Tumalo Creek 2024 Fish Monitoring Report

City of Bend - Bridge Creek Water System

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Tumalo Creek snorkel survey fish monitoring site #22 (A1-RR Upper) *Photo: Nate Dachtler*

Fish Populations Monitoring Plan

This report is produced in accordance with Forest Service Special Use Permit BEN1158, and conditions set forth for monitoring the effects of the diversion of municipal water from the Bend Municipal Watershed over the duration of the City of Bend's Special Use Permit (SUP). In accordance with the monitoring requirements for the Operation of the City of Bend Bridge Creek Water System with the Deschutes National Forest, fish populations in Tumalo Creek are to be monitored to assess effects from operation of the new system. Monitoring is to occur annually during 2016–2018, then every other year through 2024 (USDA FS 2013).

Monitoring will be conducted by Deschutes National Forest Fisheries personnel after the new system is in operation. A total of 5 sites will be surveyed annually in late summer for 3 years, then biennially over the next 6 years. This schedule is subject to change based on an annual evaluation of the monitoring program by staff from the City of Bend, Deschutes National Forest, and other stakeholders. One monitoring site will be above the City of Bend project area (between the junction with Bridge Creek and Tumalo Falls) and 4 sites will be within the affected area of Tumalo Creek within Sub-reach A1. Further, the 4 sites within Sub-reach A1 will include two sites within Sub-reach A1RR (upper and lower) and two sites within Sub-reach A1B (Figure 1). The 4 sites within the affected area will be those previously surveyed in the 2011 fisheries survey of Tumalo Creek. One site above the project is the Control Site and was first sampled in 2016. Each site will be 200 meters in length. The survey crews generally consist of two snorkelers and one data collector/safety person per team. Typically, one site per night will be surveyed per crew.

Methodology

Snorkeling was chosen as the monitoring method as it offers a reasonably efficient and cost-effective tool to assess population trends, relative abundance, distribution, and assemblages of the fish community (Goetz 1989 and Hankin and Reeves 1988). Snorkeling causes little disturbance or injury to fish, which can commonly occur with electrofishing surveys (Ainslie et al. 1998, Snyder 2003). The difficulty of deploying block nets in larger streams common to electrofishing Mark-Recapture or Depletion surveys to determine population estimates also led to the selection of snorkeling as the monitoring method. The high velocities and discharge volumes of Tumalo Creek make it difficult to effectively install block nets at most sampling sites. The low conductivity of the water in Tumalo Creek also reduces the effectiveness of electrofishing by limiting the field and strength of electrical currents in the water, reducing the ability of surveyors to stun and capture fish (Bohlin et al. 1989, Borgstrøm and Skaala 1993).

Potential limitations of collecting suitable data from snorkeling include: difficulty in observing young-of-the-year age classes due to preferred shallow depths and concealment under cover, startling fish while moving through the survey area, error in size estimations, counting the same fish more than once, difficulty in observing fish in heavy cover, difficulty in accurate counts in dense populations, and wrongly identifying species, especially when multiple species are present, experience and ability of individual snorkelers, and poor visibility which can occur after storms due to increased turbidity (Brock, 1982, Helfman 1983).

Tumalo Creek has several characteristics that make it suitable for snorkeling and having a reasonable success rate in collecting suitable data: good visibility, moderate depths (<5 feet maximum), moderate cover, and the presence of fish limited to salmonids, which maintain their position in the water column and are easy to observe and identify. In addition, most monitoring sites on Tumalo Creek have only two salmonid species, with a maximum of three, reducing the potential for misidentifying species.

To address the potential limitations and improve data collection on Tumalo Creek, surveys are conducted in an upstream direction, with two snorkelers moving at the same pace, each occupying a lane of approximately 15–20 feet wide (Hankin and Reeves 1988). The sampling effort is similar between reaches and between years, as each 200 meter reach is sampled in approximately 1–1.25 hours. Communication between the snorkelers on fish observed toward mid-channel reduces the probability of counting those fish twice. Snorkelers are trained on species identification prior to participating and utilize methods such as known "length of glove" or rulers to calibrate length measurements underwater.

All surveys are done at night, well after sunset, in late summer or fall. This duplicates the methodology utilized in 2011, reduces bias in observations, and, coupled with repeating the same reaches year after year with the same methodology, standardizes the sampling effort. There is evidence fish are more active at night and night snorkeling is more effective at observing salmonids than day snorkeling when water temperatures are colder (Hillman et al. 1992, Goetz 1989).

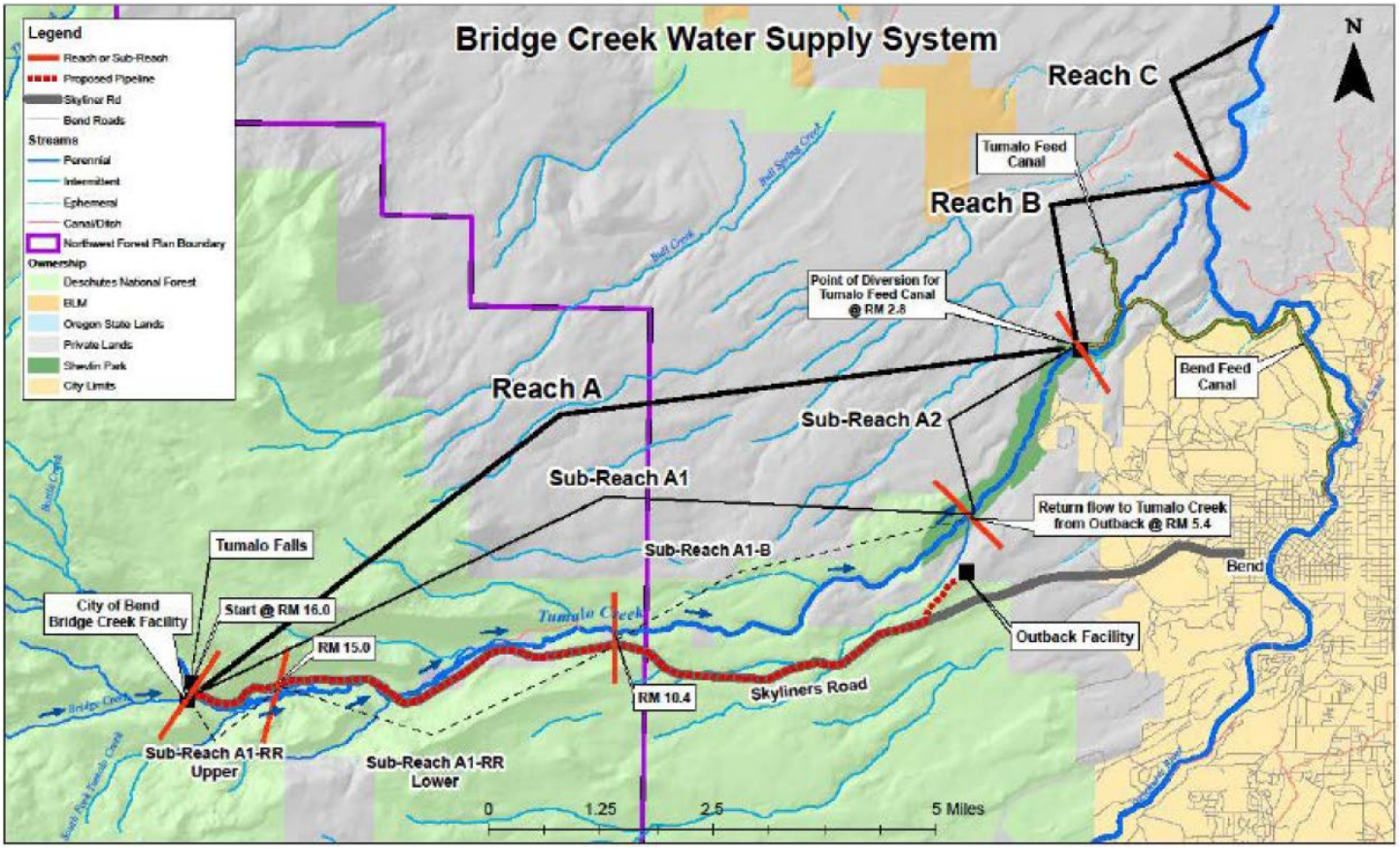

Figure 1. *City of Bend Bridge Creek water supply system reaches and sub-reaches.*

In 2022, changes to the size classes collected were made to reduce time spent identifying size classes and hopefully increase overall snorkel count accuracy. Fish size classes collected in 2022 and 2024 are as follows. Young of year (YOY) or fry (<50mm), Juvenile (50–200mm) and Adult (>200mm).

Site Descriptions

Figure 2 shows fish monitoring sites in relation to the Bridge Creek intake and Outback storage facility.

Site 32 (Control): This site is characterized by a relatively high gradient (2.74%) channel with cobble and small boulder substrate, bankfull widths of 25 to 30 feet, no side channels, and low amounts of large woody material (LWM). The site is primarily riffle habitat with depths generally less than 3 feet.

Site 22 (A1-RR Upper): This site is within the Tumalo Creek Bridge to Bridge Restoration Project area and is characterized by relatively moderate gradient (1.67%), high density of LWM, and cobble and gravel substrate along with the boulder vane structures. The site is a mixture of riffle and pool habitats, with depths up to 5 feet. The site also includes a low gradient side channel (22SC) that is a mixture of very shallow and narrow riffle and pools 2-4 feet deep, with silty bottoms. The riffles are too shallow to snorkel, and the site has very heavy brush cover. The boulder vanes and side channel pools were part of a forest service restoration project implemented in 2004–2005. Side channel data was collected separately from main channel data since the habitat is very different.

Site 23 (A1-RR lower): This site is within a canyon area and is characterized by moderate gradient (2.06%), and riffle and swift glide habitat, with little pool habitat and moderately low LWM density. Substrate is primarily cobble/gravel with small boulders and depths are generally less than 3 feet.

Site 18 (A1-B): This site is within the canyon and is characterized by high gradient (3.24%), car-sized boulders, abundant LWM, and a diversity of substrate and habitat types, with depths of up to 5 feet.

Site 29 (A1-B): This site is characterized by relatively low gradient (1.16%), gravel/cobble substrate with some small boulders, low LWM density, and is dominated by riffle habitat and contains one pool. Large amounts of aquatic moss are found growing on the substrate along the stream margins. While generally less than 2.5 feet, the one pool under the 4606 road bridge is approximately 4 feet in depth.

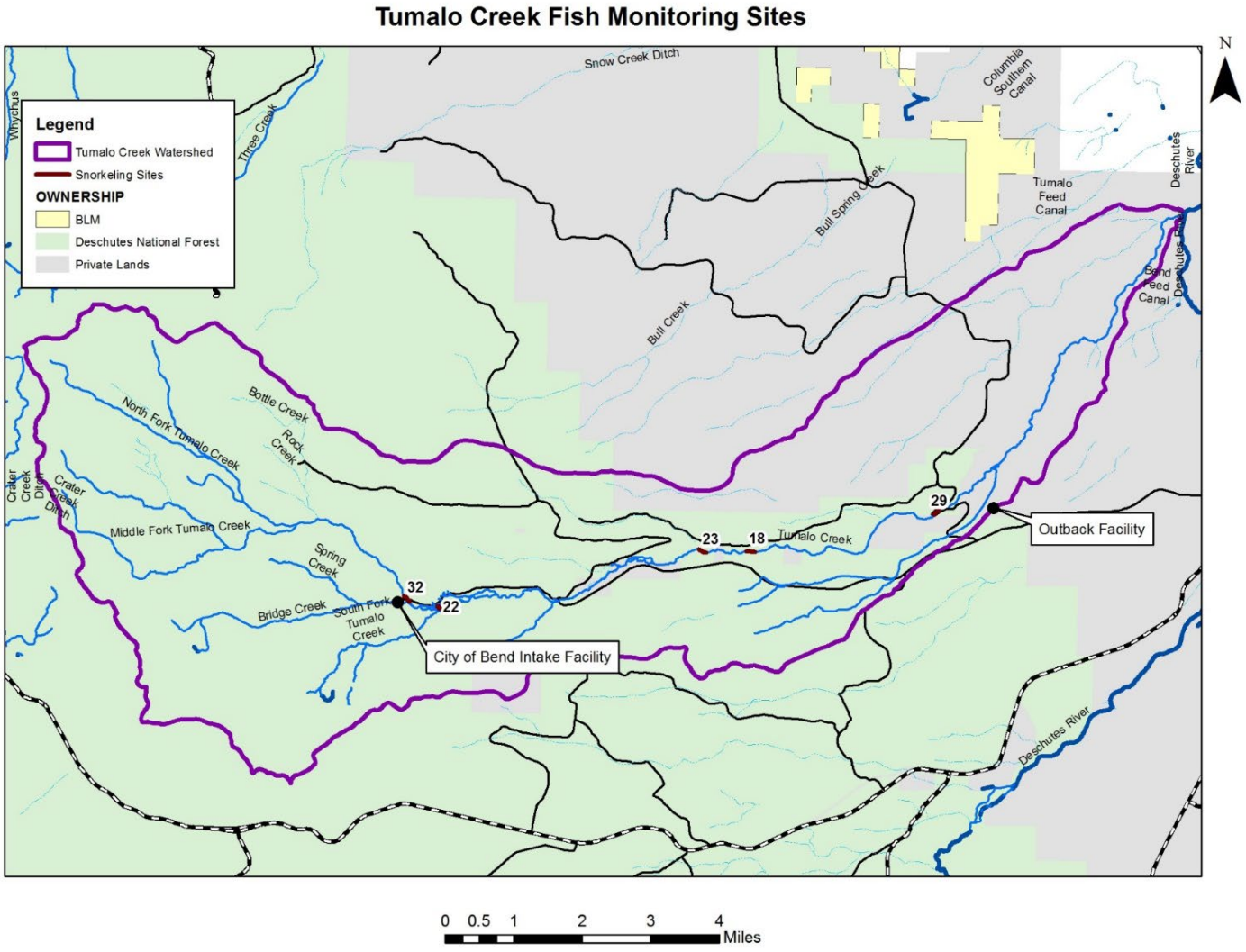

Figure 2. *Tumalo Creek fish monitoring site locations.*

2024 Fish Monitoring Results

During 2024, all five planned monitoring sites were surveyed by night snorkeling between the dates of 8/21/2024 and 8/27/2024.

Table 1 displays the data collected in 2024. Results from 2011, 2016, 2017, 2018, 2020, and 2022 can be found in Appendix A. The data collected in 2011 is considered baseline data, prior to new project operations, which began in April of 2016. A control site was not established in 2011, as the main objective for that survey was to determine the presence or absence of bull trout during the planning phase of the project.

Table 1. *Night snorkel data collected on Tumalo Creek in 2024.*

Site	Sub-Reach	Date Sampled	Lat/Long	River Mile	Grad. (%)	Water Temp (°C)	Length Surveyed (m)	ONMY YOY	ONMY <200 mm	ONMY >200 mm	Total ONMY	SAFO YOY	SAFO <200 mm	SAFO >200 mm	Total SAFO	SATR YOY	SATR <200 mm	SATR >200 mm	Total SATR	Total Fish
32	Control	8/21/24	N44.03180 W121.56524	16.1	2.74	9.0	200	2	42	31	**75**	0	8	6	**14**	0	0	0	**0**	**89**
22	A1-RR (upper)	8/21/24	N44.02980 W121.55574	15.5	1.67	7.0	160	0	67	20	**87**	0	31	6	**37**	0	0	0	**0**	**124**
22 SC	A1-RR (upper)	8/21/24	N44.02980 W121.55574	15.5	1.14	12.0	160	0	0	0	**0**	0	79	13	**92**	0	0	0	**0**	**92**
23	A1-RR (lower)	8/27/24	N44.04284 W121.47858	10.5	2.06	10.0	200	0	32	16	**48**	0	46	14	**60**	0	0	0	**0**	**108**
18	A1-B	8/27/24	N44.04303 W121.46470	9.6	3.24	11.2	200	3	58	39	**100**	0	11	9	**20**	0	0	0	**0**	**120**
29	A1-B	8/27/24	N44.05229 W121.41028	6.5	1.16	12.0	200	0	68	27	**95**	0	22	10	**32**	0	0	0	**0**	**127**

Site 32, the control site, was established in 2016 and surveys were repeated in 2017, 2018, 2020, 2022, and 2024. The numbers of redband trout were larger in all subsequent survey years compared to 2016, with a steady decline since 2017; though a rebound was observed in 2024, especially in the large size class (Figure 3). Brook trout numbers in the <200 mm size class were the lowest observed since surveys began in 2016. Only three larger brook trout were observed in 2018 and 2022, with six in 2024.

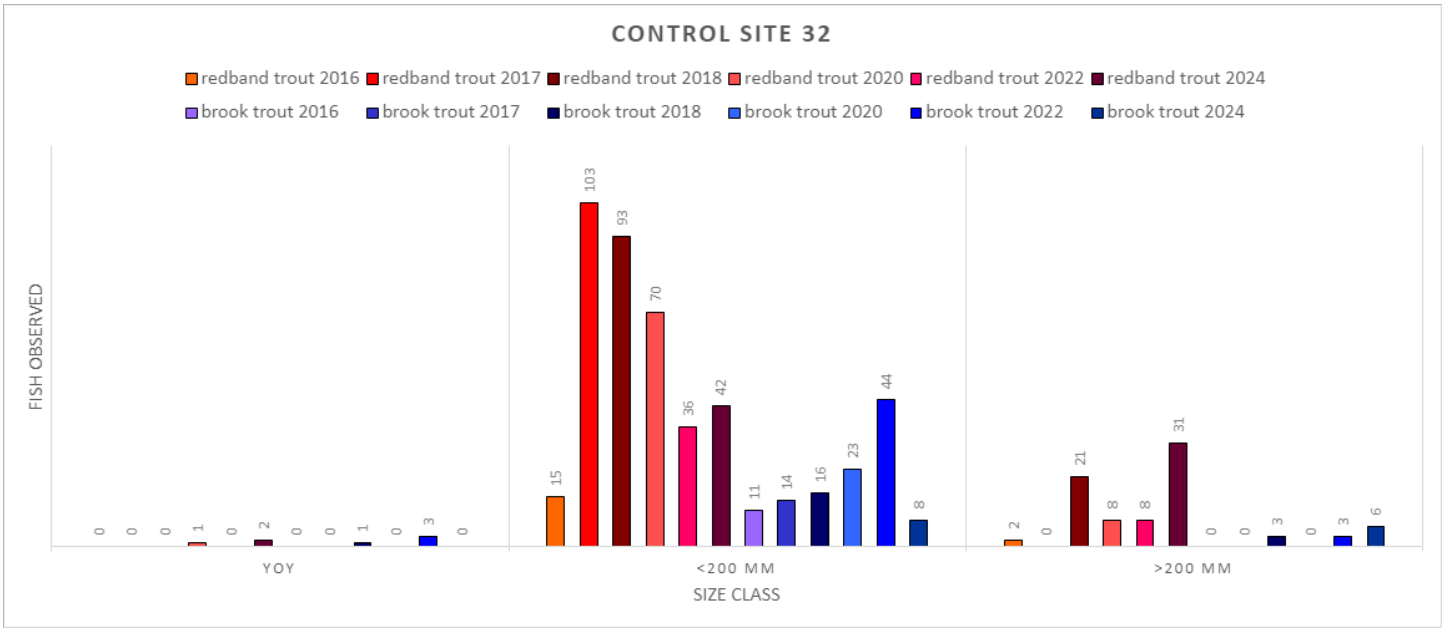

Figure 3. *Control Site 32 redband and brook trout data 2016–2024.*

Site 22 experienced a decrease in redband trout in 2024 in the <200 mm size category to the lowest numbers since 2016 (Figure 4). Large redband trout numbers rebounded slightly to those observed in 2018. Overall, the redband trout numbers have increased in this reach from the initial survey. Brook trout numbers in the <200 mm size class have been steadily increasing since 2016, with the exception of 2024, where numbers were comparable to 2017. For trend analysis, 2011 data is also presented, although this was before the establishment of the Control site. Compared to 2011, there has been an overall increase in redband trout and brook trout numbers observed within this reach.

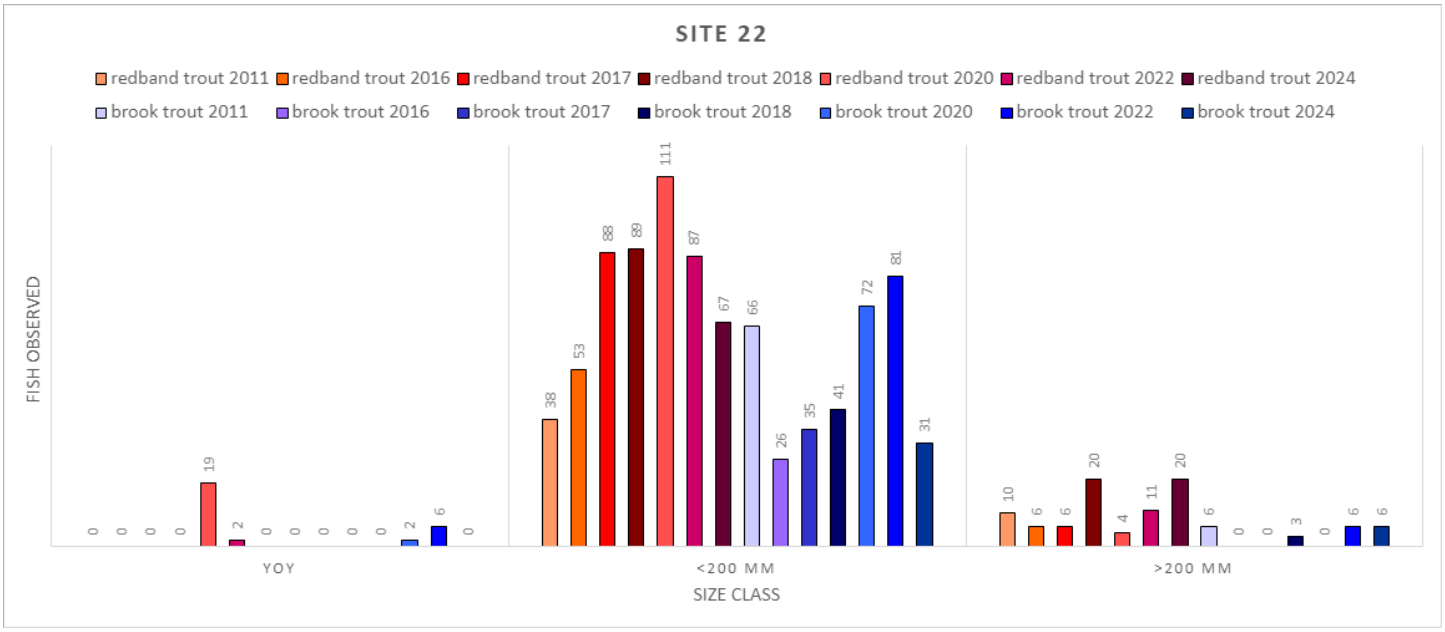

Figure 4. *Site 22 redband and brook trout data 2011, 2016–2024.*

Within the side channel of Site 22, no redband trout were observed in 2017, 2018, 2020, 2022, or 2024. Only one was observed in 2016 (Figure 5). In 2024, 79 brook trout were counted in the <200 mm size class. Brook trout numbers have fluctuated since the first survey in 2011, with a high of 168 brook trout counted in 2018. The side channel is slowly filling in with silt and is difficult to snorkel due to shallow depths, easily disturbed silty bottoms, and thick brush. Silty, low velocity habitat is not preferred by redband trout, which may explain their absence.

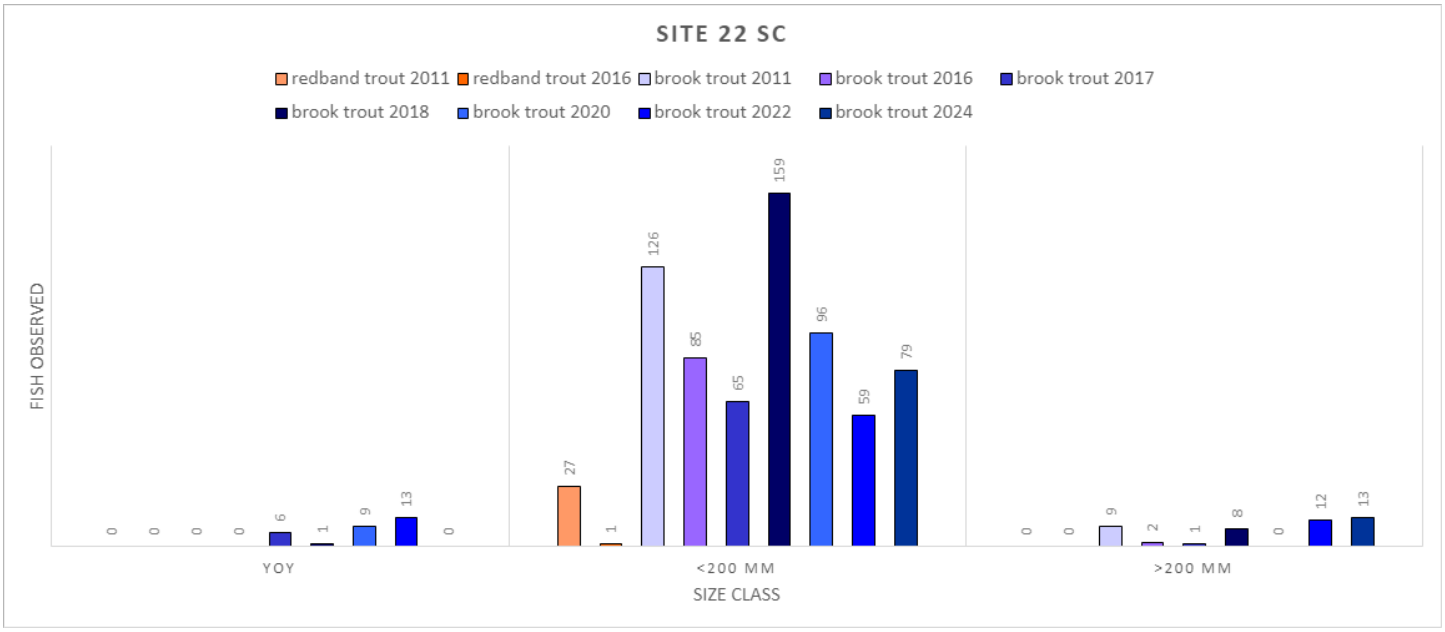

Figure 5. *Site 22 SC redband and brook trout data 2011, 2016–2024.*

Site 23 was not monitored in 2016. The numbers of redband trout in the <200 mm size class observed in 2024 were by far the lowest observed since the surveys began (Figure 6). Numbers of >200 mm redband trout were similar to 2017 and 2018. Brook trout have generally increased since 2018, with 60 observed in 2024. Five brown trout were observed in 2020, the only time in this reach since monitoring began, including two young of the year and three in the <200 mm size class. No brown trout were observed in 2022 or 2024.

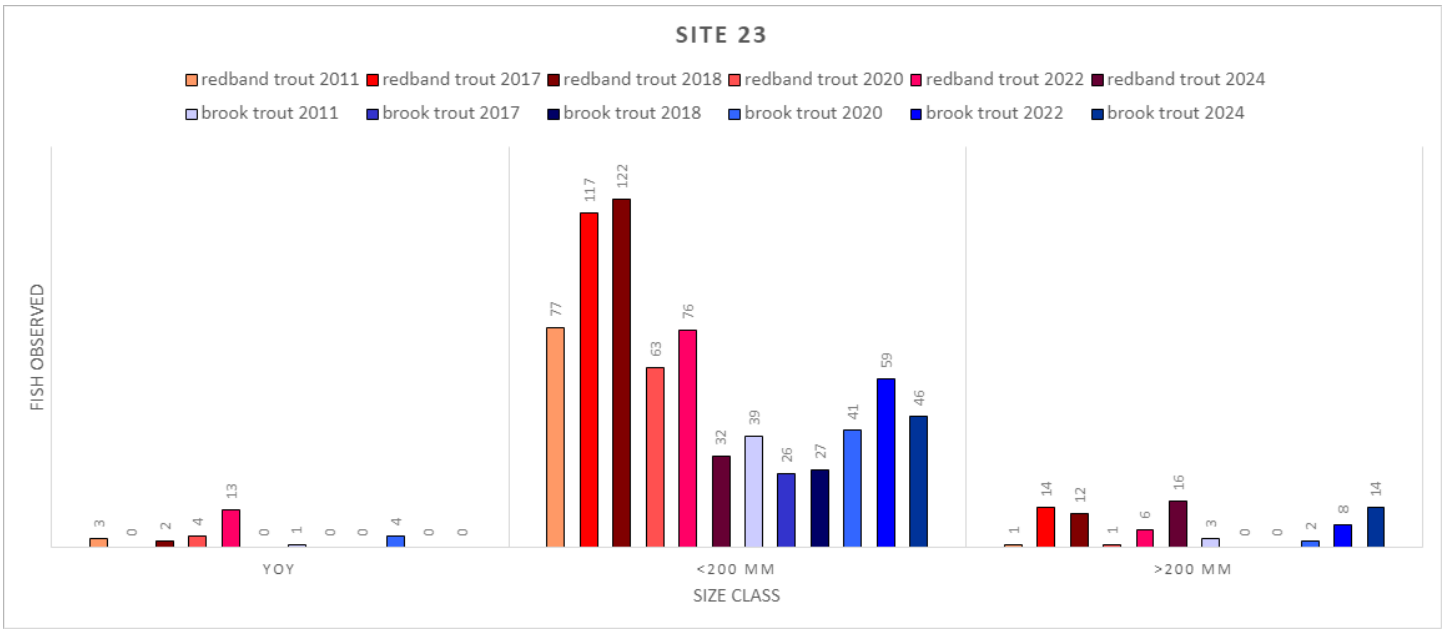

Figure 6. *Site 23 redband and brook trout data 2011, 2017–2024.*

Site 18 was also not monitored in 2016. Redband trout numbers in the <200 mm size classes have trended downward since 2017, with the lowest number observed in 2024 (Figure 7). However, 2024 numbers of older redband trout in the >200 mm size class were the highest yet observed. Overall redband trout numbers in 2024 were still the lowest, comparable to 2011. Brook trout have remained at low numbers throughout the survey years.

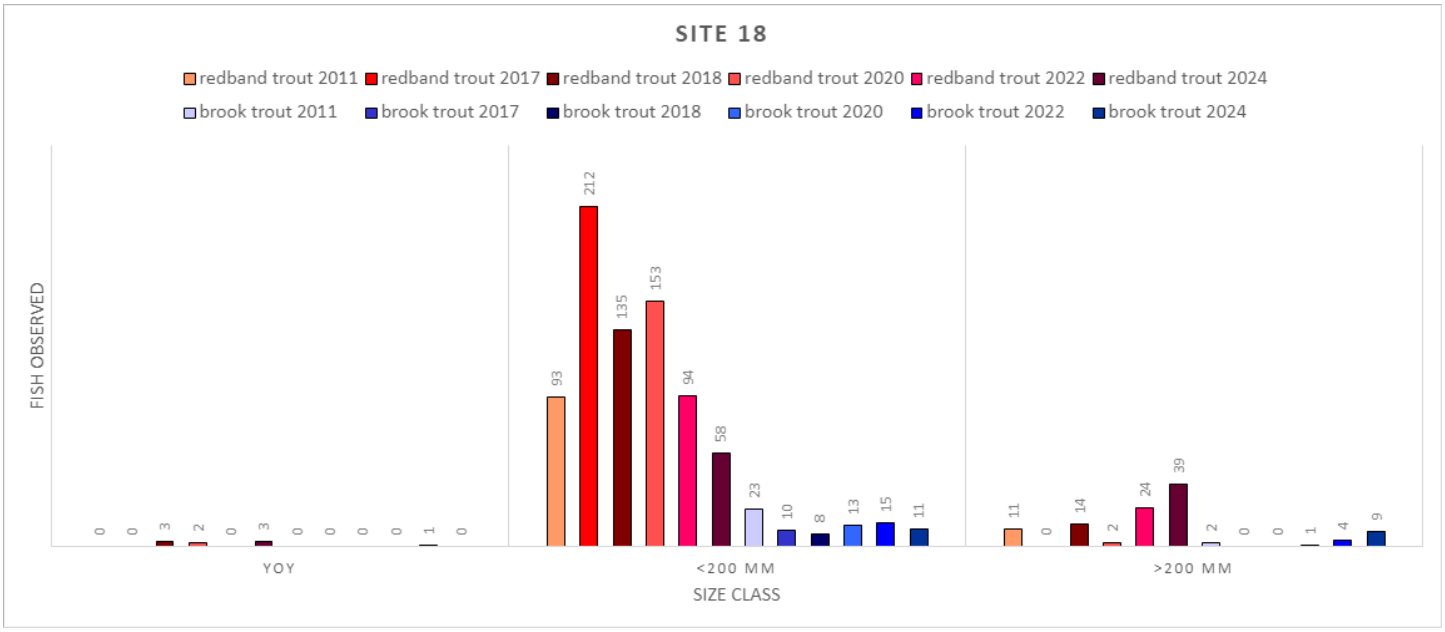

Figure 7. *Site 18 redband and brook trout data 2011, 2017–2024.*

Site 29 has experienced fluctuating redband trout numbers throughout the survey period. The lowest total numbers of redband trout were observed in 2017 and 2024, with roughly 50% to 150% more observed in 2018, 2020, and 2022 (Figure 8). Trends in brook trout numbers generally mirrored redband trout numbers in the reach across survey years, except at much lower densities. Two brown trout were observed in 2016, one was observed in 2018 and 2020, and none were observed in 2011, 2017, 2022, and 2024. Brown trout numbers do not appear to be increasing at this site.

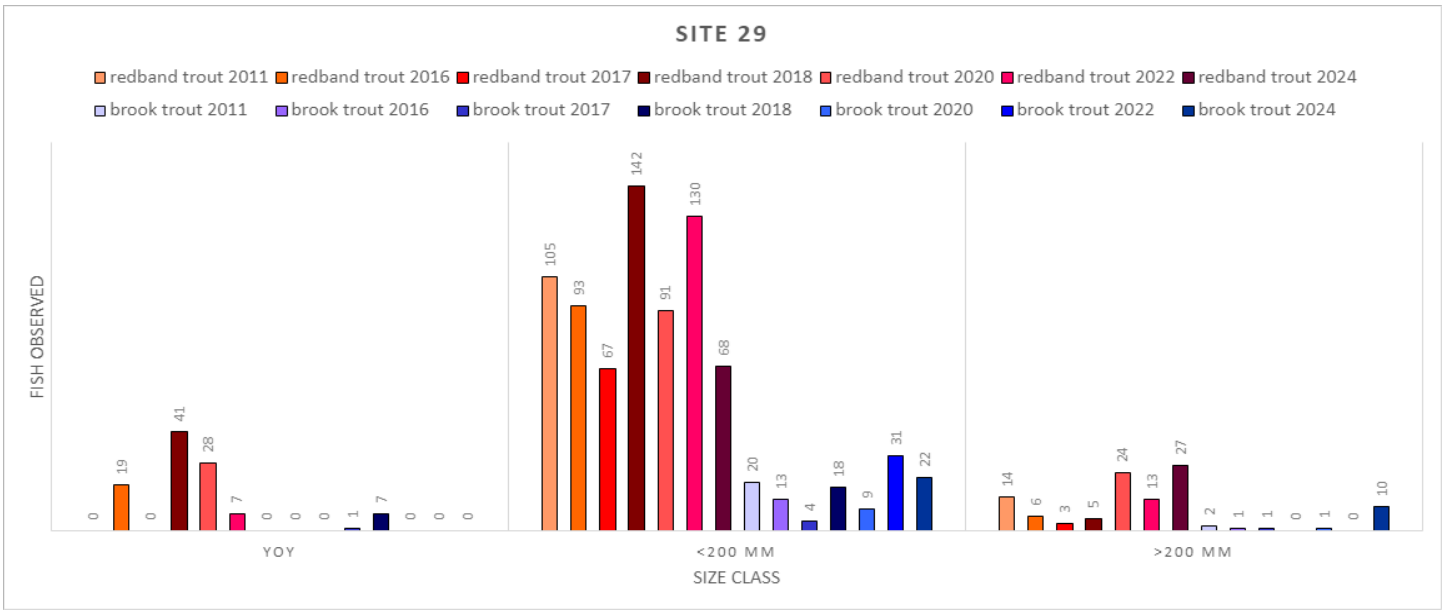

Figure 8. *Site 29 redband and brook trout data from 2011, 2016–2024.*

Summary

Figure 9 demonstrates the trends in total fish assemblage and size class structure for the project area comparing 2011 across surveys from 2017-2024, including data from Sites 18, 22, 22SC, 23, and 29. Site 32 is not included as it was established in 2016 as the control site. Data from 2016 is not included as not all reaches were surveyed that year. Project wide, the trend in 2024 is a continued decrease in YOY and <200 mm redband trout and a near doubling of the larger (>200 mm) size class. Overall brook trout numbers have remained fairly flat, though during 2024 the larger size class numbers increased to the highest observed to date.

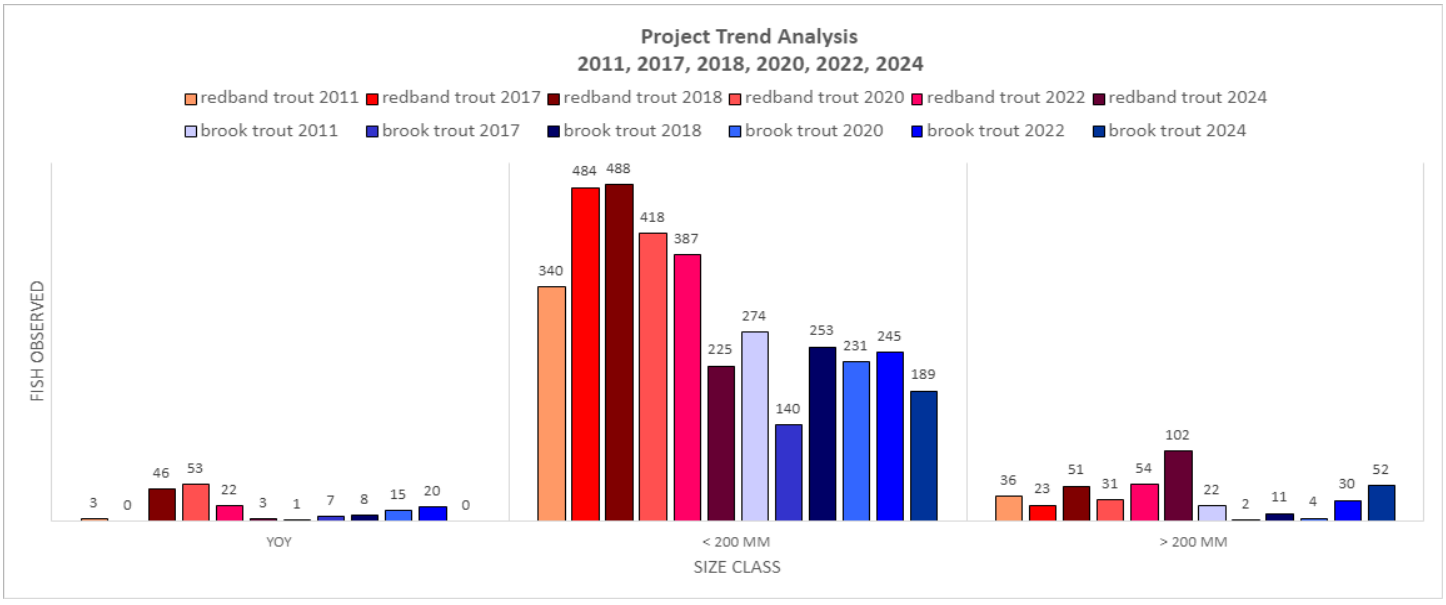

Figure 9. *Population Trend within the Entire Project Area.*

Figure 10 demonstrates the trend between 2011 and 2024 of an overall increase in redband trout to 2018 and then decreasing each subsequent survey through 2024 to numbers similar to 2011. Brook trout numbers have remained fairly flat outside of 2016 and 2017, with the highest number observed in 2022. The most brown trout were observed in 2020, but this species still represents a very small portion of the overall trout population and is restricted to Sites 23 and 29.

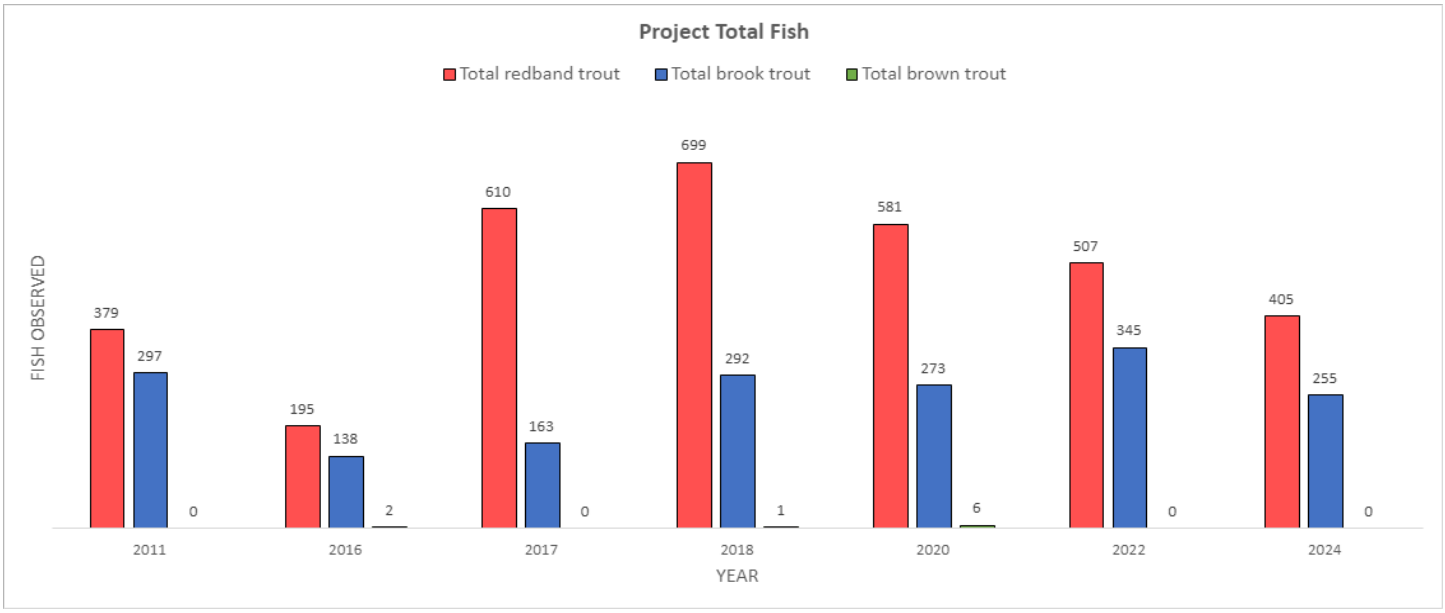

Figure 10. *Total Fish Observed within Project Area 2011, 2016–2024. In 2016, Site 32 was added; Sites 18 & 23 were not surveyed.*

Figure 11 compares water temperatures by year, collected at the time of survey for each site. Water temperature can affect fish behavior and the ability to observe them during snorkel surveys. Temperatures during 2022 surveys were generally similar to those in previous years except for the side channel at Site 22, which was significantly warmer than any other year except 2018. Over the years, surveys have been conducted anywhere from early August to mid-October, which can help explain some of the large temperature variations from year to year.

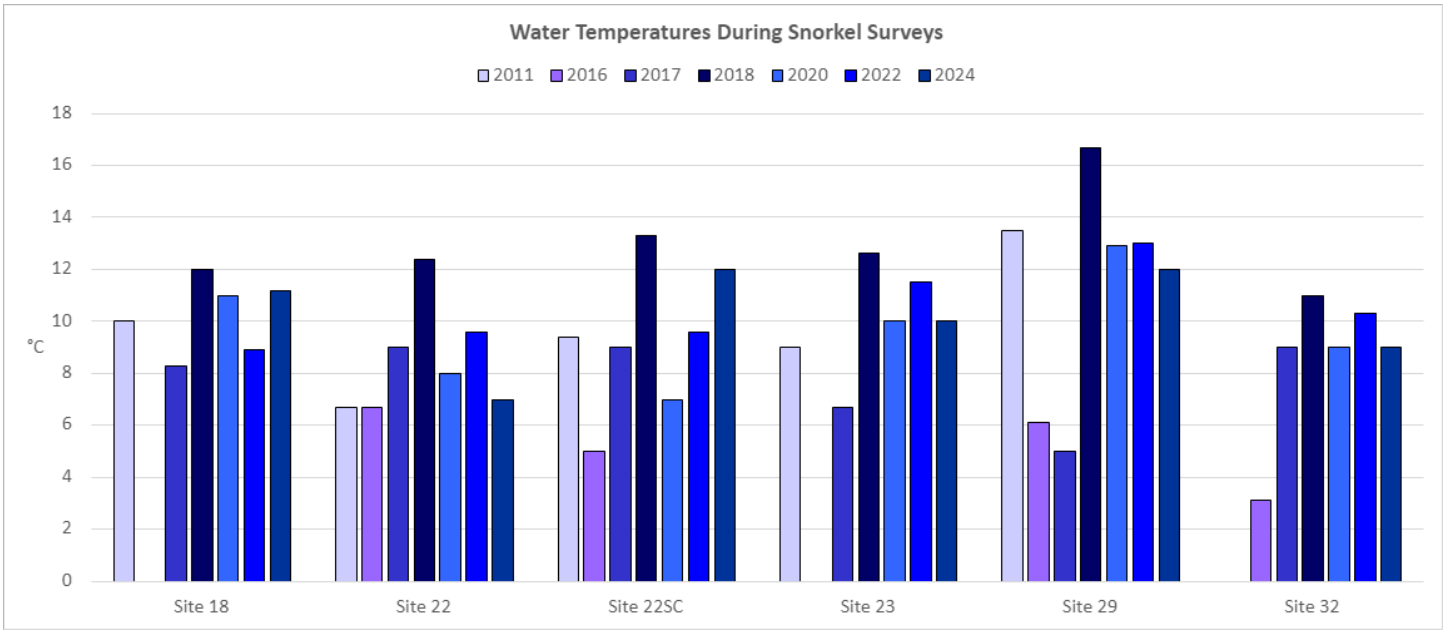

Figure 11. *Water Temperatures at Time of Survey 2011, 2016–2024.*

Figure 12 displays the discharge at the newly established gaging station immediately below the junction of Bridge Creek and Tumalo Creek during the fall when snorkel surveys were conducted. Discharge can influence fish behavior and movement, and the ability to observe them. Discharges between survey years were similar with the exception of 2017 which had substantially more discharge during the entire year with a spike in the fall. In 2016 there were three higher flow spikes in the fall.

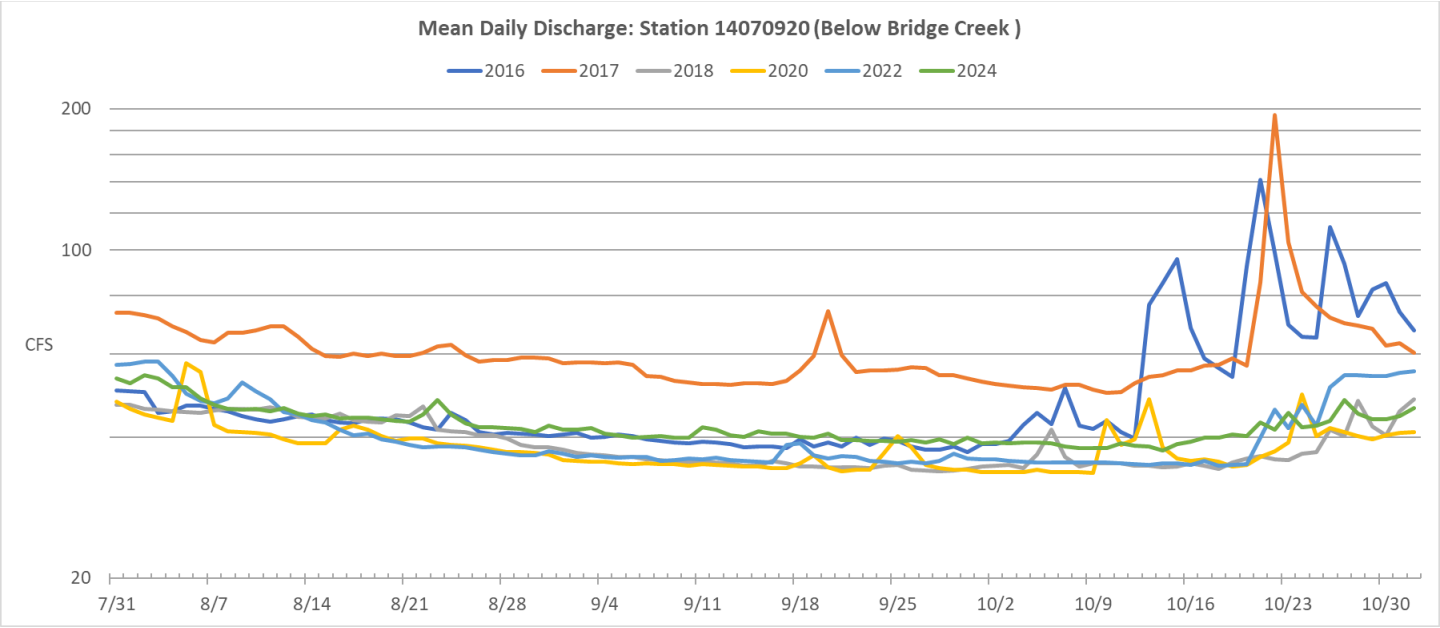

Figure 12. *Station 14070920 Mean Daily Discharge Comparison, from July 31 to November 1 of 2016–2018, 2020, 2022, and 2024.*

Figure 13 displays the discharge at the gaging station at Skyliners Bridge during the summer and fall when snorkel surveys were conducted. Flows include the contribution of the accretion zone, which includes several springs, South Fork of Tumalo Creek, and Tumalo Lake Creek. Overall, flows followed a similar pattern as those seen upstream at station 14070920, but with higher discharge.

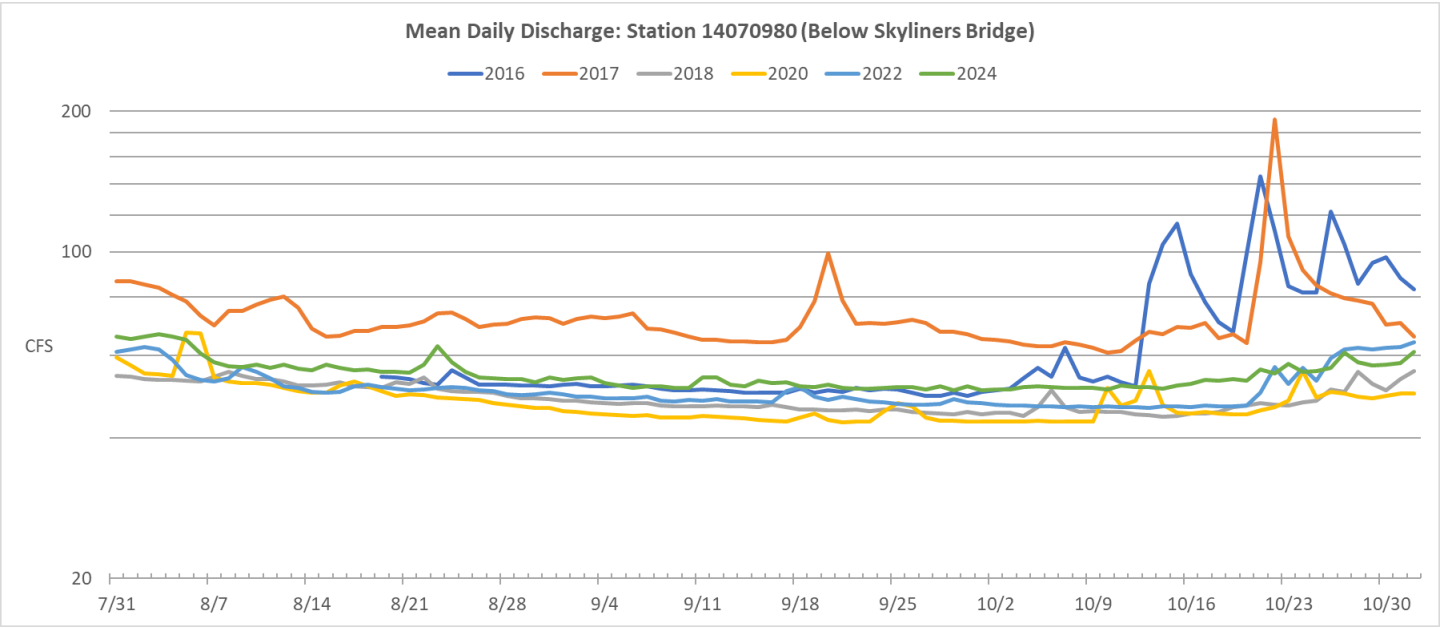

Figure 13. *Station 14070980 Mean Daily Discharge Comparison, from August 28 to November 1 of 2016 and July 31 to November 1 of 2017, 2018, 2020, 2022, and 2024.*

Table 2 displays the water temperatures and discharge at the time snorkel surveys were conducted during 2011, 2016, 2017, 2018, 2020, 2022, and 2024. The actual discharge for Site 32 is likely 10–15 cubic feet per second (CFS) lower as this site is above the junction with Bridge Creek. The actual discharge for Site 22 in 2011 would be lower, as Station 14070920 was not yet established, and the displayed discharge includes the accretion zone contribution.

Table 2. *Temperature and discharge during snorkel surveys for main channel sites.*

Site	Date	Mean Daily Q - CFS	Discharge Station	Status	Temp °C
32	11/1/2016	69.0	14070920	Provisional	3.1
32	9/6/2017	57.0	14070920	Provisional	9.0
32	7/31/2018	44.4	14070920	Provisional	11.0
32	8/11/2020	40.5	14070920	Provisional	9.0
32	8/15/2022	42.9	14070920	Provisional	10.3
32	8/21/2024	43.1	14070920	Provisional	9.0
22	9/2/2011	61.3	14073520 & 14073500	Published	6.7
22	9/19/2016	38.0	14070920	Provisional	6.7
22	9/6/2017	57.0	14070920	Provisional	9.0
22	8/9/2018	42.5	14070920	Provisional	12.4
22	8/11/2020	40.5	14070920	Provisional	8.0
22	8/15/2022	42.9	14070920	Provisional	9.6
22	8/21/2024	43.1	14070920	Provisional	7.0
23	9/2/2011	61.3	14073520 & 14073500	Published	9.0
23	9/26/2017	71.0	14070980	Provisional	6.7
23	8/2/2018	53.5	14070980	Provisional	12.6
23	8/6/2020	67.0	14070980	Provisional	10.0
23	8/18/2022	52.1	14070980	Provisional	11.5
23	8/27/2024	53.6	14070980	Provisional	10.0
18	9/14/2011	57.3	14073520 & 14073500	Published	10.0
18	9/28/2017	69.0	14070980	Provisional	8.3
18	8/2/2018	53.5	14070980	Provisional	12.0
18	8/12/2020	51.1	14070980	Provisional	11.0
18	9/14/2022	47.9	14070980	Provisional	8.9
18	8/27/2024	53.6	14070980	Provisional	11.2
29	8/30/2011	67.0	14073520 & 14073500	Published	13.5
29	10/12/2016	52.0	14070980	Provisional	6.1
29	10/6/2017	65.0	14070980	Provisional	5.0
29	8/9/2018	54.3	14070980	Provisional	16.7
29	8/25/2020	48.5	14070980	Provisional	12.9
29	8/15/2022	49.9	14070980	Provisional	13.0
29	8/27/2024	53.6	14070980	Provisional	12.0

Discussion

Compared to the 2011 data, surveyed prior to the new water system operations and considered the baseline, there was an overall increase in the relative abundance of redband trout populations each survey year through 2018. Since 2018, redband trout numbers have decreased each subsequent survey to a new low in 2024. However, there has been a steady increase in the largest size class (>200 mm) of redband trout to nearly twice that of any other survey in 2024. These trends are generally similar to those observed in Control Site 32. Relative abundance of the non-native brook trout seems to be trending steady, except in the Side Channel of Site 22, which became wholly populated by brook trout after 2016. It appeared from the 2020 results at site 23 that brown trout may be expanding their distribution up Tumalo Creek. However, in 2022 and 2024, no brown trout were observed at this site or at the lowest downstream site (29) where they have been observed in some previous years.

When trout populations are sympatric, variability in populations is typical and one species may not be able to monopolize the other. The two dominant species, redband and brook trout, have co-existed in Tumalo Creek for nearly 100 years. They are often spatially segregated to an extent, based on a combination of velocity, depth, cover types, and food availability. In Tumalo Creek, brook trout are generally observed in the lower velocity stream margins and other slow water habitats, with redband trout typically in faster water areas at the heads of pools and behind boulders mid-stream in riffles.

The trend of decreasing numbers of fish observed within the side channel (Site 22SC) in 2016 and 2017 reversed in the 2018 survey and decreased from those higher numbers since, with 2022 and 2024 numbers similar to 2016. Habitat within this site appears to be increasingly less available as pools fill in with silt and it potentially has less flow, as this site has no upstream surface connection to Tumalo Creek but is fed by groundwater. The slow velocities are favored by brook trout, which composed the entire population in 2017, 2018, 2020, 2022, and 2024.

The establishment of the Control site in 2016 gives insight into how environmental variables might influence the fish population. Redband trout numbers were significantly higher in 2017 compared to 2016, an increase of a multiple of 6. Likely the largest factor was the considerable water temperature differences between the two years, just 3.1°C in 2016 but 9.0°C during the 2017 survey. With the onset of winter, fish may move into different habitats or become concealed in the substrate (Hillman et al. 1987, Meyer and Gregory 2000), making observation during surveys difficult, and biasing the data. Other potential contributing factors include: (1) the winter of 2016-2017 experienced a good snowpack and resultant run-off, a “good” water year, which may have increased available habitat and food supply; (2) the Bridge Creek diversion at the headwaters was closed during the winter months of 2016-2017 (unplanned anomaly), resulting in additional discharge through the Control site, potentially benefiting wintering habitat; and (3) an increased population of redband within the project area resulting from individuals moving upstream into the control site. Redband numbers continued to decrease at the control site in 2022 but rebounded slightly in 2024, and remained higher than numbers found in 2016 when the project started. Brook trout numbers appeared to be increasing within the control site through 2022, but 2024 numbers dropped back down towards those observed in 2017.

In 2016 two brown trout were observed at Site 29 for the first time, which is the most downstream site, suggesting brown trout may have increased their distribution further upstream since 2011. Brown trout were again observed in Site 29 in 2020, and in Site 23 during the 2020 survey, indicating a potential expansion of their distribution up Tumalo Creek. However, in 2022 and 2024 no brown trout were observed at any of the sites. More surveys at more sites along Tumalo Creek would be needed to determine the upstream distribution and relative abundance of brown trout. The increasing velocities and cooler temperatures may be serving as a barrier to further upstream expansion of brown trout, since they have not been observed in sites farther upstream. Also, a nine-foot-high waterfall exists around river mile 8.0 that may limit upstream migration of brown trout (Dachtler 1999).

YOY are difficult to observe while snorkeling due to their propensity to occupy very shallow stream margins, less than the minimum depth for which a mask can be submerged. They also hide more at night under substrate or wood to avoid

predation. The snorkel surveys are most likely undercounting this size class. During the current monitoring efforts, fish <50 mm total length are considered YOY.

It is recommended that future surveys aim to collect data during summer months in either August or early to middle of September. This will help reduce variability in the ability of snorkelers to count fish due to them hiding under wood or substrate when water temperatures are cold and possibly when flows become higher later in the fall.

For more information on stream flow and temperature data, see the 2024 Flow and Temperature Monitoring Report for Tumalo Creek (Wright and Gritzner 2024).

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Appendix A. Tumalo Creek Fish Snorkel Monitoring Data

2011, 2016, 2017, 2018, 2020, 2022

Site	Sub-Reach	Date Sampled	Lat/Long	River Mile	Grad. (%)	Water Temp (°C)	Method	Length Surveyed (m)	ONMY YOY	ONMY <100 mm	ONMY 100-199 mm	ONMY <200 mm	ONMY 200-299 mm	ONMY >300 mm	ONMY >200 mm	Total ONMY	SAFO YOY	SAFO <100 mm	SAFO 100-199 mm	SAFO <200 mm	SAFO 200-299 mm	SAFO >300 mm	SAFO >200 mm	Total SAFO	SATR YOY	SATR <100 mm	SATR 100-199 mm	SATR <200 mm	SATR 200-299 mm	SATR >300 mm	SATR >500 mm	SATR >200 mm	Total SATR	Total Fish
32	Control	11/1/16	N44.03180 W121.56523	16.1	2.74	3.1	NS	200	0	7	8	15	2	0	2	**17**	0	0	11	11	0	0	0	**11**	0	0	0	0	0	0	0	0	**0**	**28**
32	Control	9/6/17	N44.03180 W121.56523	16.1	2.74	9.0	NS	200	0	51	52	103	0	0	0	**103**	0	5	9	14	0	0	0	**14**	0	0	0	0	0	0	0	0	**0**	**117**
32	Control	7/31/18	N44.03180 W121.56523	16.1	2.74	11.0	NS	200	0	14	79	93	21	0	21	**114**	1	2	14	16	3	0	3	**20**	0	0	0	0	0	0	0	0	**0**	**134**
32	Control	8/11/20	N44.03180 W121.56524	16.1	2.74	9.0	NS	200	1	18	52	70	8	0	8	**79**	0	10	13	23	0	0	0	**23**	0	0	0	0	0	0	0	0	**0**	**102**
32	Control	8/15/22	N44.03180 W121.56524	16.1	2.74	10.3	NS	200	0	NA	NA	36	NA	NA	8	**44**	3	NA	NA	44	NA	NA	3	**50**	0	NA	NA	0	NA	NA	NA	0	**0**	**94**
22	A1-RR (upper)	9/2/11	N44.02980 W121.55574	15.5	1.67	6.7	NS	200	0	2	36	38	9	1	10	**48**	0	2	64	66	6	0	6	**72**	0	0	0	0	0	0	0	0	**0**	**120**
22	A1-RR (upper)	9/19/16	N44.02980 W121.55574	15.5	1.67	6.7	NS	200	0	11	42	53	6	0	6	**59**	0	8	18	26	0	0	0	**26**	0	0	0	0	0	0	0	0	**0**	**85**
22	A1-RR (upper)	9/6/17	N44.02980 W121.55574	15.5	1.67	9.0	NS	200	0	19	69	88	6	0	6	**94**	0	16	19	35	0	0	0	**35**	0	0	0	0	0	0	0	0	**0**	**129**
22	A1-RR (upper)	8/9/18	N44.02980 W121.55574	15.5	1.67	12.4	NS	200	0	14	75	89	20	0	20	**109**	0	5	36	41	3	0	3	**44**	0	0	0	0	0	0	0	0	**0**	**153**
22	A1-RR (upper)	8/11/20	N44.02980 W121.55574	15.5	1.67	8.0	NS	160	19	74	37	111	4	0	4	**134**	2	44	28	72	0	0	0	**74**	0	0	0	0	0	0	0	0	**0**	**208**
22	A1-RR (upper)	8/15/22	N44.02980 W121.55574	15.5	1.67	9.6	NS	160	2	NA	NA	87	NA	NA	11	**100**	6	NA	NA	81	NA	NA	6	**93**	0	NA	NA	0	NA	NA	NA	0	**0**	**193**
22 SC	A1-RR (upper)	9/2/11	N44.02980 W121.55574	15.5	1.14	9.4	NS	160	0	9	18	27	0	0	0	**27**	0	87	39	126	9	0	9	**135**	0	0	0	0	0	0	0	0	**0**	**162**
22 SC	A1-RR (upper)	10/5/16	N44.02980 W121.55574	15.5	1.14	5.0	NS	160	0	0	1	1	0	0	0	**1**	0	52	33	85	2	0	2	**87**	0	0	0	0	0	0	0	0	**0**	**88**
22 SC	A1-RR (upper)	9/6/17	N44.02980 W121.55574	15.5	1.14	9.0	NS	160	0	0	0	0	0	0	0	**0**	6	20	45	65	1	0	1	**72**	0	0	0	0	0	0	0	0	**0**	**72**
22 SC	A1-RR (upper)	7/31/18	N44.02980 W121.55574	15.5	1.14	13.3	NS	160	0	0	0	0	0	0	0	**0**	1	69	90	159	8	0	8	**168**	0	0	0	0	0	0	0	0	**0**	**168**
22 SC	A1-RR (upper)	10/8/20	N44.02980 W121.55574	15.5	1.14	7.0	NS	160	0	0	0	0	0	0	0	**0**	9	41	55	96	0	0	0	**105**	0	0	0	0	0	0	0	0	**0**	**105**

22 SC	A1-RR (upper)	8/18/22	N44.02980 W121.55574	15.5	1.14	9.6	NS	160	0	NA	NA	0	NA	NA	0	**0**	13	NA	NA	59	NA	NA	12	**84**	0	NA	NA	0	NA	NA	NA	0	**0**	**84**
Site	**Sub-Reach**	**Date Sampled**	**Lat/Long**	**River Mile**	**Grad. (%)**	**Water Temp (°C)**	**Method**	**Length Surveyed (m)**	**ONMY YOY**	**ONMY <100 mm**	**ONMY 100-199 mm**	**ONMY <200 mm**	**ONMY 200-299 mm**	**ONMY >300 mm**	**ONMY >200 mm**	**Total ONMY**	**SAFO YOY**	**SAFO <100 mm**	**SAFO 100-199 mm**	**SAFO <200 mm**	**SAFO 200-299 mm**	**SAFO >300 mm**	**SAFO >200 mm**	**Total SAFO**	**SATR YOY**	**SATR <100 mm**	**SATR 100-199 mm**	**SATR <200 mm**	**SATR 200-299 mm**	**SATR >300 mm**	**SATR >500 mm**	**SATR >200 mm**	**Total SATR**	**Total Fish**
23	A1-RR (lower)	9/2/2011	N44.04284 W121.47858	10.5	2.06	9.0	NS	200	3	9	68	77	1	0	1	**81**	1	9	30	39	3	0	3	**43**	0	0	0	0	0	0	0	0	**0**	**124**
23	A1-RR (lower)	9/26/17	N44.04284 W121.47858	10.5	2.06	6.7	NS	200	0	54	63	117	14	0	14	**131**	0	15	11	26	0	0	0	**26**	0	0	0	0	0	0	0	0	**0**	**157**
23	A1-RR (lower)	8/2/18	N44.04284 W121.47858	10.5	2.06	12.6	NS	200	2	36	86	122	12	0	12	**136**	0	7	20	27	0	0	0	**27**	0	0	0	0	0	0	0	0	**0**	**163**
23	A1-RR (lower)	8/6/20	N44.04284 W121.47858	10.5	2.06	10.0	NS	200	4	30	33	63	1	0	1	**68**	4	18	23	41	2	0	2	**47**	2	2	1	3	0	0	0	0	**5**	**120**
23	A1-RR (lower)	8/18/22	N44.04284 W121.47858	10.5	2.06	11.5	NS	200	13	NA	NA	76	NA	NA	6	**95**	0	NA	NA	59	NA	NA	8	**67**	0	NA	NA	0	NA	NA	NA	0	**0**	**162**
18	A1-B	9/14/11	N44.04303 W121.46470	9.6	3.24	10.0	NS	200	0	5	88	93	11	0	11	**104**	0	1	22	23	2	0	2	**25**	0	0	0	0	0	0	0	0	**0**	**129**
18	A1-B	9/28/17	N44.04303 W121.46470	9.6	3.24	8.3	NS	200	0	36	176	212	0	0	0	**212**	0	2	8	10	0	0	0	**10**	0	0	0	0	0	0	0	0	**0**	**222**
18	A1-B	8/2/18	N44.04303 W121.46470	9.6	3.24	12.0	NS	200	3	42	93	135	14	0	14	**152**	0	3	5	8	0	0	0	**8**	0	0	0	0	0	0	0	0	**0**	**160**
18	A1-B	8/12/20	N44.04303 W121.46470	9.6	3.24	11.0	NS	200	2	78	75	153	2	0	2	**157**	0	5	8	13	1	0	1	**14**	0	0	0	0	0	0	0	0	**0**	**171**
18	A1-B	9/14/22	N44.04303 W121.46470	9.6	3.24	8.9	NS	200	0	NA	NA	94	NA	NA	24	**118**	1	NA	NA	15	NA	NA	4	**20**	0	NA	NA	0	NA	NA	NA	0	**0**	**138**
29	A1-B	8/30/11	N44.052291 W121.41028	6.5	1.16	13.5	NS	200	0	22	83	105	14	0	14	**119**	0	1	19	20	2	0	2	**22**	0	0	0	0	0	0	0	0	**0**	**141**
29	A1-B	10/12/16	N44.052291 W121.41028	6.5	1.16	6.1	NS	200	19	37	56	93	6	0	6	**118**	0	3	10	13	1	0	1	**14**	0	0	2	2	0	0	0	0	**2**	**134**
29	A1-B	10/6/17	N44.052291 W121.41028	6.5	1.16	5.0	NS	200	0	25	42	67	3	0	3	**70**	1	2	2	4	1	0	1	**6**	0	0	0	0	0	0	0	0	**0**	**76**
29	A1-B	8/9/18	N44.052291 W121.41028	6.5	1.16	16.7	NS	200	41	52	90	142	5	0	5	**188**	7	7	11	18	0	0	0	**25**	0	0	0	0	0	1	0	1	**1**	**214**
29	A1-B	8/25/20	N44.052291 W121.41028	6.5	1.16	12.9	NS	200	28	32	59	91	24	0	24	**143**	0	0	9	9	1	0	1	**10**	0	0	1	1	0	0	0	0	**1**	**154**
29	A1-B	8/15/22	N44.052291 W121.41028	6.5	1.16	13.0	NS	200	7	NA	NA	130	NA	NA	13	**150**	0	NA	NA	31	NA	NA	0	**31**	0	NA	NA	0	NA	NA	NA	0	**0**	**181**

NS = night snorkel YOY = young of year ONMY = redband trout SAFO = eastern brook trout SATR = brown trout