Lake Gaston Water Quality Monitoring

2023 Final Report

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Introduction

Water chemistry parameters, including temperature, dissolved oxygen, pH, and conductivity are drivers for many natural aquatic processes and can help indicate the overall health of a system. While fluctuations in these parameters are expected and can be influenced by naturally occurring events, long term data sets help identify changes that could indicate possible negative impacts to the system, such as point source pollution or erosion issues. For Lake Gaston, water chemistry fluctuations are also driven by unnatural discharge flows from the upstream Kerr Lake Dam. Kerr Lake operates as a flood control reservoir for the US Corp of Engineers and controlled releases from the dam's hypolimnetic withdrawal can rapidly alter Lake Gaston's water quality, especially flow rates, water temperature, and dissolved oxygen levels.

Temperature and dissolved oxygen are major drivers for natural processes in an aquatic system and both display natural seasonal fluctuations. As water temperatures rise in the summer months a thermocline will naturally develop within the water column and create two drastically different aquatic environments. Warm, highly oxygenated water will be located in the upper section of the water column above the thermocline, in contrast, an area of cold water with low dissolved oxygen will develop deeper in the water column below the thermocline. This area of low-oxygenated water can be a stress factor to aquatic organisms and plays a major role in natural processes that influence the nutrient dynamics of a system.

Water chemistry parameters, including pH and conductivity remain fairly constant within an aquatic system, but are monitored for temporal changes that could indicate possible harmful anthropogenic impacts. pH is an indicator of carbon dioxide levels within a system, which can be influenced by natural plant processes such as photosynthesis and decomposition or anthropogenic influences such as air pollution. Conductivity is the level of ionic substances that are dissolved in the water and remains fairly constant within individual aquatic systems.

Nutrients are an essential component to the energy flow of an aquatic system and fuels primary production and drives a system's trophic status. However, increased nutrient levels can alter ecological processes and impact aquatic ecosystems in a plethora of different ways. Monitoring temporal changes to the trophic status of an aquatic system allows managers to determine the level of primary nutrients and primary producers within a system, identify shifts in overall productivity, and help identify possible factors impacting aquatic ecosystems processes. Nine individual parameters were monitored to indicate the trophic status of Lake Gaston: total phosphorous, orthophosphorus, total nitrogen, total nitrogen / total phosphorous ratio, total Kjeldahl nitrogen, ammonia, total nitrate / total nitrite, chlorophyll-a, and secchi depth. Several of the aforementioned parameters are temperature dependent, therefore seasonal variations are expected due to seasonal fluctuations in water temperatures.

Phosphorous is a major component in processes involved in the formation of cell membranes, cellular energy, and growth of aquatic plants. However, phosphorous can be a limiting nutrient within a system. Limiting nutrients within an aquatic system are those nutrients that drive the growth of aquatic communities, however are not readily available within the system. Biologically available forms of phosphorous are limited in surface water, but can be produced within a system through the presences of phosphorous bound sediment particles or by excretion by aquatic organisms such as zooplankton. Most phosphorous enters an aquatic system from point and non-point sources such as atmospheric deposition, inflow from streams, runoff, or erosion. Internal loading of phosphorous into a system can also occur through the release of phosphorous from sediment to water column (Wu et al. 2017). Loss of phosphorous within a system occurs through sedimentation of bound particles, however environmental factors such as oxygen levels and physical turbulence can re-release this nutrient back into the water column. We report on two forms of phosphorous within Lake Gaston. Total phosphorous is the measure of all phosphorous present within a system, including those forms that are not biologically available for use by aquatic organisms. Orthophosphate is a soluble form of phosphorous and is the only directly utilizable form that is readily available for use by algae and other aquatic plants for growth.

Nitrogen, along with phosphorous, is a major nutrient that affects the productivity of an aquatic system. For plants and animals, nitrogen is needed to synthesize protein and is essential to the production of cellular tissues. Nitrogen has numerous forms, both organic and inorganic, and can be introduced into aquatic systems externally through fallout from atmospheric sources or surface water run-off and internally through nitrogen fixation. Organic forms of nitrogen are present through the excreted waste of living organisms or the decomposition process of dead organisms. Inorganic forms include nitrate, nitrite, or ammonia and commonly enter a system through point and non-point source pollution. These forms of nitrogen can be toxic to both humans and aquatic organisms at elevated levels. Inorganic forms of nitrogen are good indicators of nutrient pollution within a system due to their naturally occurring low levels and their high solubility in run-off water. Nitrogen levels within a system can display dynamic variations both spatially and temporally due to nitrogen fixation either through aquatic organisms or through nitrogen's ability to naturally transform from one form to another given proper aquatic environmental conditions. Nitrification along the water-sediment interface can be a major source of internal nitrogen loading within a system (Wu et al. 2017; Gautreau et al. 2020). We report on four forms of nitrogen within Lake Gaston. Measurements for inorganic nitrogen (nitrate/nitrite nitrogen and ammonia) can be taken directly, while organic nitrogen levels are calculated through total Kjeldahl nitrogen measurements. Total nitrogen is calculated by combining the levels inorganic nitrogen (nitrate/nitrite nitrogen) with the level of organic nitrogen (total Kjeldahl nitrogen) within a system.

Chlorophyll-a is a specific form of chlorophyll used in oxygenic photosynthesis of plants, including algae. Therefore, it can be used to estimate community levels of primary producers within a system.

Secchi depth is an indicator of water clarity and can be affected by suspended sediment, algae abundance, or overall color of the water. Since a change in average secchi depths can reflect algal blooms or impacts of sediment loading into a system, secchi depths are often compared to both total phosphorous and chlorophyll-a to determine the driving factors that influence water clarity.

To further understand the dynamics of an aquatic system, managers must understand the relationship between these nutrient factors and how they correlate with limiting or promoting growth within the aquatic communities. The trophic state index (TSI) model developed by Carlson (1977) assumes algal biomass to be the basis for trophic classification (Carlson and Havens 2005). This model uses deviations in the expected levels of chlorophyll-a, secchi depth, and total phosphorous to classify the productivity level of aquatic systems and identify limiting factors within a system (Carlson 1977). These models were designed to take complex relationships that drive productivity within aquatic ecosystems and present them in a format that is simple to understand and disseminate (Carlson and Simpson 1996). Aquatic systems with clear water and low productivity are classified as oligotrophic, a mesotrophic system has increased productivity but maintains a moderately clear appearance, and eutrophic systems are highly productive which drastically decreases the clarity of the water.

Sediment characteristics play an important role in the nutrient dynamics of a reservoir. The ability of a reservoir to retain sediments at high levels results in the accumulation of sediment-associated nutrients, including nitrogen and phosphorus (Gautreau 2020). This nutrient accumulation has the potential to influence the nutrient dynamics of a system as much as anthropogenic impacts and compromise directed efforts to improvement a system's water quality (Søndergaard et al. 2003; Wu et al. 2017). Through various ecological processes, freshwater systems can experience internal fertilization by releasing nutrients from the sediment back into the water column, making them available for the primary producers of the system (Wetzel 1983; Wu et al. 2017). Nutrient deposits can be a product of distribution of nutrient bound particles suspended in the water column or high levels of biological activity, including benthic microbial and macroinvertebrate communities, which recycle nutrients through metabolic activities and bioturbation (Wetzel 1983; Gautreau 2020). In addition, nutrient dynamics of both the sediment and water column within the littoral zone are impacted by the establishment of aquatic macrophyte communities. While most accessible nutrients for aquatic plant growth are located within the water column, rooted macrophytes can utilize phosphorous and nitrogen sources bound within the sediment. These macrophytes also provide a source of organic matter and nutrients during senescence and death.

Aquatic systems need healthy levels of nutrients, such as nitrogen and phosphorous, to support the growth of aquatic plants and animals. However, when levels become out of balance or an overabundance of these nutrients occurs, a system can experience harmful ecological impacts. Monitoring these nutrient dynamics and the chemical properties that drive them can provide early warnings of increased eutrophication within the lake and identify possible point sources of excess nutrients into the system.

The objective of this study was to perform regular water quality monitoring with the goal of 1) characterizing basic water chemistry and nutrient parameters for Lake Gaston, 2) monitoring changes in nutrient dynamics in the hydrosoil, and 3) identifying any potential negative impacts to the water quality of Lake Gaston. This research is a continuation of a robust dataset established utilizing routine monthly sampling at established sites throughout the system in 2019, 2020, and 2021.

Methods

Water Quality

Water quality sampling to measure nutrient levels and physical water chemistry parameters was conducted at 19 individual sites at Lake Gaston (Figure 1). Samples were collected bimonthly, therefore each season (winter, spring, summer, and fall) was represented by two individual sampling events. These sites were distributed across the geological extent of Lake Gaston and represented every major sub- watershed and tributary, as well as the main body of the lake. Average discharge rates for both Kerr Lake dam and Lake Gaston dam were reported by the US Army Corps of Engineers – Wilmington District and their data has been incorporated into this report (Figures 2; Figure 3).

At each sample site, a surface water sample was taken to measure nutrient levels and physical water chemistry parameters. At sites with water depths greater than 6 feet, a second sample of physical water chemistry parameters was collected from the bottom of the water column (1.5 feet above the substrate) for physical water chemistry parameters and used to evaluate benthic conditions in relation to the formation of seasonal thermoclines. . A Eurika multiprobe water quality meter measured physical parameters including temperature, dissolved oxygen, pH, chlorophyll-a, and conductivity at both surface and benthic depths. Nutrient parameters were measured from surface water samples that were collected and stored for later chemical analysis at the Weaver Laboratory at North Carolina State University and included total Kjeldahl nitrogen, ammonia, total nitrate/total nitrite, total phosphorus, and orthophosphorus. Total nitrogen levels were calculated by combining total Kjeldahl nitrogen and total nitrate/total nitrite levels. Nutrient samples were kept on ice in the field and then stored frozen until processed. Secchi depths were collected using a standard secchi disk that was lowered into the water column and then raised to a depth where it could be visually observed.

Hydrosoils

A single hydrosoil sample was collected at 19 water quality sites in January 2024. Sediment samples were collected using a petite ponar stainless steel grab. A stainless steel spoon was used to collect the hydrosoil sample from the ponar grab and transfer it to an amber I-Chem certified clean bottle. Samples were brought back to the lab and allowed to completely air dry prior to laboratory analysis. Samples were then processed by North Carolina State University's Weaver laboratory to determine the following parameters: Carbon (% weight), Nitrogen (% weight), Nitrate (mg/L), Ammonia (mg/L), Phosphorous (mg/kg), Copper (mg/kg), and Iron (mg/kg).

Results

Water Quality

The US Army Corps of Engineers – Wilmington District reports average discharge rates for both Kerr Lake dam and Lake Gaston dam (Figures 2; Figure 3) and in 2023 seasonal flow rates for Kerr Lake dam varied significantly ($p < 0.001$). A Tukey's multiple-contrast test indicated that the average flow rates during the winter months (8,737 cfs) were significantly higher than any other season. Similar average flow rates were reported during the spring (5,834 cfs) and summer (4,959 cfs) months and were not found to be significantly different. The lowest average flow rates were reported during the fall months (2,517 cfs) and were significantly lower than any other season.

Expected seasonal fluctuations in both surface water temperatures and dissolved oxygen levels were observed (Figure 4). Seasonal water temperatures were lowest during the winter months (mean = 47 °F), peaked in the summer (mean = 81°F), and were similar during the spring and fall seasonal months (spring: mean = 65°F; fall mean = 59°F). Dissolved oxygen levels followed a similar seasonal pattern, however dissolved oxygen levels were the highest during cold winter months (11 mg/L) and lowest during the warm summer months (6 mg/L). Dissolved oxygen levels for the spring and fall months were both reported to be 10 mg/L. These seasonal trends were also reported for individual watersheds, but no single watershed experienced major variations in either temperature or dissolved oxygen (Figure 5; Figure 6). All seasonal dissolved oxygen levels were above the level needed to sustain aquatic life (EPA standard = 3 mg/L). Seasonal stratification of the water column and development of a thermocline was indicated by divergent temperature and dissolved oxygen levels during the spring and summer months (Figure 7).

The average pH for Lake Gaston was 7.37 (Table 1) which is considered neutral and within the optimal range for aquatic organisms (6.5 – 9) set by the US Environmental Protection Agency (EPA). pH has experienced a slight increase each year from 6.83 reported in 2019, 7.08 in 2020, 7.21 in 2021, and 7.37 in 2023. Lake Gaston's average conductivity in 2023 was 92.82 µs/cm (Table 1) and has also displayed incremental increases from the reported 73 µs/cm in 2020, 83.61 µs/cm in 2021, and 92.82 µs/cm in 2023. The EPA does not provide standards for conductivity.

Overall, nutrient parameters were all within the range of water quality standards recommended by the EPA (Table 2), with the exception of total nitrogen. Due to the dynamic nature of aquatic systems, temporal variation was expected and did occur across all reported nutrient parameters.

Seasonal and spatial variations were reported for two forms of phosphorous, total phosphorous and orthophosphorus (Table 3; Figure 8; Figure 9). Significant seasonal variations were reported for both forms of phosphorous ($p < 0.001$). For total phosphorous, the spring months reported an average level of 39.63 ppb and were significantly higher than that reported for summer (30.86 ppb) and fall (23.01 ppb) months. Winter months reported an average total phosphorous level of 32.72 ppb and were similar to levels reported in spring and summer. Orthophosphorus followed similar seasonal variations as reported with total phosphorus. The spring months reported the highest levels (25.66 ppb) and were significantly different than those reported for the summer (18.43 ppb) and fall (14.19 ppb) months. The winter months reported an average orthophosphorus level of 23.48 ppb and was similar to levels reported in the spring and summer months. Neither form of phosphorous displayed significant geographical variation between watersheds ($p > 0.05$).

Nitrogen levels for Lake Gaston were reported in the form of total nitrogen, total Kjeldahl nitrogen, ammonia, and total nitrate/ total nitrite (Table 3; Figure 10; Figure 11; Figure 12; Figure 13). Nitrogen levels did not vary spatially across watersheds for total nitrogen ($p = 0.388$; Figure 10), total Kjeldahl nitrogen ($p = 0.489$; Figure 11), or ammonia ($p = 0.483$; Figure 12) (Table 3). Total nitrate and total nitrite also showed no spatial variability across most watersheds ($p = 0.423$; Figure 13). Significant temporal variations were detected for all forms of nitrogen ($p<0.001$), however a seasonal pattern was not determined. The ratio of total nitrogen to total phosphorous was determine for each watershed and there was no significant differences detected between watersheds ($p=0.560$; Figure 14).

Lake Gaston's average water clarity (1.2 m) fell well within the EPA standard range (Table 2). Temporal and geographical differences in water clarity were displayed throughout the system (Table 3; Figure 15; Figure 16) and average lake wide secchi depths varied significantly by watershed ($p < 0.0001$) and by season ($p < 0.0001$). Temporal variations are expected due to increased seasonal rainfall and reservoir turnover events. Overall, a Tukey's multiple-contrast test indicated water clarity was significantly lower during the winter months (0.81 m) as compared to all other seasons. Average water clarity displayed during the summer months (1.6 m) were similar to those displayed during both the spring (1.2 m) and fall months (1.7 m). However, water clarity displayed during the fall months were significantly higher than clarity experienced during the spring season. A Tukey's multiple-contrast test also indicated geographical variations in water clarity were based on the watershed's distance from the Lake Gaston dam. Pea Hill watershed, which is located directly adjacent to the dam, exhibited significantly higher water clarity than either Hawtree or Smith watersheds, which are located in the upper most part of Lake Gaston. All watersheds located mid-system displayed similar water clarities.

Average lake wide chlorophyll-a concentrations reported for 2023 (6.2 ppb) were within the EPA standard range (Table 2). Overall, a Tukey's multiple-contrast test indicated that there were no significant differences reported in lake wide chlorophyll-a concentrations between watersheds (p =0.157) (Table 3; Figure 17). There were also no seasonal variations detected (p = 0.7094) during the 2023 survey season.

Results of the trophic state index utilizing TSI values for total phosphorous and secchi depth classified Lake Gaston as a eutrophic system (Figure 18). TSI values chlorophyll-a classified Lake Gaston as a mesotrophic system (Figure 18). For all watersheds, the TSI values for both total phosphorous and secchi depth were greater than the TSI values reported for chlorophyll-a (Figure 18).

Hydrosoils

Results for hydrosoil nutrient levels for Lake Gaston's associated watersheds can be found in Table 5. Carbon ranged between 1.81 and 3.49 in % weight per sample, with Lizard – N reporting the highest levels and Lizard - S reporting the lowest levels. Overall, average levels reported in 2023 were lower than those reported in 2021, 2.89% and 3.32% respectively.

Nitrogen and phosphorous varied in spatial trends per watershed, neither followed distinct patterns when comparing levels contained within the water column and sediment (Figure 19 and 20). Songbird - N reported the lowest levels of nitrogen within the water column (305 ppb), but the second highest levels percent per sample for hydrosoil (0.30). The highest reported percent of nitrogen per sample for hydrosoil was Lizard N (0.32). Overall, average nitrogen levels for hydrosoil reported in 2023 were lower than those reported in 2021, 0.25% and 0.30% respectively. Great - N reported the highest levels of phosphorous in the water column (39 ppb) but the 4th lowest in hydrosoil concentrations (705 mg/kg). The highest level of phosphorous reported for hydrosoil was Poplar Creek (859 mg/kg) and the lowest levels were reported for Lizard - S (350 mg/kg). Overall, average phosphorous levels for hydrosoil reported in 2023 were higher than those reported in 2021, 633 mg/kg and 582 mg/kg respectively.

Metal levels reported for hydrosoil were iron and copper. Iron was highest in Poplar (76,649 mg/L) and lowest in Lizard – S (32,781 mg/kg). Overall, average iron levels for hydrosoil reported in 2023 were lower than those reported in 2021, 52,898 mg/L and 61,351 mg/L respectively. Copper levels ranged from 28.48 mg/kg in the Lizard - S watershed to 176.03 mg/kg in Pea Hill – S. Overall, average copper levels for hydrosoils reported in 2023 were higher than those reported in 2021, 65 mg/L and 49 mg/L respectively.

Discussion

Overall, water chemistry and nutrient parameters fall within the levels recommended by the

EPA for the protection of aquatic life and recreation and did not vary spatially across watersheds. The only exception was total nitrogen levels, which fell below the EPA benchmark range but did not display significantly different levels based on watershed location. All other nutrient levels were within the expected ranges or were similar to levels experienced between 2019 and 2021. Lake Gaston experiences expected seasonal fluctuations in chemical parameters including temperature, dissolved oxygen levels, and flow rates. All of which can drive responses in natural aquatic processes and impact the trophic dynamics of a system. Although dissolved oxygen levels decreased as water temperatures increased during summer months, levels never reached a critical point of negatively impacting aquatic life on a large scale. Certain parameters should remain stable within individual aquatic systems and include pH and conductivity. These parameters are used to indicate major temporal changes over multiple years that could be a potential result of anthropogenic impacts such as pollution. Overall, Lake Gaston exhibited a neutral pH and expected conductivity levels for a piedmont reservoir.

Results from the trophic state index classified Lake Gaston as a mesotrophic to eutrophic system, which indicates the ability of the system to support a healthy and diverse population of aquatic organisms. Although total nitrogen levels were below the desired benchmark, the high level of productivity in the system could be an indication that phosphorous is the limiting nutrient. Changes in total phosphorous have remained within the EPA benchmark range since 2019, but major shifts could be a driving factor for algal growth within the system. Nutrient parameters did not significantly differ across watersheds, indicating that point source nutrient pollution is not an issue on a large scale.

Chemical factors, such as dissolved oxygen levels and temperature, and the physical characteristic of a reservoirs benthic environments can impact nitrogen and phosphorus fluxes at the sediment-water column interface (Kristensen 2000; Lavery et al. 2001; and Ni and Wang 2015). During warm summer months benthic environments develop anoxic conditions which triggers the internal loading of nitrogen and phosphorous (Gautreau 2020). These warm summer months also coincide with increased primary production within a system and the combination could contribute to eutrophication. Monitoring nutrient levels within the water column gives managers an indication of the current state of nutrient dynamics within a system. However, monitoring the nutrient levels within the sediment allows managers to identify areas that could be at greater risk for future increased nutrient loading and sources for potential eutrophication.

Hydrosoil samples did not indicate potential nutrient loading within the sediment for any individual watershed. There was also no spatial indication of nutrient bound sediments falling out of the water column as water moved downstream. Nutrient levels varied for hydrosoil samples collected in 2023 when compared to those collected in 2021, however this may be a result of seasonal differences and not systemwide changes.

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Tables

Table 1. Average pH, alkalinity, and conductivity levels for Lake Gaston between 2019 and 2023. Data collected between 2019 and 2021 can be found in Baumann (2022). The water quality standards recommended by the US Environmental Protection Agency (EPA) for each parameter are also listed.

Year	Average pH	Average Alkalinity (mg/L)	Average Conductivity (µs/cm)
EPA standard	*6.5 - 9*	*> 20 mg/L*	*n/a*
2023	**7.37**	**n/a**	**92.82**
2021	7.21	25.22	83.61
2020	7.08	33.26	73.53
2019	6.83	n/a	n/a

Table 2. Lake wide average nutrients levels for Lake Gaston for 2019 – 2023. Data collected between 2019 and 2021 can be found in Baumann (2022).Total nitrogen and phosphorous, chlorophyll-a, and secchi depths (A) and individual nitrogen and phosphorous parameters (B). The water quality standards recommended by the US Environmental Protection Agency (EPA) for each parameter are also listed.

(A)

Year	Total Nitrogen (ppb)	Total Phosphorus (ppb)	TN:TP Ratio	Chlorophyll-a (ppb)	Secchi Depth (m)
EPA standard	*2000 - 6000*	*10 - 62.5*	*n/a*	*1.87 – 12.95*	*0.46 – 2.04*
2023	**593**	**32**	**19**	**6.20**	**1.2**
2021	1,039	39	27	7.55	1.2
2020	n/a	60	n/a	9.81	1.0
2019	n/a	40	n/a	n/a	1.3

(B)

Year	Total Kjeldahl Nitrogen (ppb)	Ammonia (ppb)	Total Nitrate / Total Nitrite (ppb)	Orthophosphorus (ppb)
EPA standard	*n/a*	*n/a*	*n/a*	*n/a*
2023	**552**	**26**	**83**	**20**
2021	849	40	87	13
2020	906	41	n/a	16
2019	790	40	n/a	12

Table 3. Average yearly parameter values reported for Lake Gaston's associated watersheds for 2023. Total nitrogen and phosphorous, chlorophyll-a, and secchi depths (A) and individual nitrogen and phosphorous parameters (B). Some watersheds are divided by the main section of Lake Gaston and are divided between sites located on the north (N) and south (S) shorelines.

(A)

Watershed	Total Nitrogen (ppb)	Total Phosphorous (ppb)	TN:TP Ratio	Chlorophyll –a (ppb)	Secchi Depth (m)
Smith	381	29	15	5.1	0.76
Hawtree	724	35	22	6.2	0.80
Great_N	418	39	11	8.6	0.85
Sixpound	339	37	11	6.2	0.96
Poplar	506	32	26	5.1	1.26
Songbird_N	276	28	11	5.7	1.28
Songbird_S	542	29	21	6.1	1.05
Lizard_N	554	28	23	5.9	1.63
Lizard_S	467	30	19	6.2	1.12
Pea Hill_N	435	29	29	6.2	1.68
Pea Hill_S	578	33	33	7.6	1.49

(B)

Watershed	Total Kjeldahl Nitrogen (ppb)	Ammonia (ppb)	Total Nitrate / Total Nitrite (ppb)	Orthophosphorus (ppb)
Smith	446	17	87	23
Hawtree	662	35	93	17
Great_N	502	26	77	28
Sixpound	713	23	96	17
Poplar	528	37	58	20
Songbird_N	320	27	66	18
Songbird_S	544	20	101	21
Lizard_N	524	21	44	21
Lizard_S	543	27	77	21
Pea Hill_N	476	19	49	19
Pea Hill_S	704	21	92	20

Table 4. Average trophic state index values reported for chlorophyll-a, secchi depth, total phosphorous for Lake Gaston's associated watersheds. Some watersheds are divided by the main section of Lake Gaston and are divided between sites located on the north (N) and south (S) shorelines.

Watershed	Chlorophyll-a TSI	Secchi Depth TSI	Total Phosphorous TSI
Smith	45.36	65.83	51.79
Hawtree	47.97	65.05	53.94
Great_N	51.01	67.46	56.35
Sixpound	47.54	64.34	54.02
Poplar	45.92	62.25	50.71
Songbird_N	46.29	58.91	51.72
Songbird_S	47.53	61.79	51.75
Lizard_N	46.82	54.27	51.41
Lizard_S	47.46	60.63	52.06
Pea Hill_N	47.37	54.47	51.29
Pea Hill_S	49.56	56.13	53.17

Table 5. Nutrient parameters for hydrosoils collected at Lake Gaston, NC/VA. Some watersheds are divided by the main section of Lake Gaston and are divided between sites located on the north (N) and south (S) shorelines.

Watershed	Carbon (% wt.)	Nitrogen (% wt.)	Phosphorous (mg/kg)	Nitrate (mg/L)	Iron (mg / kg)	Copper (mg / kg)
Smith	2.37	0.20	511	1.51	42,828.36	43.66
Hawtree	2.34	0.18	509	0.44	48,440.72	31.01
Great_N	3.25	0.28	705	0.515	61,098.48	41.67
Sixpound	3.29	0.27	762	0.95	64,880.14	30.31
Poplar	3.47	0.30	860	1.34	76,649.10	51.28
Songbird_N	3.30	0.30	700	1.41	71,554.69	45.47
Songbird_S	2.87	0.24	564	0.21	52,536.50	69.02
Lizard_N	3.49	0.32	663	2.29	63,931.82	97.95
Lizard_S	1.81	0.17	351	0.31	32,781.25	28.48
Pea Hill_N	2.83	0.26	680	0.89	45,863.53	49.72
Pea Hill_S	3.44	0.29	805	0.68	50,864.19	176.03

Figures

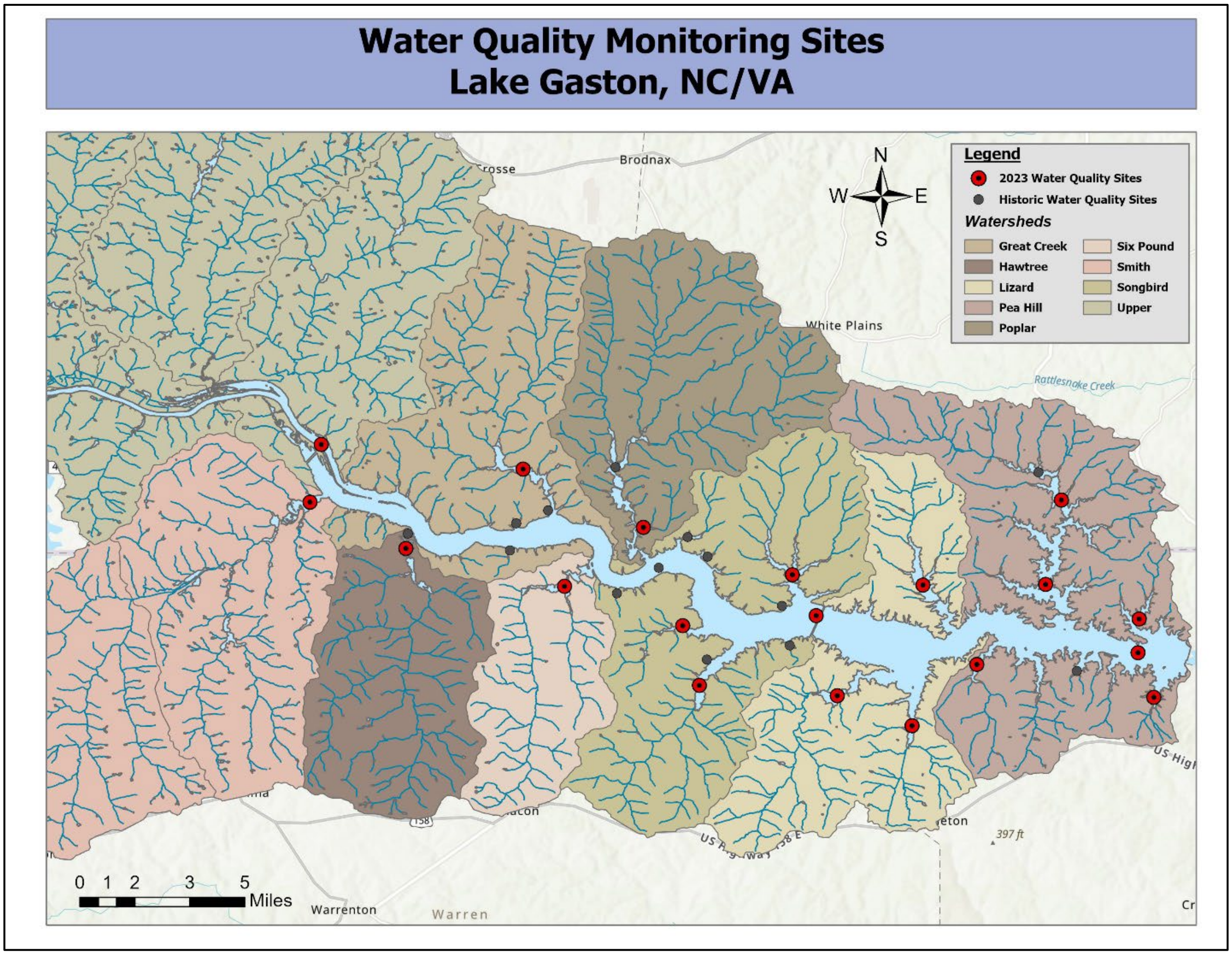

Figure 1. A map of Lake Gaston's water quality monitoring sites 2023.

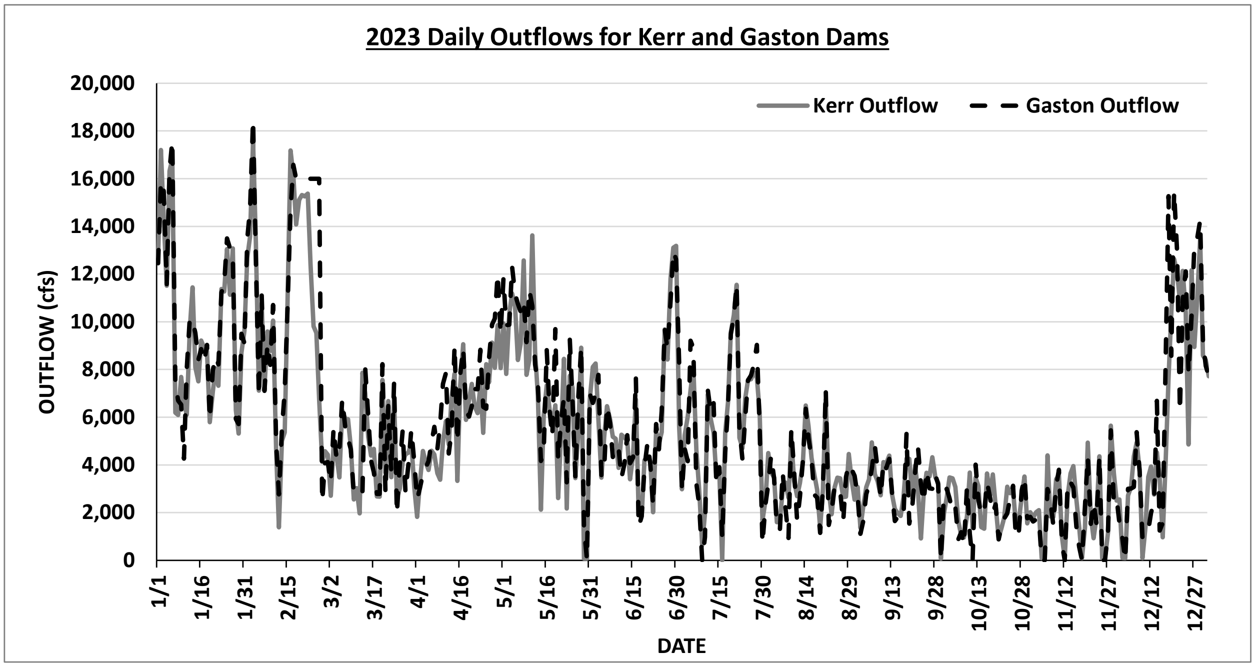

Figure 2. Average daily discharge values as reported by the US Army Corps of Engineers at Kerr Lake dam and Lake Gaston dam for 2023.

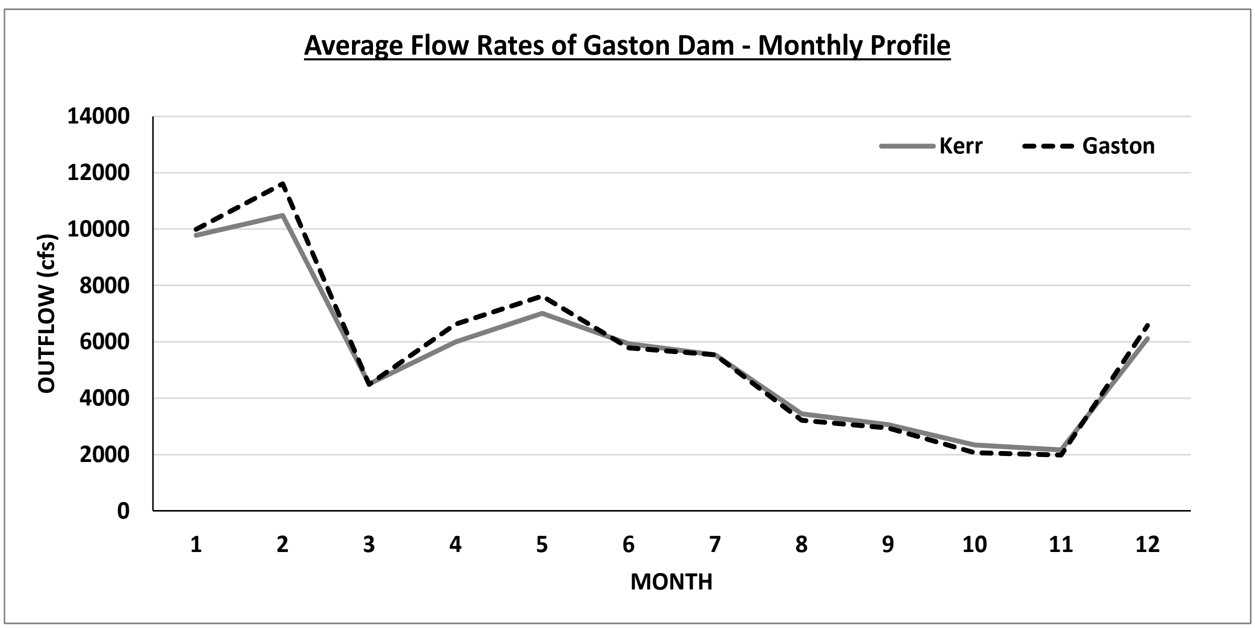

Figure 3. Average monthly flow rates as reported by the US Army Corps of Engineers for Lake Gaston dam in 2023.

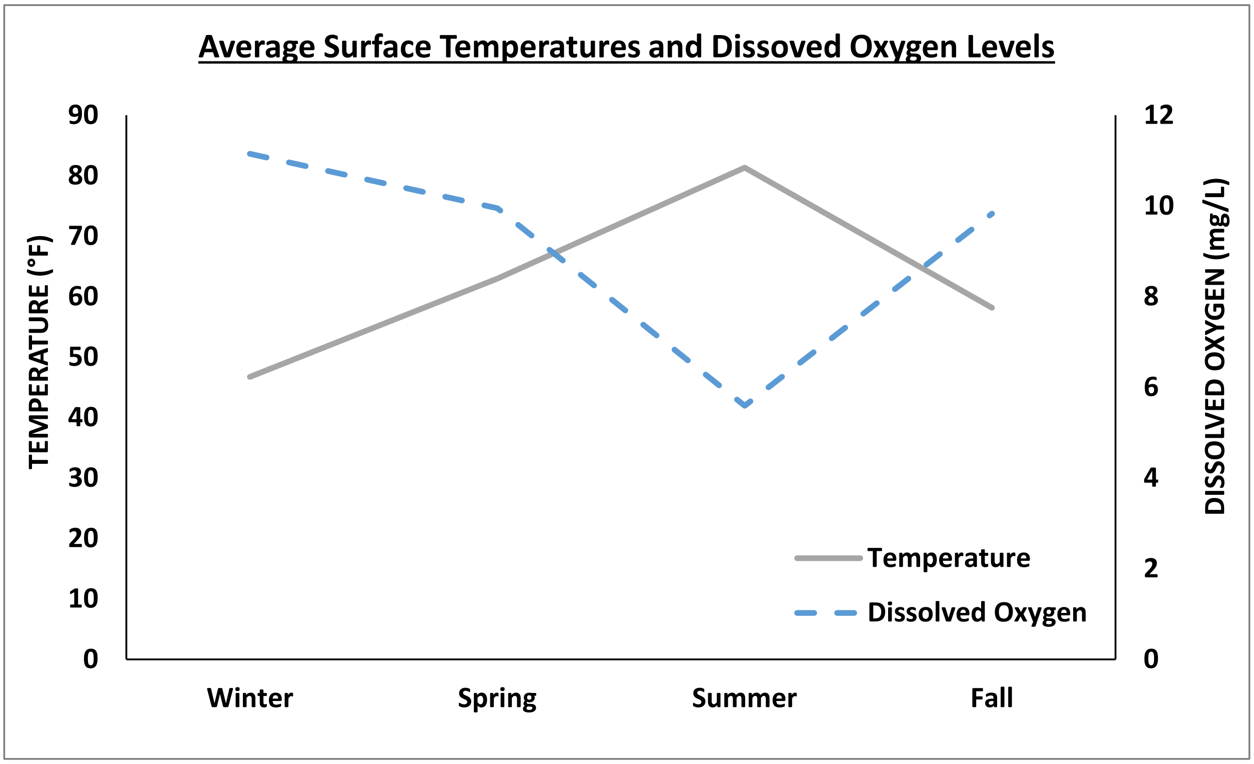

Figure 4. Average seasonal surface temperatures and dissolved oxygen levels reported for Lake Gaston in 2023.

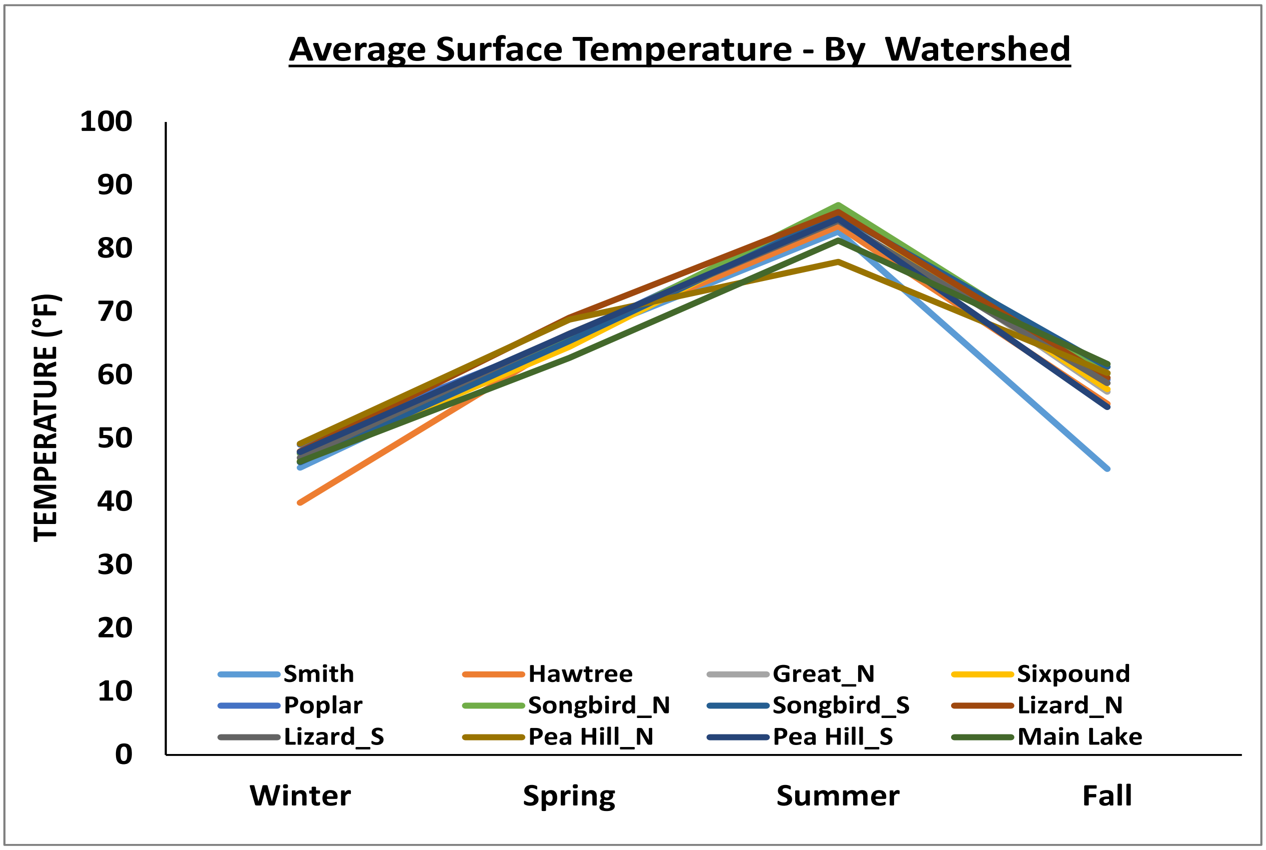

Figure 5. Average seasonal surface water temperatures reported for Lake Gaston's associated watersheds in 2023.

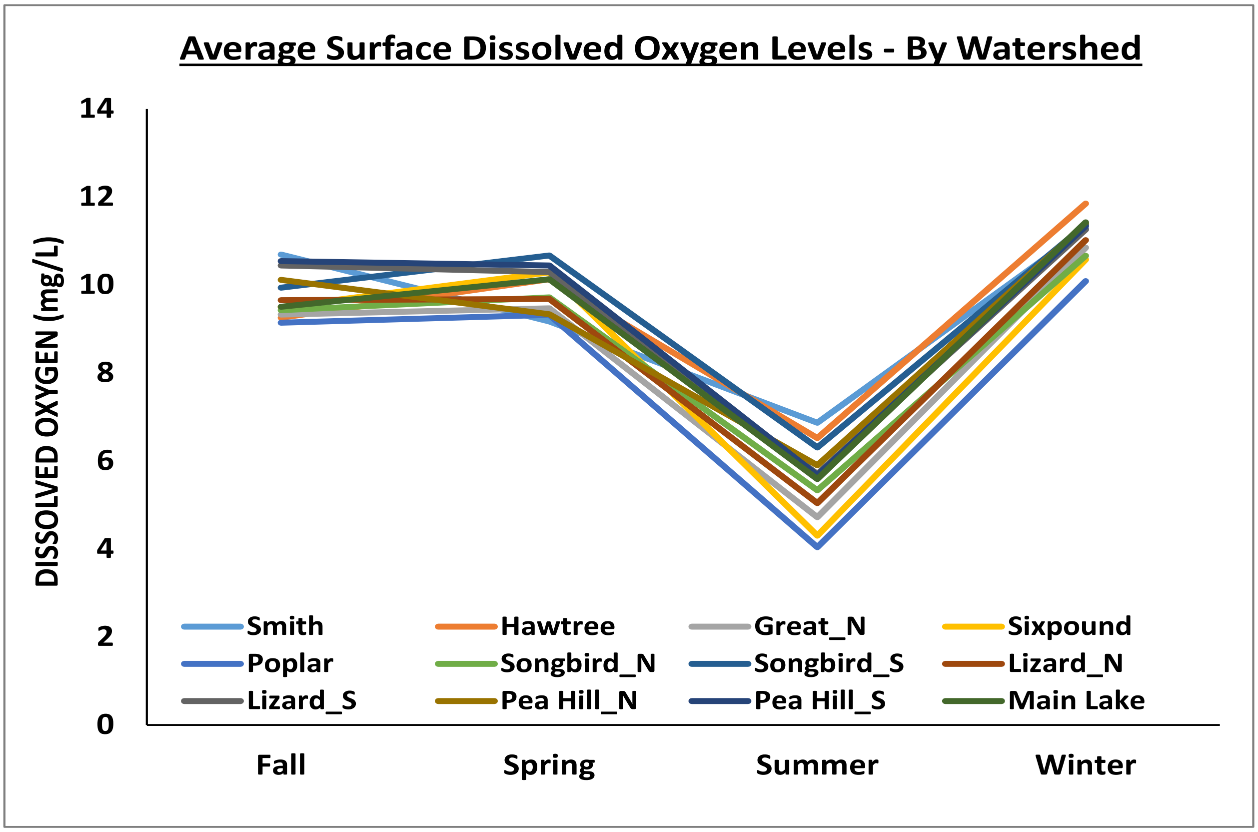

Figure 6. Average seasonal surface dissolved oxygen levels reported for Lake Gaston's associated watersheds in 2023.

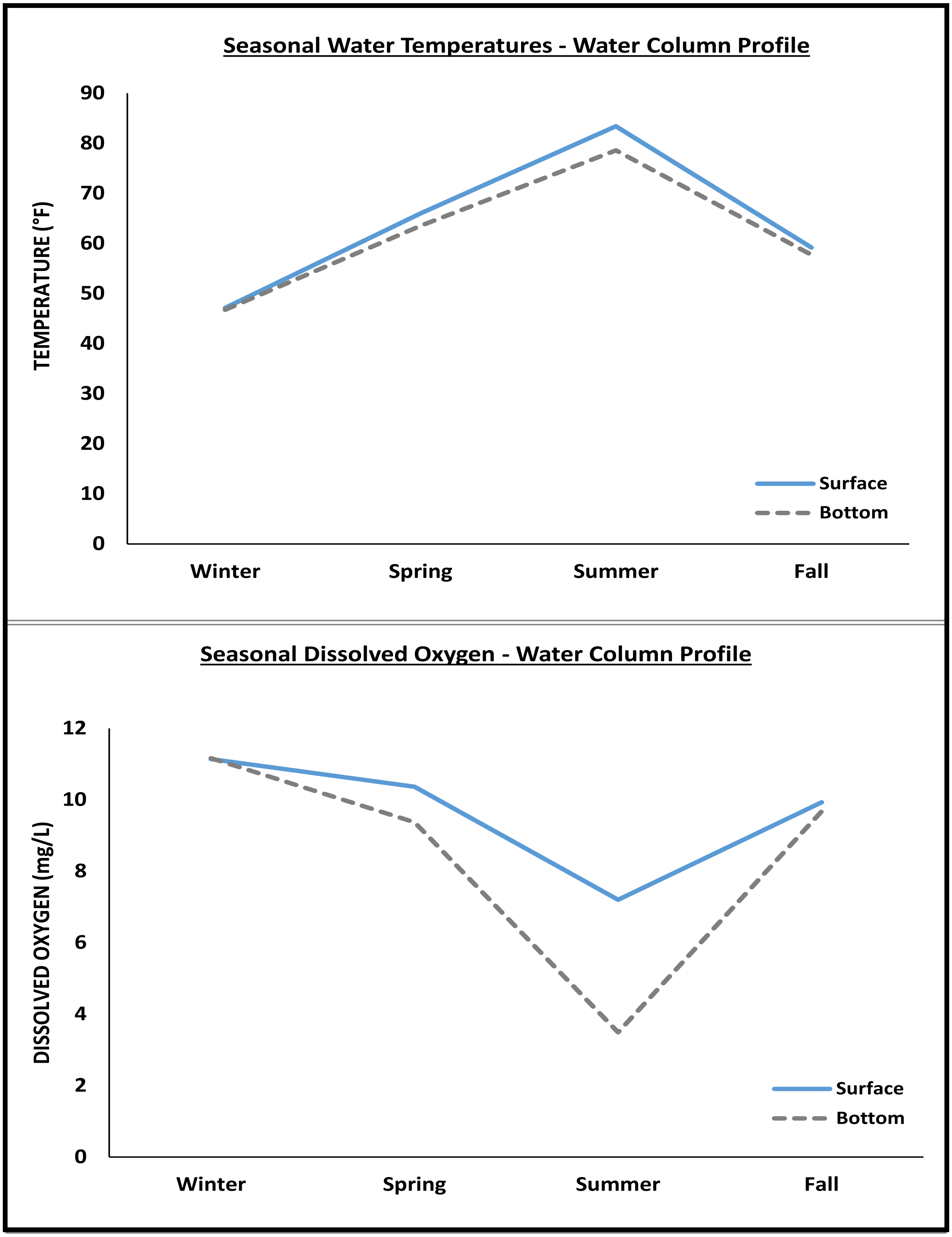

Figure 7. Average seasonal temperatures and dissolved oxygen collected from both the surface and the bottom of the water column at Lake Gaston in 2023.

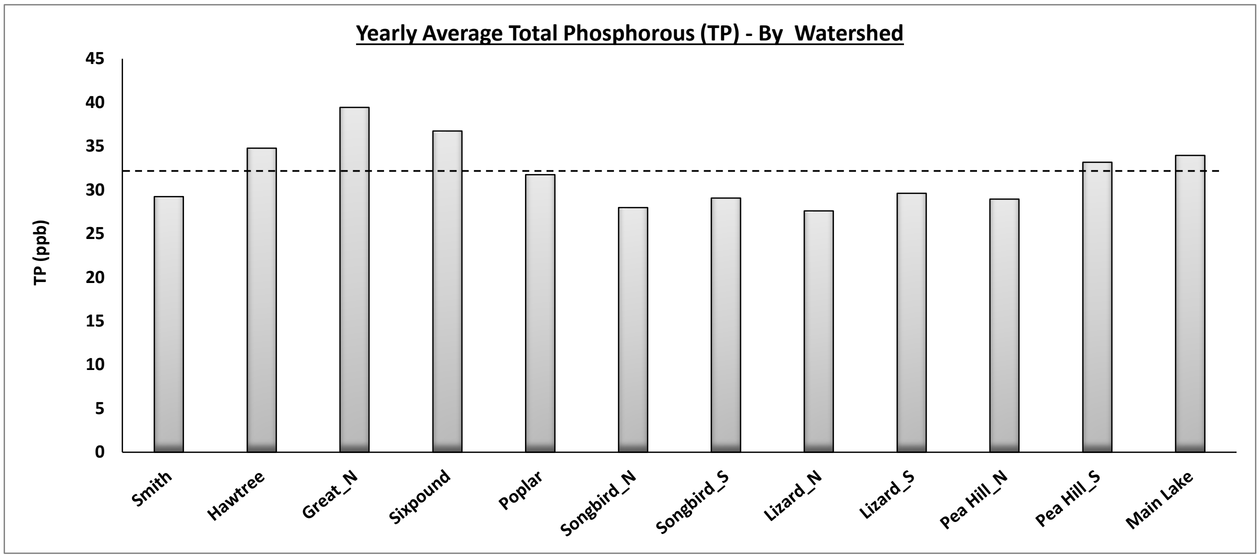

Figure 8. Average total phosphorous (TP) values reported for Lake Gaston's associated watersheds in 2023. The dotted line represents the overall lake average for total phosphorous (32 ppb). Watershed data is reported in order of most upstream to downstream locations and watersheds that encompass both the northern and southern shorelines are divided into two independent sub-watersheds (N, S).

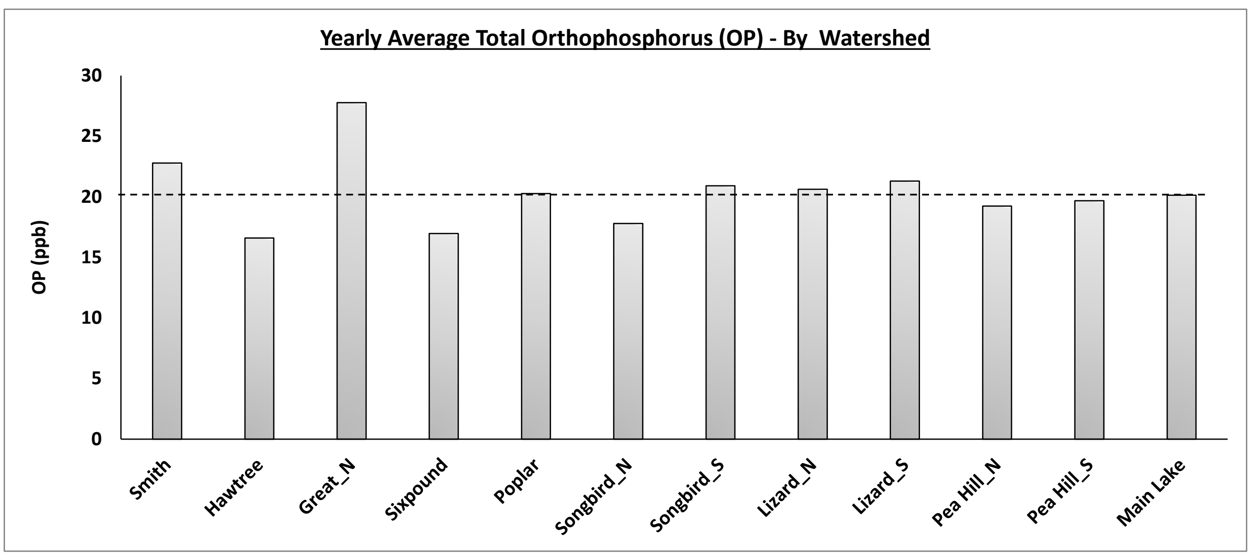

Figure 9. Average orthophosphorus (OP) values reported for Lake Gaston's associated watersheds in 2023. The dotted line represents the overall lake average for total orthophosphorus (20 ppb). Watershed data is reported in order of most upstream to downstream locations and watersheds that encompass both the northern and southern shorelines are divided into two independent sub-watersheds (N, S).

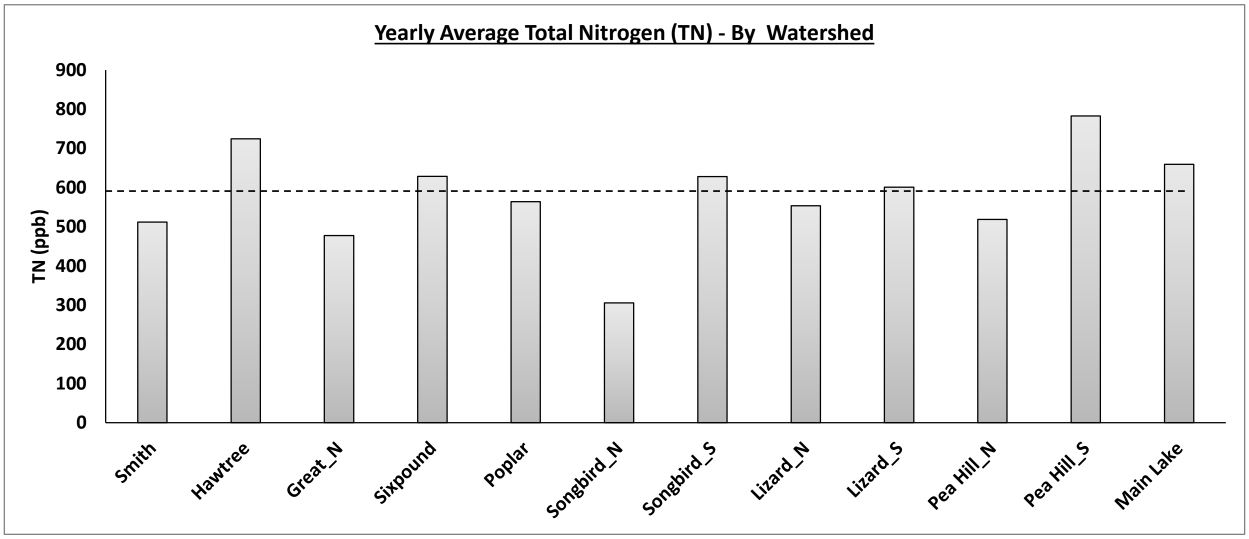

Figure 10. Average total nitrogen (TN) values reported for Lake Gaston's associated watersheds in 2023. The dotted line represents the overall lake average for total nitrogen (593 ppb). Watershed data is reported in order of most upstream to downstream locations and watersheds that encompass both the northern and southern shorelines are divided into two independent sub-watersheds (N, S).

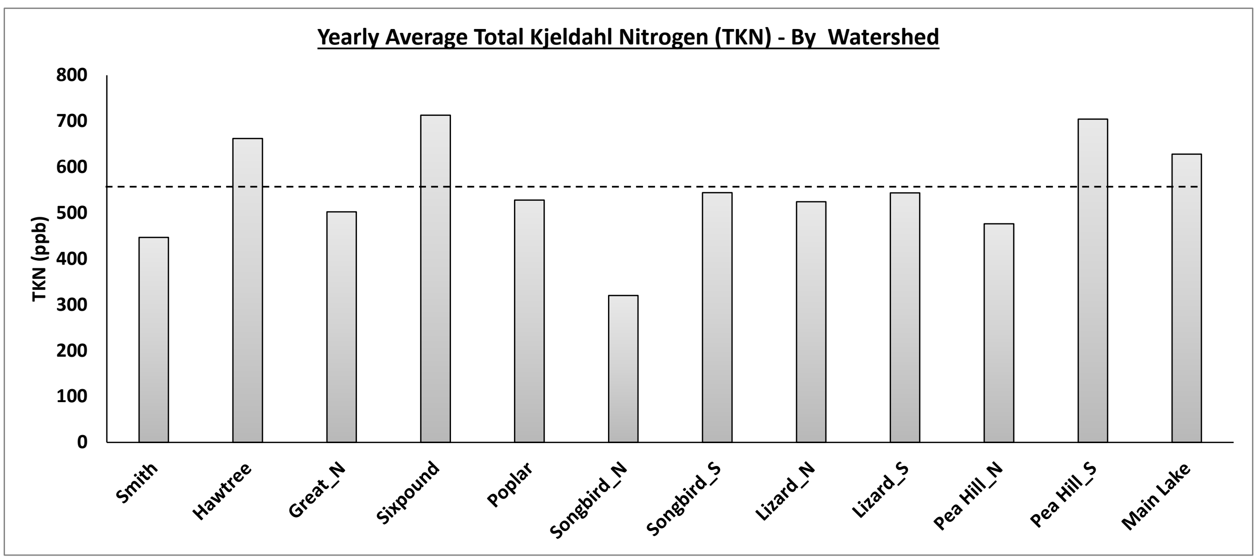

Figure 11. Average total Kjeldahl nitrogen (TKN) values reported for Lake Gaston's associated watersheds in 2023. The dotted line represents the overall lake average for total Kjeldahl nitrogen (552 ppb). Watershed data is reported in order of most upstream to downstream locations and watersheds that encompass both the northern and southern shorelines are divided into two independent sub-watersheds (N, S).

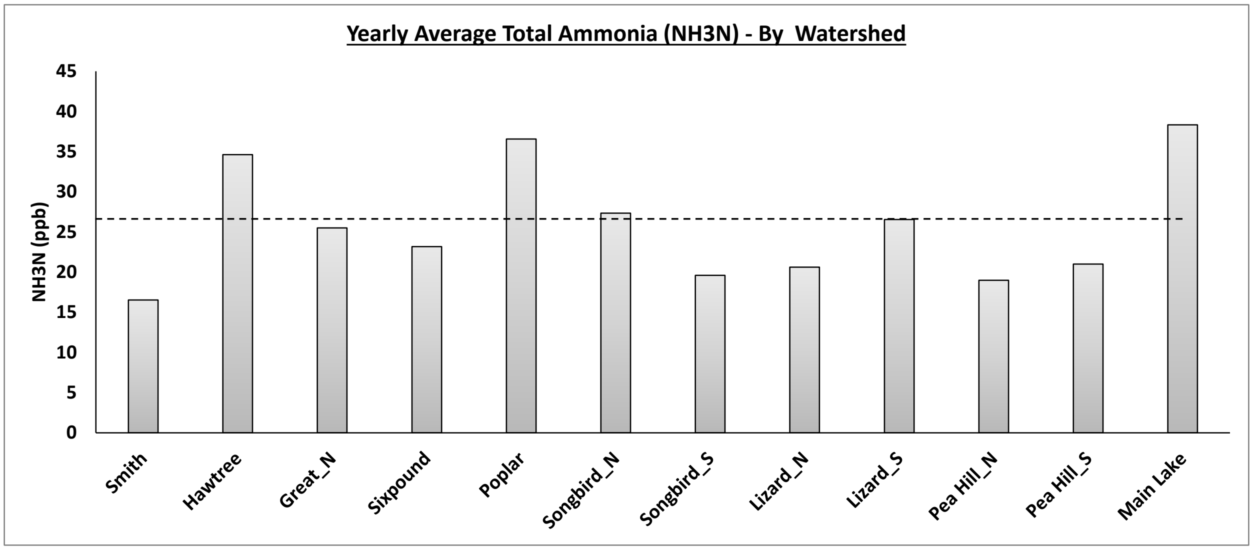

Figure 12. Average ammonia (NH3N) values reported for Lake Gaston's associated watersheds in 2023. The dotted line represents the overall lake average for total ammonia (26 ppb). Watershed data is reported in order of most upstream to downstream locations and watersheds that encompass both the northern and southern shorelines are divided into two independent sub-watersheds (N, S).

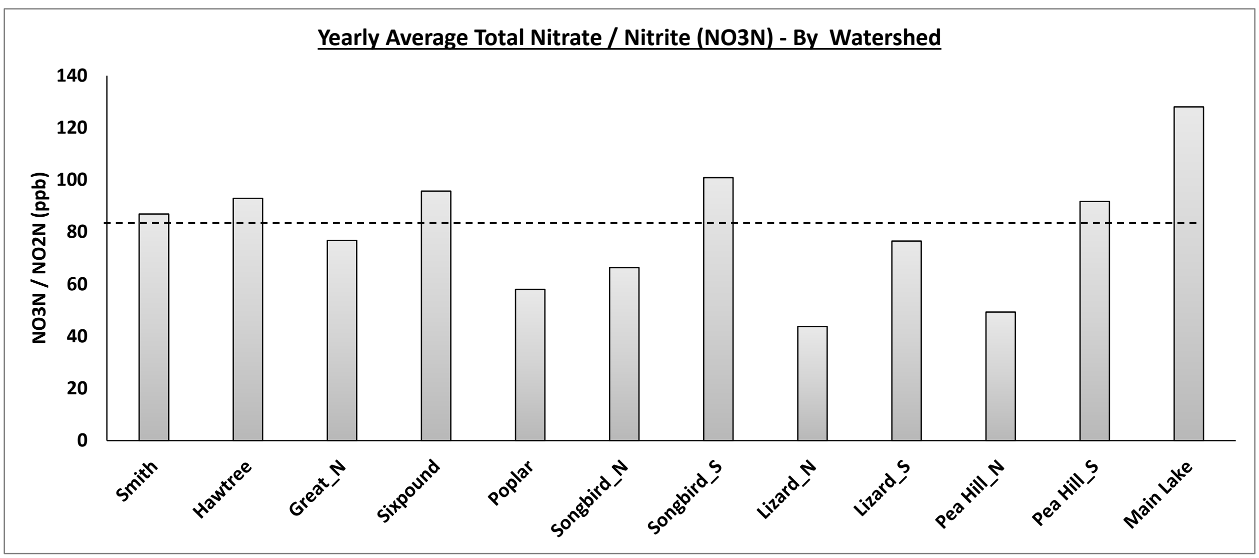

Figure 13. Average total nitrate and total nitrite (NO3N/NO2N) values reported for Lake Gaston's associated watersheds in 2023. The dotted line represents the overall lake average for total nitrate/nitrite (83 ppb). Watershed data is reported in order of most upstream to downstream locations and watersheds that encompass both the northern and southern shorelines are divided into two independent sub-watersheds (N, S).

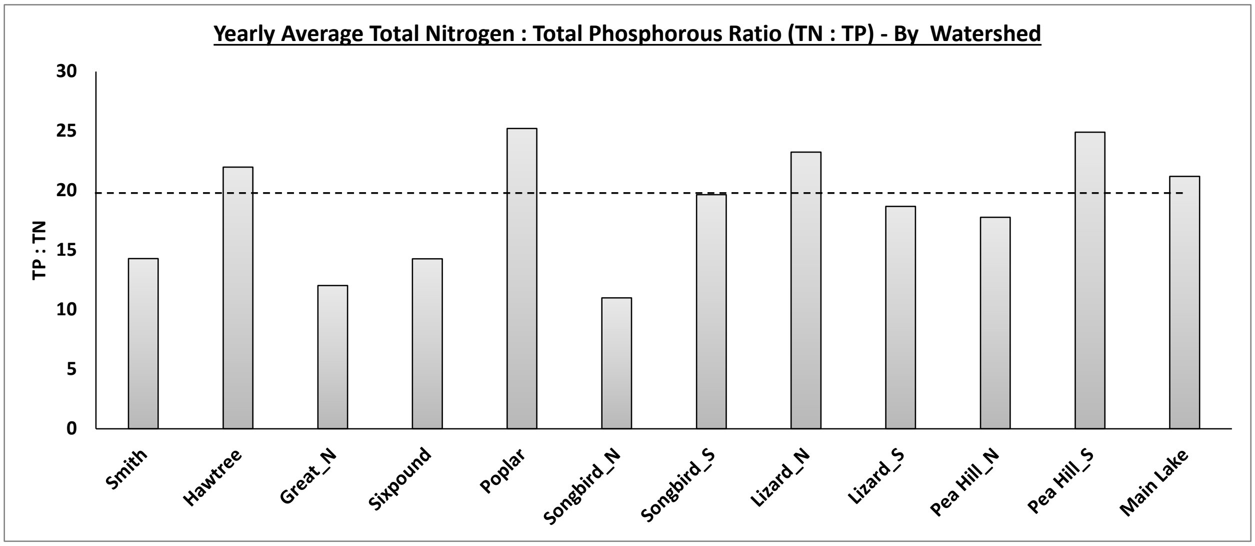

Figure 14. Average total nitrogen (TN) and total phosphorous (TP) ratios reported for Lake Gaston's associated watersheds in 2023. The dotted line represents the overall lake average for total nitrogen and total phosphorous ratio (19 ppb). Watershed data is reported in order of most upstream to downstream locations and watersheds that encompass both the northern and southern shorelines are divided into two independent sub-watersheds (N, S).

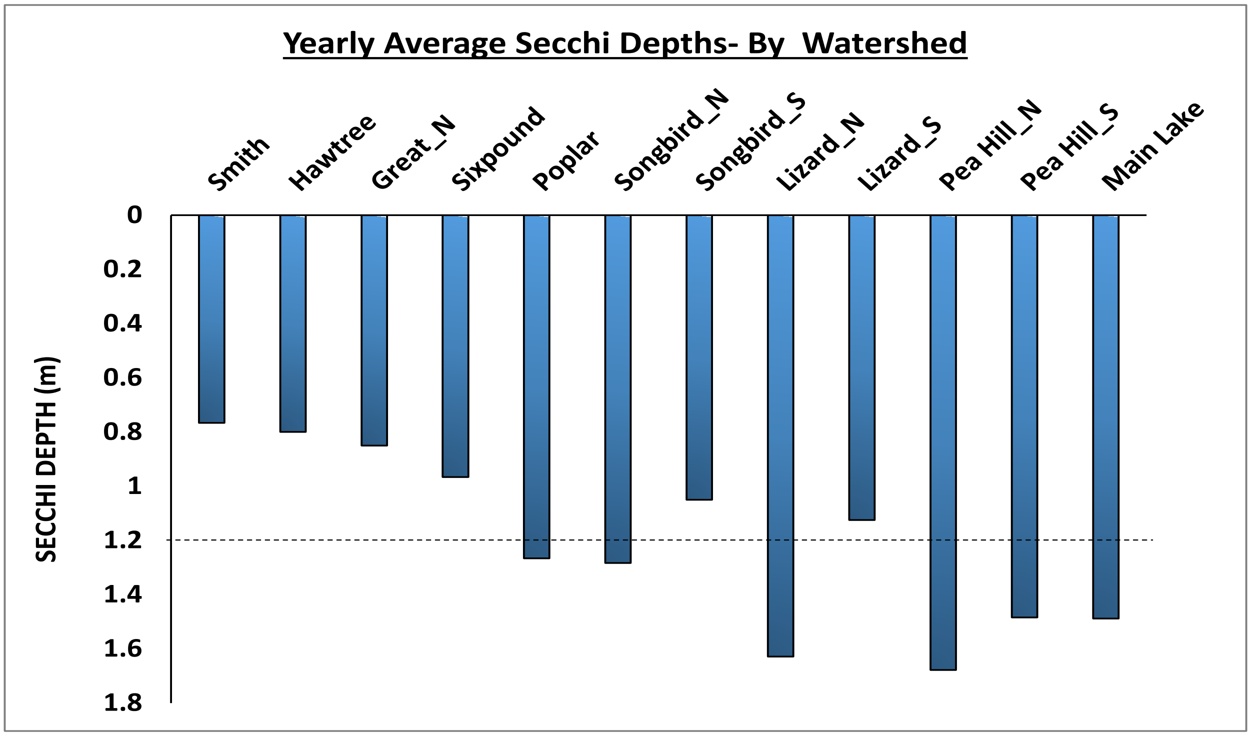

Figure 15. Average secchi depths reported for Lake Gaston's associated watersheds in 2023. The dotted line represents the overall lake average for secchi depths (1.2 m). Watershed data is reported in order of most upstream to downstream locations and watersheds that encompass both the northern and southern shorelines are divided into two independent sub-watersheds (N, S).

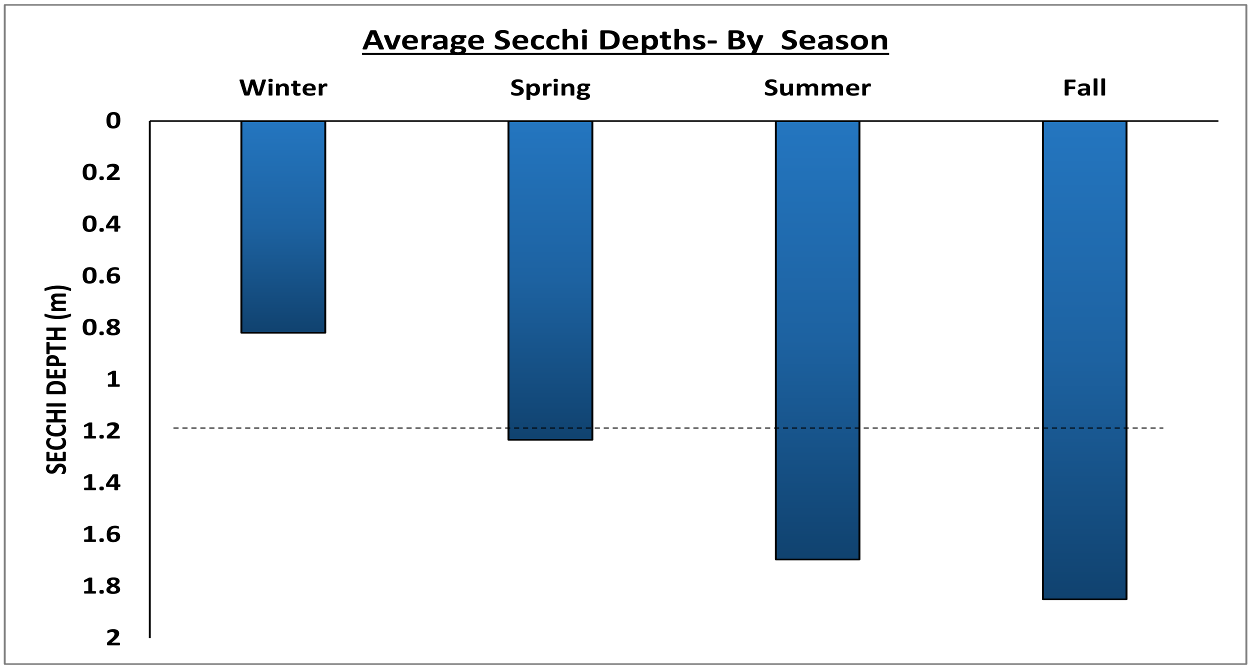

Figure 16. Average seasonal secchi depths recorded for Lake Gaston in 2023. The dotted line represents the overall lake average for secchi depths (1.2 m).

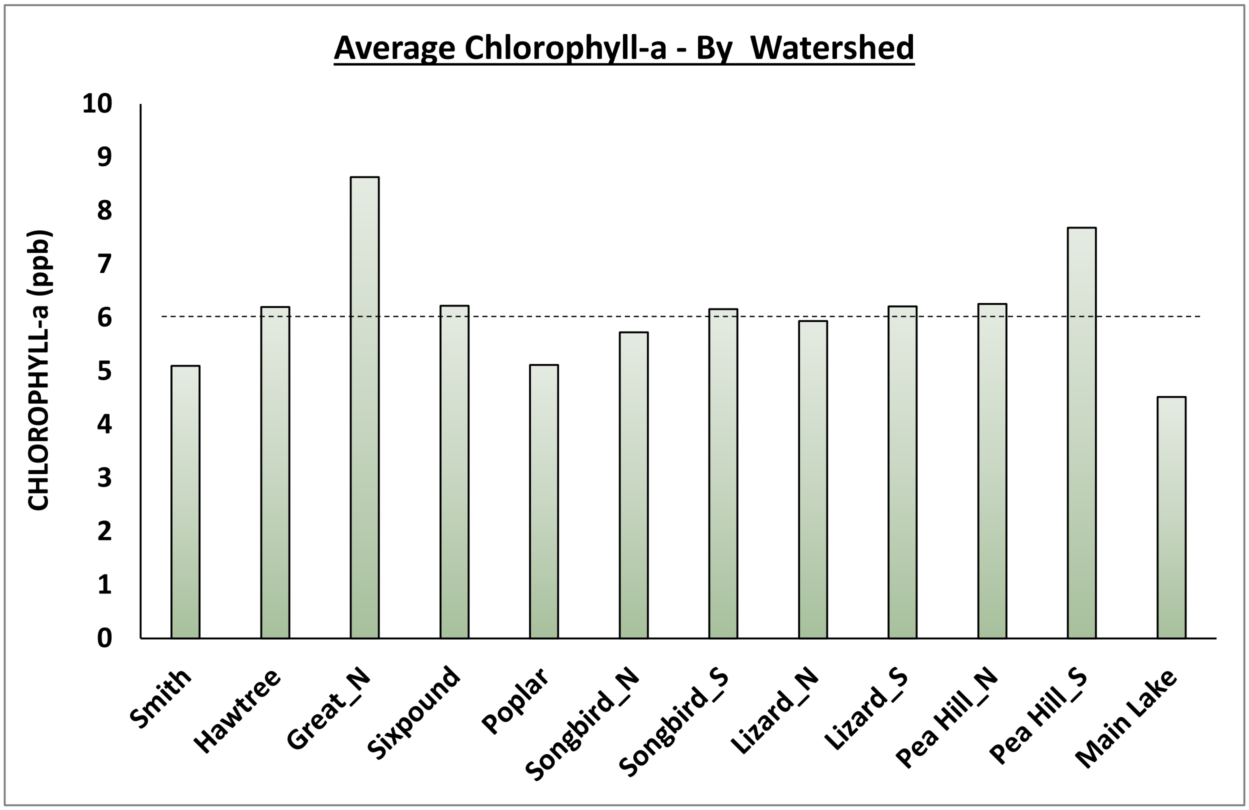

Figure 17. Average chlorophyll-a values reported for Lake Gaston's associated watersheds in 2023. The dotted line represents the overall lake average for chlorophyll-a (6.2 ppb). Watershed data is reported in order of most upstream to downstream locations and watersheds that encompass both the northern and southern shorelines are divided into two independent sub- watersheds (N, S).

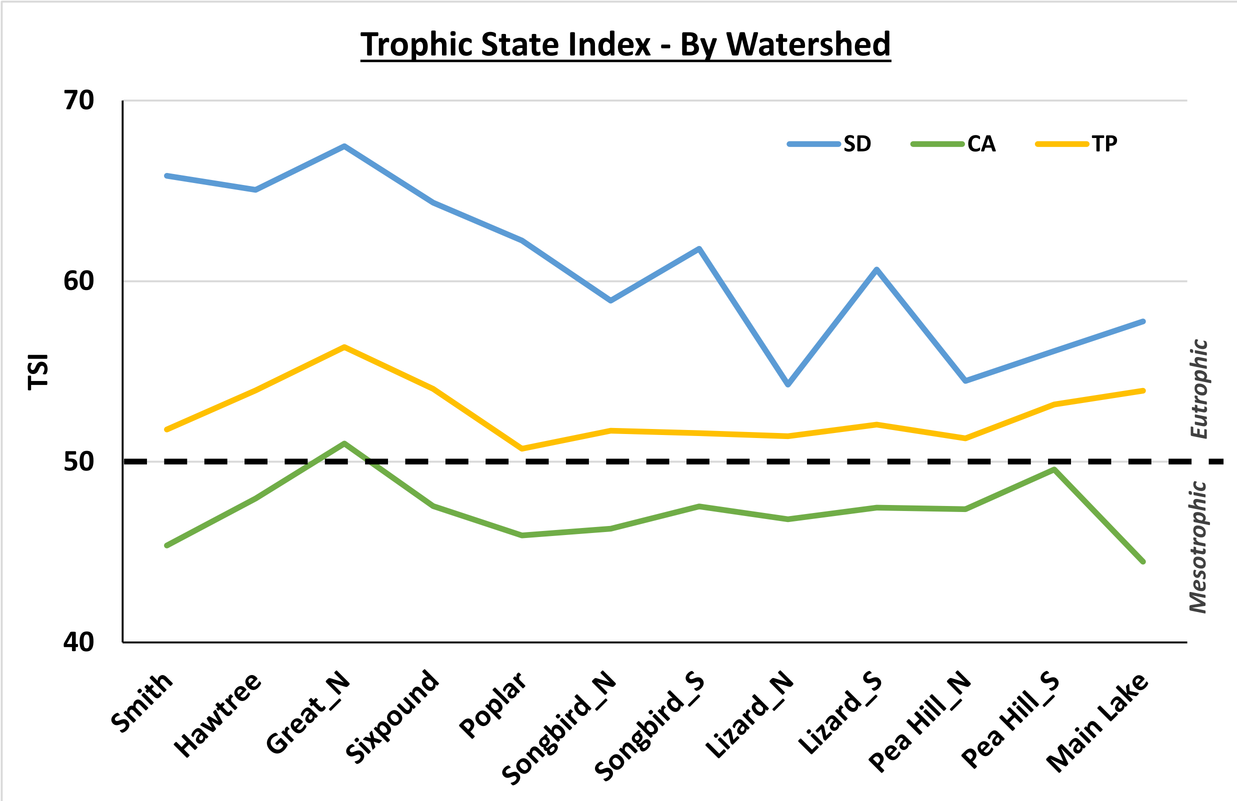

Figure 18. Trophic State Index values reported for chlorophyll-a (CA), secchi depth (SD), and total phosphorous (TP) for Lake Gaston's associated watersheds. The solid black line indicates the value (50) that separates a system from being classified as mesotrophic or eutrophic.

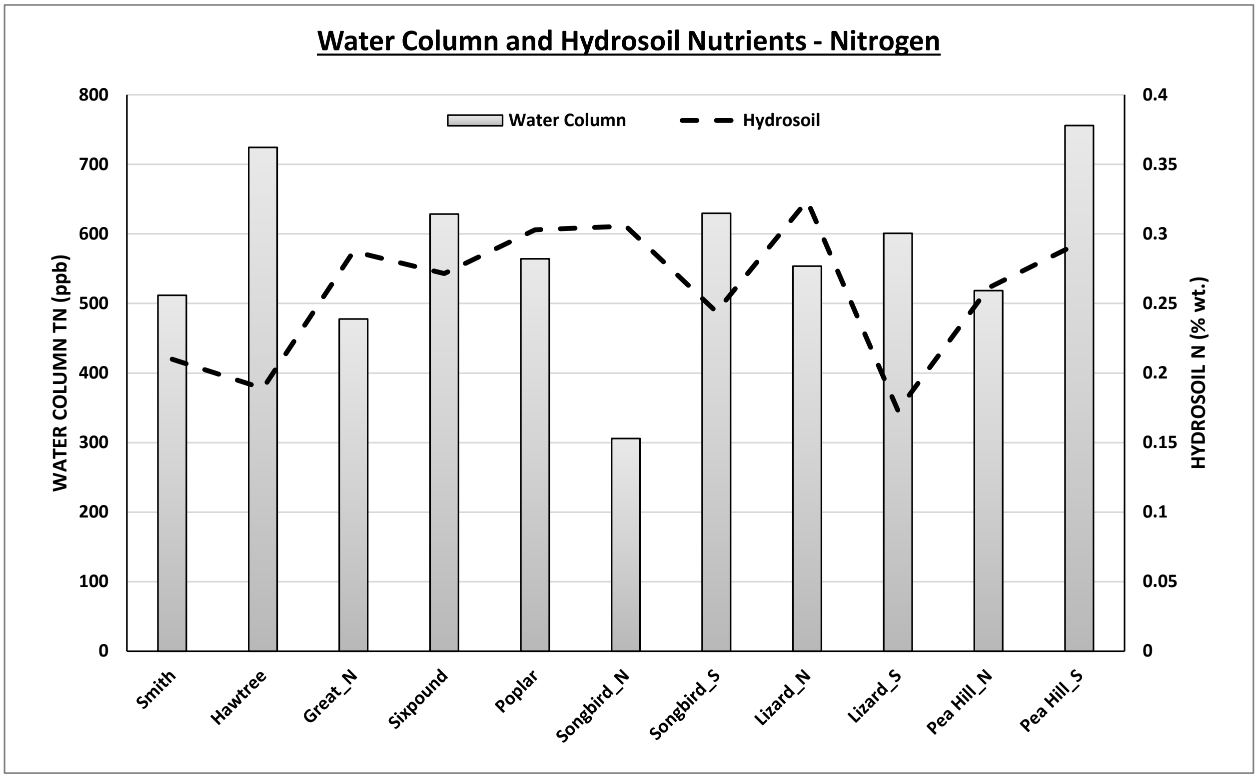

Figure 19. Hydrosoil nitrogen levels and average total nitrogen (TN) values reported for water column samples within Lake Gaston's associated watersheds. Watershed data is reported in order of most upstream to downstream locations and watersheds that encompass both the northern and southern shorelines are divided into two independent sub-watersheds (N, S).

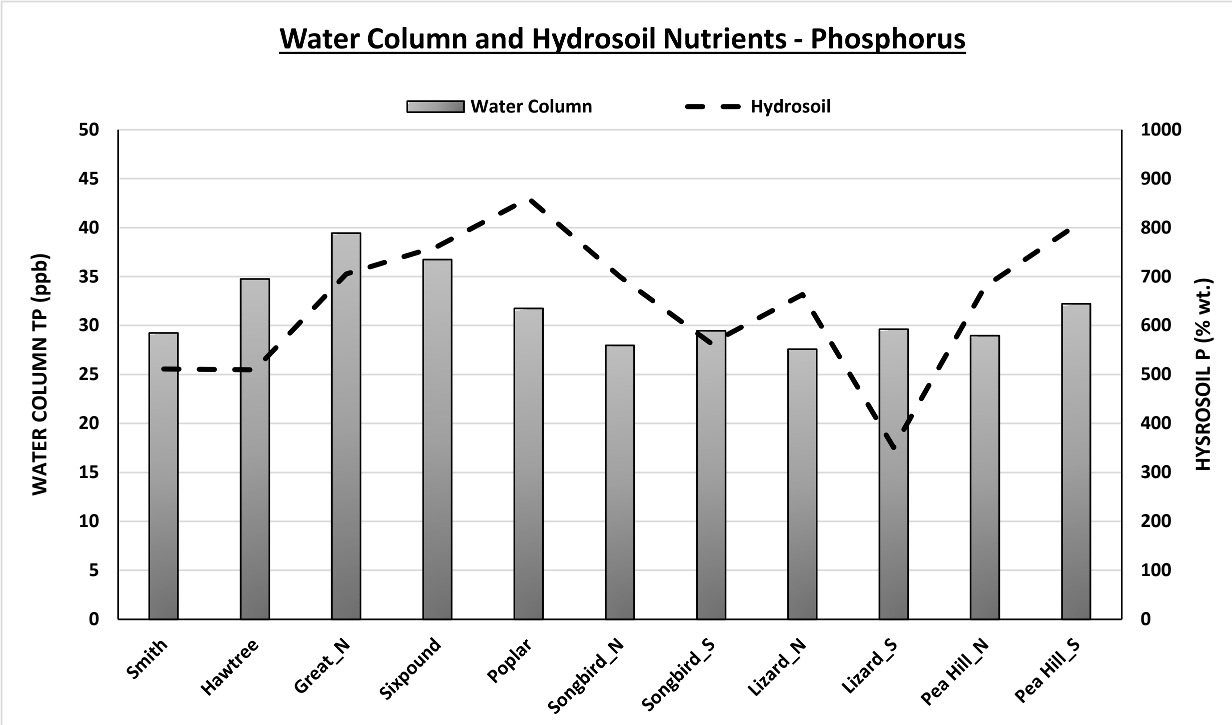

Figure 20. Hydrosoil nitrogen levels and average total phosphorous (TP) values reported for water column samples within Lake Gaston's associated watersheds. Watershed data is reported in order of most upstream to downstream locations and watersheds that encompass both the northern and southern shorelines are divided into two independent sub-watersheds (N, S).