# Charles Brook, Newfoundland – watershed overview and recommendations for conservation of its Atlantic salmon

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# Location

Charles Brook is located in central Newfoundland, just north of the community of Botwood (Figure 1). This small scheduled salmon river (Figure 2) enters the sea (49°20'23.57"N, 55°14'59.21"W) in the Bay of Exploits, which contains several other small salmon rivers (Figure 3), along with the largest on the island (Exploits River).

Much of the drainage for Charles Brook is a small peninsula. GIS estimates indicate the drainage area is 68.1 $km^2$, with a mean annual discharge of 1.97 $m^3/s$ (Table 1). The max length of the watershed is 22 km, with a relatively small amount of river habitat compared to that present in the ponds and lakes (813 hectares). There are 13 lakes above 10 hectares in surface area and 22 others between 1-10 hectares.

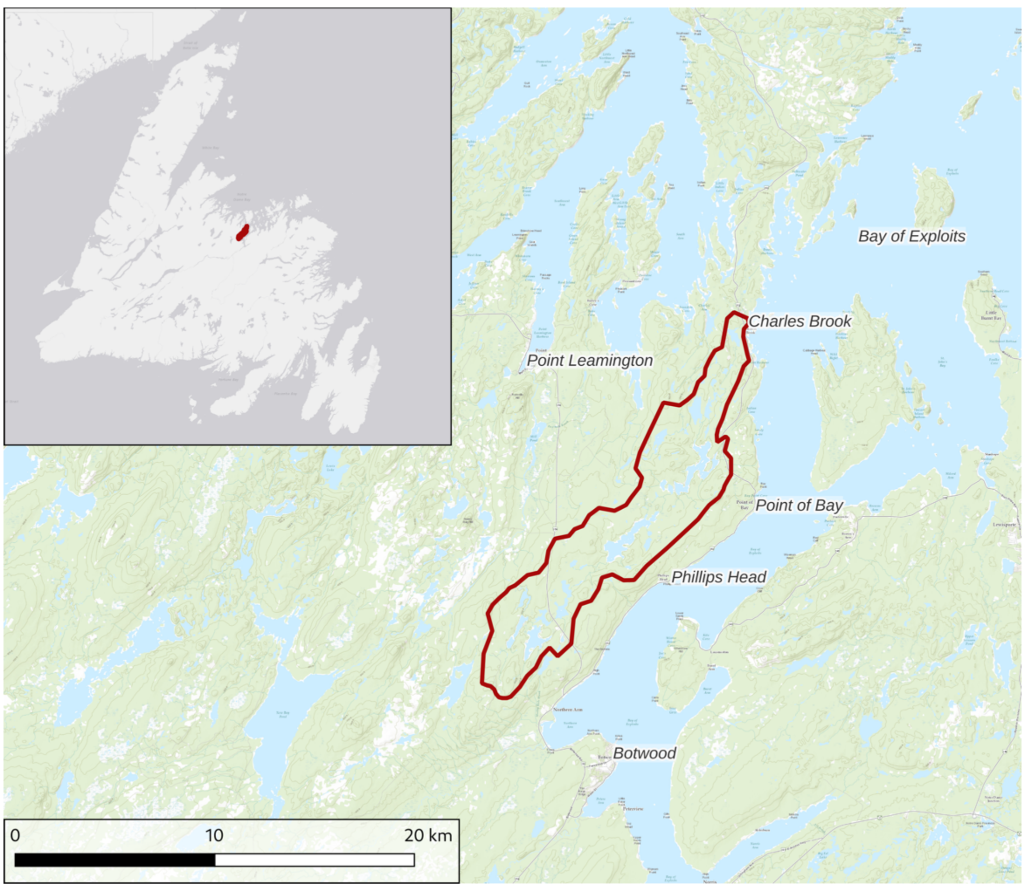


Figure 1. Map of the Bay of Exploits, indicating the Charles Brook watershed (red outline). Insert is the island of Newfoundland.


Figure 2.  Outline of the Charles Brook watershed on the northeast coast of Newfoundland.

Figure 2. Insert from the NL recreational salmon fishing regulations. Rivers are:
#40 Northwest Arm Brook,
#41 Western Arm Brook,
#42 New Bay River (aka Mill River and Point Leamington River),
#43 Charles Brook,
#44 Northern Arm Brook,
#45 Peter's River,
#46 Exploits River,
#47 Rattling Brook,
#48 Campbellton River.

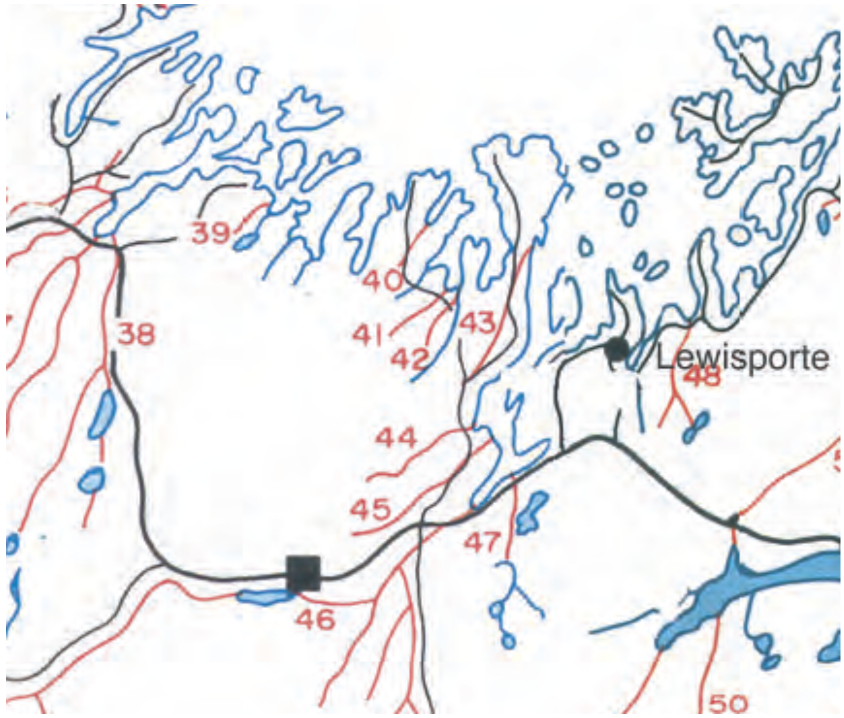


Table 1. Charles Brook physical characteristics and habitat with confirmed salmon presence from 2023-2024 surveys. GIS indicates there are 40 lakes and ponds of all sizes.

| Measure | Value |
|---|---|
| Drainage area ($km^2$) | 68.1 |
| Estimated mean annual discharge ($m^3/s$) | 1.97 |
| Length of main reach - includes main length of streams, lakes and ponds from the headwaters to the sea (km) | 22 |
| Number of lakes/ponds at least 1 hectare in surface area | 35 |
| Area of lakes/ponds in watershed ($km^2$) | 8.13 |
| *Habitat with confirmed salmon presence* | |
| Stream length (km) | 7.6 |
| Number of lakes or ponds | 9 (22.5%) |
| Area of lakes or ponds ($km^2$) | 5.25 (64.5%) |

## History

In the 18th and early 19th centuries, English settlers documented the use of Charles Brook by the Beothuk (indigenous peoples of Newfoundland at the time of European contact). This is not surprising, given how easy it would be to trap salmon in summer at the mouth of the river with a retreating tide (Figure 4). A Beothuk child, Oubee, was captured here in 1791 and brought to England, where she died. Shanawdithit (the last Beothuk, who died in 1829) spent her last summer here with her mother and sister in 1823, before living with settlers on the nearby Exploits Islands (Marshall 1996).

Figure 4. The tidal river mouth on July 31/22, taken from the author's family cabin. It got worse after this in August and September. The whole river flow is that bit of water in the middle.

Around 1900, settlers from Exploits Islands moved in the bay and established a small community at the mouth of Charles Brook (including the great-grandparents of the author of this report). They went to Labrador in summer to fish for cod, and logged and operated a sawmill to build schooners at other times of the year. After decades of logging and a substantial forest fire, the community was abandoned in the 1930s. One of only 22 known existing sites of Newfoundland’s endangered red pines (Species Status Advisory Committee 2016) is located nearby at Charles Arm (Roberts 1985). During the course of the research for this report, we located a small group of previously unknown red pines on the shore of the first lake (Figure 5) in the Charles Brook watershed (about 3km in a straight line from the site in Charles Arm). It is probable that these existing trees were too small to be of interest to loggers <1930, and are all that remain of a former larger distribution. Another sawmill was constructed later in the upper parts of the watershed that had access from the provincial highway leading to the town of Point Leamington.

Figure 5. A small previously unknown group of endangered Newfoundland red pines (*Pinus resinosa*) was found on Charles Brook Pond (Table 2) during salmon habitat surveys in 2023, raising the known number of natural red pine stands on the island from 22 to 23.

## Current use

Charles Brook has never been a popular destination for recreational salmon fishing (although there is some). The population of salmon is relatively small, and summer water levels are usually very low. The lakes are popular for recreational fishing for brook trout, both in summer and winter. There are anecdotal reports that in some parts of the watershed in recent decades there are fewer trout and more salmon than there used to be (see comment at the end of this report). Indian Cove Pond (CB-P7, Table 2) is currently the water supply for the town of Point of Bay. Because of this, the use of motorized vehicles is not permitted on this pond (boat use seems limited but there is a large amount of snowmobile use), but it is permitted on ponds upstream of it. Other nearby communities have water supplies that are outside of the Charles Brook drainage area.

Access to some parts of the watershed is easy, while other areas are quite remote (Figure 6). There are a large number of cabins along the saltwater shoreline near the river mouth, but few inland on the river itself (Figure 7). A proposed industrial wind-to-hydrogen project is planned for this area (https://evrec.energy/). The production plant will be located in Botwood and will take water from Peter's River. As of 2024, the primary zone for turbine locations are planned to be in the watersheds of Northwest Brook, Western Arm Brook, Point Leamington River, Northern Arm River, Peter's River, and Charles Brook (Figure 8).

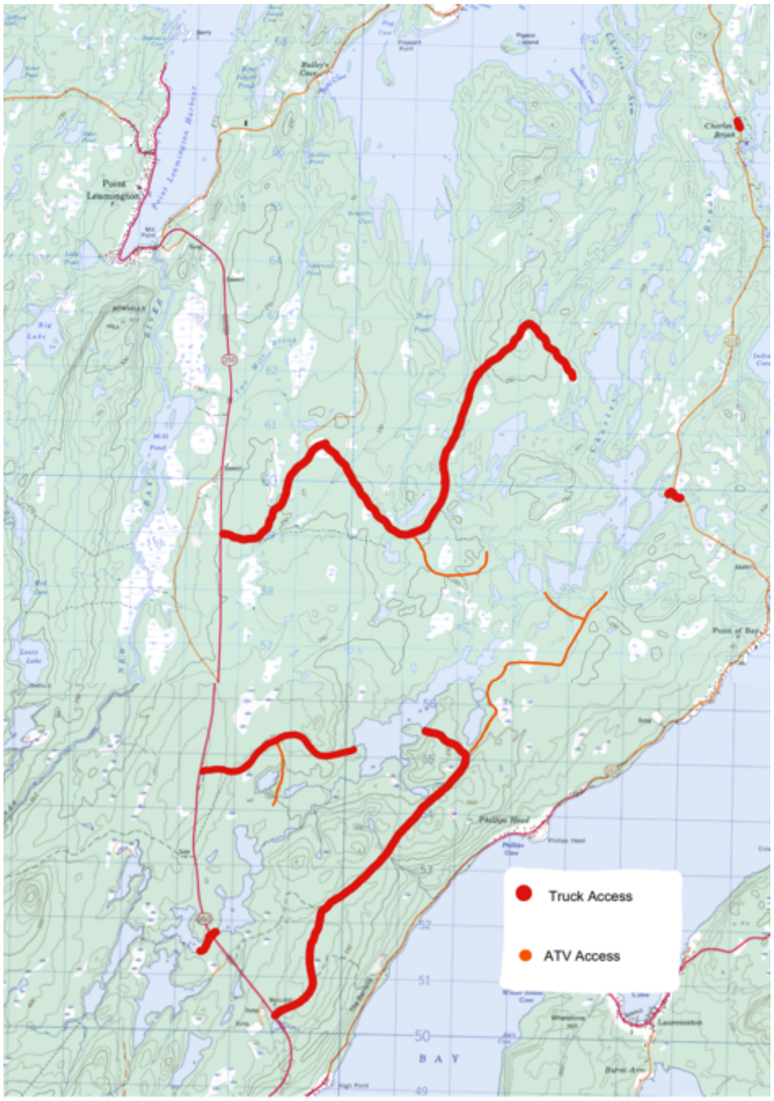


Figure 6. Access points on the Charles Brook watershed.

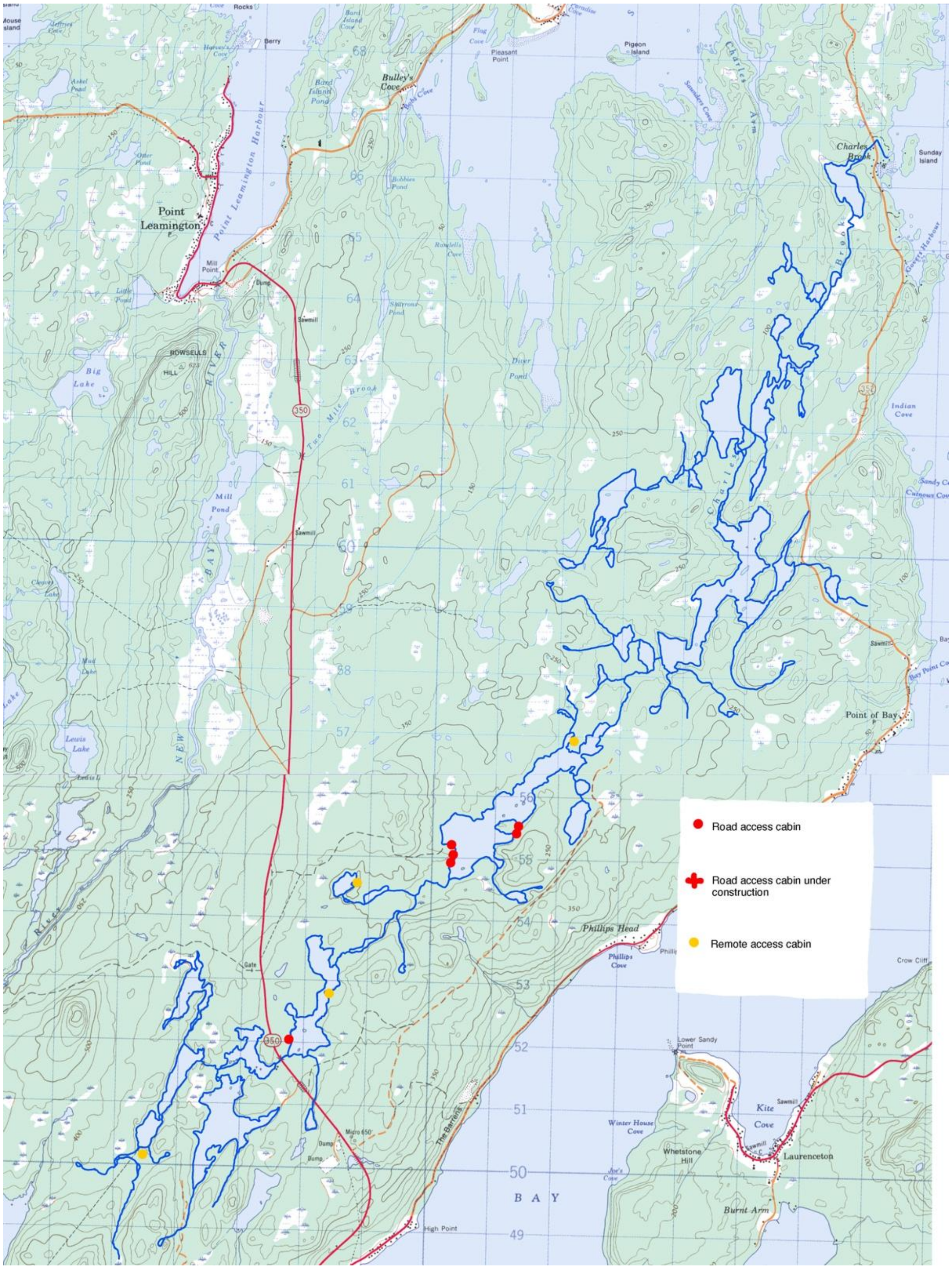


Figure 7. Cabins in the Charles Brook watershed. Numerous additional cabins (not shown) are located along the saltwater near the mouth of the river.

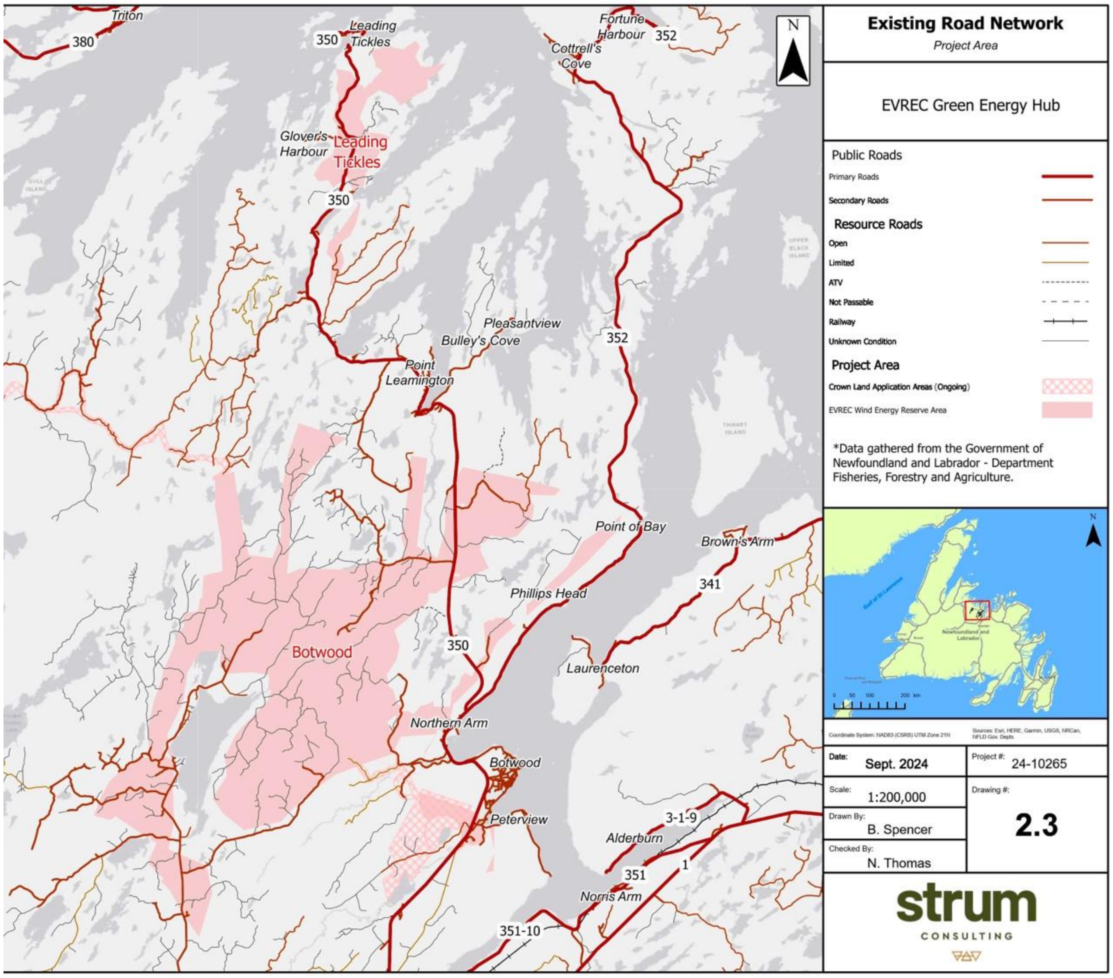


Figure 8. Eastern side of the proposed industrial wind energy project near Botwood. Pink shaded areas are land reserved for wind turbines and surround most of the Charles Brook watershed.

## Foundation for the Conservation of Atlantic Salmon (FCAS) project

Through Memorial University of Newfoundland, the author received funding to conduct work in 2023 and 2024 that led to this report. This included: 1) interviews with residents of Botwood who are very familiar with the watershed, 2) surveys to determine human access, salmon habitat (barriers to upstream migration, suitable gravel for spawning, lake depth, stream temperatures), and salmon presence/densities in different parts of the watershed, and 3) collection of salmon tissue for a genetics profile of the population. Most of the watershed was surveyed (Figure 9) and has been assigned a coding system for this report (Table 2, Figures 10a and 10b).

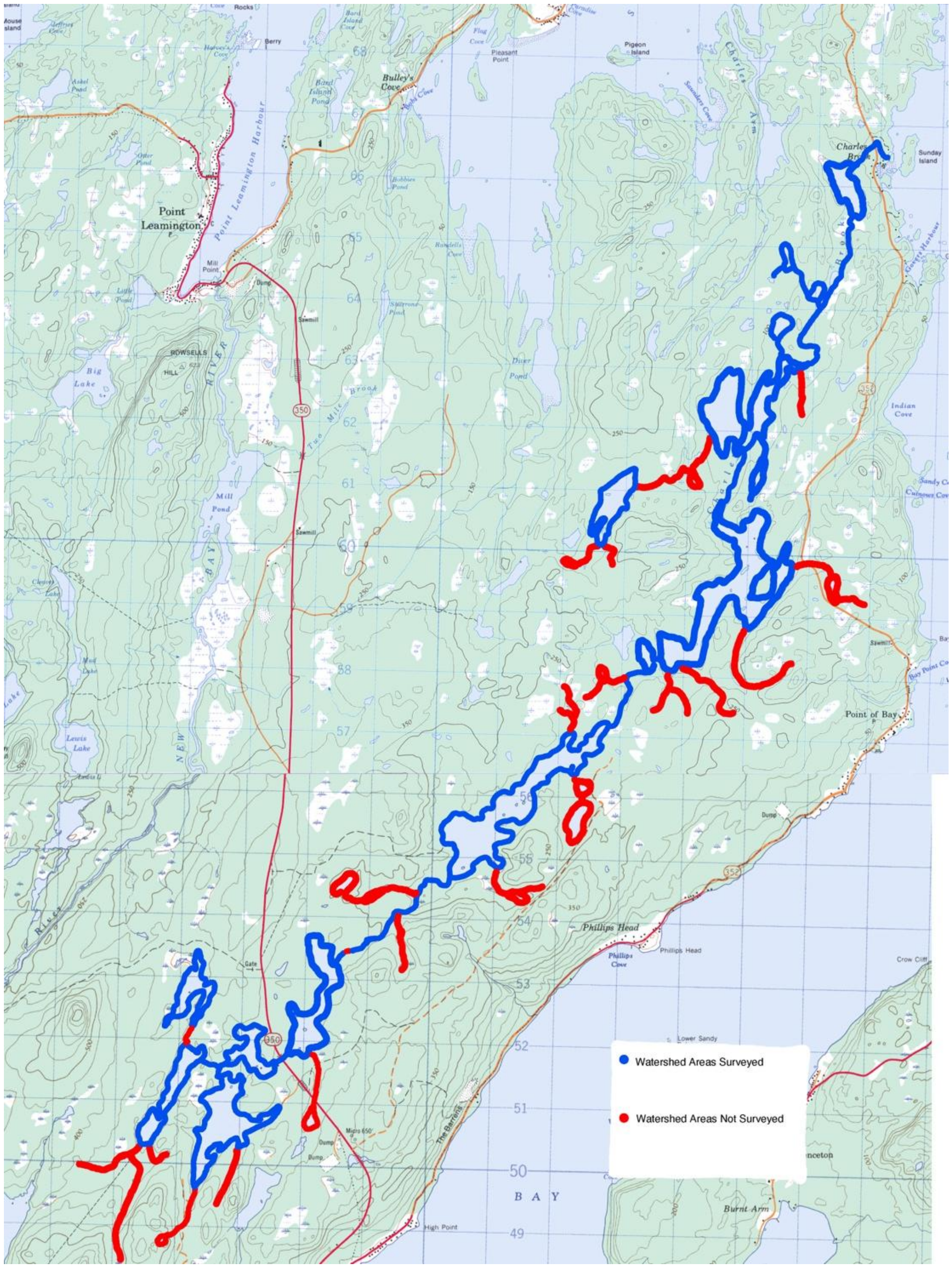


Figure 9. Survey area based on 2023 and 2024 field work.

Table 2. Local lake names in the Charles Brook watershed and associated coding system used on report maps.

| Local lake name | Lake code |
|---|---|
| Charles Brook Pond | CB-P1 |
| Side Pond | A-P1 |
| Banish Pond | A-P3 |
| 2nd Pond | CB-B-P1 |
| Eastern Shackle Pond | CB-P5 |
| Western Shackle Pond | B-P1 |
| Natty Ward Pond | B-P6 |
| Mountain Pond | B-BP1 |
| Long Pond (by Indian Cove Pond) | CB-C-P1 |
| Indian Cove Pond | CB-P7 |
| Fall Pond | CB-P8 |
| Phillips Head Pond | CB-P9 |
| Lower Weasel Pond | I-P1 |
| Upper Weasel Pond | I-P2 |
| Lower Charles Pond – includes both basins | CB-P12 |
| Upper Charles Pond | CB-P13 |
| Big Pond | K-P1 |
| Long Pond (above highway) – includes both basins | CB-P14 |
| Dawson Pond | L-P1 |

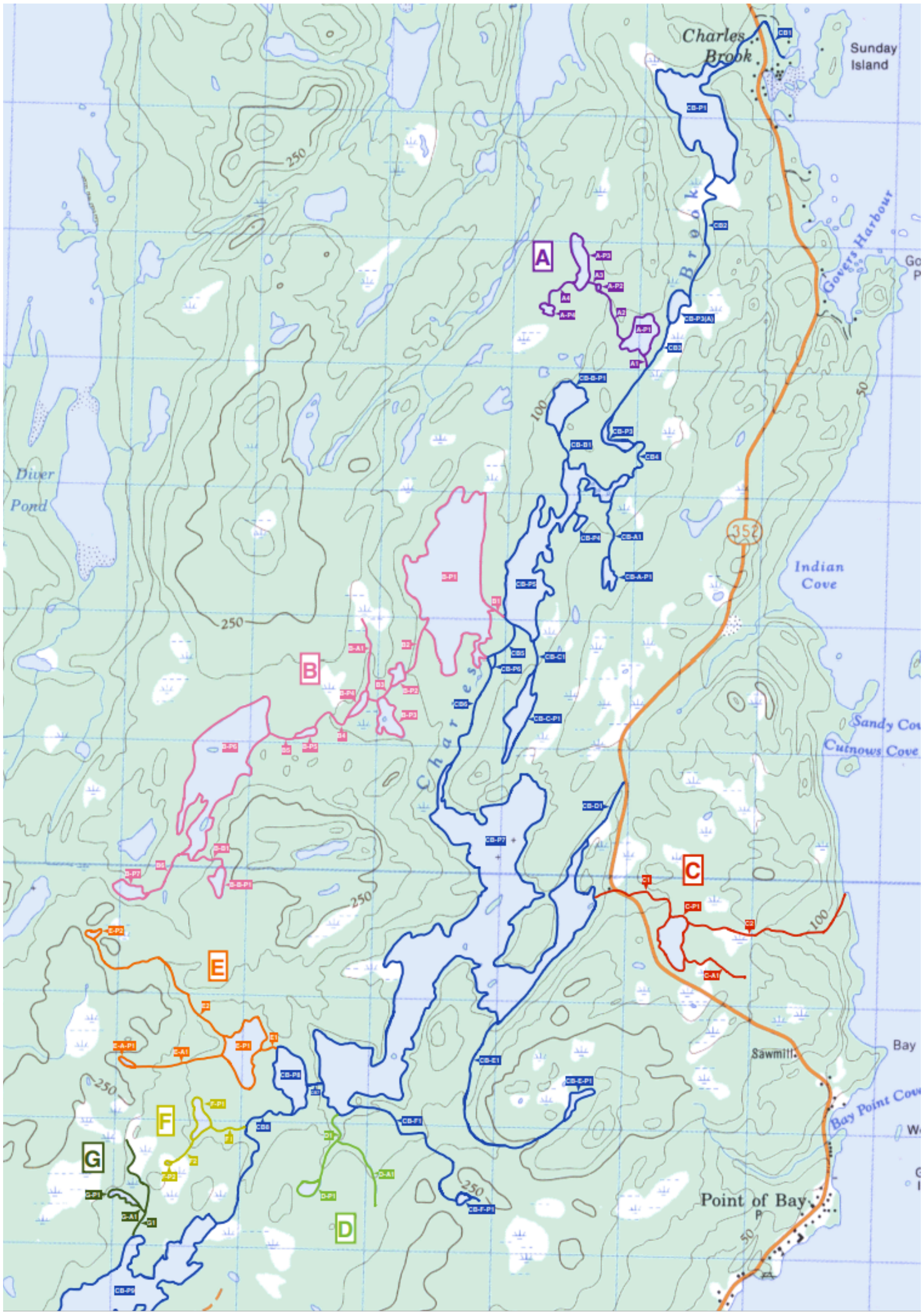


Figure 10a. Charles Brook watershed code system used in this report (north half of watershed).

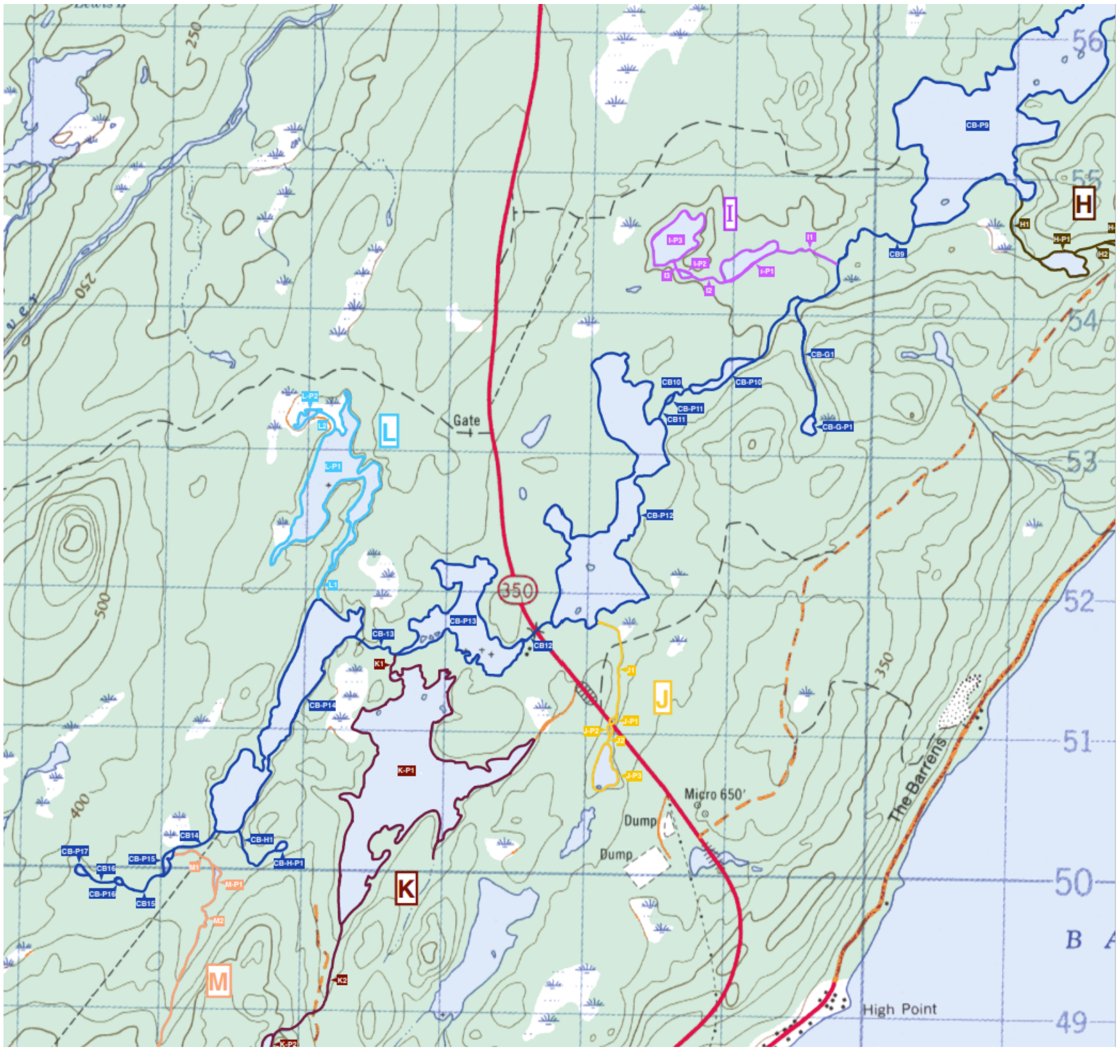


Figure 10b. Charles Brook watershed code system used in this report (south half of watershed).

## Salmon habitat

### Obstructions to migrating salmon

Nearly the entire watershed was surveyed by wading, boat, truck, atv, and snowmobile. No problems with culverts or beaver dams were found. Given the small size of the brook, the largest barrier to upstream migration is low water levels. During summer, adult salmon congregate at the river mouth and do not enter the river until there is a rain event. They can be easily seen going back and forth with the tide in July and August. In most years, salmon do enter by early September but in 2022 there were still fish in saltwater in October trying to enter the river. Once adult salmon do enter the river, they can easily become trapped if water levels are not high (Figure 11).

Figure 11. Salmon trapped in the lower part of the river in late September 2022. Photo credit to Muril Ward.

It is not believed that adult salmon enter tributaries A, B (beyond the first pond, Western Shackle Pond), C, D, E, F, G, H, I, J, K, or M (Figure 10). It is unknown if any enter L. In the "mainstem" there are some obstructions that would be at least partial barriers to upstream migration (Figure 12 ). Obstacle #1 is just upstream from saltwater and downstream from the highway. Salmon would not be able to get over this on low water, but it might be rare that they enter the river at all under such conditions. Obstacle #2 is located between Fall Pond (CP-P8) and Indian Cove Pond (CP-P7), and would be a significant barrier (Figure 13) under low water conditions. Anecdotal reports suggest this is an angling destination and the author found evidence of poaching here. Obstacles #3 and #4 are between Lower Charles Pond (CB-P10) and Phillips Head Pond (CB-P9). In particular, #4 (Figure 14) seems like a significant barrier and the author was surprised salmon could ever get over it. However, the presence of fry upstream in 2023 and 2024 indicate that some do. The upstream end of Upper Charles Pond (CB-P13) was so blocked with aquatic vegetation (Figure 15) in late summer 2023 that it would be difficult or impossible for salmon to pass until water levels increased significantly.

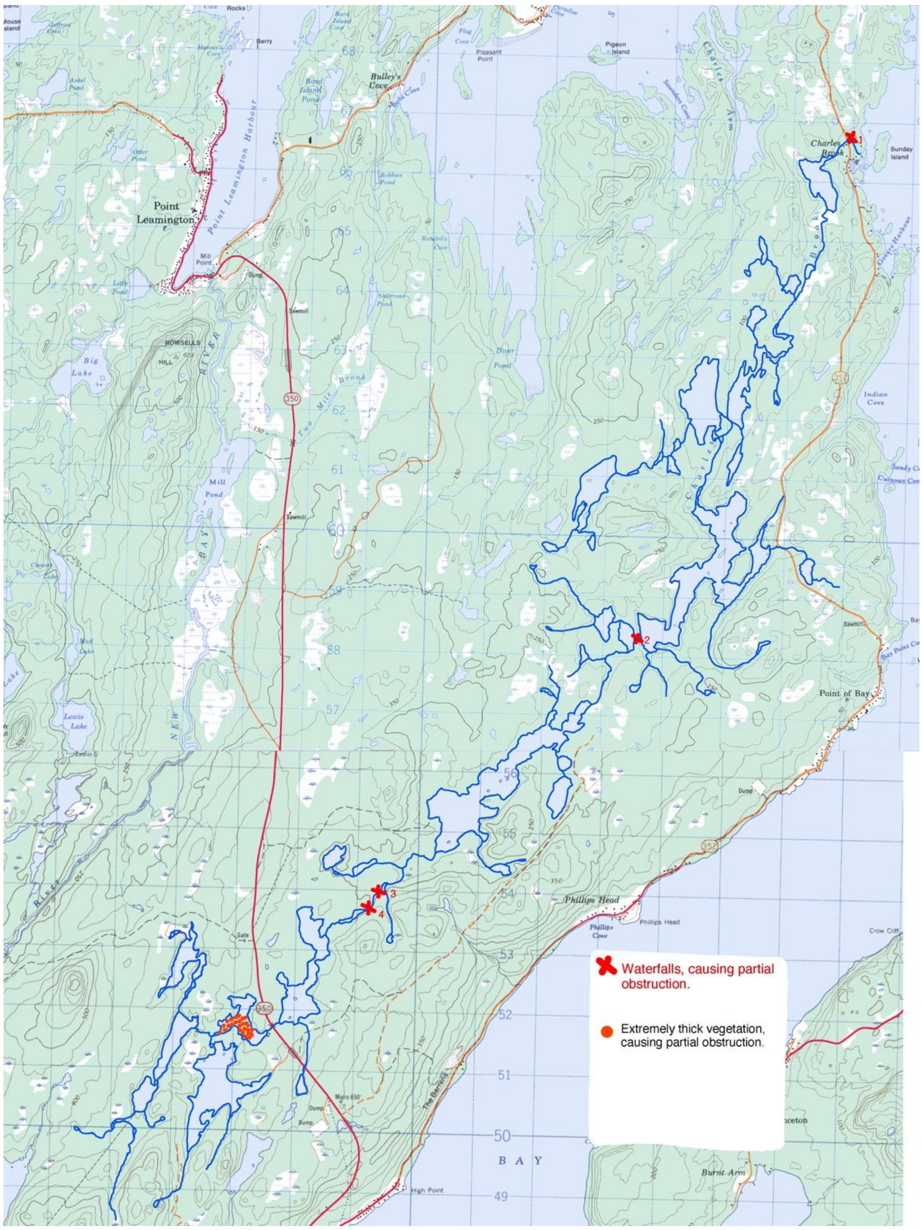


Figure 12. Potential obstructions for upstream migrating salmon, identified in August 2023.

Figure 13. Possible low water barrier between Fall Pond and Indian Cove Pond. Obstacle #2 on Figure 12. Image taken at relatively high summer water levels on August 11/23.

Figure 14. Barrier between Lower Charles Pond and Phillips Head Pond (zoomed on right image). Obstacle #4 on Figure 12. Images taken at relatively high summer water levels on August 12/23.

Figure 15. Aquatic vegetation is extremely thick in Upper Charles Pond. In places it seems impassable at summer water levels. Obstacle #5 on Figure 12. Image taken August 14/23.

**Location of potential spawning habitat**

Dedicated surveying for potential spawning habitat was undertaken in 2023 (Figure 16). As is typical for most Newfoundland rivers (Purchase 2016), most of the fluvial habitat is unsuitable for the construction of salmon redds due to the substrate being too large. Areas with gravel that might be spawning habitat were found (Figure 16, Figure 17). However, no redds were observed in the areas that were checked during retrieval of temperature loggers in November 2022, 2023, 2024.

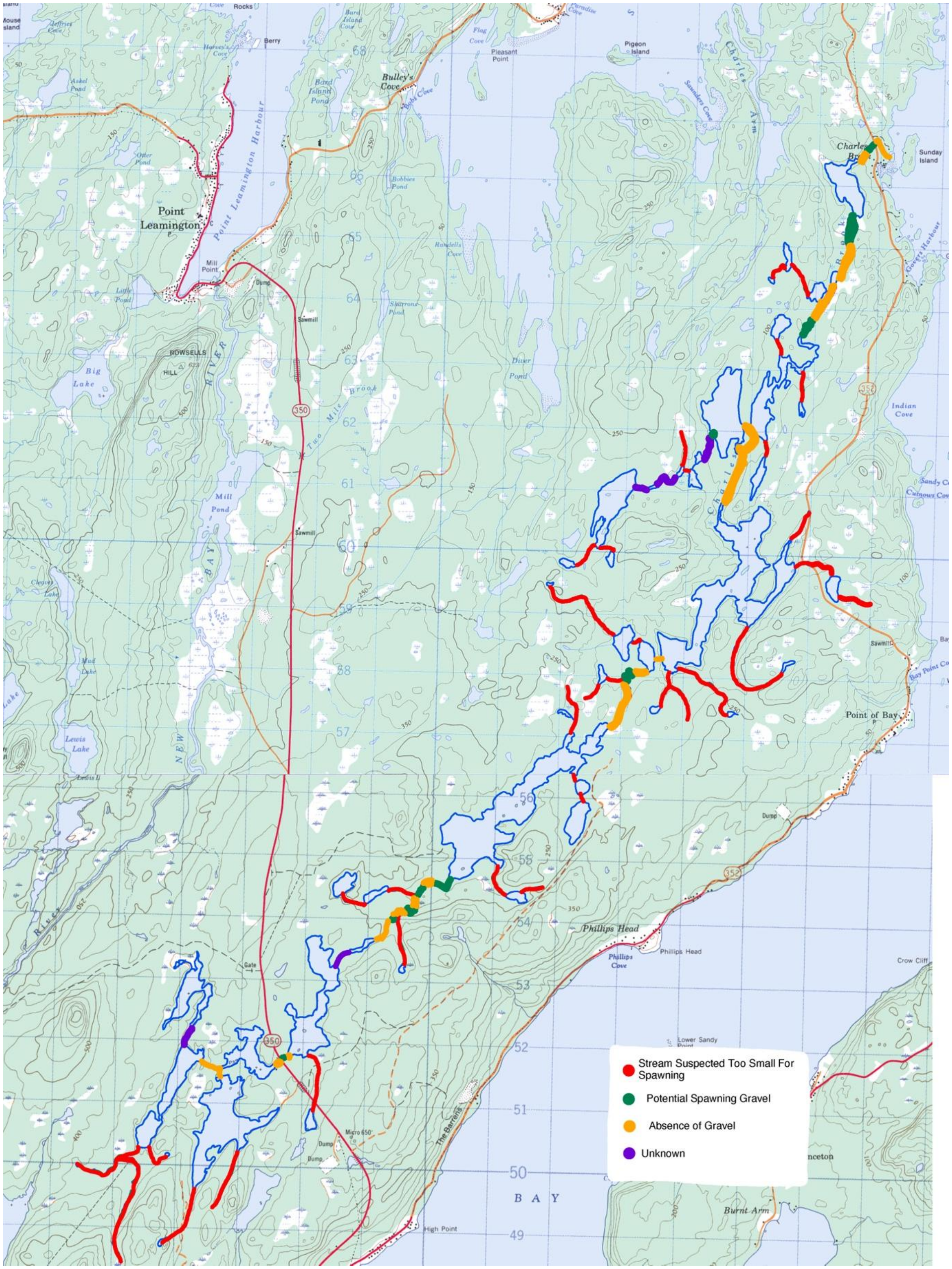


Figure 16. Areas of gravel substrate that might serve as spawning habitat at certain flow rates.

Figure 17. Some gravel was found in the watershed that might provide spawning habitat at certain flow rates. The inflows of Phillips Head Pond and Charles Brook Pond (Figure 16) contained some of the largest deposits, but no redds were observed in the parts of these areas that were checked during retrieval of temperature loggers in late fall. Image taken August 4/23.

**River temperatures**

Hobo© temperature loggers were installed (Figure 18) in the springs of 2022 (3 sites), 2023 (4 sites), and 2024 (4 sites) and retrieved in the autumn of each year. They were programed to record the temperature every hour. The brook gets very low at times, so considerable effort was given to find relatively deep locations. Sites were chosen so that the logger would still be submerged on the lowest summer water conditions, in running water. This created difficulty in retrieving some of them in the fall, if the water was high.

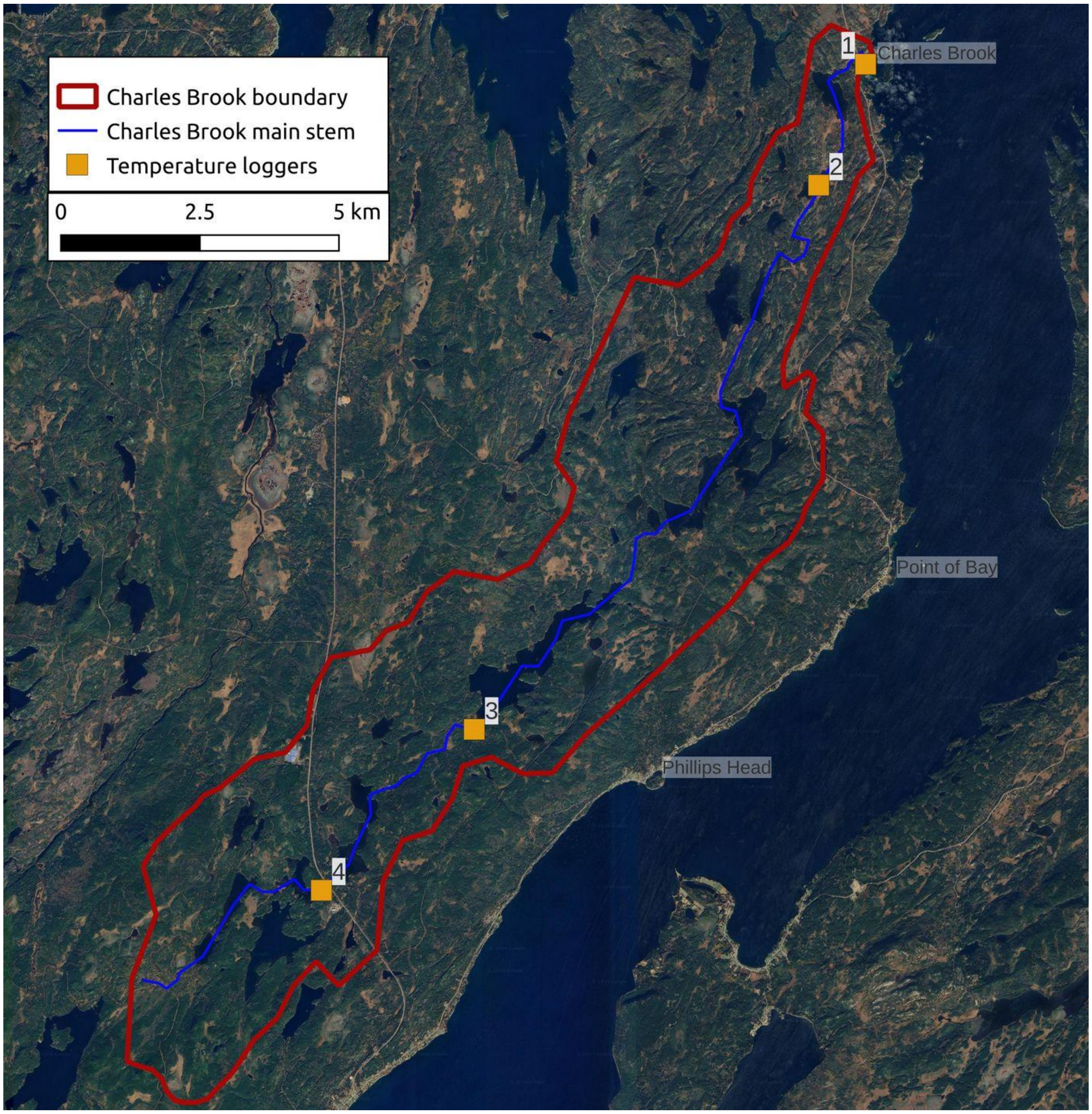


Figure 18. Location of temperature loggers installed in May-November 2022 (sites 1,2,3), 2023 (sites 1,2,3,4), and 2024 (sites 1,2,3,4).

Summer river temperatures got extremely warm (Figures 19-24). The river is small, and in some places has little canopy cover. Some variation in temperature occurred among the 4 sites. The middle 2 sites (not close to a lake outlet) achieved higher daily temperatures than the most downstream and upstream sites. The average July and August temperatures and the percentage of July and August days that went above certain threshold temperatures are summarized in Table 3 and Table 4. A high proportion of the summers were > 24$^{o}$C.

As with most Newfoundland rivers, there is no or virtually no summer thermal refugia for salmon in the fluvial environment. High temperatures are a serious concern (Van Leeuwen et al. 2020) for not only upstream migrating adult salmon, but also juveniles that are present in fresh water for many years. Lethal effects are unquantified, and sub-lethal effects are almost impossible to quantify.

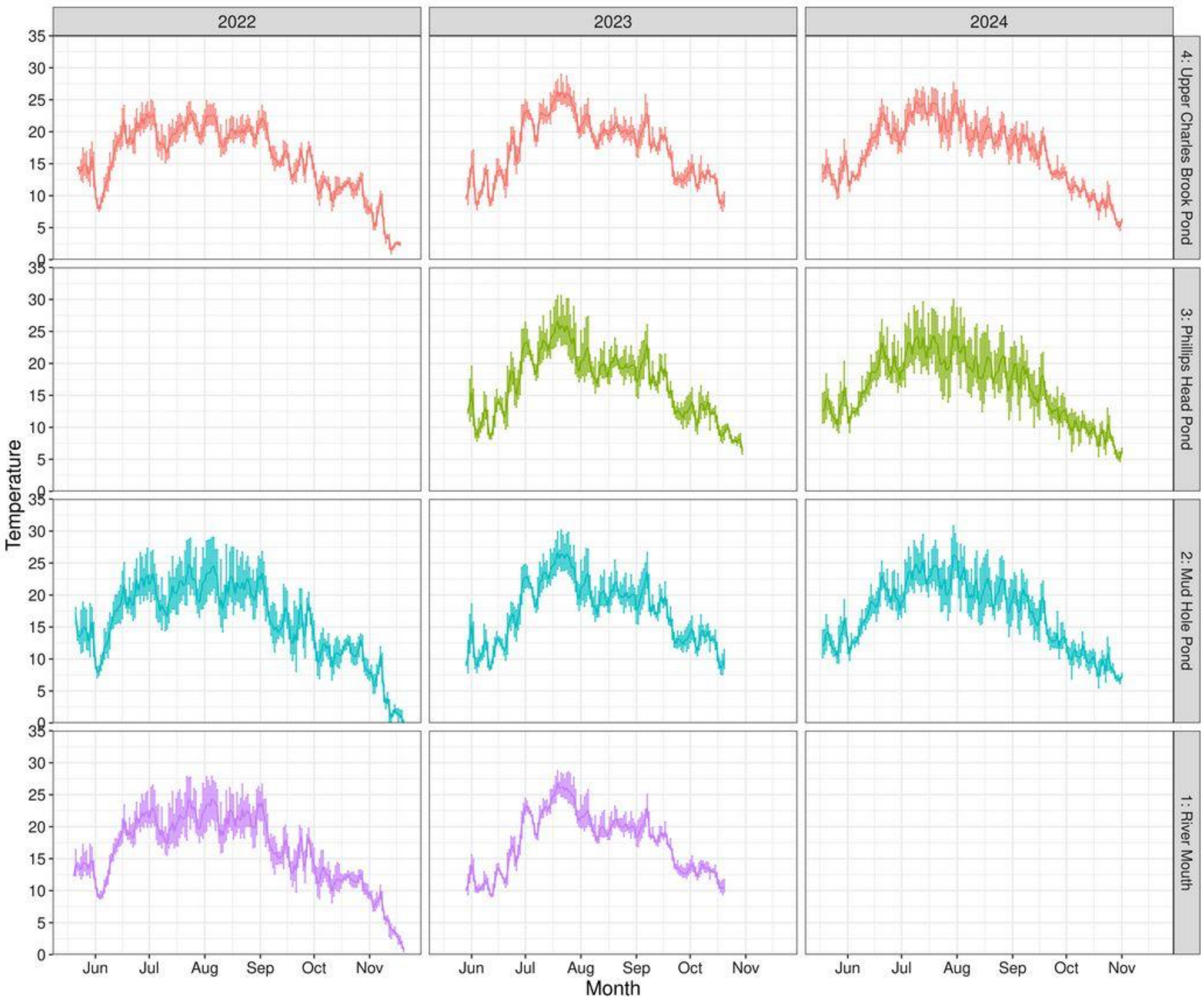


Figure 19. Daily temperature (°C) ranges at four sites in Charles Brook in spring to fall 2022-2024. Lines for each day range from minimum to maximum (see following figures for more detail). A logger at site 1 (near the river mouth) was installed in May 2024 but could not be retrieved as of January 2025 due to flow conditions (3 attempts were made in fall 2024).

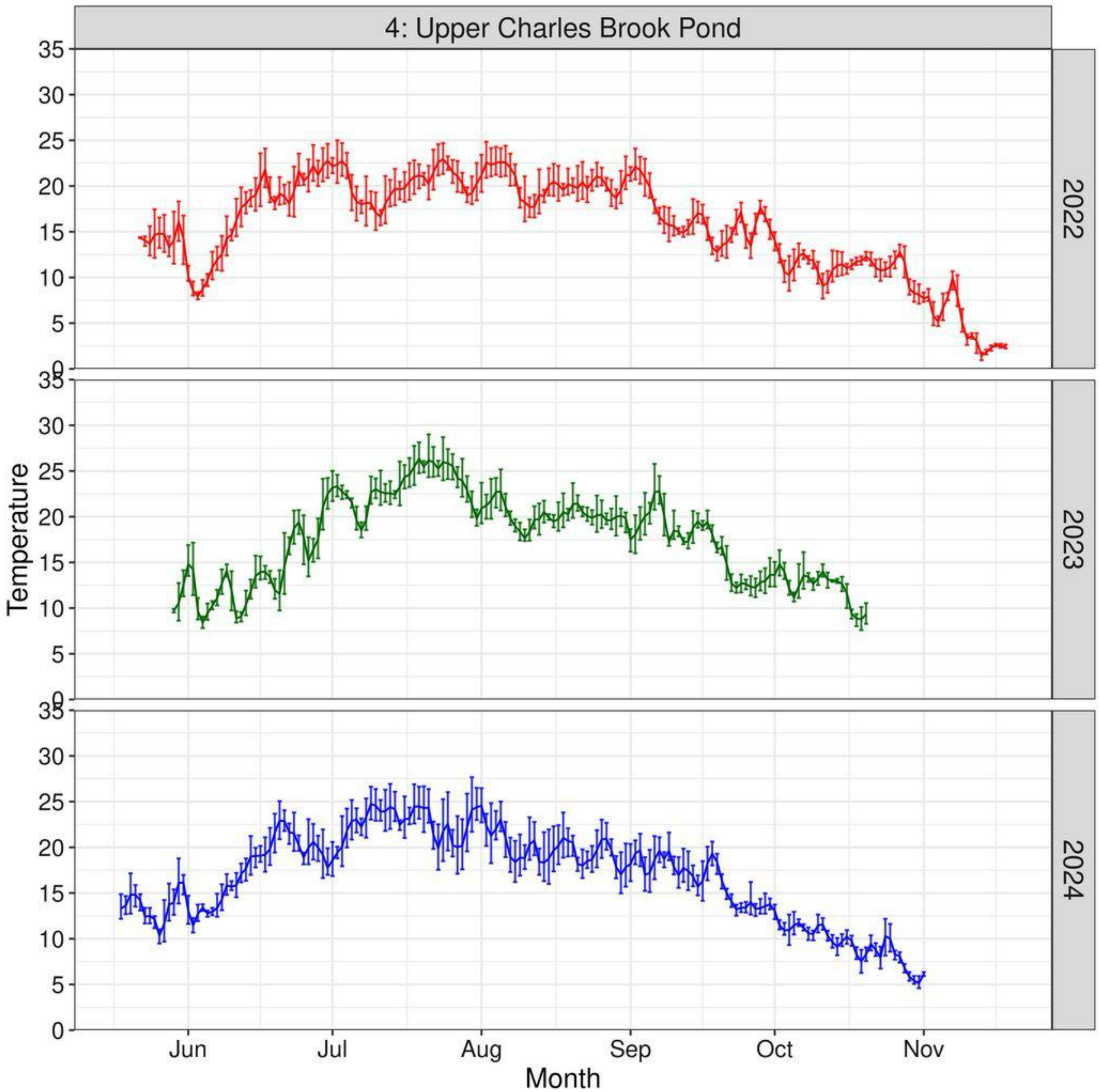


Figure 20. Daily temperature (°C) range below the outflow of Upper Charles Pond (site 4 in Figure 18) in spring to fall 2022-2024. The line across the figure is the mean and vertical lines range from daily minimum to maximum.

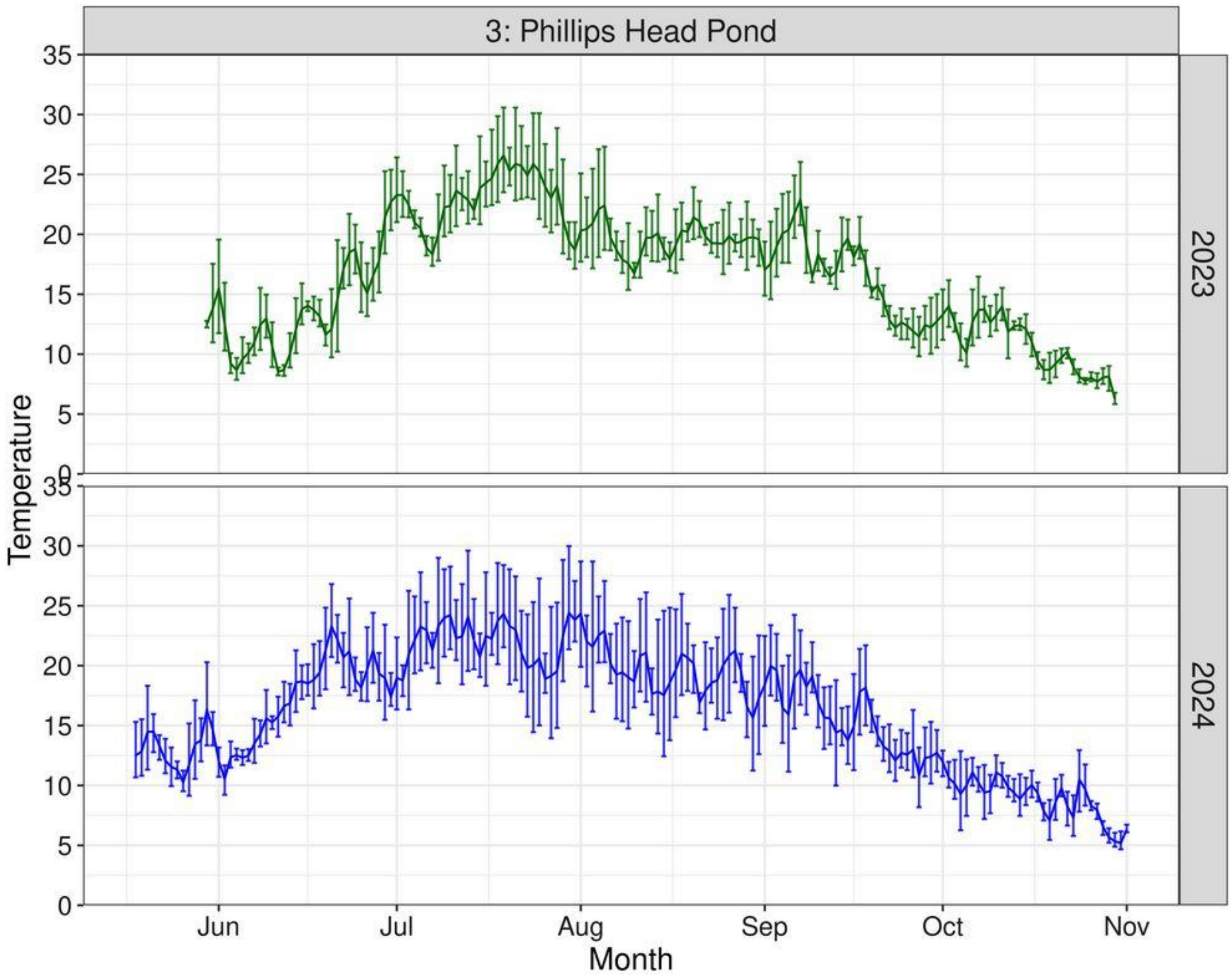


Figure 21. Daily temperature (°C) range just above the inflow to Phillips Head Pond (Site 3 in Figure 18) in spring to fall 2023-2024. The line across the figure is the mean and vertical lines range from daily minimum to maximum.

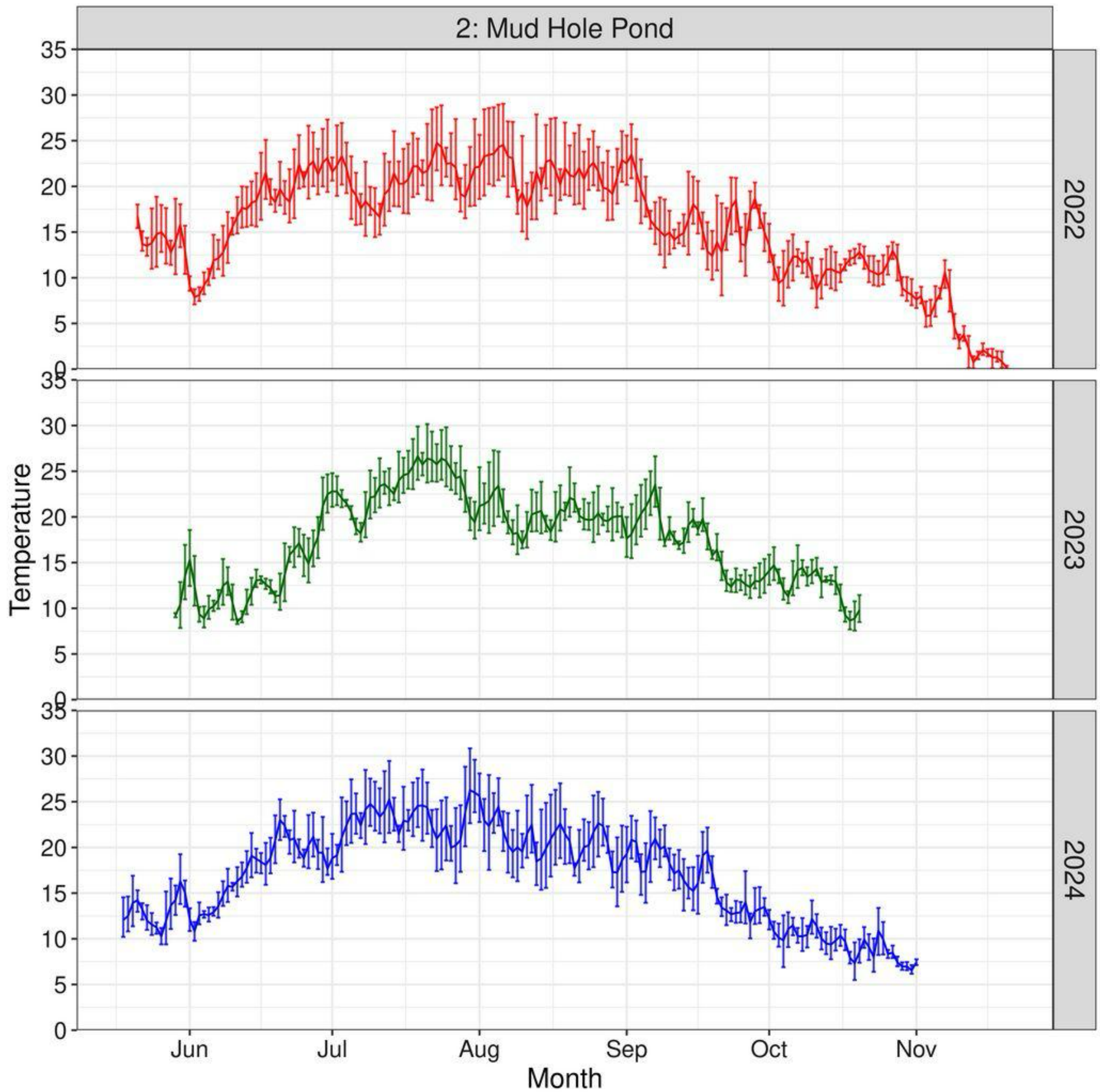


Figure 22. Daily temperature (°C) range at the inflow of the Mud Hole Pond (Site 2 in Figure 18) in spring to fall 2022-2024. The line across the figure is the mean and vertical lines range from daily minimum to maximum.

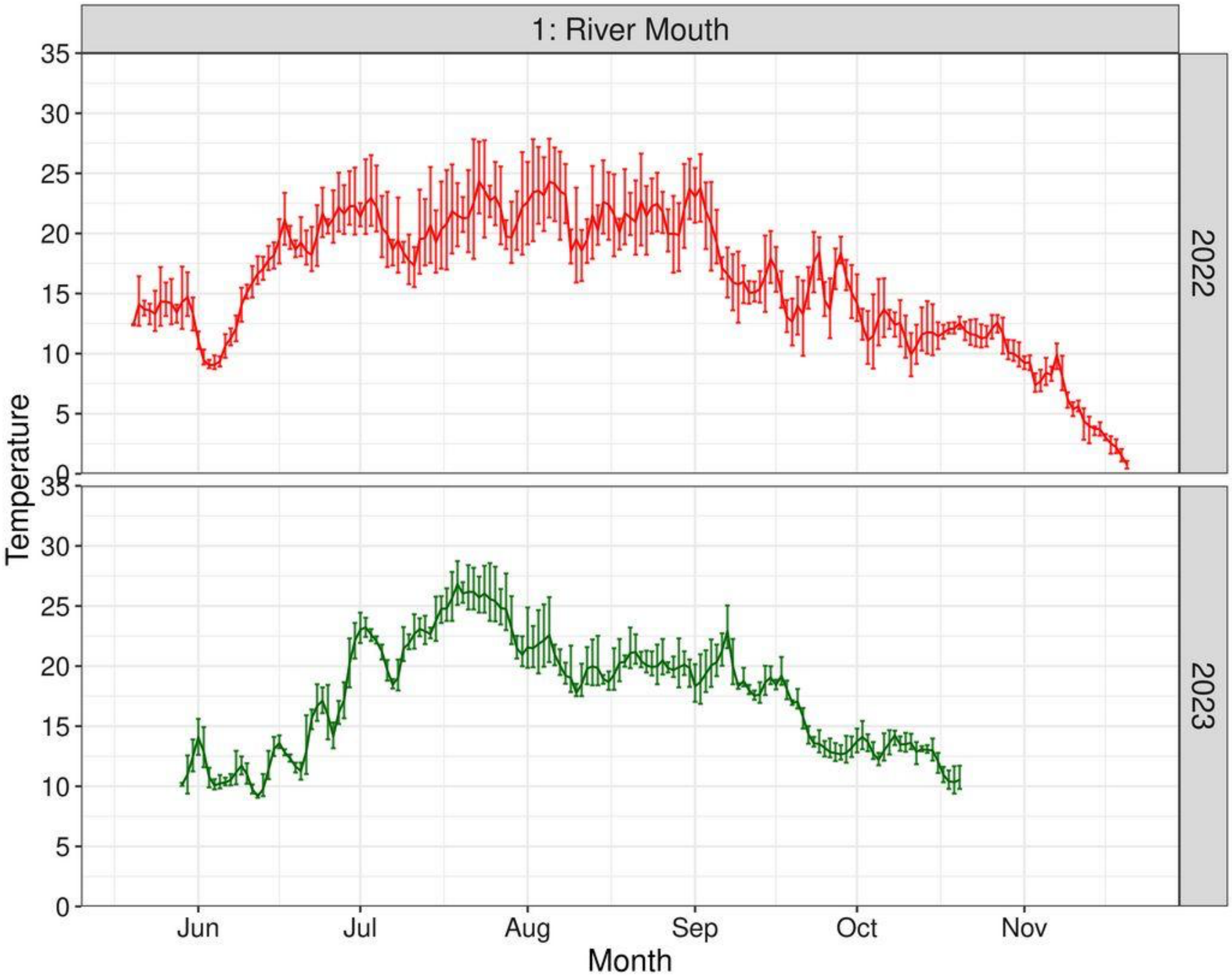


Figure 23. Daily temperature (°C) range just above the high tide mark at the river mouth of Charles Brook (Site 1 in Figure 18) from 2022-2023. The line across the figure is the mean and vertical lines range from daily minimum to maximum. A logger was installed at this site in 2024 but could not be retrieved as of January 2025.

A Hobo© water pressure logger was installed in late June 2023 in the same location as the temperature logger in site #1 (Figure 18). Changes in pressure through time are the result of differences in water height above the logger, along with changes in atmospheric pressure. Climate data for Gander Newfoundland was used to offset changes in the atmosphere, using Hobo© software. Users input the starting depth of the logger, and pressure changes are used to estimate changes in depth through time. The absolute depth is meaningless as it depends on the exact location of install, but changes in depth through time are useful to indicate relative changes in flow.

Photographs taken at the site were used to interpret data patterns. The river was atypically high when installed on June 29. There was no substantial increase in flow again until mid-August, and flow rates did not reach the installation level until after the logger was removed at the end of October (Figure 24). Salmon would have relative ease to enter the river until about July 15, but the water was likely too low from July 15 – August 13. Rain on August 11-12 brought the river up, and water levels were intermediate for over a month at levels higher than most years. Water levels came up enough on September 21 that any salmon remaining in salt water likely entered the river. The logger was installed again in May 2024, but could not be retrieved by January 2025 despite three attempts in November-December.

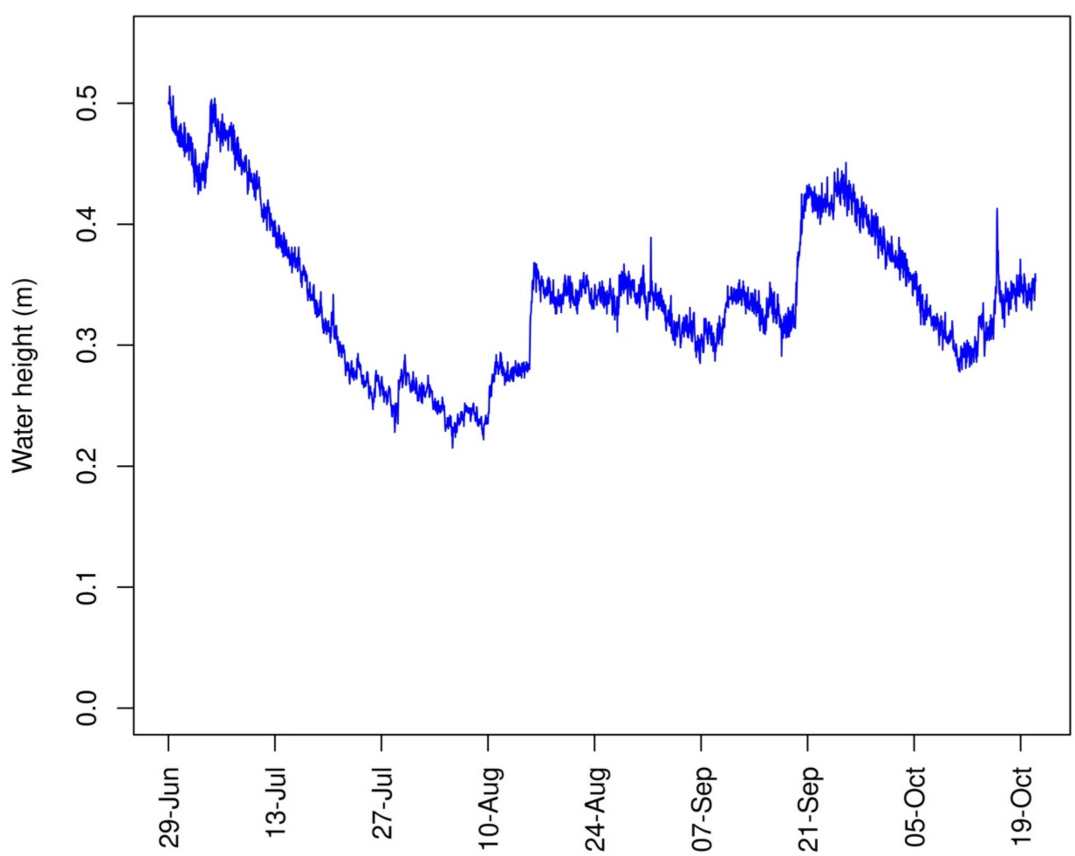


Figure 24. Water levels through time at site #1 (Figure 18).

Table 3. Summary temperatures (°C) in July and August for four sites at Charles Brook showing monthly mean, minimum (Min), and maximum (Max) for years that loggers were at each site. Site locations are in Figure 18.

| Site | Year | July | | | August | | |
|---|---|---|---|---|---|---|---|
| | | Mean | Min | Max | Mean | Min | Max |
| 4. Outflow of Upper Charles Pond | 2022 | 20.18 | 15.18 | 25.01 | 20.27 | 16.13 | 24.84 |
| | 2023 | 23.33 | 17.72 | 29.00 | 20.20 | 17.33 | 25.18 |
| | 2024 | 22.58 | 16.86 | 27.67 | 19.85 | 14.97 | 26.47 |
| 3. Inflow to Phillips Head Pond | 2023 | 23.00 | 17.12 | 30.58 | 19.62 | 15.36 | 27.32 |
| | 2024 | 21.95 | 13.94 | 29.98 | 19.62 | 11.24 | 28.70 |
| 2. Inflow to Mud Hole Pond | 2022 | 20.79 | 14.45 | 28.87 | 21.53 | 14.24 | 29.04 |
| | 2023 | 23.27 | 17.29 | 30.16 | 20.17 | 15.91 | 27.28 |
| | 2024 | 22.88 | 16.08 | 30.84 | 20.83 | 13.55 | 28.10 |
| 1. River mouth above high tide | 2022 | 20.90 | 15.53 | 27.84 | 21.70 | 15.91 | 27.88 |
| | 2023 | 23.42 | 17.97 | 27.88 | 20.15 | 17.50 | 25.74 |

Table 4. Percentage of days in July and August when the temperature (°C) went above a defined threshold for each site in Charles Brook (Figure 18).

| Month | Percentage of days above: | Outflow of Upper Charles Pond | | | Inflow to Phillips Head Pond | | | Inflow to Mud Hole Pond | | | River mouth above high tide | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2022 | 2023 | 2024 | 2022 | 2023 | 2024 | 2022 | 2023 | 2024 | 2022 | 2023 | 2024 |
| July | 20 | 81 | 97 | 100 | | 94 | 100 | 87 | 94 | 100 | 87 | 97 | |
| | 22 | 48 | 87 | 90 | | 84 | 94 | 81 | 84 | 94 | 81 | 87 | |
| | 24 | 13 | 65 | 68 | | 55 | 71 | 55 | 71 | 84 | 48 | 61 | |
| | 26 | - | 39 | 39 | | 52 | 52 | 29 | 45 | 48 | 19 | 39 | |
| | 28 | - | 10 | - | | 29 | 29 | 10 | 19 | 23 | - | 19 | |
| | 30 | - | - | - | | 13 | - | - | 3 | 3 | - | | |
| August | 20 | 84 | 87 | 83 | | 87 | 93 | 97 | 90 | 97 | 100 | 90 | |
| | 22 | 50 | 37 | 47 | | 47 | 73 | 90 | 53 | 80 | 90 | 40 | |
| | 24 | 17 | 10 | 10 | | 13 | 50 | 73 | 17 | 57 | 63 | 13 | |
| | 26 | - | - | 3 | | 7 | 13 | 50 | 7 | 23 | 30 | - | |
| | 28 | - | - | - | | - | 7 | 16 | - | 3 | - | | |

**Lake depths and likelihood of thermal refugia**

Lakes provide the opportunity for overwintering habitat for adult salmon that have survived spawning before they return to sea the following spring. Lakes also may function as summer thermal refugia, and thus allow salmon populations to persist when river temperatures get too high. However, this can only occur if lakes are deep enough to have a hypolimnion; most Newfoundland lakes are not. Thermoclines can only exist if the lake is deep enough, and the required depth is dependent on atmospheric temperature patterns, lake size, lake shape, and wind (Gillis et al. 2021). Newfoundland contains many tens of thousands of lakes, and the number and surface area of lakes within a given watershed can be readily extracted from topographical maps or GIS (geographic information systems). However, very few Newfoundland lakes have been mapped for depth.

The author acquired a Humminbird© sonar system (Helix 7 MSI GPS G3N) to survey lake bathymetry. Data was analyzed by Humminbird© Autochart Pro software to map lake depths. Detailed bathymetric maps can be created this way, but require very extensive surveying by boat. Parts of Phillips Head Pond (CB-P9) were surveyed in summer 2023, but the vast majority of the lakes in the watershed have no boat access. As an alternative, point source surveying was done in winter 2024. The sonar unit had an ice fishing mode which enabled sonar signals to be taken for lake depth at user determined intervals. On each lake, the sonar unit was placed in a sled that was towed behind a snowmobile. A lithium ion powered electric ice auger was used to cut holes in the lake, initially in a grid pattern and then fine-tuned once deeper water was found. Up to 150 holes were cut in each lake for this purpose (Figure 25), which required 6 days of work.

Maximum depths (m) of each lake are reported (Table 6, Figure 26), along with whether the lake is deep enough (and shaped in a way) to likely have a thermocline enabling summer refugia from warm water. Notably Charles Brook Pond (CB-P1, max 16m), Western Shackle Pond (B-P1, max 20m), Indian Cove Pond (CB-P7, max 16m in a small section), and Phillips Head Pond (CB-P9, max 34m) have salmon and are certainly deep enough to have cold water in summer. This may be the reason this salmon population can persist. There is no deep water, and small amounts of moderate depth water in the mainstem lakes that are upstream of Phillips Head Pond. Although Natty Ward Pond (B-P6, 21m) and 2$^{nd}$ Pond (Code CB-B-P1, 20m and contains dwarf Arctic char) are deep enough for a thermocline, salmon do not reach them.

Figure 25. Setup for surveying depths of lakes. Depending on lake surface area, up to 150 holes were drilled with a large electric auger in a grid pattern. A transducer mount was lowered through the hole and point source sonar data was taken. When relatively deep water was found, more holes were drilled to determine maximum depth in the area. Depths were calculated from Humminbird© Autochart Pro software. Images February 20/24.

Table 6: Bathymetric sampling of Charles Brook watershed lakes. Water levels were similar during all sampling. Extra depth was added to ice sampling as the transducer was lowered below ice level. * refers to no sonar data, but has information obtained from interviews.

| Local lake name | Lake code | Sampled season | Sonar max depth (feet) | Adjustment for ice (+feet) | Estimated max depth (m) | Note |
|---|---|---|---|---|---|---|
| Charles Brook Pond | CB-P1 | Ice | 50 | 2 | 16 | |
| Side Pond | A-P1 | * | | | ~2 | Based on personal experience |
| Banish Pond | A-P3 | * | | | ~3 | Based on personal experience |
| 2nd Pond | CB-B-P1 | Ice | 63 | 2 | 20 | Contains dwarf Arctic charr |
| Eastern Shackle Pond | CB-P5 | Ice | 16 | 2 | 5 | |
| Western Shackle Pond | B-P1 | Ice | 62 | 2 | 20 | |
| Natty Ward Pond | B-P6 | Ice | 67 | 2 | 21 | |
| Mountain Pond | B-BP1 | * | | | >7 | Based on interviews |
| Long Pond (by Indian Cove Pond) | CB-C-P1 | Ice | 19 | 2 | 6 | |
| Indian Cove Pond | CB-P7 | Ice | 52 | 2 | 16 | Two deep spots in separate basins |
| Fall Pond | CB-P8 | Ice | 5 | 2 | 2 | |
| Phillips Head Pond | CB-P9 | Boat | 111 | 0 | 34 | |
| Lower Weasel Pond | I-P1 | * | | | <6 | Based on interviews |
| Upper Weasel Pond | I-P2 | * | | | <6 | Based on interviews |
| Lower Charles Pond | CB-P12 | Boat | 22 | 0 | 7 | "Deep" spot is extremely small |
| Upper Charles Pond | CB-P13 | * | | | 3-5 | Based on personal experience |
| Big Pond | K-P1 | Ice | 25 | 2 | 8 | |
| Long Pond (above highway) | CB-P14 | Ice | 14 | 2 | 5 | North of the narrows (large basin) |
| Long Pond (above highway) | CB-P14 | Ice | 23 | 2 | 8 | South of the narrows (small basin) |
| Dawson Pond | L-P1 | Ice | 9 | 2 | 3 | "Deep" spot is extremely small |

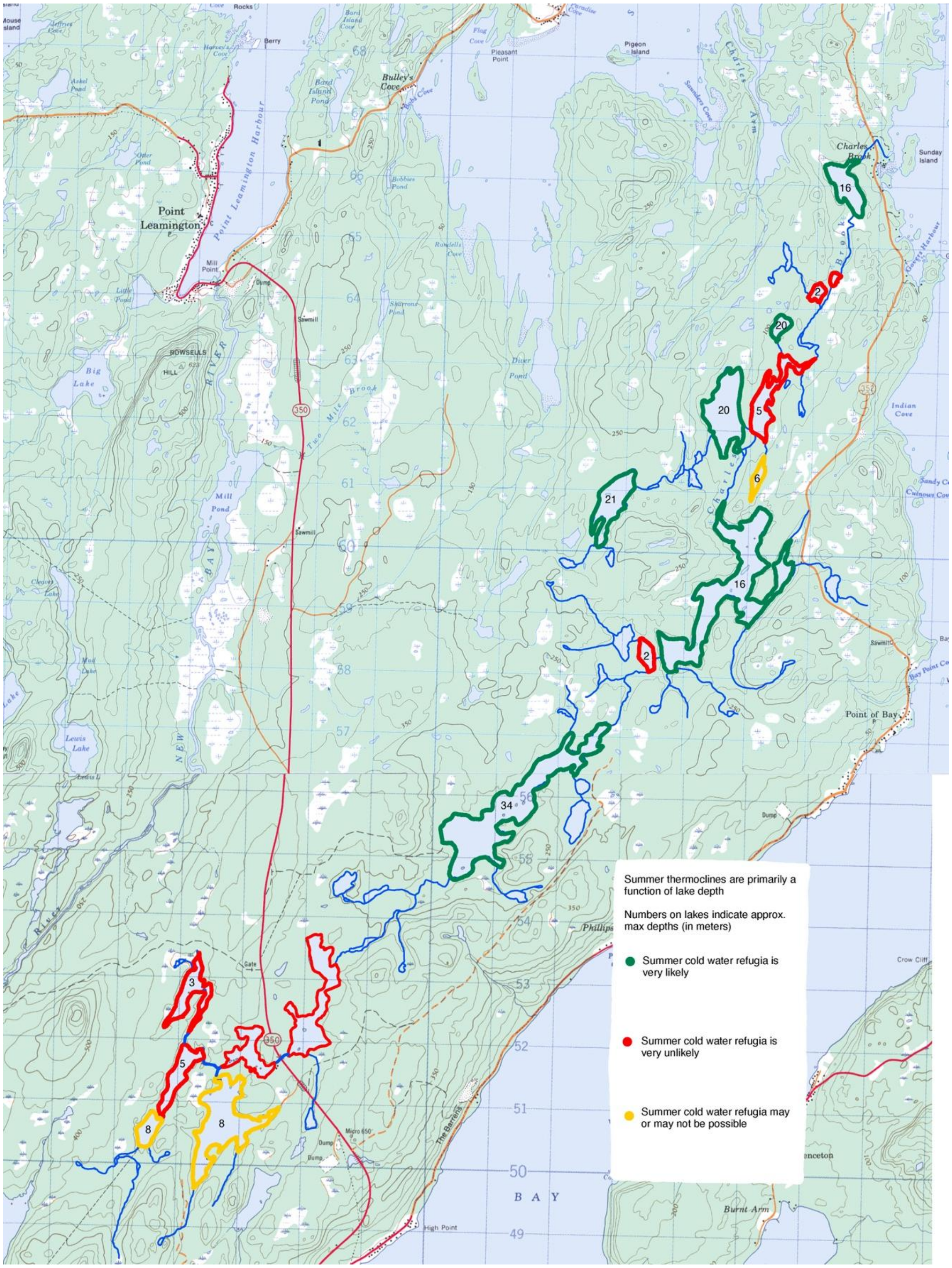


Figure 26. Charles Brook lake depths as determined by sonar or personal experience (Table 6). Numbers inserted into each lake are max depth in meters. The lake boundary colour indicates whether the author thinks a thermocline could exist that would enable a summer temperature refugia to salmonids. This includes lakes that do not contain any salmon.

## Salmon population

**Juvenile densities, sizes, and occurrences**

Sporadic electrofishing was completed in 2023 to locate juvenile salmon. Targeted effort occurred in September 2024 to estimate densities in two locations (Figure 27). A Smithroot LR-24 unit was used, with two dip netters. Substrate, and thus catchability of the electrofisher and dip net were similar between the two sites. Electrofisher settings were the same at each site, which were given similar effort (Table 7). In each site, barrier nets were placed upstream and downstream of the sampling location (Figure 28), and 5 passes were made with the electrofisher. Catch depletion was observed over the 5 passes, but some fish remained (large substrate made dip netting fry difficult). Raw density estimates are thus a bit conservative. Maximum likelihood estimates of fish density (Table 7) was calculated from catch depletion across the five electrofishing passes (Lockwood and Schneider 2000) and reported with a 95% confidence interval.

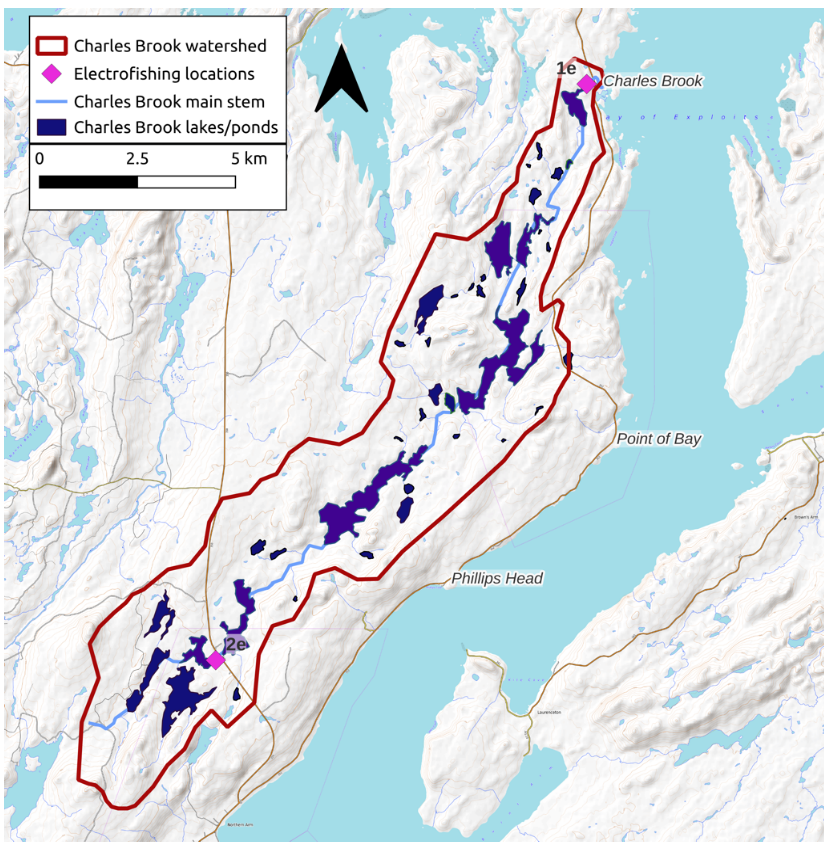


Figure 27. Electrofishing sites in the Charles Brook watershed in September 2024. Site 1e was just upstream of the highway near the river mouth, and site 2e was just upstream of the Point Leamington highway.

Figure 28a. Barrier nets used in electrofishing surveys in the lower site in Charles Brook. Image taken September 13/24.

Figure 28b. Juvenile salmon captured in Charles Brook by electrofishing September 13, 2024.

The fish community in both sites was dominated by salmon. Thirteen brook trout were captured in the upper site but none in the lower site, while two American eels were captured in the lower site, but none in the upper site. Most of the captured salmon were fry (Figure 29) with a modal size of ~ 50mm. Relatively more parr (older juveniles) were captured in the lower site. In the lower site only, 4 salmon were captured of intermediate size (68-77mm) between two histogram peaks. Three potential suggested explanations for this are: 1) they were either extremely large fry (2024 young of year, 0+); 2) they were typical (1+ parr) size parr from 2023 fry that were present in very small numbers and totally absent from the other site; or 3) they were extremely small 1+ parr (2023 fry) or 2+ parr (2022 fry) if either of those cohorts is the peak with the modal size of 95-100mm. Estimated juvenile salmon densities were 1.0 fish/$m^2$ in the upper site and 1.6 fish/$m^2$ in the lower site, Table 7.

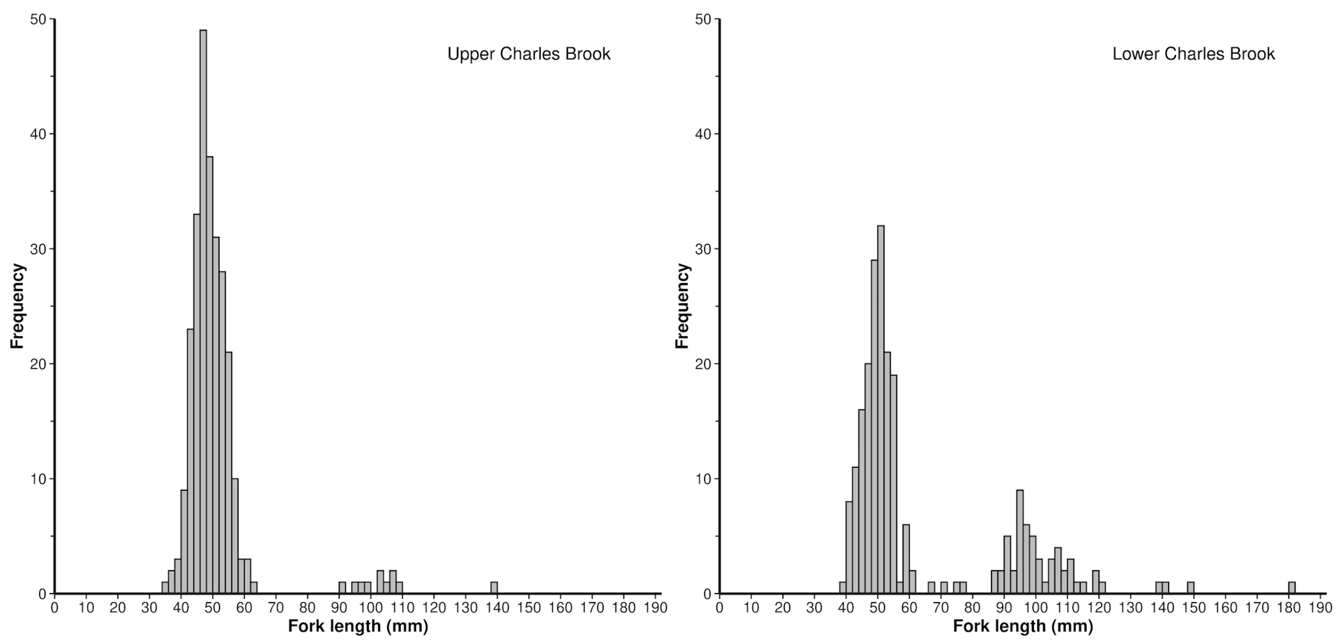


Figure 29. Histograms of juvenile Atlantic salmon fork lengths (mm) for the upper site (Figure 27- 2e) and lower site (Figure 27- 1e) based on electrofishing in September 2024.

Table 7. Results of electrofishing surveys for Atlantic salmon. Site locations are presented in Figure 27. Numbers of fish are for salmon only. Thirteen brook trout were captured in the upper site and two American eels in the lower site.

| **Site** | **Upper Charles Brook (2e)** | **Lower Charles Brook (1e)** |
|---|---|---|
| Date sampled | 9 September 2024 | 13 September 2024 |
| Length of section surveyed (m) | 65 | 37 |
| Average width of section (m) | 4.64 | 5.86 |
| Area surveyed ($m^2$) | 301 | 217 |
| Electrofishing passes | 5 | 5 |
| Electrofishing total time (sec) | 3760 | 3074 |
| Number of captured fish passes 1-5 | 96,72,50,22,26 | 64,46,55,36,26 |
| # YOY <62 mm captured | 255 | 166 |
| # 68-77 mm fish captured | - | 4 |
| # Parr >80 mm captured | 11 | 56 |
| Summed number of fish captured | 266 | 226 |
| Maximum likelihood estimated total number of fish in section | 308 (300 – 315, 95% CI) | 351 (283 – 419, 95% CI) |
| | | |
| CATCH PER UNIT EFFORT | | |
| Captured Fish/hr | 254.7 | 264.7 |
| Captured YOY <62 mm/hr | 244.1 | 194.4 |
| Captured Parr >80 mm/hr | 10.5 | 65.6 |
| | | |
| DENSITIES | | |
| Captured YOY <62 mm/$m^2$ | 0.846 | 0.766 |
| Captured Parr >80 mm/$m^2$ | 0.037 | 0.258 |
| Captured fish all sizes/$m^2$ | 0.883 | 1.043 |
| Estimated total section density/$m^2$ | 1.023 | 1.618 |

There are no lakes with ouananiche in the Charles Brook watershed. The known, and probable distribution of juvenile salmon stemming from anadromous adults is presented (Figure 30). This is based on the electrofishing surveys in 2023 and 2024, targeted angling in 2023, and interviews with local residents.

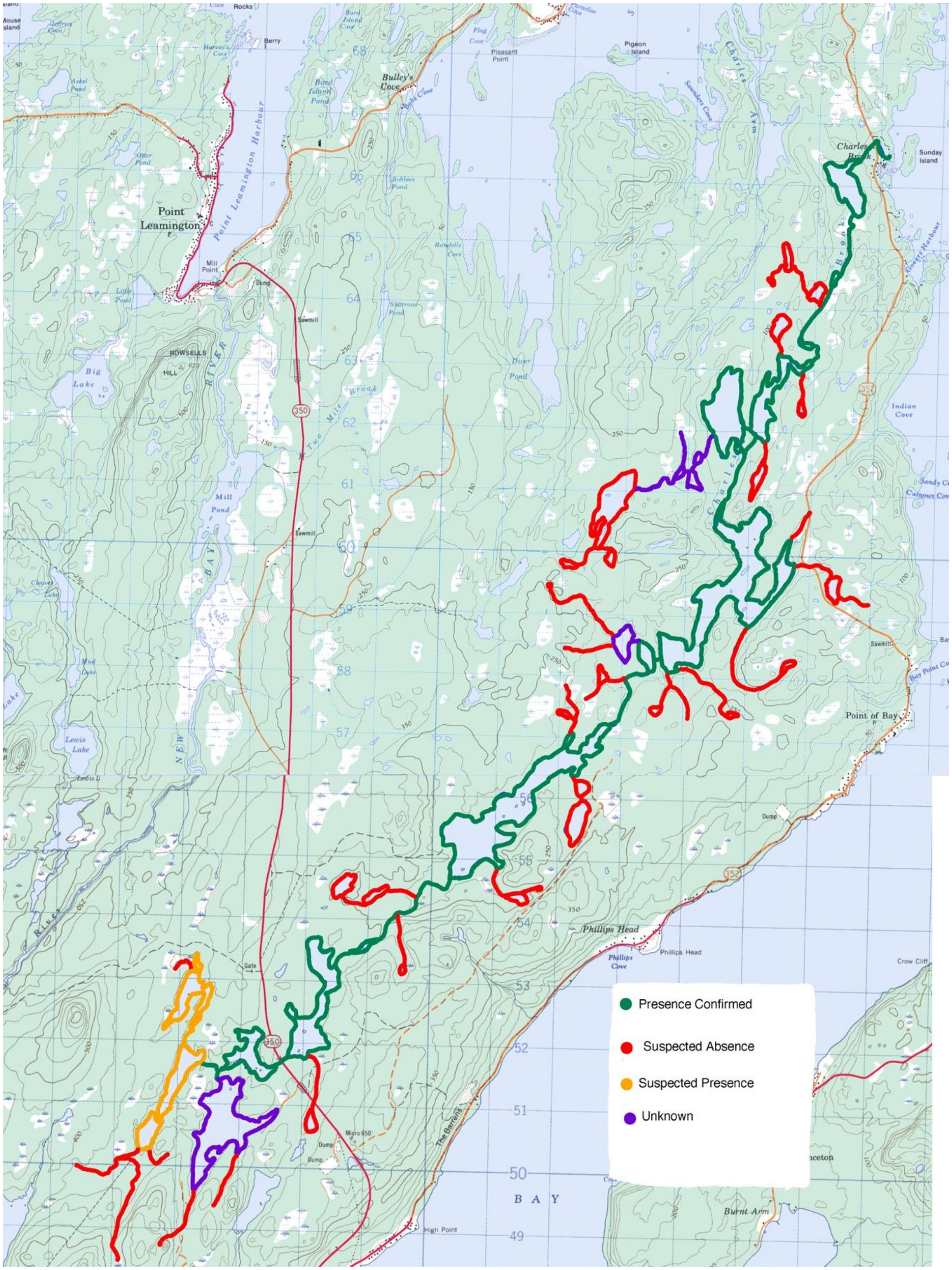


Figure 30. Confirmed and suspected salmon presence in the Charles Brook watershed. The majority of the occupied habitat are lakes.

**Genetics sampling**

How discrete or unique the salmon in Charles Brook are is unknown; no genetics work has ever been done there. The northeast coast of Newfoundland contains many small salmon rivers that comprise an obvious hole in the Fisheries & Oceans Canada (DFO) recent genetic assessments. DFO data were used to group rivers into COSEWIC Designatable Units for conservation status (Cosewic 2010), but this is based on samples from relatively few of the rivers in the area. Obtaining samples from this region for genetic analyses was identified as a top priority during DFO meetings that the author attended as an external expert. In August 2023, fin clips were taken from juvenile salmon that were captured by angling and electrofishing in Charles Brook (Figure 31). Tissues from ~60 fish were transferred to Fisheries & Oceans Canada in fall 2023 for future genetic profiling. As of January 2025, this analysis has not been initiated.

Figure 31. In 2023 parr were captured by angling and electrofishing for tissue samples (fin clip) for genetics research, and then released.

## Summary and insights

Anadromous salmon are present throughout the mainstem of Charles Brook. How many adult salmon return each year is unknown. The watershed is small and there is relatively little fluvial habitat, and thus the capacity to support many fish is limited. The habitat quality, however, is near a natural state. The author's family has had a property at the mouth of the river since ~ 1900. Salmon can be seen for months in the summer trying to enter the brook on high tide. The author guesses there are ~ 50-150 fish in a typical year. The author (b. 1974) and the author's father (b. 1947) believe there are more salmon in the watershed now than there have been in their memory. Three potential reasons for this are: 1) For the early part of the 20$^{th}$ century a community existed at the mouth of the brook and salmon would have been easy for people to catch for food when water levels were low. Present abundance may be a rebound from this historical exploitation. 2) Although poaching is a continuing problem, the author and others that he interviewed believe it to be less pronounced than it was in recent decades. 3) It is currently unknown whether the salmon of Charles Brook are a completely unique population, or whether they form a meta-population with other rivers in the Bay of Exploits. The largest salmon population on the island is in the Exploits River, and those salmon have to pass near Charles Brook on their spawning migrations. Strays from the Exploits might be supplementing Charles Brook and the degree may vary temporally. Due to enhancement activities, there are many more salmon in the Exploits River now than there were <1990, which could result in more fish in Charles Brook.

Due to low numbers of fish, the Charles Brook salmon population is particularly sensitive to acute problems. Some threats can be easily identified: (a) Poaching continues to be a problem. It is probable that there are at most a few dozen spawning females each year, and serious damage could occur in a short amount of time. Legal angling, but illegal retention of untagged fish is a recuring problem. (b) New predators are on the scene. The author never saw a single seal or cormorant in the area prior to 2000. Seals are now abundant at certain times of the year and may be a significant threat to smolts and kelts. In recent years, a large cormorant colony has been established on an island only 7.5km from the river mouth. These could consume a substantial proportion of smolt if they overlapped in time. (c) While strays from the Exploits River may be subsidizing Charles Brook, if it is a genetically unique population, hybridization may be a threat. This would have increased due to enhancement activities on the Exploits River. (d) Climate change threatens many salmon populations. Some obvious problems come from increased winter floods (which kill incubating embryos in gravel nests), low summer water levels, and high summer water temperatures. Information gathered for this report indicates that in all three summers (2022-2024) July and August fluvial temperatures were extreme. The author believes that if it were not for the abundant lakes in the watershed, the population would have already been nearly extirpated. The lakes that are deep enough to support a thermal refugia might be considered critical habitat, and thus should be protected from disturbance. (e) Legal recreational angling is limited on Charles Brook but does exist. Current regulations allow the retention of caught salmon. Given the small size of the population this may not be wise, and a catch-and-release only designation should be considered. However, the net impact of such a management change is hard to predict, as individuals who enjoy legally fishing may deter some poaching.

It is critical to compare the genetic profile of Charles Brook salmon to other nearby rivers. How similar they are to other rivers in the Bay of Exploits (Exploits River, Rattling Brook, Peter's River, Northern Arm Brook) and nearby areas (Campbellton River, Point Leamington River, Western Arm River, Northwest Arm Brook), and thus whether they are unique populations or part of a larger meta-population, greatly influences how prone they are to certain threats. For example, whether strays from the Exploits from hypothetical future hatchery supplementations are a problem or not. Adjacent rivers should be sampled to enable these comparisons.

## Key recommendations

1. Complete the genetics work.
    a. Determine how unique the Charles Brook population is.
        i. Whether other small rivers nearby are also unique.
        ii. Whether they are heavily subsidized by strays from the Exploits River.
    b. The sample of tissue from 60 fish is enough to get a genetic estimate of effective population size for Charles Brook.
2. Determine where salmon spawn. This can be done with radio telemetry tagging. Fish could be fyke netted at the outflow of Charles Brook Pond during upstream migration, and helicopter surveyed in mid/late October.
3. Deter mortality on adult salmon that have entered the river to spawn.
    a. Find ways to reduce poaching.
    b. Consider management alterations to change recreational salmon fishing to catch-and-release only.
4. Closely monitor predation on smolts in the tiny estuary.
    - The newly formed nearby cormorant colony is a significant threat to this small salmon population if the birds learn when to be there.
5. Determine juvenile densities in more sites and monitor the same places through time to detect any changes in abundance.
6. Prevent development on the deep lakes as they are likely critical habitat for this population.
7. Monitor changes to access, sediment and extreme fooding if the planned industrial wind turbines are installed.
8. There is virtually no gravel indicative of good spawning habitat in the upstream portion of the watershed. It would be relatively easy to add gravel between Upper Charles Pond and Lower Charles Pond.

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*Cover photo: Inflow to Upper Charles Pond from Long Pond in August 2023. Packrafts were used to transport electrofishing equipment to the site, which confirmed the presence of juvenile salmon.*

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