Stewardship Plan for the Memramcook River Watershed

Fort Folly Habitat Recovery
Petitcodiac Watershed Alliance
Sentinelles Petitcodiac Riverkeeper

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About this document:

What follows is the result of a collaborative effort by the three environmental organizations (Sentinelles Petitcodiac Riverkeeper (SPR), Petitcodiac Watershed Alliance (PWA), and Fort Folly Habitat Recovery (FFHR)) with the most experience dealing with issues arising from opening the Petitcodiac River causeway. This document blends the unique competencies and experiences of each participating organization to examine the consequences of past and present land management within the Memramcook River watershed to inform future decision making there. It has been constructed according to DFO's Four Level Watershed assessment methodology laid out in "Ecological Restoration of Degraded Aquatic Habitats: A Watershed Approach (Melanson et al. 2006). 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 Instead, it will be updated and superseded by subsequent editions as additional information becomes available.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

The Memramcook River flows for 56 km in Westmorland County before emptying into Shepody Bay immediately adjacent to the mouth of the Petitcodiac River at Fort Folly Point (Figure 1). It is dwarfed by that neighbor, draining a basin of 390 square kilometers, comparable in size to individual Petitcodiac tributaries such as the Little River, or the Pollett River. The headwaters of the Memramcook butt up against the Gulf of Saint Lawrence divide, dropping approximately 70 m from there down to sea level at its mouth. For most of its length the Memramcook lies within the Eastern Lowlands Ecoregion

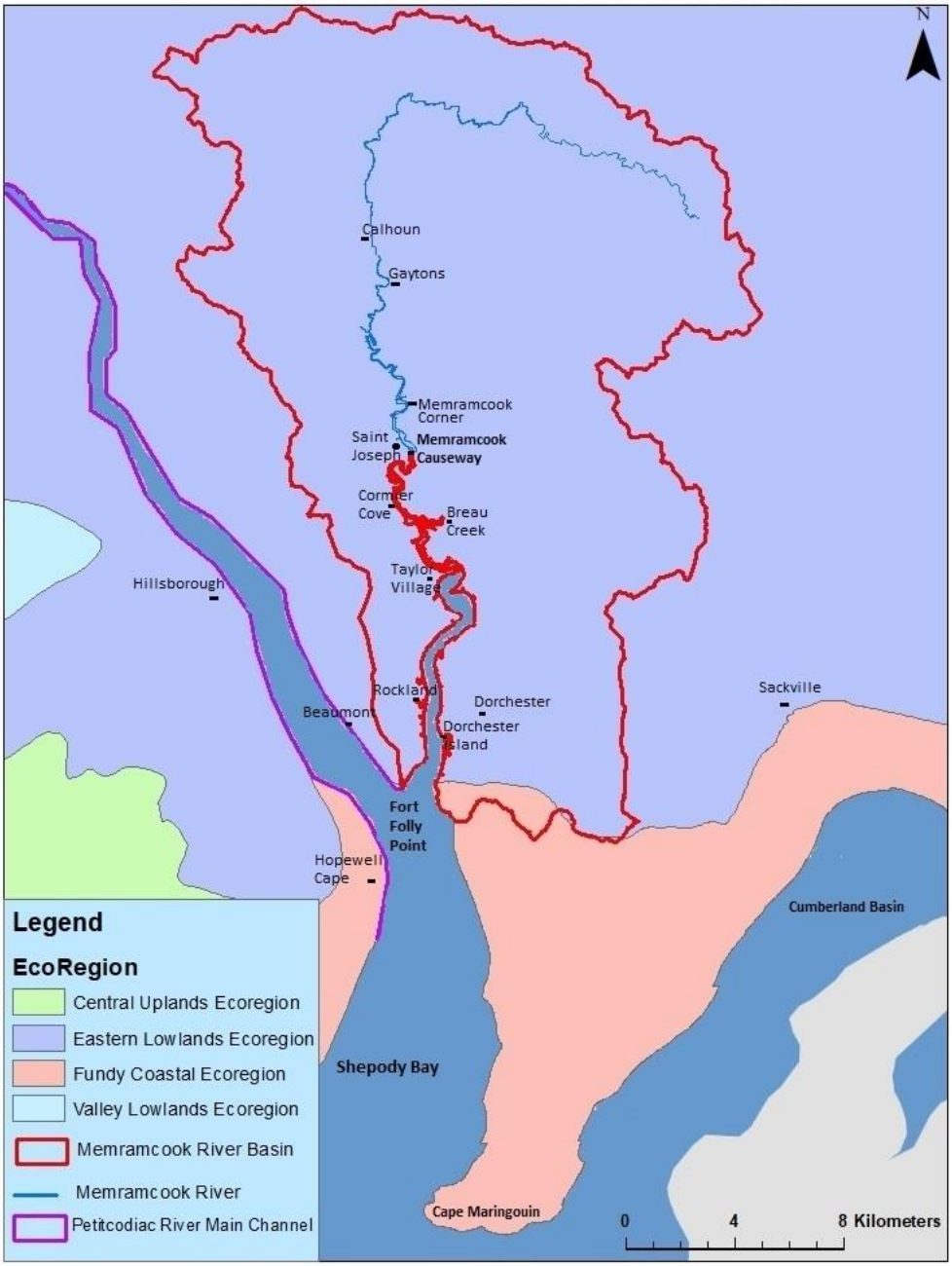

Figure 1: The Memramcook Watershed

(New Brunswick Department of Natural Resources 2007). The only exception is a small portion on the east bank at its mouth which falls within the Fundy Coastal Ecoregion. A causeway constructed in 1973 (Wells 1999) closes off the river 19.4 km above its mouth (cover: lower photo). The headpond above that causeway extends another 15.8 km up to the head-of-tide at Calhoun, just north of the Trans Canada Highway.

The upper valley is dominated by forest (cover: upper photo), while much of the lower valley is made up of marshland growing on tidal deposits overlaying a sandstone base. Large tree stumps 3,500 to 4000 years old have been found at the base of these layers surprisingly well preserved (Bowser 1986). This suggests the marshes themselves are perhaps 4000 years old, formed as tidally transported sediments inundated the valley in response to rising sea levels after the last ice age (Miller 2010). The Petitcodiac estuary (into which the Memramcook River flows) has a high natural suspended sediment load, typically around 30,000 milligrams per litre (mg/L) (AMEC 2005). To better grasp this, 30,000 mg is 30 grams (i.e., slightly more than 1 ounce) of sediment per litre of water. The primary source of this sediment is coastal erosion within the Bay of Fundy driven by the massive tides there (Plint 1986; Schell 1998; Haralampides and Rodriguez 2006). The banks and tidal flats along the estuary have accumulated a large store of this silt and clay and it is easily suspended and redistributed (Bray et al. 1982). The agricultural potential of this soil (once dyked and provided with adequate drainage) is what originally proved so attractive to Acadian settlement (Wynn 1979).

The dominant land uses within the watershed are forestry and agriculture. Approximately 79% of the watershed is forested, of which 64.8% is small private woodlots, 32.7% is industrial freehold forest land owned by J.D. Irving, and 2.5 % is crown land. Approximately 11.7% of the watershed has been converted to agriculture, 29% of which is being used to grow crops or grains, 32% pasture, and 1% blueberries (New Brunswick Department of Natural Resources 2014).

The name Memramcook itself is derived from the Mikmawísimk (Mi'kmaq language) name "Amlamgog", which (Ganong 1896) wrote as Amlamkook, meaning "all spotted yellow", or "variegated". For those unfamiliar with the latter term, it is defined by the Cambridge Dictionary (2020) as "having a pattern of different colours or marks- hence "all spotted yellow". It isn't immediately obvious how that might relate to the river, or even that it does directly. Rayburn (1975) suggests that the name may have first applied to Pink Cove on Cape Maringouin (Figure 1) in Shepody Bay about 15 km south of the mouth of the river, where the rock has variegated colours, was then applied more broadly to the area, and eventually the river itself. Early French maps refer to Shepody Bay as "Baie de Memoramkok" (Le Rouge 1755, Sartine 1778), There is a widely held local misconception that Memramcook means "crooked river", and it is unclear how or when this idea originated.

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First Level Assessment – Land Use History of the watershed

An understanding of the historical land use helps to explain the underlying causes of issues present today. The sections which follow outline the history and land use both within the Memramcook River watershed, and in the surrounding communities in both Westmorland County and across the Petitcodiac in Albert County (Figure 1). Table 1.1 outlines historic milestones along the populated portions of the Memramcook valley from Calhoun to Fort Folly Point where it empties into Shepody Bay.

Table 1.1: Brief historical background for communities along or near the Memramcook River

(Prior to 1995 when many were amalgamated to form the Village of Memramcook)

Community	Settlement Type and Dates	Notes
Breau Creek (Pointe au Bouleau)	Settled: c.1698 Pierre Gaudet Farming	**1698** First European settlement in Memramcook watershed under grant from Acadian Governor Villebon- Concurrent with Pierre Thibodeau at Chipody (Shepody), and Guillaume Blanchard at Village des Blanchard (Hillsborough) on the Petitcodiac. **1753** First church built in the valley **1755** Church burnt during Acadian Deportation (Grand Dérangement) **1898** Post Office, Population 200
Calhoun (Dungiven)	Settled: Not Available	
Cormier Cove (L'Anse des Cormiers)	Settled: c.1786 Pierre "Pierrott" Cormier Farming	**1786** Cormier and extended family return to the Memramcook from exile in Sainte-Anne (near Fredericton) displaced from there by newly arriving Loyalists carrying title to their lands **1809** Cormier et al. displaced as tenant farmers after legal dispute with Des Barres over terms of their lease
Dorchester (Dorchester Corner)	Settled c.1774 John (Andrew) Weldon	**1773** Weldon arrives from Yorkshire **1787** Named Dorchester by Loyalists in honour of Sir Guy Carleton, first Baron Dorchester **1801** Dorchester made Shiretown of Westmorland County
Dorchester Island (Botsford Island)	Settled c.1755 Amos Botsford	**1784** Amos Botsford and other Loyalists arrive **1802** Ship building begins at Ayers yard **1840** New Public wharf built **1874** Branch line connecting to railroad
Gaytons	Settled c.1809 Patrick Gayton (Keating)	**1809** Gayton, thought to have arrived from Ireland prior to 1800 acquired title to 300 acres on the Memramcook.
Hillsborough (Village des Blanchard)	Settled c. 1698 Guillaume Blanchard Re-settled 1765 Henry Steeves	**1698** Acadian Settlement (Village des Blanchard) **1755** "Battle of Petitcodiac" village cleared during Acadian Deportation (Grand Dérangement) **1765** German settlers arrive from Pennsylvania (named German Village) **1840** Renamed Hillsborough, Post Office **1866** Albert Mining company **1871** Seaport, Port of Entry, Post Office, Station on Salisbury and Hillsborough Railway, 8 stores, 2 hotels, 1 tannery, 1 carriage factory, population 700 **1966** incorporated as a village
Memramcook (Memramcook Corner)	Settled c.1700	**1700** Likely a satellite community to Pointe au Bouleau (Breau Creek)
Saint Joseph (Village des Piau)	Settled c.1730 Pierre "Petard" Cyr Re-settled c.1769 Pierre "Piau" Belliveau	**Pre-European** Mi'Kmaw Village **1730** Acadian Settlement (Butte à Petard) **1755** cleared during Acadian Deportation (Grand Dérangement) **1769** Acadian Re-settlement (Village des Piau) led by Belliveau after release from Fort Edward at Pisiguit (Windsor Nova Scotia)
Sackville (Pré des Bourgs)	Settled: 1680s Re-settled c.1763	~**1685** Acadian settlement (Pré des Bourgs) **1755** cleared during Acadian Deportation (Grand Dérangement) **1763** Resettled by New England planters from Rhode Island **1772** Arrival of Yorkshire immigrants **1837** Post Office **1839** Mount Allison University established **1871** Population 1,500 **1898** Seaport, Port of Entry, Post Office, Junction on Intercolonial Railway, Headquarters of the New Brunswick and Prince Edward Island Railway, 24 store, 3 hotels, 2 iron foundries, 3 boot and shoe factories 4 harness manufacturers, 1 foundry and machine shop, 2 woodworking factories, 1 electric light and telephone plant, 3 carriage factories, 2 sawmills, 2 tanneries, 1 grist mill, 8 churches, population 2,500. **1903** Incorporated as town
Taylor Village	Settled c.1774 George Taylor Farming	**1774** Taylor arrives From Yorkshire **1853** Post Office **1871** 25 Resident Families, Population 100 **1898** Post Office, 1 store, 1 church , Population 200

(Source: Provincial Archives of New Brunswick, 2020)

1.1 The Mi'kmaq (up to 1632)

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), noting 60 to 80 in the Chignecto region (Goodrich 2020). Physical impacts on the watershed were few compared to what was to follow.

Ganong's (1899) map (Figure 1.1) of known First Nations villages and campsites includes a Mi'kmaq summer camp site near the mouth of the Memramcook at Beaumont (on the Petitcodiac River side of Fort Folly point). A second Memramcook encampment is reported to have been near the mouth of Leblanc Creek (Saint Joseph) on the site of what is now Le Foyer Saint Thomas, an assisted living complex for senior citizens (Kristmanson 2004). This would be a logical location for such an encampment as the ridge dividing Leblanc Creek on the Memramcook side from Belliveau Creek on the Petitcodiac side is locally referred to as "le portage" (Gautreau, personal communication, 2019), and offers a shorter trip from the mouth of Leblanc Creek on the Memramcook River to the Petitcodiac than the long way around Fort Folly Point, considering how incoming tides might impede downstream movement.

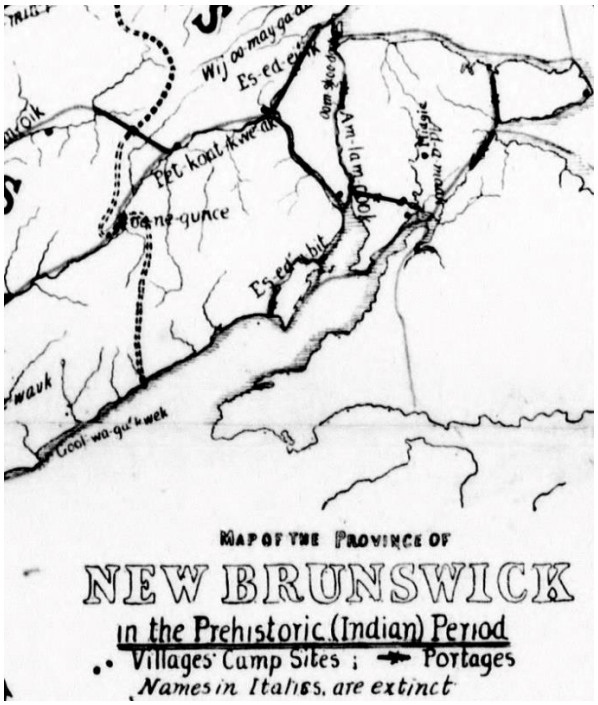


Figure 1.1: Known First Nations villages and portage routes (Ganong 1899)

That said, such tides could certainly be used to one's advantage as well. A native leaving Beaumont (or from the mouth of Belliveau Creek) could ride the 13 km per hour tidal bore upstream on the Petitcodiac River greatly facilitating travel upstream (Petitcodiac Heritage River Committee 2000). Ganong (1899) reports an encampment further along the Petitcodiac at the mouth of Halls Creek (which now delineates the border between Moncton and Dieppe). Leonard (2001) indicates that this was part of a portage route that went up Halls Creek (or alternately up Humphreys Brook) to access the Shediac River (Ejetdaik "goes way back" in Mikmawísimk (Ganong 1896)), and on to the Northumberland Strait. Going overland here facilitated travel from the Bay of Fundy to the Gulf of Saint Lawrence, avoiding the obviously impractical alternative of circumnavigating mainland Nova Scotia.

Similarly, Ganong (1899) reported yet another encampment at the head of tide on the Petitcodiac in what is now Salisbury (near the mouth of the Little River) close to the ends of a pair of portage routes leading to the Saint John River system. The more highly traveled of those two routes crossed from the main stem of the Petitcodiac River to the Canaan River (Ganong 1899) downstream of 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 the Anagance River to the Kennebecasis River (and from there to the lower portion of the Saint John River system).

Unless ultimately headed west to the Saint John River, travel to the Petitcodiac was not the only option available to those within the Memramcook itself. A shorter portage route to Shediac Bay and the Northumberland Strait was available simply by ascending the main stem of the Memramcook itself, beyond the mouth of Meadow Brook to cross over to the Scoudouc River. This Memramcook route provided yet another connection between communities in Esedabit (Shepody Bay) and Ejetdaik (Shediac Bay) (Leonard 2001), though low flow during the summer would have limited its usefulness.

Counterintuitively, what was probably the most significant portage in the Memramcook watershed begins not in its headwaters as is usually the case, but near its mouth instead. Ganong (1899) identifies a portage route that connected Shepody Bay to the Cumberland Basin (Figure 1.1). It went up Palmer's creek and then followed Ayers brook crossing the ridge into Big Brook, down into Carter's Brook and emptying into the Tantramar River at what today is Sackville. This route facilitated overland travel between peninsular Nova Scotia and the rest of the mainland by simplifying access to the Petitcodiac (and by extension on to the Saint John). Otherwise, one would be forced to contend with substantial tides while traveling the long way into Shepody Bay by going around Cape Maringouin. The location of the summer camp at Beaumont (Fort Folly Point), near the mouth of Palmer's creek, probably stems directly from the importance of this portage route.

The choice between the Petitcodiac route and the Memramcook route to Shediac Bay would have been dependent upon time of year, where one was starting from, what one was carrying, and where one was ultimately headed. Arguably the Petitcodiac was likely to be most attractive to those already on the Petitcodiac, or those headed to the Saint John River. Those in Shepody Bay or beyond would have benefited from the option to ride the tidal bore on the Petitcodiac to the mouth of Halls Creek, which would have helped to significantly shorten that route, leaving the remaining overland portions of the various portage routes to Shediac Bay much more comparable to the one on the Memramcook. Meanwhile if coming from (or headed to) the Cumberland Basin or peninsular Nova Scotia, then those headed to the Saint John River (or even on to the Saint Lawrence River) would want to use the

Petitcodiac, while those headed to Shediac or points further along the Northumberland Strait might (if traveling light) have found it simpler to head directly up the Memramcook to access Shediac Bay.

Regardless of route chosen, Leonard (1996) notes evidence of an extensive trade network using these various portages with artifacts made of stone from quarries in the Minas Basin and Washademoak Lake found in a site at the mouth of the Shediac River. Copper was also an important commodity for Mi'kmaq who lived along the Northumberland Strait and in the Gaspé and was available from the lower Saint John River, and the Bay of Fundy where there is significant evidence of local extraction and production of artifacts (Leonard 1996). Collectively the portage routes linking Shepody Bay and the Cumberland Basin to Shediac Bay or the Saint John River would have been among the most practical ways of trading between them (Ganong 1899; Ganong 1899; Leonard 2001).

First contact between Europeans and Mi'kmaq in the area was not well documented. The Bay of Fundy is recognizable as early as 1558 on a map by Portuguese cartographer Diego Homem, which appears to be the earliest surviving evidence of European knowledge of its existence (Pomeroy 1878). Homem himself was not an explorer, instead he compiled his maps based on charts and reports provided by Portuguese and French fishermen who were pioneering discovery in the region (Kohl 1869). Homem's map shows two branches of the Bay of Fundy, what we now call the Minas Basin and Chignecto Bay. Their location appears to be too far north, but that they were recorded at all at that time demonstrates more knowledge of the area than might have been assumed without such documentation.

In 1604 Pierre Duga de Mons led an expedition mapping the head of the Bay of Fundy with the assistance of Royal Cartographer Samuel de Champlain (Heidenreich and Ritch 2010). The previous year, King Henry of France had awarded Duga de Mons the exclusive right to colonize lands in North America between 40 and 60 degrees of latitude, named him Lieutenant General for Acadia, and granted him a monopoly on the fur trade in those territories. Champlain records in his memoirs how this was a follow up on earlier explorations up and down the coast by French Merchants, in particular- Jean Sarcel de Prévert (Pomeroy 1878). Prévert had reported contact with local peoples in an area Champlain interpreted to be "the cape between two bays" (now Cumberland County between Chignecto Bay and the Minas Basin). According to Prévert, his men had encountered people there who showed them a copper mine. In the summer of 1604 Champlain and Duga de Mons briefly explored Chignecto Bay looking for evidence of this mining community, coming close to the mouth of the Petitcodiac, but eventually moved on with no record of any contact in the area. Leonard (1996) indicates that the mine in question was likely part of a community at what is now Cape D'or, Nova Scotia. Once eventually found, that led to the name "Les Mines" for the shoreline there, later becoming known as the Minas Basin (Hamilton 1997). Meanwhile the explorers passed a difficult winter on St. Croix Island (on what is now the Border between Maine and New Brunswick) and the next spring moved across the Bay of Fundy (called at that point Baie Française) to found Port Royal in the summer of 1605.

Considering the degree of mobility exhibited by native people noted above with regard to their use of portage routes and evidence of trade, it is likely that though the French presence was limited in the decade or so that followed, Mi'kmaq living in the Memramcook region would have become aware of these newcomers relatively rapidly. Traders seeking furs provided a source of new and otherwise difficult to obtain goods readily incorporated into the existing trade networks- particularly since pursuing such trade was one of the primary objectives of the initial French settlement.

Port Royal was destroyed in 1613 during a raid led by Samuel Argall, an Englishman based out of the Virginia colony (Coleman 1967) and from 1613 to 1632 "Acadia" was under the control of the English who called it "Nova Scotia". This set off a series of claims and counter claims to the region, but in reality during this time very few French inhabited the region, and even fewer British (Martin 1995). The interior tended to be a matter of relative indifference to both crowns which were far more interested in the coastlines due to the massive revenue generated by exporting the bounty of their respective fisheries to Europe (Cunnigham and Prince 1976; Janzen 1996). Likewise, New Englanders regarded the shores and seas surrounding Acadia as an extension of New England, and access to the region as their birthright (MacNutt 1970). First Nations peoples remained by far the primary inhabitants of the region, especially as far away from Port Royal as the Memramcook valley, though diseases related to contact such as smallpox had already begun to exact a toll (Marble 1993).

1.2 The Acadians (1632 to 1763)

In 1632 the treaty of St. Germain-en-Laye returned Acadia to France (Coleman 1967) and forty-two Scottish settlers at Port Royal were deported to England by Isaac de Razilly. This is the point when the French began to make a serious effort to colonize Atlantic Canada, arriving in numbers significant enough to develop an enduring Acadian identity that overlayed their French heritage (Laxer 2006). Acadian settlements became self-sustaining communities (Martin 1995) at a fairly similar time frame to what was occurring in the English colonies further south.

The colony itself continued to be traded back and forth between the French and English crowns, but the resident Acadian population persisted and grew, remaining largely ambivalent in the face of shifting sovereignty (Faragher 2005). The population spread out thinly, somewhat to the consternation of colonial authorities who preferred colonists in more densely settled communities industriously producing sustenance for officials, soldiers, and licenced traders. This led one French bureaucrat to advise that inhabitants should be compelled to live at Port Royal, "for scattered as they are they are neither useful nor profitable", an attitude which by itself does a lot to explain why life further away from Port Royal might have become more attractive to many than remaining nearby.

By 1671 expanding Acadian settlements had reached Chignecto, with the arrival from Port Royal of Jacques Bourgeois and his extended family and founding the Village of Beaubassin (Cormier 1969; Faragher 2005). A generation later in 1698 Pierre Gaudet and his family were the first Europeans to settle on the Memramcook at "Pointe au Bouleau" (near Breau Creek) as part of a coordinated effort authorized by then French Governor Villebon for Acadian expansion into the Shepody, Petitcodiac, and Memramcook rivers (Rumilly 1981; Bowser 1986). The Memramcook was the third arm of the "trois rivieres", the other two being the more well-known settlements by Pierre Thibaudeau (Cormier 1969) who homesteaded at "Chipoudie" (Shepody), and Guillaume Blanchard (Hody 1969) at Village des Blanchard (Hillsborough) on the Petitcodiac River (Griffiths 2004).

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).

The Treaty of Utrecht in 1713 at the end of Queen Anne's War once again officially transferred "Acadia" to Britain though what was actually included in that concession was poorly defined (International Boundary Commission 1934). 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 Acadians of the "trois rivieres" were thriving precisely because they were under the jurisdiction of neither Great Britan 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.

One thing the treaty did clearly spell out was the right of Acadians to leave peninsular Nova Scotia and move to French Territory within one year, and in the process sell their lands and retain all their possessions (Marshall 2011). However, Francis Nicholson, the new British governor, denied Acadians the right to sell their land or take livestock with them (McCully 1969). He did so to discourage them from relocating to French territory, particularly Île Royale (Cape Breton) – fearing that those doing so would help build a massive new French fortress (Louisbourg) the construction of which was reported to be getting underway there. He likely also recognized that the region would be of little value without its hard-working population (Martin 1995). Despite such disincentives many Acadians did leave British held territory, and in the years following the fall of Port Royal the "trois rivieres" in French territory became a sanctuary for those Acadians who found it increasingly difficult to live under British occupation (Marshall 2011). Joseph Broussard, known as "Beausoleil" became a prominent leader of Acadian resistance to the British (d'Entremont 1974), and was part of this exodus, moving from Annapolis Royal to the Petitcodiac River in 1730 to settle at Le Cran (Stoney Creek, Albert County).

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.

Faced with expanding British activity, Joseph Broussard gradually shifted further upstream, founding Village de Beausoleils (Boundary Creek, Westmorland County) in 1740, a short distance below the head of tide (between what today is Salisbury and Moncton). During the turbulent years that followed he went on to lead successful attacks based out of the French controlled "trois rivieres" crossing the Memramcook valley back and forth likely making relatively frequent usage the portage up Palmer's Creek (which the Acadians called Ruisseau de Port Royal (Bowser 1986)), on his way into British controlled territory in Nova Scotia. He kept at this for what amounted to decades of continuous conflict: King Georges War (1744-1748), Father LeLoutre's War (1749-1755), and eventually the armed resistance to the expulsion of the Acadians during the Seven Years War (1756-1763) (Marshall 2011).

In 1745, in the midst of King George's War the Fortress of Louisburg was captured by a combined force of British Navy and New England Militia (Pritchard 2011). This prompted a little known (for reasons that will shortly become apparent) yet massive response (for the time) by the French. They sent the largest fleet ever assembled up to that time, across the Atlantic with orders to recapture Louisburg, take back Port Royal and all of Acadia, and to go on to burn Boston (Boileau 2017). It was an armada of 64 ships with almost 11,000 men - 7,300 sailors and 3,500 marines and artillery, under the command of the Duc d'Anville (Jean-Baptiste-Louis-Frederic de la Rochefoucauld de Royce). Plans called for this fleet to meet up at Chebucto ("big harbor" in Mikmawísimk – the name for the Bedford Basin in what is now Halifax) with another Naval squadron based out of French holdings in the West Indies. There they were to be met by an additional 700 soldiers from Quebec under Jean-Baptiste Nicholas Roch de Ramezay sailing to Baie Verte and coming overland from there, as well as 300 Abenaki from the Saint John River and 300 Mi'kmaq from Nova Scotia, and Father LeLoutre and Beausoleil with their Acadian Militia (Marshall 2011). Altogether the French intended to assemble approximately 15,000 men for the purpose. This, at a time that Statistics Canada (2020a) suggests that the Acadian population (men, women, and children) of peninsular Nova Scotia totaled about 13,000 people. The Duc d'Anville expedition was a highly ambitious undertaking, and an unmitigated disaster.

Essentially everything that could go wrong with the passage did (Pritchard 2011). There were storms that caused some ships to collide and yet also dispersed the fleet over a wide area. There were calm seas that slowed movement to a crawl. There were outbreaks typhus and typhoid with an estimated 2,000 deaths at sea (Marshall 2011). By September 1st the Duc d'Anville's fleet was weeks overdue. Only 16 of d'Anville's ships reached Chebucto by September 21st, and a week later the Duc d'Anville himself died there. Shortly there after his second in command was either murdered or committed suicide. The Captains from the West Indies never reached Chebucto to rendezvous, having encountered difficulties of their own (Pritchard 2011). Eventually a total 44 of d'Anville's ships arrived. In the weeks that followed another 2,000 men died of disease, and hundreds more were gravely ill. The remaining French decided to withdraw but lacked sufficient men to crew all their ships or even bury the dead, so sank 5 ships to prevent the British from taking them and departed Chebucto in the remaining ships on October 24th leaving beaches scattered with hundreds of corpses (Pritchard 2011). French victories in Europe in 1747 led to peace, and much to the consternation of the New Englanders who had captured Louisburg (MacNutt 1970), it was returned to France in 1748 in exchange for removal of French forces from the Netherlands (Boileau 2017).

At first glance one might conclude that the failed expedition was simply a wasted effort that changed little in the greater scheme of things and is hardly worth mentioning. The final scope of this disaster only became apparent months after the hundreds of Mi'kmaq warriors who gathered at Chebucto to meet

the expedition had come into contact with their diseased allies. Once infected, these men then went home and spread sickness throughout the region, bringing with them woolen blankets for their families that had been given as gifts, but which had also become unintentionally contaminated with typhus (Pritchard 2011). Estimates suggest that between one third (Haliburton 1829) and three quarters (McCreath and Leefe 1982) of the Mi'kmaq population died during the winter of 1746 to 1747.

Prompted in part by the use of Chebucto by the d'Anville expedition, in June 1749 Edward Cornwallis arrived there to establish 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. Unlike Acadians who dyked and farmed the marshes, English settlers tended to seize land the Mi'kmaq valued, to clear the forest for agriculture (Francis et al. 2010). 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 Authorities in Louisburg seized on the opportunity to stir further trouble through their network of Priests. Beausoleil's ally Father LeLoutre was the most prominent of these (Finn 1979), such that this turbulent period of undeclared warfare is known as Father LeLoutre's War (1749-1755). In response to Cornwallis, Louis Chevalier de la Corne was sent from Quebec in October 1749 with hundreds of men and announced that he had, "taken possession of the northern shore of the Bay of Fundy for his master the King of France" (MacNutt 1970). He organized militia companies at Chipoudie, Petitcodiac, Memramcook and fortifications along the Missaquash (Russ 1974). Amid the ensuing violence, in April 1750 LeLoutre and his men burned the Acadian Village of Beaubassin and forced its approximately 1,000 inhabitants across the Missaquash River to the French side (Leonard 2001; Marshall 2011). The British proceeded to fortify their side of the river, building Fort Lawrence, named for Colonel Charles Lawrence, who commanded the operation (Graham 1974).

In 1751 the French began to build Fort Beausejour at the border on their side of the Missaquash. A wooden palisade named Fort Gaspereau was also built at Baie Verte along with a road to aid the portage route to provide Beausejour with supplies and ammunition shipped from Quebec or Louisbourg (Leonard 2001). Prior to this point weapons and munitions had been mostly shipped through a French military supply depot in Shediac Bay, and been sent up the Shediac River, portaged along a road to Halls Creek, on to the Acadian settlement at Le Coude (Moncton), and then down the Petitcodiac (Leonard 2001). Development of such physical infrastructure indicates that the French preferred that route over the Scoudouc to Memramcook portage, at least for heavy cargo such as munitions. That isn't surprising as the upper reaches of the Memramcook can become quite shallow during the summer, limiting that route's usefulness for canoe traffic during what would otherwise be some of the best weather for such work. Meanwhile going up the Petitcodiac, express couriers were capable of delivering messages from Fort Beausejour via the Saint John River to reach Quebec City in as little as 7 days (Pote 1896). To do so they followed what Le Rouge (1755) termed the "Chemin de Quebec" – the road to Quebec- accessing the Petitcodiac by the Palmer's Creek (Ruisseau de Port Royal) portage to the Memramcook (Figure 1.2).

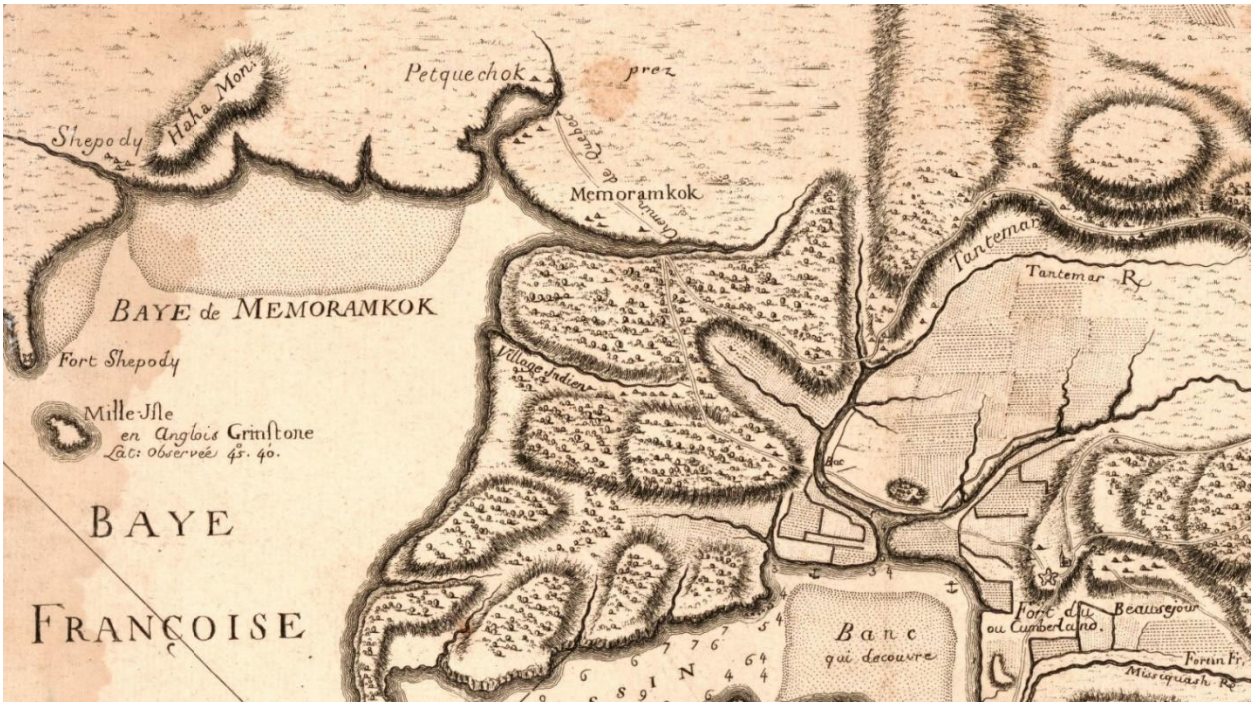


Figure 1.2: Map of the area around Fort Beausejour G. L. Le Rouge (1755).

By this point the Acadian population near Fort Beausejour had grown to 1,541 people, much of who lived in a small village that ringed the fort itself (Larracey 1985; Martin 1995). Many were Beaubassin refugees, who provided a cheap source of labor for construction of both Fort Beausejour and Fort Gaspereau (Marshall 2011). An additional 1,100 Acadians were spread out at Shepody and along the Petitcodiac and Memramcook Rivers (Census of Acadia 1752). Of these, on the Memramcook there were 51 families recorded as residents (consisting of 243 people: 50 men, 46 women, 65 boys and 82 girls). There are not separate listings on the Memramcook for Butte à Petard (Saint Joseph) and Pointe au Bouleau (Breau Creek). However, there were Hébert and Sire (Cyr) families recorded as part of the Memramcook population and these were known to have lived at Butte à Petard. Consequently, it seems likely that as a satellite community, Butte à Petard was combined with Pointe au Bouleau in the Census and the two listed collectively as Memramcook. A further 45 people living in the Memramcook Valley were described as refugees, a mixture of families and individuals: 15 men, 8 women, 11 boys and 11 girls. Combined this made for an Memramcook Acadian population of 288 people, 16% of who had apparently been displaced from elsewhere. Also noteworthy in Figure 1.2 is the "village indien".

Acadians fleeing the violence in peninsular Nova Scotia (Milner 1911), increased the population on the French side of the Missaquash, though as the burning of the Village of Beaubassin demonstrated, not all of these displaced people made the move voluntarily (Finn 1979; Marshall 2011). LeLoutre reportedly often threatened Acadians reluctant to cooperate with him with excommunication or with attack by his Mi'kmaq allies (Martin 1995). As they had done elsewhere, the Acadians built dykes and tidal control structures turning marshland into pasture and established their settlements nearby (Wright 1955). On the Memramcook the growing population likely helped promote construction of the first church in the valley near Pointe au Bouleau (Breau Creek) in approximately 1753. Tradition has it that devout Mi'kmaq from Beaumont would paddle up the Memramcook on the incoming tide to attend services at

the chapel (Bowser 1986). It is said to have been situated near the eastern bank of the Memramcook, a short distance from where the Rockland Bridge was built over a century later.

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.

Fort Beausejour fell to the British on June 16th, 1755 , taken by a combined force of 270 British Army Regulars and 2,000 New England militia under the command of Lieutenant- Colonel Robert Monckton (Steele 1979; Marshall 2011). This was the first major action by British forces before what became known as the Seven Years War (1756 to 1763) had even officially been declared and was actually the only British victory during a year with a string of British defeats in North America. The attack itself was an "unauthorized" action engineered in Boston by the Governor of Massachusetts, William Shirley with the aid of Charles Lawrence (Graham 1974) who by then had become the Lieutenant Governor of Nova Scotia. After the fort was taken, many of the local inhabitants surrendered their arms, including the prominent partisan Beausoleil (Steele 1979)

Shortly there after the British attempted to expel the Acadians. Lawrence himself issued the deportation order August 5th, with the stated objective of preventing Acadians from provisioning the Fortress of Louisbourg but was clear as well about ambitions to make the land available for English settlement. As early as August 6th Acadians at Annapolis Royal were already being rounded up and arrested (Marshall 2011). Monckton sent out couriers to each of the villages along the Petitcodiac, Memramcook, and Missaquash Rivers calling for all Acadian men to come to Fort Cumberland (Beauséjour) on August 11th to discuss an oath to the British Crown (Gaudet 1899). Being unaware of events elsewhere, Acadians here had no reason for concern (since similar oaths had typically been requested during previous transitions between French and British rule), and so close to 400 men did as they were told. These were seized, charged with rebellion, and imprisoned (Vaudreuil 1755; Marshall 2011). Troops were then sent out to round up their families, and both Fort Cumberland and Fort Lawrence became prison camps.

Acadians took flight, entire families fleeing deep into the forest (Marshall 2011). Settlements further away from the fort such as those on the Memramcook tended to be far apart- with villages often being groups of 3 to 5 houses of extended families (Shoebottom 2000). The first major expedition Monckton sent into the "trois rivieres" consisted of 184 men led by Major Joseph Frye , an amphibious operation in order to avoid marching overland and exposing the force to attack while crossing either the Memramcook or Petitcodiac Rivers. They departed Fort Cumberland August 28th and burnt houses and the church at Chipoudie and surrounding hamlets shortly there after, capturing 30 women and children (Willard 1930). From there they moved up the Petitcodiac bypassing the entrance to the Memramcook, as settlements there were mostly on the eastern side of the river a direct 20 km overland march from Beausejour, and could be visited later, without exposing themselves to the vulnerability a river crossing.

On September 3rd despite orders to not to subdivide the force, 70 men came ashore at Village des Blanchard (Hillsborough) which they referred to as "Petitcodiac" and found it to have been completely

evacuated. However, as they started to burn the church they came under fire from positions in the surrounding forest and after three hours of fighting were forced to retreat to their boats (London Magazine 1755; Willard 1930; Shoebottom 2000). This resistance was organized by Charles Boishébert, a French officer leading a force of 125 Acadians and Mi'kmaq. Reports of English casualties vary from 22 dead and 7 wounded (Thomas 1879) to 42 dead and 45 wounded (Vaudreuil 1755) the latter of which is improbable as it exceeds the size of the English force put ashore. To be fair, the British also overestimated the size of the opposing force they faced (Speakman 1755) suggesting it to have been something like 300 men. However there seems to be agreement from several sources (Vaudreuil 1755; Pote 1896) that Joseph Gorham, a Ranger from New England (Charters and Sutherland 1979) was among the English wounded. This indication that he was present on the day, is noteworthy, given the role he would play in the area later. Boishébert's forces suffered one dead and 3 wounded. Following the battle, he and his men aided 30 Acadian families from Village des Blanchard to escape to the Saint John River (Leblanc 1979). The British learned a lesson, and on the next raid on September 15th to Gaspereaux and Aulac, Colonel George Scott brought with him a much larger force of 300 men (Shoebottom 2000).

During skirmishes over the next several weeks dozens of resistance fighters were caught and imprisoned at Fort Cumberland, including Beausoleil and one of his sons. However, by October 1st he'd tunneled out and escaped along with 86 other prisoners (Marshall 2011). It was fortunate for him that he did, as on October 13th 10 ships departed the Cumberland Basin escorted by an armed vessel to transport 960 Acadian prisoners from the Beausejour district, bound for Georgia and North and South Carolina (Thomas 1879).

On November 17th, 1755 Scott marched 700 men from Fort Cumberland through the night to "Memramcook" – i.e., Pointe au Bouleau (Breau Creek), following the overland route from the Cumberland Basin and arriving at the break of dawn (Thomas 1879). Such a large-scale movement of men would have been quite a feat at that time, as the route was hardly more than a footpath through the woods (Bowser 1986). Once there, they surrounded about 20 houses. All except one were deserted, in which they found 9 women and children (Thomas 1879). Bowser (1986) suggests that Acadians in Memramcook benefited from their close relations with the Mi'kmaq, who may have warned them of approaching soldiers, easy to imagine as the approach of such a massive column (despite moving relatively quickly) would likely have been impossible to conceal. Scott's men reported burning 30 buildings some of which were presumably out buildings - barns etc. The church at Pointe au Bouleau is thought by some to have been burned at approximately this time as well, and so may have numbered among these structures. But since the church's fate was not mentioned by Thomas (1879), Bowser (1986) speculates that it may have been demolished later, reporting that timbers salvaged from the ruins of the chapel were thought to have been later used in construction of a barn in Upper Dorchester. Regardless, Thomas (1879) reports that the troops were finished by about 10 am, and marched back to Westcock (arriving at about 7 pm) with 200 head of cattle, 20 horses, and one woman as a prisoner. Considering the number of people and animals moving along the route (probably the largest movement of men and animals along it all at once up to that time) the path would likely have been correspondingly widened somewhat in the course of this action.

The ability to conduct this Memramcook operation by an overland march and thus avoid a vulnerable river crossing appears to have been central to Scott's plan. Butte à Petard (Saint Joseph) lay approximately 3 km away from Pointe au Bouleau as the crow flies, but on the opposite side of the Memramcook river. The 20 houses reported surrounded is less than what would accommodate the

aggregate 51 households resident in the valley (Census of Acadia 1752), but could easily account for Pointe au Bouleau, consequently it seems reasonable to conclude based upon the description in Thomas' (1879) diary, that Butte à Petard was not attacked during this incident. However, it likely wasn't spared for long as the Memramcook region was targeted by at least three such expeditions during the fall and early winter (Leblanc 2018). In their last raid the British came within several kilometers of an encampment from which 80 families had just fled but were unable to see their tracks due to a cover of fresh snow (Gagnon 1889). Given the approaching winter, capturing people may not have been the aim. Gillcash (1984) notes that on the Memramcook there were no reports of the wholesale loading of population onto ships. Instead, she identifies some similarity to tactics used against the Scottish during the Highland Clearances – with homes burnt and livestock seized in an attempt to simply drive people away.

Most of the troops brought in from New England either returned home or were sent to Halifax shortly there after (Willard 1930), leaving only a small garrison to defend Fort Cumberland for the winter of 1755 to 1756. Britan declared war on France the following year on May 17th, 1756, and with that the Seven Years War began in earnest (Marshall 2011). British losses in New England, and a concentration of military effort in Pennsylvania and New York during the subsequent two years left the garrison at Fort Cumberland (Beausejour) with insufficient strength to complete the expulsion locally (Shoebottom 2000). In all, 1,014 Acadians were transported from Beaubassin and the "trois rivieres" (Leblanc 2018), leaving roughly two thirds of the population. This, together with an influx of Acadians fleeing from elsewhere left the region with a larger remnant Acadian community than peninsular Nova Scotia where the majority of Acadians were expelled or fled. The garrison at Fort Cumberland had sufficient combat capacity to hold the fort but could do little to project force beyond its walls (Shoebottom 2000).

During this time Beausoleil received authorization from French authorities in Québec to outfit a small vessel as a privateer (sanctioned piracy was a common military strategy at the time) and was successful raiding British shipping in the Bay of Fundy (d'Entremont 1974). Meanwhile, in the spring of 1756 Pierre "Piau" Belliveau led a flotilla of small refugee boats across the Bay of Fundy and finding the British already in control of the mouth of the Saint John, sought shelter on the Petitcodiac. After the expulsions had begun at Annapolis Royal the previous summer, he and his family had fled the Annapolis Valley and endured a difficult winter 1755 to 1756 in the woods on an island in Saint Mary's Bay near what is now Church Point (Gaudet 1899; Murray 2017).

In Cocagne, French officer Charles Boishébert had begun operating Camp de Belair (Leonard 2009) a refugee camp that housed numerous Acadian families (including Piau and his family as well as the extended family of Beausoleil) fleeing the violence on the Petitcodiac and the Memramcook via the portage routes to Shediac Bay (Marshall 2011, Leblanc 2018). The population of Camp de Belair grew to more than 2,000 people, well beyond its capacity, and was feared to be quite vulnerable, given its proximity to the British at Fort Cumberland. Consequently, Boishébert decided to relocate further north, establishing Camp L'Esprance on the Miramichi by August 1756. Refugee camps on Île Saint Jean (Prince Edward Island) also absorbed some of this overflow. During the summer of 1756 Boishébert reported that a further 1,000 Acadians were still hiding in the woods of the "trois rivieres", of which something like 250 expressed plans to move to Camp L'Esprance, though it is unclear how many of these eventually did so (Leblanc 2018). The fishery on the Miramichi was abundant, and the hope was that by using this resource combined with aid shipped by sea from Québec (which could reach them there more easily than it could on the Saint John River), these refugees would be able to make it through the

impending winter. However, of the 1,400 thought to be at the camp nearly one third ended up dying the first winter 1756 to 1757 that the camp was in operation (Leblanc 2018), including Beausoleil's wife, Agnes (Marshall 2011).

The Fortress of Louisbourg fell in July 1758, and by November of that year efforts to expel Acadians on the Petitcodiac were stepped up, led once again by George Scott (Scott 1758). Acadians had retreated into the forest, occupying locations in the upper Petitcodiac estuary such as Fourche-à-crapaud at the mouth of Turtle Creek, and on the Coverdale (Little), and Pollett Rivers to be near the head of tide and above the reach of English Ships. The Memramcook was outside the focus of this effort, as being relatively close to Fort Cumberland the settlements there had already long been depopulated and reduced to rubble. Scott apparently found the tidal bore on the Petitcodiac challenging during his raids, nearly losing two ships on one occasion (Pincombe and Larracey 1990). None-the-less Scott's men eventually managed to reach and destroy Village Victuare (Salisbury), reportedly the largest Acadian village on the Petitcodiac upstream of Village de Beausoleils (Boundary Creek).

With post-war era on the horizon, the British authorities began to erect a legal framework to preserve the new order they were creating (Mancke 2019). In 1758 during its first sitting, the Nova Scotia Legislature passed "An Act for confirming Titles to Lands and Quieting Possessions" which specifically stated that no "no Papist hereafter shall have any right to Title to hold, possess, or enjoy any Lands or Tenements, other than by virtue of a Grant or Grants from the Crown" (Fletcher 1767). The logical extension of this came with the Nova Scotia Legislature passing in 1759, "An Act for the Quieting of Possessions to the Protestant Grantees of the Lands formerly occupied by the French Inhabitants, and for preventing vexatious Actions relating to the same" (Fletcher 1767). These pieces of legislation had two purposes (Mancke 2019). The first was to prohibit attempts by Acadians to recover title to lands by making it illegal for courts to hear cases brought for that purpose by former French inhabitants. The second was to encourage immigration from New England by settlers who would otherwise be wary of moving hundreds of kilometers north to lands which Acadians might have legal rights to recover from them.

To that end Governor Lawrence posted a proclamation in the Boston Gazette in October 1758 advertising his willingness to receive proposals from settlers seeking to move to Nova Scotia, in order to populate and cultivate lands seized from Acadians (Lawrence 1758). In January 1759 his government released its land grant policy (Lawrence 1759), offering "quantities of land in proportion to the abilities of settlers to plant, cultivate, or enclose" in addition to 100 acres of "wild woodland" to every head of household, with an additional 50 acres to be granted for every "White or Black man Woman, or Child of which such Person's Family shall consist". While family size was being made a consideration this also clearly meant an additional 50 acres were being offered to white heads of households in exchange for every black person (slave) brought into the colony. Though the economic model being imported from the New England colonies was not that of a slave centered society, slavery did exist there and prospered in coastal towns and throughout scattered agricultural settlements (Whitfield 2009). This is not to say that slavery was a uniquely English institution, as the French colonial authorities practiced it as well. The population of Louisbourg included 266 slaves between 1713 and 1758 (Donovan 2004), brought mostly out of French holdings in the West Indies, though slaves were also traded between Louisbourg and Halifax, after the latter was established in 1749. English settlers do not appear to have brought slaves into the Memramcook valley at this time, but several slaves are thought to have been working nearby lands in the Chignecto region at Aulac as early as 1760 (Raymond 1903).

With the capture of Québec in September 1759, the war was essentially over in Atlantic Canada. Seeing little point in continuing to hold out further, many Acadians, both at Camp L'Esperance and the families who remained scattered in the woods across the "trois rivieres" surrendered to Joseph Frye (who was now the commander of Fort Cumberland) in the autumn of 1759 and on into 1760, signing a treaty of neutrality and pacification. After doing so they were transported to Halifax, where they were kept in military work camps until the end of the war in 1763 (Gaudet 1996; Faragher 2005). There they built civil infrastructure and repaired the dykes essential to marshland agriculture, as captive labourers to facilitate and support the arrival of the incoming wave of New England Planters arriving from English colonies to the south. Among these Acadians were Piau Belliveau and his family (Bowser 1986; Murray 2017).

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.

1.3 The New England Planters (1763 to 1784)

The Treaty of Paris in 1763 ended the Seven Years War, with France ceding its territory in Canada and the Maritime region to Britan, 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).

In much the same way that the various levels of government had begun dividing up land amongst themselves, the process of allocating lands to private individuals (proclaimed by Governor Lawrence in 1758) progressed through grants by the crown. Among the lands being granted to attract settlers from New England were those awarded to former military officers discharged following the end of the war. One of the two most significant grants on the Memramcook was allocated to Joseph Gorham, noted here previously for his participation at the Battle of Petitcodiac (Hillsborough), though he saw action all over the region with notable actions at Louisburg, Québec, Lunenburg, and Cape Sable (Charters and Sutherland 1979).

As a military officer Gorham was awarded 20,000 acres on October 5th, 1765 (Ganong 1899). The description of his grant was as follows, "beginning at the southernmost point between the rivers Petitcodiac and Memramcook," i.e. Fort Folly Point, " and running the course of the river Petitcodiac eleven miles to a marsh", today known as Downing Creek, "thence east until it meets the river Memramcook in the west boundary of lands granted to Richard Bulkeley, Esquire; thence the course of

that same boundary and the same river until it meets the first mentioned boundary," at Fort Folly Point, "containing in the whole by estimation twenty thousand acres more or less (Kerr 1895). Given the clear natural boundaries, that is a quite readily recognizable parcel, as it accounts for most of the point of land between the Petitcodiac and the Memramcook rivers. Of those 20,000 acres, roughly half (i.e 10,000) lie within the Memramcook watershed, all of the west bank from Fort Folly Point to a short distance below the mouth of Smith Brook, quite some distance upstream beyond what had been Butte à Petard (Saint Joseph) prior to the expulsion of the Acadians.

The east bank of the Memramcook (as noted above) had previously been granted to Richard Bulkeley on May 13th, 1765, and that grant was likewise for 20,000 acres (Ganong 1899). Richard Bulkeley was at the time both a councillor and the Provincial Secretary of Nova Scotia (Blakeley 1979). Lacking the clear natural boundaries that defined Gorham's grant, Bulkeley's holdings are not as easily visualized. However, based upon its size, and the lack of a boundary with another grant holder mentioned in Gorham's description, it is reasonable to conclude that Bulkeley's grant likewise extended down to the mouth of the Memramcook. That interpretation is consistent with Bowser (1986). Given the east bank of the Memramcook as its natural boundary, there is easily enough room within the Memramcook watershed east of that to accommodate the entirety of the Bulkeley grant. This would include everything from the mouth up through Pointe au Bouleau (Breau Creek), and on well upstream beyond Memramcook Lake.

The Memramcook watershed is approximately 390 km^2 (New Brunswick Department of Natural Resources in 2014) which translates to roughly 96,371 acres. Not only did these two men collectively receive 30,000 acres within the watershed (approximately 30% of it), but between them, they held the entirety of the watershed that had attracted any significant settlement and development up to that point in time. The 70% or so that remained further upstream was essentially uninhabited forest. Even today, the vast majority of the population in the watershed lives within the area of these two grants.

British conquest did not result in rapid settlement- only lands vacated by exiled Acadians were quickly occupied (MacNutt 1970). New Englanders were attracted to the Chignecto region by Lawrence's favorable description of lands formerly cultivated by Acadians (Wynn 1979). Twenty families of New England Planters settled Amherst in 1761 (Trueman 1902) in what had been the Acadian village of Les Planches (Hamilton 1997). Two years later another twenty-five families from Rhode Island settled Sackville in 1763 at Pré des Bourgs (Milner 1967), the Cumberland Basin end of the Palmer's Creek portage route to the Memramcook. By 1765 both were formally recognized as townships. However, many New Englanders did not stay for long (Trueman 1902, Wynn 1979).

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 region (Statistics Canada 2020b).

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. This was a policy that met with some success, as despite struggling for years to avoid deportation, in 1764 Beausoleil and his remaining family and friends chartered a boat and sailed for the French West Indies, eventually settling in Louisiana (Marshall 2011). 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.

Neither Gorham, nor Bulkeley were homesteaders with the intent to develop their massive tracts of land themselves. They were clearly part of a landed elite administering the new order. The expectation of the Crown in issuing such large grants was to promote settlement of the Province by having officers such as these attract tenants, with an eye towards an end result much like the great estates in England (Ganong 1899). The settlement conditions of such grants required that tenants be found to develop the land within a certain period of time, otherwise the land would revert back to the Crown under a legal process called escheat. Like these two, many British officers went on to try their hand as such entrepreneurs (Evans 1969), and land was not only the most available commodity, but also the most common symbol of social status. One problem with this approach to development was that it tended to attract speculators who planned to rent land to tenants, let them develop it and improve its value, and then sell it as developed land at a high price to incoming immigrants (MacNutt 1963). Perversely, such an atmosphere proved to be a deterrence for settlers. In the northern colonies of British North America freehold tenure by small scale homesteaders working their own land was the accepted norm, and only marginalized individuals would settle for the insecure status of tenants.

After the peace in 1763, Gorham's Ranger unit was disbanded, and so in addition to using his connections to get grants of land he sought positions in the Nova Scotia government. Gorham had hoped to become Lieutenant Governor but lost that position to Michael Francklin. Ultimately Gorham received an appointment to the Council, and the position of deputy agent for Indian affairs in the province (Charters and Sutherland 1979). His financial situation worsened, and he amassed large debts such that even after selling most of his property except for his land grants (which he mortgaged) he remained in arrears. Bulkeley by comparison appears to have had fewer struggles and been more successful than Gorham at transitioning from military to life as a civilian administrator, maintaining his position (and income) as Provincial Secretary for decades to come (Blakeley 1979).

At the time, landlords in colonial North America were faced with the challenge of developing their estates in an environment where land was plentiful, labour was in short supply, and agricultural markets were weak (Hornsby 2011). There is abundant evidence in newspaper advertisements from the time that many grantees made vigorous efforts to obtain settlers by offering significant inducements (Ganong 1899). This is also the point with the earliest concrete evidence of slavery in what is now New Brunswick as the 1767 census recorded two slaves brought in from New England, living at Hopewell (not far from Chipoudie / Shepody) near the mouths of the Petitcodiac and the Memramcook Rivers (Raymond 1903). Halifax was largely impractical as an agricultural market for Fundy settlers because Chignecto's only overland connection to the capital was by bridle path and blazed trail (Wynn 1979). This route passed through what is now Truro, involved multiple river crossings, was poorly marked, and

time consuming (Cunningham and Prince 1976). A shorter hybrid alternative passed overland to the Minas Basin, then used the Partridge Island Ferry to cross to Windsor, after which the road to Halifax improved considerably (Clarke 1995). Water-borne trade to Windsor, Halifax, Boston or beyond provided only a meagre and unreliable outlet for agricultural produce from the region (Robinson and Rispin 1774).

In 1768, noted cartographer and fellow British officer J.F.W. Des Barres assisted Gorham in populating his grant by arranging for the settlement of 25 Acadian families on the west bank of the Memramcook at the mouth of Leblanc Creek amid the ruins of what had been Butte à Petard (Hornsby 2016). These settlers included Pierre "Piau" Belliveau and his extended family and friends, founding what became known as Village des Piau (Saint Joseph), following their internment in work camps during the years after the war at Fort Edward in Windsor Nova Scotia (Bowser 1986; Société d'histoire de Memramcook 1994; Murray 2017). Being originally from the Annapolis Valley, this was not a return to their original homes (which had by this time been occupied by Planters arriving from New England), but amounted instead to starting over and making new lives for themselves on the Nova Scotia mainland (modern New Brunswick), an adjustment experienced by many Acadians. For marginalized individuals such as these, tenancy was more of an opportunity than a deterrence (MacNutt 1963).

After a decade with little to no immigration during the 1760s, between 1772 and 1775 Lieutenant Governor Michael Francklin managed to attract approximately 900 immigrants from Yorkshire to settle in Cumberland County (Campey 2014), effectively doubling the population. Yorkshire families that could afford to purchased land from New Englanders who had decided to return south (Trueman 1902). Others, such as George Taylor became tenants (Gillcash 1984). Taylor arrived in 1774 and settled within Gorham's grant, founding Taylor village on the west bank of the Memramcook. The same year, another Yorkshireman John (Andrew) Weldon, settled on the east bank of the Memramcook in what is now Dorchester, on the land where the Penitentiary now stands (Milner 1967).

At the same time, in 1774 Gorham applied for and received a ten-year extension on his settlement grants (Charters and Sutherland 1979). He was noted as a heavy drinker at this time, the debilitating effects of which may have contributed to his financial woes. As news spread of the outbreak of armed rebellion at Lexington and Concord on April 19th, 1775 people in New England took it as a battle cry and rapidly began to challenge the British garrison in Boston (Kidder 1867). Gorham was probably thankful for the opportunity to re-enter military service, with revolution breaking out in the southern colonies. His plan for raising a corps of volunteers was quickly approved, and in June 1775 he had agents recruiting in Boston, Nova Scotia and Newfoundland for his unit, the Royal Fencible Americans. By March 17th, 1776 the British were forced to withdraw from Boston , and evacuate loyalists to Halifax, nearly doubling the population there (Clarke 1995). In May 1776 the Fencibles were made the garrison for Fort Cumberland, with Gorham was installed as its commander. The fort had been abandoned in 1768 and its troops redeployed to Halifax. On July 4th, 1776 the 13 colonies issued their Declaration of Independence. With the advent of the American Revolution, Fort Cumberland took on renewed strategic importance, coming to be viewed as key to defending the Province of Nova Scotia against invasion by an army approaching overland (Hollingsworth 1787). Significant repairs were required to the barracks and the eroded earthworks in order to make the fort both habitable for the winter and defensible (Martin 1995). Gorham's men were not much better off than the fort itself- ill trained and poorly equipped – lacking uniforms and half of them without shoes on their feet (Clarke 1988). Upon

seeing them one British officer laughed, “The Fencibles not being all clothed look so much like Yankees that [the prospect] of doing [service] with them gives me [the] Horrors”.

Focusing his efforts on military matters at this time may have been part of what motivated Gorham to finally agree to part with his large Memramcook grant, selling to J.F.W. Des Barres on April 15th, 1776 (Gorham 1776). Given the involvement of Des Barres 8 years previously in arranging for Piau and his family to settle as tenant farmers on the same property (at what is now Saint Joseph), it is likely that some sort of deal between Des Barres and Gorham had been in the works in one form or another for some time prior to that. The land had been valued £7,500 by the sheriff when Gorham had been facing escheat, but Des Barres paid him a fraction of that, just £1,100, plus £100 in fees (Gorham 1776).

It is worth noting that at this time this finger of land Gorham had owned, located between the Memramcook and the Petitcodiac, projecting into Shepody Bay appeared on maps (Figure 1.3) then as “Point Gilbert” (Des Barres 1777). Several decades later, Wilkinson (1859) referred to it on his map as Fort Folly Point. Some authors attribute the Eddy Rebellion, the local manifestation of the American Revolution, as the origin of its modern name (Rayburn 1975, Bowser 1986). Local tradition suggests that Eddy and his men temporarily fortified the point during their failed efforts to capture Fort Cumberland during the fall of 1776, and that since that period the location has been known as Fort Folly Point (Bowser 1986). Ganong (1896) observes that the name Folly in association with a point, “likely expresses the view of neighbours of an unfortunate venture”, such as Eddy’s failed rebellion.

Shortly prior to Eddy seizing “Point Gilbert” in October 1776, Gorham established an outpost there with 15 men in early September (Clarke 1995). Though Gorham had sold his land to Des Barres earlier the same year, he none-the-less considered “Point Gilbert” strategically vital to the defence of Fort Cumberland, as those factors which had led the Mi’kmaq to use the point as the site of their summer encampment at Beaumont still applied. That location was the critical link between movement along the Petitcodiac (both to and from points beyond via the portages to the Saint John) and up Palmer’s Creek on the Memramcook to the Cumberland Basin (which by extension included the approach to the fort itself). Gorham’s interest in regulating travel along this corridor was two-fold: protecting Fort Cumberland from advancing rebels, and simultaneously keeping his own men from deserting, by barring their easiest overland route back home - up the Petitcodiac to the Saint John (Clarke 1995). The latter was not an idle concern, as despite such precautions Gorham ended up losing more men to desertion (9%) than to death (6%) through combat or other causes. The officer in charge of the outpost, John Walker, was a veteran of the region- having served with Gorham in July 1758 at the capture of Louisburg, and on Scott’s expeditions in November that same year expelling Acadians from the upper Petitcodiac.

Gorham’s outpost at “Point Gilbert” had its desired effect. News that it had been established shut down efforts by local rebel organizer Samuel Rogers who had spent a good portion of the summer of 1776 trying to build a road along the portage route through the woods between the Saint John and the Petitcodiac along which he’d hoped to bring an army from New England to attack Fort Cumberland (Clarke 1995). The goal of such individuals was to bring Nova Scotia into the American Revolution as the 14th rebel colony. The rebels hoped that by seizing Fort Cumberland, and by extension the isthmus, they could split Nova Scotia in half, making it that much easier to take control.

With the Petitcodiac route effectively closed, when the attack came, it came up the Bay of Fundy instead, and involved the arrival of something less than an army. Eddy brought only 72 men with him: 20

Figure 1.3: Fort Folly Point as Point Gilbert in Des Barres (1777) Atlantic Neptune

from Machias, 9 from Passamaquoddy, 27 the Saint John River, and 16 Maliseet. Jonathan Eddy was an expelled member of the Nova Scotia House of Assembly, a New Englander and like Gorham, a veteran of Monckton's 1755 attack on the fort when it had been Fort Beausejour (Rawlyk 1983). He knew the fort well, having been stationed at Fort Cumberland from May 1759 to September 1760. After being discharged from the army in 1760 Eddy had been one of those settlers who bought land in the Cumberland Basin near Sackville and by 1763 moved there with his family as part of the wave of New England Planters (Porter 1877). Among the government jobs Eddy held after moving to Cumberland County was Deputy Provost Marshal, described by some authors as the County Sheriff (Williamson 1832). Given the time period and the small size of the local community, this begs the question to what extent Eddy and Gorham's past history may have overlapped and perhaps even somehow included the sheriff's threatened escheat of Gorham's Memramcook land grant?

The authorities in Halifax were aware of the risks Eddy and Rogers posed. During late 1775 and early 1776 Eddy in particular seemed to be obsessed with precipitating a major insurrection in the colony as quickly as possible (Rawlyk 1983). In May 1776 the Nova Scotia Council had offered a reward for the capture of Eddy and Rogers "dead or alive" (Clarke 1995). By August another of their collaborators living near Fort Cumberland, John Allan, was likewise a hunted man (Stewart 1983). Fleeing south, while Allan was in Machais he heard that Eddy and his men were in town recruiting "on their way to Cumberland" and met with them to try to convince them of the folly of their expedition (Clarke 1995). Allan having met with the Mi'kmaq, was already aware that they were unwilling to aid the rebels against the British.

Eddy who at that point had only the 20 men he'd managed to recruit in Machias, was counting on such assistance as essential to his plan. Allan "took every step and used every argument to dissuade him, but all to no effect". Eddy was convinced that in addition to the aid he would recruit along the way, once he arrived at Chignecto the countryside would rise up, with not only the local Planters but the Acadians and Mi'kmaq flocking to join the cause. His hopes were built upon the assumption of being able to multiply the size of the force he arrived with several times over by drawing on the local population. Things did not work out that way.

Eddy seized the outpost at "Point Gilbert" on October 29th, 1776 with little trouble- losing none of his men in the process and taking 14 prisoners- John Walker was wounded, and one of the Fencibles was killed (Clarke 1995). At that point however the die was cast- Gorham was going to notice that he had lost communication with his outpost and so soon or later would realize that something was afoot. Eddy divided his small force. One party went past the fort to the far side of the Tantramar to block communication with Windsor, and to spy on the fort. A second party, including the Maliseet traveled north to Cocagne to recruit among the Mi'kmaq there. A third group held "Point Gilbert" guarding the prisoners. Meanwhile Eddy led the main detachment into the Memramcook valley to recruit amongst the Acadians living there.

Eddy would later admit himself that while the Acadians "listened attentively… they saw the weakness of our party". He eventually gained only 21 Acadian recruits, but that was much more than the 4 Mi'kmaq who joined him after meeting his emissaries in Cocagne (Clarke 1995). It is not difficult to imagine the reasons for the low turn out in either case. Rebuilding their lives after enduring several costly decades of war, both the Mi'kmaq and the Acadian communities valued their neutrality and likely felt they had little to gain by helping one side or the other. This was a fight between the English, the rebels led by Eddy and the loyalists led by Gorham- both New Englanders, both veterans of and victors in the previous conflict

which had ended a little more than a decade earlier, now squabbling over how to manage the spoils. The Acadians and Mi'kmaq probably recognized that regardless of how this current dispute ended, their interests were unlikely to be made a priority by the winner.

Eddy's spies reported back to him that HMS Juno was unexpectedly at anchor in the Cumberland Basin below the fort, having escorted a supply ship, the Polly to provision the fort for the winter. Nothing could be done while the warship was there, which ruled out a rapid surprise attack. Hoping that the ship would sail quickly, Eddy redoubled his efforts to conceal the presence of his force- disarming local inhabitants and confining them in their homes to secure the countryside (Clarke 1995). Next Eddy marched his detachment along the overland route through the woods to Sackville to recruit amongst the Planters there. He was eventually joined by 88 Planters from the Cumberland Basin, and another 9 who traveled from Pictou to join him.

HMS Juno set sail November 3rd, and Gorham only became aware of Eddy's presence on November 4th, slightly less than a week after "Point Gilbert" had been seized. Understandably he assumed that the size of Eddy's force was larger than it was, as it would have been folly for anyone to attempt what Eddy was doing without enough men to pull it off. Over the weeks that followed, Eddy's force lay siege to Fort Cumberland, and managed to take control of and terrorize the countryside. Unlike the Planters, who being from New England included many rebel sympathisers, the Yorkshire settlers in Chignecto had only arrived from England a few years earlier, tended to be loyal to the Crown, and as a result were singled out for bad treatment. In the end, as he had been warned, Eddy's diverse assembly of 186 rebels were inadequate to dislodge Gorham and his superior force of 268 Royal Fencibles from their fortified position. This, despite the latter being themselves a ragtag force defending what had only shortly before been a deserted military ruin (Clarke 1995). News of Eddy's activities reached Halifax, and on the 15th of November orders were issued to transport troops from Windsor to break the siege. On the morning of November 29th HMS Vulture put ashore a combined force of 150 Royal Marines and Royal Fencibles who scattered Eddy's men, putting an end to the affair.

This turn of events also spelled the end of the revolutionary movement in the Chignecto. An exodus of rebels and their families, some 300 people fled south. Those who remained behind made peace, accepting a pardon that Gorham offered to all except the ringleaders (Clarke 1995). John Allan meanwhile was made an infantry Colonel and given authorization by the Continental Congress organize yet another expedition (Stewart 1983, Dallison 2003), with the goal of taking western Nova Scotia (now New Brunswick). Though this effort reached the Saint John River Valley in the summer of 1777, it did so with fewer than 100 men, and encountered an unreceptive population there. In the end Allan should have heeded his own advice. He fared little better than Eddy and retreated back to Machias in what is now Maine. Though unsuccessful, the participation of Mi'kmaq and Maliseet in the siege of Fort Cumberland in 1776 highlighted the vulnerability of Nova Scotia and prompted the Crown to enter into what became the final round of Maritime Peace and Friendship Treaties in 1778 and 1779, reaffirming the previous treaties (Patterson 2009).

The Revolutionary War ended with yet another "Treaty of Paris", this one on January 20th, 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 Memramcook. 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 Memramcook valley. 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).

In anticipation of the coming peace, in the fall of 1782 Amos Botsford had been appointed agent for the Lloyd Neck Associated Loyalists in New York and given a commission by Sir Guy Carleton (commander in chief of British forces in North America) to travel to Nova Scotia and arrange with Governor Parr for settlement of refugees expected to arrive the following year (Snowdon 1983). Botsford arrived in October 1782 with the advance group of New York Loyalists and spent the months after making an extensive survey of the Bay of Fundy and the Saint John River. Their report was published in the New York Royal Gazette on Mar 29th, 1783 and was enthusiastically received.

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 as well (Wright 1945, Milner 1967, Bowser 1986).

Botsford arrived at Fort Cumberland in 1783 with authority to open up "lands immediately west of Sackville Parish" i.e., the Memramcook Valley (Cunningham and Prince 1976). For himself he selected "Botsford Island" (today known as Dorchester Island), on the Memramcook River near Folly Point (Bowser 1986), at the confluence of Palmer's Creek and the river. Along with "Botsford Island" he received 44 acres of marshland and 217 acres of upland property located beyond the marshes. The "island" is known as such because it is a high point of land (that rises to 30 metres above sea level) surrounded by marshes (Figure 1.3). Prior to the modern dyke network these were occasionally inundated during the strongest tides, at which times it truly became an island (Bowser 1986). These holdings all fell on the east bank of the Memramcook, within what had been the 1765 Bulkeley Grant (Ganong 1899). It is unclear if Botsford purchased this land but seems possible given his connections that it was granted directly to him (Bowser 1986), suggesting that underutilized lands initially granted to Bulkeley may have already reverted to the crown through escheat.

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 Botsford (Snowdon 1983) and others, and was a key factor driving calls

for partition (Gilroy 1933). Edward Winslow, another 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).

1.4 New Brunswick (1784 to 1950)

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 Memramcook valley falling within what became Westmorland County (Ganong 1901). Thomas Carleton (Sir Guy Carleton's brother) arrived in November 1784 to establish the new government and direct the colonization of New Brunswick (Fellows 1971). Botsford received the appointments of clerk of the peace, judge of the Inferior Court of Common Pleas, and registrar of deeds for the newly created county (Snowdon 1983). The House of Assembly was elected in 1785, and Botsford won election as the local representative, and was chosen as the speaker during the first session of the House January 3rd, 1786.

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 New Brunswick Provincial Archives record Amos Botsford as receiving title to Botsford Island and surrounding lands from the crown October 16th 1786, under Grant 86 (Provincial Archives of New Brunswick, 2020). However, he had already occupied it for several years prior to that point, building the first house on the "island" in 1784 a mansion constructed from locally quarried stone (Bowser 1986). The grant in 1786 was required to ensure clear title within the newly established province. Likewise, 19 other owners received land nearby at the same time under Grant 86 (Provincial Archives of New Brunswick, 2020) accounting for 5,213 acres. Gideon Palmer, for who Palmer's Creek was subsequently named, received title to much of the land through which Palmer's Creek flows as part of the same Grant. The same day, another 17 owners did likewise under the adjacent Grant 87 (accounting for another 4,520 acres). These included John Weldon who had as noted previously had occupied the land where the penitentiary now stands since shortly after his arrival from Yorkshire in 1774. Together Grant 86 and Grant 87 allocated roughly half of the area that had been under the Bulkeley grant.

Botsford appears to have been the first to build a house on the "island", though reportedly a public wharf was already present prior to his time there (Bowser 1986). Good harbourage for vessels was available on both the Memramcook River and the Palmer's Creek sides of the "island" (Bowser 1986). As a harbour this site was in fact superior to conditions at Fort Cumberland, where craft had to remain at anchor in the Bay or enter a little creek at high water. This may have been one reason why the earlier Acadian name for Palmer's Creek had been Ruisseau de Port Royal.

Unlike the Bulkeley Grant (east bank of the Memramcook), on the west bank of the Memramcook, the Goreham Grant which had been sold to J.F.W. Des Barres in 1776 remained intact (Provincial Archives of New Brunswick, 2020). Des Barres, a naval cartographer, was an absentee landlord when he purchased it, having returned to England in 1773 to supervise publication of *The Atlantic Neptune*, a four-volume atlas compiling his nautical maps and charts of the east coast of North America, produced for the British Admiralty (Morgan 1987), and the source of Figure 1.3. He left management of his lands in the hands of his mistress, Mary Cannon, who lived with their five children on another of his estates, "Castle Frederick" (near Falmouth Nova Scotia). In 1776 Des Barres had appointed Cannon his agent and attorney with "full Power and Authority" over all his colonial properties, which at that point including the Memramcook covered 80,000 acres in Nova Scotia (Kernaghan 1981).

She was responsible for visiting each estate regularly, noting the progress of settlement, the number of livestock and the extent of agricultural improvements, as well as arranging tenant's leases, collecting rents, and forwarding all details to Des Barres (Kernaghan 1987). Rent collection was difficult, as given the scarcity of money at the time, payment was expected in livestock and produce which could then be resold at a profit (Kernaghan 1981). The Memramcook land was largely dyked and required constant care. Agricultural expansion was dependent upon enlargement of the drainage systems, and although her Acadian tenants were skilled at this work, it was expensive and laborious. The Memramcook estate was large, and a challenge to manage given its distance from Falmouth. By 1782 she managed to simplify this process somewhat by granting Charles Baker, who lived more locally, power of attorney to manage affairs in the Memramcook holdings. Among her tenants were Piau Belliveau and his descendants, who had been recruited by Des Barres to settle Village des Piau (Saint Joseph) in 1768 (Société d'histoire de Memramcook 1994), and George Taylor from Yorkshire who had established Taylor Village in 1774 (Gillcash 1984).

Yet another tenant, Pierre Cormier, founded the village of Cormier Cove in 1786 (White 1983). Prior to the fall of Fort Beausejour, Cormier and his family had lived on the French controlled side of the Chignecto Isthmus near Aulac. They fled to Quebec from 1761 to 1764, and by 1765 had returned south to Sainte-Anne (near Fredericton) to live with his mother and brothers. By July 1783 Cormier had cleared 20 acres there that he had farmed continuously for 13 years, however he did not have title to that land, and he and his family were displaced by Loyalists arriving with newly awarded grants that gave them legal claim to it (White 1983). Learning of vacant land available to tenants amid growing Acadian communities on the west bank of the Memramcook, they and about 20 families resettled there between the autumn of 1786 and summer of 1787.

When Nova Scotia had been partitioned in 1784, it was simultaneously split three ways, with Cape Breton also made an independent colony. Given his familiarity with the region, Des Barres was appointed as Governor of Cape Breton (Evans 1969). He returned to North America to take up his office in late 1784 and Mary met him in Halifax prior to his departure for Sydney and their relationship appeared as amicable as ever (Kernaghan 1981), with their sixth child resulting from the visit. Things became more complicated in late 1785 with the arrival of Martha Williams in Sydney along with her offspring by Des Barres during his years in England. Des Barres held the post of Governor for about 3 years, eventually returning to England in 1787, and became increasingly eccentric concerning his colonial properties (Kernaghan 1987). He rarely answered letters, failed to forward necessary legal papers, and provided little instruction or advice.

By 1790 Des Barres' tenants began applying to the Crown for individual grants on the land they were occupying on the Memramcook estate (Kernaghan 1981). It turned out that Mary Cannon had failed to properly re-register the grant Des Barres had purchased from Goreham, following the partition of New Brunswick from Nova Scotia in 1784. Consequently, no documents could be found to confirm Des Barres' ownership, despite the fact Mary Cannon had been collecting rents and financing agricultural improvements on the properties for nearly 20 years. On June 5th, 1792 Cormier and others presented documents to the New Brunswick government complaining of the extravagant demands of Mary Cannon, and arguing that the land should be escheated and awarded to them, given the substantial improvements made during their occupation (White 1983). This case between Mary Cannon and the tenants remained tied up in courts for decades to come, with Amos Botsford serving as Des Barres' Attorney dealing with the case for much of that time (Bowser 1986).

A significant if unintended consequence of this drawn-out legal battle and uncertain land tenure was the opportunity for the rebirth of an Acadian community within the Memramcook valley, coalescing around nuclei on the west bank such as the tenant hamlets of Village des Piau (Saint Joseph) and l'Anse aux Cormier (Cormier Cove) (Surette et al. 1981). Bowser (1986) notes that relatively few Loyalists settled in the Dorchester area compared to along the Saint John and other localities. Freehold tenure by small scale homesteaders working their own land was the accepted norm throughout British North America, and only marginalized individuals would settle for the relatively insecure status of tenants (MacNutt 1963). With Des Barres large estate on the west bank, many Loyalists, and English settlers that arrived after them went elsewhere attracted by the availability of grants with clear title to land and so were drawn to the Petitcodiac and further up into its more remote tributaries (Wright 1945).

Not everyone found opportunity, however. In January 1792, a little more than eight years after arriving in the region, fed up with unequal treatment, a little over one third of the black loyalists departed on a fleet bound for Africa to found Sierra Leone (White 2019). Individuals who had been fortunate enough to receive land had typically found it to be less fertile and more remote than that allocated to white Loyalists. The slightly less two thirds of black Loyalists who chose to remain petitioned the Crown for additional provisions comparable to what had been provided to the fleet bound for Africa (Blucke 1792). Meanwhile those who remained slaves obviously were not free to make such a voyage.

Nova Scotia was also dissatisfied the state of affairs. In 1792 the Assembly called for restoration of Nova Scotia's territorial rights through "an alteration in the division line between this and the neighboring Province of New Brunswick." (Allison 1916). The proponents rejected use of the Missaquash River, which had cost Nova Scotia significant and valuable land in Chignecto. Instead, they proposed adoption of one of three alternate lines they found preferable presented in order diminishing advantage to Nova Scotia:

I. A line up the Petitcodiac River to the head of tide (near Salisbury) then north to the head of tide on the Restigouche river. This line roughly corresponded to the boundary between the old Nova Scotia counties of Cumberland and Sunbury and would have left Nova Scotia and New Brunswick nearly equal in area, with the difference still somewhat in New Brunswick's favor.

2. A line going up the Memramcook River to the head of the tide at Calhoun and from there north to Cocagne Harbor.

3. A line going up the Aulac River to its head, and then by a given compass line to the Northumberland Strait. This boundary would have kept all of Cumberland township within Nova Scotia.

They stated the Memramcook River was their preferred option for a new border (Allison 1916). Ganong (1901) notes that this would not have been an unreasonable boundary, intended to retain within Nova Scotia the old settlements of New England Planters and Yorkshiremen at the head of the Bay of Fundy, whose affiliations were more with Nova Scotia than the newly arrived Loyalists in the Saint John Valley. The other two options were mostly likely just part of the negotiation process since the first would have given Nova Scotia the entire Northumberland Strait up to Quebec (and clearly wasn't going to happen), and the third offered little real difference from the existing border along the Missaquash. New Brunswick countered that those who drew the existing Missaquash border had known precisely what they were doing, as it was, "the most natural boundary that could be pointed out between the two provinces, its whole length being less than 17 miles, and the part with any uncertainty not exceeding one-fifth of the distance, and that through wilderness land". The British authorities eventually agreed with New Brunswick and left the Missaquash border as it was. However, it is not difficult to imagine that had the Memramcook become the border between Nova Scotia and New Brunswick, that such a change would almost certainly have had profound and lasting influences on how development proceeded along the river.

Ease of communication with the outside world was a vital consideration, and the wharf at Botsford Island became a bustling place, rivaling Fort Cumberland as a shipping point, due to its superior harbour (Milner 1967, Bowser 1986). The first developed road was not to Dorchester Corner (where the old Jail now stands along modern Rt 106) but to the "island" and from there headed east along the west side of Palmers pond. Another factor favoring such development was that in addition to his many other positions and responsibilities Botsford was appointed as the Provincial Commissioner of Highways from 1785 to 1800, and he pioneered the opening of the road from Botsford Island to Sackville roughly following what must be noted had been the long-established Palmer's creek portage route.

Botsford's stay on the "island" was relatively brief. In 1790 he moved 10 miles (16 km) to Westcock, just outside Sackville (Bowser 1986). In 1797 he sold the "island" including the stone mansion to "Commodore" Elijah Ayer Jr. Ayer, it is worth noting was a brother-in-law to Jonathan Eddy, and had himself been one of Eddy's rebels during the siege of Fort Cumberland 20 years earlier (Clarke 1995). Ayer encouraged settlement on the "island" and became Dorchester's first shipbuilder (Bowser 1986). He constructed a shipyard and wharf near the southeastern end of the "island". One the first vessels completed was a small schooner named "Hope" launched in Palmer's creek in 1802.

In 1801 the Westmorland County Courthouse and Jail burned to the ground (Goodrich 2012). These structures had been built years earlier at Westmorland Point, a loosely settled area near Fort Cumberland (Milner 1967) and once presented with the need to rebuild, other communities felt themselves better candidates as locations to do so. Both Dorchester and Sackville were nominated as potential successors as the new shiretown (county seat) of Westmorland County. In the end Dorchester won because while like Sackville it had the benefit of being on main road from Saint John to Nova Scotia, it also provided easier access for those living in western parts of the County on the west bank of the Petitcodiac such as Hillsborough and Hopewell Cape, now in Albert County (Bowser 1986). A ferry connection existed linking Dorchester and Hopewell Cape as early as 1797 (Goodrich 2013). An additional consideration was that John Keillor, a Yorkshire settler (Milner 1967) and dairy farmer, one of Dorchester's most prosperous and prominent citizens was willing to donate 4 acres of land for the new courthouse and jail, thereby sparing taxpayers considerable expense (Goodrich 2012).

In the meantime, Ayre opened up the stone mansion on the "island" to house the first court proceedings in Dorchester. Court was held on there for the next two years until the new wooden two-storey Courthouse and jail was built at Dorchester Corner, the beginning of the development of what is now the Village of Dorchester (Bowser 1986). The business of the courts and Dorchester's central location soon attracted lawyers and politicians to settle there (Goodrich 2012). Economic spin-offs followed and within a few years Dorchester Parish had more inhabitants than Westmorland Point or Sackville. Amos Botsford recorded the population of Westmorland County in 1803 as 3,046, of which 19 were black slaves (Bowser 1986). Nearly one third of the population (938) lived in the Memramcook / Dorchester area, two thirds of which (666) were Acadian. New Brunswick overall had grown to approximately 25,000 inhabitants by 1803 (Wynn 1981a). There were a million acres of Crown Land in the province under grant (roughly 5% of the land mass), with perhaps a thousand families occupying land without title to it.

Among the early cases heard in the new courthouse was the long running dispute between the Des Barres and their tenant farmers on the west bank of the Memramcook. Amos Botsford complained about his client, "we are laboring for a Gentleman who seems to pay no attention to his own business". (Bowser 1986). At this point Amelia Des Barres (daughter of J.F.W. Des Barres and Mary Cannon) was managing the properties (Kernaghan 1981). During the summer of 1802 Amelia announced via the local priest that all back rents were due by October 1st, and that payment was acceptable only in money, rather than cattle or produce. She eventually backed up these threats by traveling all the way to Fredericton to a higher court which decided in favour of her father. The judgement also recommended a confirmatory land grant for the disputed holdings, which Des Barres subsequently received on February 15th, 1805 (Provincial Archives of New Brunswick, 2020).

By July 1805 despite being 83 years old, Des Barres was back in North America, appointed Governor of Prince Edward Island (Morgan 1987). Given his proximity his interest in his properties renewed, and he did not like what he saw (Kernaghan 1981). Although Amelia had been successful in preventing the escheat of his Memramcook holdings, he replaced her as his agent with Dr. John Chalmers, the husband of Amelia's sister Martha. Chalmers used a heavy hand with the tenants sparking unrest, with some occupants selling their leases and vacating their farms. Des Barres' difficulties were hardly anyone else's fault- aside from his neglect, the operational model he was attempting to employ was ill suited to the circumstances. In North America the emphasis on individualism and the abundance of available freehold land gave people alternatives, creating a climate unfavorable to such feudal aspirations.

1.4.1 Forestry Practices

When the Loyalists arrived, the forests in the Memramcook valley consisted of sugar maple, red spruce, hemlock, cedar, yellow birch and beech, as well as white pine, red oak, black ash, white spruce, black spruce, white elm, ironwood, red pine, jack pine, white birch, grey birch, and balsam fir (Bowser 1986). The spruce and fir that predominate in the valley today constituted less than 5% of the natural tree cover in the 18th century. White pine in particular emerged above the canopy, towering in clearly defined groups far over the heads of their companion species.

War broke out in Europe again in 1803, initially with limited implications for New Brunswick. At first British victory at sea in October 1805 at the Battle of Trafalgar made the Napoleonic Wars even more 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). Up 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. By 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 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 enterprises sprung up wherever timber could be floated down river to the coast (Craik 1917). The mouth of the Memramcook was no exception, with much of the wood used likely originating from within the watershed. Elijah Ayer Jr. sold the "island" and his shipyard to James Sayre (another Loyalist who had arrived with Botsford) in 1807 and moved to Sackville (Bowser 1986). Sayre meanwhile continued building ships there.

Previously, settlers had cleared land to allow for agriculture, locally consuming cordwood for fuel, and lumber to build their homesteads, while generating only limited income by selecting marketable timber to be sold for shipbuilding or export (Shoebottom 1999). With this expanding market, white pine was culled from New Brunswick Forests to meet the demand for masts for the Royal Navy (Wynn, 1981b). White pines on the Memramcook were marked by government surveyors as the King's Trees to be cut and sent to England to make masts (Bowser 1986). The White Pines Act of 1722 had 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 only came under British control after that time, this exception did not apply to any of 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 had been known for earlier in the century remained. Three-hundred-year-old red spruce were also suitable for this purpose (Bowser 1986), and while spruce were more abundant, the largest were also rapidly culled. In addition to masts the forests yielded naval stores such as yards, spars, pitch, tar, and turpentine. Though there were not many extensive cutover tracts, by 1850 the character and composition of the forests were drastically modified in just 50 years of harvesting (Williams 1992).

The effects of this early economic activity were not limited to just the forests. The distortion was such that by 1820 importation of food into New Brunswick had become 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 even the fishing industry was neglected as men were drawn to the forest to supply wood (DeMerchant, 1983).

Organized record keeping on ship construction at Dorchester only began in 1825 (Milner 1967), though shipbuilding had already been happening there for over20 years by that time. During the 60 or so years that records were kept, more than 50 vessels of all sizes were built in and around Dorchester, the largest was built on the "island" by McMorran and Dunn in 1856, the Welsford, had a displacement of 1292 tons. Unfortunately, it wrecked on its maiden voyage, with the loss of most of the crew (William 1929). McMorran and Dunn launched into Palmer's Creek from the site of Ayer's original shipyard (Bowser 1986). Ship building peaked in the 40 years between 1840 and 1880, when at least eight large shipyards operated in Dorchester in addition to a number of smaller operations (Bowser 1986). Dorchester ship builders built on their own account as well as for outside owners, principally in Saint John. William Hickman began building in 1866 and built 25 vessels at his yard on the "island" opposite the remains of the McMorran and Dunn shipyard. Robert Chapman's yard across the river at Rockland built 30 large ships, and several small ones. Gideon Palmer (grandson of the Loyalist who received the land grant in 1786) built his ships next to Palmer's Creek in the upland below Palmer's Pond (Figure 1.4), dry except for at high water. Once complete he would launch them down the creek at high tide (Douglas 1984).

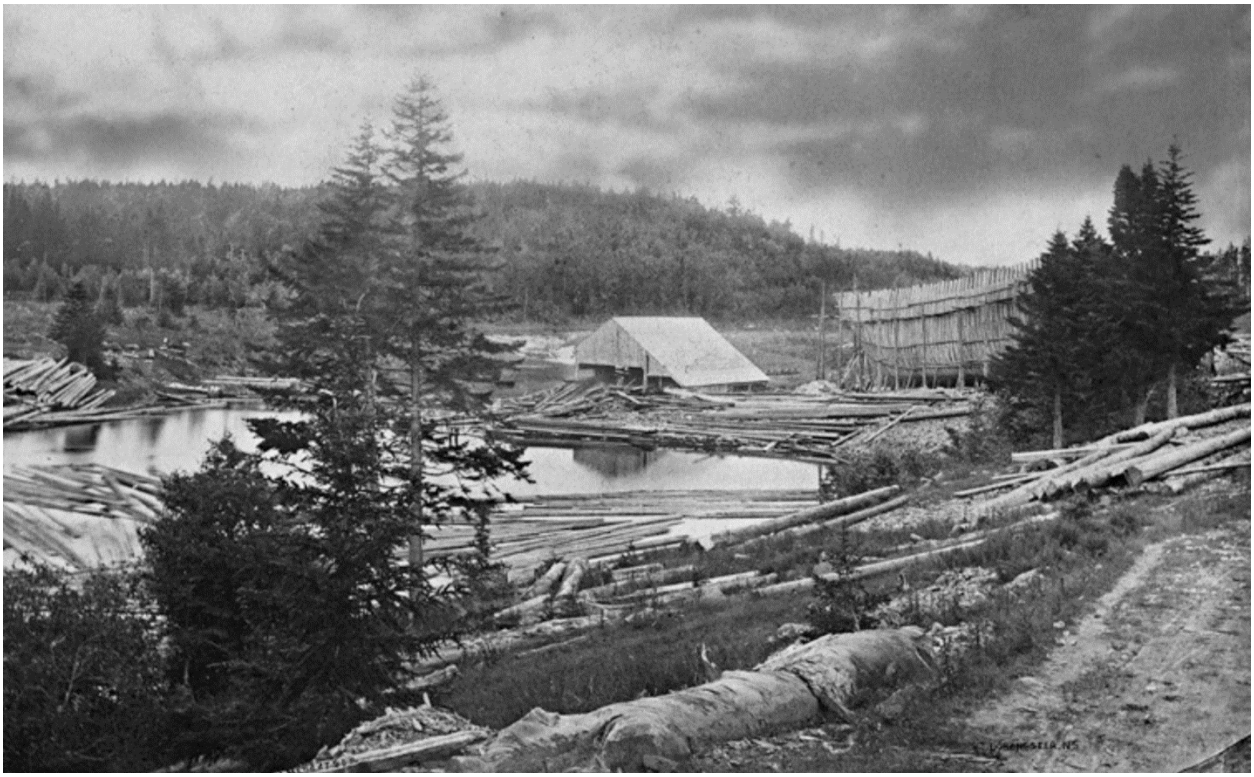


Figure 1.4: Shipbuilding at Palmer's yard 1865-1875 (Photographer Alexander Henderson / Library and Archives Canada)

At one time local owners were said to be operating three fleets of vessels trading around the world. With several shipyards on the "island" the local government acknowledged the importance of the place to the local economy by appropriating funds in 1840 for a large wharf at its northwest end (Milner 1967), completed and in service by 1846 (Bowser 1986). With these wharfs the "island" was the scene of considerable shipping activity. In addition to ferry services across the Petitcodiac to Hopewell Cape, steamships visited regularly providing connections to Saint John until the Intercolonial Railroad arrived.

By 1848 New Brunswick's preferred position in the British timber market ended. However, the demand for lumber growing industrial cities was great, and New Brunswick merchants found that they could still profitably sell their products on world markets in open competition (Bowser 1986). By 1851 prices of logs were double what they had been in 1849. Scattered across Dorchester Parish were 27 sawmills, employing 280 men. By 1861 that had increased to 29 sawmills, one of which was steam-powered, though the others remained reliant on waterpower. Some of Hickman's vessels carried lumber to France and Germany and returned with fine furniture and other luxury items that then graced many Dorchester homes. However, one should not overstate the extent of timber export activity from the Memramcook compared to the rest of the province. Production mostly served local demand (Wynn 1981b), much of which went into ship building.

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 Memramcook and 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. Population began to shift from the "island" up to the shiretown of Dorchester (Bowser 1986).

Edward Barron Chandler, a Dorchester resident, was the leader of the Government of New Brunswick from 1848 to 1854 prior to the establishment of the modern office of Premier (Swift 1972). He negotiated a reciprocity treaty with the United States that briefly allowed tariff free trade of processed lumber, fish, building stone and other natural resources, a precursor to NAFTA. He later became a Father of Confederation, and in 1868 was appointed a commissioner to oversee construction of the Intercolonial Railway connecting Quebec through New Brunswick to Nova Scotia The portion of the line from Painsec Junction, down the length of the Memramcook valley through Dorchester to the Nova Scotia border was completed in 1871 (Woods 1992). It followed the same route as today over Palmer's Creek, a short distance above Gideon Palmer's shipyard, and passengers were often startled to see ships of 900 tons rising among the trees (as in Figure 1.4) miles from any apparent water (Douglas 1984).

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. Shipbuilding in Dorchester collapsed shortly thereafter (Milner 1967).

1.4.2 Agricultural Practices

As noted in the forestry section the population of New Brunswick quintupled in a matter of just a few decades to meet the needs of both the Royal Navy and merchant fleets for naval stores in response to the Napoleonic blockade of the Baltic (Wynn 1981b). While a lucrative trade, this distorted development, shifting what had been a Province with little more than subsistence agriculture into an export driven economy, while simultaneously adding numerous mouths to feed. Though the province as a whole was not self sufficient agriculturally (DeMerchant, 1983), Dorchester Parish was an exception (Wynn 1981b), and thus likely a net source of food to the communities surrounding it.

In the uplands and across most of the rest of New Brunswick 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 contrast once dyked, marshland agriculture in the Memramcook valley along with the Chignecto and Hopewell Cape rapidly provided highly productive cropland and plentiful pastures making these areas unusual compared to the rest of New Brunswick, and even the neighbouring headwaters of the Petitcodiac (Wynn 1981b). Dorchester Parish was one of the most settled and cultivated landscapes in early New Brunswick, having been farmed almost continuously (with the exception of 1755 to 1765) for most of the previous hundred years. Over 25% of the land in Dorchester Parish had been cleared, and Sackville Parish had 16 % of its 100,000 acres fit for cultivation. Nearby in the Petitcodiac headwaters, Elgin Parish had less than 5,000 acres of cleared land (less than 4%), and it and Salisbury Parish each had population densities of less than 5 people per square mile. Consequently, the concerns that Secretary Robb expressed (DeMerchant, 1983) about how timber harvest for ship building distorted development and hampered agriculture were directed more towards the province as whole than the Memramcook Valley.

Shortly after Amos Botsford arrived in 1785 he described the conditions he found there to a friend as follows, “the soil [is] good, the meadows and pastures [are] luxuriant, [with] large stocks of cattle and sheep, in short plentiful (Bowser 1986). It is reasonable to conclude that Botsford was referring in part to the Acadian settlements already established further up the Memramcook River on Des Barres’ estate. By 1784, when Mary Cannon visited the Memramcook Estate 16 years after Des Barres had helped Gorham settle Piau and the others there, extensive improvements had been made in dyking the marshlands along both the Memramcook and the Petitcodiac banks (Hornsby 2016). Eleven years later, in 1795 Des Barres replaced Mary Cannon with John MacDonald as the agent managing his properties (Kernaghan 1981, Pigot 1983). MacDonald was immensely impressed with the Memramcook Estate and described it’s agricultural potential as follows: “In the residue of Nova Scotia, New Brunswick, Cape Breton, and St. John Island (P.E.I.) you may meet with small spaces of fine soil; but there is no where in them any thing of a tract of country comparable in the quality of soil to Memramcook. Nor have I seen anything like it between Philadelphia and this (Hornsby 2016). MacDonald went on to describe Des Barres’ Memramcook and Petitcodiac Estate as “truly a diamond hid in the rubbish of a mountain”.

The Acadian farms were not the only ones producing in the valley prior to Botsford’s arrival. John Keillor, who had arrived from Yorkshire in 1773 kept a large dairy herd (Westmorland Historical Society 2016). His agricultural success was the basis of the prosperity that allowed him to donate the land for the new Court House which made Dorchester the Shiretown in 1801 and went on to form the core of Dorchester Corner (Milner 1967). By 1805 Keillor was shipping butter and other farm produce to Saint John by schooner from Dorchester Island (Westmorland Historical Society 2016).

Though the Loyalists brought slaves with them, slavery as an institution did not thrive in New Brunswick. One indication of this was Botsford's 1803 tally of 19 slaves in Westmorland County, which then included Albert County (Bowser 1986). Twenty years after partition from Nova Scotia, slaves accounted for little more than half of 1% of the population of 3,046 people in Westmorland County. Slavery proved poorly adapted to northern climates for the purposes of agriculture (Smith 1899). The growing season is short, and winters are long. Consequently, costs for food, clothing, and shelter reduced the profitability of the practice compared to further south, where conditions favoured expansion. Slavery was not legally defined and regulated within the Province, with elements of the Government hesitant to do so because that would have made abolishing it even more complicated if they later chose to (Whitfield 2012). Judges in New Brunswick twice (1800 and 1805) upheld the lawfulness of the practice (Bell 1982). It is likely that slavery had died out by the mid 1820s, though it is impossible to be sure when the last slave either left the province or gained freedom. In 1822 the Government of New Brunswick claimed that there were no slaves within the province (Whitfield 2012). There might have been some slaves still in New Brunswick by the time of the imperial emancipation in 1834, but if so, none are known (Bell 1982).

Tenant farmers were another matter. As legal wrangling between Des Barres and his tenants wore on, in 1809 Pierre Cormier and his neighbors were evicted from their leases in Cormier Cove and forced to find other places in the Memramcook valley to live (White 1983). The very name of Des Barres became distasteful and obnoxious to these people who were "treated with great harshness and severity" (The Chignecto Post January 14th, 1886). Meanwhile, ever litigious, in 1809 Des Barres sued Mary Cannon, arguing that she had exceeded her authority by making leases with tenants, despite the fact he had made her his agent with the stated intent that she run the estates (Kernaghan 1981). This called into question the legitimacy of the previous several decades of management. Nonetheless the dyked marshlands continued to produce marketable surpluses, with hay grown in great quantities and shipped from Dorchester Island to large cities along the US Atlantic seaboard (Bowser 1986). Des Barres finally died in Halifax in 1824 at the age of 102 (Morgan 1987). However, he was substantially outlived by his legal difficulties. His will left nothing to his children by Mary Cannon, though prior to his death he had deeded Amelia and her sisters the Falmouth property (Kernaghan 1981). Des Barres left his Memramcook holdings to his children by Martha Williams, with the advice that they "band together and sell the estates as quickly as possible" (Evans 1969). He decreed his wealth should be divided into 10 shares, 2 to be given to Martha, and 1 to each of their 3 sons and 5 daughters. Within weeks of their father's death his children fell to squabbling about their shares and hiring lawyers without concern for costs, appearances, or the likelihood of settlement. By 1826 under eminent legal advice, the Acadian tenants of Des Barres Memramcook property, refused to pay rent or otherwise acknowledge Des Barres' and Martha's son Augustus as their proprietor (The Chignecto Post January 14th, 1886).

While mainly Loyalists and Yorkshire immigrants settled on the east bank of the Memramcook from Dorchester Cape to just beyond Upper Dorchester, Acadians began to receive grants adjacent to these Anglophones on the east bank continuing upstream well past Memramcook Corner (Goodrich 2020). These lands were just as large and farmable (more so in some cases than land in Dorchester Cape). Meanwhile, on the west bank in 1840 Augustus Des Barres began legal proceedings against those occupying his grant who had not previously purchased their land from him. Some 50 or 60 actions were brought against heads of families (Bowser 1986). One suit to test the question was tried in Dorchester in 1841. Des Barres was represented by Edward Barron Chandler from Dorchester, and the Acadians by Sir William Young from the Supreme Court in Nova Scotia, and George Frederick Street from Fredericton.

Great excitement prevailed during the trial, since in the event of an adverse verdict, the Acadians would have been dispossessed and deprived of their farms (as Cormier had been in 1809), land upon which some of them had toiled for more than 50 years. However, the Acadians proved successful (The Chignecto Post January 14th, 1886). The case Des Barres vs White then went to the Supreme Court of New Brunswick in 1842 (Kerr 1895). The Court upheld the decision to award the farmland to the former tenants but determined that Des Barres had a right to recover all the wilderness land within the tract which by definition had not been improved. The result was that Des Barres and his tenants were compelled to compromise, with the solution being for the tenants to purchase the adjoining forests, since their homesteads would have been valueless without such woodland, as they would have had no firewood or fencing with which to carry on farming (The Chignecto Post January 14th, 1886). The Acadians ultimately won their case based upon the argument that they had developed their lands over the years since 1826 that they had occupied them without acknowledging Des Barres as the landowner. However, the court drew a distinction between their adverse possession of the agricultural land they lived on, and the adjacent unimproved woodlands (Bowser 1986).

Thus, the quasi-feudal experiment begun on the west bank of the Memramcook on October 5th, 1765 with a large land grant to Joseph Gorham, ended 76 years later on June 24th, 1842 with the Supreme Court decision against the son of the man who had bought the estate from him (Kerr 1895, Ganong 1899). This brought Des Barres' mostly Acadian former tenants on the west bank into the mainstream of freehold homesteaders that was the norm across New Brunswick. Notably however, without Des Barres actively holding title in 1783 (via Mary Cannon), much of the land they occupied might well have been given away to land hungry Loyalists 50 years earlier (as were the large portions of Bulkeley Grant on the east bank of the Memramcook)- particularly given the valley's noted agricultural potential. Those living on the west bank would likely have been evicted a squatters by incoming Loyalists much as Pierre Cormier had been in 1783 from Sainte-Anne (near Fredericton), which is what had drawn him to the Memramcook to found Cormier Cove (White 1983). Consequently, the enduring Acadian presence in the Memramcook Valley stems partly from this history, with implications for the Province as a whole, since in the decades that followed the community in Memramcook came to be regarded as the cradle of New Acadia "Berceau de l'Acadie" (Société d'histoire de Memramcook 2020). Acknowledgement of this fact does not imply that gratitude is owed Des Barres, as the tenants were well rid of him. Des Barres' son Augustus managed to make himself such a boogie man that children playing in the post road would hide themselves with fear and consternation, depicted in their countenances, if their parents would shout "Here come Des Barres." (The Chignecto Post January 14th, 1886). That said, relations between the Anglophones and the Acadians of Dorchester Parish were cordial and became more so as the century wore on (Goodrich 2020). In 1846 Amand Landry whose family had been among the Acadian exiles, was elected to the Provincial Legislature to represent the district with strong support from his Anglophone neighbours (Spray 1972, Goodrich 2020). Most Anglophones probably shared the regret over the cruelty of the expulsion that seems to have become fairly widespread by the early 19th century.

In 1894 the Dorchester Agricultural Society reported to the province that farmers were producing hay, grains including wheat, barley and oats, root crops such as potatoes (though productivity of the latter suffered from an invasive beetle and as a result was becoming less popular) as well as carrots which were being fed to livestock (New Brunswick Department of Agriculture 1895). Not much fruit was being grown, but that which was, was of high quality. Wild fruit (presumably blueberries) were described as plentiful. Farmers were keeping Holsteins and Jerseys, indicating that dairy farming remained active, but

it was noted that the animals were not pure bred, herds were smaller than what the valley could support, and were not increasing rapidly. Such as it was, this activity was likely driven in part by the continued export of butter to Saint John that had made Keillor successful early in the century (Goodrich 2020). Meanwhile the district was well supplied with horses in terms of quantity, though like cattle, were not pure-bred stock (New Brunswick Department of Agriculture 1895).

1.4.3 Transportation and Infrastructure

Unlike the headwaters of the Petitcodiac nearby and much of the interior of province beyond, the Memramcook Valley was not remote, as it possessed its own port at Dorchester Island which offered sail-powered freight, a subsidized ferry across the Petitcodiac to Hopewell Cape (New Brunswick House of Assembly 1892, Goodrich 2013) and until the arrival of the railway relatively regular steamship connections to Saint John (Boswer 1986). Being the Shiretown, Dorchester Corner was the administrative centre for the entirety of Westmorland County, and became an overnight stop once completion of the Westmorland Great Road through the valley improved overland links. From 1835 until 1872 when the Intercolonial Railroad was completed, five stagecoach lines ran through Dorchester (Goodrich 2010), offering connections to Saint John, Miramichi, and Amherst. In addition to commercial service for travelers, such roads also linked the small communities within the valley that they passed through and facilitated the movement of goods both into and out of the valley.

In 1859 the map Wilkinson produced for the Provincial Legislature shows two bridges built across the Memramcook, the first as part of the Westmorland Great Road at Memramcook Corner, and the second further upstream at Gaytons (Wilkinson 1859). There were also crossings at minor tributaries such as Breau Creek (coming into Dorchester), and Meadow Brook (heading to Shediac), but those may have been fords, it is not possible to say from the map what sort of infrastructure was present. The map also indicates that the road down along the west bank of the Memramcook out to Fort Folly Point and then upstream along the Petitcodiac was already in place by this time.

Development of infrastructure in the watershed benefited from the political connections of its inhabitants. In 1868 Edward Barron Chandler, Father of Confederation, former leader of the Provincial Government (1848 to 1854), lawyer for Augustus Des Barres, and resident of Dorchester was appointed as a commissioner to oversee construction of the Intercolonial Railway connecting Quebec through New Brunswick to Nova Scotia (Swift 1972). Initial plans had called for the railway to take a shorter more efficient route from Shediac to Amherst, via Baie Verte and Sackville, leaving Dorchester out in the cold (Goodrich and Heap 2017). Chandler was displeased by this, so he combined his influence with that of another Dorchester resident who was also a former New Brunswick Premier (1865 to 1866), Albert James Smith (Wallace 1982, Woods 1992) to locate the headquarters of the railway in Moncton (where they both had investments) and together they arranged to run the rails to Nova Scotia through Dorchester along what came to be known as the “Dorchester Diversion”, despite the fact that doing so added half an hour to the trip (Woods 1992, Goodrich and Heap 2017). The final route in 1872 ran most of the length of the Memramcook River. It entered the watershed just past Painsec Junction (near Meadow Brook), crossed the river only once a short distance above Calhoun and then stayed along the east bank, emerging from the forest and entering the populated portion of the watershed serving Memramcook Corner and Dorchester on its way to Sackville. A short branch line was also built to serve the port at Dorchester Island (Bowser 1986).

Though frustrated by the meddling of politicians, Sir Sanford Fleming (Creet 1998), the Engineer in Chief of the Intercolonial Railway, refused to cut corners or compromise on quality (Woods 1992). Extra wide cuttings were made, and the right of way was raised well above ground level to prevent snow from drifting on the track. Good drainage was obtained by installing numerous culverts. This was essential to prevent freshets from washing out the ballast and frost from heaving the rails. Wherever possible crushed stone rather than gravel was used as ballast to cushion the tracks. Durability, not price, also determined the wood used for the cross ties: pine spruce, tamarack, and cedar. Rails were made of the new Bessemer steel, stronger yet lighter than iron. Side by side with the steel rails went telegraph poles. Steam and electricity, Fleming maintained, were the "twin agencies of civilization" (Creet 1998).

Initially the Intercolonial Railway operated with wood-burning locomotives (Cooper 2020) as had the European and North American Railway which ran from Saint John to Shediac prior to being absorbed into the Intercolonial (Stronach 1969). This wood was likely sourced locally within the watershed as part of an arrangement with providers along the line. By 1889 The Intercolonial Railway had upgraded all of its locomotives to coal, supplied regionally from sources in Spring Hill, Pictou, and Joggins (Royal Commission on the Relations of Labor and Capital in Canada 1889). According to the 1876 rail schedule, leaving Moncton at 5:45 one could be in Dorchester a little over an hour later (6:51), or on to Sackville 30 minutes after that (7:21) (Canadian Rail 2001). This linked essentially all the populated portions of the watershed with the rest of Canada, though it also spelled the end of steamer service from Dorchester Island, and stagecoach service through Dorchester Corner, as neither could compete (Bowser 1986, Goodrich 2010) . Edward Cole Jr's ferry link continued running from Dorchester to Hopewell Cape, by then the Shiretown of Albert County (The Moncton Transcript April 1st, 1897).

The road network within the watershed by 1878 looked substantially similar to most of the major roads that exist today (Dawson 2005), though obviously built to a different standard. Access for the west bank of the Memramcook to rail and other services was improved by the construction of two additional road bridges across the river in the lower portion of the watershed, both of which are present on the 1878 map bringing the valley to a total of 4 road bridges across the Memramcook. The furthest downstream was the Rockland Bridge, which crossed the river near Taylor Village, connecting it to Upper Dorchester. It had been built in 1869, with a draw span to permit the passage of sailing vessels (New Brunswick Travel Bureau 1960). It was also known as the Upper Dorchester Bridge, and was replaced twice, the first time with another draw span bridge. The second time, in 1924 it was replaced with a covered bridge, the second longest in North America at 848 ft (258 m) suggesting accommodation of sail powered traffic up the river was no longer a priority by that time (Figure 1.5 and Figure 1.6).

Upstream, between the Rockland Bridge and the bridge to Memramcook Corner was the second new bridge, College Bridge which ran between Saint Joseph and the community on the opposite bank which took its name, College Bridge, from the bridge itself. As implied by that name, the bridge was used by those crossing the river to the west bank to reach Le Collège Saint-Joseph, in Saint Joseph (the new name for Village des Piau), and eventually warranted a fairly significant railway station to aid this purpose. Le Collège Saint-Joseph was the first francophone university in the Maritime Provinces, founded in 1864 (Cormier 1975).

Figure 1.5: Rockland Bridge built in 1924 (Photo Circa 1960: Photovault.com)

Figure 1.6: Rockland Bridge a barrier to sail powered boat traffic (Photo Circa 1960: Photovault.com)

1.4.4 Quarry and Mining Practices

One of the earliest indications of stone quarrying within the Memramcook was the construction of Amos Botsford's stone house on Dorchester Island in 1784 apparently from stone quarried on the "island" itself (Bowser 1986). That said it is noteworthy that Des Barres' (1777) map of the Memramcook and Shepody Bay in the Atlantic Neptune (Figure 1.3) already referred to Grindstone Island by that name, so clearly sources of stone in the region were being identified and accessed, even before Botsford arrived. Stone houses were rare at the time, possibly found amongst Yorkshire immigrants (Bowser 1986), however John Keillor did not complete his new stone house in Dorchester Corner until 1815, and Rocklyn, Edward Barron Chandler's house in Dorchester was not built until 1831. Acadians did not appear to have been building stone houses, so it is reasonable to conclude that such structures were the exception. The Bell Inn was built in either 1811 or 1812, and today is one of New Brunswick's oldest surviving stone buildings (New Brunswick Register of Historic Places 2020). Botsford's house on the "island" has been gone for more than 150 years (Bowser 1986), with the stone apparently removed to be used as building material for other buildings in Dorchester. The Bell Inn served as the Stagecoach station in Dorchester Corner and provided overnight lodging to passengers for many of the years the various stagecoach services ran up until the railway arrived in 1872 (Goodrich 2010).

Transportation was a constraint that limited early exploitation of mineral resources to those sites near the mouth of the river which either had their own wharves or easy access to the port at Dorchester Island. Commercial grindstones, some weighing several tons were produced in quantity and shipped to the American market (Bowser 1986). In 1851 there were 3960 grindstones produced, though by 1861 the number declined to 500.

Another significant product category was building stone. The Caledonia Free Stone Quarry Company worked at least one, and perhaps several of the quarries (N 45.901980 W -64.564540) at Rockland on the west bank of the Memramcook from 1865 to until 1885 (Martin 1990), not to be confused with the Boudreau Quarry or the Beaumont Quarry on the Petitcodiac side of Fort Folly Point. The summer of their first year Caledonia advertised for "schooners of carrying capacity from 100 to 200 tons of building stone to load at the Caledonia Free Stone Quarries… for New York, Boston, and other American Ports. Once shipments began, Caledonia stone quickly made a name for itself in the New England market as one of the finest olive freestones available. The company sold about 5000 to 6000 tons of stone annually.

After the Great Fire in Saint John in June 1877, Caledonia stone was used in the rebuilding effort there in several structures, being described as of exceptionally fine quality (Martin 1990). Samples of the stone had also been submitted to the 1876 Philadelphia Exposition, and won the highest prize. Multiple shiploads were sent to the US annually, headed to New York and Boston. However, by the 1880s with the end of free trade, and improved rail networks within the US making domestic sources more accessible, the quarry did not survive. It was listed for auction July 29th, 1885 in a local weekly newspaper (The Maple Leaf, July 9th, 1885). Liquidation notices appeared days later, with company assets listed as a quarry lot, two wharves, quarry plant and tools, steam cranes, hand derricks, blacksmith tools, and 700 tons of cut stone (Martin 1990). The auction failed. No one would buy the quarry, and the equipment raised only $200. The workers, accepted reality, and found jobs elsewhere.

The last load of dimension stone taken from the Caledonia quarry was used locally, to construct the Monument Lefebvre in Saint Joseph in 1896 (Martin 1990). It was built as a memorial to Father Camille

Lefebvre who had died in 1895 (Parks Canada 2020). Lefebvre had founded Le Collège Saint-Joseph in 1864, and the Monument Lefebvre was built on campus to provide the school with a concert hall and science laboratories. The Rockland covered bridge (Figure 1.6) was not built until 1924, so the draw span bridge present at that time would have allowed transport of this heavy material upstream by boat, though stones could also have been brought into Saint Joseph by the road up the west bank of the Memramcook.

In the early 1920s, the Read Stone Company secured quarrying rights to both the Petitcodiac and the Memramcook sides of Fort Folly Point, including the Caledonia Quarry (Martin 1990). Read Stone produced what at the time was one of the few economic stone products left: pulpstones. They operated from about 1923 to 1930, until artificial abrasives eliminated the market for grindstones and pulpstones.

A copper mine was also developed in the hills a few kilometers northeast of Dorchester corner in 1898 (Bureau of Foreign Commerce 1900), at a location (N 45.936654 W -64.473870) known as Coppermine Hill (Natural Resources Canada 2011). Copper had been discovered in the area decades previously (Chignecto Post September 14th, 1876). Earlier attempts to work the resource had limited success, but this was a well funded effort by a group of American investors formed under the name of The Intercolonial Copper Company. They acquired a mineral lease from the Province for 1,280 acres, and a license to search for minerals over a further 10 square miles. On site they erected an engine house, tank house, blacksmith shop, barns, carpenter shop, powder magazine, housing for workers, an air shaft, and a 900 ft main shaft with extensive workings beyond it. Workers also lived in the nearby community of Fairfield, east of Dorchester (MacKinnon 2019). The ore was reported to range from the best at 50% copper down to the lowest at 8% copper, with some silver present as well (Bureau of Foreign Commerce 1900). However, those estimates appear to have been somewhat overstated as the Geological survey of Canada described the ore as low grade, not averaging over 3.5% copper and widely disseminated through the mass of the rock (Geological Survey Department 1900). Intercolonial Copper Company operated the mine until 1915 (New Brunswick Crown Land Department 1918). The National Chemical Company bought the mine in 1916 and ended operations in 1917 due to small extent and low grade of ore (Smith 1960, Boyle 1977, Macdonald 2010).

1.4.5 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. Treaty rights and aboriginal rights are recognized and affirmed in Section 35 of the Constitution Act 1982 (Sanderson 2017). Each treaty was briefly described in previous sections within the chronological context that gave rise to it, to track the evolution of the treaties. However, as these 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 1.2. 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 for a given treaty began on one year and was not completed until the following year.

Table 1.2: 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 Memramcook 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 Britan, 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 Maliseet (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.	

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), and no Mi'kmaq in Dorchester Parish were recipients.

That changed on August 15th, 1840 when the Provincial Government purchased 63 acres at Beaumont on the Petitcodiac side of Fort Folly Point from Amasa Weldon (Goodrich 2020) who presumably had acquired it earlier from Augustus Des Barres. 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 they had been living within Dorchester Parrish, 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. While paternalistic, the distinction is important, because it made the Fort Folly Reserve different from earlier reserves in the rest of the province in a way that avoided the worst pitfall that befell the others. Grants on other reserves were made to individuals in the same manner as settlers, except that recipients could only occupy land or lease it out. They could not sell it. In many cases when they leased it out, settlers subsequently pointed to improvements they'd made, clearing farming, fencing building- and petitioned government to make the leases permanent (much as Des Barres Acadian tenants had), with the result that such reserves tended to shrink alarmingly over time (Goodrich 2020), with little compensation for the band members.

Moses Perley was appointed the Provincial commissioner of Indian Affairs in 1839 (Spray 1976). This office came with no salary, indicating the low priority the Province assigned to it. Perley, however, appears to have taken it seriously. He visited all the Indian settlements in the province and in his first report the population of the Fort Folly Reserve was 51 adults and 75 children. Perley (1841) indicated they were not farming as much as they might with a larger land base, but that they owned boats and fished in the Bay of Fundy, making a "tolerable" living. It is probable that in doing so they were part of the shad fishery in Shepody Bay in which Perley (1852) noted fishers based out of Memramcook accounted for the largest portion of the total catch. Perley (1841) also observed that of all reserves, Fort Folly had the highest proportion of children, suggesting that it was a relatively healthy community. In

1842 Sainte Anne's chapel was built at Beaumont, the first chapel built by and for the Mi'kmaq in New Brunswick, which still stands there today (Kristmanson 2004) on essentially the site identified by Ganong's (1899) map (Figure 1.1) of a Mi'kmaq summer encampment at Fort Folly point.

The Fort Folly Reserve formed a stable community that lasted on that site for the next 70 or so years (Goodrich 2020). Among of the reasons for this stability was the opportunity for steady employment at several nearby stone quarries, on both the Petitcodiac and the Memramcook sides of Fort Folly Point. A number of band members are also said to have been coopers, producing the small barrels used for shipping butter from the Memramcook Valley to the Saint John market. By 1881 the small community was well established with 4 log cabins, 10 wigwams, and a steady population of about 40 that at times grew to over 100, with another 60 band members living off reserve within Dorchester Parish. The decline of the quarries towards the end of the 19th century had a profound effect on the population of Beaumont, with many families moving to Shediac or land the band held in Richibucto, while others returned to Dorchester and the surrounding area. By 1913 there were only three or four families still at Beaumont, the last of which left in 1955. In 1958 because Beaumont was no longer occupied, title was lost, which has subsequently been challenged in a land claim (Fort Folly First Nation 2021).

1.5 Conclusions

Nothing was inevitable about the course development followed in the Memramcook Valley. Setting aside the obvious such as had the Acadian Deportation not occurred or had Fort Cumberland been seized by Eddy's rebels, things might have been vastly different, more subtle factors were also in play. Had Mary Cannon (and her daughter Amelia Des Barres) not held the Des Barres estate on the west bank together for as long as they did, the entire valley might well have ended up Anglophone, settled by incoming Loyalists following the partition from Nova Scotia. Had the Memramcook River been made the border in 1792, then Dorchester probably would not have become the Shiretown of Westmorland County in 1801 as the argument that it was "centrally located" (Goodrich 2012) would not have applied. In turn without powerful politicians in Dorchester, the railroad would have taken the shorter route from Shediac to Baie Vert and on to Sackville, (Woods 1992) rather than the so called "Dorchester Diversion" down the east bank of the Memramcook. With a provincial boundary along the river and no rail service there would have been fewer bridges linking the west bank to the east than the four in place by 1878 (Dawson 2005). Knowing how and why things happened, is essential to understanding what happened.

Second Level Assessment – Current Impacts

2.1 Forestry Practices

Forests cover 79% of the Memramcook River watershed. Forest tenure (Figure 2.1) within the watershed today is a mixture of private woodlots (64.8%), industrial freehold forest land owned by J.D. Irving (32.7%), and crown land (2.5%) . Along most of the river south of the Trans Canada Highway, the forest is set some distance back from the river. Across much of that area that would have been the case

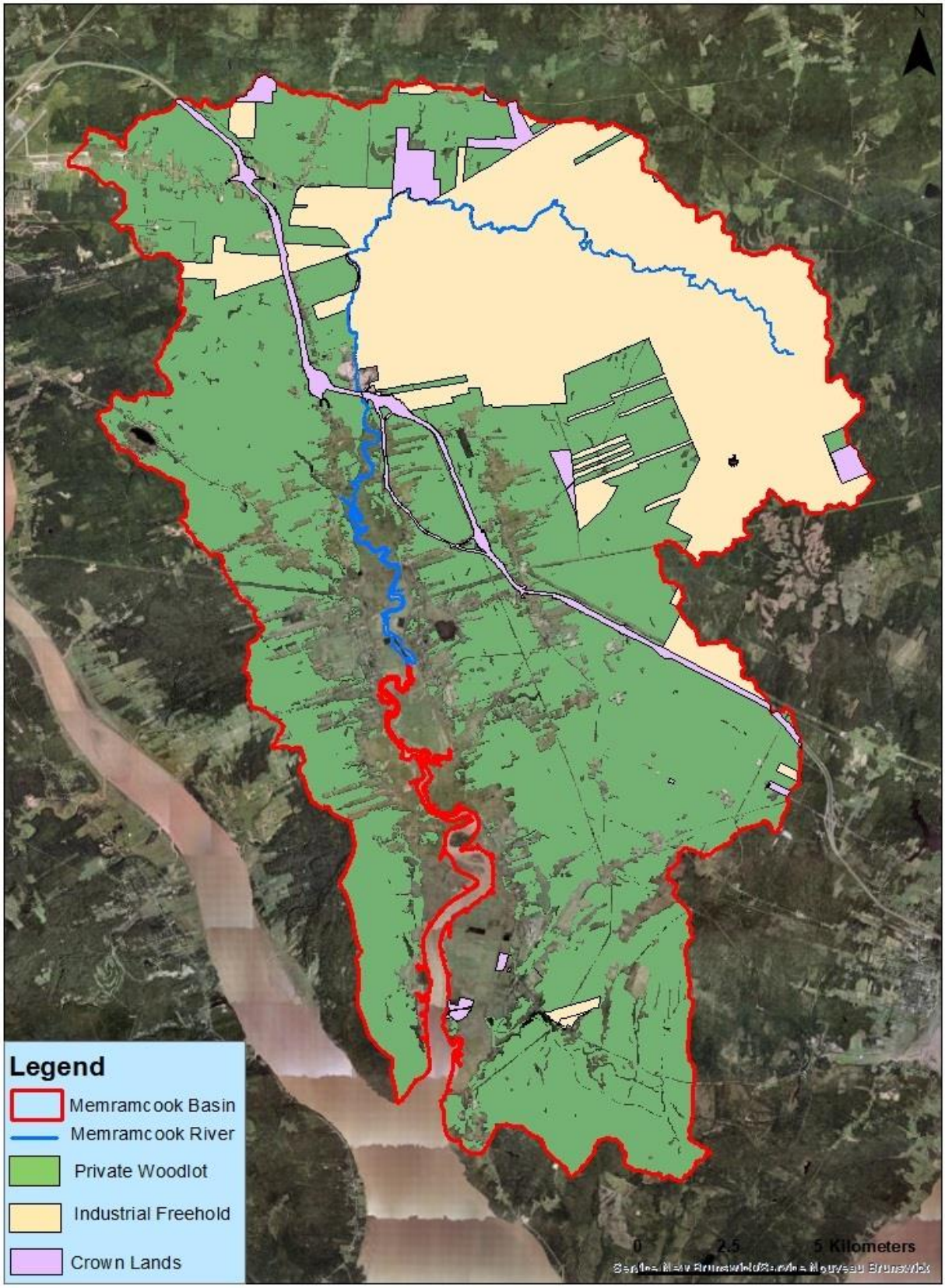


Figure 2.1: Forest Tenure within the Memramcook Watershed

naturally as well, since it is all below the head of tide at Calhoun, and the dominant natural habitat immediately along the river there would be saltmarsh, which today in most cases has been converted to agriculture. Due to its agricultural potential, this is the populated portion of the watershed. That is why it attracted early settlement and why, though private woodlots are the most common forest tenure type throughout the watershed, they account for nearly all of the forests south of the Trans Canada, compared to only approximately half of the forests north of it. In contrast there are almost no industrial freehold forest lands south of the Trans Canada. The area that stands out near Dorchester is the modern Fort Folly Reserve. The vast majority of all industrial freehold forests within the watershed lie north of the Trans Canada Highway, where they make up approximately half of the land base. Likewise crown lands are also found mostly north of the Trans Canada Highway, particularly once one includes lands associated with the Trans Canada right-of-way itself.

Red spruce is the defining species of mature Acadian Forest, frequently accompanied by white pine, and eastern hemlock, along with American beech, yellow birch, and sugar maple. Historically large-scale disturbances like forest fires, windstorms and insect outbreaks occurred hundreds of years apart in this region allowing plenty of time for trees to grow and succession to advance (Simpson 2008). However, in the last several centuries the prevalence of late successional forest types have declined greatly. Where old growth forests covered approximately 50% of the area prior to European settlement, they currently account for little more than 1% of forests in the region today (Mosseler et al. 2003). Younger forests, which are now relatively widespread, are instead dominated by balsam fir, white spruce, red maple and aspen (Loo et al. 2010). As population and industry moved westward out of the region, forest cover rebounded, increasing significantly since the extensive deforestation of the 19th century that had been caused by logging and agriculture (Degraaf et al. 2007). Balsam fir has more than doubled in frequency, likely due to generations of harvesting more economically desirable species, while the increase in white spruce has been a result of natural forest regeneration on abandoned farmland (Lutz 1997).

Currently this area is subject to varying levels of management in terms of harvesting planting and thinning, though much of that data is not publicly available because it is proprietary information on the industrial freehold land, and not registered as part of the GIS layer for almost half of the acreage in private woodlots. The small amount of crown land forest present lacks such management data as well, though there is effectively even less land than 2.5% implies since much of it is right of way for the Trans Canada Highway, and managed accordingly for that purpose, rather than for forestry. Consequently, though Figure 2.2 presents available management data for forests within the watershed it only does so for private woodlots, and only for 55% of those. Management of the rest is not publicly known.

What is clear however in Figure 2.2 is the extent to which the modern second growth forests within the Memramcook Valley are a mosaic of management types. When considering only the 55% of the private woodlots for which data is available, one is looking at 36% of the forests in the watershed, which is nonetheless a large enough proportion to be informative. What one can say about this slightly more than 1/3rd of the forests is that they are highly managed. Just under half (49%) have been clear cut. Most of the rest have been partially cut (38%). The next largest category is forests which have been thinned (12%). The approximately 1% that remains is not exactly forest cover at all- it is being managed as blueberry barrens, which is arguably somewhat agricultural usage, but is considered as a type of private woodlot management in the GIS layer. It is likely that the remaining 45% of private woodlots for

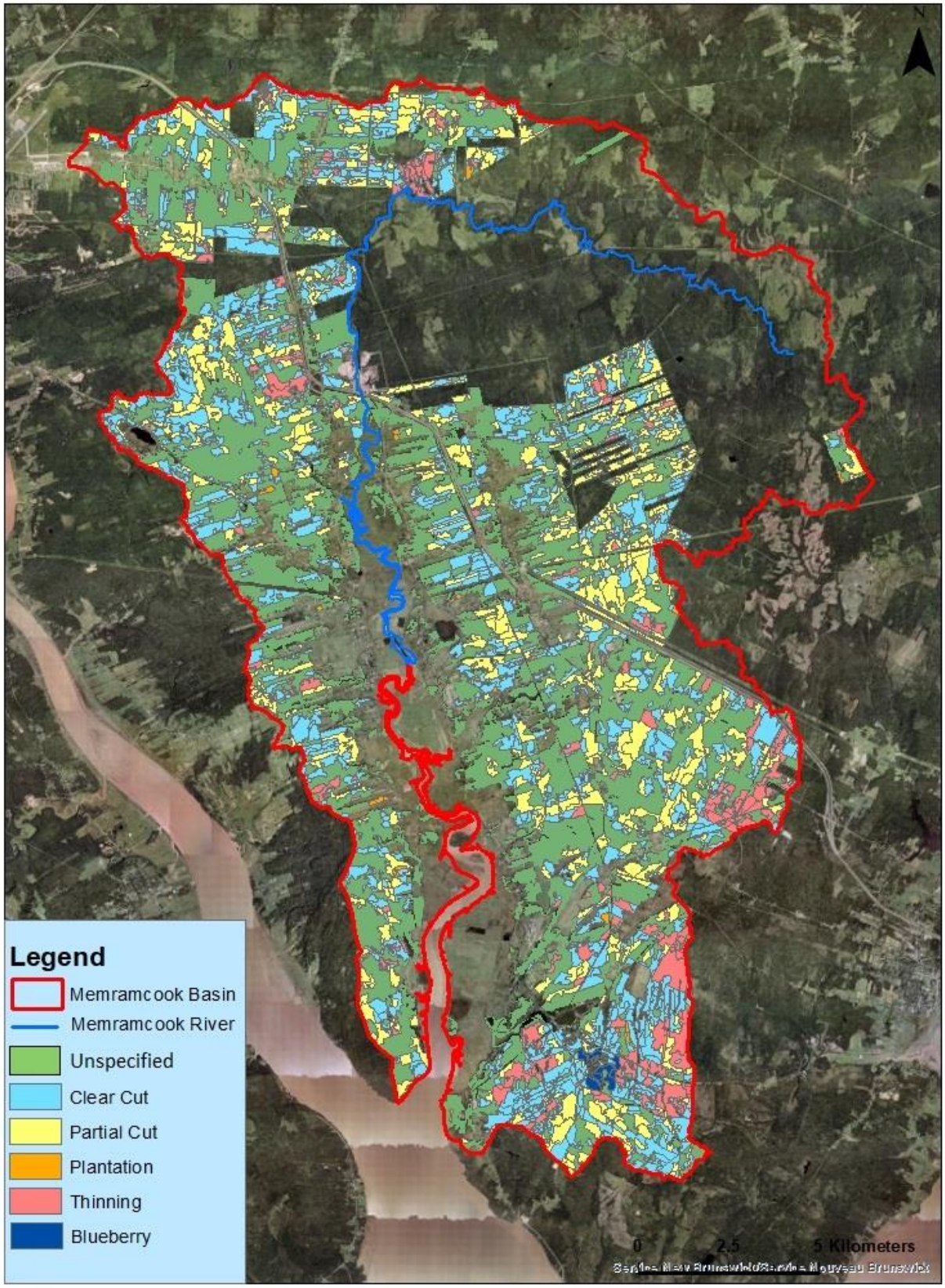


Figure 2.2: Management of Private Woodlots within the Memramcook Watershed

which management is unspecified (29% of forests in the watershed) are somewhat less intensively managed (hence the lack of data), but harvesting, thinning, etc are almost certainly taking place across much of that area as well, even if to a lesser extent. Likewise, the J.D. Irving owned industrial freehold land in the northeast corner of the watershed, as one might assume, and as can be seen in the image layer of Figure 2.2 is highly managed industrial forest.

2.2 Agricultural Practices

Agriculture is the dominant non-forestry land use within the Memramcook River watershed at 11.7% of the total land area, or 4,595.2 ha (Figure 2-3). Of this, 1,484.4 ha are identified as pasture, approximately 32%. Another 1,355.1 ha are identified as cropland, which is roughly 29%. The remaining 1,755.7 ha, or 39% is undefined agricultural land in the GIS layer. Most of this is in the river floodplain on what was naturally saltmarsh, which historically was dyked, drained, and developed agriculturally by the Acadians (Wynn 1979). At this point such land has been in production for most of the last several hundred years.

Today modern dykes are still present protecting these areas, and the Memramcook causeway, constructed in 1973 has been integrated into the dyke system and protects agricultural areas upstream of it from flooding during the strongest tides (Wells 1999). That said dykes remain along the river upstream of the causeway structure. These are not well maintained, probably because there is currently limited need for them, since the gates in the causeway control structure protect against the most extreme tides. An example of this is the aboideau that drains the outflow from Memramcook Lake, a natural waterbody a short distance above the causeway. Perhaps intentionally, this structure has no gate, allowing both continuous discharge, and some degree of tidal intrusion when the causeway gates are open.

Much of the floodplain immediately downstream of the causeway (where the blue in Figure 2.3 transitions to red) is identified on the GIS layer as crop land. However, it is clear that usage meeting this description is not limited to row crops like grains, since the fields there produce hay and alfalfa which is cut as a crop, baled, and transported for use elsewhere. Some of that material no doubt is sold and consumed outside of the watershed, but there are several dairy farms which keep their herds in the uplands of the watershed and produce much of their own silage in this manner. Where that happens, manure tends to be cycled back down to the floodplain both as a means of disposal and to recycle nutrients by fertilizing the fields. It is probable that some portion of the undefined agricultural land is also used in this manner and is simply not recognized as such the GIS layer.

Some portion of pastureland is used for dairy cattle. Until a few years ago the Federal Penitentiary in Dorchester operated fields for this purpose as part of a program aim at rehabilitation of inmates. While that has currently been phased out, periodically there is talk of restarting such a program. Numerous hobby farms and gardens are also spread across the valley, which may account for a portion of the undefined agricultural land since such usage tends to defi simple classification. In many cases such use has evolved over time from homesteads occupied by historic small-scale farmers, who's families still own and occupy the land but now work off site and earn the majority of their income elsewhere.

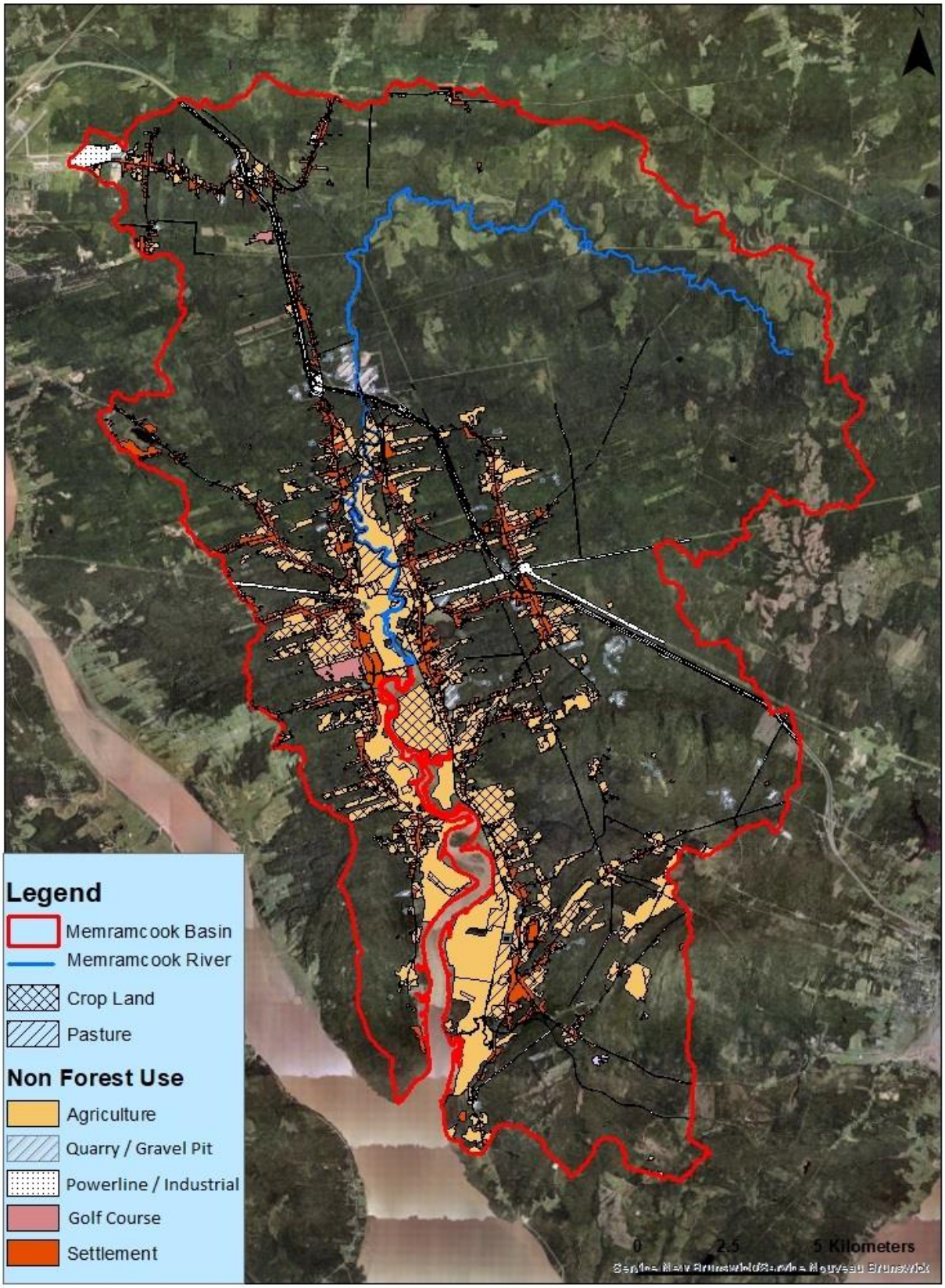


Figure 2.3: Agriculture and other non-forest land uses within the Memramcook Watershed

2.3 Transportation Development

From the perspective of the river, by far the single most significant piece of transportation infrastructure in the watershed is the Memramcook Causeway (Figure 2.4). It was built in 1973 as a rock filled causeway with a concrete and steel control structure (Wells 1999) that cuts the estuary almost in half, 15.8 km below the head-of-tide in Calhoun, and 19.4 km above the mouth of the river at Fort Folly Point. The causeway replaced an existing bridge (Figure 2.4), College Bridge, which had stood at that site in one form or another without impeding tidal exchange for approximately 100 years. A bridge was present at that location on an 1878 map of the valley (Dawson 2005), but not in Wilkinson's (1859) map. During the intervening 19 years, in 1864 Le Collège Saint-Joseph, the first francophone university in the Maritime Provinces was founded in Saint Joseph on the west bank (Cormier 1975). In 1872 the railway arrived on the east bank (Woods 1992), with a stop at College Bridge station. The structure in visible in the upper photo in Figure 2.4 appears to be a 2-span iron truss bridge, which probably replaced an earlier incarnation of the bridge at that site. Clearly a modern crossing of some sort at that location is needed as well today. However, taking an existing bridge which had allowed free tidal exchange and fish passage for about 100 years, and replacing it with a causeway that cut off both, was a questionable decision.

A lot of information is embedded within Figure 2.4. The Control Structure for the causeway was built immediately to the west of the existing iron truss bridge. Once that was completed a new river channel was excavated to redirect the river west to reroute it through the gates. The old bridge was then removed, and the old channel (still visible in the lower image) was blocked as the causeway was extended across it with the road running along the top. The old channel was then left to silt in and become marsh immediately to the east of the control structure. In addition to removal of the bridge and the river being redirected, one can see how the Memramcook River has silted in and narrowed below the causeway, much as had happened in the better documented situation next door on the Petitcodiac River below its own causeway between Moncton and Riverview.

Another early consequence of the Memramcook causeway aside from the channel downstream narrowing as it filled in with silt, may have been to whatever extent that narrowing of the channel contributed to loss of the Rockland Bridge further downstream. A little over 4 years after the causeway was completed, on January 10th, 1978 a significant winter storm coincided with extremely high tides, and the resulting tidal surge, flooding, ice, and winds destroyed the Rockland Bridge (Environment and Local Government 2020). That bridge had been built in 1924 and at the time was the second longest covered bridge in North America (New Brunswick Travel Bureau 1960). This was the third bridge on that site- the first two were draw spans which permitted passage of sailing vessels, with the first of those having been built in 1869. When the bridge was destroyed it was only open to foot traffic (Holownia 2020), suggesting that declining traffic had limited maintenance on what was then only a 53-year-old bridge. That being the case, the loss of the Rockland Bridge was more of a Heritage issue than a cause for concern about transportation infrastructure, however it was likely symptomatic of the downstream impacts that replacement of College bridge with the causeway was having on the river overall. Figure 2.5 is a one of a series of photographs that Thaddeus Hollownia took between 1981 and 2000 of the Rockland Bridge after its destruction, tracking the slow decline of the stone filled timber cribs and abutments that the bridge had rested on.

Figure 2.4: College Bridge in 1963 (upper) and the Memramcook Causeway in 2018 (lower)

Figure 2.5: Remains of the Rockland Bridge in 1981 (Photo Thaddeus Hollownia)

The next most significant piece of transportation infrastructure within the Memramcook watershed is the Trans Canada Highway. It is easily seen in Figure 2.1 the Forest Tenure map, as the long pink strip of crown land that runs between the industrial freehold land to the north and the private woodlots to the south. The Trans Canada accounts for well over half of the crown land within the watershed, with the land to either side making up the right of way managed to optimize road safety rather than forestry. Compared to the causeway however, the Trans Canada has little direct effect on the river, given the pair of massive bridges built where its two lanes in each direction cross the main stem of the river only once, just below head of tide at Calhoun.

The Trans Canada is also visible in Figure 2-6, which shows a GIS layer of the road network (paved and unpaved) within the Memramcook River watershed overlaid on the river and its tributaries. This indicates 15 additional locations where the Trans Canada crosses Memramcook in the form of its tributaries, both significant ones including the headwaters of Breau Creek and the main stem of Meadow Brook, and more minor ones such as Stoney Creek. In most cases these take the form of culverts, which unlike bridges, can develop issues that eventually block fish passage to points upstream beyond them. The route followed by the Trans Canada through the Memramcook limits that problem somewhat, with little habitat in Breau Creek upstream of it. That said for portions of river above the causeway, most of Stoney Creek and much of Meadow Brook lie upstream of where the Trans Canada crosses them. The standard to which the Trans Canada is built typically tends to limit such impacts. However, that is less true of the numerous roads and in some cases private drives that cross watercourses throughout the rest of the watershed.

As indicated in Figure 2-6 there are numerous smaller water-crossings within the watershed. This GIS analysis identified 227 crossings (126 on gravel roads and 101 along paved roads) within the watershed, for an average of 0.58 crossings per km^2 within the 390 km^2 of the Memramcook watershed. That is quite high compared to the results of similar analysis on similar sized tributaries of the Petitcodiac nearby. The Pollett River for example has only 0.5 crossings per km^2, and the Little River 0.42 crossings per km^2. The greater degree of road development within the Memramcook watershed likely reflects the larger number of residents, and longer period of time that it has been settled.

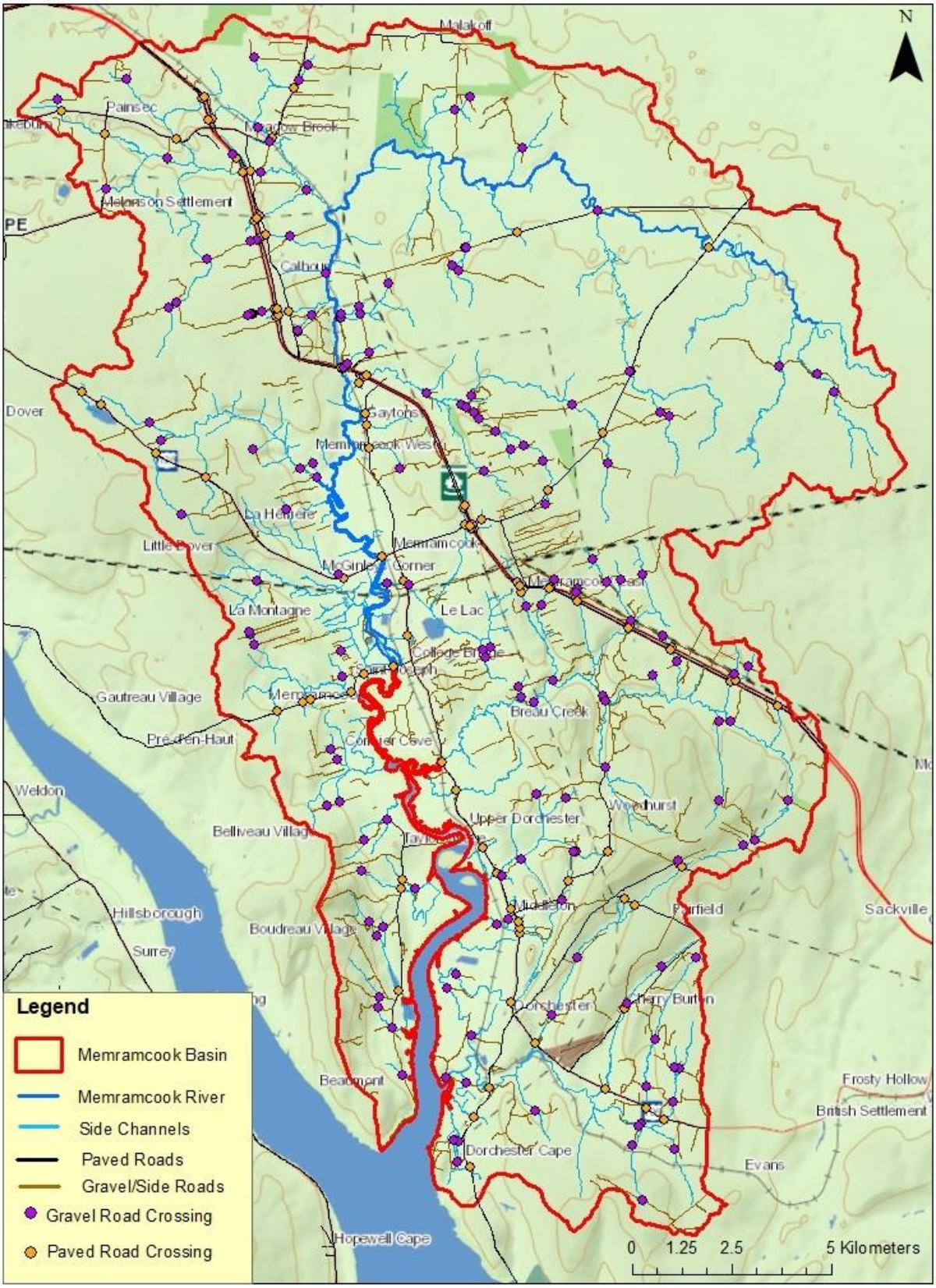


Figure 2-6: Road network and water-crossings within the Memramcook Watershed.

The Petitcodiac Watershed Alliance (PWA) has for several years conducted its Broken Brooks project, in which it surveys water-crossings to note the type of structure present (bridge, culvert, ford, etc.). They assess the condition the crossing is in according to the Atlantic Canadian Culvert Assessment Toolkit (ACCAT) protocol developed by the Adopt a Stream program (sponsored by Nova Scotia Liquor Corporation and the Nova Scotia Salmon Association) to determine if it creates a barrier to fish passage. The PWA has surveyed about 50 crossings per year in the area through this process. Their findings within the Memramcook watershed by the end of 2017 are listed in Table 2.1 (Johnston and Gauvin 2018).

Table 2.1: Water-crossings in the Memramcook Watershed identified and assessed by the PWA

Crossing Type	Quantity	% of total
Culverts assessed	105	62.5
Bridges	10	6
Fording sites	2	1
Not fish habitat	8	5
Not accessible	42	25
Crossing removed	0	0
Dams	1	0.5
Total	168	100

While this doesn't exhaust the full range of crossings identified in Figure 2-6, it provides an excellent beginning, accounting for 60% (136 of the 227) in Figure 2-6, . Of the 105 Memramcook culverts that the PWA completed detailed assessments on, their results (Table 2.2) were quite comparable to what they had seen elsewhere nearby on the Petitcodiac. Well over half of the culverts the PWA surveyed in the Memramcook watershed were determined to be either Partial (20%) or Full (46%) barriers to fish passage. Only 21% of the culverts surveyed in the watershed were classified as passable in respect to fish species attempting to gain access to upstream habitat. Four of these culverts were deemed to be barriers due to blockage by debris, where remediation was possible by clearing the debris in question, and they did so.

Table 2.2: PWA Culvert Assessment Results for the Memramcook Watershed

Barrier	Quantity	% of total
Passable	36	21
Partial barrier	21	20
Full barrier	48	46
Total	105	100

The other major category of transportation infrastructure in the watershed is the railway line, visible as a grey hatched line in Figure 2-6. The Intercolonial Railway (ICR) became the Canadian National Railway (CNR) in 1923, rebranding itself as simply CN in 1960 (CN 2021). The route that the rail line follows today through the watershed is essentially unchanged from 1872 (Dawson 2005). It enters the watershed shortly after Painsec Junction and runs down along Meadow Brook to the main stem of the river. The modern bridge over the Memramcook River (still the only place where it crosses the main

stem) is a short distance above the head-of-tide at Calhoun. It sits immediately downstream of the abutments of an older decommissioned version. The amount of concrete in that older bridge suggests that it was of recent enough vintage to not have been the original bridge at that site either. Further down the line the route roughly parallels the river taking advantage of the flat terrain in the bottom of the valley to maintain an even and low grade. It passes beneath the Trans Canada Highway under the same pair of massive highway bridges as the river, crosses a small bridge over Stoney Creek and emerges from the woods to continue down through Memramcook Corner and College Bridge, both now amalgamated into the Village of Memramcook. The stations at these locations, including the substantial one that had been present at College Bridge are now gone. Though Via Rail passenger service from Halifax to Montreal still exists, there are no stops within the valley. The nearest passenger stations are in Sackville at one end of the line, and Moncton at the other. Today this line is mostly used for freight. Beyond College Bridge, below the causeway on the way to Dorchester there are numerous culverts under the line draining tributaries (Breau Creek in particular) into the Memramcook (Natural Resources Canada 2010). From Dorchester the line curves up along Palmer's Creek, crosses Palmer's Pond with yet another bridge, and continues along the old portage route to Sackville in the Cumberland Basin.

The portion of rail line between College Bridge and Dorchester all runs downstream of the causeway. While Sir Sanford Fleming was noted for not cutting corners during construction of the railway line (Woods 1992), in recent decades problems have emerged with the modern incarnations of the rail line's culverts. The "Dorchester Diversion" presents a somewhat challenging environment, with high tides from the Bay of Fundy backing up tributaries and preventing discharge which can be a problem during spring freshets or after significant rain events. When tides are particularly strong, where there is no aboideau to prevent it the tide will backflow through culverts and up the tributary channel. The narrowing of the River channel below the causeway (Figure 2-4), and the closed gates during the most extreme tides have reduced the volume of incoming water that the channel can accommodate at high tide. On several occasions, most recently in 2014 Turner Creek (CBC 2014) and Breau Creek in 2017 (CBC 2017) portions of the route 106 have been flooded for extended periods of time forcing residents to detour through Sackville to get between the Village of Memramcook and the Village of Dorchester. This happens due in part to complications arising from culverts under the CN line and is often at its worst in years when the spring freshet occurs at the same time as the strongest point in the tide cycle.

Given the prospect of sea level rise due to climate change, this issue is only expected to get worse over time. In it's Climate Change Adaption Plan (Dorchester Municipal Council 2017) the Village of Dorchester specifically notes as "Priority #5" the need to prevent flooding of the rail bed and sections of Rte. 106 between Memramcook and Dorchester. The plan calls for discussions with both the Provincial Government and CN Rail about steps to address this issue. Aside from improving the drainage and raising the level of the road/rail bed, among the solutions noted is upgrading Walker Road to make it a Four-Season road to provides access to the Trans Canada. Currently when Rte. 106 floods in the spring, conditions on Walker Road also tend to be poor due to the exact same weather. Likewise flooding further down along Rte. 106 where it meets Rte. 935 near Westcock (between Dorchester and Sackville) at times can cut off travel in that direction (CBC 2018). This area is also along the rail line, near the mouth of Carters Brook at the other end of the old portage route to the Cumberland Basin.

2.4 Quarry and Mining Practices

While the building stone quarries at Fort Folly Point no longer operate, today there are two large quarries further upstream actively producing crushed stone. In much the same way that location of the quarries at Fort Folly Point were dictated as much by access to sea transport as by quality of material, the location of the two modern quarries, just off of the Trans Canada Highway is no accident. They are visible in Figure 2.1 just above the Trans Canada Highway, one on each side of the river, and in Figure 2.3 labeled as a quarry/gravel pit. They produce crushed stone, barite- a pink to orange coarse grained granite (Government of New Brunswick 2021a). The operation on the west bank of the Memramcook is the Calhoun Quarry, operated by the Miller Group (Miller 2021). Immediately opposite that, on the east bank of the Memramcook operates the Gayton Quarry, owned by J.D. Irving (Gulf Operators 2021). The main stem of the river and the CN Rail line both pass along a narrow corridor between these two operations just before going underneath the Trans Canada Highway bridges.

The copper mine near Dorchester had been closed with the shaft collapsed for safety when it was shut down in 1917, but in 1951 Kennco Explorations (Canada) reopened the main shaft to map the interior and assess commercial viability, but left apparently having found little (MacDonald 2010, Sabina 2015). The most recent mineral report on the deposit was conducted by Falconcrest Resources in 1993 which determined that copper could be extracted through acid and microbial leaching, however no extraction project has since been undertaken (Gilders and Cheung 1993).

There are two companies that hold oil and natural gas leases within the Memramcook watershed. The largest holdings are by Pieridae Production Limited Partnership (Pieridae Energy 2021), primarily on the west bank of the Memramcook below the causeway, between Rockland and Saint Joseph (Government of New Brunswick 2021b). The other, smaller lease within the watershed is held by Orlen upstream Canada Ltd (Orlen Upstream 2021). This lease includes almost all of Fort Folly Point below Beaumont (Government of New Brunswick 2021b). It is unknown how many wells may have already been drilled within these leases, or how active they are. Orlen owns at least one gas well drilled and capped at an adjacent lease that includes Gautreau Village on the Petitcodiac side, so it is likely that other such exploration may have taken place, though there does not currently appear to be active exploitation of the resource within the watershed. In 2014 the Provincial government run by the Conservatives at the time made a clear commitment to promoting shale gas development in New Brunswick (Alward 2014). However, after an election the incoming Liberal government enacted a moratorium on expansion (Government of New Brunswick 2014). Following yet another change in Government in 2018, the new Conservative Government quietly passes regulatory changes to create an exception allowing shale gas development to resume near Sussex (CBC 2019a). However, the proponent there has indicated that the Government has since stated that it is unable to consider applications for an exemption to the moratorium as they undertake a consultation process with New Brunswick First Nations (CBC 2019b). If additional wells are eventually added in the Memramcook watershed, anticipated impacts would include freshwater extraction from streams, habitat destruction and sedimentation for whatever road building is required , and the potential for wastewater spills contaminating surface waters.

2.5 Herbicide and Pesticide Use.

Based on general information available from Service New Brunswick J.D. Irving as Forest Patrol conducts herbicide application in the Memramcook watershed. Within the area of Industrial Freehold forest land owned by J.D. Irving in the upper portion of the watershed (Figure 2.1) signs were posted indicating that recent herbicide application had occurred (Figure 2.7).

Figure 2.7: Sign indicating application of VP480 Herbicide took place September 5th, 2020.

VP480 is a form of glyphosate produced by Corteva Agriscience for nonselective weed control in cropland systems, forestry, and other non-cropland areas (Corteva 2020). 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 (rail, transmission lines, etc.). These companies may have used triclopyr 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 total sales but do not provide a breakdown relevant to individual purchasers. It is difficult to find information of individual grower or vendor pesticide or herbicide use.

2.6 Urban development

Dorchester today has been eclipsed by Sackville and Moncton (Goodrich 2012). Likewise, Saint Joseph lost its college to Moncton when in 1963 what had become the Université Saint-Joseph was relocated as part of its amalgamation with Le Collège du Sacré-Coeur (Bathurst) and Le Collège Saint-Louis (Edmonston) to form the Université de Moncton (Cormier 1975). Saint Joseph and the other Acadian communities of the valley were amalgamated into the Village of Memramcook in 1995 (Provincial Archives of New Brunswick 2020). There has been little residential development directly along the banks of the Memramcook River, though there are scattered houses. Figure 2.3 shows areas of denser settlement in orange, which occur primarily in Dorchester, Saint Joseph, and College Bridge, as well as concentrations here and there along roads. It is all set well back from the riverbanks, and most of it is in the valley bottom closely associated with agriculture as per historic settlement patterns.

Almost no residential development has taken place in the forested part in the north end of the watershed. The exceptions to that are: 1) in the upland east of the Trans Canada Highway (Memramcook East) an area that also saw some agricultural development outside of the valley bottom; and 2) in the Meadow Brook area. The latter is also concentrated in narrow bands along roads, and historically probably tied to upland agricultural development driven by construction of the railway through that area, and more recently as Dieppe has grown, the nearby Romeo Leblanc International Airport and surrounding industrial area. In much the same way that agriculture is notably concentrated in the Memramcook valley bottom, so to is population.

2.7 Fort Folly First Nation

The 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 on December 24th, 1969 when the current Fort Folly First Nation Reserve was established near Palmer's Pond on Rte. 106 on land purchased by Chief Israel Knockwood. 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 Mikmawísimk name for the reserve is Amlamgog, which as noted in the introduction has morphed over time into the name for the watershed "Memramcook". 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. The proximity to Palmer's pond was not a random choice based simply on being close to the community of Dorchester. Bowser (1986) notes that in addition to Fort Folly Point, traditionally there had also been another encampment located in the bottom of the Palmer's Creek valley, along the portage route. The "village indien" on the map produced by Le Rouge (1755) in Figure 1.2 may well approximate such a location. Fort Folly First Nation is also in the process of regaining title to the original reserve land at Beaumont (Fort Folly First Nation 2021).

Third Level Assessment – Aquatic and Riparian Habitat Assessment

3.1 Fish Passage through the Memramcook Causeway

Monitoring movement of fish into the Memramcook River above the causeway took place from May to October 2020 to examine the current state of diadromous fish populations and assess the success of the existing gate management protocol at providing passage between the estuary and the headwaters. Based upon previous experience conducting similar activities next door on the Petitcodiac, it was apparent there would be limited value in continuous sampling at a fixed point, and that a better strategy would be to conduct a series of focused efforts targeting specific species at locations distributed across the watershed spread throughout the field season. The objective was to determine what fish species are present in the Memramcook system today under the current gate management regime to:

1) quantify the consequences of the Memramcook Causeway to the fish community of the river;
2) identify what, if anything, may be gained if changes were to be made.

Prior to construction of the causeway in 1973, the Memramcook River watershed was likely home to the same diverse community of co-evolved diadromous fishes found in most rivers draining into the Gulf of Maine (Saunders et al. 2006). Table 3.1 presents the species documented next door on the Petitcodiac prior to construction of the causeway there in 1968 (Locke 2000). Though less information is available about the historical fish community on the Memramcook, given the proximity of the two rivers, it is reasonable to assume the species mix found there would have been quite similar. The difference in size of the two watersheds suggests that some species on this list may have been either largely absent in the Memramcook (such as sturgeon), or limited users of the upstream habitat (such as striped bass), but it provides a good place to begin when considering what species were likely present historically.

Table 3.1: Pre-causeway fish species list for the Petitcodiac River (from Locke 2000)

Petitcodiac	Diadromous	Freshwater
fished: commercial, recreational, or both	Alewife Blueback herring American shad Rainbow smelt Atlantic salmon Brook trout Atlantic tomcod American eel Striped bass Sturgeon	White perch
not fished	Sea lamprey Threespine stickleback Fourspine stickleback	White sucker Creek chub Lake chub Blacknose dace Northern redbelly dace Blacknose shiner Golden shiner Banded killifish Ninespine stickleback

The Memramcook Causeway lacks a fishway (Wells 1999) to allow passage, which has been acknowledged as problematic for the river. For the last 20 years the two Memramcook causeway gates have been kept continuously open during periods of low tidal amplitude to mitigate the negative impacts of the causeway on the river by allowing limited fish passage during some of the most important parts of the year. Under this regime one or both gates can be kept open for 1 to 2 weeks at a time (Robichaude 2020, Personal Communication). The tidal threshold for closure of the gates is when the Saint John Tide Tables (Canadian Hydrographic Service 2020) forecast a tide more than 7.3 metres (24 feet). It is unclear why Saint John was selected, as there are closer stations (Belliveau Village for example). It may have been arbitrary, based on the familiarity of the person making the choice with Saint John. Regardless, the experience of the gate managers informs them this is the level of tide at which there may be a danger of tidally transported silt blocking structures such as aboideaux upstream of the causeway (Robichaude 2020, Personal Communication). The Memramcook Causeway gates are held closed at those times, again for periods often around 1 to 2 weeks.

Fyke nets were deployed at three sites across the watershed, Memramcook Lake, Folly Lake, and a pool on the main stem of the Memramcook River just above the CN Railway Bridge (Figure 3.1). The lakes were sampled in May to target spawning alewife. The main stem was sampled in June to target spawning blueback herring, spawning sea lamprey and movement of brook trout. The main stem was revisited from mid August to early October to target out-migrating young-of-the-year (YOY) blueback herring, eel movement, and the possibility of returning salmon, though given the lack of a returning wild salmon during 10 years of sampling the Petitcodiac, the later would have been a surprise. Deployment of the nets was structured around forecast tides, to account for gate management by ensuring that the gates were open for much of each sampling period. Actual gate activity relative to fishing is in the Appendix. Electrofishing was also conducted to sample three sites further upstream in the headwaters.

Memramcook Lake is the largest lake in the Memramcook watershed, a natural waterbody covering 0.23 $km^{2.}$, a short distance above the causeway, about 10 m above sea level, approximately 2 km upstream of the river. The net was set at the mouth of the outflow (N 45.989038, W -64.538084) with a lead that spanned much of the channel to guide fish entering or exiting the lake into the wings and mouth of the net. While this did not indicate the direction fish were headed, the goal was detection of presence or absence, and some indication of abundance.

Folly Lake is the second largest lake in the watershed, a natural waterbody covering 0.18 km^2, and located about 90 m above sea level, approximately 8 km upstream of the river at the head of Smith Brook. The net was located at the mouth of the outflow (N 46.038393, W -64.645025) and set like the one at Memramcook Lake. The name Folly Lake has no relation to Fort Folly Point. It was called Smith Lake until the 1930s, when it was renamed for Neil's Folly, a dance hall and restaurant located at the lake along what is now Rte. 106 (Rayburn 1975)

A short distance above the head of tide on the main stem of the Memramcook River two nets were deployed in a pool (N 46.081932 W -64.567422) just upstream of the CN Railway Bridge a little over 10 m above sea level. One net targeted fish headed downstream, while the other targeted those headed upstream. The river at this location was sufficiently narrow that while the chambers of the two nets rested within the deeper water of the pool, the wings closed off the channel. The way for fish to get past this point was to be caught, tallied, and transferred past the opposite net and beyond the pool in the direction of travel.

Figure 3.1: Distribution of fish monitoring activities above the Memramcook Causeway

The three electrofishing sites further upstream were selected based upon road access and site conditions favorable to backpack electrofishing, thus each was associated with a bridge. Bridge C (N 46.19861 W -64.58583) is furthest downstream where the main forest road crosses the main stem. Bridge B (N 46.22556 W -64.73583) is where Rte. 933 crosses the main stem of the Memramcook. Bridge A (N 46.11306 W -65.1625) is furthest upstream, on a side road off the main forest road.

Table 3.2 summarizes the 2020 catch by presenting the 6 diadromous species detected, allowing easy comparison to the suite of 13 diadromous species (Table 3.1) that may have inhabited the Memramcook historically. Table 3.3 presents numbers of these encountered broken down by where they were seen.

Table 3.2: Summary of fish species FFHR detected on the Memramcook in 2020.

Memramcook 2020	**Diadromous**	**Freshwater**
fished: commercial, recreational, or both	Alewife Blueback herring Brook trout American eel	White perch
not fished	Sea lamprey Threespine stickleback	White sucker Lake chub Blacknose dace Golden shiner Banded killifish Brown bullhead (Invasive)

Table 3.3: Total FFHR catch of diadromous and freshwater species in 2020 organized by location.

Location	**Alewife**	**Blueback herring**	**Sea lamprey**	**Brook trout**	**American eel**	**Stickleback**	**Freshwater species**	**Total fish**
Memramcook Lake Fyke Net (May 12th to May 22nd)	61 Adult	0	0	0	2	60	White sucker 323 White perch 1,427 Golden shiner 616 Banded killifish 288 Blacknose dace 2 Brown bullhead 4	2,783
Folly Lake Fyke Net (May 13th to May 22nd)	0	0	0	0	1	0	White sucker 32 Common shiner 97 Brown bullhead 32	162
Memramcook River headed upstream Fyke Net (June 3rd to October 7th)	0	4 Adult 1 YOY	0	1 Adult	1	2	White sucker 69 White perch 4 Common shiner 14 Blacknose dace 176 Lake chub 24	296
Memramcook River headed downstream Fyke Net (June 3rd to October 7th)	0	139 Adult 3 YOY	1 Adult 1 juvenile	2 Adults 17 YOY	3	2	White sucker 25 White perch 9 Common shiner 21 Blacknose dace 230 Lake chub 53	506
Bridge C Electrofishing (September 28th)	0	0	18 juvenile	7	8	5	Blacknose dace 65 Lake chub 55	158
Bridge B Electrofishing (September 28th)	0	0	21 juvenile	4	12	2	White Sucker 1 Common Shiner 3 Blacknose dace 127 Lake chub 16	186
Bridge A Electrofishing (July 15th)	0	0	0	5	11	3	White Sucker 8 Blacknose dace 27 Lake chub 86	140

The existing gate management protocol appears to have been successful at maintaining some degree of fish passage during the last 20 years. Sturgeon and striped bass were not detected, probably because the portions of the river being sampled above the causeway are not habitat they visit with much frequency. This was expected. Sturgeon have yet to be caught at the trap on the Petitcodiac either, despite 11 years of monitoring (Redfield 2021), though they have been sighted in the area. Striped bass are known to utilize the mouth of the Memramcook well below the causeway, as large adults are caught regularly in the lower estuary by anglers near Dorchester (Knockwood, personal communication 2012).

Failure to find rainbow smelt was likely a matter of timing Smelt spawn in April, prior to when fixed trap nets can be safely installed, and so were unlikely to be caught. Early spawning smelt are usually gone from the river by the time water temperatures reach 10 °C, and late spawning smelt by the time it reaches 15 °C (Scott and Crossman 1973). The week that fishing began in May 2020 water temperatures averaged about 9°C, so while encountering smelt was not impossible, sampling was only practical near what would have been the end of their run.

Likewise, Tomcod spawn in January, long after the season ended. Tomcod often arrive prior to that point in September and October, but typically on strong tides (Redfield 2021) precisely the sort that prompts closure of the gates, so tomcod were unlikely to be seen, and may well be largely excluded by the existing gate management regime.

Atlantic salmon and American shad were also not detected, but this was also as expected. Both species were effectively extirpated on the Petitcodiac due to the causeway there (Locke et al 2003), and wider trends across the region. Salmon found on the Petitcodiac currently are the result of ongoing stocking efforts, and there is no comparable effort underway on the Memramcook. Shad are periodically encountered on the Petitcodiac, the last was caught at the trap there in 2018 (Redfield 2021), but like the shad fished commercially in the Petitcodiac estuary, these are thought to be strays originating in other rivers within the Gulf of Maine and probably make little or no use of headwaters above the causeway. Diadromous species encountered above the Memramcook causeway in significant numbers, were alewife, blueback herring, brook trout, American eel, sea lamprey, and stickleback.

Given the ubiquity of alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) in the Petitcodiac, it was reasonable to assume that they probably were spawning above the causeway on the Memramcook, but was unknown where they might do so given other numerous potential barriers to passage between them and their spawning habitat. This work established that spawning alewife can and do access Memramcook Lake. Folly Lake meanwhile does not currently appear to be accessible. Blueback herring (Figure 3.2) do make use of the river channel above the head of tide. Gate closure during the sampling period may have truncated their spawning run somewhat but it is not clear that the arrival of additional adults would have made much difference. 2020 appears to have been a bad year for spawning of blueback herring, as the number of adults caught coming back downstream far outnumbered the numbers of young-of-the-year (YOY) later in the season (Figure 3.3).

Figure **3.2**: Adult blueback Herring caught coming downstream after spawning June 4th, 2020.

Figure 3.3: Young-of-the-year Blueback herring on the Memramcook September 3rd, 2020

Large spawning adult sea lamprey (*Petromyzon marinus*) were observed (Figure 3.4) on the main stem for a second year, suggesting that it is a regular event, corroborated by identification of multiple age classes of juveniles during electrofishing (Figure 3.5). No lampreys were seen in the lakes. Among the juveniles were ammocoetes, filter feeding larval phase lamprey important because they release pheromones which attract spawning adults into the river by providing empirical evidence of spawning habitat upstream (Teeter 1980). Together such observations indicate the Memramcook supports a demographically complex population of sea lamprey capable of recruiting spawning adults in the future.

Figure 3.4: Large (61.2 cm) adult lamprey captured returning downstream June 18th, 2020.

Figure 3.5: Filter feeding ammocoete (top) vs parasitic phase sea lamprey (bottom) captured during electrofishing on September 28th.

Brook trout (*Salvelinus fontinalis*) were seen only on the river, not in the lakes. Observations of brook trout at the fyke nets included both an adult (Figure 3.6) returning upstream in the spring after feeding in either the headpond or estuary, and evidence of recent successful spawning with numerous (17) young-of-the-year (YOY) detected dispersing in the river in search of foraging habitat as they grew to parr size (Figure 3.7). Electrofishing yielded 16 trout (5 parr at Bridge A, 2 parr and 2 older trout at Bridge B, and all parr at Bridge C). None of the bigger than parr sized trout seen were particularly large, but they were comparable to those seen on the Petitcodiac during the same period.

Figure 3.6: Upstream migrating trout caught June 5th, 2020 (Length 20 cm)

Figure 3.7: Trout parr (4 cm) caught coming downstream June 18th, 2020.

American eels (*Anguilla rostrata*) were the only species encountered at every single site (fyke nets and electrofishing) sampled in the Memramcook watershed in 2020 (Table 3.3, Figure 3.1). That said, only 7 eels were seen in the fyke nets: 2 in Memramcook Lake; 1 in Folly Lake; 1 in the Memramcook River upstream net; and 3 in the Memramcook River downstream net. There were 31 eels detected at the electrofishing sites, fairly evenly distributed with 8 at Bridge C, 12 at Bridge B, and 11 at Bridge A. Eels are catadromous, rather than anadromous like gaspereau or salmon, meaning that eels spawn at sea, and spend most of their adult lives in freshwater (Facey et al 1987). Consequently, each subsequent generation must discover and colonize the river anew as juveniles, rather than hatching in it. The distribution of this species throughout the Memramcook watershed is likely indicative of its ability to travel across damp ground and, even up wet vertical surfaces such as dams (as juveniles). When the gates of the Memramcook causeway are closed, it is probably a barrier that can dramatically impede passage of eels. However, the current gate management regime has allowed eels some degree of passage. The presence of eels above the Memramcook causeway had previously been noted in 2019 both during geophysical surveys and electrofishing. The goal in 2020 was to get a better idea of the distribution of eels within the watershed and to assess their movement.

Eels have experienced widespread declines across their range (Castonguay et al. 1994; Pratt and Mathers 2011). Given that and the traditional cultural significance of this species for the Mi'kmaq, eels warrant interest beyond that assigned to other species encountered. Blocked or reduced passage in rivers has been identified as one of the factors contributing to these declines (Haro et al. 2000). Accordingly, eels were designated as a species of "Special Concern" in 2006 by COSEWIC (COSEWIC 2006). The status of eels was re-examined and raised to "Threatened" in May 2012 (COSEWIC 2014). Eels are the only diadromous species detected above the Memramcook causeway with such status, though acknowledgement of this sort does not offer protection. Public consultations held November 23rd, 2015 to March 28th, 2016 evaluated the listing of American eels under the Species at Risk Act, SARA (SARA Registry 2015a; SARA Registry 2015b). Currently, however, eels have no special status (SARA Registry 2019).

While gates of the Petitcodiac causeway were closed, eels were one of the few diadromous species that demonstrated the ability to navigate the fishway (Locke et al 2003). Despite that there is ample evidence that eels have benefited from the permanent opening of the causeway gates. Electrofishing data in the Petitcodiac headwaters shows a progressive increase in eel biomass since the gates were opened. At the Petitcodiac trap site records were broken yearly for the size of the largest individual eel for 5 consecutive years (2014 through 2018). With the Petitcodiac causeway gates open, eels have improved mobility, allowing them opportunities to undertake seasonal migrations; overwintering in freshwater, moving to the estuary to feed in summer, and returning upstream in fall. This allows them to be more successful – optimizing their behaviour in ways that were less available to previous generations of Petitcodiac eels while the gates were closed (Redfield 2021).

Currently, eels on the Memramcook have some similar degree of mobility with their gates periodically open. However, eels use rising tides to facilitate their movements upstream (Dutil et al. 1988). Consequently, closure of the causeway gates to hold back the strongest tides on the Memramcook cuts off movement of eels during precisely the times that the most movement would be expected to occur.

With so few eels encountered, there are limited conclusions that can be drawn based on the fyke net data, beyond their distribution throughout the watershed. The eel in Folly Lake was noteworthy for providing evidence of some degree of connectivity via Smith Brook between Folly Lake and the rest of the watershed, but given the unique mobility of eels, this was not surprising. Though this individual was not particularly large compared to eels caught on the Petitcodiac (Redfield 2021) at 40 cm it was bigger than any of the 6 other eels caught in the fyke nets at other locations on the Memramcook during 2020. It was also larger than any of the 31 eels caught during electrofishing on the Memramcook in 2020. The only Memramcook eel seen so far that has been bigger (55.1 cm) than this Folly Lake eel was encountered during electrofishing on the Memramcook main stem at Bridge A in 2019. Of the 31 eels caught during electrofishing in 2020: 15 were shorter than 15 cm; 9 were between 15 and 25 cm long; and 6 were longer than 25 cm (the largest being 30.5 cm).

Rates of capture for sticklebacks (multiple genera, not differentiated) were inline with expectations (low) throughout most of the watershed apart from Memramcook Lake, which was unusually rich in sticklebacks, with 60 caught, 2% of what was in that net. This one site accounted for 81% of all the sticklebacks detected within the Memramcook watershed in 2020 (fyke net and electrofishing data combined). Several species of stickleback may have been present in Memramcook Lake. Threespine stickleback, is the species of particular interest, as it can be anadromous, and may have been spawning during the period sampled. Sticklebacks were not identified to species because there had not been an expectation that threespine stickleback would be encountered in sufficient numbers to make doing so worthwhile. Given the results in Memramcook Lake, and the availability of a newly published field guide (Gautreau and Curry 2020) to aide in reliably doing so, an attempt will be made during future work planned for 2021 to identify threespine stickleback so that they can be better quantified.

Finding brown bullhead in both lakes was not surprising, but it was notable as the first time this species had been documented in the Memramcook Watershed. Whether this was a result of natural spread or recent introduction by humans (as on the Petitcodiac), it is reasonable to conclude that the species is now well established and a permanent part of the river community above the Memramcook causeway.

3.2 Water quality Monitoring

The Petitcodiac Watershed Alliance (PWA) has been monitoring water quality across the region, including the Memramcook watershed for decades. As one of their contributions to this project they increased the frequency at which seven sites in the Memramcook were sampled from monthly to weekly (Cormier and Thongboonmee 2021). All of these sites but one are located above the causeway within the freshwater reaches of the river (Figure 3.8). Along the main stem of the river this includes one site at the bridge (Bridge B) near the top of the system where Rte. 933 crosses the main stem of the Memramcook (Memramcook River Upper), and one site a short distance below the head-of-tide where the Trans Canada Highway crosses the river (Memramcook River Lower). Tributaries with sample sites above the causeway include Memramcook River South Branch, Smith Creek (aka Smith Brook), Meadow Brook, and Stoney Creek. Breau Creek, the only site below the causeway is a freshwater site as well, on the largest tributary in the watershed not blocked off by the causeway.

They visited each at one-week intervals from May 7th to October 26th to record the following parameters: Air Temperature, Water Temperature, Dissolved Oxygen (DO), E. Coli, pH, Total Dissolved Solids (TDS), Nitrates, Phosphates, Total Coliforms, Conductivity, and Turbidity. Table 3.4 provides an indication of what this looks like. Plots of several parameters are in Appendix B.

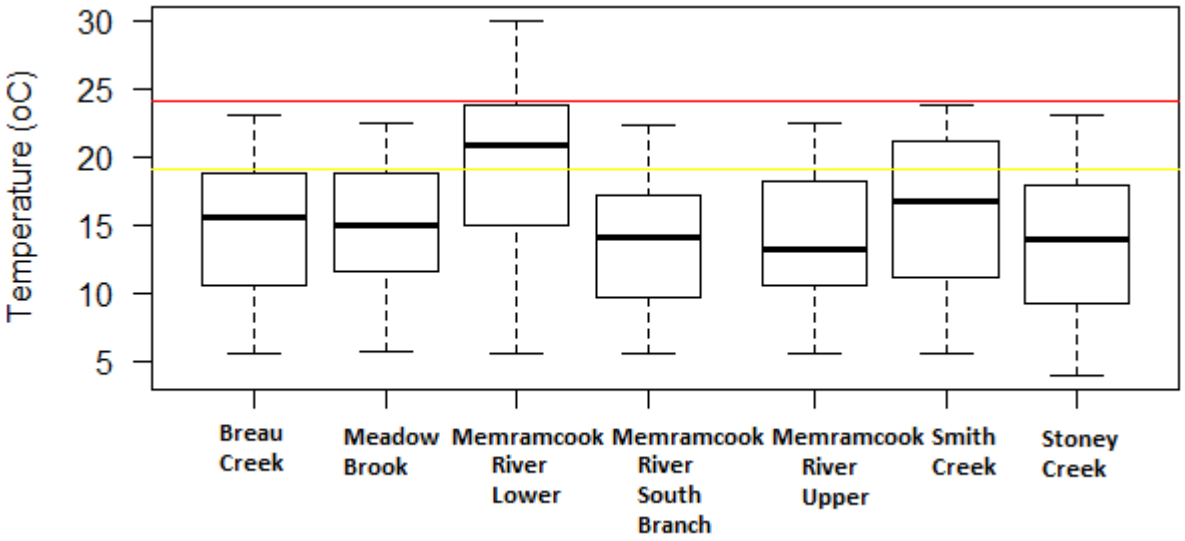
Figure 3.8: Water Quality monitoring sites on the Memramcook and its tributaries.

Table 3.4: PWA Water Memramcook Water Quality May 7th, 2020 (Cormier and Thongboonmee 2021).

Site	Time	Air Temp ℃	Water temp ℃	Dissolved Oxygen mg/L	E. coli MPN	pH	Salinity ppt	TDS mg/L	Nitrates mg/L	Phosphates mg/L	Total Coliforms MPN	Specific Conductivity	Turbidity
Memramcook River Upper	12:30 pm	14	7.1	14.2	14.6	6.51	0.01	13.65	0.830	0.08	461.1	21	0.49
Memramcook River South Branch	11:55 am	12	6.5	13.9	7.2	7.15	0.01	14.95	0.479	0.15	686.7	23.5	1.99
Meadow Brook	1:40 pm	16	8.2	13.4	17.3	7.45	0.06	78.65	0.52	0.16	648.8	121.4	4.51
Memramcook River Lower	1:00 pm	14	8.6	13.7	17.1	7.23	0.02	31.85	0.461	0.02	461.1	49	4.29
Stoney Creek	11:00 pm	16	5.6	14.9	10.8	7.8	0.03	39	0.403	0.00	410.6	59.5	2.07
Smith Creek	11:30 am	6.2	5.5	12.1	13.5	6.74	0.03	36.4	0.54	0.02	579.4	56	2.88
Breau Creek	12:51 pm	24.3	11	13.3	15.8	8.11	0.04	61.1	0.158	0.22	980.4	93.9	2.16

Taken on an individual day, this data provides snapshot in time. However, at weekly intervals over the entire field season it provides a clearer understanding of conditions, and how they differ from one site to another. In Figure 3.9 one can see that water temperature is fairly homogenous at most sites, and generally remains relatively cool across the season. The two exceptions to this are Memramcook River Lower (just below the head of tide) and the mouth of Smith Creek (also subject to tidal influence. Both sites are also more open and exposed as compared to the others which are mostly under forest cover.

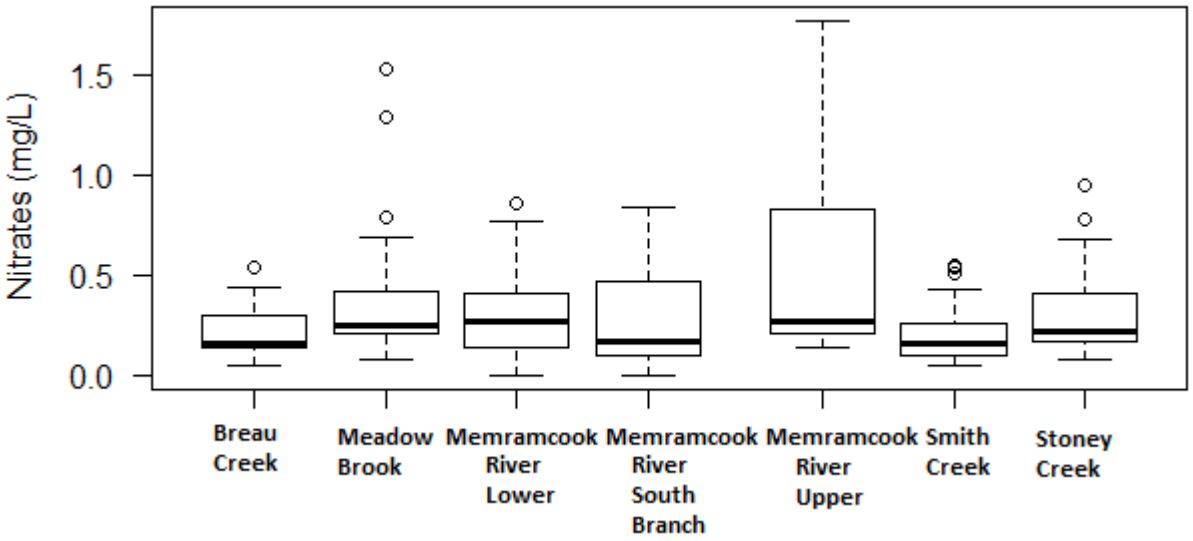
Figure 3.9: Water temperature at monitored sites during the 2020 field season



Yellow line: the maximum weekly average temp (19°C) for the protection of aquatic life. Red Line: Long term Lethal Limit (24°C).

Nitrates reveal another difference between sites (Figure 3.10), where the Memramcook River Upper site is well beyond others. This might seem odd in the midst of a forested part of the watershed. However, that is true of most sites. What sets the Memramcook River Upper site apart from the others is likely the type of forest management, as the woods surrounding it are dominated by Industrial Freehold forest, rather than private woodlots. It is likely that the more intensive management produces a greater degree of disturbance which increases the rate at which nitrates leach out of those forest soils.

Figure 3.10: Nitrates at monitored sites during the 2020 field season



3.3 Canadian Aquatic Biomonitoring Network (CABIN) sampling

Fort Folly Habitat Recovery (FFHR) utilizes the Canadian Aquatic Biomonitoring Network (CABIN) protocol (Environment Canada 2011) as another means of monitoring water quality and variations in habitat quality. The goal of benthic macro-invertebrate biomonitoring is to preserve ecological integrity and sustainability of water systems. The water quality monitoring in section 3.2 collects data on various elements of the river such as dissolved oxygen, pH, conductivity, and dissolved solids as shown in Table 3.4. Biomonitoring helps fill the gaps that water monitoring may overlook as measuring such parameters quantify very specific conditions during only a snapshot in time. Nor is it possible to test for all substances of concern at all sites. Biomonitoring meanwhile accounts for cumulative effects of pollutants or measures habitat degradation. The health of the organisms or presence/absence of certain species reflects the water quality available for various fish species, and also provide insight into forage available to fish.

Benthic macro-invertebrates are used for biomonitoring because they are easy to collect, universal, relatively long lived, have well developed protocols, and they reflect the effects of contaminants or disturbance at a site. Mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) are used as indicators, referred to as EPT, and are sensitive to polluted waters. The presence or absence of these species is used to reflect the water quality. In general, well-balanced and diverse communities indicate good stream health while a community dominated by few taxa suggests some type of environmental stress in the region (Barbour et al. 1999).

The same three sites on the main stem of the Memramcook River used for electrofishing were also used for CABIN sampling- Bridges A, B, and C (Figure 3.1). By acquiring water quality data, fish data and benthic macro-invertebrates (through CABIN and electrofishing) for these three sites, a bigger picture of the health of these sites can be determined. Land use along the river consists largely of clear cutting, which is likely to disturb the surrounding riparian habitat, and cause sedimentation in the watercourse which may influence water quality and fish habitat.

EPT species are typically the most sensitive to habitat disturbance, and even distribution and high numbers serve as good indicators of water quality. The Shannon-Weiner Diversity Index is used in CABIN biomonitoring to assess the number of taxa present in a region and their abundance is scaled from 0 to 5, with higher being better. The Shannon Index increases as both the richness and evenness of the community increase. The Shannon-Weiner Diversity Index was calculated for all sites and Table 3.5 states the overall Shannon Index associated with each site in 2020. The overall Shannon-Weiner Diversity of all sites were moderate values, within the 2's, ranging from 2.38 to 2.53. Numbers of EPT species at both Bridge A and Bridge C were low compared to Bridge B.

In regard to the effective number of species (ENS), the three sites on the Memramcook River ranged from 10.86 to 12.57 (Table 3.5). These values represent the number of species in a community with equally common abundances. ENS values are not necessarily ranged from "good to bad", but rather are used to compare sites within a river from year to year. That is to say if values change drastically between years it can be assumed that the benthic community is undergoing stress, and if the values are relatively similar year to year it can be assumed the benthic community is relatively stable.

Equitability considers how evenly distributed numbers are between taxa, scaled from 0 to 1, with higher indicating more diversity and thus less stress.. On the Memramcook River values of equitability ranged from 0.72 to 0.86 (Table 3.5). These values indicate that the benthic communities at each site experience similar levels of stress.

Table 3.5: Overall EPT populations and diversity indexes calculated for FFHR CABIN sites.

Site	Ephemeroptera (Mayflies)	Plecoptera (Stoneflies)	Trichoptera (Caddisflies)	Shannon-Weiner Diversity	Equitability	ENS	%EPT Abundance
Bridge A	4	0	6	2.385178352	0.86027125	10.861	33.33333333
Bridge B	228	154	1072	2.480834818	0.72243566	11.95124	49.82864976
Bridge C	7	11	33	2.531499418	0.73718953	12.57234	26.99619772

The percent abundance of EPT taxa (calculated as the sum of all EPT taxa over the sum of all species in the community) at each site was calculated as a way of measuring its overall health. As EPT taxa are sensitive to pollutants, it is thought that a higher percentage of EPTs indicates cleaner water, and thereby a healthier system. Overall, it was found that all sites within the study area had moderately good system health with Bridge C having the lowest EPT taxa abundance at 27%. Bridge A and B had an EPT abundance of 33.3% and 49.8% respectively.

Benthic macro-invertebrate diversity and EPT data from 2019 was compared to assess the change in site health over time. Figure 3.11 and Figure 3.12 show the comparison of Shannon-Weiner Diversity values and EPT species percentage for each site between 2019 and 2020. Shannon-Weiner Diversity increased at Bridge B, and decreased at Bridge A. The values at Bridge C were slightly lower in 2020 but essentially consistent. It can be determined from these values, again on a scale of 0 to 5 that all sites are still in moderately good health. Overall, EPT species abundance decreased at both Bridge A and Bridge C in 2020 relative to 2019 with Bridge B being the exception.

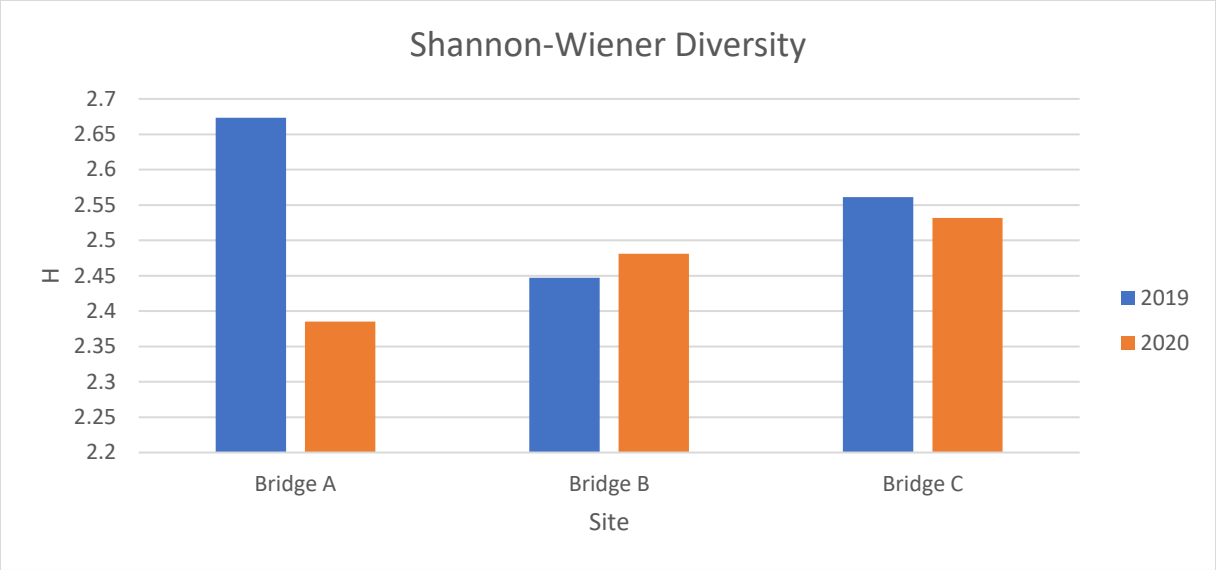


Figure 3.11: Comparison of Shannon-Weiner Diversity at three CABIN sites between 2019 and 2020

The relative instability in Shannon-Weiner Diversity, EPT taxa abundance and ENS values at Bridge A compared to Bridge B and Bridge C could be attributed to the higher concentration of clear and partial cutting surrounding this site which leave this site more susceptible to sedimentation and thereby decrease water quality at this site. Between CABIN monitoring in 2019 and in 2020, Hurricane Dorian impacted the region. It delivered 121.3 mm in 24 hours (the largest rainfall event in the last 10 years) and destroyed a large beaver dam a short distance above Bridge A. Runoff may have been amplified by harvesting, and the resulting dam failure may have created disturbance which influenced the results.

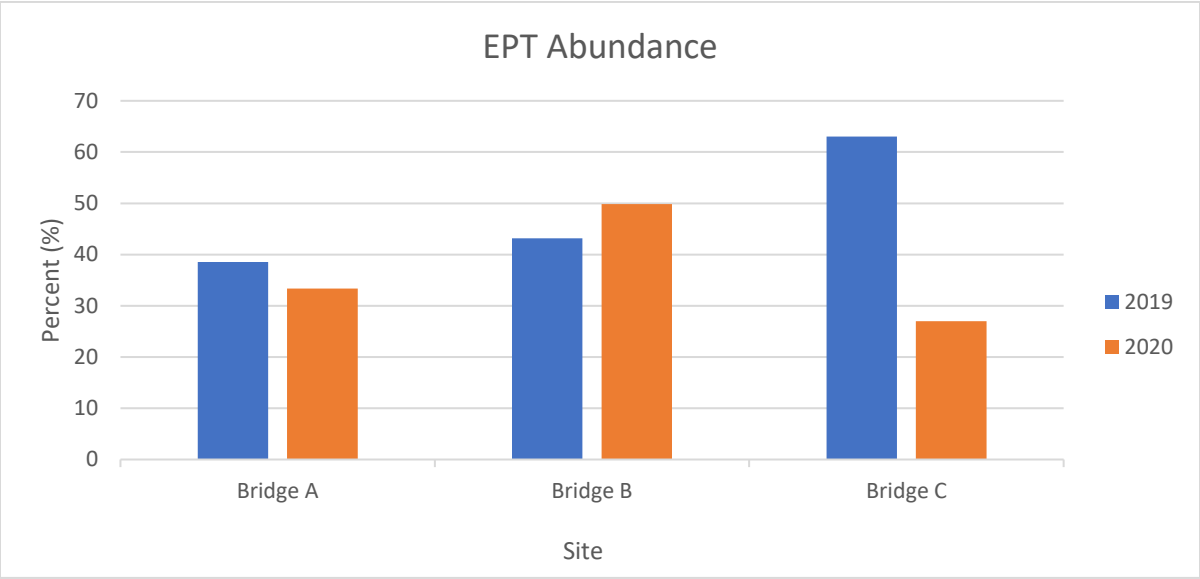


Figure 3.12: Comparison of EPT taxa abundance at three CABIN sites between 2019 and 2020.

Conditions at Bridge B may be better than at the other two sites because it is not in close proximity to the Gayton Quarry and the surrounding forest at this site has not been as heavily cut compared to that surrounding Bridge A.

Effective number of species was also compared to 2019 values at each site. ENS values increased slightly since 2019 at the Bridge B site, decreased markedly at Bridge A, and were essentially unchanged at Bridge C (Figure 3.13).

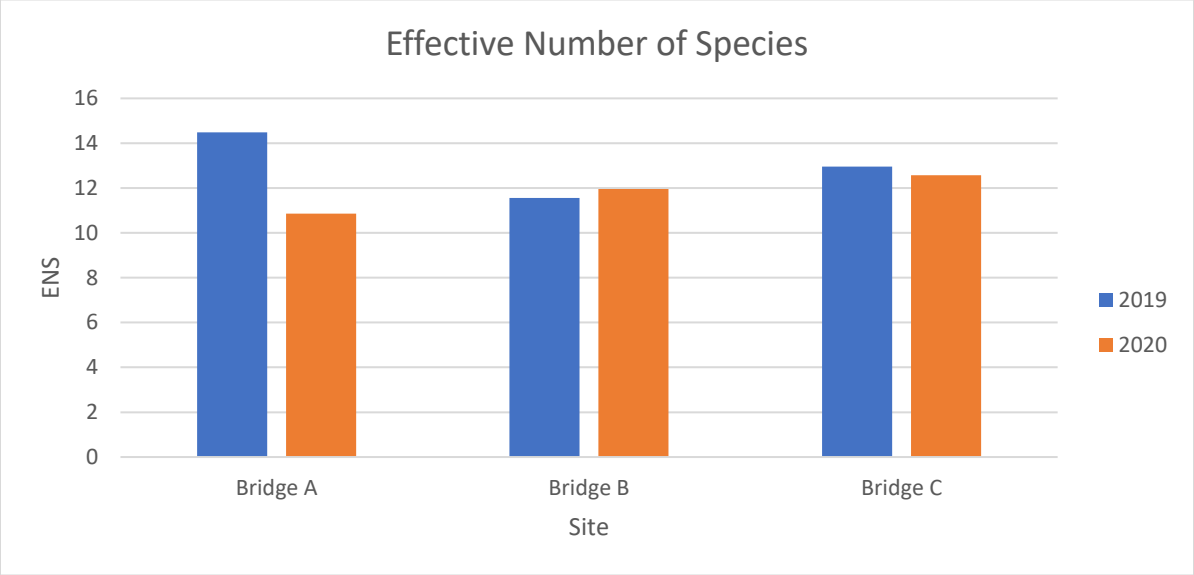


Figure 3.13: Comparison of effective number of species at three CABIN sites between 2019 and 2020

3.4 Rapid Geomorphic Assessment (RGA) and Rapid Stream Assessment (RSAT)

The following is taken from a report prepared by 5R Environmental based upon the rapid geomorphic assessments (RGAs) and rapid site assessments (RSATs) data collected on the Memramcook River between July 17th and August 01st, 2019 by Fort Folly Habitat Recovery.

This rapid geomorphic assessment of the Memramcook River was conducted on a stretch of the river starting at the confluence of the South Branch Memramcook River and the Memramcook River and continued downriver approximately 26.45 kilometres to where the Memramcook River flows under the Trans Canada Highway, as shown in Figure 3.14. This methodology is of limited utility in the silt and saltmarsh dominated conditions that predominate below the head-of-tide, which extends a short distance above the quarries. Consequently, the survey ended at the Trans Canada Highway. Given a focus at this time on the main stem of the river above the causeway, significant tributaries such as Breau Creek were likewise not part of this survey. This area is primarily forest, approximately half which is private woodlots (Figure 2.1) and the other half of which is industrial freehold owned by J.D. Irving. There is also a small amount of scattered crown land.

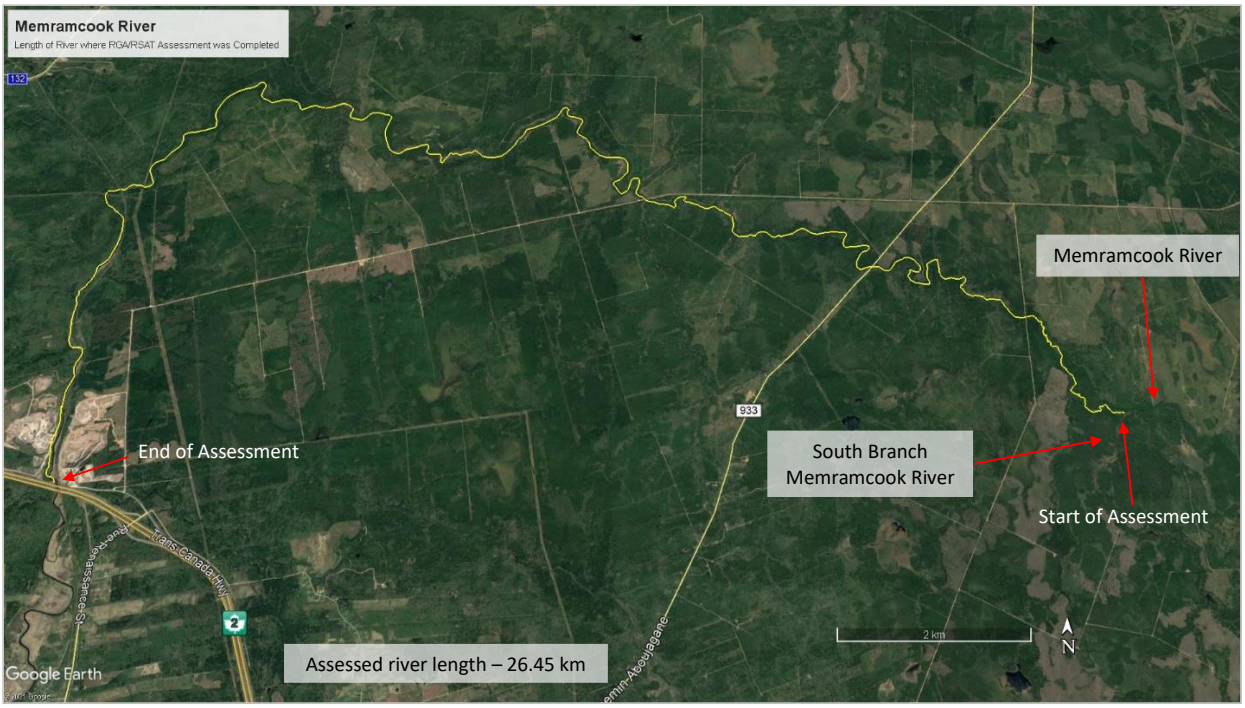


Figure 3.14: RGA/RSAT Assessed Section of the Memramcook River

Geomorphic Assessment

The method of Rapid Geomorphic Assessment (RGA) was used to determine the geomorphic condition and stability of the assessed sections of the Memramcook River. The assessed section of river was divided into 40 reaches based on substrate and geological features, gradient, meander pattern, and instream structures that influenced the hydraulic regime and flow of the river. In order to view the geomorphic data, the watercourse is highlighted according to reach stability and dominant geomorphic processes. The geomorphic processes identified were aggradation, degradation, channel widening, and planform adjustment.

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. Some indicators of 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 this 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 also be seen with degradation, as it occurs with an increase in flows or decrease in sediment supply. Widening ultimately occurs because the stream bottom materials eventually become more resistant to erosion (harder to move) by the flowing waters than the materials in 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 smaller watershed with a high percentage (>10%) of impervious surface (urban land use)

Planimetric 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 of planform change 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 alignment
- Change or loss in bed form structure, 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 meander bends)
- Thalweg not aligned 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 stray from this pattern.

Channel Stability Index

The channel stability index is a key piece of data obtained from the RGA. This is based on the degree of departure of the channel from its reference stream type and is evaluated by the magnitude and combination of adjustments underway in the stream channel. Upon completion of the field inspection, indicators were tallied by category and used to calculate an overall reach stability index. There are three stability classes that refer to altered sediment and flow regimes (Table 3.6).

Table 3.6: Channel Stability Index Ratings

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

Geomorphic Conditions of the Assessed Reaches of the Memramcook River

The section of the Memramcook River that was assessed to understand the geomorphic conditions and function was divided into 40 reaches. Reaches are distinguished, for the purpose of a geomorphic assessment by some natural or man-made feature that has an influence on the hydrology of the system. This could be a bridge, culvert, rock outcrop, change in geology, change in the meander pattern, or the confluence with another watercourse. Of the ten reaches that were identified for this project, not all appear to exhibit the characteristics that would influence the hydrology of the river. Together, Figure 3.15, Figure 3.16, Figure 3.17, and Figure 3.18 identify the reach locations on the section of the Memramcook River that was assessed.

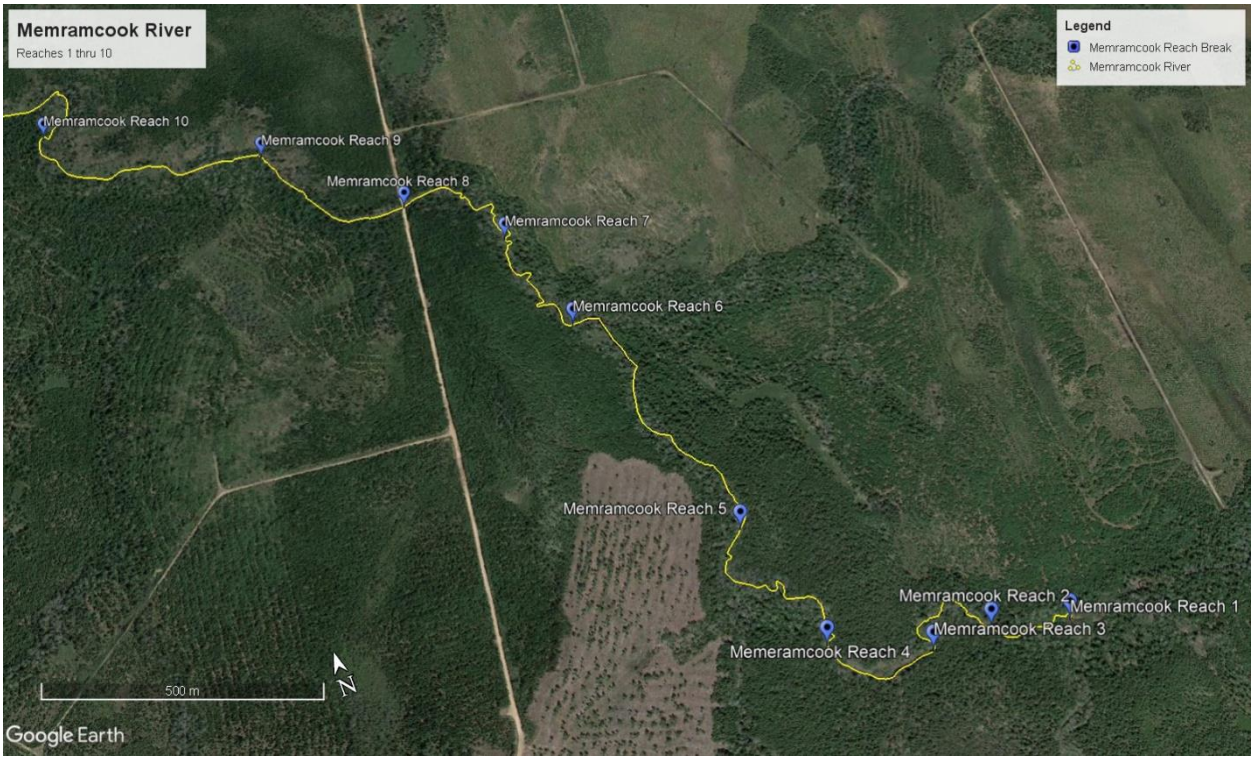


Figure 3.15: Locations of Reaches 1 to 10 on the Memramcook River

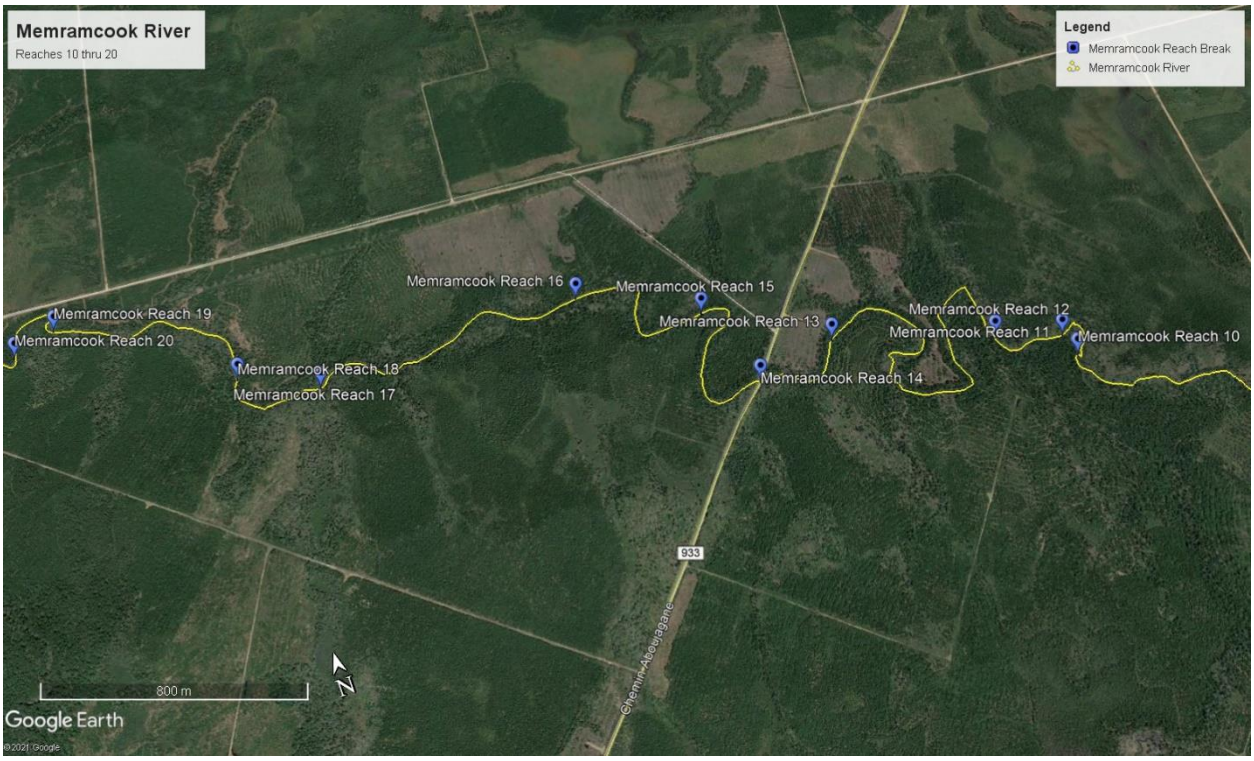


Figure 3.16: Location of Reaches 10 to 20 on the Memramcook River

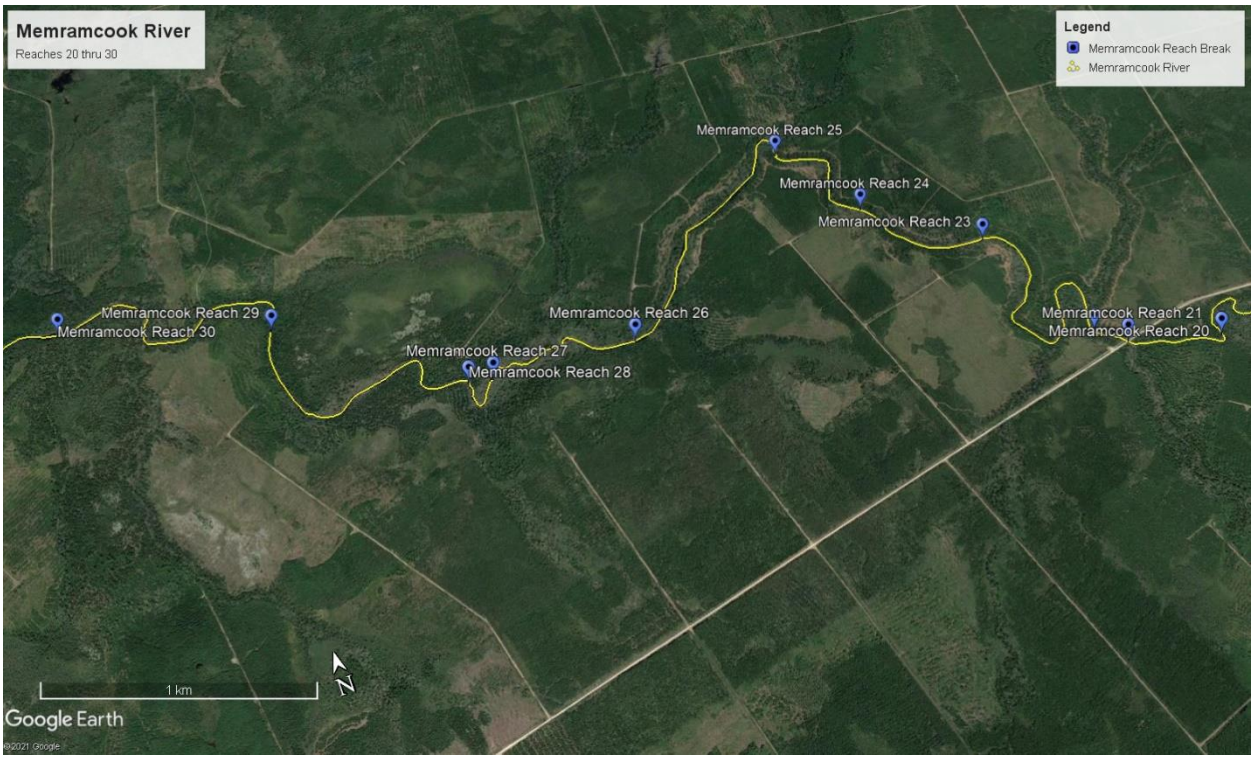


Figure 3.17: Location of Reaches 20 to 30 on the Memramcook River

Figure 3.18: Location of Reaches 30 to 40 on the Memramcook River

Based on the selected reach locations, the results of the 2019 geomorphic assessment indicates that the assessed sections of the Memramcook River are either in a state of transition/stressed or in adjustment. Figure 3.19 provides a graphical view of the stability index of the reaches. Approximately 12.5% or 3.31 km of river length assessed is considered to be in a state of transition or stress meaning that the river is either moving into an adjustment phase or towards a state of regime (somewhat stable or at least as stable as dynamic watercourses can be). The RGA data suggest that Reaches 7, 23, 3, 21, and 36, the reaches identified to be in a state of transition/stressed, with the exception of Reach 7 are trending towards a state of adjustment. Reach 7 appears to be moving in a direction of channel regime given that the RGA data indicates that the geomorphic channel processes indices are all under 50% of occurrence. The remaining assessed river length of 23.14 km or 87.5%, as previously mentioned, is in a state of adjustment. The RGA data for these reaches show that at least two, and more often than not three out of the four of the geomorphic processes have indicators that occur more than 50% of the time in each reach. Figure 3.20 shows the stability index of the section of the Memramcook River assessed, while Table 3.7 lists the reaches and highlights the primary geomorphic process dominating each reach as well as the stability index of each reach.

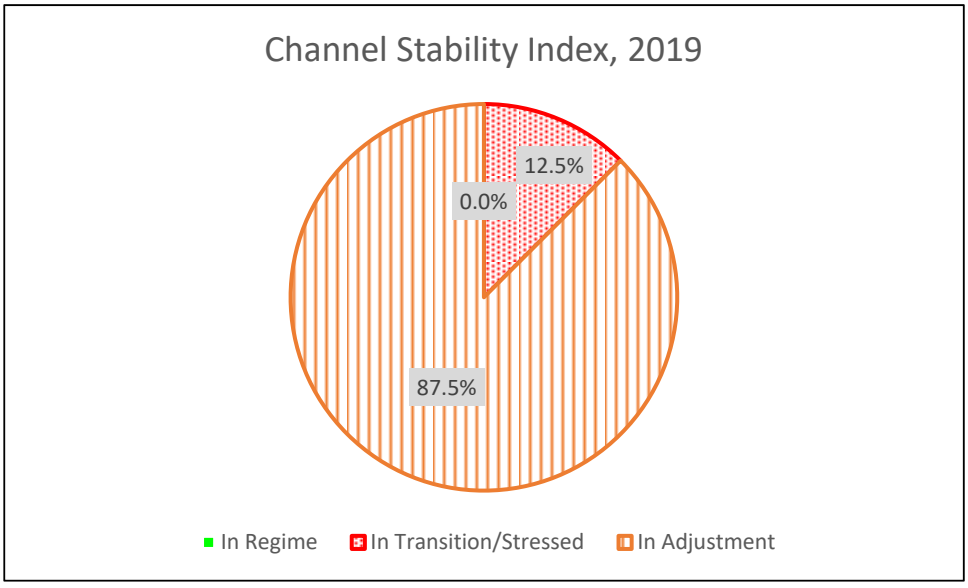


Figure 3.19: Channel Stability Index of the Assessed Section of the Memramcook River

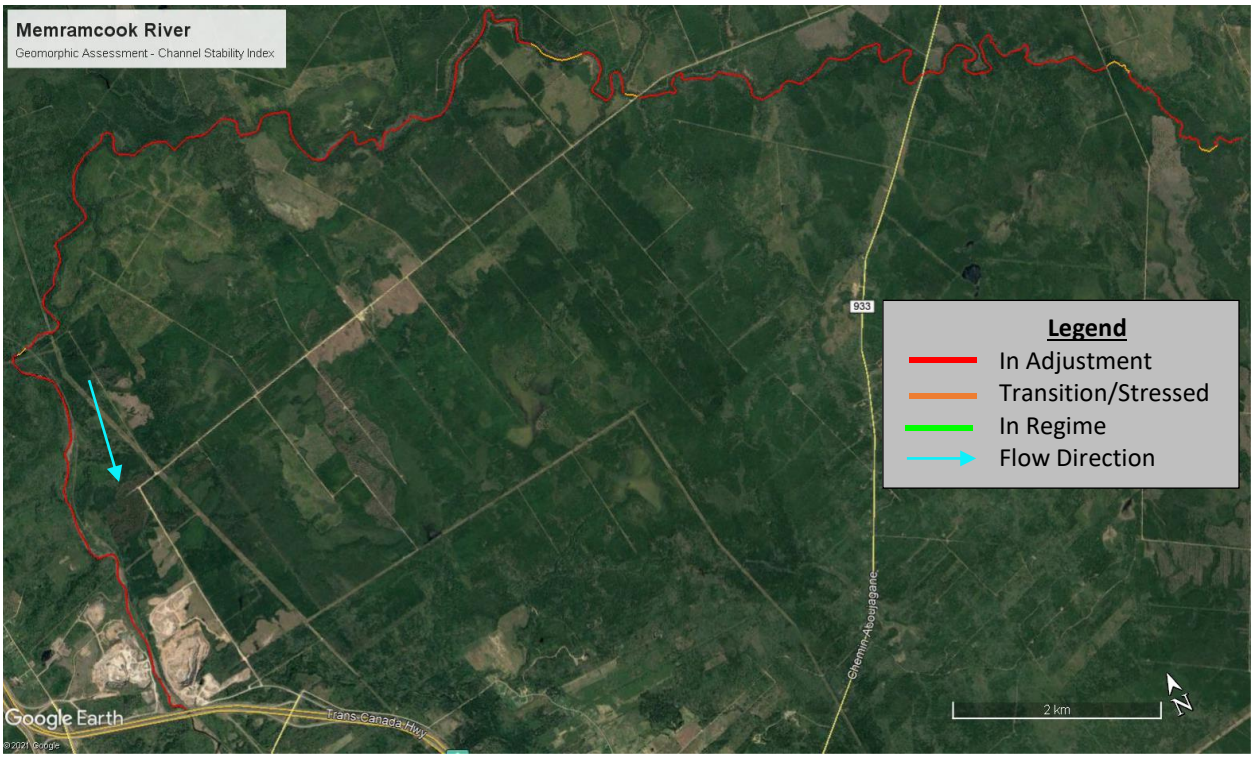


Figure 3.20: Stability Index on the Assessed River Length of Memramcook River

Table 3.7: Primary Geomorphic Process for each Reach assessed on the Memramcook River

Site	Aggradation	Degradation	Widening	Planimetric Adjustment	Stability Index	Site	Aggradation	Degradation	Widening	Planimetric Adjustment	Stability Index
Reach 1	0.556	0.429	0.750	0.143	0.469	Reach 21	0.222	0.714	0.250	0.286	0.368
Reach 2	0.222	0.714	0.625	0.143	0.426	Reach 22	0.889	0.714	0.750	0.429	0.695
Reach 3	0.556	0.286	0.500	0.143	0.371	Reach 23	0.556	0.286	0.500	0.143	0.371
Reach 4	0.556	0.571	0.500	0.286	0.478	Reach 24	0.444	0.571	0.500	0.143	0.415
Reach 5	0.778	0.429	0.625	0.000	0.458	Reach 25	0.444	0.571	0.625	0.143	0.446
Reach 6	0.889	0.143	0.500	0.429	0.490	Reach 26	0.556	0.429	0.625	0.143	0.438
Reach 7	0.556	0.286	0.500	0.143	0.371	Reach 27	0.556	0.571	0.625	0.143	0.474
Reach 8	0.556	0.429	0.750	0.143	0.469	Reach 28	0.889	0.429	0.750	0.143	0.553
Reach 9	0.222	0.714	0.625	0.143	0.426	Reach 29	0.778	0.571	0.625	0.286	0.565
Reach 10	0.444	0.714	0.625	0.143	0.482	Reach 30	0.889	0.429	0.500	0.000	0.454
Reach 11	0.556	0.571	0.750	0.143	0.505	Reach 31	0.889	0.286	0.875	0.286	0.584
Reach 12	0.556	0.429	0.750	0.143	0.469	Reach 32	0.667	0.571	0.750	0.286	0.568
Reach 13	0.444	0.429	0.750	0.143	0.441	Reach 33	0.889	0.286	0.500	0.286	0.490
Reach 14	0.778	0.571	0.875	0.143	0.592	Reach 34	0.889	0.429	0.500	0.429	0.562
Reach 15	0.333	0.571	0.750	0.000	0.414	Reach 35	0.667	0.571	0.625	0.571	0.609
Reach 16	0.556	0.714	0.875	0.571	0.679	Reach 36	0.444	0.286	0.375	0.000	0.276
Reach 17	0.556	0.571	0.625	0.143	0.474	Reach 37	0.778	0.429	0.875	0.571	0.663
Reach 18	0.444	0.571	0.625	0.286	0.482	Reach 38	1.000	0.571	0.875	0.429	0.719
Reach 19	0.556	0.571	0.625	0.143	0.474	Reach 39	0.667	0.143	0.750	0.286	0.461
Reach 20	0.444	0.714	0.875	0.286	0.580	Reach 40	0.889	0.286	0.750	0.143	0.517

The dominant primary process occurring was noted to be channel widening, which was observed in 18 of the 40 reaches. This equates to 45% of the assessed section of the Memramcook River undergoing

channel widening. This is followed closely by channel aggradation, which was observed in 40% or 16 of the assessed reaches. Channel degradation was determined to be occurring in six of the reaches or on 15% of the assessed channel. When referring to channel length this breaks down as 12.92 km where channel aggradation is occurring, 11.31 km of channel widening, and 2.20 km of channel degradation as the primary geomorphic process. Figure 3.21 shows the primary geomorphic process that were dominated for the 2019 Memramcook River assessment.

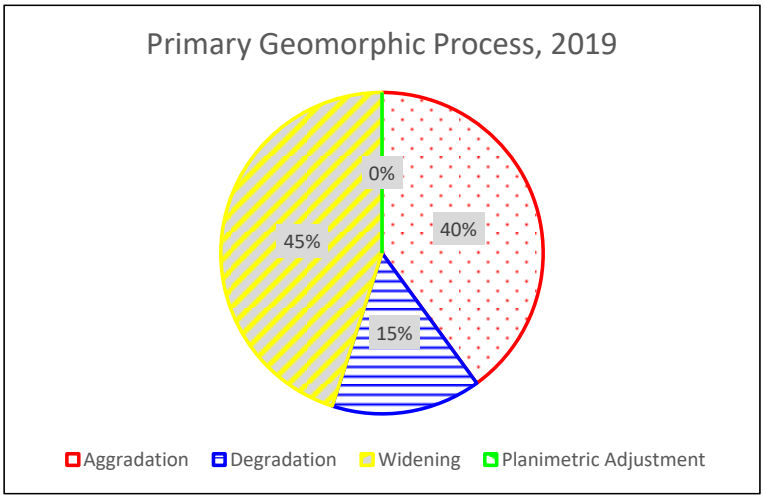


Figure 3.21: Primary Geomorphic Processes Occurring of the Memramcook River, 2019 Assessment

Figure 3.22 illustrates the geomorphic processes occurring at each reach of the assessed section of the Memramcook River during the 2019 assessment.

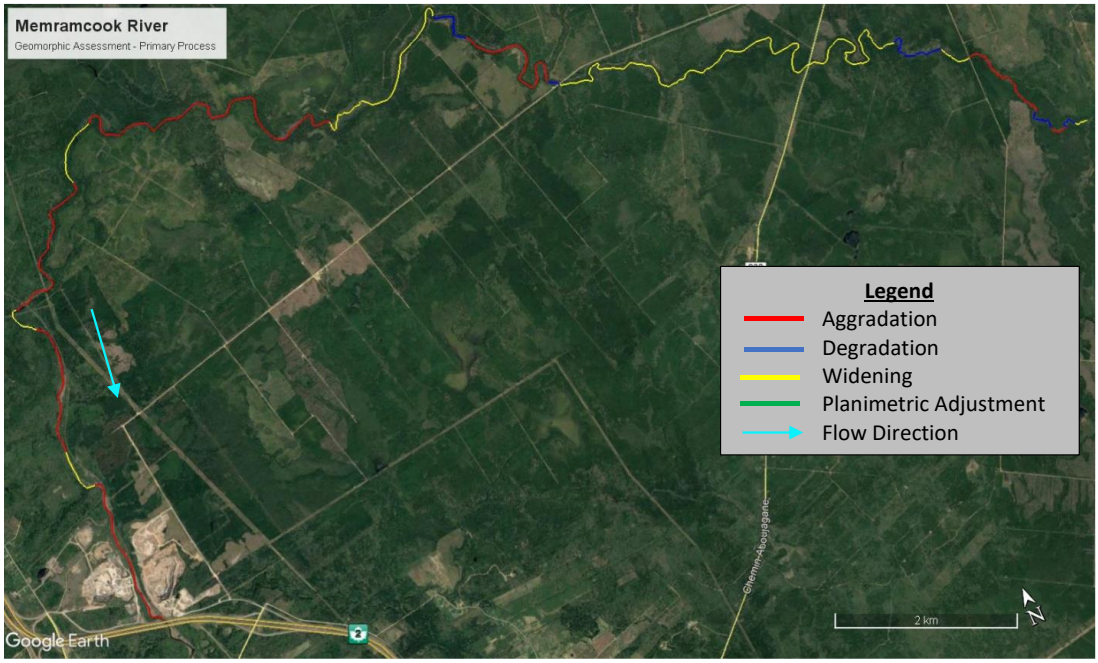


Figure 3.22: Primary Geomorphic Process at each Assessed Reach of the Memramcook River

The secondary geomorphic processes, which are important to understand in conjunction with the primary processes, particularly when it comes to using this information to assist in selecting instream habitat improvement features and channel enhancement locations, are identified in Table 3.8 for the assessed reaches of the Memramcook River. The secondary processes are highlighted in a lighter shade compared to the primary processes.

When the indices numbers for each geomorphic process in a reach are in close range, attention should be given to any habitat restoration or channel enhancement plan for that reach to ensure that the proper technique or feature used for the enhancement or restoration does not significantly alter one process above the others. An example would be Reach 4. Aggradation, and channel widening are within 0.015 to 0.071, respectively from the dominant process of channel degradation. Instream habitat restoration or channel enhancement efforts would need to consider techniques that would balance channel function and not increase channel scour, channel deposition, or channel widening.

Table 3.8: Primary and Secondary Geomorphic Process on the assessed portion of the Memramcook

Site	Aggradation	Degradation	Widening	Planimetric Adjustment	Stability Index	Site	Aggradation	Degradation	Widening	Planimetric Adjustment	Stability Index
Reach 1	0.556	0.429	0.750	0.143	0.469	Reach 21	0.222	0.714	0.250	0.286	0.368
Reach 2	0.222	0.714	0.625	0.143	0.426	Reach 22	0.889	0.714	0.750	0.429	0.695
Reach 3	0.556	0.286	0.500	0.143	0.371	Reach 23	0.556	0.286	0.500	0.143	0.371
Reach 4	0.556	0.571	0.500	0.286	0.478	Reach 24	0.444	0.571	0.500	0.143	0.415
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Reach 8	0.556	0.429	0.750	0.143	0.469	Reach 28	0.889	0.429	0.750	0.143	0.553
Reach 9	0.222	0.714	0.625	0.143	0.426	Reach 29	0.778	0.571	0.625	0.286	0.565
Reach 10	0.444	0.714	0.625	0.143	0.482	Reach 30	0.889	0.429	0.500	0.000	0.454
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Reach 15	0.333	0.571	0.750	0.000	0.414	Reach 35	0.667	0.571	0.625	0.571	0.609
Reach 16	0.556	0.714	0.875	0.571	0.679	Reach 36	0.444	0.286	0.375	0.000	0.276
Reach 17	0.556	0.571	0.625	0.143	0.474	Reach 37	0.778	0.429	0.875	0.571	0.663
Reach 18	0.444	0.571	0.625	0.286	0.482	Reach 38	1.000	0.571	0.875	0.429	0.719
Reach 19	0.556	0.571	0.625	0.143	0.474	Reach 39	0.667	0.143	0.750	0.286	0.461
Reach 20	0.444	0.714	0.875	0.286	0.580	Reach 40	0.889	0.286	0.750	0.143	0.517

Primary Geomorphic Process Seconday Geomorphic Process

The most dominate secondary geomorphic channel process identified during the 2019 assessment of the Memramcook River was channel widening, which was occurring in 50% of the reaches. Channel aggradation and channel degradation were similar to each other at 25% and 23% respectively. Planimetric adjustment was noted to be occurring as a secondary geomorphic process in only 3% of the assessed river channel. Figure 3.23 illustrates the secondary geomorphic processes.

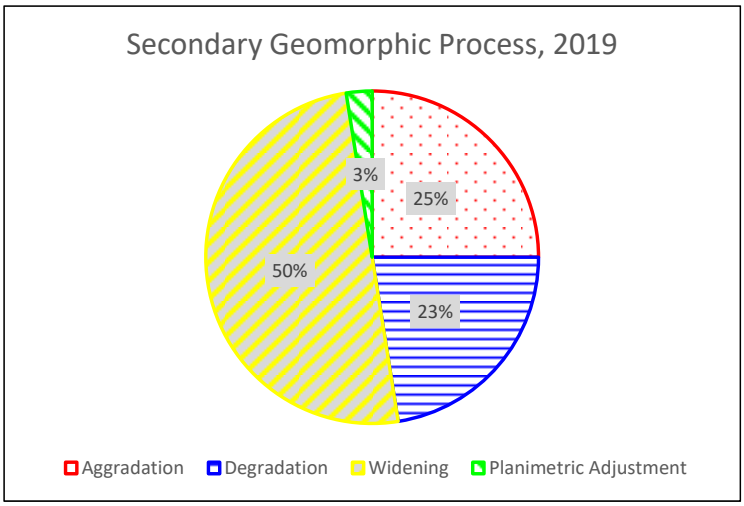


Figure 3.23: Secondary Geomorphic Processes Occurring on the Assessed Reaches of the Memramcook River

Figure 3.24 shows the secondary geomorphic processes identified at each reach during the 2019 assessment of the Memramcook River.

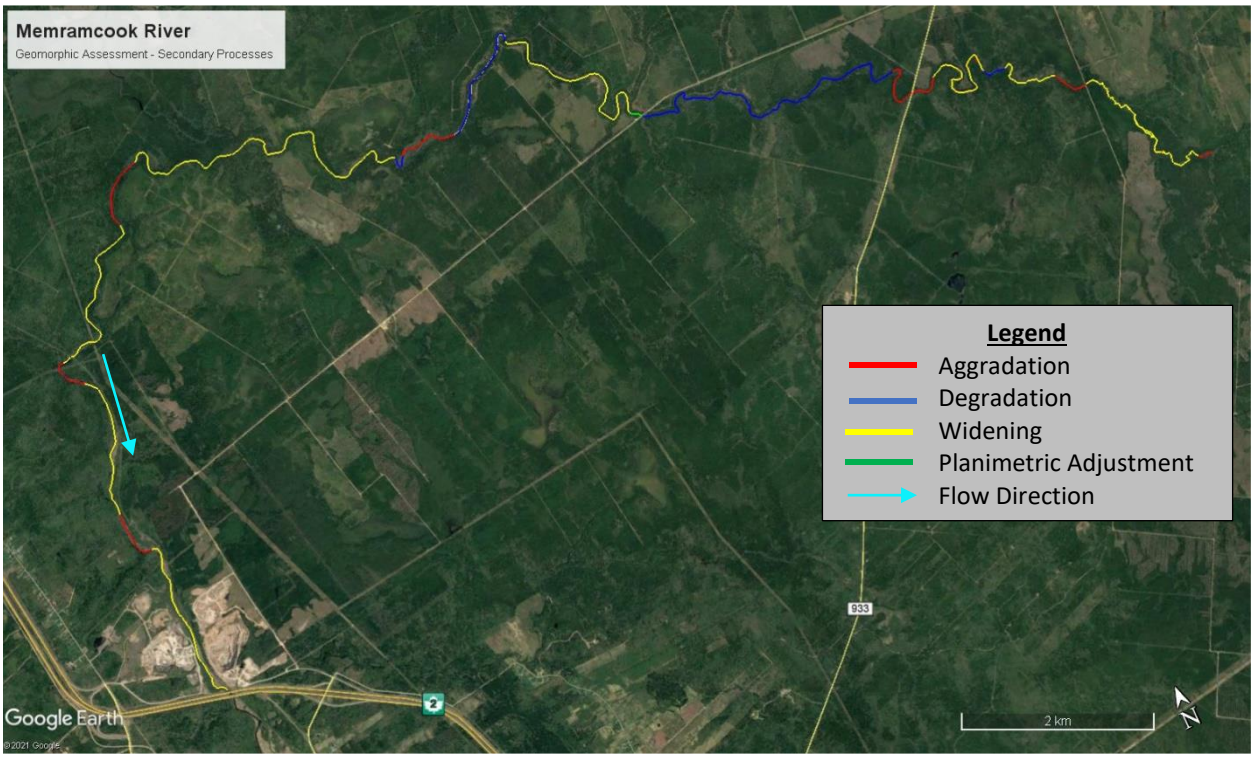


Figure 3.24: Secondary Channel Processes on the Assessed Reaches of the Memramcook River

Rapid Stream Assessment

The RSAT data for each reach of the Memramcook River that was assessed in 2019 was collected at the same time as the RGA data. The RSAT data consists of two categories, channel stability rankings and

channel dimensions. When referring to the channel dimensions, the field crew made estimations rather than physically measuring each parameter.

The overall channel stability ranking is based on six parameters and relies on the visual perception of the field crew to identify, interpret, and score each parameter as excellent, good, fair, or poor. The six parameters are Channel Stability, Channel Scour and Deposition, Instream Habitat, Water Quality, Riparian, Conditions, and Biological Indicators.

Overall, the channel stability based on the RSAT data collected, indicates that on average for the 40 reaches, Memramcook River is considered to be good. To achieve this ranking of good the field crew would have determined that through most of the reaches, overall bank erosion appeared low and there was minimal bank overhang. As well, tree roots would not be overly exposed or undercut and woody debris in the watercourse channel would be providing adequate habitat but not creating channel blockages.

Channel scour ranked as being “good” as well. Channel scour is determined by how much riffle embeddedness there is, the amount of silt and sediment in the bottom of pools, if banana-shaped deposit were visible on the streambed, and the amount of or lack of deposition on point bars, in the channel, or on the overbank zone. With a ranking of good with regards to channel scour, the field crew would have noted that embeddedness around the riffle material on average was likely less than 50% for most of the riffles throughout the assessed reaches. As well, gravel bars were most likely stable with minimal signs or markings that indicate fresh scour or disposition has occurred.

The instream habitat was given a ranking of good. The field crew presumably observed a diversity of flow through the riffles, runs, and pools, as well as these instream features having a variation in shapes and sizes. As well, the stream bed material in the riffles, runs, and pools was a mixture of bedload material and not just one size or type of substrate. The field crew would have also noted that pool depth was adequate even on low flow conditions and there was sufficient overhead cover.

The destination of water quality can be difficult without the use of water quality metres or samples collected for analysis. However, for the purpose of this assessment, the field crew would have been looking for such indicators as, substrate fouling, water clarity, and any noticeable odors coming from the water or out of the bedload material. The ranking of good was given for the water quality for the assessed reaches of the Memramcook River.

The riparian conditions of the assessed section of the Memramcook Rover were given a ranking of good by the field crew. A ranking of good would have required the field crew to observe a riparian area with a mixture of tree and vegetation species as well as a suitable canopy cover that would provide leaf litter and shade to the river.

Biological indicators would require the observation of aquatic species in the river. Macroinvertebrates under rocks or fish swimming in the watercourse would suffice as an indication that there is a biological presence in the system. The field crew provided a ranking of good for this parameter. This would mean that the field crew identified or sighted a variety of species utilizing the assessed reaches of the Memramcook River.

Table 3.9 lists the channel stability parameters and average rankings for the 40 assessed reaches.

Table 3.9: RSAT Channel Stability Ranking, Memramcook River

Parameter	Channel Stability	Scour Deposition	Instream Habitat	Water Quality	Riparian Conditions	Biological Indicators	Stability Ranking
Ave. Score	7.925	5.85	6.925	6.3	6.025	7.1	40.125

The overall stability ranking of 40.125 indicates that the assessed section of the Memramcook River is stable based on the field crews' observations.

Based on the RGA data of the 40 reaches that were assessed on the Memramcook River in 2019, all of the reaches are undergoing a channel adjustment or in a state of stress. Channel widening and channel aggradation are the two primary geomorphic processes dominating the 40 reaches with channel degradation as the primary geomorphic process in a few of the reaches. Although the following figure, Figure 3.25, is bursting with data, it does show all the reaches with each geomorphic process and stability index scores.

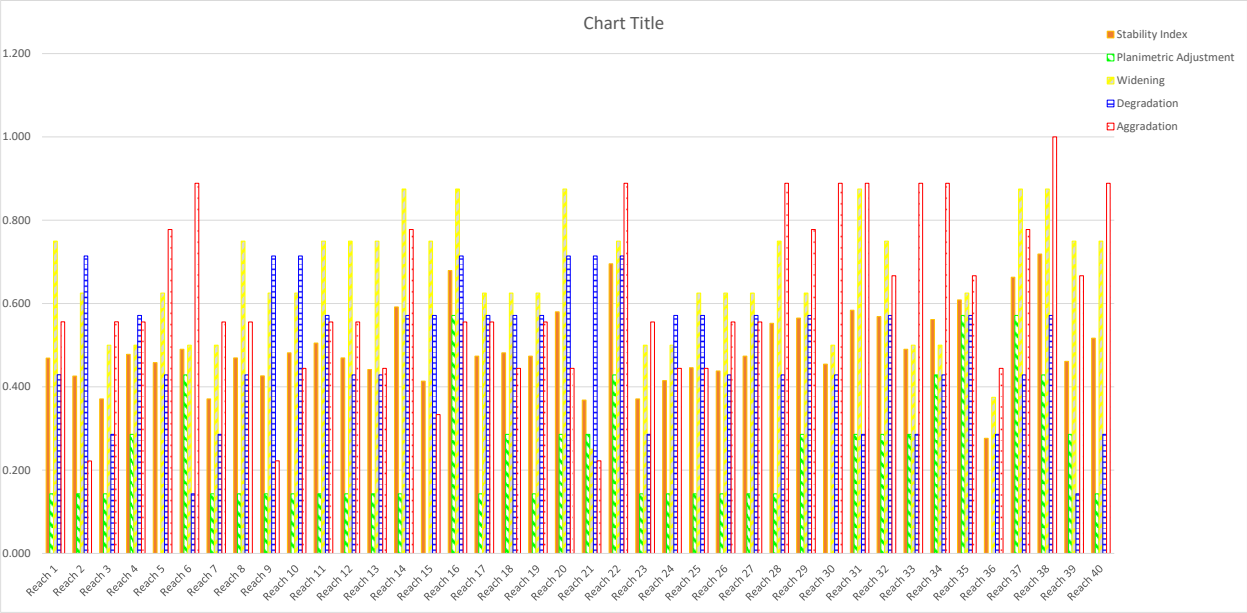


Figure 3.25: Geomorphic Process and Stability Index for the 40 Reaches on the Memramcook River

When comparing the RSAT findings to the RGA data, the RSAT data indicates that the assessed reaches are stable while the RGA data indicates that the reaches are in a state of unstableness. While the data from each type of assessment seems to contradict the findings of the other, the results can be interpreted as showing that the field crew observations provide the rational for channel enhancement or habitat restoration work, while the RGA data indicates the issues and approaches that should be considered when contemplating such works. Recommendations for how to proceed based on this data are found within the Fourth Level Assessment- Aquatic Habitat Rehabilitation Plan.

3.5 Identification of wood turtle habitat

Fort Folly Habitat Recovery also conducted surveys to identify Wood Turtle (*Glyptemys insculpta*) habitat within the watershed. The purpose of these surveys was to gather information on the presence and/or location of habitat features associated with possible Wood Turtle overwintering, nesting, and juvenile rearing. This information could then be used include Wood turtle habitat as a factor influencing decision making regarding projects within the Memramcook River Watershed, such as exercising additional caution at sites in likely wood turtle habitat if undertaking a bank stabilization project, or even selecting a different site altogether to avoid disturbing wood turtles if need be.

According to COSEWIC, changing conditions in Canadian watersheds have increased mortality and put Wood Turtle sub-populations at risk. Wood Turtle abundance has declined by 24-30% over the last 100 years and is expected to decline another 10-70% within the next 100 years. Wood turtles are currently defined as threatened under the Species at Risk Act (SARA Registry 2021).

The Wood Turtle is a freshwater species that is considered more terrestrial than most others of its kind (COSEWIC 2018) and can be found dispersed throughout their respective home range in specific habitat elements dependant on the seasonal timing (Government of Ontario 2021). During the Wood Turtle active season from spring through to early fall, turtles can be found wandering riparian and terrestrial landscape (COSEWIC 2018). Commonly they forage in bogs, agricultural fields/ marshy pastures, beaver ponds, meadows, shrubbery, and mixed forest.

Wood Turtles require three core habitat features: A stream or river, sandy nesting substrate, and forest (MacGregor and Elderkin, 2003). In northern Ontario, a Wood turtle habitat model was created to determine environmental features that were crucial in predicting Wood Turtle presence. This included: "(1) at least some sand or gravel bars; (2) deep pools, undercut muddy banks, log jams or beaver dams; and (3) open/herbaceous, short shrub, tall shrub and wooded habitat types present in the riparian zone" (Government of Ontario 2021). Wood Turtles are most often found in proximity to meandering rivers or streams that have moderate current with substrate of sand or gravel (COSEWIC 2018). Wood Turtles rely on access to water for thermoregulation, movement, hibernation, and mating (MacGregor and Elderkin, 2003). Wood Turtles begin hibernation between the months of October and November and re-emerge during the month of April. Hibernation habitat requires flowing water that does not freeze to the bottom (Government of Ontario 2021).

For nesting purposes Wood Turtles require areas that have abundant sunlight exposure on sand or gravel beaches (Government of Ontario 2021). However, they are also recognized to nest in areas that encompass these qualities that are less than ideal such as road shoulders, gravel pits or railway beds (COSEWIC 2018). Research conducted by Buech et al. (1997) discovered that "natural nesting areas in Minnesota occurred along south-facing sandy points and cutbacks of third-order or larger meandering rivers. Nests were excavated 1 meter or more above the water in areas with less than a 40-degree slope and less than 20 percent ground vegetation that were close to water and had low disturbance. While some females nested up to 150 metres from water, most nested within 10 metres of the stream." (Government of Ontario 2021).

GIS analysis was used to highlight sections forming oxbows or that were close to wetland areas. Then photos taken along the river during the Rapid Geomorphic Assessments (RGAs) were reviewed to narrow down areas that contained quality habitat features. The main features staff looked for were

sand/gravel bars or beaches, banks that were not steeply eroded (less than a 40° slope) and good transitional habitat (riparian areas with deep grasses and/or herbaceous shrubs). These steps narrowed down the 40 sections of river (based off the 2019 RGA reaches) to 30 possible sections to investigate. Then FFHR staff did targeted surveys of approximately 20 km of river by walking the identified stretches of river looking for the above habitat criteria as well as footprints and signs of digging along sandy portions of the banks. Staff also swept through more promising sections of transitional habitat for turtles themselves, but none were found.

Very few areas of good quality Wood Turtle habitat were found in the freshwater reaches of the river above the causeway (Figure 3.26). There were 2 pools and a sand gravel bar in Reach 13, a sandy gravel beach in Reach 22, and sand gravel bar in reach 38. Most of the river is made up of exposed bedrock or large boulders and cobble, and steeply eroded/overhanging banks. These conditions prevent Wood Turtles from digging nests, overwintering and from accessing the surrounding riparian zone. There is little to no transitional habitat in most areas and large sandy beaches, sand bars and deep overwintering pools are scarce. It is also apparent based on aerial imagery that the area surrounding the Memramcook River has been heavily disturbed by clear cutting, which is not ideal for Wood Turtles.

Figure 3.26: Map of Wood Turtle habitat features observed along the Memramcook River

3.6 Tidal Barrier Assessment

The Petitcodiac Watershed Alliance undertook assessment of tidal barriers in the Memramcook watershed as something of an expansion upon their earlier Broken Brooks project to examine where, above the causeway infrastructure such as aboideaux that are part of the dyke network, and culverts under either roads or the CN rail line above the causeway, at or below the head-of tide might be cutting off free tidal exchange and fish access to freshwater habitat beyond it. They analysed these potential barriers using the Tidal Barrier Assessment Protocol of the Nova Scotia Salmon Association. The PWA identified 28 potential barriers above the Memramcook causeway, of which so far they have assessed 12 (Table 3.10 and Figure 3.27). Of these, one was deemed passable, two were identified as partial barriers, five were assessed as full barriers to passage. There were three that were defined as not being fish habitat, and one location at which no culvert was found. Remedial measures were identified for the two partial barriers identified (construction of rock weirs), and the five full barriers (two where a rock weir would be adequate; two which would likely require construction of both a rock weir and an outflow chute; and one where full culvert replacement appeared to be the only solution).

Table 3.10: Results of tidal barrier assessments upstream of the Memramcook Causeway

Assessed Site	Status	Proposed Remediation	Latitude	Longitude
1	*Not Fish Habitat*	*None*	N 45.985246	W -64.547835
2	*Not Fish Habitat*	*None*	N 45.989367	W -64.572523
3	Partial Barrier	Rock Weir	N 45.997569	W -64.548523
4	*Not Fish Habitat*	*None*	N 46.026880	W -64.564718
5	Partial Barrier	Rock Weir	N 46.027455	W -64.561297
6	Full Barrier	Rock Weir and Outflow Chute	N 46.027656	W -64.559642
7	Full Barrier	Rock Weir and Outflow Chute	N 46.027816	W -64.558896
8	Passable	None	N 46.033793	W -64.560290
9	Full Barrier	Rock Weir	N 46.033073	W -64.559473
10	Full Barrier	Culvert Replacement	N 46.035536	W -64.560579
11	Full Barrier	Rock Weir and Outflow Chute	N 46.035704	W -64.559574
12	Not Found	None	N 46.046135	W -64.566515

Of those sites yet to be visited it is worth noting that both of those downstream of the Partial Barrier identified on the outflow from Memramcook Lake in Figure 3.27 (one at the dysfunctional aboideau in the dyke structure and the other under the CN line) can at this stage be estimated as at worst being demonstrably only partial barriers, since Alewife were recorded getting past those (Section 3.1) to access Memramcook Lake for spawning in the spring. This of course raises the question – will that aboideau need to made functional to protect areas beyond it from flooding during extreme tides? Currently these areas are protected at such times by the causeway, while fish have passage into Memramcook Lake at low points in the tide cycle when the gates are open. Closure of that with a functioning aboideau as part of opening the causeway would result in less fish passage to Memramcook Lake than the status quo. Those are the kinds of competing interests that would need to be examined prior to undertaking major changes in the system.

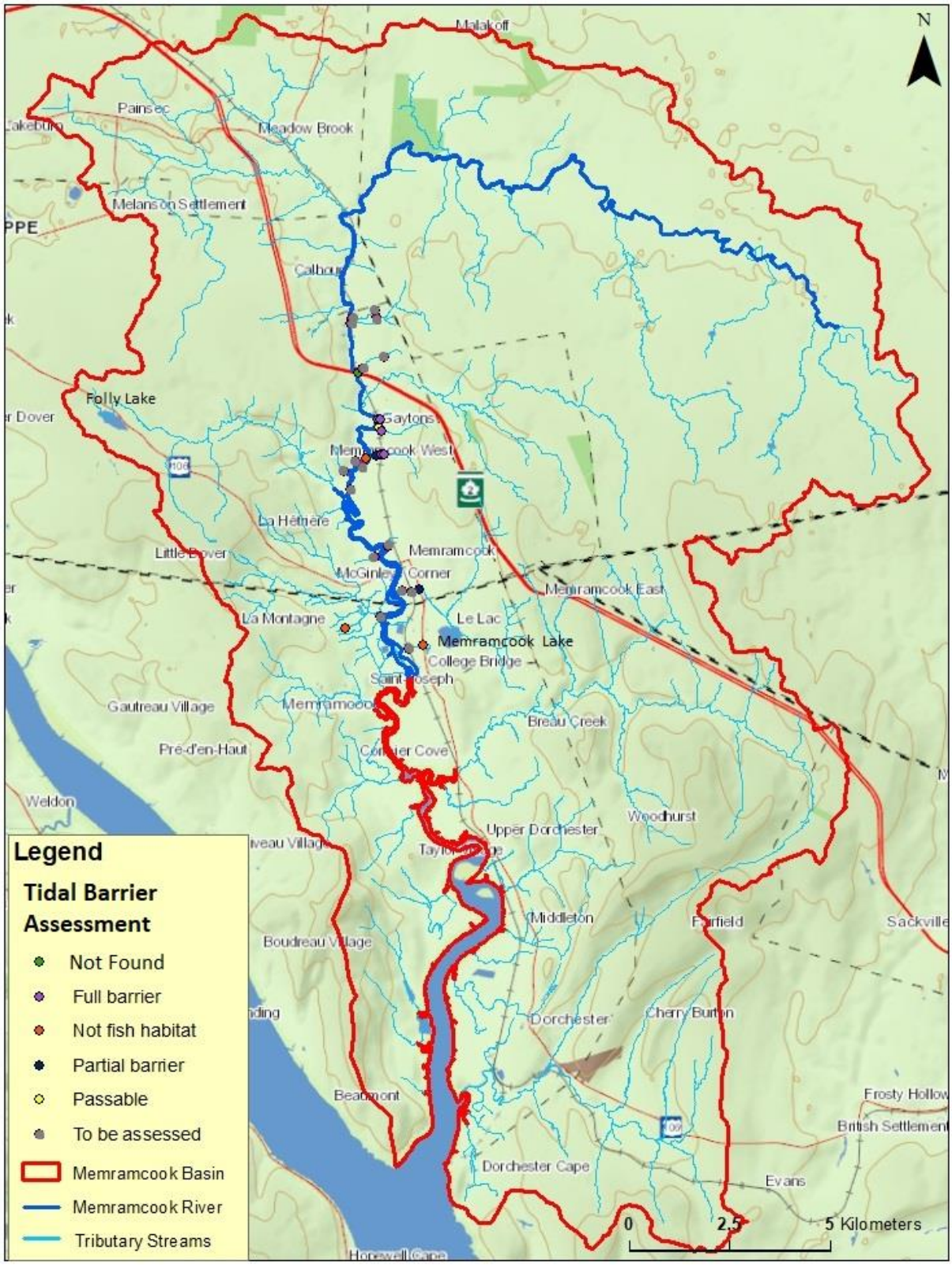


Figure 3.27. Tidal barrier assessments upstream of the Memramcook Causeway

Fourth Level Assessment- Aquatic Habitat Rehabilitation Plan

4.1 Issues Identified by Resource Users and Stakeholder Groups

By far, the biggest issue identified in the watershed is the future of Memramcook River causeway. Most other concerns (flooding, fish passage, recreational use) are tied to this in one way or another. The causeway has been a top priority for the Village of Memramcook and a critical component of their Green Plan for nearly a decade (Riverkeeper 2020a). One clear indication of this is that in 2001, when a feasibility study was being done in Moncton regarding the future of Petitcodiac River Causeway, the village of Memramcook offered their community as a testing ground for opening the Memramcook Causeway and allowing the Memramcook River to return to its natural flow to model the potential impacts for Moncton. The Petitcodiac was eventually opened without such testing on the Memramcook, but the offer provides some indication of the degree of interest locally, and how far back it goes.

The NB Department of Transportation and Infrastructure manages the Memramcook causeway and also acknowledges the impending need for some kind of decision on its fate. Planning to repair, modify, or remove it is required, and once a course has been selected, the choice made will determine conditions for the next 40 years. The causeway has been eroding under the force of weather and salt for the last 47 years. It will soon reach a point of no return and planning must begin to do needed work to prevent serious consequences, including increased flooding and the threats to the Acadian dykes and local eco-tourism. The options are to repair, modify, or remove it, and once a course has been selected, that will determine conditions in the river for the next 40 years.

In 2019, Sentinelles Petitcodiac Riverkeeper engaged a retired engineer who had managed the Memramcook Causeway gates from 2000 to 2002 to help develop a "Preliminary Assessment of Options for the long-term viability of the Memramcook River Causeway" (Riverkeeper 2020b). Riverkeeper then held two public dialogue sessions to present their findings to the public in early 2020 (Riverkeeper 2020a), fortunately being able to complete both prior to everything was shut down shortly afterwards by the Covid 19 Pandemic. Invitations were sent to over 40 stakeholders, including non-profit organizations, municipal, provincial, and federal government stakeholders, community groups and associations, as well as Fort Folly First Nation. These public dialogues were advertised on social media, in local papers, and in community newsletters. The first session was held in English in Dorchester on February 25th, 2020, with over 40 attendees. The second session was in French in Memramcook on March 5, 2020, with over 50 people in attendance.

These public dialogues were intended to bring people from these communities together to gather their feedback and engage with them regarding three possible options for the Memramcook River Causeway identified within the Preliminary Assessment Document (Riverkeeper 2020b):

1. Repair - Status Quo
2. Partial Reconstruction- Stabilizing the structure but leaving the gates permanently open
3. Removal of the Causeway and Replacement with Bridge

All community members and stakeholders who attended the public dialogue sessions were strongly in favour of advocating for Option three, removing the causeway and replacing it with a bridge. Participants ruled out Options one and two (Riverkeeper 2020a). Similarly, during conversations with the Department of Transport and Infrastructure it was indicated that Option two was not practical as the Memramcook Control Structure is different than the Petitcodiac Causeway Control Structure and if left permanently open would rapidly be undermined and become unsafe (Robichaude 2020, Personal Communication).

The primary concern about the causeway that community members expressed at these meetings was the issue of flooding, which as noted in Section 2.3 is a frequent occurrence in the region under the status quo. They repeatedly highlighted the need to protect the community and farmlands from flooding and silt deposits. Areas particularly vulnerable to flooding currently are the low-lying lands in the region downstream of the causeway. There is a clear need to invest in repairs and maintenance of the dykes and aboideaux along the river to reduce flood risk. Flooding has extended to main roads which can be blocked for days as a result. Even some houses in the region experience flooding. Residents have noted that it does not take a large tide for the river to overflow. The community is concerned that due to the effects of climate change and anticipated sea level rise, that this issue will continue to worsen unless government action is taken immediately to protect the region.

Farmers are particularly concerned about what happens to the causeway and what that would do to fields upstream of it and gave as an example the adverse outcomes in the past when the causeway gates had been held opened for several weeks (3-4 weeks based on community estimates) without communicating this decision to the community. During the highest tides silt entered the ditches and went up into farmland. Farmers lost income, were unable to plant or retrieve the same yield on these lands and ended up paying a lot of money and investing a lot of time to remove the silt. Some farmers are still feeling the impacts of this many years later. Thus, farmers are very concerned with the need to build up the infrastructure surrounding the river, such as dykes and aboideaux, to protect their fields. The Department of Transport and Infrastructure is aware of this concern, which is why the causeway gates are now kept closed during the strongest tides (Robichaude 2020, Personal Communication), and only opened periodically to allow some fish passage.

The sense from the community was that while they favored Option three, replacing the causeway with a bridge, implicit in that approach would be the need for further investment to ensure that the tides that after that point would then be once more flowing freely under that bridge did not damage fields upstream, or flood roads or houses. The work that the Province did upstream on the Petitcodiac prior to opening the Petitcodiac Causeway was specifically cited as good example of what people hoped to see done within the Memramcook Valley.

Going forward, future steps involve circulating a report on these public sessions (Riverkeeper 2020a) among stakeholders that summarizes the discussion during the public dialogues to solicit feedback, further investigation into the expenses involved in the various options, and ongoing engagement with the public and politicians to work towards a decision on the future of the causeway.

4.2 Issues Identified from Information on Current Impacts

One of the areas identified in the Second Level Assessment where additional work would be useful came from the elements of the Petitcodiac Watershed Alliances Broken Brooks project that took place within the watershed. Such future work could take several forms. The first is that of the 105 culverts that the PWA assessed, only 21% were defined as passable by fish, with 20% creating partial barriers, and 46% creating full barriers to fish passage. Therefore, the Memramcook is full of culverts warranting remediation. That said, it is not unique in this manner as those results were consistent with what the PWA has seen nearby on the various tributaries of the Petitcodiac. Consequently, there is a need to prioritize by identifying where the most benefit can be gained through the best use of limited resources. FFHR's work with fyke nets and electrofishing found that several anadromous fish species can and do access the portions of the watershed upstream of the causeway, however it does place some constraints on them. The absence of significant movement up into Folly Lake along the 8 km of Smith Brook indicates one example of habitat that is demonstrably cut off, likely due to issues with water-crossings along Smith Brook between the lake and the river. However, there is an argument to be made that regionally speaking, culvert remediation efforts ought to focus instead on the Petitcodiac where there is no longer a tidal barrier such as the causeway, as that may be a better use of resources at this time. Particularly given the salmon stocking efforts that are currently underway on the Petitcodiac (Fundy Salmon Recovery 2021).

The second is that there are likely more problem culverts remaining to be found. The PWA gained access to and assessed 126 water crossings. There were 42 more that they identified but which were inaccessible due to either poor road quality or being on private property to which they had no access. What is more, the GIS analysis that produced Figure 2.6 found 227 water-crossings in the watershed. That indicates something like 101 of these that were not assessed, 59 of which were not part of the PWA's list of target sites, assuming perfect alignment between their list of targets and the targets in Figure 2.6. If one assumes that a third of those will not be accessible as well- then assuming the high rate (46%) of culverts that were full barriers is a constant, perhaps another 20 or so additional full barrier culverts may remain to be found. Once again however, the value of doing such work must be weighed against that of doing the same work elsewhere, such as on the Petitcodiac instead.

4.3 Issues Identified from Habitat Assessments

Particularly noteworthy are competing interests between fish passage and protection from flooding noted during the assessment of tidal barriers in section 3.6. Fish passage into Memramcook Lake was noted in section 3.1 However, the Alewife get into Memramcook Lake by passing through a currently dysfunctional aboideau in the dyke system. Will that aboideau need to be made functional to protect areas above it from flooding during extreme tides? Currently these areas are protected at such times by the causeway, while fish have passage into Memramcook Lake at low points in the tide cycle while the gates are open. Closure of that with a functioning aboideau as part of opening the causeway would result in less fish passage to Memramcook Lake than the status quo. Those are the kinds of competing interests that would need to be examined prior to undertaking major changes in the system.

Table 4.1 provides a list of the reaches and the priority order that should be considered if channel or instream restoration work is being considered for the Memramcook River. Since the 40 assessed reaches are all in a state of transition/stressed or in adjustment the priority rankings are listed as critical, high, and medium. Typically, it is always a best practice when it comes to watercourse restoration or enhancement to start as far up in the watershed as possible and with work progression moving downstream. However, given the state of the Memramcook River, the reaches that are listed in the critical table should be given top priority when addressing a restoration management plan for the Memramcook River.

Although each reach is ranked in priority of requiring some type of restoration or enhancement, factors such as, site access, budget, and overall cost benefit should be considered when determining which areas should be restored or enhanced first.

Moving forward, monitoring locations should be established on selected reaches of the Memramcook River. These monitoring locations would collect cross-section profiles of the reach, thalweg alignment through the reach, pebble and substrate date as well as information the channel banks the installation of erosion pins. By establishing such monitoring sites, which should be considered long-term, a much better understanding of the geomorphic processes occurring on the Memramcook River would be obtained. The selected reaches do not necessarily need to be reaches that are considered critical in the priority list. Ideally one or two reaches should provide a representation of the channel in a relatively state of stableness. Reach 40, although is low in the systems appears to be somewhat stable when looking at the RGA data and could be used as a reference site. As well, a monitoring site should be established further up in the system to identify any changes to the river that might be occurring from issues within the headwaters of the Memramcook River. Budget and available team members will determine the total number of monitoring sites that can be established but a general rule of thumb is ten sites.

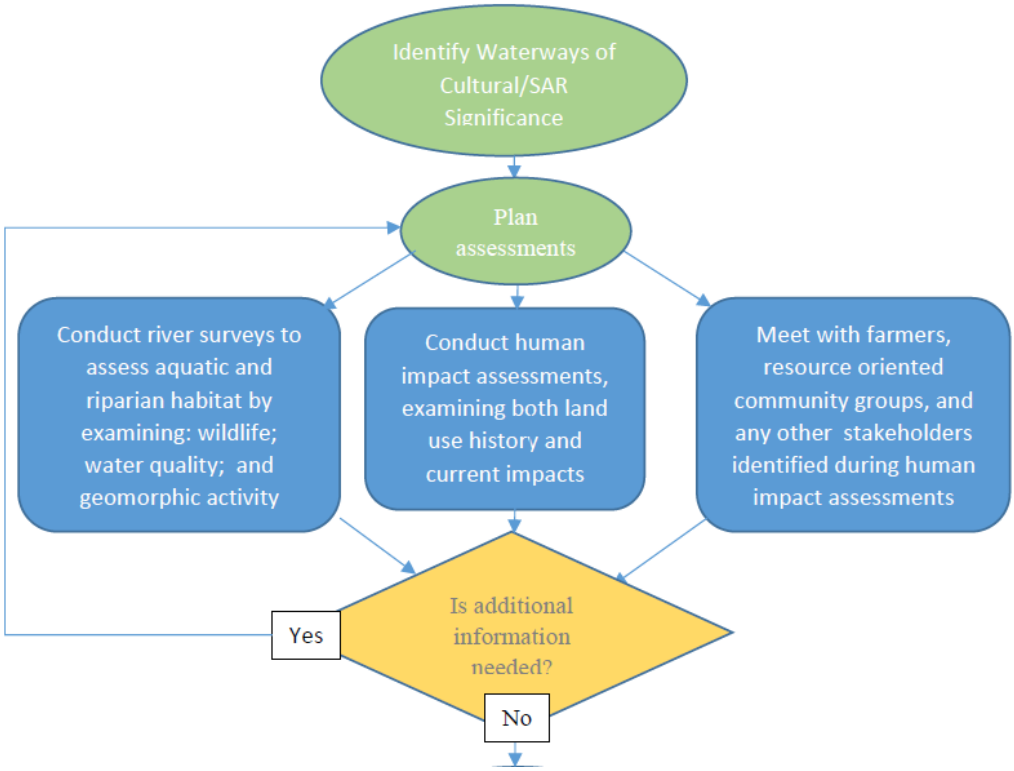
FFHR can add sites on the Memramcook based on Table 4.1 to its existing inventory of other potential bank restoration projects. That said, bank stabilization is an intensive activity, both in terms of financial costs and organizational capacity. Proper engineering is required to ensure that projects do not make matters worse. Typically, FFHR only undertakes one such project per year. Ultimately selection of a site will depend upon factors such as how much of a priority a site is from a conservation perspective (its biological importance), the interest expressed by landowners in participation, and how practical the project is with regard to access and other logistical factors.

Table 4.1: Priority Listing for the Assessed Reaches of the Memramcook River

Priority - Critical		Aggradation	Degradation	Widening	Planimetric Adjustment	Stability Index
1	Reach 38	1.000	0.571	0.875	0.429	0.719
2	Reach 22	0.889	0.714	0.750	0.429	0.695
3	Reach 16	0.556	0.714	0.875	0.571	0.679
4	Reach 37	0.778	0.429	0.875	0.571	0.663
5	Reach 35	0.667	0.571	0.625	0.571	0.609
6	Reach 14	0.778	0.571	0.875	0.143	0.592
7	Reach 31	0.889	0.286	0.875	0.286	0.584
8	Reach 20	0.444	0.714	0.875	0.286	0.580
9	Reach 32	0.667	0.571	0.750	0.286	0.568
10	Reach 29	0.778	0.571	0.625	0.286	0.565
11	Reach 34	0.889	0.429	0.500	0.429	0.562
12	Reach 28	0.889	0.429	0.750	0.143	0.553
13	Reach 40	0.889	0.286	0.750	0.143	0.517
14	Reach 11	0.556	0.571	0.750	0.143	0.505
Priority - High		Aggradation	Degradation	Widening	Planimetric Adjustment	Stability Index
15	Reach 5	0.889	0.143	0.500	0.429	0.490
16	Reach 33	0.889	0.286	0.500	0.286	0.490
17	Reach 10	0.444	0.714	0.625	0.143	0.482
18	Reach 18	0.444	0.571	0.625	0.286	0.482
19	Reach 4	0.556	0.571	0.500	0.286	0.478
20	Reach 17	0.556	0.571	0.625	0.143	0.474
21	Reach 19	0.556	0.571	0.625	0.143	0.474
22	Reach 27	0.556	0.571	0.625	0.143	0.474
23	Reach 8	0.556	0.429	0.750	0.143	0.469
24	Reach 12	0.556	0.429	0.750	0.143	0.469
25	Reach 1	0.556	0.429	0.750	0.143	0.469
26	Reach 39	0.667	0.143	0.750	0.286	0.461
27	Reach 6	0.778	0.429	0.625	0.000	0.458
28	Reach 30	0.889	0.429	0.500	0.000	0.454
29	Reach 25	0.444	0.571	0.625	0.143	0.446
30	Reach 13	0.444	0.429	0.750	0.143	0.441
31	Reach 26	0.556	0.429	0.625	0.143	0.438
32	Reach 9	0.222	0.714	0.625	0.143	0.426
33	Reach 2	0.222	0.714	0.625	0.143	0.426
34	Reach 24	0.444	0.571	0.500	0.143	0.415
35	Reach 15	0.333	0.571	0.750	0.000	0.414
Priority - Medium						
36	Reach 7	0.556	0.286	0.500	0.143	0.371
37	Reach 23	0.556	0.286	0.500	0.143	0.371
38	Reach 3	0.556	0.286	0.500	0.143	0.371
39	Reach 21	0.222	0.714	0.250	0.286	0.368
40	Reach 36	0.444	0.286	0.375	0.000	0.276

FFHR's stewardship planning process for identifying and selecting projects is summarized in Figure 4.1. Projects must meet both the needs of the river, and those of the landowners on who's property the project is taking place. Fort Folly Habitat Recovery (FFHR) has developed Stewardship Plans (http://ffhr.ca/stewardship-plans/) like this one for the Memramcook watershed, on a watershed by watershed basis within the Petitcodiac River system as a means of tackling the challenging task of identifying problems, determining which projects warrant immediate attention, and determining how to proceed with them once selected.

Figure 4.1: Stewardship Planning Process Part 1: Needs of the River

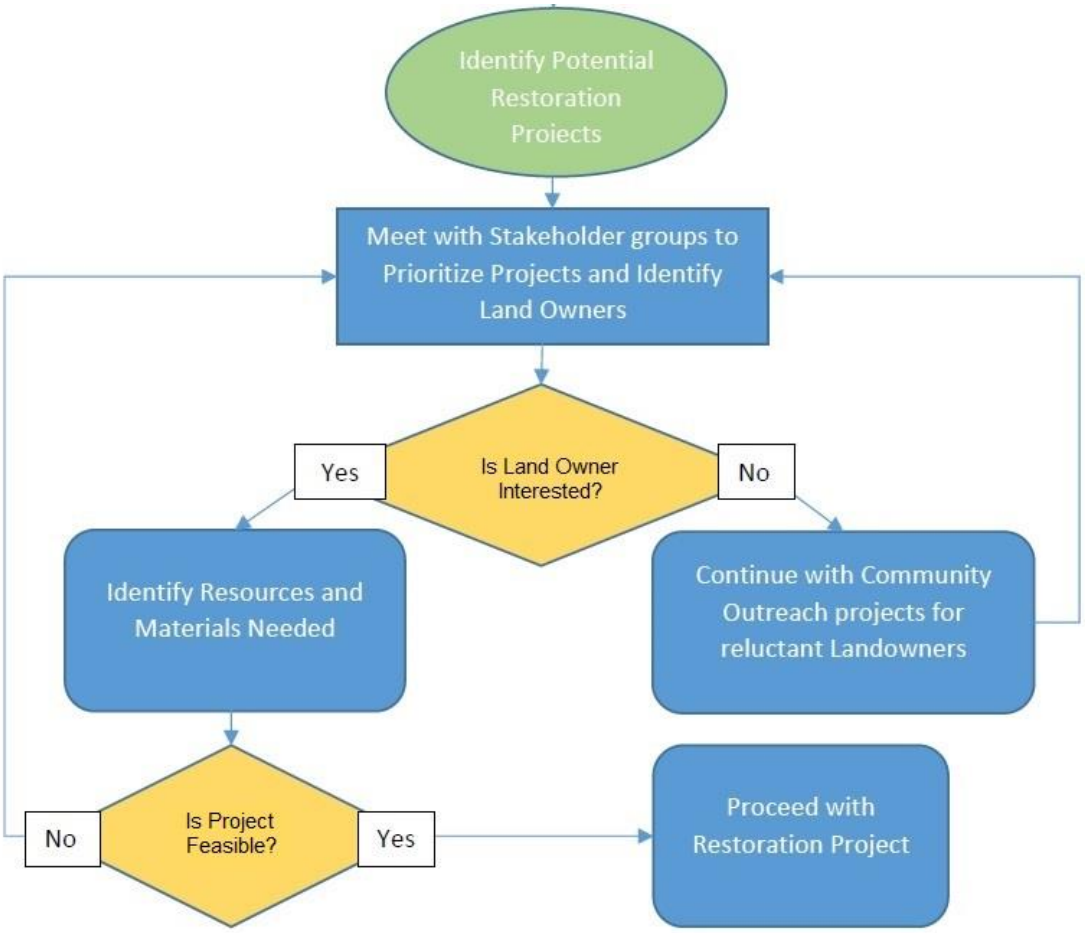


Basic fieldwork carried out across the watershed, with field surveys such as Rapid Geomorphic Assessments (RGAs), Rapid Stream Assessment Technique (RSATs), and monitoring associated with ongoing salmon recovery efforts (such as redd surveys), informs decision making by providing the wide context necessary 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 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 4.2, 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. Then the project must meet the terms dictated by the Provincial WAWA permit, and the needs set out by FFHR's own Species at Risk (SAR) checklists (Appendix A)

Figure 4.2: Stewardship Planning Process Part 2: Meeting Landowner Needs



The Third Level analysis did not detect any salmon in the Memramcook. This was not a surprise, since 11 years of monitoring on the Petitcodiac has only occasionally detected salmon returning to the Petitcodiac under their own power. Essentially all the salmon encountered on the Petitcodiac are stocked fish, and there is no comparable stocking effort going on in the Memramcook. Consequently, at least in the short term, sites on the Petitcodiac are likely to take precedence over those on the Memramcook. The latter tend to rank lower in terms of biological importance and will likely continue to do so, especially for as long as the Memramcook Causeway is blocking the river with its gates closed approximately half the time.

4.4 Restoration Activities Undertaken

The only documented remediation activities undertaken so far with any impact on the ground within the Memramcook watershed are 4 culverts that had been identified as full barriers to fish passage, which the Petitcodiac Watershed Alliance made passable in 2017 by clearing debris away from them (Table 4.2). Before and after photos are in Figure 4.3, Figure 4.4, Figure 4.5, and Figure 4.6.

Table 4.2: PWA debris removals remediating culverts deemed full barriers to passage

Crossing ID	Upstream Habitat Gain (km)	Latitude	Longitude
C-151	2	N 45.89976	W -64.48060
C-154	0.5	N 45.93202	W -64.46172
C-172	0.2	N 45.93553	W -64.48457
C-224	1	N 46.03413	W -64.63985

Figure 4.3 Culvert C-151 before and after PWA removed debris to make it passible in 2017

Figure 4.4 Culvert C-154 before and after PWA removed debris to make it passible in 2017

Figure 4.5 Culvert C-172 before and after PWA removed debris including a mattress in 2017

Figure 4.6 Culvert C-224 before and after PWA removed debris to make it passible in 2017

4.5 Opportunities for Future Restoration Activities

The activity likely to produce the most significant results within the watershed would be to act upon the consensus that emerged during the public dialogs that Riverkeeper held in early 2020 and follow through on Option #3 to replace the causeway with a bridge. That of course is a massive undertaking involving numerous stakeholders and is work that in the end would be done by the Department of Transportation and Infrastructure and its contractors, once such a decision had been made. That process would likely require years, given the need to demonstrate a wide public consensus to influence political decision makers, do the engineering, environmental assessment, permitting, and design work, and finally the time required to implement it not just by replacing the causeway control structure with a bridge, but in terms of making the upgrades to the dykes upstream needed to meet the community objectives of solving flooding problems rather than creating new ones.

If that were done, then benefits to be gained through any other activities, whether bank stabilization or remediating culverts to improve fish passage, or even perhaps expanding the Fundy Salmon Recovery program to include releases on the Memramcook would be significantly amplified. In the absence of such work, or for that matter if the causeway were to be refurbished to extend its life decades into the future, it is more difficult to make the case for such work to address deficiencies in the Memramcook. Doing projects in the Memramcook comes at the expense of undertaking similar projects elsewhere that under the status quo are likely to yield greater benefits. That said, the existing gate management protocol has been successful at maintaining some degree of fish passage during the last 20 years. Thus, there is some value to remediation efforts in the Memramcook even without changes to the status quo.

As discussed in Section 4.2 there are numerous culverts that pose full or partial barriers to passage once fish make it into the portion of the watershed above the causeway. Likewise, there are numerous culverts in portions of the watershed downstream of the causeway that may warrant attention as well, though those that are upstream of functioning aboideaux are, as a consequence of that, constrained by tidal barriers of their own.

With regards to bank stability Reach 38 is the section of the river identified as the most disturbed in table 4.1, with a Stability Index of 0.719, indicating that its channel morphology is not within the range of variance and evidence of instability is widespread. It is not alone in that- there were 13 other reaches along the assessed portion of the Memramcook identified as critical, it is simply the most extreme example. Any of these could be considered, but for the purposes here reach 38 will be examined. One potential advantage to work along this reach is that as can be seen in Figure 2.1 the land tenure is as private wood lots, rather than industrial freehold as is the case for much of the river further upstream. Depending upon the owners involved they may be more receptive to a project than a large Industrial freehold owner such as J.D. Irving. If not, that would be an immediate indicator to consider another site.

According to Figure 2.2 there has been significant clear cutting in that area, which likely helps explain the local instability being expressed in reach 38 as aggradation and widening in the river channel. Service New Brunswick shows most of that reach belongs to just two PIDs (Government of New Brunswick 2021c), which are separate from the PIDs within which the clear cutting has been occurring. Even if these two PIDs belong to two different landowners, that still makes for a fairly simple number of owners to work with. Access might become a complication however as one of the PIDs lacks road frontage, though the other does not. This all fits in to part 1 of the planning process, in Figure 4.1. If there was an interest in proceeding with such a project on the Memramcook at this time, then it would be worth engaging with the landowner. At that point, the process of determining their degree of interest in such a project, the resources, materials, and engineering required to carry it out, and ultimately the feasibility of the project would follow the flow laid out in Figure 4.2.

Information on Species at Risk currently available within the watershed suggests that American eels are likely the primary species about which there should be concern when planning such a project, though the appropriate checklists (Appendix A) would be followed in each case. The fish passage work suggests that salmon are not present, but eels are distributed through out the system. Few habitat features that favour wood turtles were found, though Reach 38 was one that did contain a sand gravel bar (likely due to the aggradation taking place). The Petitcodiac Watershed Alliance will conduct brook floater surveys on the Memramcook in 2021 which will better inform further on the status of that species, however little habitat has been seen that appeared consistent with the needs of brook floaters.

REFERENCES

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 Earth and Environmental (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.

Barbour, M., J. Gerritsen, B. Snyder, and J. Stribling. (1999). Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C. 344 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.

Bell, D. (1982). Slavery and the Judges of Loyalist New Brunswick. University of New Brunswick Law Journal 31:9-42.

Blakeley, P. (1979). Bulkeley, Richard. *In:* Dictionary of Canadian Biography Volume 4. University of Toronto/Université Laval. 913 pages.

Blucke, S. (1792). Petition of Stephen Blucke. https://blackloyalist.com/cdc/documents/official/blucke_petition-1791.htm Web September 13th, 2020.

Boileau, J. (2017). Unlucky Armada – The destruction of the Duc d'Anville's Fleet. Historical Paper No.5. Halifax Military Heritage Preservation Society. Halifax, Nova Scotia. 7 pages.

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

Boyle, R. (1977). Cupriferous bogs in the Sackville area, New Brunswick, Canada. Journal of Geophysical Exploration 8(3):495-527.

Bray, D., D. DeMerchant, and D. Sullivan. (1982). Some hydrotechnical problems related to the construction of a causeway in the estuary of the Petitcodiac River, New Brunswick. Canadian Journal of Civil Engineering 9: 296-307.

Buech, R., L. Hanson, and M. Nelson. (1997). Identification of wood turtle nesting areas for protection and management. *In:* Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles- an international conference. Pp. 383-391. J. Van Abbema (ed.). New York Turtle and Tortoise Society, New York, New York.

Bureau of Foreign Commerce. (1900). Commercial Relations of the United States with Foreign Countries During the Year 1899. In Two Volumes. Volume 1. Bureau of Foreign Commerce, Department of State. https://babel.hathitrust.org/cgi/pt?id=mdp.39015067319825&view=1up&seq=346 Web January 3rd, 2021

Cambridge Dictionary. (2020). Variegated. https://dictionary.cambridge.org/dictionary/english/variegated 0 Web April 17th, 2020

Campey, L. (2014). The English In Canada Historical 3-Book Bundle: Planters, Paupers, and Pioneers / Seeking a Better Future / Ignored but not Forgotten. Dundurn Press. 1,548 pages.

Canadian Hydrographic Service. (2020). Tide Tables, Saint John, #65. Available online: http://tides.gc.ca/Content/tidetables-tablesdemarees/2020/vol_1/wlev_ref/00065MF_public.pdf Web February 15th, 2020
Canadian Rail. (2001). The Intercolonial -1876. Canadian Rail 483: 111-129.

Castonguay, M., P.V. Hodson, C.M. Couillard, M.J. Eckersley, J.D. Dutil, and G. Verreault. (1994). Why is recruitment of the American eel, *Anguilla rostrata*, declining in the St. Lawrence River and Gulf? Canadian Journal of Fisheries and Aquatic Sciences 51(2):479-488.

CBC. (2014). Dorchester residents want fix for flooded Route 106. https://www.cbc.ca/news/canada/new-brunswick/dorchester-residents-want-fix-for-flooded-route-106-1.2626680 Web March 9th, 2021.

CBC. (2017). Section of Route 106 near Dorchester closed by flooding. https://www.cbc.ca/news/canada/new-brunswick/section-106-dorchester-flood-1.4001696 Web March 9th, 2021.

CBC. (2018). Days-long road closure leaves hundreds of Sackville residents far from services. https://www.cbc.ca/news/canada/new-brunswick/west-sackville-road-closure-flooding-1.4892706 Web March 9th, 2021.

CBC. (2019a). PCs give shale gas development quiet go-ahead in Sussex area. https://www.cbc.ca/news/canada/new-brunswick/higgs-shale-gas-go-ahead-sussex-1.5162253 Web March 10th, 2021.

CBC. (2019b). Sussex-area fracking plans shelved over 'regulatory uncertainty'. https://www.cbc.ca/news/canada/new-brunswick/corridor-fracking-sussex-regulatory-uncertainty-1.5245024 Web March 10th, 2021.

Census of Acadia. (1752). January 1752 General List of Inhabitants of French Acadia by Name, Families, Villages, and number of boys and girls in each family. http://www.acadian-home.org/census1752.html Web April 12th, 2020.

Charters, D., and S. Sutherland. (1979). Goreham, Joseph. *In:* Dictionary of Canadian Biography Volume 4. University of Toronto/Université Laval. 913 pages.

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.

Clarke, E. (1988). Cumberland planters and the aftermath of the attack on Fort Cumberland. In: They Planted Well: New England Planters in Maritime Canada. M. Conrad ed. Pages 42-60.

Clarke, E. (1995) The Siege of Fort Cumberland 1776: An episode in the American Revolution. McGill-Queen's University Press. Montreal, Québec. 302 pages.

CN (2021). CN History. https://www.cn.ca/en/about-cn/history/ Web March 9th, 2021

Coleman, M. (1967). Acadian Settlement in the Atlantic Provinces. National and Historic Parks Branch. Department of Indian Affairs and Northern Development. National Historic Sites Service. Manuscript Report Number 8. 32 pages.

Cooper, C. (2020). 7-Industrial Railways- Charles Cooper's Railway Pages. Web November 10th, 2020.

Cormier, C. (1969). Bourgeois, Jacques. *In:* Dictionary of Canadian Biography Volume 2. University of Toronto/Université Laval. 759 pages.

Cormier, C. (1975). Université de Moncton: Historique. Centre d'etudes acadiennes. Archives de l'UdeM. https://www.umoncton.ca/umcm-ceaac/files/umcm-ceaac/wf/wf/pdf/umhist.pdf Web December 15th, 2020

Cormier, B., and N. Thongboonmee. (2021) Water Quality Monitoring Coastal Restoration Project. Petitcodiac Watershed Alliance. Moncton, New Brunswick. 68 pages.

Corteva. (2020). VP480 Herbicide. Corteva Agriscience Canada Company. Calgary Alberta. 52 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.

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

COSEWIC. (2018). Wood Turtle (*Glyptemys insculpta*): COSEWIC assessment and status report 2018. https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/wood-turtle-2018.html Web March 7th, 2021.

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

Creet, M. (1998). Fleming, Sir Sanford. *In:* Dictionary of Canadian Biography Volume 14. University of Toronto/Université Laval. 1100 pages.

Cunningham, R. and J. Prince. (1976). Tamped Clay and Saltmarsh Hay: Artifacts of New Brunswick. University Press of New Brunswick. Fredericton New Brunswick. 280 pages.

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.

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.

d'Entremont, C. (1974). Broussard, Beausoleil, Joseph. *In:* Dictionary of Canadian Biography Volume 3. University of Toronto/Université Laval. 782 pages.

Des Barres, J.F.W. (1777) The Isthmus of Nova Scotia. Atlantic Neptune, Image 14. https://www.loc.gov/resource/g3301pm.gan00004/?sp=14&r=-0.633,0.29,1.544,0.764,0 Web May 16th, 2020.

Donovan, K. (2004). Slaves in Île Royale, 1713-1758. French Colonial History 5: 25-42

Dorchester Municipal Council. (2017). Climate Change Adaption Plan. Prepared by EOS Eco-Energy Inc. 40 pages.

Douglas, A. (1984). 'The Lion' And the Shipbuilders. The Atlantic Advocate February 1984. Page 38-39.

Dutil, J.D., A. Giroux, A. Kemp, G. Lavoie, and J.P. Dallaire. (1988). Tidal influence on movements and on daily cycle of activity of American eels. Transactions of the American Fisheries Society 117:488-494.

Environment and Local Government. (2020). Flood Details - 1978-01-09 - 1978-01-10. https://www.elgegl.gnb.ca/0001/en/Flood/Details/202 Web February 12th, 2020.

Environment Canada. (2011). Canadian Aquatic Biomonitoring Network field manual - wadeable streams. Environment Canada. Ottawa, Ontario. 57 pages.

Evans, G. (1969). Uncommon Obdurate: The several Public Careers of J.F.W. Des Barres. University of Toronto Press. Toronto, Canada. 130 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.

Facey, D. and M. Van Den Avayle. (1987). Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic)—American eel. U.S. Fish and Wildlife Service Biological Report 82(11.74). U.S. Army Corps of Engineers, TR EL-82-4. 28 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

Finn, G. (1979). LeLoutre, Jean-Louis. *In:* Dictionary of Canadian Biography Volume 4. University of Toronto/Université Laval. 913 pages.

Fletcher, R. (1767). An Act for the Quieting of Possessions to the Protestant Grantees of the Lands, formerly occupied by the French Inhabitants, and for preventing vexatious Actions relating to the same. Anno 33. Geo. II, III. Page 73. https://www.canadiana.ca/view/oocihm.64814/103?r=0&s=1 Web April 22nd, 2020.

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.

Fundy Salmon Recovery. (2021). Fundy Salmon Recovery. https://www.fundysalmonrecovery.com/ Web March 12th, 2021

Gagnon, C. (1889). Lettre de M. L'abbé Le Guerne Missionaire de l'Acadie. Trouvée Récemment dans les Archives de la Cure N.-D. De Québec. A. Cote et Co. 50 pages https://archive.org/details/cihm_08646 Web May 1st, 2020.

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. https://www.canadiana.ca/view/oocihm.12511/1?r=0&s=1 Web April 14th, 2020

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. https://www.canadiana.ca/view/oocihm.12510/1?r=0&s=1 Web April 16th, 2020

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. https://www.canadiana.ca/view/oocihm.74004/1?r=0&s=1 Web April 16th, 2020

Gaudet, P. (1899). The Acadian Fugitives. In: The New Brunswick Magazine, Volume 2. Pages 34-45. https://archive.org/details/newbrunswickmaga00stjo/page/n77/mode/2up?q=Piau Web April 8th, 2020

Gaudet, P. (1996). Acadian Genealogy and Notes Concerning the Expulsion. Quintin Publications. Pawtucket, Rhode Island. 372 pages.

Gautreau, M, and A. Curry. (2020). Inland Fishes of New Brunswick. Canadian Rivers Institute, University of New Brunswick. Fredericton, New Brunswick. 208 pages.

Gautreau, R. (2020). Resident of Pré-d'en-Haut, personal communication

Geological Survey Department. (1900). Summary Report of the Geological Survey Department for the year 1899. Geological Survey of Canada. Dawson Printers, Ottawa. 269 pages.

Gilders, R. and L. Cheung. (1993). Agglomeration and bio-leaching of a secondary copper bearing ore. Unpublished report prepared for Falconcrest Resource Inc. Saint John, New Brunswick. 27 pages.

Gillcash, E. (1984). Taylor Village. College Bridge, New Brunswick. 124 pages.

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. (2012). Why Dorchester became the Shiretown and Sackville did not. Westmoreland Historical Society Newsletter. Volume 47(2): 8-10

Goodrich, G. (2013). A Dorchester Ferry Tale. Westmoreland Historical Society Newsletter. Volume 48(1): page 9.

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

Goodrich, G., and J. Heap. (2017). Albert J. Smith, Dorchester's Stepfather of Confederation. Westmorland Historical Society Newsletter. Volume 52(3):5-12.

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.

Gorham, J. (1776). Letter to J.F.W. Des Barres from Halifax, April 15th, 1776, agreeing to sale of Memramcook Land Grant. Des Barres Papers Series V, p. 3303 https://heritage.canadiana.ca/view/oocihm.lac_reel_c1458/795?r=0&s=1

Government of New Brunswick. (2014). Government introduces moratorium on hydraulic fracturing in New Brunswick. https://www2.gnb.ca/content/gnb/en/news/news_release.2014.12.1404.html Web March 10th, 2021.

Government of New Brunswick. (2021a). Industrial Minerals Summary Data: Calhoun (Gayton) Barite. https://www1.gnb.ca/0078/GeoscienceDatabase/IndustrialMinerals/qryIndMinSummary-e.asp?Num=1048 Web March 9th, 2021.

Government of New Brunswick. (2021b). GeoNB Oil and Natural Gas (ONG) Viewer. http://geonb.snb.ca/ong/index.html Web March 9th, 2021.

Government of Ontario. (2021). Wood Turtle Recovery Strategy. https://www.ontario.ca/page/wood-turtle-recovery-strategy Web March 7th, 2021.

Graham, D. (1974). Lawrence, Charles. *In:* Dictionary of Canadian Biography Volume 3. University of Toronto/Université Laval. 782 pages.

Griffiths, N. (2004). From Migrant to Acadian: A North American Border People, 1604-1755. McGill-Queens University Press. Montreal, Québec. 604 pages.

Gulf Operators. (2021). Aggregate Sources and Product Information. https://www.gulfoperators.com/gulf-operators-services-aggregate-supply-aggregate-sources.aspx Web March 9th, 2021.

Haliburton, T.C. (1829). An Historical and Statistical Account of Nova Scotia Volume 1. 340 pages. https://archive.org/details/cihm_35690 Web June 9th, 2020.

Hamilton, W. (1997). Place Names of Atlantic Canada. University of Toronto Press. Toronto, Ontario. 502 pages.

Haralampides, K., and A. Rodriguez. (2006). Erosional properties of the sediments in the Petitcodiac River estuary at Moncton, New Brunswick. Canadian Journal of Civil Engineering 33: 1209-1216.

Haro. A., W. Richkus, K. Whalen, A. Hoar, W-D. Busch, S. Larry, T. Brush, and D. Dixon. (2000). Population Decline of the American Eel: Implications for research and management. Fisheries 25(9):7-16.

Heidenreich, C., and K. J. Ritch. (2010). Samuel de Champlain Before 1604: Des Sauvages and Other Documents Related to the Period. The Champlain Society. 490 pages

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

Hody, M. (1969). Blanchard, Guillaume. *In:* Dictionary of Canadian Biography Volume 2. University of Toronto/Université Laval. 759 pages.

Hollingsworth, S. (1787). The Present State of Nova Scotia: With a Brief Account of Canada, and the British Islands on the Coast of North America. Creech, Edinburgh. 221 pages. https://archive.org/details/presentstateofno00holl/page/n7/mode/2up Web August 10th 2020.

Holownia, T. (2020). Rockland Bridge 1981-2000. https://www.corkingallery.com/artists/thaddeus-holownia/artworks/rockland-bridge-1981-2000 Web February 13th, 2020.

Hornsby, S. (2011). Surveyors of Empire: Samuel Holland, J.F.W. Des Barres and the Making of the Atlantic Neptune. Carleton Library Series 221. McGill-Queen's University Press. Montreal, Québec. 269 pages.

International Boundary Commission. (1934). Joint Report on the Survey and Demarcation of the Boundary between the United States and Canada from the source of the St. Croix River to the Atlantic Ocean. United States Government Printing Office, Washington. D.C. 318 pages.

Janzen, O. (1996). The illicit trade of English cod into Spain, 1739-1748. International Journal of Maritime History 8(1):1-22.

Johnston, T., and L. Gauvin. (2017). Broken Brooks: Assessing and remediating culverts in the Petitcodiac and Memramcook River watersheds. Petitcodiac Watershed Alliance, Moncton New Brunswick. 49 pages.

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

Kernaghan, L. (1987). Cannon, Mary. *In:* Dictionary of Canadian Biography Volume 6. University of Toronto/Université Laval. 960 pages.

Kerr, D. (1895) Reports of Cases: Determined in the Supreme Court of New Brunswick, Volume 3. Second Edition. The Caswell Company Ltd, Toronto. 704 pages.

Kidder, F. (1867). Military Operations in Eastern Maine and Nova Scotia During the Revolution. Chiefly compiled from the journals and letters of John Allan with notes and a memoir of Colonel John Allan. Joe Munsel. 348 pages. https://archive.org/details/militaryoperatio00kidd Web August 6th 2020.

Knockwood, M. (2012). Mi'kmaq striped bass angler, Fort Folly First Nation, Personal Communication.

Kohl, J. (1869). History of the Discovery of Maine. *In* History of the State of Main Volume 1, W. Willis. Ed. Maine Historical Society. Portland Maine. 535 pages.

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.

Lawrence, C. (1758). Proclamation October 31st, 1758. The Boston Gazette and Country Journal, November 6th, 1758. http://nshdpi.ca/is/proc/ns-proclamation1758oct12-bostgaz-1106.html Web: April 22nd, 2020.

Lawrence, C. (1759). Proclamation, January 11th, 1759. John Draper, Boston. http://nshdpi.ca/is/proc/ns-proclamation1759jan11.html Web April 22nd, 2020.

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

Leonard, K. (1996). Mi'kmaq culture during the late woodland and early historic periods. PhD. Thesis. Department of Anthropology, University of Toronto. 129 pages.

Leonard, K. (2001). A survey for French military supply depots built 1749-1750 at the port of Shediac and on the Shediac River. Research conducted by the Shediac Bay Watershed Association. Archaeoconsulting. 50 pages.

Leonard, K. (2009). Camp de Belair: Ten Years After. Archaeoconsulting Inc. Prepared for Groupe de développement durable du Pays de Cocagne Sustainable Development Group inc. 22 pages.

Leblanc, P. (1979). Deschamps de Boishébert et de Raffetot, Charles. *In:* Dictionary of Canadian Biography Volume 4. University of Toronto/Université Laval. 913 pages.

Leblanc, R. (2018). The Acadian Refugee Camp on the Miramichi, 1756-1761. Translated by J. DeRoche. Earlier published in French in 2012 the Journal Acadiensis. Les réfugiés acadians au camp d'Espérance de la Miramichi en 1756-1761: un episode méconnu du Grand Dérangement. Acadiensis 41(1): 128-168

Le Rouge, G.L. (1755). L'Isthme de L'Acadie, Baye du Beaubassin, en Anglois Shegnekto, environs du Fort Beausejour. Chez le Rouge, Paris. https://www.loc.gov/resource/g3432c.ct008227/ Web March 31st, 2020.

Locke, A. (2000). Fish communities of the Petitcodiac River and tributaries in 1999. Pages 123-162 in Environmental Monitoring Working Group. Environmental Monitoring of the Petitcodiac River system, 1999. Petitcodiac River Trial Gate Opening project. October 2000. 308 pages.

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. 39-54.

London Magazine (1755). Boston October 8th. Page 627. London Magazine, or Gentleman's Monthly Intelligencer Volume 24 for the Year 1755. https://babel.hathitrust.org/cgi/pt?id=mdp.39015021267748&view=1up&seq=24 Web April 20th, 2020.

Loo, J., L. Cwynar, B. Freedman, and N. Ives. 2010 Changing Forest Landscapes in the Atlantic Maritime Ecozone. Chapter 3 In: Assessment of Species Diversity in the Atlantic Maritime Provinces Edited by D. McAlpine and I. Smith NRC Research Press. Ottawa, Canada. Pages 35 – 42.

Lutz, S. 1997. Pre-European settlement and present forest composition in King's County New Brunswick, Canada. M.F. Thesis, University of New Brunswick, Fredericton, New Brunswick.

MacDonald, S. (2010). Developmental history of a cupriferous swamp in southeastern New Brunswick, Canada. M.Sc. Thesis, University of Waterloo. 70 pages.

MacGregor, M. K., & Elderkin, M. F. (2003). Protecting and Conserving Wood Turtles: A Stewardship Plan for Nova Scotia. Biodiversity Program, Wildlife Division Nova Scotia Department of Natural Resources. Kentville Nova Scotia. 23 pages.

MacKinnon, C. (2019). Public Buildings and Community Volunteers at Fairfield, Westmorland County, New Brunswick in the late 1880s. The White Fence: Newsletter of the Tantramar Heritage Trust. 85:2-8

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.

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, G. (1990). For Love of Stone. Volume 1: The story of New Brunswick's Building Stone Industry. Miscellaneous Report, no. 9. New Brunswick Department of Natural Resources and Energy, Mineral Resources Division. Fredericton, New Brunswick. 176 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.

McCully, B. (1969). Nicholson, Francis. *In:* Dictionary of Canadian Biography Volume 2. University of Toronto/Université Laval. 759 pages.

McCreath, P. and J. Leefe. (1982). A History of early Nova Scotia. Four East Publications, Tantallon. 320 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.

Miller, R. (2010). Environmental History of the Atlantic Maritime Ecozone. *In* Assessment of Species Diversity in the Atlantic Maritime Ecozone. *Edited by* D. McAlpine and I. Smith. NRC Research Press, Ottawa, Canada. Pages 13-33.

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

Miller. (2021). Aggregates. https://www.millergroup.ca/materials/aggregates/ Web March 9th, 2021.

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

Morgan, R. (1987). Des Barres, Joseph Frederick Wallet. *In:* Dictionary of Canadian Biography Volume 6. University of Toronto/Université Laval. 960 pages.

Mosseler, A., J. Lynds, and J. Major 2003. Old-growth forests of the Acadian Forest Region. Environmental Reviews, 2003, 11:(S1) S47-S77

Murray, B. (2017). Piau: Journey to the Promised Land. Dundurn, Toronto. 266 pages.

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

Natural Resources Canada. (2011). Amherst, Nova Scotia. Topographic Map, 1:50,000. 21-H/16, 5th Edition. Centre for Topographic Information, Ottawa.

New Brunswick Crown Land Department. (1918). Annual Report of the Crown Land Department of the Province of New Brunswick for the year 1917, Volume 57. Fredericton, New Brunswick.

New Brunswick Department of Agriculture (1895). Report on Agriculture for the Province of New Brunswick for the year 1894. New Brunswick Department of Agriculture. Fredericton New Brunswick.
https://books.google.ca/books?id=6R5GAAAAYAAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

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 (2014). Forestry, Agriculture, and Transportation GIS Data.

New Brunswick House of Assembly. (1892). Journal of the House of Assembly of the Province of New Brunswick. Third Session of the Twenty Seventh General Assembly. Fenety. Fredericton New Brunswick. 227 pages.

New Brunswick Register of Historic Places. (2020). Bell Inn, 3515 Cape Road, Dorchester. Record 56, Version 2. https://www.rhp-rlp.gnb.ca/Page1.aspx?blnLanguageEnglish=True&RID=56&VER=2&dp=1 Web December 12th, 2020.

New Brunswick Travel Bureau (1960) Upper Dorchester Bridge. Sign. (Photovault.com)

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.

Orlen Upstream. (2021). Orlen Upstream Canada. https://www.orlenupstream.ca/EN/Pages/default.aspx Web March 10th, 2021.

Parks Canada. (2020). Monument-Lefebvre National Historic Site. https://www.pc.gc.ca/en/lhn-nhs/nb/lefebvre Web January 7th, 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. (1852). Reports on the Sea and River Fisheries of the Province of New Brunswick. Simpson, Fredericton. 294 pages.
https://archive.org/details/cihm_22313/page/n173/mode/2up?q=Memramcook Web February 23rd, 2021

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.

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

Pieridae Energy. (2021). Pieridae Energy. https://pieridaeenergy.com/ Web March 10th, 2021.

Pigot, F. (1983). MacDonald of Glenaladale, John. *In:* Dictionary of Canadian Biography Volume 5. University of Toronto/Université Laval. 1,044 pages.

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.

Plint, A. (1986). Slump blocks, intraformational conglomerates and associated erosional structures in Pennsylvanian fluvial strata of eastern Canada. Sedimentology 33(3):387-399.

Pomeroy, C. (1878). Champlain's Voyages / Voyages of Samuel de Champlain translated from French. Publications of the Prince Society. John Wilson and Son, Boston. 384 pages. https://www.canadiana.ca/view/oocihm.26912/3?r=0&s=1 Web April 10th, 2020.

Porter, J. (1877). Memoir of Col. Jonathan Eddy of Eddington, Me. : with some account of the Eddy family, and of the early settlers on Penobscot River. Sprague, Owen, & Nash Printers. Augusta, Maine. https://archive.org/details/memoirofcoljonat00port Web May 1st, 2020.

Pote, W. (1896). The Journal of Captain William Pote Jr. During his Captivity in the French and Indian War. Published by Dodd, Mead, and Company, New York. 223 pages. https://www.canadiana.ca/view/oocihm.12097/1?r=0&s=1 Web April 21st, 2020.

Pratt, T.C., and A. Mathers. (2011). 2010 update on the status of American Eel (*Anguilla rostrata*) in Ontario. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/050. vi + 18 p.

Pritchard, J. (1995). Anatomy of a Naval Disaster: The 1746 French Expedition to North America. McGill-Queens University Press Montreal, Québec. 322 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. (2020). Place Names of New Brunswick: Where is Home? New Brunswick Communities Past and Present. https://archives.gnb.ca/exhibits/communities/Home.aspx?culture=en-CA Web March 22nd, 2020

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

Rawlyk, G. (1983). Eddy, Jonathan. *In:* Dictionary of Canadian Biography Volume 5. University of Toronto/Université Laval. 1,044 pages.

Rayburn, A. (1975). Geographical Names of New Brunswick. Surveys and Mapping Branch, Department of Energy, Mines and Resources. Ottawa, Ontario. 304 pages.

Raymond, W. (1903). The Negro in New Brunswick. https://archives.gnb.ca/exhibits/forthavoc/html/Negro-in-NB.aspx?culture=en-CA#link1 web June 3rd, 2020.

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

Redfield, E.(2021) Petitcodiac Fish Trap Results, 2020 Season. Fort Folly Habitat Recovery, Dorchester New Brunswick. 96 pages.

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

Riverkeeper. (2020a). Memramcook Causeway Replacement Feasibility Report (Draft Report). Sentinelles Petitcodiac Riverkeeper. Moncton, New Brunswick. 20 pages.

Riverkeeper. (2020b). Preliminary Assessment of Options for the log-term viability of the Memramcook River Causeway. Sentinelles Petitcodiac Riverkeeper. Moncton, New Brunswick. 10 pages.

Robichaude, C. (2020) New Brunswick Department of Transportation and Infrastructure, personal communication.

Robinson, J. and T. Rispin. (1774). A journey through Nova Scotia containing a particular account of the country and its inhabitants. Printed for the Authors by C. Etherington https://www.biodiversitylibrary.org/item/87368#page/6/mode/1up Web May 3rd 2020.

Royal Commission on the Relations of Labor and Capital in Canada. (1889). Royal Commission on the Relations of Labor and Capital in Canada: Evidence New Brunswick. Ottawa, Ontario. 580 pages. https://www.canadiana.ca/view/oocihm.9_08110/249?r=0&s=1 Web January 15th, 2021.

Rumilly, R. (1981). L'Acadie Francaise, 1497-1713. Editions Fidas, Montreal. 253 pages.

Russ, C. (1974). La Corne, Louis de, Chevalier de la Corne. *In:* Dictionary of Canadian Biography Volume 3. University of Toronto/Université Laval. 782 pages.

Sabina, A. (2015). Roches et Minéraux du Collectionneur: baie de Fundy (Nouveau-Brunswick et Nouvelle-Écosse) et côte sud de la Nouvelle-Écosse. Commission géologique du Canada. Géosciences pour tous 97. Ottawa, Ontario. 495 pages.

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

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

SARA Registry (2015a) American Eel: Consultations on listing under the Species at Risk Act. https://www.registrelep-sararegistry.gc.ca/default.asp?lang=En&n=104010E0-1 Web 18 Dec 2015

SARA Registry (2015b). Aquatic Species at Risk, American Eel Consultations. http://www.sararegistry.gc.ca/virtual_sara/files/public/eel-anguille-eng.pdf Web 18 Dec 2015

SARA Registry (2019) Species at Risk Public Registry- Species Profile (Anguilla rostrata). http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=891 Web 10 January 2018

Sartine, A. (1778). Plan de l'isthme de l'Acadie comprenant le Beau-Bassin avec une partie de la Baie Verte. Publisher not Identified, Paris. https://www.loc.gov/item/73696324/ Web April 1st, 2020

Saunders, R., M. Hachey, and C. Fay. (2006). Maine's diadromous fish community: past present, and implications for Atlantic salmon recovery. Fisheries 31(11): 537 – 547

Schell, T. (1998). Compilation of Suspended Particulate Matter (SPM) recorded in the Shepody Bay / Petitcodiac River system. Canadian Technical Report of Fisheries and Aquatic Sciences 2246. vii + 29 pages.

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 Beauséjour - Fort Cumberland National Site of Canada, Aulac NB.

Scott, W., and E. Crossman. (1973). Freshwater Fishes of Canada. Bulletin 184. Fisheries Research Board of Canada. 966 pages.

Shoebottom, B. (1999) Branch Lines and Politics: The case of southern Albert County Railways 1864-1911. University of New Brunswick, International Graduate History Conference. Fredericton. 62 pages.

Shoebottom, B. (2000). The Battle of the Petitcodiac, September 2nd, 1755. https://www.academia.edu/176323/The_Battle_of_the_Petitcodiac_September_2_1755 Web April 7th 2020.

Simpson, J. 2008. Restoring the Acadian Forest: A Guide to Forest Stewardship for Woodlot Owners in the Maritimes. Four East Publications. Tantallon, Nova Scotia. 154 pages

Smith, A. (1960). Heavy Metal (Zn, Pb, Cu) content of stream sediments of part of Westmorland County, New Brunswick. Geological Survey of Canada, Paper 59-12. 8 pages.

Smith, T. (1899). The slave in Canada. Collections of the Nova Scotia Historical Society. Volume 10. Pages 1-161. https://archive.org/details/collectionsofnov10nova/page/n15/mode/2up Web August 15th, 2020.

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

Société d' Histoire de Memramcook. (1994). Le Village-des-Piau à la Butte à Pétard. Plaque Commemorating settlement of Village-des-Piau unveiled in 1994.

Société d'histoire de Memramcook. (2020). Bienvenue. https://histoirememramcook.ca/ Web December 11th, 2020.

Speakman, T. (1755). Letter to John Winslow, 5th September 1755. Pages 336 to 338 In: Haliburton, T.C. (1829). An Historical and Statistical Account of Nova Scotia Volume 1. 340 pages. https://archive.org/details/cihm_35690/page/n367/mode/2up Web June 9th 2020.

Spray, W. (1972). Landry, Amand. *In:* Dictionary of Canadian Biography Volume 10. University of Toronto/Université Laval. 823 pages.

Spray, W. (1976). Perley, Moses, Henry. *In:* Dictionary of Canadian Biography Volume 9. University of Toronto/Université Laval. 967 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. (2020a) Acadians (1752 to 1784). https://www150.statcan.gc.ca/n1/pub/98-187-x/4064810-eng.htm Web March 13th, 2020

Statistics Canada. (2020b). 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

Steele, I. (1979). Monckton, Robert. . *In:* Dictionary of Canadian Biography Volume 4. University of Toronto/Université Laval. 913 pages.

Stewart, A. (1983). Allan, John. *In:* Dictionary of Canadian Biography Volume 5. University of Toronto/Université Laval. 1,044 pages.

Stronach, I. (1969). The European and North American Railway. Canadian Rail 206:15-19.

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.

Swift, M. (1972). Chandler, Edward Barron. *In:* Dictionary of Canadian Biography Volume 10. University of Toronto/Université Laval. 823 pages.

Teeter, J. (1980). Pheromone communication in sea lampreys (*Petromyzon marinus*): implications for population management. Canadian Journal of Fisheries and Aquatic Sciences 37:2123-2132.

Thomas, J. (1879). Diary of John Thomas. In: Report and Collections of the Nova Scotia Historical Society for the year 1878. Volume 1. Halifax, Nova Scotia. Pages 119-140. https://archive.org/details/collectionsofnov01novauoft/page/n123/mode/2up?q=Frye Web April 21st, 2020.

Trueman, H. (1902). The Chignecto Isthmus, and its first settlers. William Briggs. Toronto. 268 pages. https://archive.org/details/chignectoisthmus00trueuoft/page/n7/mode/2up Web May 3rd 2020.

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

Vaudreuil, P. (1755). Letter to M. de Machault, September 18th, 1755. *In:* Documents Relative to the Colonial History of the State of New York. Volume 10, 1858. E.B. O'Callaghan ed. Albany, New York. Page 358-359. https://archive.org/details/documentsrelativ10newyuoft/page/358/mode/2up?q=Vaudreuil+ Web April 20th, 2020.

Wallace, C. (1982). Smith, Sir Albert James. . *In:* Dictionary of Canadian Biography Volume 11. University of Toronto/Université Laval. 1092 pages.

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.

Wells, P. (1999). Environmental Impact of Barriers on Rivers Entering the Bay of Fundy: Report of an ad hoc Environment Canada Working Group. Technical Report Series No. 334, Canadian Wildlife Service, Ottawa ON. 43 pages.

Westmorland Historical Society (2016). John Keillor Esq. 1761-1839. http://keillorhousemuseum.com/website/wp-content/uploads/WOF_Keillor.pdf Web Feb 10th, 2021

White, S. (1983). Cormier, Pierre. *In:* Dictionary of Canadian Biography Volume 5. University of Toronto/Université Laval. 1,044 pages.

White, M. (2019). Liberty to Slaves: The Black Loyalist Controversy. Thesis, Master of Arts, University of Maine. 66 pages.

Whitfield, H. (2009). Slavery in English Nova Scotia, 1750-1810. Journal of the Royal Nova Scotia Historical Society 13: 23-40.

Whitfield, H. (2012). The Struggle over Slavery in the Maritime Colonies. Acadiensis 41(2):17-44

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

Willard, A. (1930). Journal of Abijah Willard of Lancaster Mass: an officer in the expedition which captured Fort Beauséjour in 1755. Reprinted from Collections of the New Brunswick Historical Society No. 13. https://archive.org/details/McGillLibrary-rbsc_journal-abijah-willard_FC2499F67W551930-17650/page/n3/mode/2up Web April 22nd, 2020.

William, W. (1929). Record of Canadian Shipping: a list of square-rigged vessels, mainly 500 tons and over, built in the eastern provinces of British North America from the year 1786 to 1920. The Musson Book Company Ltd. Toronto, Ontario. 302 pages. https://archive.org/details/recordofcanadian00wall/page/286/mode/2up?q=Welsford Web. January 10th, 2021

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

Williamson, W. (1832). The History of the State of Maine; from its first discovery, A.D. 1602, to the Separation, A.D. 1820, Inclusive. Volume 2. Hallowell: Glazier, Masters, & Co. 605 pages.

Wilkinson, J. (1859) Map of the British Province of New Brunswick from the best existing materials by the Authority of the Provincial Legislature. With Adjacent parts of Canada, Nova Scotia, and Maine.

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.

Woods, S. (1992). Cinders & Saltwater: The Story of Atlantic Canada's Railways. Nimbus Publishing Ltd. Halifax. 227 pages.

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.

Wright, E. (1955). The Loyalists of New Brunswick. Fredericton, New Brunswick. 364 pages.

Wynn, G. (1979) Late eighteenth-century agriculture on the Bay of Fundy marshlands. Acadiensis 8(2): 80-89

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 A: FFHR CHECKLISTS TO MINIMIZE IMPACTS ON PROTECTED SPECIES

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_____

APPENDIX A: FFHR Checklists to minimize impacts on protected species

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_____

APPENDIX A: FFHR Checklists to minimize impacts on protected species

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_____

APPENDIX A: FFHR Checklists to minimize impacts on protected species

Checklist for projects in Brook Floater (*Alasmidonta varicosa*) habitat

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 _____

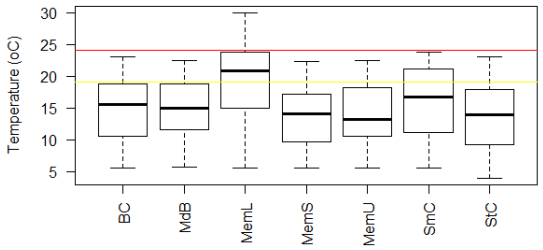
8). If cattle are present, measures to protect newly planted vegetation by excluding cattle (i.e. fencing) will also protect brook floaters. Open access to streams by cattle can cause direct mortality to mussels by trampling of mussel beds and lead to habitat degradation through sedimentation and eutrophication.

☐ Done ☐ Does not apply Comment _____

APPENDIX B: PWA 2020 WATER QUALITY PLOTTED PARAMETERS

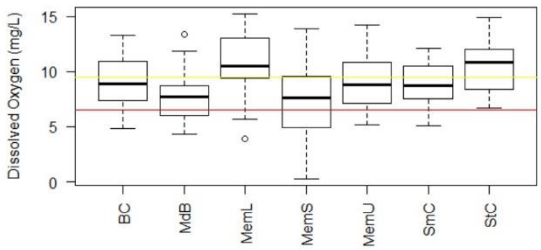
Taken from the Petitcodiac Watershed Alliance Memramcook Water Quality Report (Cormier and Thongboonmee 2021).

Water Temperature



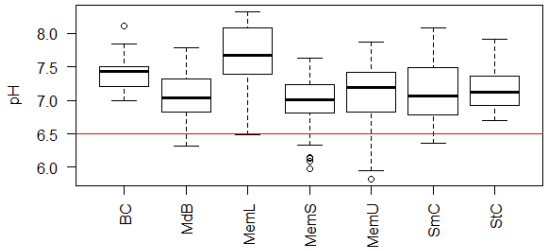
Yellow line: the maximum weekly average temp (19°C) for the protection of aquatic life
Red Line: Long term Lethal Limit (24°C)

Dissolved Oxygen



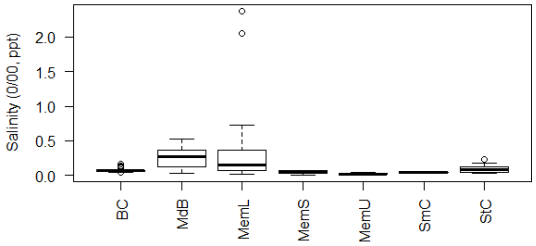
Yellow line: lowest DO level (9.5 mg/L) suitable for early life stages.
Red line: lowest DO level (6.5 mg/L) suitable for other life stages

pH

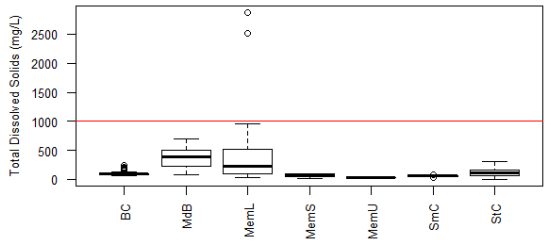


Red line: lowest pH (6.5) suitable for aquatic life

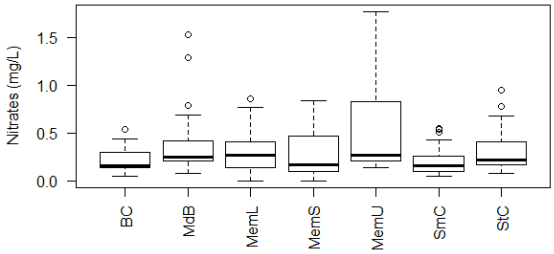
Salinity



Total Dissolved Solids

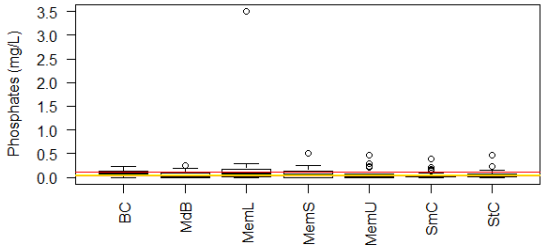


Nitrates



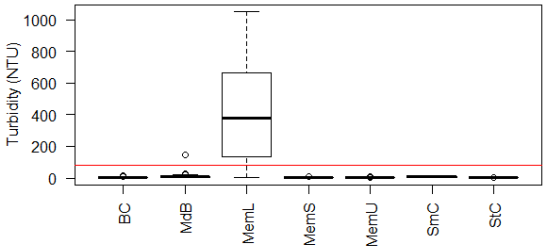
Red line: Demarcation between freshwater and brackish water (TDS levels > 1000 mg/L)

Phosphates



Red line: CCME guideline (0.1 mg/L) for streams not flowing into lakes or reservoirs.
Yellow line: CCME guideline (0.05 mg/L) for streams flowing into lakes or reservoirs

Turbidity



Red line: Turbid water (>80 NTU)

APPENDIX C: GPS COORDINATES FOR START OF RGA/RSAT ASSESSMENTS

Memramcook River Reach Start Locations

Site	Latitude	Longitude	Site	Latitude	Longitude
Reach 1	46.053750	-64.412750	Reach 21	46.080117	-64.482683
Reach 2	46.054050	-64.414567	Reach 22	46.080967	-64.483983
Reach 3	46.054033	-64.416033	Reach 23	46.085767	-64.486950
Reach 4	46.054667	-64.418250	Reach 24	46.088867	-64.492533
Reach 5	46.056891	-64.419100	Reach 25	46.092450	-64.495567
Reach 6	46.061433	-64.421133	Reach 26	46.086133	-64.507450
Reach 7	46.063550	-64.422050	Reach 27	46.086283	-64.515300
Reach 8	46.064883	-64.424350	Reach 28	46.086417	-64.516600
Reach 9	46.066933	-64.427700	Reach 29	46.090950	-64.525967
Reach 10	46.068900	-64.433417	Reach 30	46.093383	-64.537050
Reach 11	46.069650	-64.433600	Reach 31	46.095300	-64.548383
Reach 12	46.070250	-64.436417	Reach 32	46.096433	-64.549783
Reach 13	46.071800	-64.443233	Reach 33	46.091467	-64.555200
Reach 14	46.071200	-64.446933	Reach 34	46.088600	-64.560117
Reach 15	46.073900	-64.448250	Reach 35	46.082717	-64.563533
Reach 16	46.075683	-64.453317	Reach 36	46.081717	-64.568667
Reach 17	46.075250	-64.465117	Reach 37	46.081500	-64.570000
Reach 18	46.076350	-64.468500	Reach 38	46.078817	-64.568367
Reach 19	46.079850	-64.475917	Reach 39	46.065900	-64.571033
Reach 20	46.079083	-64.477750	Reach 40	46.061583	-64.568867