

Stream Flows, Water Quality and Nutrient Export in Morrell Creek: Seeley Swan High School Students in Action Monitoring Results 2020 Supplement to the 2015 Report

With Assistance from the Clearwater Resource Council,
Seeley Lake Sewer Board, and Missoula County

Introduction

Water quality in the Clearwater Watershed is essential for the success of our local economy, ecology, and society. For this reason, it is important to understand the function and health of the rivers and streams that feed into the lower elevation lakes in our basin. In particular, Seeley and Salmon Lakes are waterbodies of great interest to the surrounding community because they are popular locations for recreation. Both lakes receive inputs from the Clearwater River and its tributaries. Surface runoff and groundwater contamination due to population growth and land use such as logging, road construction, and the growing number of septic systems, are sources of potential water pollution. It is necessary to monitor a variety of tributaries in the Clearwater Watershed in order to gain an understanding of the impact that population growth and human activity have on our lakes and streams.

In 2011, the Seeley-Swan High School (SSHS) initiated the “Students-in-Action Morrell Creek Water Monitoring Project”. The goal of this project is to engage students in real world science relevant to the local community. SSHS uses Morrell Creek as a hands-on learning opportunity linking hydrology, ecology, chemistry, climatology, statistics, and mathematics to a local stream. SSHS’s objectives of this program have been to: 1) monitor the flows of Morrell Creek at the High School site continuously in order to estimate the water yield, 2) estimate nutrient, turbidity, and total suspended solids (TSS) concentrations throughout the hydrologic cycle, and combine those with flow estimates to estimate total nutrient export from above the sampling site, and 3) provide a foundation for more complete nutrient loading estimates in the larger basin, a baseline for monitoring long-term changes in Morrell Creek, and a comparison with other more heavily altered watersheds influenced by non-point sources.

Morrell Creek is an important stream for bull trout and westslope cutthroat trout, offering 18.2 miles of habitat for these important native fish (FWP). Further, Morrell Creek is a significant aesthetic and recreational resource, as it flows through a large residential area and the Double Arrow Golf Course in Seeley Lake within the Clearwater Watershed. Morrell Creek and its tributaries flow into the Clearwater River, so monitoring its water quality helps provide a wider understanding of the stream-to-lake relationships within this watershed.

This report presents data from 2012 to 2020 as a supplement to the most recently published 2015 report with the intent to determine new or consistent trends and to identify any anomalies that may require further investigation. Monitoring of Morrell Creek through Students-in-Action continues to be an active program supported by CRC.

Methods

The Students-in-Action program kicked off in 2011 and consistent monitoring on Morrell Creek near SSSH has been conducted from 2012-2020. This report presents the data collected from 2012-2020. The monitoring location is on Morrell Creek above the Airport Road bridge next to the SSSH campus. 2020 was the ninth consecutive year of water quality monitoring at this site. Total nitrogen (TN), total phosphorous (TP), nitrite (NO₂)/nitrate (NO₃), soluble reactive phosphorous (SRP), and total suspended solids (TSS) were collected by teachers, students and volunteers through 2019. These parameters were collected by CRC staff in 2020 due to the COVID-19 pandemic.

All water samples collected through 2020 were sent to the Flathead Lake Biological Station (FLBS) for analysis, with the exception of analyses in 2013 that were done through Energy Labs (EL) with less sensitive detection capabilities than FLBS (Table 1). All sample collection, handling, and analyses were done as detailed in the CRC Sampling and Analysis Plan previously submitted and accepted by MT DEQ (2014). In 2020, sampling began in April and concluded in early October. Lab analysis of nutrient samples is complete through October of 2020 at the time of this report. Below we summarize the results and provide comparisons with data collected in earlier years. Some of the 2013 data are not comparable due to differences in detection sensitivities of the labs and the values being below the limits of EL's testing.

Results and Discussion

TSS peaked in the spring with runoff each year (Figure 1). Variability in TSS was higher in 2012-2013, 2018, and 2020 and lower in 2014-2016 and 2019. This variability was measured by the range of recorded TSS values. The maximum TSS in 2020 was 16.5, which is comparable to the recorded 15.30 mg/L maximum in 2018 and 15.64 mg/L maximum in 2012. In 2019, TSS peaked at 6.70 mg/L, similar in magnitude to 2015-2016 maximum TSS recordings of 5.10 and 4.90 mg/L respectively. As previously noted in the 2015 Students-in-Action report, turbidity and TSS are highly correlated, and turbidity is strongly associated with stream flow (CRC 2015). The higher TSS values in 2018 and 2020 may be a reflection of higher flows. The overall TSS data over the nine-year sampling period has no significant trend.

Total N tended to peak in winter or early spring and decline to lower concentrations in late spring or early summer (Figure 2). In 2016, total N ranged from 28.30 to 172.00 ug/L, in 2017 from 32.60 to 324.00 ug/L, in 2018 from 71.70 to 345.00 ug/L, in 2019 from 156.00 to 633.00 ug/L, and in 2020 from <25.0 to 411 ug/L. The most recent 4 years of data (2017-2020) had the highest recorded total N concentrations compared to any of the previous years. Nitrate and nitrite followed similar seasonal trends to total N, peaking in winter or early spring and declining through spring and summer (Figure 2). Similar to the pattern in total N, there has been a general positive increase in nitrate and nitrite over the entire 9-year monitoring period, with the past 4 years having the highest recorded NO₂/NO₃ values. The general increase in total N, nitrate and nitrite may be due to impacts associated with the Rice Ridge fire in 2017.

Total P peaked in early spring with the high flows (Figure 3). In 2016, total P ranged from 1.50 to 32.90 ug/L, in 2017 from <1.5 to 13.20 ug/L, in 2018 from 2.50 to 33.40 ug/L, in 2019 from 1.7 to 51.4 ug/L, and in 2020 <1.5 to 20.1 ug/L. Similar to the nitrogen peaks, the highest total P values were recorded during 2018-2019. As was noted in the 2015 report, total P is correlated with TSS (and thus with turbidity and flow), so the lower P values in earlier years are likely associated with lower flows and less suspended sediments that may carry absorbed P. Although higher total P values were recorded in recent years, overall, there has been no noticeable or significant trend over the nine-year monitoring period. Soluble reactive phosphorous (SRP) was generally low and often below detection for many years (although more often in earlier years before the lab source was changed from EL to FLBS) (Figure 3).

Conclusion

Overall, there seems to be a slight upward trend in total N and NO₂/NO₃, while the other parameters (total P, SRP, and TSS) exhibit constant or statistically insignificant positive changes over time. However, beyond these overall trends, it is also important to examine individual years, to account for specific events that occurred in the Clearwater Valley that most likely affected the nutrient content of the streams. In 2017, the Rice Ridge Fire burned over much of the upper Morrell Creek sub-basin, which substantially increased nutrient loading in 2018 in all fire-affected streams. Further, 2018 was a high flow water year, with snowpack and flows in the Blackfoot and Clearwater basins at record highs. These anomalous events should be accounted for when assessing the results presented here.

The continuation of the Students-in-Action program remains important as the Seeley Lake community continues to struggle with water quality concerns. The Morrell Creek site at the High School is an important location due to its proximity to downtown, the fact that this site precedes the inputs of other streams, and the influence Morrell Creek eventually has on the Clearwater River, and thus, Salmon Lake. Expansion, construction, and land use continue to influence the ecology and health of Morrell Creek, so future studies on water quality and physical condition at this site are key to understanding the larger watershed at hand.

References

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Figures

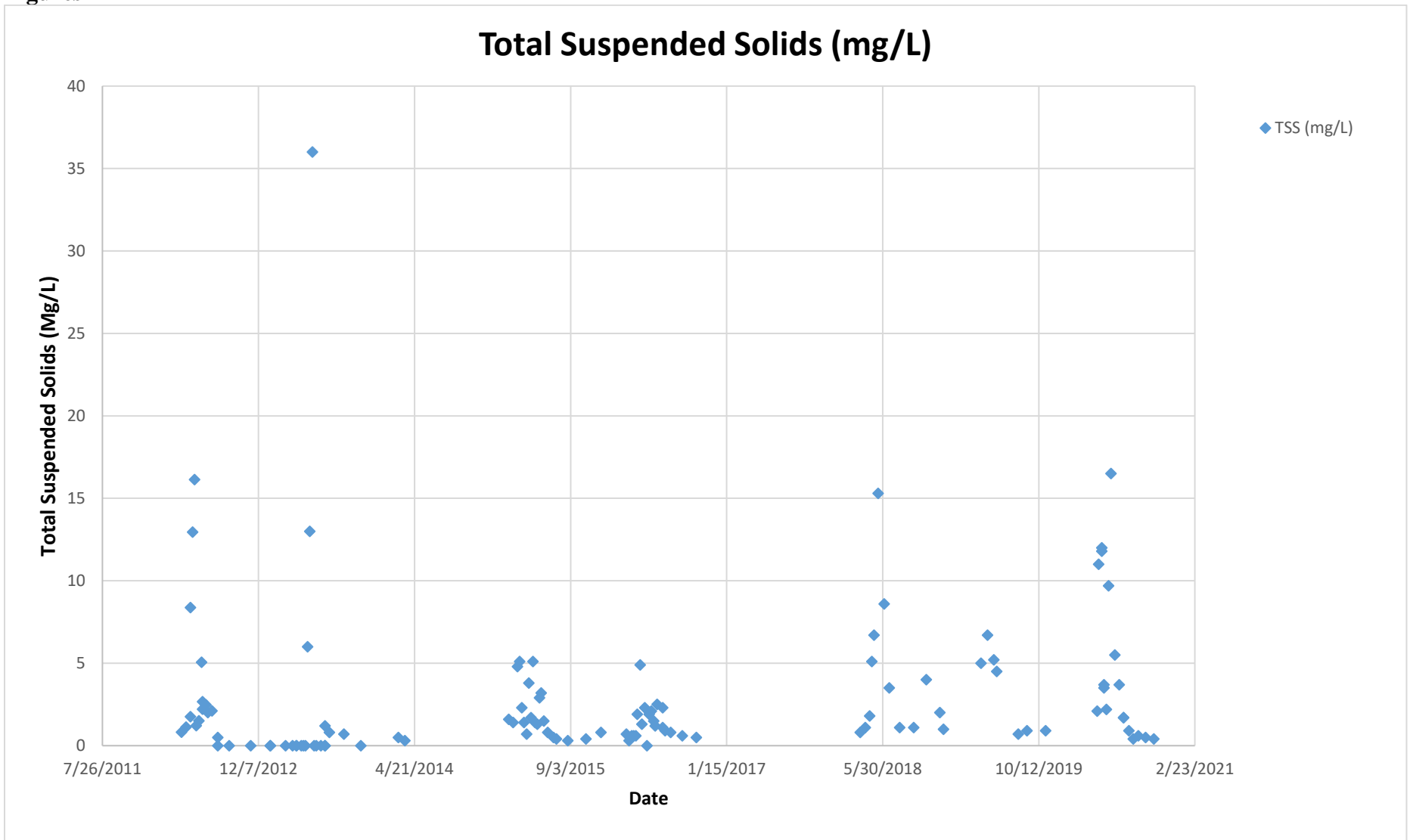


Figure 1. Total suspended solids in Morrell Creek at SSSS from 2012 through 2020. TSS points at 0.000 are below the detection limits for the laboratory (Table 1).

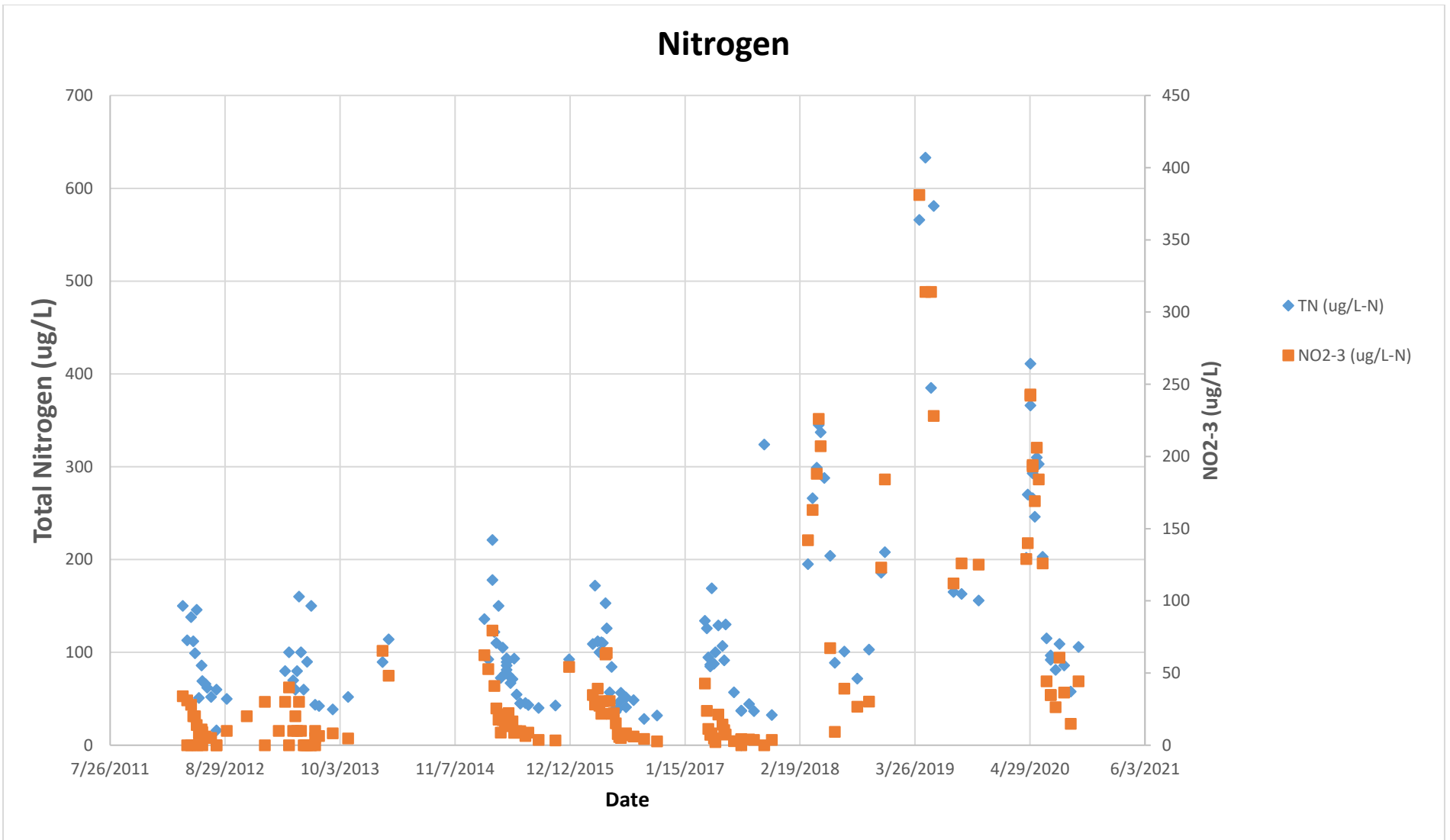


Figure 2. Nitrogen concentrations (ug/L) in terms of both total nitrogen and nitrate/nitrite in Morrell Creek at the SSHS site from 2012 through 2020. Samples at 0.0 are below detection limits for the laboratory.

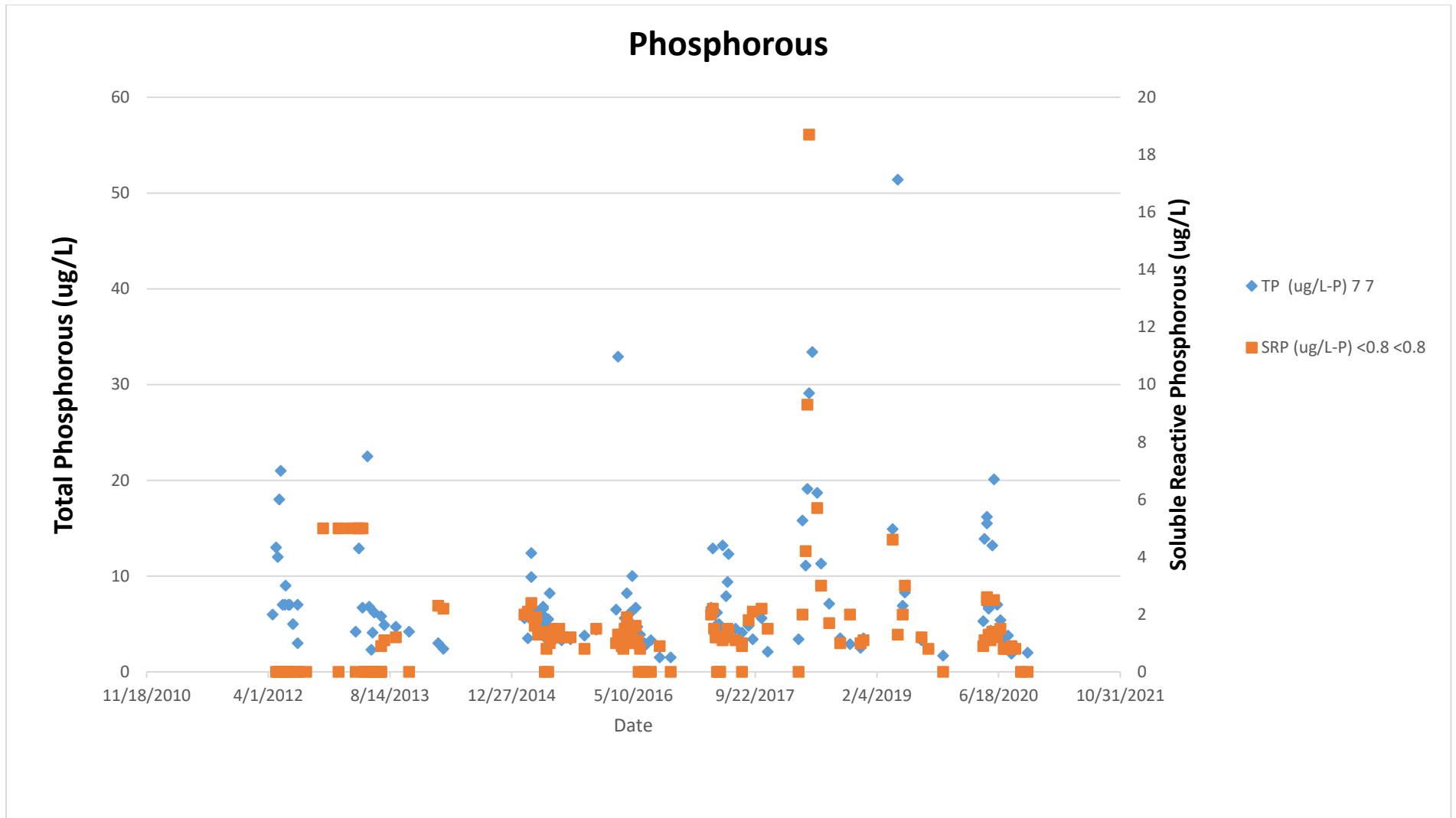


Figure 3. Phosphorous concentrations (ug/L) in terms of both total phosphorous and soluble reactive phosphorous in Morrell Creek at the SSHS site from 2012 through 2020. Samples at 0.0 are below detection limits for the laboratory.

Table 1. Measured flow and water quality parameters sampled from Morrell Creek at the SSHS site from 2012 through 2020. Values shown in red are below the detection limits for that parameter at that laboratory. FLBS is Flathead Lake Biological Station. EL is Energy Labs. All turbidity and conductivity analyses were done at SSHS.

Date	Flow (cfs)	Turbidity (NTU)	Conductivity (uS)	TSS (mg/L)	TN (ug/L-N)	TP (ug/L-P)	NO2-3 (ug/L-N)	SRP (ug/L-P)	Lab Source
4/4/12	25.37			0.82	150.00	7.00	34.00	<0.8	FLBS
4/19/12	69.89	2.65	112.20	1.13	113.00	7.00	31.00	<0.8	FLBS
4/19/12	66.70	2.19	112.00			6.00			FLBS
5/3/12	100.80	2.39	117.00	1.76	138.00	13.00	28.00	<0.8	FLBS
5/3/12		2.28	115.00	8.38					FLBS
5/10/12	154.32	5.00	109.20	12.95	112.00	12.00	20.00	<0.8	FLBS
5/16/12	252.32	8.75	83.00	16.14	99.00	18.00	20.00	<0.8	FLBS
5/22/12	268.28	10.23	104.00	1.21	146.00	21.00	14.00	<0.8	FLBS
5/25/12	137.37	3.19	80.45						SSHS
5/30/12	88.32	1.47	78.60	1.51	51.00	7.00	8.00	<0.8	FLBS
6/8/12	150.00	3.31	73.50	5.06	86.00	7.00	11.00	<0.8	FLBS
6/11/12	86.84	1.97	107.60	2.21	69.00	9.00	9.00	<0.8	FLBS
6/11/12	86.40			2.66					FLBS
6/22/12	154.32	2.91	79.00	2.47	66.00	7.00	6.00	<0.8	FLBS
6/28/12	106.62	2.67	74.60	2.00	62.00	7.00	5.00	<0.8	FLBS
7/11/12	55.35	2.55	76.60	2.11	52.00	5.00	5.00	<0.8	FLBS
7/30/12	13.69			<4.000	60.00	3.00	<10.0	<0.8	EL
7/30/12	13.69	1.41	87.40	0.50	16.00	7.00	<5.0	<0.8	FLBS
9/4/12	10.72			<4.000	50.00		10.00	<0.8	EL
11/12/12	12.00			<4.000			20.00	5.00	EL
1/14/13	10.00			<4.000			30.00	<5.0	EL
1/14/13	10.00			<4.000				5.00	EL
3/4/13	11.07			<4.000			10.00	5.00	EL
3/26/13	14.23	0.90		<4.000	80.00	4.20	30.00	<5.0	EL
4/8/13	79.44	4.02		<4.000		12.90		5.00	EL
4/8/13	79.44	4.18		<4.000	100.00		40.00	5.00	EL
4/23/13	38.89			<4.000	70.00	6.70	10.00	5.00	EL
4/30/13	85.66	4.70		<4.000	60.00		20.00	<5.0	EL
5/6/13	93.58	6.91		<4.000	80.00		10.00	<5.0	EL

5/13/13	328.18	25.60		6.00	160.00	22.50	30.00	<5.0	EL
5/20/13	129.24	2.60		13.00	100.00	6.80	10.00	<5.0	EL
5/29/13	150.95	3.86		36.00	60.00	2.30	<10.0	<5.0	EL
6/3/13	125.10	0.98		<4.000	<50.0	4.10	<10.0	<5.0	EL
6/10/13	163.87	1.57		<4.000	90.00	6.20	<10.0	<5.0	EL
6/25/13	97.17	0.67		<4.000	150.00		<10.0	<5.0	EL
7/8/13	44.15	1.29		<4.000	<50.0		10.00	<5.0	EL
7/8/13	44.15	0.90		<4.000			<10.0	<5.0	EL
7/8/13	44.15	0.63		1.20	43.70	5.80	5.10	0.90	FLBS
7/22/13				0.80	42.20	4.90	6.40	1.10	FLBS
9/7/13	14.38	0.45		0.70	38.50	4.70	8.20	1.20	FLBS
10/31/13	17.28	0.49		<0.200	51.90	4.20	4.70	<0.8	FLBS
2/28/14	10.00			0.50	89.70	3.00	65.40	2.30	FLBS
3/21/14	10.00			0.30	114.00	2.40	48.10	2.20	FLBS
2/17/15	7.17	2.41		1.60	135.90	5.60	62.40	2.00	FLBS
3/3/15	38.23	2.61		1.40	92.40	3.50	52.70	2.10	FLBS
3/17/15	109.53	5.19	105.90	4.80	177.90	9.90	79.40	2.40	FLBS
3/17/15	109.53	4.82	105.90		221.10	12.40			FLBS
3/24/15	77.35	2.81	102.30	5.10	122.00	5.60	41.10	1.90	FLBS
3/31/15	97.35	2.79		2.30	110.00	6.50	25.40	1.60	FLBS
4/7/15	58.16	1.94	101.80	1.40	150.00	4.50	17.70	1.90	FLBS
4/15/15	48.45	1.59	106.10	0.70	72.60	4.10	8.80	1.30	FLBS
4/22/15	100.72	2.50	101.80	3.80	105.00	6.20	17.30	1.40	FLBS
4/29/15	92.44	2.31	98.70	1.70	77.10	5.30	13.10	1.30	FLBS
5/5/15	143.64	4.05	101.80	5.10	89.70	6.80	21.50	1.40	FLBS
5/5/15	143.64	4.26	101.70		85.80	5.90			FLBS
5/5/15	143.64	3.79	101.80		81.30	5.10			FLBS
5/5/15	143.64	3.92	101.90		93.50	6.60			FLBS
5/12/15	84.66	1.91	104.10	1.40	75.50	3.60	22.20	<0.8	FLBS
5/19/15	84.66	0.98	108.00	1.30	67.10	4.80	13.70	0.80	FLBS
5/26/15	150.37	2.42	95.80	2.90	71.30	5.50	16.60	<0.8	FLBS
6/1/15	157.32	4.17	45.50	3.20	93.30	8.20	8.50	1.00	FLBS
6/9/15	100.72	1.93	91.50	1.50	54.70	4.20	9.70	1.20	FLBS
6/22/15	28.27	0.76		0.80	44.80	4.30	9.80	1.50	FLBS
6/22/15					45.10	3.40			FLBS

7/10/15		0.26		0.50	45.30	3.50	6.40	1.50	FLBS
7/20/15	15.42	0.40		0.40	43.20	3.30	8.70	1.20	FLBS
8/25/15	10.06			0.30	40.10	3.40	3.60	1.20	FLBS
10/12/15	10.00								
10/22/15	8.40	1.33	124.40	0.40	42.70	3.80	3.30	0.80	FLBS
12/9/15		1.20	119.20	0.80	92.60	4.40	54.20	1.50	FLBS
2/29/16				0.70	109.00	6.50	34.80	1.00	FLBS
3/8/16				0.30	172.00	32.90	28.20	1.30	FLBS
3/17/16				0.60	112.00	3.20	39.20	1.30	FLBS
3/23/16				0.60	100.00	3.00	27.30	0.90	FLBS
3/30/16				0.60	111.00	2.50	21.80	0.80	FLBS
4/4/16				1.90	110.00	5.60	30.60	1.50	FLBS
4/13/16				4.90	153.00	8.20	62.90	1.90	FLBS
4/18/16				1.30	126.00	5.40	63.90	1.30	FLBS
4/28/16				2.30	56.90	6.20	30.60	1.20	FLBS
5/5/16				< 0.2	84.30	10.00	21.70	1.20	FLBS
5/12/16				1.90	37.90	3.80	22.10	1.00	FLBS
5/19/16				2.10	36.00	6.70	15.10	1.60	FLBS
5/26/16				1.50	39.20	4.70	7.80	1.10	FLBS
5/31/16				1.20	46.60	2.50	5.70	< 0.8	FLBS
6/6/16				2.50	56.40	3.90	5.10	0.80	FLBS
6/24/16				1.10	51.60	3.00	6.80	< 0.8	FLBS
6/24/16				2.30	40.90	2.70	8.20	< 0.8	FLBS
7/2/16				0.90					FLBS
7/20/16				0.80	48.70	3.30	6.10	< 0.8	FLBS
8/26/16				0.60	28.30	1.50	4.40	0.90	FLBS
10/10/16				0.50	32.00	1.50	2.70	< 0.8	FLBS
3/25/17					134.00	6.70	42.70	2.00	FLBS
4/1/17					126.00	12.90	23.80	2.20	FLBS
4/6/17					94.50	4.20	11.30	1.50	FLBS
4/13/17					86.80	4.60	7.60	1.20	FLBS
4/13/17					84.90	4.80	7.30	1.20	FLBS
4/18/17					169.00	6.20	8.20	< 0.8	FLBS
4/26/17					87.70	5.00	4.70	< 0.8	FLBS
5/1/17					100.00	4.60	2.20	< 0.8	FLBS
5/11/17					129.00	13.20	21.30	1.10	FLBS

5/25/17		107.00	7.90	14.40	1.20	FLBS
5/31/17		91.50	9.40	10.40	1.50	FLBS
6/5/17		130.00	12.30	7.40	1.40	FLBS
7/4/17		57.00	4.50	2.80	1.10	FLBS
7/30/17		37.10	3.00	4.20	1.00	FLBS
7/30/17		37.30	4.10	4.10	0.90	FLBS
7/30/17		< 25.0	< 1.5	< 1.5	< 0.8	FLBS
8/26/17		44.40	4.80	4.00	1.80	FLBS
9/12/17		36.70	3.40	3.60	2.10	FLBS
10/18/17		324.00	5.60	< 1.5	2.20	FLBS
11/13/17		32.60	2.10	3.70	1.50	FLBS
3/19/18	0.80	195.00	3.40	142.00	< 0.8	FLBS
4/4/18	1.10	266.00	15.80	163.00	2.00	FLBS
4/18/18	1.80	299.00	11.10	188.00	4.20	FLBS
4/25/18	5.10	345.00	19.10	226.00	9.30	FLBS
5/2/18	6.70	337.00	29.10	207.00	18.70	FLBS
5/15/18	15.30	288.00	33.40			FLBS
6/4/18	8.60	204.00	18.70	67.20	5.70	FLBS
6/20/18	3.50	88.80	11.30	9.20	3.00	FLBS
7/23/18	1.10	100.90	7.10	39.20	1.70	FLBS
9/6/18	1.10	71.70	3.50	26.60	1.00	FLBS
10/17/18	4.00	103.00	2.90	30.20	2.00	FLBS
11/29/18	2.00	186.00	2.50	123.00	1.00	FLBS
12/11/18	1.00	208.00	3.50	184.00	1.10	FLBS
4/10/19	5.00	566.00	14.90	381.00	4.60	FLBS
5/1/19	6.70	633.00	51.40	314.00	1.30	FLBS
5/21/19	5.20	385.00	6.90	314.00	2.00	FLBS
5/30/19	4.50	581.00	8.30	228.00	3.00	FLBS
8/7/19	0.70	165.00	3.30	112.00	1.20	FLBS
9/4/19	0.90	163.00	2.40	126.00	0.80	FLBS
11/3/19	0.90	156.00	1.70	125.00	< 0.8	FLBS
4/16/20	2.1	202	5.3	129	0.9	FLBS
4/21/20	11.0	270	13.9	140	1.1	FLBS
5/1/20	11.8	366	15.5	242	2.5	FLBS
5/1/20	12.0	411	16.2	243	2.6	FLBS
5/8/20	3.5	266	6.6	193	1.2	FLBS

5/8/20	3.7	293	6.8	194	1.3	FLBS
5/16/20	2.2	246	4.3	169	1.1	FLBS
5/23/20	9.7	310	13.2	206	1.4	FLBS
5/30/20	16.5	303	20.1	184	2.5	FLBS
6/12/20	5.5	203	7.0	126	1.2	FLBS
6/26/20	3.7	115	5.4	44.2	1.5	FLBS
7/10/20	1.7	91.9	3.3	34.7	0.8	FLBS
7/10/20	1.7	96.6	3.0	34.8	0.8	FLBS
7/27/20	0.9	81.3	3.8	26.4	0.8	FLBS
8/10/20	0.4	109	1.9	60.7	0.9	FLBS
8/26/20	0.6	86.0	2.6	36.4	0.8	FLBS
9/18/20	0.5	57.9	< 1.5	14.8	< 0.8	FLBS
10/15/20	0.4	106	2.0	44.3	< 0.8	FLBS