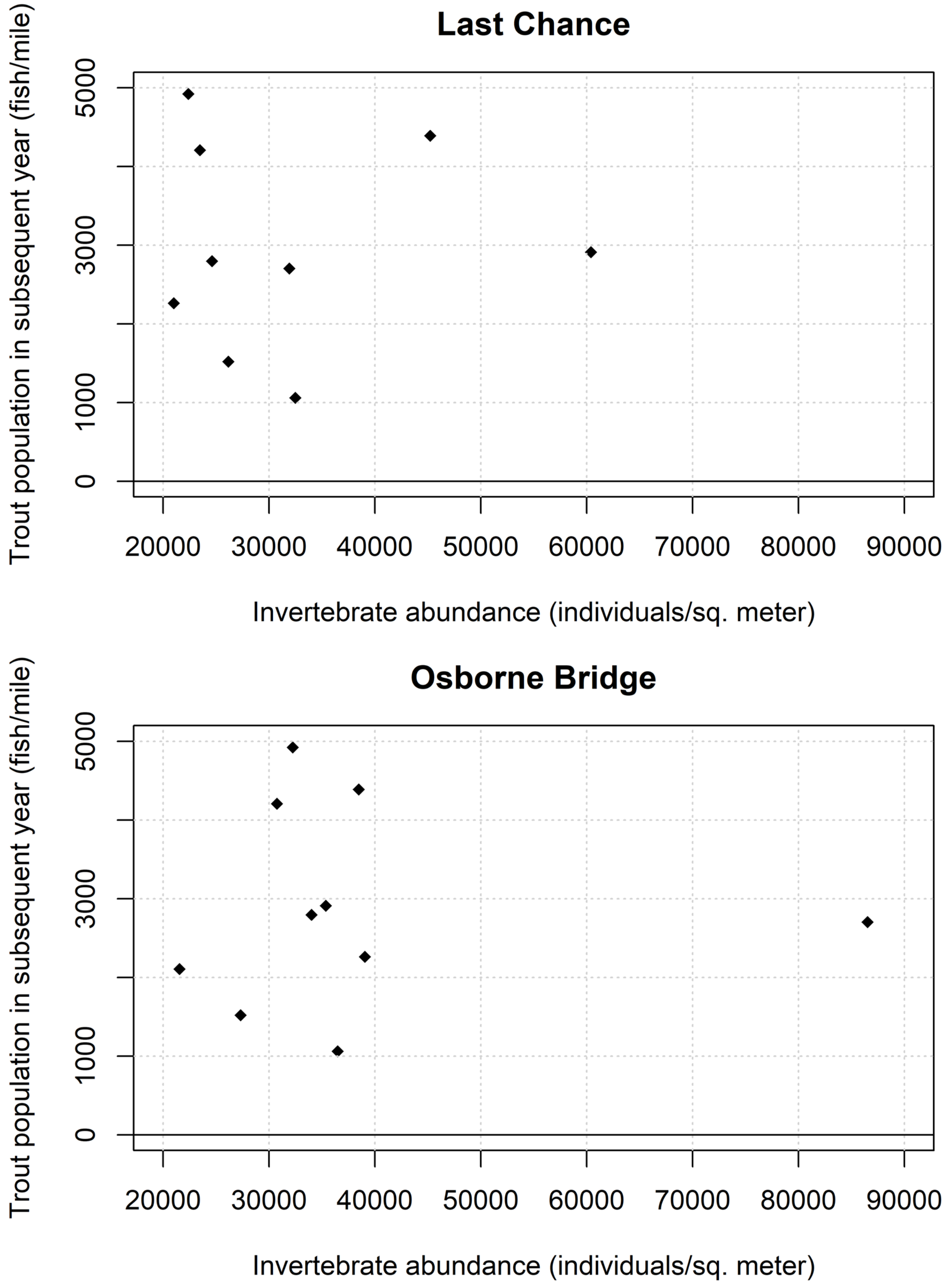


Figure 50. *Box Canyon trout population plotted as a function of total invertebrate abundance at Last Chance and Osborne Bridge. Correlations are* $r = 0.13$ *at Last Chance and* $r = 0.0015$ *at Osborne.*

In Summer 2024, anglers reported that hatches were not occurring on the Henry's Fork as expected—hatches were either occurring at different times of day or not at all. Therefore, the Henry's Fork Foundation launched the Henry's Fork Hatch Observation Survey, an online survey for river visitors to submit their hatch observations. The survey asks users to share their name and email (for verification), where they visited the river (reach), when they visited the river (date, time of arrival, time of departure), if they observed aquatic insects hatching (yes/no), and, if so, what insects they observed. Insect selection is branched, where respondents first check boxes for Mayfly, Stonefly, Caddisfly, and Midge and then are routed through the options under each insect category (except for Midge). All aquatic insect selection options are accompanied by a photo freely available online or presented with permission (obtained in 2024) from and credit to the photographer. The survey can be viewed at: tinyurl.com/hfhatchreport and an accompanying blog post detailing the survey is available at https://henrysfork.org/post/whats-hatching-on-the-henrys-fork/. Survey recruitment was conducted via HFF social media channels (Facebook and Instagram), as well as in the monthly e-newsletter and quarterly newsletter (distributed via print and email).

The Henry's Fork Foundation does not share hatch observation reports in real time. This is partially due to staff capacity, but is also in response to participation hesitancy—anglers expressed a disinterest in participating if their responses would be shared in (near) real time. The implicit concern is that if hatch observations are reported in (near) real time, angling traffic may increase on given reaches in hindrance to preferred fishing experiences. This document serves as a summary of the 2025 submissions to the survey.

Survey Response Statistics

- 47 individuals reported hatch observations from a total of 104 river visits between March 20, 2025 and October 9, 2025 (Figure 51).
    - Of these 104 river visits, 72% occurred in May and June.
    - Of these 104 river visits, 88% reported seeing aquatic insects hatching.
    - Of these 104 river visits:
        - 22% were from Ashton Dam to Chester Dam
        - 20% were from Log Jam to Osborne Bridge
        - 14% were from Osborne to Riverside
        - 12% were from Last Chance to Log Jam
        - Of the remaining 12 reaches available for reporting in the survey
            - 2 reaches had zero reports (Buffalo River and Parker to South Fork confluence)
            - The remaining 10 reaches represent the remaining 32% of submissions, with each reach representing 1–9% of submissions

Reach Summary

This information is presented for the reaches that represent the top four reach submissions, presented from upstream to downstream.

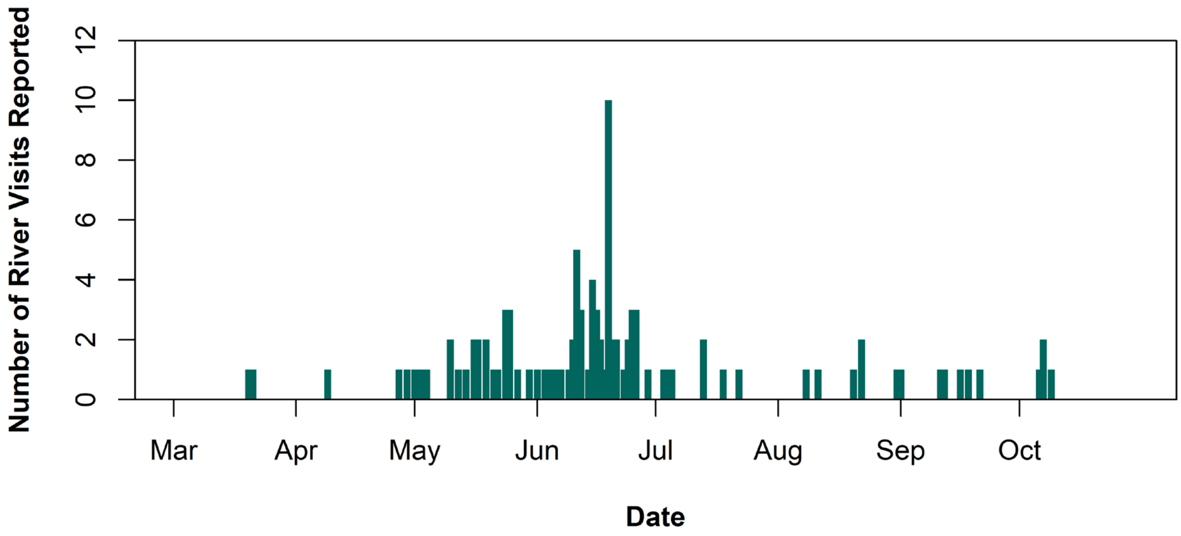


Figure 51. *Number of river visits reported during the 2025 fishing season.*

Last Chance to Log Jam

- 12 submissions from 8 individuals
- Observation range was June 4–July 18, 2025 (Figure 52).
- All submissions were for river visits that occurred between 8am and 2pm
- 58% of submissions reported observing aquatic insects hatching
  - Caddisfly (unknown) and Pale Morning Dun (dun and spinner) were the most observed aquatic insects hatching.

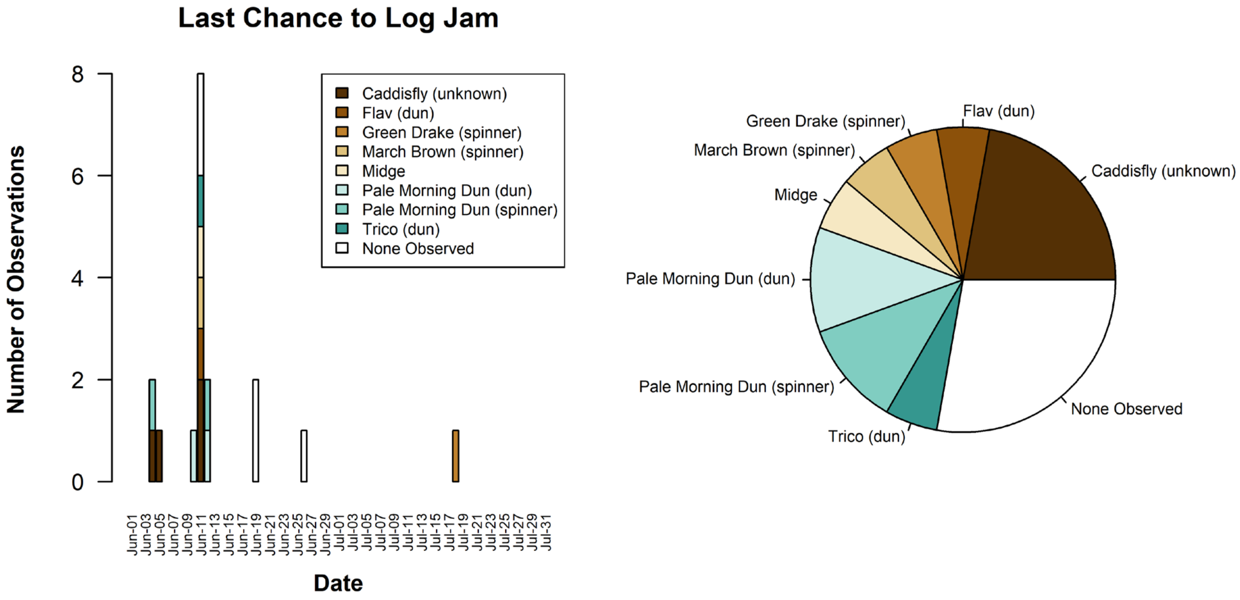


Figure 52. *Hatch observations from Last Chance to Log Jam by date (left) and insect type (right).*

Log Jam to Osborne Bridge

- 21 submissions from 10 individuals
- Observations were from June 15–July 13 and August 31–October 9, 2025 (Figure 53).
- All submissions were for river visits that occurred between 7:45am and 10pm
- 85% of submissions reported observing aquatic insects hatching
    - Blue Winged Olive (dun) and Pale Morning Dun (dun and spinner) were the most observed aquatic insects hatching. (Figure 54).

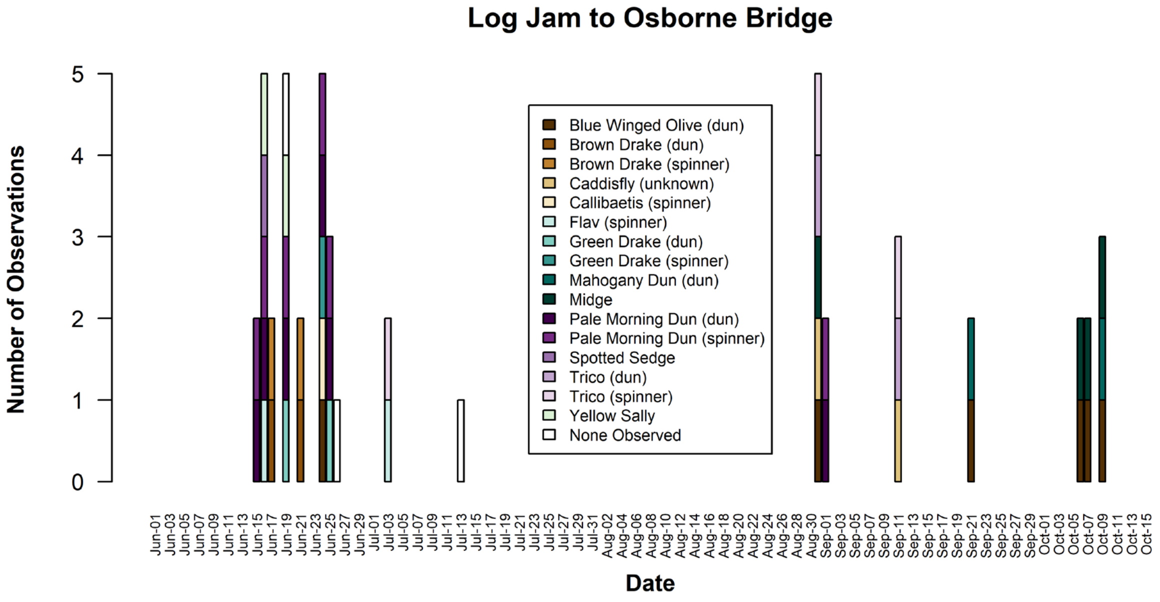


***Figure 53**. Hatch observations from Log Jam to Osborne Bridge, by date.*

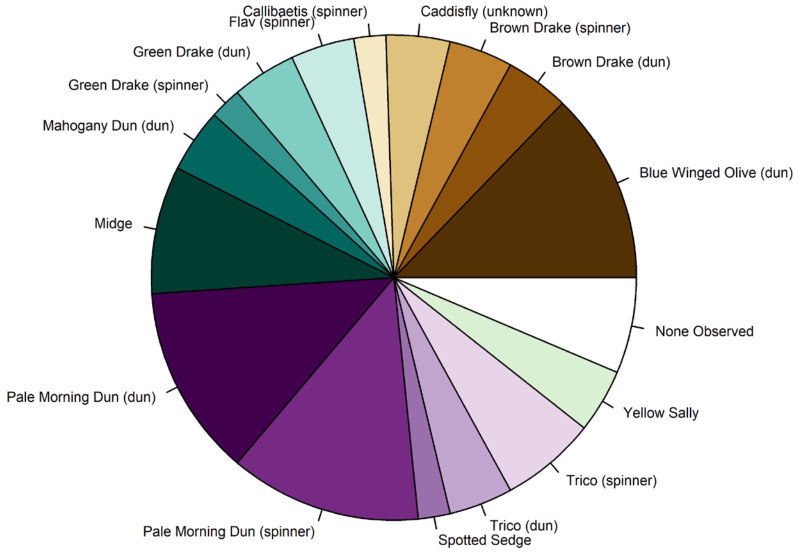


***Figure 54**. Hatch observations from Log Jam to Osborne Bridge, by insect type.*

Osborne to Riverside

- 15 submissions from 8 individuals
- Observation range was May 21–September 18, 2025, with most observations occurring in the last two weeks of June. There were no observations from June 26–August 11 (Figure 55).
- All submissions were for river visits that occurred between 5am and 10pm
- 100% of submissions reported observing aquatic insects hatching
    - Pale Morning Dun (dun and spinner) and Brown Drake (dun and spinner) were the most observed aquatic insects hatching (Figure 56).

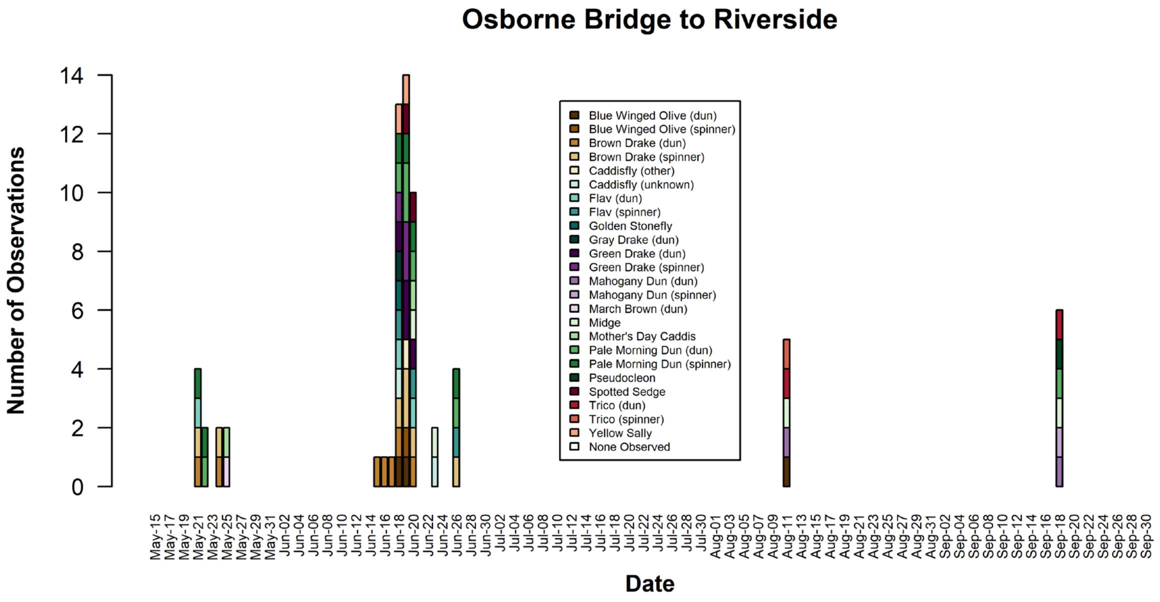


***Figure 55**. Hatch observations from Osborne Bridge to Riverside, by date.*

Ashton Dam to Chester Dam

- 23 submissions from 17 individuals
- Observations range was April 29–September 12, 2025. Most observations were from April 29–July 13, 2025 (Figure 57).
- All submissions were for river visits that occurred between 7am and 10:15pm
- 100% of submissions reported observing aquatic insects hatching
    - Mother’s Day Caddis and Pale Morning Dun (dun and spinner) were the most observed aquatic insects hatching (Figure 58).

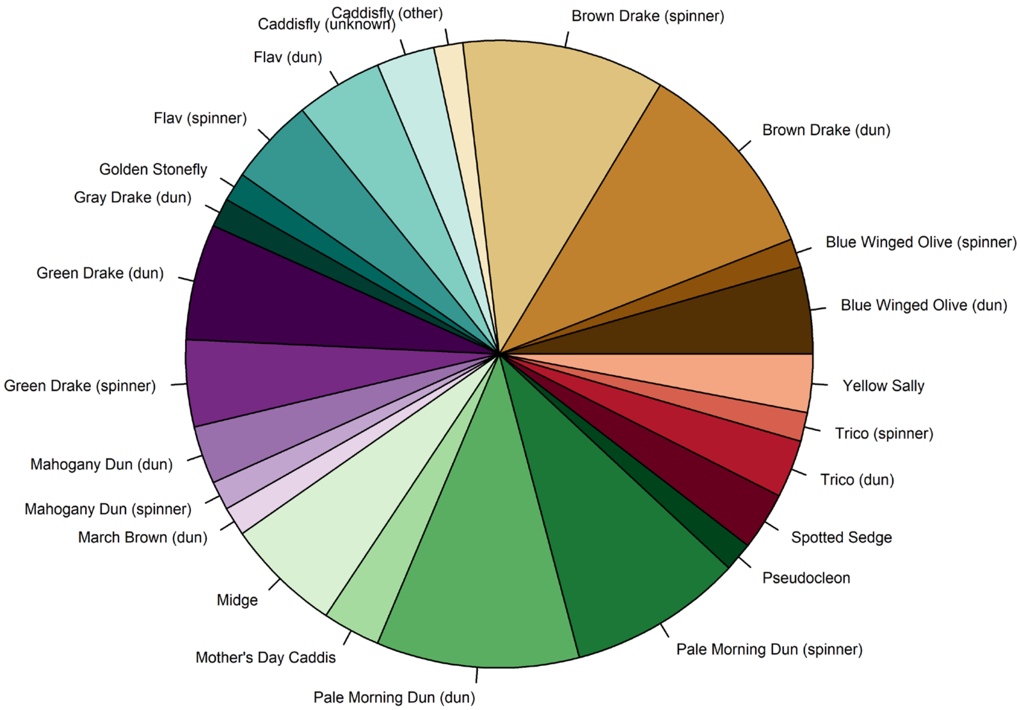


Figure 56. Hatch observations from Osborne Bridge to Riverside, by insect type.

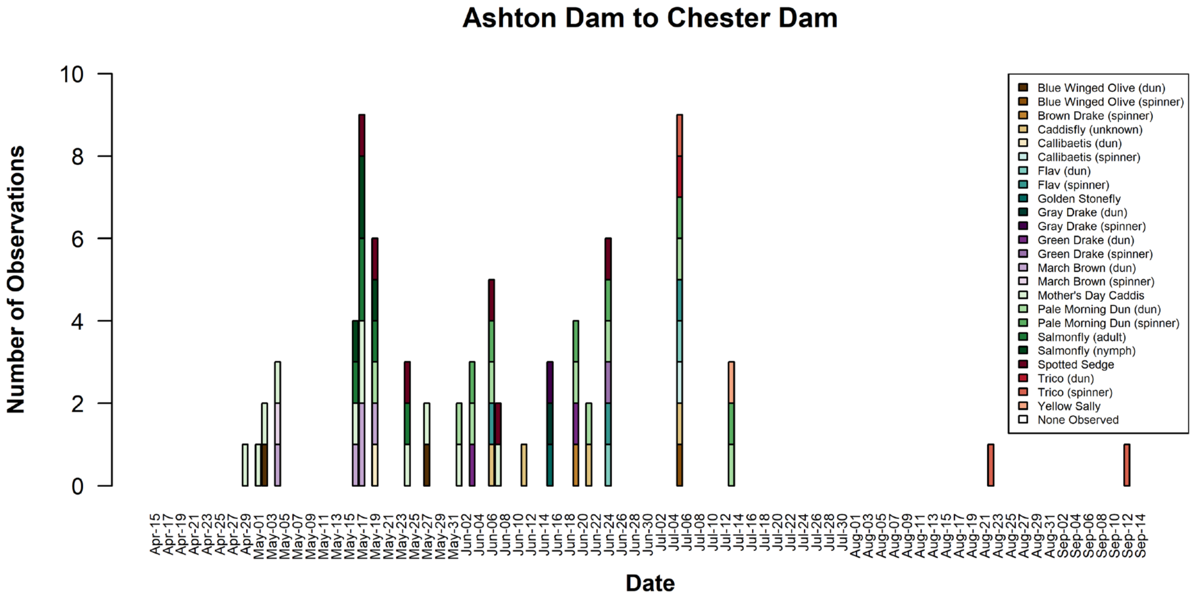


Figure 57. Hatch observations from Ashton Dam to Chester Dam, by date.

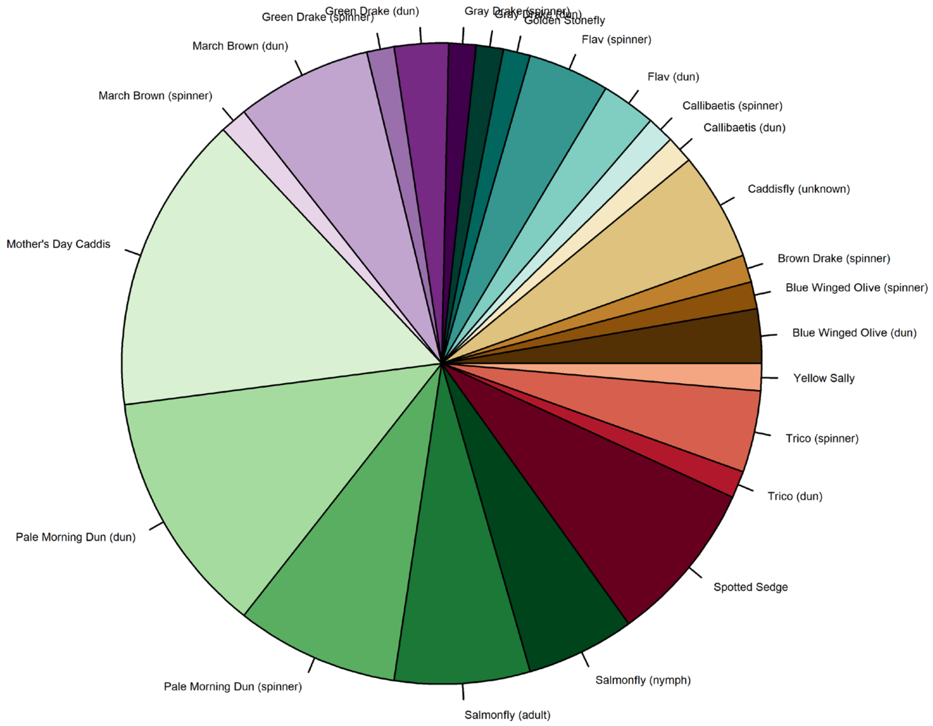


***Figure 58**. Hatch observations from Ashton Dam to Chester Dam, by insect type.*

Hatch summary

Across the 104 river visits, there were 288 total hatch observations submitted (including no hatches observed). Of those 288 observations, 61% were for mayflies, 12.5% were for stoneflies, 17% were for caddisflies, 4.5% were for midges, and 4.5% reported no hatches observed (Figure 59). Blue Winged Olive and Pale Morning Dun mayflies and Mother's Day and Spotted Sedge caddisflies were the most frequently observed species.

Blue Winged Olive

- 17 submissions from 11 individuals
  - 16% of total hatch observation submissions for 2025 reported observing Blue Winged Olive duns or spinners.
- Observation range was April 9–October 9, 2025
- 88% of BWO observations were for duns
- Blue Winged Olives were observed at 7 reaches in the Henry's Fork Watershed
  - 35% of observations were from the Log Jam to Osborne Bridge reach
  - 24% of observations were from Osborne Bridge to Riverside
  - 18% of observations were from Ashton Dam to Chester
  - And each of the following reaches had 1 observation (or 6% of BWO observations):
    - Henry's Lake Outlet to Island Park Reservoir (Mack's Inn)
    - Island Park to Last Chance
    - Riverside to Warm River/Stonebridge
    - Warm River to Ashton Reservoir

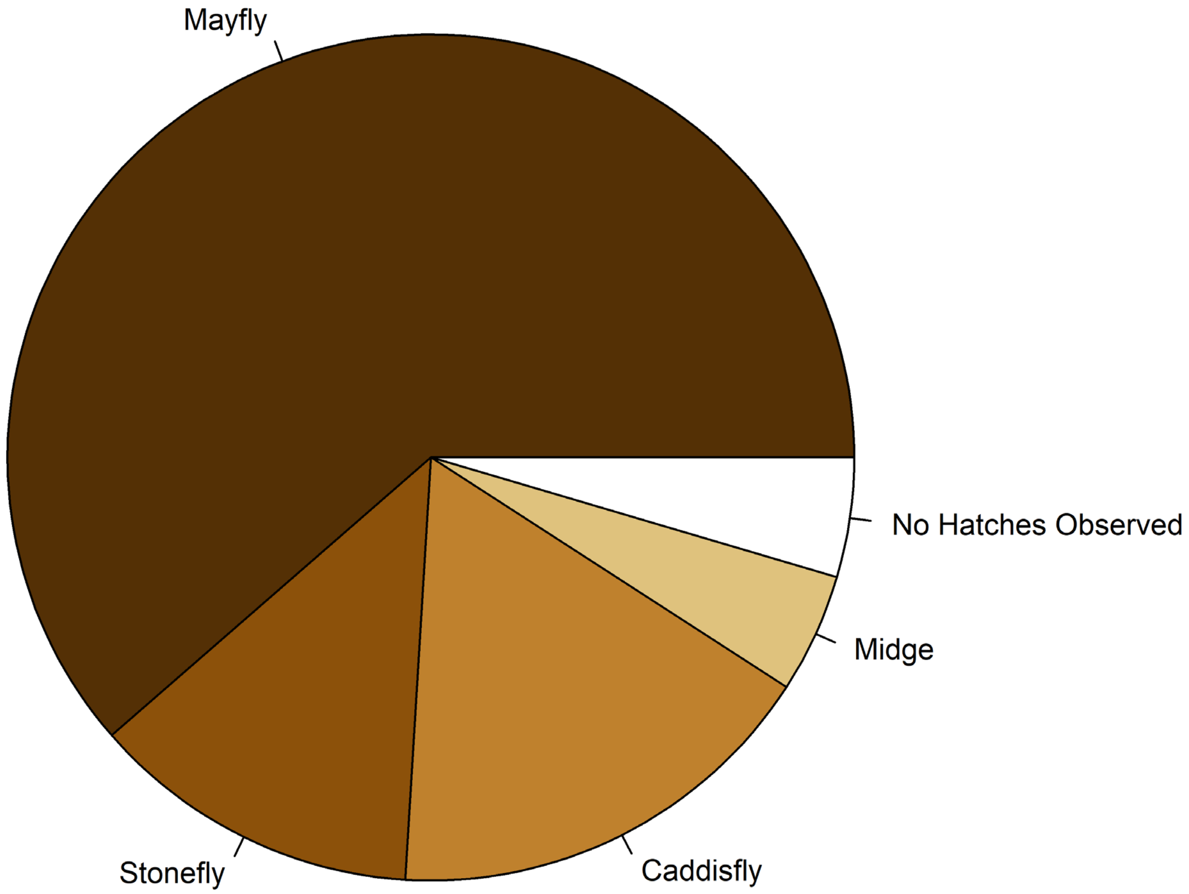


Figure 59*. Summary of all hatch observations, by insect type.*

Pale Morning Dun

- 57 observations from 22 individuals
    - 54% of total hatch observations for 2025 reported observing Pale Morning Dun duns or spinners.
- Observation range was May 10–September 18, 2025
- 56% of PMD observations were for duns.
- Pale Morning Duns were observed at 10 reaches in the Henry’s Fork Watershed
    - 26% of observations were from Ashton Dam to Chester Dam
    - 23% of observations were from Osborne Bridge to Riverside
    - 21% of observations were from Log Jam to Osborne Bridge
    - 7% of observations were from each of Last Chance to Log Jam and Fall River
    - Other reaches were 2–5% of observations

Mother’s Day Caddis

- 19 observations from 16 individuals
    - 18% of total hatch observations for 2025 reported observing Mother’s Day Caddis

- Observation range was April 27–June 20, 2025
- Mother’s Day Caddis were observed at 7 reaches in the Henry’s Fork Watershed
    - 57% of observations were from Ashton Dam to Chester Dam
    - 11% of observations were from Osborne Bridge to Riverside
    - 11% of observations were from Island Park to Last Chance
    - Other reaches had each of 5% of observations

Spotted Sedge

- 15 observations from 9 individuals
    - 14% of total hatch observations for 2025 reported observing Spotted Sedge
- Observation range was May 17–June 24, 2025
- Spotted Sedge were observed at 8 reaches in the Henry’s Fork Watershed
    - 40% of observations were from Ashton Dam to Chester Dam
    - 13% of observations were from Osborne Bridge to Riverside
    - 13% of observations were from Fall River
    - Other reaches had each of ~7% of observations

Discussion

Hatch observation reports from the top four reaches were nearly absent in July and August. Reporting recovered in September and October for the Log Jam to Osborne Reach, with sparse fall-season reporting for the Osborne Bridge to Riverside and Ashton Dam to Chester Dam reaches. No reports were submitted for Last Chance to Log Jam after mid-July. The lull in summertime reporting is likely due to persistently high turbidity in outflow from Island Park Dam that occurred from mid-July to September. Such turbidity likely reduced angler visitation, as Henry’s Fork anglers value clear water. Angler visitation may also have diminished as turbidity changed fish feeding and/or hatch behavior, reducing dry-fly fishing success.

In alignment with the River Continuum Concept, hatch observations from the top four reaches demonstrate an increase in aquatic insect diversity with downstream progression from Last Chance to Chester Dam, as we have observed in our annual stream-bottom sampling. However, given that no reports were submitted for Last Chance to Log Jam after July, it is also possible that the diversity in downstream observations is also influenced by a longer reporting season.

The relatively low percentage of “no hatch” observations may also be the result of no-report bias. Although survey recruitment language encourages observations with every river visit, even if no hatch is observed, it is possible reports are biased towards positive experiences.

Overall, this project will require far greater participation to be useful in understanding hatch timing both within a given year and day-to-day relative to weather and water management.

9. Buffalo River Fish Ladder: 20-year Review

In 2025, we completed the 20th year of monitoring fish passage at the Buffalo River fish ladder on the Buffalo River Hydroelectric Project, owned and operated by Fall River Rural Electric Cooperative. While a full formal report on 20 years of monitoring is being prepared separately for submission to the Federal Energy Regulatory Commission, we are including the primary content of that report here.

Introduction

This report has three objectives. First, it compiles and presents standardized annual spring passage summaries for 2006–2025. Second, it describes interannual variation in passage magnitude and run timing of spawning-sized Rainbow Trout (*Oncorhynchus mykiss*). Third, it evaluates whether annual variation in spring passage of spawning-sized Rainbow Trout is consistent with variation in antecedent winter flow through Box Canyon. Accordingly, the report is intended not only to satisfy recurring compliance needs but also to assess whether the fishway record is consistent with a well-supported recruitment mechanism central to Rainbow Trout population dynamics in the upper Henry's Fork.

The Buffalo River and Buffalo River Hydroelectric Project are situated within the Caldera reach of the Henry's Fork, defined here as the river corridor between Island Park Dam and Upper Mesa Falls. This broader spatial setting adds important context for interpreting the fishway record because the Buffalo River functions as one component of a larger hydrologic and ecological system with considerable economic significance. The Caldera reach is embedded within a highly managed water-supply system that supports the region's dominant agricultural economy. At the same time, it supports a nationally recognized wild Rainbow Trout fishery and is widely regarded as a premier fly-fishing destination, with substantial angler use and associated economic activity tied to river-based recreation. As part of annual refill operations, outflows from Island Park Reservoir are reduced during fall and winter. Numerous scientific studies have shown that winter discharge strongly affects habitat conditions in Box Canyon—the roughly 6 km (~4 mi) mainstem reach immediately downstream of the reservoir—and that juvenile overwinter survival there is the principal driver of Rainbow Trout recruitment and abundance in the Caldera reach. Together, those findings establish the winter-flow recruitment bottleneck as the dominant biological framework for understanding Rainbow Trout population dynamics in the reach.

The Buffalo River is the largest tributary in the Caldera reach and enters the Henry's Fork roughly 0.4 mile downstream of Island Park Dam. Along with Box Canyon, it represents one of the two principal concentrations of suitable spawning habitat in the reach and supports an annual spawning migration. In contrast to the highly regulated mainstem, it is a groundwater-dominated tributary with a comparatively stable flow and thermal regime and provides suitable Rainbow Trout habitat across multiple life stages. Despite that apparent habitat potential, available evidence indicates that its population-level contribution in the Caldera reach is limited. Extensive observational and modeling research by HFF has concluded that the tributary's principal contribution is through spawning and rearing, rather than enhancement of overwinter survival, and that improved access to the Buffalo River provided by the 2005 construction of the current fish ladder has contributed only an additional 3% to the mainstem population from the few juvenile trout that choose to spend the winter in the Buffalo River. The spawning migration it supports is therefore drawn from a population whose abundance is governed primarily by winter-flow-mediated juvenile survival in Box Canyon rather than by habitat conditions in the tributary alone.

Because the Buffalo River fishway is situated near the downstream end of one of the principal spawning areas in the Caldera reach, it provides a fixed-site, long-term record of spring spawning passage. That record provides a basis for evaluating whether interannual variation in passage of spawning-sized Rainbow Trout is consistent with the winter-flow mechanism known to structure recruitment and abundance in the Caldera reach.

Methods

Upstream fish passage into the Buffalo River was monitored between 2006–2025 using an integrated trap at the head of the Buffalo River fishway at the Hydroelectric Project. The current fishway configuration reflects substantial modifications completed in 2005 under the project license to improve upstream passage conditions, particularly for smaller trout, relative to the earlier ladder configuration, which had limited passage. As part of those modifications, a trap was incorporated at the head of the fishway to allow capture, enumeration, and biological sampling of upstream migrants during monitoring periods. Continuous monitoring under the improved configuration began in March 2006.

Fishway operation has varied over the monitoring record. From 2006 through 2012, the trap was generally operated continuously and checked at least three times per week, such that fish ascending the fishway were routed into the trap, processed, and released upstream. Beginning in 2013, operation became less continuous, with recurring periods in which the trap screen was removed to allow free passage without capture or processing. In later years, monitoring shifted to a spring-focused regime in which the trap was generally operated from late winter through early summer and then opened for free passage. During free-passage periods, fish were not counted or measured; these intervals were therefore treated as unsampled periods in the complied dataset.

During trap checks, captured fishes were identified to species and measured for total length (mm) prior to release upstream. Analyses in this report focused on Rainbow Trout. Spawning-sized Rainbow Trout were defined as individuals at least 300 mm (11.8 inches) in total length. This threshold has been used in prior fishway reports and provides a practical index of the spawning component of the migration. Because maturity is not strictly length-based, the threshold should not be interpreted as a definite biological maturity boundary.

All fishway records from 2006–2025 were compiled into a single database of upstream trap captures. To support cross-year comparability under variable operation schedules, annual analyses were standardized to a fixed spring window of March 1 through June 15 to capture the period of most consistent overlap. Within that window, annual spring passage magnitude was summarized as the total number of spawning-sized Rainbow Trout captured migrating upstream. Run timing was summarized from the cumulative distribution of daily captures, with the primary timing metric reported as the median migration date, defined as the date on which cumulative passage first reached or exceeded 50% of the annual total. This metric also follows prior fishway reports and provides a consistent index of spring run timing among years. Due to operator error and equipment failures, years 2015 and 2023 were excluded from all analyses and summary products to preserve comparability across years. Periods in which the trap screen was removed and fish passed freely were retained as unsampled intervals and were not gap-filled.

To evaluate whether interannual variation in spring spawner passage was associated with winter-flow conditions in the Henry's Fork mainstem, winter flow was summarized as mean daily discharge over December 1–February 28 for each year in the Box Canyon flow record, defined as the sum of Island Park Dam outflow and Buffalo River inflow. Although the Box Canyon flow series was plotted for all years in the available hydrologic record, the regression analysis included only spawning years retained in the biological dataset.

The spawning-age fish present in a given spawning year t are primarily fish of ages 2, 3, 4, and 5, which experienced recruitment-limiting winter flow, respectively, 1, 2, 3, and 4 years prior to their observation in the fishway in year t. Assuming that recruitment is proportional to winter flow, and that a typical annual adult survival rate is 0.5, an adjusted winter-flow predictor was calculated as a weighted mean of the winter flow during years t–1, t–2, t–3, and t–4:

$$Q_{adj}(t) = \frac{1.0Q_{t-1} + 0.5Q_{t-2} + 0.25Q_{t-3} + 0.125Q_{t-4}}{1.875}$$

where Q_t is the mean December 1–February 28 Box Canyon discharge for water year year t. The weighting scheme reflects the adult survival rate of 0.5, relative to the current cohort of 2-year old fish. That is, we expect half as many 3-year olds as 2-year olds, half as many 4-year olds as 3-year olds, etc. Thus, the spawning population in year t consists of 2-year olds, which experienced recruitment-limiting winter flow in year t–1, followed by 3-year olds, which experienced recruitment-limiting winter flow in year t–2, etc. The relationship between annual spring spawner abundance and adjusted winter flow were evaluated using a log–log linear regression. Annual spawner abundance, $Count_t$, was defined as the total number of spawning-sized Rainbow Trout captured between March 1 and June 15 in year t. Both $Count_t$ and $Q_{adj}(t)$ were transformed using base-10 logarithms prior to analysis, and the fitted model was

$$log_{10}(Count_t) = \beta_0 + \beta_1 log_{10}(Q_{adj}(t)) + \varepsilon_t$$

where $Q_{adj}(t)$ is the adjusted winter-flow covariate for spawning year t, β_0 is the intercept, β_1 is the slope parameter, and ε_t is the residual error term. Model adequacy was evaluated using standard linear regression diagnostics.

Results

Across analyzed years, observed spring passage of spawning-sized Rainbow Trout through the fishway varied substantially among years (Figure 60). Excluding 2015 and 2023, annual counts within the standardized March 1–June 15 window ranged from 88 fish in both 2006 and 2018 to 748 fish in 2021. Mean annual passage across analyzed years was 247 fish, whereas the median was 220 fish, indicating a right-skewed distribution driven in part by the exceptionally large run observed in 2021. Most years fell well below that peak, with counts generally between roughly 100 and 400 fish. Interannual variability was evident throughout the record. Relatively high spring passage was observed in 2008, 2010, 2013, and 2021, whereas comparatively low passage was observed in 2006, 2007, 2014, 2017, and 2018. Following the record high in 2021, observed spring passage declined to 280 fish in 2022 and then remained within the mid-range of the time series in 2024 (218 fish) and 2025 (266 fish).

Median migration date also varied among years, though less dramatically than annual passage magnitude. Among years analyzed, annual median migration date ranged from April 13 to May 20, with a cross-year median of April 29. Earlier median migration dates were observed in 2017, 2018, and 2020, whereas later timing was observed in 2006, 2009, 2013, and 2016. Despite this interannual variation, most annual median dates clustered within a relatively narrow period spanning mid-April through early May. The cumulative timing distributions for 2024 and 2025 were broadly consistent with the long-term pattern (Figure 61). In both years, cumulative passage began increasing in March, accelerated through April, and approached completion by late May or Early June. Relative to the long-term average and historical range, both 2024 and 2025 tracked within the envelop of past variability for most of the spring migration period, indicating that recent run timing was not anomalous within the context of the full monitoring record.

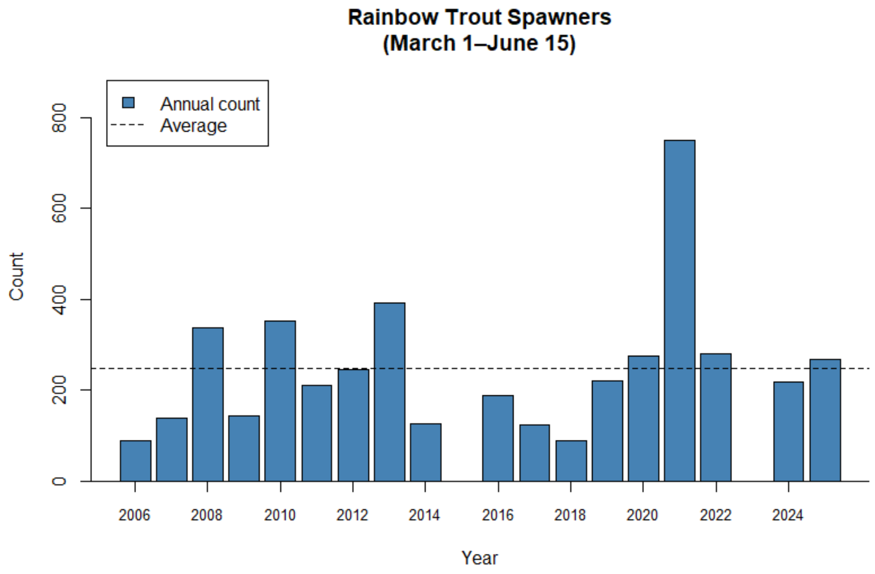


***Figure 60**. Annual spring passage of spawning-sized Rainbow Trout (≥ 300 mm total length) captured at the Buffalo River trap during the standardized monitoring window, 2006–2025. The dashed horizontal line indicates the long-term average (247).*

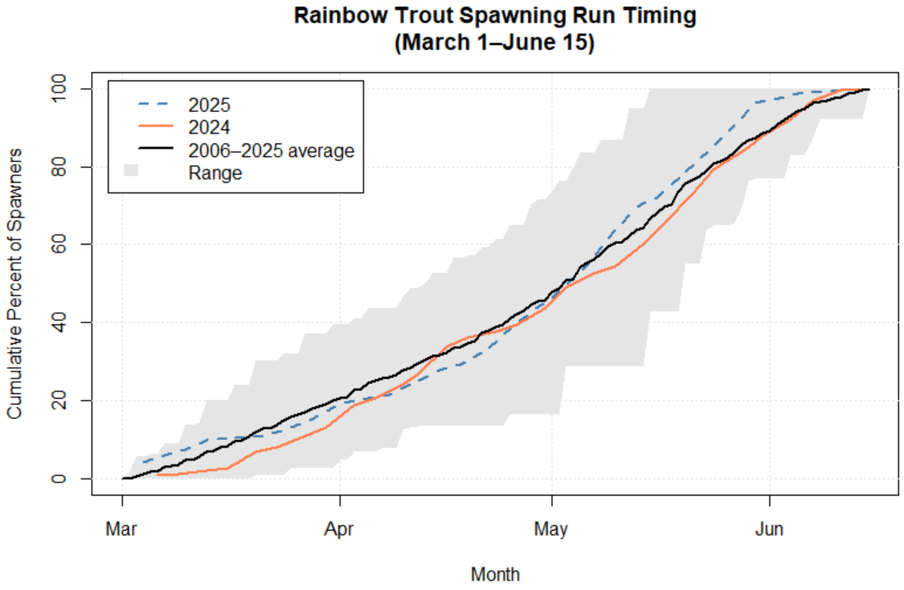


***Figure 61**. Cumulative spring passage of spawning-sized Rainbow Trout (≥ 300 mm total length) captured at the Buffalo River trap during the standardized monitoring window, shown for 2024 (orange) and 2025 (blue dashed) relative to the long-term mean (black) cumulative pattern and historical range (gray).*

Mean winter discharge in Box Canyon, summarized over December 1 through February 28, varied appreciably among years (Figure 62). The winter-flow time series shown in Figure 62 spans 2002–2025, thereby including the antecedent winters needed to calculate the adjusted winter-flow predictor for the first analyzed year (2006; dependent on winter flows in 2002–2005). Years 2015 and 2023 were retained in the hydrologic series for context but excluded from biological analyses. Winter discharge was well below the long-term mean in several years, especially 2002–2005, 2008, 2014–2017, and 2022–2023, to well above the mean in 2012 and again during 2018–2021. The Buffalo River contribution was comparatively stable among years relative to total Box Canyon flow, indicating that most interannual variation in winter discharge was associated with variation in Island Park Dam outflow rather than with large shifts in Buffalo River inflow.

Annual abundance of spawning-sized Rainbow Trout was strongly and positively dependent on adjusted winter flow (Figure 63). The fitted log–log regression had an intercept of -3.19 and a slope of 2.03 and explained 59.7% of the interannual variation in annual spawner abundance. The overall model was significant ($F_{1,16} = 23.69$; $p = 0.0002$), with a residual error of 0.156. Thus, adjusted winter flow accounted for the majority of the observed year-to-year variation in spring spawner passage.

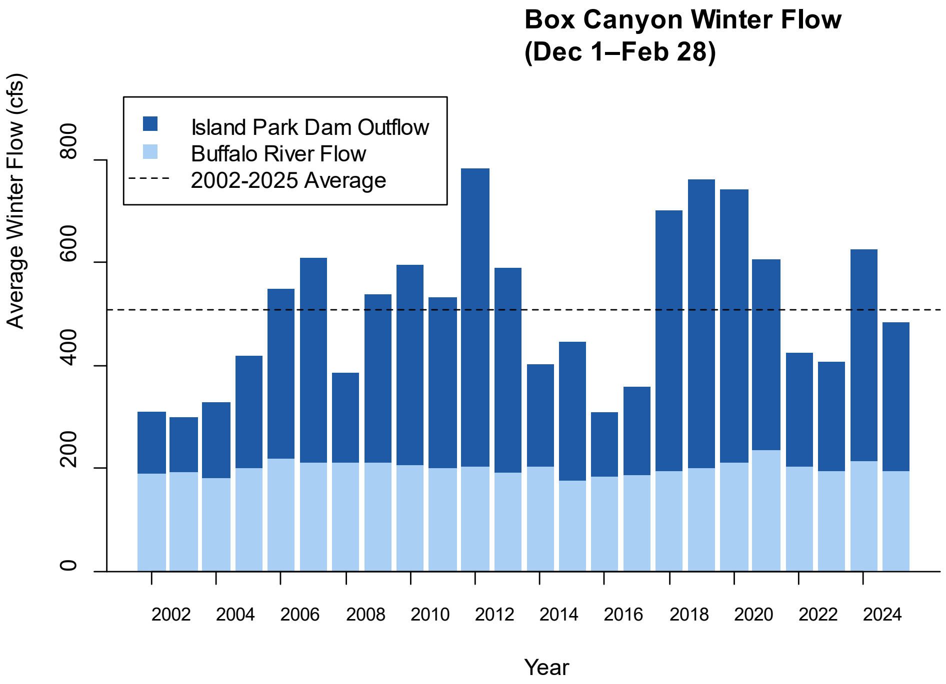


***Figure 62**. Winter flow in Box Canyon, showing the respective contributions from the Buffalo River and Island Park Dam. The dashed horizontal line is the long-term average (509 cfs).*

Length-frequency distributions of all measured Rainbow Trout indicated that fishway captures spanned a broad range of body sizes in most years, with annual distributions typically extending from roughly 100 mm to more than 500 mm total length. In most years, captures included substantial representation of fish in the 100–200 mm range as well as larger individuals at or above the spawning-sized threshold.

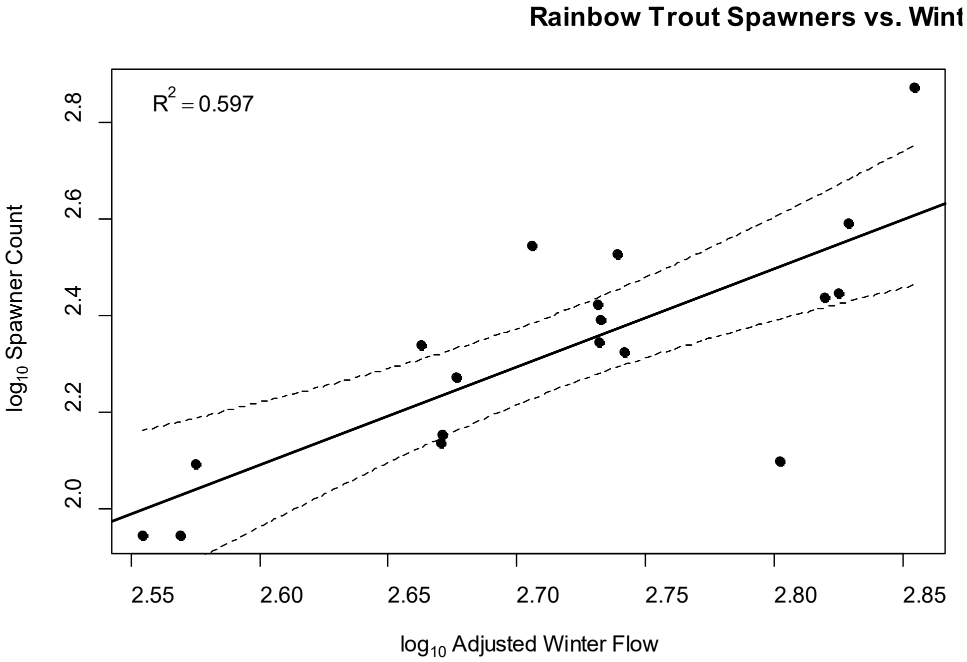


Figure 63. *Relationship between abundance of spawning-sized Rainbow Trout in the Buffalo River fish ladder (≥ 300 mm total length) and adjusted winter flow in Box Canyon for analyzed years 2006–2025, excluding 2015 and 2023.*

Annual species totals indicated that Rainbow Trout and Brook Trout (*Salvelinus fontinalis*) dominated trap captures throughout most of the monitoring record, whereas Mountain Whitefish (*Prosopium williamsoni*) and other species—Mountain Suckers (*Pantosteus platyrhynchus*), Speckled Dace (*Rhinichthys osculus*), Longnose Dace (*Rhinichthys cataractae*), Redsided Shiner (*Richardsonius balteatus*), and Sculpin (*Cottus*)—were generally much less abundant. Across analyzed years, median annual totals for Rainbow Trout, Brook Trout, and Mountain Whitefish were 719, 230, and 2, respectively. Except for 2006, Rainbow Trout were the most abundant species in all years and strongly dominated the assemblage, most notably in 2021, when 1,103 individuals were recorded and no other species were captured. Brook Trout were also numerous in several years, particularly earlier in the record, and in some years comprised a substantial share of total captures. Mountain Whitefish occurred inconsistently and usually in low numbers, although counts were comparatively elevated in 2007 and 2010. Other species remained minor in most years but increased in some later years, including 86 and 143 individuals in 2019 and 2025, respectively. Overall, these descriptive summaries indicate that spring fishway use was dominated by Rainbow Trout and Brook Trout, with limited but recurring passage by Mountain Whitefish and other taxa.

Discussion

The monitoring record indicates that the Buffalo River fishway provides functional upstream passage into a major spawning tributary. Across the 2006–2025 monitoring period, Rainbow Trout consistently dominated spring fishway use, but Brook Trout and several other species were also passed. In addition, observed Rainbow Trout spanned a wide range of body sizes, indicating use by multiple age classes rather than by adults only. Taken together, these observations suggest that the fishway is not simply passable in an engineering sense but is used recurrently by fishes present in the Caldera reach.

The relationship between spring spawners and antecedent winter flow adds to the extensive body of evidence identifying winter flow as a principal bottleneck shaping Rainbow Trout population dynamics in the reach. Earlier work focused primarily on age-0 survival, juvenile overwinter habitat, and age-2 recruitment. The present analysis suggests the same basic mechanism is also detectable in the abundance of spawners using the Buffalo River in spring. That inference is strengthened by the hydrologic context surrounding the record 2021 spawning run. Rather than following a single favorable winter alone, the 2021 peak occurred after a sequence of unusually high winters, with 2018, 2019, and 2020 ranking fourth, second, and third, respectively, among winters in the 2002–2025 Box Canyon flow record. Viewed in that context, the 2021 response is more plausibly interpreted as the cumulative expression of several favorable antecedent winters than as an isolated annual anomaly, and is consistent with a population that experiences flow-limited recruitment but subsequent constant adult survival.

Winter flow, however, remained only a partial explanation of annual variation in tributary passage. The fitted relationship explained roughly 60% of the variation in annual abundance of spawners, suggesting that antecedent winter flow is not solely determinative of spawning-run magnitude. That outcome is consistent with the fact that the trap record reflects one component of a broader and spatially structured population. Annual counts are therefore best interpreted as an index of tributary spawning use rather than as a measure of total adult abundance in the Caldera reach. Subsequent survival, growth, age at maturity, repeat spawning, annual allocation of adults among available spawning habitats, and other local or reach-scale processes likely all contribute to the remaining unexplained variation.

Furthermore, several limitations and caveats should be recognized. First, standardization to a fixed March 1–June 15 window improved comparability among years, but it did not eliminate all possible effects of differences in sampling intensity and necessarily excluded some early migration documented in February in some years. Second, the 300 mm total-length threshold was used as a practical index of the spawning component of the migration, not as a definitive measure of maturity. Some fish smaller than 300 mm, particularly males, nevertheless exhibited reproductive condition, a pattern consistent with the literature. Third, the weighted winter-flow variable was biologically motivated but applicable only if the adult survival rate is constant at 0.5. Lastly, the analysis was correlative and should be interpreted as testing consistency with the established recruitment framework rather than as independently demonstrating causation. Additional refinement could improve understanding of the mechanisms linking winter flow to annual spawning-run magnitude.