Stewardship Plan for the Little River:

A Tributary of the Petitcodiac River

Fort Folly Habitat Recovery

Fort Folly First Nation

2024 Edition

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Disclaimer:

This document claims no authority by which to drive its implementation. Instead, it is intended simply to serve as a public resource that organizes available information and helps inform future decision making by identifying, and prioritizing needs and sites for restoration activities that will enhance habitat quality and promote species recovery. This is a reference, not intended to be read cover to cover. It is also a living document, current and definitive to the time of writing, but constantly evolving and will never assume an absolute "final" form. Instead, it will be updated and superseded by subsequent editions as additional information becomes available.

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Introduction

This Little River Stewardship Plan is one of a series of seven such documents compiling, detailing, and presenting information about tributaries of the Petitcodiac River and surrounding watersheds. The purpose of this series of documents is to enable prioritization and planning of restoration activities within the following watersheds: 1) Demoiselle Creek, a small watershed that drains directly into Shepody Bay, near the mouth of the Petitcodiac River estuary, 2) the Memramcook River, immediately adjacent to the mouth of the Petitcodiac River at Fort Folly Point, 3) the main-stem of the Petitcodiac extending between the Village of Petitcodiac (where the Petitcodiac "begins") down to the head-of-tide at Salisbury, and four tributaries of the Petitcodiac River system, 4) Little River, 5) Pollett River, 6) Anagance River, and 7) the North River. The location of these watersheds in or near the Petitcodiac system, (just outside of Moncton New Brunswick) is presented below in Figure 1. Each watershed was assessed according to the four-level approach laid out in the Department of Fisheries and Oceans document, "Ecological Restoration of Degraded Aquatic Habitats: A Watershed Approach" (Melanson et. al 2006). Under this process the first level of assessment is an examination of the land use history of the watershed. The second level of assessment looks at the current impacts. The third level of assessment considers the aquatic and riparian habitat, and the fourth level of assessment then brings this information together to develop an aquatic habitat rehabilitation plan that identifies priorities and opportunities for interventions within each watershed to advance the goal of habitat restoration.

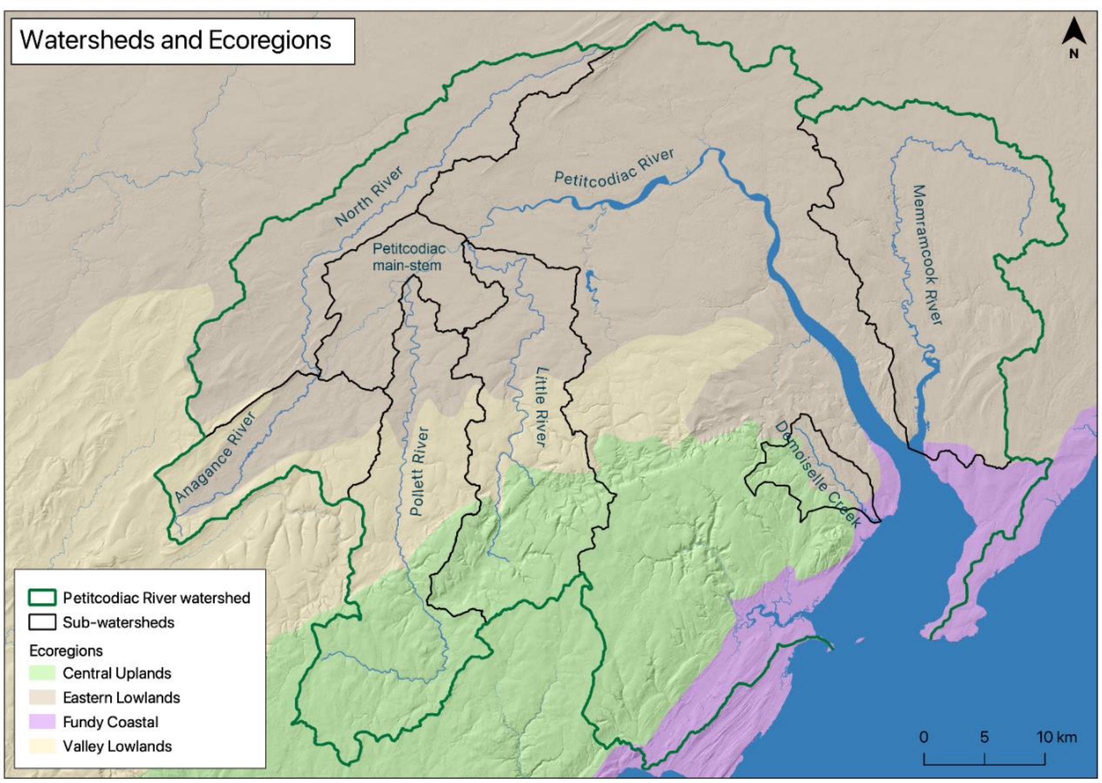

Figure 1: Location of examined watersheds within or near the Petitcodiac system

Little River

The Little River (also referred to as the Coverdale River), flows for its entirety in Albert County before emptying into the Petitcodiac River (Figure 2) which marks the boundary with Westmorland County. The Little River is, despite its name, the second largest tributary in the Petitcodiac watershed (after the Pollett River), draining a basin of 276 square kilometers. Its headwaters are at the base of Gowland

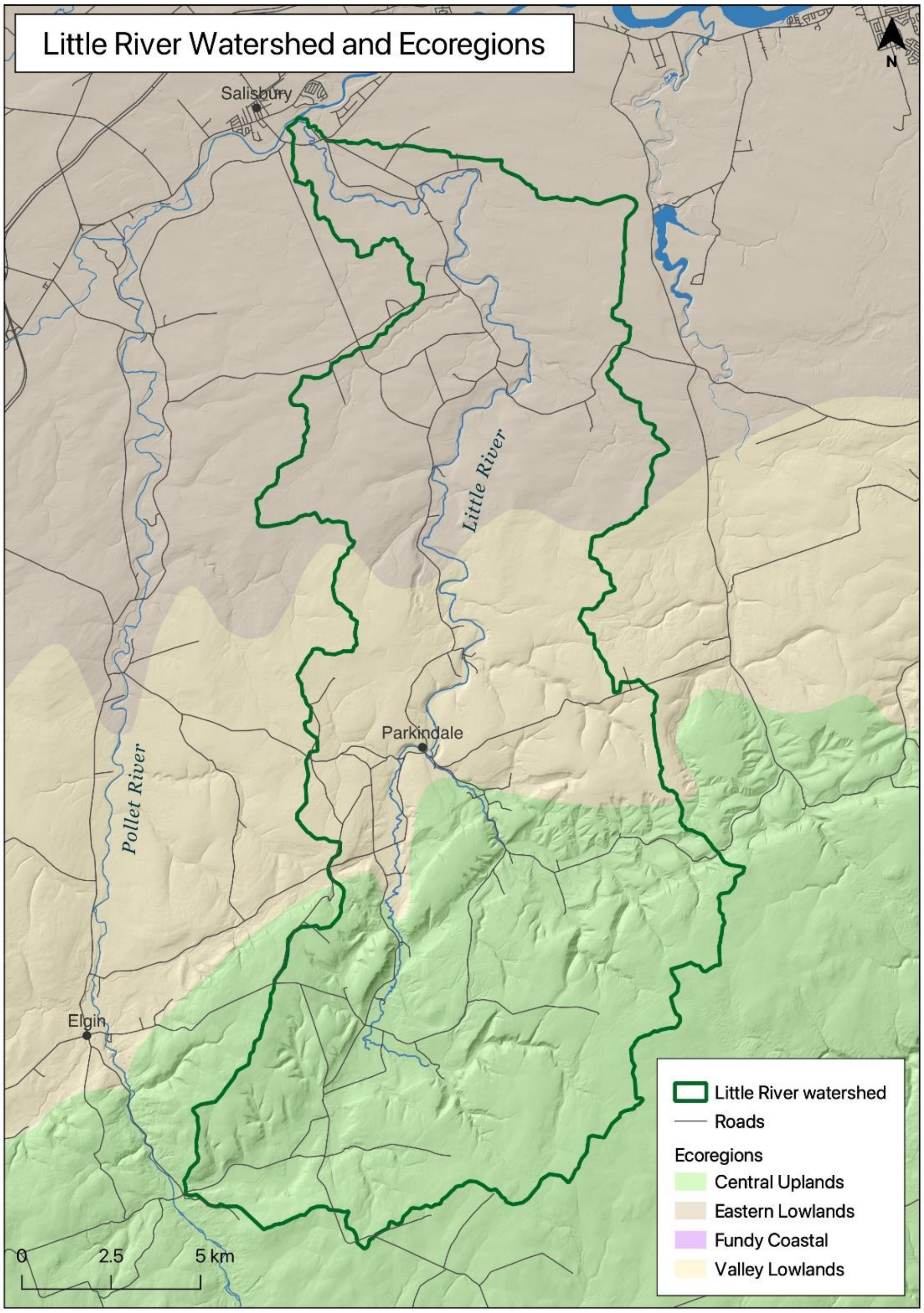

Figure 2: Little River Watershed

Mountain in New Brunswick's Central Uplands Ecoregion (New Brunswick Department of Natural Resources 2007) a few kilometers southeast of Elgin. From there the river flows 51 km north through the communities of Parkindale in the Continental Lowlands Ecoregion, on through Colpitts Settlement in the Eastern Lowlands Ecoregion, ending finally at Salisbury where it joins the main stem of the Petitcodiac River near the head of tide. Along the way the Little River drops nearly 200 m in elevation between its headwaters and its mouth. In addition to its main stem, named tributaries of the Little River include: Bull Creek; East Branch Little River; Ferndale Brook; Hopper Brook; Leaman Brook; Mitton Brook; Pow Brook; Prosser Brook; Stiles Brook; and Upham Brook. The river usually runs clear, and often has a gravel bottom though in places bedrock is visible. During the spring freshet or after a storm it can become turbid for several days, before resuming its more normal condition.

The dominant land uses within the watershed are forestry and agriculture. Approximately 89% of the watershed is forested, 58% of which is small private woodlots, 41% is crown land, and 1% is industrial freehold forest land owned by J.D. Irving. Approximately 7% of the watershed has been cleared for agriculture, 75% of which is being used to grow row crops or grains, 12% pasture or hay, and 12% blueberries (New Brunswick Department of Natural Resources in 2023).

Government maps today label it as the Little River (Natural Resources Canada, 2010), though the Department of Fisheries and Oceans produced documents referring to it as the Coverdale River as recently as the mid-1980s (Ashfield et al 1984), and when speaking with the general public, both names are still frequently encountered. For much of its history since English settlement the river was known as the Coverdale River, from which Coverdale Parish took its name when it was split off from Hillsborough Parish in 1828 (Provincial Archives of New Brunswick 2023). The name, Little River, is not distinctive, and should not be confused with several other rivers in New Brunswick bearing the same name: one of which is a tributary of the upper Saint John River in northwestern New Brunswick near Grand Falls; another of which flows into Indian Lake before that drains into Grand Lake and eventually the Saint John River at Jemseg; and yet another which lies within the city limits of Saint John, and flows directly into Saint John Harbour. The situation has improved somewhat however, as Ganong (1896) noted the name "Little River", in use for 7 other rivers within the Province, though not this one, which he referred to as the Coverdale River.

The name Coverdale remains part of the modern landscape in the nearby localities of Upper Coverdale, Coverdale, and Middle Coverdale spread out along the main stem of the Petitcodiac towards Riverview, as well as Lower Coverdale, downstream between Riverview and Hillsborough. Riverview itself is the result of the amalgamation in 1974 of several communities including Coverdale (Hamilton 1996). Ganong (1896) noted usage of the name Coverdale in reference to the river on a land grant dating from 1788, though he indicated that the origin was unknown to him. Interestingly he also pointed out that an 1889 Postal map referred to it as the Scadouck River by mistake, an error which was also repeated 6 years later in the Electoral Atlas of the Dominion of Canada 1895 (Library and Archives Canada 2015). This usage presumably should have been applied to the nearby Scadouc River, which flows into the Northumberland Strait at Shediac. Baillie's (1832) An Account of the Province of New Brunswick… with advice for emigrants; Perley's (1857) Handbook of Information for Immigrants to New Brunswick; Walling's (1862) Topographical Map of Westmoreland and Albert Counties; and the Roe Brothers 1878 Atlas of the Maritime Provinces (Dawson 2005), all confirm Ganong's (1896) statement that Coverdale was the official name in use for the Little River at that time. That said, there still appears to have been some ambiguity and dual name usage even then, as in 1889 a complaint was registered with the

Provincial Legislature over the state of the John Mitton Bridge, described as “crossing the Little River a few miles from Salisbury Station, in Coverdale Parish, Albert County” (New Brunswick House of Assembly 1890).

Two theories exist about where the name Coverdale itself came from (Kanner and Geldart 1984). One is that it was a tribute to Myles Coverdale, a British Bishop in 16th century England who produced the first translation of the Bible from Latin to English. The other suggests that it comes from the first English settlers at the mouth of the river, Joshua Geldart and his nephew John who arrived in May 1774, both of who were born in Coverham in the Dale of Cover in Yorkshire (also near where Myles Coverdale was born, and from which he took his name). Given Ganong’s (1896) observation that the name Coverdale had been applied to the river as early as 1788, just 14 years after the arrival of the Geldarts, their use of the name in reference to their home in Yorkshire seems the simpler and more persuasive of the two theories. In either case though, it is clear that the name arrived with early English settlers and was contemporary with the arrival of the Geldarts.

Colpitts Settlement was itself known as Little River from 1857 to 1903 (Provincial Archives of New Brunswick, 2023), which is how it was listed by the Electoral Atlas of the Dominion of Canada (1895). In 1904 the community changed its name to Colpitts Settlement in recognition of the Colpitts family, the first English settlers at that location along the river (Provincial Archives of New Brunswick, 2023), and who’s descendants subsequently accounted for much of the early population at that location (Walling 1862). John Colpitts arrived from England as a teenager with his father (Robert Colpitts, who settled along the Petitcodiac near Salisbury in 1783). In 1786, John moved off the main stem, up along a tributary (then called the Coverdale River) to develop his own homestead at Little River (Moncton Daily Times, Thursday August 26th 1920; Provincial Archives of New Brunswick, 2023). This may explain the origin of the name Little River for the river itself today, taken from the prior English name for that settlement along its banks. That name is also still in use, now referring to a smaller community further upstream between Colpitts Settlement and Parkindale (Natural Resources Canada, 2010).

First Level Assessment – Land Use History of the watershed

An understanding of the historical land use within a watershed provides context that helps explain the causes of issues affecting the watershed today. The following sections outline the historical land use both within the Little River watershed, and in the surrounding communities in both Westmorland County and Albert County. Within the Little River watershed this includes the communities of Colpitts Settlement, Parkindale, and Pleasant Vale; and outside the watershed, the community of Salisbury at the river's confluence with the Petitcodiac; and Elgin (on the Pollett River) as the centre serving the upper reaches of the Little River (Table 1).

Table 1: Brief historical background summary for communities along or near the Little River

Community	Settlement Type and Dates	Notes
Colpitts Settlement *(Little River)*	Settled c.1786 by Colpitts family Farming	**1898** population 250, post office, store, 2 grist mills, church
Elgin *(Pollett River)*	Settled c.1811 by Geldart family Farming and lumbering	**1871** population 250 **1876** connected to the Intercolonial Railway at Petitcodiac by completion of branch line, The Elgin, Petitcodiac, & Havelock Railway **1898** post office, railway station, 6 stores, 3 hotels, 2 churches sawmill, grist mill, tannery, carriage shop, and cheese factory
Parkindale *(Little River)*	Settled c.1817 by Parkin family Lumbering	**1898** population 150, post office, store, store, and a church
Pleasant Vale *(Little River)*	Settled c.1831 Farming	**1898** population 190, post office, sawmill, grist mill, furniture factory, church
Prosser Brook *(Little River)*	Farming	**1898** population 150, post office, sawmill, store, and a church
Salisbury *(Petitcodiac River)*	Settled c.1774 Farming and lumbering	**1898** population 400, railway station, post office, 6 stores, 2 hotels, carriage factory, 3 churches

(Source: Provincial Archives of New Brunswick, 2023)

The Maritimes have had human inhabitants for the last 11,000 years (Wicken 2002), though for most of that time precise cultural identities are impossible to determine today. By the early 1600s, when Europeans arrived, much of the native population of coastal Atlantic Canada shared a common culture and language identifying themselves as the L'nuk, "the People", and recognized by Europeans as the

Mi'kmaq. During this time, the Mi'kmaq lived in large villages along the coasts from April to November. They grew corn in small garden plots but were mostly dependent upon fish and game for nourishment. Therefore, they tended not to stay in one place for long given the need to follow their food sources so dispersed inland during the winter to hunt moose and caribou (Wicken 2002). Estimates of the pre-contact population vary between 15,000 to 35,000 in what is now Nova Scotia and New Brunswick (Miller 1976, Marble 1993). This declined between 75% to 90% due to social disruption and epidemics brought by Europeans (such as smallpox) during the first century of contact. By 1616, Jesuit priest Pierre Biard estimated the population as 3,500 (Mooney 1928). Physical impacts on the watershed were few compared to what was to follow.

Ganong's (1905) map of known First Nations villages and campsites includes a Mi'Kmaq site at Salisbury located along the north bank of main stem of the Petitcodiac, near the head of tide between the mouths of Little River and the Pollett River. A native leaving Beaumont (where there was another camp in the lower Petitcodiac estuary) could ride the 13 km per hour tidal bore upstream to Salisbury, greatly facilitating such travel (Petitcodiac Heritage River Committee 2000). The importance of the Salisbury encampment was due to its location both at the head of tide and near the ends of a pair of portage routes leading to the Saint John River system. The more highly traveled of the two routes crossed from the main stem of the Petitcodiac River to the Canaan River (Ganong 1914) near what is now the Village of Petitcodiac, as doing so provided the best access to the upper St. John and on to the St. Lawrence (Petitcodiac Heritage River Committee 2000). The other route crossed from a tributary of the Petitcodiac, the Anagance River, to the Kennebecasis River (and from there to the lower portion of the Saint John River system). In fact the name Anagance comes from Wolastoqey "Oo-ne- guncé" meaning portage (Ganong 1896), presumably a reference to the link provided by that tributary.

In the 1630's the French began to make a serious effort to colonize Atlantic Canada, beginning to arrive in numbers significant enough to develop an enduring Acadian identity (Laxer 2006), at a fairly similar timeframe to the English colonies further south. By 1676 the first Acadian settlers arrived at Beaubassin, near the current Nova Scotia Visitor's Centre along the Trans-Canada Highway at the New Brunswick border (Larracey 1985). During this time there was much Acadian and Mi'kmaq intermarriage (Marshall 2011) weaving a complex web of family relationships. French authorities encouraged intermarriage to produce a colonial hybrid population, while further south the English tended to aggressively enforce racial segregation (Prins 1996). Meanwhile the Mi'kmaq had begun to adopt Catholicism from the French, while the British were Protestants, at a time when such differences added fuel to conflicts. Acadians also maintained good relations with the Mi'kmaq in part because the lands Acadians occupied either complemented native use, as with fur traders, or were in areas that were marginal to native concerns as in the case of the Acadian farmers on the tidal flats (Mancke 2005).

By 1710, Acadians and Mi'kmaq in peninsular Nova Scotia fell under British control, which was subsequently formalized in 1713 under the treaty of Utrecht. Previous to the treaty, the French had claimed that the borders of Acadia reached all the way to the Kennebec River (well within in what is now Maine). After the treaty however French Authorities claimed that Acadia was just Port Royal (renamed Annapolis Royal by the British after they seized it in 1710) and the peninsula (modern Nova Scotia excluding Cape Breton). Based on that assertion, the French continued to occupy the mainland (now New Brunswick), in addition to the territory they retained officially under the treaty (Martin 1995) i.e.: Île Saint-Jean (Prince Edward Island), and Île Royale (Cape Breton Island). The British were not in a position to contest this reality due to a lack of soldiers and settlers (Ganong 1901). By 1730 the Acadian community in the Petitcodiac was thriving precisely because they were under the jurisdiction of neither Great Brittan nor France (Faragher 2005). That situation did not last, however. With no agreed boundary between English and French territory provided by the Treaty of Utrecht, the French eventually adopted and defended the Missaquash River as the de facto boundary between the two powers (Milner 1911), the same boundary that is in modern use between New Brunswick and Nova Scotia. To Europeans the treaty had merely changed the status of Nova Scotia from a fairly uninhabited French territory with disputed boundaries, to a fairly uninhabited British territory with disputed boundaries (Martin 1995). It was rather more personal to the Mi'kmaq and Acadians who lived there.

Meanwhile, after 1713, New England fisherman pushed more aggressively into Nova Scotia's coastal waters sparking conflict with the Mi'kmaq (Wicken 2002). By 1726 the Mi'kmaq and the British signed the first of a series of Peace and Friendship treaties. What the British wanted from the agreement was native recognition of the Treaty of Utrecht whereby natives agreed not to molest His Majesty's subjects in "lawfully" made settlements, and the Crown could regulate the movement of European nationals into Acadia – i.e., exclude the French. In exchange the British agreed not to interfere with native hunting, fishing, planting activities.

In June 1749 Edward Cornwallis established Halifax with 2,500 settlers as a new capital for Nova Scotia (Beck 1979) and constructed the citadel there as a fortress to defend it. This marked the beginning of meaningful efforts by the British to settle the Maritimes. Prior to this time British authority at Annapolis Royal "had been no more than a mock government" that "did not extend beyond the cannon reach of the fort" (Philipps 1720). The Mi'kmaq immediately recognized the implications of this change and reacted with outrage to what they regarded as establishment of an unlawful settlement in violation of the Treaty of 1726, and theft of their land. No responsible indigenous leader could ignore the reality that environmental change brought about by such agricultural settlement was the most lethal threat that British imperial expansion posed to the existing economy, livelihood, and health of the Mi'kmaq (Reid 2013). Violence escalated until by late 1749 Governor Cornwallis proclaimed a policy aimed at "extirpation" of the Mi'kmaq (Paul 2000).

The French built Fort Beausejour in 1751 at the border to protect Acadian communities in what is now New Brunswick from attack by the British. By this time the Acadian population near the Fort had grown to 1,541 people, with an estimated additional 1,100 spread out at Shepody and along the Petitcodiac and Memramcook Rivers (Larracey 1985). Their physical impacts on the Little River, what for them was a remote hinterland, were limited.

In 1752 the British signed yet another treaty with the Mi'kmaq reaffirming the 1726 treaty and also modifying it to formalize a commercial relationship between the British and the Mi'kmaq (Wicken 2002), encouraging not only hunting and fishing, but ensuring "free liberty" to sell the products of such activities in Halifax or any other settlement. For the British this provision was critical as an attempt to wean the Mi'kmaq from their friendly relationships with the Acadians and French officials in Louisburg. This treaty subsequently formed the basis of the 1999 Supreme Court Marshall decision and subsequent ongoing modern lobster fishery disputes.

Ganong (1899) notes that like First Nations, the French made use of the Kennebecasis- Petitcodiac portage along the Anagance to maintain communication between Fort Beausejour and Acadian settlements on the lower St. John. However, the French route between the Canaan and the Petitcodiac to access the upper St. John was slightly different than the one favoured by First Nations, reportedly crossing overland to the Canaan from the North River, rather than the main stem of the Petitcodiac (Raymond 1891). From there messengers from Fort Beausejour, and the Fortress of Louisbourg passed up along the St John to reach Quebec.

After the fall of Fort Beausejour in 1755, the British attempted to expel the Acadians, to open up land for English settlers. There is a record of an Acadian settlement, Village Victuare, located nearby in Salisbury, close to the Mi'kmaq encampment there (Ganong 1930). It was documented in 1758 by British Major George Scott as he was forcefully removing Acadian families from the upper Petitcodiac (Scott 1758). The village appears to have been composed of approximately 10 homesteads, settled in about 1751, and was reportedly the largest Acadian village along the Petitcodiac upstream of Beausoleil Village, modern day Allison. Ganong (1930) suggests that it is likely that in the wake of the expulsion, Acadians briefly occupied locations such as Fourche-à-crapaud at the mouth of Turtle Creek, and on the Coverdale (Little), and Pollett Rivers in order to be near the head of tide and thus above the reach of English Ships. Major Scott apparently found the tidal bore on the Petitcodiac problematic during his raids in 1758, nearly losing two ships on one occasion (Pincombe and Larracey 1990).

Arsenault (2004) suggests that a settlement named Village des Babineau existed at the mouth of the "Coverdale" (Little) River near Salisbury. That is a surprisingly specific and questionable location given that Ganong (1899) using a map from 1754, puts Village des Babineau downstream, in what is now Riverview, at a location that prior to amalgamation in 1974 was called Coverdale (Provincial Archives of New Brunswick 2023). Surette et al. (1981) confirm this, indicating the Village des Babineau was an alternate name for a community named Fourche-à-crapaud, located at the mouth of Turtle Creek (Provincial Archives of New Brunswick 2023), an area later known as Coverdale. Presumably Arsenault (2004) confused Turtle Creek and the later English community of Coverdale with the Coverdale (i.e. Little) River. Though Village des Babineau was reportedly destroyed by Scott in 1758 (Ganong 1905), it does not appear on his map at either location (Scott 1758).

The Mi'kmaq sided with the French (Wicken 2002), participating in the defense of Fort Beausejour, as well as the short guerilla war which followed its capture (Grenier 2008). There were several reasons that Mi'kmaq in New Brunswick did so. In addition to intermarriage, prior to the arrival of the British, native communities had already established trade networks with the Acadians for steel tools, weapons and other European goods (Walls 2010). Another source of friction was that the Mi'kmaq had begun to adopt Catholicism from the French, while the British were Protestants, at a time when such differences added fuel to conflicts. Acadians also had had good relations with the Mi'kmaq in part because the lands Acadians occupied either complemented native use, as with fur traders, or were in areas that were marginal to native concerns as in the case of the Acadian farmers on the tidal flats (Mancke 2005). English settlers on the other hand tended to seize land the Mi'kmaq valued, to clear the forest for agriculture (Francis et al. 2010).

Throughout 1760 and 1761 the British also signed a series of Peace and Friendship treaties with individual native communities, reaffirming the treaties of 1726 and 1752 (Wicken 2002), with the signature at Chignecto/ Missaquash occurring on July 8th, 1761. The important distinction with this iteration of the treaties was the provision by which natives agreed not to trade with the French. To ensure that such trade did not occur the British agreed to establish "truck houses" as points of trade near native communities.

The Treaty of Paris in 1763 ended the Seven Years War, with France ceding its territory in Canada and the Maritime region to Britain, except for the small islands of St. Pierre and Miquelon in the Gulf of St. Lawrence (Ganong 1901; Faragher 2005). The latter France retained in the interest of preserving its access the lucrative fishery in the Gulf of St. Lawrence and the Grand Banks (MacNutt 1970). Shortly there after a royal proclamation set the boundary between Canada (Québec) and Nova Scotia as being the watershed between the Saint Lawrence and points south until reaching the north coast of the Bay of Chaleur. All of Nova Scotia north of the Bay of Fundy (modern New Brunswick) was made part of Cumberland County. In 1765 that was changed to make the Saint John River into Sunbury County. There was no formally defined boundary between Sunbury and Cumberland Counties until 1770 when it was set as a somewhat arbitrary line beginning at Mispec (a short distance along the coast east of the mouth of the Saint John River) headed due north to the Canadian (Québec) border (Ganong 1901).

With peace, in 1763, Acadians throughout the region became British subjects, but this was not the case for First Nations, whose situation was more complex (Beaulieu 2014). The British defeat of France at Louisburg in 1758 encouraged the political collapse of the Mi'kmaq population in Nova Scotia as a fighting force as the peace and friendship treaties signed between 1760 and 1761 brought an end to Indigenous-French relations and alliances (Patterson 1993). Between typhus brought by the d'Anvill expedition, violence promoted by LeLoutre, and Cornwallis' policy of Mi'kmaq extirpation, by 1763 First Nations had been decimated by decades of warfare and disease, with some estimates suggesting that there may have been fewer than 500 individuals remaining in the Maritimes (Statistics Canada 2020).

In 1764 the British government began to allow Acadians to resettle in Nova Scotia with the provision that they remain in small groups scattered throughout the province (MacNutt 1963). Initially they were not allowed to settle in groups larger than 10 persons, the goal being to keep them at great distances from each other, or even ultimately discourage them from remaining in the colony at all. Since the authorities did not give those Acadians who remained a fully legal position by making grants of land, their status was little better than squatters (MacNutt 1963). It is an important and sobering reminder that eighteenth-century people understood that military disruptions did not have the long-term permanence that they might want, without civil validation (Mancke 2019). Consequently, the ultimate dispossession of Acadians came not through the barrel of a gun, but through the power of the pen, and less in the heat of war, than in the quiet of peace.

During the American Revolution, control of Fort Cumberland (formerly Fort Beausejour) was briefly contested by rebels in 1776. Though unsuccessful, the participation of Mi'kmaq and Wolastoqiyik in the siege highlighted the vulnerability of Nova Scotia and prompted the Crown to enter into what became the final round of Maritime Peace and Friendship Treaties with First Nations in 1778 and 1779, reaffirming the previous treaties (Patterson 2009).

The Revolutionary War ended with yet another Treaty of Paris, this one in 1783 (MacNutt 1963, Ganong 1901). Early in the war the Americans had taken it for granted that winning their independence also implied the acquisition of the two provinces (Nova Scotia and Canada) that had not revolted. In the end however, the agreed terms established rough boundaries between British holdings and the newly recognized United States, that while not yet finalized along the St. Croix River, were distant from the Little River. The peace fell short of the hopes and expectations both sides had harbored during the war, but despite the distance from the border, was not without implications for the Little. For every Loyalist within British lines, there were five left living within territories dominated by the Continental Congress

(MacNutt 1963). To such Loyalists, peace and recognition of the United States meant surrender of themselves and their possessions to those that had been their enemies. Although the Treaty of Paris promised Loyalists a safe return to their pre-war homes, persecution of “Tories” escalated with the rebel victory (Dallison 2003). An attractive and safer alternative became clear. Across the water lay Nova Scotia, a (comparatively) vacant land which remained beneath the British Crown (MacNutt 1963).

As things warmed in the spring of 1783 the movement began, with all parts of the coastline receiving refugees, many of which landed on the north shore of the Bay of Fundy (Squires 2000), of which approximately 11,000 eventually stayed on (Wynn 1981a), tripling the population from a little more than 5,000 to more than 16,000 in less than a year. Almost 10% of the refugees were black loyalists, and 10% of those (i.e., approximately 1% of total Loyalist refugees) arrived in the region as slaves. (Hodges 1996). The main point of penetration was the Saint John River Valley, however, the Petitcodiac, Memramcook, and Chignecto regions each received a share Loyalist refugees as well (Wright 1945, Milner 1967, Bowser 1986).

Even before departure from New York, Loyalists had begun to contemplate a separate and distinct province (Dallison 2003), and support for the concept only grew once they arrived in Nova Scotia. Governor Parr began escheating parts of pre-Revolution grants immediately to provide lands for the newcomers jamming into port towns clamouring for land (Fellows 1971). The need for land was paramount as it meant survival, food, and fuel- as well as status and wealth. Parr’s inability to release land quickly enough frustrated Loyalists (Snowdon 1983) and was a key factor driving calls for partition (Gilroy 1933). Edward Winslow, an individual responsible for settling Loyalist Regiments in Nova Scotia became a leading proponent for partition arguing in a letter to his friend Ward Chipman in 1783, “Take the general map of this province (even as it is now bounded) observe how detached this part is from the rest, how vastly extensive it is, notice the rivers, harbours, etc. Consider the numberless inconveniences that must arise from its remoteness from the metropolis and the difficulty in communication. Think what multitudes have and will come here, and then judge whether it must not from the nature of things immediately become a separate government” (Winslow 1783).

Halifax was opposed to Nova Scotia being subdivided for obvious reasons (Chipman 1784), however the authorities in London agreed (Gilroy 1933). On June 18th, 1784, Nova Scotia was partitioned, and the north shore of the Bay of Fundy became New Brunswick, a self governing “Loyalist” province. Once again the Missaquash River was selected as the boundary (Allison 1916), with the Little River watershed falling within what became Westmorland County (Ganong 1901). Thomas Carleton arrived in November 1784 to establish the new government and direct the colonization of New Brunswick (Fellows 1971). With access to title to land having been a driving factor in its formation, the newly established Province of New Brunswick required that existing land grants be re-registered both to facilitate escheat and to establish clear title for active landowners (Kernaghan 1981), and the House of Assembly focused on allocation of land as one of its initial priorities (Fellows 1971).

The dates that various communities listed in Table 1 were first settled (where available) indicate how movement by English colonists into the upper reaches of the Petitcodiac River above the head of tide occurred first along the more easily accessible main stem. Many of the early dates coincide with the arrival of United Empire loyalists from the 13 colonies (late 1770's - 1780's). After the arrival of the Loyalists, Mi’kmaq in what is now New Brunswick were moved off their lands and onto "reserves" (Walls

2010). This was done partially to provide land to incoming settlers, and partially to punish the Mi'kmaq for aligning themselves with the French.

Subsequent generations of English settler families and those that arrived after them then pushed further up the Petitcodiac and into its more remote tributaries such as the Little River, and the Pollett River (Wright 1945). An early example would be John Colpitts, the eldest son of Robert Colpitts who had settled near Salisbury in 1783. John Colpitts arrived from England as a teenager with his father, and had already moved on to develop his own homestead just a few years later, founding Colpitts Settlement on the Little River (Moncton Daily Times, Thursday August 26th 1920).

Forestry Practices

Early settlers cleared the land to allow for agriculture, locally consuming cordwood for fuel, and lumber to build their homesteads, while generating income by selecting marketable timber to send downriver to be sold for shipbuilding or export. The latter became a significant aspect of the local economy. By 1803, war had broken out in Europe yet again- initially with limited implications for New Brunswick. At first British victory at sea in October 1805 at the Battle of Trafalgar kept the Napoleonic Wars remote, with the primary risk of conflict locally being with the Americans (MacNutt 1963, Mancke et al 2017). In February 1807 however, ports in the Baltic were closed to British shipping (Raymond 2010). Until this point Britain had been largely dependent upon the Baltic for its supply of naval stores (Davey 2011) Procurement of timber, hemp, iron, pitch, tar, and flax was essential to Britain not just militarily, sustaining its trade and economic power was reliant upon maintaining the capacity of its merchant fleet as well. In 1809 Edward Winslow, then the deputy surveyor of the King's Woods in New Brunswick noted, "The interruption of the Baltic trade and other causes have occasioned a most extraordinary demand for ton timber" (Winslow 1809). The Napoleonic blockade of the Baltic pushed England to expand New Brunswick's lumber production twentyfold, transforming what had been an "undeveloped backwater" of 25,000 people largely engaged in subsistence agriculture into a bustling colony of 190,000 with an export driven economy over a matter of just a few decades (Wynn 1981b, Gordon 2014).

Ship building and shipping were linked directly to the timber trade (Sager and Fischer 2007). Timber was the major cargo of colonial-built vessels, with the ship itself often being sold along with its cargo upon reaching Great Britain. Even after the war, once the capacity had been established, the trade continued, stimulated until 1848 by a British tariff that favored supplies imported from North America (Bowser 1986). Shipbuilding sprung up wherever timber could be floated down river to the coast (Craik 1917).

Timber harvest in the Petitcodiac timber district as a whole grew from 260 tons in 1818 to 3,137 tons by 1836 (Wynn 1981b), though this paled in comparison cutting in other more accessible portions of the province such as in numerous timber districts along the Saint John and Miramichi Rivers where harvests taking place at the same time were in some cases an order of magnitude greater.

During the early 1800s white pine was gradually culled from New Brunswick Forests to meet the demand for masts for the Royal Navy (Wynn, 1981b). The White Pines Act of 1722 established the requirement of a royal license to fell white pines with a diameter exceeding 24 inches unless they were privately owned, and in 1729 Parliament reserved all such trees to the government except those already in private hands before 1690 (Purvis 1999). Since New Brunswick came under British control well after that time, this exception did not apply at all to its forests. During the American Revolution and the Napoleonic Wars from 80 to 90 percent of all masts supplied to the Royal Navy came from Canada, mostly New Brunswick (Williams 1992). Pines could still be found in 1850, but few of the magnificent trees the region was known for earlier in the century remained. Spruce was more abundant, but the largest had also been cut. Though there were not many extensive cutover tracts, by 1850 the character and composition of New Brunswick forests had been drastically modified by just 50 years of harvesting.

There were no corporate, individual, or sales taxes at this time (Goodrich 2010). Consequently, the primary source of government revenue was import and export duties. It was only once the province began to collect duties on the timber and lumber shipped to England during and after the Napoleonic Wars- and the goods brought back from there- that in 1816 it had been finally able to get serious about building infrastructure such as the system of "Great Roads" linking principal population centres. The Westmorland Great Road from Saint John to the Nova Scotia border had been surveyed and well traveled by foot and horseback since the 1790s, locally following roughly of what is now route 106 from the Village of Petitcodiac through Moncton and on to Dorchester. By the mid 1830s this route had been fully graveled and was smooth enough to run a coach over at a full trot (when the weather was good), and regular mail and stagecoach service began.

The effects of this early economic activity were not limited to just the forests. By 1820 importation of food into New Brunswick was the rule rather than the exception, everything hinged on the timber trade, though there were warning signs of the danger of single source economy (DeMerchant, 1983). James Robb, professor of Natural Science at Kings College in Fredericton (now the University of New Brunswick), was appointed Secretary of the Provincial Board of Agriculture when it was established in 1858. He warned that timber harvesting was so lucrative that it distorted development, and that when the market in Europe declined, the farmer neglecting his homestead to work in the woods would be "surprised to find his fences down, his fields grown up with bushes, and both himself and his snug little clearing generally all gone bad". It was not just agriculture that was falling short of its potential. In the years that shipbuilding boomed at St. John and other towns along the coast, even the fishing industry was neglected as men were drawn to the forest to supply wood (DeMerchant, 1983).

Unlike the Pollett River, which Elson (1962) describes as having had several large dams to power sawmills, McLeod (1973) reports that the Coverdale (Little) River had no major obstructions and that salmon were able to use the lower 40 km of the river extensively between the early 1800s to the 1970s, such that the Coverdale actually produced a majority of salmon smolts in the Petitcodiac system during that time. It is somewhat of a challenge to reconcile this description with the 3 sawmills and 3 grist mills present on the Little River by 1898 in Table 1 (Provincial Archives of New Brunswick 2023), since presumably those were all water powered. It may be that the situation on the Little River was simply better relative to the Pollett, which after all had a major mill dam just 16 km above the mouth of the river at Forest Glen that reportedly for much of that time had no functioning fishway and so blocked passage beyond it (Elson 1962). This situation was exacerbated in 1910 when the Sanatorium Dam was put in 6 km below Forest Glen- just 10 km above the mouth of the Pollett River. In contrast fishways on dams on the Coverdale were described as being in good order in 1876, and though there were declines in catches of salmon that year, these were blamed upon recent increases in milling and "mill rubbish" (sawdust etc.) fouling the water (Commissioner of Fisheries 1877). This confirms that sawmills on the river were powered by dams (as one would expect), but is consistent with McLeod's (1973) conclusion that the dams on the Little River did not block fish passage. Mill wastes were a problem because, other than burning, dumping into the river was the most common form of disposal of sawdust, bark, and other waste (Department of Fisheries 1890). Such material covered river bottoms, smothering spawning sites.

By 1877 the railway branch line, The Salisbury - Albert Railway opened, connecting the lower portion of the Little River watershed to the Intercolonial Railway (Chignecto Post Thursday May 24th 1877). Its main focus was serving points beyond the watershed however, running only a short distance up the Coverdale, (no further upstream than near to Colpitts Settlement). A time table notes a stop there at a point referred to as "Coverdale" located 4 miles from Salisbury Station (The Maple Leaf, Thursday February 18th 1885). This suggests it is the modern community of Synton, which is the correct distance down the line and right on the river (hence the name Coverdale). From there the railway headed east, crossing Turtle Creek and nearly paralleling the Petitcodiac on to Hillsborough, with much of the area described as "unsettled country". From there it traveled south on to Albert Mines, the mouth of the Demoiselle and the Shepody River on the Bay of Fundy, ending at that time at Riverside. Ten years later, during the whole of 1887, it carried to market 2,334 cords of firewood, and 8,913 tons of timber (The Maple Leaf Thursday January 12th 1888). Some of this material may have originated within the Little River watershed, but much of it probably just passed through going either direction.

Judging by the roads present in 1878 (Dawson 2005), the headwaters at the southern end of the watershed were more remote and less populated than the area between what is now Colpitts Settlement and Salisbury. These upper reaches were not served by the Salisbury – Albert Railway, but did have access to the Elgin, Petitcodiac, & Havelock Railway which came up the adjacent Pollett River watershed, and ended a short distance away at Elgin. As a consequence the road network of the time tied communities in the Coverdale headwaters more closely to Elgin than to Coverdale Station, which was quite a distance downstream (Dawson 2005), and explains why they were part of Elgin Parish instead of Coverdale parish. The Chignecto Post in Sackville wrote of the Elgin, Petitcodiac, & Havelock Railway opening on September 14th 1876, "Within a few months over 350 cars of lumber (which could not have otherwise profitably been put in the market) have been hauled over the railway. The estimated shipments of lumber per year is about six million. Besides this there is ship timber from the virgin forests of Elgin, bark, sleepers, cordwood, country produce, local and passenger traffic." It goes on, "There is said to be enough timber in her (referring to the Elgin region) hills to keep the shipyards in Saint John busy for a century." How "virgin" the forests may have been is an interesting question given a population at that time (Table 1) of over 250 people in Elgin, plus hundreds elsewhere in the Pollett River watershed and surrounding communities on the Little River who had been there, in some cases for much of the previous 50 years. Such things are relative however, given that, as noted previously, other more easily accessible portions of the Province, had experienced more intensive harvesting. Eleven months later The Daily Times of Moncton noted on August 15th 1877 that "during the year a great quantity of ship timber has been got out at Elgin for consumption in Saint John."

At that point the age of wooden ships was winding down however, causing a reduction in the scale of the demand for timber exports both as wood and manufactured into ships. By the end of the Crimean war in 1856, virtually all of the ships in the British Royal Navy had already been fitted with steam engines rendering masts irrelevant (Evans 2004), and the conversion to iron hulls began within a decade.

A non-timber forest product that was commercially significant at the time was maple sugar. In the 1840s the Colpitts family was already producing marketable surpluses, gathering enough sap to produce 6,200 pounds of maple sugar (Albert County Museum 2015). By 1851 the annual output from Elgin Parish (which included all of the forested upper reaches of the Little River where sugar maple is common) was approximately 80,000 pounds (Fellows 1980).

Agricultural Practices

As noted in the timber section, before crops could be planted settlers were faced with cutting and clearing the forest. Stumps were often left a few years to rot, and crops were sown amongst them (DeMerchant, 1983). In Perley's (1857) Handbook of Information for Emigrants to New Brunswick, he suggests that "No emigrant should undertake to clear land and make a farm, unless he has the means of supporting his family for 12 months." However, it was not just a matter of the financial resources of individuals. Since in the early 1800's the province as a whole was not self-sufficient agriculturally, it is unlikely the communities along the Little River were either. Given the initial logistical challenges of transporting food to remote homesteads, it is doubtful that importation of food was as practical as in urban centres. More likely for the early English settlers, subsistence agriculture was supplemented with food available from the forest and river. Even as late as 1876 fishing regulators noted that farmers devoted a significant portion of their time to fishing salmon, with most of the entire catch being used for home consumption (Commissioner of Fisheries 1877). This pattern had been established previously on the Petitcodiac River. In 1783 while Robert Colpitts first crop at his farm near Salisbury was ripening, his family's main source of food was salmon (Moncton Daily Times, Thursday August 26th 1920). In fact as early as 1852, concerns were being expressed about noticeable declines in the once abundant salmon population on the Petitcodiac (Elson 1962). At first this was presumed to be a consequence of overfishing, though by the 1870s it was recognized to be a result of issues with fish passage at dams.

Baillie (1832) indicated that a "tolerably good" road went up the Coverdale River. However he went on to qualify that by noting that "generally speaking it is not fit for carriages", which suggests that foot, horse, and perhaps limited cart traffic may have been the norm. Thus it is reasonable to conclude that the arrival of the Salisbury – Albert railroad in 1877 reduced many of the logistical constraints on bringing supplies into the lower end of the Little River watershed, and moving surpluses out to trade. Freight traffic of food along this line in 1887 amounted to 384.9 tons of flour, 190.9 tons of grain, and 873 head of livestock (The Maple Leaf Thursday January 12th 1888). However, as was mentioned earlier in the forestry section, much of that would have been in transit through the watershed, originating from points beyond such as Hillsborough or communities at or near the Fundy coast, and so does not actually provide much of an indication one way or the other of the productivity of the watershed. Also, unlike the forest products (which, given the abundance of forests locally, would likely have been a one-way flow out to market), a portion of the total agricultural freight carried may have been inbound for local consumption rather than an outbound surplus being sold elsewhere. Comparison of the roads in 1878 (Dawson 2005) serving the area from what later became Colpitts Settlement on downstream to Salisbury, to those in the rest of the watershed upstream of that point, suggests that like today, the bulk of agricultural activity was in the lower valley (New Brunswick Department of Natural Resources 2023).

Nearby, marketable surpluses of food were being produced on the Pollett River with reports of potatoes being sent via the Elgin, Petitcodiac, & Havelock Railway to as far away as Boston in 1887 (Moncton Daily Times, Monday October 1887), and cattle to Saint John the following year (The Maple Leaf, Albert NB, Thursday October 18th 1888). Similarly from along the Fundy coast the Salisbury – Albert Railway was carrying hay from Riverside to Halifax, and cattle from Harvey to Saint John (The Maple Leaf, Thursday January 12th 1888). So communities in the Little River watershed were likely tied into such economic activity and (particularly in the case of those in the upper reaches of the river) if they were not contributing to these agricultural surpluses, then they likely served as local markets.

Dawson (2005) shows that by 1878 the road network within the Little River watershed looked quite recognizable to the modern eye, with roads of some kind present along many of the routes that are significant enough to be paved today, though obviously these wouldn't have been developed to that extent then. In 1893 the lack of good roads was still described as one of the greatest constraints on agriculture (The Daily Times, Saturday April 23rd, 1893). Next door on the Pollett River, upstream of Elgin, there were actually many more roads in place by 1878 than remain in the area today (Dawson 2005; Natural Resources Canada 2010). Between the First and Second World Wars most of the scattered farms that had been established on the Pollett above Elgin were abandoned and allowed to revert back to forest (Elson 1962), as many people left the area during that time to search for more arable land out west (Department of Natural Resources 2007; Degraaf et al. 2007). In contrast, the headwaters of the Little River in 1878 had fewer roads (Dawson 2005), suggesting these areas were not nearly as settled. While no doubt this region also lost population, the effect was less pronounced.

In May 1911 the portion of the Salisbury – Albert Railway south from Hillsborough to Albert was in financial distress and was temporarily closed down, leaving the line operating only from Salisbury to Hillsborough (Sackville Tribune, Thursday July 13th 1911). It was eventually purchased by the Dominion of Canada and operated by the Intercolonial Railway (New Brunswick Railway Museum 2015a). The Section of track from Albert to Salisbury continued to operate although with only one train per week up to 1946, though the section from Hillsborough to Salisbury still had daily trains during this period. Meanwhile the Elgin, Petitcodiac, & Havelock Railway was not profitable either, and went bankrupt in 1890. It was sold to the government in 1918 and operated by the Intercolonial Railway (New Brunswick Railway Museum 2015b) until that was taken over by Canadian National in 1919 (Marsh 1999).

Mining Practices

There are records of mineral exploration and discovery in the watershed, but little evidence of significant subsequent development of these resources. Coal was noted along the Coverdale River (Johnston 1850; Monro 1855), but not much was said about its properties or location, other than an indication that the deposits were not thought to be large. In 1864 L. W. Bailey, a Professor of Chemistry and Natural History at the University of New Brunswick reported that "thin pieces of gold of considerable size" were found in an unnamed (perhaps not surprisingly) stream that is a branch of the Coverdale River, near Elgin Corner (Bailey 1864). The same year, in another document Bailey also describes bituminous shale in the upper reaches of Prosser Brook that he concludes is likely a local extension of the deposit from which Albertite was being extracted at Albert Mines (Bailey 1865). Thus, while there was an awareness of mineral resources, their extraction was not economically viable.

Indian Affairs

As laid out in previous sections, the Mi'kmaq and the Crown entered into a series of Peace and Friendship treaties between 1726, and 1779 (Nova Scotia Archives 2020), which form the basis of treaty rights held by the Mi'kmaq today. These were not treaties that surrendered land, but negotiations between sovereign entities. The Mi'kmaq never surrendered title to Mi'kma'ki (Mi'gmawe'l Tplu'taqnn 2023). Treaty rights and aboriginal rights are recognized and affirmed in Section 35 of the Constitution Act 1982 (Sanderson 2017). These treaties were briefly described in previous sections within the chronological context that gave rise to it, to track the evolution of the treaties. However, as these

Table 2: Peace and Friendship Treaties between the Mi'kmaq and the Crown

Year	British Objective	Mi'kmaq Objective
1726	Mi'kmaq Recognition of 1713 Utrecht Treaty, "Lawful" British Settlements to be left undisturbed. British right to regulate Europeans	British Recognition of the legitimacy of Mi'kmaq Hunting, Fishing, and Planting activities
Comment:	When signed, the application of this treaty was within British controlled territory. The British interpretation of the 1713 treaty of Utrecht between them and France was that it gave them claim to all of Acadia including the north shore of the Bay of Fundy (modern New Brunswick), but effectively British authority did not go outside of peninsular Nova Scotia. Arguably it "did not extend beyond the cannon reach of the fort" at Annapolis Royal.	
1749	Reaffirm 1726, to end King George's War addressing Mi'kmaq cooperation with the Duc d'Anville expedition, and antipathy to British expansion beyond Annapolis Royal i.e. founding of Halifax. From British perspective did not modify 1726 in any way.	Reaffirm 1726 - British recognition of hunting and fishing
Comment:	Nothing new was offered in the treaty, just reaffirmation of the 1726 treaty. The context however was that it demanded acceptance of the fact the British were becoming more assertive than they had been previously. Among the Mi'kmaq, only the community at Chignecto signed - others refused to do so because British founding of Halifax a few months earlier was considered to be a violation of 1726.	
1752	Reaffirm 1726, to calm the effects of Father LeLoutre's War. Formalized commercial relationship between British and Mi'kmaq to wean Mi'kmaq from relationships with Acadians and French officials in Louisburg.	Reaffirm 1726 - British recognition of hunting and fishing rights, and ensured the "free liberty" to sell the products of these activities in Halifax or any other settlement.
Comment:	By this point the French were actively defending the Missaquash River as the border with British territory in Father LeLoutre's War. Mi'kmaq in the Petitcodiac watershed were "on the front line", while those in peninsular Nova Scotia were "behind the lines", living amongst expanding British settlements. This treaty forms the basis of the Supreme Court of Canada 1999 Marshall Decision affirming the treaty rights of First Nations people all across Canada to hunt and fish and earn a moderate livelihood while doing so (Supreme Court of Canada 1999). Resistance to this ruling by non-native lobster fishermen prompted the Burnt Church Crisis between 1999 and 2002 (Wicken 2002). Recently tensions have flared up over lobster in Saint Mary's Bay	
1760/61	Reaffirm 1726 after defeat of the French in North America. This ended Indigenous-French relations and alliances, and required natives to end trade with the French.	Reaffirm 1726 - British recognition of hunting and fishing rights, and with the end of French alliances and trade the British pledged to establish "truck houses" near native communities to provide alternative trade now that trade with the French was prohibited.
Comment:	This marked the end direct relations between the French Government and Native communities in the Maritimes. That was finalized in 1763 with the Treaty of Paris which ended the Seven Years War in which France ceded its territory in Canada and the Maritime region to Britain, except for the small islands of St. Pierre and Miquelon in the Gulf of St. Lawrence, which France retained to preserve access to fisheries there.	
1778/1779	Reaffirm 1726 within the new context of British North America being fractured by the American Revolution	Reaffirm 1726 - British recognition of hunting and fishing rights, and maintain peace going forward to avoid being drawn into violence between the British and American revolutionaries
Comment:	While the French were no longer a concern, the participation of Mi'kmaq and Wolastoqiyik (albeit only a few) in Eddy's siege of Fort Cumberland in 1776, and Allan's expedition into the Saint John Valley in 1777 highlighted the vulnerability the Maritimes to attempts by US agents to stir rebellion against the British.	

treaties are still in effect and still relevant in New Brunswick from that time up to today, there is also value in compiling these within a single section to provide focus, make them more easily accessible, and by doing so make them more easily understood in their entirety. The five treaties are listed and identified in Table 2. In several cases a given treaty has more than one year attached to it. That is because of the complexity of negotiations, the large number of signatory communities, and the distances between venues at a time when mobility and communications were challenging meant that in several cases the signing process began on one year and was not completed until the following year.

After the arrival of the Loyalists in 1783, Mi'kmaq in New Brunswick were gradually moved onto "reserves" (Walls 2010), to provide land to incoming settlers. This was made possible in part by a legal technicality. The Treaty of Paris in 1763 ended the French presence in the Maritimes, and the subsequent Royal Proclamation of 1763 recognized the property rights of the native peoples in the recently won portions of North America, but it had never been construed as applying to New Brunswick, which had been part of Nova Scotia at that time (Upton 1974). Safeguards concerning Indian lands and indebtedness, however questionable their ultimate value elsewhere, did not even exist in New Brunswick. Initially there had been little practical need for a policy as Mi'kmaq were few in number, and so scattered that they were not considered a threat to incoming whites. With the arrival of the Loyalists, "the Indians were driven back into the wilderness without much ceremony". The first real expression of concern amongst the government arose during the lead up to the War of 1812 (Upton 1974) that discontent might become a problem if war with the United States created an opportunity for trouble. Despite the fact some lands had been allocated to native people, they still maintained their nomadic way of life; and the colonial government's refusal to do anything further for them led to a complaint of "an injurious distinction between them and the Indians of Canada on one side and those within the limits of the neighboring American States on the other." The first listing of reserved lands was not published until 1838 and it identified 15 reserves in the Province ranging from 10 up to 16,000 acres. About 60,000 total acres had been designated as Indian reserves in the early 1800s, but none were in Westmorland County (Goodrich 2020).

That changed in 1840 when the Provincial Government purchased 63 acres at Beaumont near Fort Folly Point (Goodrich 2020) at the head of Shepody Bay. The Province then conveyed this land to the Magistrates of Westmorland County in Dorchester to hold in trust as a reserve. Then 126 Mi'kmaq moved there from various places within Westmorland County that they had been living to form the Fort Folly Reserve (Perley 1841, Ganong 1899). The land was not turned over to the Mi'kmaq themselves, but vested in the county to be held for their exclusive use.

Second Level Assessment- Current Impacts

Forestry Practices

Forest tenure within the Little River watershed is a mixture of private woodlots, industrial freehold, and crown land, which are subject to varying levels of management in terms of harvesting planting and thinning (Figure 3). Forests cover 89% of the watershed (New Brunswick Department of Natural Resources in 2023). Unlike the Pollett (the next watershed over to the west) where the proportion of private woodlots

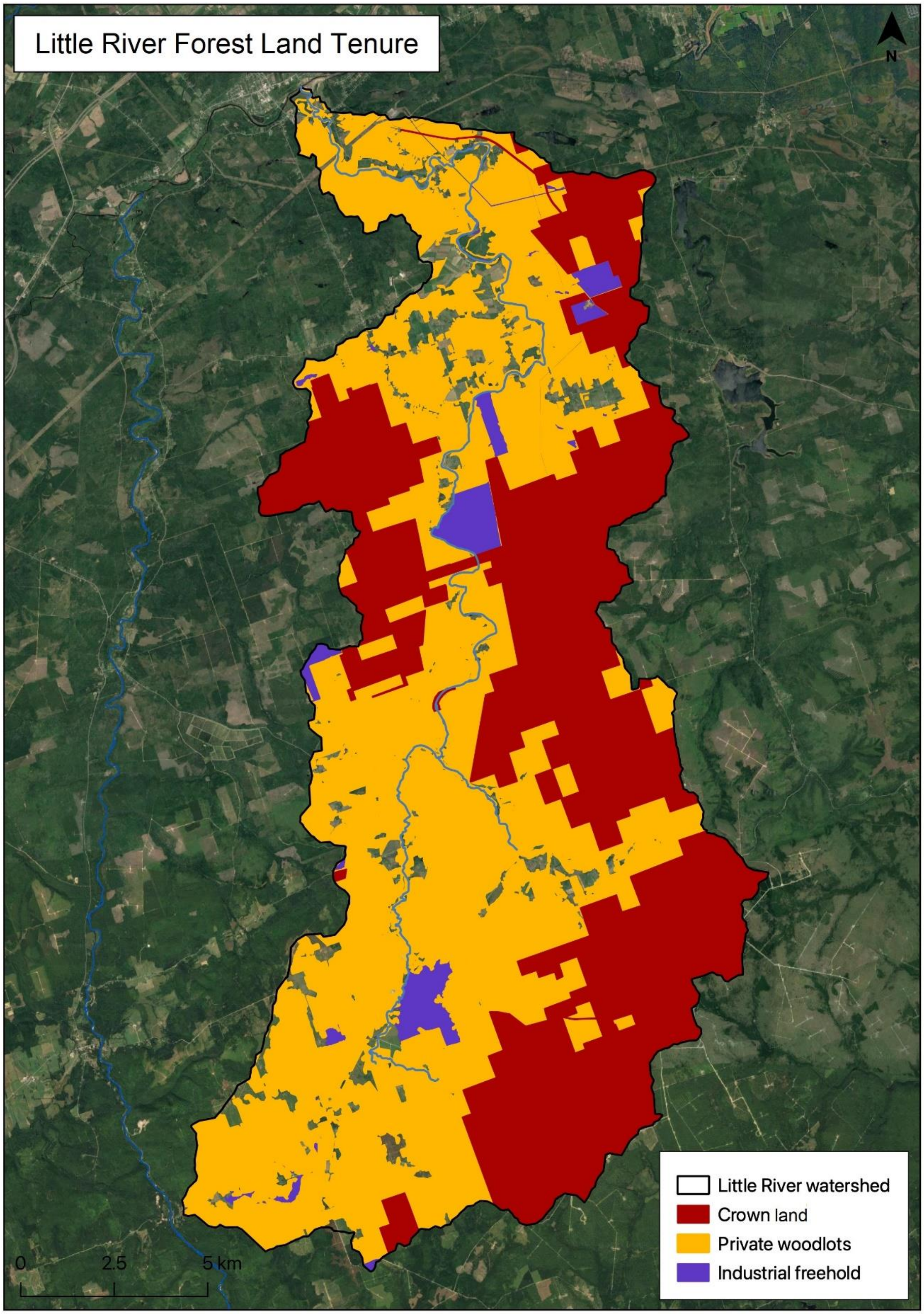

Figure 3: Forest Tenure within the Little River watershed

increases along a gradient from the headwaters downstream towards its mouth, on the Little River private woodlots are common throughout. Private woodlots account for 58% of the forested area of the watershed, dominating the west, and making up much of the eastern half. Crown forests make up most of the rest at 41% of the forested area, primarily in the eastern half of the watershed. Industrial freehold forest lands account for about 1% of the forested area of the watershed, scattered throughout.

Maple syrup production remains a significant activity in the area. In addition to small scale private production there is a large commercial operation, Briggs Maples, tapping over 12,000 sugar maple trees in Albert County on both private and crown land near Fundy National Park (Briggs Maples 2015), with distribution through both Sobeys and CO-OP Atlantic.

Agricultural Practices

Agriculture is the dominant non-forest land use within the Little River watershed. There are two major farms in the watershed (one of which is a dairy farm), as well as numerous hobby farms (Petitcodiac Watershed Alliance 2010). The dairy farm allows its cattle unrestricted access to the river with predictable consequences (Figure 4). Row crops and grains predominate across the watershed (Figure 5), representing about 75% of the agricultural activity (New Brunswick Department of Natural Resources 2023). The rest is divided nearly evenly between blueberry fields 12 % and pastureland 13%. The blueberry fields are concentrated at higher elevation in the remote upper reaches of the watershed, while pastureland, row crops and grains are distributed throughout at lower elevations along the valley floor, with the latter particularly concentrated within about a 2 km radius near and below Colpitts Settlement.

Figure 4: Failing banks on both sides of the river due to unrestricted access by dairy herd

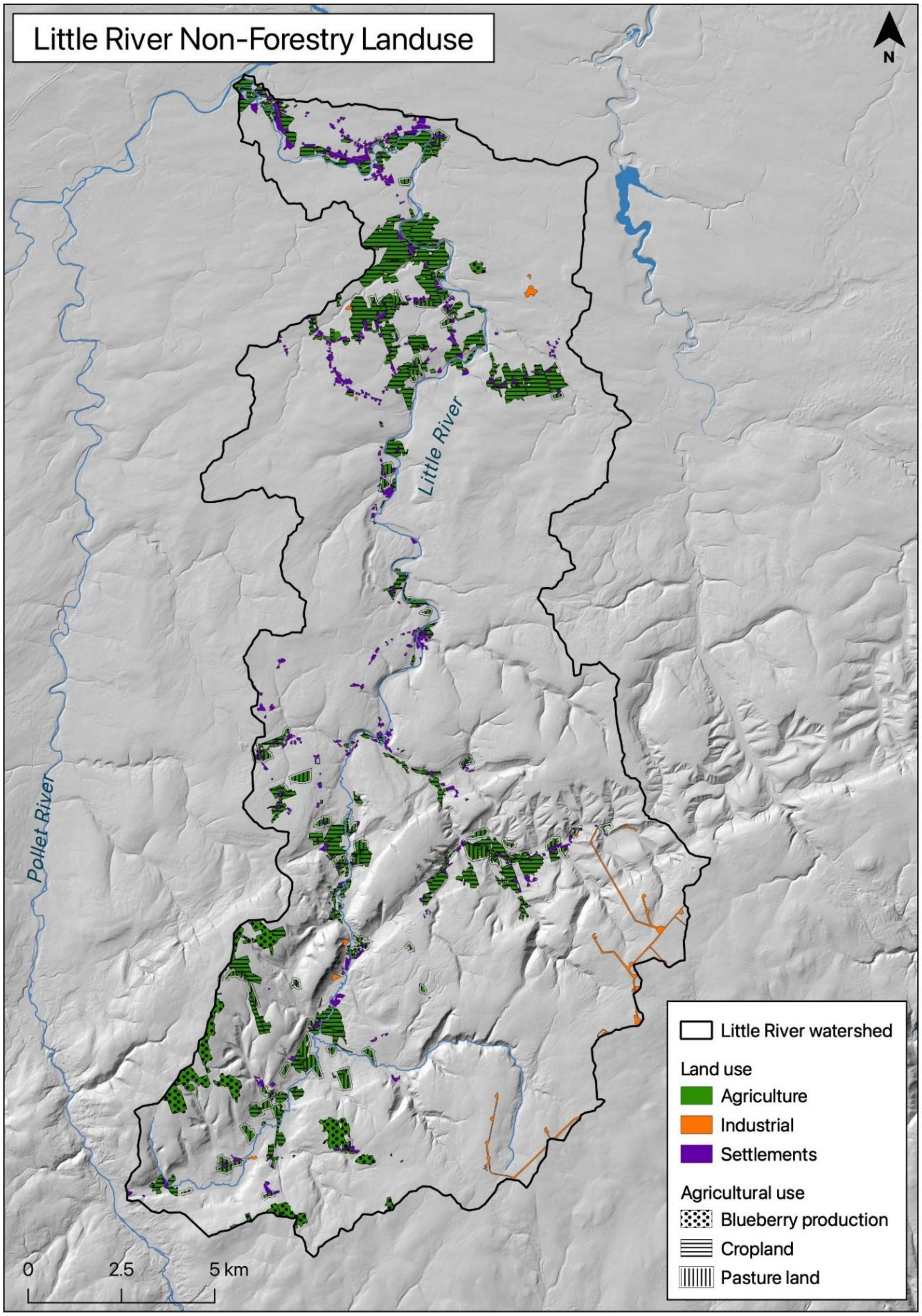

Figure 5: Agriculture and other non-forest usages of land in the Little River watershed

Transportation Development

A GIS layer of the road network (paved and unpaved) within the Little River watershed was overlaid on the river and its tributaries, to yield Figure 6. In 2023 this process identified 64 crossings (22 unpaved and 42 paved) within the watershed. That was fewer than were identified with the data used in 2014 which at that time found 63 paved and 52 unpaved crossings. This is not to suggest that numbers of roads within the Little River watershed have declined over the intervening years, nor was such comparison the purpose of the exercise. Instead, here the goal was to provide a tool to help identify and catalogue crossings within the watershed to aid in tracking the impacts of such crossings on fish passage. One possibility at least for the unpaved crossings is that in 2014 railway crossings and powerlines may have been lumped into the overall total. However, that doesn't account for the lower number of paved crossings, which one would have expected to be more likely to show up in both analyses. Follow up to better understand differences in the data available is warranted. It is possible using the naked eye to note several locations in Figure 6 where both the paved and the unpaved road layers cross the water layer yet a crossing wasn't flagged – perhaps due to the weight assigned to the watercourse. Likewise there are several places where crossings were identified while a road is not displayed at all- suggesting not necessarily an error but a road not prominent enough to display. These differences may account for much of discrepancy in the GIS analyses between 2014 and 2023.

Fieldwork to physically survey the actual water crossings and assess the individual impacts of these structures on fish passage has been carried out by the Petitcodiac Watershed Alliance (PWA) between 2014 and 2022 throughout the Petitcodiac watershed as part of their Broken Brooks project. Annual reports detailing that work are available for download on the publications section of their website https://www.petitcodiacwatershed.org/, the results of which are presented in Figure 7 and summarized below.

During their work the PWA located 64 crossings within the Little Watershed, the same number identified in the results of the 2023 GIS analysis noted above. However, even a cursory comparison of the two shows that even though most of this line up fairly well, the numbers being the same is entirely coincidental. Several of the crossings identified in Figure 6 were not part of the PWA inventory, and likewise quite a few of the crossings that PWA catalogued were not part of the GIS analysis in Figure 6. Given the 115 potential crossings identified in 2014 (63 Paved and 52 unpaved) there were numerous possibilities for such discrepancies.

The 64 crossings within the Little watershed that the PWA successfully visited and assessed fell into three categories: Bridges (19); Culverts (27); and Not Fish Habitat (18). Bridges are automatically defined as passable. Not Fish Habitat is fairly self explanatory- a culvert located at a site fish don't use, so passage upstream of that site is not a cause for concern. The 27 culverts that were identified in the Little Watershed required individual assessment, through which the PWA determined if they were: Passable (9); a Partial Barrier to Passage (5); or a Full Barrier to Passage (13). Passable culverts were not cause for concern, though Partial and Full Barriers to Passage were identified as problems, and where possible PWA prescribed mitigations. Proposed methods of mitigation identified varied depending upon the nature of the barrier to fish passage. These ranged from clearing debris, to building vortex rock weirs to raise the water in plunge pools below perched culverts, to modification of flow through the culvert through installation of baffles and / or an outflow chute.

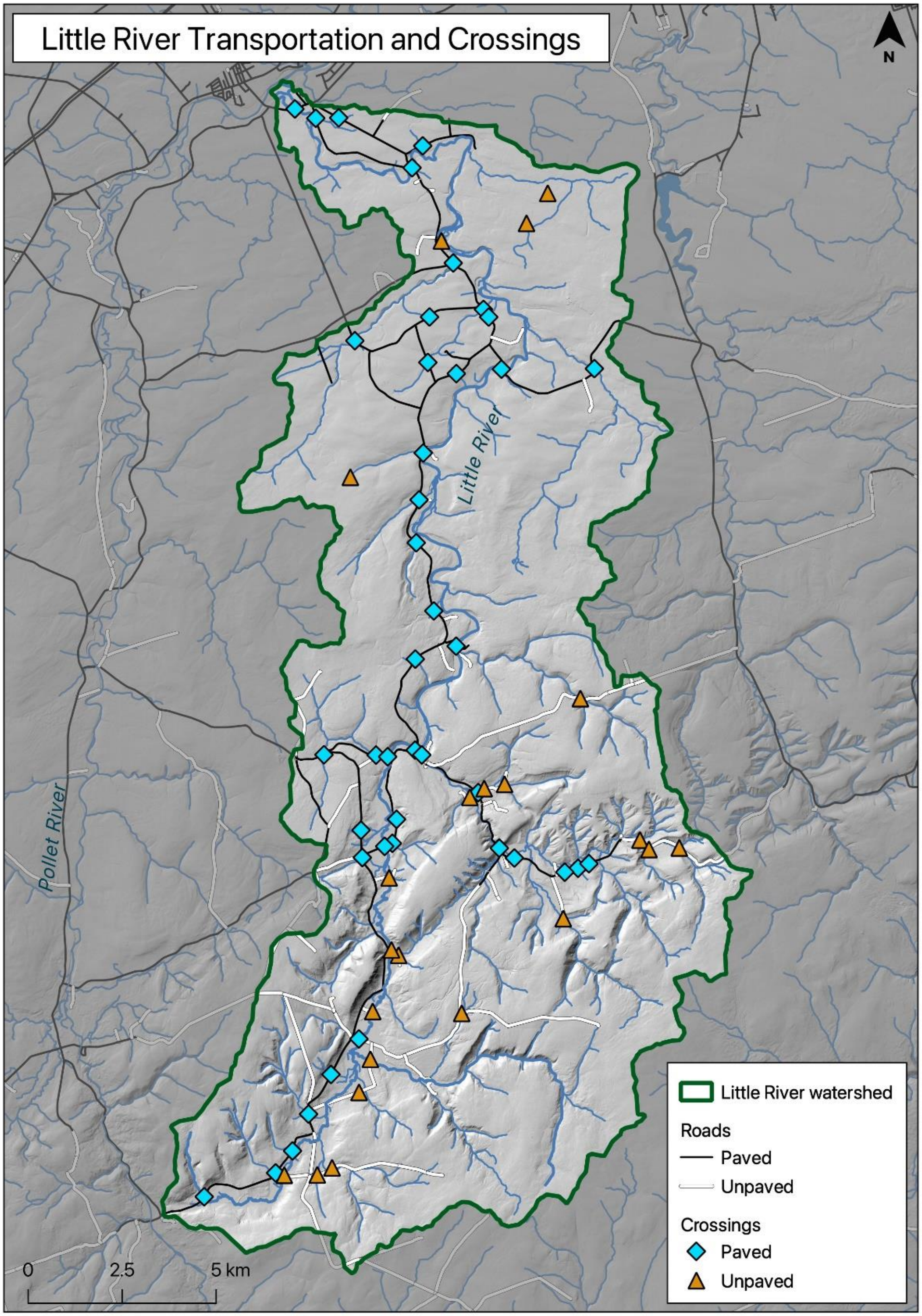

Figure 6: GIS analysis of locations of road / water crossings in the Little River watershed.

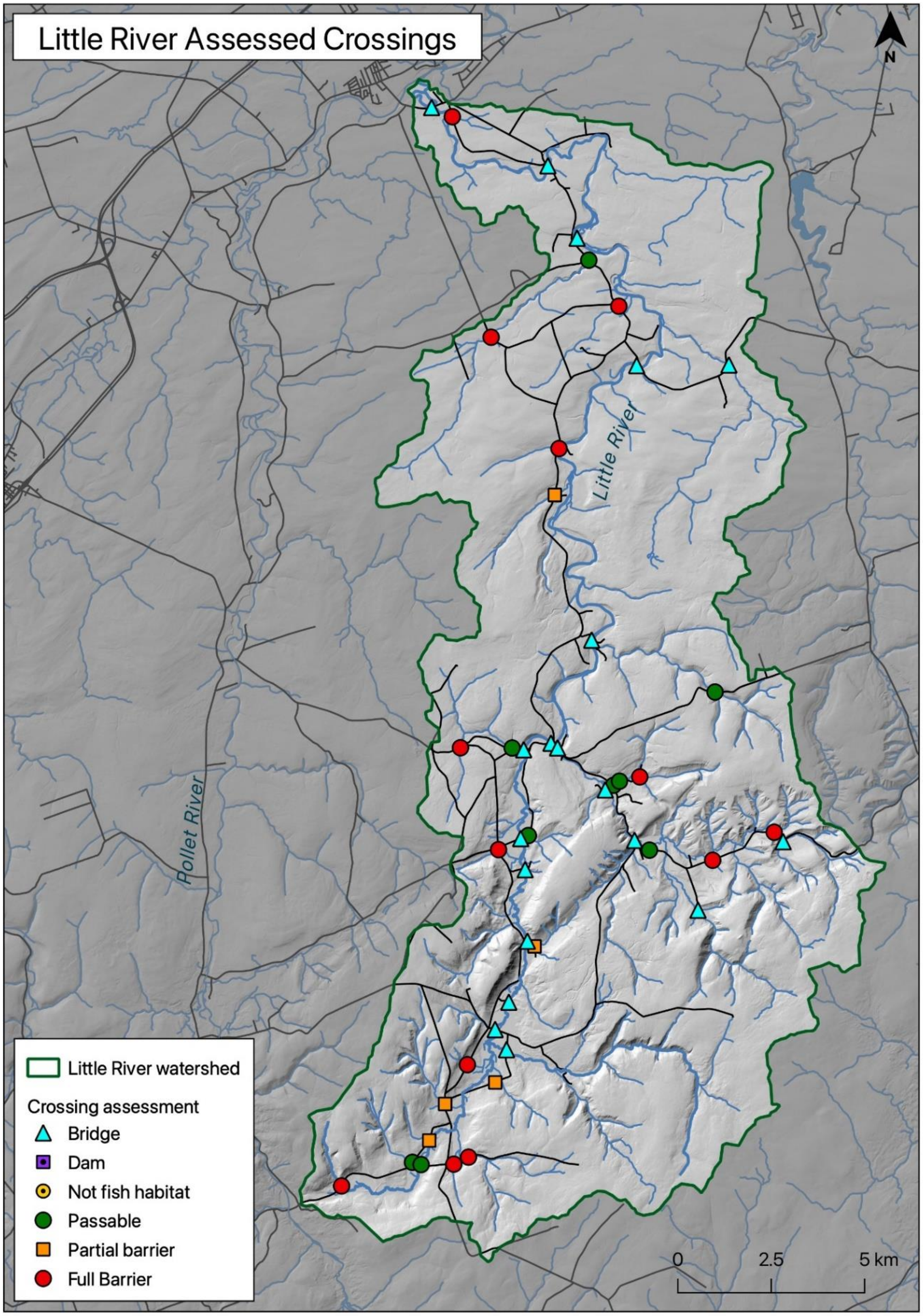

Figure 7: Water crossings visited and assessed by the Petitcodiac Watershed Alliance

While the New Brunswick Department of Transportation and Infrastructure (DTI) is responsible for bridges and culverts on the public paved roads, they are not responsible for the vast majority of those on the unpaved roads which are likely to be on either private woodlots, industrial freehold, or crown land. If a problem culvert is identified and there is a question of who is responsible (private landowner versus DTI), GPS coordinates should allow responsibility to be confirmed through further discussions with DTI.

Rail service on the section of track from Albert to Hillsborough was closed in 1955 (New Brunswick Railway Museum 2015b). The Salisbury to Hillsborough portion of the line remained profitable until 1981 when the gypsum plant in Hillsborough closed. Shortly thereafter, in 1982, Canadian National abandoned the line. As with service to Albert, rail service from Petitcodiac to Elgin was ended in 1955, and the line abandoned.

In 1968, 22 kilometers downstream of the mouth of Little River, the Maritime Marshland Rehabilitation Administration (MMRA) built the Moncton to Riverview Causeway (Rudin 2021). The purpose of this structure was to protect agricultural land upstream of it from tidal flooding and storm surges while also providing a second link for vehicular traffic between the two cities. A bridge combined with less expensive upgrades to the existing system of dykes and aboiteaux could have secured these lands just as well. Either option would have satisfied the transportation needs of greater Moncton, but with different implications in terms of both short-term matters connected with financing and long-term implications for the environment (Rudin 2021). The fishway built into the causeway proved to be ineffective (Locke et al 2003). The causeway gates created a barrier to fish passage with significant consequences for native fish species in the river, which led to the decline in the populations of species such as alewife, blueback herring, rainbow smelt, and sea-run brook trout. Some species disappeared altogether from the upland reaches of the Petitcodiac (such as the Pollett), including Atlantic tomcod, American shad, and striped bass. Atlantic salmon only remained present in the river because of ongoing stocking efforts (AMEC 2005)

In April 2010 the Moncton to Riverview Causeway gates were opened as part of the Petitcodiac River Restoration Project. From 2017 to 2021 a new bridge was built to partially replace the Petitcodiac Causeway. During April of 2021 the causeway was breached and a new 160-metre-wide channel was opened up underneath it. Following the restoration of fish passage in 2010, thirteen years of monitoring movement of anadromous fish have been carried out using a fish net trap at the head of tide in Salisbury (2010 to 2022). (Redfield 2023). On October 4th, 2021 (the first year with the new channel under the bridge) the trap caught the first wild returning salmon recorded since the monitoring program began. There were 170 striped bass caught that year at the trap, nearly as many as 2018 (65 striped bass), 2019 (65 striped bass), and 2020 (43 striped bass) combined. While additional returning wild salmon weren't caught in 2022, another 155 striped bass were - demonstrating that the 2021 result had not been a fluke. Meanwhile, numerous 40+ cm striped bass have been observed as high up in the system as a pool in the lower portion of the Pollett during snorkel surveys every year between 2018 and 2022 (except for 2021). Likewise American shad, American eels, and Atlantic tomcod have all been noted returning to the river. Of these, the latter two have shown sustained and progressive increases in numbers over the years, while invasive non-native smallmouth bass and chain pickerel have declined. Consequently, it is clear from these results that the fish community of the Petitcodiac has the capacity to recover, given the right conditions, and appears to be on its way to doing so.

Herbicide and Pesticide Use

Based on general information provided by Service New Brunswick, two forestry operators (JD Irving as Forest Patrol and Natural Resources) may have conducted work in the Little River watershed. While intended blocks of land to be treated were identified by operators that does not necessarily mean that they were treated with herbicides. Products used in these industries may contain the active ingredient glyphosate. Glyphosate is found in several formulations under the trade names Arsenal (PCP 23713), Forza (PCP 26401), Vantage (PCP 26884), Vision (PCP 19899) and Vision Max (PCP 27736). The active ingredient triclopyr has also been used in the past as Release (PCP 22093).

In addition, two industrial operators (Asplundh and NB Power Transmission) may have conducted work with respect to an industrial right-of way perspective (transmission lines) in the Little River watershed. These companies may have used tricoplyr as Garlon 4 (PCP 21053), Karmax (PCP 21252) and any of the aforementioned glyphosate products. Private growers must be individually certified (hold a valid pesticide applicator certificate) but do not report their usage. Likewise, vendors must report sales but do not provide a breakdown relevant to individual purchasers. It is difficult to find information of grower or vendor pesticide or herbicide use.

Mining Practices

Oil and Natural Gas lease rights within the Little River watershed are currently registered to both SWN Resources Canada Inc. and Headwater Exploration Inc. (Government of New Brunswick 2023a). SWN's lease extends from the mouth of the river a short distance upstream, going past the Rt. 112 Bridge but not reaching the first Rt. 895 bridge near Synton. Headwater's lease is in the western portion of the watershed running much of the length upstream to about Pleasant Vale- though notably at no point does it include the river channel, just tributary streams in the hills along the ridge dividing the Little River watershed from the Pollett.

In 2014 only a small portion of the Little River watershed around Parkindale and Prosser Brook was subject to leases, held primarily by Petroworth Resources Inc (Government of New Brunswick 2015). In July 2013 Petroworth Resources Inc. changed its name to First Sahara Energy Inc. (Marketwired.com 2013). Then in December 2014 First Sahara Energy Inc. changed its name again to M Pharmaceutical Inc. and announced its intention to pursue interests in pharmaceuticals and biomedical devices (Marketwired.com 2014). As a consequence, it was unclear at that time how serious this company was about developing its leases. In the intervening years these appear to have been allowed to lapse, without uptake by other parties. That is somewhat surprising considering that this is the area that was noted for bituminous shale by Bailey (1865), so these has been interest in hydrocarbons in that portion of the watershed for some time.

The Alward government made a clear Provincial commitment to promoting shale gas development in New Brunswick (Alward 2014), and controversy erupted. Shortly there after the Gallant government came into office and enacted a moratorium on expansion (Canadian Broadcasting Corporation 2014). The concern if additional wells were added, impacts would include freshwater extraction from streams, habitat destruction and sedimentation during road building, and the potential for wastewater spills contaminating surface waters. The current Provincial government under Blaine Higgs has signalled openness to shale gas in recent years (Canadian Broadcasting Corporation 2022).

Fort Folly First Nation

Mi'kmaq never surrendered title to Mi'kma'ki (Mi'gmawe'l Tplu'taqnn 2023), however have limited contemporary presence on the Little River (despite it being traditional territory). There are relatively few Mi'kmaq, and government policies concentrated these downstream on the Fort Folly reserve at Beaumont (in Shepody Bay), at the mouth of the Petitcodiac. Economic decline of the building stone quarries at Fort Folly Point in the 1890s, profoundly effected the reserve. Many families moved to Shediac or land the band held in Richibucto, while others went to Dorchester and the surrounding area. By 1913 only three or four families remained at Beaumont, the last of which left in 1955. In 1958, Beaumont was no longer occupied, title was lost, which has subsequently been challenged in a land claim (Fort Folly First Nation 2021).

Mi'kmaq continued to be part of the community in and around Dorchester throughout the 1950s and 1960s after Beaumont ceased to be a reserve (Goodrich 2020), living as individual families with "status" but without a reserve. That changed in 1969 when the current Fort Folly First Nation Reserve was established near Dorchester at Palmer's Pond on Rte. 106. It was initially named Palmer's Pond Reserve (Fort Folly First Nation 2021), but the decision was soon made to rename it the Fort Folly Indian Reserve. The present band, which is mostly descended from those who had occupied Beaumont (Kristmason 2004), does not consider this to be a new foundation, but continuity, with a relocation from Beaumont (Goodrich 2020). Fort Folly, which had been the name of the original reserve at Beaumont, was named geographically for the location on which it existed (Perley 1841, Ganong 1899). Today the band has thirty-six members living on reserve, and a further ninety-six living off reserve.

Urban Development

There is no large urban centre within the Little River watershed. Large areas of privately owned land along the river have been developed into homes or cottages, leaving little or no buffer in the riparian zone in order to obtain clear views of the river (Petitcodiac Watershed Alliance 2010). Such properties are also a potential source of sewage contamination as rural septic systems are not always properly maintained. Several sites were noted where homeowners had pipes discharging directly into the river. Local Governance Reform by the Province (Government of New Brunswick 2023b) divided the Little River watershed between 2 local governments: Salisbury (from the mouth of the river up to a short distance below where it is joined by Prosser Brook) and The Community of Three Rivers (which runs from where Salisbury ends, and takes in the rest of the watershed above that point with the exception of the Little River side of Gowland Mountain in the west and Sweet Mountain in the east which each remain unincorporated parts of Southeast Rural District RD 7.

Third Level Assessment – Aquatic and Riparian Habitat Assessment

Wildlife

Several species of wildlife warranting specific attention occur in the Little River watershed: iBoF Atlantic salmon (*Salmo salar*), Brook Floaters (*Alasmidonta varicosa*), American eels (*Anguilla rostrata*), and wood turtles (*Glyptemys insculpta*). Observations of Atlantic salmon are plotted in Figure 8.

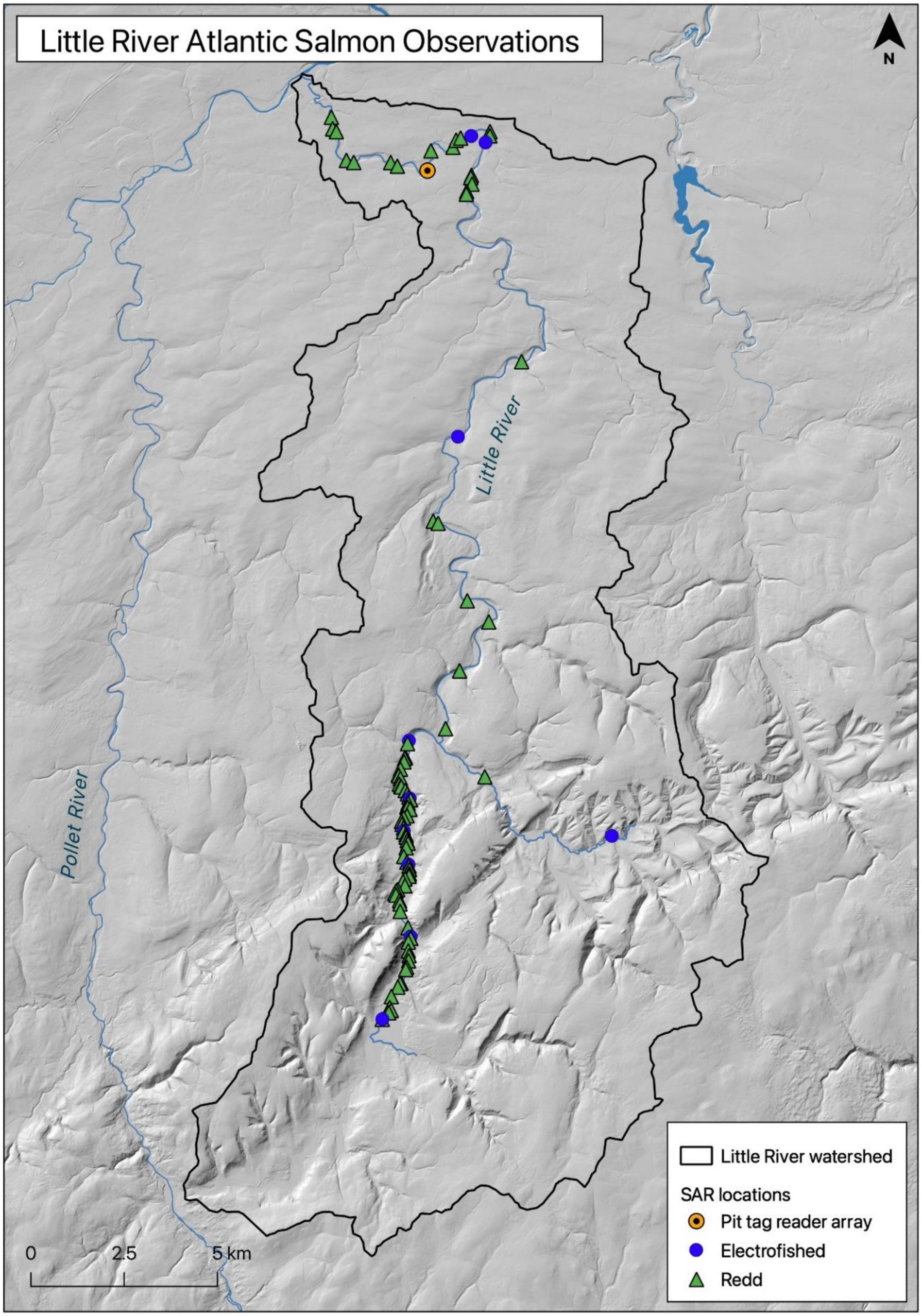

Figure 8: iBoF Atlantic salmon occurrences within the Little River

Inner Bay of Fundy (iBoF) Atlantic salmon populations were listed as endangered under the Species at Risk Act in 2003 (DFO, 2010; SARA Registry, 2013a). Salmon are considered extirpated from the Petitcodiac, except for those introduced in stocking programs (AMEC 2005). American eels were designated as "Special Concern" by COSEWIC in 2006 (COSEWIC 2006). Their status was re-examined and raised to "Threatened" in 2012 (COSEWIC 2014a). This species is being considered for listing under the Federal Species at Risk Act, but currently it has no status (SARA Registry 2013b). Wood turtles were designated as "Special Concern" by COSEWIC in 1996 which was raised to "Threatened" in 2007 (COSEWIC 2007; COSEWIC 2011). This species is listed as "threatened" under the Species at Risk Act (SARA Registry, 2012). Brook Floaters are a medium sized species of freshwater mussel listed as Special Concern by COSEWIC (COSEWIC 2009), and as Schedule 1, Special Concern, under the Species at Risk Act (SARA) in 2013 (DFO 2016). Guidelines for restoration projects in areas with these species are in Appendix. Unlike the Pollett, striped bass have not been documented in the Little River, but given their presence on the Pollett, likely venture into the mouth of the Little River and possibly as far upstream as the Rt. 112 bridge. Striped bass in the Bay of Fundy were designated "Endangered" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2012 (COSEWIC 2014b) and are being considered for listing under the federal Species at Risk Act (SARA), but currently have no status (SARA Registry 2018).

The modern decline in iBoF salmon within the Petitcodiac is a marked contrast to the abundance described by early settlers. Construction of the Moncton to Riverview causeway in 1968 eliminated fish passage for adult salmon and smolts and effectively (but for ongoing intervention) extirpated the species from a river system that represented 20% of the total iBoF population (Locke, et al. 2003). That said numbers of this species had been decreasing for decades due to the impacts of other human activities (Elson 1962), long prior to construction of the causeway.

Survival and development of salmon fry released along the Little River since the causeway gates were opened in 2010 have been monitored by annual electrofishing at the release sites and occasional use of fyke nets and a counting fence. In recent years, adult salmon have been released into the river- as non-targeted fish from DFO's Live Gene Bank at Mactaquac. Unlike the Pollett River, the Little River does not receive Fundy Salmon Recovery (FSR) adults grown to maturity in sea cages in Grand Manan. The purpose of adult releases is to repopulate the river with their progeny. These offspring will have undergone natural selection for conditions within the Petitcodiac, and will recognize its headwaters as their natal streams, preferentially returning to it to spawn (rather than the Big Salmon River- the origin of the DFO Live Gene Bank fish).

Large numbers of salmon redds detected in the upper Little shown in Figure 8 show that significant spawning takes place following these stocking efforts. Electrofishing of release sites and the counting fence have detected numerous fry, parr, and smolt indicating that the spawning has been successful and survival of juveniles has been good. Numerous smolt have subsequently been incorporated into the FSR program and sent to the Sea cages at Grand Manan. In the late summer and fall of 2021 four PIT tagged salmon were detected returning to the Little River by an automated PIT tag reader antenna array FFHR operates located at the first Rt. 895 bridge. Of these salmon, three were FSR Little River origin fish, having been collected by the counting fence near that bridge in the spring of 2019 as smolts, raised to adulthood in Grand Manan and released on the Pollett River (where all FSR fish are released) in the fall of 2020. Yet in 2021, when these Little River salmon returned to spawn yet again, they did so preferentially to their natal river, the Little River. Subsequently, in 2022 electrofishing found fry in that part of the Little River (where no fry or adults had been released) suggesting that successful spawning took place nearby in the lower Little during the fall of 2021.

Completion of the new bridge between Moncton and Riverview in 2021 to partially replace the Petitcodiac Causeway has strongly advanced iBoF Atlantic salmon recovery efforts in the Petitcodiac. That fall, the first wild returning adult was captured upstream of the mouth of the Little River, along the main stem of the Petitcodiac at the head-of-tide in Salisbury on October 4th. She lacked both a PIT tag and a floy tag. She showed no scars from having shed either type of tag, nor did it look as though a tissue sample had been taken from her caudal fin. In short, there was no sign that she had been previously handled- so scale and tissue samples were taken to allow further investigation. Stable Isotope Analysis carried out by the Stable Isotopes in Nature Laboratory (SINLAB) at the University of New Brunswick (UNB) confirmed that she was a returning wild iBoF Atlantic salmon (Samways personal communication 2021; Redfield 2022), never handled by FFHR prior to her capture. Having been captured on the main stem of the Petitcodiac beyond the mouth of the Little River, it seems reasonable to speculate that she was on her way upstream back to the Pollett River, the other Petitcodiac tributary that offers significant spawning habitat.

She is probably not alone - the FNT merely samples what is in the river. Catching one indicates that numbers have reached a level where the trap can detect them. It is premature to attribute detection of the wild salmon in 2021 entirely to the new channel under the bridge. That said however, she must have passed under the bridge, and the improved passage can only have helped her to return. No additional returning wild adults were caught during the following year. The lack of such fish in 2022 was noteworthy, and though somewhat disappointing, not particularly surprising. It does not mean that the individual caught in 2021 was a fluke, but merely highlights the fact that catching the first wild return was an unusual event. Two things can be simultaneously true: i.e. that the odds of catching such a fish have increased as a result of ongoing iBoF Atlantic salmon recovery efforts, and that yet such fish are still uncommon enough that doing so remains unlikely.

Brook Floaters (cover, bottom photo) have been found in the lower reaches of the Little River from the mouth up to the Rt. 895 Bridge near Synton (Figure 9). During the surveys DFO conducted in the late 1990s this portion of the river was home to the best sites with the most abundant populations of Brook Floaters within the entire Petitcodiac Watershed (Hanson and Locke 2001). Twenty years later, when FFHR revisited these sites in 2018 only a few of those at which Hanson and Locke (2001) detected brook floaters retained their original abundance. The biggest change occurred on the Little River above the Rt 112 Bridge. That site had had the greatest population in 1997-98, rated as common (Hanson and Locke 2001), suggesting that this site supported a density somewhere between 0.1 and 1 brook floaters per m2 at that time. Hanson's communication with the authors of the 2009 COSEWIC Assessment indicated that would have been consistent with the presence of certainly hundreds, possibly thousands of brook floaters. FFHR's 2018 surveys found 5 brook floaters there. When contacted for his insights, Hanson (Personal Communication 2018) confirmed that just as extrapolating the reported density in 1997-98 to the area surveyed suggested, this site had supported hundreds of brook floaters when they surveyed it-so many in fact, that it had not been practical to count them individually.

In addition to being a DFO scientist, Hanson is an angler, and regularly fishes the Little River recreationally. He indicated that one challenge with brook floaters is that their specific habitat needs tend to make them occur in clumps. Specifically in the area above the 112 bridge on the Little River, the

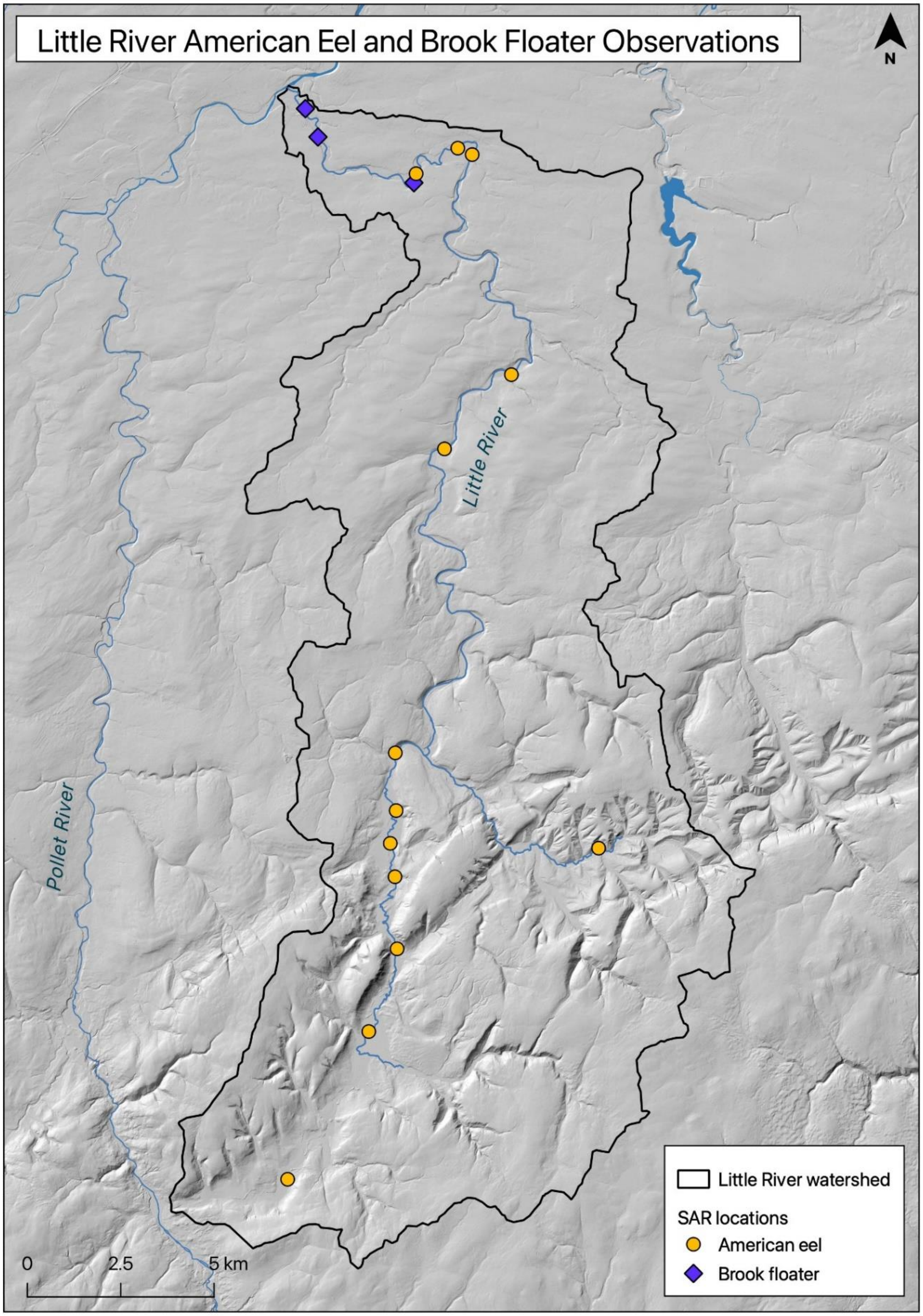

Figure 9: Brook Floater and American eel occurrences in the Little River

persistent sand and gravel bar there was home in 1997-98 to literally hundreds of brook floaters. In either 2011 or 2012, this entire bar (plus the rest of the area), was completely covered by a thick mat of algae (15 cm or more). These thick mats of green algae extended over most of the lower 4 or 5 km of the Little River. If one moved the algae, hydrogen sulfide and methane erupted in amounts sufficient to make one gag. Every freshwater mussel was killed in that part of the Little River, including the brook floater bed at this site above the 112 Bridge. A short distance below the mouth of the Little River, on the main stem of the Petitcodiac, Fort Folly Habitat Recovery was operating its fish trap downstream on the main stem of the Petitcodiac at the same time in both 2011 and 2012, and extreme quantities of algae were observed there as well, creating operational challenges by fouling the net.

Hanson (Personal Communication 2018) indicated that for the next three or four years, there were no brook floaters in this area. He found zero mussels of any species at that site in 2013, when looking on behalf of the DFO SARA office. He has only seen a few to perhaps a dozen during each of the last several years at this site. There has been some recolonization by eastern floater (in backwaters) and some pearl mussels washed downstream during spring and fall freshets – but nothing like the numbers that used to be present. There are still a lot of nutrients washing into the river both as manure (turning the water dark grey and cloudy with a very strong manure smell) and pelleted lawn fertilizer. He reports standing in the river and being pelted by a shower of lawn fertilizer at least once every fishing season. The algae growth, however, has never again approached the state observed in 2011 or 2012. Another very clear difference he has observed now compared to 20 years ago is that fine grey or black silt is almost always present over what had been gravel / cobble / boulder habitat and that he has noticed a decrease in numbers of mayflies, caddisflies and stoneflies from the 895 bridge down to the head of tide.

American eels were encountered at numerous sites (Figure 9a) the full length of the Little River. Eels have been seen while electrofishing, in the counting fence just below the 895 bridge, and in the case of The Ducks Unlimited Canada (DUC) empondment at the very top of the Little – in eel pots. In the decades that the causeway gates were closed downstream on the Petitcodiac, eels had more success than salmon or striped bass navigating the fishway and accessing the upper reaches of the river, such as the Pollett. Aside from that, being catadromous, instead of anadromous like salmon, the eel population was less vulnerable to extirpation as they are not dependent upon consistently accessing a river to perpetuate future generations within that river. Instead, their spawning takes place in the Sargasso Sea, and young eels arrive at and reside in different rivers than those in which their parents had lived (COSEWIC, 2006). This allowed for a steady stream of incoming eels, despite the causeway, arriving to colonize the river anew each generation. The fact they are found at the very top of the Little in the DUC empondment indicates that they can be assumed to be at least periodically present at any location downstream of that point. This suggests that eels have access to the entire watershed, which is not surprising given the ability of this species to spend extended periods of time out of water while navigating overland around barriers (Van Den Avyle 1984), as well as the ability of juveniles to climb damp vertical surfaces.

Wood Turtles have frequently been encountered within the little while conducting field work, is more a reflection of where FFHR does field work in the river than the result of years of surveys on the scale that yielded locations for salmon, striped bass, and eels. That said, from 2014 to 2016 the Petitcodiac Watershed Alliance (PWA) carried out Wood Turtle surveys across the Petitcodiac watershed, and in the process documented numerous Wood Turtles within the Little River. Due to their small home range, and vulnerability to poaching, encounters with wood turtles are considered to be sensitive information, and so are being withheld here. Wood turtles are terrestrial turtles that require forest cover, clean water courses, and access to gravel or sand for nesting. Disturbance caused by failing riverbanks appears to create gravel bar habitat favorable to Wood Turtles, prompting concern about impacts of bank stabilization projects on Wood Turtles in nearby habitat.

Water Quality

The PWA has been monitoring water quality within the Petitcodiac Watershed with the help of government organisations and volunteers since 1997, and has been collecting its own monthly water quality data since 1999 (Petitcodiac Watershed Alliance 2022). That being the case their data set has decades of time depth available for comparisons. PWA collects from a single fixed monitoring site, near the mouth of the Little River, the logic being to provide an indication of conditions for the entire watershed upstream of that point. Greater resolution would be challenging, as PWA also conducts similar monitoring for numerous other tributaries distributed across the Petitcodiac and Memramcook watersheds. The location on the Little River monitoring site is below the Rt 112 Bridge (the first bridge on the Little, roughly 1km above its confluence with the main stem of the Petitcodiac. Data is collected monthly from May to October, measuring a range of parameters including those focused on below in Table 3: Dissolved Oxygen, Conductivity, pH, and Temperature.

Table 3: Water Quality on the Little River in 2021 (Petitcodiac Watershed Alliance 2022)

Monthly at Site	Dissolved Oxygen	Conductivity	Temperature °C	pH
May	13.0 mg/L	38.2 µS	7.7 °C	7.49
June	5.2 mg/L	66.8 µS	22.8 °C	7.46
July	6.7 mg/L	59.3 µS	19.1 °C	7.64
August	10.2 mg/L	53.4 µS	20.1 °C	7.19
September	8.8 mg/L	63.0 µS	13.8 °C	7.32
October	10.2 mg/L	62.7 µS	10.3 °C	7.52
Average	9.0 mg/L	52.7 µS	15.6 °C	7.44

Rapid Geomorphic Assessment (RGA)

The following is taken from the report prepared by 5R Environmental Consulting based upon the rapid geomorphic assessments (RGAs) Fort Folly Habitat Recovery conducted in 2019.

Geomorphic Analysis

Data collected from the Rapid Geomorphic Assessment (RGA) was used to evaluate the geomorphic condition and stability of the assessed reaches of the Little River. In order to interpret the geomorphic data, the included maps of the watercourse are highlighted according to reach stability as well as the Primary Geomorphic Processes, and Secondary Geomorphic Processes impacting each reach.

Rapid Geomorphic Assessments are used to quantify channel stability based on the presence and (or) absence of key indicators of channel adjustment with respect to four categories: 1) Aggradation, 2) Degradation, 3) Channel Widening, and 4) Planimetric Form Adjustment. Each indicator is described in detail below.

Aggradation

Channel aggradation may occur when the sediment load to a river increases (due to natural processes or human activities) and it lacks the capacity to carry it. Piles of sediment in the river can re-direct flows against the banks, leading to erosion and channel widening.

Typical indicators used to identify aggradation include:

- Shallow pool depths.
- Abundant sediment deposition on point bars.
- Extensive sediment deposition around obstructions, channel constrictions, at upstream ends of tight meander bends, and in the overbank zone.
- Most of the channel bed is exposed during typical low flow periods.
- High frequency of debris jams.
- Coarse gravels, cobbles, and boulders may be embedded with sand/silt and fine gravel.
- Soft, unconsolidated bed.
- Mid-channel and lateral bars.

Degradation

Degradation occurs as the river cuts deeper into the land and decreases its gradient. This can occur from a rapid removal of streambed material due to an increase in discharge, water velocity, or a decrease in sediment supply. Bed lowering can move in both an upstream (as a headcut or nick point) and/or downstream direction. Indicators of degradation include:

- Elevated tree roots.
- Bank height increases as you move downstream.
- Absence of depositional features such as bars.
- Head cutting of the channel bed.
- Cut face on bar forms.
- Channel worn into undisturbed overburden/bedrock.

Widening

Widening typically follows or occurs in conjunction with aggradation or degradation. With aggradation, banks collapse when flows are forced on the outside, and the river starts to widen. Wide, shallow watercourses have a lower capacity to transport sediment and flows continue to concentrate towards the banks. Widening can be seen with degradation, as it occurs with an increase in flows or decrease in sediment supply. Widening occurs because the stream bottom materials become more resistant to erosion (harder to move) by flowing waters than the stream banks.

Indicators of widening include:

- Active undermining of bank vegetation on both sides of the channel, and many unstable bank overhangs that have little vegetation holding soils together.
- Erosion on both right and left banks in riffle sections.
- Recently exposed tree roots.
- Fracture lines at the top of banks that appear as cracks parallel to the river, which is evidence of landslides and mass failures.
- Deposition on mid-channel bars and shoals.
- Urbanization and storm water outfalls leading to higher rate and duration of runoff and channel enlargement typically in small watersheds with >10% impervious surface.

Planform Adjustment

These are the changes that can be seen from the air when looking down at the river. The river's pattern has changed. This can happen because of channel management activities (such as straightening the bends of the river with heavy equipment). Planform changes also occur during floods. When there is no streambank vegetation with roots to hold soil in place, rivers cut new channels in the weak part of the bank during high water. Planform adjustments typically are responses to aggradation, degradation, or widening geomorphic phases. Indicators include:

- Flood chutes, which are longitudinal depressions where the stream has straightened and cut a more direct route usually across the inside of a meander bend.
- Channel avulsions, where the stream has suddenly abandoned a previous channel.
- Change or loss in bed form, sometimes resulting in a mix of plane bed and pool-riffle forms.
- Island formation and/or multiple channels.
- Additional large deposition and scour features in the channel length typically occupied by a single riffle/pool sequence (may result from the lateral extension of meanders).
- Thalweg not lined up with planform. In meandering streams, the thalweg typically travels from the outside of a meander bend to the outside of the next meander bend.
- During planform adjustments, the thalweg may not line up with this pattern.

Upon completion of the field inspection, indicators are tallied for each category to produce an overall reach stability index. The index classified the channel in one of three stability classes:

Table 4: RGA reach stability index classification

Factor Value	Classification	Interpretation
≤0.20	In Regime or Stable (Least Sensitive)	The channel morphology is within a range of variance for streams of similar hydrographic characteristics – evidence of instability is isolated or associated with normal river meander propagation processes.
0.21-0.40	Transitional or Stressed (Moderately Sensitive)	Channel morphology is within the range of variance for streams of similar hydrographic characteristics, but the evidence of instability is frequent.
≥0.41	In Adjustment (Most Sensitive)	Channel morphology is not within the range of variance and evidence of instability is widespread.

The RGA stability index results for the Little River found that approximately 55% of the reaches are in adjustment - as per Table 4- the most sensitive state. Only 2% of the reaches assessed were found to be stable (in regime). The remaining 43% were transitional between these two states.

Limitations of the ranking regime are reflected in the loss of some of the variability within the stability index down the length of the Little in Figure 10 - due to the wide range between ranks. Figure 10 and Table 5 show that stability throughout the system is poor, but there is something of a gradient. Most of the first half of Figure 11 had an average rank 0.40 or below, illustrating how reaches located high in the system mostly tended to be ranked as “transitional or stressed” (0.21 to 0.40) while lower in the system most reaches averaged above 0.41, ranking them as “in adjustment”. Problems in the river move one direction- downstream. By the time one reaches the lower portions of the Little River, instability is common- but variable and has plateaued somewhat.

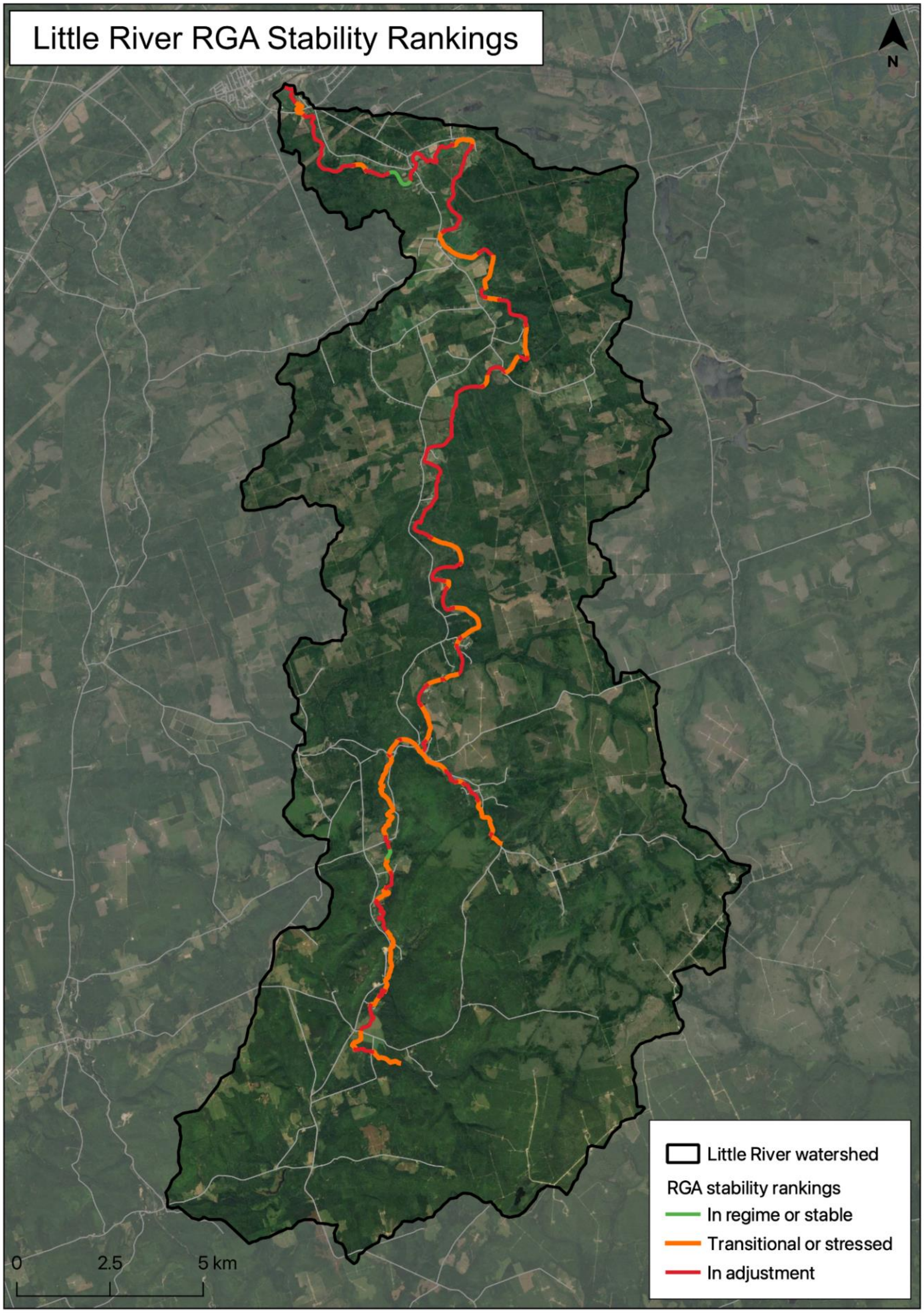

Figure 10: Little River RGA Stability Rankings

Table 5: Stability Index Scores from RGA Surveys

Reach	Stability Index	Class		Reach	Stability Index	Class		Reach	Stability Index	Class
PB01	0.36	Transitional		LR22	0.27	Transitional		LR63	0.54	In adjustment
PB02	0.44	In adjustment		LR23	0.21	Transitional		LR64	0.55	In adjustment
PB03	0.40	Transitional		LR24	0.30	Transitional		LR65	0.43	In adjustment
PB04	0.30	Transitional		LR25	0.30	Transitional		LR66	0.45	In adjustment
PB05	0.32	Transitional		LR26	0.27	Transitional		LR67	0.46	In adjustment
PB06	0.33	Transitional		LR27	0.22	Transitional		LR68	0.44	In adjustment
PB07	0.53	In adjustment		LR28	0.46	In adjustment		LR69	0.55	In adjustment
PB08	0.33	Transitional		LR29	0.29	Transitional		LR70	0.35	Transitional
PB09	0.43	In adjustment		LR30	0.55	In adjustment		LR71	0.53	In adjustment
PB10	0.56	In adjustment		LR31	0.34	Transitional		LR72	0.41	Transitional
PB11	0.31	Transitional		LR32	0.37	Transitional		LR73	0.30	Transitional
PB12	0.41	In adjustment		LR33	0.56	In adjustment		LR74	0.30	Transitional
PB13	0.43	In adjustment		LR34	0.53	In adjustment		LR75	0.36	Transitional
PB14	0.45	In adjustment		LR35	0.45	In adjustment		LR76	0.61	In adjustment
PB15	0.25	Transitional		LR36	0.32	Transitional		LR77	0.57	In adjustment
EBLR01	0.34	Transitional		LR37	0.36	Transitional		LR78	0.42	In adjustment
EBLR02	0.31	Transitional		LR38	0.69	In adjustment		LR79	0.22	Transitional
EBLR03	0.41	In adjustment		LR39	0.37	Transitional		LR80	0.50	In adjustment
EBLR04	0.40	Transitional		LR40	0.45	In adjustment		LR81	0.39	Transitional
EBLR05	0.40	Transitional		LR41	0.21	Transitional		LR82	0.52	In adjustment
LR01	0.46	In adjustment		LR42	0.42	In adjustment		LR83	0.31	Transitional
LR02	0.46	In adjustment		LR43	0.31	Transitional		LR84	0.31	Transitional
LR03	0.26	Transitional		LR44	0.48	In adjustment		LR85	0.53	In adjustment
LR04	0.47	In adjustment		LR45	0.32	Transitional		LR86	0.55	In adjustment
LR05	0.46	In adjustment		LR46	0.29	Transitional		LR87	0.43	In adjustment
LR06	0.34	Transitional		LR47	0.38	Transitional		LR88	0.58	In adjustment
LR07	0.38	Transitional		LR48	0.54	In adjustment		LR89	0.45	In adjustment
LR08	0.36	Transitional		LR49	0.41	In adjustment		LR90	0.48	In adjustment
LR09	0.34	Transitional		LR50	0.34	Transitional		LR91	0.38	Transitional
LR10	0.49	In adjustment		LR51	0.32	Transitional		LR92	0.62	In adjustment
LR11	0.46	In adjustment		LR52	0.49	In adjustment		LR93	0.53	In adjustment
LR12	0.70	In adjustment		LR53	0.44	In adjustment		LR94	0.45	In adjustment
LR13	0.59	In adjustment		LR54	0.59	In adjustment		LR95	0.47	In adjustment
LR14	0.29	Transitional		LR55	0.32	Transitional		LR96	0.18	Stable
LR15	0.34	Transitional		LR56	0.40	Transitional		LR97	0.62	In adjustment
LR16	0.46	In adjustment		LR57	0.44	In adjustment		LR98	0.62	In adjustment
LR17	0.44	In adjustment		LR58	0.45	In adjustment		LR99	0.35	Transitional
LR18	0.28	Transitional		LR59	0.55	In adjustment		LR100	0.52	In adjustment
LR19	0.38	Transitional		LR60	0.51	In adjustment		LR101	0.54	In adjustment
LR20	0.13	Stable		LR61	0.42	In adjustment		LR102	0.41	In adjustment
LR21	0.47	In adjustment		LR62	0.50	In adjustment		LR103	0.61	In adjustment

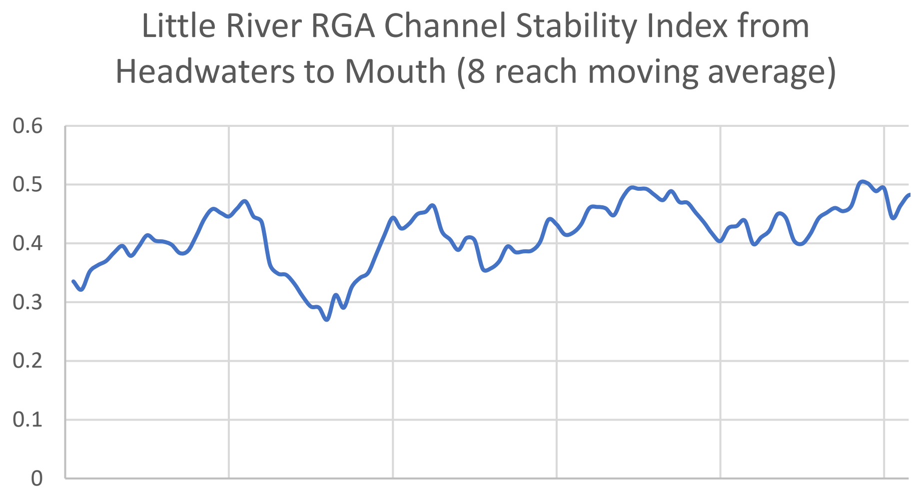

Figure 11: Variations in RGA Stability Index as one moves downstream

Figure 12 shows how calculated based on the portion of the Little River assessed, 43% of its length is made up reaches that are stressed, 55% of it is reaches that are going through a state of transition and only 2% of the assessed length is stable (in regime). Next door on the Pollett there was greater variability in the length of reaches, and so some difference when percentages were based upon the number of reaches, rather than upon the assessed length of the river. On the Little River the differences between these two approaches were insignificant.

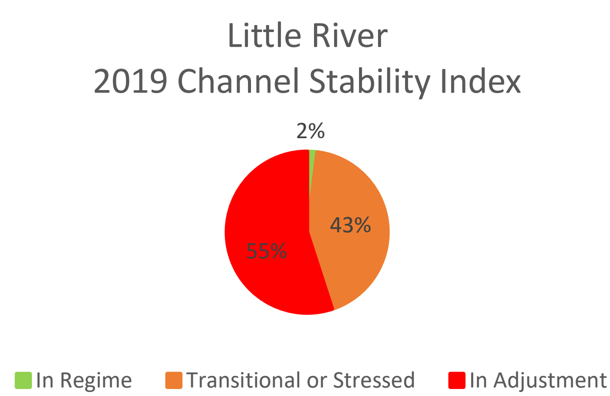

Figure 12: Little Channel Stability Index Based on the Number of Reaches

Primary Geomorphic Processes

The primary geomorphic process identified on the assessed reaches of the Little River are shown in Figure 13. There were only slight differences calculated when comparing percentages based upon individual reaches to overall number of reaches or length of the assessed channel to individual reach lengths. These results indicate that widening is the primary geomorphic process occurring in 46% of the

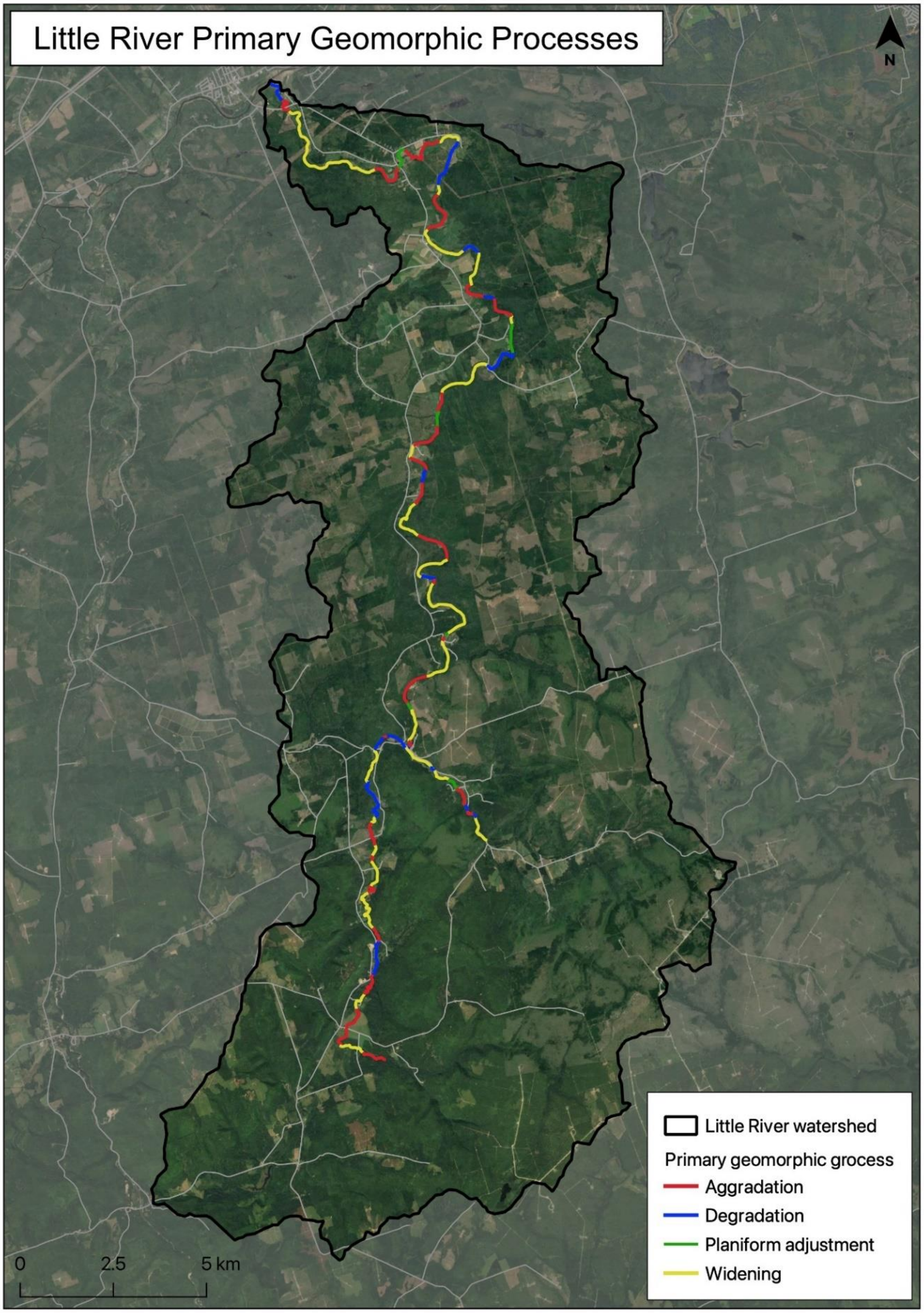

Figure 13: Little River Primary Geomorphic Processes

assessed length of the river (45% of reaches). This was the most common of all the primary geomorphic processes identified in each of the 123 reaches along the Little River (15 on Proser Brook, 5 on the East Branch of the Little River and 103 along the Little River main stem down to its confluence with the Petitcodiac). Channel aggradation drives conditions in 32% percent of these reaches while degradation was identified as the primary geomorphic process in 17% of the reaches, and planform adjustment dominates 5% of them (Figure 14).

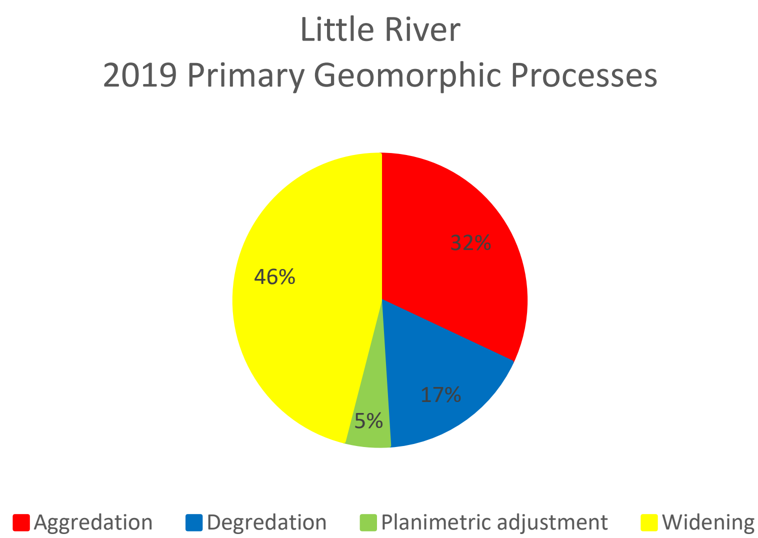

Figure 14: Little River Primary geomorphic processes based upon number of reaches

Secondary Geomorphic Processes

Secondary Geomorphic Processes (Figure 15 and Figure 16) are a bit more evenly distributed amongst the various types. Aggradation (33%) and widening (27%) still dominate as the most common two secondary processes occurring, however degradation (24%) and planform adjustment (16%) more prevalent here than these were among the primary processes. Combined, widening is either the primary or secondary geomorphic process along 73% of the assessed length of the Little River, while aggradation is either the primary or secondary geomorphic process along 65% of the river.

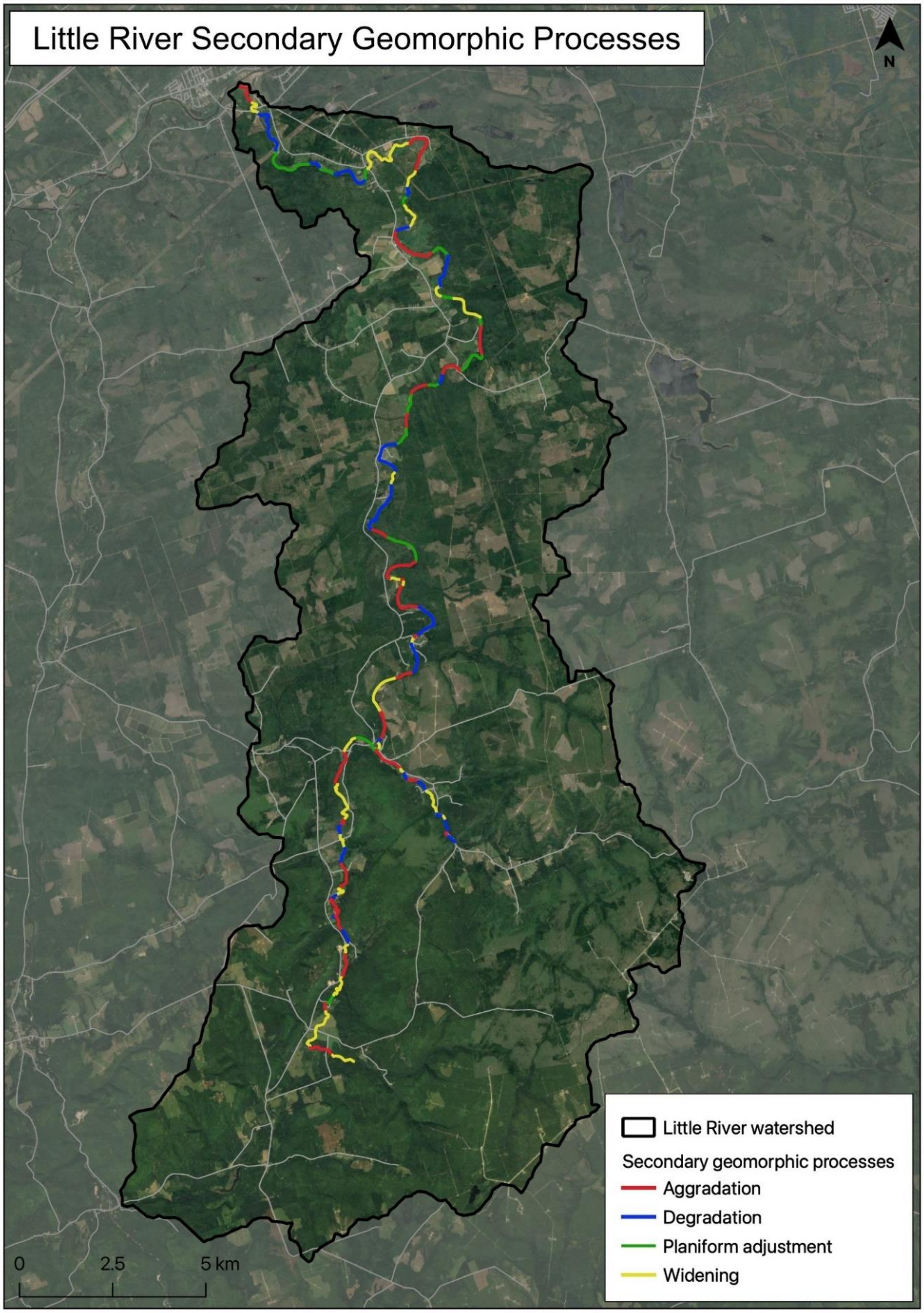

Figure 15: Little River Secondary Geomorphic Processes

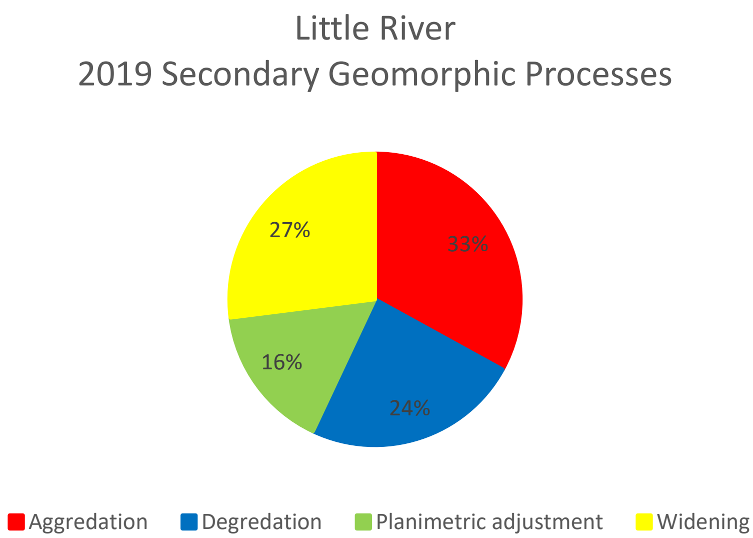

Figure 16: Little River Secondary Geomorphic Processes based on number of reaches

With 55% of the assessed length of the Little River ranked as "in adjustment" and only 2% is stable i.e. "in regime", while the remaining 43% lies somewhere in between ranked as "transitional or stressed", it is clear that the Little River is experiencing significant levels of disturbance. Much of this is likely due to the combined impacts of land use practices (both agriculture and forestry), increasing sediment load to the system, an increase in runoff during rain or freshet events, possibly even adjustment to the channel depth and width due to impacts from climate change.

Reaches with aggradation factor score of greater than 0.5 should be considered priority reaches for instream habitat or channel restoration activities. However, as mentioned, identifying the source of the aggradation would be the first priority so any works completed instream would not be buried by excess sediment or bedload material. Once the source of channel aggradation has been identified, any instream restoration techniques or designs would need to consider the management of the excess channel material so that it is dispersed or relocated in areas that are natural depositional locations. The installation of bank restoration techniques or instream structures will also need to be designed around attaining the channel back to a more natural width. The correct channel width should be calculated for each reach to ensure that the channel width is able to accommodate the flows based on the hydraulic flow conditions of that reach.

Fourth Level Assessment - Aquatic Habitat Rehabilitation Plan

Summary of Issues Identified from Information on Current Impacts

Culvert surveys by the Petitcodiac Watershed Alliance as part of their Broken Brooks program noted 13 culverts that were full barriers to fish passage and 5 culverts that were partial barriers to passage (Figure 7) within the watershed, a total of 18 impacted culverts. The PWA reports having taken steps to remediate 6 of these, suggesting that at least 7 known culverts remain which require attention.

Summary of Issues Identified from Aquatic and Riparian Habitat Assessment

Based on length – Rapid Geomorphic Assessments (RGAs) identified roughly 55% of the Little River as "in adjustment" indicating that instability is widespread. In only about 2% of the Little River's length was Channel Stability found to be "stable". Widening is the primary geomorphic process taking place on 46% of reaches, and the secondary geomorphic process in 27% of reaches. That is a combined 73% of reaches in the river where widening is either the primary or secondary geomorphic process underway.

Restoration Activities Undertaken

Restoration activities conducted within the Little River have taken the three main forms shown in Figure 17: Bank Stabilization, Dump Site Clean up, and culvert remediation. Bank Stabilization work has been done by the Petitcodiac Watershed Alliance (PWA), Fort Folly Habitat Recovery FFHR). Clean up of illegal dump sites has been done by PWA and FFHR. Culvert Remediation has been done by the PWA.

Bank Stabilization

Little River Headwaters 2016 (Petitcodiac Watershed Alliance)

The first bank stabilization project on the Little River was done by the Petitcodiac Watershed Alliance in 2016 with the assistance of Matrix Solutions and Fort Folly Habitat Recovery. The site is in the headwaters of the system (Figure 17). The cause of instability at the site was likely cattle accessing the river. Unfortunately, this issue was never adequately addressed. Fort Folly Habitat Recovery monitored the site for several years afterwards. The landowners demonstrated limited interest in protecting the site as the fencing put up following construction was knocked down and cattle graze freely across the site. This has been hard on the vegetation and called into question the wisdom of making further investments of time and energy there. The geotextile held up for the most part. When last observed in 2020 the bank was still reasonably well stabilized by the close-cropped grass (Figure 18), indicating few short term consequences aside from localized damage due to cattle paths accessing the river (Figure 19). That said, the woody vegetation was stressed and declining suggesting that long term self sustaining vegetative stabilization of the site is unlikely.

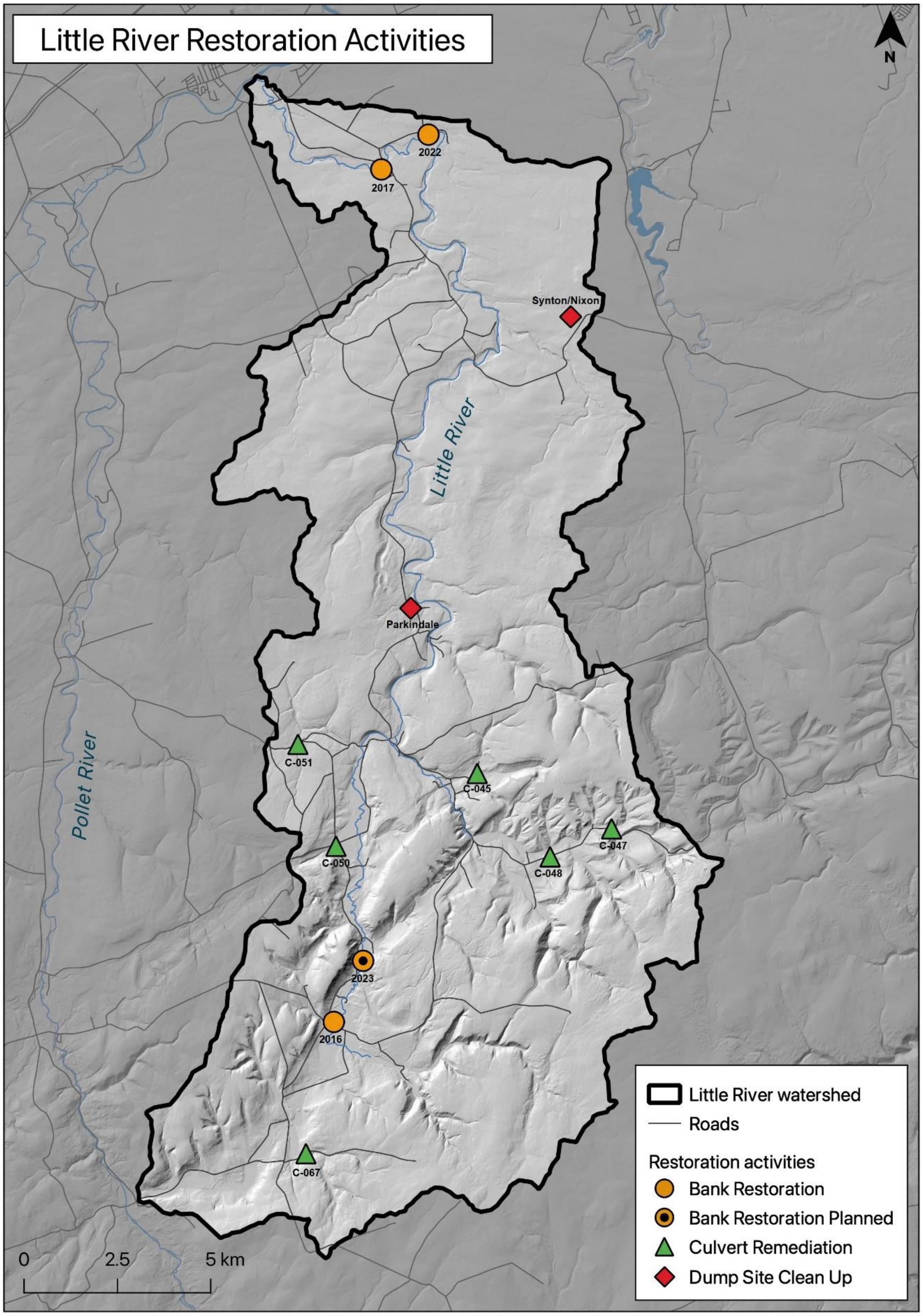

Figure 17: Restoration Activities Undertaken within the Little River Watershed

Figure 18: Poor state of vegetation at 2016 site: close cropped 1 year and 2 years later (fence is down)

Figure 19: Source of disturbance: cattle allowed to knock down fence and access river

The only significant weeds on the site appear to be similarly grazing resistant species such as the common mullein with its large unpalatable (and somewhat toxic) woolly leaves and the spikey purple flowered bull thistle. Numerous individuals of each are scattered across the site. Though neither is native, both are fairly ubiquitous in the area, so their presence is unlikely to have much effect. Growing as they currently are, neither threatens to compete with the planted vegetation. Instead, each offers some benefit to the site as their roots help hold the soil and at least in the case of the thistle, its spines help keep cattle off that part of the bank. That said, cattle certainly move around such thistles, doing some localized damage to the slope in the process. Though bull thistle can become a colonial species on disturbed sites, it is more commonly seen growing just as scattered individuals, so it is unlikely to achieve a density that will prove helpful in keeping cattle off the site as a whole.

The problems with the bank restoration at this site appear mostly to stem from a lack of interest and engagement on the part of the owners, as only they can ensure on a consistent basis that fencing is maintained and their cattle do not damage the site. Aside from that, the choices of species (too many palatable herbs), and low stocking density (due in part to use of expensive nursery stock for some species when either non-landscaping sized trees or live stakes would have sufficed). The lack of follow up has been a problem at this site. However, while upgrading the fences and replanting with more appropriate planting stock would be beneficial, such work is not recommended at this point without first addressing concerns about the degree of interest of the landowners. They were certainly willing to undertake the project, but apparently do not necessarily have much interest in it.

Little River below the first 895 Bridge 2017 (Fort Folly Habitat recovery)

The cause of the instability at this site appears to be water (and energy) deflected off the footings of the first Rt 895 bridge over the Little River, approximately 200 metres upstream. Little can be done to change the bridge, however the bank after this work is now better able to withstand forces directed against it. Figure 20 illustrates based on historical imagery how during the 7 years between 2010 and 2017 an area of 1,235 m^2 of bank was lost. This area is marked in white- the right side indicating the bank in 2010, and the left the bank in 2017. An average of 176 m^2 were lost per year as the river widened and shallowed to produce the gravel bars filling what had been the old channel, as the main flow shifted into the now missing bank area. Assuming approximately 1 m^3 of soil per m^2 of bank lost suggests something like an average of 176 m^3 of sediment per year every year were entering the river at that site.

This section of bank lies a short distance upstream of a site (Figure 8) where redd surveys for iBoF Atlantic salmon have regularly detected use of spawning gravel to build redds in which to deposit eggs during spawning. The large volumes of silt coming off this site posed a risk of smothering such redds, suffocating the eggs within them. It is also worth noting that not only is this site itself home to brook floaters which are vulnerable to sediment, but the massive brook floater bed downstream that Hanson (Personal Communication 2018) noted was suffocated by eutrophication in 2013 (Figure 9) lies only about 4 km below this site. This is not to suggest that the soil coming off this site was uniquely the cause of the eutrophication event that wiped out that mussel bed, however given the volume of soil being lost and the time that both were happening, soil from this bank almost certainly would have contributed to that result. Figure 21 provides a cross-section of the reconstructed bank while Figure 22 shows the lay out of the site with the rock toe running the length and bank lifts stepped back above it.

Figure 20: Area of bank lost at this site between 2010 and 2017: 1,235 m^2

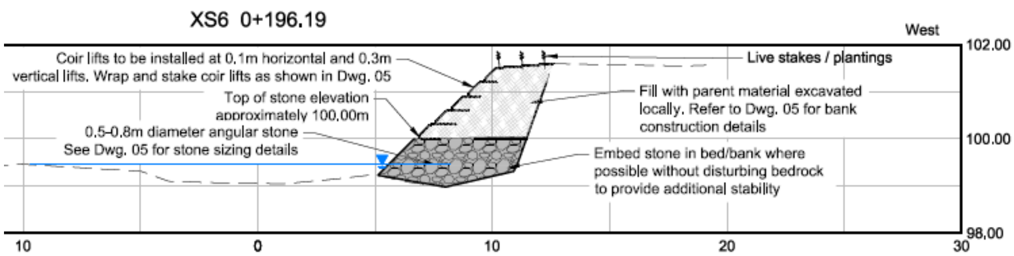

Figure 21: 2017 Project Design cross-section

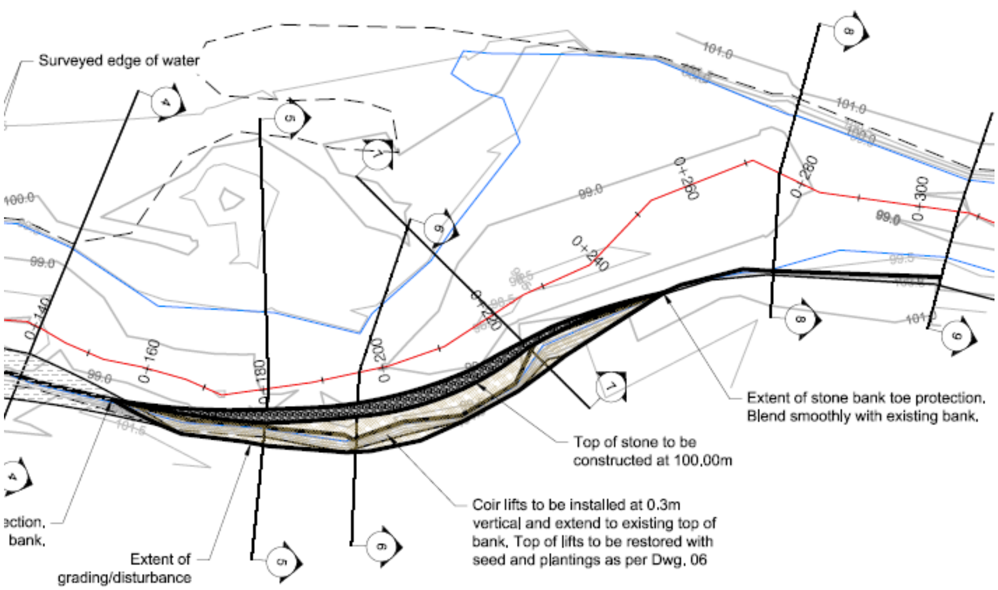

Figure 22: 2017 Project Design view from above

Figure 23:Distribution of vegetation planted at 2017 site

Vegetation was planted as per Figure 23. Initial density across the entire 750 m^2 of revegetated bank averaged approximately 0.95 stems per m^2. The site was damaged somewhat by a storm in 2018 during the first winter after it had been restored, prior to the point where the vegetation had had much opportunity to establish roots. Follow up work at the site in the spring of 2018 addressed these issues, reseeding and replanting as needed. Vegetation survey in 2022 found that density had increased to 1.19 stems per m^2 as a result of natural recruitment, with 5 additional species present on site (Table 6)

Table 6: Survival of woody vegetation planted at 2017 site to 2022

Species	Planted in 2017	Planted in 2018	Growing 2022	Establishment and Survival
White elm	38	-	7	18%
Black cherry	62	-	11	18%
White pine	30	-	14	47%
Silver maple	50	-	23	46%
Balsam poplar	30	-	11	37%
Willow	300	1,000	329	25%
Red-osier dogwood	200	200	40	10%
Grey birch			72	Natural Recruitment
Speckled alder			323	Natural Recruitment
Trembling aspen			55	Natural Recruitment
Hawthorn			7	Natural Recruitment
Sweet fern			4	Natural Recruitment
Total	710	1,200	896	126% of original
% recruits				51%

The recruitment of sweet fern (*Comptonia peregrina*) to the site is of particular interest (Figure 24). Contrary to the name this is not a fern, but a woody shrub with fern-like leaves. The species itself is not rare per se, ranked S5 (Secure) meaning it is common, widespread, and abundant in New Brunswick (ACCDC 2023). However sweet fern has a fairly spotty distribution within the Petitcodiac watershed, and this is the first time FFHR had noted it on Little River, though it has been seen previously here and there on the Pollett and along the main-stem of the Petitcodiac. Presumably sweet fern is present somewhere upstream on the Little River and the seed simply washed in and was deposited on the site during one or more flood events over the last several years. Other species showing up on the site due to natural recruitment are less remarkable. These were likely present among the vegetation on site before the bank was reconstructed. The alder and the aspen probably developed from root fragments that persisted in the soil. Meanwhile hawthorn and grey birch may have grown from a combination of seed produced by vegetation immediately adjacent to the site, from seed lying dormant in the soil, or like the sweet fern, from seed transported some distance and deposited on the site during a flood event.

Figure 24: Sweet fern found at the 2017 site in 2022

Figure 25 shows a repeat photography time series of photos of the site taken from upstream looking downstream, from 2016 (before work was done there) until 2022. Since 2018, in addition to the vegetation becoming well established, slope stability has remained high. This observation was documented and quantified by surveying a series of cross sections across the length of the site, post construction in 2017, and subsequently repeating the survey in 2022 to allow comparison. Other long term monitoring ongoing at the site compared to 2017 pre-construction baselines includes electrofishing to assess how fish are responding to the work done, and Canadian Aquatic Biomonitoring Network (CABIN) wadeable streams monitoring (Environment Canada 2011). The latter examines aquatic insect populations - particularly Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and

Figure 25: 2017 site before (2016) and after (up to 2022)

Trichoptera (Caddisflies)- EPT species- as these are typically the most sensitive to habitat disturbance. Even distribution and high numbers serve as good indicators of water quality. As residents of the site the state of such populations can provide longer term insights into conditions there than conventional water sampling which provides only a snapshot in time.

Little River, Synton 2022 (Fort Folly Habitat Recovery)

In 2019, the landowner of this site approached FFHR for help with his failing bank after he had visited the 2017 site below the first Rt. 895 bridge. Sites for such projects are prioritized through FFHR's Stewardship planning process. Rapid Geomorphic Assessments on the Little River in 2019 classified 55% of the river as "In adjustment", the most unstable ranking, including his section of bank (Figure 10). Salmon redds have been found in spawning gravel several hundred meters downstream of this site on multiple occasions in 2013, 2016, and 2020 (Figure 8). This is particularly noteworthy as logistical constraints limit adult releases to sites some distance away, so fish are clearly exploring the river and preferentially choosing to use this particular gravel. The concern is that silt being eroded from such a failing bank can pose a threat of suffocating salmon eggs within such redds.

In 2021 four PIT tagged salmon were detected returning to the Little River by an automated PIT tag reader antenna array FFHR operates located at the 895 bridge approximately 3 km downstream of this site. Three of these salmon were Little River origin fish, having been collected near that bridge in 2019 as smolts, raised to adulthood in Grand Manan by FSR and released on the Pollett River (where all FSR fish are released) in the fall of 2020. Yet in 2021, these Little River salmon returned preferentially to their natal river. Given a motivated landowner, a threat to high quality habitat, and evidence of salmon accessing that habitat under their own power, this site was prioritized in 2021, for work in 2022.

Instead of employing a rock toe as had been done in 2017 at the site below the first Rt. 895 bridge, this project in 2022 used four log deflectors installed at key points along the toe of the bank (Figure 26) to re-establish the radius of curvature through this portion of the river. These log deflectors were built out of pairs of 10 m long hemlock logs (90% of each of which was embedded back into the final bank). The bank was reconstructed with a system of interlocked Flex MSE bags (Trexiana Wholesale and Distribution LTD, Surrey, BC) filled with a mixture of clay, sand, pebbles, seed and organics, stacked to the desired height and stepped back to achieve the required slope (cover, top photo). The lower levels of bags were wrapped with plastic geogrid that was anchored deep into the bank to provide additional support. Similarly, the upper levels were wrapped in jute. The bank above the bags was seeded with grass and forbs and the 140 m^2 of reconstructed bank was planted with 620 live stakes to a density of 4.4 stems per m^2 (Figure 27). These were a mix of several species of willow (460 live stakes) and red-osier dogwood (160 live stakes). The grass and forbs germinated quickly and will immediately help stabilize the site over the winter. In the spring of 2023 the live stakes will root out, and as these grow this woody vegetation will bind together the newly rebuilt bank reinforcing it further, becoming progressively stronger as these get bigger and once well established will provide opportunities for recruitment of additional vegetation.

Figure 26: Reconstructed riverbank at 2022 site

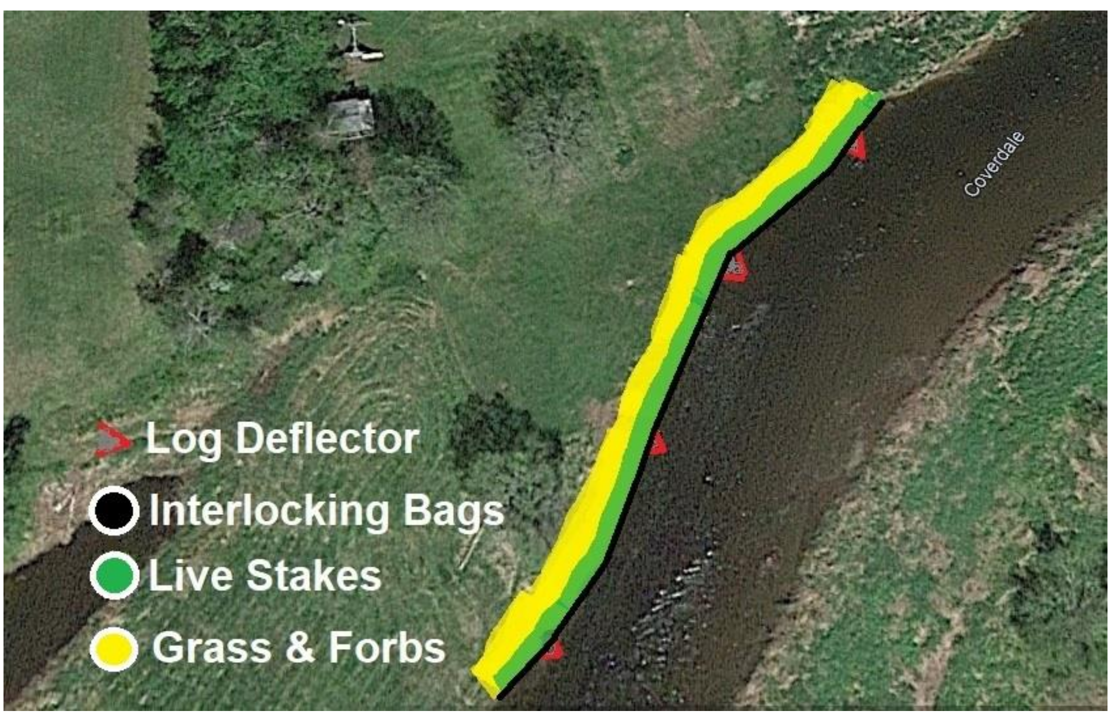

Figure 27: Distribution of vegetation planted at 2022 site

Figure 28 is the beginning of a repeat photography time series of photos of the site taken before work was done there in 2021 and again afterwards in 2022. Post construction, cross sections were surveyed across the length of the site to record the new bank slope so that in the future comparisons can be made to document and quantify the extent to which stability has been achieved and maintained.

Figure 28: 2022 site before (2021) and after bank reconstruction (2022)

As with FFHR's other sites, additional long-term monitoring at this site required collection of 2022 pre-construction baselines includes electrofishing to assess how fish are responding to the work done, and Canadian Aquatic Biomonitoring Network (CABIN) wadeable streams monitoring (CABIN 2012). It is noteworthy that the electrofishing survey detected salmon fry (Figure 8) in 2022 just below the site. Given that no fry or adults were released nearby, this provides confirmation that salmon (possibly the Little River origin returns detected by the array downstream in 2021) successfully spawned in the area during the previous fall.

Figure 29: Salmon fry caught below 2022 site during electrofishing monitoring.

Culvert Remediation

Work to remediate culverts identified as barriers to fish passage has been undertaken within the Little River by the Petitcodiac Watershed Alliance as part of their Broken Brooks project between 2014 and 2022. Culvert C-051 located where Route 895 intersects Mitton Brook was found to be a full barrier to fish passage during the 2014 culvert survey. It was identified as a candidate for construction of a rock weir below the outflow and provides an example of the technique. Installing this rock weir allowed fish access to approximately 2.5 km in length and 6.03 km² of upstream habitat. The PWA has identified and remediated 6 culverts in this manner within the watershed (Figure 17 and Table 7).

Table 7: Petitcodiac Watershed Alliance "Broken Brooks" Culvert assessment and mitigation

Culvert ID	Latitude	Longitude	Assessment	Remediation Method	Upstream habitat gain
C-045	N 45.85859	W -64.9552	Full Barrier	Rock Weir (2017)	1 km
C-047	N 45.84430	W -64.9097	Full Barrier	Rock Weir (2017)	4 km
C-048	N 45.83959	W -64.9236	Full Barrier	Rock Weir (2017)	6 km
C-050	N 45.82360	W -65.0558	Full Barrier	Rock Weir (2017)	1 km
C-051	N 45.86600	W -65.0174	Full Barrier	Rock Weir (2017)	2.5 km
C-067	N 45.76728	W -65.0171	Full Barrier	Rock Weir (2017)	3.5 km

Culverts that are not properly designed can create a drop, or change in elevation, between the culvert outflow and the stream flowing through it. Culvert C-051 has a downstream slope of 3.79% and an outflow drop of 19 cm, potentially blocking approximately 2.5 km of upstream habitat for brook trout and other species. Large changes in elevations between the outflow drop and stream can prevent fish from jumping into the culvert and migrating upstream. The PWA follows the guidelines for remediation options listed in Table 8.

Table 8: Guidelines followed by PWA for Culvert Remediation Options

Culvert measurements	Remedial Option
Outflow drop less than 15 cm	Rock weir
Outflow drop less than or equal to 25 cm	Outflow chute
Outflow drop between 25 cm and 40 cm	Outflow chute with downstream weirs
Outflow drop greater than 40 cm	Mini-fishway
Slope greater than 0.5%	Baffles

To reduce this barrier, a vortex rock weir design was selected. By installing this type of structure water levels are raised in the plunge pool and the barrier outflow drop is effectively eliminated. The size and volume of the rock weir is based upon the stream and culvert characteristics and can be calculated using data collected from the culvert assessment.

The apex or low flow notch (located at the center of the weir where water can flow during times of lower volume) has the lowest point of elevation and points upstream. The wings of the weirs were built at a 30° angle from the base of the weir (Figure 30). Gradual reduction of the outflow drop was visible during rock weir construction. Comparison of before and after outflow drop photos below show that the outflow drop was successfully reduced (Figure 31). Over time, the watercourse will naturally deposit material within the rock weir and fortify the structure. Stream-crossing structures should be inspected and maintained on a regular basis, especially following high water flow season and large rainfall events.

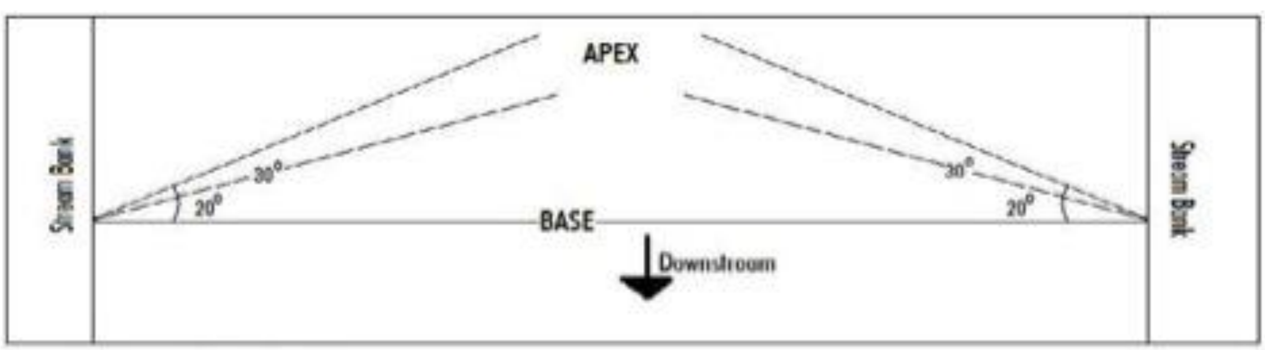

Figure 30: Schematic for Rock weir construction

Figure 31: Plunge pool at C-051 before (top row) and after (bottom row) rock weir construction

Dump Site Clean Up

Illegal dumping is a problem within the Little River watershed. What is found tends to be construction material and household items, rather than hazardous materials. Nonetheless this material degrades the environment. The solution is for it to be collected and properly disposed of. Several locations where such illegal dumping has been taking place were identified (Figure 17) and were addressed, resulting in the removal and transport of waste to the Eco 360 Waste Management Facility in Moncton.

Parkindale

This site is located on retired farmland and contained evidence of historical dumping, consisting of many antique items. This site revealed 3 broken down golf carts and numerous amounts of partially decomposed metals from cans and appliances. A total of 480 kg was removed from this site in 2022.

Synton/Nixon Road(s), Turtle Creek

This is an active illegal dump site spread over a large area. Figure 32 was photographed after previous clean up efforts in the area. It had to be revisited as it was by far the largest dump Fort Folly Habitat Recovery teams observed in 2021. Unfortunately, regardless of previous efforts this site had newly compiled garbage from multiple dumps. Figure 33 shows a portion of this site before and after clean up. Over the course of the 2022 field season teams would continuously return to the site and fresh deposits would be discovered. The contents of waste at this site varied and could contain anything from children's toys to animal carcasses. A total of 2,600 kg was removed from this site during 2022.

Figure 32: Synton/Nixon site in 2022 despite having been previously cleaned up

Figure 33: Portion of the Synton/Nixon site in 2022 before and after a clean up effort.

Opportunities for Future Restoration Activities

Restoration Framework –Stewardship Planning, Prioritization and Engagement

To address concerns within the watershed through an efficient use of finite resources (both human and financial), projects must be well prioritized, both in terms of the needs of the river, and those of the landowners on who's property the project is taking place. Fort Folly Habitat Recovery has developed a series of Stewardship Plans on a watershed by watershed basis within the Petitcodiac River system, of which this Little River Stewardship Plan is one. These plans provide a means of tackling the challenging task of identifying local problems, determining which ones warrant immediate attention, and determining how to proceed with them once chosen. This process is laid out in Figure 34 and Figure 35.

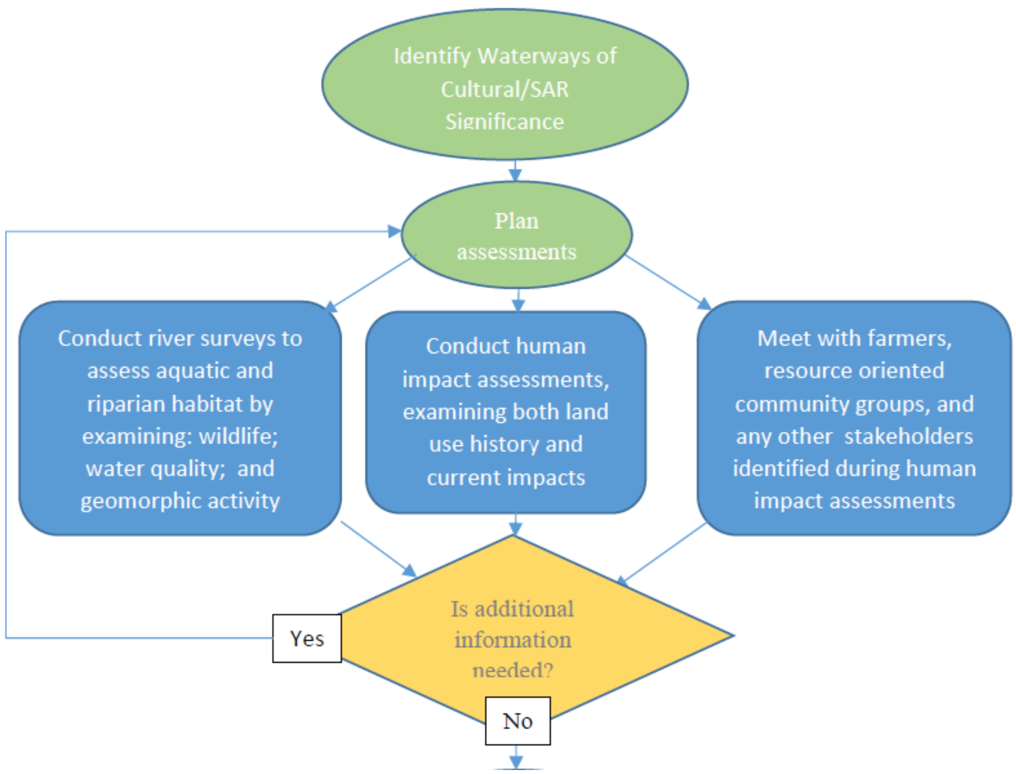

Figure 34: Stewardship Planning Process Part 1: Needs of the River

The field work that makes up the Third Level Assessment (Aquatic and Riparian Habitat Assessment) informs decision making by providing the wide context necessary to prioritize and target project selection. Without it, decisions about which project to undertake would be made without proper appreciation of how needs at a given site compare to those at other sites elsewhere in the system. At this point there is also an opportunity to ensure that efforts are well distributed across the watershed by including consideration of where previous projects have been done, to avoid focusing too much effort in just one area within too short a time period.

Applying such information, project selection can then proceed along the flowchart presented in Figure 35, where once identified, potential projects can be ranked according to their anticipated impact and viability. Viability is determined in part by the costs and benefits of the project, but is also dependent upon landowner interest, which comes from (to the extent practical) incorporation of landowner input into planning the project so that it is consistent with the landowner's needs.

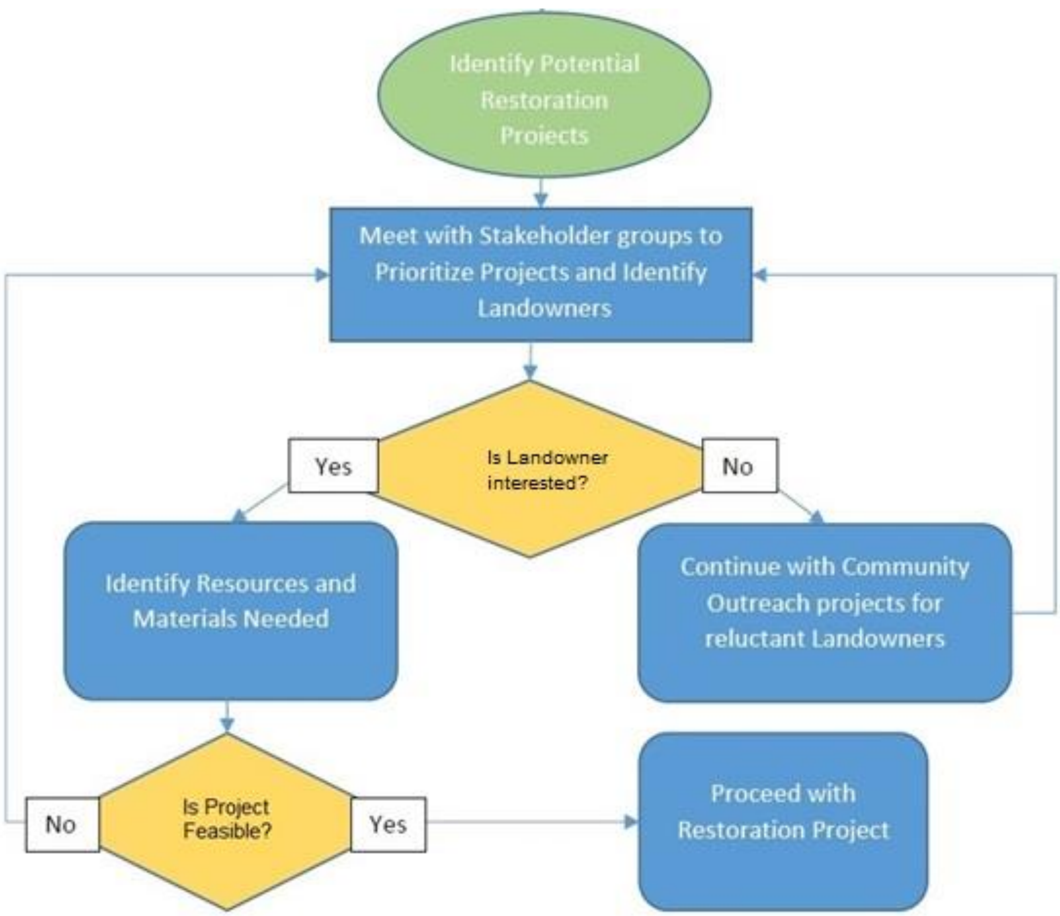

Figure 35: Stewardship Planning Process Part 2: Meeting Landowner Needs

Following this two-part selection process not only aids in decision making within the organization, doing so subsequently builds the case for any individual project when pursuing resources from outside the organization to undertake it, by providing the evidence to explain to others why it is necessary. This also creates further opportunities for outreach and engagement with landowners, through accessing and participating in existing social networks. Only once a project has been determined to be both worthwhile and feasible through this process should it then proceed to the design phase. In near term- following this process the next project that has been identified to undertake (in 2023) is a failing section of bank located high up in the headwaters of the Little River in Pleasant Vale (Figure 17)

Figure 36: Riprap hardened bank upstream of the 2023 project

The cause of instability at this site is water (and energy) deflected off a riprap hardened bank of an upstream neighbour (Figure 36). The bank used to be roughly even with the base of the rock but has been eroded back a considerable distance. This location is higher up in the Little River watershed than recent projects, but is a short distance downstream of the one PWA did in 2016 (Figure 17). This site was selected partially because it has been some time since the last bank restoration was done in this portion of the river. It is important that such activities be well distributed through out the watershed both in terms of benefiting target species, and equitability of opportunity for landowners as well as generating public awareness of work that can be done to protect the river.

Beyond those considerations, this section of bank warrants attention based upon its own merits given numerous salmon redds detected here in 2020 as well as consistently over many previous years (Figure 8). This reach of the river was ranked "transitional or stressed" during the Rapid Geomorphic Assessments (Figure 10), which is considered less sensitive than those that are "in adjustment". However, the same is true of most of the upper reaches of the Little River- so would be the case at most locations where one might take steps to protect the spawning gravel in this part of the river.

Figure 37: Looking downstream along the failing bank at the 2023 project

The dead elm tree at a 45° angle in Figure 37 provides a graphic illustration of the extent to which the bank has failed. This tree died recently along with numerous other elms nearby as a result of Dutch elm disease, not the failing bank. That said, stress caused by the roots being undermined may have increased its susceptibility to the disease.

The site was surveyed during the fall of 2022, and a restoration design has been developed that will be implemented in the fall of 2023. Once the work indicated by this design is implemented, this portion of the riverbank will be better able to absorb and tolerate the forces directed against it from upstream. Such an extended timeline is typically what is required allow sufficient time to develop plans, line up funding, acquire permits and implement projects within the operational window defined by the permit (June 1st to September 30th) which is set to minimize negative impacts upon fish inhabiting the river.

The province sets this work window to protect salmon by limiting such work to the summer between the point in the year where salmon fry spawned the previous fall have emerged from their redds, and a point the next fall before the adult salmon are spawning in the river (establishing the next set of redds). Beyond salmon, the presence of other threatened and endangered species in the watershed also means that such projects must be planned and implemented with awareness of the vulnerabilities of these species. Fort Folly Habitat Recovery has developed project checklists (Appendix) based on species biology to provide guidelines to help avoid or minimize the risk of negative impacts.

References

ACCDC. (2023). Species ranks. Atlantic Canada Conservation Data Centre. http://www.accdc.com/en/species-ranks-app.html Web February 22nd, 2023

Albert County Museum. (2015). Maple Syrup. Web. March 10th 2015. http://www.albertcountymuseum.com/maple-syrup/

Allison, D. (1916). The History of Nova Scotia. Volume 2. A.W. Bowen & Company, Halifax Nova Scotia. 570 pages. https://archive.org/details/historyofnovasco02alliuoft Web April 9th, 2020.

Alward, D. (2014) State of the Province Address, January 30, 2014. Government of New Brunswick. Fredericton, New Brunswick. 54 pages.

AMEC (2005) Environmental Impact Assessment Report for Modifications to the Petitcodiac River Causeway. Submitted to New Brunswick Department of Supply and Services by AMEC Earth and Environmental. Fredericton, New Brunswick. 376 pages.

Arsenault, B. (2004) Histoire des Acadiens. Éditions Fides. Montreal, Québec. 505 pages.

Ashfield, D., D. MacPhail, P. Mandell and G. Farmer.(1984). Chemical characteristics of selected rivers in Nova Scotia and New Brunswick during 1983. Canadian Data Report of Fisheries and Aquatic Sciences 489: 18 pages.

Bailey, L.W. (1864). Report on the Mines and Minerals of New Brunswick. Fenety. Fredericton, New Brunswick. 73 pages.

Bailey, L.W. (1865). Observations on the Geology of Southern New Brunswick. Fenety. Fredericton, New Brunswick. 293 pages.

Baillie, T. (1832) An Account of the Province of New Brunswick; Including a Description of the Settlements, Institutions, Soil, and Climate of that Important Province; with Advice to Emigrants. J.G.& F. Rivington. London, England. 134 pages.

Beaulieu, A. (2014). "Under his majesty's protection": The meaning of the conquest for the aboriginal peoples of Canada. Chapter 4 In: The Culture of the Seven Year's War. Bruyn, F. and S. Regan eds. University of Toronto Press. Pages 91-115.

Beck, J.M. (1979). Cornwallis, Edward. In: Dictionary of Canadian Biography Volume 4. University of Toronto/Université Laval. 913 pages.

Bowser, R. (1986). Dorchester Island and Related Areas. Dorchester New Brunswick. 178 pages.

Briggs Maples. (2015). Briggs Maples. Web March 10th 2015. http://www.briggsmaples.com/splash.html

Canadian Broadcasting Corporation. (2014). Interactive Map of New Brunswick's Shale Gas Industry. http://www.cbc.ca/nb/features/fracturedfuture/rights_map.html Web 5 March 2014.

Canadian Broadcasting Corporation. (2023). Higgs pitches First Nations on up to $1.6B in revenue with possible shale gas expansion. https://www.cbc.ca/news/canada/new-brunswick/new-brunswick-fracking-shale-gas-first-nations-1.6794489 Web March 30th, 2023.

Chipman, W. (1784). Letter to Edward Winslow, March 7th, 1784. Winslow Family Papers, Volume 3-62 https://web.lib.unb.ca/winslow/partition.html Web August 12th, 2020.

Commissioner of Fisheries. (1877). Report of the Commissioner of Fisheries: Supplement No. 4 to the Ninth Annual Report of the Minister of Marine and Fisheries for the year 1876. Ottawa, Ontario. 387 pages.

COSEWIC. (2006). COSEWIC assessment and status report on the American eel *Anguilla rostrata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 71 pages.

COSEWIC (2007) COSEWIC assessment and status report on the Wood Turtle *Glyptemys insculpta* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 49 pages.

COSEWIC. (2009). COSEWIC assessment and status report on the brook floater *Alasmidonta varicosa* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 79 pages

COSEWIC (2011) Species Database: Turtle, Wood. http://www.cosewic.gc.ca/eng/sct1/searchdetail_e.cfm?id=286 Web 6 March. 2014.

COSEWIC (2014a) Species Database: Eel, American. http://www.cosewic.gc.ca/eng/sct1/searchdetail_e.cfm?id=891 Web 31 Dec. 2014.

COSEWIC (2014b) Species Database; Bass, Striped. http://www.cosewic.gc.ca/eng/sct1/searchdetail_e.cfm?id=830&StartRow=351&boxStatus=All&boxTaxonomic=All&location=All&change=All&board=All&commonName=&scienceName=&returnFlag=0&Page=36 Web 31 Dec. 2014.

Craik, W. (1917). Canada's Boom in Shipbuilding: The romantic revival of a one time prosperous industry. Macleans, January 1st, 1917. Page 16-17.

Dallison, R. (2003). Hope Restored: The American Revolution and the Founding of New Brunswick. The New Brunswick Military Heritage Series, Volume 2. Goose Lane Editions, Fredericton, New Brunswick. 126 pages.

Davey, J. (2011). Securing the sinews of sea power: British intervention in the Baltic 1780 to 1815. International History Review 33(2): 161-184.

Dawson, J. (2005). Historical Atlas of the Maritime Provinces 1878. Reprinting the Atlas of the Maritime Provinces of the Dominion of Canada, A. Rowe and W. Rowe, 1878 St John New Brunswick. Nimbus Publishing Ltd. Halifax, Nova Scotia. 72 pages.

Degraaf, R., M. Yamasaki, W. Leak, and A. Lester. 2007. Technical Guide to Forest Wildlife Habitat Management in New England. University of Vermont Press. University Press of New England. Lebanon, New Hampshire. 328 pages.

DeMerchant, E. (1983). From Humble Beginnings: The Story of Agriculture in New Brunswick. New Brunswick Department of Agriculture and Rural Development, Fredericton. 94 pages.

Department of Fisheries. (1890). Annual Report of the Department of Fisheries, Dominion of Canada, for the Calendar Year 1889. Brown Chamberlin. Ottawa, Ontario. 92 pages.

DFO (2010). Aquatic Species at Risk – Atlantic Salmon Inner Bay of Fundy. http://www.dfo-mpo.gc.ca/species-especes/species-especes/salmon-atl-saumon-eng.htm Web 6 March. 2014.

DFO. (2016). Management Plan for the brook floater (Alasmidonta varicosa) in Canada [Proposed]. Species at Risk Act Management Plan Series. Department of Fisheries and Oceans Canada, Ottawa. 41 pages.

Electoral Atlas of the Dominion of Canada. (1895). Electoral District of Albert. New Brunswick No. 172

Elson, P. (1962) Predator-prey relationships between fish eating birds and Atlantic salmon (with a supplement on fundamentals of merganser control). Bulletins of the Fisheries Research Board of Canada Bulletin No. 133. Ottawa.

Environment Canada. (2011). Canadian Aquatic Biomonitoring Network Field Manual Wadeable Streams 2012. En84-87/2012E-PDF Environment Canada. Ottawa, Ontario. 57 pages.

Evans, D. (2004). Building the Steam Navy: Dockyards, Technology and the Creation of the Victorian Battle Fleet, 1830 to 1906. Chrysalis Books Group. London, England. 208 pages.

Faragher, J. (2005). A Great and Noble Scheme: The Tragic Story of the Expulsion of the French Acadians from Their American Homeland. W.W. Norton and Company, New York, New York. 562 pages.

Fellows, R. (1971). The Loyalists and Land Settlement in New Brunswick, 1783-1790: A study in Colonial administration. The Canadian Archivist 2(2): 5-15

Fellows, R. (1980). The New Brunswick Census of 1851, Albert County, New Brunswick, Canada.

Fort Folly First Nation. (2021). Fort Folly Land Claim. https://fortfolly.ca/land-claim-submission Web January 21st, 2021.

Francis, J., R. Jones, and D. Smith. (2010). Journeys: A History of Canada. 6th Edition. Nelson Education Ltd. Toronto, Ontario. 641 pages.

Ganong, W. (1896). A Monograph of the Place-Nomenclature of the Province of New Brunswick. (Contributions to the History of New Brunswick – No. 2). Transactions of the Royal Society of Canada, Second Series, Volume 2, Section 2, pages 175-289.

Ganong, W. (1899). A Monograph of Historic Sites in the Province of New Brunswick. (Contributions to the History of New Brunswick – No. 4). Transactions of the Royal Society of Canada, Second Series, Volume 5, Section 2, pages 213-357.

Ganong, W. (1901). A Monograph of the Evolution of the Boundaries of the Province of New Brunswick. (Contributions to the History of New Brunswick – No. 5). Transactions of the Royal Society of Canada, Second Series, Volume 7, Section 2, pages 139-449.

Ganong, W. (1905). A Monograph of the Origins of the Settlements in New Brunswick (Contributions to the History of New Brunswick - No. 5) Transactions of the Royal Society of Canada, Second Series, Volume 7, Section 2, pages 139-449.

Ganong, W. (1930). The report and map of Major George Scott's expedition to remove the French from the Petitcodiac in 1758. New Brunswick Historical Society 13: 97-114.

Gilroy, M. (1933). The Partition of Nova Scotia, 1784. Canadian Historical Review 14(4): 375-391.

Goodrich, E. (2010). Stagecoach Days on the Westmorland Great Road 1835-1872. Westmorland Historical Society. 196 pages.

Goodrich, G. (2020). Dorchester's Mi'kmaq. Westmorland Historical Society Newsletter. Volume 55(3): 4-14.

Gordon, G. (2014). When Money Grew on Trees: A. B. Hammond and the Age of the Timber Baron. The University of Oklahoma Press. Norman, Oklahoma. 496 pages.

Government of New Brunswick. (2015) GeoNB Oil and Natural Gas (ONG) Viewer. http://geonb.snb.ca/ong/index.html Web March 10th 2015.

Government of New Brunswick. (2023a). GeoNB Oil and Natural Gas (ONG) Viewer. http://geonb.snb.ca/ong/index.html Web March 23rd 2023.

Government of New Brunswick. (2023b). Local Governance Reform: Working together for vibrant and sustainable communities. https://www2.gnb.ca/content/gnb/en/corporate/promo/local-governance.html Web February 27th 2023.

Grenier, J. (2008). The Far Reaches of Empire: War in Nova Scotia 1710-1760. University of Oklahoma Press. Norman, Oklahoma. 270 pages.

Hamilton, W. (1996). Place Names of Atlantic Canada. University of Toronto Press. Toronto Ontario. 456 pages.

Hanson, J., and A. Locke. (2001). Survey of freshwater mussels in the Petitcodiac River Drainage, New Brunswick. Canadian Field-Naturalist 115(2): 329-340

Hanson, J. (2018). DFO Science, Moncton New Brunswick. Personal Communication

Hodges, G. (1996). The Black Loyalist directory: African Americans in exile after the American Revolution. Garland Publishing, New York. 318 pages.

Johnston, J. (1850). Report on the Agricultural Capabilities of the Province of New Brunswick. Simpson. Fredericton, New Brunswick. 262 pages.

Kanner, K., and V. Geldart. (1984). Marriage register Albert County New Brunswick (1846-1887). 186 pages.

Kernaghan, L. (1981). A man and his Mistress: J.F.W. Des Barres and Mary Cannon. Acadiensis 11(1): 23-42.

Kristmanson, H. (2004). A Short History of Beaumont, New Brunswick. New Brunswick Manuscripts in Archaeology 37. Archaeological Services, Heritage Branch, Culture and Sport Secretariat. Fredericton New Brunswick. 17 pages.

Larracey, E. (1985). Chocolate River: A story of the Petitcodiac River from the Beginning of Habitation in the Late 1600's Until the Building of the Causeway at Moncton. Lancelot Press Ltd. Hantsport, Nova Scotia. 254 pages.

Laxer, J. (2006) The Acadians: In Search of a Homeland. Doubleday Canada, Toronto, Ontario. 336 pages.

Library and Archives Canada (2015) Electoral Atlas of the Dominion of Canada 1895: #172 Albert County New Brunswick. Web May 10th http://www.collectionscanada.gc.ca/electoral-atlas/032001-119.01-e.php?image_id=e000835676&prov_page_nbr=172

Locke, A., J. Hanson, G. Klassen, S. Richardson, C. I. Aubé. (2003) The Damming of the Petitcodiac River: Species, Populations, and Habitats Lost. Northeastern Naturalist Vol. 10. No. 1. pp 39-54.

MacNutt, W. (1963). New Brunswick A History: 1784-1867. MacMillan of Canada, Toronto. 496 pages.

MacNutt, W. (1970). The making of the Maritime Provinces 1713-1784. The Canadian Historical Association Booklets. No. 4. Ottawa, Ontario. 21 pages.

Mancke, E. (2005). Spaces of Power in the Early Modern Northeast. In: New England and the Maritime Provinces: Connections and Comparisons. Hornsby, S., and J. Reid, editors. McGill-Queen's University Press. Montreal, Québec. 424 pages.

Mancke, E. (2019). Decorous Dispossession: Legally Extinguishing Acadian Landholding Rights. Blog post: https://earlycanadianhistory.ca/2019/07/30/decorous-dispossession-legally-extinguishing-acadian-landholding-rights/ Web April 29th, 2020.

Mancke, E., D. Bent, and M. Mclaughlin. (2017). "their unalienable right and privilege": New Brunswick's challenge to the militarization of the British Empire, 1807-1814. Acadiensis 46(1): 49-72.

Marble, A. (1993). Surgeons, smallpox, and the poor in Nova Scotia 1749 -1799. McGill-Queen's University Press. Montreal, Québec. 376 pages.

Marketwired.com. (2013).PetroWorth Resources Inc. announces change of name to First Sahara Energy Inc., share consolidation and the closing of claim purchase agreement with iant Exploration Inc. http://www.marketwired.com/press-release/petroworth-resources-inc-announces-change-name-first-sahara-energy-inc-share-consolidation-cnsx-ptw-1807972.htm Web March 10th 2015.

Marketwired.com. (2014). M Pharmaceutical Inc. (formerly First Sahara Energy Inc.) announces name change, glucose self-monitoring device letter of intent, board changes and private placement. http://www.marketwired.com/press-release/m-pharmaceutical-inc-formerly-first-sahara-energy-inc-announces-name-change-glucose-cnsx-fse-1973374.htm Web March 10th 2015.

Marsh, J. (1999). Intercolonial Railway. in Canadian Encyclopedia: Year 2000 Edition. McClelland & Stewart. Toronto, Ontario. p. 1174.

Marshall, D. (2011). Heroes of the Acadian Resistance: The story of Joseph Beausoleil Broussard and Pierre II Surette 1702-1765. Formac Publishing Company, Ltd. Halifax. Nova Scotia. 207 pages.

Martin, C. (1995). Fort Beauséjour (New Brunswick, Canada). In: International Dictionary of Historic Places: Volue 1, Americas. T. Ring, N. Watson, and P. Schellinger eds. Routledge, London. Pages 218 to 222.

McLeod, C. (1973). Petitcodiac River system: An outline of potential for Atlantic salmon development in the Pollett River tributary. Unpublished manuscript. Canada Department of the Environment, Resource Development Branch, Fish Habitat Protection Section. 17 pages.

Melanson, T., Murphy, L., Goff, D., MacInnis, C., Keen, D., Bastien-Daigle, S., Ritchie, B., Ferguson, E., Haché, D., Weldon, J., Caissie, D., LeBlanc, M., Cormie, M. (2006). Ecological Restoration of Degraded Aquatic Habitats: a Watershed Approach. Gulf Region Publication. 180 pages.

Mi'gmawe'l Tplu'taqnn. (2023). MTI Communities initiate process for Mi'gmaq Title Recognition. Press Release February 15th, 2023. Mi'gmawe'l Tplu'taqnn Incorporated. Natoaganeg, NB.

Miller, V. (1976). Aboriginal Micmac Population: A review of the evidence. Ethnohistory 23(2): 117-127

Milner, W. (1911) Records of Chignecto. In: Collections of the Nova Scotia Historical Society Volume 15. McNab and Son. Halifax, Nova Scotia. 86 pages.

Milner, W. (1967). Early History of Dorchester and the Surrounding Area. Second Edition, reprint of 1932. 37 pages.

Mooney, J. (1928). The aboriginal population of America north of Mexico. Smithsonian Institution, Miscellaneous Collections 80 (7): 1-40

Monro, A. (1855). New Brunswick; with a brief outline of Nova Scotia, and Prince Edward Island. Their History, Civil Divisions, Geography, and Productions. Nugent, Halifax, Nova Scotia. 384 pages.

Natural Resources Canada. (2010). Hillsborough, New Brunswick. Topographic Map, 1:50,000. 21-H/15, 5th Edition. Centre for Topographic Information, Ottawa.

New Brunswick Department of Natural Resources (2007). Our Landscape Heritage. The Story of Ecological Land Classification in New Brunswick. Second Edition. Fredericton. 359 pages.

New Brunswick Department of Natural Resources (2023). Forestry, Agriculture, and Transportation GIS Data.

New Brunswick House of Assembly. (1890). Journals of the House of Assembly of the Province of New Brunswick. First Session of the Twenty Seventh General Assembly, Fredericton. 138 pages +xxxiii.

New Brunswick Railway Museum. (2015a). Riding the Rails 26: Albert Railway. http://www.virtualmuseum.ca/sgc-cms/histoires_de_chez_nous-community_memories/pm_v2.php?id=story_line&lg=English&fl=0&ex=398&sl=2812&pos=1 Web. March 10th 2015.

New Brunswick Railway Museum. (2015b). Riding the Rails 03: European and North American Railway. http://www.virtualmuseum.ca/sgc-cms/histoires_de_chez_nous-community_memories/pm_v2.php?id=story_line&lg=English&fl=0&ex=398&sl =2789&pos=1 Web March 10th 2015.

Nova Scotia Archives (2020). Peace and Friendship Treaties at the Nova Scotia Archives. https://archives.novascotia.ca/mikmaq/results/?Search=AR5&SearchList1=all&TABLE2=on Web January 12th, 2021.

Patterson, S. (1993). Indian-White relations in Nova Scotia: 1749-61: A study in Political Interaction. Acadiensis 23 (1): 23-59.

Patterson, S. (2009). Eighteenth-Century Treaties: The Mi'kmaq, Maliseet, and Passamaquoddy Experience. Native Studies Review 18 (1): 25-52.

Paul, D. (2000). We Were not the Savages: A Micmac Perspective on the Collision of European and Aboriginal Civilization. Fernwood Publishing Co. Ltd. 359 pages.

Perley, M. (1841). Reports on Indian Settlements, extracts from Mr. Perley's First Report Respecting the Indians on the Saint John. Journal of the House of Assembly of the Province of New Brunswick from the Nineteenth day of January to the Fourth day of April, Being the Sixth Session of the Twelfth General Assembly. John Simpson. Fredericton, New Brunswick.

Perley, M. (1857) Hand-Book of Information for Emigrants to New-Brunswick. Edward Stanford. London, England. 95 pages.

Petitcodiac River Heritage Committee. (2000). The Petitcodiac River System Shepody Bay Estuary. Pre-screening Report submitted to the Canadian Heritage Rivers Board. Moncton. 18 pages.

Petitcodiac Watershed Alliance. (2010). Little River Habitat Assessment. Petitcodiac Watershed Alliance. Moncton, New Brunswick. 31 pages.

Petitcodiac Watershed Alliance. (2022). 2021 Water Quality Monitoring: Making Waves in Environmental Stewardship. Petitcodiac Watershed Alliance. Moncton, New Brunswick. 134 pages.

Philipps, R. (1720). Governor of Nova Scotia to Board of Trade, 27th September 1720. United Kingdom National Archives. CO217/3. No.18.

Pincombe, A. and E. Larracey. (1990). Resurgo: The History of Moncton . Volume 1: The History of Moncton From its Beginning to Incorporation as a City in 1890. City of Moncton, New Brunswick. 448 pages.

Prins, H. (1996). The Mi'kmaq Resistance, Accommodation, and Cultural Survival. Harcourt Brace College Publishers. Fort Worth Texas. 250 pages.

Provincial Archives of New Brunswick (2023). Where is Home? New Brunswick Communities Past and Present. Web 30 March 2023. http://archives.gnb.ca/exhibits/communities/Home.aspx?culture=en-CA

Purvis, T. (1999). Colonial America to 1763. Almanacs of American Life. Facts on File Inc. Infobase Publishing. New York, New York. 381 pages.

Raymond, W. (1891). Paper on the Early Days of Woodstock. Proceedings at the Centennial Commemoration of the ordination of Rev. Frederick Dibblee. Saint John, New Brunswick. 28 pages.

Raymond, D. (2010). The Royal Navy in the Baltic from 1807 to 1812. Ph.D. Thesis, Florida State University. 231 pages.

Redfield, E. (2022) Petitcodiac Fish Trap Results, 2021 Season. Fort Folly Habitat Recovery, Dorchester New Brunswick. 40 pages.

Redfield, E. (2023) Petitcodiac Fish Trap Results, 2022 Season. Fort Folly Habitat Recovery, Dorchester New Brunswick. 39 pages.

Reid, J. (2013). The three lives of Edward Cornwallis. Journal of Nova Scotia Historical Society 16: 19-45.

Rudin, R. (2021). Against the Tides: Reshaping Landscape and Community in Canada's Maritime Marshlands. UBC Press. University of British Columbia. Vancouver. 279 pages.

Sager, E., and L. Fischer. (2007). Atlantic Canada and the age of sail revisited. The Northern Mariner 17(3): 1-22

Samways, K. (2021). University of New Brunswick, researcher studying recovery of iBoF Atlantic salmon. Personal communication.

Sanderson, S. (2017). Constitution Act 1982: Implementation of Section 35 (1) and (2). Federation of Sovereign Indigenous Nations. Saskatoon, Saskatchewan. 4 pages.

SARA Registry (2012, July 6th) Species at Risk Public Registry- Species Profile (*Glyptemys insculpta*). http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=286 Web 6 March. 2014.

SARA Registry (2013a) Species at Risk Public Registry- Species Profile (*Salmo salar*).. http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=672 Web 6 March. 2014

SARA Registry (2013b) Species at Risk Public Registry- Species Profile (Anguilla rostrata). http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=891 Web 6 March. 2014.

SARA Registry (2018) Species at Risk Public Registry- Species Profile (Morone saxatilis). http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=830 Web 11 January 2018

Scott, G. (1758). Draught of the River Pittuiquack in the Bay of Fundy. Map produced during Major Scott's expedition on the Petitcodiac. Available as part of display at Fort Beausejur - Fort Cumberland National Site of Canada, Aulac NB.

Snowdon, J. (1983) Botsford, Amos. In: Dictionary of Canadian Biography Volume 5. University of Toronto/Université Laval. 1,044 pages.

Squires, L. (2000). Loyalist Settlement in New Brunswick. The New Brunswick Loyalists. In: Loyalists of the Maritimes. Page 27–38. United Empire Loyalists Association of Canada.

Statistics Canada. (2020). Aboriginal Peoples. Censuses of Canada 1665 to 1871. https://www150.statcan.gc.ca/n1/pub/98-187-x/4151278-eng.htm Web April 2nd, 2020

Surette, P., H. Michaud, R. Gibbs-Thériault, R. Leblanc, B. Leblanc. (1981). Histoire des Trois Rivières: volume premier 1763 à 1806 Memramkouke. Petcoudiac, et la Reconstruction de l'Acadie. la Société historique de la vallée de Memramcook. 176 pages.

Upton, L. (1974). Indian affairs in Colonial New Brunswick. Acadiensis 3(2):3-26.

Van Den Avyle, M., and L. Shanks. American Eel. Species Profiles: Life Histories and Environmental requirements of Coastal Fishes and Invertebrates (South Atlantic). U.S. Fish and Wildlife Service. U.S. Army Corps of Engineers. M TR EL-82-4. 20 pages.

Walling, H. (1862). Topographical Map of Westmoreland and Albert Counties. W.E. & A. A. Baker. New York, New York.

Walls, M. (2010). No Need of a Chief for This Band: The Maritime Mi'kmaq and Federal Electoral Legislation, 1899 to 1951. University of British Columbia Press. Vancouver, British Columbia. 216 pages.

Wicken, W. (2002). Mi'kmaq Treaties on Trial: History, Land, and Donald Marshall Junior. University of Toronto Press. Toronto Ontario. 336 pages.

Williams, M. (1992). Americans and Their Forests: A Historical Geography. Cambridge University Press. Cambridge, England. 624 pages.

Winslow, E. (1783). Letter to Ward Chipman, July 7th, 1783. Winslow Family Papers Volume 2-104 https://web.lib.unb.ca/winslow/partition.html August 12th, 2020.

Winslow, E. (1809). Letter to Edward Winslow Jr. August 3rd, 1809 Winslow Family Papers Volume 15-20. https://web.lib.unb.ca/winslow/lumber.html August 12th 2020.

Wright, E. (1945) The Petitcodiac: A Study of the New Brunswick River and of the People Who Settled Along It. Tribune Press, Sackville, New Brunswick. 72 pages.

Wynn, G. (1981a) Population patterns in pre-confederation New Brunswick. Acadiensis 10(2): 124-137.

Wynn, G. (1981b). Timber Colony: A Historical Geography of Early Nineteenth Century New Brunswick. University of Toronto Press. Toronto Ontario. 224 pages.

Appendix: SAR Species Checklists for Restoration Projects

Checklist for projects in Atlantic Salmon (*Salmo salar*) habitat

1). Determine if there are any obvious downstream natural or manmade barriers to fish passage (waterfalls, dams, perched culverts, etc) that could prevent salmon from accessing the site.
☐ Done Comment____

2). If manmade barriers are found, note them for possible future action, or, if practical, consider mitigating them as part of the current project.
☐ Done ☐ Does not apply Comment______________________________

3). Even where such barriers exist, electrofish or otherwise sample the site to confirm current presence or absence of salmon as part of project planning, prior to any modification of site.
☐ Done Comment____

4). If no salmon are found and the reason is determined to be a natural barrier, reconsider the need for the project. Perhaps the site should not be considered a priority unless reasons other than promotion of salmon are motivating factors, as resources might be better used elsewhere.
☐ Done ☐ Does not apply Comment______________________________

5). If no salmon are found at the site but there is no barrier to fish passage (manmade or natural) it is likely that this is a result of the declining population of wild salmon in the region. If salmon are found elsewhere on the river then treat the site as if it has salmon. If no salmon are found in that river then reevaluate the need for the project as resources might be better used elsewhere.
☐ Done ☐ Does not apply Comment______________________________

6). Plan project thoroughly and allow sufficient lead time to secure necessary permits and schedule work during optimal work conditions. This will help minimize the duration of in stream work, reduce negative impacts, and control costs.
☐ Done Comment____

7). In sites where salmon are found, observe an operating window of July 1st to September 30th to time any earth moving operations between the end of alevin emergence and the start of spawning.
☐ Done ☐ Does not apply Comment______________________________

8). In sites where salmon are found, always assume that juveniles and / or migrating adults are present while doing any work during the operating window allowed in item 7. The window indicates reduced sensitivity of fish, not their absence. Care must still be taken to minimize direct harm to fish during work.
☐ Done ☐ Does not apply Comment______________________________

9). Incorporate erosion and sediment control practices into work plan as laid out in Section 3 of DFO's Land Development guidelines for Protection of Aquatic Habitat (http://www.dfo-mpo.gc.ca/Library/165353.pdf)
☐ Done Comment____

10). Retain riparian vegetation to protect natural stream conditions and structure and promote stability of the bed and banks. Doing so maintains shade, water temperatures, dissolved oxygen, food supplies, organic debris, cover etc.
☐ Done Comment____

Checklist for projects in American Eel (*Anguilla rostrata*) habitat

1). Determine if there are any obvious downstream natural or manmade barriers to fish passage (waterfalls, dams, perched culverts, etc) that could prevent eels from accessing the site.

☐ Done Comment____

2). If manmade barriers are found, note them for possible future action, or, if practical, consider mitigating them as part of the current project.

☐ Done ☐ Does not apply Comment______________________________

3). Even where such barriers exist, electrofish or otherwise sample the site to confirm current presence or absence of eels as part of project planning, prior to any modification of site.

☐ Done Comment____

4). Evaluate and estimate quantity and quality of watershed upstream of site for value to eels to better understand and document potential impacts of any gain or loss of access

☐ Done Comment____

5). Where upstream habitat warrants it, ensure that project design will not create a barrier to eel passage when complete. The best means of maintaining unobstructed passage will be site and project specific, varying significantly between fords, dams, culverts etc.

☐ Done ☐ Does not apply Comment______________________________

6). If the project site is within 200 meters of the head of tide then time operations for July and August if possible in order to minimize risk of direct harm to elvers migrating upstream (May/June) and eels migrating downstream (September) that could be concentrated and sheltering amid substrates.

☐ Done ☐ Does not apply Comment______________________________

7). If the project site is more than 200 meters beyond the head of tide then if possible avoid operations during September in order to minimize risk of direct harm to eels migrating downstream that could be concentrated and sheltering amid substrates.

☐ Done ☐ Does not apply Comment______________________________

8). The primarily way that humans spread the swim bladder nematode (*Anguillicola crassus*) is by moving infected eels into unimpacted watersheds. Most restoration projects pose no risk of this. None the less, understand the nematode's lifecycle, and ensure that the project avoids spreading it.

☐ Done Comment____

Checklist For Projects in Wood Turtle (*Glyptemys insculpta*) habitat

1). Conduct series of 3 surveys of the site and surroundings at appropriate time of year (spring is best) to determine presence of turtles as part of project planning, prior to any modification of site.
☐ Done Comment______________________________

2). In addition to looking for individual turtles, assess project site (and surrounding area) to identify turtle nesting sites (best done during nesting season (May/June) the prior year).
☐ Done Comment______________________________

3). Consider value of site for turtles (if present) relative to other species: stream bank stabilization may benefit salmon, but harm turtles. On a non salmon bearing stream that is home to turtles, taking no action may be the best management.
☐ Done ☐ Does not apply Comment______________________________

4). Be aware that shortly prior to nesting females concentrate in undisturbed sites adjacent to nest sites, so minimize impacts on the immediate surroundings of nest sites during nesting season.
☐ Done ☐ Does not apply Comment______________________________

5). If turtles or nest sites are present then plan to conduct restoration activities at both time of year and time of day to try to avoid encounters with turtles.

Time of year	Stage	distance from water	habitat use	most active
Jan/Feb/Mar	hibernating	in pools	in stream	not active
Late Mar/Apr	pre nesting	100 m	aquatic	morning & late afternoon
May /Jun	nesting	3km +	terrestrial	morning & early evening
Jul/ Aug/Sep	post nesting	100 m	aquatic	morning
October	pre hibernation	100 m	aquatic	morning & late afternoon
Nov/Dec	hibernating	in pools	in stream	not active

☐ Done ☐ Does not apply Comment______________________________

6). If turtles are present, do not stabilize or vegetate any sites that possess ALL of the following characteristics, as these may be nest sites:

a) full sun exposure to afternoon / evening sun (SW aspect)
b) slope less than 40 degrees (nests usually atleast 1.5 m above water surface)
c) sand or sand gravel substrate with little or no ground vegeation (>20% cover)

☐ Done ☐ Does not apply Comment______________________________

7). If intervention on nesting sites is unavoidable, then mitigate:

- time work either prior to nesting or after hatching (either April or November) if possible, to avoid destroying existing nests
- create compensatory habitat (witch characteristics of item 6: a, b, & c) nearby

☐ Done ☐ Does not apply Comment______________________________

8). If manipulating project site in turtle habit in July or August and air temps remain over 26° C, search directly affected portions of site for estivating turtles prior to beginning operations.
☐ Done ☐ Does not apply Comment______________________________

9). Maintain access across finished project site to adjacent suitable nest sites- a low profile wood structure with sod cap is preferable to large rocks or other material that results in slippery surface
☐ Done ☐ Does not apply Comment______________________________

10) If project has increased human access to site, protect nests with predator exclusion boxes, as human activity increases the density of nest predating species like raccoons and skunks.
☐ Done ☐ Does not apply Comment______________________________

<u>Checklist for projects in Brook Floater (*Alasmidonta varicosa*) habitat</u>

1). Plan project thoroughly and allow sufficient lead time to carry out necessary site surveys, secure required permits and schedule work during optimal conditions.

☐ Done Comment ____

2) . Compare site to the Petitcodiac map of distribution and abundance of brook floater (https://www.biodiversitylibrary.org/item/108793#page/347/mode/1up) (Hanson and Locke 2001, Canadian Field Naturalist 115(2) 329-340). This habitat lies along the main stem of the Petitcodiac (above the head of tide), and the lower portions of the Little River, and the North River.

☐ Done ☐ Does not apply Comment ______________________________

3). If the site lies within the area identified in #2 then, prior to disturbing it, survey (snorkel or viewing buckets as conditions warrant) to determine if brook floater is present at the site or within 100 metres downstream. Ideal time is June to September (water levels low, turbidity minimal, light penetration best) to allow completion of the work before falling leaves obscure the river bottom in autumn.

☐ Done ☐ Does not apply Comment ______________________________

4). If surveys detect brook floaters at or near the site, then ensure that all subsequent survey work and subsequent long term monitoring (electrofishing, CABIN, etc.) is conducted in a manner consistent with such awareness in order to avoid or minimize impacts on brook floaters.

☐ Done ☐ Does not apply Comment ______________________________

5). If brook floaters detected near site then fording heavy equipment or carrying out in-stream work is problematic. Consult authorities (NB DELG, DFO) as part of WAWA process, and consider alternatives.

☐ Done ☐ Does not apply Comment ______________________________

6). During earthmoving activities with equipment working along the river bank, incorporate erosion and sediment control practices into work plan as laid out in Section 3 of DFO's Land Development guidelines for Protection of Aquatic Habitat (http://www.dfo-mpo.gc.ca/library/165353.pdf)

☐ Done Comment ____

7.) Retain and if possible enhance riparian vegetation, to protect natural stream conditions and promote the structure and stability of the bed and banks. A healthy riparian zone maintains shade, retains sediment, and filters nutrients keeping them out of aquatic ecosystems.

☐ Done Comment ____

8). If cattle are present, measures to protect newly planted vegetation by excluding cattle (i.e. fencing) will also protect brook floaters. Open access to streams by cattle can cause direct mortality to mussels by trampling of mussel beds and lead to habitat degradation through sedimentation and eutrophication.

☐ Done ☐ Does not apply Comment ______________________________