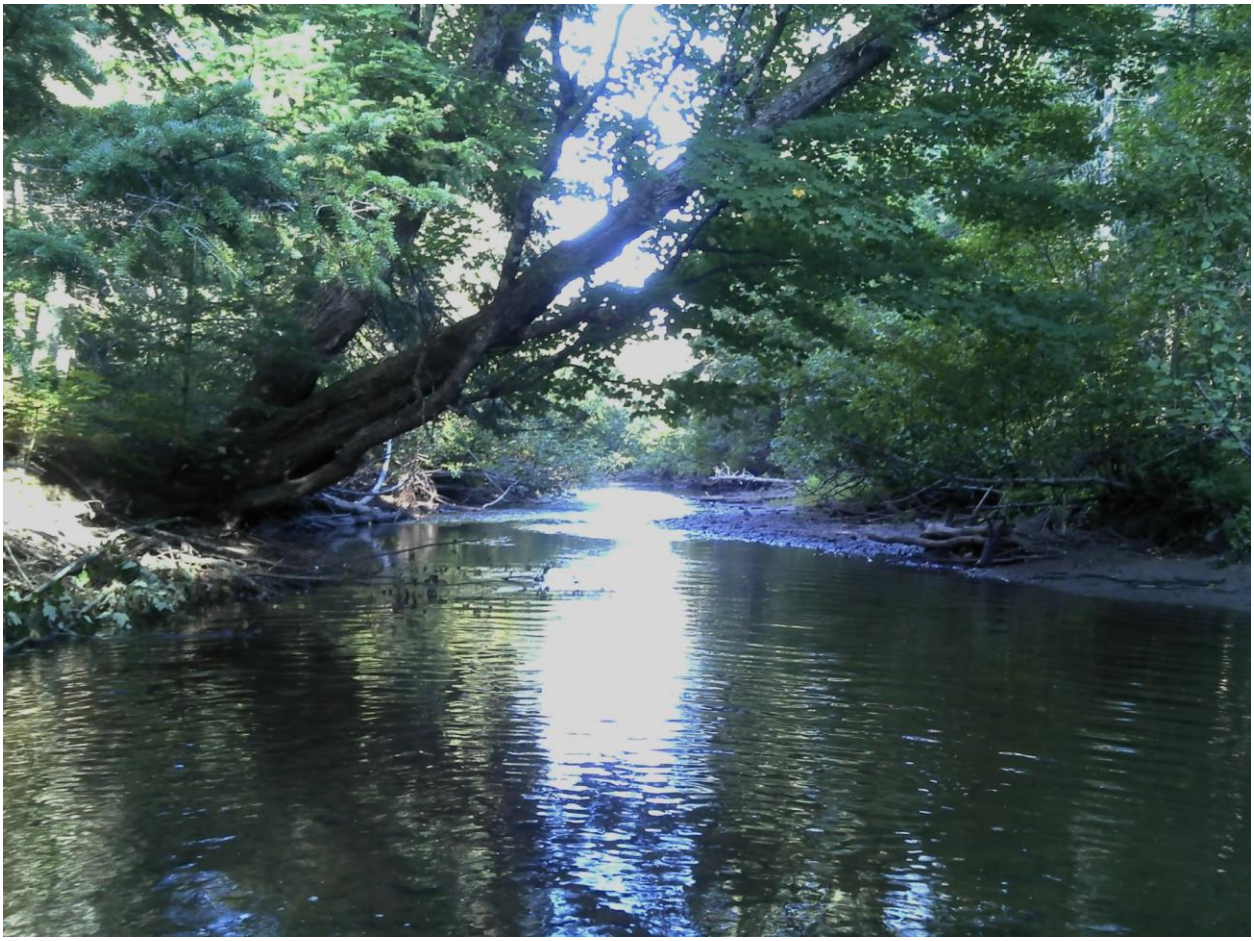
RICHIBUCTO RIVER WATERSHED

ATLANTIC SALMON CONSERVATION STRATEGY



Richibucto River Watershed

Atlantic Salmon Conservation Strategy

November 2023

Harry Collins

Neil Collins

Miramichi River Environmental Assessment Committee

PO Box 85, 21 Cove Road
Miramichi, New Brunswick
E1V 3M2

Phone: (506) 778-8591
Fax: (506) 773-9755

Email: mreac@nb.aibn.com
Website: http://mreac.org

Acknowledgements

The Miramichi River Environmental Assessment Committee (MREAC) would like to thank the Foundation for Conservation of Atlantic Salmon (FCAS) for their funding support and this opportunity to work on Atlantic salmon conservation on the Richibucto River drainage basin. The MREAC volunteer and outfitter, Timothy Humes, is likewise acknowledged for his field support and for the use and loan of outdoor equipment. The staff and students at New Brunswick Community College (NBCC-Miramichi) in the Environmental Technologies Program provide equipment, lab space and field support annually; thanks to all.

Executive Summary

In 2023, the Miramichi River Environmental Assessment Committee (MREAC) was supported by the Foundation for Conservation of Atlantic Salmon (FCAS) to prepare an Atlantic salmon conservation strategy for the headwaters main branch of the Richibucto River. The target watershed boundary assesses the Atlantic Samon habitat and status on this largest of the eight significant tributaries of the Richibucto watershed. MREAC staff and volunteers completed significant environmental monitoring and habitat assessment during the open water season of 2023. Both current and historical data was available for this drainage basin. Interviews with local recreational fishers were conducted when possible.

Based on available data, visual observations, river monitoring, and communication with river stakeholders, the Richibucto River appears to have habitat characteristics required to sustain significant Atlantic salmon production. Limiting factors to Atlantic salmon production, have been identified. Some natural limiting factors will be unsurmountable. Future efforts should concentrate on maintaining the existing ecological values that sustain the existing stock of Atlantic salmon and other indigenous fish species. Additional and ongoing monitoring of this keystone species is needed. The long-term trend for fry and parr production shows significant reduction. Intervention in way of habitat protection and ongoing monitoring is recommended.

This and other comparable sized tributaries in eastern New Brunswick should be assessed further to determine the actual size of the annual spawning population. Resource protection through enforcement or citizen engagement should be enhanced as opportunities allow.

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1.0 Introduction

The Miramichi River Environmental Assessment Committee (MREAC) undertook the production of a Richibucto River Watershed Atlantic Salmon Conservation Strategy in 2023. This project was supported by the Foundation for Conservation of Atlantic Salmon (FCAS). Based on available watershed data, recent monitoring efforts, other research, and opportunistic interviews, MREAC herein presents this strategy.

The Richibucto River watershed is the second largest of the watersheds situated entirely within the province of New Brunswick. Situated on New Brunswick's eastern shoreline, the Richibucto is composed of eight significant tributaries. This report is limited to the main branch of the Richibucto River as the largest of the waterways within the overall watershed. This is the target waterway for this Atlantic salmon conservation strategy.

This Richibucto River drainage basin is a stream order 4 riverine system and covers an area of 264.9 km² (Figure 1). It is known to have an Atlantic salmon population, but relatively little is known about the current size or sustainability of this population.

Of the approximate 38-kilometre length of the main branch from the headwaters to head of tide, just above Browns Yard, the MREAC survey team was able to complete a canoe reconnaissance of 12 kilometres during higher flow conditions on April 26, 2023. Other reaches have been covered by this same team in previous years.

A one-kilometer reach on the Richibuto River west of Hwy 126 was surveyed, applying the established (DNR/DFO) Stream Habitat Inventory protocol. Six temperature loggers were deployed at widely distributed locations on the main branch and its tributaries Hudson Brook, Duffs Brook, Smith Meadow Brook, Trout Brook, and an unnamed brook. Four were successfully recovered to provide season long temperature profiles from each waterway.

An electrofishing site was surveyed on Smith Meadow Brook. These current-year data sets have contributed to the habitat assessment and to the overall conservation strategy.

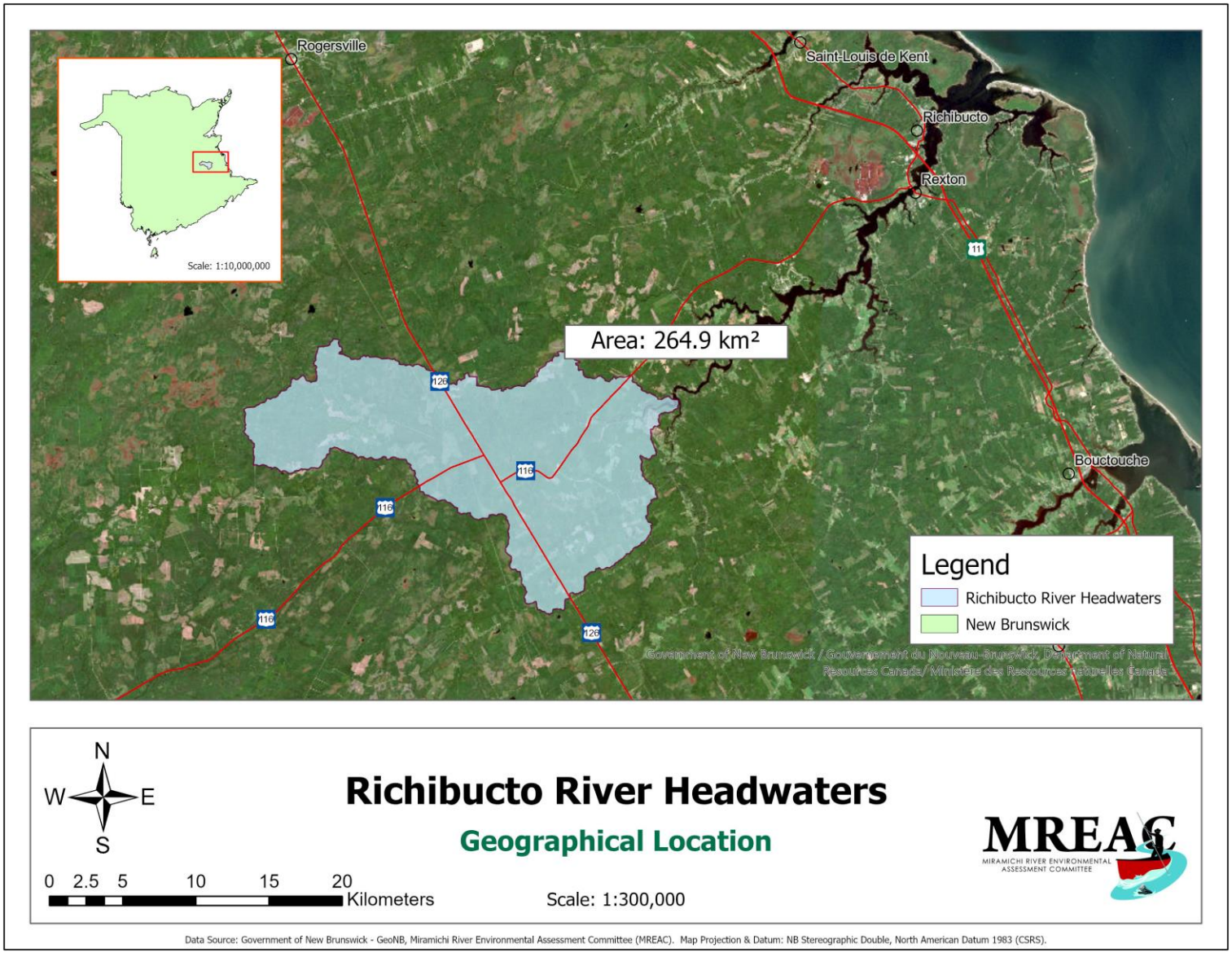

Figure 1 Richibucto River Drainage Basin Geographical Location

The Richibucto River flows into tidal waters just above Browns Yard and ultimately drains into the Northumberland Strait. The Richibucto is among a suite of smaller waterways south of the Restigouche and Miramichi rivers on the eastern New Brunswick shore. Each of these smaller waterways has its challenges due to intensive resource harvesting, their limited size and often significant development pressures. Most development, as on the Richibucto watershed, is concentrated along the tidal waters of these respective estuaries.

In discussions with recreational fishers, available resource information, and as confirmed by our own electrofishing, the Richibucto does have resident Atlantic salmon. However, little is known about the level of salmon angling on the Richibucto River and the river's potential in producing Atlantic salmon. Temperature monitoring, field surveys, habitat assessment, electro-fishing, and opportunistic interviews were completed in 2023 to contribute to this strategy. The scope of this 2023 work on the Richibucto cannot determine the current level of Atlantic salmon production. Nor does the Richibucto have a means of monitoring returning Atlantic salmon to spawn each year. The technology referenced as "ARIS Sonar Population Tracking" should be considered, and when and if feasible assess the numbers of returning spawners on the Richibucto.

Recommendation: *When feasible, the Richibucto River (and other smaller waterways) should be assessed using "ARIS Sonar Population Tracking" to determine the actual size of the annual spawning population.*

This report considers the river's limiting factors and approaches to sustain the existing level of salmon production and the prospect of enhancing that production.

Trout are the target species of the few local fishers we encounter on the freshwater reaches of the river. Like most other rivers of this scale in eastern New Brunswick, the Richibucto has a fall run of spawning salmon. Typically, low summer water levels and high-water temperatures limit access during the mid-summer months. The habitat survey showed that there are several naturally occurring pools and good conditions for resident juvenile salmon as well as adequate spawning conditions for returning salmon.

2.0 Conservation Strategy Objectives for Atlantic Salmon on the Richibucto River

1. To maintain the ecological and existing recreational fishing values that the Richibucto River currently possesses.

2. To conserve and protect existing Atlantic salmon stocks and their habitat.

3. To contribute to existing environmental knowledge and tap into the existing traditional knowledge through monitoring and interviews of recreational fishers.

4. To promote the cooperation and support of residents, landowners, recreational users, and other interested parties in effective management of recreational fisheries resources.

5. To promote shoreline stewardship principles among the camp, cottages, and full-time residents along the Richibucto River to reduce negative impacts of siltation and shoreline destabilization.

6. To promote equity and fairness for all users in the application of management measures for recreational fishing.

7. To present a long-term strategy to conserve and maintain recreational fish and their habitat.

3.0 River Setting & Access

The Richibucto River watershed - above the approximate head-of-tide at its junction with the Coal Branch river at Browns Yard - covers 264.9 km² (Figure 1). The basin consists of the main branch and its numerous tributaries. Several large brooks add to the drainage system. Six of the larger tributaries were selected to monitor the season-long temperature regime. (Figure 10) The flow conditions involving warm, low water during a 'normal' hot and dry summer limits the movement of larger fish. This restricts the Richibucto River to a fall-run stream for spawning Atlantic salmon.

East of Hwy 126, much of the land is in private hands including significant land holdings by Irving Pulp and Paper Ltd. West of the highway, Crown lands predominate with JDI control of most of this land under lease-hold for forest harvesting. Of note, the Richibucto enters tidal influenced waters just above Browns Yard. From this head of tide to the Northumberland Strait the Richibucto River continues for another 36.4 kilometers.

4.0 Physical Setting & Climate

In 2023, conditions were much wetter and somewhat cooler than the record-breaking drought and heat of 2020. Climate Normals for Harcourt New Brunswick (1981-2010) show a mean July temperature of 18.5°C and a mean January temperature of -10.2°C. The mean annual precipitation was 1160.2 mm. The past decade has shown that summer temperatures are on the rise, and this is in keeping with the expected climate change scenario.

The Richibucto River drainage basin is part of the Eastern Lowlands Ecoregion (Figure 3). This makes the river a fairly even, low gradient river with an average drop of 4 meters per kilometer.

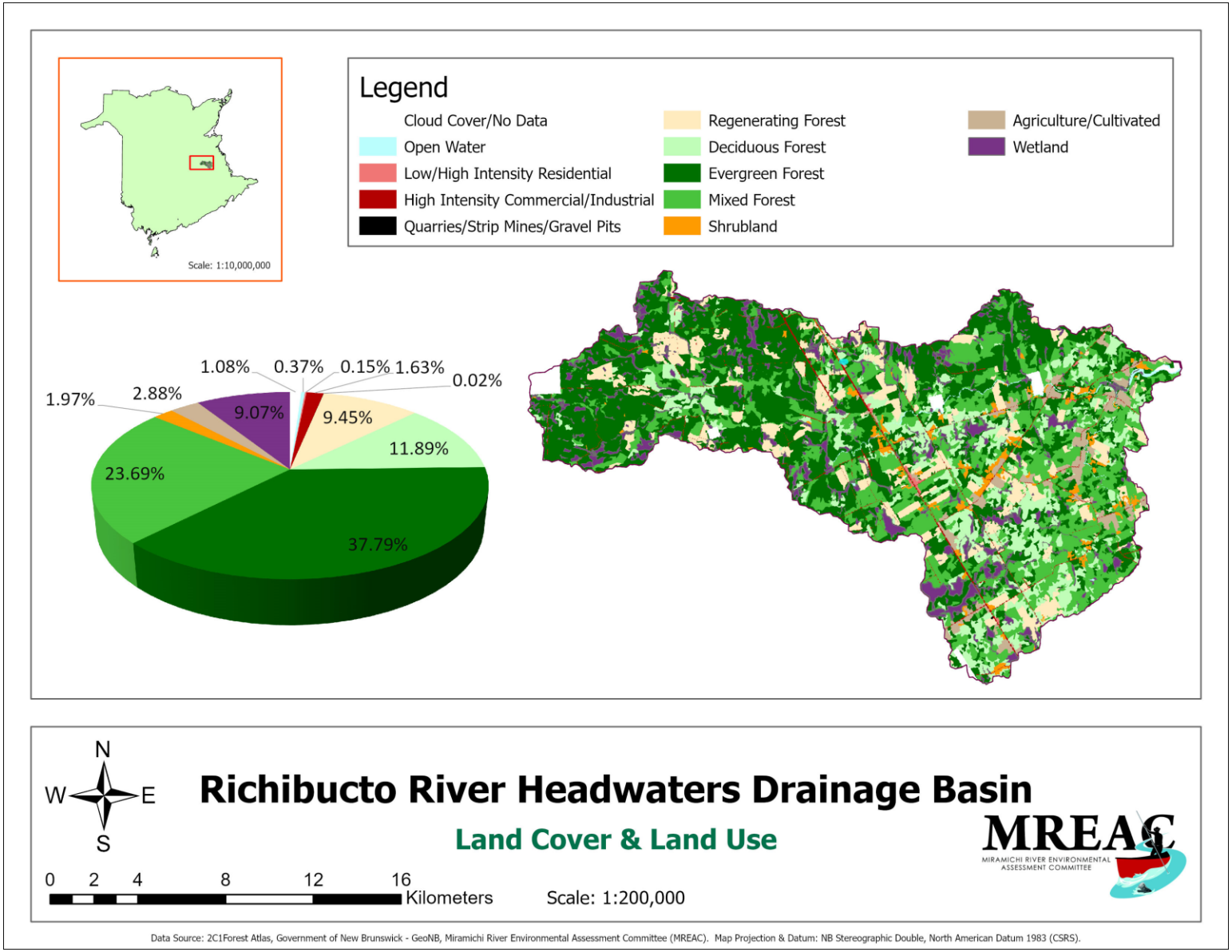

Figure 2 Richibucto River Land Cover & Land Use

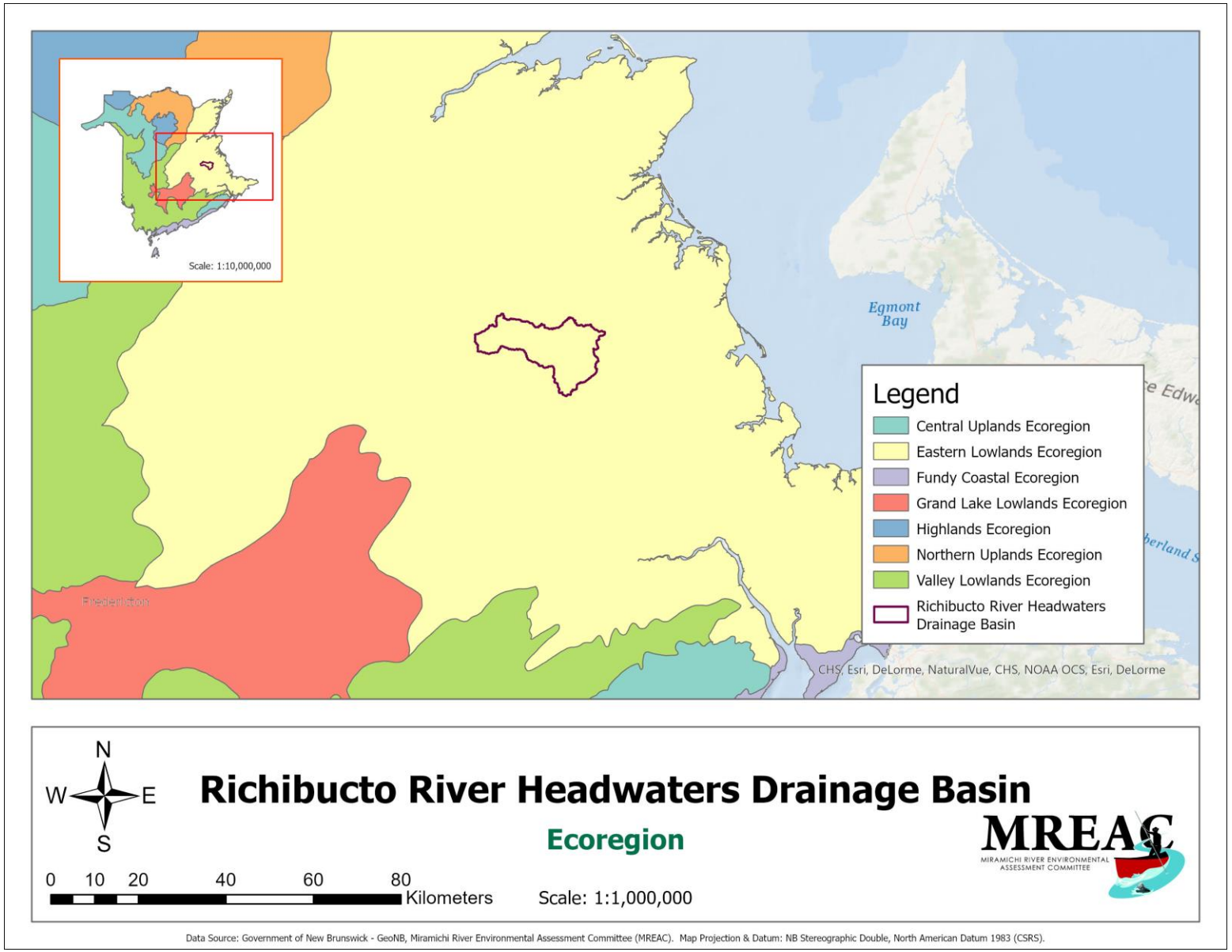

Figure 3 Richibucto River Drainage Basin Within New Brunswick Ecoregions

4.1 Bedrock Geology

The bedrock geology of the Richibucto River drainage basin is typical to that of the eastern lowlands ecoregion which is generally composed of grey sandstone and red mudstone. The stratum dates to the Carboniferous (Pennsylvanian) geologic era (Figure 4) (NBDNR, 2000). Exposed bedrock is a feature of some stretches of the river bottom with little other surficial material as a cover. More commonly the river has a cobble/gravel bottom and suitable habitat for the variety of resident aquatic species.

The surficial geology of the Richibucto River drainage basin is primarily composed of silt, sand, gravel, rubble, loamy lodgement till, and minor ablation till. The organic sediments found in bogs or fens are typically 1 to 5 meters thick. Wetlands are a prominent part of the landscape. Water clarity is impacted from bog drainage, giving the water a brownish hue.

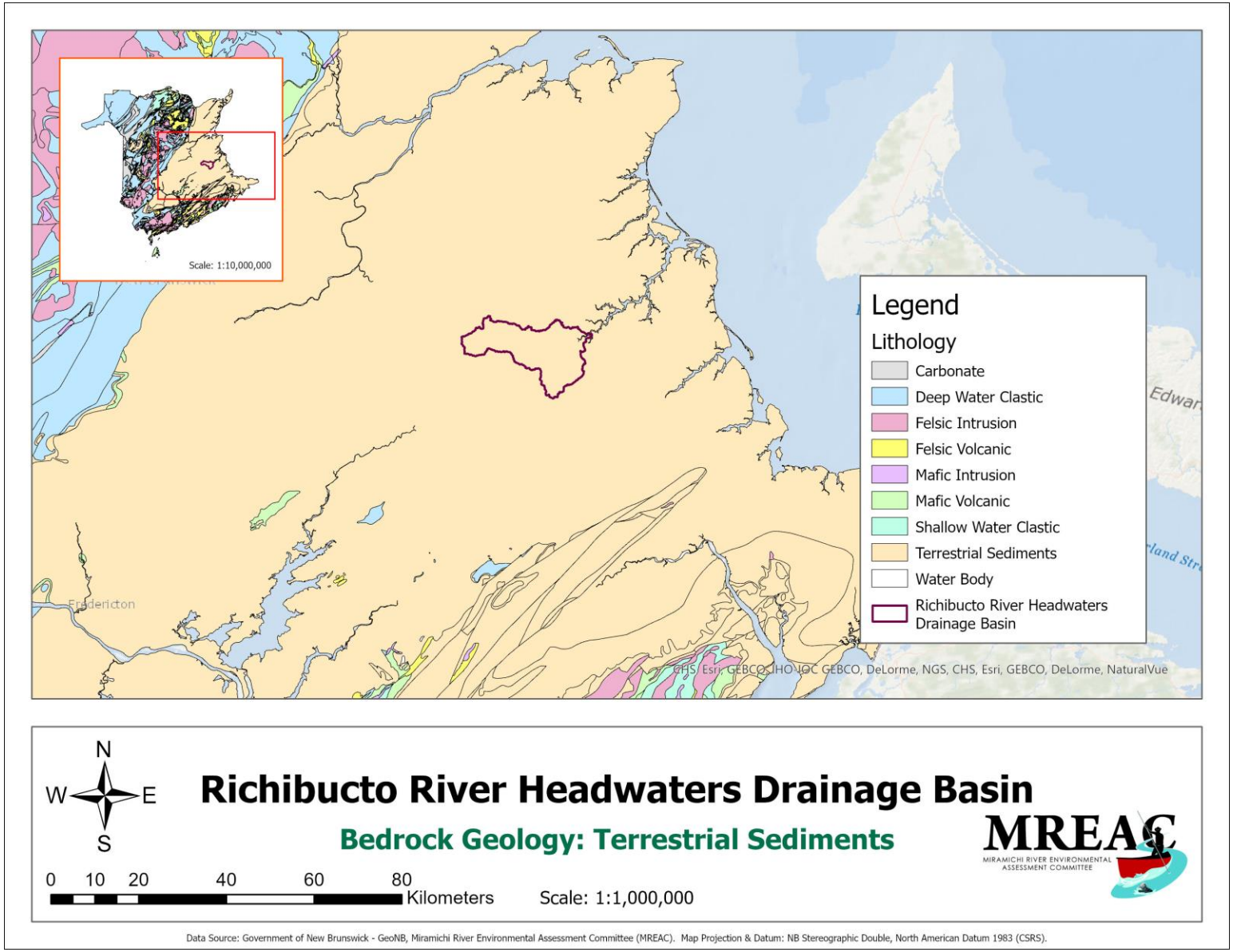

Figure 4 Richibucto River Drainage Basin Bedrock Geology

5.0 Land Cover, Land Use & Land Use History

The predominant land-cover on the main branch of the Richibucto River is forest, comprising about 70% considering the various forest types (Figure 2). Forestry is the main economic activity on the watershed and has the greatest anthropogenic impact on the watershed. Most of the forest harvesting is industrial scale, worked by Irving-owned forest companies with large holdings of both private and lease-hold crown lands. Harvesting on private woodlots is also common. Forestry is followed by other activities as shown in Figure 2.

Wetlands comprise 9.1 % of the landscape and are widely distributed throughout the watershed. In areas of low topographic relief and slow discharge, organic sediment on the river bottom offers poor substrate for spawning.

There is no active tracking of the level of recreational fishing activity and even less resource data available on Atlantic salmon. Anglers on the Richibucto target Brook trout with little expectation of catching Atlantic salmon.

- Results in 2023 from sampling the general chemistry of Richibucto River water did not flag any specific industry related compounds that would limit habitat conditions for Atlantic salmon. (See Appendix C.)
- A CABIN (Canadian Aquatic Biomonitoring Network) site on the Richibucto at the bridge crossing of Hwy 116 indicates near-reference habitat conditions for this waterway identifying a healthy benthic community.
- Past electrofishing results by the Richibucto River Association and the Southeastern Anglers suggest it is typical of smaller waterways along this eastern New Brunswick shoreline. Atlantic salmon inhabit these waterways but are nowhere abundant.

Figure 5 pH Monitoring on the Richibucto River watershed

Recommendation: *Monitoring of the Richibucto River for pH levels should continue annually in late-winter, spring and throughout the field season as part of a watershed monitoring program.*

6.0 Beaver Dams

From field work and other river travels in 2023, beaver dams were present but offered little impairment to fish passage. While these dams are a common feature on the Richibucto watershed exceptionally high-water levels throughout much of 2023 limited their impact on fish passage. Access to many of the smaller tributary streams is limited and beaver activity may be more of a factor in these waterways. Under more typical conditions beaver dams have impeded fish passage. When this occurs a late fall program of notching problematic beaver dams is recommended to enhance salmon access to headwater reaches.

***Recommendation**: An annual program of notching beaver dams in the late fall during spawning season should be implemented to extend spawning further into the Richibucto River headwaters.*

7.0 Habitat Assessments

One detailed stream habitat survey was completed in 2023 on a one-kilometer reach of the main branch, Richibucto River. (Appendix A). This reach, west of Hwy 126 and accessible from the Salmon River Road (Hwy 116) by a restored ancient native portage trail, was representative of the overall headwaters. The results of the habitat assessment showed physical conditions conducive to rearing Atlantic salmon. The DNR&E / DFO – New Brunswick Stream Habitat Inventory field forms indicate that the overall physical characteristics show favorable conditions in the number and depth of pools, available shade, potential cover with woody debris, bank stability, available shade and vegetated river banks. The substrate would allow for nesting activity (i.e. the creation of a salmon redd).

Water temperature loggers were placed at six Richibucto watershed sites, distributed on various tributaries and the main branch. Only four of these were successful recovered. Figure 7 represents a water temperatures composite from these four Richibucto River sites from 2023 monitoring.

Higher temperatures and low water levels of the summer normally prohibit an early run of Atlantic salmon. No testimonial evidence suggested that the high flows in 2023 resulted in salmon entering the headwaters earlier than normal. As a fall-run river, adult salmon are thus not at risk due to high stresses of water temperatures. Resident juvenile salmon will seek out cold water pools to wait out warm-water conditions. The four temperature loggers recovered provide profiles (Figure 7) that extend for over four months with deployment in the spring and extraction in the fall.

Figure 6 Habitat Assessment on Headwaters of Richibucto River

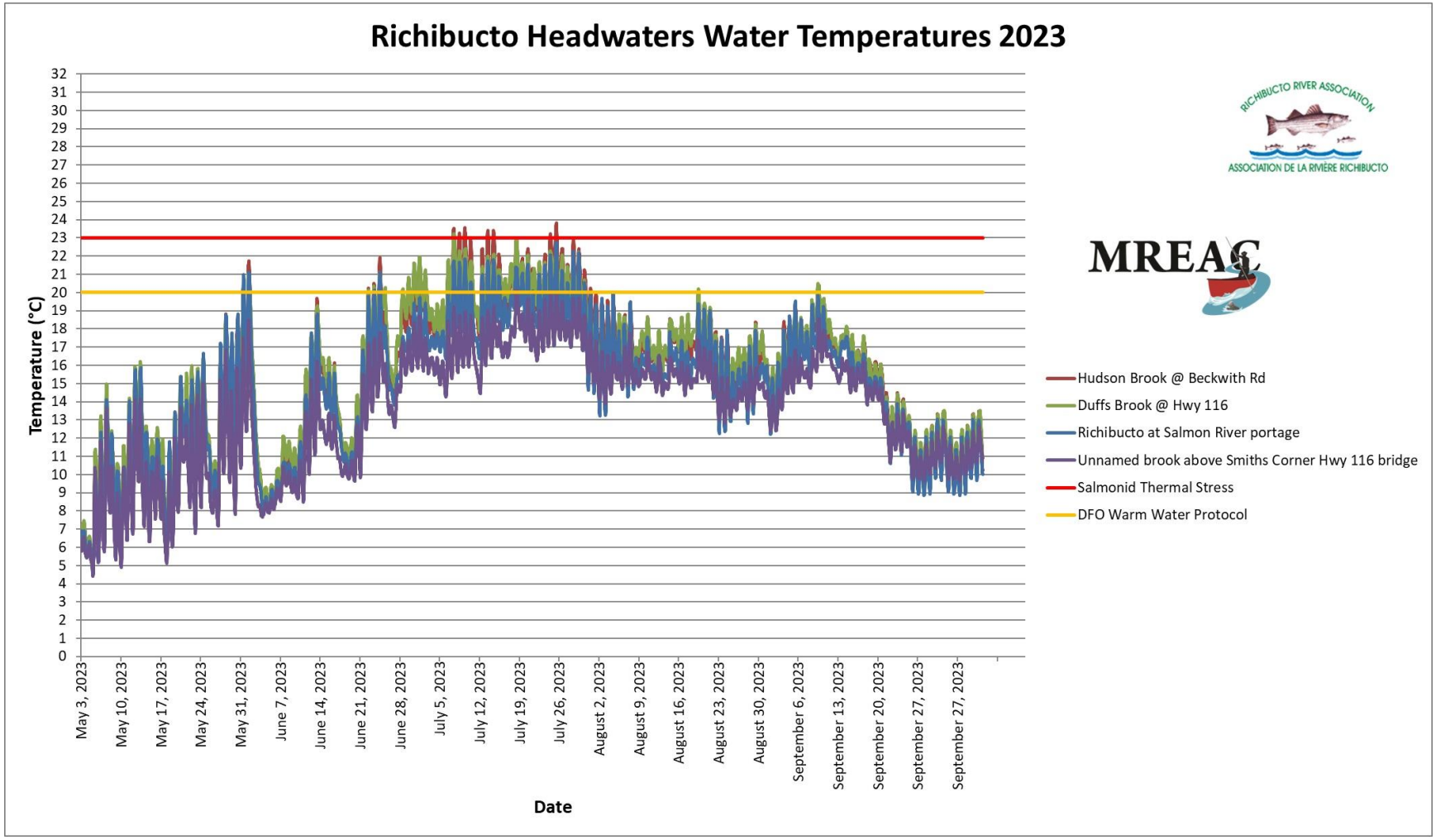

Figure 7 Water Temperature Profiles of Four Coal Branch Waterways

***Recommendation**: The Richibucto River should be included in a comprehensive monitoring /program of water temperature in eastern New Brunswick rivers to monitor long-term trends with the intent of providing special protection of colder water streams and pools as fish refuges*.

One electrofishing site was fished by Mr. Rod Currie, fish biologist with Hilcon Ltd, Fredericton, on September 24th 2023. Mr. Currie was assisted by two MREAC staff. Figure 9 shows the capture variety and relative production abundance. Electrofishing data is presented in Appendix A.

Figure 8 Salmon Parr - Electrofishing on the Smith Meadow Brook

The major current economic activity in the watershed is lumber harvesting. Very limited agriculture production occurs. These activities do not appear to pose any significant threat to

fish habitat. Both sectors have a required buffer zone along waterways. The 30-meter buffer imposed on the forest sector seems adequate to limit significant siltation on this gentle landscape. Testimonial reports from former Richibucto River Association members and a recreational fisherman identified poaching as an issue but the impact is hard to quantify.

Electrofishing capture results: Smith Meadow Brook (Richibucto River) @ Route 116.

Estimates of population density were generated using the Microfish 3.0 formula (Van Deventer and Platts, 1989).

Species	Age Class	Population estimate/100m2
Atlantic salmon	0+	5.26
	1+	5.70
	total	10.96
Brook trout		0.88
Blacknose dace		38.13
Northern redbelly dace		1.75
Common shiner		1.31
Lake chub		0.88
Creek chub		0.88
Lamprey *		0.44
Ninespine stickleback *		0.44
Bullhead *		1.31
American eel *		0.44
Total fish		57.41

*As the formula could not accommodate our catch pattern for this species, the population estimate per 100 m^2 is simply our total catch per m^2 x 100.

Figure 9 Electrofishing Results Featuring Atlantic Salmon Fry and Parr Production

8.0 Water Quality

Water quality monitoring on the Richibucto in 2023 indicated that most parameters show conditions that are acceptable to support fish populations, including Atlantic salmon. Appendix C shows the general chemistry results taken in 2023 from the Richibucto at the Hwy 116 bridge in Smiths Corner. The general chemistry sample was processed by the RPC Laboratory (Fredericton). These results were compared to the Canadian Council of Ministers of the Environment's (CCME) Water Quality Guidelines for the Protection of Aquatic Life. No issues were noted.

Water temperature, however, is a water quality issue that has increasingly become a limiting factor for Atlantic salmon on the Richibucto River and other eastern New Brunswick waterways. Larger and more productive salmon producing rivers in eastern New Brunswick have adopted a warm water protocol, closing pools under conditions when water temperatures create high stress for salmonids, (e.g. Restigouche and Miramichi rivers). This protocol requires "real-time" monitoring to track current conditions, something the Richibucto watershed should move toward to safeguard habitat conditions. The Richibucto, as a smaller-scale river, reaches water temperatures that would trigger such a protocol if put in place. In 2023, however, the exceptionally high river flows moderated water temperatures when compared to previous years but would still have triggered closures for short periods of time. (Figure 7). Water quantity can be another limiting factor. Not so in 2023, due to the frequent and significant rainfall events. The Atlantic salmon spawning run is normally limited to the more favorable cooler and higher water conditions in the fall. No indications of a departure from this were observed in 2023.

***Recommendation**: A real-time monitoring station should be installed in the Richibucto River watershed to track water temperatures and with such data trigger a "warm water protocol" as needed to reduce stress to salmonids.*

***Recommendation**: The Richibucto River should be included in a comprehensive monitoring program of water temperature in eastern New Brunswick rivers to monitor long-term trends with the intent of providing special protection of colder water streams and pools as fish refuges.*

Dissolved Oxygen (DO) levels have been acceptable in repeated monitoring over multiple visits during 2022. The river's pH values are also within an acceptable range.

Sedimentation issues appear to be minimal. Industrial level forest harvesters comply with the 30m buffer zone along waterways. Some river fording sites were noted in the spring river reconnaissance, but none seemed to contribute significant sediment to the watercourse. There is no extensive delta at the river mouth above Browns Yard to suggest the river deposits large amounts of sediment.

Recommendation: *Monitoring of the Richibucto River site at Smiths Corner for pH levels should continue annually in late winter and spring.*

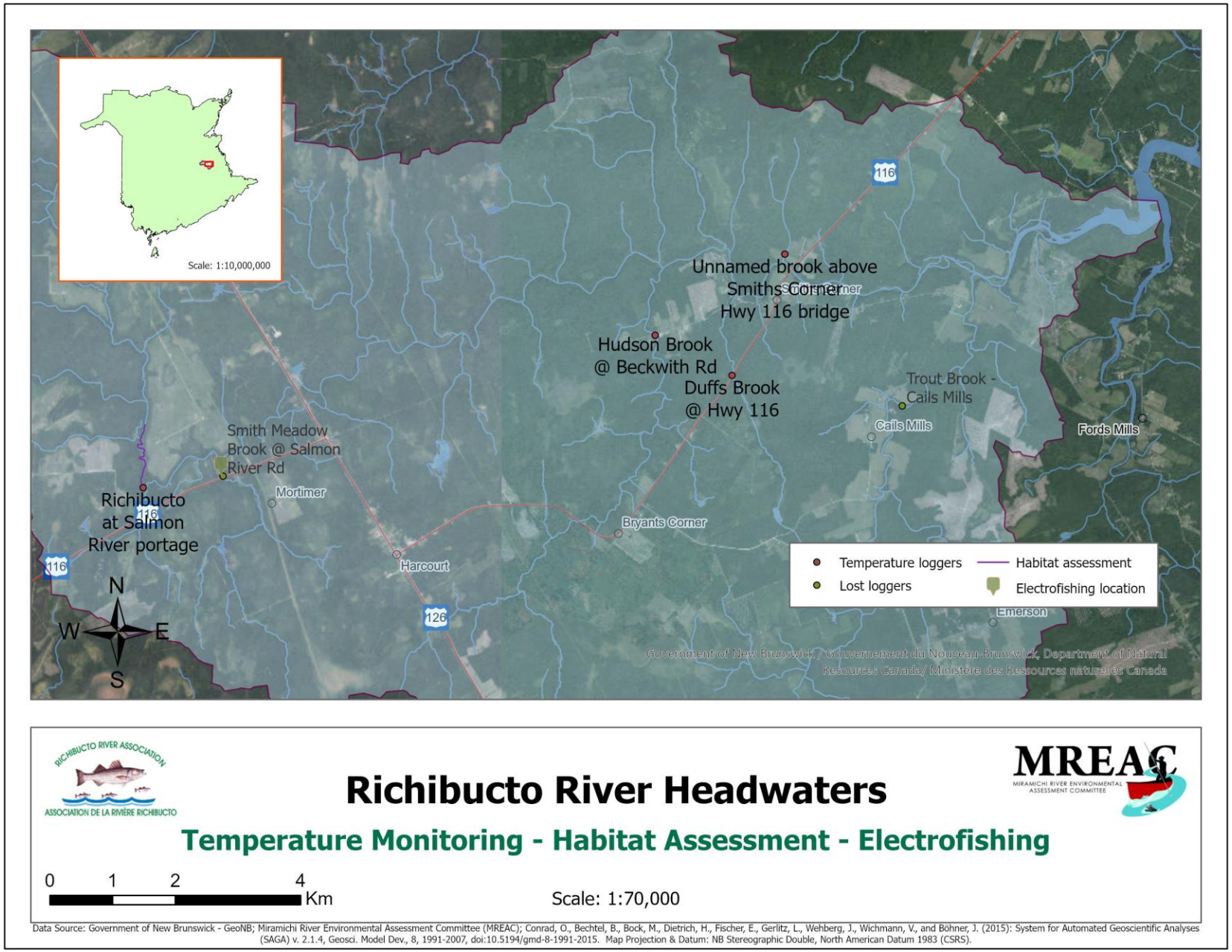

Figure 10 Richibucto Watershed Monitoring in 2023

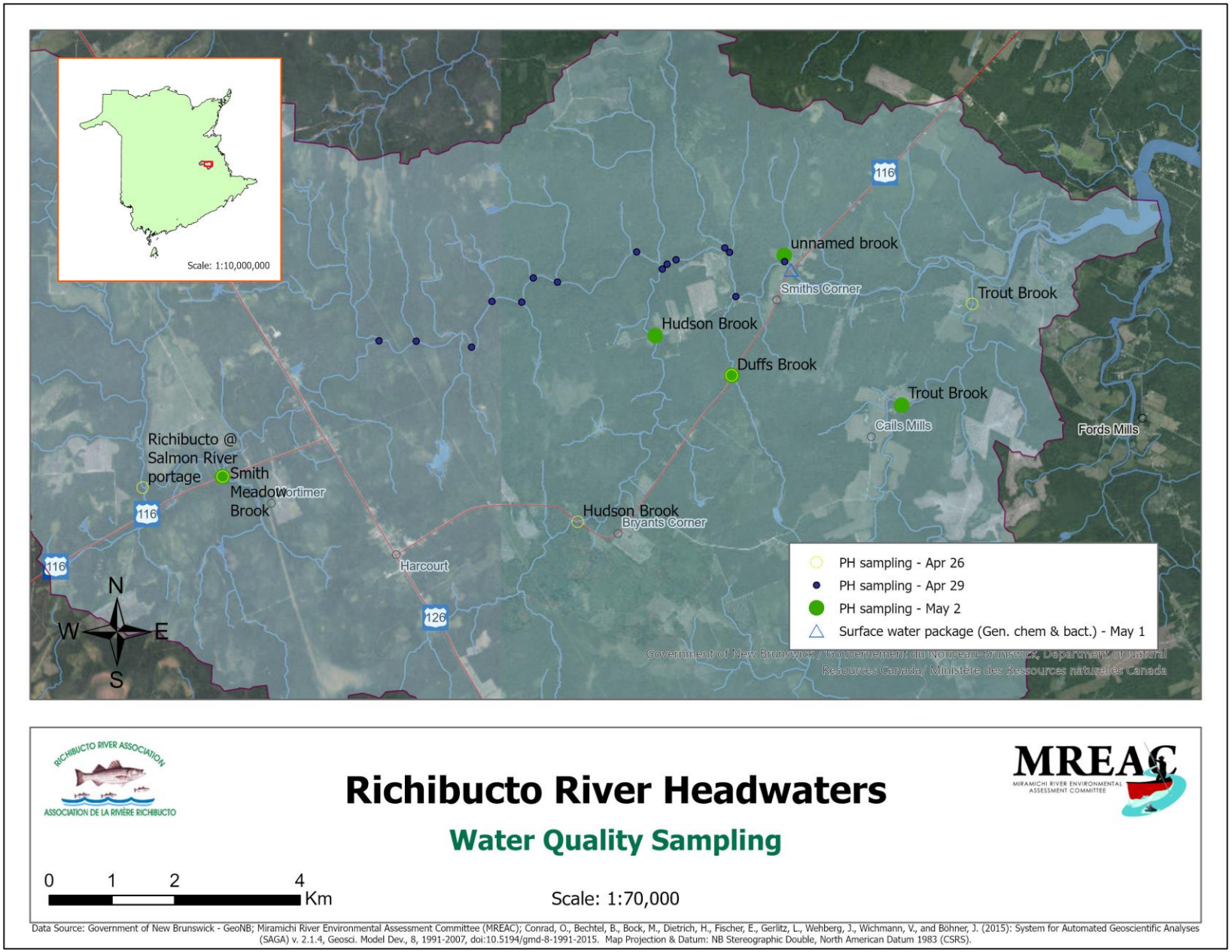

Figure 11 Water Quality Sampling 2023

9.0 Land Tenure

A review of private land holdings on the Richibucto River (GeoNB) and a river reconnaissance by canoe show a limited number of river-side properties. Several hunting and fishing camps are used seasonally on leased land higher in the watershed, west of Hwy 126. Privately owned properties are common east of Hwy 126, with few developed as cottage or permanent residences. River travels through private lands did not result in identifying significant violations of harvesting within buffer zones. MREAC has directed private property owners to the New Brunswick Federation of Woodlot Owners who promote best management practices on these waterfront properties.

***Recommendation**: Strategies to promote the use of best management practices among private woodlot owners can be promoted through the New Brunswick Federation of Woodlot Owners.*

***Recommendation**: Strategies to promote shoreline protection and river stewardship should include full-time residents along with camp and cottage owners.*

10.0 Conclusion

The Richibucto River is an intact waterway with an extant Atlantic salmon population. The watercourse is not a destination for recreational salmon anglers by virtue of a very limited salmon run and low productivity. The trend in juvenile productivity is negative with data from 2009 to 2021 showing Fry and Parr production on the Richibucto/Coal Branch systems down 60% and 12% respectively (DFO 2022). The threat of poaching of existing stock is flagged as an issue via testimonial reports but its impact is unknown. The limited fishing pressure on this waterway suggests the Atlantic salmon stock, albeit small, is not in peril from angling.

MREAC monitoring and research on the Richibucto River in 2023 was important to the development of this strategy as limited recent or historic information was available.

Climate change impacts, as they increase, will be problematic on this waterway. Already suffering high temperatures during the peak of summer, the habitat for juvenile salmon seems limited at best and will not likely improve in the face of warming conditions. Apart from high temperatures and often low water quantity during hot dry summers, other water quality parameters seem acceptable for Atlantic salmon survival.

Industrial scale forestry using clear-cutting methods is the major industrial use of the headwaters of the Richibucto River watershed. Along with other rivers in New Brunswick, it continues to be "flashy", with quickly rising and quickly falling water levels associated with larger rainfall events. The riparian zone along the Richibucto is in generally good shape and with a narrow channel that offers good shading.

Few waterfront properties are found along the main branch of the Richibucto. These are predominantly hunting camps. Few cottages or full-time residents are found along the river even where private lands are the norm.

Based on the data, visual observations recorded, and personal communications, the Richibucto River does not appear to have significant production of Atlantic salmon. However, the seemingly limited pressure from recreational fishers suggest that the existing salmon stock is currently secure. The long-term trends noted by the federal study and increasing impacts from a warming climate suggest that the future of a sustainable salmon stock on the Richibucto River, over the long-term, may be in question. The prospect of seeding this waterway with salmon eggs from brood stock collected on the river should be explored. In the interim, implementing the recommendations from this conservation strategy will assist in stabilizing the Atlantic salmon stock over the shorter-term.

Recommendation: Seeding the Richibucto watershed (main branch) with salmon eggs from brood stock collected from the river should be explored and implement if feasible.

All this considered, the future of Atlantic salmon in eastern New Brunswick waterways, including the Richibucto River, seems more likely to be determined by far reaching and challenging global factors rather than local limiting conditions.

11.0 Summary of Recommendations

Recommendation: *Monitoring of the Richibucto River for pH levels should continue annually in late-winter, spring and throughout the field season as part of a watershed monitoring program.*

Recommendation*: An annual program of notching beaver dams in the late fall during spawning season should be implemented as needed to extend spawning further into the Richibucto headwaters.*

Recommendation*: Strategies to promote shoreline protection and river stewardship should include full-time residents along with camp and cottage owners.*

Recommendation: *When feasible, the Richibucto River (and other smaller waterways) should be assessed using "ARIS Sonar Population Tracking" to determine the actual size of the annual spawning population.*

Recommendation*: A real-time monitoring station should be installed in the Richibucto River watershed to track water temperatures and serve as the trigger to institute a "warm water protocol" as needed to reduce stress to salmonids*.

Recommendation*: The Richibucto River should be included in a comprehensive monitoring program of water temperature in eastern New Brunswick rivers to monitor long-term trends with the intent of providing special protection of colder water streams and pools as fish refuges.*

Recommendation: *Monitoring of the Richibucto River site at Smiths Corner for pH levels should continue annually in late winter and spring.*

Recommendation*: Strategies to promote the use of best management practices among private woodlot owners can be promoted through the New Brunswick Federation of Woodlot Owners.*

Recommendation: *Seeding the Richibucto watershed (main branch) with salmon eggs from brood stock collected from the river should be explored and implement if feasible.*

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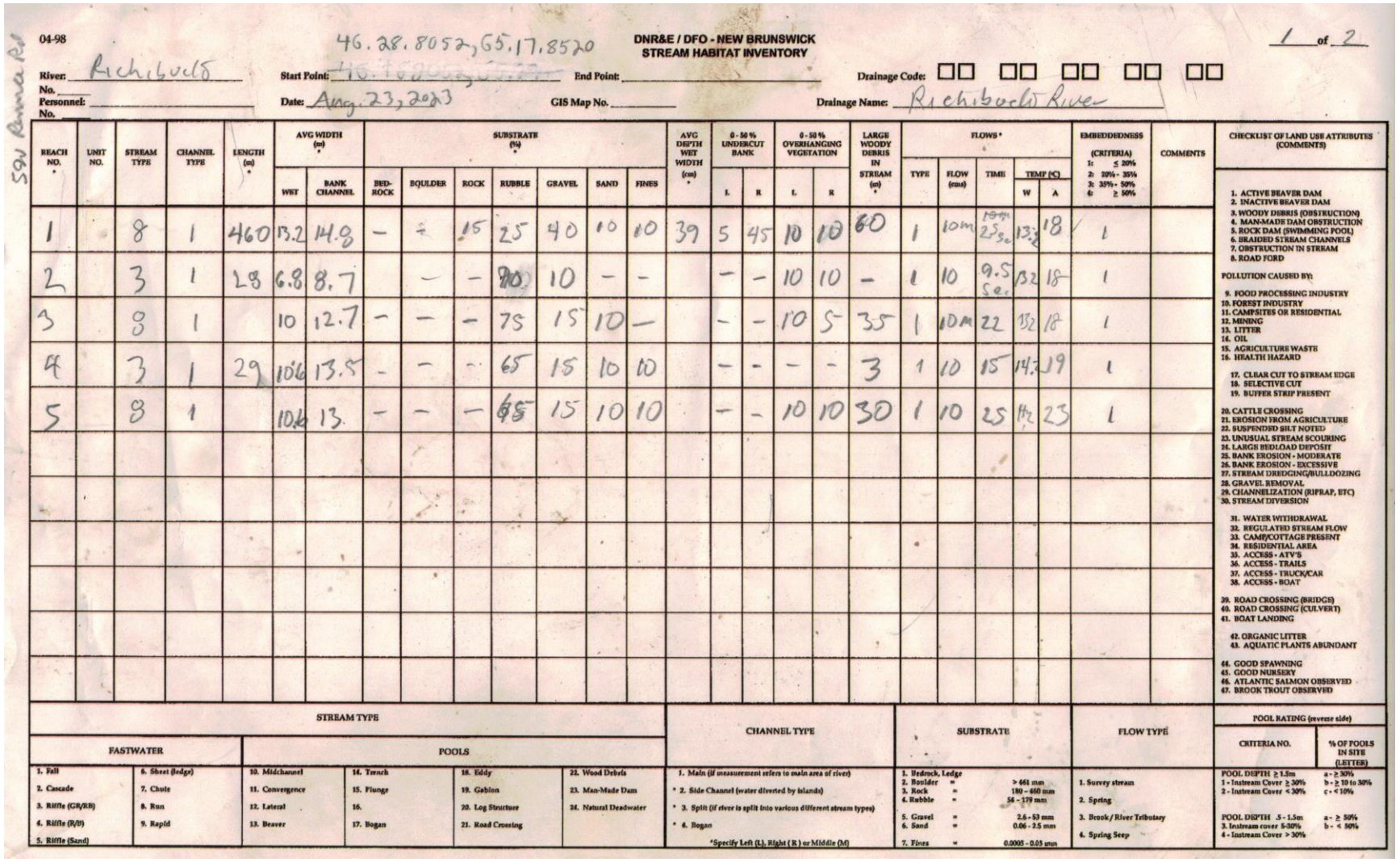
Appendix A: Fish Habitat Assessment Field Sheets – Richibucto River



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DNR&E / DFO - NEW BRUNSWICK
STREAM HABITAT INVENTORY

1 of 2

River: Richibucto
No.
Personnel:
No.

Start Point:
End Point:
Date: Aug. 23, 2023
GIS Map No.
Drainage Code:
Drainage Name: Richibucto River

REACH NO.	UNIT NO.	STREAM TYPE	CHANNEL TYPE	LENGTH (m)	AVG WIDTH (m) WET	AVG WIDTH (m) BANK CHANNEL	SUBSTRATE (%) BED-ROCK	BOULDER	ROCK	RUBBLE	GRAVEL	SAND	FINES	AVG DEPTH WET WIDTH (cm)	0-50% UNDERCUT BANK L	UNDERCUT BANK R	0-50% OVERHANGING VEGETATION L	OVERHANGING VEGETATION R	LARGE WOODY DEBRIS IN STREAM (m)	FLOWS* TYPE	FLOW (cms)	TIME	TEMP (°C) W	TEMP (°C) A	EMBEDDEDNESS (CRITERIA) 1: ≤ 20% 2: 20% - 35% 3: 35% - 50% 4: ≥ 50%	COMMENTS
1		8	1	460	13.2	14.8	–	–	15	25	40	10	10	39	5	45	10	10	60	1	10m	25 Sec	13.2	18	1	
2		3	1	28	6.8	8.7		–	–	80	10	–	–		–	–	10	10	–	1	10	9.5 Sec	13.2	18	1	
3		8	1		10	12.7	–	–	–	75	15	10	–		–	–	10	5	35	1	10m	22	13.2	18	1	
4		3	1	29	10.6	13.5	–	–	–	65	15	10	10		–	–	–	–	3	1	10	15	14.2	19	1	
5		8	1		10.6	13.	–	–	–	65	15	10	10		–	–	10	10	30	1	10	25	14.2	23	1	

CHECKLIST OF LAND USE ATTRIBUTES (COMMENTS)

1. ACTIVE BEAVER DAM
2. INACTIVE BEAVER DAM
3. WOODY DEBRIS (OBSTRUCTION)
4. MAN-MADE DAM OBSTRUCTION
5. ROCK DAM (SWIMMING POOL)
6. BRAIDED STREAM CHANNELS
7. OBSTRUCTION IN STREAM
8. ROAD FORD

POLLUTION CAUSED BY:

9. FOOD PROCESSING INDUSTRY
10. FOREST INDUSTRY
11. CAMPSITES OR RESIDENTIAL
12. MINING
13. LITTER
14. OIL
15. AGRICULTURE WASTE
16. HEALTH HAZARD

17. CLEAR CUT TO STREAM EDGE
18. SELECTIVE CUT
19. BUFFER STRIP PRESENT

20. CATTLE CROSSING
21. EROSION FROM AGRICULTURE
22. SUSPENDED SILT NOTED
23. UNUSUAL STREAM SCOURING
24. LARGE BEDLOAD DEPOSIT
25. BANK EROSION - MODERATE
26. BANK EROSION - EXCESSIVE
27. STREAM DREDGING/BULLDOZING
28. GRAVEL REMOVAL
29. CHANNELIZATION (RIPRAP, ETC)
30. STREAM DIVERSION

31. WATER WITHDRAWAL
32. REGULATED STREAM FLOW
33. CAMP/COTTAGE PRESENT
34. RESIDENTIAL AREA
35. ACCESS - ATV'S
36. ACCESS - TRAILS
37. ACCESS - TRUCK/CAR
38. ACCESS - BOAT

39. ROAD CROSSING (BRIDGE)
40. ROAD CROSSING (CULVERT)
41. BOAT LANDING

42. ORGANIC LITTER
43. AQUATIC PLANTS ABUNDANT

44. GOOD SPAWNING
45. GOOD NURSERY
46. ATLANTIC SALMON OBSERVED
47. BROOK TROUT OBSERVED

STREAM TYPE

FASTWATER
1. Fall
2. Cascade
3. Riffle (GR/RB)
4. Riffle (R/B)
5. Riffle (Sand)
6. Sheet (ledge)
7. Chute
8. Run
9. Rapid

POOLS
10. Midchannel
11. Convergence
12. Lateral
13. Beaver
14. Trench
15. Plunge
16.
17. Bogan
18. Eddy
19. Gabion
20. Log Structure
21. Road Crossing
22. Wood Debris
23. Man-Made Dam
24. Natural Deadwater

CHANNEL TYPE
1. Main (if measurement refers to main area of river)
* 2. Side Channel (water diverted by islands)
* 3. Split (if river is split into various different stream types)
* 4. Bogan
*Specify Left (L), Right (R) or Middle (M)

SUBSTRATE
1. Bedrock, Ledge
2. Boulder = > 661 mm
3. Rock = 180 - 660 mm
4. Rubble = 56 - 179 mm
5. Gravel = 2.6 - 53 mm
6. Sand = 0.06 - 2.5 mm
7. Fines = 0.0005 - 0.05 mm

FLOW TYPE
1. Survey stream
2. Spring
3. Brook / River Tributary
4. Spring Seep

POOL RATING (reverse side)

CRITERIA NO.	% OF POOLS IN SITE (LETTER)
POOL DEPTH ≥ 1.5m	a - ≥ 30%
1 - Instream Cover ≥ 30%	b - ≥ 10 to 30%
2 - Instream Cover < 30%	c - < 10%
POOL DEPTH .5 - 1.5m	a - ≥ 50%
3. Instream cover 5-50%	b - < 50%
4 - Instream Cover > 30%	

REACH NO.	SITE (50m - interval)	% SITE		SHADE (%)	STREAM BANKS											O₂ (mg/l)	pH	DEPTH						POOL RATING (CRITERIA ON OTHER SIDE)		POOL TAIL			% TURBULENCE
					VEGETATION (%)				EROSION (%)									¼ (m)		½ (m)		¾ (m)						
		RIFFLE/ RUN	POOLS		BARE GROUND	GRASSES	SHRUBS	TREES	LEFT BANK (0 - 50%)			RIGHT BANK (0 - 50%)						Wet	CHANNEL	Wet	CHANNEL	Wet	CHANNEL	NO.	LETTER	EMBEDDEDNESS (CRITERIA) 1: ≤ 20% 2: 20% - 35% 3: 35% - 50% 4: ≥ 50%	MEAN SUBSTRATE SIZE (cm)	% FINE	
									STABLE	BARE STABLE	ERODING	STABLE	BARE STABLE	ERODING															
1		85	15	10	–	5	90	5	100	–	–	100	–	–		9.08	6.49	32	115	45	120	40	115	1		2	15	40	0
2		100	–	15	–	5	90	5	100	–	–	100	–	–		9.08	6.47	22	100	16	95	10	95	–		1	3	–	
3		95	5	5	–	5	95	–	100	–	–	100	–	–		9.09	6.49	50	110	46	120	55	105	1		2	8	80	–
4		100	–	5	–	10	80	10	100	–	–	100	–	–		10.00	6.9	43	120	50	114	50	110	1		2			
5		85	15	5	–	15	80	5	100	–	–	100	–	–		8.76	6.64	42	110	66	140	45	120	1		2	5	–	4

REACH NO.	UNIT NO.	STREAM TYPE	WET WIDTH (m)	DEPTH (cm)			AVERAGE DEPTH SUM/4		COEFFICIENT (0.9 - SMOOTH) (0.8 - ROUGH)	LENGTH (1m)	FLOAT TIME (sec)				COMMENTS (LOCATION)
				⅛ WAY	½ WAY	⅞ WAY	CENTIMETERS (cm)	METERS (m)			½ WAY	½ WAY	⅞ WAY	AVERAGE	
															Reach 1 - Pool - 125 cm - Length 35

FORMULA (CMS) = W _____ (m) x D _____ (m) x A _____ x L _____ (m) / T _____ (sec) Where: W = width, D = depth, L = length, A is coefficient for the stream bottom

Appendix B: pH Sample Results from the Richibucto River and Tributary Streams

Appendix D: pH Sample Results from the Richibucto River and Tributary Streams

Date	Site	River Water pH	Temperature
26-Apr-23	Richibucto River (portage trail end)	7.7	5.5
	Hudson Rrook	7.25	6.3
	Smith Meadow Brook	7.24	6.3
	Duffs Brook	7.85	6.8
	Trout Brook	7.91	7.9
April 29 2023	(Hwy 126 to Smith Corner reconnaisance)		
	Taylor Brook	8.26	10.4
	unnamed river left	8.39	11.9
	unnamed river right	7.6	12.3
	unnamed river left	8.01	13.2
	Kollock Brook	7.77	10.4
	Craigy Brook	7.85	10.3
	Flaggy Brook	7.74	9.7
	Richibucto (main branch)	7.56	11.3
	Hudson Brook	7.56	11.2
	Cold Spring Brook	7.62	11.6
	unnamed river left	7.46	10
	Davies Brook	7.44	13.3
	unnamed river left	7.39	8.4
	Duffs Brook	7.42	12.1
	unnamed river left	7.62	11.2
May 2 2023	Temperature Logger Sites		
	unnamed river left	7.99	7.8
	Hudson Brook	7.8	8.6
	Duffs Brook	7.41	8.9
	Smith Meadow Brook	7.18	9.1
	Trout Brook	7.27	9.7
May 16 2023	Molus River	7.58	10.1
	Bass River	7.42	10.5

Appendix C: Richibucto River Water Chemistry Results 2023

Report/Rapport: 481154-ML-W1
Date: 03-May-23
Date Received/Reçu: 02-May-23

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE
for/pour
Miramichi River Environmental
Assessment Committee
21 Cove Road
Miramichi, NB E1V 0A6

Attention: Harry Collins

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1368
Fax: 506.452.1395
www.rpc.ca

Client Location: Richibucto River
Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				481154-1
Client Sample ID/ID d'échantillon du client:				Richibucto River @ Smith's Corner
Date collected/Date du prélèvement				1-May-23
Time sampled/Heure du prélèvement				2:00:00 PM
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
E. coli	MICRO10	2-May-23	MPN/100mL	178.5

This report relates only to the sample(s) and information provided to the laboratory.
Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.

Cathy Hay
Microbiology Supervisor
Applied and Experimental Bioscience

Page 1 of/de 1

Gabrielle Gervais
Microbiology Technician
Applied and Experimental Bioscience

Report ID: 481154-IAS
Report Date: 09-May-23
Date Received: 02-May-23

CERTIFICATE OF ANALYSIS

for

Miramichi River Environmental
Assessment Committee
21 Cove Road
Miramichi, NB E1V 0A6

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Harry Collins
Project #: Not Available
Location: Richibucto River

Analysis of Surface Water

RPC Sample ID:			481154-1
Client Sample ID:			Richibucto River @ Smith's Corner
Date Sampled:			1-May-23
Analytes	**Units**	**RL**	
Sodium	mg/L	0.05	2.77
Potassium	mg/L	0.02	0.30
Calcium	mg/L	0.05	5.06
Magnesium	mg/L	0.01	0.73
Alkalinity (as $CaCO_3$)	mg/L	2	16
Chloride	mg/L	0.5	3.1
Fluoride	mg/L	0.05	0.10
Sulfate	mg/L	1	2
Bromine	mg/L	0.01	< 0.01
Ammonia (as N)	mg/L	0.05	0.06
Un-ionized @ 20°C	mg/L	-	< 0.001
Nitrate + Nitrite (as N)	mg/L	0.05	< 0.05
Nitrite (as N)	mg/L	0.05	< 0.05
Nitrate (as N)	mg/L	0.05	< 0.05
Nitrogen - Total	mg/L	0.2	0.4
Phosphorus - Total	mg/L	0.002	0.018
Carbon - Total Organic	mg/L	0.5	8.1
Colour	TCU	5	81
Conductivity	µS/cm	1	46
pH	units	-	7.4
Turbidity	NTU	0.1	1.2
Calculated Parameters			
Bicarbonate (as $CaCO_3$)	mg/L	-	15.9
Carbonate (as $CaCO_3$)	mg/L	-	0.038
Hardness (as $CaCO_3$)	mg/L	0.2	15.6
TDS (calc)	mg/L	-	32
Saturation pH (20°C)	units	-	9.4
Langelier Index (20°C)	-	-	-1.98

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

Matthew Norman
Interim Director
Inorganic Analytical Chemistry

SURFACE WATER CHEM

Brannen Burhoe
Supervisor
Inorganic Analytical Services

Report ID: 481154-IAS
Report Date: 09-May-23
Date Received: 02-May-23

CERTIFICATE OF ANALYSIS

for
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21 Cove Road
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921 College Hill Rd
Fredericton NB
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Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Harry Collins
Project #: Not Available
Location: Richibucto River

Analysis of Surface Water

RPC Sample ID:			481154-1
Client Sample ID:			Richibucto River @ Smith's Corner
Date Sampled:			1-May-23
Analytes	**Units**	**RL**	
Aluminum	mg/L	0.001	0.114
Antimony	mg/L	0.0001	< 0.0001
Arsenic	mg/L	0.001	< 0.001
Barium	mg/L	0.001	0.028
Beryllium	mg/L	0.0001	< 0.0001
Bismuth	mg/L	0.001	< 0.001
Boron	mg/L	0.001	0.003
Cadmium	mg/L	0.00001	< 0.00001
Calcium	mg/L	0.05	5.06
Chromium	mg/L	0.001	< 0.001
Cobalt	mg/L	0.0001	< 0.0001
Copper	mg/L	0.001	< 0.001
Iron	mg/L	0.02	0.19
Lead	mg/L	0.0001	0.0006
Lithium	mg/L	0.0001	0.0007
Magnesium	mg/L	0.01	0.73
Manganese	mg/L	0.001	0.026
Molybdenum	mg/L	0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001
Potassium	mg/L	0.02	0.30
Rubidium	mg/L	0.0001	0.0005
Selenium	mg/L	0.001	< 0.001
Silver	mg/L	0.0001	< 0.0001
Sodium	mg/L	0.05	2.77
Strontium	mg/L	0.001	0.017
Tellurium	mg/L	0.0001	< 0.0001
Thallium	mg/L	0.0001	< 0.0001
Tin	mg/L	0.0001	< 0.0001
Uranium	mg/L	0.0001	< 0.0001
Vanadium	mg/L	0.001	< 0.001
Zinc	mg/L	0.001	0.005

Report ID: 481154-IAS
Report Date: 09-May-23
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Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	IAS-M47	APHA 4500-NH_3 G	Phenate Colourimetry
pH	IAS-M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	IAS-M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	IAS-M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	IAS-M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	IAS-M45	APHA 4500-SO_4 E	Turbidimetry
Nitrate + Nitrite (as N)	IAS-M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
Nitrite (as N)	IAS-M49	APHA 4500-NO2- B	Ferrous Ammonium Sulfate Colourimetry
Nitrogen - Total	IAS-M57	ASTM D8083-16	Combustion/Chemiluminescence
Phosphorus - Total	IAS-M17	APHA 4500-P E	Digestion, Manual Colourimetry
Carbon - Total Organic	IAS-M57	APHA 5310 B	Combustion/NDIR
Turbidity	IAS-M06	APHA 2130 B	Nephelometry
Colour	IAS-M55	APHA 2120 Color (A,C)	Single Wavelength Spectrophotometry
Conductivity	IAS-M04	APHA 2510 B	Conductivity Meter - Electrode
Trace Metals	IAS-M01/IAS-M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES