Fish Community Assessment, Junction Creek 2019 SUMMARY REPORT – by Brandon Holden and Miranda Virtanen

Introduction

The Junction Creek Stewardship Committee (JCSC) maintains strong research programs and long-term monitoring initiatives to gain a better understanding of the Junction Creek watershed and for guidance in restoration and management. The stewardship committee collaborates with local experts and stakeholders to develop projects, collect data and produce reports on the current state of various ecological components of the upper reaches of Junction Creek.

Fish communities are commonly used as indicators of stream health. Maintaining a long-term monitoring program offers an essential database to support effective planning for science-based watershed management and environmental restoration. The data is shared with stakeholders at the municipal, provincial and national level to fill data deficiencies, produce watershed reports and provide input to watershed conservation strategies.

In the summer of 2019, the JCSC led a fish community assessment study of the urban reaches of Junction Creek as part of a 'Monitoring and Promoting Urban Stream Health' project supported by WWF-Canada's Loblaw Water Fund. The study was designed to assess fish diversity and distribution in the main stem of Junction Creek upstream of Kelly Lake, and followed protocols established in previous Junction Creek fish assessments from 2004 and 2008. In addition, the 2019 project integrated the measurement of fish health as part of an undergraduate thesis study, and a pilot assessment of Brook Trout habitat.

Site Selection

The urban reaches of Junction Creek are found between Garson and Kelly Lake. This area was divided into 16 reaches with 100m length sites. Every alternating site of Junction Creek were surveyed, starting with Site 1 at the headwaters in Garson, and ending with Site 240 at the Junction Creek outlet to Kelly Lake. Additionally, the Maley Tributary was partially sampled following the same protocol. A total of 114 sites were surveyed in the 2019 study.

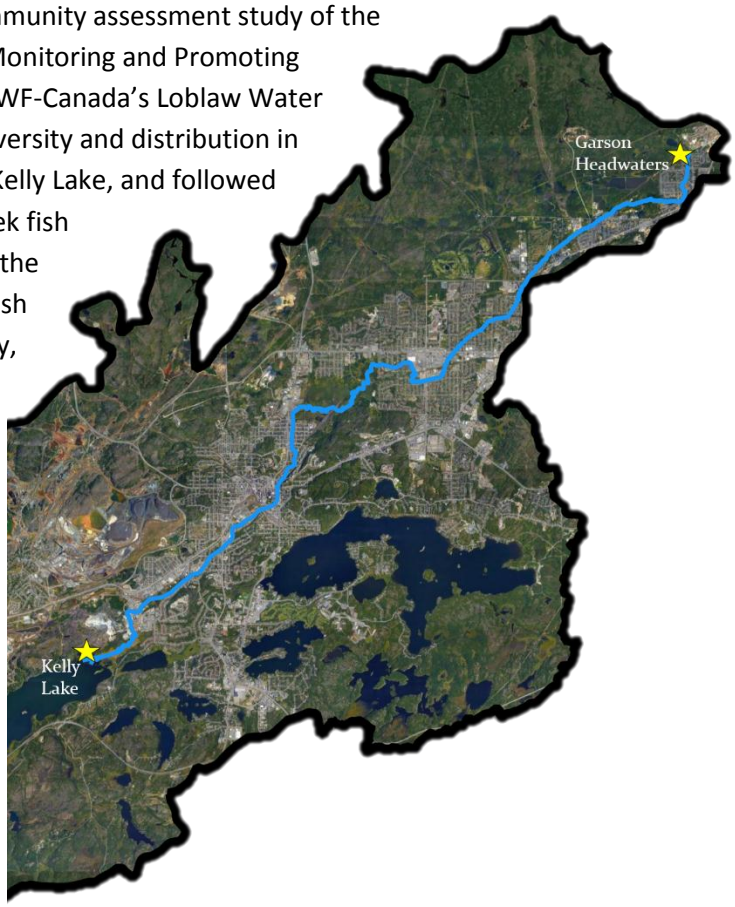


Figure 1: Map of Junction Creek, highlighting beginning and end points of the JCSC's 2019 Fish Community Assessment.

Fish Sampling & Processing

A combination of electrofishing and minnow trapping were used for the fish community assessment. Electrofishing was selected as the preferred survey method and was used for 19 out of the 114 sites surveyed. Minnow traps were used when site conditions were unsuitable for electrofishing (water depth greater than 1m and/or substrate was too soft) and comprised the remaining 95 sites.

Due to creek conditions, in 2019 more sites were surveyed using minnow traps compared to previous years (see figure 2 on the right).

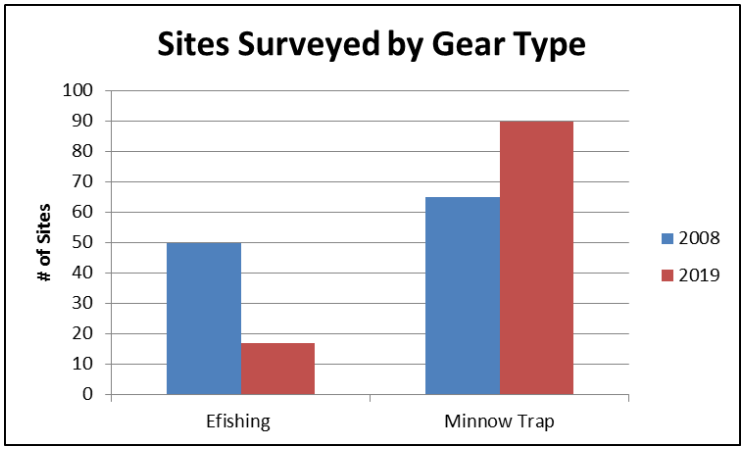


Figure 2: Number of mainstem sites surveyed by survey method for the 2008 and 2019 fish community assessments.

Electrofishing was generally carried out by teams of 2-4, most commonly 4, with one person running the backpack, two netters, and an additional team member following behind holding the bucket.

Sites surveyed using minnow traps were typically surveyed using 4 traps evenly spaced along the length of the site, with live Google Maps used to aid in the placement of traps. The minnow traps were baited with dog food and left in the water for a range of 18 to 25 hours.

Regardless of the survey type, captured fish were sedated in order to facilitate identification and processing. The first 30 individuals of each species at each site were tallied, weighed and photographed, while individuals over the 30 mark were only tallied. Captured fish were released back into the creek after recovering from sedation.

Habitat Assessment

In addition to assessing the fish communities through Junction Creek, observations regarding basic habitat conditions were made to build the basis for future research. Chemical and physical parameters of the creek and surrounding land were recorded for each site and included: conductivity, salinity, pH, temperature, dissolved oxygen, water depth, channel structure and substrate composition. The extent of information collected differed depending on site accessibility, personnel, and resources.

Water chemistry measurements were always taken prior to fish surveying. For sites that were electrofished measurements were taken at the beginning, middle and end of the site, while for sites where minnow traps were used measurements were taken at the location of each trap.

In addition to the individual site measurements, 9 HOBO water temperature loggers were installed in the creek to continuously record water temperature at 30-minute intervals for the duration of the summer, June 21st – September 23rd, 2019. See Figure 3 below for a map of data logger placement.

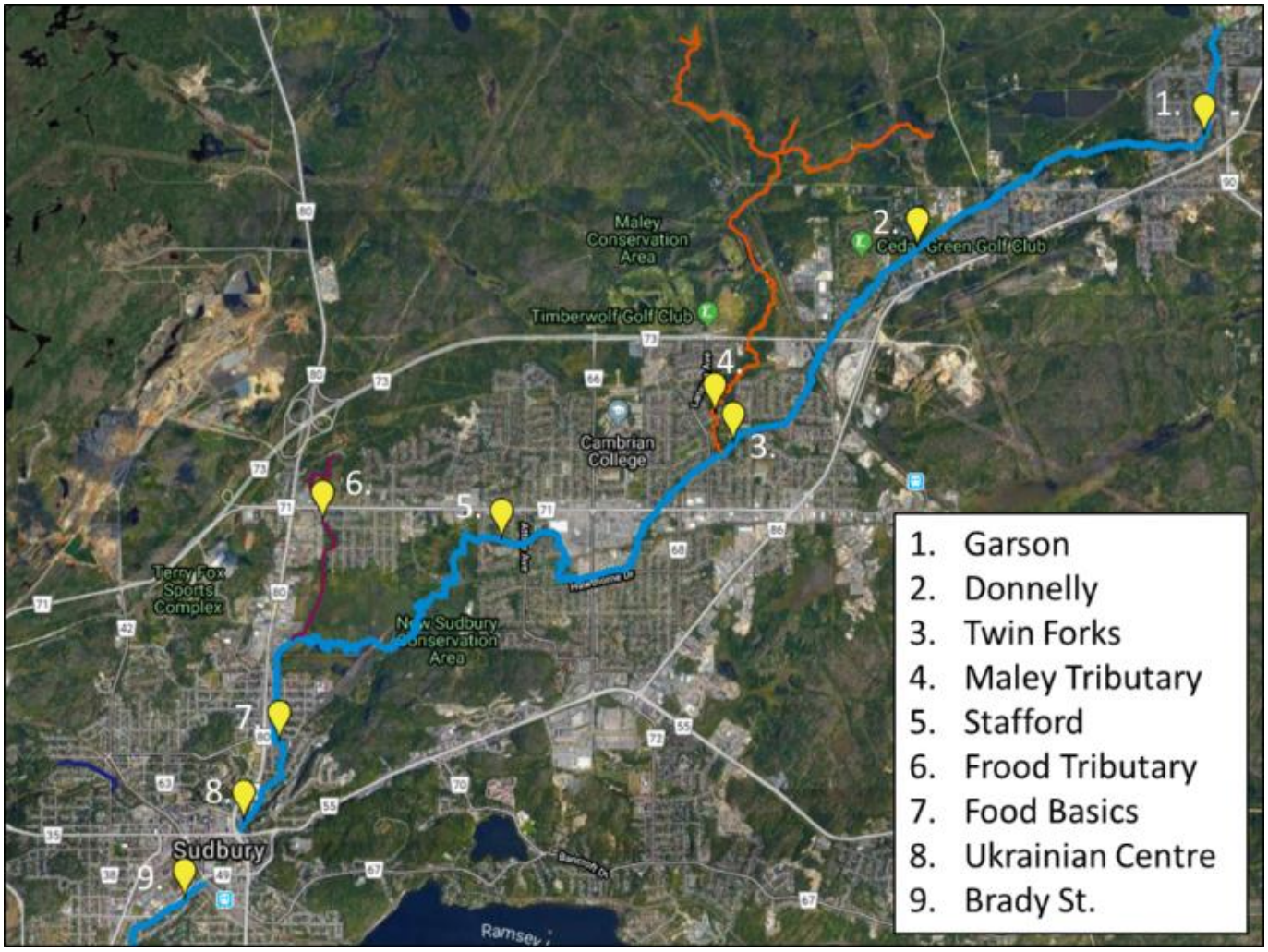


Figure 3: Location of water temperature data loggers in Junction Creek from June 21st to September 23rd 2019.

Results & Analysis – Fish Assessment

Throughout the course of the 2019 assessment, 9974 fish from 17 different species were captured in Junction Creek. At the time of the previous study, 16 species of fish were known to inhabit Junction Creek. A 17th species, Pumpkinseed, were documented in Junction Creek in 2017, and Logperch were discovered during the 2019 assessment and became the 18th species. The only species that was previously documented in Junction Creek but not caught during 2019 study was the Golden Shiner.

Total Catch 2019

The majority of fish captured during the 2019 fish community assessment were Creek Chub, making up approximately 57% of total catch. Figure 4 (below) provides a breakdown of the percent of total catch for each species. Note that the study focused on presence/absence and not population dynamics, therefore Figure 4 is not a complete representation of the fish communities in Junction Creek.

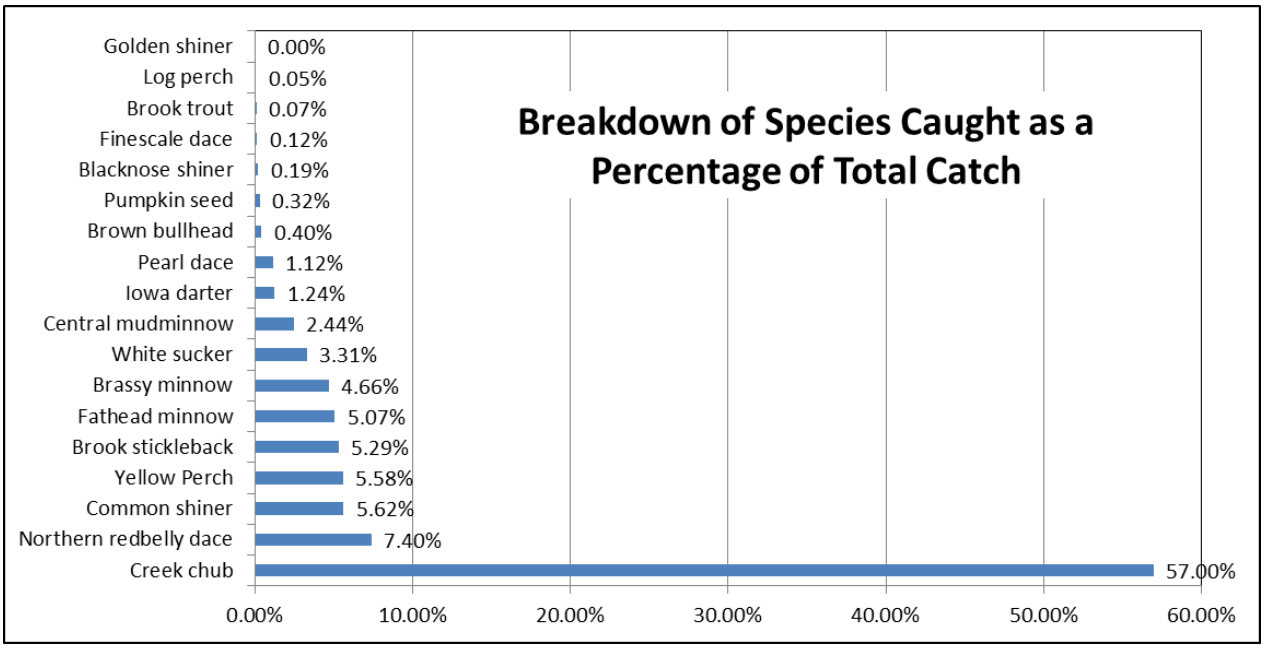


Figure 4: Species caught as a percentage of total catch during 2019 Junction Creek fish community assessment.

Indicator Species and Stream Health 2019

Fish species are used as an indicator of stream health based on their sensitivity to water quality. Species that are 'intolerant' require pristine conditions to thrive, while species that are 'tolerant' can survive in more degraded environmental conditions. The presence of intolerant species indicates healthy stream conditions.

Table 1. Fish species diversity in Junction Creek by reach, 2019 Fish Community Assessment.

Reach #	Number of Species	Number of Sensitive Species
1	12	1
2	9	1
3	9	1
4	14	1
5	14	2
6	12	1
7	10	0
8	5	0
9	10	0
10	9	0
11	12	1
12	4	0
13	7	0
14	9	1
15	7	0
16	11	1

Based on the number of sensitive species found in each reach (see Table 1 on the left), Reach 5 had the highest stream health (2 out of 3 sensitive species present) and reaches 6 to 10, 12, and 15 had the lowest (no observations of sensitive species). This indicates a geographic trend in stream health (see Figure 5 below); starting from the headwaters of Junction Creek, stream health improves at the Maley Tributary (between Maley Drive and Lasalle Boulevard) then declines moving downstream from New Sudbury. Reaches 11, 14, and 16 show an intermittent increase in stream health downstream of New Sudbury. This may be attributed by positive influences from riparian buffers and neighbouring wetlands.

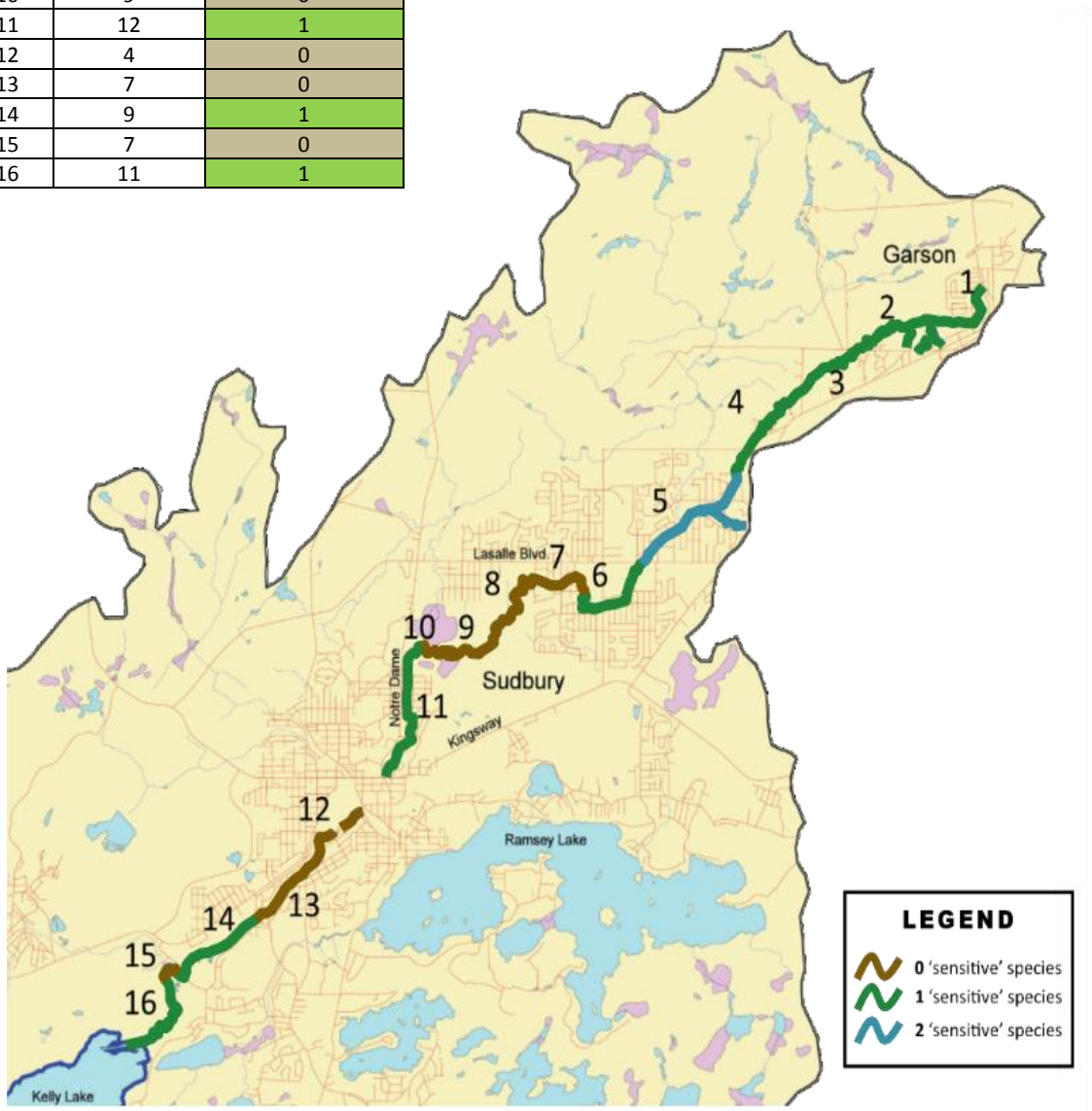


Figure 5: Stream health of Junction Creek based on presence of sensitive species observed in 2019 fish community assessment.

Species Richness and Distribution 2019

A thriving ecosystem is composed of a diverse range of species. By determining the number of fish species (species richness) present in each reach of Junction Creek, we gain a better understanding about the ecological health of the stream. During the 2019 fish community assessment, there were a total of 17 species of fish captured in Junction Creek. Species richness varied between reaches, with the maximum number of species in reaches 4 and 5 (14 species) and the lowest being in reaches 12 and 8 (4 and 5 species respectively). This suggests that the aquatic ecosystem is healthiest in reaches 4 and 5, between Carr Avenue and Lasalle Boulevard, and poorest in reaches 12 and 8, in downtown Sudbury and New Sudbury.

Species distribution in Junction Creek was determined based on species presence/absence in each reach (see Table 2 below). During data analysis it became apparent that for some species, capture rates were heavily influenced by surveying technique and therefore the absence of these species in certain sites may not be definite. In particular, the species that showed limitations to capture success with minnow trap surveys were the Iowa Darter, Central Mudminnow and Brown Bullhead (these species and reaches are marked with an Asterix in Table 2).

Table 2. Fish species presence in each reach of Junction Creek during fish community assessment study in 2019.

Fish Species	Reach # (Garson to Kelly Lake)															
	1*	2*	3	4	5	6	7*	8*	9*	10*	11	12*	13	14*	15*	16*
Intolerant species																
Blacknose Shiner																
Brook Trout																
Logperch																
Intermediate species																
Brassy Minnow																
Common Shiner																
Finescale Dace																
Iowa Darter	*	*					*	*	*			*			*	
Northern Redbelly Dace																
Pearl Dace																
Pumpkinseed																
Yellow Perch																
Tolerant species																
Brook Stickleback																
Brown Bullhead	*	*					*	*		*		*		*	*	*
Central Mudminnow								*		*		*		*	*	*
Creek Chub																
Fathead Minnow																
White Sucker																

**Reaches that were only surveyed via minnow traps. Some species are heavily influenced by surveying technique and may actually be present in these reaches.*

Based on the 2019 study results, 'tolerant' and 'intermediate' species have a larger distribution throughout the main stem of Junction Creek, with Creek Chub and Fathead Minnow present in all 16 reaches. The Brook Trout, Logperch, and Brown Bullhead showed the smallest distribution, and were only found in 1-2 reaches. This suggests that there are stream characteristics, such as water quality and/or habitat features, that are limiting the distribution of 'intolerant' species.

Comparison to Past Studies

Changes in Indicator Species' Richness and Distribution

By comparing species tolerance groups between studies, it can reveal temporal changes in stream health. Table 3 (below) compares the presence of fish species by water quality tolerance level between the 2004, 2008 and 2019 fish studies.

Table 3: Comparison in fish species found in Junction Creek between studies, categorized by species' tolerance to degraded water conditions.

Tolerance Level to Poor Water Quality	2004	2008	2019
Intolerant Species	Brook Trout	Blacknose Shiner Brook Trout	Logperch Blacknose Shiner Brook Trout
Intermediate Species	Yellow Perch Brassy Minnow Common Shiner Iowa Darter Northern Redbelly Pearl Dace	Finescale Dace Yellow Perch Brassy Minnow Common Shiner Iowa Darter Northern Redbelly Pearl Dace	Pumpkinseed Finescale Dace Yellow Perch Brassy Minnow Common Shiner Iowa Darter Northern Redbelly Pearl Dace
Tolerant Species	Golden Shiner Brook Stickleback Brown Bullhead Central Mudminnow Creek Chub Fathead Minnow White Sucker	Golden Shiner Brook Stickleback Brown Bullhead Central Mudminnow Creek Chub Fathead Minnow White Sucker	Brook Stickleback Brown Bullhead Central Mudminnow Creek Chub Fathead Minnow White Sucker

The data reveals that the temporal changes in species richness in Junction Creek is increasing for 'intolerant' and 'intermediate' species and decreasing for 'tolerant' species. In addition to the increase in

the diversity of sensitive species, the data also reveals an increase in distribution of more sensitive species over time. Figure 6 (below) shows an increase in Brook Trout ('intolerant' species) distribution from 1 to 2 reaches, and an increase in Blacknose Shiner ('intolerant' species) from 0 to 6 reaches.

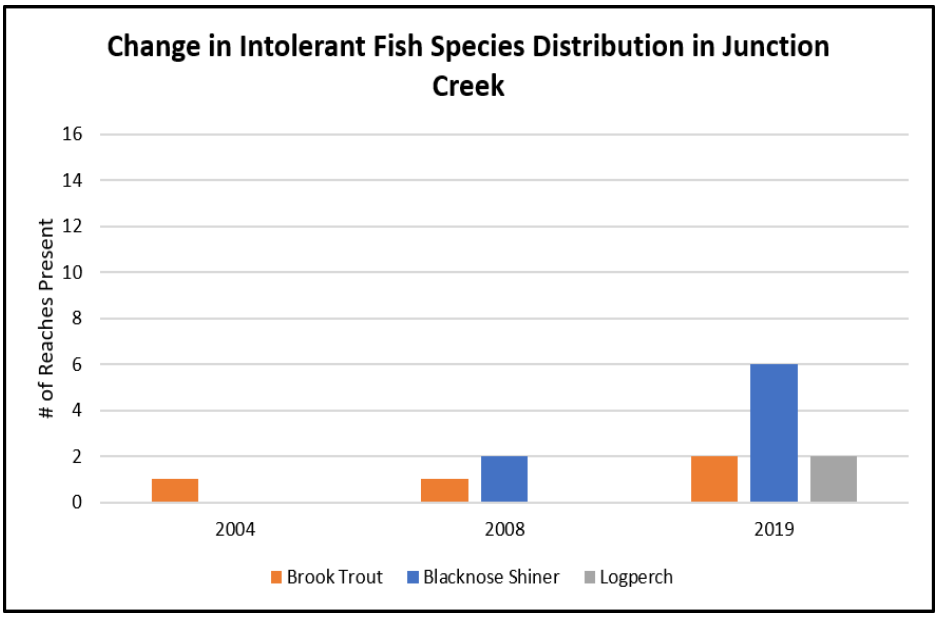


Figure 6: Comparison of distribution of sensitive fish species within the mainstem of Junction Creek over time.

Species distribution increased for 13 species of fish (including 4 new species) and decreased for 5 species between 2004 and 2019 (see Table 4 on the right). The species showing the most improvement in distribution are the Brassy Minnow and Yellow Perch (both 'intermediate' species; increased by 9 reaches between 2004 and 2019), followed by the Pumpkinseed and Blacknose Shiner ('intermediate' and 'intolerant' species respectively; increased by 6 reaches between 2004 and 2019). The species showing a decrease in distribution are the Brook Stickleback, Brown Bullhead, Central Mudminnow, Golden Shiner, and Iowa Darter. Note that the decrease in distribution for the Iowa Darter between 2008 and 2019 may be due to surveying technique.

The increases in both species' richness and distribution of sensitive fish from 2004 to 2019 suggests an increase in aquatic habitat in Junction Creek.

Table 4: Comparison of species distribution in Junction Creek over time.

Species	# of Reaches Detected		
	2004	2008	2019
Intolerant species			
Blacknose Shiner	0	2	6
Brook Trout	1	1	2
Logperch	0	0	1
Intermediate species			
Brassy Minnow	2	4	11
Common Shiner	11	12	14
Finescale Dace	0	5	2
Iowa Darter	9	13	9*
Northern Redbelly Dace	10	10	11
Pearl Dace	7	13	11
Pumpkinseed	0	0	6
Yellow Perch	4	9	13
Tolerant species			
Brook Stickleback	13	16	12
Brown Bullhead	3	9	1*
Central Mudminnow	10	13	10*
Creek Chub	14	15	16
Fathead Minnow	15	15	16
Golden Shiner	2	3	0
White Sucker	12	14	13

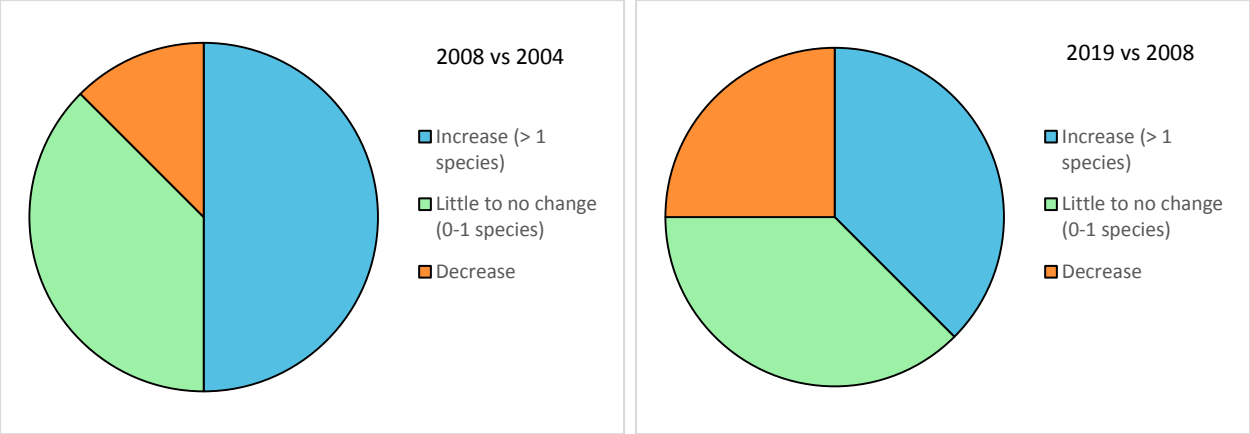
**species heavily influenced by survey technique*

Change in Species Richness

By comparing species richness between studies, we can identify temporal changes in the Junction Creek ecosystem and potential areas of concern to focus restoration efforts. The increase in species richness by 2 or more species suggests an improvement in stream conditions while the decrease in species richness by 2 or more species suggests a potential impairment or deterioration in stream conditions.

After comparing the change in species richness between studies, it was noted that there continues to be improvements in sections of Junction Creek, however more reaches are starting to experience a decrease in species richness. Between the 2004 and 2008 study, only 2 reaches (12.5%) experienced a decrease in species richness (a reduction of 2 or more species), while between the 2008 to 2019 study there were 4 reaches (25%) that experienced a decrease in species richness (see Figure 7 below).

Figure 7: Change in fish species richness by reach in Junction Creek between 2008 vs 2004 (left) and 2019 vs 2008 (right).



This difference in change of species richness between studies may be attributed to the survey methods used in the 2019 study, which would account for the absence of species in 2 of the reaches that showed a decrease in species richness, as well as 2 of the reaches with little to not change. Once this is taken into consideration, it would appear that the change in species richness by reach has remained consistent over time, suggesting that around half of the study area continues to experience improvements from restoration efforts while other sections are still experiencing impairment.

Figure 8 (below) shows geographic trends in the change in species richness between 2008 and 2019 in the upper reaches of Junction Creek. This suggests that areas of concern are Margaret Street to Carr Avenue (Garson), Arthur Street to Ponderosa wetland (New Sudbury), and from downtown Sudbury to Regent Street.

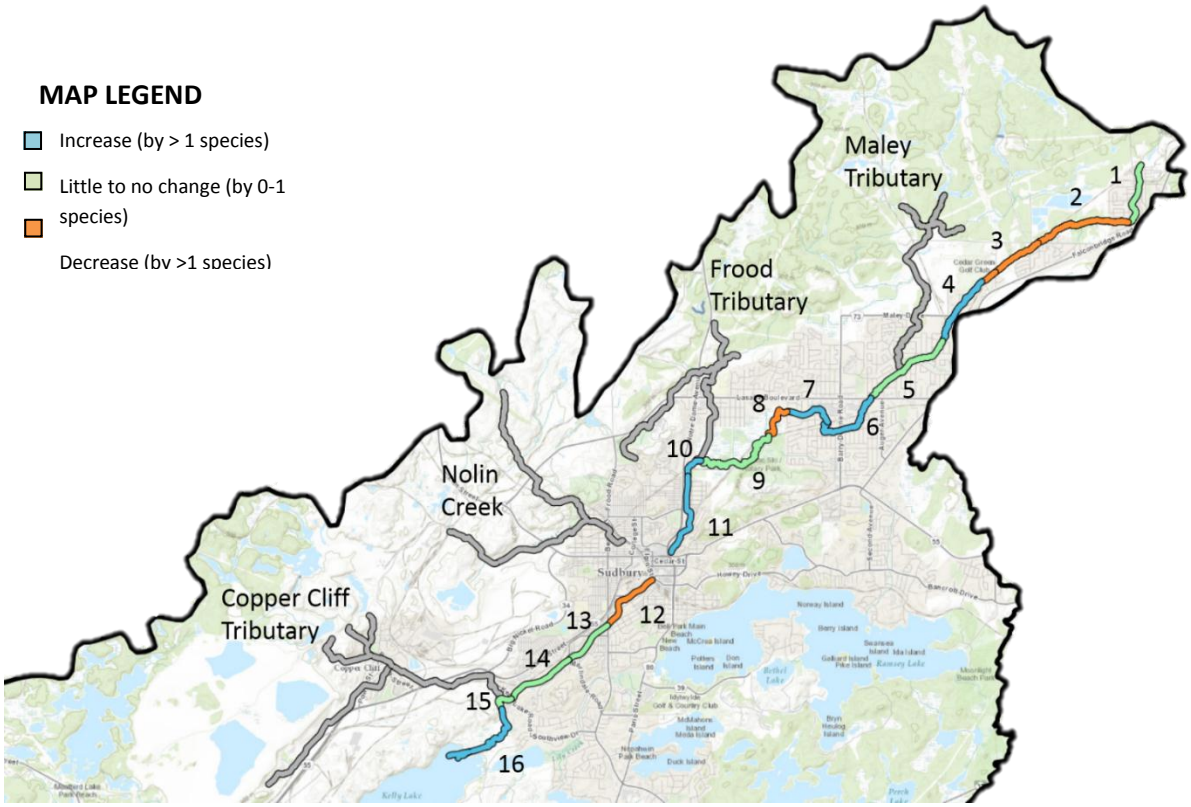


Figure 8: Map showing change in fish species richness in the upper reaches of Junction Creek between 2008 and 2019.

Table 5 (on the right) provides a comparison of species richness in Junction Creek between all 3 fish community assessment studies conducted in 2004, 2008, and 2019, revealing temporal trends by reach.

The sections of Junction Creek that showing an increase in species richness included reaches 1, 4-7, 9, 11, 14 and 16.

- Species richness improved the most in reaches 14 and 16 (from 1 to 9 species and from 4 to 11 species respectively).
- Reach 1 (Pine Street to Margaret Street in Garson) and reaches 4-7 (Carr Avenue to Arthur Streer in New Sudbury) have shown an increasing trend in species richness over time.
- Reach 11 (Wilma Street to Lloyd Street, upstream of downtown) and Reach 16 (upstream of Kelly Lake) continue to show the largest improvements in species richness.

Table 5: Comparison of species richness in Junction Creek over time.

Reach	# Species Present		
	2004	2008	2019
1	10	11	12
2	7	11	9
3	10	11	9
4	12	10	14
5	11	13	14
6	8	10	12
7	9	8	10
8	6	9	5
9	4	11	10
10	9	7	9
11	7	9	12
12	8	7	4
13	8	8	7
14	1	10	9
15	6	6	7
16	4	6	11

- Reach 9 (Ponderosa wetland) and Reach 14 (Martindale Road to Kelly Lake Road) had drastic improvements between 2004 and 2008, however they have shown little to no change since.

The sections of Junction Creek experiencing little to no change in species richness include Reach 10* (downstream of Ponderosa), Reach 13 (Regent Street to Martindale Road) and Reach 15* (near the Copper Cliff Tributary). ** Note that survey method used in the 2019 study may have influenced the ability to capture 2 species in reaches 10 and 15, which alternatively would have resulted in an increase in species richness in these reaches.*

Between 2008 and 2019, species richness declined by 2- 4 species in 4 reaches in Junction Creek (reaches 2, 3, 8, and 12) which would suggest areas of concern for potential impairment.

- Reach 12* (downtown to Regent Street) has shown a decline in species richness since 2004 from 8 to 7 and then 4 species.
  **Note that the 2019 survey method used in this reach may not have captured up to 3 species of fish, which would alternatively mean little to no change in species richness.*
- Reaches 2* and 3 (Margaret Street to Carr Avenue) and Reach 8* (Arthur Street to Ponderosa wetland) have shown a recent decline in species richness by 2 and 4 species respectively since 2008.
  **Note that the decline in species richness in reaches 2 and 8 may be attributed to survey method used in the 2019 study.*

<u>Brook Trout in Junction Creek</u>

Since 2000, stock Brook Trout from the Ministry of Natural Resources and Forestry have been released by the community into Junction Creek in efforts to re-introduce a sustainable population. Additional monitoring of Brook Trout success and habitat conditions are therefore an interest to the JCSC as well as the general public.

Throughout the course of the 2019 fish community assessment, 7 Brook Trout were captured in a total of 2 reaches in Junction Creek. Five of the trout were caught by electrofishing and 2 were caught with minnow traps. All 7 individual fish were determined to be part of the 2019 trout release held in May. In comparison to past studies, the total catch and distribution of Brook Trout in Junction Creek have increased.

Due to the limitations of electrofishing and minnow traps to detect larger trout in deep water, as well as inability to conduct surveys throughout the tributaries, it is likely that the 2019 assessment under reports both the abundance and distribution of Brook Trout in Junction Creek. Moving forward, angling surveys are recommended to provide a more accurate assessment of Brook Trout distribution.

Results & Analysis – Habitat Assessment 2019

Thermal Habitat

For each site assessed during the 2019 fish study, water temperature, pH, dissolved oxygen, conductivity, and salinity were measured. The water chemistry parameters ranged substantially depending on location, with the more extreme readings found in the south western section of Junction Creek, just upstream of Kelly Lake (see Table 6 below).

In addition to the site-specific measurements, 9 water temperature data loggers were placed in Junction Creek to take continuous thermal readings to monitor fluctuations in water temperature during the Summer (See Table 7 below). Water temperatures in Junction Creek were highest in the headwaters near Garson and cooled as the creek flowed downstream towards Twin Forks Playground, where the lowest temperatures were recorded. Moving downstream of Twin Forks, temperatures steadily increased as the creek flowed through New Sudbury and downtown Sudbury.

Table 6: Mean and range of measured water quality metrics in Junction Creek during the 2019 fish assessment.

	Junction Creek	
	Mean	**Range**
Conductivity (µs)	1126	246 - 2790
Salinity	0.64	0.12 - 1.41
pH	7.13	3.16 - 9.58
Dissolved Oxygen (mg/l)	6.51	0.13 - 11.16
Temperature (°C)	19.34	14.75 - 25.01
Depth (cm)	54	13 - >100

Table 7: Summer 2019 Junction Creek water temperatures by site.

	Minimum Summer Temperature (°C)	Maximum Summer Temperature (°C)	Mean Summer Temperature (°C)
Garson	13.68 (Sept 9)	28.65 (Jul 3)	21.00
Donnelly	11.84 (Sept 9)	27.93 (Jul 20)	19.61
Twin Forks	9.09 (Sept 9)	25.27 (Jul 20)	17.47
Maley Tributary	12.91 (Sept 15)	25.35 (Jul 20)	18.77
Stafford	12.48 (Sept 13)	26.04 (Jul 20)	18.97
Frood Tributary	11.24 (Sept 9)	29.34 (Jul 20)	19.2
Food Basics	12.4 (Sept 9)	27.67 (Jul 20)	19.73
Ukrainian Centre	12.61 (Sept 9)	26.55 (Jul 20)	19.34
Brady St	12.99 (Sept 13 & 15)	25.48 (Jul 19)	18.57

Stream Characteristics

Observations of basic stream characteristics, including substrate composition and in-stream cover, were made during the 2019 fish study. The assessment revealed that the Junction Creek is highly variable in both metrics as it flows from the headwaters in Garson down through urban Sudbury and out towards Kelly Lake. While much of the creek is dominated by silts and fine sands, substrates composed of gravel and cobble ideal for Brook Trout were discovered. Sections of creek running through forested areas with abundant riparian cover (such as Maley Drive to Lasalle Boulevard) commonly had an abundance of downed woody debris providing excellent fish cover. In contrast, the impaired sections encroached by development (such as New Sudbury and downtown Sudbury) had little to no riparian cover and low levels of in-stream cover. Further research is recommended to collect more data and map the habitat features.

Brook Trout

Habitat conditions suitable for Brook Trout include cool water temperatures, gravely substrate, and abundant in-stream and riparian zone cover.

Brook Trout require cooler water that is below 20°C, with an optimal range between 11°C and 16°C. When the stream conditions are above their optimal range, they will seek refuge at cold-water inputs. Due to their sensitivity to water temperature, the distribution and health of the Brook Trout will be limited by the thermal characteristics of the stream.

Thermal readings from the data loggers in 2019 (see Table 7 above) reveal only a few sections of the main stem of Junction Creek with suitable thermal conditions for Brook Trout. The most ideal reaches are found upstream of Lasalle Boulevard and in the Maley Tributary. Further research is recommended to locate the coordinates of cold-water inputs and other key Brook Trout habitat features. In addition, continued riparian restoration focusing on the upstream reaches, is strongly encouraged to improve stream cover and cooler stream conditions.

Figure 9: Map of the upper reaches of Junction Creek (in blue) indicating suitable habitat for Brook Trout (highlighted in orange).

In conclusion, the sections of Junction Creek that offer conditions most suitable for Brook Trout preferences are between Maley Drive and Lasalle Boulevard (see Figure 9 on the left). Not surprisingly, this stretch of creek had the greatest species richness and number of sensitive species surveyed and was the only location that Brook Trout were observed during the 2019 fish community assessment.

Conclusion and Highlights

Results from the 2019 Junction Creek Fish Community Assessment highlight the importance of a consistent long-term biomonitoring program with frequent sampling, especially within urbanized areas where environmental pressures are constantly changing. Building a database on stream health indicators will increase our understanding of Junction Creek to tailor future restoration efforts, provide science-based decisions for watershed management, and ensure efficient use of resources to provide maximum benefit to the long-term recovery of freshwater ecosystem health.

The data reveals an increasing trend in the number of intolerant species as well as species richness from 2004 to 2019. This suggests that overall, stream health conditions for Junction Creek are improving. The results suggest that fish community conditions are improving in many reaches in Junction Creek, particularly between Martindale Road and Kelly Lake, but deteriorating in the New Sudbury and downtown Sudbury area. This can be attributed to focused stream restoration work conducted in the Martindale to Kelly Lake region and the impaired riparian habitat from anthropogenic factors identified in the New Sudbury and downtown Sudbury. Additional data on stream health bioindicators and water chemistry will provide further insight.

<u>Project highlights from the 2019 fish community assessment</u>

- 9,974 fish were catalogued
- 17 species of fish were identified
- New species sighting for Junction Creek; Logperch, found in 2 reaches (reaches 11 & 14).
- No Golden Shiners were found during the 2019 fish community assessment
- Pumpkinseed absent from the creek in prior fish community assessments (discovered in 2017), were found in 6 reaches
- Creek chub and fathead minnow were the most widely distributed species; both were found in all 16 reaches
- Reaches 4 and 5 had the highest number of observed species (14 species)
- Reach 12 had the lowest number of observed species (4 species)
- Reach 5 had the highest number of sensitive species (2)
- Reaches 7-10, 12-13, and 15 had no sensitive species

<u>Comparison to past studies</u>

- Increase in species richness, number of sensitive species and their distribution
- Increase in Brook Trout sightings and distribution; observed in two reaches (4 & 5)
- Brassy Minnow and Yellow Perch showed the greatest increase in distribution (by 9 reaches)
- Brook Stickleback, Brown Bullhead, and Golden Shiner showed a reduction in distribution
- Reaches 14 and 16 (furthest downstream reaches) showed the greatest increase in species richness (by 8 and 7 species respectively)
- Reaches 8 and 12 showed the greatest decrease in species diversity (by 3 and 4 species respectively between 2004 and 2019)

Stream Health Conclusions

Overall, the stream health in Junction Creek is continuing to improve with the exception of a few sections. Spatially, the stream health of Junction Creek appears to deteriorate moving downstream from New Sudbury and downtown Sudbury, with an improvement after the Ponderosa Wetland, near Little Britain, and entering Kelly Lake. The geographic fluctuations in stream health may be attributed to urban, industrial, and/or mining pressures and creek restoration and wetland systems.

- Reach 5 (Robin Street to Lasalle Boulevard) had the highest species richness and number of sensitive species, indicating good stream health conditions. This may be attributed to several factors including various restoration efforts that have been conducted in the area and the input of cleaner water, such as from the Maley Tributary which is the only tributary in the upper reaches of Junction Creek (including the headwaters) that does not have active mining operations. The increase in species richness in the surrounding reaches (reaches 4, 6 and 7) suggest that the restoration efforts are improving stream conditions and having positive impacts downstream.
- Areas of most concern are Reaches 3, 8, and 12. Reach 3 (O'Neil Drive to Carr Avenue in Garson) has shown a recent decrease in species richness (by 2 species) since the 2008 study, suggesting a potential impairment to stream conditions. Reach 8 (Arthur Street to Ponderosa wetland in New Sudbury) and Reach 12 (downtown Sudbury to Regent Street) have the lowest species richness and no sightings of sensitive species, indicating poor stream health conditions. Species richness in reaches 8 and 12 have shown little to no improvement in past studies and a recent decline since 2008, suggesting ongoing impairment to stream health.
- Reaches 14 and 16 (Gatchell and Copper Cliff area) had the largest increase in species richness since 2004 (from 1 to 9 species) including the addition of species that are intolerant to poor water quality, indicating substantial improvement to stream health. This may be attributed to several factors including restoration efforts (particularly tree planting in this section over the past 15 years), and the accumulative improvement of water quality upstream and from the Copper Cliff Tributary.

Recommendations for future studies

Long-term monitoring of fish communities in Junction Creek should be considered an essential component of the restoration of Junction Creek, as changes in the fish community can identify degradation to the Junction Creek ecosystem and data can be used to guide watershed management. It is highly recommended that fish community assessments are conducted along the upper reaches and tributaries of Junction Creek on a regular basis, every 3-5 years.

There are opportunities for further research to fill data gaps and compliment current data on the Junction Creek watershed. More information allows for tailored projects and effective management, which will benefit the health of the watershed and community. Research goals moving forward include the following:

I. **Thermal Profiling and Temperature Monitoring of Junction Creek**
   - Short-term focus: identify cold water inputs into Junction Creek and protect thermal refuge habitat for Brook Trout.
   - The secondary, and long-term focus: to maintain water temperature monitoring within the creek using thermal data loggers.

II. **Habitat Quality Assessment of Junction Creek**
   - Conduct a focused habitat assessment, using Fish Assessment Protocols for site selection, would provide more detailed information than can be gathered while conducting a fish assessment. Focus would be on physical features of the creek (width, depth, substrate composition, riparian zone quality, etc.)
   - Suggested to carry out habitat assessment the year prior to a fish community assessment. This will allow teams carrying out fish assessments to utilize updated information on the physical features of Junction Creek and be more efficient with their time in the field.

III. **Further Brook Trout Assessment**
   - As an umbrella species and indicator of stream health, the establishment of a healthy Brook Trout population in Junction Creek has been a restoration goal for the JCSC, and a greater understanding of reintroduction efforts should be prioritized moving forward.
   - Continued assessment of Brook Trout would include angling and electrofishing within known and fringe Brook Trout habitat within Junction Creek.

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