
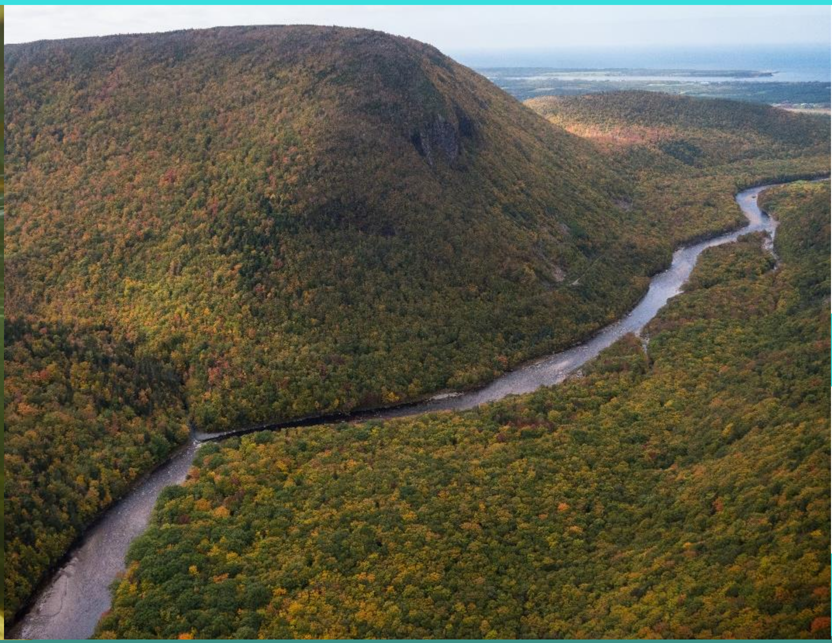

# Atlantic salmon conservation plan for the Cheticamp River

*A resource to guide planning and management decision-making*


**Cheticamp River Salmon Association**
**In collaboration with Cape Breton Highlands National Park**


**2021**

*Atlantic salmon conservation plan for the Cheticamp River,* prepared by the Cheticamp River Salmon Association, 2021.

Cover images courtesy of Jimmie Pedersen (left) and Vision Air Services Inc. Tim L'Esperance (right)

Cape Breton Highlands National Park has made significant contributions to the preparation of this document, with other contributions and input from multiple partners.

The development of this plan, including much of the data collection and other fieldwork that were important parts of the development process, was made possible thanks to the support and generous funding contributions from the following partners:

Atlantic Salmon Conservation Foundation
Nova Scotia Salmon Association's Adopt-a-Stream Program
Atlantic Canada Opportunities Agency
Sage Environmental Program

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# Executive summary

The Cheticamp River Salmon Association (CRSA) is a non-profit organization with 40 years of experience undertaking outreach, restoration, and conservation activities in the Cheticamp River watershed. While the CRSA was the driving force behind recent restoration work on the Cheticamp River and is collaborating with Parks Canada on a water temperature study focused on the Cheticamp River, the development of this conservation plan is the result of the CRSA and Parks Canada's conviction that strategic planning focused on managing Atlantic salmon and other cold-water species in a changing climate will help protect the Cheticamp River's Atlantic salmon population.

This conservation plan sets out to do this by including historical data and summaries of past restoration and conservation activities, summaries of recent water quality monitoring and efforts to inventory habitat, identification of limiting factors and sites of concern, and recommendations for restoration, maintenance, and enhancement opportunities, as well as ongoing and future research needs.

The CRSA's concerns about the Cheticamp River's population of Atlantic salmon are shared by Cape Breton Highlands National Park (CBHNP). As managers of the Cheticamp River (the river is located on the southwestern edge of Cape Breton Highlands National Park), Parks Canada has worked closely with the CRSA throughout the plan development process – from early planning, to data collection and analysis, consultation with other stakeholders, and identification of recommended conservation measures/actions. The collaborative nature of this process is undoubtedly one of its strengths.

Parks Canada developed an interim management plan for Atlantic salmon in CBHNP in the late 1980's, at which time the authors described the management of Atlantic salmon as "the single greatest resource management concern in Cape Breton Highlands National Park" (Petersen et al., 1987, pg. iv). v). In 1996, CBHNP followed up with the Cape Breton Highlands National Park Atlantic salmon management plan covering the Cheticamp River and five other watersheds within the Park. While this plan was and is an important guide, climate change and the passage of almost 25 years has undoubtedly brought significant changes to the watershed, and a follow-up to the Parks' earlier management plan is timely.

This conservation plan sets out to fill this information gap. While Parks Canada is not obligated to follow any recommendations included in this plan, CBHNP recognizes this initiative as a valuable piece of stakeholder input intended to help guide their management planning for the Cheticamp River.

It also seems appropriate that the development of this conservation plan was initiated in 2019, the focal year of the International Year of the Salmon - a five-year initiative seeking to raise public awareness, encourage stakeholder collaborations, stimulate new science and research projects, and inspire action to protect salmon.

The International Year of the Salmon (IYS) is an initiative of the North Atlantic Salmon Conservation Organization and the North Pacific Anadromous Fish Commission. and While 2019 is the focal year of the IYS, the intention is that outreach and research related to the IYS will continue through to 2022.

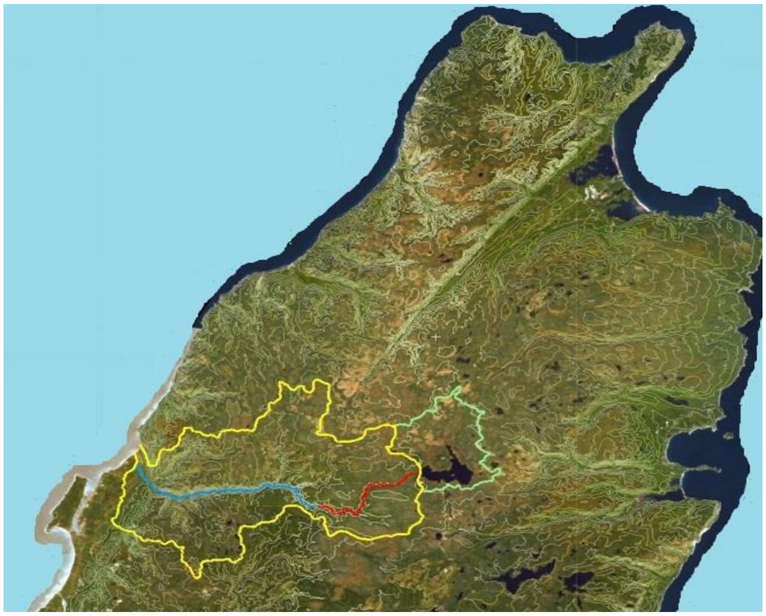
# An introduction to the Cheticamp River

The Cheticamp River is an important Atlantic salmon watercourse, supporting the most northern population of Atlantic salmon in Nova Scotia bordering the Gulf of St. Lawrence. The Cheticamp River is also the second largest salmon river in Cape Breton and has one of only a few remaining spring salmon runs left in Nova Scotia.

The Cheticamp River is located on Cape Breton Island, almost entirely within the boundaries of Cape Breton Highlands National Park. Originating in the northern plateaus of the Cape Breton highlands at an altitude of 460 meters above sea level, the Cheticamp River flows in a generally westerly direction through steep river canyons, picturesque pools, and a variety of mixed forest habitat before eventually emptying into the Gulf of St. Lawrence. The total distance of the watercourse is roughly 33 kilometers, and the drainage area of the Cheticamp River is 272km$^2$.

**Aerial view of some of the rapids and deep pools created as the Cheticamp River makes its way through the upper river canyons. Photo credit: Vision Air Services Inc. Tim L'Esperance.**

A barrier falls is located 20.5 kilometers from the mouth of the river, making over a third of the Cheticamp River inaccessible to Atlantic salmon and other migrating fish. The Cheticamp River also has a number of significant tributaries (Table 1), as well as numerous smaller tributaries along its length. Most of the tributaries have their own barrier falls in their lower reaches, limiting their habitat potential for Atlantic salmon. Exceptions include the tributaries of Roberts Brook and Aucoin's Brook. Roberts Brook is located within the Park boundaries, but little information is available on access for salmonids. Aucoin's Brook, a relatively healthy watercourse located entirely outside the Park, as approximately eight kilometers of the brook accessible to salmonids.



**Map showing watershed boundaries for the Cheticamp River (secondary watershed). The green boundary shows the watershed area diverted for the Wreck Cove hydroelectric project. The portion of the river coloured in red indicates where there is no fish passage above the barrier falls. Image credit: James Bridgland, CBHNP.**

| Name of tributary | Distance from mouth (km) |
|---|---|
| Cranberry Tributary | 29.68 |
| Artemise Brook | 24.8 |
| Bakeapple Tributary | 17.2 |
| Big NE Tributary | 14.84 |
| Faribault Brook | 6.15 |
| Robert's Brook | 3.42 |
| Aucoin Brook | 2.0 |

**Table of significant tributaries of the Cheticamp River and their distance from the mouth. Photo left of some of the falls on Faribault Brook.**

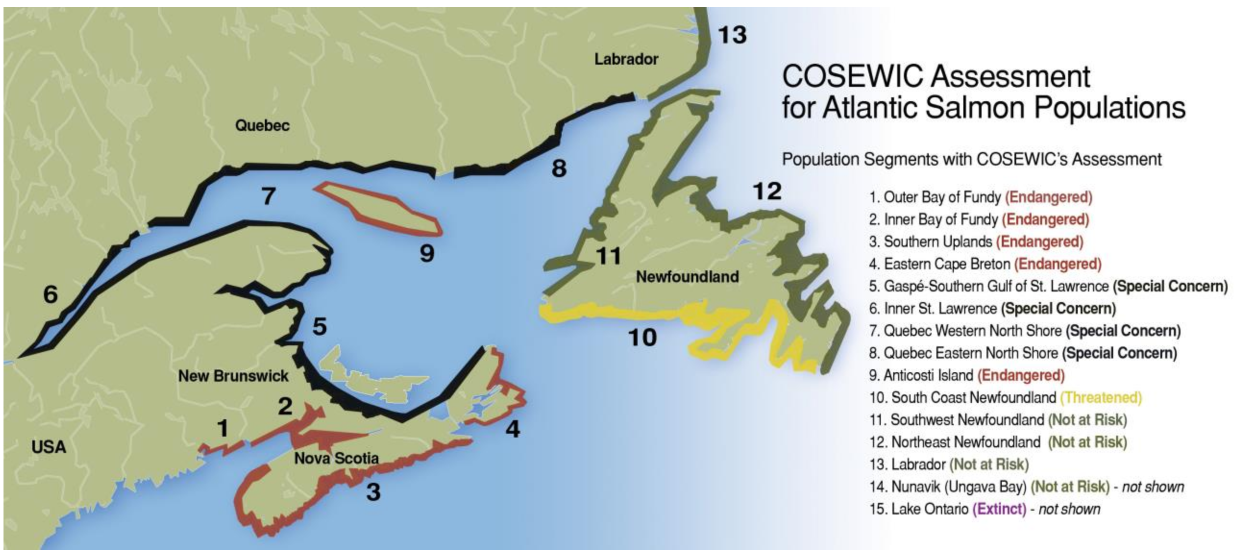
The Cheticamp River originates in the plateaus and runs through the Cheticamp Lake. In 1978, however, Nova Scotia Power (NSP) completed the constructed a dam along the western boundary of Cheticamp Lake as part of the Wreck Cove Hydroelectric Project. With the construction of the dam, the upper reaches of the Cheticamp River were diverted to provide water for the hydroelectric project and Cheticamp Lake has subsequently been referred to as the Cheticamp Flowage (or reservoir). Of the 272km$^2$ of the Cheticamp River watershed, an area of 49km$^2$ (~18% of the watershed) was diverted in 1978 for use as part of the Wreck Cove Hydroelectric Project. Some modification of water levels in the Cheticamp River has occurred as a result of this development, however, an agreement exists between Nova Scotia Power, Parks Canada, and Environment Canada to ensure that NSP maintains a minimum flow of 43ft$^3$/s (1.22m$^3$/s) during the summer months at Artemise Brook above the barrier falls.

**Aerial view of the dam on the western boundary of the Cheticamp reservoir, with a closer view of the outlet for the Cheticamp River (inset). Image credit: Vision Air Services Inc. Tim L'Esperance**

# Status of Atlantic salmon on the Cheticamp

While Atlantic salmon have been in decline in recent decades across the Maritimes, the population on the Cheticamp River appears to remain relatively healthy. Yet, the salmon on the Cheticamp are part of the Gaspé-southern Gulf of St. Lawrence population segment of Atlantic salmon, a population that was designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSWEIC) in 2010.

The Gaspé-southern Gulf of St. Lawrence population segment extends from just east of Rivière Ouelle near Gaspé to include all southern Gulf of St. Lawrence rivers continuing up to the northern tip of Cape Breton Island. Other significant salmon rivers in this segment include the Margaree River in Nova Scotia and the Miramichi in New Brunswick. According to COSWEIC's 2010 Assessment summary, the Gaspé-southern Gulf of St. Lawrence population has been in decline since at least the 1980s, with a net decline over the last three generations of approximately 28% of all mature individuals.




**Map showing Atlantic salmon population segments and COSWEIC 2010 designations. Image credit: Atlantic Salmon Federation.**

**Calculation of the conservation requirement in terms of eggs and large salmon equivalents for the Cheticamp River (Table adapted from Landry et al., 2005)**

| | Estimate | Reference |
|---|---|---|
| Habitat area for salmon ($m^2$) | 318915 | Boates et al., 1985 |
| Conservation egg deposition rate ($eggs/m^2$) | 2.4 | Anon. 1991a,b |
| Conservation egg requirement (eggs) | 765396 | |
| Fecundity (eggs/kg) | 1764 | Elson 1995 |
| Average weight (kg) | 4.02 | Petersen et al., 1987 |
| Annual min-max | 3.6-4.4 | |
| Proportion female | 0.65 | Petersen et al., 1987 |
| Annual min-max | 0.55-0.81 | |
| Conservation requirement | 166 | |
| Large salmon, min-max | 122-222 | |

# Population assessments & monitoring

Accurate estimates of adult salmon populations are an essential to effective management and conservation of Atlantic salmon. Aware of the importance of population assessments, CBHNP has used a variety of methods to attempt to estimate salmon populations on the Cheticamp River over the park's history, including counting fences, mark and recapture studies, and electrofishing. Although swim through surveys are conducted on the Clyburn River in CBHNP, swim through monitoring has not been an important part of monitoring on the Cheticamp due to challenges posed by the discolouration of the water, size of the river, and difficulty accessing salmon habitat above 3rd Pool (Petersen et al., 1987). The CRSA, having always had a keen interest in better understanding the population of Atlantic salmon on the Cheticamp River, has contributed to a number of these Parks-led population monitoring activities over the last thirty-five years. Yet, despite COSWEIC's special concern designation and widespread evidence of diminishing stocks throughout their range, efforts to estimate the population size have been somewhat sporadic on the Cheticamp River. For CBHNP, budget cutbacks and generally limited resources have made regular monitoring challenging. The result has been periods of as long as 14 years with no accurate estimates of the population size of salmon on the Cheticamp River.

## Summary of population monitoring activities

The following is a summary of past attempts to estimate returning Atlantic salmon populations on the Cheticamp River.

**Mark recapture**

CBHNP initiated a mark recapture experiment to estimate adult population of Atlantic salmon on the Cheticamp River in 2004. A trapnet was installed below the turn at Terre Rouge, near the head of the tide, approximately 1.6 kilometers from the mouth of the river. The trapnet covered about a third of the pool and was in place between July 26 and November 1st, during which time it was fished at least once a day. All catches were identified, recorded, and measured for length before being released. In addition, all adult Atlantic salmon caught were sexed, had scale samples taken, and were tagged with individually numbered tags before being released. A total of 62 salmon (41 large/MSW, 21 grilse/small) were caught in the trapnet.

**One of the large male salmon tagged as part of the mark recapture experiment on the Cheticamp River.**

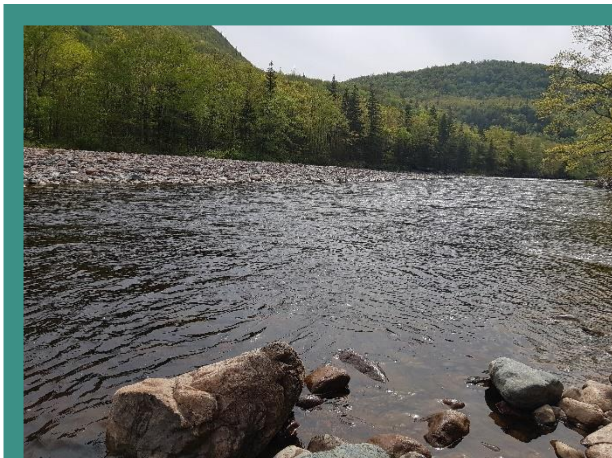
The recapture data was collected from angler creel forms that CBHNP distributed to all anglers throughout the recreational fishing season on the Cheticamp River (May to October). Anglers were requested to record fishing effort (hours fished), fishing locations, catch numbers (broken down to small and large salmon), and to make note of any tagged fish (also recording tag numbers if possible). 23 of the 83 anglers who purchased licenses returned creel forms at the end of the fishing season. While the fishing effort and catch data were incomplete on some of the forms, the total reported fishing effort from the 23 forms was 209 rod das, and 100 Atlantic salmon were reported to be caught (47 MSW, 23 grilse, and 30 unspecified size).

Based on the mark recapture data, CBHNP was able to estimate exploitation rates and total returns of Atlantic salmon in 2004. The estimated total return of salmon was 409, with 66% of the population (or 270 fish) estimated to be returning large salmon (95% confidence interval – 227 to 1270 fish). The estimated returns based on the mark recapture experiment suggests that the conservation requirement was exceeded in 2004.

The mark recapture program was continued in 2005 and 2006, with similar results. In 2006, a total of 55 salmon were caught (34 MSW, 17 grilse). Based on the results of the recapture effort, CBHNP estimated a total return of 947 salmon in 2006, with 645 MSW. Again, the estimates in 2006 suggested that the conservation requirement was exceeded.

**Counting fence**

The CRSA was contracted by CBHNP to operate a counting fence between 1984 and 1989. The fence was installed 3.75 kilometers above the head of tide and remained in the river from May to October. The design was an inverted 'V' spanning the width of the river, with a box in the middle that fish were counted in. Once in the box, the species were determined, and approximate size was estimated using a scale along the bottom of the box. This setup allowed the fence to be operated without the fish being handled. The fence was prone to damage during high water events, and suffered washouts on several occasions, resulting in incomplete data for several years.



Fence Pool (pictured above) was created as a result of the installation of the counting fence in the 80's – hence its name. There was no pool at the location prior to the use of the counting fence.

The yearly total counts for large salmon ranged from 164 (1985) to 497 (1986), and total counts for small salmon ranged from 26 (1985) to 64 (1986). Assuming all large salmon counted survived to reproduce, CBHNP staff determined that the conservation limit for the Cheticamp River was met or exceeded every year between 1984 and 1989.

**Electrofishing**

Cape Breton Highlands National Park conducted a juvenile Atlantic salmon monitoring program as far back as at least the 1980s and continues to use electrofishing to collect data on juvenile salmonids on the

Cheticamp River. In the ’80s, CBHNP used its juvenile monitoring program to estimate population sizes and survivorship of different age classes, using fork length measurements to separate small and large parr. A report from CBHNP’s 1985 and 1986 studies identified areas for improvement in order to improve future juvenile monitoring. Specifically, the author identified a need for both improved data collection and approach to analysis and suggested taking scale samples from deceased parr to help with age determinations (Petersen 1987).

Juvenile monitoring efforts in recent years have been more limited. While the species of the catch are recorded as well as weights and fork length measurements, insufficient data is often collected to make population and survivorship estimates with any confidence. The continued monitoring does provide records of presence/absence of different species, however, as well as some indication of relative abundance of different species. The 2019 catches, for example, included a single brook trout parr, compared to 30 Atlantic salmon parr and eight brown trout parr. This is a significant change from early juvenile monitoring, as brown trout were historically uncommon on the Cheticamp River.

**Parks staff collecting data on juvenile salmonids caught electrofishing on the Cheticamp River in 2019.**

**Creel census**

Creel census monitoring is possible on the Cheticamp River as it is the only river in CBHNP where the salmon run overlaps with the angling season. Used in the past on the Cheticamp River, creel forms provided by CBHNP to all anglers who purchased fishing licences for the Cheticamp River provided an additional source of data on Atlantic salmon populations. While data on total catches was obtained from as early as 1925, catch data from 1976 onward was more complete as it included data on sex, weight and length of fish caught, as well as estimates of angling pressure.

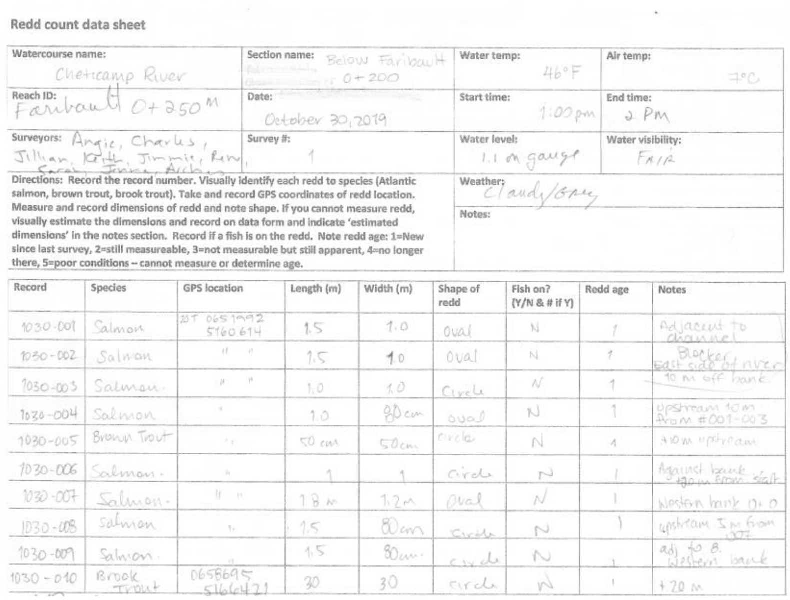
CBHNP continued to conduct an annual creel census up until angling for Atlantic salmon on the Cheticamp River was changed from allowing retention of grilse to full catch and release. Juvenile monitoring in combination with creel census data – while creel forms were in use – were thought to provide sufficient data to on adult salmon run size and spawning success to monitor long-term adult salmon population changes (Petersen et. al, 1987). And monitoring of adult salmon populations on the Cheticamp River may be possible using creel census data as CBHNP staff found during their studies in the 1980s that for MSW salmon, there was a strong correlation between salmon run size and fish caught and released by anglers.

## Exploring the potential of redd counts

Charles MacInnis (Consultant & former DFO Habitat Coordinator), far right, pointing out a large salmon redd as part of a training session held in 2019 on the Cheticamp River.

Counting redds is another way to estimate adult salmon populations and it can be a particularly useful monitoring tool on watercourses that lack counting facilities. There is a long history of using redd counts elsewhere to monitor salmonid abundance and evaluate population trends (add sources), and the CRSA started actively working in 2017 to include redd counts as part of monitoring activities on the Cheticamp River. Among the reasons that the CRSA has been interested in conducting redd counts is their potential to be a less expensive and less intrusive alternative to other methods of estimating populations, including mark recapture programs, counting fences, and using underwater observation. Additionally, conducting redd counts provides information on spatial and temporal spawning distributions, and can help identify spawning habitat that is being underutilized – information that can be used as part of efforts to identify opportunities for restoring and/or improving spawning habitat.

The CRSA organized a redd count training session in the fall of 2019 with the goal of training staff, partners, and volunteers in a protocol for conducting effective redd counts. The CRSA's hope is that a pilot study can be conducted to evaluate the effectiveness of using redd counts on the Cheticamp River before considering a larger-scale and long-term monitoring program involving salmon counts. Prior to this session, CRSA prepared a redd count data sheet (see Appendix B), modelled closely on the sample provided in *The Salmonid Field Protocol Handbook - Techniques For Assessing Status and Trends in Salmon and Trout Populations*.



Redd count data sheet

| | | | |
|---|---|---|---|
| Watercourse name: Cheticamp River | Section name: Below Faribault 0+200 | Water temp: 46°F | Air temp: 7°C |
| Reach ID: Faribault 0+250 M | Date: October 30, 2019 | Start time: 1:00 pm | End time: 2 PM |
| Surveyors: Angie, Charles, Jillian, Keith, Jimmie, Ken, Sarah, Jenna, Archie | Survey #: 1 | Water level: 1.1 on gauge | Water visibility: Fair |

Directions: Record the record number. Visually identify each redd to species (Atlantic salmon, brown trout, brook trout). Take and record GPS coordinates of redd location. Measure and record dimensions of redd and note shape. If you cannot measure redd, visually estimate the dimensions and record on data form and indicate 'estimated dimensions' in the notes section. Record if a fish is on the redd. Note redd age: 1=New since last survey, 2=still measureable, 3=not measurable but still apparent, 4=no longer there, 5=poor conditions – cannot measure or determine age.

Weather: Cloudy/Grey

Notes:

| Record | Species | GPS location | Length (m) | Width (m) | Shape of redd | Fish on? (Y/N & # if Y) | Redd age | Notes |
|---|---|---|---|---|---|---|---|---|
| 1030-001 | Salmon | 20T 0651992 5160614 | 1.5 | 1.0 | Oval | N | 1 | Adjacent to channel |
| 1030-002 | Salmon | " " | 1.5 | 1.0 | Oval | N | 1 | Blocker East side of river |
| 1030-003 | Salmon | " " | 1.0 | 1.0 | Circle | N | 1 | 10 m off bank |
| 1030-004 | Salmon | " | 1.0 | 80 cm | Oval | N | 1 | upstream 10 m from #001-003 |
| 1030-005 | Brown Trout | " | 50 cm | 50 cm | Circle | N | 1 | +10 m upstream |
| 1030-006 | Salmon | " | 1 | 1 | Circle | N | 1 | Against bank +30 m from start |
| 1030-007 | Salmon | " " | 1.8 m | 1.2 m | Oval | N | 1 | Western bank 0+0 |
| 1030-008 | Salmon | " | 1.5 | 80 cm | Circle | N | 1 | upstream 3 m from 007 |
| 1030-009 | Salmon | " | 1.5 | 80 cm | Circle | N | 1 | adj to 8 Western bank |
| 1030-010 | Brook Trout | 0658695 5166421 | 30 | 30 | Circle | N | 1 | +20 m |

Sample of completed redd count data sheet from the Cheticamp River, including georeferenced locations, measurements and age of redds, and species information.


**Map showing locations of redds identified on October 30th, 2019 redd count training session. The area surveyed was a 1km reach above and below Faribault brook.**

## RECOMMENDATIONS MOVING FORWARD:

1. ***Re-evaluate current electrofishing program and consider ways to improve, including ensuring standardized methods of application (e.g., using catch-per-unit-effort CPUE or closed-site depletion) between watercourses within CBHNP, and possibly adopting the same methods/protocols as other organizations and agencies (e.g., DFO) to allow for comparisons. Ensure objectives of the monitoring program are defined (e.g., estimate juvenile abundance of Atlantic salmon, acquire presence/absence data and relative abundance for Atlantic salmon and other native and non-native species, help evaluate the effectiveness of restoration activities, etc.). Note, as well, in some cases, electrofishing locations may need to be adjusted as a result of changes in the river.***

2. ***Add redd counts to annual monitoring efforts on the Cheticamp River, recognizing that conditions (e.g., timing of high-water events) are likely to result in some years with incomplete or missing data. Ensure clear objectives are established (e.g., determining locations of spawning activity, relative abundance of spawning in different reaches, evaluating effectiveness of restoration activities) and protocols followed.***

3. ***Carefully evaluate the benefits and costs of including additional methods of population monitoring, especially labour-intensive methods like operating counting fences and smolt wheels. Ensure that lessons from previous experiences operating counting fences (both on the Cheticamp River and comparable watercourses) are factored into decision-making, including challenges resulting from high-water events.***

# Salmon fishing on the Cheticamp

The Cheticamp River has a long history of sport fishing for Atlantic salmon and other salmonids. People were catching salmon on the river long before the resource was managed and have continued fishing for salmon despite a series of management changes to the sport fishery over the years following the creation of Cape Breton Highlands National Park.

| | |
|---|---|
| **1983** | Regulations were changed allowing only grilse to be retained and restricting the adult salmon fishery to catch and release only. |
| **1984** | Anglers were permitted to keep one grilse per day, up to a maximum of five fish during the season. |
| **1985** | Commercial fishery for Atlantic salmon was suspended in the Maritime provinces by the Department of Fisheries and Oceans |
| **1987** | Separate salmon licensing system was introduced in CBHNP. Anglers were required to purchase a separate license to fish for Atlantic salmon within the National Park, in addition to the general national park fishing permit |
| **1988** | The Cheticamp becomes a live release river – all angling for salmon is now catch and release |
| **2012** | First time Cheticamp River was closed for angling due to low water conditions |

Recreational sport fishing for Atlantic salmon continues to be a popular activity on the Cheticamp River, enjoyed by locals and visitors to Cape Breton. CBHNP permits recreational fishing on the scheduled waters of the Cheticamp River, with angling restricted to fly fishing using artificial flies. Salmon angling is permitted upstream of and including Terre Rouge pool to 3rd Pool from May 18th – September 30th, and from the lower end of Terre Rouge up to and including Fence Pool (including tributaries), salmon angling is permitted from May 18th to October 31st. In addition to the seasonal closures for the Cheticamp River, daily closures during the permitted season also occur from one hour after sunset to one hour before sunrise on the following day.

## Temporary closures

Options for different levels of closures are discussed in Cape Breton Highland National Park's Atlantic Salmon Management Plan for the Cheticamp River. These range from total watershed closures, to seasonal and daily closures, and finally temporary closures. At the time, CBHNP did not recommend total closures of the Cheticamp River to angling (or specifically salmon angling) or changes to existing seasonal and daily closures for the Cheticamp.

There is a need, however, for clear and formal criteria for enacting temporary closures and subsequent reopening of the Cheticamp River. These are necessary as management decisions must be made quickly and efficiently in order to reduce stress and mortality of Atlantic salmon during periods of elevated water temperatures and/or low water. In 2012, CBHNP made the decision temporarily close the Cheticamp River as a result of low water in 2012. Fisheries and Oceans have also reported that elsewhere in eastern Canada there has been an increased frequency of temporary recreational Atlantic salmon fishery closures in response to environmentally stressful conditions occurring more frequently (DFO 2012).

The recommendations made in CBHNP's most recent (1996) management plan for Atlantic salmon were for temporary closures to only be considered in extreme cases involving low water. Specifically, recommendations were for the Cheticamp River to be closed to angling if the Robert's Brook station recorded a discharge of 1.65 $m^3/s$ or lower and the water temperature reached or exceeded 18°C. If a closure is made, CBHNP's recommendation for reopening as outlined in their 1996 management plan is to wait until discharge has reached 1.80 $m^3/s$ and then delay reopening a further 36 hours after the water level meets the minimum level.

For the nearby Margaree River, new protocols were established in 2019 for in-season management measures during environmentally stressful conditions. For the Margaree River system, water temperature has been identified as the main parameter to monitor, and the one that can trigger further consideration of additional secondary parameters (water level, air temperature, long-term forecast and fish behaviour). When minimum water temperatures exceed 20°C for two consecutive periods of 24 hours, DFO will begin to implement angling restrictions. The level of temporary closure increases as temperatures and secondary parameters exceed additional thresholds.

While protocols for temporary closures due to low and warm water were established in CBHNP's 1996 Atlantic salmon management plan, they have not been used.

## RECOMMENDATIONS MOVING FORWARD:

1. ***Update guidelines for temporary closures on the Cheticamp River and ensure that, once finalized, guidelines are communicated to anglers and the public and are closely followed.***

2. ***Consider developing and implementing a system to direct anglers who purchase licenses to fish in Cape Breton Highlands National Park to an online creel survey to be completed to greatly assist with gathering data on salmonid populations.***

3. ***Ensure that angling restrictions are clearly communicated to anglers wishing to fish on the Cheticamp River and that CBHNP staff are aware of rules, including restrictions on gear, seasons, and locations where angling is, and is not, permitted.***

# Interactions with other salmonids

Through their various life stages, Atlantic salmon are preyed on by, and compete with, other species for ecological resources. These interactions include the threat of Atlantic salmon eggs and juveniles being consumed by other salmonids, including brook trout and brown trout, as well as Atlantic salmon juveniles and smolt being preyed on by striped bass and other predators in the estuarine environment.

Brown trout, a non-native species to Nova Scotia, has been established in the Cheticamp River for over a decade. There is also recent anecdotal evidence as well as some data from electrofishing surveys that suggests the native brook trout populations are in decline, and brown trout have become the more abundant species of trout on the Cheticamp River. Given that brown trout can better tolerate warmer water temperatures than brook trout, there is reason to expect that brook trout will continue to be outcompeted by brown trout with the projections of warming trends associated with climate change.

**CRSA President Rene Aucoin with a large brown trout landed on the Cheticamp River in 2021.**

Rainbow trout, another non-native species in Nova Scotia, are seen in small numbers on the Cheticamp River but there is no concern of them establishing a self-sustaining population on the Cheticamp River.

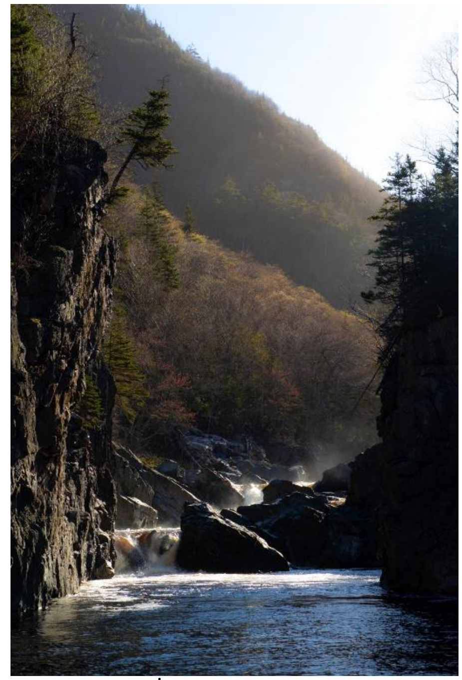
While there is anecdotal evidence of a changing composition of species in the Cheticamp River, there is little scientific data to confirm and quantify these observed changes.

## RECOMMENDATIONS MOVING FORWARD:

1. ***Include determining accurate estimates of relative abundance of salmonids as a goal of population monitoring assessments on the Cheticamp River (e.g., improve existing electrofishing program develop and implement online creel census).***

2. ***Consider reducing daily bag limits for brook trout on the Cheticamp River to reflect changes in population sizes and relative abundance.***

# Habitat restoration & enhancement efforts



View from 2nd Pool looking upstream. Photo credit: Jimmie Pedersen.

The earliest record of human intervention to the Cheticamp River undertaken with the goal of benefiting Atlantic salmon dates to the late 19th century. In 1898, the channel was modified at 2nd Pool when a set of barrier falls were blasted in order to allow fish to access the upper river. This major modification occurred well before the establishment of Cape Breton Highlands National Park.

With the creation of CBHNP in 1936, Parks Canada was given jurisdiction over management and monitoring of the Cheticamp River. CBHNP has prioritized monitoring, having implemented and experimented with a variety of methods for monitoring the Cheticamp's adult and juvenile salmon populations (summarized in preceding section). Habitat improvement or enhancement projects, for the most part, would have been contrary to Parks' policy for most of the history of CBHNP. In 1979, the National Park Policy was revised to identify the preservation of ecological integrity as the priority for National Parks in Canada. The preference for management of natural resources within National Parks in Canada was to maintain the physical environment in as natural state as possible. Specifically, the 1979 Canada Parks Policy document states that "caution should be exercised before any active manipulation of park resources is undertaken with preference given to allowing natural processes to function unless they have been clearly altered or made inoperative by man-induced changes" (p. 41, Parks Canada Policy, 1979).

As a result, intervention by CBHNP to modify or improve conditions for Atlantic salmon on the Cheticamp River has been limited. In the past (prior to the development of the 1996 Atlantic salmon management plan for CBHNP), dredging took place on several occasions to restore fish passage on the Cheticamp River. This was deemed necessary to reopen the outlet of the river after storms left it blocked with gravel and other deposits.

The Cheticamp River was regularly stocked with Atlantic salmon as part of early management practices. Between 1903 when the stocking program was initiated by the Federal Department of Fisheries and 1970 when it was discontinued, a total of 7.4 million salmon were stocked in the Cheticamp River (Petersen et al., 1987). Parks Canada policies no longer allow for stocking activities in Parks' waters, except under exceptional circumstances – e.g., in attempts to re-establish representative fish species that have become wholly extirpated (Hoffman & Bridgland, 1996).

CBHNP also took steps to restore fish passage on Robert's Brook, a tributary that empties into the river near the Cheticamp campground. A small dam was built on the brook in 1964 as part of the Parks' water supply system for the Cheticamp campground and visitor facilities. In 1994, part of the spillway and concrete apron were removed in an attempt to restore fish passage to spawning and rearing habitat on Robert's Brook (Hoffman & Bridgland, 1996).

## Summary of recent (2014-2018) habitat restoration activities

Members of the habitat restoration team involved with the 5-year project on the lower Cheticamp River posing with project signage below the Cabot Trail bridge.

More recently, the Cheticamp River Salmon Association and CBHNP partnered in 2014 to undertake a significant habitat restoration project focused on improving fish passage on the lower Cheticamp River. A number of sites had been identified where the channel was unnaturally and critically overwidened, limiting and in some cases preventing fish passage during periods of low flows. Surveying of the sites revealed that the channels were up to 100% wider than the natural channel width. The overwidening was attributed to a combination of human activities, including past (prior to the creation of CBHNP) extensive logging and poor bridge placement and design. As such, CBHNP approved the recommended restoration work and worked with CRSA to co-manage what turned into a five-year restoration project.

Between 2014 and 2018, a total of 70 instream structures were installed between nine work sites (summary in table on following page). Many of the structures were rock retarding bars, low-profile structures made of rocks and large boulders (~1m in diameter). The structures were tied into the stream banks and the bars were sloped down toward the centre of the channel in order to concentrate the flows and encourage the river to dig a deeper thalweg. Additional structures included rock deflectors and sills. While the focus of the restoration work was on restoring sites where the channel was critically overwidened, the work also addressed other issues that were limiting fish passage, including excessive bedload deposition, split flows, and large mid-channel diagonal bars.

**Sample project photos from downstream start of Below Fence Pool work site in 2015 showing view looking upstream from right bank just before work started (left), after rock retarding bars were installed (middle), and the changes to the site following major flood event in August 2015 (right).**

**Sample project photos of the Above Cabot Trail work site in 2014 showing view looking upstream from the bridge of the channel just before work started (left), after rock retarding bars were installed (middle), and the changes to the site following major flood event in August 2015 (right).**

**Table summarizing the restoration project undertaken on the lower Cheticamp River between 2014 – 2018, including identification of restoration sites, habitat issues addressed by the project, and restoration activities completed.**

| Site | Habitat issues | Restoration work completed | Date completed |
|---|---|---|---|
| **Below Cabot Trail bridge** | Severely overwidened channel, heavy bedload deposition, massive mid-channel bar | Three rock retarding bars on right bank + armour stone to actively eroding section of left bank | 2014 |
| | | Three rock retarding bars (1 right bank, 2 left bank) | 2016 |
| **Above Cabot Trail bridge** | Overwidened channel, mid-channel diagonal bar, absence of pool habitat | 11 structures installed: one rock deflector on left bank + five pairs of rock retarding bars (five on left bank, five on right bank) | 2014 |
| **Above Robert's Brook** | Overwidened channel, excessive bedload deposition, potential for breach with Robert's Brook | Five rock retarding bars installed on right bank | 2015 |
| | | Five structures - additional four rock retarding bars on right bank + hybrid rock deflector/retarding bar below bars on right bank | 2016 |
| **Robert's Brook** | Severe downcutting + serious breach potential with Cheticamp River | Two sills + repairs to two potential breach locations | 2016 |
| **Petit Cap** | Overwidened channel, split thalwegs, excessive bedload deposition | Six structures installed – three rock retarding bars on left bank three rock deflectors (2 on left, 1 on right bank) + channel blocker | 2017 |
| | | Five structures installed – additional two rock retarding bars + rock deflector on left bank + one rock sill | 2018 |

| | | | |
|---|---|---|---|
| **Below Fence Pool** | Overwidened channel | Total of ten rock retarding bars – five on right bank + five on left bank<br><br>Two rock deflectors installed on right bank upstream of 2015 structures | 2015<br><br>2017 |
| **Above Fence Pool** | Overwidened channel, severe bed load deposition, md-channel diagonal bar | Installed three rock retarding bars on left bank + series of five deflectors + armour stone on eroding/vulnerable right bank<br><br>Five structures installed -two additional rock retarding bars on left bank, above 2015 structures, and three deflectors further upstream on left bank | 2015<br><br>2017 |
| **Below Faribault Brook** | Overwidened channel, potential breach location | One low head deflector installed on right bank | 2016 |
| **Above Faribault Brook** | Severely overwidened channel, extreme bedload deposition, mid-channel bars | Four rock retarding bars on right bank<br><br>1 rock deflector installed on left bank above 2016 bars | 2016<br><br>2018 |

While the completed restoration work has been considered largely successful, continued monitoring is still important, especially as the river continues to process the large bedload deposits from the 2015 flood. For example, at the time this plan was completed, a site below the Cabot Trail bridge had become a threat to fish passage. The river splits below the Cabot Trail bridge and the divided section of river can be characterized by a combination of channel braiding, an overwidened channel, and an over-abundance of poorly sorted bedload. The August 2015 flood contributed to the current problems in this section, as it resulted in extreme sediment deposition and the downstream migration of a large mid-channel bar – conditions that further divided flows below the bridge leaving several long sections in each split where salmon migration is not possible in low water.

Note: a more detailed summary, including results of pre- and post-restoration channel surveys, and evaluation of the effectiveness of the 2014-2018 restoration activities undertaken on the Cheticamp River is also included as an appendix to this plan.

# RECOMMENDATIONS MOVING FORWARD:

1. ***Address existing barriers to fish passage, including physical and thermal barriers resulting from sustained periods of low flow, and continue to both assess fish passage and consider interventions when conditions warrant.***

2. ***Prioritize restoration activities on tributaries with greatest needs and potential for gains of quality spawning and rearing habitat, including Aucoin Brook and the possibility of Robert Brook.***

3. ***Continue to monitor the lower Cheticamp River for changes to quality and availability of habitat, including barriers/threats to fish passage, and consider future habitat restoration and/or enhancement activities if conditions warrant.***

4. ***In addition to pre- and post-restoration channel surveys, consider completing pre- and post-restoration habitat suitability index (HSI) assessments, following the Nova Scotia Fish Habitat Assessment Protocol, to be able to measure changes and evaluate the effectiveness of any restoration activities on the Cheticamp River more accurately.***

# Water quality

Atlantic salmon require clean, cool, well-oxygenated water, free of pollution and other contaminants. Atlantic salmon are also particularly sensitive to acidity, with pH of 5.0 or lower toxic to salmon. CBHNP collects water quality data regularly at two sites on the Cheticamp River – a site below the dam and another near Robert's Brook. Data collected covers a wide range of water quality parameters, including pH, dissolved oxygen, total organic carbon, and the presence of a number of nutrients and heavy metals. Fortunately, the results have not revealed any issues in recent years: the Cheticamp River has generally good water quality with circumneutral pH.

This contrasts with many rivers in Nova Scotia that have been heavily impacted by acid. According to the Nova Scotia Salmon Association, acid rain has been responsible for stock collapse of Atlantic salmon in 57 rivers in Nova Scotia and resulted in the loss of fully one third of Atlantic salmon productivity in the province in the span of decades.

While acidity is not a concern, elevated water temperatures have been identified as a limiting factor for Atlantic salmon on the Cheticamp River.

## Water temperature

Atlantic salmon – like other salmonids – are sensitive to water temperature, and exposure to elevated temperatures can cause a range of harmful effects, including decreased oxygen supply, disrupted metabolism, increased vulnerability to toxins and disease, and reduced ability for juveniles to avoid predation. While temperatures above 20°C can begin to cause stress for Atlantic, temperatures 25°C and above can have lethal effects. As temperatures on the Cheticamp River have been regularly recorded above this upper threshold in recent years, elevated water temperature has become a significant threat to Atlantic salmon.

While CBHNP started collecting limited water temperature data from the Cheticamp River in the 1980s, it wasn't until 2004 that the Park started using digital temperature loggers to monitor temperature more widely on the Cheticamp River. In its current Park-wide management plan, CBHNP identified the monitoring of summer water temperatures as an objective as part of a strategic goal related to better understanding the scale and impact of climate change on park ecosystems. In 2007, CBHNP also developed its water temperature monitoring protocol (still in use) to help with meeting its water temperature monitoring goals.

**Table 2. Water temperature records from the Cheticamp watershed by location and year**

| Logger location | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Below dam | | | | X | X | X | X | X | X | X | X | X | X |
| Above Faribault | X | X | X | | | | | | | | | | |
| Below Faribault | | X | X | | | | | | | | | | |
| Petit Cap | | | X | | | | | | # | # | | | |
| Robert's Brook | | | X | X | X | X | X | X | X | X | | | |
| Warden's Station | X | X | X | | | | | | | | X | L | L |
| Below CT bridge | | | | | | | | | # | # | | | |
| Terre Rouge | # | | # | | | | | | | | | | |

**X – Complete data set (June 15 to September 15); # - incomplete data set; L – logger lost. Table credit: James Bridgland, CBHNP 2018.**

More recently, the CRSA and CBHNP initiated a water temperature study in 2017 and have continued their investigation through 2021. The goal of the study, which has focused on the Cheticamp River, key tributaries, and the Cheticamp reservoir, is to gain a better understanding of summer water temperatures on the Cheticamp. This includes attempting to identify potential thermal barriers and/or sources of thermal pollution, as well as cool-water inputs (tributaries as well as groundwater seeps and springs) that are potential cool-water refugia. These cold water refugia may become more important for salmonids as the effects of climate change increases the river's water temperature.

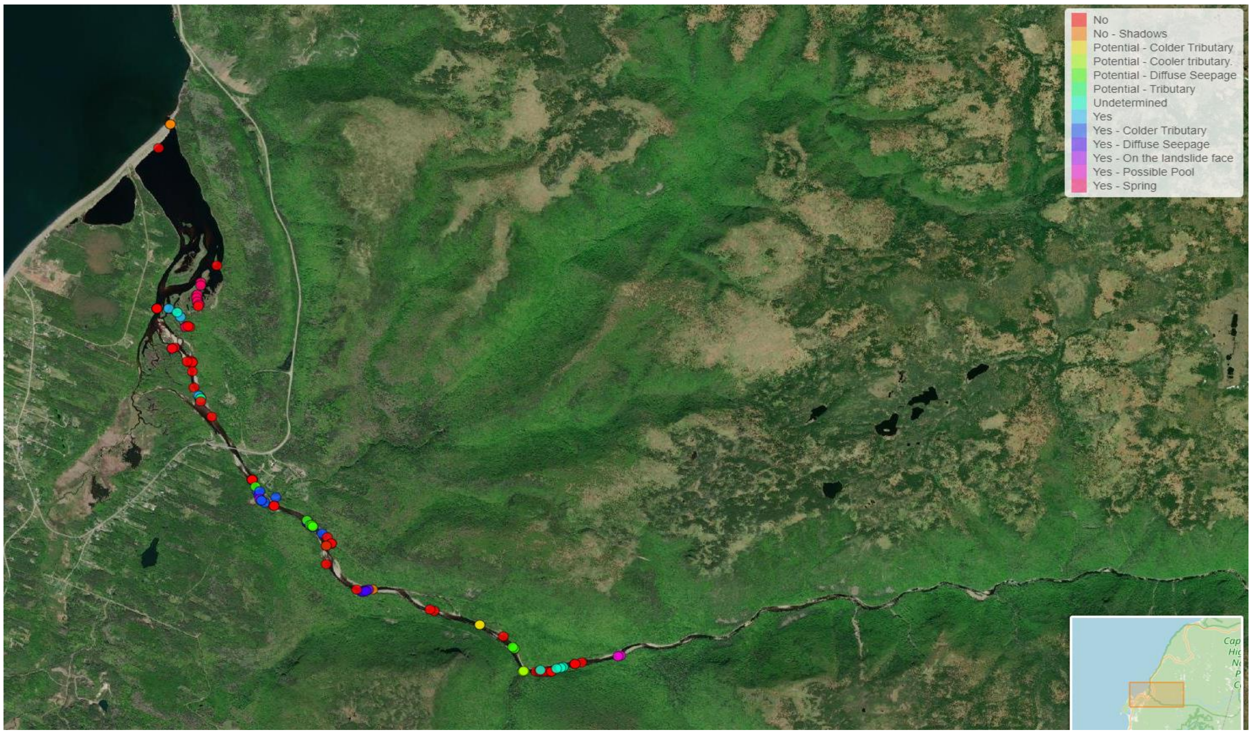
The findings of the study include that all locations on the main river where temperatures were monitored regularly exceeded 20°C and many also occasionally passed the 25°C mark. Data also revealed that water temperature decreases somewhat as it makes its way down from the outlet at the dam to the barrier falls, likely as a result of cool water being introduced by the upper tributaries (e.g., Cranberry Tributary and Artemise Brook). However, any cooling effects of the lower tributaries appear to be negligible. In addition, temperature data from loggers in the lower river also suggested that there may previously unidentified cool-water inputs – a possibility that the CRSA, CBHNP, and other project partners have sought to explore further.

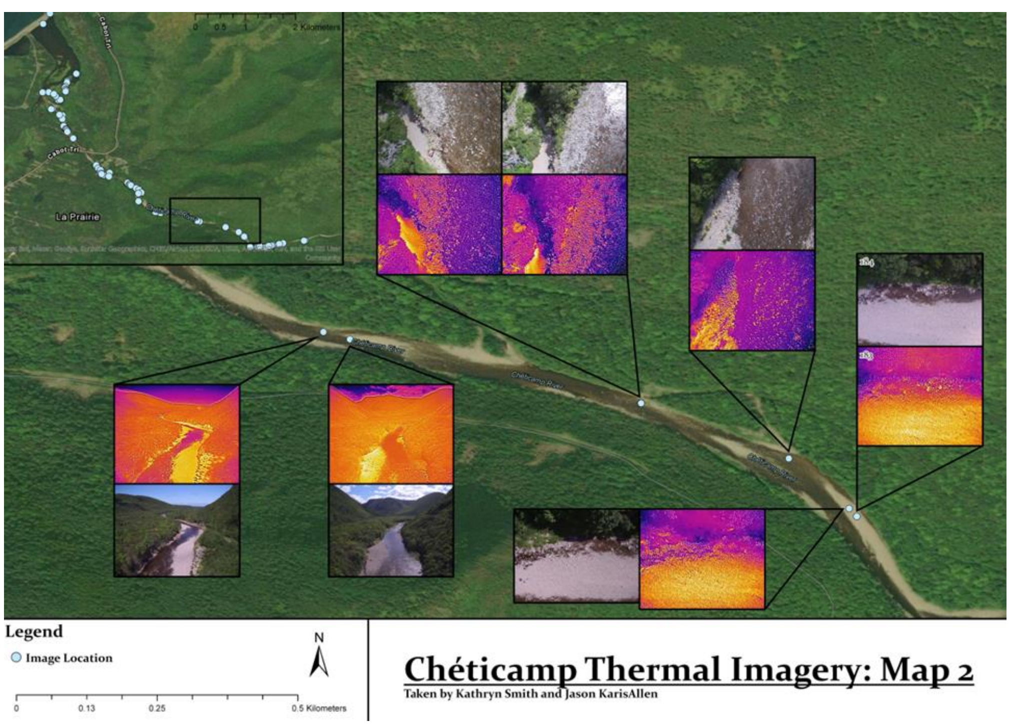
Being able to identify cool-water inputs (groundwater and surface water), however, requires spatially extensive temperature monitoring – monitoring that is difficult to do solely with conventional temperature loggers (this has been a limitation of the CRSA and CBHNP's study). Fortunately, a partnership with Dr. Barret Kurylyk with Dalhousie University's Groundwater Lab (part of the university's Centre for Water Resource Studies) resulted in opportunities for greatly increasing the spatial and temporal resolutions of the water temperature data being collected on the Cheticamp River using a drone equipped with thermal imaging camera.

In 2020, a graduate team with Dalhousie's Groundwater Lab led by Kathryn Smith used a Matrice 210 V2 RTK drone equipped with an XT2 thermal/visual camera to collect data on the lower Cheticamp River. The Over several days, the operator manually flew the drone at low elevations, scanning the watercourse for thermal variations. The researchers were able to use these scouting flights to identify areas in the river with potentially significant variations in water temperature. The researchers successfully conducted scouting flights from the tidal area to approximately a kilometer above Faribault Brook. Although the thermal imaging camera was equally capable of identifying sites of warm water/thermal pollution, the sites identified by the research team were all locations of potential cool-water inputs (e.g., groundwater seeps or springs).

**Kathryn Smith operating a drone equipped with a thermal imaging camera above Fence Pool on the Cheticamp River, collecting data as part of 2020 fieldwork.**

Using the thermal imagery obtained in the field, the team from Dalhousie produced a preliminary thermal map of the lower Cheticamp River using ArcGIS, identifying potential and confirmed coldwater input locations. These resources contain important data that can be used to help inform follow-up monitoring and mapping of thermal refugia locations, as well as guide investigations into possible future coldwater habitat enhancement activities.




**Two screenshots of the ArcGIS map developed by Kathryn Smith to identify potential and confirmed coldwater input locations on the lower Cheticamp River. The map above uses colour-coded dots to locate various coldwater input locations, and the map to the left includes examples of the thermal images of interest obtained as part of fieldwork in 2020.**

## Climate change concerns

Climate change is already having impacts on Atlantic salmon in parts of their range, in both their marine and freshwater environments, and these impacts are expected to increase as the effects of climate change intensify. Broadly speaking, climate change is likely to affect the abundance and distribution of Atlantic salmon populations, as well as have effects on growth, feeding, survival, and migration patterns (ICES, 2017).

While the effects of climate change will vary regionally and the specifics of what to expect are largely unknown, climate change scenarios projected for Cape Breton include warmer temperatures and more precipitation. For western Cape Breton, Nova Scotia Environment has projected an increase in average temperatures of +2°C from historical averages in the 1980s to the 2050s. Western Cape Breton is also projected to experience higher total precipitation amounts, but with that increased variability in precipitation patterns is expected, including increased frequency of both periods of drought and severe storm events.

As temperature and precipitation are primary drivers affecting Atlantic salmon in their freshwater habitats, the projections for western Cape Breton suggest that the Cheticamp River's Atlantic salmon population will be impacted by climate change. And an increase in water temperatures is not the only likely impact. In addition to being the primary influencers of water temperature, air temperature and precipitation also have the potential to affect other important environmental factors, including dissolved oxygen and water levels. Changes in temperature and precipitation can also result in changes to food availability and degrees of interspecific competition, both potentially affecting the productivity of Atlantic salmon in their freshwater environments.

# RECOMMENDATIONS MOVING FORWARD:

1. ***Continue to collect summer water temperature data (target period of June 15 – September 15) at the monitoring locations included in the recent Cheticamp River water temperature investigation, with a goal of ensuring a long-term dataset that will enable identification of trends, ability to identify potential thermal barriers and other issues of concern, and robust data that may help justify future conservation activities.***

2. ***Confirm locations of potential cool-water inputs identified through thermal imaging fieldwork and other methods, quantify temperature variations, assess suitability of sites for coldwater habitat conservation activities, including thermal refugia creation***

***or enhancement, and implement measures to conserve and increase coldwater habitat.***

3. ***Continue to collect summer water temperature data at the Cheticamp reservoir (minimum of three loggers – surface and bottom of reservoir and at the outlet).***

4. ***Engage with Nova Scotia Power to explore options for***
    a. ***making adjustments to the timing of the water release schedule from the reservoir, and***
    b. ***drawing from cooler bottom layer of water at the reservoir.***

# Habitat quality & availability

Freshwater habitat that supports their production is another limiting factor for Atlantic salmon. The quality and availability of habitat strongly influences the distribution and abundance of Atlantic salmon populations. Focusing on their freshwater needs, Atlantic salmon require habitat suitable for migration, spawning, and survival and growth of juveniles. These include holding pools with enough depth and cover to offer protection from predators and places to rest, and areas with gravel and cobble substrate combined with moderate current and depth for spawning.

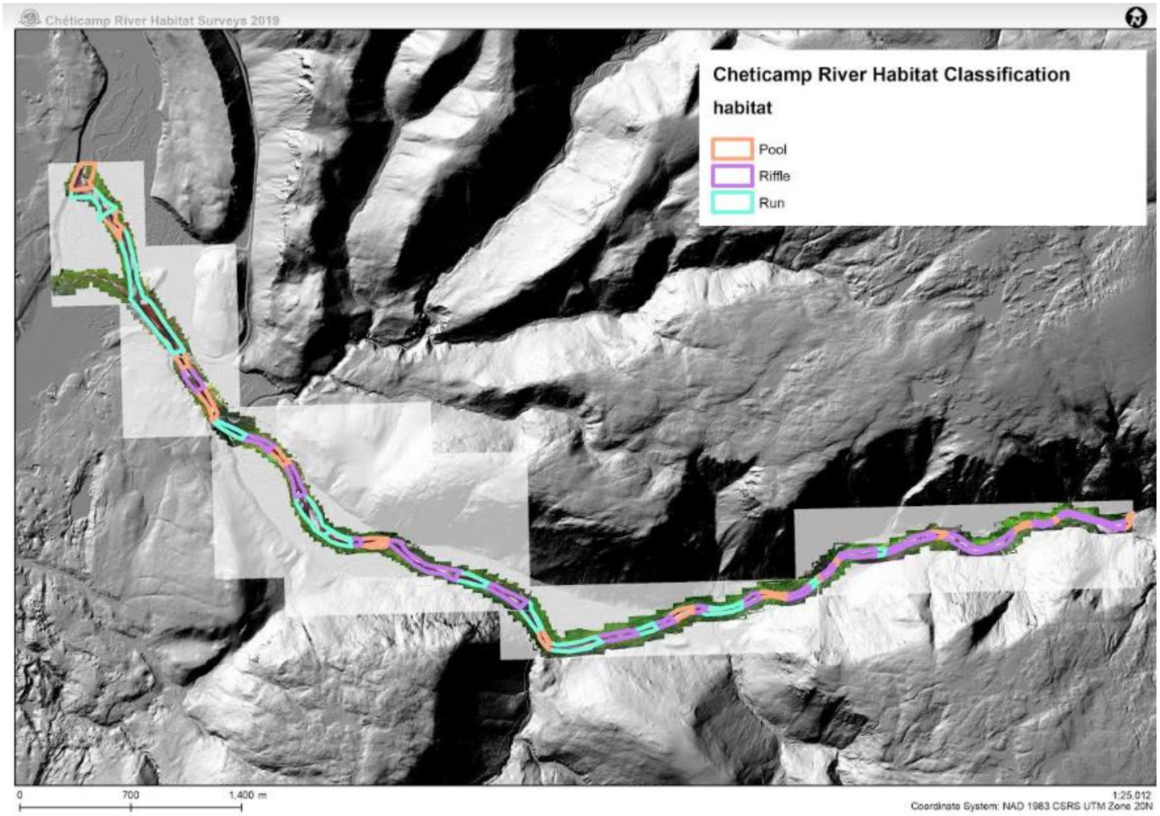
CBHNP had previously conducted a survey of salmon habitat on the Cheticamp River in the early 1980s. At this time, the habitat was surveyed from the tidal area to within 750m of the barrier falls. The surveyors concluded that the Cheticamp River had good rearing habitat throughout, and that spawning habitat was more restricted to the mid- to upper portions of the river (Petersen et al., 1987). The surveyors estimated the Cheticamp River's total area of salmon habitat as 318,915m$^2$. While it was recommended that these surveys be periodically repeated, this has not been attempted since the original study in the 80s.

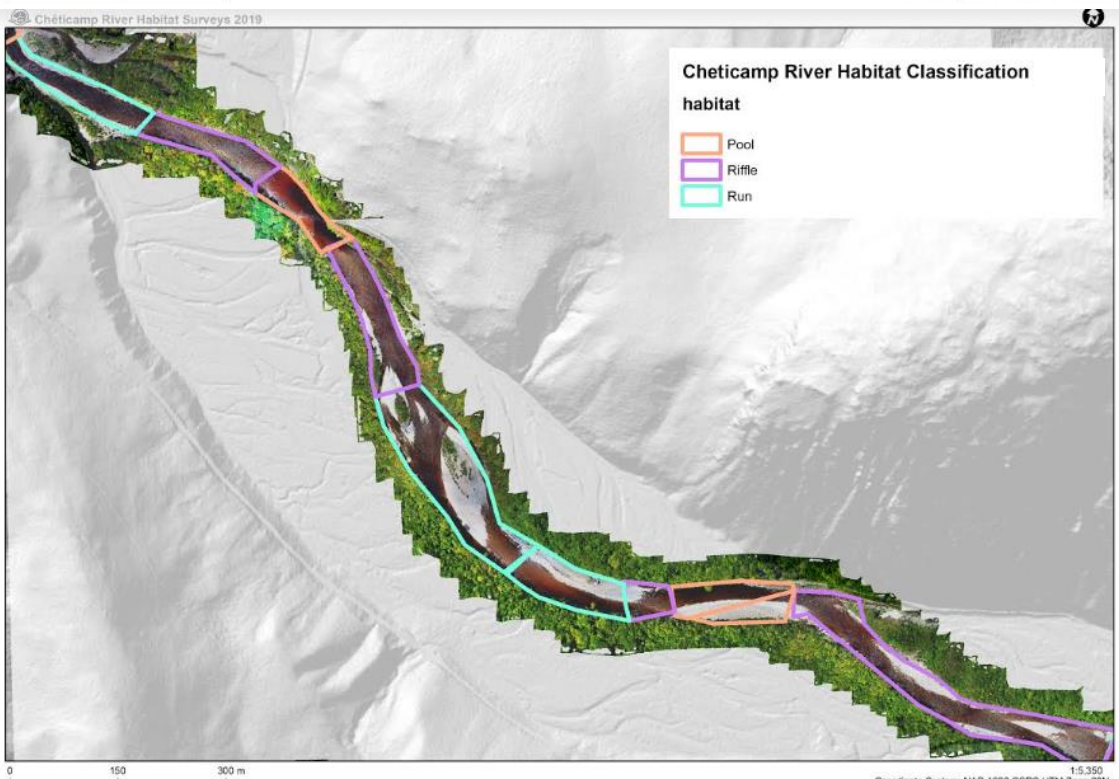
**Summary of results of habitat surveys of Cheticamp River conducted in 1982 and 1983 by CBHNP. Table modified from Petersen et al., 1987.**

| Habitat surveyed – Cheticamp River | | | | | Habitat composition (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length (km) | Mean width (m) | Mean depth (m) | Water surface area | Mean discharge m$^3$/s | Pool | Flat | Run | Riffle | Run/riffle |
| 18.5 | 15.7 | 0.6 | 31.9 | 3.5 | 13.8 | 8.9 | 13.7 | 18.7 | 44.9 |

Landslides, floods and other natural events have undoubtedly wrought significant changes to the Cheticamp River since the earlier habitat surveys. As part of the development of this conservation plan, CBHNP worked with CRSA to start the process of collecting updated habitat information for the lower Cheticamp River (estuary to Third Pool). A geomatics technician with CBHNP used a drone to collect a combination of videos and photographs for the entire study area, data that was later used to develop preliminary maps of habitat types.

**CBNHP geomatics technician Michée Lemieux reviewing footage obtained with a drone as part of efforts at remote habitat classification work on the Cheticamp River.**




**Maps developed in using newly collected drone data to broadly classify habitat types on the lower Cheticamp River (estuary to Third Pool). The above map shows the results of the entire habitat mapping exercise, and the lower map shows a magnified section from the middle of the study area. Images produced by CBHNP, 2019.**

In addition to the habitat classification work using the drone data, CBHNP and CRSA collected more detailed data, including channel widths and depths, substrate type and composition, and type and amount of riparian vegetation, by conducting habitat assessments at 30 locations between the estuary and Third Pool. CBHNP staff made the decision to conduct modified habitat suitability index (HSI) assessments, essentially collecting the same data required for an HSI, but collecting data at a single transect for each location, as opposed to a series of transects through a site, roughly every two channel widths, as recommended in the Nova Scotia Fish Habitat Assessment Protocol. As a result, the habitat assessments could be used to ground truth the habitat classification work carried out with the remotely collected drone data but were not able to be used to assess habitat quality and identify limiting factors.

## RECOMMENDATIONS MOVING FORWARD:

1. ***Resurvey the Cheticamp River using same/similar methodology used in the habitat surveying work undertaken in the early 1980s, including identification and estimates of spawning habitat for Atlantic salmon, as the river has undergone significant changes in the last 40 years.***

2. ***Conduct habitat suitability index (HSI) assessments following the Nova Scotia Fish Habitat Assessment Protocol (NSFHAP) at minimum at sites of concern identified through visual surveys and at locations where restoration activities are planned or being considered; HSI data can be used to identify limiting factors, establish new baseline data, facilitate comparisons between watercourses, and identify and quantify changes in habitat more accurately.***

# Adjacent land use and developments

Among the threats facing Atlantic salmon throughout their range are human impacts and anthropogenic land uses that degrade and/or restrict access to freshwater habitat. Fortunately, as it is almost entirely located within the boundaries of the Cape Breton Highlands National Park, the Cheticamp River is largely protected from the types of human impacts affecting other salmon rivers.

Yet, the Cheticamp region has been experiencing significant development in recent years, including the clearing of lands for new tourism accommodations and residential properties. In the case of the Cheticamp River, new developments are taking place outside the national park boundaries, including the creation of multi-unit short term rental properties and RV camping facilities. With these developments come new impacts and potential pressures on the river that should be understood and monitored, including water withdrawals, potential pollution from sewage effluents, and clearing of riparian vegetation.

There are also locations outside the national park boundaries where land is being cleared to the banks along tributaries of the Cheticamp River, in some cases to make way for building cabins. As there is no riparian buffer regulation in Nova Scotia related to development or agriculture, there is currently no regulations in place to protect riparian vegetation.

**Example of a location where trees are being heavily cut in upper reaches of Faribault Brook tributary.**

## RECOMMENDATIONS MOVING FORWARD:

1. ***Engage with landowners along Cheticamp River and discuss benefits of developing landowner stewardship plans, including providing access to resources, information, assistance with implementing plan.***

2. ***Explore possibility of working with Municipality of the County of Inverness to establish new bylaw requiring setback to better protect riparian vegetation along all watercourses in the Cheticamp River watershed.***

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## Appendix A

PREPARED FOR:
CHETICAMP RIVER SALMON ASSOCIATION (CRSA)

PREPARED BY:
DANIELLE GOFF-BEATON
CHARLES MACINNIS

**Lower Cheticamp River Habitat Assessment – Restoration Activities 2014-2020**

**March 2021**

## Executive Summary

The Cheticamp River, an important Atlantic salmon river, has been negatively affected by habitat loss as a result of human activities. Direct impacts such as infrastructure development (bridges, roads & culverts), logging and forestry practices and the diversion of tributary drainage have all contributed to the decline of suitable Atlantic salmon habitat. Less direct impacts such as climate change are also having an equally detrimental role in the degradation of salmon habitat. As a result of climatic changes, the Cheticamp River has experienced higher water temperatures, lower flow levels during salmon migration periods, as well as increased rates of flash flooding. Decreasing snow pack levels have also greatly reduced the freshwater input to the watershed during the spring melting period, this is particularly concerning for the Cheticamp River's late spring and early summer run of Atlantic salmon. As a result of lower flow levels and decreased channel depth, anecdotal evidence suggests that during 2012 and 2014 the June migration of Atlantic salmon was severely compromised and possibly unable to occur for the first time in living memory. Without intervention, the impacts of human activity will continue to negatively affect the Atlantic Salmon populations in the Cheticamp River. Atlantic salmon are regarded by First Nations as a culturally significant species, and locally their existence plays an important role in the economy through recreational angling and tourism related activities.

The Cheticamp River Salmon Association partnered with Parks Canada and has taken steps to identify the major problem areas in the Cheticamp River and resolve them through stream restoration. The Cheticamp River Salmon Association produced habitat assessment and restoration reports from 2014 to 2020 to accompany each of their major restoration endeavors in the lower Cheticamp River. This report is a compilation of all previous reports detailed below and provides a final update on the status of the restoration results and overall success of the project. Each report prior to this document is summarized below.

***Lower Cheticamp River Habitat Assessment and Restoration Recommendations (2014)***

Written in July 2014, a survey and initial report, including a restoration plan, was produced and identified the section of river on both sides of the Cabot Trail bridge as severely degraded habitat. This area was over-widened, extremely shallow and as a result was a barrier to fish passage during critical migration periods. The restoration recommended in this first report was successfully completed in August 2014.

***Lower Cheticamp River Habitat Assessment and Restoration Recommendations Part 2 (2014)***

A second survey, report and restoration plan for a second phase of the project was completed in November 2014 and focused primarily on sites further upstream. The restoration work for this second plan was completed in July and August 2015.

Preliminary indications after the 2014 restoration showed the thalweg had been significantly deepened (up to 80cm in some places). The ultimate aim of Part One and Part Two restoration recommendations was to narrow the channel in the over-widened areas to a more natural and calculated design width of 38m with a fully functional pool riffle sequence. The river restoration resulting from these recommendations should process bedload through the trouble areas in the Cheticamp River, protect cold water refuges and improve salmonid access to spawning areas.

***Lower Cheticamp River Habitat Assessment and Restoration Recommendations Part 3 (2015)***

The third report presents the post restoration survey results for work completed in the second phase (summer 2015) of the project at the following locations: Site 4 (Robert Brook), Site 3(Above Fence Pool), Site 1 (Faribault Brook), Site 5a, the 2014 restoration site upstream of the Cabot Trail bridge and a previously un-surveyed location (called Site 5b) downstream of the Cabot Trail bridge where the main channel of the Cheticamp River has moved into an historical channel. Channel and wetted widths as well as thalweg depths and cross-sectional profiles post restoration were presented in the document.

Fairbault Brook (Site 1) was not restored as originally planned but was resurveyed in light of the changes from the 2015 flood. This report outlined planned restoration works for 2016.

This 2015 report documented that a major flood event occurred in August, 2015. Intense rainfall over a short period resulted in flash flooding that necessitated evacuations and closures affecting the Parks' Cheticamp campgrounds and facilities. The flood also resulted in significant changes to the river, including large scale movement of bedload, bank erosion, and the formation of new pools. The flood also impacted completed and proposed restoration work, and the resulting pivot in structure placement is detailed in this report and subsequent reports.

***Lower Cheticamp River Restoration 2017 -Petit Cap Pool and Fairbault Brook & Cheticamp Reservoir Temperature Investigation (2016)***

This report was completed in November 2016 to guide restoration works in the 2017 field season.  The impetus for this report was the extreme changes in the streambed profiles due to the 2015 flood and the need to redesign the restoration plan identified in previous reports. This report was the inaugural presentation of stream survey data at the Petit Cap Pool Site (now called Site 3a), though the location had been surveyed in previous years. The changes noticed at the Petit Cap site post 2015 flood showed extreme instability and a huge potential for the main channel to become abandoned and affect the pool quality and sequence downstream.

***Cheticamp River Survey- Petit Cap Site & Above and Below Fence Pool (2018)***

This report presents survey results from July and August 2018 at the location knows as Petit Cap Pool and the portion of the Cheticamp River known as Above Fence Pool (Site 2) and Below Fence Pool (Site 3). Petit Cap Pool site survey results were two-fold, to assess the effect of 2017 restoration works at the Petit Cap location and to inform the survey works done in 2018 at the site. The survey results from Above Fence Pool and Below Fence Pool are compared to survey results from previous years to assess the stability of the restoration work through the years of flooding and bedload movement. Channel and wetted widths as well as thalweg depths and cross-sectional profiles were presented in this document.


| **Location** | **Planned Restoration** | **Completed Work** |
|---|---|---|
| Site 5b: Cabot Trail Bridge Site (downstream of bridge) | - Install deflectors on one side and groins on the other in the Eastern channel | -Deflectors installed in both channels to maximize passage depths |
| Site 5a: Cabot Trail Bridge Site (upstream of bridge) | Paired retarding bars to narrow the straight run upstream of the bridge | -Fewer pairs than initially planned were required |
| Site 4: Robert Brook | - Robert Brook: Install 3 sills across; crop large gravel bar<br>- Cheticamp River: re-profile banks at breech by installing 5 retarding bars along right bank; restore pool on left | -Robert Brook: 2016 installed 3 sills, repair of breach including deflector<br>-Cheticamp River: 5 retarding bars installed post flood |
| Site 3a: Petit Cap Pool | -Install 3 retarding bars on the western bank | -Installed 3 retarding bars on the western bank and one rock sill at breech location |
| Site 3 and 2: Below and Above Fence Pool | - Install 4 retarding bars on the left bank above Fence Pool; crop bedload deposits immediately downstream;<br>- install deflector to protect holding pool | -Installed 3 retarding bars on left bank above Fence Pool + bedload cropping<br>and installed deflector |

| | | |
|---|---|---|
| | - Install 4 retarding bars on the right bank below Fence Pool; crop bedload deposits immediately downstream<br>- Additional armour stone on the trail side of the pool to prevent bank erosion | -4 retarding bars installed on left downstream + bedload cropping<br>-Armour stone plus series of deflectors along trail |
| Site 1: Faribault Brook | - Install 4 retarding bars on the right bank above Faribault Brook outlet; crop bedload deposits immediately downstream and upstream of retarding bars<br>- Install deflector to protect this important cold water holding pool<br>- Install 4 retarding bars on the left bank below Faribault Brook outlet; crop bedload deposits immediately downstream | Completed 2017 and 2018 work consisted of cropping gravel bars and installation of large rock deflectors at all previously identified “retarding bar” locations |

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## Problem Definition

The Cheticamp River is the defacto southwest border of the Cape Breton Highlands National Park on the Gulf of St. Lawrence side of the park. According to angler reports, for several years before the restoration of the Cheticamp River began, migration of salmon upstream to spawning areas had been affected by extremely shallow sections of river throughout the lower reaches of the Cheticamp River. The shallow sections are particularly damaging to the spring (June) salmon runs during periods of low flow, so much so that the 2012 spring run (comprising 80-90% of the run) was unable to ascend the river. Anecdotal information from local anglers suggests that very few fish were able to ascend the river that year.

Over-widening of the Cheticamp River combined with an overabundance of bedload that is poorly sorted are the main culprits of the critically shallow locations. Calculations of predicted channel width were done based on guidance from *A View of the River* (Leopold, 1994) and “The Morphology of Large Rivers: Morphology and Management” (Kellerhals & Church, 1989). The Cheticamp River also has the added dimension of a very steep sloped upland drainage area that empties into the much shallower lower reach of main channel. This compounds the deposition of sediment in the lower reach. When watercourses are over widened the flows are spread too thinly to provide sufficient depth for passage. Excess bedload material creates conditions whereby stream flow is lost to the interstitial spaces of the cobble and the flow moves downstream in this way drastically reducing the swimmable channel dimensions. Diagonal bars, mid-channel bars, and islands, which are red flags that indicate excess bedload and or poor processing of sediment, are seen in the study area and throughout the lower reaches of the Cheticamp River. The source of the excess bedload is well documented to be numerous slope failures upstream which are a feature of the topography but also being exacerbated in recent years by increasing storm events and loss of vegetation due to spruce budworm (Wahl, Spooner, & Colville, 2007) and grazing of an overabundant moose population (Parks Canada, 2014). The figure below from the study titled "*Thin-skinned Debris Flows in Cape Breton Highlands National Park, Nova Scotia Canada*" (Wahl, Spooner, & Colville, 2007) shows locations of landslides that are part of the excess bedload equation. Intensive logging in the highlands on the western side of the Park may have also contributed to the problem. The general goal throughout the restoration planning process has been to restore natural channel dimensions and a deeper thalweg (75-85cm). Structures installed in 2014 and 2015 were sized to guide flows to attain a natural channel width of 38m, ideally located to match winter flow channel. Watershed size and flood flow method determined the natural channel width.

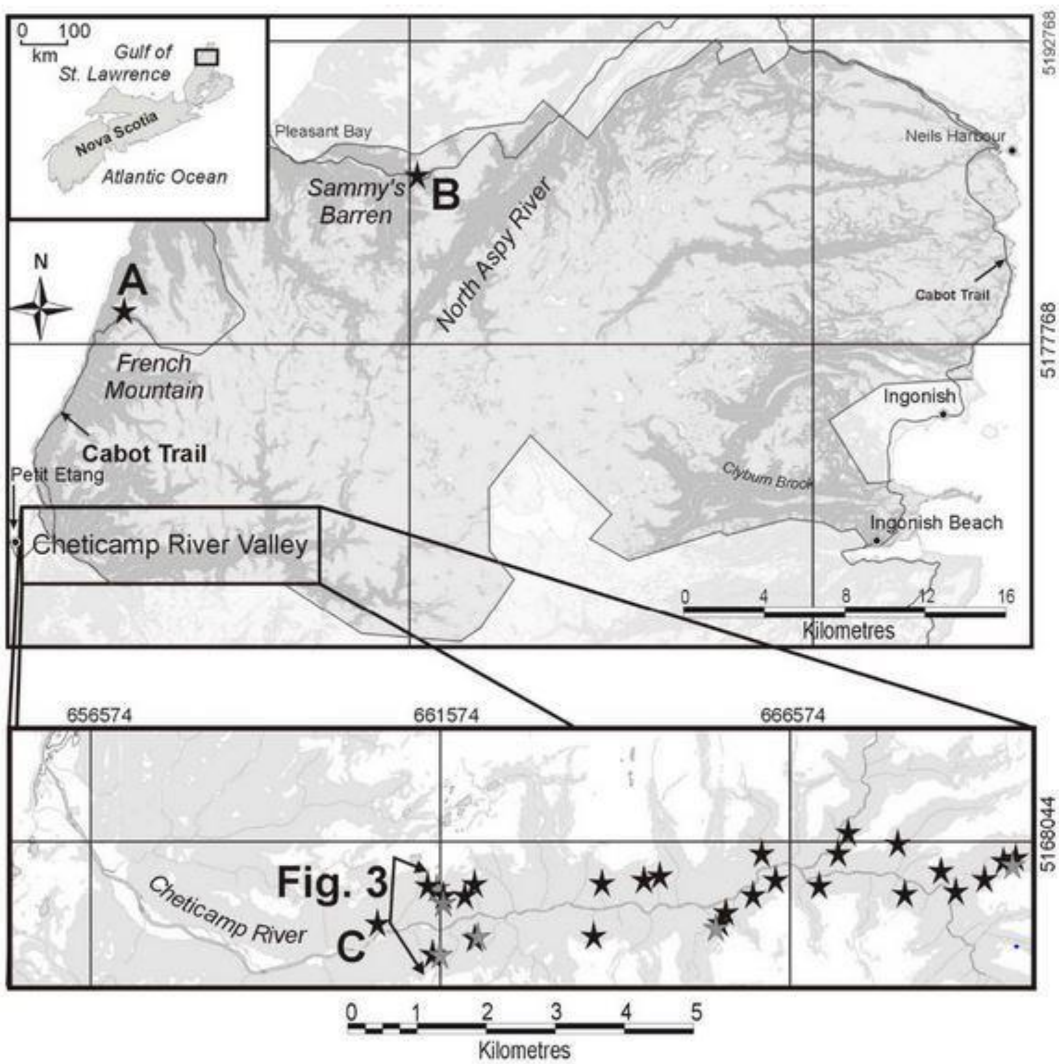



**Fig. 1** Landslide sites investigated within CBHNP and the Chéticamp River Valley area (Sites A, B, C). The Chéticamp River Valley has the greatest concentration of debris flows with over 32 recent and relict landslide scars documented. Not all landslides in CBHNP are shown on this map. Stars (black and grey for visibility) indicate landslide sites in the Chéticamp River Valley identified from 1999 aerial photographs.

With the goal of improving access to spawning areas for the extremely valuable Atlantic salmon, the Cheticamp River Salmon Association partnered with Parks Canada to restore critically degraded sections of the river. Over the course of the 7-year restoration project, seven locations in the lower Cheticamp River were identified and biologists, work crews, Parks Canada team members and students worked together with the CRSA on the project. Initially, the work focused on the area immediately upstream and downstream of the Cabot Trail bridge, but quickly the number of areas requiring restoration grew to the following seven locations:

Site 5b Downstream of Cabot Trail Bridge

Site 5a Upstream of Cabot Trail Bridge

Site 4 Robert Brook Location

Site 3a Petit Cap Pool Location

Site 3 Below Fence Pool Location

Site 2 Above Fence Pool Location

Site 1 Faribault Brook Location

The lower Cheticamp River is a large watercourse with reactive flood flows, a steep watershed, and which, due to its size, also requires high-cost restoration techniques and machine access. The eastern border of the Cheticamp River is a National Park (Cheticamp Highlands National Park) and is another complicating factor in planning the restoration design. The restoration work was planned in stages and expanded through the years as budgets and conditions allowed. A significant rain event over a degraded reach of river (as occurred in 2015) could set planning back to square one so restoration biologists chose to collect baseline data on a site and restore that same area soon after to minimize re-surveying efforts. Smaller watercourse restorations can often be planned and completed in a season but that was not practical for the Cheticamp. As a result, five separate reports were produced over the years as surveys, restoration work, and re-surveys of the project sites were planned and executed.

The first report, completed in July of 2014 titled *Lower Cheticamp River Habitat Assessment and Restoration Recommendations*, profiled the river bottom of two areas - immediately upstream and downstream of Cabot Trail bridge crossing of the Cheticamp River, suspected to be so shallow as to impact fish migration (Goff-Beaton & MacInnis, Lower Cheticamp River Habitat Assessment and Restoration Recommendations: July 2014, 2014) . That report made restoration recommendations of retarding bars in the locations, designed to narrow the overly widened channel so bedload could be processed more efficiently and to deepen the thalweg to a more suitable depth for salmonids to pass during low flow periods during critical (June) migration times. The restoration was completed in September 2014. Preliminary indications from measurements taken during low flow conditions in October 2014 showed that this work has been successful in deepening the thalweg to approximately 85cm in the location upstream of the Cabot Trail bridge.

A second report, *Lower Cheticamp River Habitat Assessment and Restoration Recommendations Part 2* (Goff-Beaton and MacInnis), was completed in November 2014 and focused on restoration recommendations for sites further upstream. Only a portion of the restoration work for this second plan was completed in July and August 2015. High water conditions prevented the completion of the work.

A third report, *Lower Cheticamp River Habitat Assessment and Restoration Recommendations Part 3* (Goff-Beaton and MacInnis, 2015), provided an evaluation of the effectiveness of restoration work undertaken in 2014 and 2015. It included resurveyed cross sections in locations where planned restoration structures and gravel cropping were not completed due to high rainfall events. Post restoration measurements and cross sections were taken at the following locations:

Site 5b: Downstream of Cabot Trail Bridge

Site 5a: Upstream of Cabot Trail Bridge

Site 4: Upstream of the outlet of Robert Brook

Site 2: Above Fence Pool

Site 1:  Faribault Brook location

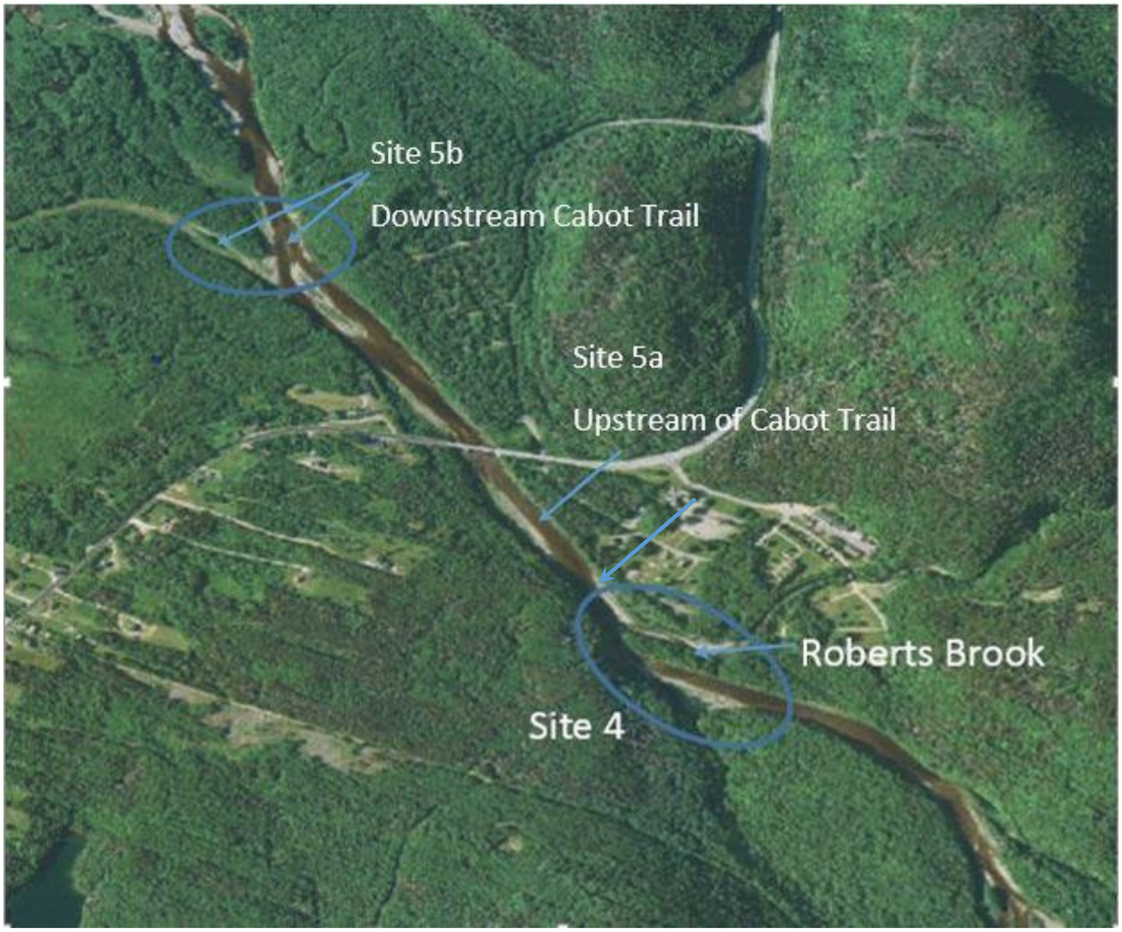



***Figure 1a.*** *Site 5a: Upstream of Cabot Trail Bridge; Site 5b: Downstream of Cabot Trail Bridge and Site 4: Robert Brook*

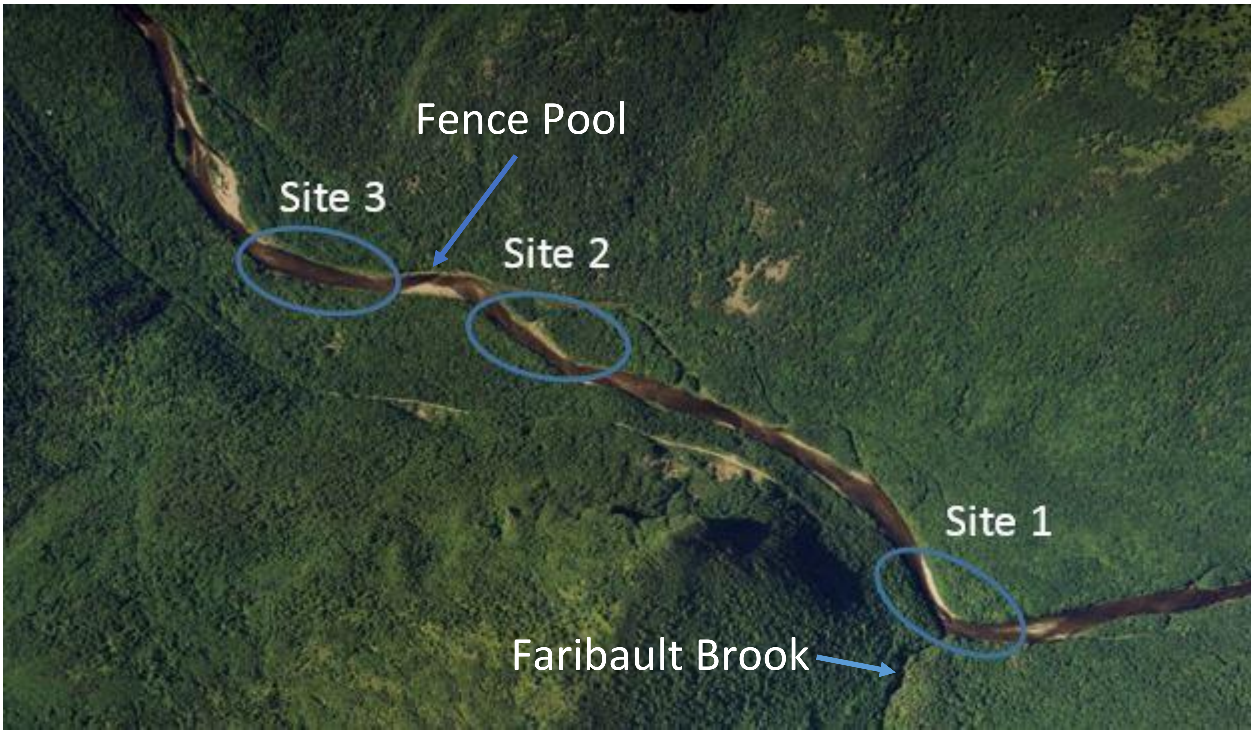



**Figure 1b**. *Sites 3 and 2: Below and Above Fence Pool and Site 1: Faribault Brook Location*

**Flood Impacts**

On August 22, 2015 the Cheticamp River experienced an extreme flood flow event. Approximately 150mm of precipitation fell in a 3-hour period. This caused flash flooding and a significant rise of the river and required the emergency evacuation of the Cape Breton Highlands National Park's Cheticamp campground - a first time occurrence in over 80 years of operation. Unfortunately, this flooding also caused damage to the river at Site 4: Robert Brook where restoration structure construction was due to start. Clearing of the access road to Robert Brook and a stockpile of armour rock waiting to be placed diverted the flood flows at a vulnerable area of the bank. This flood also impacted work at the Fence Pool site and required significant reconstruction of the Salmon Pools trail.

***Figure 2a.*** *Location at Robert Brook Site where access road damaged riverbank*

***Figure 2b.*** *View looking downstream through Robert Brook site post flood. Notice the debris and erosion on both banks*

***Figure 2c.*** *Rock stockpile at Robert Brook site*

***Figure 2d.*** *View looking upstream above Fence Pool. Flood damage visible on trail and right/eastern bank*

The post restoration survey data was collected on September 26 and September 29th 2015. Flow conditions were similar to the time of the stream survey in September 2014. A laser level survey system was again employed to measure bottom profile and water surface elevations. Wetted width and channel width measurements were taken manually at 25m intervals. The cross-sectional profile locations matched the locations from prior year surveys. Due to changes in localized flow conditions and time and weather constraints, not all cross sections were resurveyed.

## Restoration Summary by Site

## Site 5b Downstream Cabot Trail Bridge

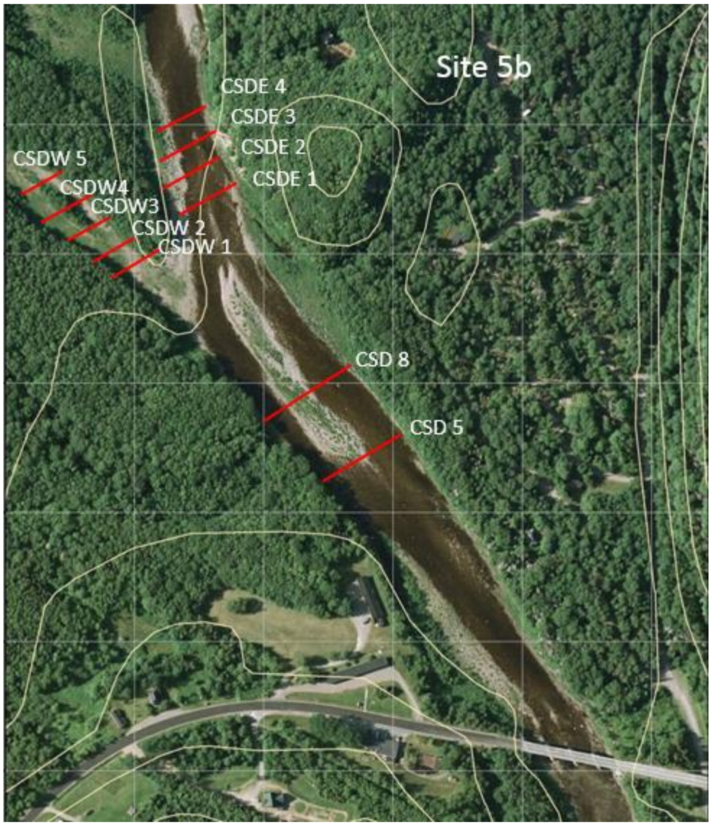



***Figure 3a.*** *Overview of cross section locations in Site 5b 2015. Note the mid-channel bar at CSD8 location is no longer present at that location but has moved downstream to plug the eastern channel*

Site 5b, downstream of the Cabot Trail bridge has undergone significant changes since 2010 and continues to change. The bridge replacement of 2010 significantly altered the flow regime and the mobilization of downstream point bars has been dramatic through the years. The extreme sediment deposition from the August 2015 storm event has also had a huge effect on the channel in this location. As well, this reach of the lower Cheticamp River has the lowest slope of the restored portions of river and is the farthest location downstream so it makes sense that it is prone to sediment deposition, bedload movement, and channel changes. The survey of 2015 shows the 2013 mid-channel bar responsible for splitting the flows in 2013 has migrated downstream (see Figure 3b). The material moved downstream several hundred meters and has plugged off the main eastern channel. As a result, the flow in 2015 was diverted into the historical western 1930's channel with an average wetted width of 20m. In September 2015, 4 cross sections, at 25m spacing, were taken at both the old eastern channel and the western channel. See Figure 3a for the locations of survey cross sections. The survey shows that the bottom elevation of the western split is much higher than the bottom elevation of the historical eastern main channel even though most of the surface flow is in the western channel. The slope between the first two cross sections in the old eastern channel is 1.9% and the slope between the first two cross sections of the western channel is 0.4%. This slope differential means the eastern channel bottom will be much more mobile in flood flows. The bottom profiles are shown in Figure 3c and Figure 3d shows the eastern channel to be 30cm deeper than the western channel at CS1 and 139cm deeper just 75m farther downstream at CS4.

This stream profile continued to change and the 2020 survey (see Figure 3b-4) shows flows moving back into the eastern channel at about a 50/50 split. The survey done in 2020 overlapped the previous year's surveys for the first 4 cross sections in the eastern spilt and the remaining CS5 through CS10 are in essence a newly surveyed location and the cross sections are presented this way. The channel width comparison is not helpful at this site because the main flows have been so erratic, switching from left to right and into and out of a split channel.

As previously noted, since the start of restoration efforts in 2014, this area downstream of the Cabot Trail bridge has been extremely dynamic and reactive and held the minds of restoration biologists as far as deciding what approach is the best fit for restoring the site (see Figure 3b-2). The elevations of the eastern channel and hydraulic effect of the bridge upstream have determined the eastern channel to be the most suitable. The proposed work for the 2021 field season is to install deflectors on the east and west banks of the eastern channel which appears to be the most suitable to carry the main flows.

***Figure 3b-1.*** *Deflector in western split installed summer 2020 to prevent an imminent breach*


***Figure 3b-2.*** *Looking downstream from Cabot Trail Bridge Sept 26, 2015 (on left) and July 2020. Large bedload is still moving down through the river*

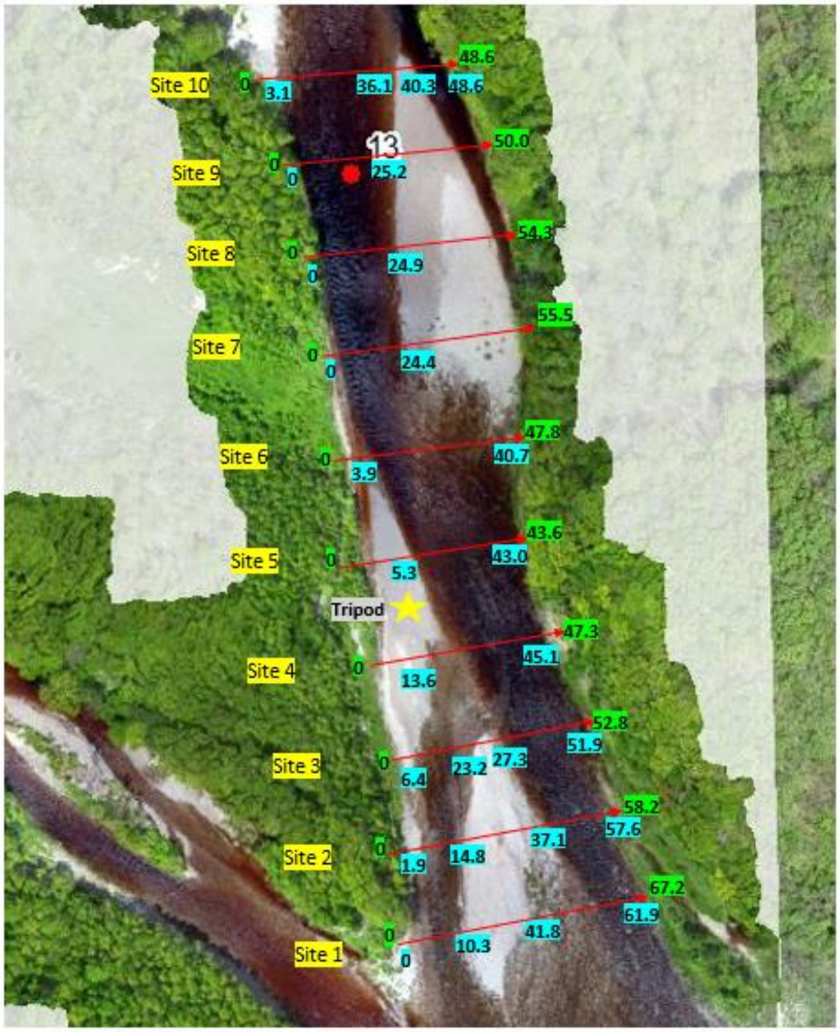



***Figure 3b-3*** *Cross section locations for July 2020 survey*

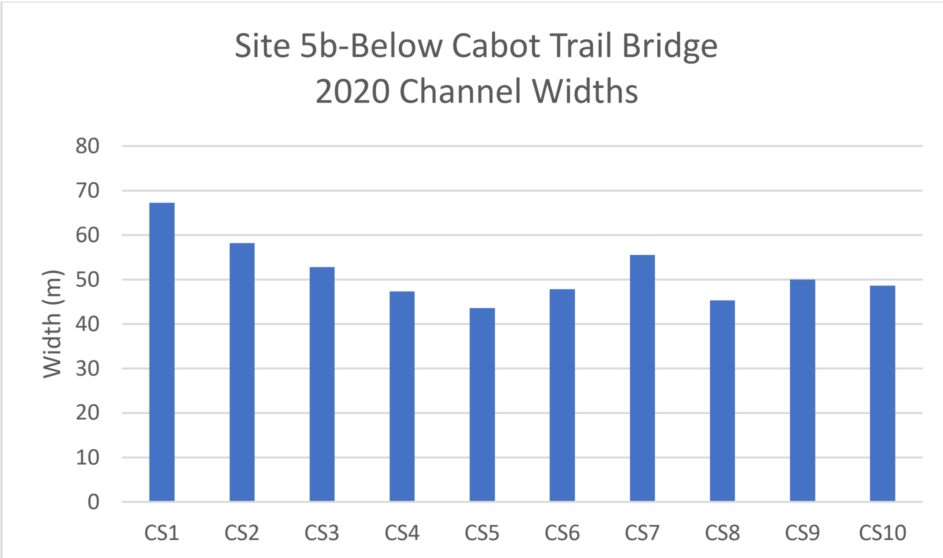



***Figure 3b-4*** *2020 channel widths at each cross section*

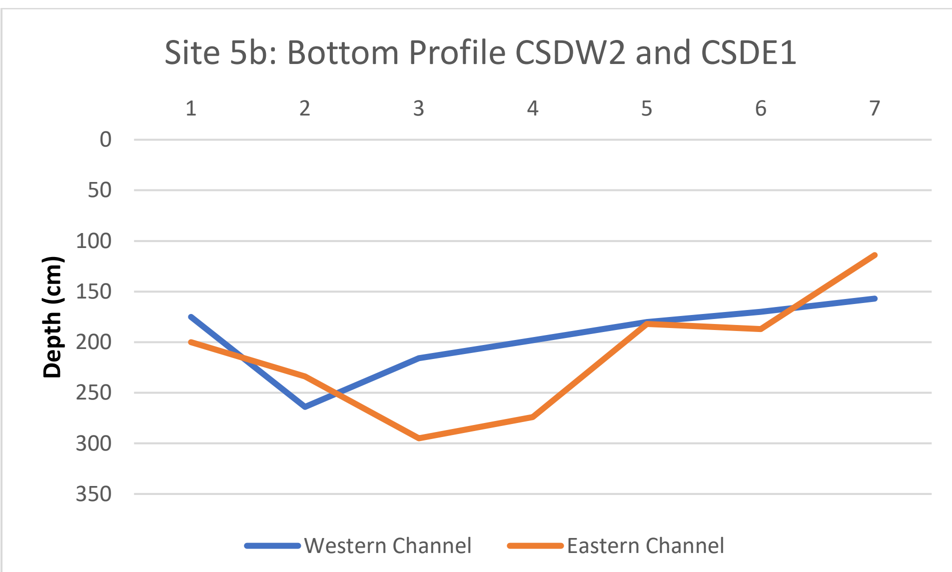



***Figure 3c.*** *Bottom profiles at head of split (September, 2015)*

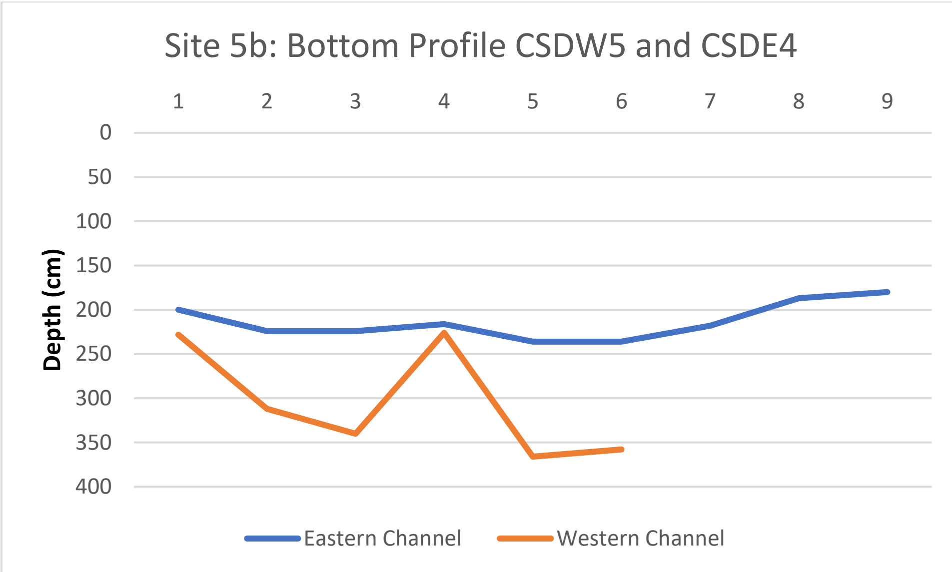



***Figure 3d.*** *Bottom profiles 75m downstream of split (September, 2015)*

Two cross sections from the 2013 survey were re-evaluated and are shown in Figures 3e and Figure 3f below. CSD5 shows the thalweg has continued to move westward as was intended, and the thalweg has significantly deepened to 67cm at CSD5 and to 76cm at CSD8. This is quite encouraging and evidence that the restoration retarding bars on the eastern bank continue to guide flows to sort the abundance of bedload. As is also evident in Figure 3b, a new large mid-channel deposit has grown at the outlet of the Cabot Trail bridge. This is expected to be processed through the site in the coming years by the restoration rock retarding bars.

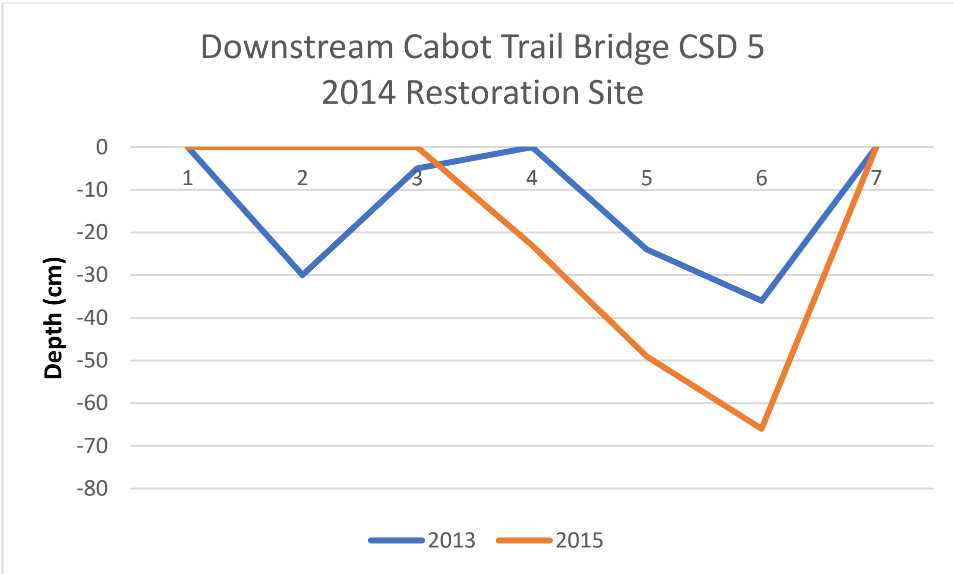



***Figure 3e.*** *CSD5 2013 and 2015 profiles*

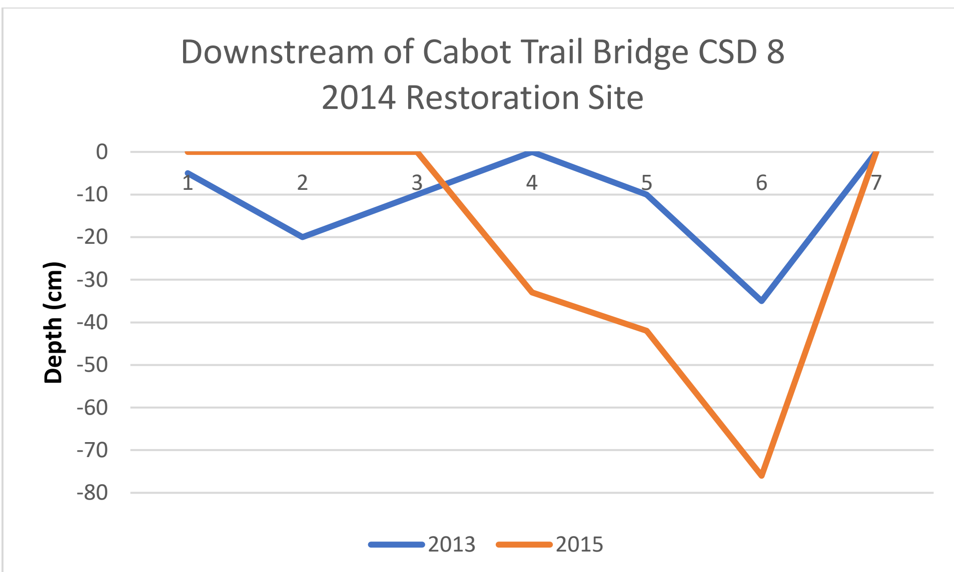



***Figure 3f.*** *CSD8 2013 and 2015 profiles*

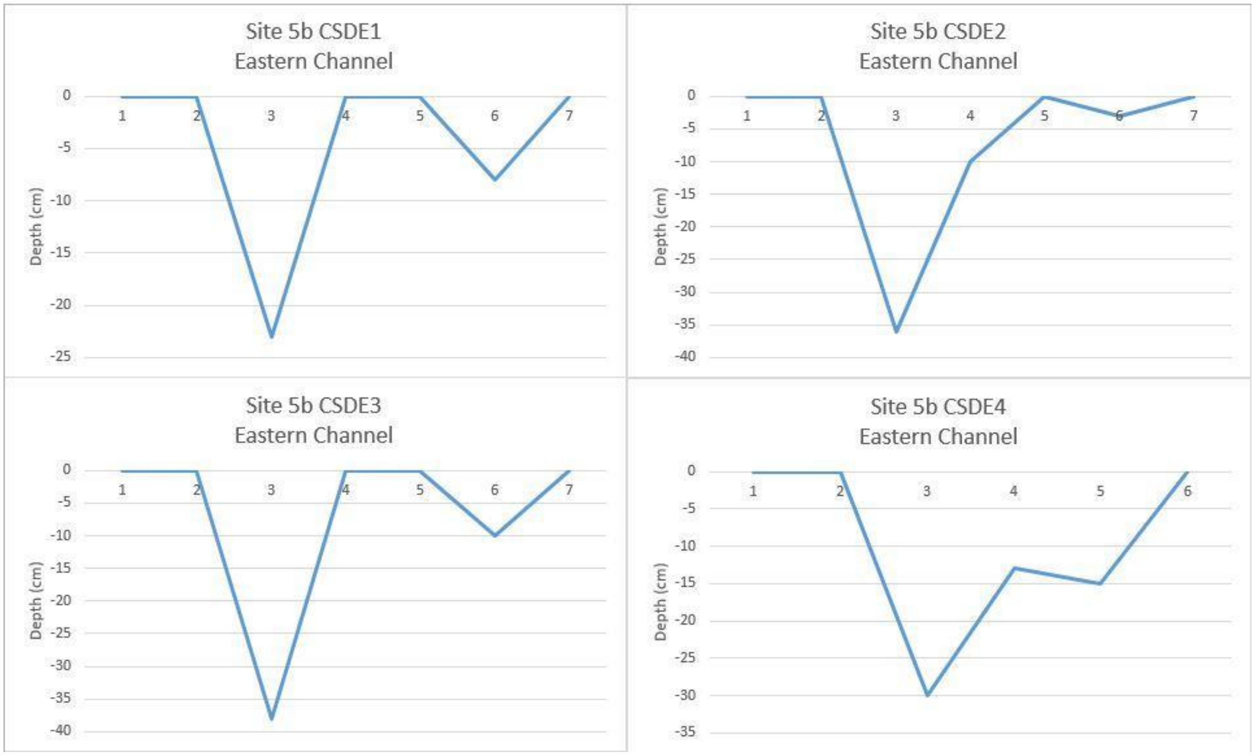
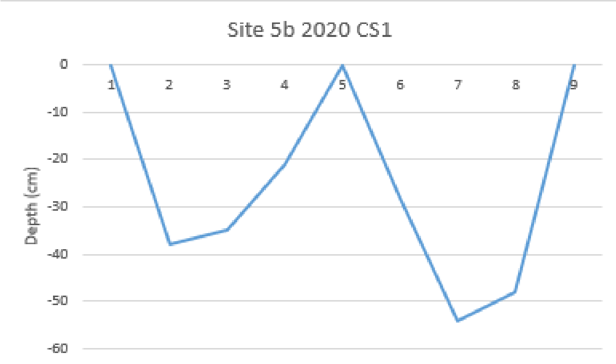
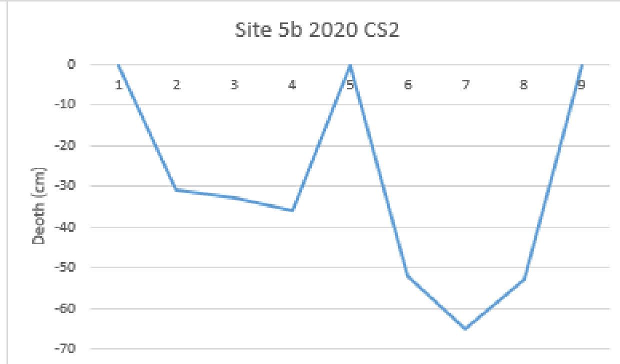
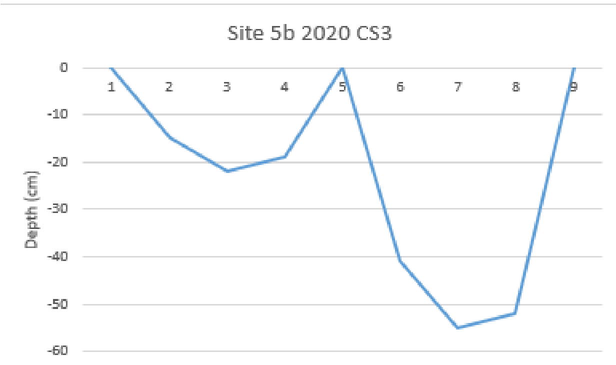



***Figure 3g.*** *Cross sectional profiles eastern channel 2015*


Site 5b 2020 CS1
Depth (cm)
0
-10
-20
-30
-40
-50
-60
1 2 3 4 5 6 7 8 9


Site 5b 2020 CS2
Deoth (cm)
0
-10
-20
-30
-40
-50
-60
-70
1 2 3 4 5 6 7 8 9


Site 5b 2020 CS3
Depth (cm)
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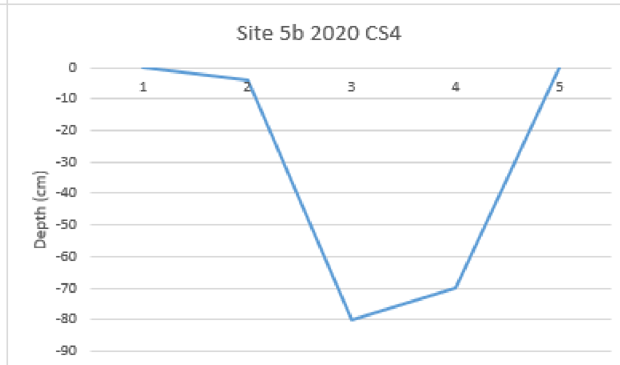
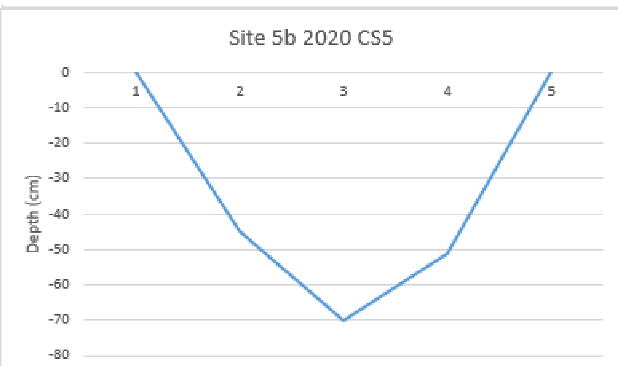
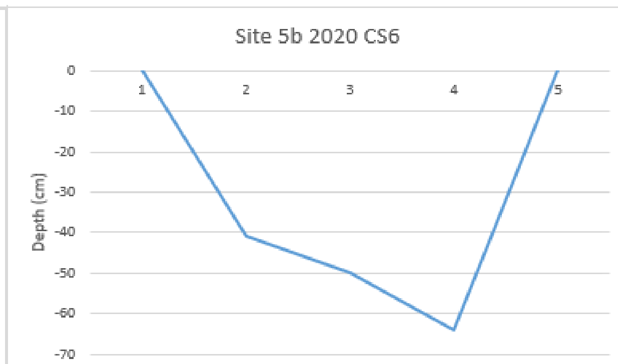
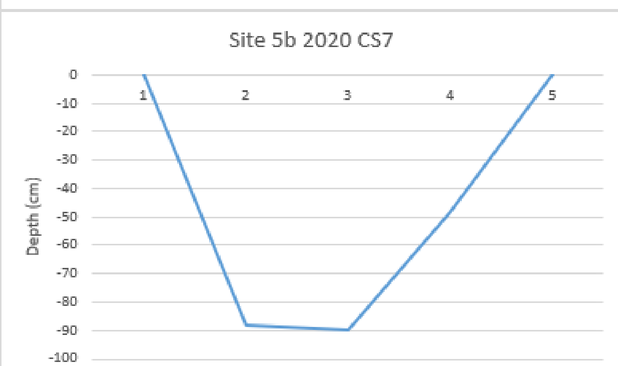
-10
-20
-30
-40
-50
-60
1 2 3 4 5 6 7 8 9


Site 5b 2020 CS4
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1 2 3 4 5


Site 5b 2020 CS5
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
-80
1 2 3 4 5


Site 5b 2020 CS6
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
1 2 3 4 5


Site 5b 2020 CS7
Depth (cm)
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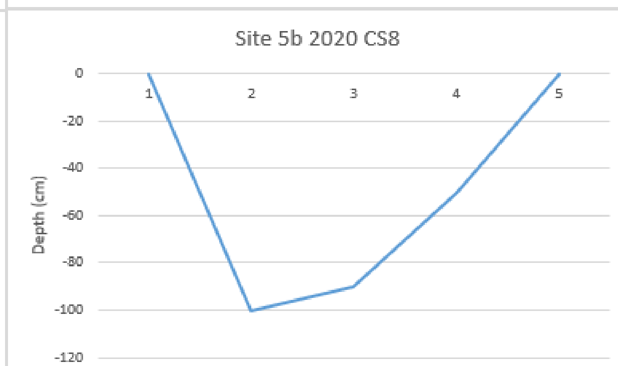
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
1 2 3 4 5


Site 5b 2020 CS8
Depth (cm)
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-20
-40
-60
-80
-100
-120
1 2 3 4 5

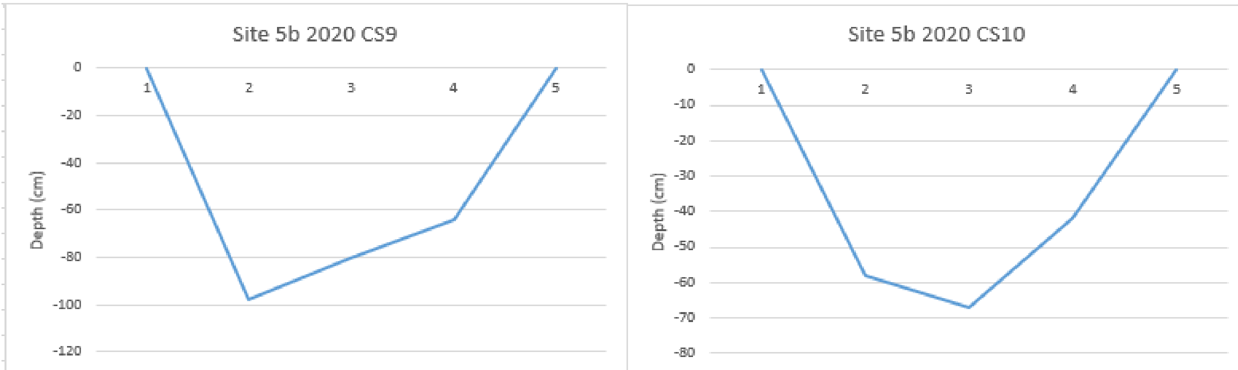


***Figure 3g-1*** *Cross sections of the eastern split 2020. Cross sections 1 through 4 are at the same location as the 2015 survey.*

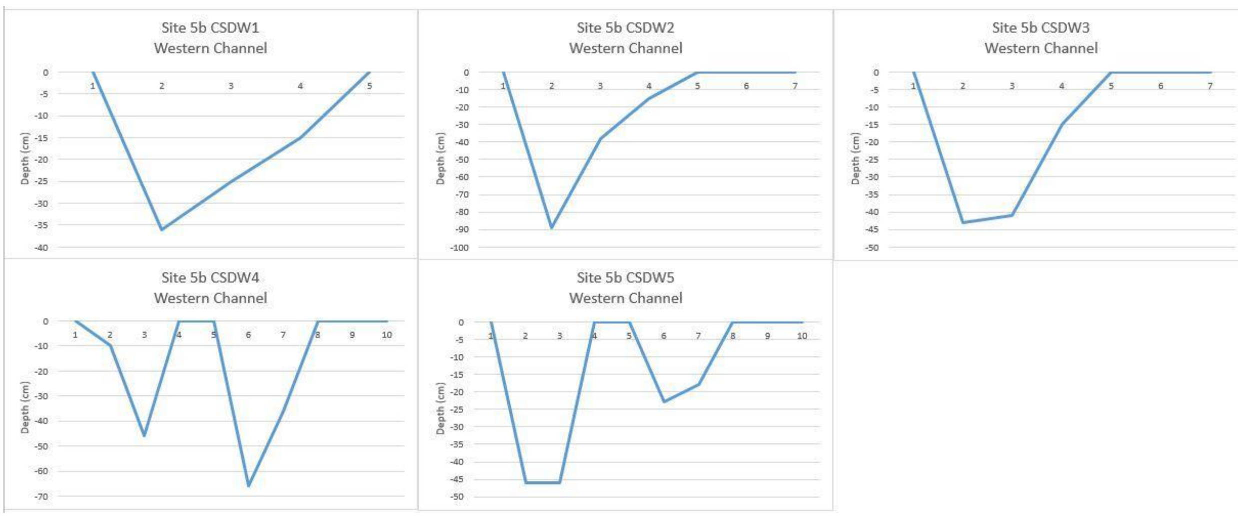


***Figure 3h**. Cross Sections of western split 2015*

## Site 5a Upstream of Cabot Trail Bridge

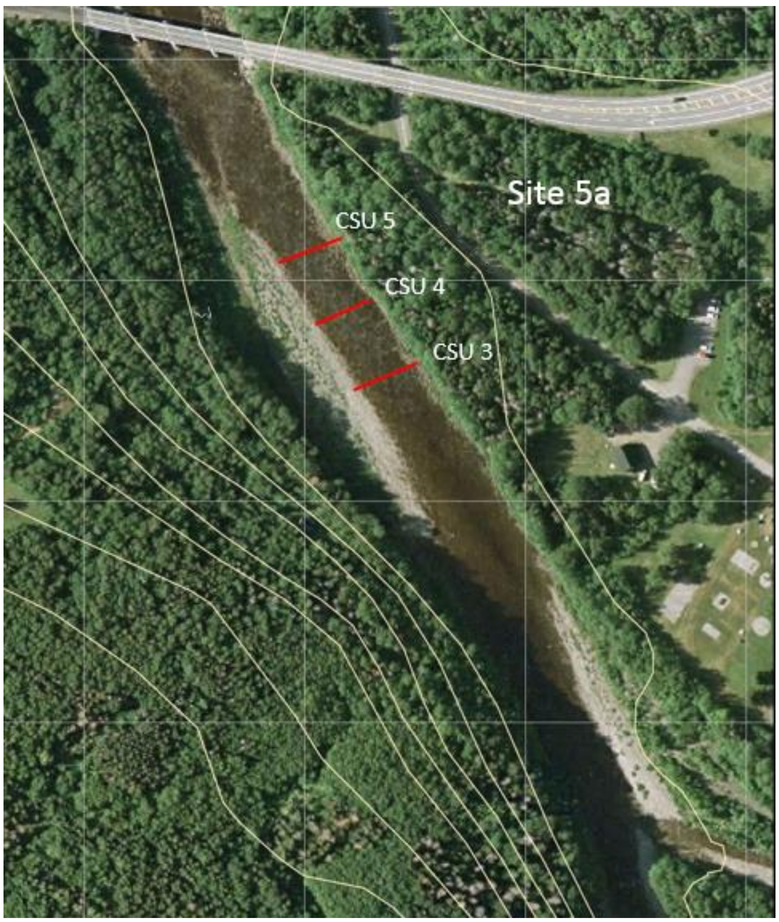


***Figure 4a.*** *Location of CS for Site 5a Upstream of Cabot Trail Bridge resurveyed in 2015*

Upstream of the Cabot Trail bridge was resurveyed in July of 2015, about a month before the flood in August. Cross sections CSU3, CSU4, and CSU5 were resurveyed, and wetted widths measured.

***Figure 4b.*** *Site 5a looking upstream from Cabot Trail bridge. Top image shows the site pre-restoration, in2013; bottom image shows the site post-restoration, in 2015*

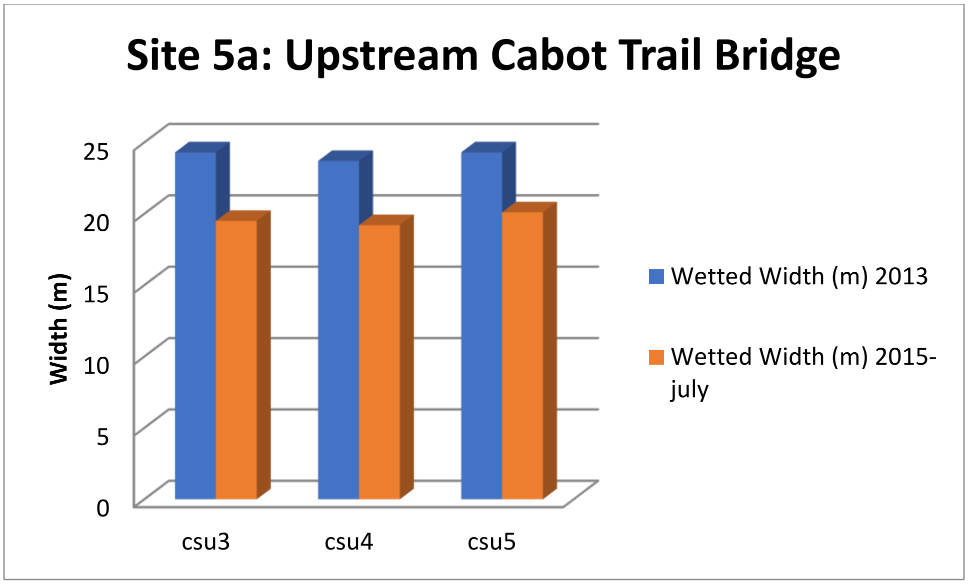


***Figure 4c.*** *Wetted widths pre and post restoration*

Figure 4c shows the wetted widths have narrowed by 19% from an average of 24m to an average of 19m. This has resulted in a deepening of the thalweg as seen in the cross-sectional profiles below (Figure 4d). CSU4 and CSU5 have a thalweg that is 20 and 10cm deeper respectively.


***Figure 4d.*** *Profiles at CSU3, CSU4 and CSU5*

## Site 4: Robert Brook

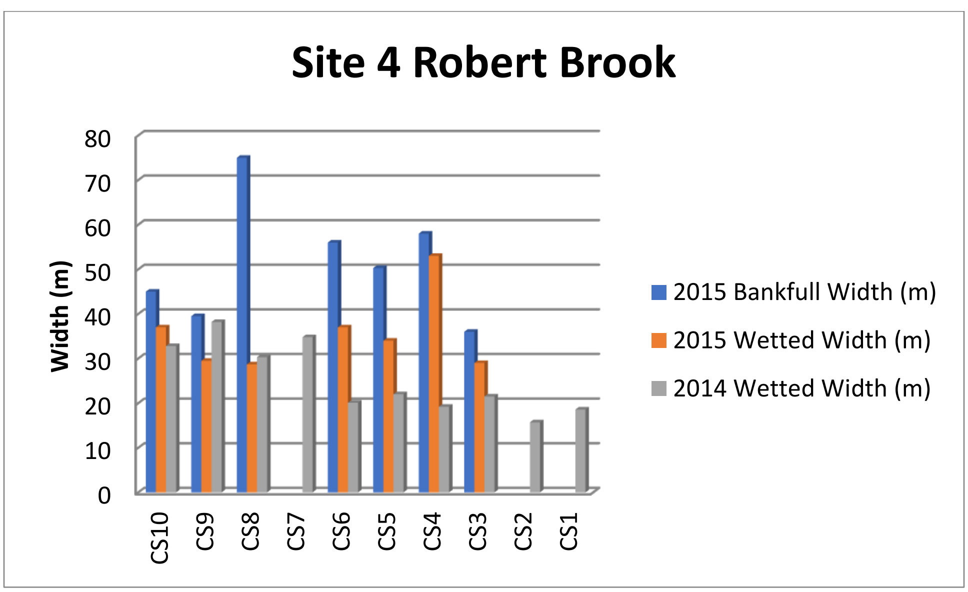


***Figure 5a.*** *Site 4: Robert Brook - wetted and channel widths*

Figure 5a displays the bankfull and wetted widths at the cross sections at Robert Brook from 2014 and 2015. Wetted widths range from 5 to over 30m wider in 2015 than in 2014. The effect of the flood flows on the bank from the access road and armour rock stockpile is evident in these wider wetted widths.

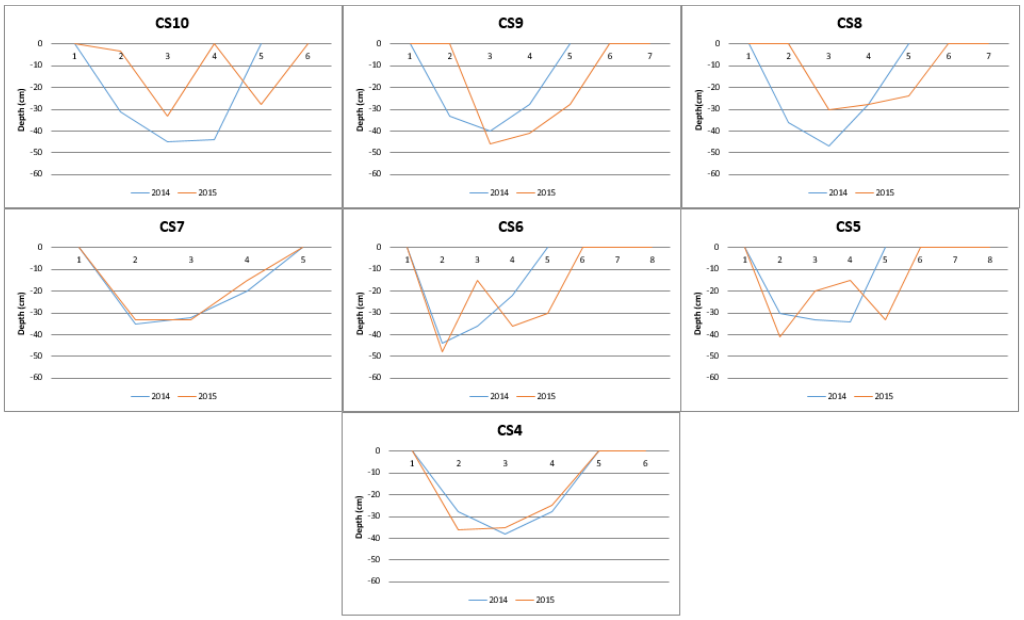


***Figure 5b-1.*** *Site 4: Robert Brook cross sectional profiles*

Figure 5b-1 shows the cross-sectional profiles at Site 4. The 2015 thalweg depth at the survey location upstream ranges from 30 to 46cm. CS10, CS6, and CS5 demonstrate the effect of large bedload deposition experienced during flooding - the development of mid channel bars and split flows. It is important to note that this survey was undertaken in September when flows are not considered to be "low flow," so the thalweg depths are generous when compared to what is expected in summer low flows. At this location, the depth of thalweg has not significantly increased from pre restoration conditions and is not near the 80cm thalweg identified as a measure of success in prior reports. Retarding bars were only just installed prior to survey and they had not had any channel forming flows on them at the time of the survey.

In 2016 Robert Brook underwent modified restoration work consisting of three sills (Figure 5b - 2,3 & 4) and repair of the breach. A deflector was built into the bank repair.


***Figure 5b-2.*** *Sill during construction in 2016*

***Figure 5b-3.*** *2016 - lower sill post installation looking downstream*

***Figure 5b-4.*** *2016 - upper sill post installation looking upstream*

## Site 3a. Petit Cap Pool


**Figure 6a** *Structure placement at Petit Cap location 2017*

The drone shot from 2016 (Figure 6a) quite clearly shows even the previously long term stable and well vegetated mid channel islands of the Petit Cap site to be disintegrating due to massive bed load deposition upstream. The western split had severe bank erosion along the entire western bank and flood flows were finding routes into the western wooded area during spring flows. The 2015 flood significantly contributed to this erosion in the western channel bank. Diagonal bars were obstructing fish passage through the site. Restoration required to block off this breech began in 2017 with the construction of a channel blocker and 3 deflectors/retarding bars. Concentration of flows through the center portion of the eastern channel was the main focus of structure placement. This location is particularly vulnerable to becoming plugged and impassable because it is at an elevation contour.

The Petit Cap site was surveyed on July 19th, 2018. Survey results confirmed that the restoration work from 2017 had an extremely positive effect on the site. Figure 6b below shows the majority of flows from the western split have been diverted into the eastern channel. The eastern channel is the dominant channel with good water depth and cover, however, there is a diagonal bar in the eastern channel at the upstream end of the island that requires additional specific restoration measures (Figure 6c). The debris jams previously blocking the eastern channel have been mostly broken up and the accumulated bedload is moving downstream. Unfortunately, the Petit Cap Pool immediately downstream of the survey area has become filled. This is a bedrock outcrop area and the bedload should continue processing through the pool as the structures continue flushing the debris jam remnants. Structures installed in 2018 should also assist in the movement of bedload out of Petit Cap Pool.

**Figure 6b** *View of the western spilt on July 19, 2018. The channel at the outlet is almost completely dry (right) and the view at the upstream end shows minimal flow*

**Figure 6c** *Looking upstream at eastern main channel at approximately cross section 10. (0% of the main flow is in the eastern channel. A diagonal bar to be addressed with restoration summer 2018*

**Figure 6d** *View looking upstream from deflector between cross sections 6 and 7*

The survey cross sections for this 2018 survey matched the cross section locations surveyed in 2014. Figure 6e below shows a comparison of wetted widths at each cross section. Wetted widths overall are considerably wider in in the 2018 survey. A combination of concentrated flows in the eastern channel, as well as bedload and debris blockages being processed through the site, account for the wider wetted width. Fortunately, in this instance the wider wetted width does not equal a shallower channel. Depths at most cross sections are considerably deeper in 2018 than they were in 2014 (see Figures 6e, 6f, and 6g).

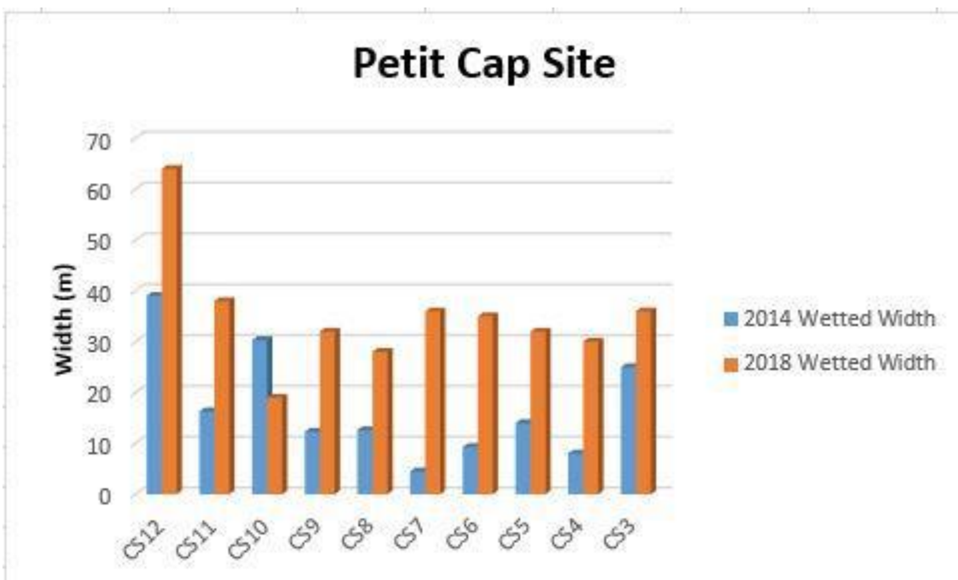


**Figure 6e** *Wetted width at cross section in Petit Cap location*

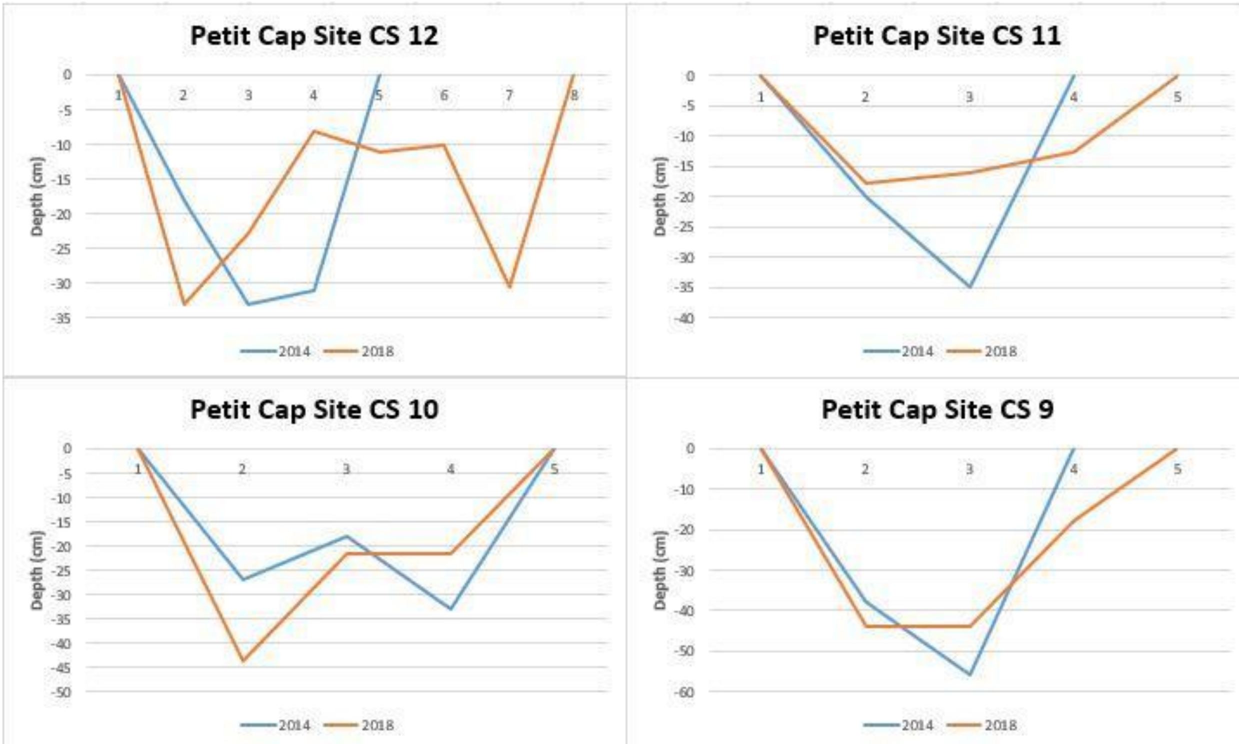


**Figure 6f.** *Cross section depth profiles from cross section 12 to cross section 9 showing depth in cm*

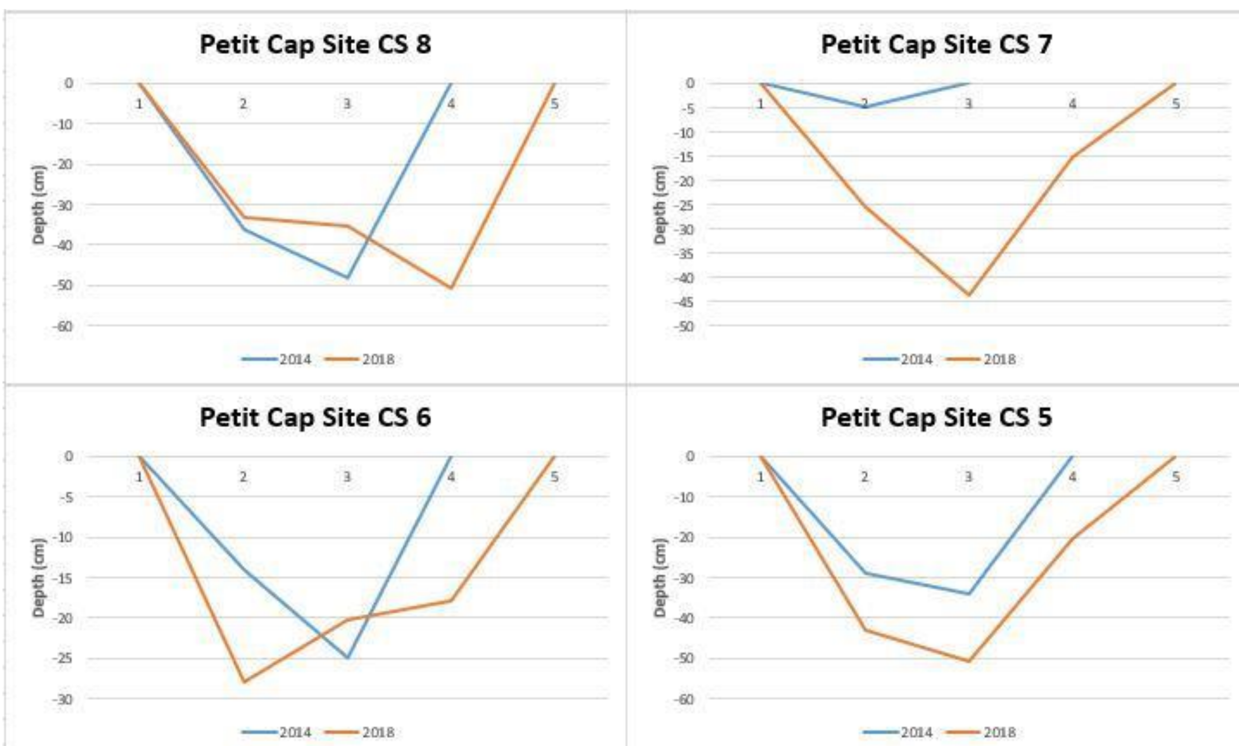


**Figure 7b.** *Cross section depth profiles from cross section 8 to cross section 5 showing depth in cm*

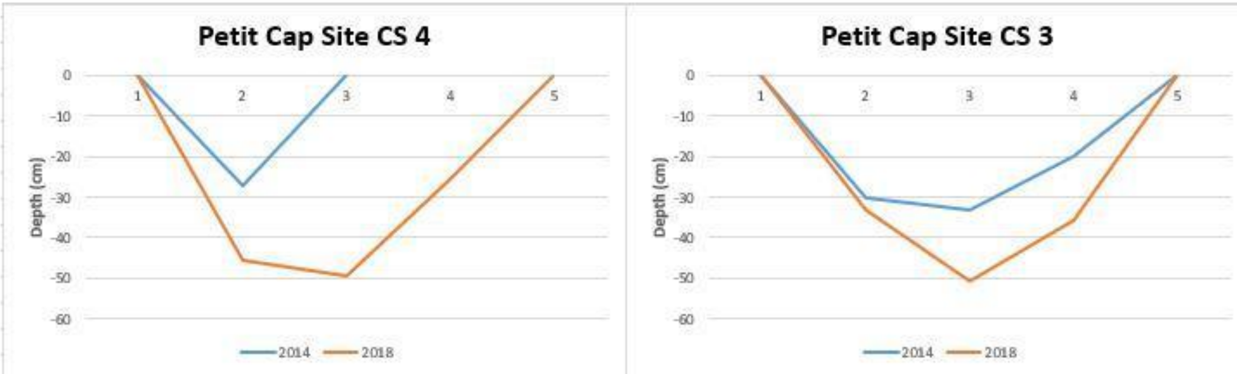

**Figure 6g.** *Cross section depth profiles for cross section 4 and 3 showing depth in cm*

The cross-sectional profiles show the areas of the Petit Cap site at the upper end of the reach have lower thalweg depths than further downstream. The thalwegs in 2018 at CS12 down to CS9 are comparable to those of 2014. This corresponds with the location of the diagonal bar yet to be addressed by restoration (Figure 6c). CS8 down to CS3 show a much deeper thalweg in 2018 than 2014; at least 20-30cm deeper than 2014. This is a considerable improvement when taking the debris jam into account. Cross section data collected in 2014 was prior to the debris jams and huge bedload deposits associated with the 2015 flood event. It is promising to see such a rapid clearing of a debris jam and sorting of excess bedload to the point of significant improvement in thalweg depths in only one year of restoration.

## Site 3 Below Fence Pool

Site 3, known as Below Fence Pool site, is located upstream of Petit Cap (Site 3a) and immediately below Fence Pool (Figure 7a). Survey cross sections for this 2018 survey matched the cross-section locations surveyed in 2014. Flow conditions were similar to the time of the stream survey in 2014. A laser level survey system was again employed to measure bottom profile and water surface elevations. Wetted width and channel width measurements were taken manually at 50m intervals. The cross-sectional profile locations matched the locations from prior year surveys.

Figure 7b below shows a comparison of wetted widths at each cross section. Wetted widths overall are considerably narrower in the 2018 survey, except for CS1 where the wetted width has increased considerably. The lower CS1 is below restoration structures and has experienced impact from the 2015 flood event. Quite a lot of bedload has been deposited in this area (Figure 7e).

**Figure 7a.** *View from the uppermost cross section of Site 3: Below Fence Pool looking up into Fence Pool*

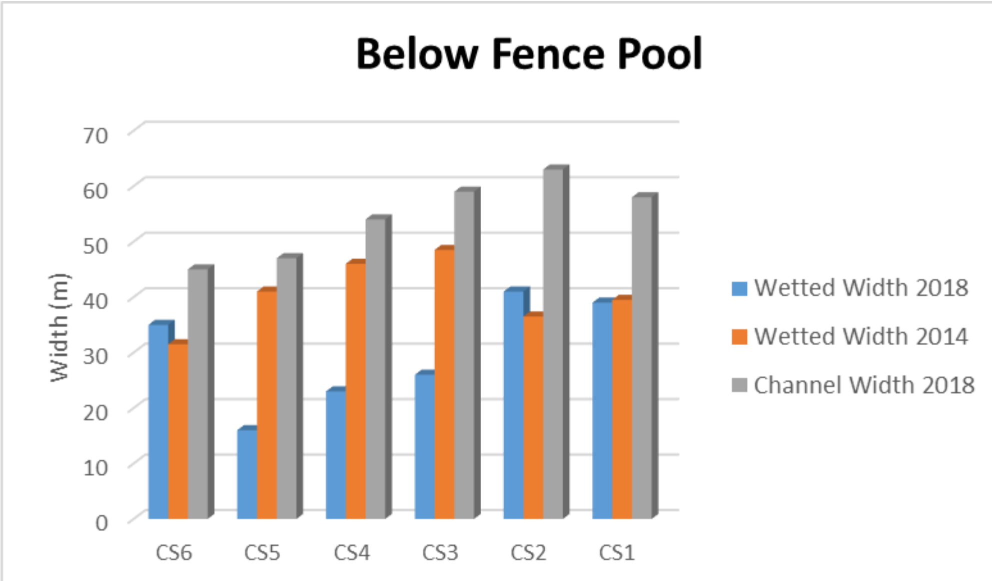


**Figure 7b.** *Wetted widths at cross sections in Site 2: Below Fence Pool site*

The cross-sectional profiles show the areas of the lower Fence Pool site to have improved thalwegs from 2014 to 2018 (Figure 7d). CS5, CS4, and CS3 demonstrate nicely the development of a high-quality pool of depths ranging from 60 to 100cm (Figure 7d). This pool is at the outside of a turn where most stable pools are found and the wetted widths are narrowest at these 3 cross sections (Figure 7d). As noted above, the farthest cross section downstream (CS1) shows a very over widened channel with a large amount of bedload deposition and large mid channel bar. Plans for restoration at CS1 for 2018 included a large sill spanning the width of the river, however, due to budget constraints a small deflector was constructed instead. Overall, this site is remaining stable and the paired deflectors at CS6 at the top end of the site are holding Fence Pool proper quite nicely.

**Figure 7c.** *Excellent quality pool in Site 3: Below Fence Pool*

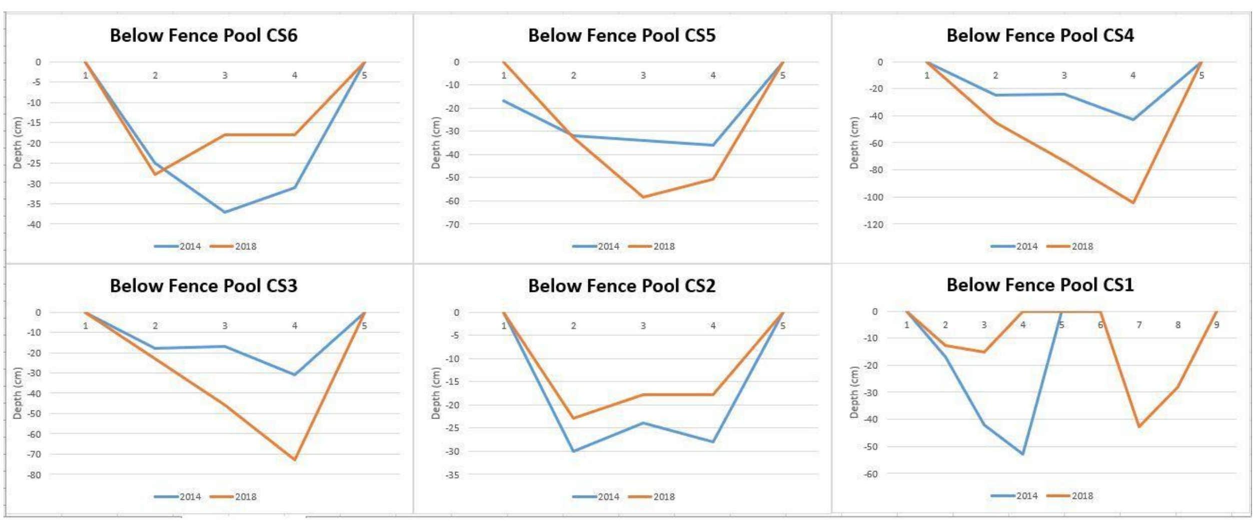


**Figure 7d.** *Cross sectional profile Site 3 Below Fence Pool*


**Figure 7e.** *View upstream through Site 3: Below Fence Pool from CS1. This is the cross section farthest downstream and contains a large midchannel bar*

## Site 2 Above Fence Pool

**Figure 8a.** *Site 2 Above Fence Pool August 2018 (left), September 2015 (right)*

Flow conditions were similar to the time of the stream survey in September 2015. A laser level survey system was again employed to measure bottom profile and water surface elevations. Wetted width and channel width measurements were taken manually at 50m intervals. The cross-sectional profile locations matched the locations from prior year surveys.

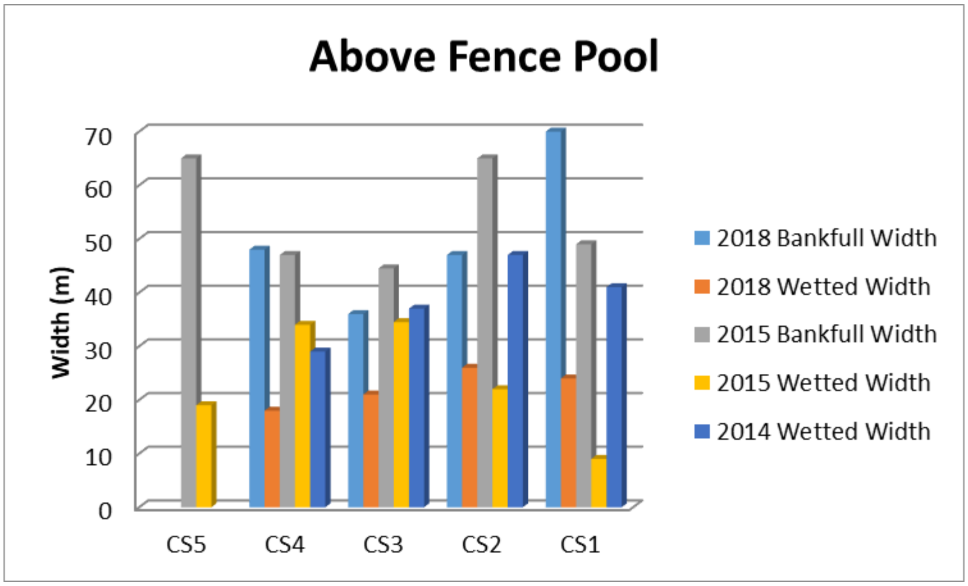


***Figure 8b.*** *Bankfull and wetted widths. Site 2: Above Fence Pool*

Wetted widths for Site 2: Above Fence Pool have significantly narrowed post restoration (see Figure 8b). At this site, restoration structures were completely installed prior to the flood event of August 22, 2015, and so the deflectors were able to function as designed to process sediment through the site and maintain the desired channel morphology. Improvement in narrowing from 2014 to 2015 continues to be stable. The 2018 survey shows wetted widths are holding steady on average. CS3 and CS4 have narrowed from 2015, while CS2 and CS1 have widened slightly.

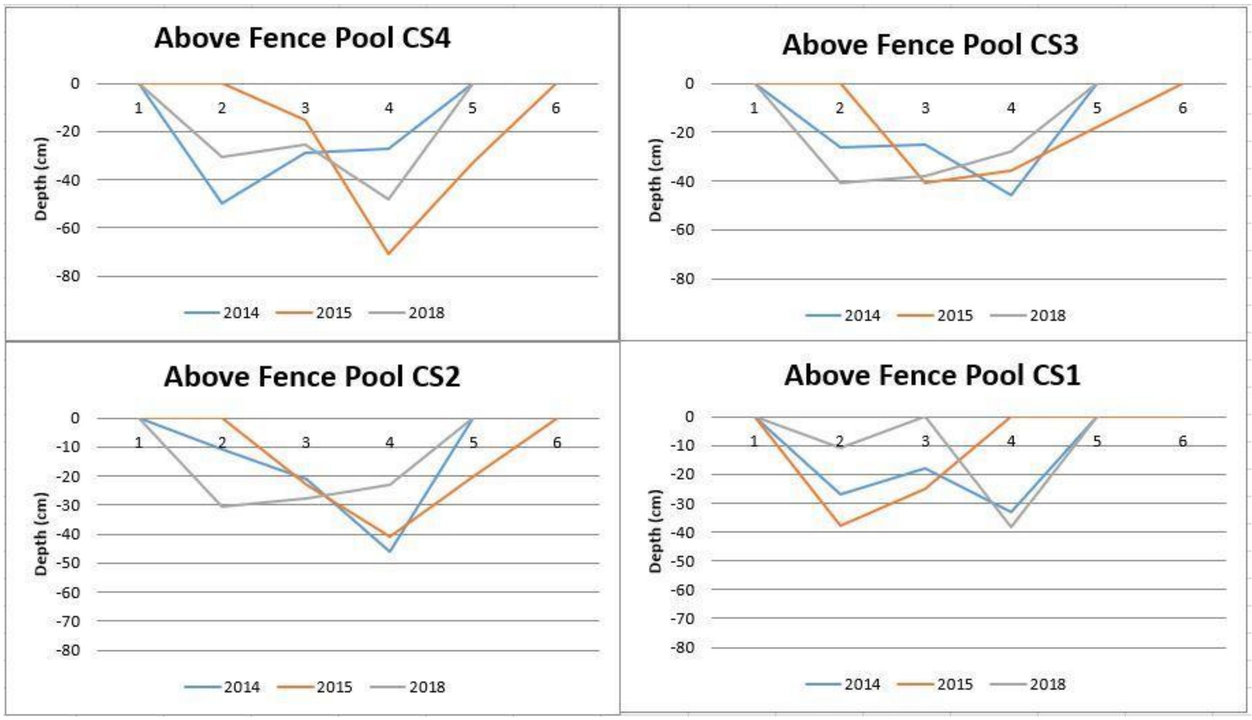


***Figure 8c.*** *Cross sectional profiles Site 2: Above Fence Pool*

The cross-sectional profiles for Site 2: Above Fence Pool show the thalweg (see Figure 8c) and defined channel of 2015 is holding steady; the comparison photos of the site in 2018 and post restoration 2015 (Figure 8a) show this quite well. When compared to the picture of the site in 2014 vs 2015 (Figure 8d), the stability of the watercourse and ability it now has to process bedload is evident. This is proving key to maintaining the depth and quality of Fence Pool (Figure 8e).

**Figure 8d**. *Looking upstream from Fence Pool at Site 2. 2014 left photo and 2015 right photo*

**Figure 8e**. *Fence Pool 2018*

## Site 1: Faribault Brook Location

The restoration work that is required in this section was unfortunately not completed during the restoration work of 2015 as initially planned. Bad weather and budget issues delayed getting into this remote site with machinery. Instead, the restoration structures were installed during the 2017 and 2018 seasons. This cross sections previously surveyed in 2014 were resurveyed in 2015 (where accessible) as it was anticipated that the rain even in August 2015 would have an effect on the stream profile. 2014 and 2015 data both represent a “pre-restored” picture of the Cheticamp River at the confluence of Fairbault Brook. The high bedload source from both slope failures in the main channel of the Cheticamp River upstream, and Faribault Brook itself, is quite unstable and continues to move through the site. Elevations were recorded at depth of bottom and at the water surface at intervals across each cross section. The survey overview below (Figure 9b) shows the thalweg pre-restoration is divided by mid channel bars both above and below the confluence of Faribault Brook with the Cheticamp River. This general profile has completely changed post restoration. The channel upstream of the entrance of the Faribault Brook moved westward in 2015 and the thalweg has remained on the western side and is encouraged by the deflectors built on the eastern bank upstream. The wetted width of the Cheticamp River below Faribault Brook has narrowed nicely and the pool depth at this location is such a depth that the CS5 channel data is incomplete due to the surveyor being unable to wade through the pool to get wetted or channel measurements. Figure 9b shows the profiles of cross sections in the location of Site 1. The thalweg depth at the survey location pre-restoration ranges from 25 to 70cm. Remember that the 2014 and 2015 surveys were completed in the fall at a time of deeper flows and underestimate the poor passage that was evident during low flows. After the stone deflector installation, the 2020 survey (August 9, 2020) shows the thalweg ranges from 25 to 140cm. The pool quality at Fairbault Brook is now excellent. The pool is deeper, has extended downstream, and flows into a quality run habitat. There is no longer a mid-channel bar upstream of the pool and the channel downstream of Fairbault Brook is no longer plugged with sediment. Bankfull channel widths and wetted channel width are both generally narrower now (Figure 9a).

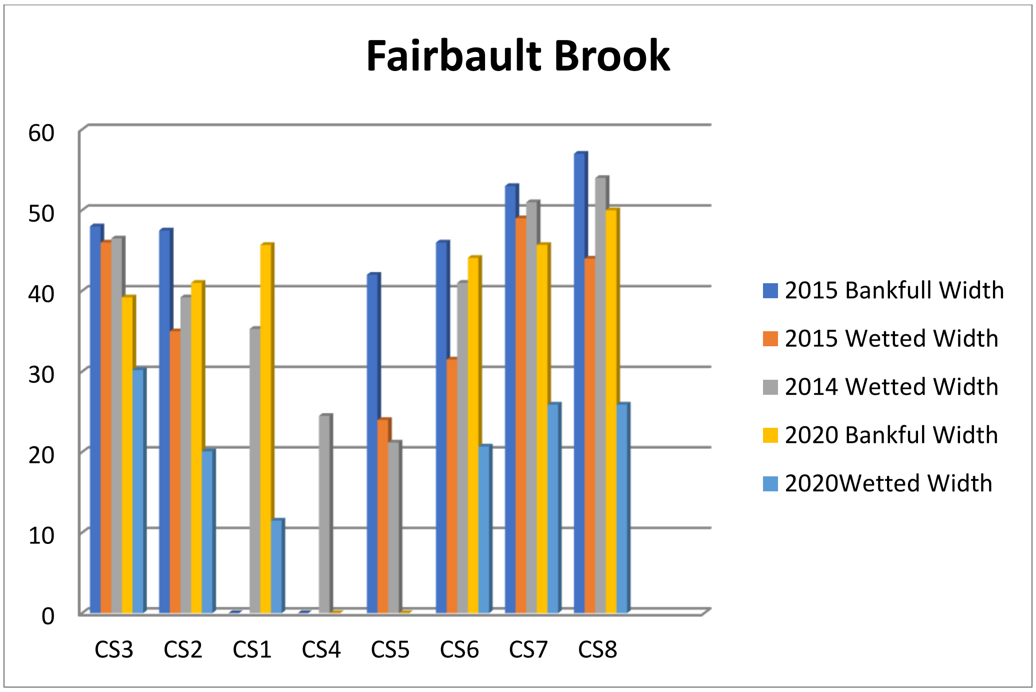


***Figure 9a.*** *Bankfull widths and wetted widths Site 1: Faribault Brook*

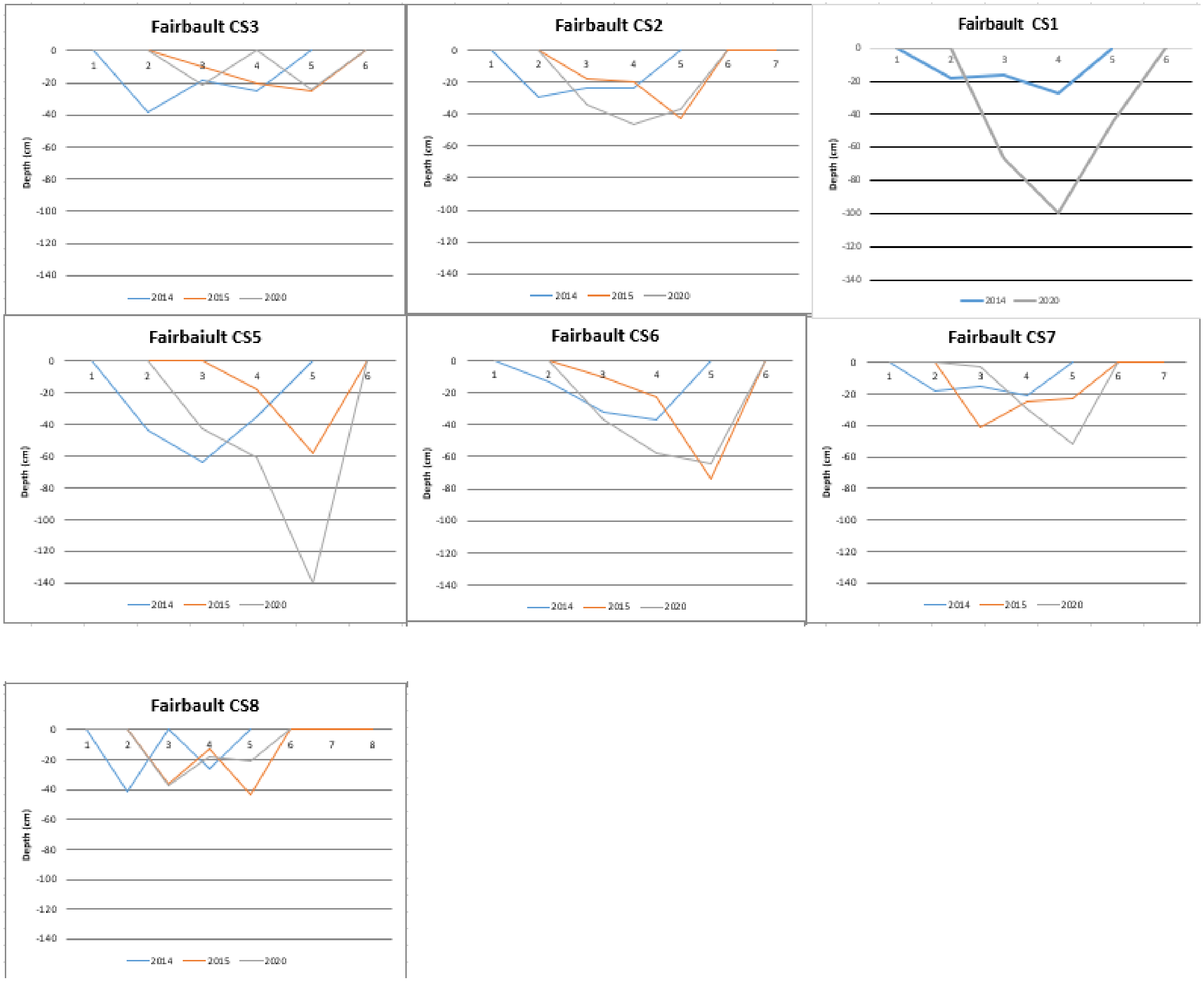


***Figure 9b.*** *Cross section profiles Site 1: Faribault Brook, 2014, 2015, and 2018*

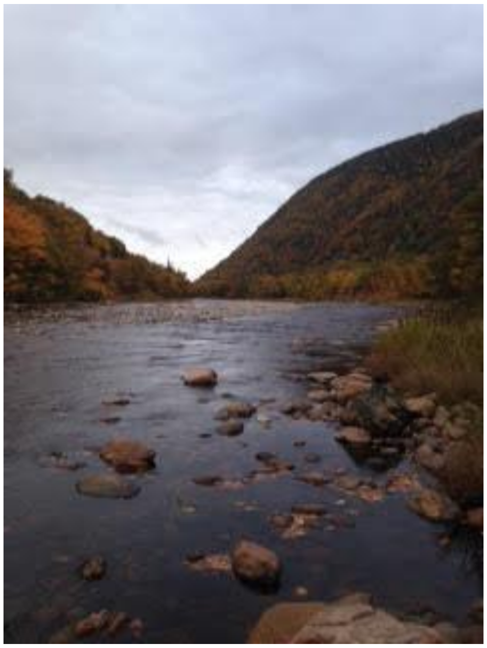

**Figure 9c**. *Looking downstream at the mid channel bar at cross section 8*

**Figure 9d**: (Left) *Looking upstream in Cheticamp River from Faribault Brook at location of mid-channel island.* (Right) looking at the set of deflectors installed in the same location, 2020

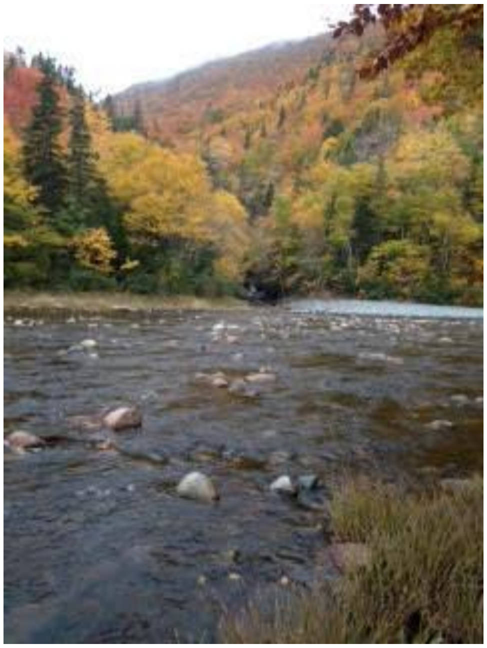

**Figure 9e**. (Top) *Looking across at the entrance of Faribault Brook into the Cheticamp River. 80% blocked with bedload. (Bottom) looking up at the clear access and new pool at the same location in 2020 at the outlet of Fairbault Brook*

# Discussion

## Measuring Success of the Project

At the outset of the project in 2014, the authors advised the Cheticamp River Salmon Association of the various ways to evaluate the success of restoration works. There are three ways we previously recommended measuring success of this restoration project:

1) Assess if fish are able to navigate these sections of river and ascend unimpeded. Methods to assess this include angler records, direct observation of fish, and/or evidence of spawning via redd counts.

2) Measure the thalweg at sites chosen for restoration at 2-year intervals for 6 years. The goal is to deepen the thalweg to 75-85cm during low flows.

3) Measure the channel width along the length of the restoration sites annually to track how it changes. Once the channel width has narrowed to the design width of 38m it will be considered a success. If the channel width does not narrow to the design width, but fish are able to ascend and the thalweg is sufficiently deep to facilitate this, the project should still be considered a success.

At the reach scale, habitat heterogeneity is crucial to provide the required conditions for all life stages to be successful; specifically, adult salmon habitat selection is related to pools before and after spawning while juvenile success is related to riffles (Baglinière, 2000). Salmon must be able to access pools in order to complete the spawning activity and in this aspect the project was a success.

The overall increase in the quality and depth of pools as well as the increase in depth of thalweg (providing access to pools during adult migration periods) in the lower Cheticamp River over the course of 7 years has increased access for Atlantic salmon. This has been observed by anglers of the Cheticamp River:  the salmon fishing is much improved from 2012 when no salmon were able to ascend the lower Cheticamp. This is also evidenced by spawning activity. In 2012 there was virtually no evidence of redds in the entire lower Cheticamp River. A redd count undertaken in 2019 by Charles MacInnis documented 35 Atlantic salmon redds in a 2km stretch of river centered around the Fairbault Brook site. Also worthy of mention, several brown trout redds were also noted in spawning areas typically selected by trout. In the opinion of the authors, this meets the first measure of success outlined in *Lower Cheticamp River Habitat Assessment and Restoration Recommendations: Part 2 November 2014.*

The second measure of success detailed in the initial report (Goff-Beaton & MacInnis 2014) is to deepen the thalweg to 75-85cm during summer low flows. As seen in Figure 10a below, the average thalweg depths have not quite deepened to the desired 75-85cm, however, the overall trend has been an increase in the average thalweg depth after restoration. The individual thalwegs at each cross section for each location are available in the site-by-site restoration summary. It is interesting to note that sites with the most time between the pre and post-restoration surveys (Site 5b -Below Cabot Trail Bridge and Site 1-Fairbault Brook) have the greatest improvement in thalweg depth. Site 5b was surveyed in 2013 and 2020. Site 1 was surveyed in 2015 and 2020. This could be attributed to more seasonal flood flows being directed by the restoration structures to do progressively more structural improvements to the streambed profile. As with most well-designed restoration plans, the structures continue to improve stream profiles over time and then blend into the landscape. This is what we are seeing in many of the sites in the lower Cheticamp. The document *Guidance for Stream Restoration* (Yochum, 2018) discusses the longevity and effectiveness of restoration structures and notes that in 2002 over 70% of 70-year-old wooden habitat structures are *still* effective and functioning to provide a habitat benefit.

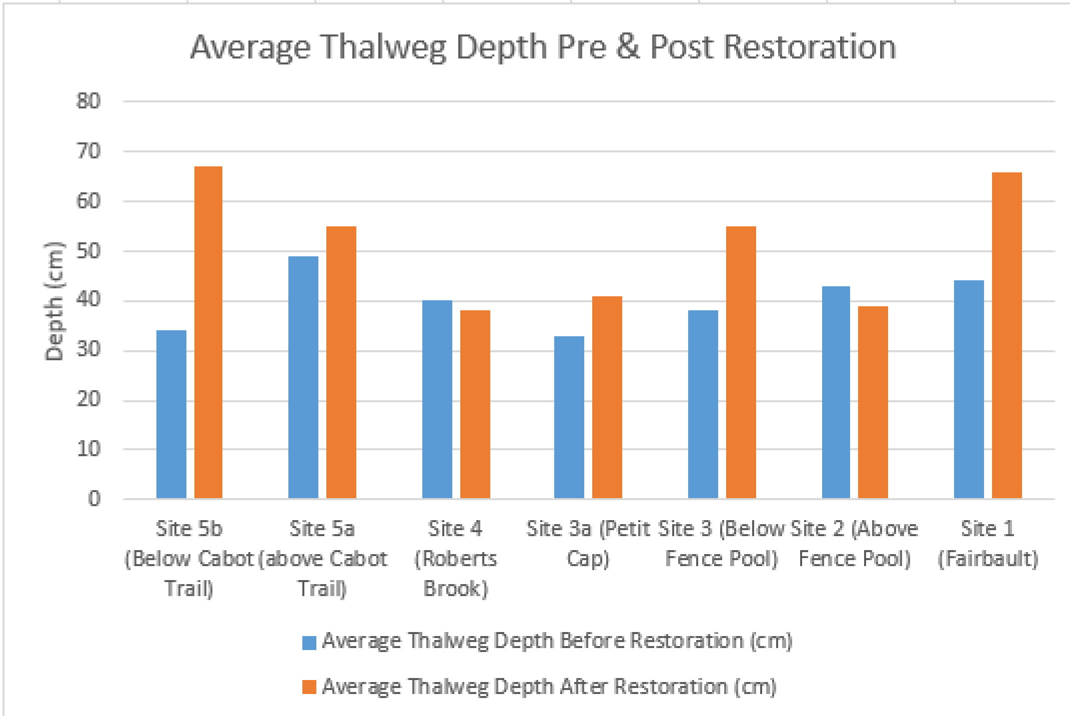


***Figure 10a***. *Average thalweg depths by restoration site pre and post restoration*

The final measure of success laid out by the authors in the initial restoration plans was to take channel measurements annually with a goal to narrow the channel width to 38m, which is the design channel width calculated using restoration hydrology design principles. Figure 10b below shows the average channel width at most of the sites. Due to time constraints, these measurements were not taken annually but at most sites they were recorded in pre-restoration surveys and again in a post-restoration survey. The Petit Cap (Site 3a) is not included in the chart because bankfull distance is so great in that area and obscured by an island that measurements were not taken. Bankfull channel widths were not taken pre-restoration at Robert Brook (Site 4) and Below Fence Pool Site (Site 3), however, post restoration bankfull widths are included in the chart. The design channel width of 38m has not yet been attained but there is a significant narrowing of the bankfull channel at all sites in the few short years between the pre and post measurements. The authors believe this will only improve over time as more flood flows help to sort sediments and deepen the thalweg. As well, because the longitudinal connectivity of the lower Cheticamp River has been restored and fish can ascend unimpeded and some narrowing of the bankfull width has occurred, we are inclined to state the project also meets the third pre-stated measure of success and fully expect to see the bankfull width narrow in the restored sections.

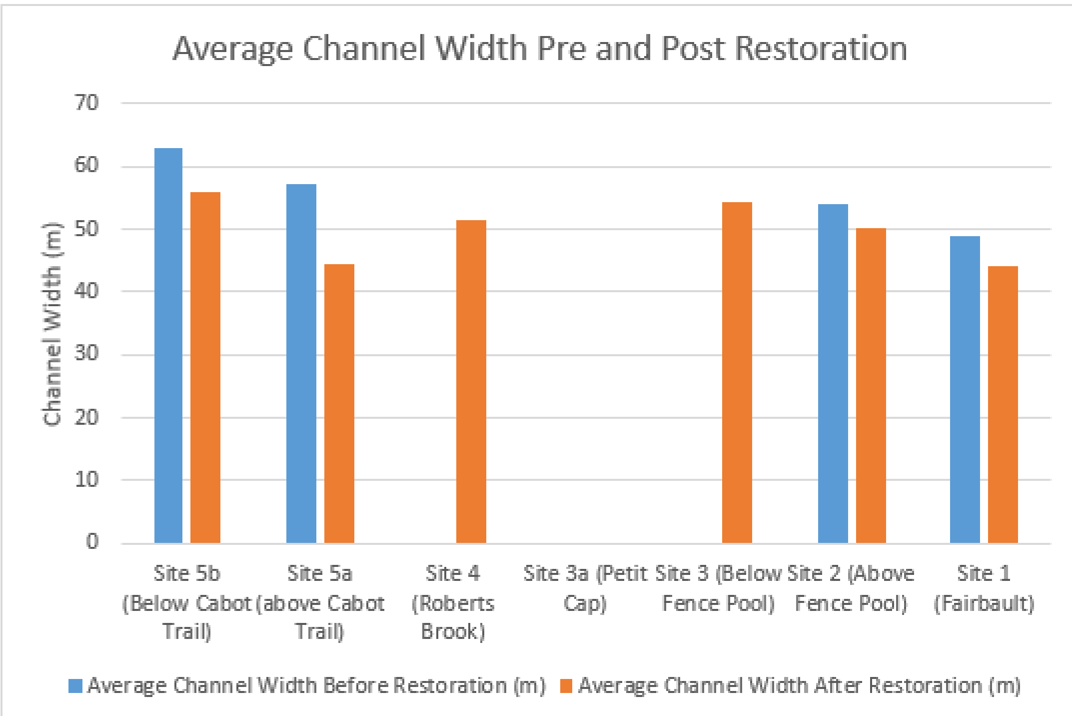


***Figure 10b.*** *Average channel widths by restoration site pre and post restoration*

## Thanks

The Cheticamp River Salmon Association wishes to thank the following organizations for their generous financial support, interest, and assistance to improve Atlantic salmon habitat in the lower Cheticamp River throughout this ambitious project. Without their support, this restoration project would not be possible!

Cape Breton Highlands National Park

Atlantic Salmon Conservation Foundation

Nova Scotia Salmon Association's Adopt-a-Stream Program

Atlantic Canada Opportunities Agency

DFO's Recreational Fisheries Conservation Partnership Program

Atlantic Salmon Federation

Atlantic Water Network

Nova Scotia Power

Tag You're It! Conservation Funding Program

Clean Foundation Leadership Program

Young Canada Works Program

Canada Summer Jobs Program

Sue and Graham Smith

Royal Bank of Canada Cheticamp branch


*Charles MacInnis (restoration designer), Archie Doucette (Parks Canada), Jillian Baker (CRSA)*

*Aerial photo above Fence Pool, post restoration*

*Site 5a. Restoration structures during installation, completed structure in the foreground*


*Archie Doucette (Parks Canada), Rene Aucoin (CRSA), Charles MacInnis (restoration designer)*


*Catherine, one of many students employed over the years and learning about fish habitat restoration*

*So many funders to thank! Archie Doucette, Jillian Baker, and Charles MacInnis standing at a nicely narrowed reach of the river downstream of Cabot Trail bridge (Site 5b)*

*Fresh air, biology, and hard work for these students!*

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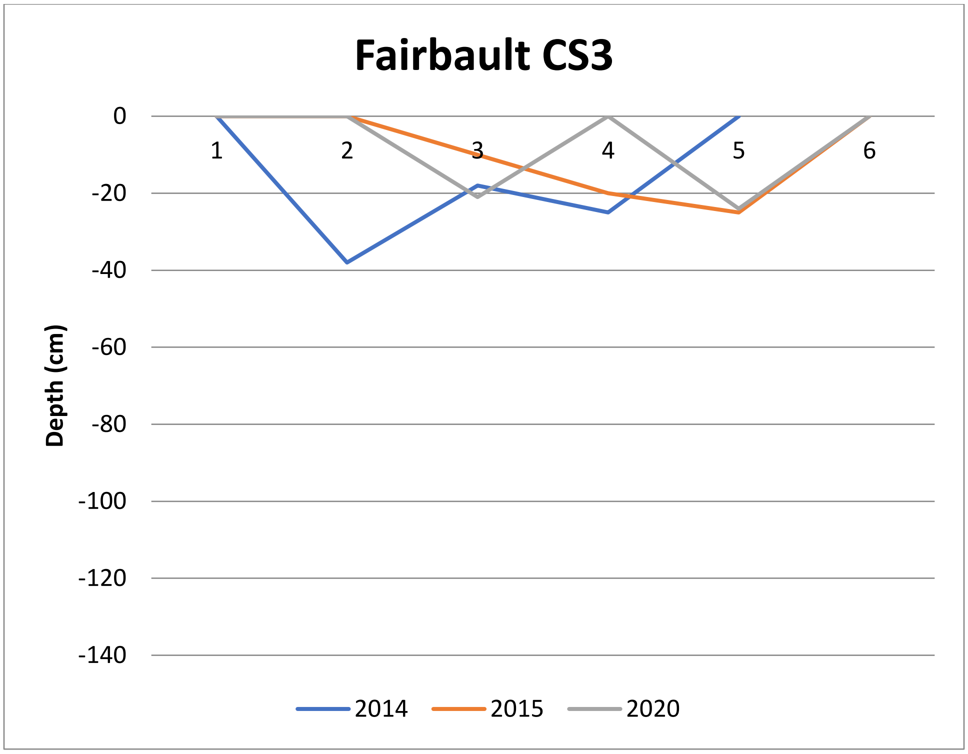
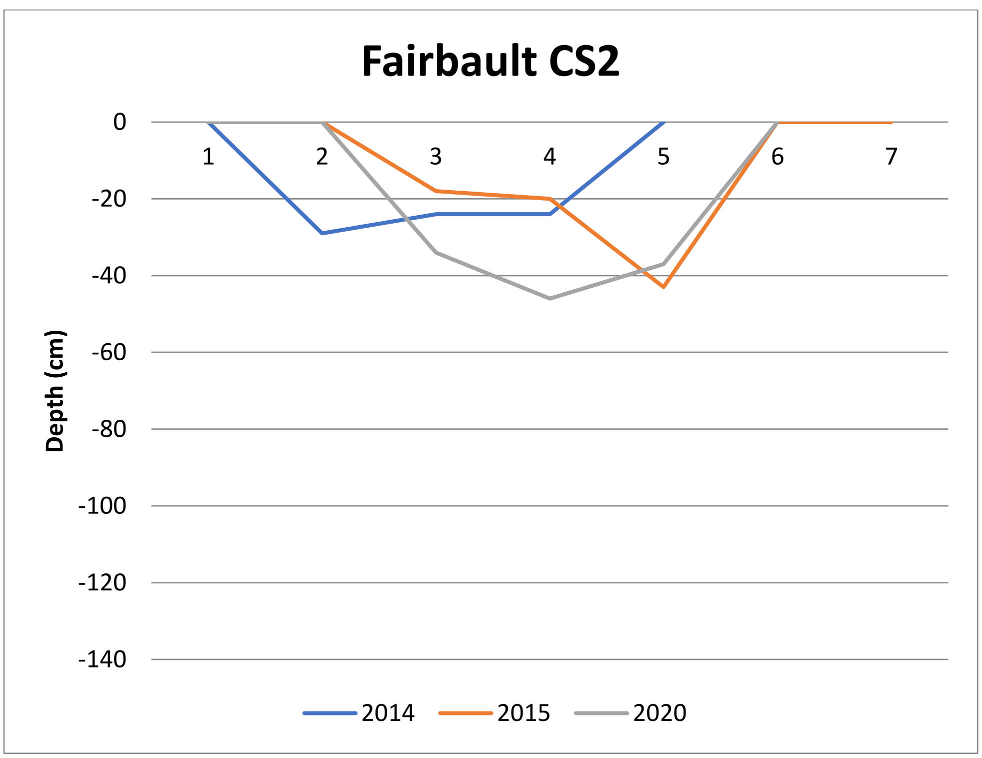
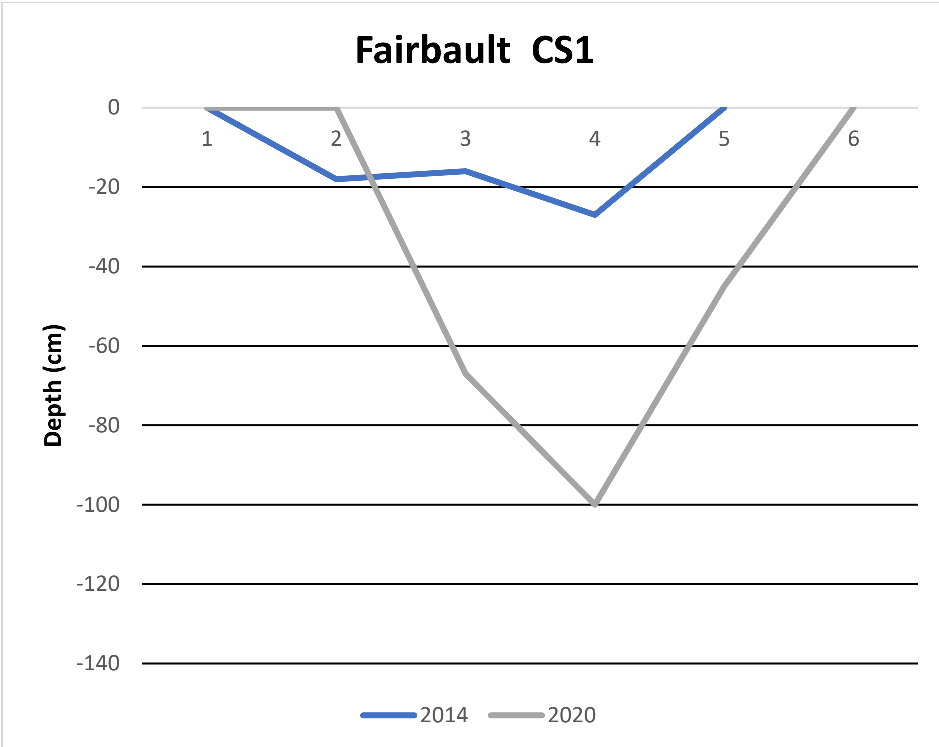
# Appendix

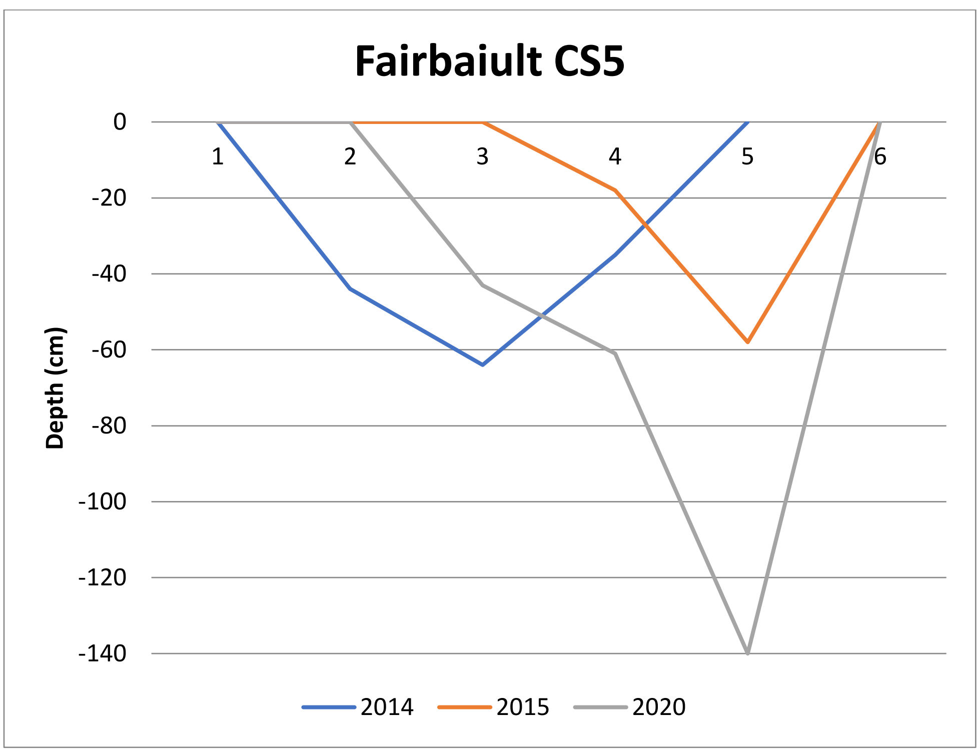
# Wetted Width Depth Profiles

## Site 1 - Fairbault Brook




Fairbault CS1
Depth (cm)
0
-20
-40
-60
-80
-100
-120
-140
1
2
3
4
5
6
2014
2020


Fairbaiult CS5
Depth (cm)
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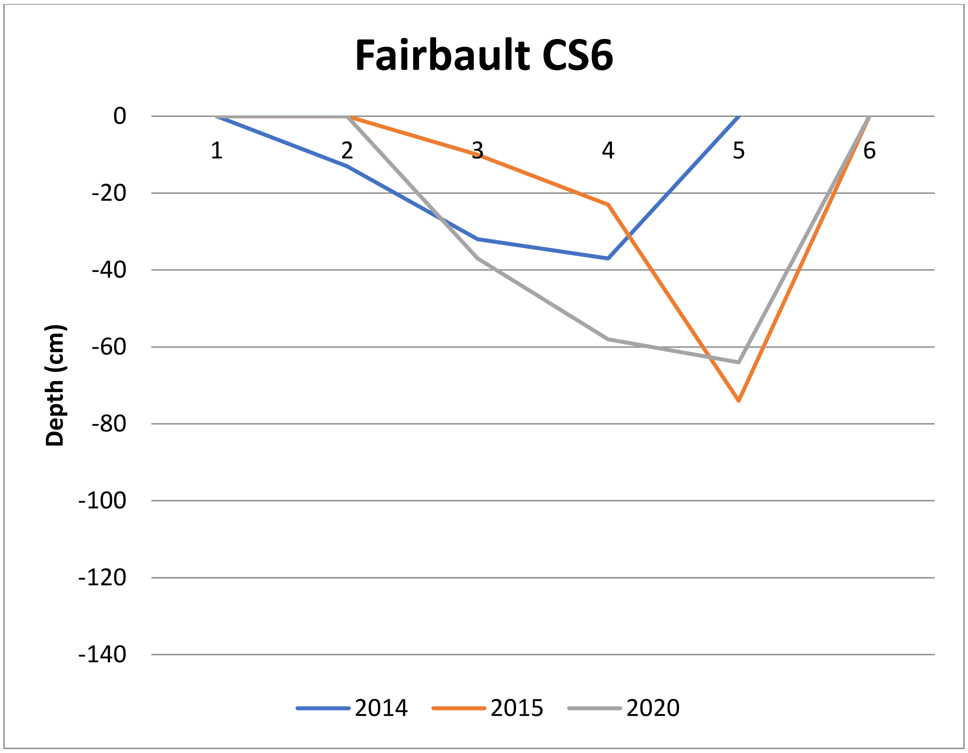
-60
-80
-100
-120
-140
1
2
3
4
5
6
2014
2015
2020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0
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Depth (cm)
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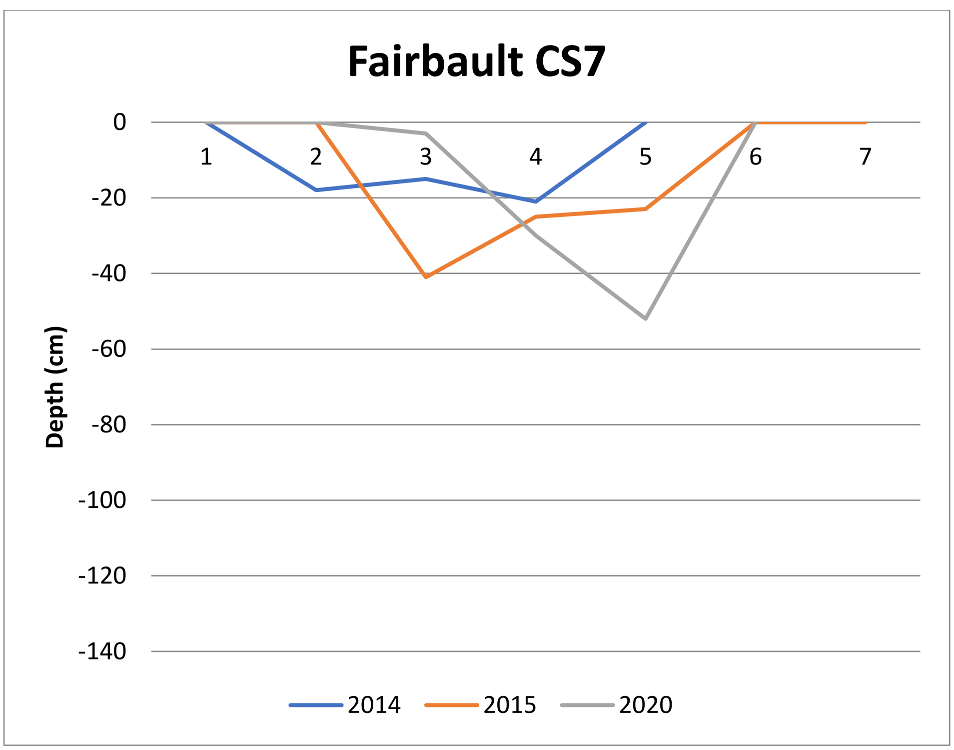
2
3
4
5
6
2014
2015
2020


Fairbault CS7
0
-20
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-60
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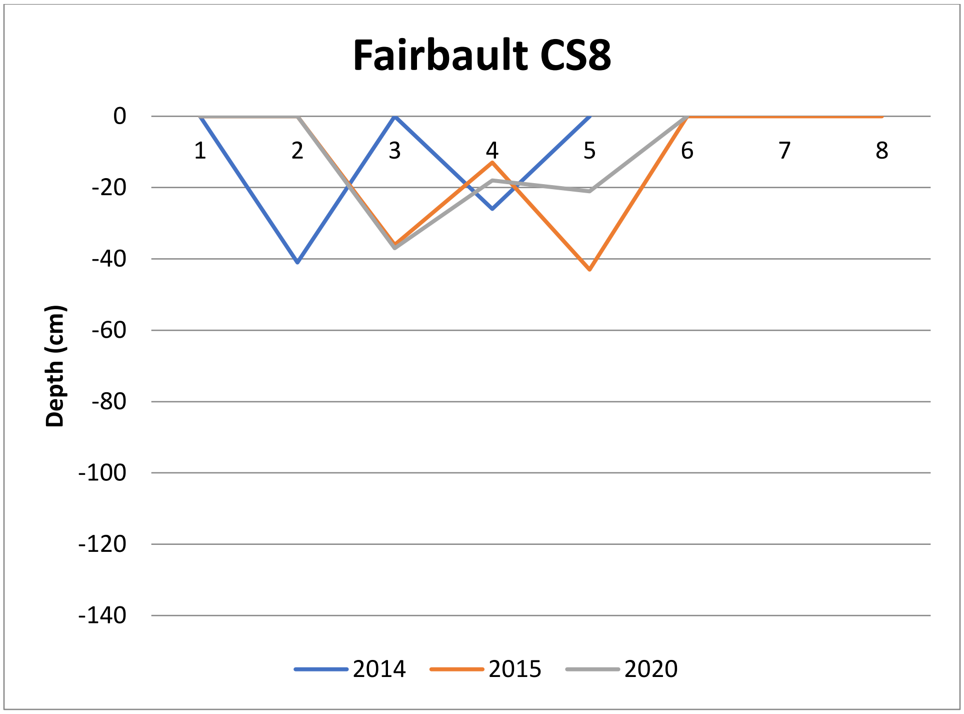
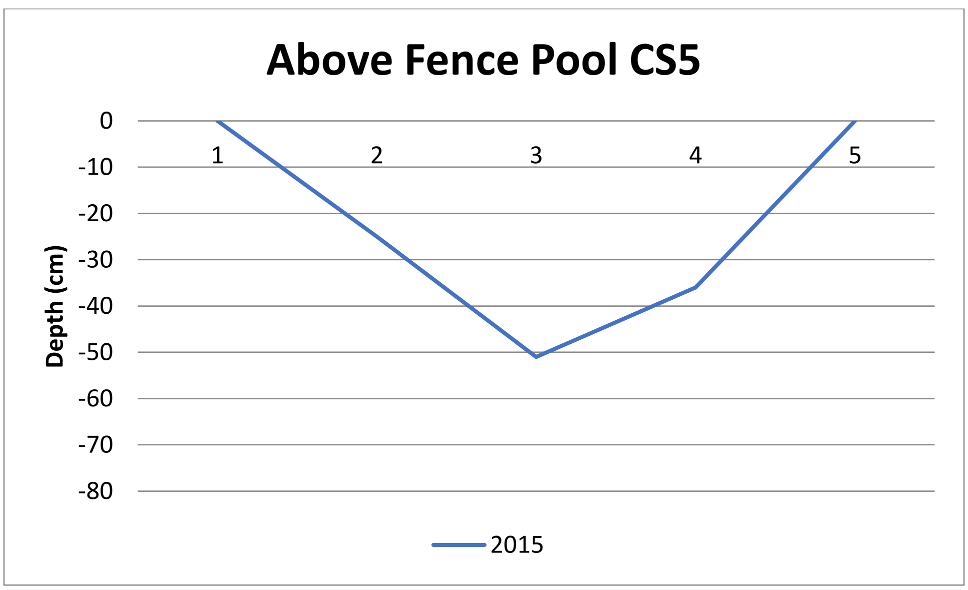
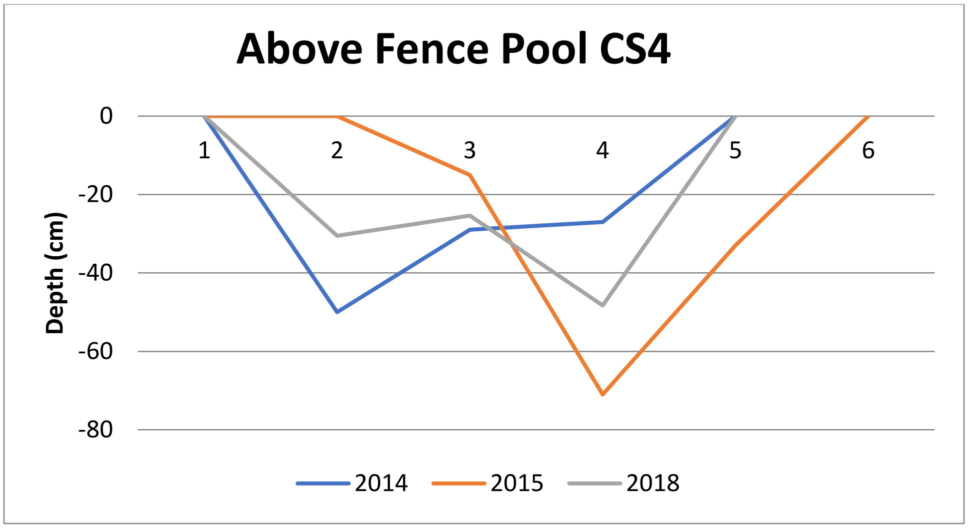
-100
-120
-140
Depth (cm)
1
2
3
4
5
6
7
2014
2015
2020




**Site 2 -Above Fence Pool**




Above Fence Pool CS4
Depth (cm)
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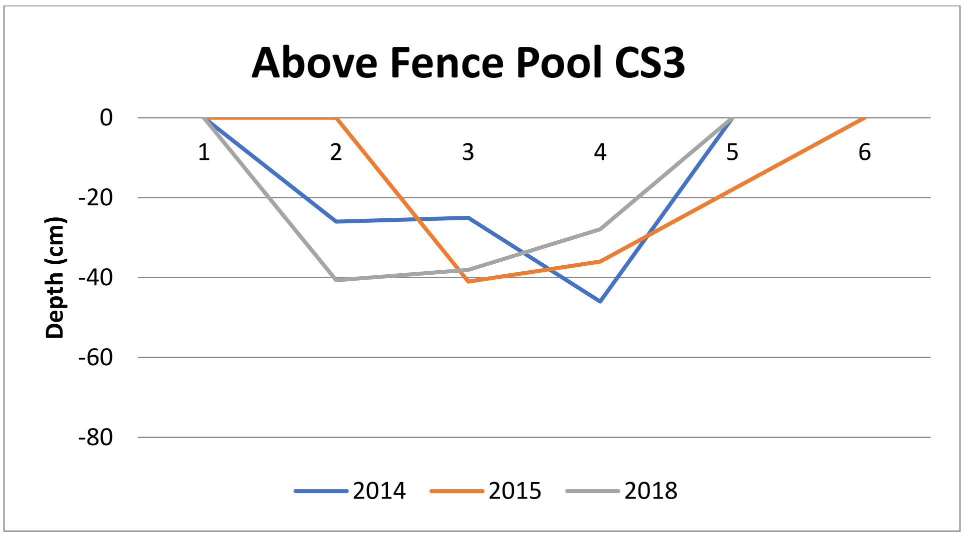
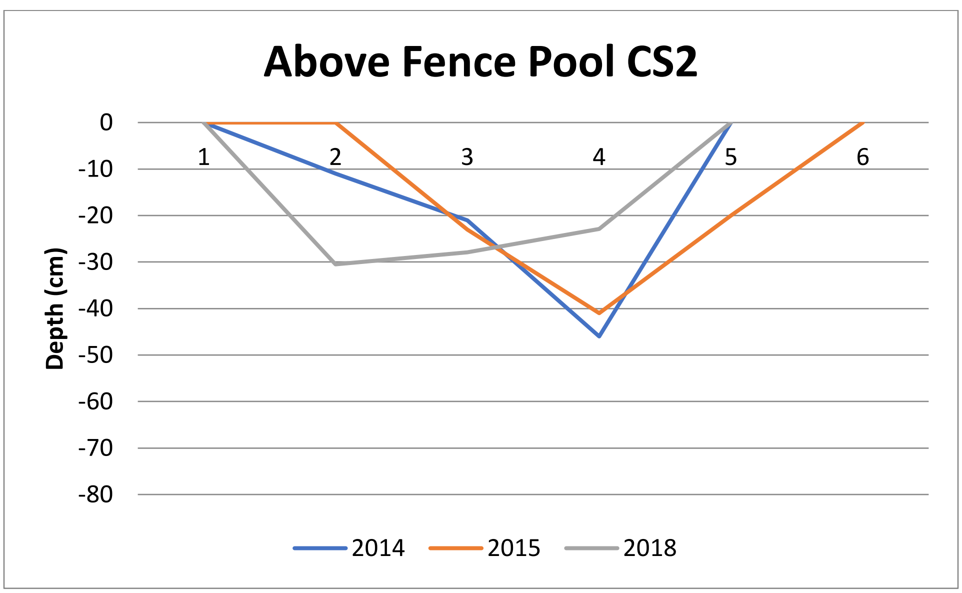
-20
-40
-60
-80
1
2
3
4
5
6
2014
2015
2018


Above Fence Pool CS3
Depth (cm)
0
-20
-40
-60
-80
1
2
3
4
5
6
2014
2015
2018


Above Fence Pool CS2
Depth (cm)
0
-10
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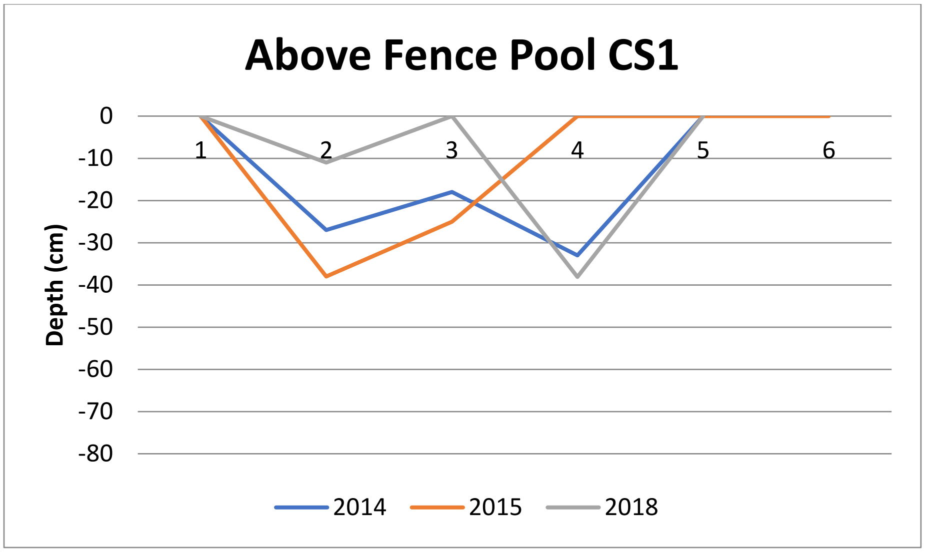
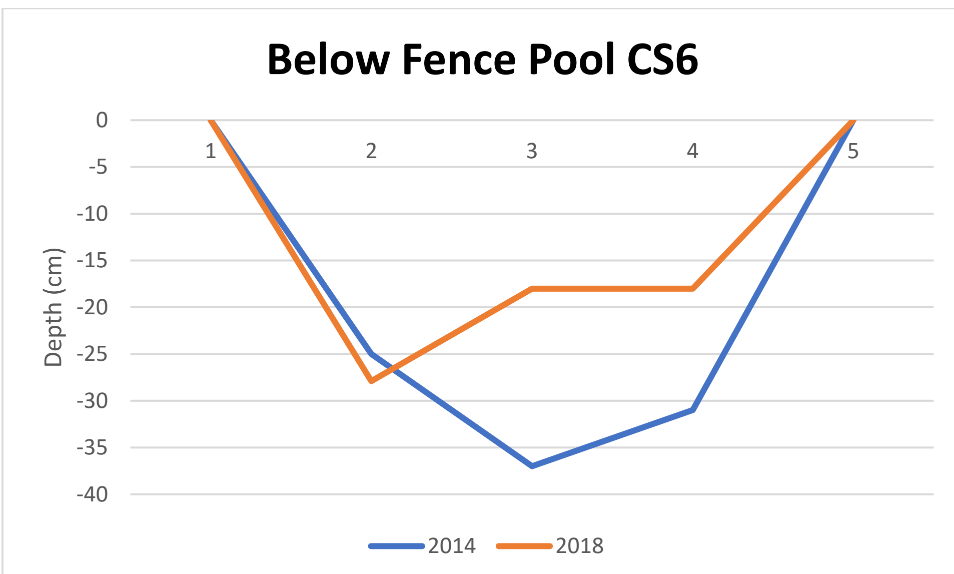
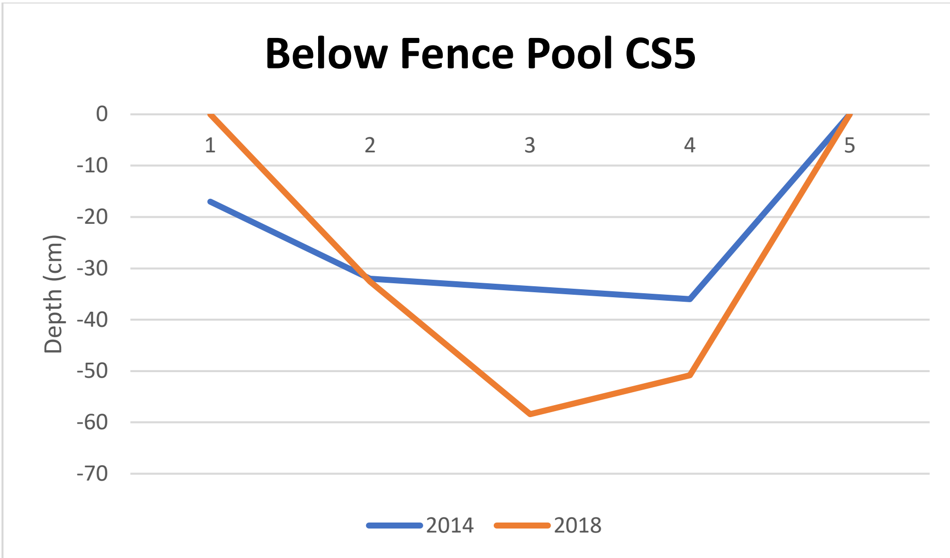
-30
-40
-50
-60
-70
-80
1
2
3
4
5
6
2014
2015
2018




## Site 3 - Below Fence Pool




Below Fence Pool CS5
Depth (cm)
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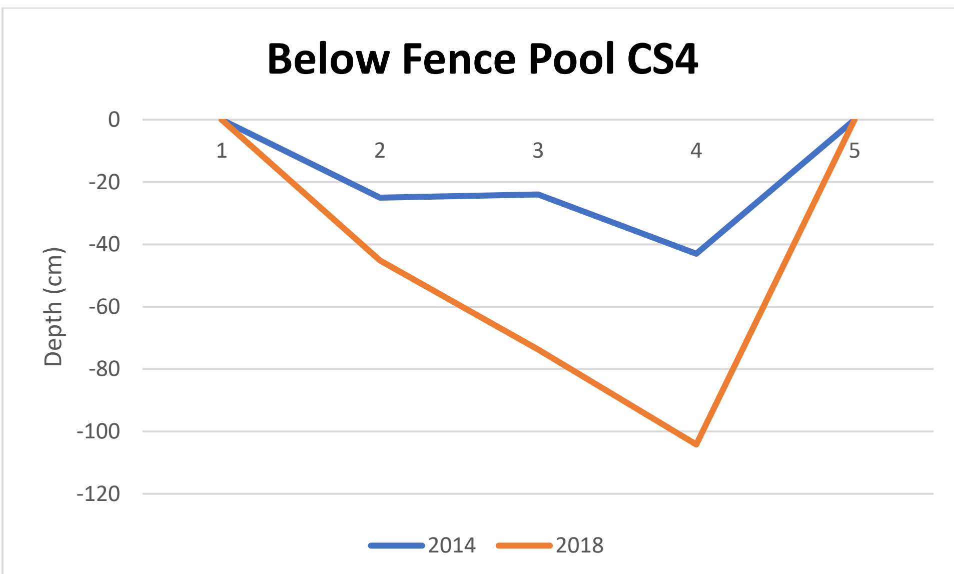
-50
-60
-70
1
2
3
4
5
2014
2018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Depth (cm)
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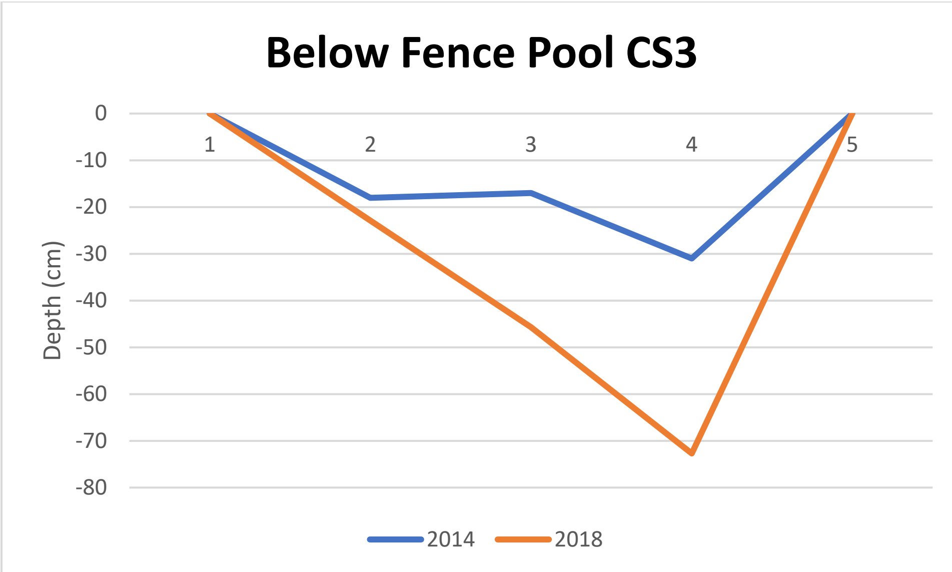
2
3
4
5
2014
2018


Below Fence Pool CS3
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-10
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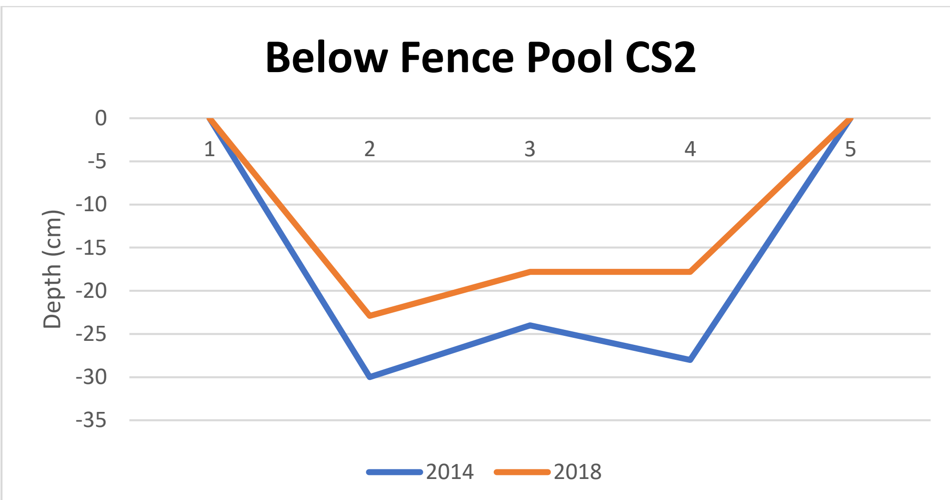
-30
-40
-50
-60
-70
-80
Depth (cm)
1
2
3
4
5
2014
2018


Below Fence Pool CS2
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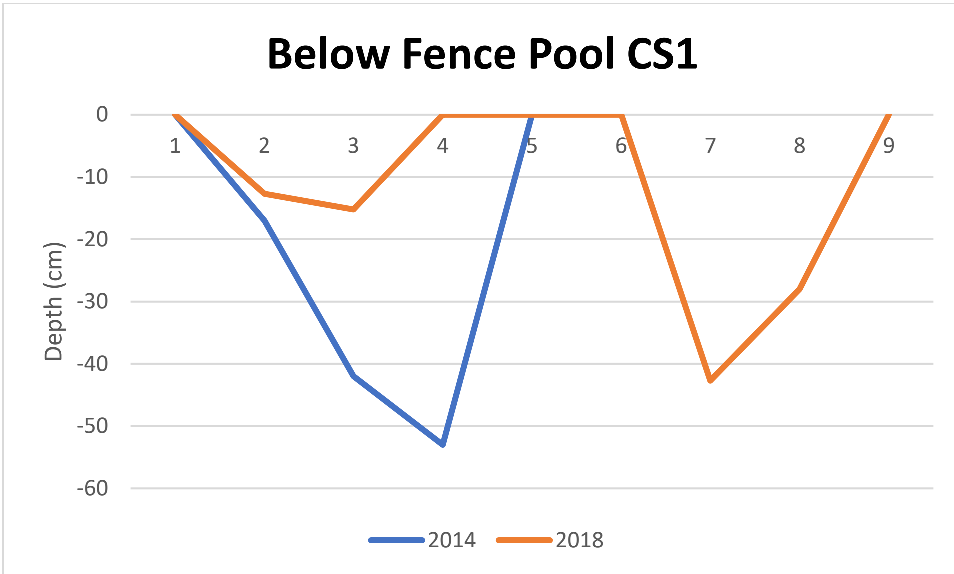
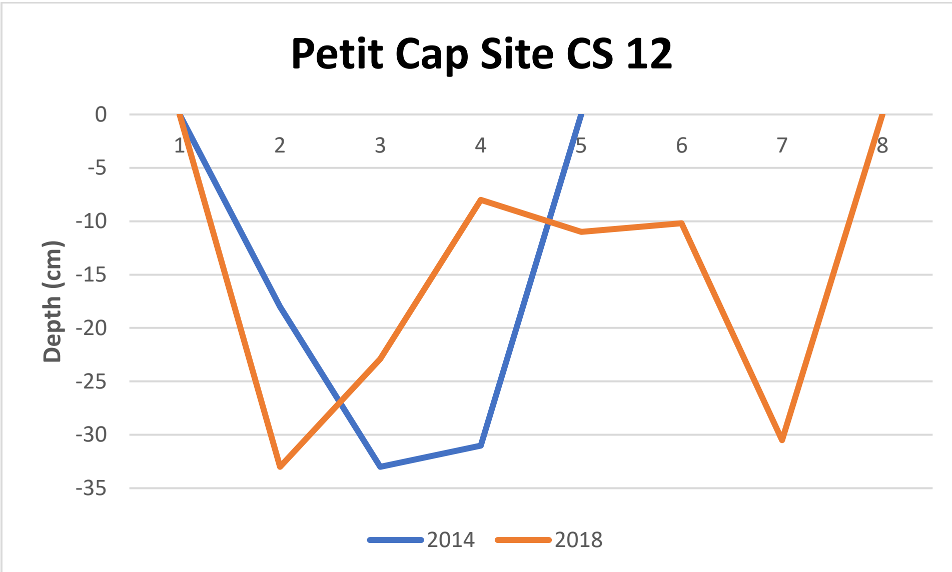
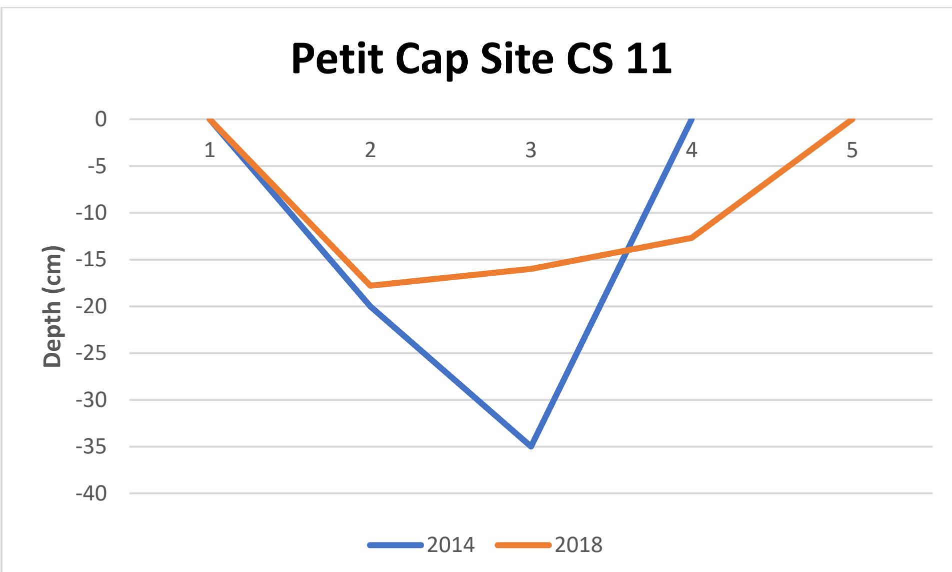
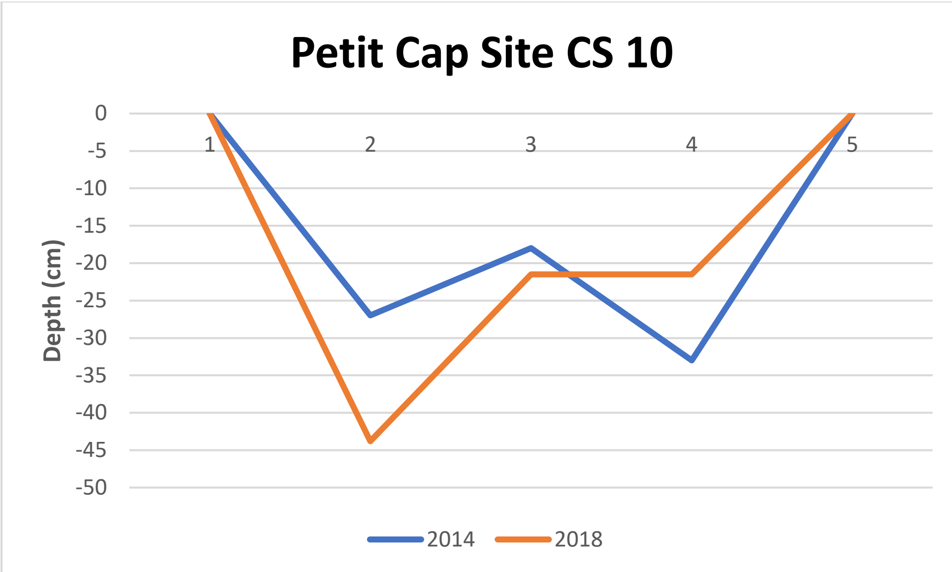
-15
-20
-25
-30
-35
Depth (cm)
1
2
3
4
5
2014
2018

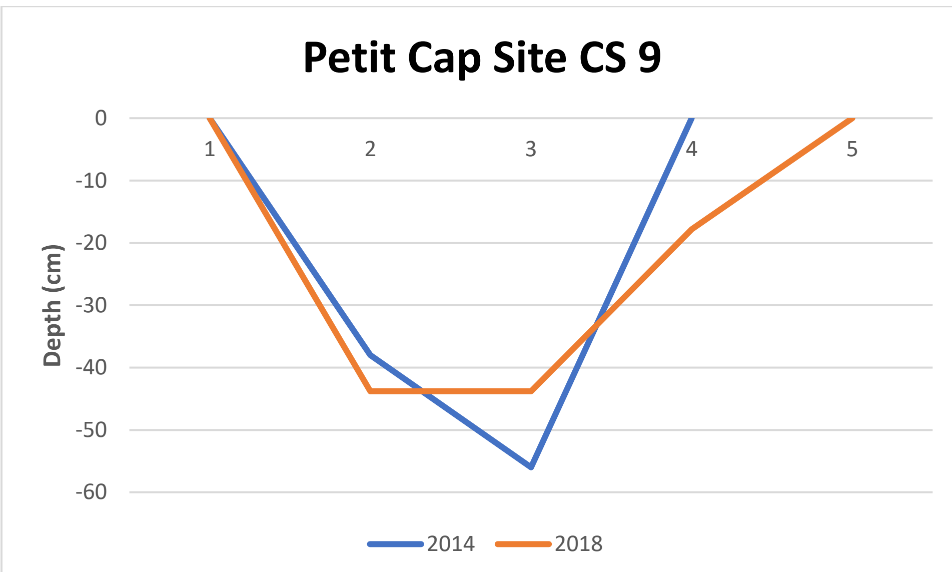

Below Fence Pool CS1
0
-10
-20
-30
-40
-50
-60
1
2
3
4
5
6
7
8
9
Depth (cm)
2014
2018

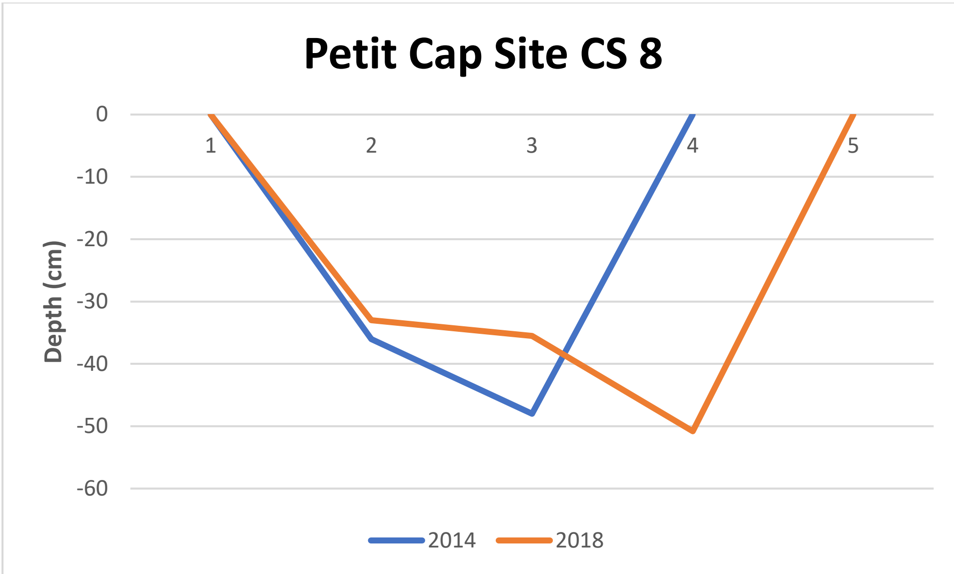
## Site 3a Petite Cap Site

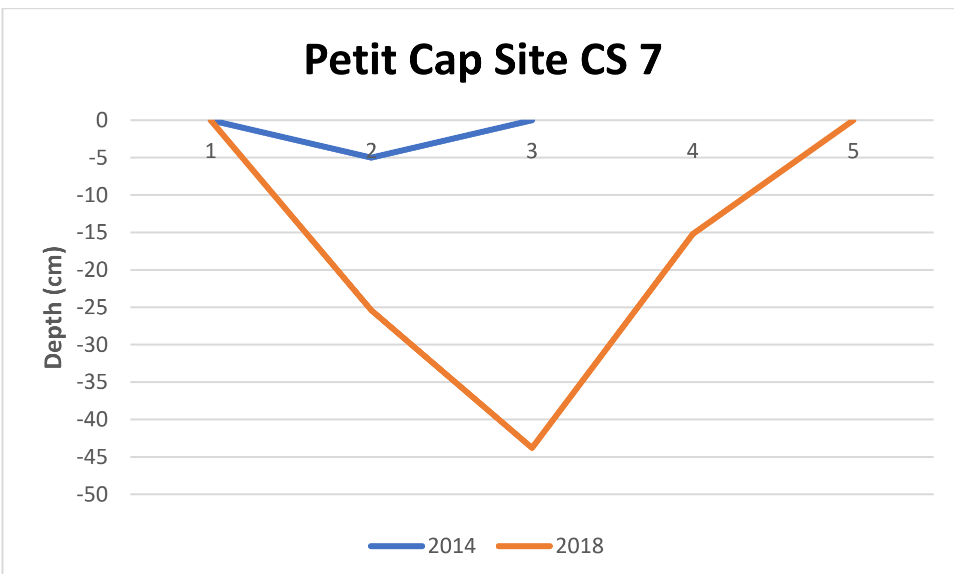


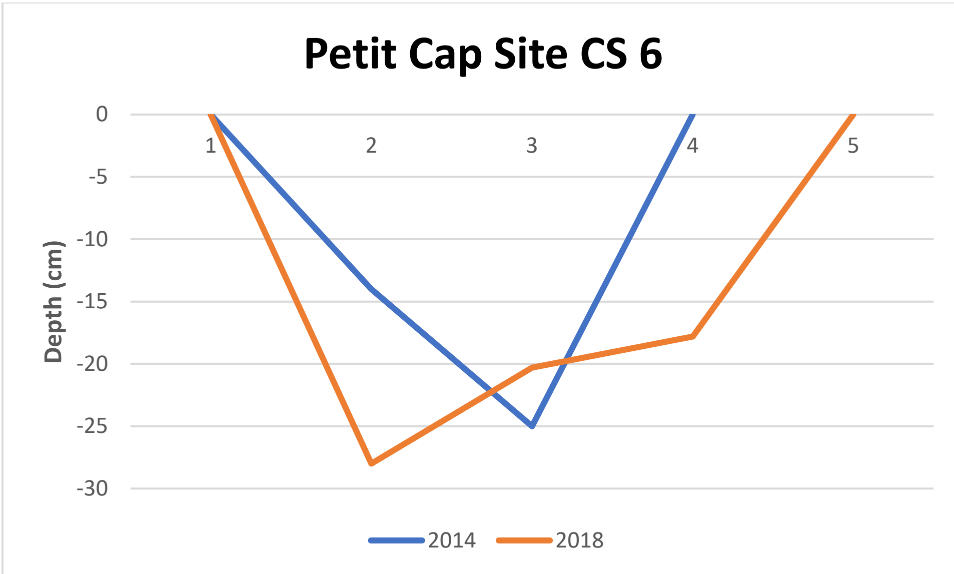



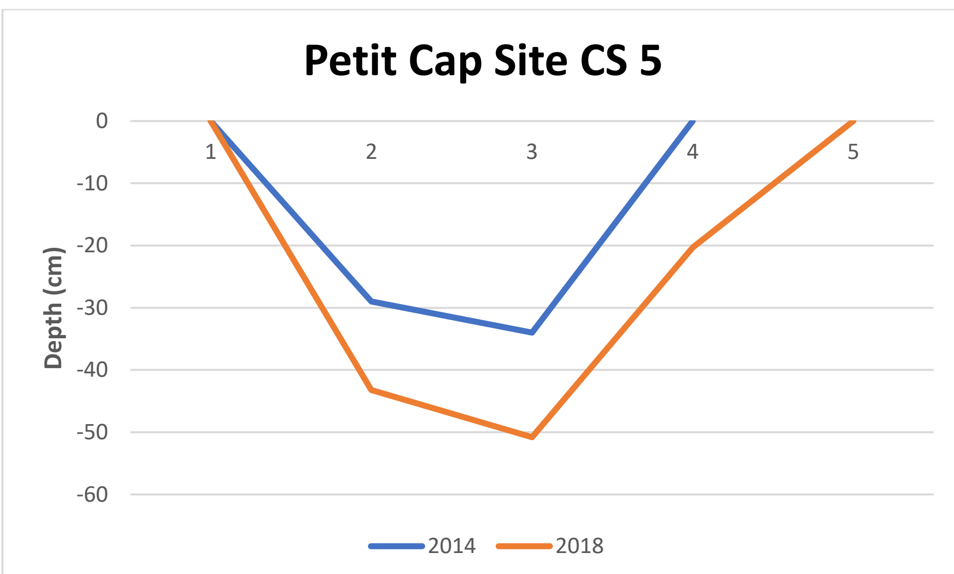

Petit Cap Site CS 10
Depth (cm)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1
2
3
4
5
2014
2018

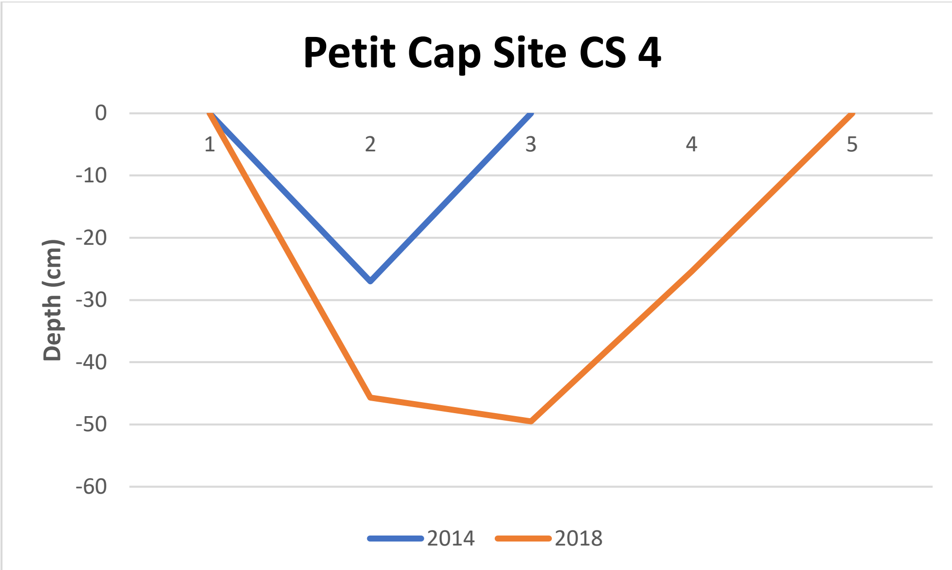

Petit Cap Site CS 9
Depth (cm)
0
-10
-20
-30
-40
-50
-60
1
2
3
4
5
2014
2018

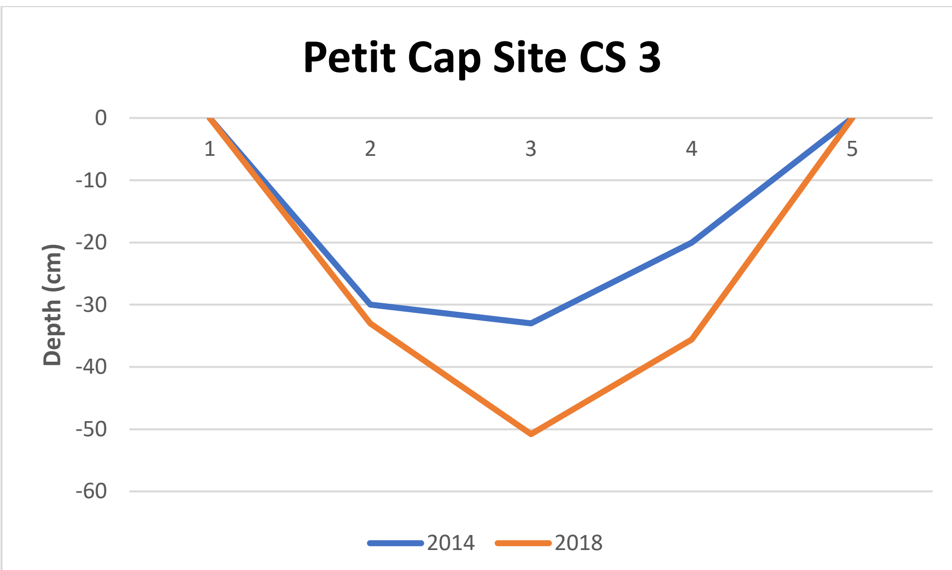

Petit Cap Site CS 8
Depth (cm)
0
-10
-20
-30
-40
-50
-60
1
2
3
4
5
2014
2018


Petit Cap Site CS 7
Depth (cm)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1
2
3
4
5
2014
2018

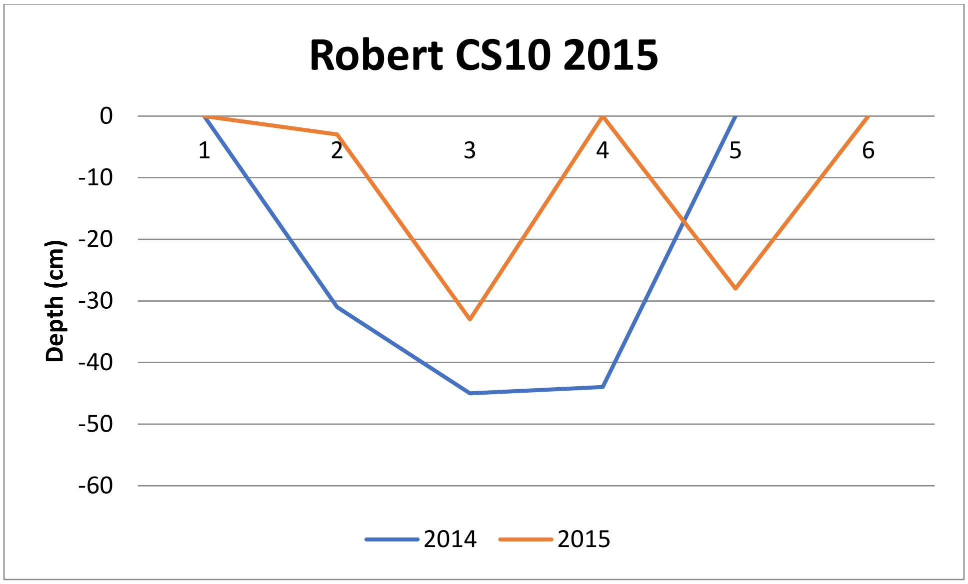

Petit Cap Site CS 6
Depth (cm)
0
-5
-10
-15
-20
-25
-30
1
2
3
4
5
2014
2018


Petit Cap Site CS 5
Depth (cm)
0
-10
-20
-30
-40
-50
-60
1
2
3
4
5
2014
2018

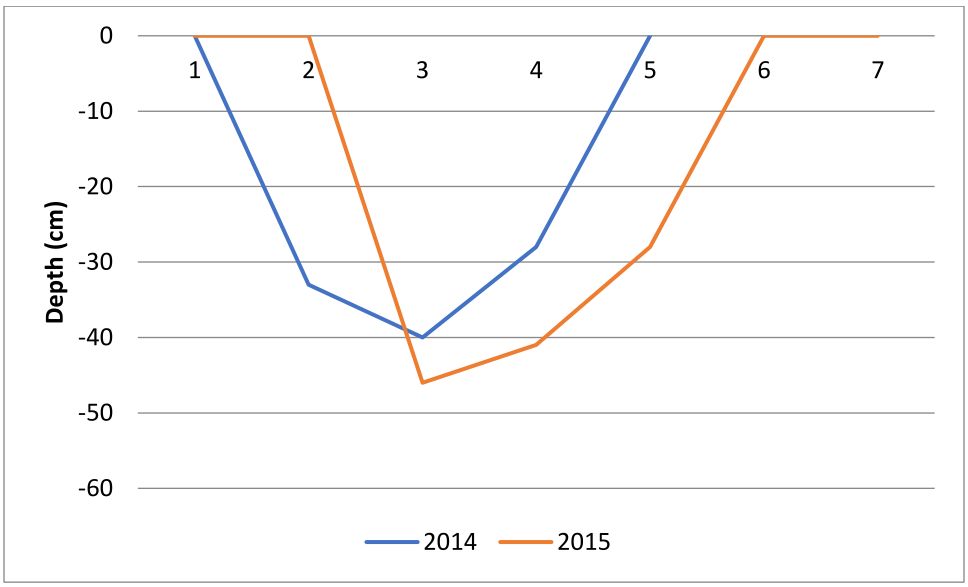


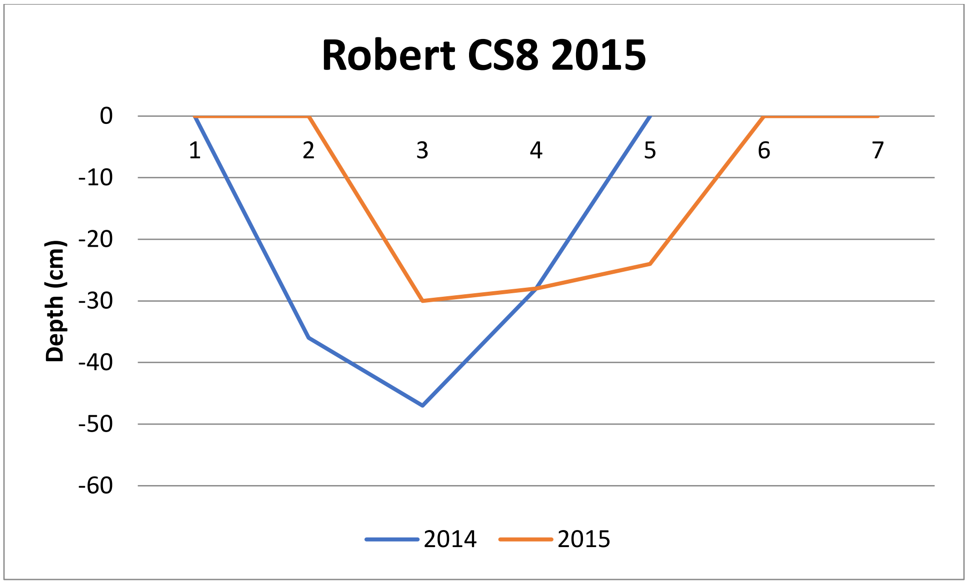

## Site 4 Robert Brook

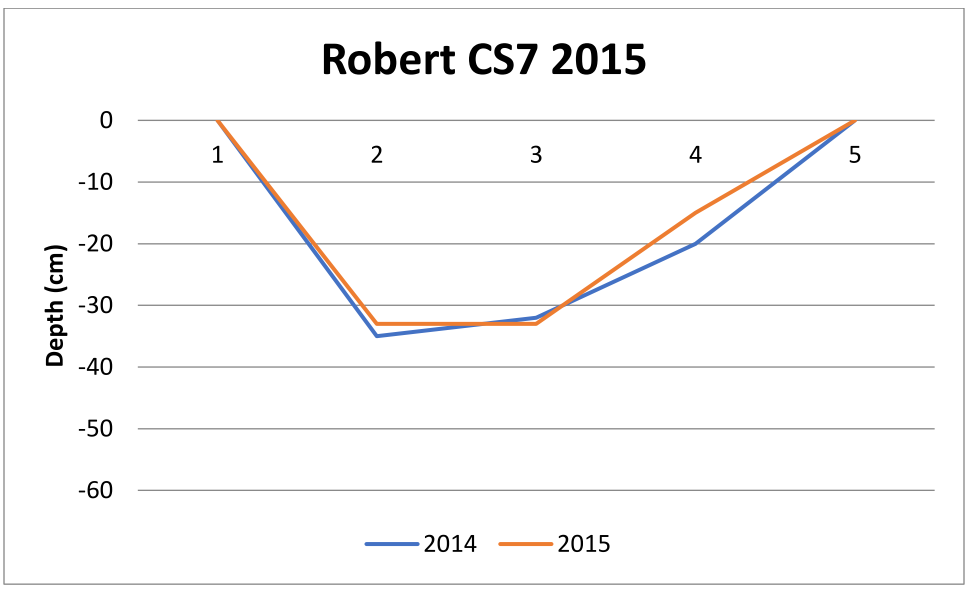


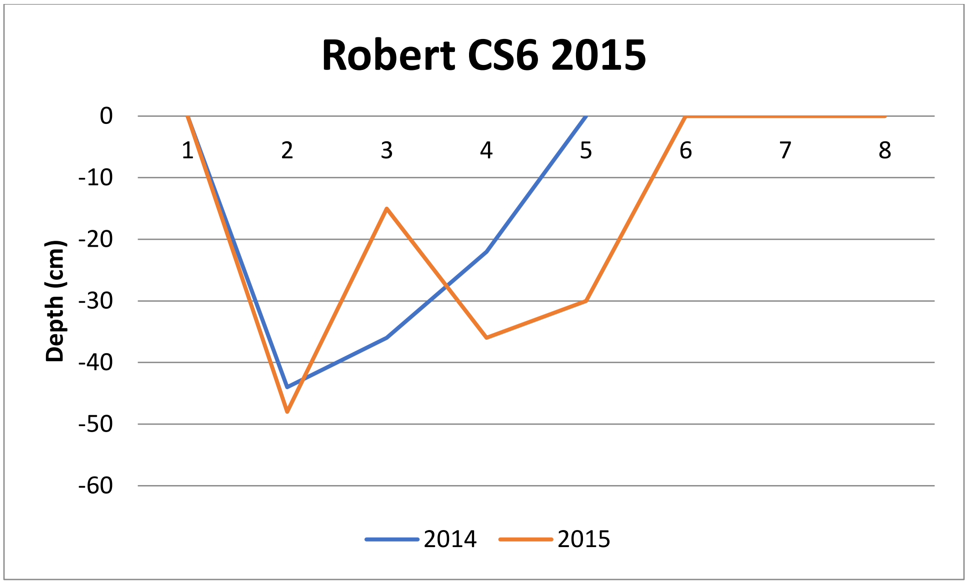
Robert CS10 2015
0
-10
-20
-30
-40
-50
-60
Depth (cm)
1
2
3
4
5
6
2014
2015

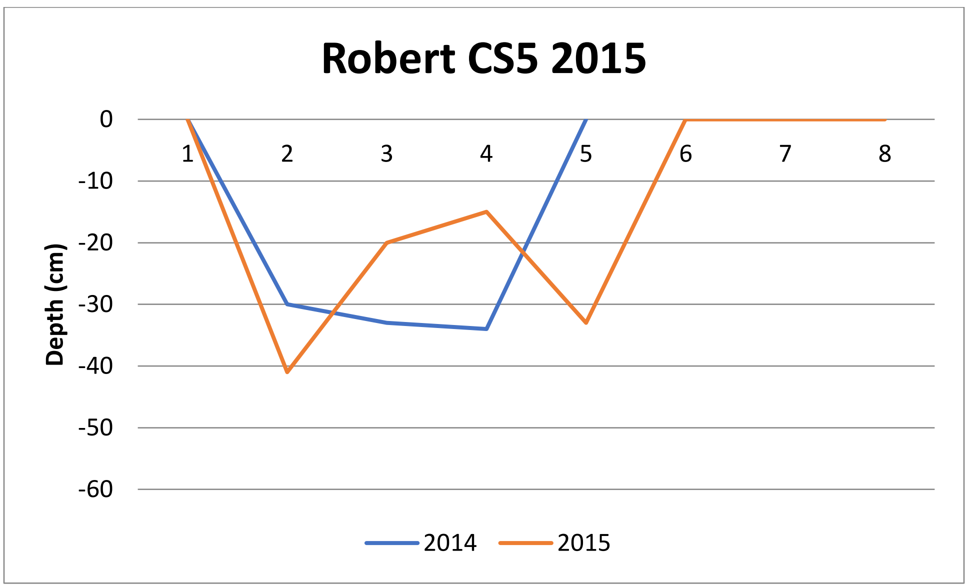



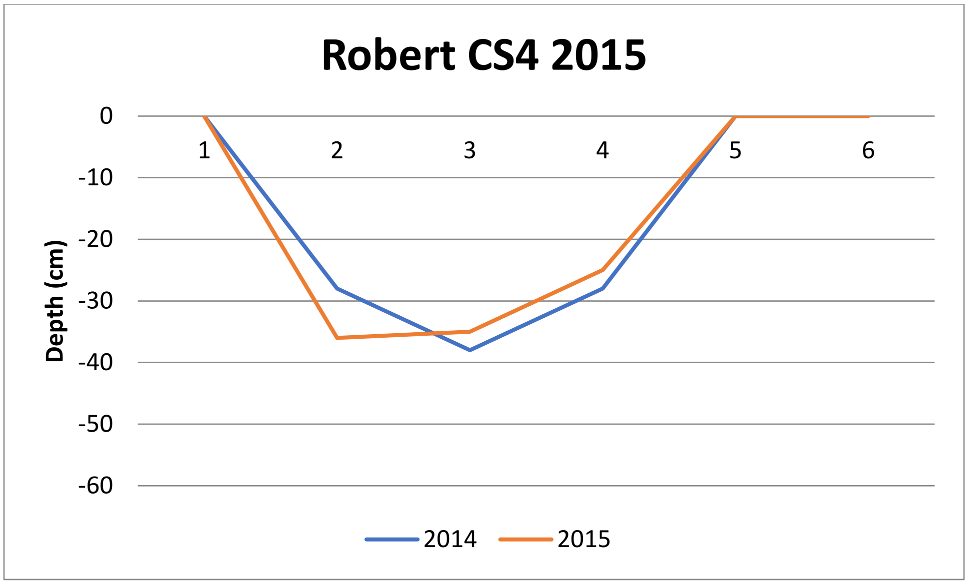
0
-10
-20
-30
-40
-50
-60
Depth (cm)
1
2
3
4
5
6
7
2014
2015


Robert CS8 2015
0
-10
-20
-30
-40
-50
-60
Depth (cm)
1
2
3
4
5
6
7
2014
2015

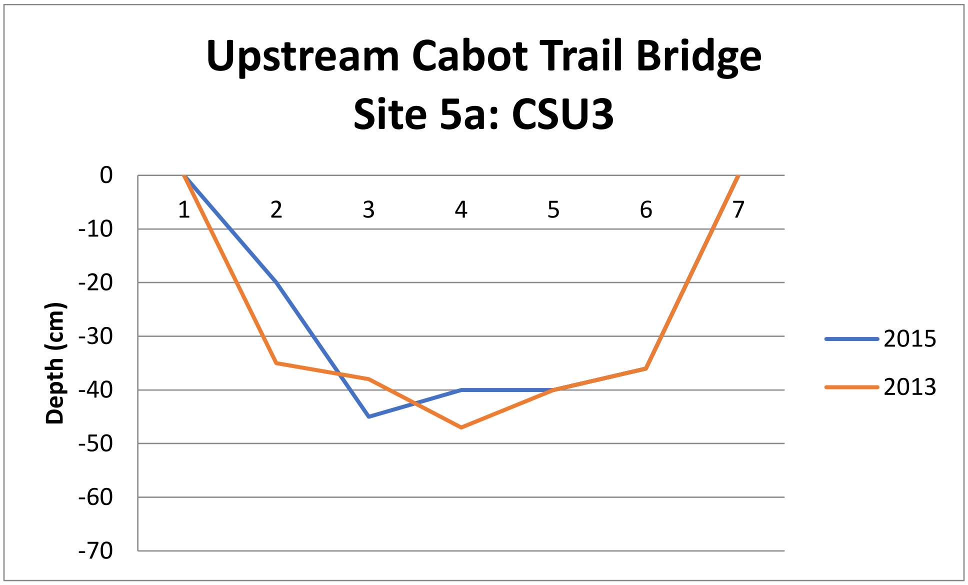

Robert CS7 2015
0
-10
-20
-30
-40
-50
-60
Depth (cm)
1
2
3
4
5
2014
2015

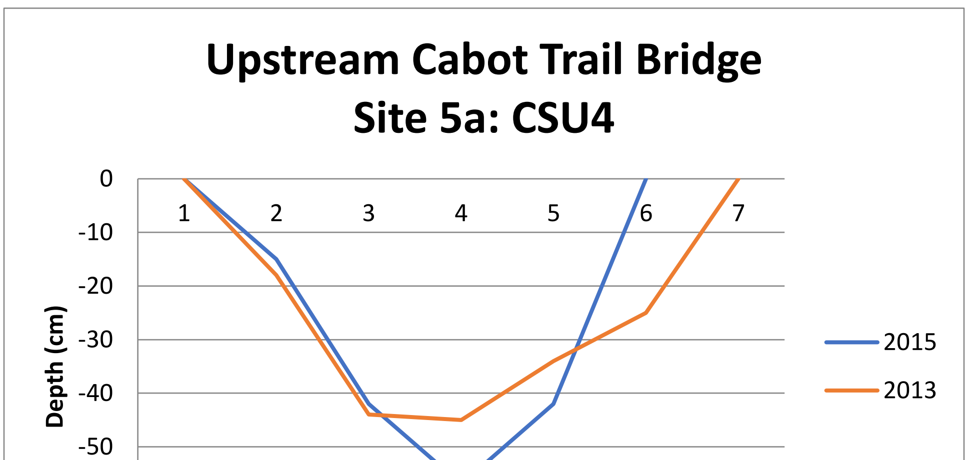

Robert CS6 2015
0
-10
-20
-30
-40
-50
-60
1
2
3
4
5
6
7
8
Depth (cm)
2014
2015

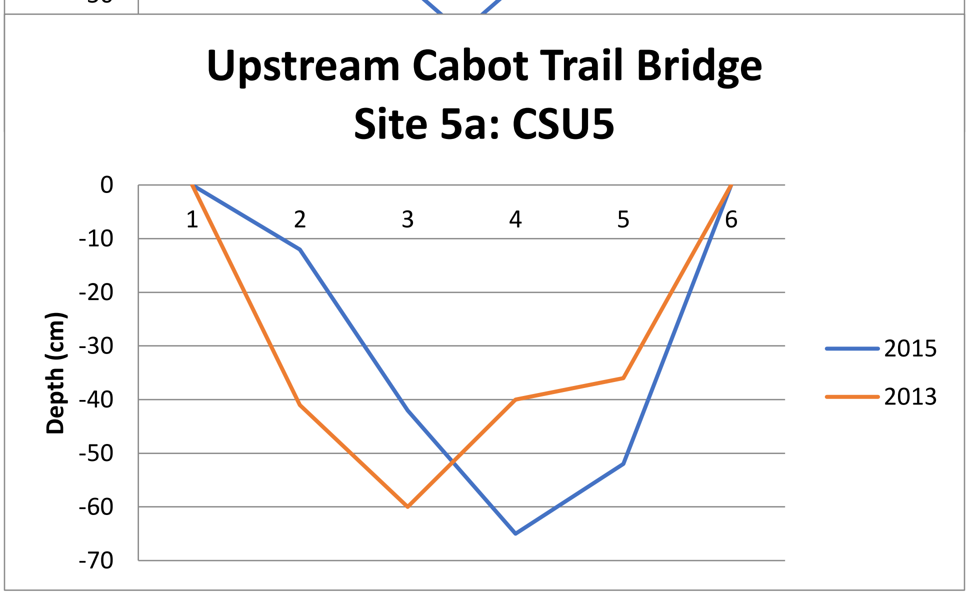

Robert CS5 2015
0
-10
-20
-30
-40
-50
-60
1
2
3
4
5
6
7
8
Depth (cm)
2014
2015


Robert CS4 2015
0
-10
-20
-30
-40
-50
-60
Depth (cm)
1
2
3
4
5
6
2014
2015

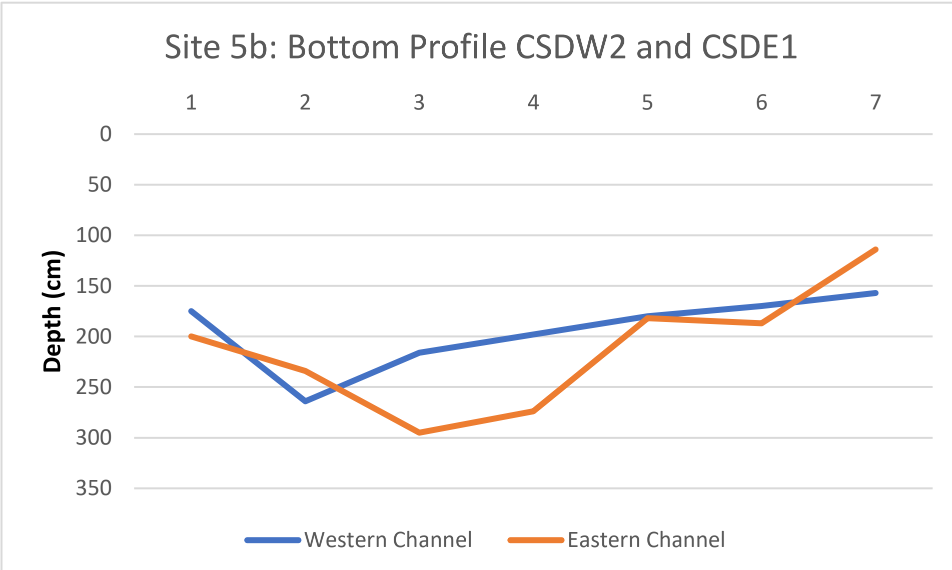
## Site 5a - Above Cabot Trail Bridge

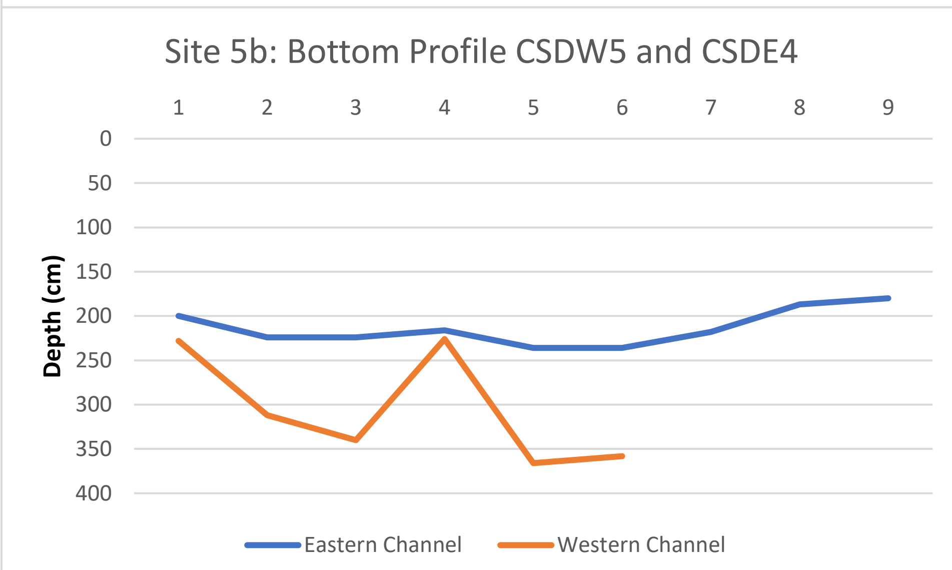


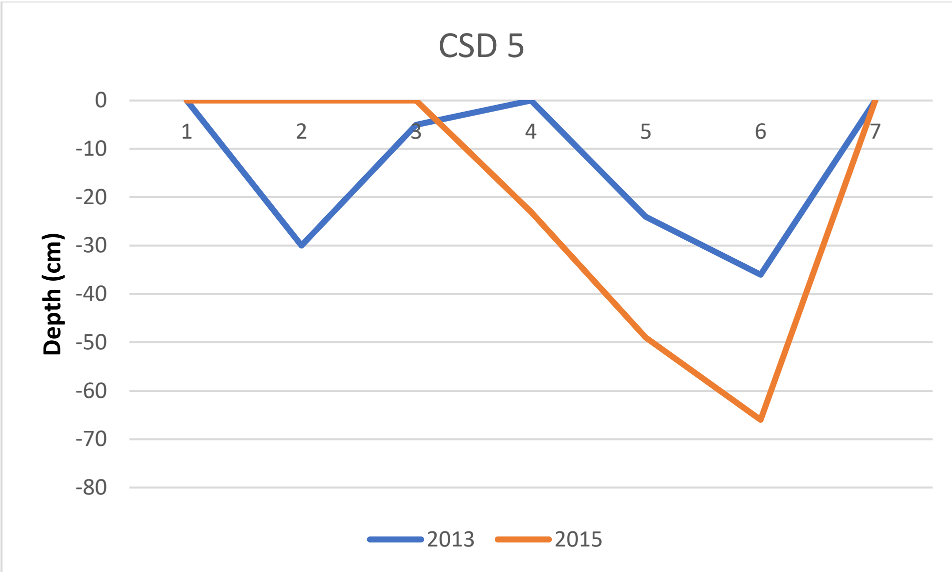



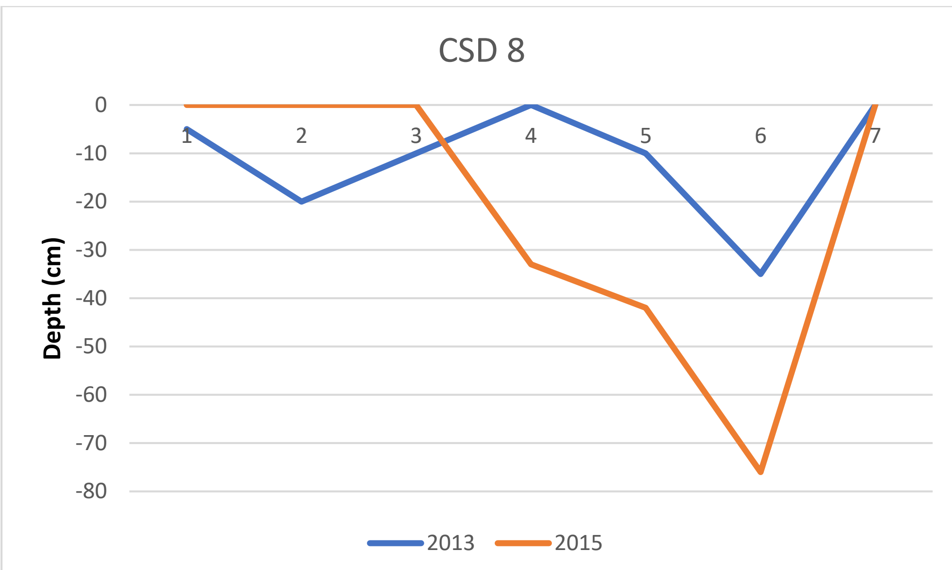



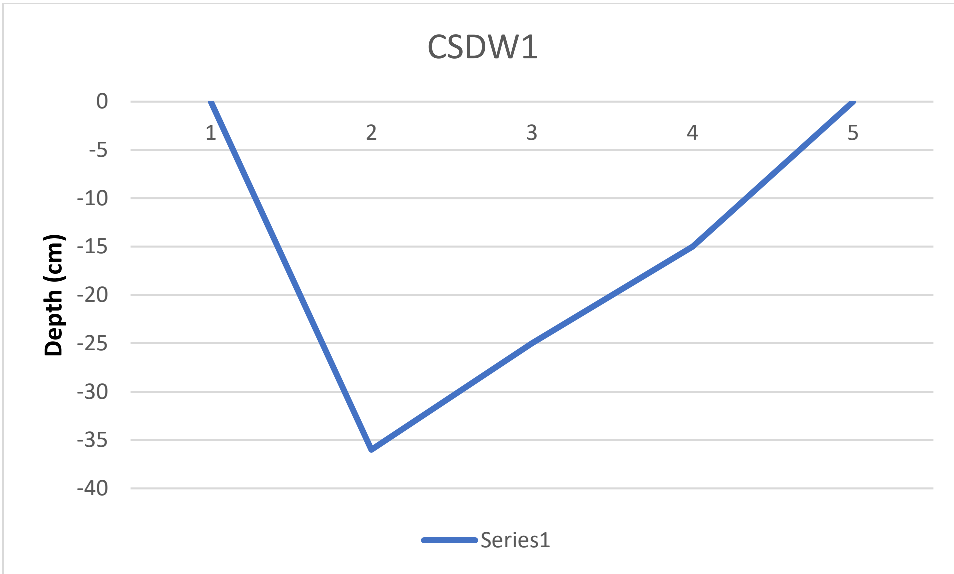
## Site 5b Below Cabot Trail Bridge (2013 &2015)

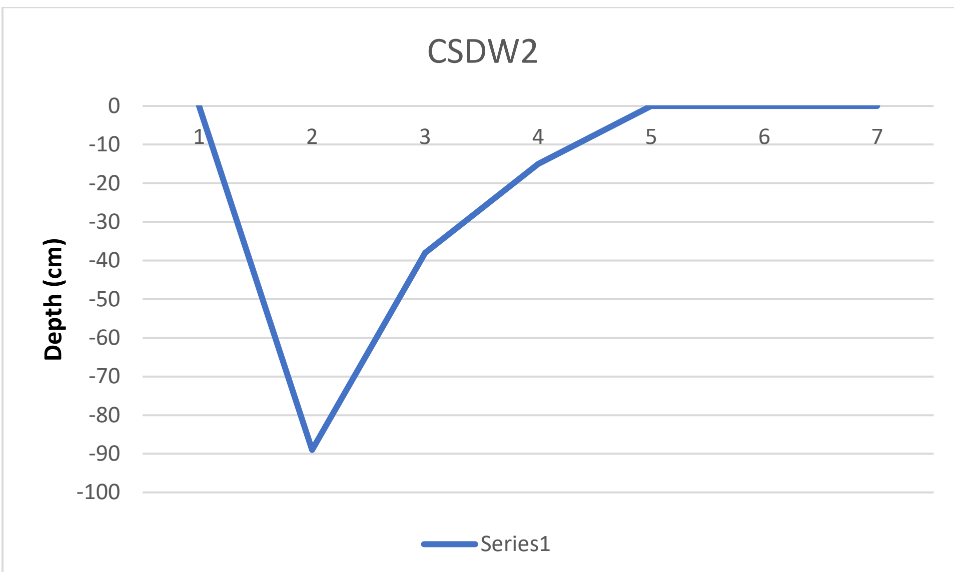


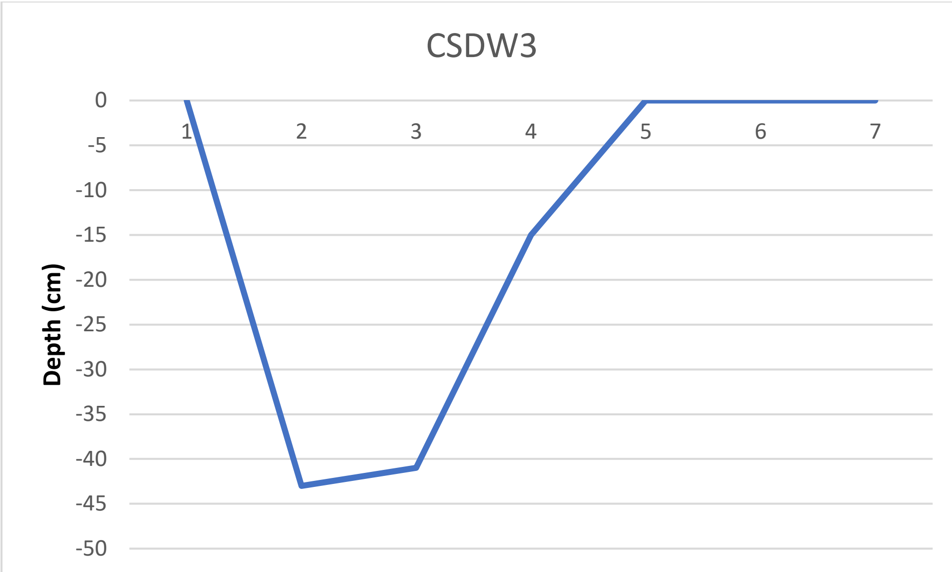



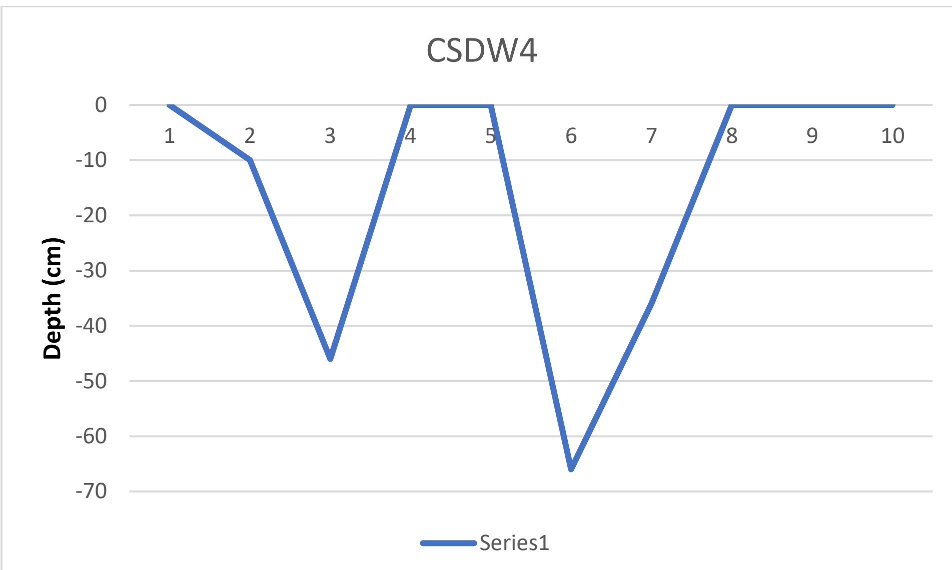

CSD 5
0
-10
-20
-30
-40
-50
-60
-70
-80
Depth (cm)
1
2
3
4
5
6
7
2013
2015

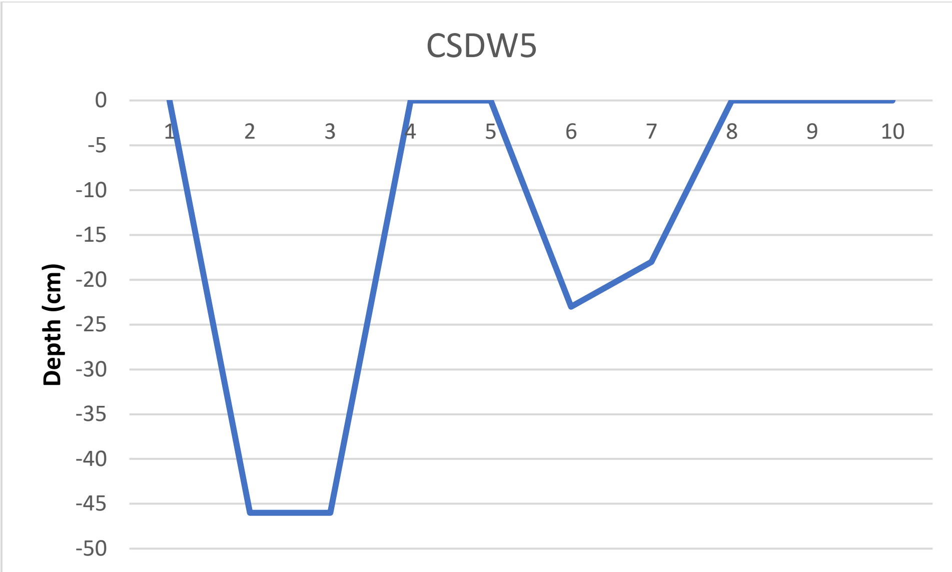

CSD 8
0
-10
-20
-30
-40
-50
-60
-70
-80
Depth (cm)
1
2
3
4
5
6
7
2013
2015

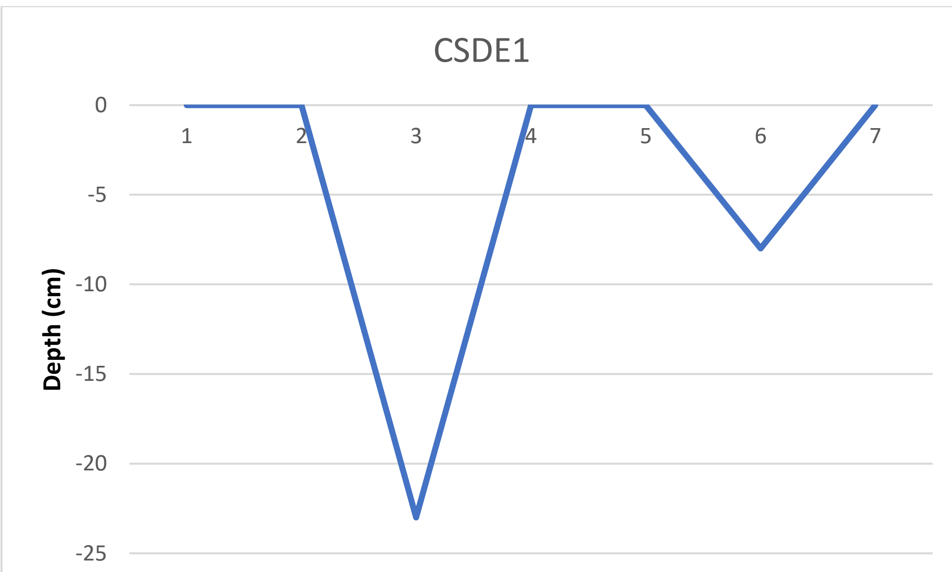

CSDW1
Depth (cm)
0
-5
-10
-15
-20
-25
-30
-35
-40
1
2
3
4
5
Series1

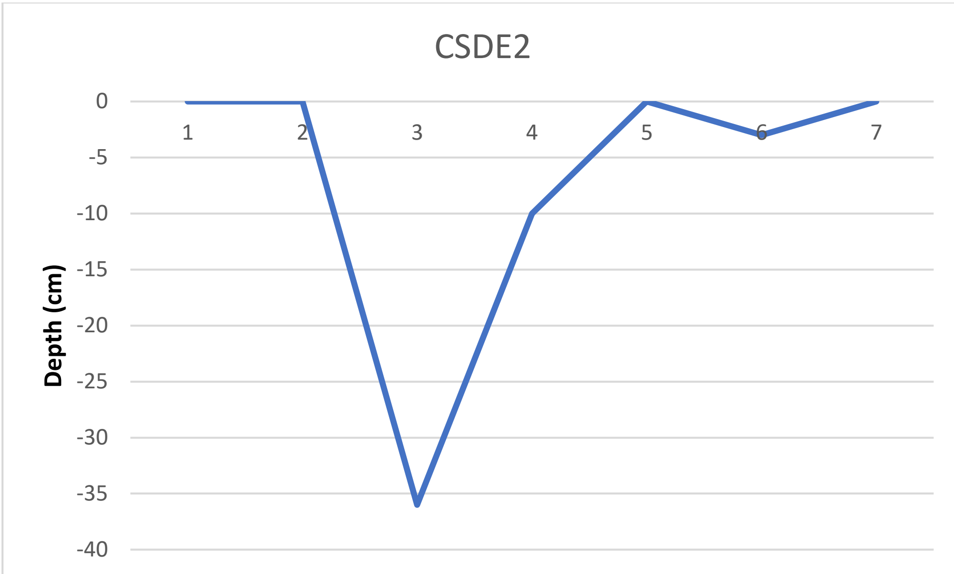

CSDW2
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
1
2
3
4
5
6
7
Series1

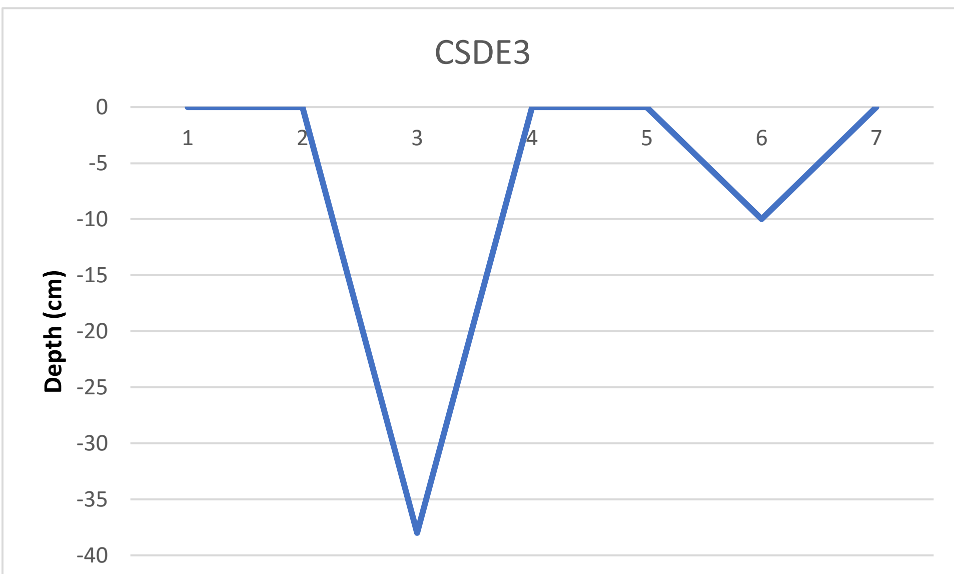

CSDW3
Depth (cm)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1
2
3
4
5
6
7

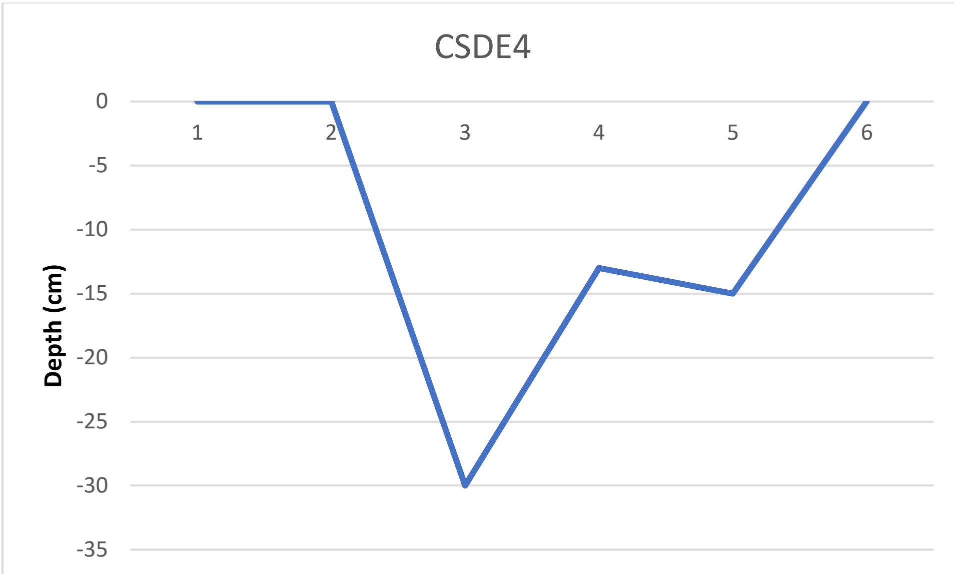

CSDW4
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
1
2
3
4
5
6
7
8
9
10
Series1


CSDW5
Depth (cm)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1
2
3
4
5
6
7
8
9
10

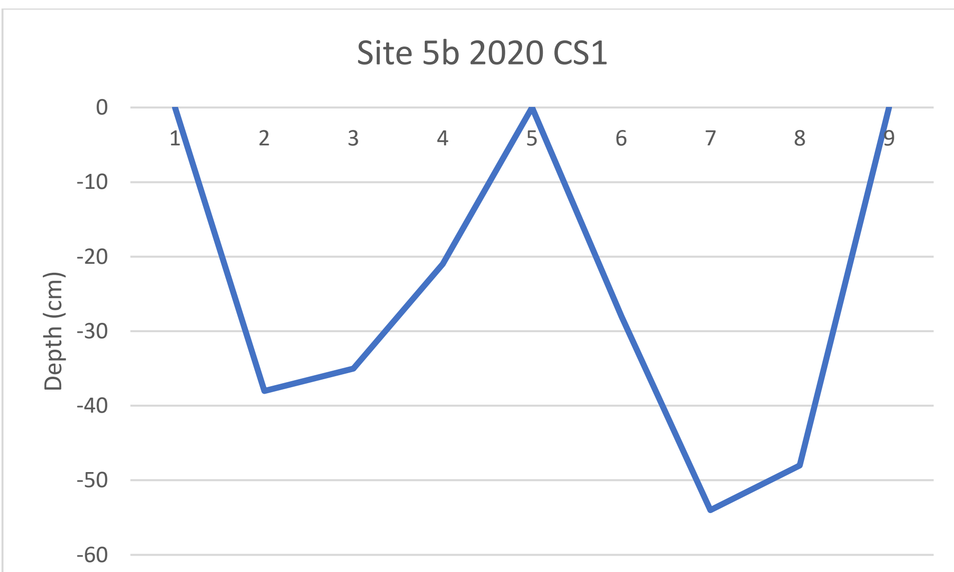

CSDE1
Depth (cm)
0
-5
-10
-15
-20
-25
1
2
3
4
5
6
7

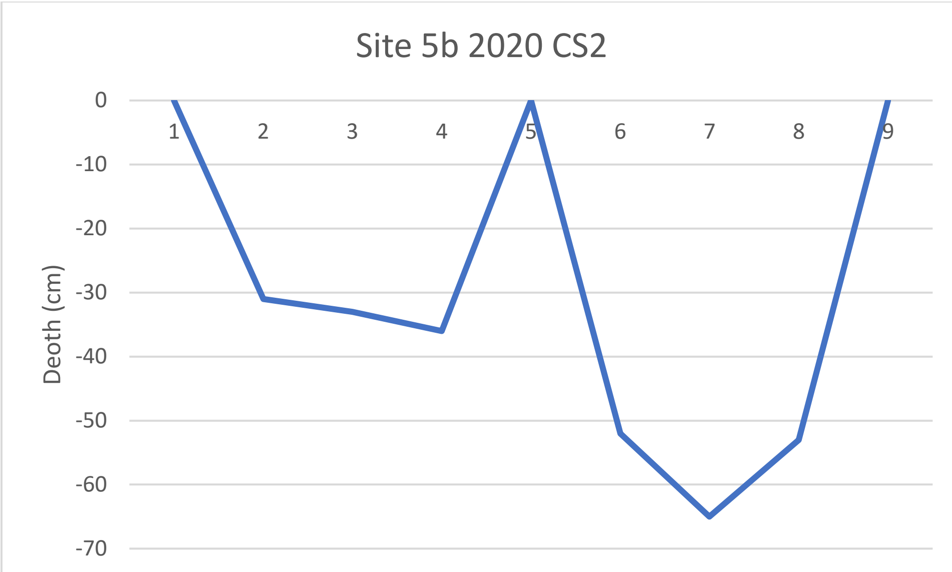

CSDE2
0
-5
-10
-15
-20
-25
-30
-35
-40
1
2
3
4
5
6
7
Depth (cm)

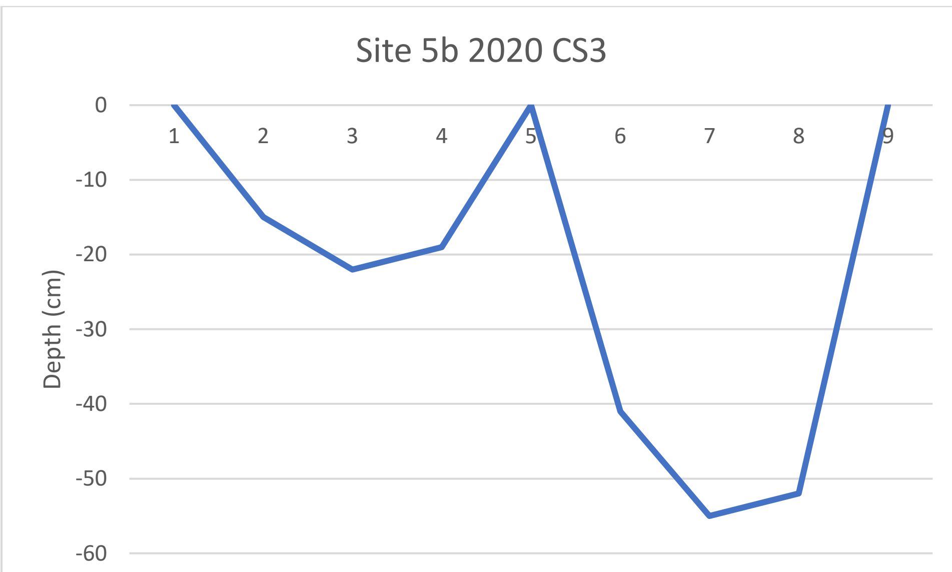

CSDE3
0
-5
-10
-15
-20
-25
-30
-35
-40
1
2
3
4
5
6
7
Depth (cm)

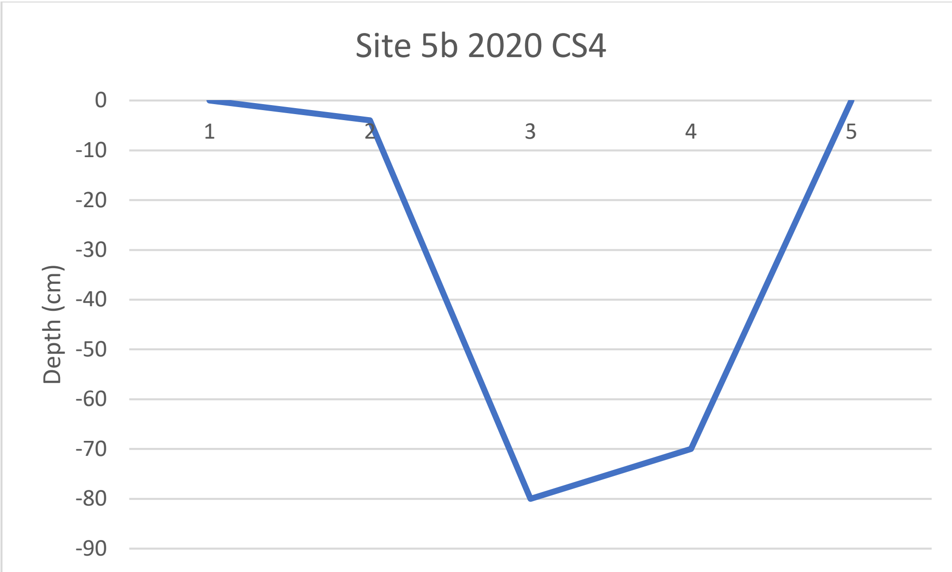


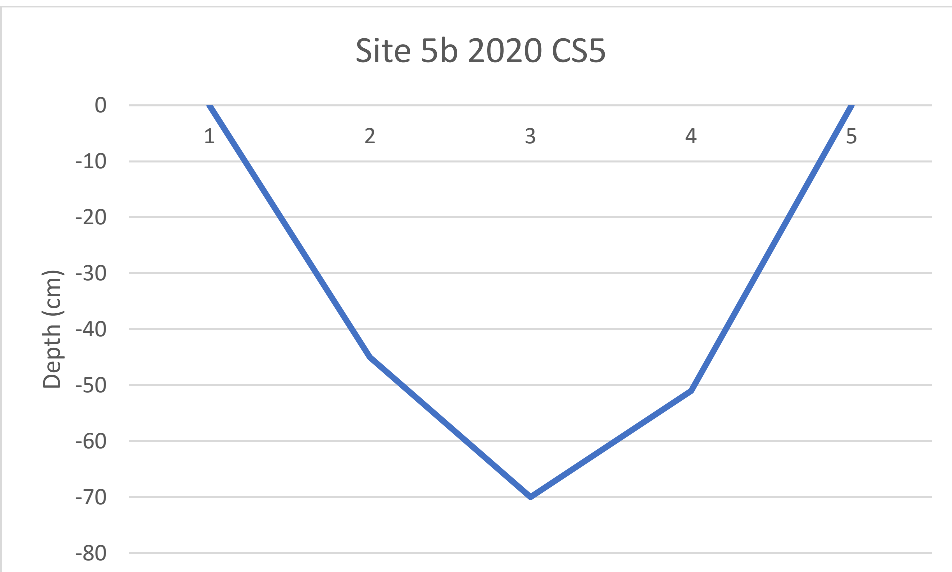

## Site 5b Below Cabot Trail Bridge (2020)

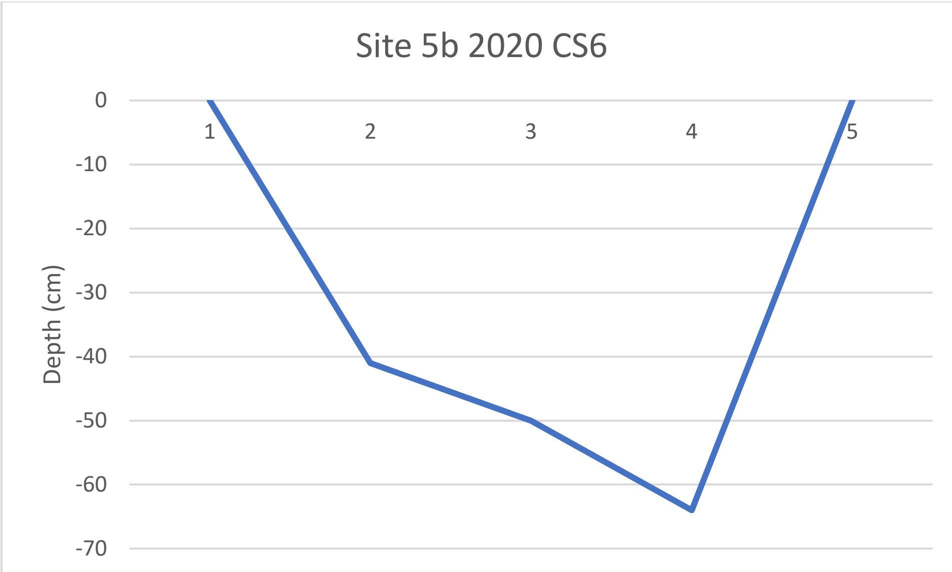


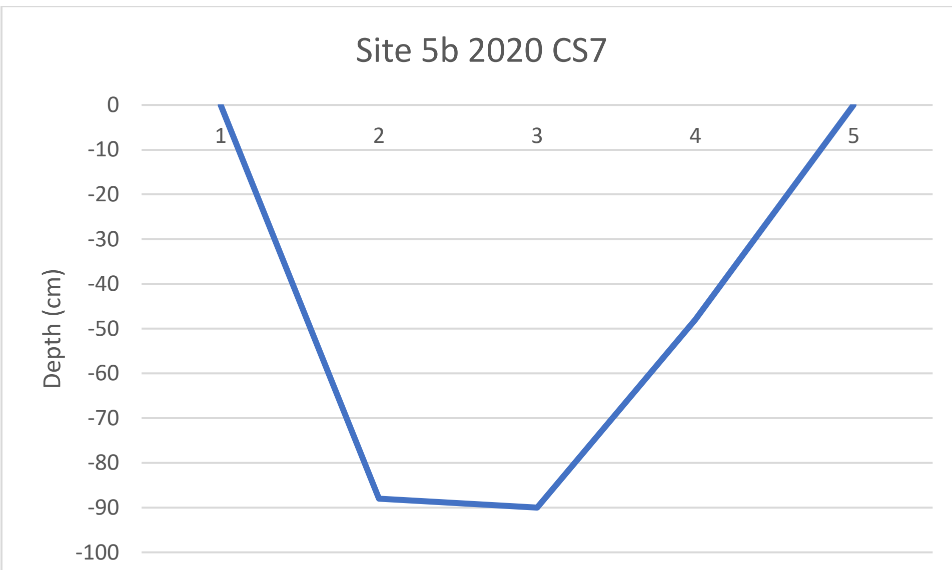

Site 5b 2020 CS2
Deoth (cm)
0
-10
-20
-30
-40
-50
-60
-70
1
2
3
4
5
6
7
8
9

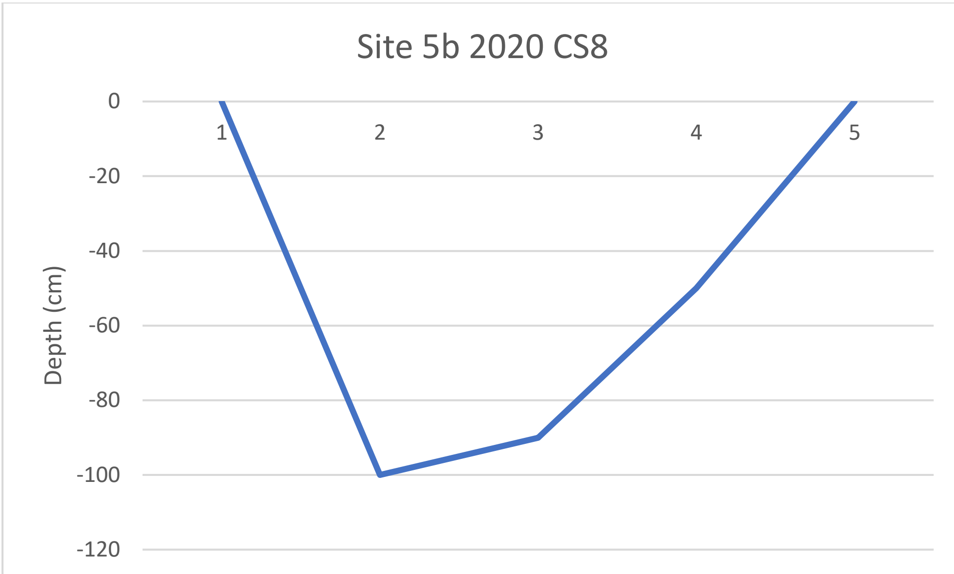

Site 5b 2020 CS3
Depth (cm)
0
-10
-20
-30
-40
-50
-60
1
2
3
4
5
6
7
8
9

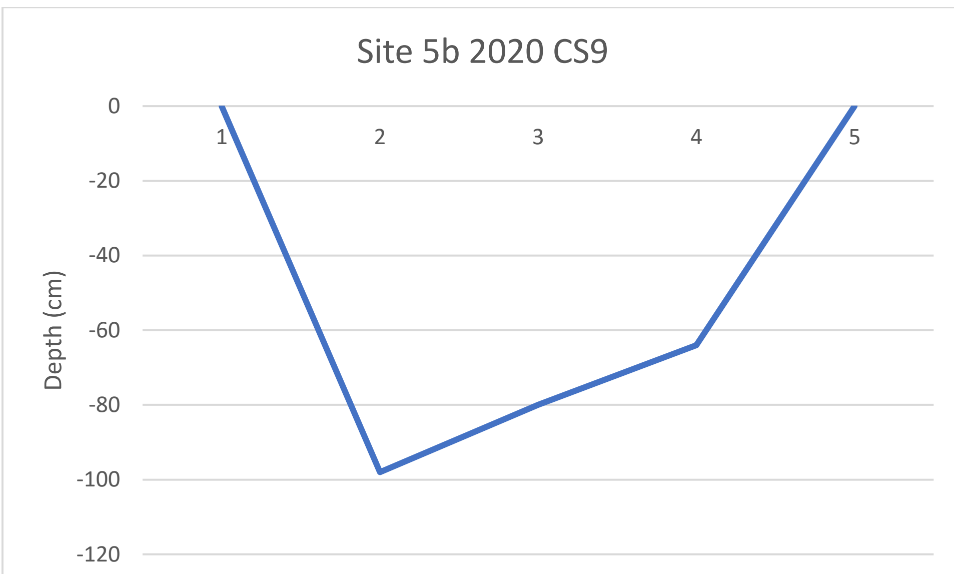

Site 5b 2020 CS4
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
2
3
4
5


Site 5b 2020 CS5
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
-80
1
2
3
4
5


Site 5b 2020 CS6
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
1
2
3
4
5


Site 5b 2020 CS7
Depth (cm)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
1
2
3
4
5


Site 5b 2020 CS8
0
-20
-40
-60
-80
-100
-120
Depth (cm)
1
2
3
4
5


Site 5b 2020 CS9
0
-20
-40
-60
-80
-100
-120
Depth (cm)
1
2
3
4
5


# Appendix B

**Redd count data sheet**

| | | | |
|---|---|---|---|
| **Watercourse name:** | **Section name:** | **Water temp:** | **Air temp:** |
| **Reach ID:** | **Date:** | **Start time:** | **End time:** |
| **Surveyors:** | **Survey #:** | **Water level:** | **Water visibility:** |
| **Directions: Record the record number. Visually identify each redd to species (Atlantic salmon, brown trout, brook trout). Take and record GPS coordinates of redd location. Measure and record dimensions of redd and note shape. If you cannot measure redd, visually estimate the dimensions and record on data form and indicate 'estimated dimensions' in the notes section. Record if a fish is on the redd. Note redd age: 1=New since last survey, 2=still measurable, 3=not measurable but still apparent, 4=no longer there, 5=poor conditions – cannot measure or determine age.** | | **Weather:**<br>**Notes:** | |

| **Record** | **Species** | **GPS location** | **Length (m)** | **Width (m)** | **Shape of redd** | **Fish on? (Y/N & # if Y)** | **Redd age** | **Notes** |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
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