Central Queens Branch of the Prince Edward Island Wildlife Federation

West River Atlantic Salmon Habitat Management Plan

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Atlantic Salmon Habitat Management Plan for West River

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1.0 Introduction

1.1 History of the watershed & Purpose of the project

From 2005 – 2007, a watershed management plan (WMP) was developed by the Central Queens Wildlife Federation, with help from numerous local residents and stakeholders (see West River Watershed Management Plan 2008). The PEI Wildlife Federation has been in existence for over a century and branches such as Central Queens have been driving forces in watershed planning and ecosystem management. Details about the overall objectives and long-term planning can be found in the WMP, but essentially the Wildlife Federation hopes to encourage good land stewardship within the drainage basin and restore and enhance wildlife habitat both within watercourses and in their adjacent riparian buffer zones.

The Central Queens Branch of the PEI Wildlife Federation (CQWF) has been actively managing the West and Clyde Rivers in Queens County PEI and has made considerable progress in restoring watershed integrity from many aspects. CQWF has transformed sections of the river that had very little productivity for Atlantic salmon into areas that now have seen salmon return to spawn and now support local populations. In several areas over the last ten years, by following a strategic approach, limiting factors were addressed and a major habitat transformation occurred (Curley's property in Brookvale is a good example). For the purpose of this report it will focus on the limiting factors and description of the freshwater portion of the Atlantic salmon's life cycle on the West River.

1.2 Indigenous History to PEI

Indigenous people living on the land now known as Prince Edward Island are the Mi'kmaq, who have lived in Mi'kma'ki, traditional Mi'kmaq territory, for at least 12,000 years they are the only people Native to PEI. The Mi'kmaw originally named PEI as 'Epekwitk', meaning "lying in the water". The Mi'kmaq lived in an annual cycle of seasonal movement between living in dispersed interior winter camps and larger coastal communities during the summer **(Indigenous Canada)**. The name Ji'ka'we'katik is now the name of the main trail in the Bonshaw Hills Provincial Park and means "the place where bass are plentiful", which is the traditional Mi'kmaq name for the West River.

1.3 Forming a Habitat Management Plan

When managing any species, the basic fundamentals for a species to thrive need to be understood and related to current and historical habitat usage within an area. The history and current habitat usage by a species will play a key role in identifying areas of habitat restoration efforts. To begin the planning process certain questions must be answered: how many salmon are returning during each spawning season, what is the juvenile survival rate/densities, what areas are currently being used to support certain life stage aspects, what is different about the current habitat usage compared to historical usage? The first step in improving or restoring local salmon populations must begin with identifying what the current situation is, recent watershed restoration efforts, ongoing issues, and current knowledge of species abundance. In this report, a structured approach will be implemented when all current and historical factors are considered to address certain life stage limiting factors that when relieved will help increase local populations in an efficient and effective manner.

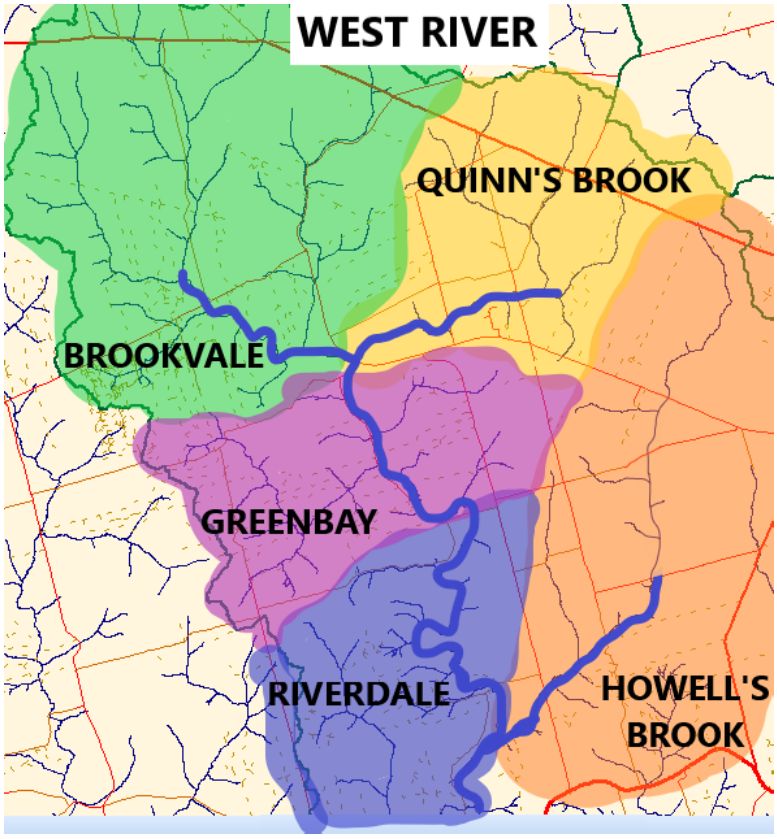


Figure 1. The West River watershed drainage area separated based on geographic orientation and major tributaries with areas utilized historically and currently by Atlantic salmon highlighted in bold blue.

2.0 Overview and Description of Watershed

The West River drainage basin is the third largest watershed on Prince Edward Island (PEI), draining 20,525 ha of land and supporting more than 320 km of stream. The bulk of the West River drains from the Bonshaw Hills and many of the streams have above average gradients when compared to other watercourses on PEI. The river is heavily spring-fed, which moderates seasonal water temperatures and flows.

For the purpose of this report the West River will be divided into management zones based on stream channel morphological (main river) and geographic separation (tributaries). The watershed can be divided into five (5) sub-watersheds or tributaries, which currently support local salmon populations and include: Brookvale (including Skye Brook), Quinn's Brook, Howell's Brook, and the main West River can be broken into two sections: Riverdale / Green Bay. About 52% of the upper watershed is under forest cover, 42% in agriculture and about 4.5% developed. However, in each sub-watershed the proportion of forested land can vary considerably. For example, Black Brook subwatershed is 70% forested, while Quinn's Brook has a mere 27% under forest cover.

The Riverdale section of the West River is the lower section of the main branch, which begins at Crosby's Pond (just above head-of-tide) and up to Green Bay (~8.5 km of river). This section of river contains the bulk of salmon habitat and population. This area contains the majority of salmon spawning

habitat and juvenile rearing habitat and is relatively productive habitat. It contains the Riverdale "Horseshoe", which is considered an old growth forest. The remaining riparian habitat is mature forest and is almost entirely protected below the Bolger Park Road as it is a part of the Bonshaw Hills Provincial Park. Black Brook tributary also enters above Crosby's Pond and does not have local salmon populations.

Above the Riverdale area still on the main branch of the River is the Green Bay section. There is a major transition of forest cover at one point, shifting from a mature forest cover in the Riverdale reach to dense alder growth as you enter the Green Bay area. The stream channel follows the shift in forest cover; where the forest cover is full and mature the meander is slower and more gentle, while in the dense alder growth areas the meander is tighter turning, and more inconsistent. The sediment bed load in this section is considerably higher when compared to the lower Riverdale reach. CQWF has recently covered this entire reach thinning out the alders and constructing brushmats to help address the sediment issue. The sediment bedload is the greatest limiting factor in this reach of the river.

The Quinn's Brook sub-watershed includes several kilometres of varying gradient stream below Carragher's Pond, the pond itself and three high-gradient but relatively short reaches of stream above. In recent years Atlantic salmon have spawned along a 200m section below Carragher's Pond and this area will be a priority for protection. The riparian buffer zone is mostly intact and there are several areas of mature riparian forest. In the past, however, soil eroded from a small number of steep fields and roadways, resulting in much sediment reaching this brook. A few gullies persist, although farming practices have improved markedly in very recent years. Salmon redds were last detected in 2014 below Carragher's Pond, but recently during electrofishing surveys juveniles were found. The juveniles found were likely the result from the Bluefield High School Fish Friends Program where students raised and released Atlantic salmon in 2019 and 2020.

Howell's Brook sub-watershed was historically described as the best Atlantic salmon habitat on the West River. Today, while a few salmon continue to spawn in the lower reaches, most of the brook (above Peters Rd) is heavily choked with sediment and excessive alder growth. Major progress has been made in such alder choked areas in recent years. A 700m section above the Wynn road has made remarkable progress since 2016; starting as a oozing flow through excessive alder growth and now has a meandering, free flowing channel with trace amounts of spawning substrates beginning to appear. A strategically placed sediment trap above Peter's Road captures mobile sediment released during restoration activities, protecting habitat downstream.

The uppermost area of the West River is the Brookvale area and contains several tributaries. Each stream reach has different in-stream and riparian zone habitat dependent upon gradient, deforestation and land use activities. The Brookvale sub-watershed has a low gradient immediately upstream from Route 13. This 1 km zone was heavily inundated with alders, both in and along the stream prior to 2010. Excessive sediment deposition occurred in the reaches with dense alders. Upstream from the "flat" reach, the gradient increases. Other than attempting to "fix" roadway or agricultural input problems, most activity will be focused on in-stream alterations to improve juvenile trout and salmon habitat. The riparian zone quality in these reaches varies but often many of the desirable tree species are present. These upper reaches of the West River should be prime production areas for salmonids because of water quality, but basic ingredients (spawning gravel, easy movement, appropriate cover, etc.) are often lacking. The removal of sediment just upstream from Route 13 should afford protection for all the important downstream river reaches where trout and salmon spawn. Salmon

redds were detected for the first time in decades in 2018 and 2019 and are considered a major success as this is a direct result of following a strategic restoration plan with suitable actions.

3.0 Monitoring Programs

Water temperature: Temperature data loggers were installed at 9 sites throughout the West River to monitor annual temperature regimes in 2019 and 2020 (Figure 6). Gaps in data in Figure 2 were because in 2020 there was one logger that went missing and another two loggers stopped working. The highest recorded temperature for 2020 was 18.4 degrees Celsius on August 14th. The highest recorded temperature for 2019 was 16.9 degrees Celsius on July 30. Figure 2 displays the monthly temperature average from May 2019 to April 2020.

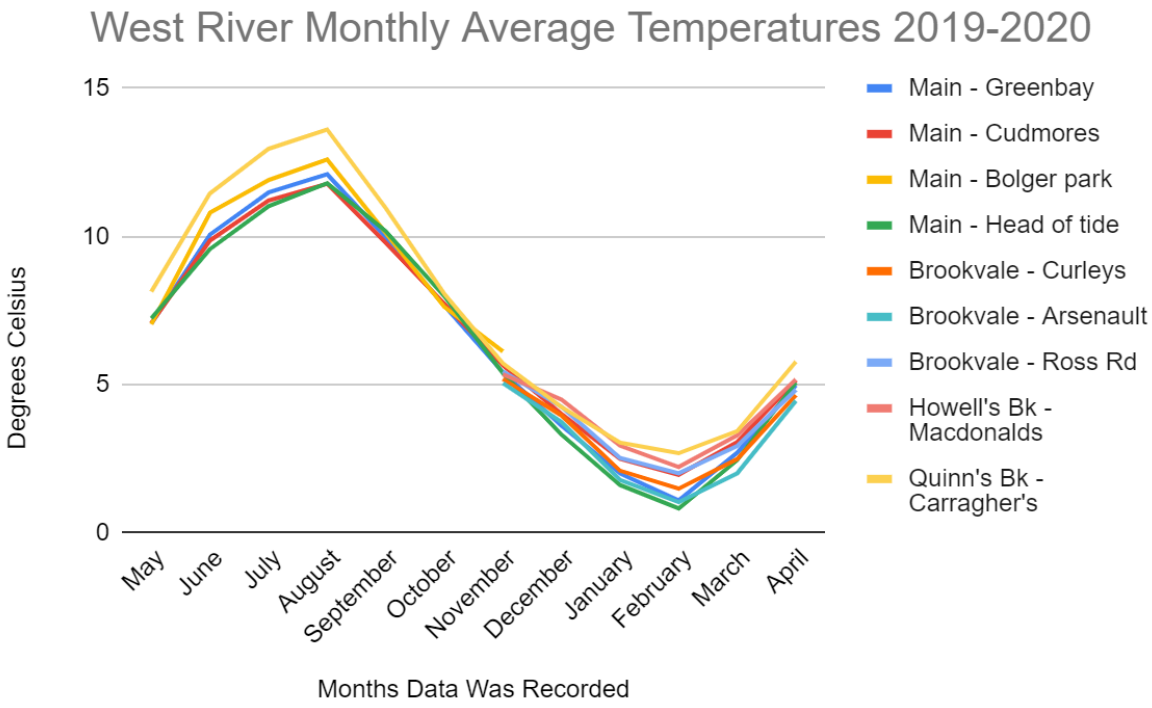


Figure 2. Monthly temperature averages on the West River at 9 locations from May 2019 to April 2020.

Nitrate monitoring: On major tributaries nutrient concentrations were monitored twice annually; once during low and high flow periods (Figures 3 and 4). In total 10 index sites are monitored on the West River (Figure 6).

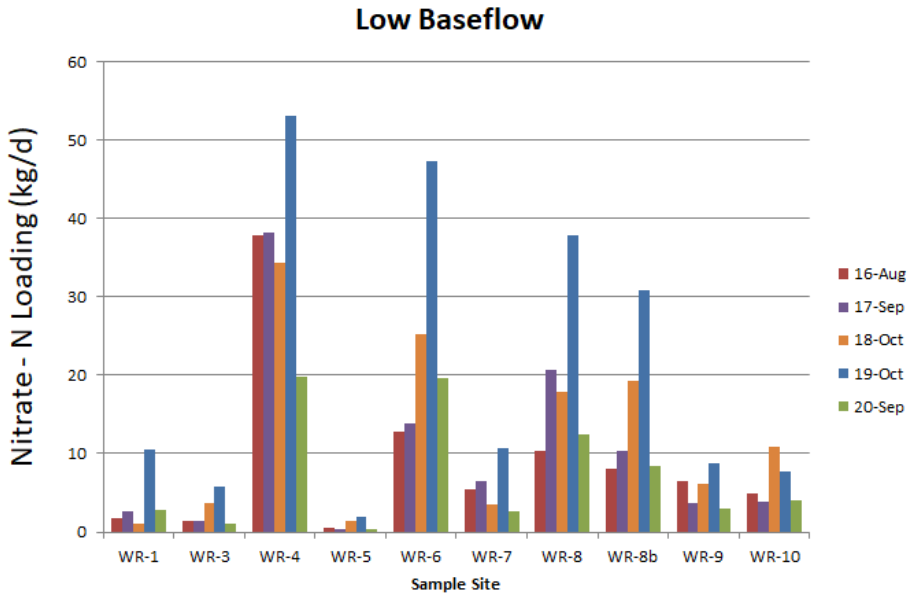


Figure 3. Site comparison of nitrate loading during fall season low flow period on the West River from 2016-2020.

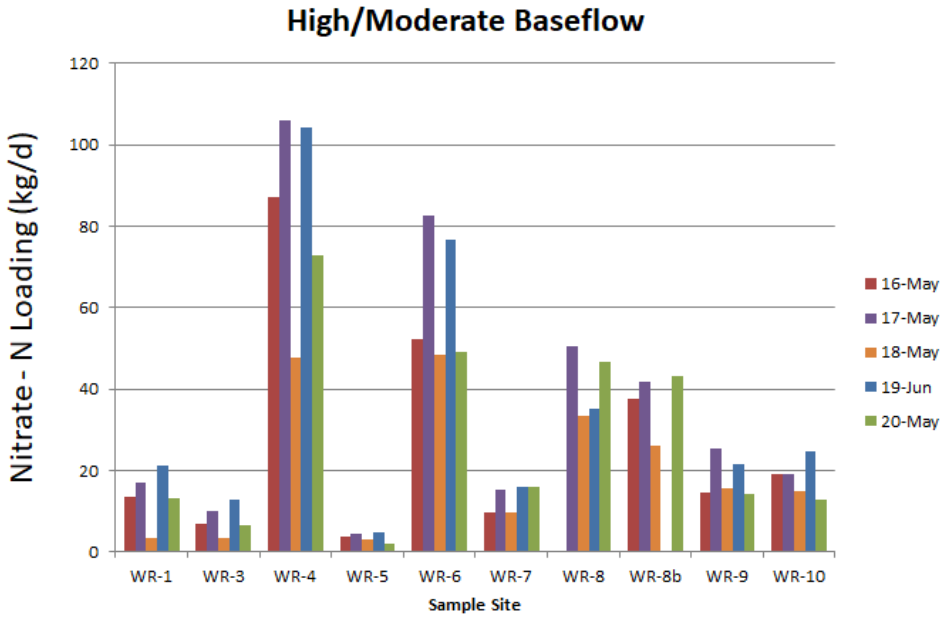


Figure 4. Site comparison of nitrate loading during fall season high/moderate flow period on the West River from 2016-2020.

Electrofishing data: In 2020 eight index sites were surveyed for salmonid densities (Figure 6). A three pass technique was used with barrier nets at all sites except the main Riverdale site. The data is presented below in Figure 5. Atlantic salmon were present at all sites except for the Skye Brook site with densities ranging from 0 - 68.9 per 100 m2.

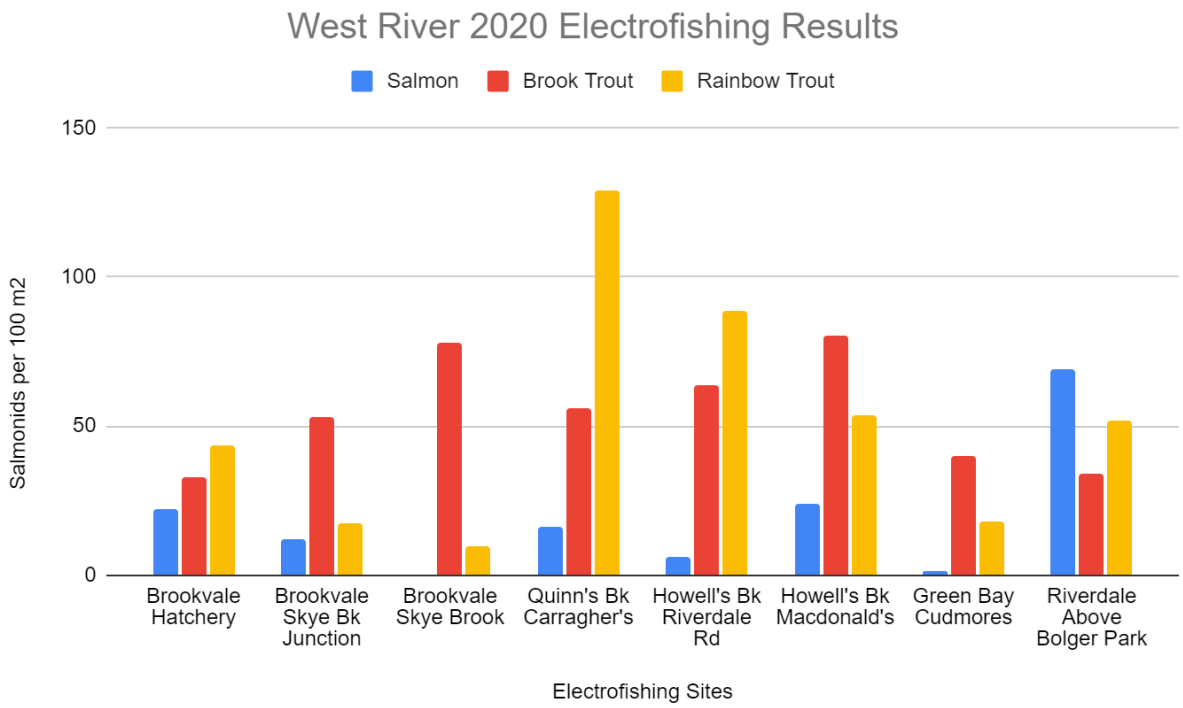


Figure 5. Electrofishing data from 2020 at eight sites on the West River showing salmonid density per 100m2.

Redd Surveys:

Annual redd surveys have also been conducted for Atlantic salmon on the West River from 1990 – 96 and 2008 – 20; while conducting redd surveys, trout spawning areas and other critical habitats were always noted. Table 1 displays Atlantic salmon redds counted from 2010 to 2020. All major tributaries are surveyed along with the entire main branch. In recent years salmon redds have been found in areas that are newly restored and this is encouraging as they are responding in a positive manner to restoration activities. It is important to record the total number redds but also the areas in which spawning occurs to further target management activities.

Table 1. Salmon redd count surveys on the West River since 2010 (* indicates an incomplete count).

Year	2010	2011	2012	2013	2014	2015	2016	2016	2017	2018	2019	2020
# of Redds	88	90	89	168	113	113	113	146	149	124*	113	101

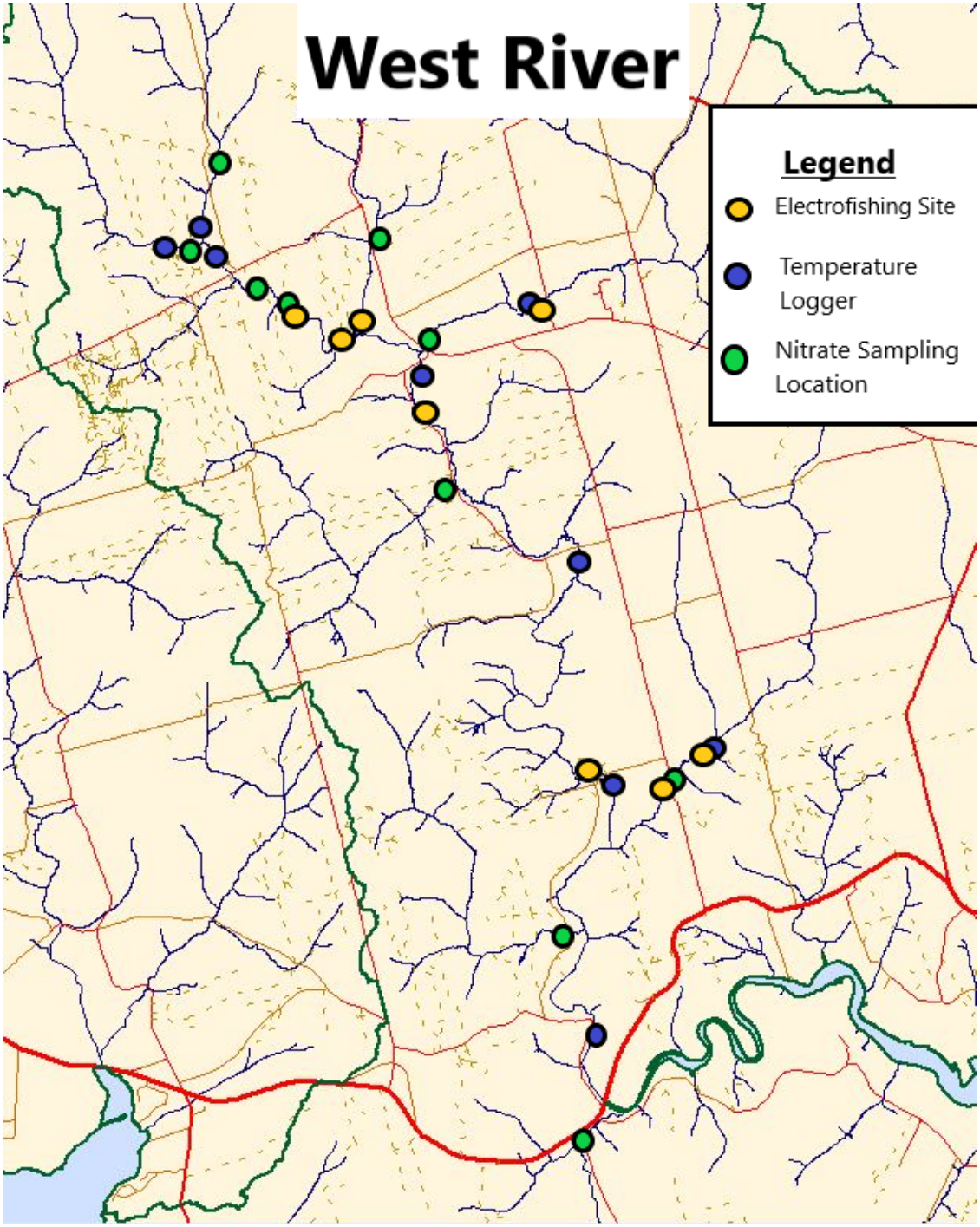


Figure 6. Map of the West River with data collection sites labeled.

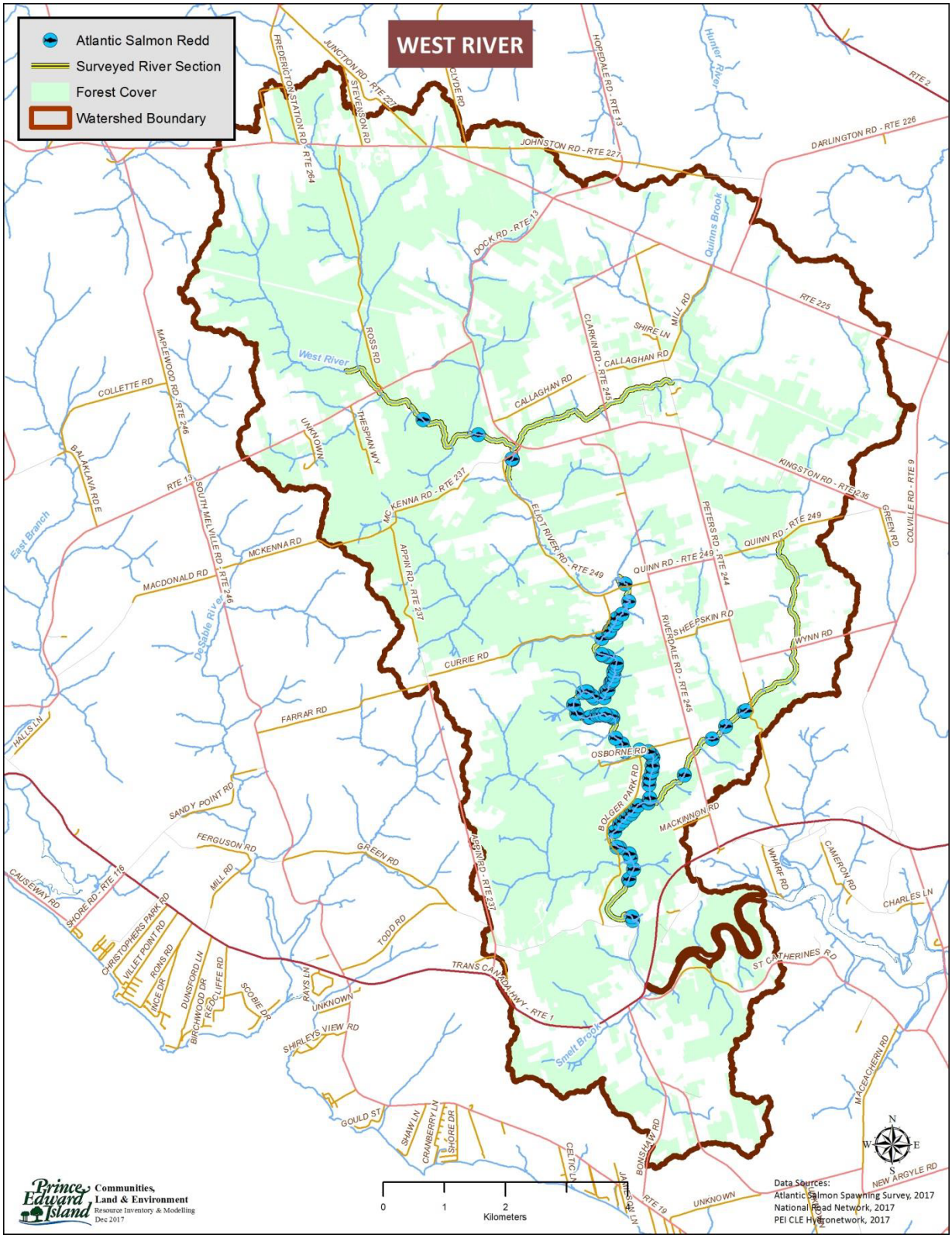


Figure 7. Salmon redds on the West River in 2017.

4.0 Habitat Requirements

_____Each life stage of salmon utilizes unique habitat components with an array of requirements and pressing limiting factors. Life stage requirements can be broken down into three general habitat components that should be targeted to improve early life stage success and productivity in streams. The three are: **spawning habitat**, **juvenile rearing habitat**, and **migratory areas**. When managing a section of river these three general habitat components should be identified to gage the level of productivity and also have limiting factors associated with the degradation of said areas identified. Limiting factors that negatively affect local salmon populations usually target one of these general habitat components. For example, severe sedimentation negatively impacts spawning habitat quality and juvenile rearing habitat which will ultimately lead to reduced productivity and local population declines. By addressing sources of sediment, the spawning habitat and rearing habitat should be easier to enhance and re-establish with additional restoration tactics. The historic usage of said identified habitat components is very important when moving forward with habitat management. The current situation of salmon and habitat usage may be the result of many decades of habitat degradation and may not always be the most ideal or productive area for salmon production. The following categorizes the life stage requirements into three general habitat components used during the salmon freshwater residency.

4.1 Spawning and Egg Incubation

The first task is to conduct annual redd surveys to identify which areas are currently being used for spawning activity. Talking to anyone who has historic knowledge on the area is also key in this step as some local experts may have prior knowledge of historic areas salmon used for spawning, which should be considered in management implications. Once ideal spawning areas are identified for targeting, the quality of spawning habitat can be improved via reducing instream sediment bedload, un-imbedding spawning substrate by manually breaking up substrate, and adding desired fist sized spawning substrate to identified areas. Salmon chose the placement of redds in a location with accelerating water velocity and decreasing depth (means of providing eggs with oxygen) in the transition area from pool to riffle and an area with coarse spawning substrate to ensure high egg survival. Other factors that should be considered in spawning habitat quality include nearby pools for salmon to stage in with adequate cover (under banks or LWD), quality of spawning substrate (round fist sized rock is preferred with minimal fine sediments), and chronic sources of sediment sources upstream of spawning areas. Woody debris can also be positioned in-stream to help create areas with ideal water velocities to increase available spawning habitat.

4.2 Juvenile Rearing Habitat

Young salmon prefer occupying riffle areas (<15cm in depth with coarse streambed) while depth preference for coarse substrate increases with body size. Juvenile salmon are territorial and higher densities can be found in riffle/run areas when coarse substrate and ideal flow are present. The first step in improving this habitat component is relating juvenile rearing habitat to spawning areas. Juvenile salmon will migrate downstream over time so rearing habitat should be located directly below spawning areas and progress down to the estuary. If it is identified that rearing habitat areas are lacking or are impaired, coarseness of the streambed can be improved upon. Using local rock sources (i.e. bedrock slabs or embedded boulders) to create boulder clusters in riffle/run areas is a way to increase streambed coarseness and also increase interstitial spacing between rocks. It is important to remember that juvenile

salmon have preferred dietary items (mayflies and stoneflies) so improving habitat requirements for desired invertebrates also improves the quality of habitat for juvenile salmon (i.e. leave woody debris in stream channel, rocks with interstitial spacing also improve habitat for invertebrates, etc).

4.3 Migratory corridor

To complete the salmon life cycle adults must return from sea to the freshwater environment to spawn and begin the life cycle again. The most important aspect of this stage is to ensure the adult fish can reach spawning areas. Annual monitoring of migratory corridors is required to ensure any major blockages (beaver dams, log jams etc) are removed before spawning season. It is also important to consider that adult fish are anadromous and require a transition period when leaving the salt water environment and entering the freshwater. This requires adequate holding areas in the head-of-tide region to allow the salmon to slowly adjust to the changing environment. Another factor to consider is the frequency of adequate holding pools that an adult fish can comfortably stage in while migrating upriver. When attempting to encourage adult fish to enter into major tributaries the frequency of holding pools should be every 200-500m. Ideally holding areas should be situated nearby spawning areas. If class A pools cannot be achieved large cover structures can be installed (ie full length cover logs or multi log structures) nearby spawning areas to encourage them to stage nearby prior to spawning. Also, an avoidance of stretches with low water should be resolved if possible, by resolving any braids and narrowing the stream channel in over widened areas.

When considering all life stage components, the current areas used by salmon should be targeted for enhancement and future restoration efforts should be targeted on areas that had historical significance for range expansion. The following will discuss important historic areas utilized by Atlantic salmon, identified limiting factors, and possible restoration techniques that could be utilized to improve habitat components.

5.0 Threats to Salmon

5.1 Climate Change

A changing climate has posed a range of challenges to salmon survival during the freshwater portion of their lifecycle. During fall of 2014 and spring 2015 the West River experienced two events described as “one in one hundred year floods”. Record breaking snowfall resulted in a massive spring freshet, which would have had severe negative effectives on egg survival. Redds could have been washed away and/or buried in sediment. If there is an increase in dramatic flooding events like experienced in 2014/2015 this may result in an increase of sedimentation and reduced egg survival.

A prediction with climate change is an increase in rainfall events during the winter months, which may result in a “super cooling” event as water runs off the land at near freezing temperatures. This may result in a hypothermic shock to the eggs resulting in a reduced egg survival. On the other end of the spectrum during 2020 there were drought like conditions experienced resulting in low water levels during the spawning season. Salmon redds were not recorded up any major tributary and were recorded in abnormal areas resulting in eggs placed in lower quality habitat. Another note with low water conditions was the increase in sightings of salmonids with fungal infections. A graduate study was ongoing during 2020 and resulted in multiple adult salmon captured with a fungal infection. During low

water the water is concentrated and rates of this type of infection increases, which has unknown consequences to the broodstock population. During the same period dozens of adult brook trout were found dead covered in the same fungal infection.

5.2 Sedimentation

Sediment is the biggest threat to salmon on PEI and the West River. It reduces habitat quality in multiple aspects. It reduces egg survival by infiltrating the spawning substrate which reduces the oxygen supply to the eggs during the incubation period. When the salmon fry emerge they require a coarse stream bed bottom for cover. After the fry emerge they become territorial and the size of the territories are directly related to the habitat quality. A coarse streambed bottom can support a higher number of individuals compared to a homogenous streambed bottom with no interstitial spaces. Another factor that can affect the growth of juveniles is the available dietary items present. Ideal dietary items are benthic macroinvertebrates, such as mayflies and stoneflies, and are usually found in high quality habitat with rocky streambed bottom opposed to a silt dominated stream, which would contain lower quality food items (midges, worms, etc). Sediment runoff enters the stream from a range of sources, in the West River area the main sources are secondary roads and agricultural fields. CQWF has been actively working with local landowners and the Department of Transportation Infrastructure and energy to resolve problematic areas. See Appendix for sediment trap locations for future excavations.

5.3 Fish Kill Events

Sadly, fish kills happen far too often and are recurring events here on PEI. On the Clyde River, the most recent fish was in 2016 on the West branch originating close to the Colville road. In the past, there were other fish kills recorded in 2002, and 1999. The most recent fish kill recorded on the West River was in 1971. Fish kill events devastate local populations as the young age classes are typically completely whipped out having detrimental long term effects. Agricultural fish kill event impacts are also likely to intensify as a result of climate change.

5.4 Barriers to Migration

Beaver issues arise from time to time on the West River watershed. With their low densities they are considered more of an annoyance with minimal effort to manage when compared to other watersheds. CQWF has a beaver management plan and manages a beaver free zone. Culverts problems as well as impoundments generally cause little to no problem on the West River, but can and do cause drastic effects on other watersheds. One of the most significant impacts for salmonids is the warming effect on downstream waters. This is especially important in watersheds such as the Morell where numerous impoundments flood low relief land, changing the temperature regime for the river. **(Guignion conservation strategy)**.

5.5 Invasive Species

Rainbow trout can be found throughout the entire West River watershed drainage basin and have been an ongoing problem for decades. Intraspecific competition for spawning area, food, as well as cover and space have created large drawbacks for native salmonid populations. While brook trout and salmon both spawn in late autumn, rainbow trout spawn in April. On the West River, rainbow trout have

been observed to excavate their redds on top of Atlantic salmon spawning sites from the previous fall. Rainbow trout are known to be aggressive and fast growing and their impacts on salmon in PEI streams is not fully understood. Recent studies in PEI suggest that because of habitat separation between the three salmonid species, the impacts of rainbow trout may not be the most significant threat to native salmonid populations. A large rainbow trout hatchery in Brookvale has been a sight for concern. In recent years, worry was expressed around water quality exiting the facility and the quantity of water pumped to operate the hatchery **(Guignion conservation strategy)**.

6.0 Action Plans

6.1 Riverdale

The Riverdale area can be described as the main branch of the West River that flows into Crosby's Pond, up river through the "Riverdale Horseshoe and Boyscout Camp" area and into Green Bay. The majority of the riparian area along this section contains mature forest with a healthy functioning meander sequence. In total it contains ~7 km of river, which CQWF maintains on an annual basis and promotes as an enjoyable canoe route. This section of river contains the majority of salmon habitat and populations considering in 2019 91 out of 113 salmon redds were found along this section of river. Some of the recent restoration achievements CQWF has made include the following:

- This section of river is passable via canoe or kayak as of 2017
- Repeat areas used for spawning have been identified and annually enhanced
- 30+ riffle sites enhanced for juvenile rearing habitat
- Major cover structures installed in +15 holding areas
- Over widened areas that posed a fish passage issue during low flow were addressed

Major limiting factors that threaten Atlantic salmon populations include the following:

- Sedimentation (mainly from secondary roads and agricultural fields)
- Poor spawning habitat quality in areas due to sedimentation
- Reduced juvenile rearing habitat due to sedimentation
- Deforestation in the "Riverdale Boy Scout" area

Many factors contribute to these limiting factors and when considering all factors, a complex situation is illustrated. For example, sources of sedimentation are a factor that affects spawning habitat quality (embeds spawning substrate and reduces oxygen supply to eggs) and also affects juvenile rearing habitat by reducing the streambed interstitial spacing and limiting insect productivity (food sources and cover for juvenile). To resolve this issue the source of sediment must be resolved, instream sediment must be removed or managed then finally work can begin to reverse said damages.

Habitat Description

The first reach of this section of river is from Crosby's Pond up to Bolger Park bridge consisting of ~3km of river. During spawning season redds can be found through the entire section and in 2019 35 of 113 redds were found along this stretch. During 2020 major riffle sites were targeted at +30 locations with the goal of improving juvenile rearing habitat via boulder clusters. Very little riparian enhancement

occurs along this section as it already contains a well established mature forest and a majority of this area is owned and protected by the Provincial Government.

The next reach is the section above Bolger Park Road and contains ~4km of river. It contains the best salmon habitat on the West River and PEI. Being surrounded by mature old growth forest this section of river has minimal sediment related problems and contains highly productive riffle areas. A graduate study found that in multiple locations the salmon densities were in range of 70 fish per 100m2. The bulk of salmon spawn along this section indicated in 2019 as 51 of 113 redds were found along this section.

Recommendations

The following are objectives to help further improve local populations of salmon along the Riverdale section:

- On an annual basis survey for redds to monitor areas that are repeatedly used for spawning and use information for future enhancement activities
- Continue monitoring electrofishing index site below Bolger Park Road
- Maintain 7 km of stream connectivity by ensuring the migratory corridor from sea to spawning areas remains clear of blockages and beaver activity
- Work with DTIE to resolve sediment runoff from Bolger park and Currie rd
- Monitor secondary roads and agricultural fields for sediment input
- Enhance current spawning areas by loosening substrate (up to 30cm deep) with rakes and removing fine sediments to ensure future spawning efforts have ideal substrate to create high quality redds. Addition of preferred substrate (fist sized rock) can be added in areas where shale/flat rock is dominant (most important below Bolger Park Rd)
- In areas with ideal spawning substrate but lacks preferred flow velocities install structures to encourage spawning by creating ideal hydraulic parameters (both above and below Bolger Park Road.
- Monitor for fish with fungal infection and keep detail records of # of infected fish, # of dead fish and # of salmon with fungal infection
- Continue to improve juvenile rearing habitat in riffle/run areas above and below Bolger Park Road
- Monitor sediment trap in Crosby's Pond for future re-excavation
- Monitor deforestation activities
- Expand spawning beds into Riverdale horseshoe

Table 2. Management recommendations for the Riverdale region of the West River

Annual To-Do Checklist	Long Term (5+ years)	Short Term (1-5 years)	Cost/Benefit	Priority
Area: Riverdale				
Redd surveys	X		Low/High	1
Electrofish index site below Bolger Park Road	X		Low/High	1
Walk section to ensure no barriers to fish passage		X	Low/High	1

Work with DTIE to resolve sediment runoff from Bolger park and Currie rd	X		Low/High	1
Monitor secondary roads and agricultural fields for sediment input		X	Low/High	1
Rake spawning areas identified via redd surveys		X	Low/Medium	1
Addition of preferred substrate to spawning areas where shale/flat rock is dominant		X	Low/Medium	2
Install structures to create ideal hydraulic parameters above and below Bolger Park Road		X	Medium/Medium	2
Monitor fungal infection frequency	X		Low/High	2
Increase/Improve Juvenile rearing habitat		X	Low/high	2
Monitor sediment level in Crosby's Pond for future re-excavation	X		High/high	3
Monitor deforestation activities	X		Low/Medium	3
Expand spawning beds to Riverdale horseshoe	X		Low/Medium	3

6.2 Howells's Brook

Howell's Brook has been a main focus for CQWF over recent years for restoration activities. Since 2014, CQWF has improved many habitat aspects for Atlantic salmon on Howell's Brook with the objective of creating high quality habitat to increase local populations. Some major achievements on Howell's Brook include:

- Improving almost 7 km of stream connectivity
- Constructing a sediment by-pass pond above Peter's Rd (re-excavated 2 times)
- Addressing and identifying major sources of sediment (Peter's Rd in 2016)
- Improved riparian zone habitat (+750 trees in +45 patch cuts)
- Increased number of holding pools on the lower 1.2km of stream (2019)
- Improved riffle habitat at ~45 sites on lower 3.2 km of river
- Improved/increased spawning areas
- Monitor/identify spawning areas every year during November/December (see Figure 7)
- Monitor salmonid densities at Riverdale Rd, Mcdonalds, Wynn Rd, and Quinn Rd

Major limiting factors that threaten Atlantic salmon populations on Howell's Brook include the following:

- Sedimentation (mainly from secondary roads and agricultural fields)
- Poor spawning habitat quality in areas due to sedimentation
- Reduced juvenile rearing habitat due to sedimentation
- Inadequate migratory corridor (lack of deep holding pools and/or suitable cover)
- Poor riparian habitat along certain areas.

Habitat Description

On Howell's Brook the lower 1.2km (section below Riverdale Rd) has been identified primarily as ideal juvenile habitat with many long riffles/run sections with desired coarse substrate. Not many, but few areas in this 1.2 km section have been identified as spawning areas. During 2019 this section of stream was targeted to improve the migratory corridor by increasing the amount and frequency (goal every 200m) of deep-water holding pools for migrating adult fish. This entire stretch has a well-established mature riparian zone containing mature Eastern hemlocks and hardwood species.

The following 1.4km stretch of stream (between Riverdale Road and Peters Road) contains ideal spawning habitat and in 2019 the bulk of salmon redds were found along this reach. In recent years CQWF has improved the stream channel meander sequence by altering problematic LWD, and installing brush mats to help restore a healthy flowing stream channel. Recently CQWF has spent a tremendous amount of effort in improving riffle habitat for rearing habitat, improving/increasing spawning areas, and installing cover structures in pools nearby potential spawning areas. The first several hundred meters of this section (directly above Riverdale Rd) is predominately alder growth but eventually changes to a mature hardwood forest. CQWF has created alder patch cuts and planted with native trees/shrubs in this area to help improve the riparian habitat.

The next section is 1.3km and spans from Peter's Rd to Wynn Rd and is the last section that has been identified of importance for salmon habitat. The lower to mid reaches of this stretch have been identified mainly as habitat for spawning with few reaches for juvenile rearing habitat. This section has a by-pass sediment pond constructed ~700m above Peter's Rd and plays a very important role in protecting all habitat below by capturing and permanently removing mobile sediment. This section has moderate riparian habitat quality as much of it is predominately alder growth and early succession forest. Over 30+ alder patch cuts have been created along this stretch in order to help improve the riparian habitat.

The remainder of upstream stream habitat is not significantly important to salmon but is important in enhancing and maintaining this section for other salmonid species. The upper reaches of Howell's Brook (+3km) had significant sediment load and was addressed by selectively removing alders and installing brush mats. It is important to keep managing this section to ensure the legacy sediment issue is resolved and does not impair the progress made downstream. Improving the riparian habitat in weakened areas, working with Dept of Transportation Infrastructure and Energy (DTIE) and local farmers to reduce sediment input is very essential to continue progress.

Recommendations

The following are objectives and goals for future improvement of habitat components on Howell's Brook:

- On an annual basis survey for redds to monitor areas that are repeatedly used for spawning and use information for future enhancement activities
- Continue monitoring electrofishing index site below (Riverdale rd, MacDonald's, Wynn rd, and Quinn rd)
- Maintain almost 7 km of stream connectivity by ensuring the migratory corridor from sea to spawning areas remains clear of blockages and beaver activity
- Work with DTIE to resolve sediment runoff from Sheepskin and Peter's rd

- Monitor secondary roads and agricultural fields for sediment input
- Enhance current spawning areas by loosening substrate (up to 30cm deep) with rakes and removing fine sediments to ensure future spawning efforts have ideal substrate to create high quality redds. Addition of preferred substrate (fist sized rock) can be added in areas where shale/flat rock is dominant. This is most important on the lower 1.2km stretch below Riverdale Rd as this section will support the majority of juvenile individuals and also should occur immediately downstream of spawning areas.
- In areas with ideal spawning substrate but lacks preferred flow velocities install structures to encourage spawning by creating ideal hydraulic parameters. This will be important on the lower 1.2km reach (below Riverdale Rd) where the substrate is mainly shale. Enhancing spawning habitat is mostly important on the middle section (between Riverdale Road and Peter's Road) where excessive fine sediment is an issue.
- Establish adequate holding areas nearby spawning areas to ensure adult fish are willing to stage and spawn nearby (pool creating deflectors and/or large cover structures an adult salmon can hide underneath)
- Monitor for fish with fungal infection and keep detail records of # of infected fish, # of dead fish and # of salmon with fungal infection
- Continue to improve juvenile rearing habitat in riffle/run areas below important spawning areas and along entire 1.2km section below Riverdale Road
- Monitor sediment trap on Peters rd for future re-excavation
- Continue improving stream meander function by monitoring problematic LWD, alder growth, and installing brushmats to narrow over widen sections (most important on section above Peter's Rd)
- Continue improving weakened riparian habitat areas by planting native hardwood trees and shrub species (creating alder patch cuts, planting alongside agriculture fields, expanding buffer zones)

Table 3. Management recommendations for the Howell's Brook region of the West River

Annual To-Do Checklist	Long Term (5+ years)	Short Term (1-5 years)	Cost/Benefit	Priority
Area: Howells' Brook				
Redd surveys	X		Low/High	1
Electrofishing index sites (Riverdale rd, MacDonalds, Wynn rd, and Quinn rd)	X		Low/High	1
Walk section to ensure no barriers to fish passage		X	Low/High	1
Work with DTIE to resolve sediment runoff from Sheepskin and Peter's rd	X		Low/High	1
Monitor secondary roads and agricultural fields for sediment input		X	Low/High	1
Rake spawning areas identified via redd surveys		X	Low/Medium	1
Addition of preferred substrate to spawning areas where shale/flat rock is dominant		X	Low/Medium	2

Install structures to create ideal hydraulic parameters above and below Bolger Park Road		X	Low/Medium	2
Install structures to create pools		X	Low/Medium	2
Monitor fungal infection frequency	X		Low/High	2
Increase/Improve Juvenile rearing habitat		X	Low/High	2
Monitor sediment levels on Peters Road sediment trap for future re-excavation	X		High/High	2
Installing brushmats to narrow over widen sections		X	Low/High	2
Continue improving weakened riparian habitat areas	X		Low/High	2

6.3 Brookvale

The Brookvale region of the West River is the uppermost region of the watershed drainage basin and was one of the firstly targeted areas of restoration beginning in 2010. The Curley's Property was one of the first endeavours that CQWF began back in 2010 and since then the habitat quality for salmon has made a complete transformation. Since 2010 CQWF has made the following achievements:

- Installed and maintained a sediment by-pass pond along the Curley's Property (excavated 2 times)
- Maintained an instream sediment trap immediately above Ross Rd (excavated 3 times)
- On an annual basis ~6.6 km of stream habitat is maintained
- Survey for redds during spawning season
- Improved riparian habitat (over +1000 trees in +55 alder patch cuts)
- +50 cover structures installed
- 10 pool creating structures installed (cross vane and digger logs)
- Monitor salmonid densities via electrofishing at Curley's, Arsenault's, below hatchery, Skye Brook junction and Skye Brook

Major limiting factors that threaten local Atlantic salmon populations in the Brookvale region include:

- Sedimentation reducing juvenile rearing habitat and spawning habitat (Ross road and agricultural fields near Route 225)
- Lack of ideal spawning substrate in midsection of the Brookvale region
- Brookvale rainbow trout hatchery (water quality concerns and escaped rainbow trout)
- A new landowner in the headwater region began a maple syrup operation and cut a significant amount of trees in the buffer zone. The landowner was contacted but the issue was not resolved. This area could be a possible sediment runoff source and should be resolved immediately

Habitat Description

The Brookvale area begins at the junction of Skye brook and continues up river into head water regions. This uppermost area of the drainage basin has three tributaries: Skye Brook, which enters at the

lower region of Brookvale, Ross Brook, which is the east tributary at the Curley's property, and main West River, which is the west tributary at the Curkey's property. Skye brook does not have local populations of salmon and without stocking efforts neither tributary on the Curley's property would have local populations either. Both tributaries above the Curley's property contain ideal juvenile rearing habitat and minimal predators (large trout), hence the reason stocking has occurred along these sections. Stocking in the Brookvale area started back in 2015 and has occurred yearly since. The riparian habitat varies along both tributaries containing sections with dense alder thickets and mature Acadian forest. The main tributary contains some mature old growth forest as you travel further up the branch with minimal alder thickets when compared to Ross brook.

The midsection of this area extends from the junction of Skye brook up to Curley's property forks above Rte 13 covering ~3km of stream and contains ideal salmon juvenile rearing habitat as the streambed bottom is dominantly shale/larger sized substrate. There are areas with smaller and ideal sized substrate for spawning but activities should take place to improve this aspect. The best spawning habitat is located above Rte 13 along the Curley's Property where redds were detected for the first time in decades in 2018 (n= 3) and 2019 (n= 1). Considering the entire Brookvale area there were 14 redds in 2019. The reach of stream from the Skye brook junction to the Brookvale hatchery has a well established riparian margin with mature Acadian species (yellow birch, eastern hemlock, red & sugar maple). The section of stream extends above the hatchery and reaches up past Route 13 to the Curley's forks is mainly alder and early succession species. This early succession area has been the focus for tree planting and alder patch cuts since 2010 and has resulted in +35 plantations with +500 native trees/shrubs planted.

Recommendations

The following are objectives and goals for future improvement of habitat components for Brookvale:

- On an annual basis survey for redds to monitor areas that are repeatedly used for spawning and use information for future enhancement activities (Curleys, Arsenault's, hatchery, Skye brook and Skye brook junction)
- Continue monitoring electrofishing index sites (Curleys, Arsenault's, hatchery, Skye brook and Skye brook junction)
- Maintain 6.6 km of stream connectivity by ensuring the migratory corridor from sea to spawning areas remains clear of blockages and beaver activity
- Work DTIE to resolve sediment runoff from Ross rd
- Monitor secondary roads and agricultural fields for sediment input
- Enhance current spawning areas by loosening substrate (up to 30cm deep) with rakes and removing fine sediments to ensure future spawning efforts have ideal substrate to create high quality redds. Addition of preferred substrate (fist sized rock) can be added in areas where shale/flat rock is dominant. This is most important along the midsection below the Brookvale hatchery as this section will support the majority of juvenile individuals and should also occur immediately downstream of spawning areas.
- In areas with ideal spawning substrate but lacks preferred flow velocities install structures to encourage spawning by creating ideal hydraulic parameters. This should occur in areas where suitable substrate is present without ideal flow velocities

- Monitor for fish with fungal infection and keep detail records of # of infected fish, # of dead fish and # of salmon with fungal infection
- Continue to improve juvenile rearing habitat in riffle/run areas below important spawning areas and below hatchery
- Monitor sediment by-pass pond at Curley's and in stream sediment trap on Ross rd for future re-excavation
- Investigate the hatchery as a probably cause for the high rates of broodstock fungal infections and water quality issues
- Continue improving weakened riparian habitat areas by planting native hardwood trees and shrub species (creating alder patch cuts, planting alongside agriculture fields, expanding buffer zones)

Table 4. Management recommendations for the Brookvale region of the West River

Annual To-Do Checklist	Long Term (5+ years)	Short Term (1-5 years)	Cost/Benefit	Priority
Area: Brookvale				
Redd surveys	X		Low/High	1
Electrofishing index sites (Curleys, Arsenault's, hatchery, Skye brook and Skye brook junction)	X		Low/High	1
Walk section to ensure no barriers to fish passage		X	Low/High	1
Work with DTIE to resolve sediment runoff from Ross rd		X	Low/High	1
Monitor secondary roads and agricultural fields for sediment input		X	Low/High	1
Rake spawning areas identified via redd surveys		X	Low/Medium	1
Addition of preferred substrate to spawning areas where shale/flat rock is dominant		X	Low/Medium	2
Install structures to create ideal hydraulic parameters above and below Bolger Park Road		X	Low/Medium	2
Monitor fungal infection frequency	X		Low/High	2
Increase/Improve Juvenile rearing habitat		X	Low/High	2
Monitor and re-excavate the sediment by-pass pond at Curley's and in stream sediment trap on Ross Road	X		High/High	2
Investigate the hatchery for the high rates of broodstock fungal infections and water quality issues		X	Low/High	2
Continue improving weakened riparian habitat areas	X		Low/High	2

6.4 Quinn's Brook

Quinn's Brook is the next major tributary downstream of Brookvale, located just ~1km below the junction of Skye Brook. This tributary has a long history of restoration activities with CQWF since the early 2000's. Carragher's Pond is located on Quinn's Brook just above Peter's Road and was completely re-excavated in the early 2000's and had the upper sediment trap cleaned out twice since then. Historically this tributary had local salmon populations up until 2014. It is believed that rainbow trout were the main reason salmon disappeared from this section as rainbow trout redds were detected to be superimposed over salmon redds. This tributary has the highest densities of rainbow trout detected during 2020 electrofishing surveys (Figure 5). Quinn's Brook also has the highest temperatures recorded which may contribute to the rainbow trout success as they emerge later than native salmonids and warmer water temperatures allow for faster growth rates.

Some major achievements on Quinn's Brook include:

- Improving almost ~6 km of stream connectivity
- Constructing a sediment by-pass pond between Peter's and Mill Road (re-excavated once)
- Carraghers Pond enhancement project in early 2000's and maintaining in-stream sediment trap at upper end (re-excavated twice since 2000's)
- Improved riparian zone habitat (+600 trees in +30 patch cuts)
- Monitor/identify spawning areas every year during November/December
- Monitor salmonid densities at electrofishing index site below Carragher's Pond

Major limiting factors that threaten Atlantic salmon populations on Quinn's Brook include the following:

- Sedimentation (mainly from the Mill road)
- Poor spawning habitat quality in areas due to sedimentation (below Clarkin Road)
- Reduced juvenile rearing habitat due to sedimentation (below Clarkin Road)
- Poor riparian habitat along certain areas
- Competition from invasive rainbow trout (highest densities are along Quinn's Brook)

Habitat Description

The junction of Quinn's Brook to the main West River is located immediately above Mckenna Road. This section of stream extends up to Clarkin Road covering 2 km of stream. Along this reach there are select areas for spawning and juvenile rearing. The main limiting factor for this reach is embedded substrate and lack of spawning substrate. This section has a mature and well established riparian area up until the last 300m before Clarkin Road where it transitions into alder thickets. Along this 300 m stretch CQWF has +15 alder patch cut plantations, in which native Acdian species have been planted.

Proceeding above Clarkin Road the alder thicket continues for 150m until a well established and mature riparian area returns and continues up to Peter's Road. This section from Clarkin Road to Peter's road is relatively short (~1.2 km), but contains the best spawning habitat for salmon on Quinn's Brook where salmon redds were historically found. These sections contain ideal substrate for spawning and since Carragher's Pond is located upstream these sections are protected from sedimentation. CQWF in 2020 worked through this section and has initiated the restoration process of restoring a properly functioning stream meander sequence by resolving problematic LWD and blockages. This section between Clarkin Road and Peter's Road is the most ideal habitat for salmon on Quinn's Brook and should be a targeted focus to eventually have salmon return to this area. The Fish Friends Program with

Bluefield High School raises juvenile salmon in a classroom setting then has the students release the salmon back into streams. Bluefield releases the salmon fry into Quinn's Brook below Carragher's Pond and electrofish surveys have indicated that the salmon are indeed surviving. If this program continues salmon may eventually return to section to spawn and a local population may become self sustaining.

The last remaining section proceeds above Peter's Road and contains Carragher's Pond and the headwater region of Quinn's Brook. Carragher's Pond plays an important role in protecting downstream habitat from sedimentation and also providing recreational angling opportunities. The Mill Road sediment trap should also be maintained. Mill Road is a known chronic source of sediment input and DTIE has been advised on several occasions about the current issue but no serious actions have been taken to resolve this issue yet. The headwater region is not a significantly important area for salmon but historically was important for brook trout spawning and should be maintained for such reasons.

Recommendations

The following are objectives and goals for future improvement of habitat components for Quinn's Brook:

- On an annual basis survey for salmon redds (mainly below Carragher's Pond)
- Continue monitoring electrofishing index sites below Carragher's Pond
- Maintain 6 km of stream connectivity by ensuring the migratory corridor from sea to spawning areas remains clear of blockages and beaver activity
- Monitor Mill Rd for sediment runoff and work with DTIE to resolve issues or close road entirely
- Monitor secondary roads and agricultural fields for sediment input
- Monitor for fish with fungal infection and keep detail records of # of infected fish, # of dead fish and # of salmon with fungal infection
- Monitor and re-excavate as needed at Carragher's Pond in-stream sediment trap and Mill Road by-pass pond
- Continue to improve weakened riparian areas by planting native tree/shrub species below/above Clarkin Road
- Continue to work with the Fish Friends Program and stock salmon fry below Carrragher's Pond

Table 5. Management recommendations for the Brookvale region of the West River

Annual To-Do Checklist	Long Term (5+ years)	Short Term (1-5 years)	Cost/Benefit	Priority
Area: Quinn's Brook				
Redd surveys	X		Low/High	1
Electrofishing index sites (Below Carragher's pond)	X		Low/High	1
Walk section to ensure no barriers to fish passage		X	Low/High	1
Work with DTIE to resolve sediment runoff from Mill rd		X	Low/High	1
Monitor secondary roads and agricultural fields for sediment input		X	Low/High	1

Monitor fungal infection frequency	X		Low/High	2
Monitor and re-excavate as needed at Carragher's Pond in-stream sediment trap and Mill Road by-pass pond	X		High/High	2
Continue improving weakened riparian habitat areas	X		Low/High	2
Bluefield Fish friends program		X	Low/Medium	2

6.5 Green Bay

The Green Bay area of the West River is located in the midst of the main branch nestled between Brookvale and Riverdale and contains ~5.5 km of stream channel. The distinguishing feature between Riverdale and Green Bay is the riparian habitat. Green Bay is early successional and dominated by alder growth. CQWF began restoring this section in 2016 (1.3 km below Green Bay culvert) and 2017 (4.2 km above Green Bay culvert along Eliot River Road). Since 2017 CQWF has made the following achievements:

- Restored 5.5 km of stream channel (lower Green Bay promoted as canoe route)
- Installed 20 large brush mats
- Planted ~550 trees at +30 alder patch cuts
- Installed 10 cover structures
- Monitor salmonid spawning activity during November/December
- Monitor salmonid densities at electrofishing index site at Cudmore's property

Major limiting factors that threaten Atlantic salmon populations in the Green Bay region include the following:

- excessive sediment bedload reducing juvenile rearing and spawning habitat quality
- lack of riffle habitat with coarse substrate and ideal spawning substrate
- early successional forest and alder dominant landscape
- prior to restoration activities the entire stream channel was congested with dense alder growth

Habitat Description

Below the Green Bay culvert the stream meander sequence consists of a tight meandering channel that lacks rifle habitat and is mainly run/pool habitat. There is a major problem with excessive sediment and fine substrates. This section is of low priority for salmon habitat restoration as it contains lower habitat quality when compared to the rest of the West River. This section is 1.2 km in length before entering the Riverdale area. However, a year after restoration activities (2017) began in this area 7 salmon redds were detected proving this area has potential to support local populations of salmon if restoration continues.

Proceeding above the Green Bay culvert the stream follows the Eliot River Road for 4.2 km and contains slightly better salmon habitat qualities than the lower region. The stream meander sequence contains some rifle areas with ideal spawning habitat in certain areas. In 2020 this area was fully surveyed for salmon redds and 8 salmon redds were recorded. Since the restoration process has only begun recently this section has potential to support local salmon populations and will continue to

improve as the excessive sediment bedload is addressed. This area also contains a weakened riparian area with early successional forest and dense alder growth. CQWF has started alder patch cuts plantations in two locations along this section and will continue to do so.

Recommendations

- On an annual basis survey for redds to monitor areas that are repeatedly used for spawning and use information for future enhancement activities
- Monitor salmonid densities at electrofishing index site at Cudmore's property
- Maintain 5.5 km of stream connectivity by ensuring the migratory corridor from sea to spawning areas remains clear of blockages and beaver activity
- Work DTIE to resolve sediment runoff from Mckenna Road
- Monitor secondary roads and agricultural fields for sediment input
- Monitor for fish with fungal infection and keep detail records of # of infected fish, # of dead fish and # of salmon with fungal infection
- Continue improving stream meander function by monitoring problematic LWD, alder growth, and installing brushmats to narrow over widen sections
- Enhance riparian habitat in alder dominated areas by creating alder patch cut plantations and planting of native tree/shrub species

Table 6. Management recommendations for the Green Bay region of the West River

Annual To-Do Checklist	Long Term (5+ years)	Short Term (1-5 years)	Cost/Benefit	Priority
Area: Green Bay				
Redd surveys	X		Low/High	1
Electrofishing index sites	X		Low/High	1
Walk section to ensure no barriers to fish passage	X		Low/High	1
Work with DTIE to resolve sediment runoff from Mill rd		X	Low/High	1
Monitor secondary roads and agricultural fields for sediment input (Mckenna Rd)		X	Low/High	1
Monitor fungal infection frequency	X		Low/High	2
Installing brushmats to narrow over widen sections		X	Low/High	2
Continue improving weakened riparian habitat areas	X		Low/High	2

https://docs.google.com/spreadsheets/d/1-5ZoT856WoO5-LyXYZ-tVktzRYeogL_cPMI-rka7Eso/edit?usp=sharing

7.0 Potential Sources of Funding for Atlantic salmon projects:

- HSP (https://www.dfo-mpo.gc.ca/species-especes/sara-lep/hsp-pih/index-eng.html)
- ASCF (https://www.salmonconservation.ca/)
- WCF (https://www.peiwcf.ca/)
- WMF (https://www.princeedwardisland.ca/en/information/environment-water-and-climate-change/watershed-management-fund)
- Canada Nature Fund for Aquatic Species at Risk (https://www.canada.ca/en/fisheries-oceans/news/2020/11/canada-nature-fund-for-aquatic-species-at-risk--projects-in-atlantic-provinces.html).

8.0 References/Technical documents

Visit: https://peiwatershedalliance.org/?page_id=26319 to find the following documents:

- West River WMP
- Watershed Technical Manual
- 2019 renewed conservation strategy
- Native Plants and Watersheds: A Natural Combination

Canada, Department of Fisheries and Oceans. (n.d.). *Atlantic Salmon Integrated Management Plan 2008-2012 Gulf Region* (https://waves-vagues.dfo-mpo.gc.ca/Library/332473e.pdf).

Leblanc-Poirier, N., Comeau, C., & Maillet, M. (2014, February). Stewardship Plan to Protect and Restore the Atlantic Salmon (Salmo salar) Habitat in the Cocagne River. Retrieved December 22, 2020, from https://ecopaysdecocagne.ca/images/publications-bassin-versant/salmon-habtiat-cocagne.pdf

https://indigenoustourism.ca/regions/prince-edward-island/

9.0 Appendix

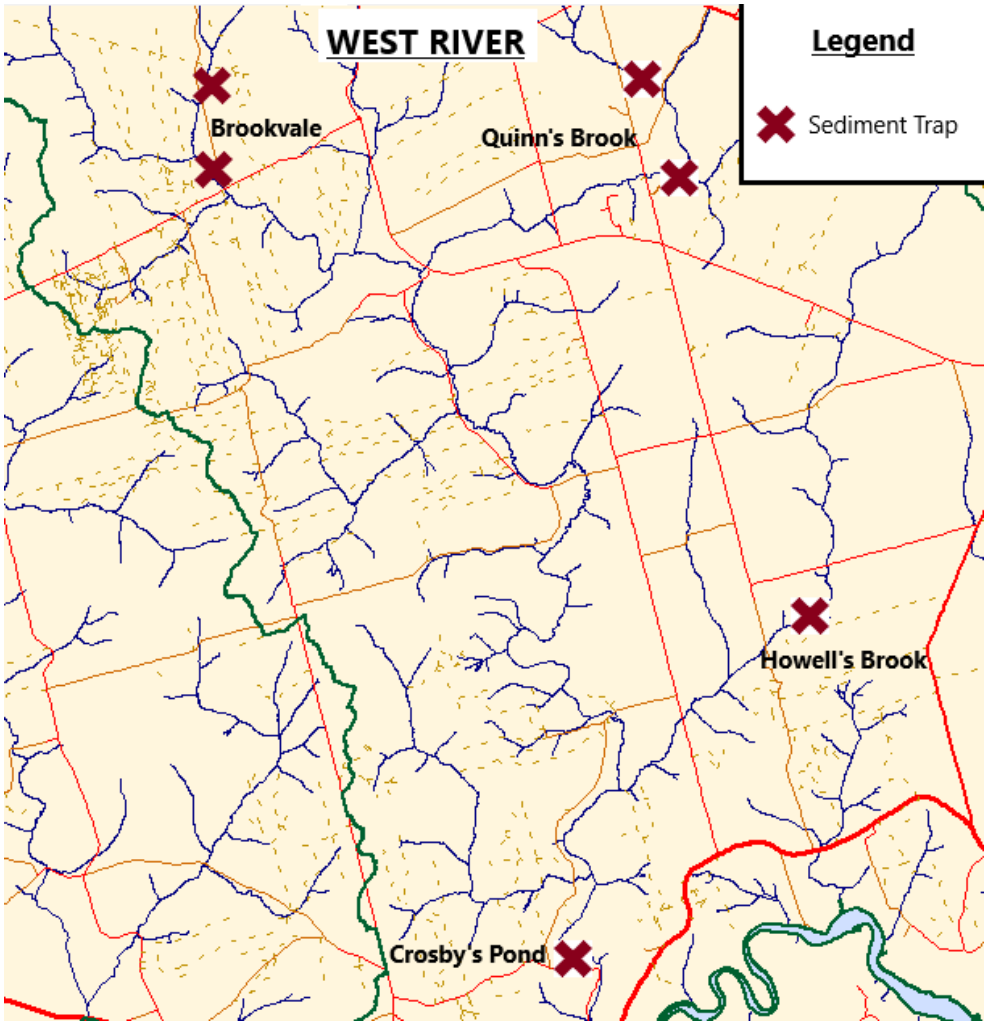
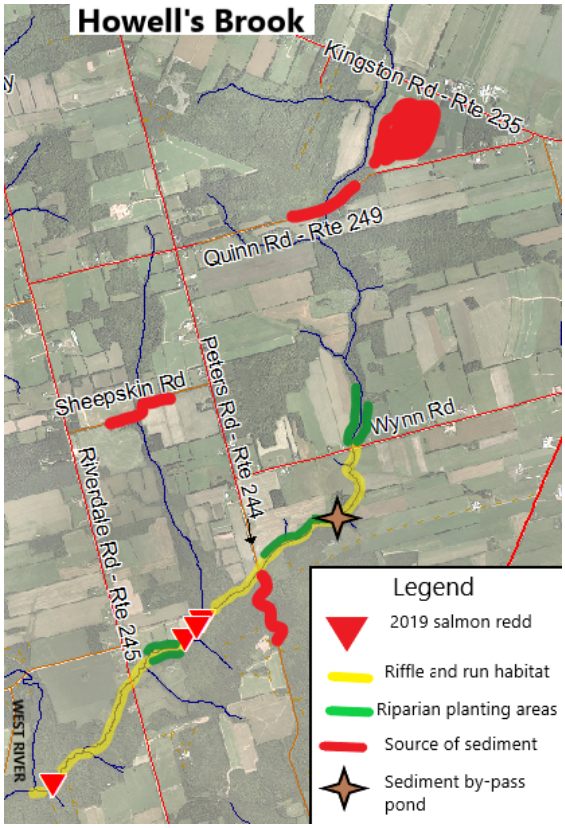


Figure 8. Sediment traps locations on the West River



Map 6. Howell's Brook identified habitat areas along with 2019 Atlantic salmon redds, riparian planted areas, sediment by-pass pond and sources of sediment also highlighted.