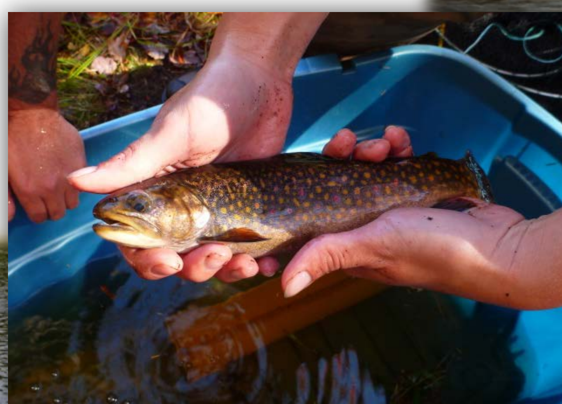
The Nictaux Sub-watershed: A Restoration Management Plan

Restoring fish habitats and ecological health in the Nictaux River sub-watershed



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March, 2014

1st Revision:

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NSLC Adopt A Stream, Fisheries and Oceans Canada

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Acronyms

AAS	NSLC Adopt A Stream
CARP	Clean Annapolis River Project
CCME	Canadian Council of Ministers of the Environment
CSSC	Canadian System of Soil Classification
DFO	Fisheries and Oceans Canada
DO	Dissolved Oxygen (mg/L)
DOSAT	Saturated Dissolved Oxygen (%)
EPT	Ephemeroptera, Plecoptera, Trichoptera
HSI	Habitat Suitability Index
NSE	Nova Scotia Environment
NSFHAP	Nova Scotia Fish Habitat Assessment Protocol
NTU	Nephelometric Turbidity Unit
pH	Power of Hydrogen
SpC	Specific Conductivity

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Executive Summary

Management of watersheds is increasingly complex with the changes wrought upon ecological systems through anthropogenic activities, proliferation of invasive species, and shifting environmental conditions. Ecosystems are more commonly being managed at a watershed scale so a holistic approach may be taken to more effectively address cumulative downstream impacts. CARP began to develop restoration plans for tributaries of the Annapolis River in 2012, in partnership with AAS. In 2013, the Nictaux River sub-watershed was selected for the development of a sub-watershed restoration plan to guide future action in the system.

As part of the work in developing this plan, background information was gathered about the Nictaux River sub-watershed by disseminating surveys to the public to solicit local knowledge, through meetings with anglers, via foot surveys of the sub-watershed, habitat connectivity assessments, fish population surveys, water quality surveys, and habitat suitability assessments. Additional was information gathered in 2016 for the purposes of updating the plan.

Fish population surveys were conducted using electrofishing techniques, fyke nets, and minnow traps. Forage fish such as white suckers, northern redbelly dace, and banded killifish were collected from sites, and smallmouth bass were caught in the lower end of the system at NIC01, and brook trout in the upper end at NIC03.

As part of the habitat suitability assessments, transects were monitored for depth, grain size, cover, pools, vegetative cover, and macroinvertebrates, using the Nova Scotia Fish Habitat Assessment Protocol (NSFHAP). From these assessments, it was determined that values obtained from the data exhibited fair to optimum quality ranges for salmonid habitat within upper reaches of the river system, and poor to optimum water for habitat within the lower reaches.

As part of the habitat connectivity assessments, watercourse crossings were evaluated to determine if they posed barriers to fish passage. Of the crossings determined to be present on fish-bearing streams in the Nictaux sub-watershed, these were further classified as being either bridges or culverts. Culverts were categorized as being fully passable, partial or full barriers, based on a target species of a 5 cm brook trout. These criteria were adapted from Nova Scotia Environment (NSE), Fisheries and Oceans Canada (DFO), and Terra Nova National Park protocols (refer to Freeman, 2014 and Wagner, 2013 for more information). Of the culverts measured within stretches of fish habitat, 9% were determined to be passable, and 91% were determined to be barriers to fish passage.

Water quality samples collected from the main stem of the Nictaux River system during the fall of 2013 generally showed results that were considered to be good for salmonids (pH between 5.5 to 6.1, and Dissolved Oxygen (DO) ranging from 9.1 to 10.7 mg/L). Comparatively, water quality measured in feeder brooks was not as ideal, with pH values ranging from 4.2 to 7.1 and DO values ranging from 1.26 to 7.62 mg/L. Water temperatures measured in the summer of 2016 on the lower portion of the main channel consistently exceeded acceptable values for salmonids ($>20°C$), which may also be attributable in part to the especially hot, dry conditions of that particular year. It is recommended that additional water quality information be collected to gain a clearer understanding of water temperature variability within the system, and its continued viability to support cold water species such as salmonids.

The plan presented in this report outlines some restoration opportunities as well as limiting factors within the sub-watershed that will need to be addressed in order to improve the ecological integrity of the overall Nictaux River system. This report is a working document; as such, revisions include the addition of updated information and a progress report on completion of restoration projects to date.

1.0 Introduction

Many species of fish which historically exhibited widespread distribution now show precipitous population declines throughout their ranges (Taylor et al., 2010; Hendry and Cragg-Hine, 2003; Bohn and Kershner, 2002). It is a tale of woe that is, unfortunately, all too common. While threats to fish populations are numerous and diverse, degradation of freshwater habitats resulting from human activities remains the most significant contributor to observed declines in species (Taylor et al., 2010; DFO, 2006; Bohn and Kershner, 2002; Bardonnet and Baglinière, 2000). Land use changes such as deforestation, increased urbanization, drainage of wetlands and increased tile drainage from agricultural lands all impact the water retention time and general hydrological characteristics of an area, and can have severe impacts for fish populations by reducing base flow rates or exacerbating the effects and frequency of flooding (Taylor et al., 2010). In addition to hydrological changes, other threats to fish populations often include in-stream habitat alterations through channel modification, sedimentation or alterations to water quality (Bohn and Kershner, 2002).

While the aim of ecological restoration is to return degraded habitats to pre-disturbance conditions, oftentimes changes in the natural environment or irreversible impacts prevent this. Therefore, ecological restoration more commonly attempts to mitigate impacts from disturbances and restore ecosystem structure and functions (DFO, 2006; Kauffman et al., 1997). The process of restoration however, is often confronted with complex socio-economic and ecological challenges to which there is no simple solution. The constant state of flux and dynamic interactions that occur in an ecosystem mean that alterations made at a local scale can have unknown downstream effects. Therefore, when undertaking restoration planning, focus has more and more predominantly begun to shift towards managing ecosystems at a watershed scale (DFO, 2006). Watershed boundaries do not change much over time and utilizing watersheds as management units provides the opportunity to take a holistic approach at addressing cumulative downstream impacts and the causes of degradation rather than simply providing site specific fixes (Bohn and Kershner, 2002).

Part of the work that CARP does focuses on enhancing the ecological health of the Annapolis River watershed, which is the third largest watershed in Nova Scotia, encompassing an area of approximately 2,650 km^2. While projects have been completed on a large scale across the watershed, it is also necessary to address the issues leading to the degradation of the ecological health of the river. To do so, the watershed has been broken down into smaller, sub-watershed management units. As of 2012, CARP began to develop restoration plans for these sub-watersheds, with a focus on habitats previously identified and prioritized as suitable for salmonids. This will allow for a more comprehensive assessment of the entirety of each of the systems, will lead to closer examination of root causes of degradation in each of the river's sub-watersheds, and will allow a more targeted approach to managing fish habitat.

In 2013, CARP focused its efforts in the Nictaux River sub-watershed, the largest priority sub-watershed in the Annapolis River Basin. This report provides an overview of the Nictaux sub-watershed, identified land uses and impacts, a summary of monitoring data collected to date, and outlines recommendations for moving forward with restoration work to improve fish habitat. In 2016, this plan was reviewed and updated to incorporate more recently collected data and restoration activities undertaken within the sub-watershed.

2.0 Restoration Plan Objectives

The intent of this fish habitat restoration plan is to provide a strategy to improve fish habitat conditions and fish populations within the river system on a watershed-wide basis. The plan focuses on how to improve watershed conditions for fish while also taking into consideration water and land uses by other resident plants and wildlife. By taking a watershed-based approach to restoration planning we gain a comprehensive look at restoration needs, and determine specific activities that can be undertaken to improve habitat and environmental conditions generally.

The plan focuses on, but is not limited to, improving salmonid habitat and the habitat of other native fish species in the watershed. By using salmonid species as a biological indicator, improvements can be made to fishery resources, stream functionality, and the aesthetic and ecological value of the watershed environment.

Objectives	To assess the existing condition of fish habitat within the Nictaux sub-watershed, to determine likely limiting habitat factors and fish habitat restoration needs, and to develop a strategy with regard to various projects and activities that can be undertaken to restore and improve the habitat on a watershed basis.
Specific Goals	▪ To assess the existing degree of habitat connectivity within the watershed, to identify any fish passage problem areas, and to prescribe solutions at applicable sites ▪ To assess existing water quality within the river system and to determine projects / actions that can be undertaken for improvement ▪ To determine where physical habitat has been altered and / or degraded and to determine applicable projects for physical in-stream habitat restoration ▪ To assess riparian zone quality and function and to determine activities that may be undertaken for improvement of riparian areas ▪ To identify land use practices that may be impacting habitat within the watershed and to outline activities and / or projects that may be undertaken to encourage better watershed stewardship ▪ To prioritize proposed restoration projects specific to the watershed, based on their potential to improve aquatic productivity, watershed conditions and environmental health

3.0 The Nictaux Watershed – Introductory Information

The Nictaux River watershed is the largest sub-watershed in the Annapolis River Basin. Unlike most other tributary river systems in the Annapolis River watershed, the Nictaux River system remains largely unaffected by agricultural activities, and still contains large tracts of undisturbed, forested lands. In order to better identify restoration strategies for this sub-watershed, background information was compiled and is presented in Sections 3.1 and 3.2.

3.1 Background

1	**Location in province (town[s], county and region)**	Nictaux, Torbook West, New Albany, Albany Cross ; Annapolis County; Annapolis Valley
2	**Watershed area (square km)**	295 km^2
3	**Watershed drains into (include coordinates of confluence)**	Annapolis River 20T 337212 4978197
4	**Distance of watercourse mouth from ocean (km)**	Approximately 86.4 km from mouth of the Nictaux River to the mouth of the basin
5	**Distance of watercourse mouth from head of tide (km)**	Approximately 18.1 km from mouth of the Nictaux River to the bridge at Paradise Rd, Paradise.
6	**Natural watercourse width at mouth (m)**	Approximately 23.1 m on Annapolis River, and 20.5 on Nictaux River
7	**Length of watercourse (km)**	Main Channel: 46.6 km Total Length of all Tributaries: 251.3 km
8	**Elevation at headwaters (m)**	256 m (from Google Earth)
9	**Elevation at mouth (m)**	11 m (from Google Earth)
10	**Lake(s) within watershed (square km)**	Bezant Lake, 0.029 km^2 Big Molly Upsim Lake, 5.960 km^2, dam at outflow Big Mud Lake, 0.339 km^2 Carter Lake, 0.056 km^2 Cedar Lake, 0.076 km^2 Cliff Lake, 0.031 km^2 Connell Lake, 0.168 km^2 Deerland Lake, 0.039 km^2 Dilberry Lake, 0.136 km^2 Durland Lake, 0.008 km^2 East Branch Lake, 0.282 km^2 East Lake, 0.285 km^2, development

		First Grimm Lake, 0.115 km^2 Hollyhock Lakes, 0.081 km^2 Lake Fredericks, 0.274 km^2 Little Bear Lake, 0.046 km^2 Little Cranberry Lake, 0.091 km^2 Little Molly Upsim Lake, 0.252 km^2 Little Pine Lake, 0.063 km^2 Long Lake, 0.066 km^2 McEwan Lake, 0.090 km^2 McGill Lake, 3.004 km^2, dam at outflow Moosehead Lake, 0.553 km^2 Nineteen Mile Lake, 0.049 km^2 Pine Lake, 0.454 km^2 Quilty Lake, 0.328 km^2 Scragg Lake, 1.873 km^2 Second Grimm Lake, 0.056 km^2 Shannon Lake, 1.541 km^2 Skunk Lake, 0.017 km^2 Small Stoney Lake, 0.059 km^2 Snowshoe Lake, 0.077 km^2 Stoddart Lake, 0.062 km^2 Third Grimm Lake, 0.033 km^2 Trout Lake, 1.637 km^2, dam at outflow and development: cottages Twenty Mile Lake, 0.056 km^2 Wamboldt Lake, 0.054 km^2 Waterloo Lake, 1.371 km^2, development Zwickers Lake, 0.504 km^2, development: cottages
11	**Significant tributaries within watershed (name[s] and length[s])**	Beals Brook, 11,535 m Bezant Lake Brook, 2,098 m Black Brook, 2,607 m East Branch Brook, 8,069 m

		Kelly Brook, 5,854 m Oakes Brook, 9,435 m Scragg Brook, 1,083 m Snell Meadow Brook, 4, 816 m Walker Brook, 6,363 m Waterloo River, 3,300 m Wheelock Meadow Brook, 1,717 m
12	**Most common substrate type and size**	Predominately cobble (6.01 – 40 cm)
13	**Soil type(s) and geological characteristics**	***Soil Types: (CSSC, 1998)*** ***Humic Regosols:*** From the Regosolic order, these soil types are associated with landforms where the surface has been unstable and soil horizons are weakly/not developed. Humic Regosols have a higher content of organic materials mixed into the soils ***Gleysols:*** These soils are often found in areas with prolonged water saturation and are clay dominated soils which are often characterized by oxygen depletion. ***Humo-Ferric Podzols:*** A Podzolic soil type that are dominant in sandy deposits, typically in coniferous or heath vegetation, and characterized by leached layers low in nutrients, with an acidic pH. ***Mesisols:*** An Organic order soil type where soils are saturated with water most of the time (commonly found in bogs, peats, fens etc.), and have accumulated organic materials. Mesisolic soils are generally at an intermediate level of decomposition. ***Geological Characteristics:*** The Nictaux watershed is typified by an array of geological characteristics from glacial and fluvial activities: alluvial deposits, glaciofluvial deposits (i.e. outwash fans, kames and eskers), ground moraines, till plains (silty and stony), organic deposits, silty drumlins and bedrock. ***Geological Formations:*** ***Annapolis Formation***: shale, grit, sandstone, conglomerate ***Devonian and Carboniferous Granite Formations:*** Granite, granodiorite, quartz monzonite, minor granophyre, pegmatite, porphyry, aplite dykes, biotite chief mica, muscovite chief mica ***Goldenville Formation:*** greywacke, minor argillite, shale, mica shist, argillite, slate, small granitic dykes, minor andalusite, minor cordierite, minor sillimanite ***Halifax Formation:*** slate, siltstone, minor argillite, minor cordierite schist, minor

		andalusite schist ***Kentville Formation***: shale, siltstone, slate, shallow marine slate, silty slate, siltstone, limestone, granite, granodiorite, quartz monazite, minor granophyte ***Torbrook Formation***: shale, siltstone, quartzite, minor shaly limestone, iron formation, shallow marine-subaerial silty mudstone, mudstone, sandstone ***White Rock Formation***: paralic-nearshore marine quartzite, conglomerate, siltstone, slate with rhyolite and basalt ***Wolfville Formation***: fluvial sandstone and conglomerate, awolian sandstone
14	**Average water temperature in summer (June-September)**	Summer Average (July – September): 22.57°C *NOTE: This is only from HSI survey data. To gain a more accurate reflection of peak water temperatures, consistent monitoring at select sites would be required.
15	**Peak water temperature**	July 14, 2016: 25.1°C Location: 20T 339253mE, 4976291mN *NOTE: This is only from HSI survey data. To gain a more accurate reflection of peak water temperatures, consistent monitoring at select sites would be required.
16	**pH range**	5.1-7.01 *NOTE: This is only from HSI survey data. To gain a more accurate reflection of pH range, consistent monitoring at select sites would be required.
17	**Native fish species present**	Species observed during fish population surveys: American eel, banded killifish, brook trout, brown bullhead, northern redbelly dace, ninespine stickleback, sea lamprey, smallmouth bass, threespine stickleback, white sucker, yellow perch
18	**Non-native fish species present**	Smallmouth bass
19	**Endangered / threatened / at risk species present (aquatic or non-aquatic)**	Within Annapolis County and Kings County: Atlantic salmon, Peregrine falcon, Blanding's turtle, wood turtle, Eastern ribbonsnake, Southern flying squirrel, moose, sweet pepperbush, water-pennywort, Striped bass, Northern red-belly dace
20	**Fish stocking**	Spring stocking program by Inland Fisheries: Trout Lake (Brook trout) Zwickers Lake (Brook trout) Fall stocking program by Inland Fisheries: Shannon Lake (Brown trout) * NOTE: Last stocking date unknown for all sites
21	**Angling (existing angling regulations for the watershed; popular angling locations)**	Trout: Apr 1 – Sept 30; bag limit = 5; EXCEPTION: Sept 1 – Sept 30, no brook trout may be retained and natural bait is prohibited for all trout species Atlantic salmon: Closed all year American eel: Apr 1 – Sept 30; min. size no less than 35 cm; bag limit = 10

		Shad: Apr 1 – Sept 30; bag limit =5 White sucker: Apr 1 – Sept 30; bag limit = 25 Yellow and White perch: Apr 1 – Sept 30; bag limit = 25
22	**Forestry activities and impacts**	Most of the forestry in the Nictaux watershed occurs to the south of New Albany along Highway 10, east towards Scragg and Waterloo Lakes, west towards Medicraft Lake, and south to McGill Lake. Most of the roads (other than West Dalhousie and Highway 10) in this area were created for logging purposes, and contribute to potential habitat fragmentation as well as forest cover loss in the headwaters of the watershed.
23	**Urban/residential development impacts**	More heavily populated along the downstream section of the river, from Alpena Rd to the mouth of the river, which are primarily residential developments. Most of the headwaters have minimal residential development; however some of the lakes (i.e. Zwickers Lake, Trout Lake etc.) have substantial cottage development.
24	**Agricultural impacts**	Farms are located primarily near the mouth of the river, and less so in the headwaters, which reach into the south mountain region. Agricultural activity in this watershed is relatively minimal.
25	**Other industry impacts**	Hydroelectricity has a major impact in this watershed, as NS Power has one generating station and several dams in this watershed which impact flow conditions and habitat accessibility.
26	**Historical conditions, impacts and considerations**	Historically, Martyn's Mill Dam was the first barrier to upstream fish migration in the Nictaux River, however in recent years, the structural integrity of the dam was compromised, and ice activity has since made that portion of the river passable. The Nictaux River historically supported populations of Atlantic salmon, but has experienced a decline in their numbers, likely attributable to a number of factors such as habitat fragmentation and alteration, water chemistry changes and flow modifications.
27	**Barriers present on the main river stem**	There are several barriers on the main river stem. NS Power has one generating station at Nictaux Falls, which is fed by an underground pipeline, constructed to divert water from a headpond upstream. Further upstream is the man-made waterfall called Wamboldt Falls, where the aforementioned main NS Power storage headpond is located on the main stem of the Nictaux River. Additionally, NS Power has two dams upstream on the main stem, in the headwaters of the Nictaux River: the storage reservoir at McGill Lake, and the Big Molly Upsim Lake storage reservoir. An additional dam is located at Scragg Lake, which feeds into the Waterloo River, one of the main tributaries in the Nictaux system. None of these dams or generating stations have fish ladders to allow fish passage to upstream portions of the river or watershed. *NOTE: If the storage reservoir were to be removed at the Wamboldt Falls location, the falls would still pose a barrier, unless work was completed to re-divert the main channel of the river back to its original channel.

28	**Other information**	Smallmouth bass were found in the lower portion of the Nictaux River below the Nictaux Falls generating station, but have not yet been found above the generating station in upper reaches of the Nictaux and Shannon rivers. However, smallmouth bass have been found in the headwaters of McGill Lake, Little Molly Upsim Lake, and Waterloo Lake.

3.2 Labeled Topographic Maps

The following are topographical maps of the Nictaux River sub-watershed, divided into stream sections. Sections have been created based on tributary confluences, lake inlets/outlets, road crossings, and/or significant features. Each section has been numbered, and stream features within those sections have been identified by letter. Refer to section 6.0 for descriptions of labeled stream features.

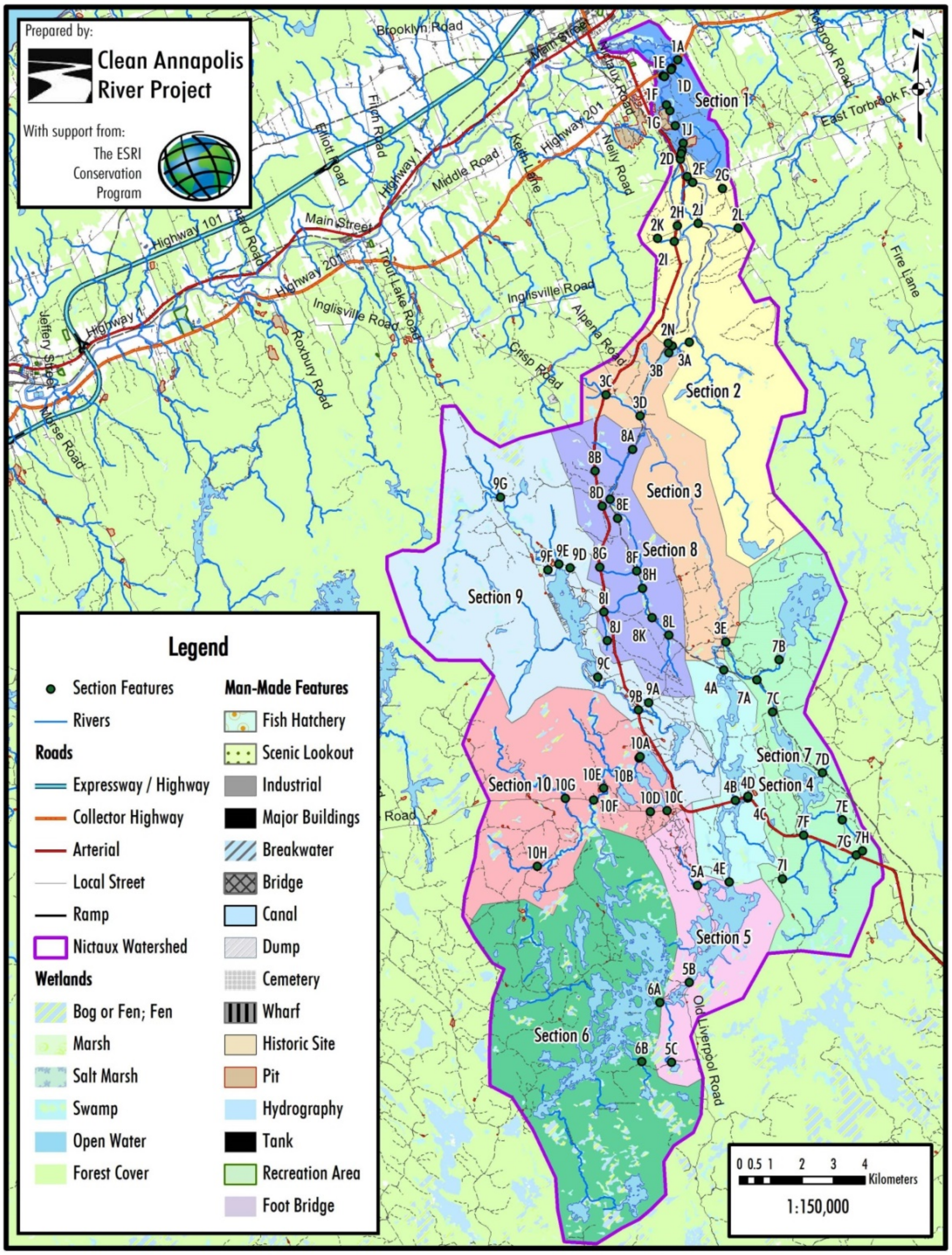

Figure 1. Labeled topographic map of the entire Nictaux sub-watershed, subdivided into stream sections.

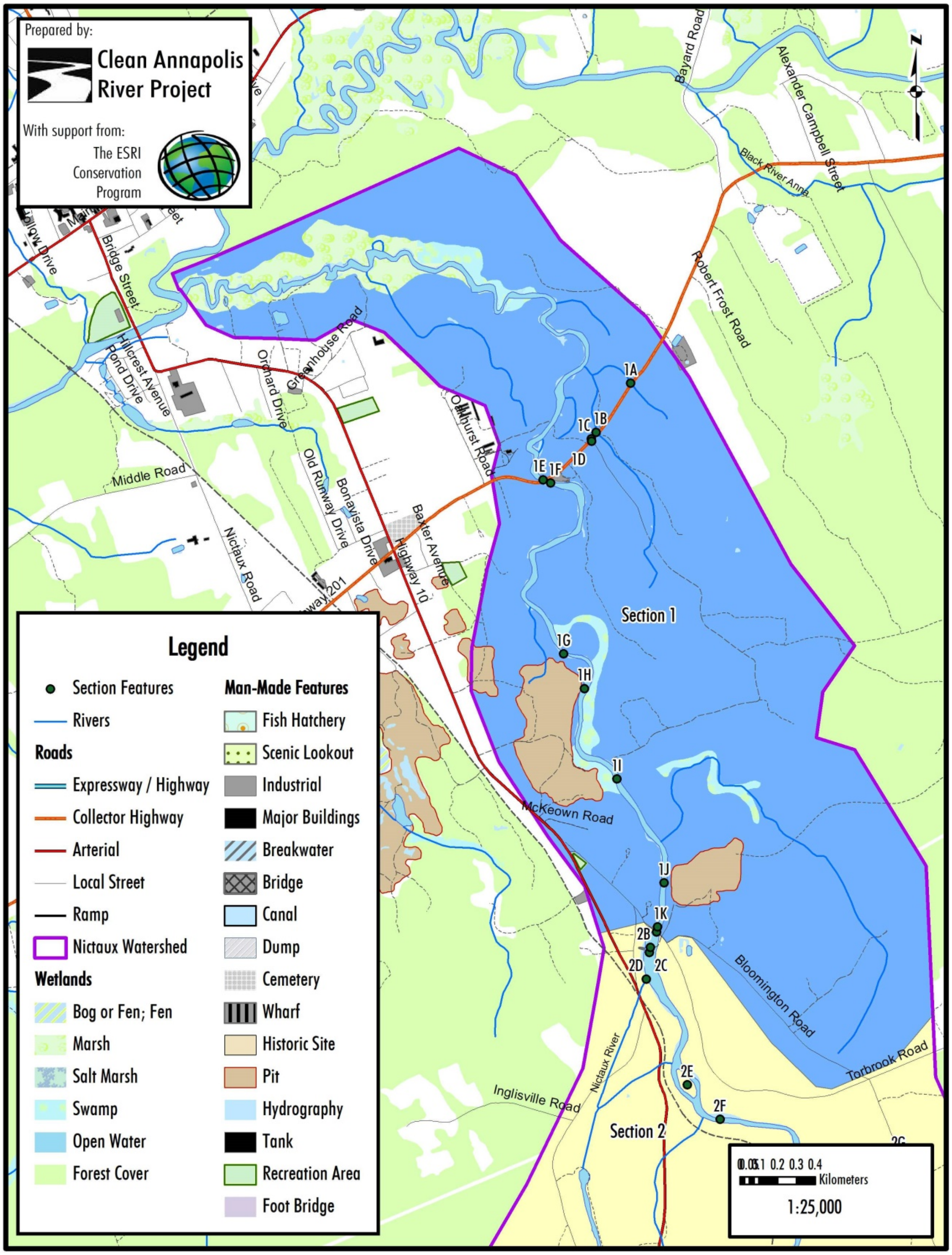

Figure 2. Feature labels for Section 1 of the Nictaux River.

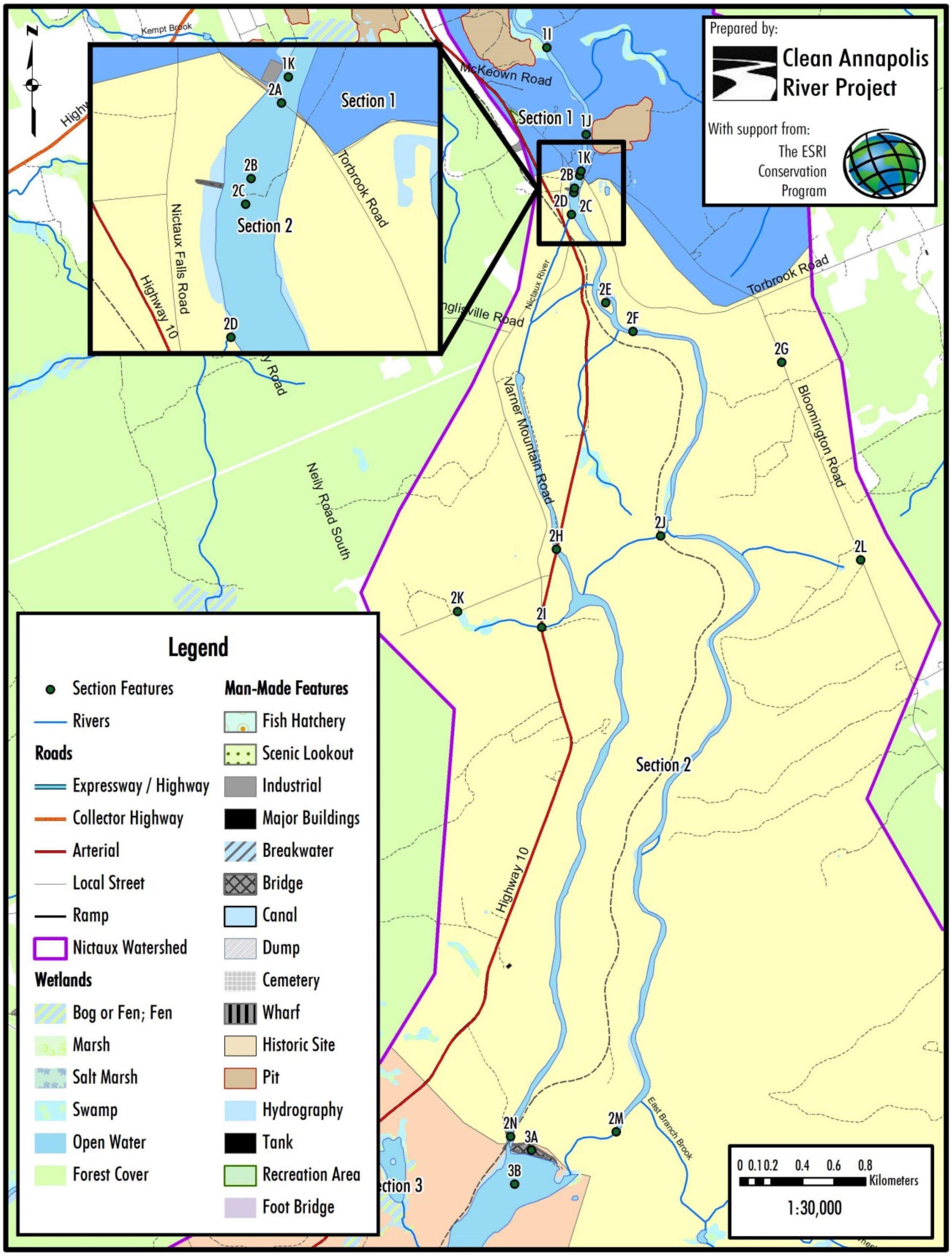

Figure 3. Feature labels for Section 2 of the Nictaux River.

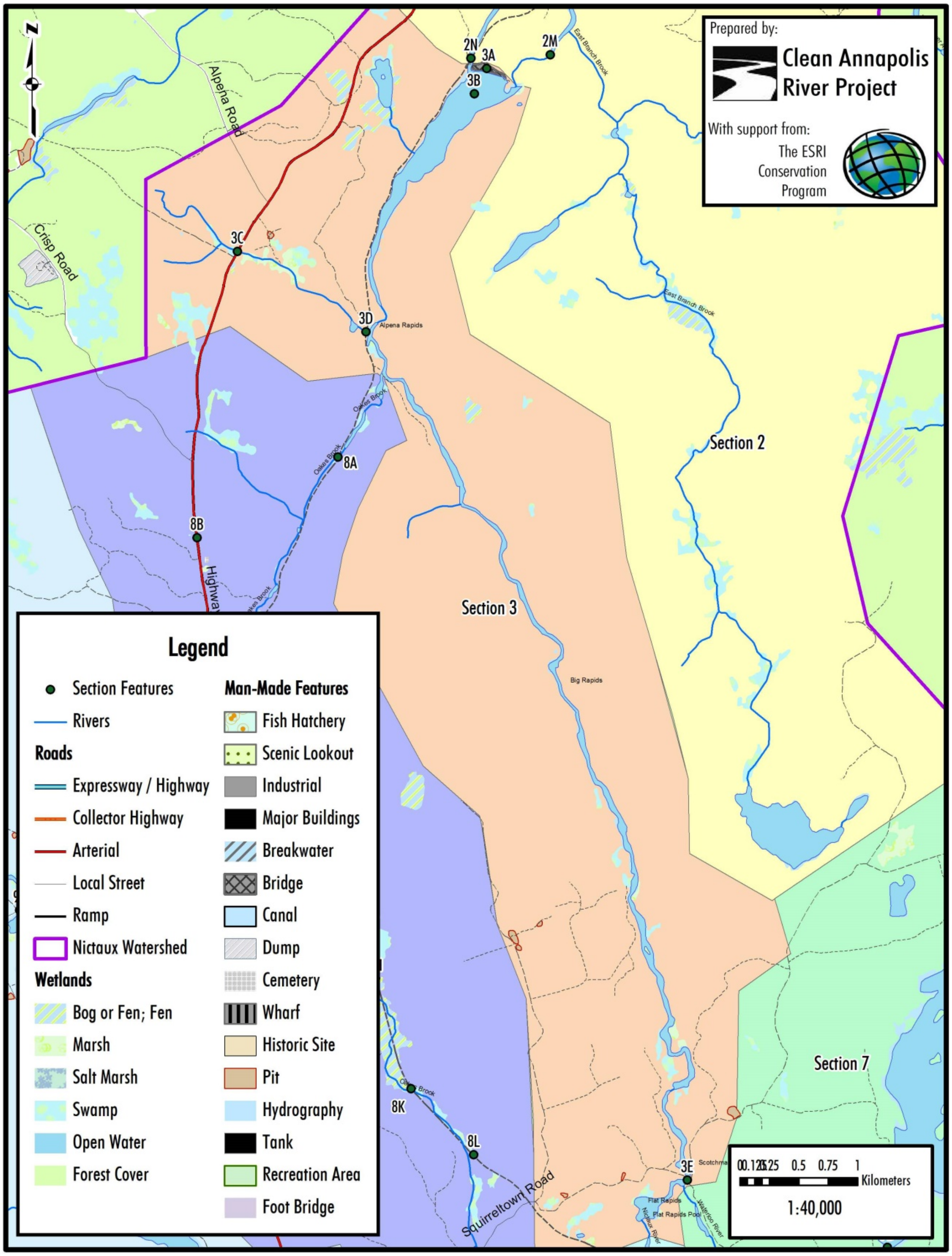

Figure 4. Feature labels for Section 3 of the Nictaux River.

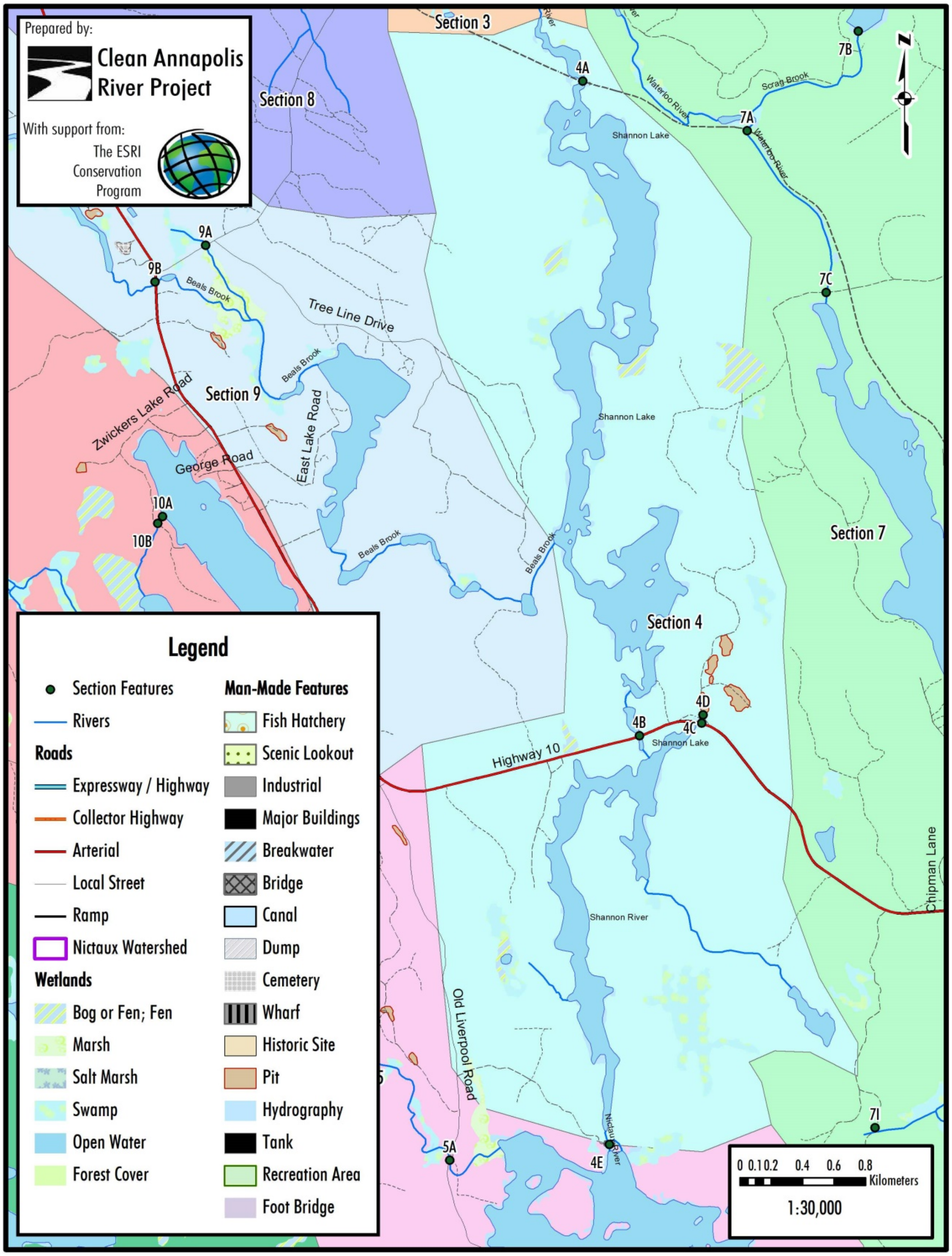

Figure 5. Feature labels for Section 4 of the Nictaux River.

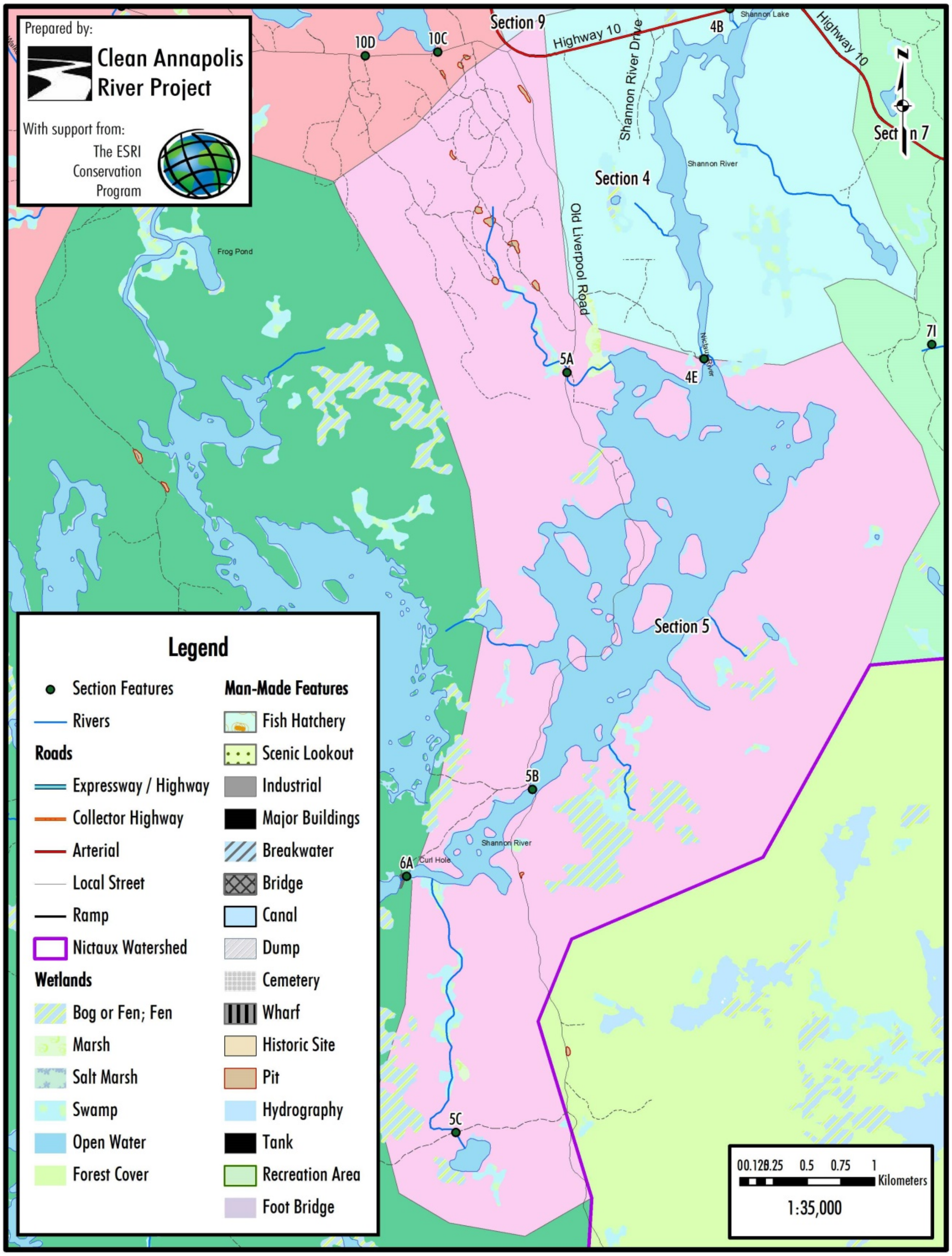

Figure 6. Feature labels for Section 5 of the Nictaux River.

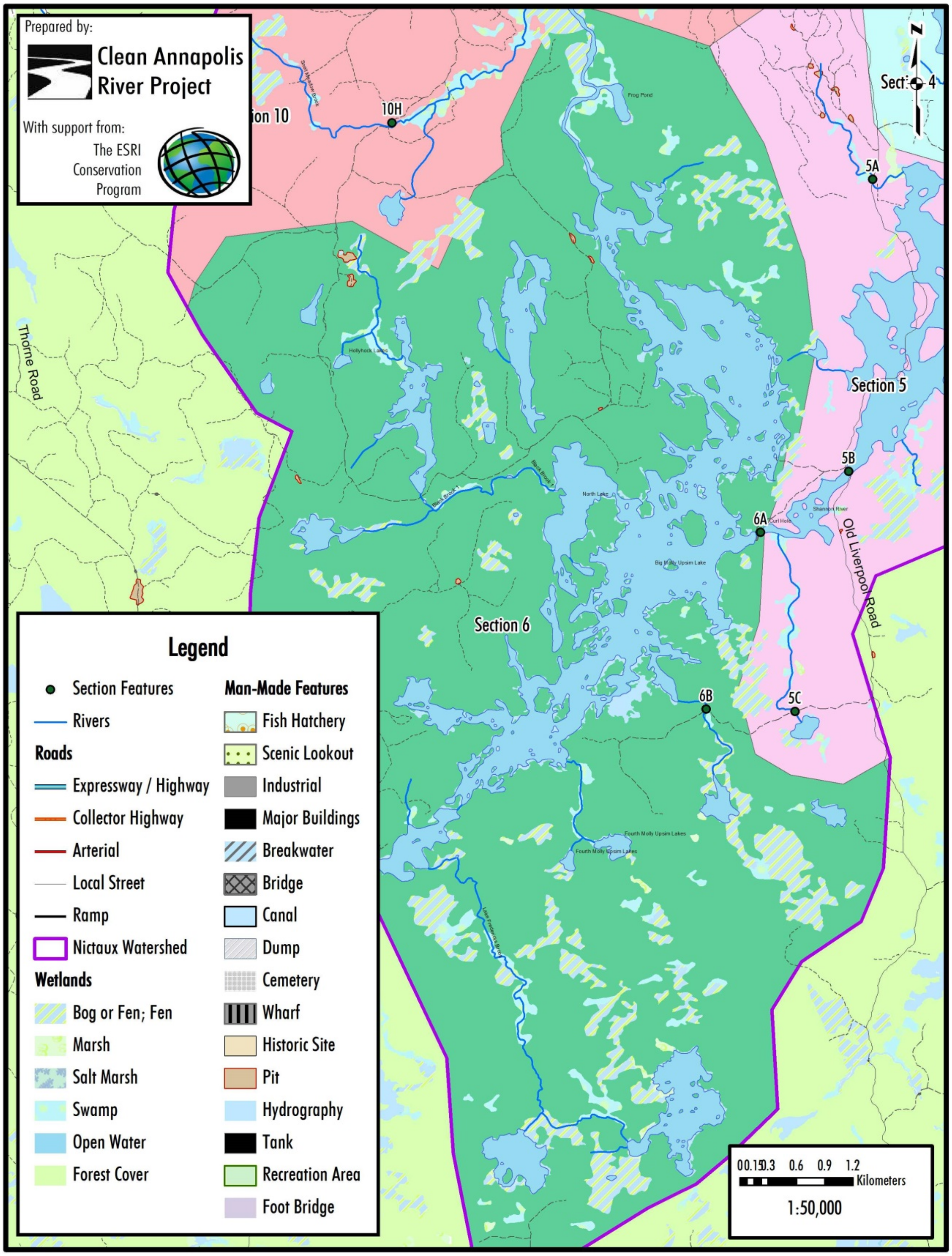

Figure 7. Feature labels for Section 6 of the Nictaux River.

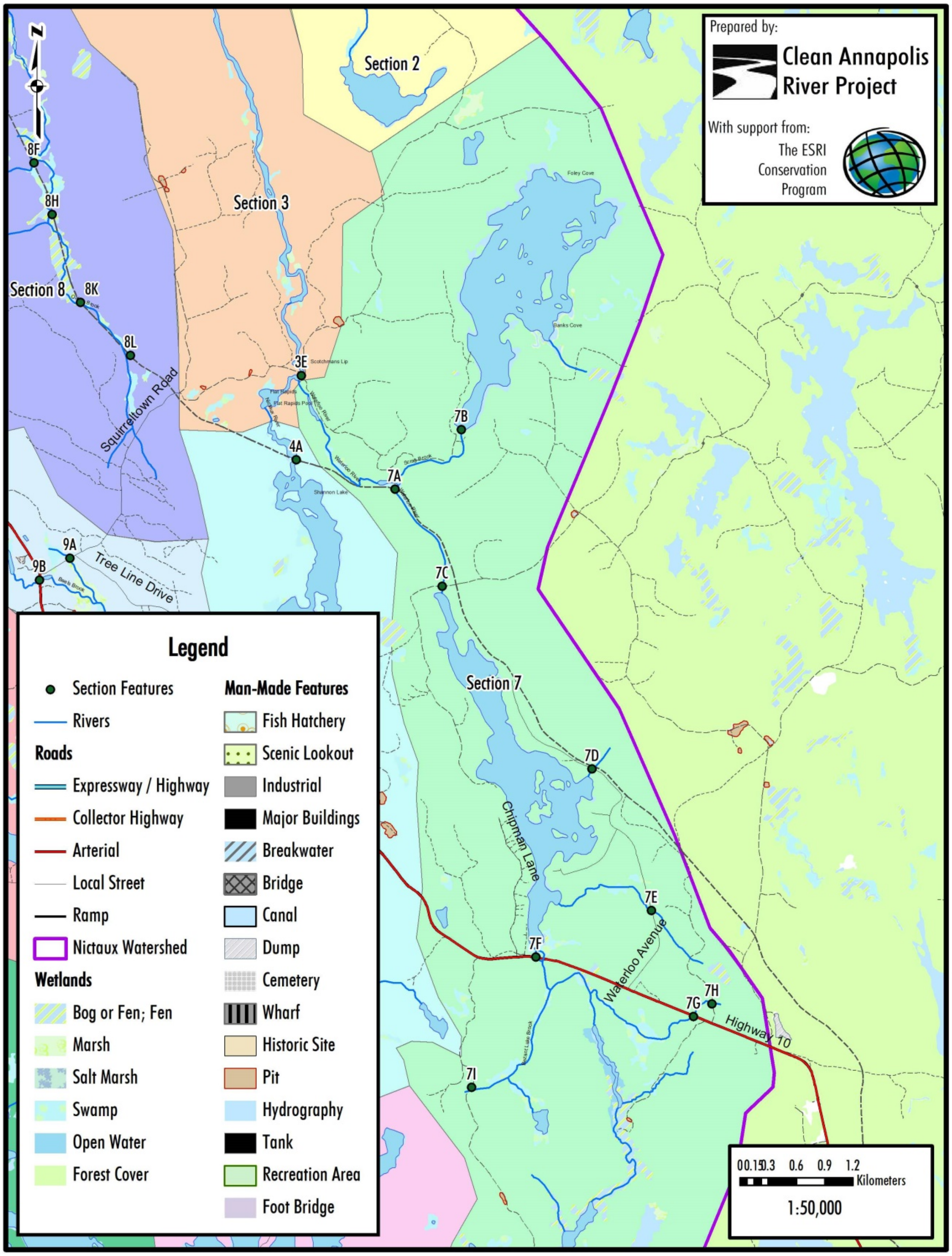

Figure 8. Feature labels for Section 7 of the Nictaux River.

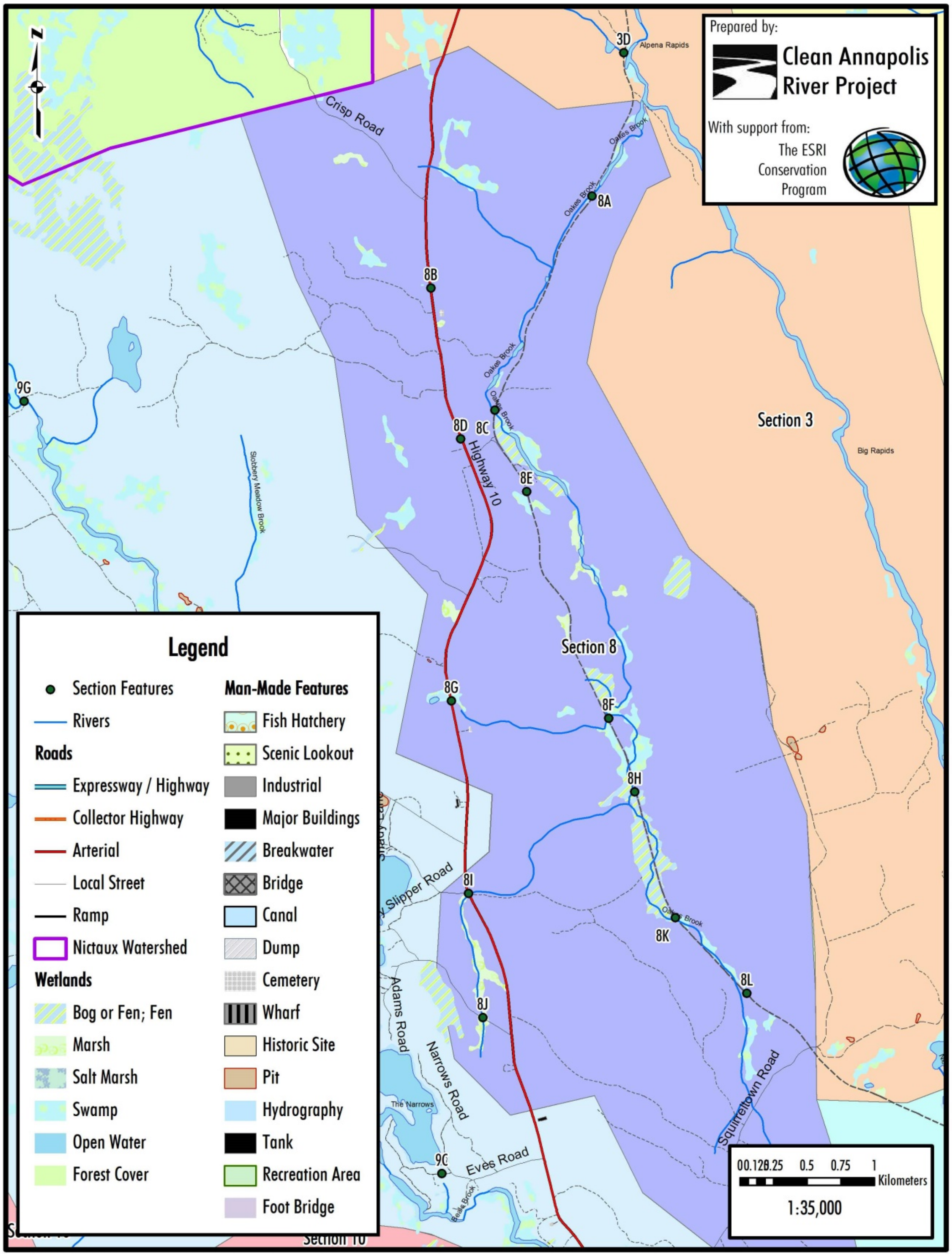

Figure 9. Feature labels for Section 8 of the Nictaux River.

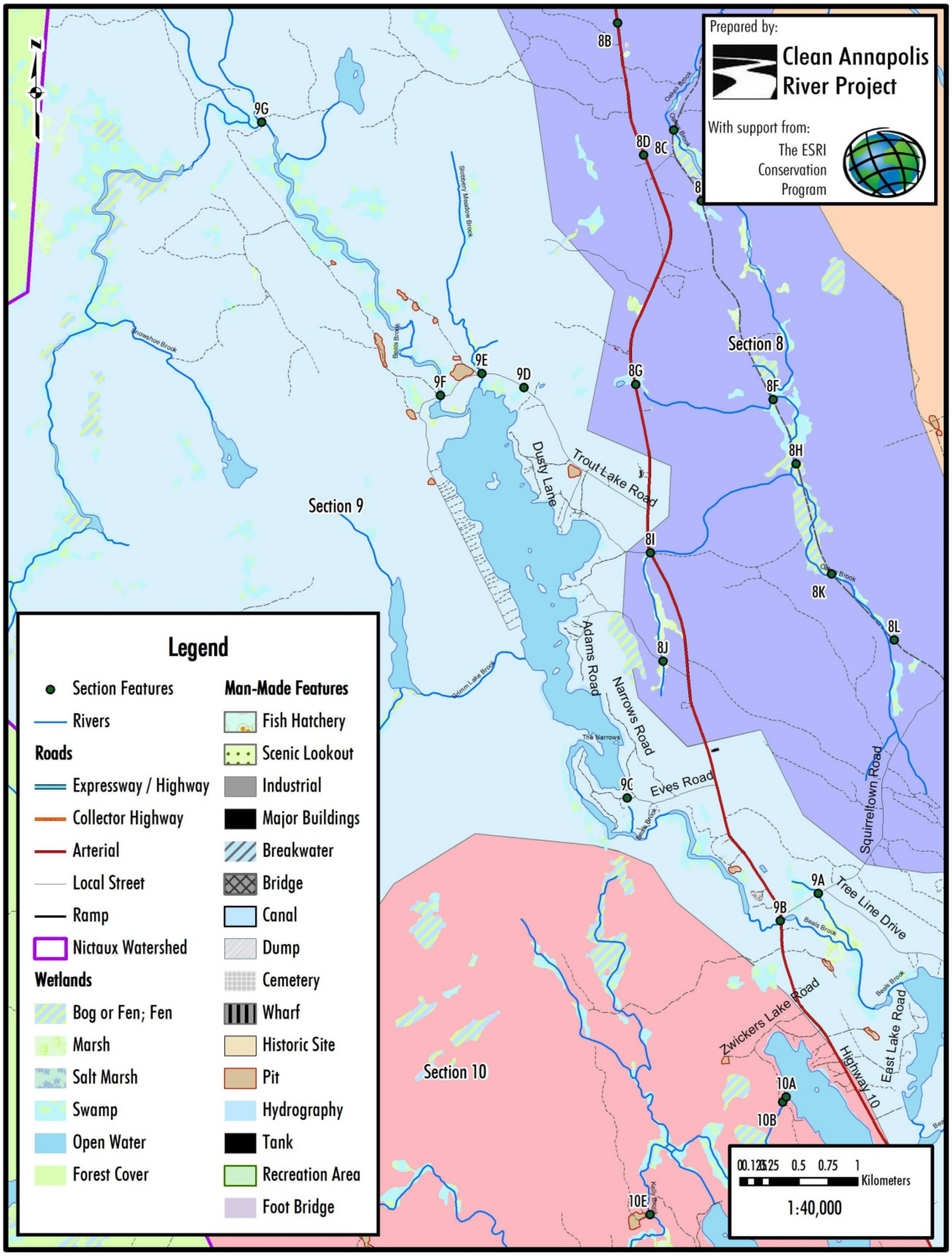

Figure 10. Feature labels for Section 9 of the Nictaux River.

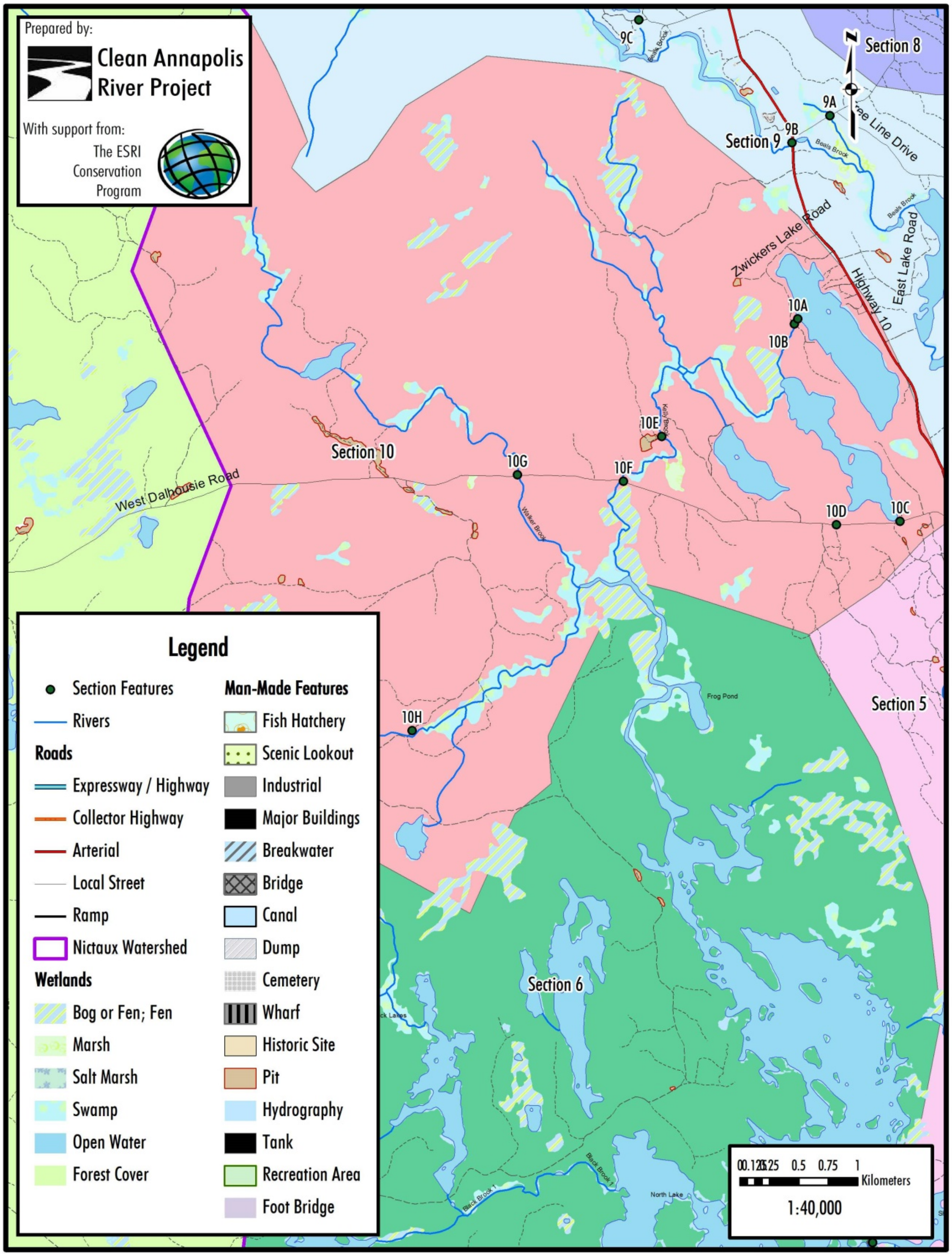

Figure 11. Feature labels for Section 10 of the Nictaux River.

4.0 Additional Monitoring Data

Over the course of a field season, field surveys were conducted to complement the gathered background information on the Nictaux River sub-watershed, and to gain a better biological and hydro-morphological understanding of the system. Fish population, benthic macro invertebrate, and habitat suitability surveys were completed to advance current knowledge of the habitat quality available in various reaches of the river, in addition to what sorts of species were utilizing the available habitats. Connectivity assessments were also completed throughout 2012 and 2013 to identify barriers to passage and migration on the system. The data collected to date is presented below and provides a very coarse snapshot of a system as large as the Nictaux River sub-watershed, but will provide beneficial information to assist with restoration activity decision-making. Further surveying should be completed however, to continue to gain a better understanding of the system and fill in knowledge gaps.

4.1 Fish Population Surveys

Fish population surveys were completed in 3 sections within the Nictaux sub-watershed, utilizing a combination of electrofishing, minnow traps and fyke net surveys. Table 1 presents the locations of each of the surveys, and Sections 4.1.1 through 4.1.3 provide a cursory overview of catch records for the surveyed sites.

Table 1. Fish population survey locations within the Nictaux River sub-watershed.

Site ID	Watercourse Name	Easting	Northing	Assessment Type	Date Assessed
NIC01E	Nictaux River	338949	4978187	Electrofishing	19-Sep-13
NIC01F	Nictaux River	339176	4978195	Fyke Net	06-Oct-13
NIC01M	Nictaux River	339036	4978189	Minnow Trap	06-Oct-13
NIC02E	Nictaux River	339805	4974395	Fyke Net	05-Oct-13
NIC02F	Nictaux River	339854	4974366	Minnow Trap	05-Oct-13
NIC02M	Nictaux River	339913	4974284	Electrofishing	20-Sep-13
NIC03E	Nictaux River	340995	4959130	Electrofishing	18-Sep-13
NIC03F	Nictaux River	341022	4959125	Fyke Net	04-Oct-13
NIC03M	Nictaux River	341019	4959125	Minnow Trap	04-Oct-13

4.1.1 Electrofishing

Three sites were surveyed using electrofishing techniques, using a Smith-Root Model 12 POW Electrofisher, with a pulse width setting of 4 ms, a pulse frequency of 60 Hz, and 400V. Site selection was based on site characteristics such as location in the sub-watershed, river depth, water velocity, and accessibility. Tables 2 to 4 present site-specific catch records for NIC01, NIC02, and NIC03, respectively.

4.1.1.1 NIC01E

NIC01E was a site located downstream of the Old Martyn's Mill Dam and the 201, on the main stem of the Nictaux River. A total of 50 fish were caught, predominantly American eel and juvenile smallmouth bass. No salmonids were caught at this site; however, it was not possible to adequately sample some of the deeper pools in the reach, as they were too deep to safely take the electrofishing unit. Additional sampling in these pools should therefore be undertaken with fyke nets. Table 2 shows catch data for the site. Figure 12 displays the proportion of each type of species caught from the electrofishing surveys at NIC01E.

Table 2. Electrofishing species-specific catch records for NIC01E.

Species	Total Catch
American eel	17
Ninespine stickleback	1
Northern redbelly dace	4
Sea lamprey	3
Smallmouth bass	13
Threespine stickleback	2
White sucker	10

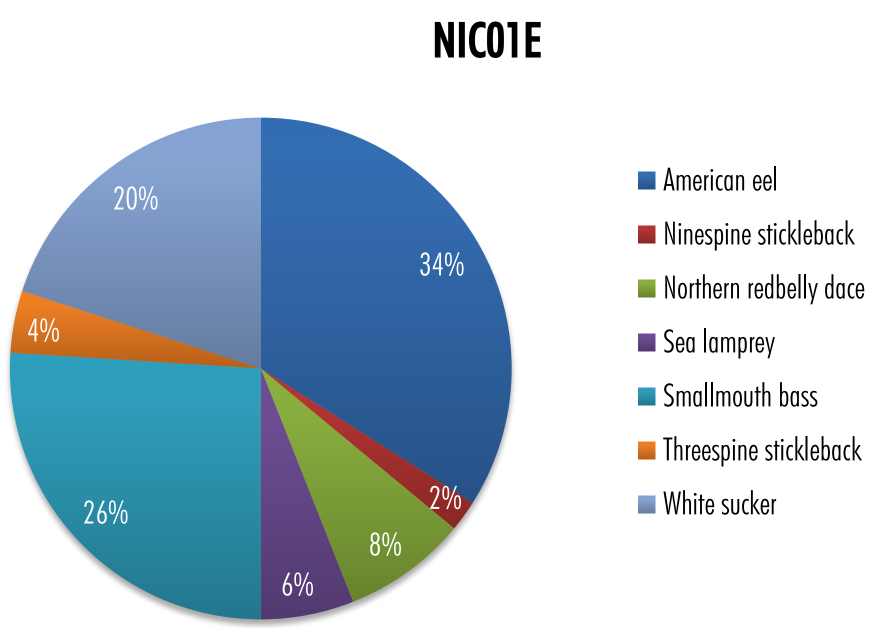

Figure 12. Pie chart displaying electrofishing catch data for site NIC01E.

4.1.1.2 NIC02E

NIC02E was a site located upstream of the headpond at the Nictaux Falls dam, on the main stem of the Nictaux River. A total of 24 fish were caught, predominantly dace and white suckers. This part of the river is subject to drastic flow fluctuations due to upstream influences from the dam at the main NS Power reservoir further upstream at Wamboldt Falls. Table 3 shows the catch data for this site. Figure 13 displays the proportion of fish of each species caught at NIC02E.

Table 3. Electrofishing species-specific catch records for NIC02E.

Species	Total Catch
American eel	2
Northern redbelly dace	11
White sucker	11

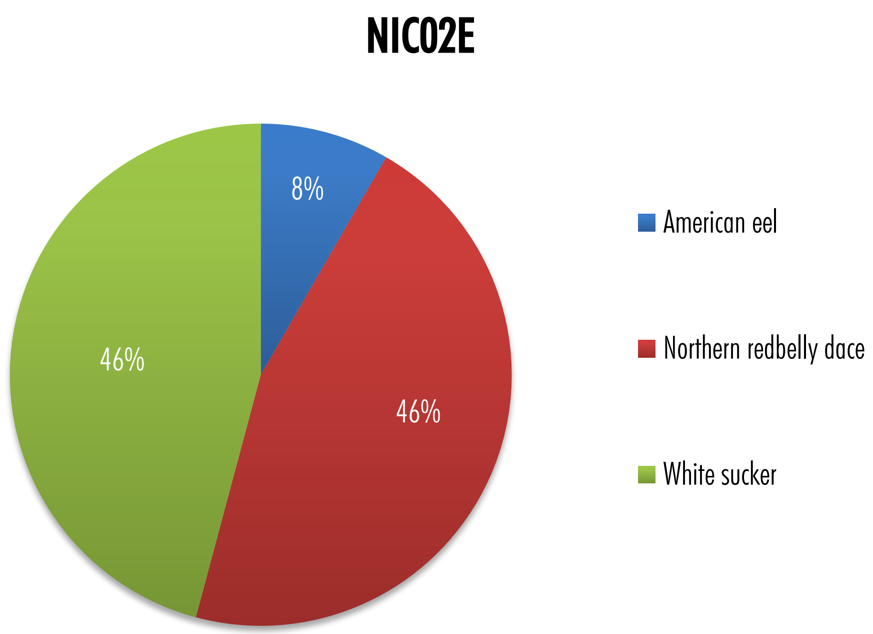

Figure 13. Pie chart displaying electrofishing catch data for site NIC02E.

4.1.1.3 NIC03E

NIC03E was a site upstream of the main headpond at Wamboldt falls, above the confluence of the Waterloo and Shannon Rivers. It was located on the main stem of the Shannon River, just upstream of Squirreltown Rd. A total of 25 fish were caught at this site, the most predominant species being the Banded killifish. Table 4 displays the electrofishing catch data for this site. Figure 14 displays the proportion of fish of each species caught at NIC03E.

Table 4. Electrofishing species-specific catch records for NIC03E.

Species	Total Catch
American eel	2
Banded killifish	11
Brown bullhead	5
Northern redbelly dace	3
White sucker	4

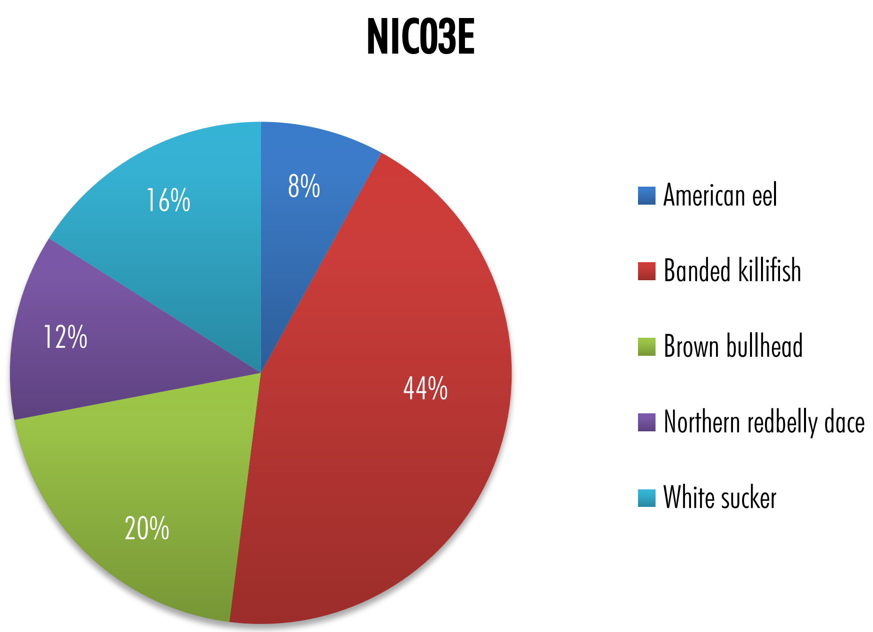

Figure 14. Pie chart displaying electrofishing catch data for site NIC03E.

4.1.2 Fyke Net

Fyke nets were installed at 3 sites along the Nictaux River in the early fall. Site selection was limited to areas with reduced currents so that nets would not be ripped out by the high fall flows. Tables 5 to 7 present the catch data results for each of the three sites. It is recommended that these sites be revisited in the summer to minimize data loss from high flow conditions.

4.1.2.1 NIC01F

The NIC01F site where the fyke net was installed was in the same reach as the electrofishing site, but slightly further upstream from where the electrofishing occurred. It should be noted however, that the fyke net data for this site is unreliable, as the fyke net was ripped out by the current prior to removal, due to a combination of high velocities, and falling leaves.

Table 5. Fyke net species-specific catch records for NIC01F.

Species	Total Catch
White sucker	1

4.1.2.2 NIC02F

The fyke net installed at NIC02F was installed just upstream of the Nictaux Falls headpond, and downstream of the location where electrofishing occurred. A total of 4 fish were caught at this site, predominantly eels. Table 6 shows the catch results for the site.

Table 6. Fyke net species-specific catch records for NIC02F.

Species	Total Catch
American eel	3
White sucker	1

4.1.2.3 NIC03F

The fyke net installed at NIC03F was installed above the confluence of the Shannon and Waterloo Rivers, on the downstream end of where the electrofishing survey began. A total of 15 fish were caught at this site, including 2 salmonids (brook trout). The most abundant species caught were yellow perch.

Table 7. Fyke net species-specific catch records for NIC03F.

Species	Total Catch
Brook trout	2
Brown bullhead	4
White sucker	3
Yellow perch	6

4.1.3 Minnow Traps

Minnow traps were installed at 3 sites along the Nictaux River in the fall. Minnow traps were placed in reaches near the sites where either fyke nets or electrofishing had occurred. Tables 8 to 10 display the catch result data from minnow traps. Traps were checked 24 hours after installation at a site.

4.1.3.1 NIC01M

The minnow trap installed at NIC01M was placed in a shaded pool at the upstream end of the electrofishing site, and downstream of the fyke net installation site. One fish was caught in the trap, and Table 8 shows the summative catch data for the site.

Table 8. Minnow trap species-specific catch records for NIC01M.

Species	Total Catch
American eel	1

4.1.3.2 NIC02M

The minnow trap installed at NIC02M was placed in a pool upstream of the fyke net installation site. A total of 3 fish were caught in the trap (See Table 9).

Table 9. Minnow trap species-specific catch records for NIC02M.

Species	Total Catch
White sucker	3

4.1.3.3 NIC03M

The minnow trap installed at NIC03M was placed in a pool on the bank opposite where the fyke net installation site was located. One fish was caught in the trap (see Table 10).

Table 10. Minnow trap species-specific catch records for NIC03M.

Species	Total Catch
Brown bullhead	1

4.2 Habitat Suitability Assessments

Habitat suitability assessments are a method of evaluating the characteristics of a stream or river, using the habitat requirements and limiting factors for target species, to determine whether the studied systems provide viable habitats. Habitat suitability assessments were completed in the 2013 field season according to the Nova Scotia Fish Habitat Assessment Protocol (NSFHAP) developed by Clean Nova Scotia and AAS. The NSFHAP was created in 2012 to standardize the province-wide field methodologies used for fish habitat assessments, and to provide procedures to assess habitat suitability for salmonid species. The features being assessed in the field methods are largely based on a Habitat Suitability Index (HSI) for Brook trout that has been adapted to suit conditions in Nova Scotia. Brook trout are considered an indicator species in the rivers of Nova Scotia, meaning that their presence, absence, and overall health can indicate changes in environmental conditions. The online NSFHAP data entry evaluates data collected in the field based on suitability models so that limiting factors can be easily identified.

HSI surveys were conducted along the main stem of the Nictaux River in 2013 and 2016. Between those years, the NSHAP received a review and updates to underlying concepts and field methods. These changes included the addition of criteria tailored to Atlantic salmon; changes to criteria and an increase from 13 to 15 variables; a halving of the site length; the removal of the hierarchy of methodologies; and changes to quality categories. Since the 2013 field data could not be inputted into the updated online data entry sheet without significant modification, HSI results between sample years could not be easily compared. As such, 2013 and 2016 data have been presented separately in this plan. It is recommended that sites assessed in 2013 be revisited and completed using the revised protocols to provide updated and comparable information on the conditions of the river system for salmonids. For the 2013 fish habitat assessment procedure, refer to Brunner (2012) and Wagner (2013). For the 2016 fish habitat assessment procedure, refer to AAS (2016) and Stoffer (2017).

4.2.1 2013 HSI Assessments

A summary of data gathered from habitat assessments in 2013 has been presented to provide a more comprehensive understanding of the habitats found in the Nictaux River system. Three sites were assessed on the Nictaux River sub-watershed, and their locations are displayed in Figure 15. Full assessment data and habitat quality values for brook trout have been presented in Appendix B.

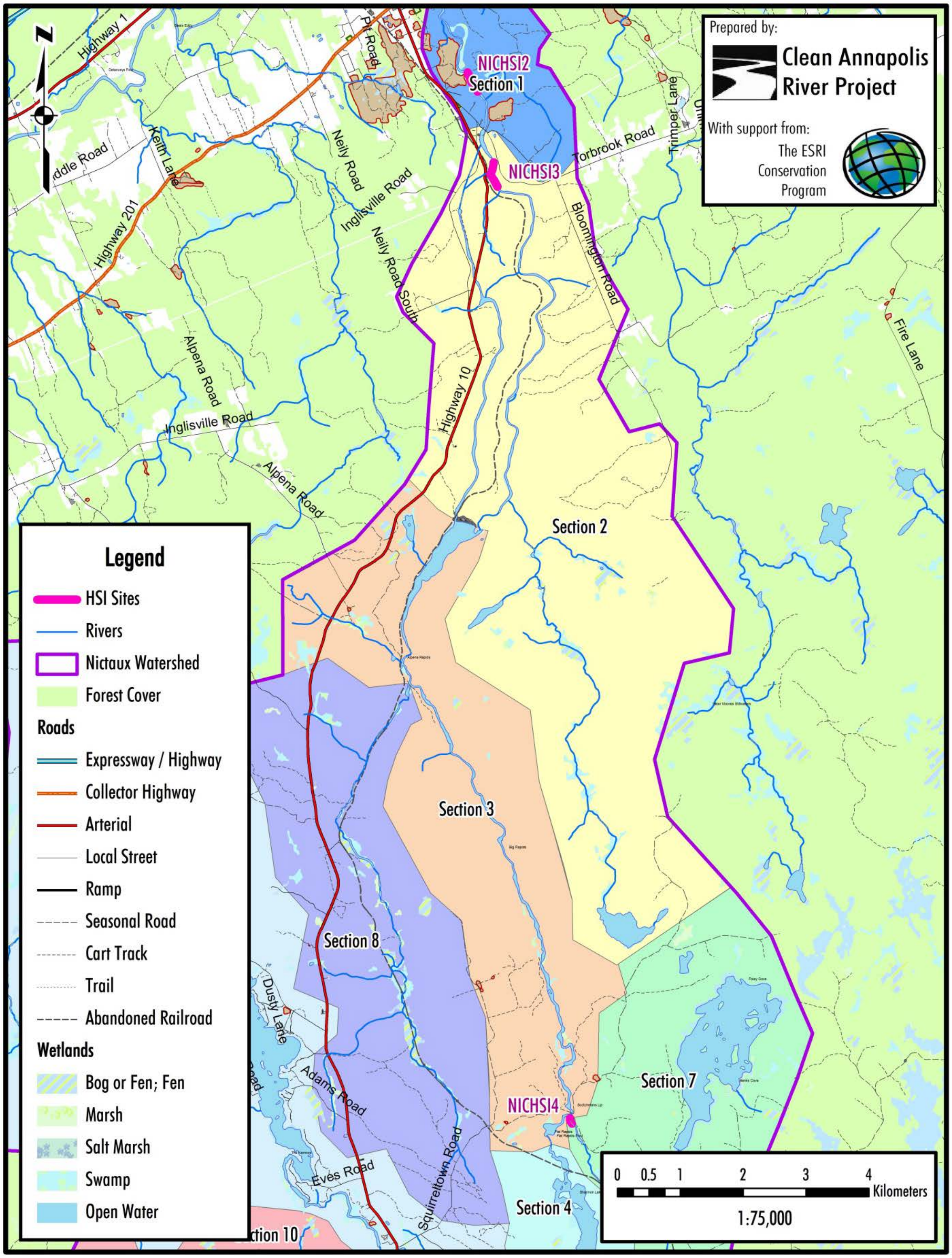

Figure 15. HSI monitoring sites on the Nictaux River system.

The site of NICHSI2 was located in Section 1, where previous restoration activities had been completed by the DFO in the early 2000s. The assessed site was downstream of the powerhouse at Nictaux Falls, and no major impediments were found to exist to date that prevent fish from accessing the site from the downstream portions of the Nictaux River. The transects at this site were spaced approximately 56 to 60 m apart, and generally fell within a fairly uniform type of reach with a minimal number of pools or cover, and fairly uniform bottom substrate. There was minimal habitat complexity in this location, only that created by the rock weirs installed in previous years. In general, average substrate size at NICHSI2 fell within the cobble size class, while the dominant size classes overall at NICHSI2 were gravel. Consequently, both cobble and boulder were also almost equally abundant at this site. Percent fines ranged from 3 to 15% between the six different transects, indicating fair and optimum values for brook trout (refer to Appendix 10.B.2).

The NICHSI3 reach was located upstream of the headpond at Nictaux Falls in Section 2. This reach displayed more habitat complexity than NICHSI2, with a larger number of pools and overall cover. The reach is not accessible for migrating species however, as there are barriers (dams) upstream and downstream. The average substrate size class for NICHSI3 was also determined to be cobble, which was also the dominant substrate type in this case as well. There was a fairly equal amount of gravel and boulder in the site reach as well, indicative of fair food production quality values for brook trout. The percent fines varied widely, with a range from 0.7 to 15%, which provided fair and optimum quality values.

The NICHSI4 reach was located on the Waterloo River, just above the confluence with the Shannon River in Section 3. The reach exhibited good habitat complexity, with a wide array of pools, eddies, runs, and riffles. There was also a good amount of overall cover. This reach is accessible to fish in some of the headwaters on the Nictaux River, but dams downstream at Wamboldt Falls, upstream at Scragg Lake and McGill Lake, prevent further migration through this system. The average substrate size and most dominant substrate class was determined to be cobble. While there were fewer boulders and gravel present at NICHSI4, they were still comparatively high compared to fines and bedrock, and would make fair quality food production sites. The percent fines all fell within the optimal quality values for brook trout, ranging from 0.7 to 5%.

According to HSI surveys conducted on the Nictaux River in 2013, the amount of cover available for salmonids was higher in the two upstream sites on the main stem of the Nictaux River and the Waterloo River. However, all sites displayed cover values that were considered to be optimum quality values according to Brunner (2012). In addition, riparian vegetation values for all sites indicated optimum bank stability. Tables 11 through 13 summarize the findings from each of the HSI surveys at the three sites surveyed in the Nictaux River sub-watershed in 2013. NICHSI2 had the fewest variables that fell into the optimum quality range, whereas both NICHSI3 and NICHSI4 had an equal amount of variables that fell within both the fair and optimum quality ranges. For a full description of the criteria for each category, please refer to Table 27 in Appendix A.

Table 11. Summary of HSI assessment survey results at NICHSI2.

Variable	Poor Quality	Fair Quality	Optimum Quality
Average Thalweg Depth			✓
Percent In-stream Cover			✓
Average Substrate Size		✓	
Dominant Substrate for Food Production		✓	
Percent Pools		✓	
Average Percent Streambank Vegetation			✓
Average Percent Rooted Vegetation/Stable Ground			✓
Pool Class		✓	
Percent Fines		✓	

Table 12. Summary of HSI assessment survey results at NICHSI3.

Variable	Poor Quality	Fair Quality	Optimum Quality
Average Thalweg Depth			✓
Percent In-stream Cover			✓
Average Substrate Size		✓	
Dominant Substrate for Food Production		✓	
Percent Pools			✓
Average Percent Streambank Vegetation			✓
Average Percent Rooted Vegetation/Stable Ground			✓
Pool Class		✓	
Percent Fines			✓

Table 13. Summary of HSI assessment survey results at NICHSI4.

Variable	Poor Quality	Fair Quality	Optimum Quality
Average Thalweg Depth			✓
Percent In-stream Cover			✓
Average Substrate Size		✓	
Dominant Substrate for Food Production		✓	
Percent Pools			✓
Average Percent Streambank Vegetation		✓	
Average Percent Rooted Vegetation/Stable Ground			✓
Pool Class			✓
Percent Fines			✓

4.2.2 2016 HSI Assessment

Tables 14 through 17 summarize the findings from each of the HSI surveys at two sites in the Nictaux River sub-watershed in 2016. Surveys were conducted a few weeks before, and one week after restoration activities at two sites: one that received fine sediment removal within the streambed (NICSW), and one upstream control site (NICCON). Refer to Figure 16 for a map of HSI sites, and Stoffer (2016) for information on sediment removal activities. The intent of these HSI surveys was to evaluate restoration activities on in-stream habitat quality.

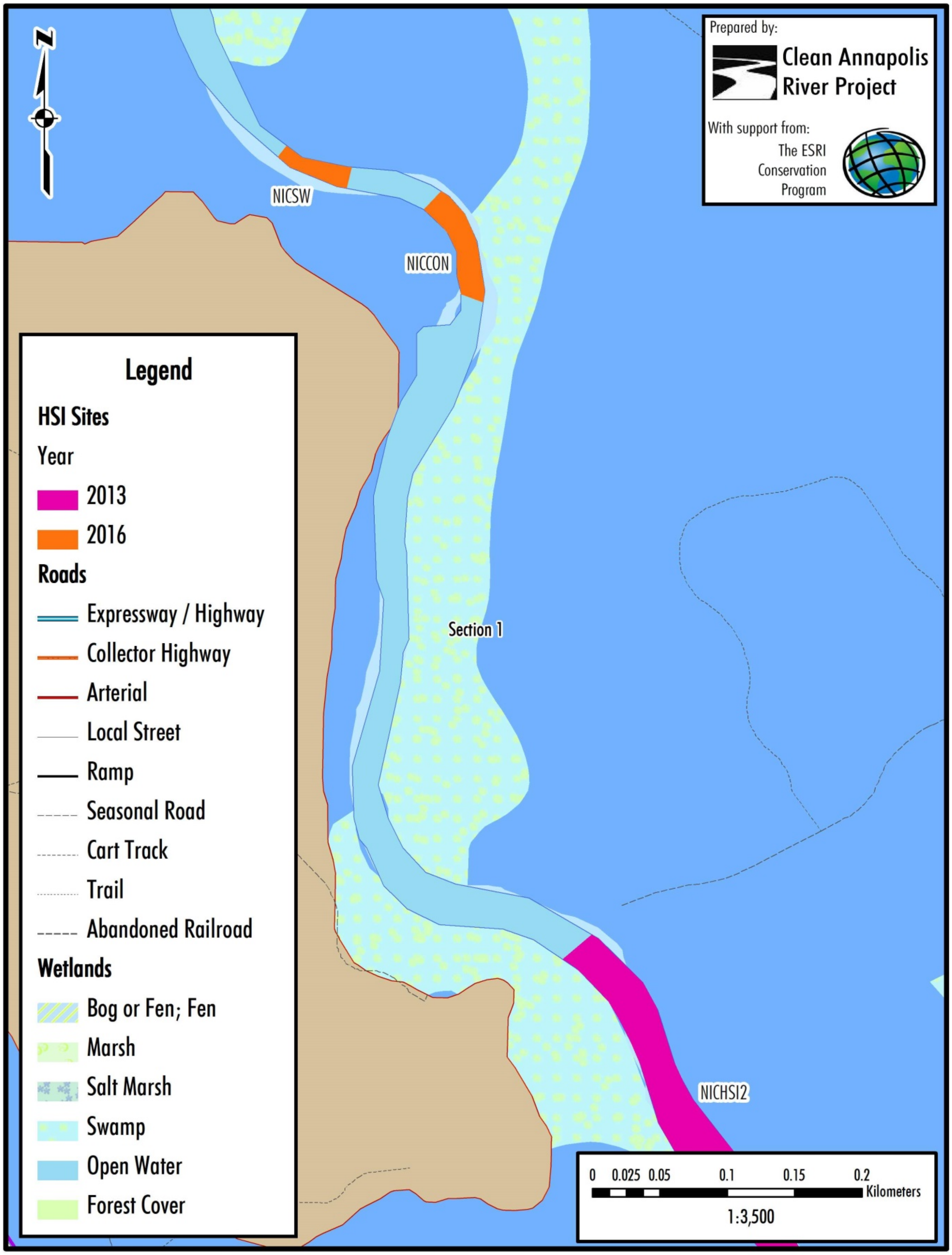

Figure 16. HSI monitoring sites on the Nictaux River system for 2016 (sites surveyed in 2016 were half the length of sites surveyed in 2013).

Two criteria displayed immediate, noticeable changes after restoration activities within NICSW. The percentage of fines (substrate <0.2 cm) in spawning areas showed improvements for both target species. Criteria for brook trout improved from poor to moderate quality, and Atlantic salmon criteria upgraded from poor to good quality. The same criteria in the control site remained constant for trout, and decreased in quality for salmon. This could be attributed to a heavy rainfall and dam release during the restoration period providing an influx of fine sediment to the site. Substrate for spawning and incubation, a unique criteria for Atlantic salmon, improved from moderate to optimal quality after restoration activities, while conditions in the control site remained constant. Two additional criteria displayed changes before and after restoration activities; the percentage of pools decreased for both sites and the percent in-stream cover for juveniles decreased for target species. These observations could also be attributed to the upstream dam release, as the high water flow made identifying and measuring pools more difficult during post-restoration surveys, and an influx of sediment could have filled the interstitial spaces that were determined to provide in-stream cover in pre-restoration surveys.

These results only show a snapshot of impacts to the physical habitat, and whether the treatment will have long term benefits is unknown. Changes to embeddedness and sediment transport from fine sediment removal will likely affect the surveyed criteria over the high-flow seasons; therefore, sites will need to be reassessed during the following field season to document the long term impacts of restoration activities.

Table 14. Summary of HSI assessment survey results for brook trout at NICSW before and after fine sediment removal.

	Before			**After**		
Variable	Poor Quality	Fair Quality	Optimum Quality	Poor Quality	Fair Quality	Optimum Quality
Percent pools		✓		✓		
Pool class rating	✓			✓		
Percent in-stream cover (juveniles)			✓			✓
Percent in-stream cover during late growing season (adults)	✓			✓		
Dominant substrate type in riffle-run areas			✓			✓
Average percent vegetation along the streambank			✓			✓
Average percent rooted vegetation/stable ground			✓			✓
Average maximum water temperature	✓			✓		
pH			✓			✓
Average size of substrate in spawning areas	✓			✓		
Percent fines in spawning areas	✓				✓	
Percent fines in riffle-run areas			✓			✓
Percent substrate size class for winter escape			✓			✓
Average thalweg depth during late growing season	✓			✓		
Percent stream shade		✓			✓	

Table 15. Summary of HSI assessment survey results for Atlantic salmon at NICSW before and after fine sediment removal.

	Before			After		
Variable	Poor Quality	Fair Quality	Optimum Quality	Poor Quality	Fair Quality	Optimum Quality
Percent pools	✓			✓		
Pool class rating	✓			✓		
Percent in-stream cover (juveniles)			✓			✓
Percent in-stream cover (adults)	✓			✓		
Dominant substrate type in riffle-run areas			✓			✓
Average percent vegetation along the streambank			✓			✓
Average percent rooted vegetation/stable ground			✓			✓
Summer rearing temperature during growing season	✓			✓		
pH			✓			✓
Substrate for spawning and incubation		✓				✓
Percent fines in spawning areas	✓					✓
Fry water depth			✓			✓
Parr water depth			✓			✓
Stream order			✓			✓
Percent stream shade		✓			✓	

Table 16. Summary of HSI assessment survey results for Brook trout at NICCON before and after fine sediment removal.

	Before			After		
Variable	Poor Quality	Fair Quality	Optimum Quality	Poor Quality	Fair Quality	Optimum Quality
Percent pools		✓		✓		
Pool class rating	✓			✓		
Percent in-stream cover (juveniles)			✓		✓	
Percent in-stream cover during late growing season (adults)	✓			✓		
Dominant substrate type in riffle-run areas			✓			✓
Average percent vegetation along the streambank			✓			✓
Average percent rooted vegetation/stable ground			✓			✓
Average maximum water temperature	✓				✓	
pH			✓			✓
Average size of substrate in spawning areas	✓			✓		
Percent fines in spawning areas		✓			✓	
Percent fines in riffle-run areas			✓			✓
Percent substrate size class for winter escape			✓			✓
Average thalweg depth during late growing season	✓				✓	
Percent stream shade		✓			✓	

Table 17. Summary of HSI assessment survey results for Atlantic salmon at NICCON before and after fine sediment removal.

	Before			After		
Variable	Poor Quality	Fair Quality	Optimum Quality	Poor Quality	Fair Quality	Optimum Quality
Percent pools		✓		✓		
Pool class rating	✓			✓		
Percent in-stream cover (juveniles)			✓		✓	
Percent in-stream cover (adults)	✓			✓		
Dominant substrate type in riffle-run areas			✓			✓
Average percent vegetation along the streambank			✓			✓
Average percent rooted vegetation/stable ground			✓			✓
Summer rearing temperature during growing season	✓				✓	
pH			✓			✓
Substrate for spawning and incubation			✓			✓
Percent fines in spawning areas			✓	✓		
Fry water depth			✓			✓
Parr water depth			✓			✓
Stream order			✓			✓
Percent stream shade		✓			✓	

4.3 Canadian Aquatic Biomonitoring Network Results

Benthic macroinvertebrates are small, relatively long-lived, sedentary aquatic organisms that live in the sediments, on woody debris, or rocks present on streambeds (Bouchard Jr, 2004). These include insects (e.g. mayflies), molluscs (e.g. clams) and other organisms that spend part or all of their life cycle on the bottom of watercourses. They are a source of food for many fish species, including salmonids. Some aquatic invertebrates are also very sensitive to pollution, while others are pollution tolerant and can thrive in a contaminated environment. Measuring the relative abundance and diversity of both sensitive and tolerant invertebrates at a site can provide information on the water quality. For example, if species that are intolerant of pollution (e.g. mayflies and caddisflies) are either absent or present in low numbers at a site, whereas more tolerant species (e.g. midge larvae, snails, leeches) are abundant, it is highly likely that the site is polluted. Benthic invertebrate sampling adds another dimension to ecological monitoring. While the measurement of physical and chemical parameters provides a picture of the river's health at a given time, the type of organisms existing in the system can provide a longer-term indication of its health. For example, a rainfall event can cause a river's total suspended solid count to spike for a short period and then quickly return to normal, whereas benthic life will show a greater sensitivity to long-term effects, because of the longer lifespan of some of these organisms.

The CABIN sampling program undertaken by CARP has pursued three objectives:

- To collect a sufficient number of samples from reference, or pristine, sites in order to allow the development of a reference condition approach model (RCA) for Nova Scotia or Atlantic Canada. The development of an RCA model is a long-term objective, requiring contributions from many partners and the collection of samples from across the region.
- To annually collect benthic invertebrate samples from water quality monitoring sites along the main Annapolis River in order to allow a time series analysis to be performed, highlighting temporal changes. This objective has been undertaken with the view that the CABIN analysis will compliment CARP's traditional chemical and physical water quality monitoring activities.

- To utilize benthic invertebrates as a tool to assess before and after changes in aquatic quality at sites undergoing habitat restoration activities.

CARP has worked with Environment Canada since 2002 to build a network of benthic invertebrate sample stations in the Annapolis watershed. Table 18 describes the location and status of CABIN samples collected in the Nictaux sub-watershed by CARP in 2013. No additional samples have been collected in the Nictaux River since 2013.

Table 18. CABIN sampling sites within the Nictaux River sub-watershed.

Site ID	Watercourse Name	Easting	Northing	Assessment Type	Date Assessed
NIC01	Nictaux River	339548	4975582	CABIN Sampling	7-Oct-2013
NIC02	Nictaux River	339830	4974167	CABIN Sampling	7-Oct-2013
NIC03	Shannon River	341007	4959119	CABIN Sampling	7-Oct-2013

To present the results of the CABIN samples collected in the Nictaux River sub-watershed, the Hilsenhoff Family Biotic Index has been used, as indicated by the CABIN analysis procedure. The index produces a value from 0 to 10, 0 being excellent water quality and 10 being poor water quality. The CABIN procedures outline categories for evaluation of water quality using the Family Biotic Index (Reynoldson et al., 2004). These categories are presented below, in Table 19.

Table 19. Evaluation of water quality using the Family Biotic Index.

Family Biotic Index	Water Quality	
0.00 – 3.75	Excellent	
3.76 – 4.25	Very Good	
4.26 – 5.00	Good	
5.01 – 5.75	Fair	
5.76 – 6.50	Fairly Poor	
6.51 – 7.25	Poor	
7.26 – 10.00	Very Poor	

Figure 17 illustrates the Family Biotic Index results for three sites in the Nictaux River. CABIN sampling at these sites indicate good water quality results, with the Family Biotic Indices for the three sites falling under the 'Excellent' or 'Very Good' categories. The 2013 results indicate an improving downstream trend, however this is very minor, and the variances between sites are relatively small.

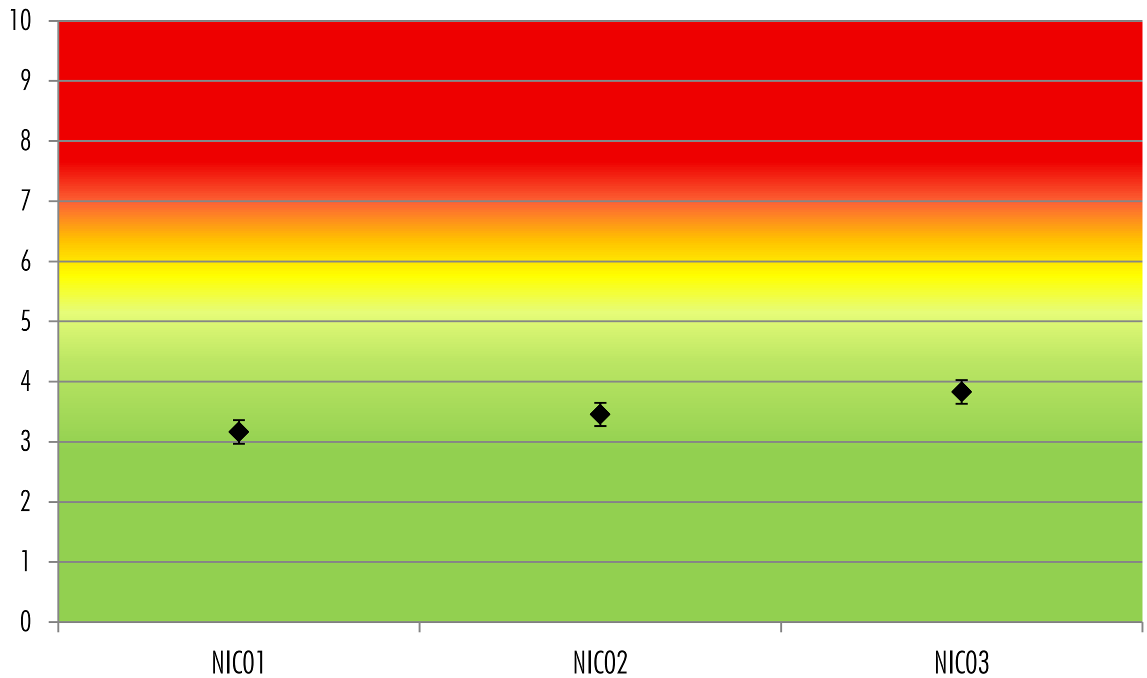

Figure 17. Family Biotic Indices for the Nictaux River 2013 CABIN sites.

Results calculated from 2013 were identified by Craig Logan, a certified taxonomist from Craig Logan Consulting. In addition to the Family Biotic Index, several other results were calculated to characterize the benthic invertebrate samples collected from the Nictaux River sub-watershed. Table 20 displays these results.

Table 20. 2013 Benthic invertebrate results for the Nictaux River.

	NIC01	NIC02	NIC03
Family Biotic Index	3.16	3.45	3.83
Taxonomic Richness	25	29	22
Total EPT	2212	2940	1485
Percentage EPT in sample (%)	59.00	40.16	31.32
Diversity	2.34	2.50	2.19
Evenness	0.27	0.29	0.27
Total Abundance	3750	7320	4742

The different measurements are described below.

- **Taxonomic Richness** refers to the number of different families of invertebrates in the sample.
- **Total EPT** refers to the number of organisms in the sample that come from the orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) or Trichoptera (caddisflies). These organisms tend to have low pollution tolerance, so larger relative numbers of them tend to indicate less contaminated waters.
- The **Diversity Index** measures the relative abundance of each family. Mackie (2004) describes guidelines for using the species diversity index in assessing water quality. Since the samples taken by CARP were not all identified to species, the index was

modified to be used at the family level. A diversity index of <1 indicates polluted water, an index result of 1-3 indicates sub-polluted water and an index of >3 indicates clean water. However, Mackie does emphasize that these results treat all organisms as identical and does not take into account the pollution sensitivity of each different taxonomic grouping. The test is also optimized for analysis at the genus level of taxonomy and loses reliability at higher levels, such as family.

- **Evenness** also measures how the organisms are distributed between families. The closer the sample is to an even distribution, the closer this value will be to 1. Stresses to the aquatic environment tend to cause some taxa to shrink in number or disappear while causing others to increase in population resulting in populations skewed toward a small number of taxa. Thus, evenness results close to 1 tend to indicate a relatively uncontaminated environment.
- **Total Abundance** refers to the total numbers of organisms in a sample.

4.4 Water Quality Results

Survival and successful spawning of salmonid species is greatly impacted by their surrounding water conditions. Impaired water quality can therefore impair the habitat quality of a river system and reduce survival success of fish populations. Guidelines have been outlined by the Canadian Council of Ministers of the Environment (CCME) of acceptable thresholds for the protection of aquatic life, and Fisheries and Oceans Canada (DFO, 2006) have discussed tolerable pH and water temperature values for certain fish species such as salmonids. Table 21 outlines the general water quality guidelines for some commonly measured water parameters, and Tables 22 and 23 denote acceptable values described by the DFO.

Table 21. Water quality guidelines listed by parameter.

Water Quality Parameter	CCME Guideline	Other Guidelines	
		Threshold	Source
Dissolved Oxygen	>6.5 mg/L	> 60 % (saturated)	Mackie, 2004
pH	6.5 to 9.0	N/A	
Water Temperature	No greater than ±1°C change	<20°C	Macmillan et al., 2005
Specific Conductivity	N/A	N/A	
Turbidity	Increase no greater than 10% of background levels	N/A	

Table 22. Range of tolerated water quality values for species of salmonids. (Adapted from DFO, 2006).

Life Stage	Species	Water Temperature (°C)			Dissolved Oxygen (mg/L)		
		Excellent	Good	Poor	Excellent	Good	Poor
Embryo Development	Atlantic salmon	3 – 7	1 – 8	< 0.5, > 9	>13	>10	<9
	Brook trout	4 – 11	2 – 15	< 1, > 17	<15°C: >6.5 >15°C: >8.5	<15°C: 4.5 >15°C: 6.5	<15°C: <4 >15°C: <6
Parr	Atlantic salmon	11 – 19	9 – 21	<6, >24	> 6	> 6	< 6
	Brook trout	10 – 16	5 – 20	<3, >22			

Table 23. Range of tolerated pH values (DFO, 2006).

Species	Excellent	Good	Poor
Atlantic salmon	> 6	> 5.5	< 5
Brook trout	6.5 – 8	5.5 – 8.5	<5, >9

Water quality samples were not taken as part of a regular monitoring regime in the Nictaux River sub-watershed, but instead were collected as discrete samples from site visits for HSI surveys, fish habitat surveys or watercourse crossing assessments. It is recommended that further water quality data be collected on a regular basis from established sites to gain a clearer idea of the changes that occur in the system over a season and from fluctuating hydrologic conditions within the sub-watershed. Sections 4.4.1 and 4.4.2 provide the results from water quality data gathered in the 2012, 2013 and 2016 field seasons.

4.4.1 General Water Quality Data

Water quality measurements were taken in the fall of 2013 and summer of 2016, as part of HSI and fish surveys (see Table 24). During the fall sampling sessions of 2013, water temperatures were below levels found to be stressful to fish (20°C), and pH levels, while below the acceptable range outlined by the CCME, mostly fell within the 5.5 – 6.5 range, which is still considered good for species of salmonids (Table 23). Dissolved oxygen levels at these sites were also considered to be excellent, ranging from 9.1 to 10.7 mg/L. Water temperatures collected during the summer of 2016 stayed above the 20°C, exceeding acceptable values for salmonid species, while dissolved oxygen and pH levels remained within CCME and DFO guidelines.

Table 24. Water quality results from HSI and fish surveys.

Easting	Northing	Sample Date	Water Temperature	Air Temperature	pH	SpC (µS/cm)	TDS (mg/L)	DO (mg/L)	DOSAT (%)	Turbidity (NTU)
340995	4959130	18-Sep-13	16.98		5.1	29	0	9.1	94	0
338949	4978187	19-Sep-13	16.25		6.03	39	0	10.06	102.3	0
339913	4974284	20-Sep-13	15.21		5.95	37	0	10.5	104.1	0.5
339548	4975581	07-Oct-13	14	14.4	5.61	34.6	22.75	10.6	102.8	
339830	4974167	07-Oct-13	13.6	13.1	5.62	35.4	22.75	10.66	102.5	
341006	4959119	07-Oct-13	13.8	12.8	5.18	36.9	17.55	9.16	88.4	
339885	4974292	16-Oct-13	12.06	12.41	6.12	32	0	11.08	103	0.8
341106	4959112	17-Oct-13	11.75	16.26	5.45	33	0	9.62	88.7	1.5
339486	4975714	18-Oct-13	12.05	10.7	5.88	31	0	11.57	107.5	2.2
339253	4976291	14-July-16	25.1	29	6.61	30	0	8.72		
339383	4976265	20-July-16	22.4	26	6.5	31	0	8.89	101.7	
339253	4976291	1-Sep-16	22.4	26	7.01	27	0	8.39		
339383	4976265	1-Sep-16	20.39	26	6.86	33	0	8.07		

4.4.2 *Culvert Water Quality Data*

Water quality measurements were also collected as part of watercourse crossing assessments, for those crossings which were considered to be present in areas of fish habitat. The majority of these were located on tributaries of the main stem of the Nictaux River however, and therefore more adequately reflect the water quality present in smaller spawning streams than the larger main river body. Not all assessed culverts were tested for water quality however, and it would be ideal for those where water quality measurements were not taken to be revisited if possible. Table 25 presents the water quality results from assessments completed in the 2012, 2013, and 2016 field seasons. Sampling occurred during the summer of 2012 and 2013, and the summer and fall of 2016. The water temperatures observed in the summer months ranged from approximately 15 to 23ºC. It is difficult to ascertain without more information whether the variation in temperatures observed is more attributable to varying patterns in weather, or differences in habitat quality. Consequently, some of the temperatures observed were in a range considered to be stressful to fish populations (i.e. 20 to 23ºC).

The measured pH values also ranged widely from about 4.2 to 7.1. Approximately 46% of the culverts where water quality measurements were taken displayed pH values that were less than 5.5, below which the acidity of the water is deemed to become more stressful to fish populations. Additionally, about 53% of monitored crossings exhibited DO levels which fell below the CCME guideline of 6.5 mg/L, the recommended guideline for coldwater fish species, and 46% fell below the 5.5 mg/L guideline that the CCME described for warm water species. The sites exhibit poor water quality for embryo development of salmonids (Table 22), but about 46% had adequate DO levels for parr.

Table 25. Water quality results from culvert assessments.

Site Code	Easting	Northing	Sample Date	Water Temperature	Air Temperature	pH	SpC (mS/cm)	TDS (mg/L)	DO (mg/L)	DOSAT (%)
NIC007	338642	4968942	4-Jul-13	15.52	20.18	5.91	123	100	1.26	13.5
NIC011	339506	4971966	8-Aug-12	21.8		7.1		45.5	6.7	76
NIC035	339276	4953795	5-Jul-13	17.86	25.66	5.6	45	0	4.94	50.3
NIC036	338737	4953767	8-Jul-13	14.05	21.06	4.23	33	0	2.15	20.3
NIC038	336030	4954187	8-Jul-13	21.18	20.17	4.27	31	0	7	78.5
NIC041	338676	4957241	5-Jul-13	18.1	26.98	6.08		100	1.29	13.3
NIC042	337105	4960564	8-Jul-13	17.74	18.9	6.64	28.8	200	3.11	32.4
NIC043	336183	4961534	8-Jul-13	16.18	18.9	4.9	31	0	2.07	20.9
NIC048	336977	4964627	9-Jul-13	17.07	16.86	6.07	34	0	7.62	78.9
NIC049	338377	4955470	9-Jul-13	23.11	20.1	6.6	45	0	6.74	79.2
WLC001	344213	4955009	12-Jul-13	15.4	18.42	4.89	30	0	5.84	58
WLC002	344850	4953499	12-Jul-13	18.51	22.4	5	30	0	6.22	66.3
NIC030	340273	4951524	10-Aug-16	17.57	23	4.84	33	0	1.95	
NIC067	340255	4972523	17-Oct-16	8.45	11	6.9	110	100	9.83	
NIC069	338414	4966381	17-Oct-16	9.25	11	5	110	100	9.73	

4.5 Habitat Connectivity Assessments

Fish passage in aquatic ecosystems is an essential consideration for the survival of many species. Fish species such as brook trout and Atlantic salmon migrate through stream systems in search of favourable habitats for spawning, feeding, overwintering, and thermal refuge (Savoie and Haché, 2002). The construction of watercourse-crossing structures such as culverts has the potential to significantly affect the ecological integrity of aquatic ecosystems. Watercourse crossings that are poorly designed, installed incorrectly, or that do not receive regular maintenance can become barriers to fish passage. Barrier crossings can result in habitat fragmentation which can destroy existing habitat, restrict fish access to upstream habitats, isolate fish populations, and increase fish vulnerability to predation and disturbance (Gibson et al., 2005). Therefore, assessing habitat connectivity within the Nictaux sub-watershed was an important component in the creation of a sub-watershed management plan.

In 2012 and 2013, CARP staff assessed watercourse crossings within the Nictaux sub-watershed to determine whether they would pose a barrier to fish passage. The target species used in the assessments was a brook trout of 5cm in size or greater. Assessments were continued in 2016, along with visits to previous restoration sites within the sub-watershed to determine Table 26 provides a summary of the results. For more detailed information about the assessments, please refer to Freeman (2013) and Wagner (2013). Barrier crossings were listed as high, medium or low priority depending upon the amount of upstream habitat to be gained from remediation, in addition to the number of downstream barriers present on the same system. Refer to Appendix C for details on prioritization scoring and Section 6.0 for more detailed descriptions of habitat features and watercourse crossings.

Table 26. Watercourse crossing assessment results for the Nictaux River sub-watershed.

Culvert ID	Stream Name	UTM Easting	UTM Northing	Barrier Type	Outflow Drop (cm)	Slope (%)	Priority	Recommendations
BEL003	Beals Brook	335477	4961466	Bridge				
BEL005	Beals Brook	337060	4958051	Partial Barrier	6.99	-0.083	Low	Tailwater control
BEL006	Beals Brook	338361	4957007	Bridge				
BEL007	Beals Brook	338391	4956672	Not Fish Habitat				
BEZ001	Bezant Lake Brook	343630	4953001	Bridge				
BEZ002	Bezant Lake Brook tributary	342949	4951627	Partial Barrier	0.59		Low	Tailwater control
BEZ004	Bezant Lake Brook tributary	345302	4952378	Partial Barrier	8.9	0.16	Low	Tailwater control
BEZ005	Bezant Lake Brook	345507	4952516	Full Barrier	2.6	3.09	Low	Baffle installation
KEL003	Kelly Brook tributary	337869	4953793	Not Fish Habitat				
KEL004	Kelly Brook	336931	4954137	Bridge				
KEL013	Kelly Brook tributary	337894	4953792	Not Fish Habitat				
NIC001	Nictaux River	339132	4977211	Bridge				
NIC002	Nictaux River tributary	339410	4977432	Full Barrier	12.5	5.21	Medium	Baffle installation and tailwater control
NIC003	Nictaux River tributary	339426	4977464	Full Barrier	6.9	4.21	Medium	Baffle installation and tailwater control
NIC004	Nictaux River	339624	4977744	Full Barrier	30.2	6.20	Medium	Baffle installation and

Culvert ID	Stream Name	UTM Easting	UTM Northing	Barrier Type	Outflow Drop (cm)	Slope (%)	Priority	Recommendations
	tributary							tailwater control
NIC006	Nictaux River	339709	4974841	Bridge				
NIC008	Nictaux River tributary	337309	4967042	Partial Barrier	8.2	1.15	Low	Tailwater control
NIC009	Nictaux River tributary	340572	4973958	Not Fish Habitat				
NIC010	Nictaux River tributary	341031	4973625	Partial Barrier	2.2	0.91	Low	Tailwater control
NIC011	Nictaux River tributary	339506	4971966	Full Barrier	66.1	1.93	Low	Removal of structure/ fish ladder
NIC012	Nictaux River tributary	338968	4972040	Partial Barrier	-9	1.01	Low	Debris removal
NIC013	Nictaux River tributary	341316	4972907	Not Fish Habitat				
NIC014	Nictaux River tributary	341534	4972368	Full Barrier	10.6	-0.63	Low	Tailwater control
NIC015	Nictaux River tributary	340019	4974748	Not Fish Habitat				
NIC016	Shannon River	341437	4954106	Bridge				
NIC017	Shannon River tributary	341824	4954199	Full Barrier	18.1	-0.09	Low	Tailwater control
NIC018	Shannon River tributary	341850	4954251	Full Barrier	1.9	12.08	Low	Removal of structure/ fish ladder
NIC021	Shannon River tributary	340320	4953827	Not Fish Habitat				
NIC024	Nineteen Mile Lake drainage	339416	4945770	Full Barrier	19	-1.84	Low	Tailwater control
NIC026	Little Cranberry Lake drainage	338443	4945783	Bridge				
NIC027	Nictaux River	339593	4972441	Bridge				
NIC028	Nictaux River tributary	339403	4977420	Full Barrier	43	1.77	Medium	Removal of structure/ fish ladder
NIC029	McGill Lake	339974	4948318	Bridge				
NIC030	McGill Lake tributary	340273	4951524	Full Barrier	10.7	-0.757	Medium	Debris removal
NIC035	Quilty Lake tributary	339275	4953795	Partial Barrier	-23.2	1.67	Low	Tailwater control
NIC036	Quilty Lake tributary	338737	4953767	Partial Barrier	-0.5	1.11	Low	Tailwater control
NIC037	Connell Lake tributary	338524	4953790	Not Fish Habitat				
NIC038	Walker Brook	336030	4954187	Passable	-36.1	0.32		
NIC039	Beals Brook	338962	4955844	Not Fish				

Culvert ID	Stream Name	UTM Easting	UTM Northing	Barrier Type	Outflow Drop (cm)	Slope (%)	Priority	Recommendations
	tributary			Habitat				
NIC040	Beals Brook tributary	338856	4956056	Not Fish Habitat				
NIC041	Beals Brook	338676	4957241	Partial Barrier	0.9	-1.17	Low	Tailwater control
NIC042	Trout Lake tributary	337105	4960564	Not Fish Habitat				
NIC043	Trout Lake tributary	336183	4961534	Full Barrier	-61.6	3.38	Low	Baffle installation
NIC044	Trout Lake tributary	336944	4960675	Not Fish Habitat				
NIC045	Oakes Brook tributary	337545	4959441	Not Fish Habitat				
NIC046	Oakes Brook	337458	4963720	Bridge				
NIC047	Oakes Brook tributary	337017	4964363	Not Fish Habitat				
NIC048	Oakes Brook tributary	336977	4964627	Partial Barrier	7.7	1.71	Low	Tailwater control
NIC049	Zwicker's Lake tributary	338377	4955470	Full Barrier	24.7	-3.63	Low	Baffle installation and tailwater control
NIC052	Walker Brook	335133	4952025	Bridge				
NIC053	Walker Brook	335147	4952032	Not Fish Habitat				
NIC054	Walker Brook tributary	335333	4951254	Not Fish Habitat				
NIC057	Snell Meadow Brook tributary	334339	4950612	Not Fish Habitat				
NIC058	Big Mud Lake tribuary	334826	4948747	Not Fish Habitat				
NIC060	Oake's Brook tributary	338296	4961427	Partial Barrier	1.6	-1.33	Low	Tailwater control
NIC061	Oake's Brook	338723	4960865	Bridge				
NIC062	Oake's Brook tributary	337690	4963117	Bridge				
NIC063	Oake's Brook	338793	4959956	Bridge				
NIC064	Oake's Brook	339325	4959385	Bridge				
NIC065	Nictaux River	341140	4959177	Bridge				
NIC066	Nictaux River	341070	4958288	Bridge				
NIC067	Nictaux River tributary	340255	4972523	Full Barrier	58.8	7.031	Low	Removal of structure/fish ladder
NIC068	Wambolt Lake Drainage	338807	4967897	Not Fish Habitat				
NIC069	Nictaux River tributary	338414	4966381	Full Barrier	18.9	-4.450	Low	Tailwater control
OAK005	Oakes Brook	337209	4963508	Passable	-31.9	-0.24		

Culvert ID	Stream Name	UTM Easting	UTM Northing	Barrier Type	Outflow Drop (cm)	Slope (%)	Priority	Recommendations
	tributary							
OAK006	Oakes Brook tributary	337128	4961560	Partial Barrier	-52.8	1.46	Low	Tailwater control
OAK007	Oakes Brook tributary	337261	4960139	Passable	-0.114	-0.39		
OAK009	Oakes Brook tributary	337365	4959200	Full Barrier	30.7	0.52	Low	Tailwater control
OUT002	Trout Lake tributary	336888	4960282	Not Fish Habitat				
SLB002	Slobbery Meadow Brook	335827	4961650	Bridge				
WLC001	Waterloo Lake tributary	344213	4955009	Partial Barrier	-2.49	2.49	Low	Debris removal
WLC002	Waterloo Lake tributary	344850	4953499	Partial Barrier	2.99	1.139	Low	Debris removal

5.0 Public Outreach and Information Gathering

The intent behind continuous public outreach and information gathering for this project is twofold. First, to gather empirical knowledge of current and historical fishing conditions of local waterways from resident anglers, and second, to inform the community and raise awareness about CARP's fish habitat restoration and sub-watershed planning work. As part of the initiative to reach out to the local community, as well as communities outside the Annapolis River watershed, several outreach tools were used, primarily in the form of presentations and workshops. Some of the methods that were used to deliver and gather information for the project and build linkages are presented in sections 5.1 and 5.2.

5.1 Community Outreach

5.1.1 Presentations

Since the program's inception in 2010, presentations regarding CARP's sub-watershed planning and restoration work through the Fish Passage Restoration and Habitat Enhancement project (formerly *Broken Brooks*) have been delivered to a wide variety of audiences. These include:

- Local schools, universities, colleges, community groups;
- Exhibitions at community events; and
- Recreational Fishing Advisory Committee meetings for areas 4 (Queens, Shelburne, Yarmouth & Digby counties) & 5 (Annapolis, Kings & Hants counties)

Community outreach through presentations will continue as restoration plans are put into action, and as the sub-watershed planning document undergoes further revision.

5.1.2 Fly Tying Workshops

Two fly tying workshops were held in the Annapolis watershed, with intent to reach out to the fishing community, provide a forum for sharing local fishing knowledge of the Nictaux River sub-watershed, and inform the community about CARP's fish habitat monitoring and restoration work in the watershed. The first workshop was held in the CARP office in Annapolis Royal, on November 26th, 2013 and the second was held February 11th, 2013 at the Middleton Lion's Hall, in the community of Nictaux. Both events were advertised through flyers distributed to public event boards and local businesses in the communities of Middleton, Nictaux, Annapolis Royal, Lequille, Bridgetown and Cornwallis. Additionally, workshops were advertised through social media, press releases, and ads in local flyers such as the Bridgetown Reader.

Figure 18. Fly-tying workshop at the Middleton Lion's Hall in Nictaux.

Attendees at the workshops were diverse and numbered from 8 to 12 community members per workshop. The workshop held in Annapolis Royal drew in a crowd of younger, inexperienced community members, while that held in Nictaux attracted a selection of older, experienced fishermen and fly tiers (Figure 18). Overall, both workshops were well received, and were an effective means to develop a relationship with folks who had no previous ties to CARP.

5.2 Information Gathering

To build upon knowledge gathered in the 2012 season by Wagner (2013), additional meetings were held with knowledgeable anglers in an attempt to learn more about historical fishing conditions in the Nictaux River sub-watershed. Surveys about the Nictaux River were also distributed to gather responses from the larger angling community. Sections 5.2.1 and 5.2.2 provide more information about these efforts.

5.2.1 Survey Results

A Nictaux River survey (Appendix D) was created as an addition to the Atlantic salmon survey created by Wagner (2013) in the 2012 field season. The Nictaux River survey was created to target the Nictaux sub-watershed, to gather information about current and historical salmonid habitat in the river and its headwaters. The surveys were distributed at meetings, presentations and fly tying workshops, as well as to local hunting and angling shops in Lequille, Middleton, and Aylesford. An electronic version of the survey was also created on SurveyMonkey, and the link for the survey advertised in the newspaper, on CARP's Facebook page, and in the Nova Scotia Federation of Anglers and Hunters newsletter. Results from the survey are discussed below.

There were a total of 8 respondents that filled out either the online survey forms or the paper surveys. Individuals that returned the surveys were from a variety of communities, such as Digby, Nictaux, Middleton, Margaretsville, Lawrencetown, Torbrook, Lunenburg, and Black Rock. Figure 19 shows the percentage of respondents that caught various fish species in the Nictaux sub-watershed, and Figure 20 displays the locations where respondents have fished. Shad (88 %) and Brook trout (75%) were the most commonly fished species in the Nictaux River system, with the majority of fisherman fishing either below Nictaux Falls or on the Shannon River.

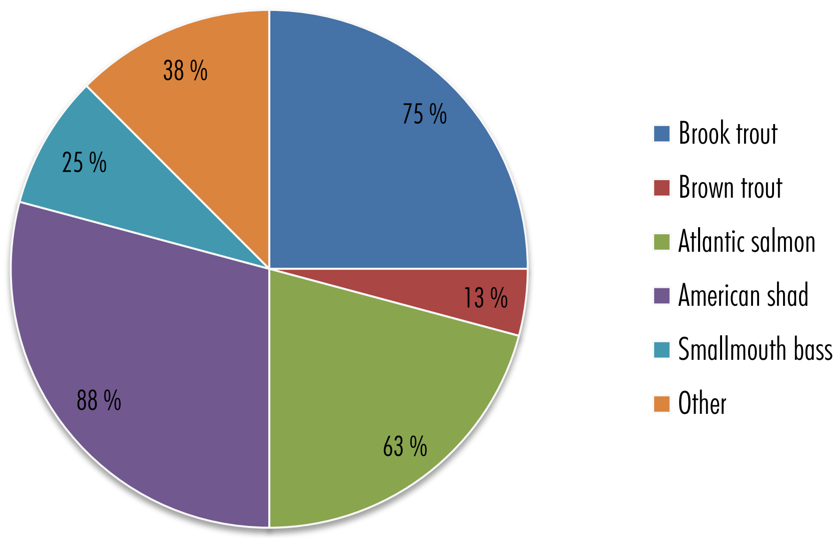

Figure 19. Species that have been observed or caught by respondents on the Nictaux River system.

Figure 20. Locations where respondents like to fish in the Nictaux River sub-watershed.

Of the survey respondents, 50% had reported having caught an Atlantic salmon as bycatch while out fishing (Figure 21). Of these individuals, 75% had caught an adult, 50% had caught a smolt, and 25% had caught a salmon parr (Figure 22).

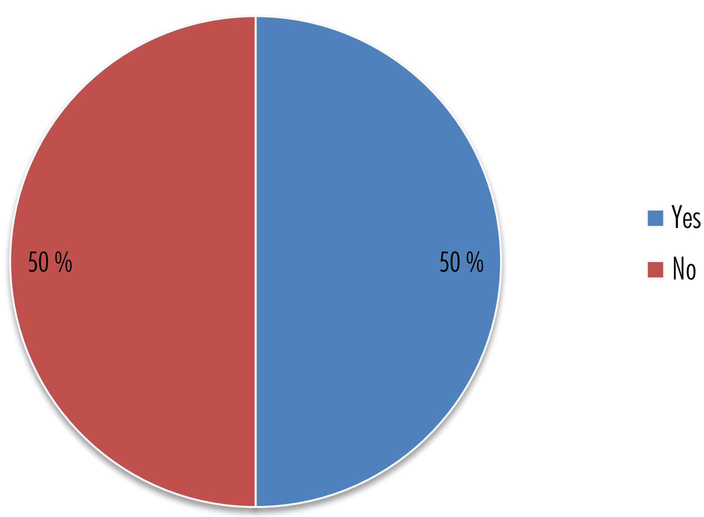

Figure 21. Percentage of survey respondents who have caught Atlantic salmon as bycatch while fishing the Nictaux River system.

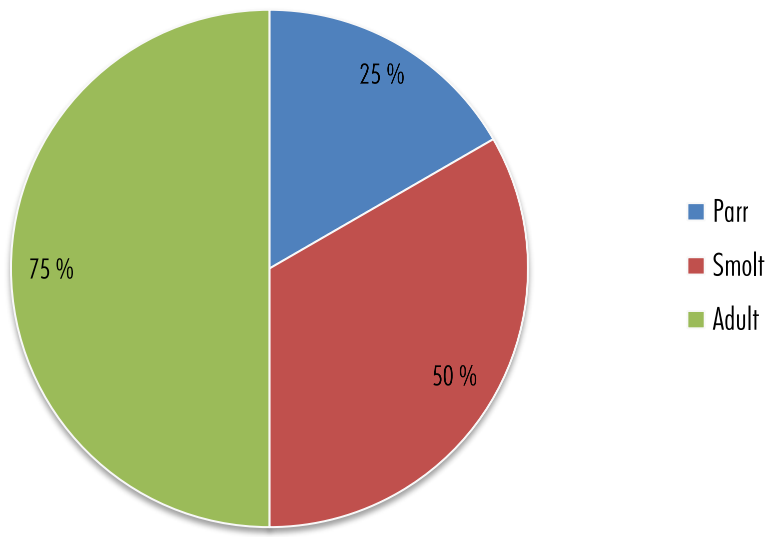

Figure 22. The percentage of survey respondents that caught an Atlantic salmon as bycatch, and the life stage they caught.

Figure 23 shows the years that respondents had caught Atlantic salmon in the Nictaux River sub-watershed. It may be possible that the age of respondents also influenced the results received for this question as well. The decades in which survey respondents were successful in observing/catching Atlantic salmon were in the 1960s, 1980s, 1990s, 2000s, and 2010s or later. Comments from respondents indicated that the majority of catches occurring after 2010 were of smolts, either below the power house at Nictaux Falls or below the old Martyn's Mill dam.

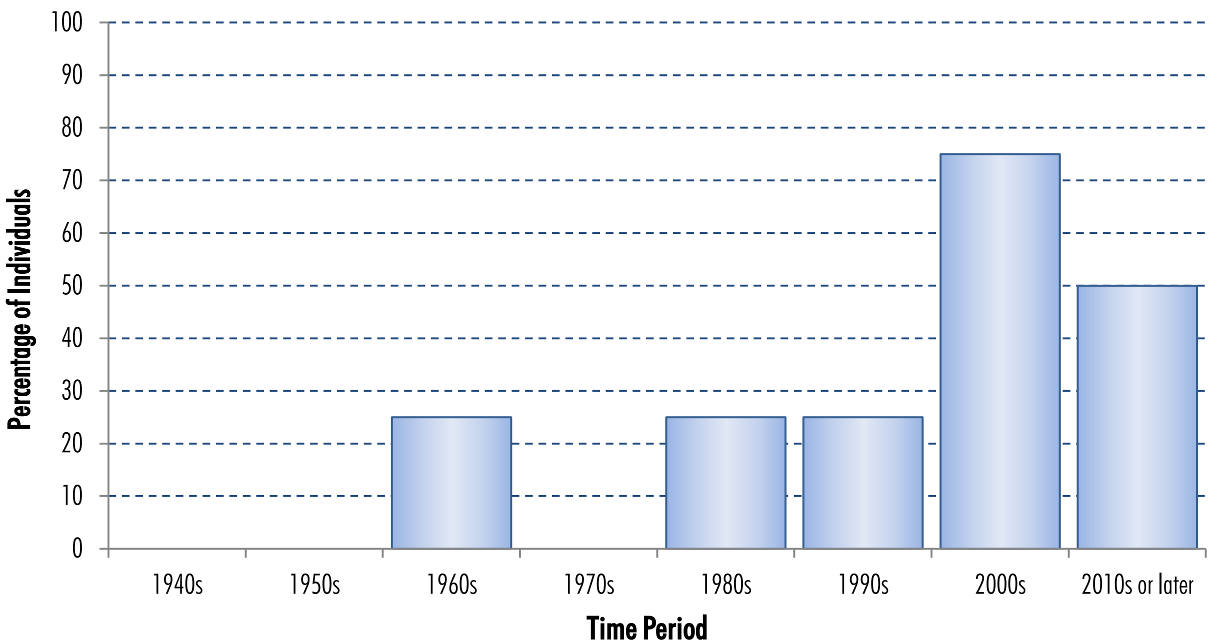

Figure 23. The decade(s) in which survey respondents caught Atlantic salmon in the Nictaux River system.

When individuals were asked about what they believed the main issues were that were contributing to the observed decline in salmon in the Nictaux River system, several responses were received:

- Water levels are too low in the Nictaux due to the power dam holding water
- Changes to spawning grounds, other fish predation, and water quality
- Alterations to runoff and erosion rates from forestry activities on the mountain
- Aquaculture fish causing issues for wild salmon populations
- Habitat destruction, introduction of smallmouth bass
- Fish passage restrictions
- Too much waste water in the Annapolis River/ water quality
- The tidal power plant in Annapolis Royal

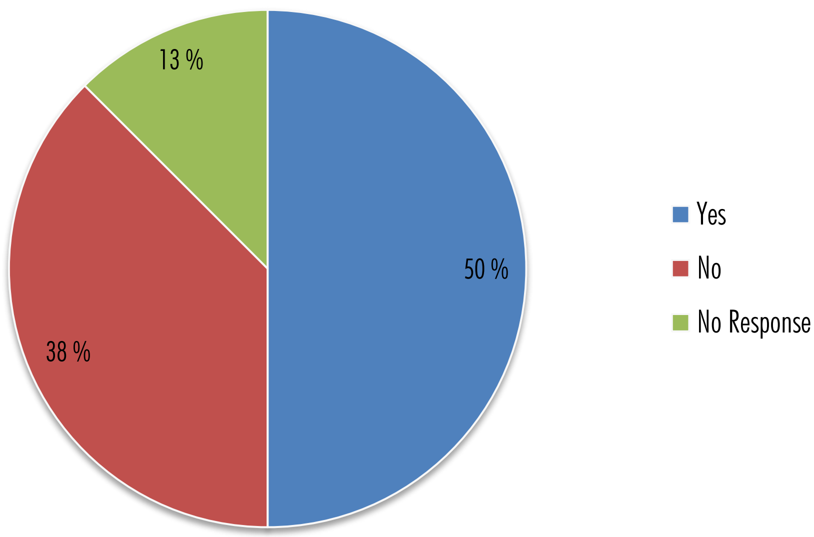

Figure 24.Percentage of individuals who have noticed a change in the Nictaux system.

Some of the changes described by those respondents who had answered that they'd observed a change in the condition of the rivers/streams in the Nictaux sub-watershed were:

- Martyn's Mill Dam washed out
- The lack of all kinds of water life
- Increase in the amount of algae in the summer – water almost cloudy with algae sometimes near the dam
- Marked changed in water quality since the 1970s (probably a lot to do with acid rain), especially in the early 1980s. More algae growth and a lot less minnows (may be a result of bass introduction in Waterloo Lake in early 2000s)

Respondents were also asked whether they had additional comments or concerns to provide, and these included:

- Often difficult/impossible to restore watersheds without serious commitments. How do we bring back water levels and eliminate predatory alien fish species?
- I'd look for fecal contaminants in the water or fertilizer from farmers' fields
- Maybe if we could stock the river upstream and close it for a few years and have some tagged fish to track we could get a better picture to see if fish can come back and live. It is a great river, fast water, lots of great nesting spots and should be saved
- Very important to do everything possible for salmon conservation. Smolts are coming back, which means there are larger fish coming up
- In the past 4-5 years most of my angling has been at Waterloo Lake (where I have a camp) or below the powerhouse. Trout

catches below the powerhouse have been small in number and size. Trout fishing at the lake has been poor for 15 years or so. All of the fish species (with the exception of smallmouth bass) that I catch seem to be smaller in size than when I started fishing. Even the shad I catch average 19"-20" and I recall in the late 70s and early 80s they were probably more like 28" average. Not sure what can be done about any of this, I think that it is the environment we have created

- I have caught a lot of salmon parr in the South Annapolis River in Millville. I think they're salmon parr, that's what the locals say. I don't seem to catch them anywhere else but there. I would say it's a 5 to 1 ratio parr to brook trout. I would like to see the salmon population return to the Nictaux. I do some salmon fishing in Cape Breton and enjoy it. It would be nice to go salmon fishing after work or on the weekend locally. Not take time off and go for a five hour drive, book rooms, etc. It costs a lot

5.2.2 Meetings

In addition to the interview of Earl Saunders in 2012 (see Wagner, 2013), a few other interviews were held with experienced local anglers in 2013. A discussion was held with Reg Baird on November 26th, 2013 at the fly tying workshop at the CARP office. Additionally, Perry Munro was interviewed on December 4th, and Hal Elliott on December 10th. Discussions are described in sections 5.2.2.1 through 5.2.2.3.

5.2.2.1 Reg Baird

Reg Baird is a long-time hunter and angler who has lived in and around Clementsport, NS. He is an experienced angler, who has fished rivers in Nova Scotia for over 65 years, and also assisted with salmonid research in Kejimkujik National Park for several decades. He attended the CARP fly tying workshop on November 26th, and staff sat down with him to discuss his angling experiences and inquire about his experience with the Nictaux River system in particular. Reg stated that his fishing experience on the Nictaux River was rather limited, although he did conduct some salmon research a few years ago. He stated that only one or two get above the dam now. Reg recommended that other fishermen to meet with who might have better knowledge of the Nictaux River system would be Roy Bertaux, Ed Coleman, Hal Elliott, and Perry Munro.

5.2.2.2 Perry Munro

Perry Munro is also a long-time hunter and angler, having grown up near Lawrencetown, NS. He is an experienced fly fisherman and has been a Nova Scotia Master Guide for over 30 years. He was contacted for a meeting, and an interview date was set up for December 4th, 2013. Perry has experience with many of the rivers in Nova Scotia, and the Nictaux River is no exception. He was familiar with the system, and provided valuable insight as to the problem of water level regulation and alternating flow for spawning populations of fish. He recommended that the turbine at the NS Power generating station on the main stem of the Nictaux River be replaced with a smaller one, as the one that currently is in place is too large to adequately control flows in the river. He also recommended that collaboration should occur with NS Power to better regulate spring and summertime flows in the river. For the full discussion from the interview, please refer to Appendix E.

5.2.2.3 Hal Elliott

Hal Elliott is an experienced angler from Melvern Square, NS. He was a long-time member of the Annapolis Fly Fishers Association before it dissolved. Hal was contacted for a meeting, and an interview date was set up for December 10th, 2013 with CARP staff. Hal is familiar with many of the anglers who once fished the Nictaux system, and fished it himself as well, although with little luck. He was well acquainted with the area, from his angling days, and from the past work he helped with for remediation work on the main stem of the Nictaux, in collaboration with the DFO. He was amenable to seeing further restoration work conducted in that same stretch to improve the functionality and effectiveness of existing rock sills. He also made mention of the noted low flow conditions in summer which appear to impair spawning habitat below the power dam and shared some of his stories of his past fishing on the river. For the full discussion from the interview, please refer to Appendix F.

6.0 Habitat Descriptions and Restoration Opportunities

This section outlines the stream features that have been identified in the Nictaux River, as well as potential areas where restoration work has occurred or still needs to be addressed. Please refer to Figures 1 through 11 for detailed maps of stream sections and site numbers outlined in the table below.

Section Number	Stream Feature	Lower Limit (coordinates and landmarks)	Upper Limit	Site Details	Adjacent Land Use Considerations	Prescription for Restoration	Project Priority Ranking	Project Status
Section 1	**Section 1 begins at the mouth of the Nictaux River (337233mE, 4978218mN) and continues upstream to the hydroelectric generating station at Nictaux Falls (339753mE, 4974840mN). This section is approximately 7.1 km in length, and about 11.29 km of tributaries drain into the main stem.**							
1A	Road watercourse crossing	339624mE 4977744mN	N/A	Full barrier culvert (NIC004)	Forest, Residential, Pasture	Removal of structure or construction of fish ladder	Medium	Incomplete
1B	Road watercourse crossing	339426mE 4977464mN	N/A	Full barrier culvert (NIC003)	Forest, Residential, Pasture. Downstream runs through private property	Debris removal; baffle installation and tailwater control	Medium	Incomplete
1C	Road watercourse crossing	339410mE 4977432mN	N/A	Full barrier culvert (NIC002)	Forest, Residential, Pasture	Debris removal; tailwater control; removal of structure or construction of fish ladder	Medium	Partially complete: Debris removal (2012), Tailwater Control (2015)
1D	Road watercourse crossing	339403mE 4977420mN	N/A	Full barrier culvert (NIC028)	Forest, Residential, Pasture	Debris removal; removal of structure or construction of fish ladder	Medium	Partially complete: Debris removal (2012)
1E	Bridge	339132mE 4977211mN	N/A	Bridge on main channel of the Nictaux River (NIC001)	Residential, Agricultural	N/A	N/A	N/A
1F	Old Martyn's Mill Dam	339184mE 4977197mN	N/A	Old footings of washed out dam on main channel of Nictaux River	Agricultural, Residential	None needed	N/A	N/A
1G	In-stream restoration project	339253mE 4976291mN	339307mE 4976267mN	Restoration project consisting of fine sediment removal	Forest, privately owned camp on the right downstream side.	Fine sediment should be removed in areas utilized by salmonids (pools, riffle crests)	High	Complete (2016)

Section Number	Stream Feature	Lower Limit (coordinates and landmarks)	Upper Limit	Site Details	Adjacent Land Use Considerations	Prescription for Restoration	Project Priority Ranking	Project Status
1H	Gravel pit on left bank	339362mE 4976110mN	Approx. 339529mE 4975599mN	Gravel pit is close to river	Gravel pit borders wetland beside the left bank of the main stem of the Nictaux River	Some riparian planting may be possible after further site inspection	N/A	Incomplete
1I	In-stream restoration project	339535mE 4975629mN	339722mE 4975331mN	Restoration project consisting installation of digger logs and rock sills in 2000s	Lower end of site has low-lying marshy riparian areas, and gravel pit on the left downstream side.	Habitat complexity could be added to areas where previous work was completed.	N/A	Partially Complete: Weir reconstruction (2014), weir reconstruction and digger log/deflector installations (2015). Installed structures need reassessment
1J	Gravel pit on right bank	339787mE 4975077mN	N/A	Gravel pit in right floodplain	Industrial, Forest, Residential	Some riparian planting may be possible after further site inspection	N/A	Incomplete
1K	Hydroelectric generating station	339753mE 4974840mN	N/A	NS Power generating station at Nictaux Falls	The site is accessible by road. Located near a residential area along the main stem of the Nictaux River	Construction of a fishway, and collaboration with NS Power to regulate water levels	N/A	Incomplete
Section 2	**This section starts at the hydroelectric power generating station at Nictaux Falls (339753mE, 4974840mN) to the main NS Power reservoir further upriver (339439mE, 4968608mN). This section is approximately 7.98km and 27.4 km of tributaries drain into the main stem at this reach.**							
2A	Bridge	339709mE 4974841mN	N/A	Bridge over Nictaux Falls/ hydroelectric station (NIC006)	The Nictaux Power generating station and Nictaux Falls are on either side of this bridge, upstream and downstream	Construction of a fishway past the Nictaux Power generating station.	N/A	Incomplete
2B	Dam	339717mE 4974721mN	N/A	Dam just upstream of hydroelectric generating station	This dam is no longer used to generate hydroelectricity, instead it is the pipeline that runs from the canal to the generating station	Fish ladder/fishway, dam removal, and/or bottom draw installation.	N/A	Incomplete

Section Number	Stream Feature	Lower Limit (coordinates and landmarks)	Upper Limit	Site Details	Adjacent Land Use Considerations	Prescription for Restoration	Project Priority Ranking	Project Status
					that does. The dam poses a barrier to fish migration.			
2C	Stillwater	339735mE 4974805mN	339862mE 4974378mN	Slight headpond and stillwater created from the dam at Nictaux Falls	Residential, Forest	N/A	N/A	N/A
2D	Canal	339752mE 4974864mN	339288mE 4968602mN	Man-made canal that powers generating station at Nictaux Falls	The canal passes in between Highway 10 and the main channel of the Nictaux River, through residential and forested areas	Discover whether a barrier net exists to prevent fish from entering the underground pipeline portion of the canal and the power generating station	N/A	Incomplete
2E	Braided channel	339856mE 4974093mN	339959mE 4973912mN	Large island (Smiths) breaks the main stem of the Nictaux River into two channels for about 250m	Forest	N/A	N/A	N/A
2F	Dam	340097mE 4973843mN	N/A	Old derelict concrete dam that intersects the main channel of the Nictaux River.	Forest	Evaluation should be completed to determine how much of a barrier the dam poses at low water levels	N/A	Incomplete
2G	Road watercourse crossing	341031mE 4973625mN	N/A	Partial barrier culvert (NIC010)	Agricultural, Residential, Forest	Debris removal; tailwater control	Low	Incomplete
2H	Bridge	339593mE 4972441mN	N/A	Bridge over man-made Nictaux canal (NIC027)	Residential, Forest	N/A	N/A	N/A
2I	Road watercourse crossing	339506mE 4971966mN	N/A	Full barrier culvert (NIC011)	Residential, Forest	Removal of structure or construction of fish ladder	Low	Incomplete
2J	Trail watercourse crossing	340255mE 4972523mN	N/A	Full barrier culvert (NIC067)	Forest	Removal of structure or construction of fish ladder	Low	Incomplete
2K	Road watercourse	338968mE	N/A	Partial barrier culvert	Forest, Agricultural, Residential	Debris removal	Low	Complete (2012)

Section Number	Stream Feature	Lower Limit (coordinates and landmarks)	Upper Limit	Site Details	Adjacent Land Use Considerations	Prescription for Restoration	Project Priority Ranking	Project Status
	crossing	4972040mN		(NIC012)				
2L	Road watercourse crossing	341534mE 4972368mN	N/A	Full barrier culvert (NIC014)	Agricultural, Residential	Tailwater control	Low	Incomplete
2M	Wamboldt Falls	339977mE 4968726mN	N/A	Man-made falls from channel diversion	Forest, Industrial	Re-divert portion of the river back to its natural channel or create a fishway to allow passage beyond the falls	N/A	Incomplete
2N	Bridge	339310mE 4968698mN	N/A	Bridge over man-made Nictaux canal	Forest, Industrial	N/A	N/A	N/A
Section 3	This section starts at the beginning of the headpond from the main NS Power reservoir (339439mE, 4968608mN) and ends further upstream where the Shannon River and the Waterloo River join and the Nictaux River begins (340831mE, 4958693mN). This section is approximately 11.84km in length and has 7.85km of tributaries which drain into the main stem of the Nictaux River.							
3A	Nictaux Headpond Dam	339439mE 4968608mN	N/A	Man-made dam and diverted channel to Wamboldt Falls	Industrial, Forest	Fishway installation and improved summertime water level control, and investigate using bottom draw in reservoir	N/A	Incomplete
3B	Headpond	339438mE 4968576mN	338531mE 4966610mN	Headpond from dam	Forest	N/A	N/A	N/A
3C	Road watercourse crossing	337309mE 4967042mN	N/A	Partial barrier culvert (NIC008)	Forest	Tailwater control	Low	Incomplete
3D	Trail watercourse crossing	338414mE 4966381mN	N/A	Full barrier culvert (NIC069)	Forest	Tailwater control	Low	Incomplete
3E	Bridge	341140mE 4959177mN	N/A	Bridge over Nictaux River (NIC065)	Forest	N/A	N/A	N/A
Section 4	Runs from the mouth of the Shannon River (340831mE, 4958693mN) to the McGill Lake dam (341255mE, 4951522mN). This section is approximately 8.34km in length, and has approximately 6.30 km of tributaries feeding into the main channel of the Shannon River.							
4A	Bridge	341083mE	N/A	Bridge over Shannon River	Forest	N/A	N/A	N/A

Section Number	Stream Feature	Lower Limit (coordinates and landmarks)	Upper Limit	Site Details	Adjacent Land Use Considerations	Prescription for Restoration	Project Priority Ranking	Project Status
		4958284mN		(NIC066)				
4B	Bridge	341437mE 4954106mN	N/A	Bridge over Shannon River (NIC016)	Forest	N/A	N/A	N/A
4C	Road watercourse crossing	341824mE 4954199mN	N/A	Full barrier culvert (NIC017)	Forest, Forestry, Gravel pit	Debris removal	Low	Partially complete: Debris removal (2012), beaver dam reconstructed in culvert outflow
4D	Road watercourse crossing	341850mE 4954251mN	N/A	Full barrier culvert (NIC018)	Forest, Forestry, Gravel pit	Removal of structure or construction of fish ladder	Low	Incomplete
4E	McGill Lake dam	341255mE 4951522mN	N/A	NS Power reservoir at McGill Lake	Forest, Cottage developments	Fishway construction	N/A	Incomplete
Section 5	**This section runs from the dam at the outflow of McGill Lake (341255mE, 4951522mN) to the Curl Hole dam at Big Molly Upsim Lake (339044mE, 4947671mN). The length of this section is approximately 3.07km and has 6.68km of tributaries that drain into McGill Lake.**							
5A	Road watercourse crossing	340273mE 4951524mN	N/A	Full barrier culvert (NIC030)	Forest	Debris removal	Low	Complete (2012)
5B	Bridge	339974mE 4948318mN	N/A	Bridge over Big Molly Upsim Lake (NIC029)	Forest	N/A	N/A	N/A
5C	Road watercourse crossing	339416mE 4945770mN	N/A	Full barrier culvert (NIC024)	Forest	Tailwater control; debris removal	Low	Incomplete
Section 6	**This covers a large area that mostly consists of Big Molly Upsim Lake, starting at the Curl Hole dam (339044mE, 4947671mN) and extending to the convergence of three feeder brooks (336581mE, 4953256mN): Kelly Brook, Walker Brook, and Snell Meadow Brook. This section also extends south into the Lake Fredericks area (336448mE, 4940911mN). The total approximate length of this section is approximately 17.1km, with 10.43km of lakes and tributaries that drain into it.**							
6A	Curl Hole Dam	339044mE 4947671mN	N/A	NS Power Big Molly Upsim Reservoir	Forest, Cottage developments	Fishway installation/ dam removal.	N/A	Incomplete
6B	Bridge	338443mE 4945783mN	N/A	Logging road bridge (NIC026)	Forest	N/A	N/A	N/A

Section Number	Stream Feature	Lower Limit (coordinates and landmarks)	Upper Limit	Site Details	Adjacent Land Use Considerations	Prescription for Restoration	Project Priority Ranking	Project Status
Section 7	This section runs from the mouth of the Waterloo River (341114mE, 4959109mN) to the end of Bezant Lake Brook (342934mE, 4951563mN) and covers a distance of about 9.28km. There are approximately 16.76km of tributaries that flow into Bezant Lake Brook, Waterloo Lake, and the Waterloo River.							
7A	Bridge	342152mE 4957966mN	N/A	Bridge over Waterloo River	Forest	N/A	N/A	N/A
7B	Dam	342836mE 4958604mN	N/A	NS Power reservoir at Scragg Lake	Forestry, Forest, Industrial	Fishway installation/ dam removal.	N/A	Incomplete
7C	Bridge	342633mE 4956940mN	N/A	Bridge over Waterloo River	Forest	N/A	N/A	N/A
7D	Road watercourse crossing	344213mE 955009mN	N/A	Partial barrier culvert (WLC001)	Forest	Debris removal	Low	Complete (2013)
7E	Road watercourse crossing	344850mE 4953499mN	N/A	Partial barrier culvert (WLC002)	Forest	Debris removal for lowest culvert	N/A	Complete (2013)
7F	Bridge	343630mE 4953001mN	N/A	Bridge over Bezant Lake Brook (BEZ001)	Forest	N/A	N/A	N/A
7G	Road watercourse crossing	345302mE 4952378mN	N/A	Partial barrier culvert (BEZ004)	Forest	Tailwater control; debris removal	Low	Incomplete
7H	Road watercourse crossing	345507mE 4952516mN	N/A	Full barrier culvert (BEZ005)	Forest	Debris removal	Low	Complete (2012)
7I	Road watercourse crossing	342949mE 4951627mN	N/A	Partial barrier culvert (BEZ002)	Forest	Tailwater control	Medium	Incomplete
Section 8	Section 8 runs from the mouth of Oakes Brook, where it meets the Nictaux River (338538mE, 4965987mN) to where it ends up around Squirreltown road (339588mE, 4958179mN). It runs a length of approximately 9.04km, through marshy terrain, and has 8.12km of tributaries that feed into it.							
8A	Bridge	338177mE 4965323mN	N/A	Bridge over Oakes Brook	Forest, Marsh	N/A	N/A	N/A
8B	Road watercourse	336977mE	N/A	Partial barrier culvert	Forest, Residential	Debris removal; tailwater	Low	Incomplete

Section Number	Stream Feature	Lower Limit (coordinates and landmarks)	Upper Limit	Site Details	Adjacent Land Use Considerations	Prescription for Restoration	Project Priority Ranking	Project Status
	crossing	4964627mN		(NIC048)		control		
8C	Bridge	337458mE 4963720mN	N/A	Bridge over Oakes Brook (NIC046)	Forest, Residential	N/A	N/A	N/A
8D	Road watercourse crossing	337209mE 4963508mN	N/A	Non-barrier culvert (OAK005)	Forest, Residential	N/A	N/A	N/A
8E	Bridge	337690mE 4963117mN	N/A	Bridge over Oakes Brook (NIC062)	Forest, Marsh	N/A	N/A	N/A
8F	Road watercourse crossing	338296mE 4961427mN	N/A	Partial barrier culvert (NIC060)	Forest, Marsh	Debris removal; tailwater control	Low	Partially Complete: Debris removal (2014)
8G	Road watercourse crossing	337128mE 4961560mN	N/A	Partial barrier culvert (OAK006)	Forest, Marsh	Baffle installation	Low	Incomplete
8H	Bridge	338504mE 4960886mN	N/A	Bridge over Oakes Brook (NIC061)	Forest, Marsh	N/A	N/A	N/A
8I	Road watercourse crossing	337261mE 4960139mN	N/A	Non-barrier culvert (OAK007)	Forest, Marsh	N/A	N/A	N/A
8J	Road watercourse crossing	337365mE 4959200mN	N/A	Full barrier culvert (OAK009)	Forest, Marsh	Removal of structure or construction of fish ladder	Low	Incomplete
8K	Bridge	338793mE 4959955mN	N/A	Bridge over Oakes Brook (NIC063)	Forest, Marsh	N/A	N/A	N/A
8L	Bridge	339325mE 4959385mN	N/A	Bridge over Oakes Brook (NIC064)	Forest	N/A	N/A	N/A
Section 9	**Section 9 starts at the mouth of Beals Brook (340905mE, 4955340mN) and extends north to the headwaters of the brook (332342mE, 4966604mN). The total approximate length of the brook is about 20.1km, and has about 16.60km of tributaries that feed into its main stem before it drains into the main stem of the Nictaux River.**							
9A	Road watercourse crossing	338676mE 4957241mN	N/A	Full barrier culvert (NIC041)	Forest	Debris removal; tailwater control	Medium	Incomplete
9B	Bridge	338361mE	N/A	Bridge over Beals Brook	Forest	N/A	N/A	N/A

Section Number	Stream Feature	Lower Limit (coordinates and landmarks)	Upper Limit	Site Details	Adjacent Land Use Considerations	Prescription for Restoration	Project Priority Ranking	Project Status
		4957007mN		(BEL006)				
9C	Road watercourse crossing	337060mE 4958051mN	N/A	Partial barrier culvert (BEL005)	Forest, Cottage/Residential Development	Tailwater control	Low	Incomplete
9D	Road watercourse crossing	336183mE 4961534mN	N/A	Full barrier culvert (NIC043)	Forest, Cottage/Residential Development	Baffle installation; tailwater control	Low	Incomplete
9E	Bridge	335827mE 4961650mN	N/A	Bridge over feeder stream to Trout Lake (SLB002)	Forest Cottage/Residential Development	N/A	N/A	N/A
9F	Bridge	335477mE 4961466mN	N/A	Bridge over tributary to Trout Lake (BEL003)	Forest, Residential/Cottage	N/A	N/A	N/A
9G	Bridge	333954mE 4963789mN	N/A	Bridge over Beals Brook	Forest	N/A	N/A	N/A
Section 10	**Section 10 starts at Zwickers Lake (338452mE, 4955527mN), and extends north to the headwaters of Kelly Brook (336968mE, 4957391mN) and west to the headwaters of Walker Brook (333808mE, 4956458mN). It is a complex network of brooks that are located in the headwaters of the Nictaux River system, and drain into Big Molly Upsim Lake. The total length of brooks and tributaries that drain into Big Molly Upsim Lake from Section 10 is 26.61km.**							
10A	Dam	338408mE 4955515mN	N/A	Small water level control dam at outflow of Zwickers Lake	Cottage/Residential development	N/A	N/A	N/A
10B	Road watercourse crossing	338377mE 4955470mN	N/A	Full barrier culvert (NIC049)	Cottage/Residential development	Baffle installation and tailwater control	Low	N/A
10C	Road watercourse crossing	339276mE 4953795mN	N/A	Partial barrier culvert (NIC035)	Forest, forestry	Debris removal; tailwater control	Low	Incomplete
10D	Road watercourse crossing	338737mE 4953767mN	N/A	Partial barrier culvert (NIC036)	Forest, forestry	Tailwater control	Low	
10E	Bridge	337252mE 4954515mN	N/A	Bridge over Kelly Brook	Forest, Gravel pit	N/A	N/A	N/A
10F	Bridge	336931mE 4954137mN	N/A	Bridge over Kelly Brook (KEL004)	Forest	N/A	N/A	N/A

Section Number	Stream Feature	Lower Limit (coordinates and landmarks)	Upper Limit	Site Details	Adjacent Land Use Considerations	Prescription for Restoration	Project Priority Ranking	Project Status
10G	Road watercourse crossing	336030mE 4954187mN	N/A	Non-barrier culvert (NIC038)	Forest	N/A	N/A	N/A
10H	Road watercourse crossing	335133mE 4952025mN	N/A	Bridge over Walker Brook (NIC052)	Forest	N/A	N/A	N/A

7.0 Restoration Plan Summary

Changes in the watershed - current conditions compared to historical conditions. Future changes to the natural environment expected in the watershed	***Current conditions:*** The Nictaux River watershed currently has several dams and reservoirs along its length, is mostly forested, with minimal agricultural land use. Water levels and pH fluctuate widely on a seasonal basis in the lower portion of the river below the main reservoir and above the generating station at Nictaux Falls. ***Historical conditions:*** Historically, prior to the construction of several hydroelectric developments in the 1950s, the Nictaux River supported a vibrant population of salmonids. These species were able to migrate as far up the sub-watershed as to be able to reach spawning grounds up in the Waterloo and Shannon Rivers. Some salmon were able to jump up past the dam at Nictaux Falls, but once the larger reservoir and Nictaux canal were built further upstream in 1954, this created an impassable barrier. Flow conditions prior to dam installations did not fluctuate as widely. ***Future changes:*** Changes that can be expected to occur would include increased summer water temperatures, leading to greater stress to fish populations. Additionally, recent changes in and around the watershed, such as the sale of Bowater Forestry lands and an increased amount of protected areas in the area could impact land use activities in the watershed. If forestry operations expand, it is reasonable to assume that there may be an increased number of logging roads and culverts, resulting in the potential for further habitat fragmentation. Hydrological changes to the river system should be expected with impacts from climate change, including weather pattern changes such as extended periods of drought and severe storm events. It is anticipated that low and peak flows will be influenced by these events.
Most likely limiting factors with regard to aquatic productivity in the watershed	1) **Habitat Fragmentation** – This is a major issue in the Nictaux sub-watershed, as 91% of the culverts measured within fish habitat were considered to be either partial or full barriers to fish migration. The presence of several dams also plays a significant role in habitat fragmentation in this watershed. 2) **Water quantity issues (pulsing flows)** – This is also a major issue in the watershed, as parts of the Nictaux River are susceptible to widely varying flow regimes, with the water control by the hydroelectric stations. In the summer, water levels in certain parts of the river can reach significantly low levels. 3) **Water quality issues** – Although there has not been enough water quality monitoring yet in this watershed, one water quality issue so far that has been noted are the high summer water temperatures (>20°C), particularly within the downstream reaches of the watershed. In addition, pH has been shown to fluctuate widely between seasons and sections of the river. 4) **Competition from invasive species** – The presence of invasive species in the lower end of the river, Waterloo Lake, McGill Lake and Little Molly Upsim Lake (i.e. smallmouth bass) could potentially be a limiting factor to productivity of salmonid species. Currently, these are restricted to the lower portion of the Nictaux River (Section 1) and the lakes they have been found in due

	to the barriers posed by dams on the system. Work to reduce habitat fragmentation in this system should take this into account. 5) **Habitat quality issues** –Over several decades, the lower portion of the river has filled in with fine sediments. Fine sediment accumulation has been widely recognized to pose detrimental effects to river ecosystems. Salmonid species, preferring coarse gravel and stone bottoms for spawning, are particularly vulnerable to sediment accumulation.
Most important habitat restoration needs in the watershed	▪ **Addressing water quantity issues (i.e. improved flow regulation regime)** ▪ **Habitat fragmentation issues** ▪ **Water quality fluctuations** ▪ **Habitat quality (i.e. cover, water quality)**
Habitat connectivity restoration projects, in order of importance*	1) **Fishway at dam above Nictaux Falls [2B]** 2) **Fishway at Wamboldt Falls/Nictaux reservoir [2I/3A]** 3) **NIC030 (5A)-** Debris removal (received in 2012) 4) **NIC003 (1B)-** Debris removal, baffle installation, tailwater control 5) **NIC028 (1D)-** Debris removal, removal of structure/fish ladder (received debris removal in 2012) 6) **NIC004 (1A)-** Removal of structure/fish ladder 7) **NIC002 (1C)-** Debris removal, tailwater control, removal of structure/fish ladder (received debris removal in 2012, tailwater control in 2015) 8) **NIC024 (5C)-** Debris removal, tailwater control 9) **NIC041 (9A)-** Debris removal, tailwater control 10) **NIC011 (2I)-** Removal of structure/fish ladder 11) **NIC043 (9D)-** Baffles installation, tailwater control 12) **NIC048 (8B)-** Debris removal, tailwater control 13) **WLC002 (7E)-** Debris removal (received in 2013) 14) **NIC036 (10D)-** Tailwater control 15) **NIC067 (2J)-** Removal of structure/fish ladder 16) **NIC008 (3C)-** Removal of structure/fish ladder 17) **NIC012 (2K)-** Debris removal (received in 2012) 18) **BEZ004 (7G)-** Debris removal, tailwater control 19) **NIC010 (2G)-** Debris removal, tailwater control 20) **NIC014 (2L)-** Tailwater control

	* As the number of barriers on the main channel heavily influenced priority rankings, order of importance has been largely based on upstream habitat gain.
Water quality improvement and/or monitoring projects, in order of importance	▪ **Water quality monitoring** – Full water quality assessments should be taken at regular intervals at pre-defined sites within the watershed to collect background water quality data (i.e. water temperature, dissolved oxygen, pH, conductivity, turbidity and metals). ▪ **Water quantity monitoring** – Discharge measurements should be taken to gain a better understanding of the variation in flow levels between seasons, and what quantities of water are moving through different points in the sub-watershed at a given point in time. ▪ **Habitat quality assessments** – These should be continued in order to further assess what sort of cover, food availability and quality of habitat is available for salmonids in various reaches of the Nictaux sub-watershed.
Riparian buffer zone restoration projects, in order of importance	▪ Riparian planting along shoreline for farms and/or gravel pits in Section 1 ▪ Lakeshore riparian planting for cottage shorelines
Physical habitat restoration projects, in order of importance	1) Continuing the improvement of habitat complexity and cover in Section 1 2) Improving habitat quality for spawning in Section 1 3) Creating more natural flow regimes throughout the entire Nictaux system through collaboration with NS Power 4) Addressing habitat connectivity issues within the entire Nictaux system (i.e. such as the construction of fish ladders or remediation of barrier culverts) 5) Reducing pH fluctuations in the river below the main reservoir

8.0 Summary

The information used in the creation of the restoration plan came from a variety of sources; culvert assessments, fish population surveys, water quality assessments, fish habitat quality assessments and traditional knowledge from the local community. This report provides the foundation of a restoration plan for the Nictaux River system, to guide future restoration actions on a sub-watershed scale. With collaboration between the local community, industry, and regulators, this system may have the potential to support a vastly improved recreational fishery, and provide a substantial amount of high quality habitat for threatened populations of Atlantic salmon or other salmonids.

9.0 References

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10.0 Appendices

10.A Appendix A: HSI Tables

Table 27. HSI Variables and quality values for brook trout (applicable for assessments completed in 2013; from Brunner, 2012).

Variable	Poor Quality Values	Fair Quality Values	Optimum Quality Values
Average Maximum Temperature	<3°C, >23°C	3-10°C, 16-23°C	10-16°C
Average Thalweg Depth	Width ≤5m: <13cm, Width >5m: <25cm	Width ≤5m: 13-27cm, Width>5m: 25-42cm	Width ≤5m: >27cm, Width >5m: >42cm
Percent In-stream Cover	<2%, <4%	2-15%, 4-25%	>15%, >25%
Average Substrate Size	<0.7cm, >8.5cm	0.7-2.5cm, 6-8.5cm	2.5-6cm
Percent Cover Substrate	<3%	3-8%	>8%
Dominant Substrate for Food Production	Cobble or aquatic vegetation dominant, and gravel, boulders or bedrock less dominant	Cobble, gravel, boulders, and fines occur in approximately equal amounts or gravel is dominant	Fines, boulders, or bedrock are dominant. Gravel and cobble is less dominant.
Percent Pools	<5%	5-30%, 60-100%	30-60%
Average Percent Streambank Vegetation/Stable Ground	<60%	60-150%	>150%
Annual Minimum or Maximum pH	<5,>9	5-6.5, 8-9	6.5-8
Pool Class	<10% 1st class pool, <50% 2nd class pool	10-30% 1st class pool, ≥50% 2nd class pool	≥30% first class pool
Percent Fines	>45%, >20%	13-45%, 7-20%	<13%, <7%
Percent Stream Shading	<5%	5-50%, 75-100%	50-75%

10.B Appendix B: 2013 HSI Data

10.B.1 Stream Profiles

Cross-sections were taken along six transects at each of the sites where HSI surveys were completed. Transect spacing at each site was calculated from measured bankfull widths. Each transect was divided into 4 sections, where water depth was measured. The cross-sectional profiles for each transect are displayed in sections 10.B.1.1 through 10.B.1.3, where a depth of 0 indicates the water surface, and negative values indicate the depth below the water's surface.

Hendry and Cragg-Hine (1997) state that the preferred water depth for spawning in Atlantic salmon is between 17 to 76 cm, while the preferred velocity is 0.25 to 0.9 m/s. Tables 28 and 29 show the optimum water depths and velocities for juvenile salmon and also optimum thalweg depths brook trout. The NSFHAP field protocol does not take velocity measurements however, so water velocity information pertaining to each of the transects was not taken.

Table 28. Typical stream habitat characteristics preferred by juvenile salmon (Hendry and Cragg-Hine, 1997).

	River Conditions	
Life Stage	Water Depth	Velocity
Fry and underyearling parr	≤ 20 cm	0.5 – 0.6 m/s
Yearling and older parr	20 – 40 cm	0.6 – 0.75 m/s

Table 29. HSI Thalweg depth values for brook trout (Brunner, 2012).

Variable		**Poor Quality Values**	**Fair Quality Values**	**Optimum Quality Values**
Average Thalweg Depth	Width ≤5 m	<13 cm	13 – 27 cm	>27 cm
	Width >5 m	<25 cm	25 – 42 cm	> 42 cm

10.B.1.1 NICHSI2

Figures 25 through 30 illustrate the cross-sectional profiles of each transect. The average water depth in Transect 1 was 85.6 cm at the time of sampling, with a thalweg depth of 94 cm. Similarly, the average water depths for Transects 2 and 3 were 72 cm and 64 cm, respectively, while the measured thalweg depths were 84 cm and 70 cm. These values represent good habitat values for brook trout (Table 28); however, the values may be subject to considerable fluctuation throughout the entire reach, due to influences of water level controlling activities by hydroelectric impoundments and dams further upstream on the river system. The average depths for Transects 4, 5 and 6 were 72.9 cm, 88.3 cm, and 78.5 cm, respectively. Similarly, thalweg depths were 80 cm, 102 cm, and 100 cm, respectively. These all represent good quality values for brook trout according to HSI quality values (Table 29).

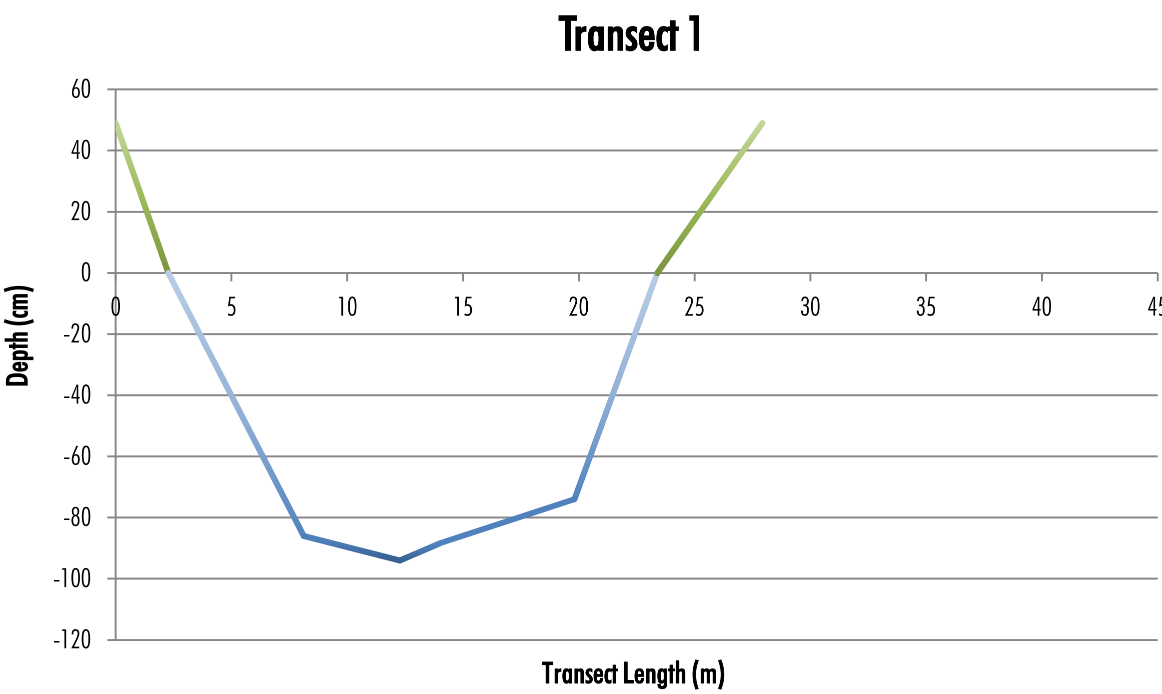

Figure 25. Cross-sectional transect profile of NICHSI2 Transect #1, from bankfull to bankfull.

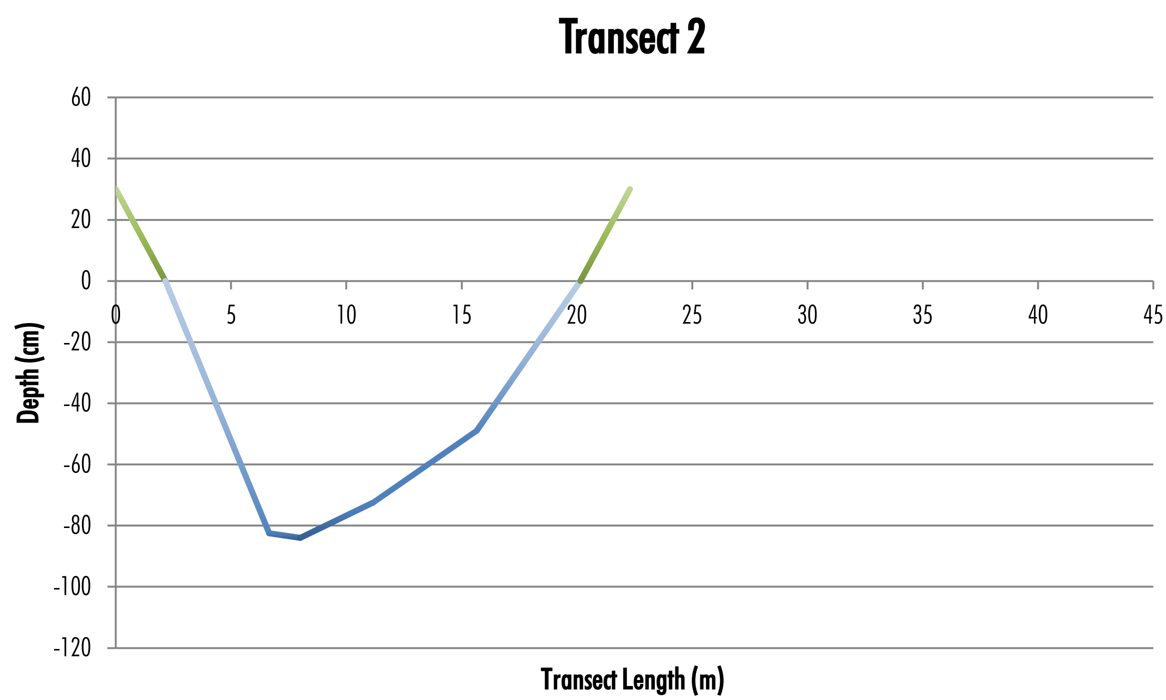

Figure 26. Cross-sectional transect profile of NICHSI2 Transect #2, from bankfull to bankfull.

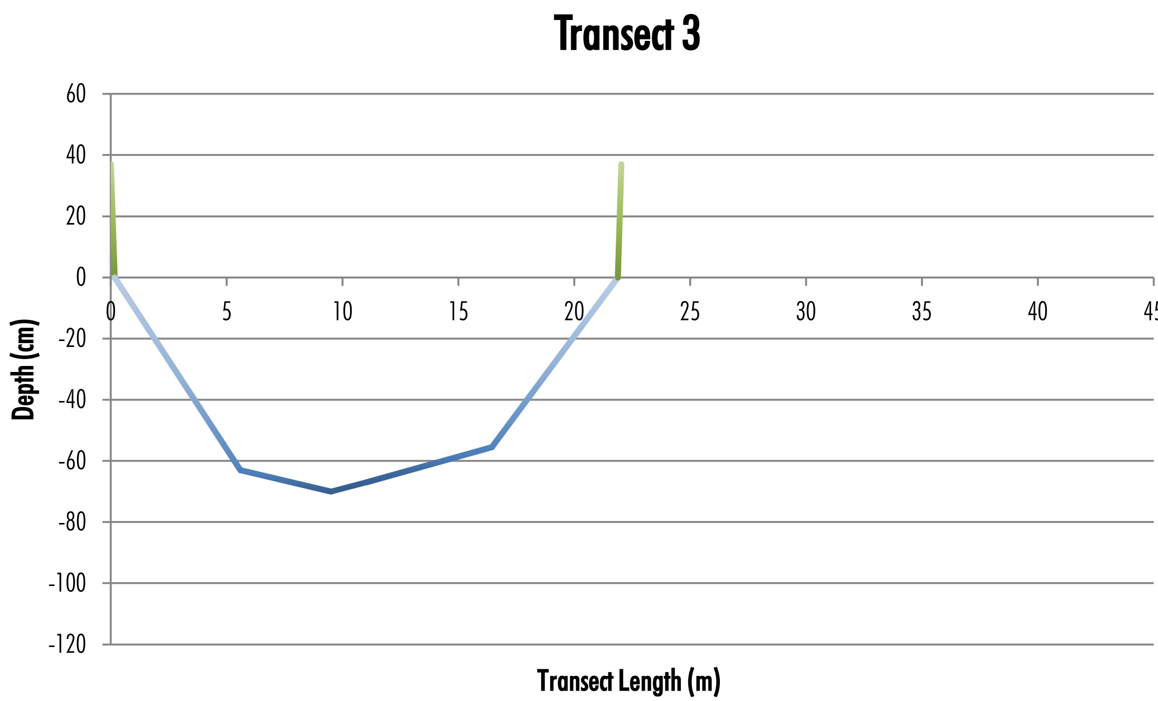

Figure 27. Cross-sectional transect profile of NICHSI2 Transect #3, from bankfull to bankfull.

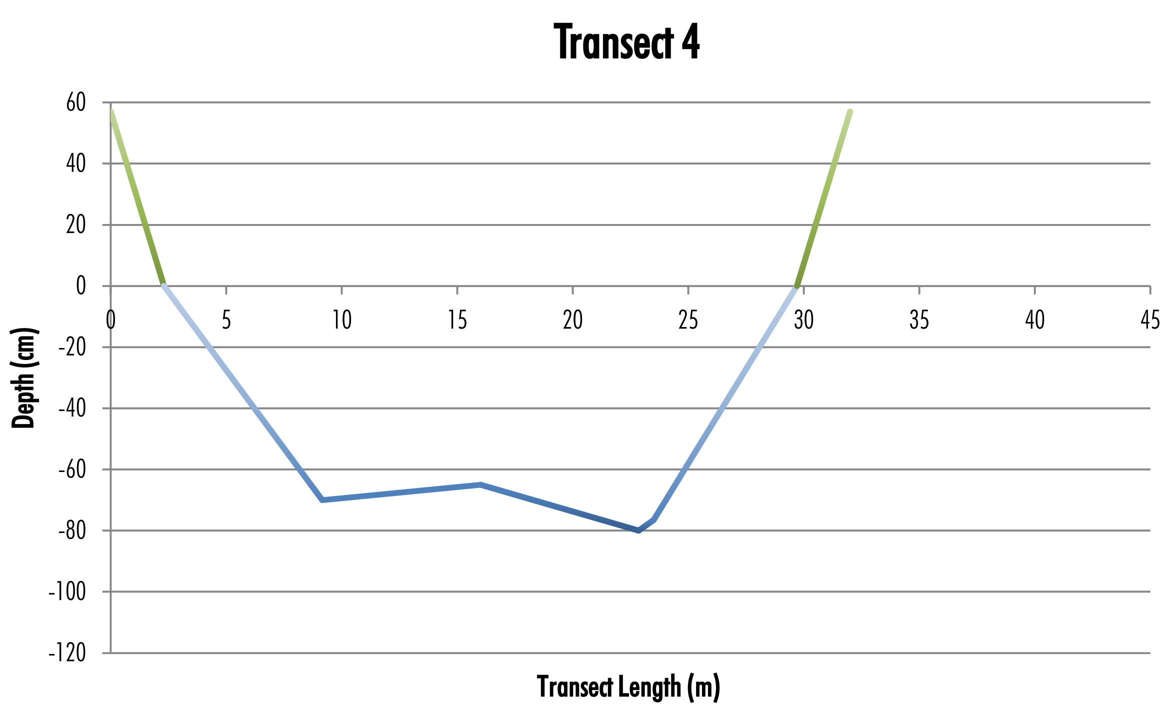

Figure 28. Cross-sectional transect profile of NICHSI2 Transect #4, from bankfull to bankfull.

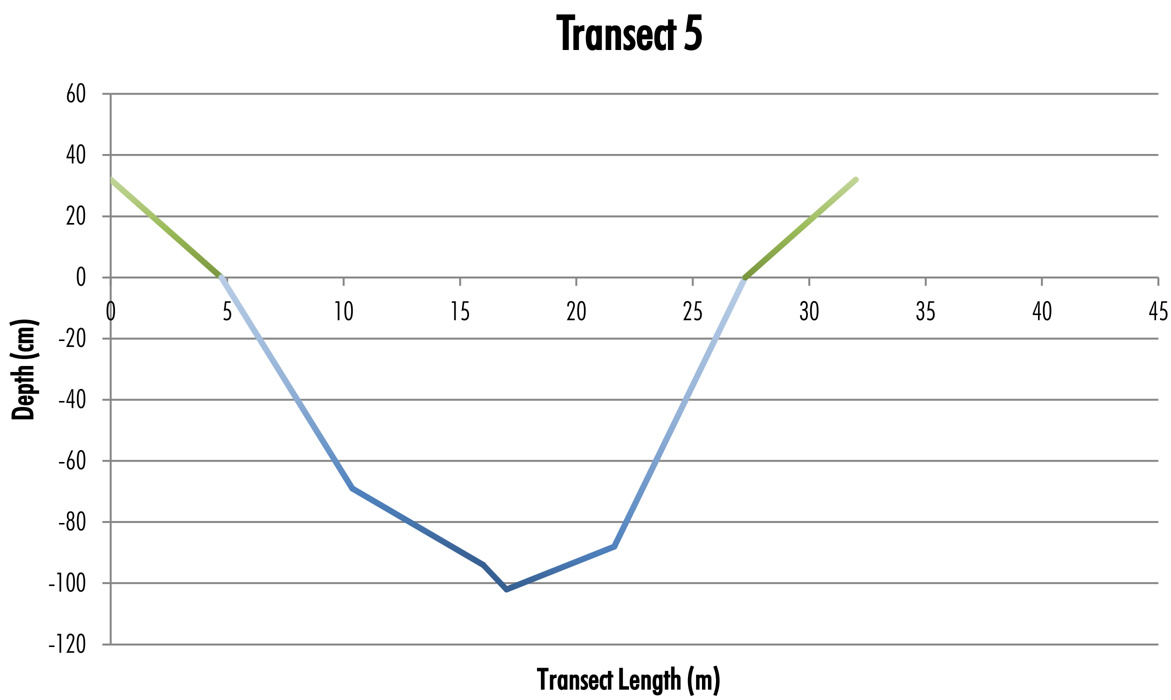

Figure 29. Cross-sectional transect profile of NICHSI2 Transect #5, from bankfull to bankfull.

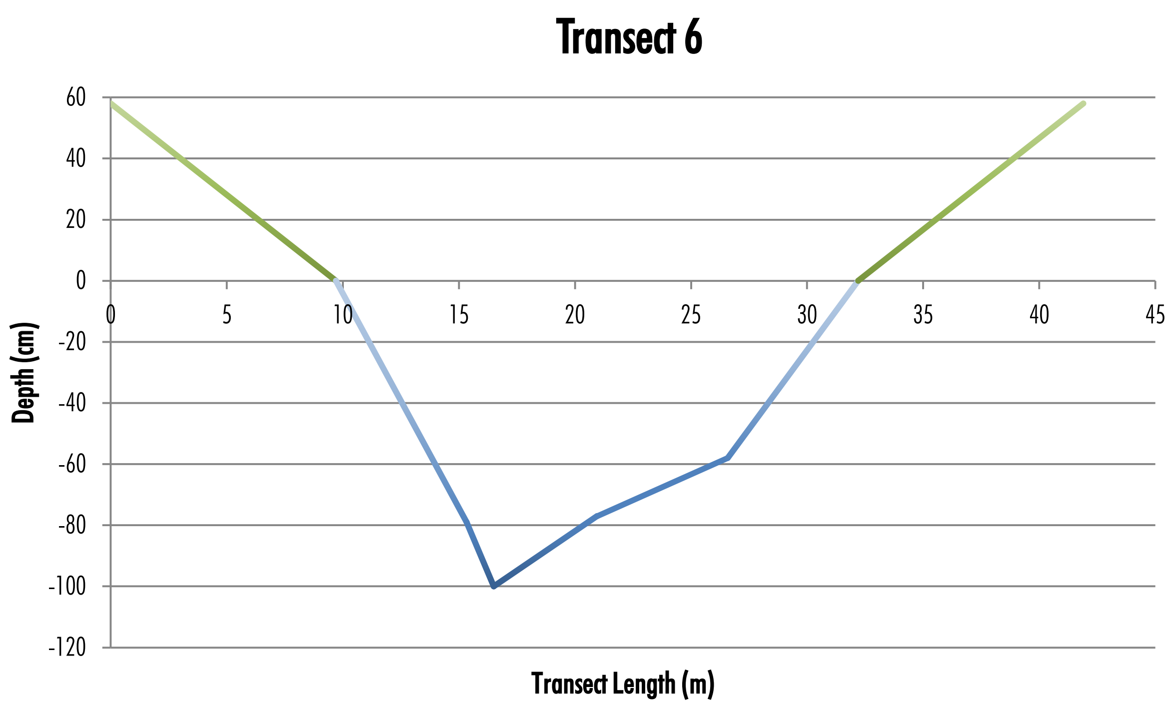

Figure 30. Cross-sectional transect profile of NICHSI2 Transect #6, from bankfull to bankfull.

10.B.1.2 NICHSI3

Transect spacing at this site was approximately 82m apart. The reach contained a large island, which resulted in a braided stream (Figure 3, Section 2E), therefore transects that dissected the braided channel were measured as two separate stream cross-sections. While there is some variation between sites, the thalweg depth remained within the range of 40 to 75 cm, indicating good quality values for brook trout in general in the fall when there are higher flows being released from the dam upstream at Wamboldt Falls. Figures 31 through 38 illustrate the cross-sectional profiles of each transect.

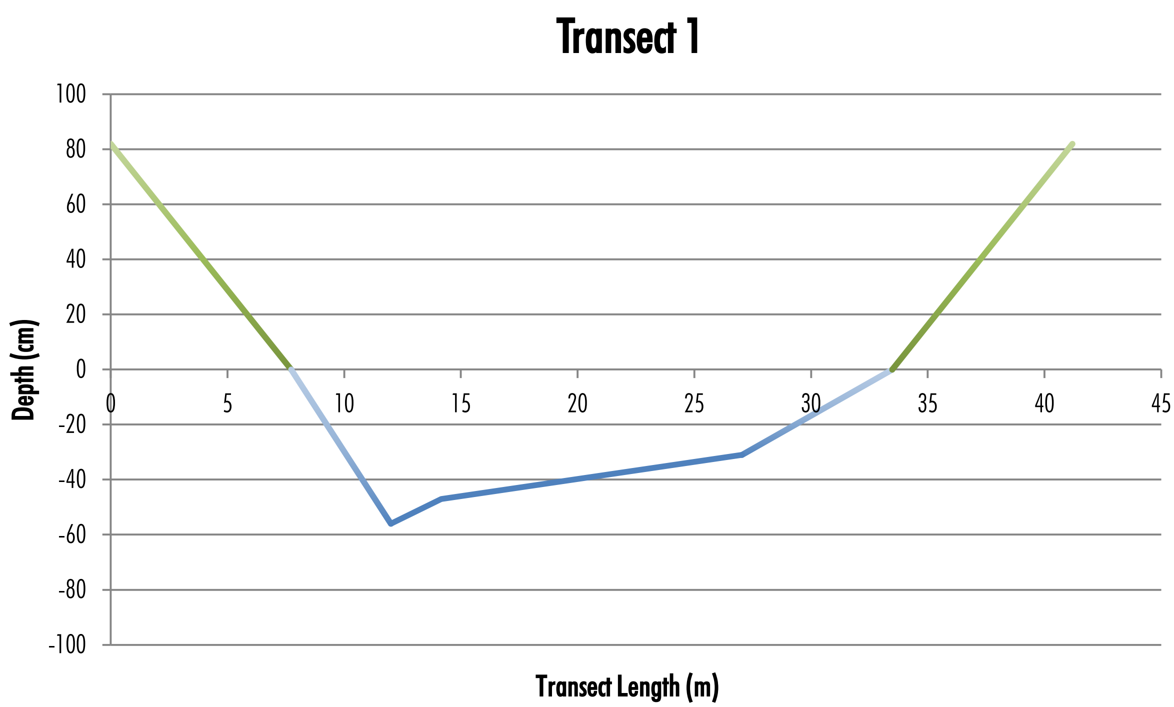

Figure 31. Cross-sectional transect profile of NICHSI3 Transect #1, from bankfull to bankfull.

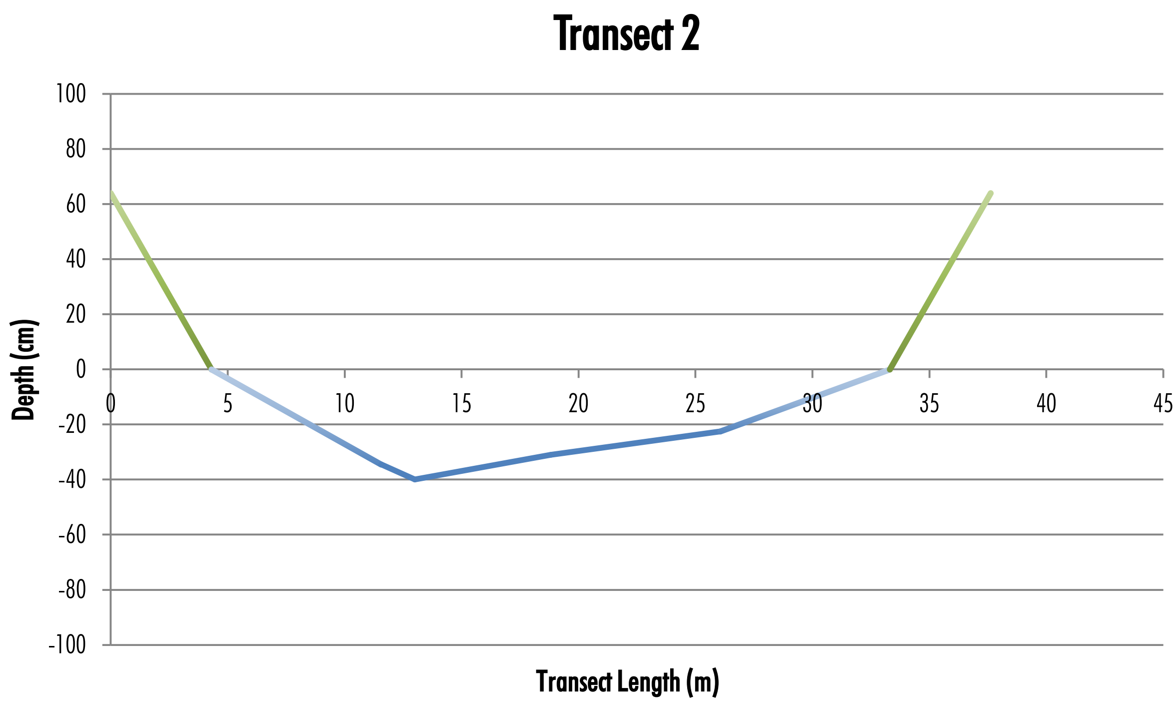

Figure 32. Cross-sectional transect profile of NICHSI3 Transect #2, from bankfull to bankfull.

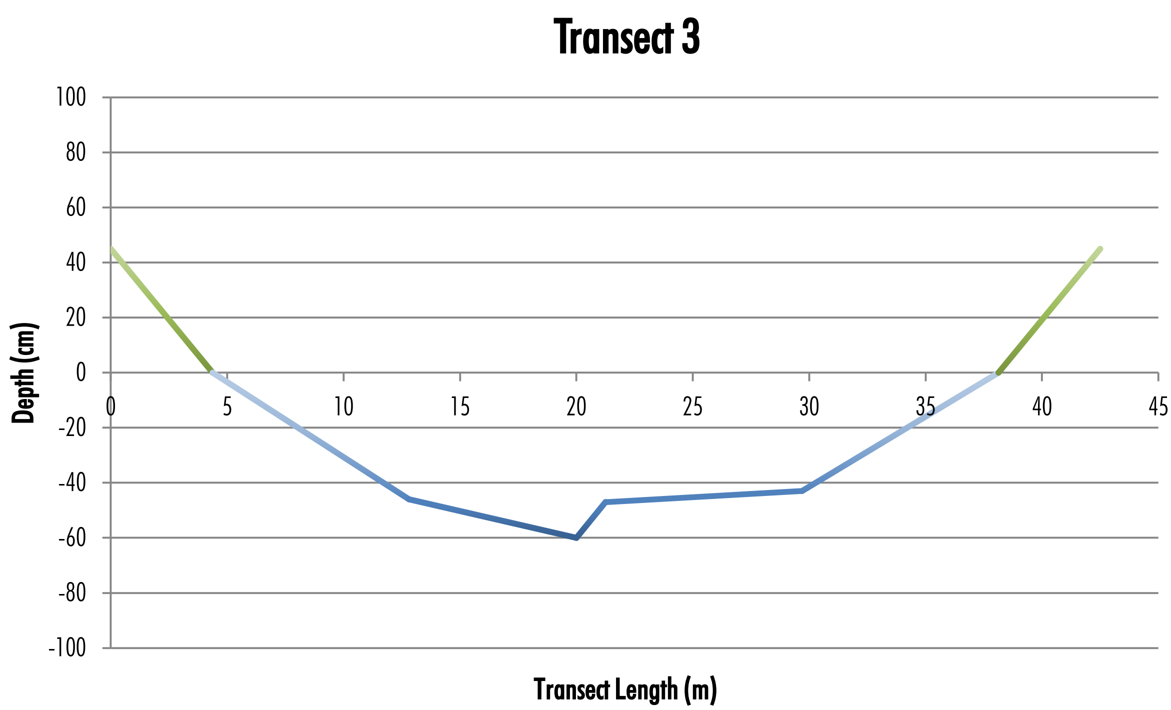

Figure 33. Cross-sectional transect profile of NICHSI3 Transect #3, from bankfull to bankfull.

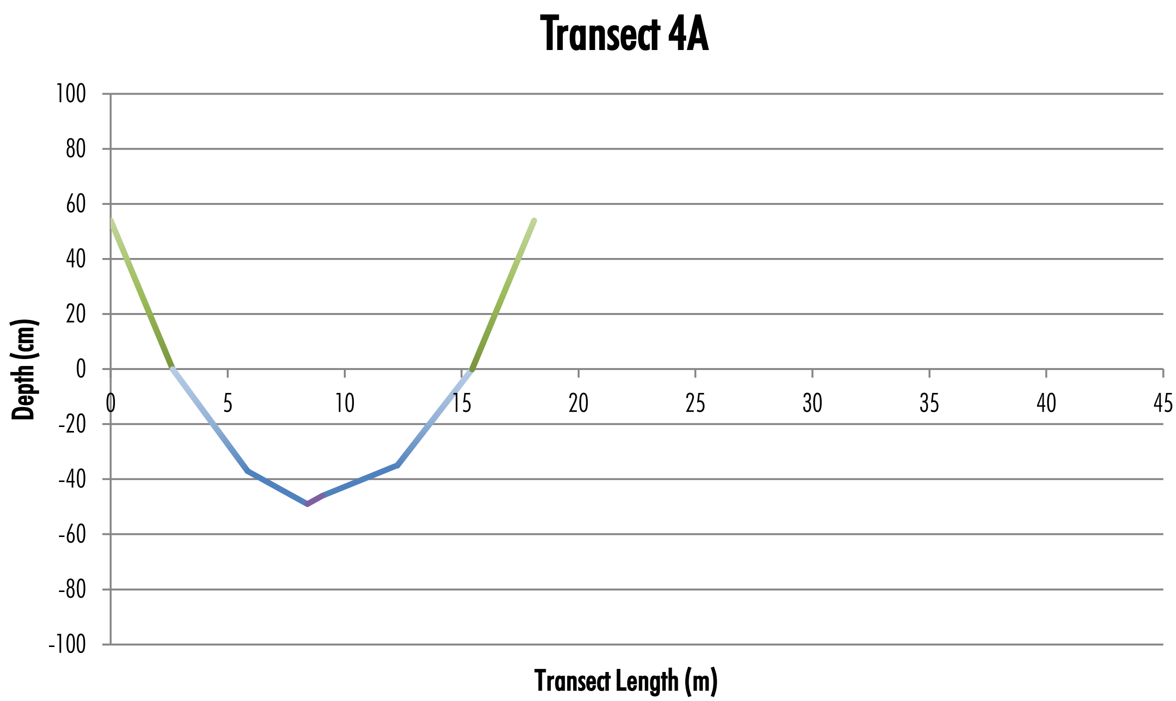

Figure 34. Cross-sectional transect profile of NICHSI3 Transect #4A, from bankfull to bankfull.

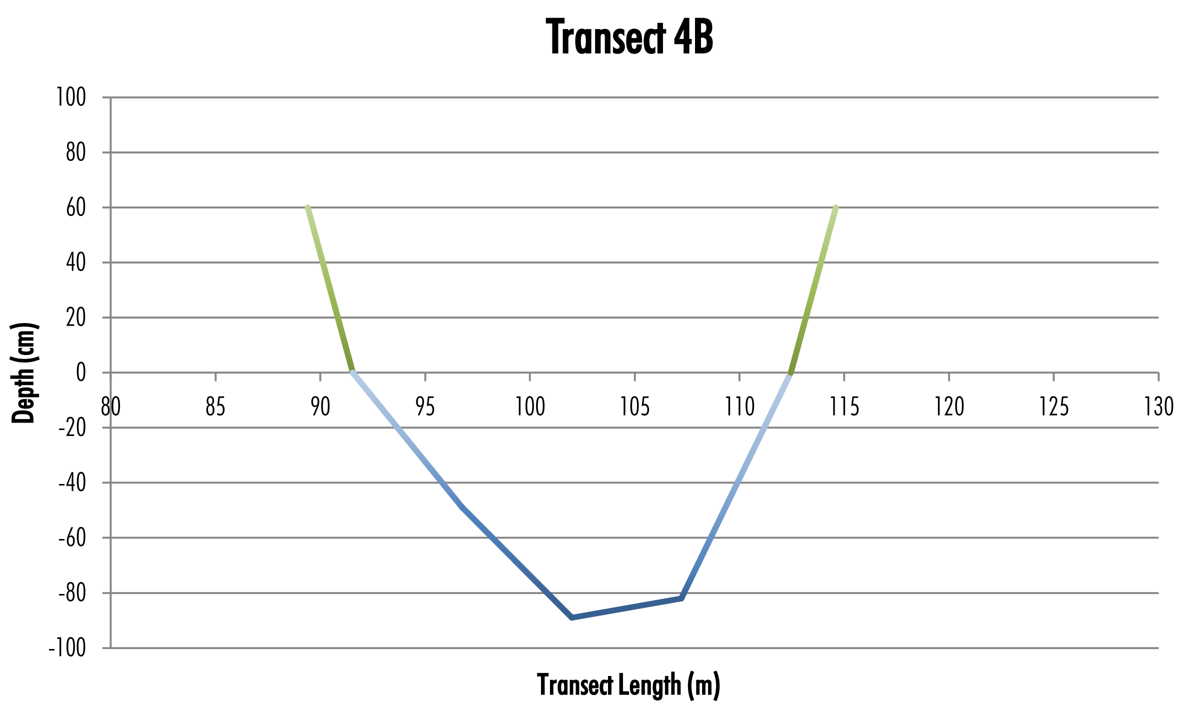

Figure 35. Cross-sectional transect profile of NICHSI3 Transect #4B, from bankfull to bankfull.

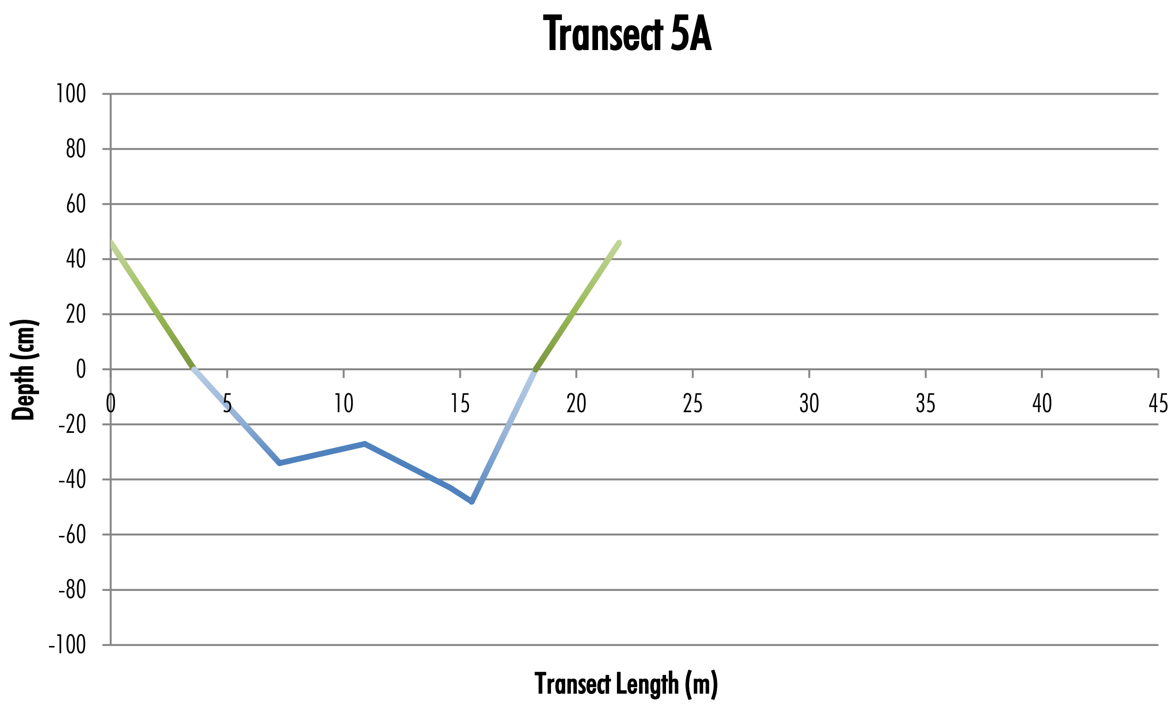

Figure 36. Cross-sectional transect profile of NICHSI3 Transect #5A, from bankfull to bankfull.

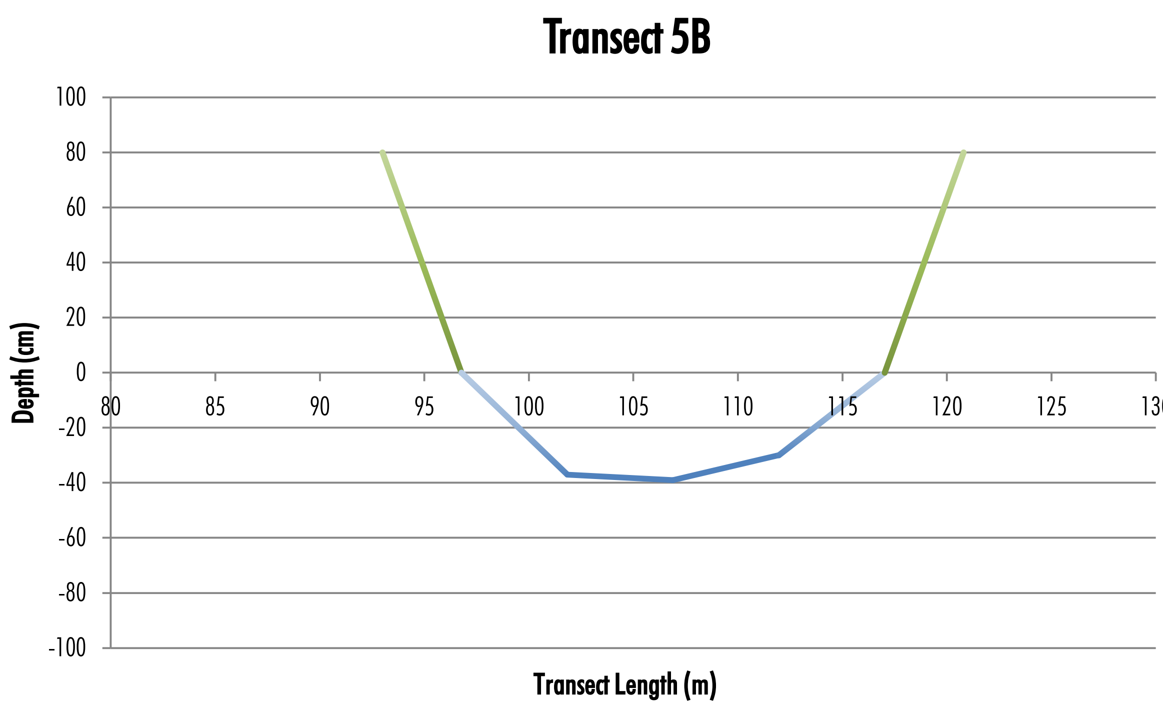

Figure 37. Cross-sectional transect profile of NICHSI3 Transect #5B, from bankfull to bankfull.

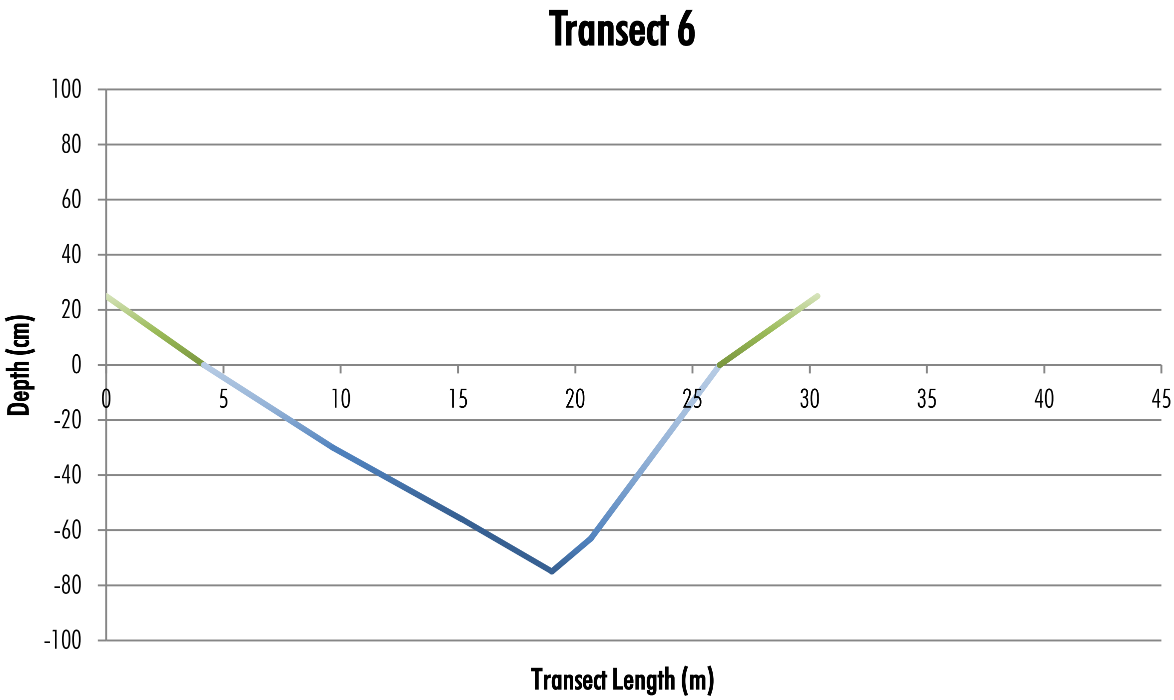

Figure 38. Cross-sectional transect profile of NICHSI3 Transect #6, from bankfull to bankfull.

10.B.1.3 NICHSI4

Transect spacing at this site was approximately 14m apart. Figures 39 through 44 illustrate the cross-sectional profiles of each transect. Thalweg depths vary between 45 and 74 cm, indicating overall good quality (optimum) values for brook trout.

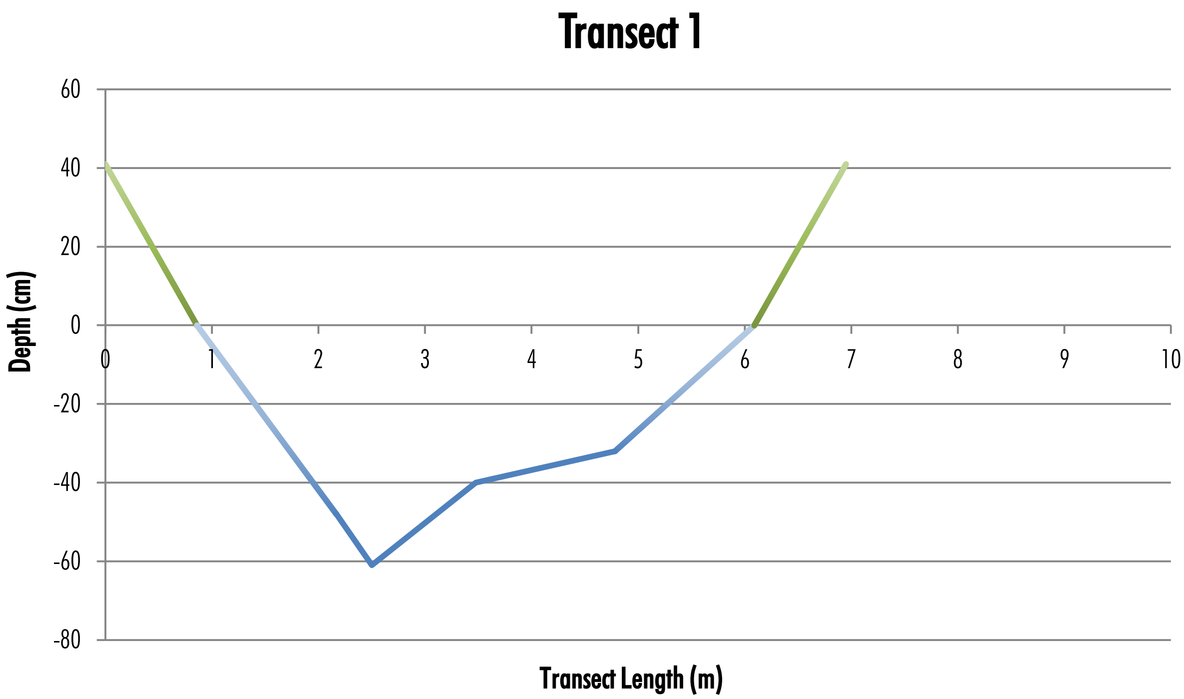

Figure 39. Cross-sectional transect profile of NICHSI4 Transect #1, from bankfull to bankfull.

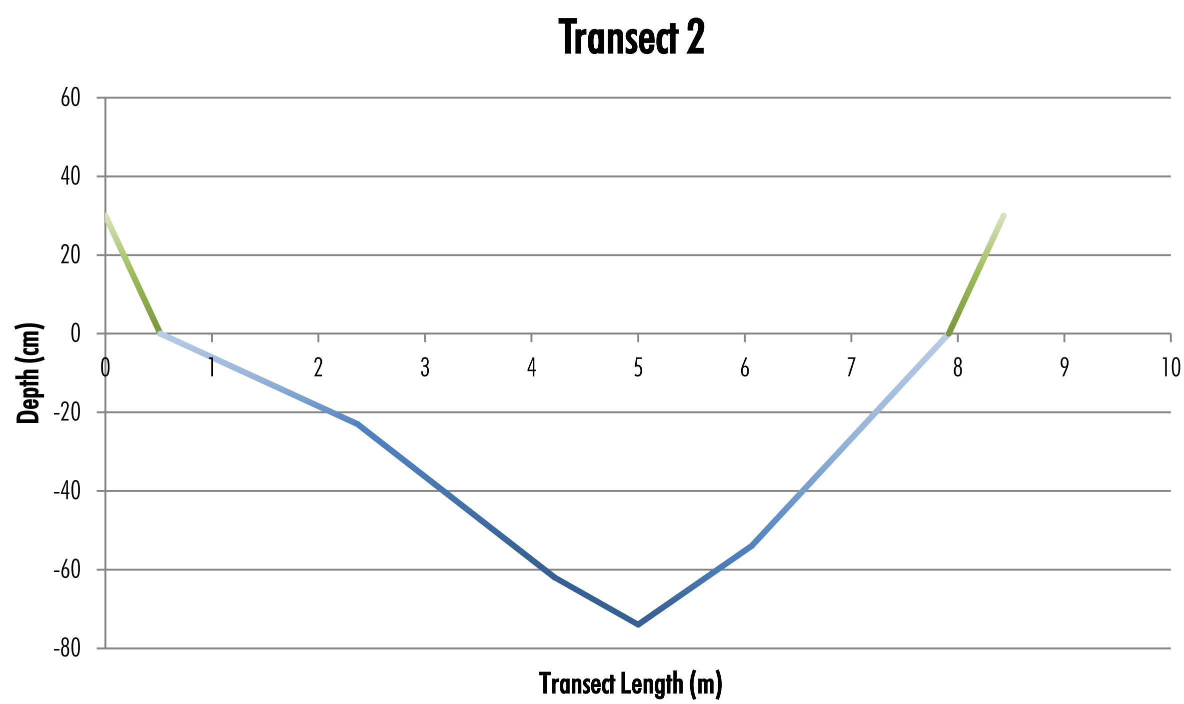

Figure 40. Cross-sectional transect profile of NICHSI4 Transect #2, from bankfull to bankfull.

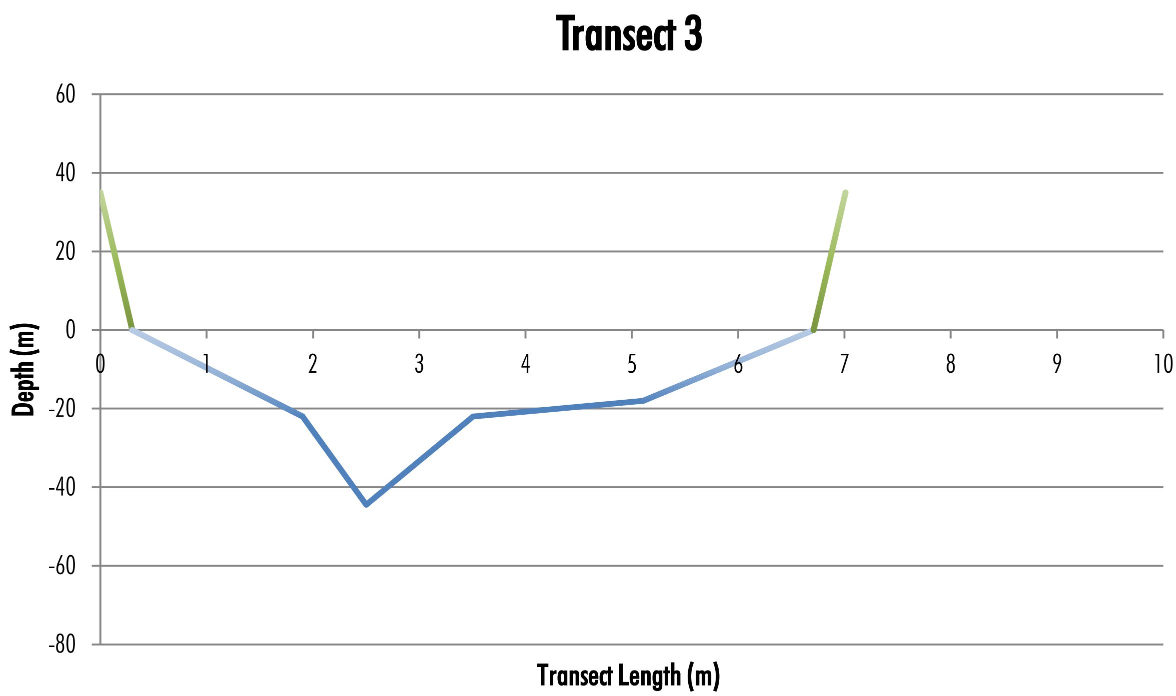

Figure 41. Cross-sectional transect profile of NICHSI4 Transect #3, from bankfull to bankfull.

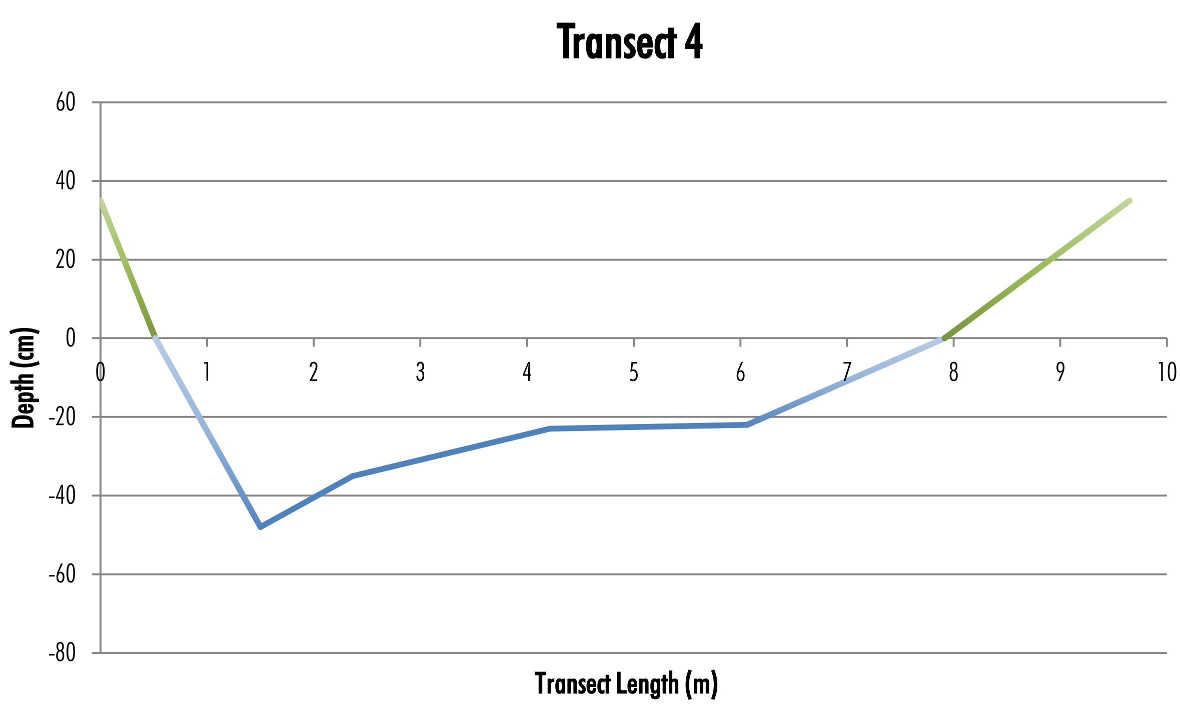

Figure 42. Cross-sectional transect profile of NICHSI4 Transect #4, from bankfull to bankfull.

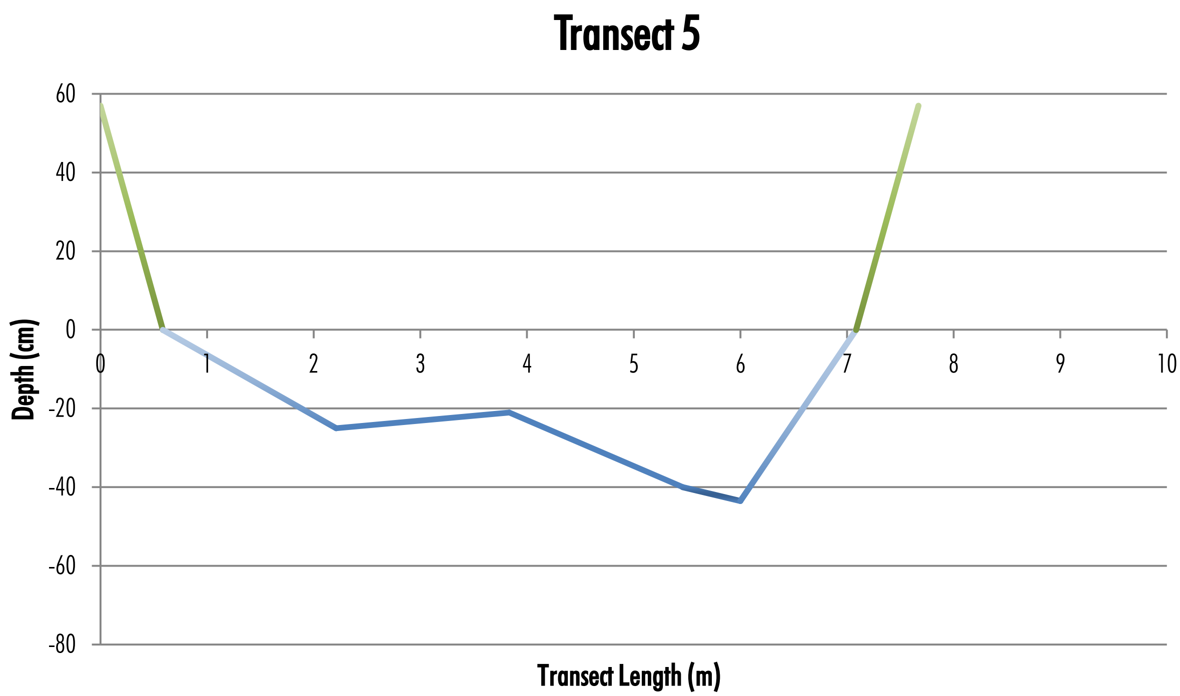

Figure 43. Cross-sectional transect profile of NICHSI4 Transect #5, from bankfull to bankfull.

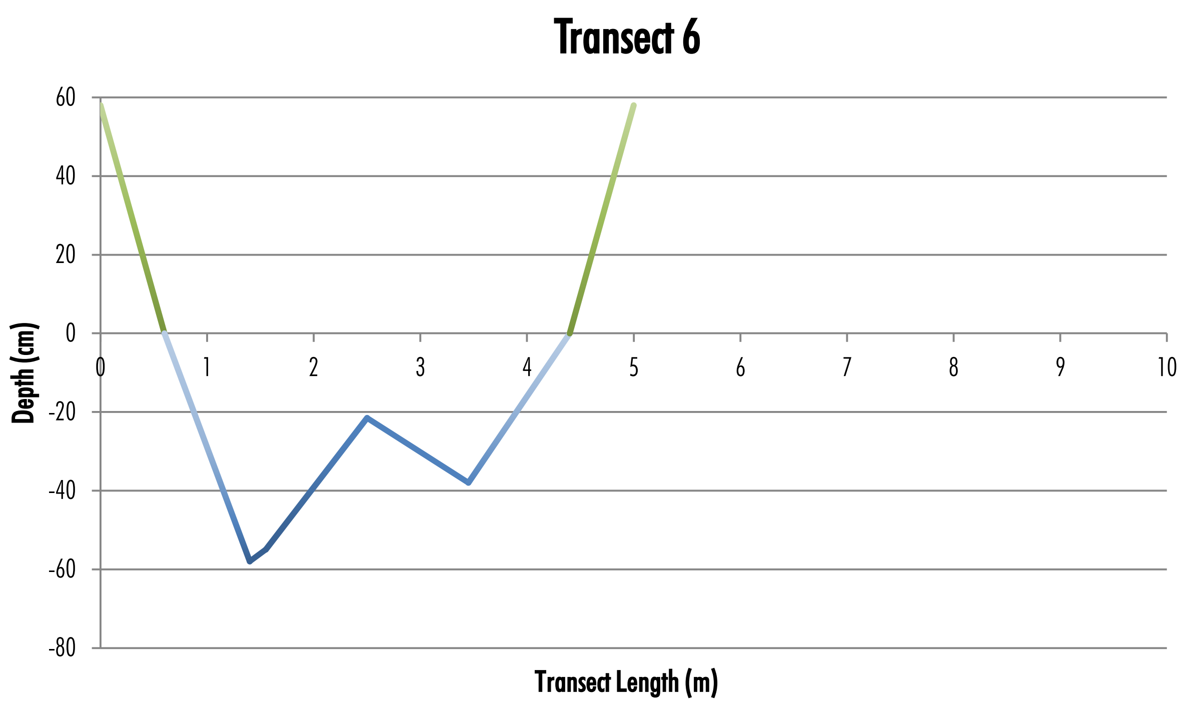

Figure 44. Cross-sectional transect profile of NICHSI4 Transect #6, from bankfull to bankfull.

10.B.2 Substrate Surveys

The types of substrates present in stream habitats have a great impact on the sorts of fish species which can use them for spawning. Substrate preference varies between salmonid species, however, coarse gravel and stone bottoms are generally preferred for spawning, while areas with deep water, large rocks and loose substrate provide good habitat for growing juveniles (Hendry and Cragg-Hine, 2003; Klemetsen et al., 2003). Table 30 displays typical habitat substrate characteristics of juvenile salmon, while Table 31 outlines optimum substrate presence for food production and overall brook trout use. The three sites that were surveyed on the Nictaux for depth were also assessed for substrate size, along the same transects. Each transect was divided into thirds, and the percent grain size assessed. Sections 10.B.2.1 through 10.B.2.3 display the results from these assessments. Size class categories are displayed in Table 32.

Table 30. Typical habitat characteristics of juvenile Atlantic salmon (Hendry and Cragg-Hine, 1997).

	Substrate Type	
Life Stage	Summer	Winter
Fry and underyearling parr	Gravels and Cobbles (1.6-6.4 cm)	Cobble up to boulder (6.4-25.6 cm)
Yearling and older parr	Cobble up to boulder (6.4-25.6 cm)	

Table 31. HSI substrate variables and habitat quality for brook trout (Brunner, 2012).

Variable	**Poor Quality Values**	**Fair Quality Values**	**Optimum Quality Values**
Average Substrate Size	<0.7cm, >8.5cm	0.7-2.5cm, 6-8.5cm	2.5-6cm
Dominant Substrate for Food Production	Cobble or aquatic vegetation dominant, and gravel, boulders or bedrock less dominant	Cobble, gravel, boulders, and fines occur in approximately equal amounts or gravel is dominant	Fines, boulders, or bedrock are dominant. Gravel and cobble is less dominant.
Percent Fines	>45%	7-45%	<7%

Table 32. Substrate size categories (Brunner, 2012).

Substrate	Size (cm)
Fines (sand, silt)	<0.3
Fine gravel	0.31-0.7
Medium gravel	0.71-2.5
Coarse gravel	2.51-6
Boulder	>40

10.B.2.1 NICHSI2

Figure 45 displays the general breakdown of substrate size class distribution across individual transects, whereas Figures 46 and 47 illustrate the average substrate composition for the entire site. To determine which size class was most dominant, the various gravel sizes were classed together and compared against other size classes. Overall, gravel was slightly more dominant than cobble, but the cobble and gravel occurred in fairly equal quantities. Table 33 shows the average substrate size and the amount of fines that were present at NICHSI2. As substrate was assessed based on percentage composition of size class categories, determination of a concrete value for the average substrate size was not possible, however, the average size class was determined based on the available information.

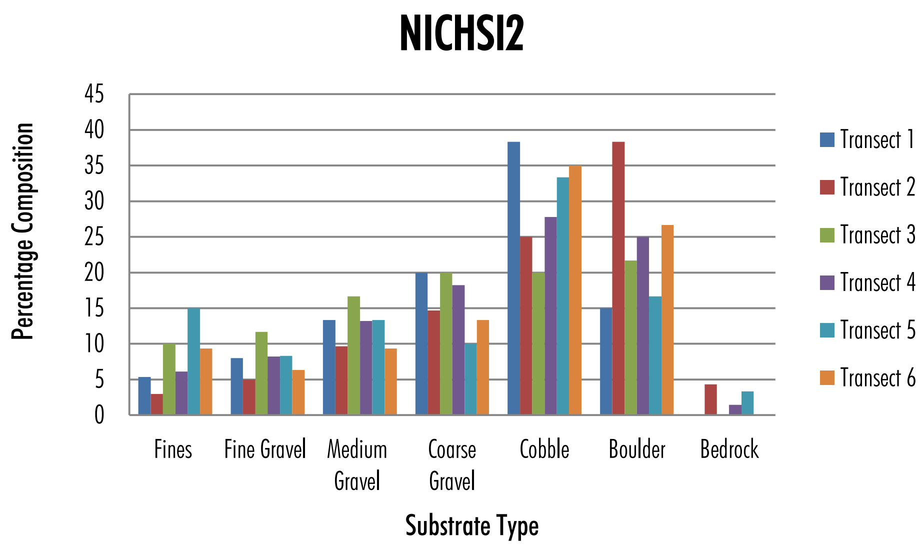

Figure 45. Percentage composition of substrates for individual transects at NICHSI2.

Table 33. Average substrate size and percent fines for transects in NICHSI2.

	Transect #1	Transect #2	Transect #3	Transect #4	Transect #5	Transect #6
Average Substrate Size*	6.1-40cm	6.1-40cm	6.1-40cm	6.1-40cm	6.1-40cm	6.1-40cm
Percent Fines	5.3	3	10	15	15	9.3

*Average substrate size could not be adequately calculated, as grain sizes were classed into broad categories, therefore a rough estimate based on category mean sizes was calculated to determine what categorical range the average size values fell within.

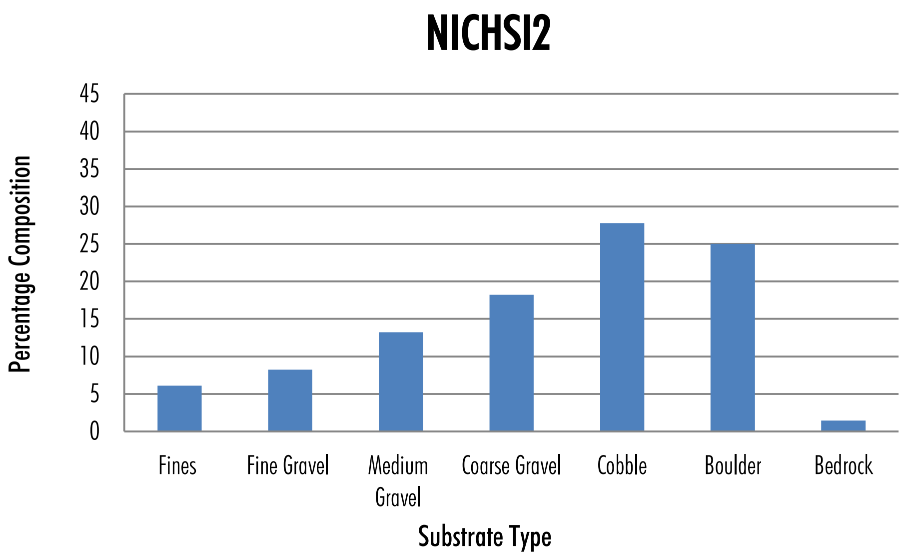

Figure 46. Percentage composition per substrate type for NICHSI2.

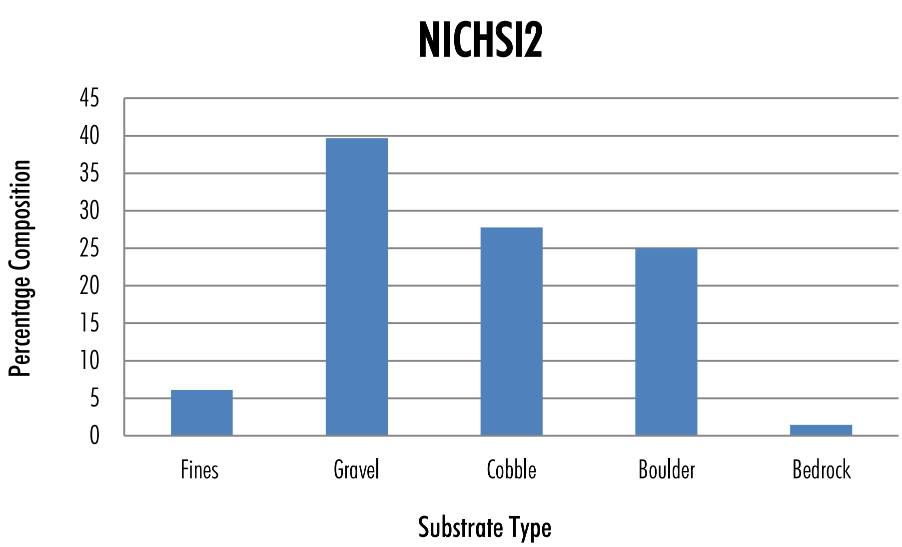

Figure 47. Percentage composition of substrate types at NICHSI2, displaying all gravel samples together.

10.B.2.2 NICHSI3

The site at NICHSI3 was characterized by a large braided section of stream due to an island in the center of the main stem of the river. Distribution of substrate varied between the two separate channels that were formed in the braid. The "A" channel of the braid was narrower, with a smaller volume of water moving through the channel, especially at transect 5, where transect "5B" ran through fast moving waters that closely resembled rapids. The presence of the high velocity waters is reflected in the substrate, as there is a higher presence of cobble and boulder present at transect "5B" than "5A".

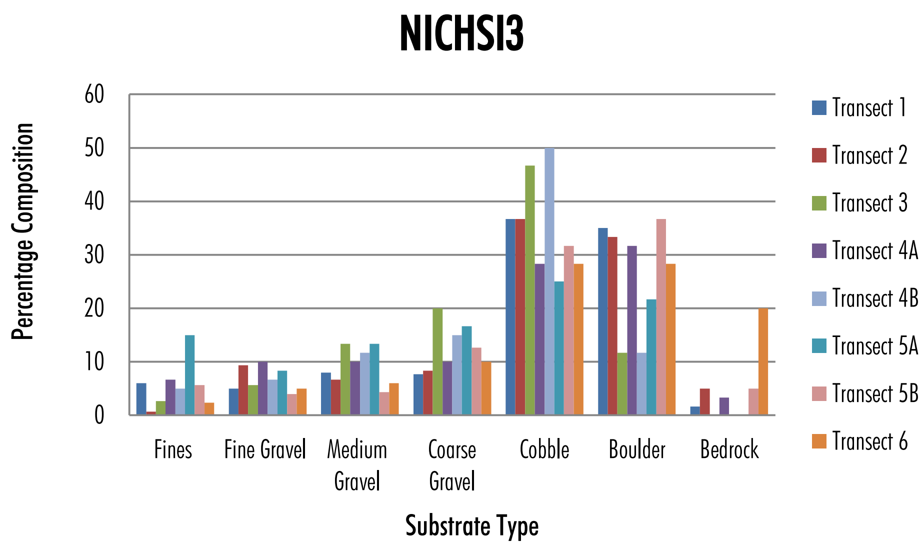

Figure 48. Percentage composition of substrates for individual transects at NICHSI3.

Table 34. Average substrate size and percent fines for transects in NICHSI3.

	Transect #1	Transect #2	Transect #3	Transect #4A	Transect #4B	Transect #5A	Transect #5B	Transect #6
Average Substrate Size*	6.1-40cm	6.1-40cm	6.1-40cm	6.1-40cm	6.1-40cm	6.1-40cm	6.1-40cm	6.1-40cm
Percent Fines	6	0.7	2.7	6.7	5	15	5.7	2.3

*Average substrate size could not be adequately calculated, as grain sizes were classed into broad categories, therefore a rough estimate based on category mean sizes was calculated to determine what categorical range the average size values fell within.

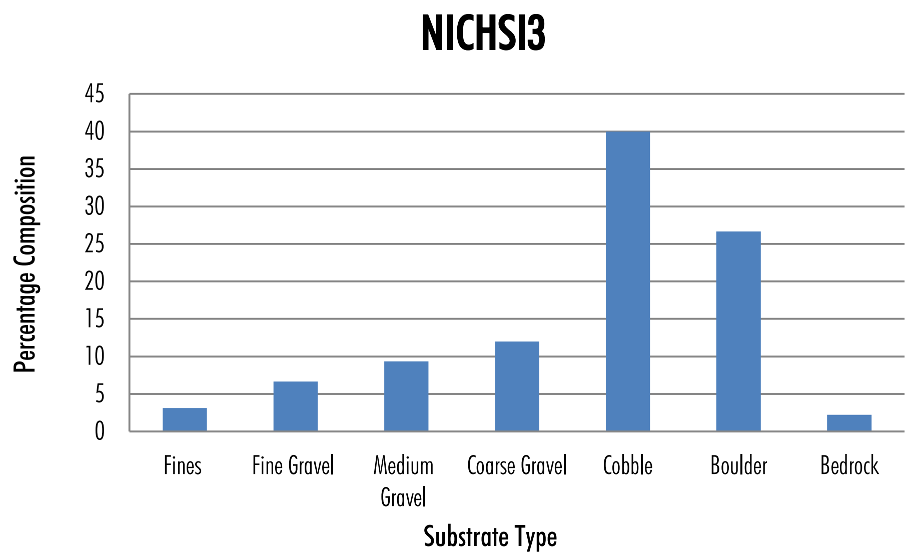

Figure 49. Percentage composition per substrate type for NICHSI3.

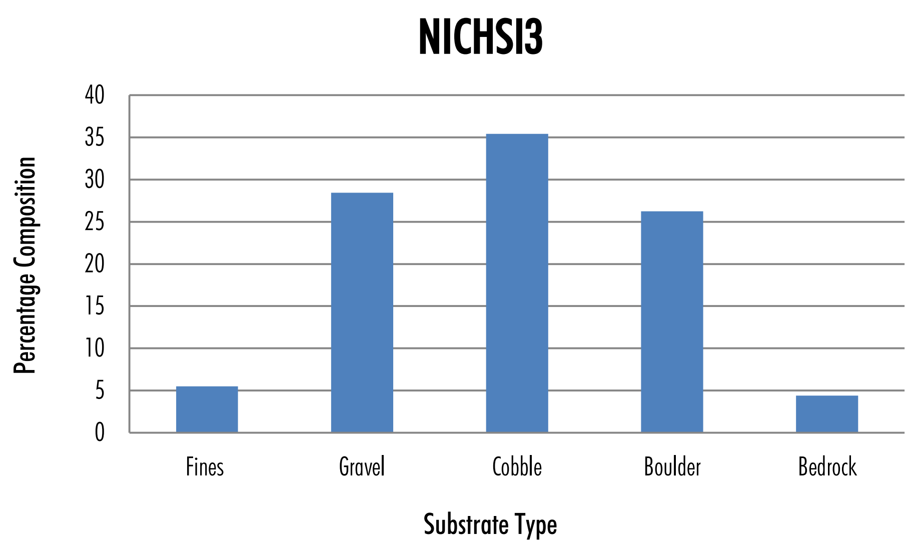

Figure 50. Percentage composition of substrate types at NICHSI3, displaying all gravel samples together.

10.B.2.3 NICHSI4

The substrate at NICHSI4 varied between transects primarily in the amounts of cobble and boulder present at each transect. This is likely partly attributable to the size of the stream (the Waterloo River), which was rather narrow, and therefore the presence of a large boulder would significantly alter the percent composition of boulders as part of the substrate, for example. The composition of fines and gravels remained fairly consistent between transects, but were not the dominant substrate types observed (Figures 52 and 53).

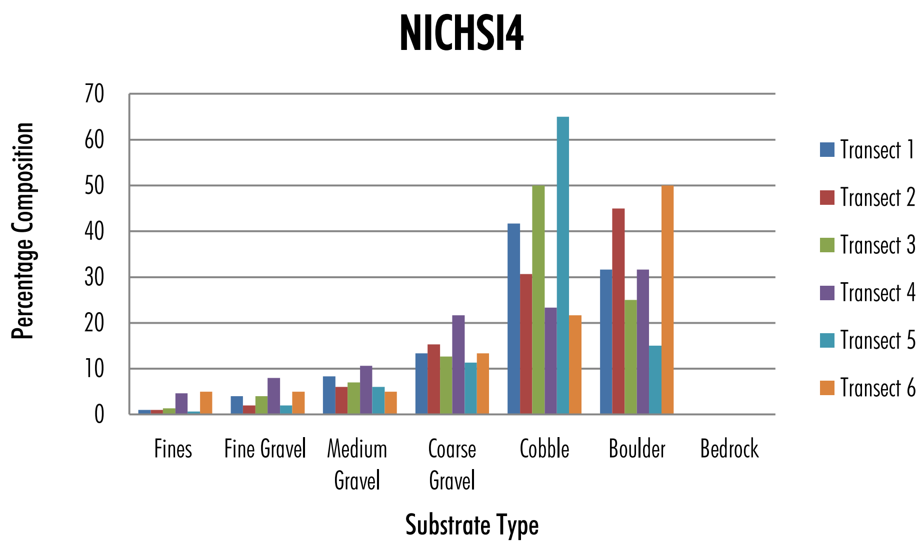

Figure 51. Percentage composition of substrates for individual transects at NICHSI4.

Table 35. Average substrate size and percent fines for transects in NICHSI4.

	Transect #1	Transect #2	Transect #3	Transect #4	Transect #5	Transect #6
Average Substrate Size*	6.1-40cm	6.1-40cm	6.1-40cm	6.1-40cm	6.1-40cm	6.1-40cm
Percent Fines	1	1	1.3	4.7	0.7	5

*Average substrate size could not be adequately calculated, as grain sizes were classed into broad categories, therefore a rough estimate based on category mean sizes was calculated to determine what categorical range the average size values fell within.

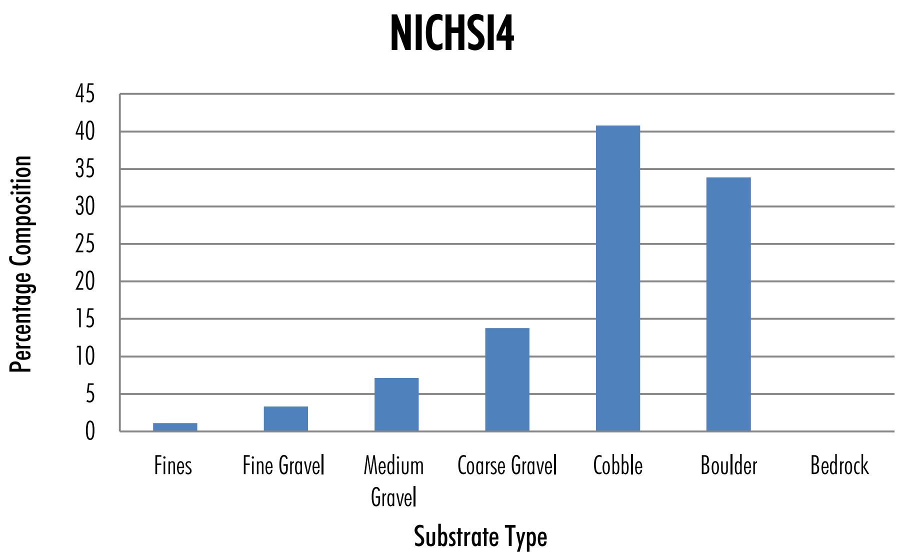

Figure 52. Percentage composition per substrate type for NICHSI4.

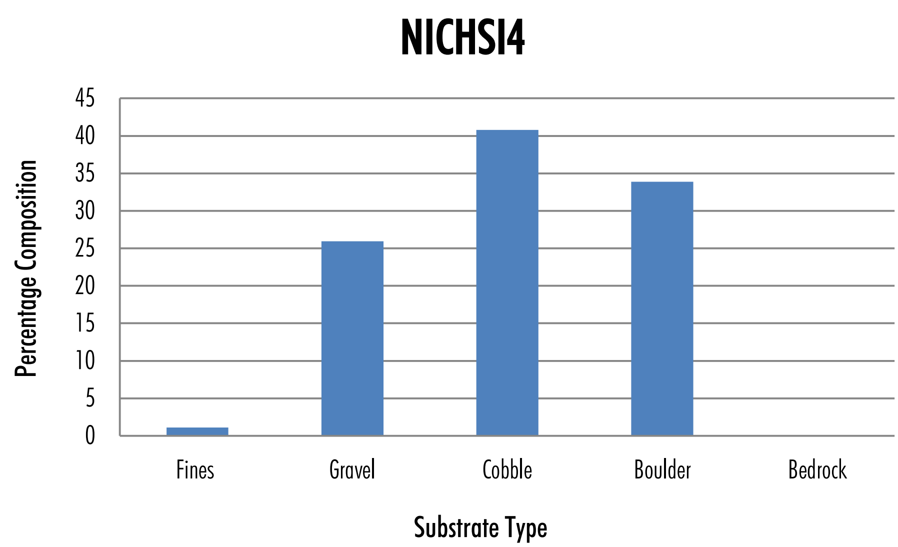

Figure 53. Percentage composition of substrate types at NICHSI4, displaying all gravel samples together.

10.B.3 In-Stream Cover

In-stream cover is an important component of fish habitat quality. Spawning areas with adequate cover help to reduce the risk of predation and/or disturbance to fish populations (Bjorn & Reiser, 1991). Table 36 presents suitable cover quality values for brook trout. Sections 10.B.3.1 through 10.B.3.3 present more details on individual site cover information, displaying the cover values for individual transects at each site.

Table 36. HSI in-stream cover quality categories for brook trout (Brunner, 2012).

Variable		Poor Quality Values	Fair Quality Values	Optimum Quality Values
Percent In-stream Cover	Adults	<2%	2 – 15 %	>15%
	Juveniles	<4%	4 – 25 %	>25%

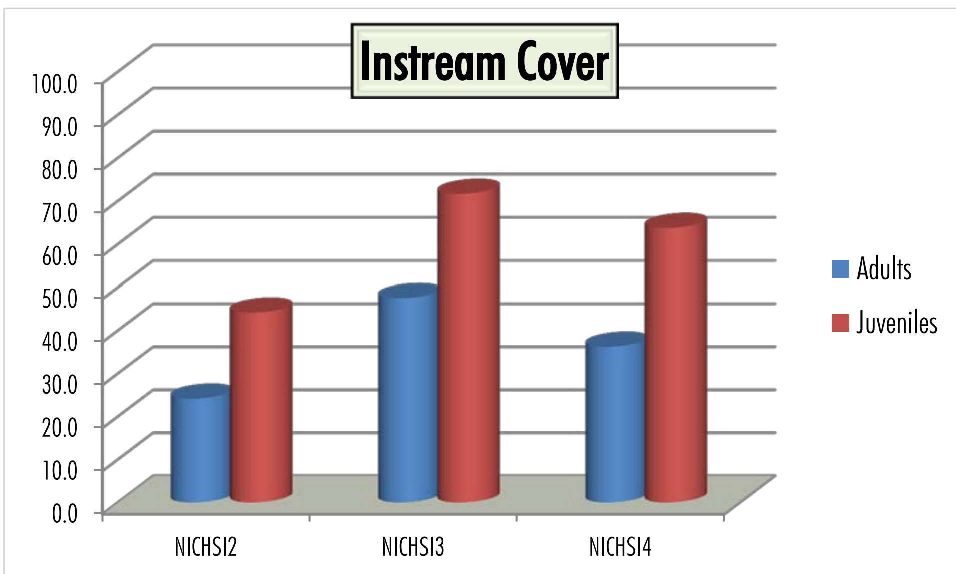

Figure 54. Overall percent in-stream cover for adult and juvenile salmonids, listed by site.

10.B.3.1 NICHSI2

The site at NICHSI2 (Figure 55) displayed the lowest percent cover values of the three sites assessed, with cover values for adults ranging from 10 to 40%, and from 30 to 60% for juveniles. There was plenty of cobble substrate present at this site, which provided small amounts of cover. There were also some larger rocks present in the rock weirs that could provide some cover for adults, however, there was a lack of larger cover in the spaces between the weirs, and a lack of habitat complexity (i.e. pools, eddies, riffles, etc.). It should also be noted as well that the percent cover recorded at these sites may be subject to change as water levels fluctuate widely on this river system due in part to hydrological controls at the power dams along its length.

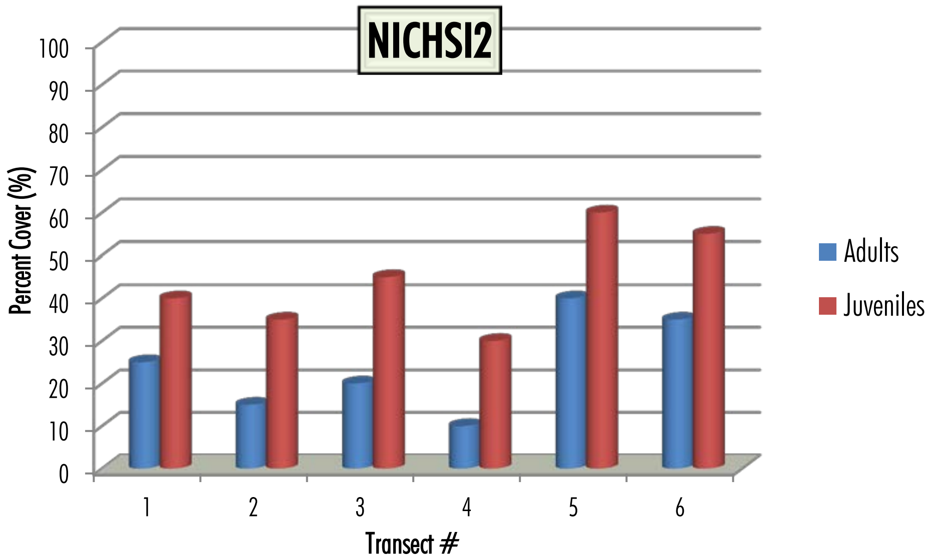

Figure 55. Percent in-stream cover for juvenile and adult salmonids at NICHSI2.

10.B.3.2 NICHSI3

The site at NICHSI3 displayed the highest site average for the amount of cover available for juvenile and adult salmonids at the time of sampling. NICHSI3 also had the highest variability between transect values, ranging from adult cover of 10 to 75%, and 30 to 90% for juveniles.

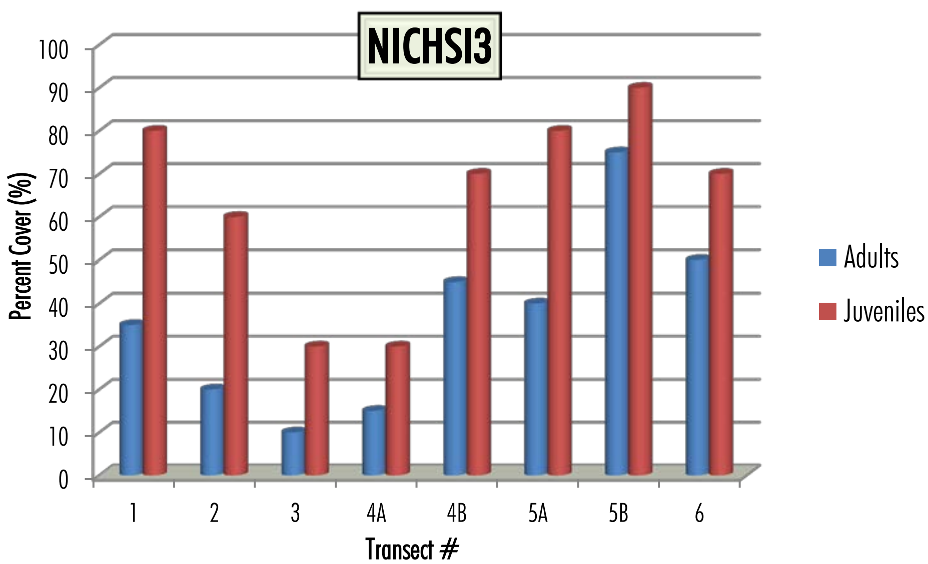

Figure 56. Percent in-stream cover for juvenile and adult salmonids at NICHSI3.

10.B.3.3 NICHSI4

The site at NICHSI4 had cover values that ranged from 25 to 70% for adults, and from 50 to 90% for juvenile salmonids, which are optimal cover values. The site contained an array of various habitat types as well, such as a mix of pools, eddies, riffles, and runs.

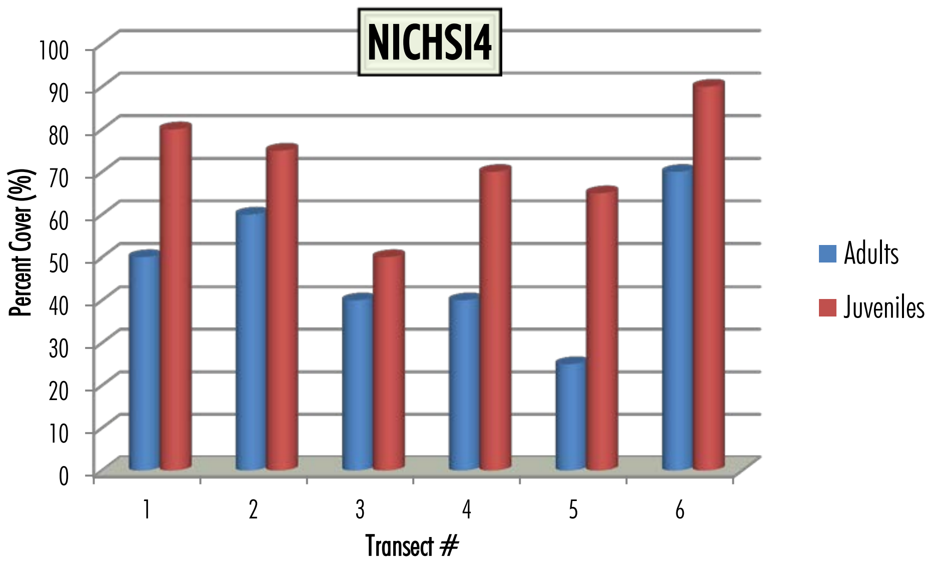

Figure 57. Percent in-stream cover for juvenile and adult salmonids at NICHSI4.

10.B.4 Vegetative Cover

The presence of adequate vegetative cover on streambanks is essential for good quality habitat for fish species, as it helps to provide stream shade, and stabilize eroding banks. Table 37 lists the vegetative cover categories for suitable habitat quality for brook trout. Figure 58 shows the percent cover and exposed ground for each of the sites assessed, while Figures 59 through 61 illustrate the cover for each of the individual sites, for each bank. Figures 59 through 61 display little to no variation between banks at each of the sites, in terms of the amount of cover present. All values fell within desired ranges (i.e. Fair or Optimum) for brook trout.

Table 37. HSI vegetative cover categories for brook trout (Brunner, 2012).

Variable	Poor Quality Values	Fair Quality Values	Optimum Quality Values
Average Percent Streambank Vegetation	<60%	60-150%	>150%
Average Percent Rooted Vegetation/Stable Ground	<25%	25-75%	>75%

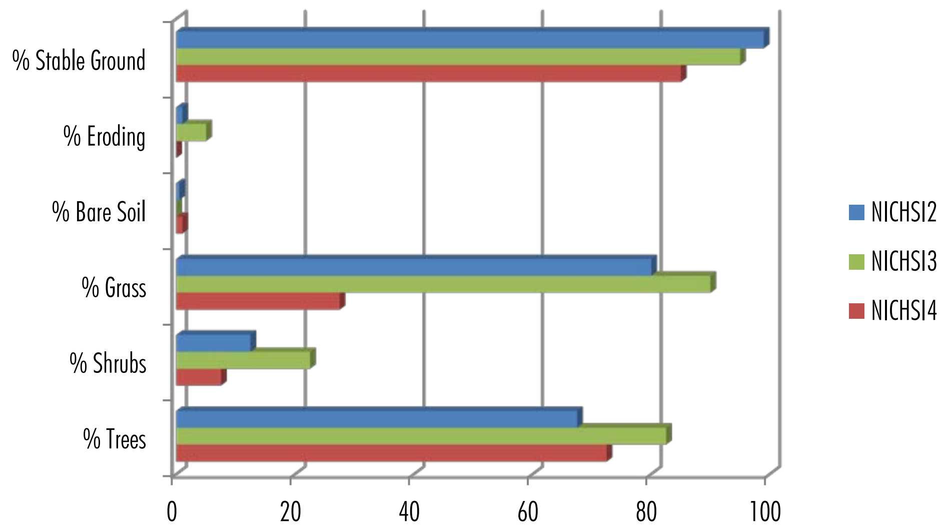

Figure 58. Overall vegetative cover for the Nictaux River, portrayed by site.

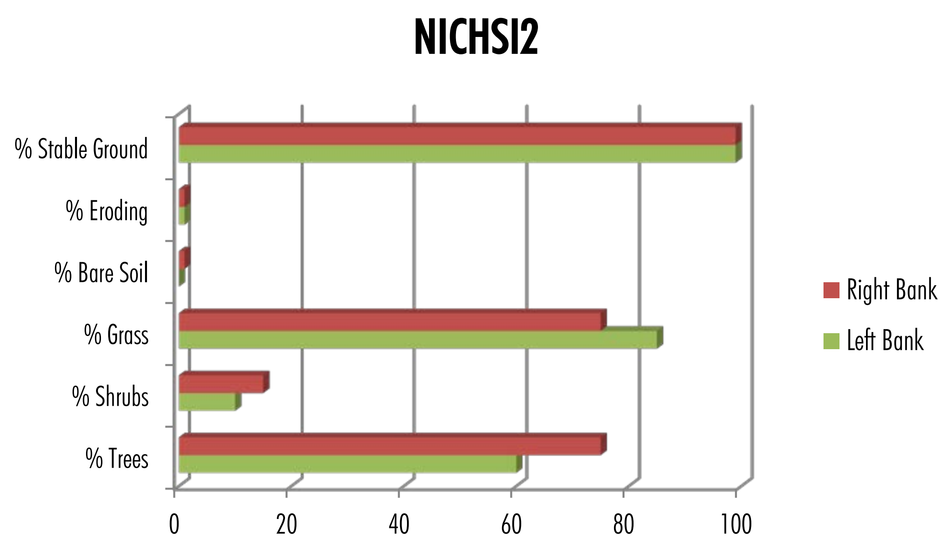

Figure 59. Vegetative cover for NICHSI2, portrayed by riverbank.

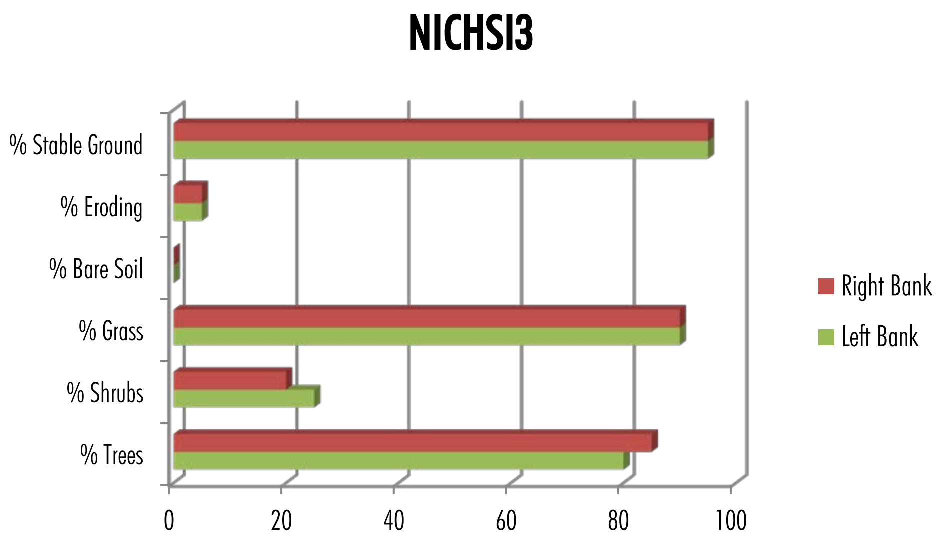

Figure 60. Vegetative cover for NICHSI3, portrayed by riverbank.

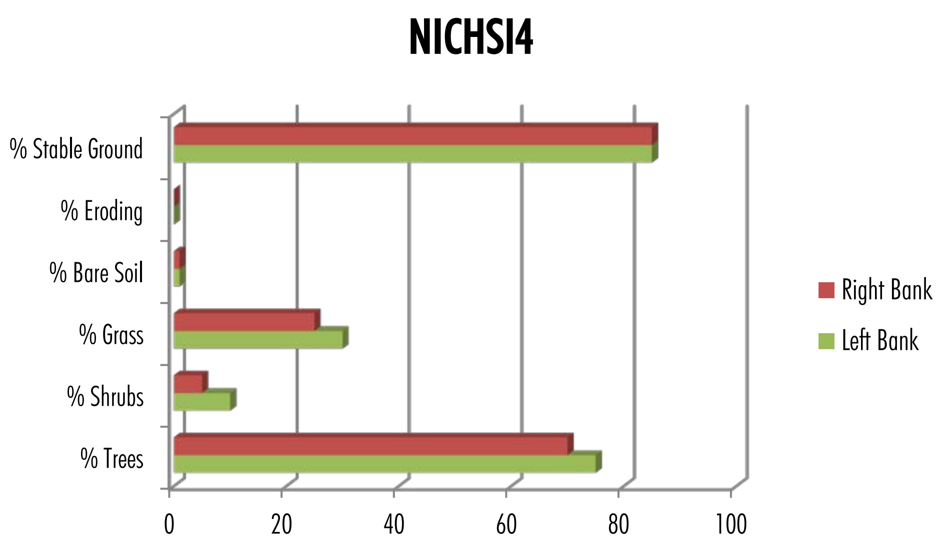

Figure 61. Vegetative cover for NICHSI4, portrayed by riverbank.

10.B.5 Benthic Macroinvertebrate Rapid Assessments

There are a few methods of benthic macroinvertebrate assessment from detailed studies (i.e. CABIN sampling) to coarser-level studies. As part of the HSI protocols, rapid assessments were completed to gain a coarse understanding of the types of aquatic insects present at a study site. Rock grabs were completed at each site, and all invertebrates were identified on the rocks until a minimum of 100 bugs had been detected. Sampling was conducted in the fall, and invertebrates were classified to order (except for the chironomidae, which were identified to family). Figures 62 through 64 display the relative abundance of each type of macroinvertebrate order identified from the rock grabs. In general, in the Nictaux River system, using the rapid assessment tool, it was noted that the order Trichoptera (caddisflies) were present in the most abundant numbers.

Figure 62 shows the results from the rock grab performed at NICHSI2, where Trichoptera (caddisflies), Plecoptera (stoneflies) and Chironomidae (midges) were the most abundant. The presence of higher numbers of insects such as Trichoptera, Plecoptera and Ephemeroptera (mayflies) generally are indicative of better water quality as they are less tolerant to the presence of pollutants in a water body. The percent of these in a water column is called the %EPT, and represents a proportion of the amount of these insects that are present in a water column as compared to other more tolerant species. Other measures are also used in analyses, but require more precise sampling and identification of insects. The %EPT in the sampling conducted at NICHSI2 was 61%.

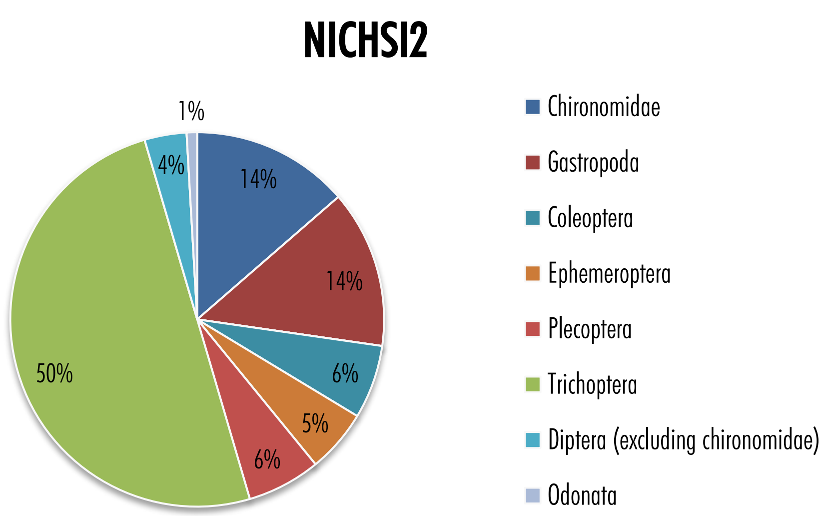

Figure 62. Relative abundance of benthic macroinvertebrates from rock grab sampling at NICHSI2.

Figure 63 shows the results from rock grab sampling at NICHSI3, where there was a much lower diversity in insect types observed than at NICHSI3. Nearly the entire sample consisted of species of Trichoptera (83.3%) or Chironomidae (12.6%), whereas all other species made up less than 5% of the sample. The percent EPT in the sample was 86.1%. While the presence of Trichoptera is encouraging, the lack of diversity in insects may make this site less preferable as a food source than other reaches. It is difficult to say also whether water level fluctuations in this reach may have played a role in influencing the species observed, or whether the particular series of rocks analyzed presented a skewed sample of the population of invertebrates at the site.

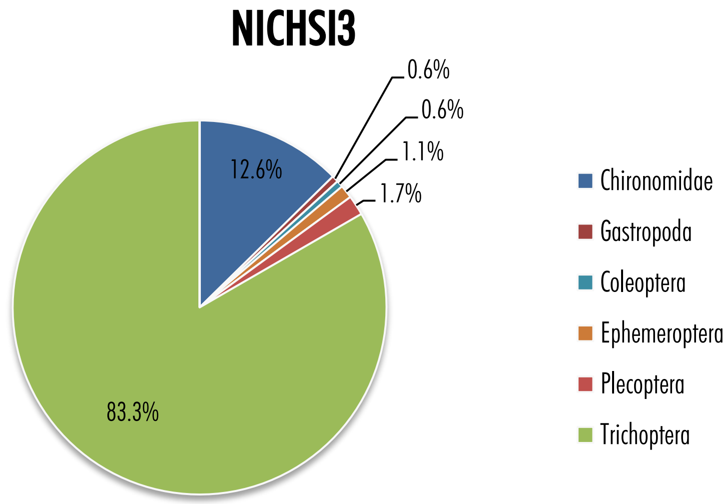

Figure 63. Relative abundance of benthic macroinvertebrates from rock grab sampling at NICHSI3.

The site in the Nictaux headwaters, NICHSI4, displayed the highest diversity of aquatic insects of all three sites observed (Figure 64). Trichoptera were still the most abundant order observed (28%), followed closely by Chironomidae (25%). This site also contained a higher mixture of other invertebrates such as Coleoptera (beetles), Bivalvia (clams), and Plecoptera. The percent EPT in the sample was 41%. Overall, the presence of such an array of invertebrates likely indicates good water quality at this site.

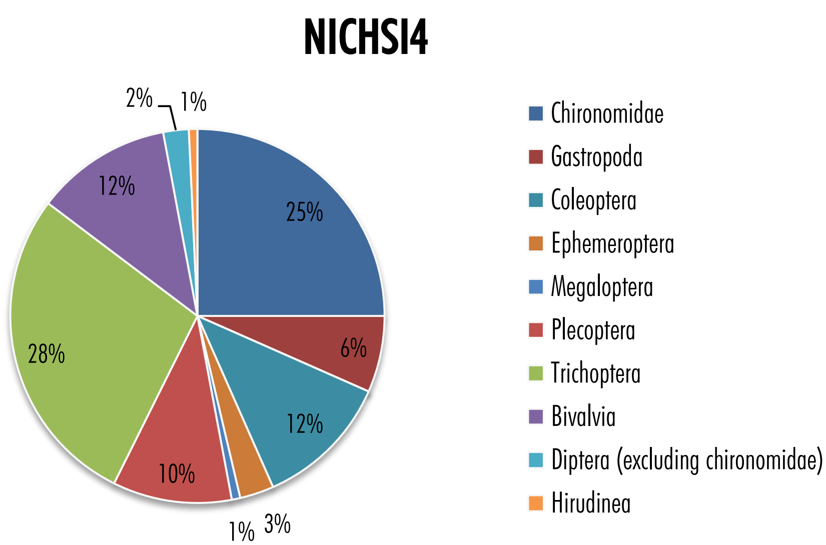

Figure 64. Relative abundance of benthic macroinvertebrates from rock grab sampling at NICHSI4.

For more detailed benthic macroinvertebrate results, refer to the CABIN sample results described in Section 4.3.

10.C Appendix C: Culvert Classification and Prioritization Tables

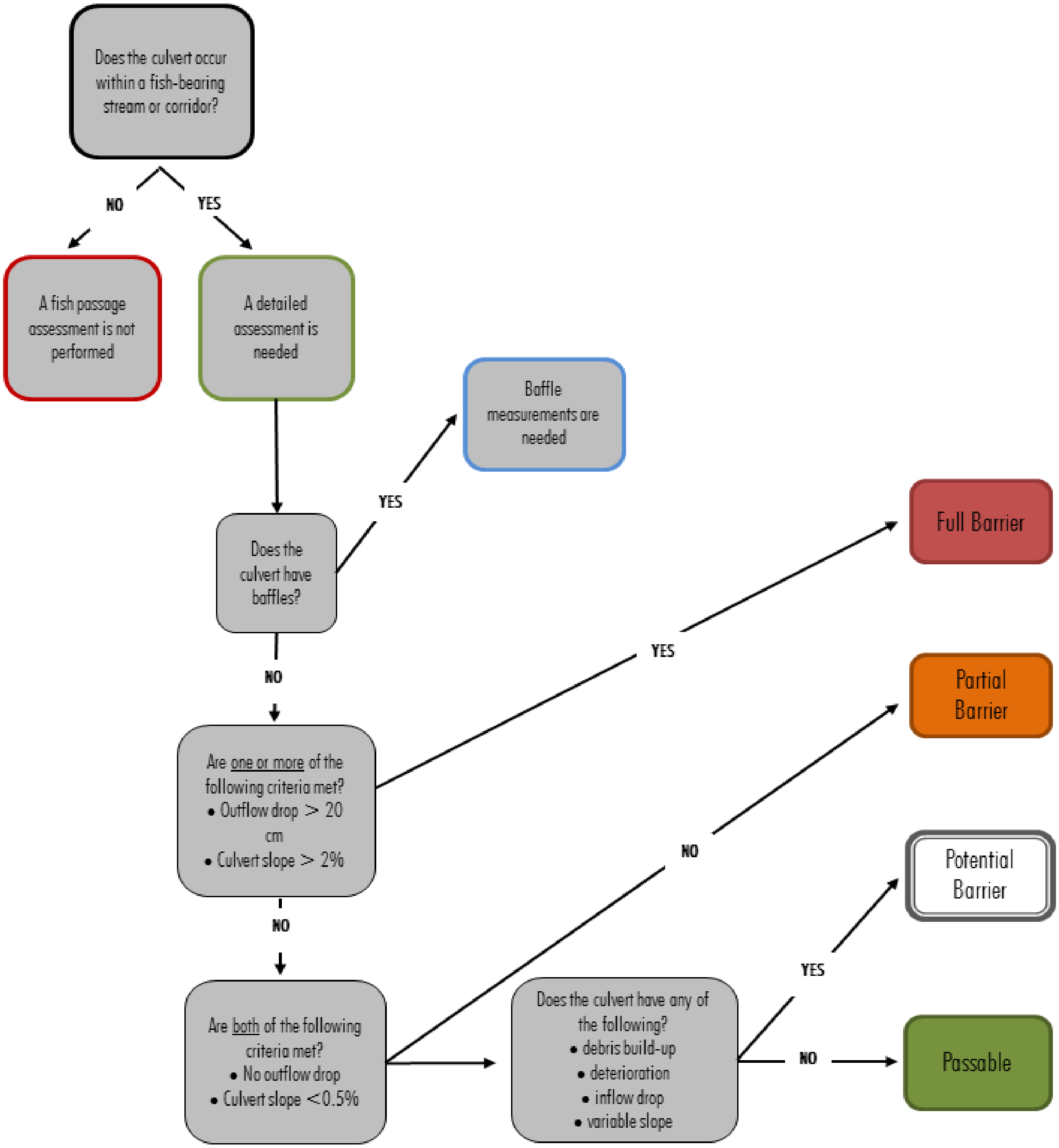

Figure 65. Flowchart for classification of barriers.

Table 38. Barrier type and criteria for determining fish passage.

	Barrier Type	Criteria
Meets Provincial Guidelines	**Non-Barrier**	Both of the following criteria must be met: No Outflow drop Culvert slope < 0.5%
Does Not Meet Provincial Guidelines	**Partial Barrier**	One or more of the following criteria are met: Outflow drop < 2 body lengths of the target species Culvert slope between 0.5% - 2.5%
	Full Barrier	One or more of the following criteria are met: Outflow drop > 2 body lengths of the target species Culvert slope > 2.5%

Table 39. Barrier culvert remediation options for culverts that do not meet provincial guidelines.

Barrier Type	Remediation Option	Criteria
Partial Barrier	Debris removal	No outflow drop Slope < 0.5% Debris obstructing inflow or outflow
	Channel roughening	No outflow drop Slope < 1.0%
	Tailwater control	Outflow drop < 30 cm Slope < 2.0%
	Baffle installation	Outflow drop < 1 body length of target species Slope ≥ 2.5%
Full Barrier	Baffle installation and tailwater control	Outflow drop < 30 cm Slope ≥ 2.5%
	Removal of structure/ fish ladder	Outflow drop > 30 cm Slope ≥ 7.0%

Table 40. Road watercourse crossing prioritization index.

Variable	Criterion	Score
Number of downstream barriers	0 barriers	10
	1 barrier	5
	>2 barriers	0
Upstream habitat gain	>4.5 km	20
	4 – 4.5 km	18
	3.5 – 4 km	15
	3 – 3.5 km	14
	2.5 – 3 km	12
	2 – 2.5 km	10
	1.5 – 2 km	8
	1 – 1.5 km	6
	0.5 – 1 km	4
	<0.5 km	2

Table 41. Prioritization categories for culverts based on prioritization scores.

Priority Category	Prioritization Score Range
High	24 to 30
Medium	9 to 23
Low	2 to 8

10.D Appendix D: Nictaux River Angler Survey

Nictaux River Angler Survey

This survey can also be filled out online at: https://www.surveymonkey.com/s/LDB2X3B

This survey was created by Clean Annapolis River Project to gather current and historic recreational fishing information on the Nictaux River – where species have been found in the past, where they are no longer found, and how conditions in the rivers have changed – to help guide future actions for the Nictaux subwatershed.

1. What community do you live in?

2. Which parts of the Nictaux River system do you like to fish?

☐ Below Martyn's Mill Dam
☐ Below the power house (Nictaux Falls)
☐ Below the main storage reservoir (and above the power house)
☐ Between the main storage reservoir and Shannon Lake
☐ Other: ____________________
☐ Oakes Brook
☐ Shannon River
☐ Waterloo Creek
☐ McGill Lake

3. Have you observed and/or ever caught the following species in the Nictaux system? (check all that apply)

☐ Brook trout ☐ Brown trout ☐ Atlantic salmon
☐ American shad ☐ Smallmouth bass ☐ Other ____________

4. If you answered 'Yes' to Question 4, where have you observed/caught the fish on the Nictaux River system?

☐ Below Martyn's Mill Dam
☐ Below the power house (Nictaux Falls)
☐ Below the main storage reservoir (and above the power house)
☐ Between the main storage reservoir and Shannon Lake
☐ Other: ____________________
☐ Oakes Brook
☐ Shannon River
☐ Waterloo Creek
☐ McGill Lake

5. Have you ever observed/caught Atlantic salmon as bycatch while fishing for other species in the Nictaux River?

☐ Yes ☐ No

6. If you answered 'Yes' to Question 5, what age class was observed/caught?

☐ Parr (< 5 inches) ☐ Smolt (5-6 inches) ☐ Adult (>6 inches)

7. When was/were the fish observed/caught? (check all that apply, and please specify the year, if possible, in the space below)

☐ Before and including the 1930s
☐ 1940s
☐ 1950s
☐ 1960s
☐ 1970s
☐ 1980s
☐ 1990s
☐ 2000s
☐ 2010s or later

Notes:

8. What do you think are the main issues that have led to the decreased numbers of Atlantic salmon?

9. Have you noticed any changes in the condition of the rivers/streams in the Nictaux sub-watershed?

☐ Yes ☐ No

10. If you answered 'Yes' to Question 9, please describe these changes.

11. Do you have any other comments or concerns? (i.e. restoration work you'd like to see, other points of note about fish in the Nictaux River system, etc.)

Contact Information

Please provide your contact information if you are interested in discussing this matter further, or if you have additional information to provide. Any contact information provided will remain confidential.

Name:
Phone Number:
Email:

This survey was created by Clean Annapolis River Project

10.E Appendix E: Interview with Perry Munro

Perry: You're trying to find how to find how to enhance the river. There's quite a story behind the whole thing. I have a bit of information, an economic study on the River, how many economic days it takes to catch a salmon, and so on. You can get a taste of what it was like, except that there's no data from before when the dam went in.

Lindsey: Ok

Perry: They put the dam in, and that eliminated a lot of the Nictaux River's potential. There's two things wrong with that: one thing was that they control the water, and the second thing is that they control it very badly. The reason for this is the turbine's too big. It always has been. If I was going to improve the Nictaux River, I would insist that the Power Corp put a smaller turbine in.

Lindsey: Ok, you mean for the large one-

Perry: Yes, that's for the big one. The problem is that the turbine's so big they can't run a normal flow, so they run it flat out til the thing's empty and the river goes dry.

Lindsey: Great.

Perry: Yes, that's the only reason the river goes dry. It's the inability of the Power Corps to manage that water better. That they're holding back. Their reservoir in other words and their supply of water, cannot keep up to the demand of their turbine. So the turbine runs flat, and as slow as it goes, it's going too fast. So by the time, say, the snowmelt is gone, we are into July and August, there's no water left.

Lindsey: Yeah, we were doing habitat work in the river –

Perry: Especially when you're dealing with salmon, uh which require riffly water. Trout, they can live in more pond, pool areas. The water goes, they can still exist in pools. Different species require different habitats. The problem is you have a dry river, you've got no river. You can't maintain it. So, years ago, I wanted Martyn's Mill dam taken out, and they said, oh we can't do that, and I said "Why not?". "The thing is an impediment to a lot of spawning habitat in the river, and uh, for shad, for salmon. There was salmon at the time. So they built a ladder. They spent a lot of money building a ladder. Then they found out that they had to manage the ladder. So when they found out they had to manage the ladder, they thought it was probably easier to tear the dam out. Nobody tore the dam out, and the ladder there now exists. They were willing to spend that kind of money on that, well, they should find a way of managing the water. What they didn't negotiate on the Nictaux River should be negotiated at least, I think. We own the water. It's our water. They are messing around with our water. So every six or five years we sign an agreement with the power corps on the use of the water. I've been part of the negotiation of different things like smallmouth bass spawning in spring, so we'd have to have stable water levels here. Gaspereau spawn here, salmon spawn here, trout spawn here, all different species. Pickerel spawn here, so all these different species with different requirements.

So the Power Corps has to modify and morph their use of the water based on our requirements for wildlife.

Lindsey: Right. Yes, I believe they told me that they were only required to flow 6 cfs in the summer.

Perry: That's what you have to negotiate. You have to say, "This is what 6 cfs looks like, and this is what 10 looks like, and this is what 15 looks like, and this is what 25 looks like. We want 20. Then they'll say, 'Nah, we can't do that.' Well, you can if you put a different turbine in. You know, and say well you can't use the water, we want the waterway free and easy. You want the dam gone. They're not going to do that. They'll negotiate something with you, because it's not like they lose the power. What they lose is evaporation. When the summer comes on the impoundments, on the reservoir, they'd just love to drain it, because what happens in the summer coming down as the water levels drop, evaporation takes over, and they lose power. So that's what you have to do, you have negotiate with them on a minimum flow on the river, even though that minimum flow now is not sufficient. You just say "What we want to do is this …, and we require this… to do it, and it doesn't affect you at all, except that you have to supply us with this water in the summertime." That's all we ask.

Lindsey: Now what about fish access to upstream reaches?

Perry: They should've had a ladder. But then again, the impoundment they built also destroyed a lot of the spawning habitat. So you lost that. From the headwaters of the Shannon all the way through. It's a beautiful watershed, and it's funny how fish don't migrate all the way through that watershed. Because, like Squirreltown up and around in that area you've got brown trout, you've got all these species. They don't make it through. They're small in these areas, and for some bizarre reason they don't migrate nearly that quickly.

Then everybody thinks that smallmouth take over that whole system, a whole watercourse. Well, yes and no. I use the example of the Nictaux and the Annapolis quite frequently. The spread of smallmouth bass is dependent upon habitat, same as any fish. And it's obvious that not all rivers have the habitat that smallmouth need or want. Nictaux does. Not a lot, because it doesn't expand very much. They are only in about a 300 yard stretch on any consistent basis.

Lindsey: We found some smallmouth below where the Falcourt is.

Perry: Yeah, well the Falcourt Inn comes down around the - well, actually, there's an abutment, I don't really know what the abutment is for, but you come up from the confluence, you come up through about a mile, there's an abutment, it's a big cement abutment. I've caught smallmouth in that area. Years, ago I caught one by the Falcourt Inn. That's all. But that's interesting too. That Falcourt Inn was the largest sporting lodge in Nova Scotia. That shows you how valuable the Nictaux was. And when they put the dam in, the way they planned on saving the river was to build a fish hatchery.

Lindsey: Whereabouts did they build that?

Perry: It's still there. Just below the bridge in Nictaux River. Across the bridge on your left-hand side.

Lindsey: The bridge by the Falcourt?

Perry: Yep. See what they did there, they realized they screwed up the salmon run. Big time. So, they then had a mitigating plan, where they would mitigate the dam by raising the fish. So the salmon from there would be taken, they would strip the eggs, hatch the eggs, and then put them back in the river. But then all of a sudden they decided to expand this program. So, all of a sudden, the Nictaux salmon spread all over Nova Scotia. It was a bizarre thing, because they didn't understand that genetics of salmon changes from river to river. They didn't understand that each river has its own genetic component. They just thought salmon were salmon. So it was a failed experiment. Eventually, they found a way of getting themselves out of that hatchery. That's what the difference is. It was part of that hatchery, part of the history of the river that saved salmon. I grew up in Lawrencetown, so I spent a lot of time in that country. I had a camp back in Slippery Lake, in that area, by Shannon River. When I was a kid growing up, the Shannon River only had white perch, it didn't even have trout. Hundreds of them. So, some of them say, "the good ol' days". Well, in the good ol' days, some places were better than others. Now I can go down the Shannon River and I can catch brown trout, all the way through to Squirreltown. Decent too. So that's changed. However that's changed I don't know, but as a kid growing up I could fish trout in Zwicker Lake and the stillwaters in back. And I all I was fishing in the Shannon River was perch, and that's all I did because that's all there was. All that country back in there is good fish habitat. The soil is fairly/semi buffered, your pH is not all acidic. It needs those things. And there should be more known about it. I think it's one of the nicest little rivers. It's only nice in May/June, because of the water.

I remember one time I was filming a TV show, one of those fishing shows, and I wanted water in Nictaux for the show, so I asked for water. I wanted to make sure there was water that day. So I went up, and got all set up to do the show, and there was no water. So I drove up and I said "There's no water", and they were like "Oh right, today's the day for water" and they flicked a switch. But of course they can't put a small flow on, they can only go full. So they flooded us right out.

Lindsey: Yeah, we had the same problem in the fall, when we were trying to do an electrofishing survey, as they told us they weren't going to let out the flow until the end of September, and then they let it out early.

Perry: That's because they have no way of regulating back. The lowest flow they can give you is too much. They don't want to talk about that, and I don't blame them. It's not their fault, it's the way the thing was built. You see in those days they just built power dams and they didn't care. Paradise, Nictaux. Nothing but canals, pipelines, power dams. But we've negotiated a reasonable, uh we've given up/ sacrificed some lakes, we call them sacrificial lakes, and say, well okay, we'll write these off. And use those for that purpose. But that has to be that. They've been pretty good about it. We always butt heads with them – they're an arrogant bunch. We hired a lawyer one time to phone them up and say, if you don't start to smarten up, we'll just do everything through a lawyer.

Lindsey: Did that work for you?

Perry: *Laugh*. Yes. They don't want the publicity. They don't want a bunch of people trying to do good work in the environment being stonewalled by a large corporation to every person in this province who has to dig in their pocket every month and give them way more than they deserve. They're not popular to begin with anyway. Nobody likes them. But I thought I'd give you this to look at and uh, it's a commercial sportfish document. It goes back into the, actually 1700s, when they first started supporting salmon. There was no sportfishing for salmon. It was just for commercial purposes; it was all sold and shipped back to England. In the mid-1980s there were no salmon in the Medway River. Anyways, in the back of this book, if you have a look at it, there's different calculations on the province's salmon rivers. And it qualifies, it's quite a big river actually, even with the dam in place it's a pretty big river. *Looks through pages*. 13 salmon. If you look, you'll see all these other rivers don't have any by this time. 1935, these rivers don't have any, they're all gone by then.

It's just now that this happened, it happened years and years ago, and no one gives a shit. Nobody even knows. Some of these rivers now have salmon, they've been re-introduced. In those days none.

Lindsey: Is anybody still recording these numbers?

Perry: No. Not really. They're supposed to be. They're very important numbers if you want to manage something, but they're not managing anymore. Here's the Nictaux.

Lindsey: In 1937 they got quite a lot.

Perry: Yep, '37… 253. You see that's when the dam, before it was still a historic right. Now look what happened after the dam went in.

Lindsey: So what year did it go in?

Perry: In the '30s… that's all I can find. But you have a bunch of salmon there… and then none… none… and none… See with the falls, Nictaux Falls, pictures of Nictaux Falls – I have a picture up at home. It wasn't impassable to salmon. The water's excellent.

Lindsey: Mmm hmm. It is. And then once they put the dam in it became impassable?

Perry: Well, the dam came along, and they allowed them to put that dam in without a fish ladder. But, remember, you have to put yourself back in time too. Back during the Second World War was ending they needed power, so salmon weren't going to get in the way of that. Nor should they have at the time. But they should've at the time afterwards, they should've gone back and said 'Ok, we've messed this river up, let's put a fish ladder in it'. It takes millions and millions to do it now. The way it could be done is a form of sea link, but then they put in the Tidal Power plant in Annapolis, and that destroyed the striper run in the Annapolis, and also, basically, destroyed the salmon run. It's like every time you turn around, problems with fish, and power is somehow involved.

If you look here, '63, '64, '65, they stopped doing the Nictaux. Last year in the Inner Bay of Fundy I caught 18 salmon, and the Cornwallis River, and the next year there wasn't any.

Lindsey: Have you caught any on the Nictaux?

Perry: Yeah. Actually, I hooked one, I didn't bother landing it. And I hooked it and let it go… (Looking at book again) 1955… 1600 raw days, 71 salmon. So, yeah, you can get a feel for it out of that. Just have a look at it and photocopy what you want. Yeah, uh, I've seen people catching parr in the Nictaux.

Lindsey: Just in the lower region?

Perry: Yeah. But I don't think that was part of taking the broodstock up the ladder. They were collecting broodstock, collecting the eggs and hatching the eggs, and then raising the parr in the river. I've been there in the summertime, and it was not conducive to spawning.

Lindsey: Ok. Umm, another question I have for you… I know there's concern that's been raised about providing fish access past the dam with having smallmouth bass present in the lower reaches and not wanting them to gain access to the upper reaches. What do you think about that?

Perry: Well, first of all, smallmouth bass don't like velocity in water. So, I don't see them moving up, especially there, because they haven't moved. They haven't expanded their range and they haven't expanded their size. They are all the same size, little things. Not a lot of big ones. And always I'm fishing shad or trout. They're only in a small part of the river. Uh, moving the fish above the river, you have to go above the river, above the dam, to see what's there. Do a habitat inventory, before you move fish.

Lindsey: Yes, we were doing some electrofishing surveys up there. (Shows on map). So we were doing some below the power house down around here, and then one between the power house and the reservoir, and then another up around Squirreltown Rd. So, up here we were finding some trout, and down here we were finding smallmouth bass. (More showing of locations).

Perry: The person who would know the answer to that is Andrew Hebda. He's with the Natural History Museum in Halifax. He did his PhD on water velocity and smallmouth bass. So there you go, he'd know the answer to that. We've been pondering the question for some time about what actually goes on here, because if you ask the ordinary person, they'll blame everything on smallmouth bass. It used to be acid rain, now it's smallmouth, or it's the tidal power plant… it's always something, but never them. Never them. But the reality is, there's a couple of examples I know of smallmouth bass that have not migrated in a system. The Gaspereau River. Now, in the bottom of the

Gaspereau River we have stripers, smelts, gaspereau. They migrate through the whole system up to Gaspereau Lake down through all the lakes. Now, smallmouth bass, extensively the best smallmouth fishing in Nova Scotia is in those lakes, or headwaters. When you come down into the river part, there's no smallmouth. There's a gazillion smallmouth in Gaspereau Lake, so many smallmouth that they have a harvest, a bag limit extended beyond 10 or 15 fish per day. And there's so many smallmouth bass in Gaspereau Lake that it's affecting everything. The reality is, the gaspereau run maintains its strength, and the trout are still in the river, and you don't get smallmouths in the river. We always believed there was something with velocity, something, that whatever was keeping those bass from moving, they don't move. The Gaspereau's been like that now for… 30 years. It hasn't changed. Smallmouths still stay in the lakes.

Lindsey: So if you could get ideal velocity all year round…

Perry: Well, of course, they're not going to move. The thing about a fish ladder…

Lindsey: I was just thinking, because you were mentioning about getting some sort of regulation for the flow…

Perry: I think its fine to be worrying about the dam flow, not worrying about getting fish up over. Uh, you could develop the top part as a trout stream, and the bottom part you'd have a wonderful sea run from the stem of the Annapolis to the end of that pit. It's a wonderful run. There's been a lot of work done for trout in the river. It could be a nice river, but you know there are a lot of people there who I've seen some awful big tanks of trout. People are greedy. And so, they limit the river itself too. So… habitat. You have to decide what the habitat's for. If the habitat's for salmon... that's too much effort, too much time, and you've got the sea cages and everything. You could have a good speckled trout fishery though, if they weren't so tasty. One time I was at a meeting, and they were talking about trout in Nova Scotia, and they had a professor from a university here, and he was talking about genetic modifications and so on. And I suggested to them at the meeting, if they wanted to have speckled trout return in the province, they should genetically modify them so that they are uglier than hell, full of bones and taste awful. *Laughs*.

The best eating fish in the province is the white perch, but nobody even bothers with that, because they've got bones. Trout, they take the trout, remove the backbone, and it's wonderful. I'd like to see the river come back, even for spawning for shad. It's pathetic what happened to the shad there. They drop the water too soon – last year they dropped the water early.

Lindsey: When did they drop the water?

Perry: Oh, the water was, I was guiding down there… it would be early in June, and the shad had just got in the river, and they had been ready to spawn, and they started their circles. Then they took the water away. The river was just solid shad, and in fact there were some shad dying. I complained about it and it seemed to get water back to a degree, but then it went back to the same old problem, where they started throwing water back in the river, and it would flood. All they really need is to be able to open it a little bit to let the water come through, or regulating that water better. I've only been told these things – it's not my expertise, I'm not an engineer. But I'm always suspicious of things when I see that it's not working, when it doesn't want to work. So when I heard that from an engineer who knew of the thing, who insisted that the problem is the turbine's too big for the amount of water it gets.

So, we take the shad run – we'd need to insist on more than a minimum flow of water in the Nictaux, because I'd say a lot of the shad spawn there. If you go up that river to the Falcourt – you can take a boat all the way up from the salt water to Martyn's Mill. I've taken a gander in a 26 ft canoe with a motor on the back, and I've taken all the way up through, and found shad all the way up. The closer you get to Middleton, the more shad there's going to be, and you've got this division between the two. The Nictaux seems to have way more fish, in my mind, than the stem of the Annapolis.

Acadia was doing a study at the time and they wanted me – I was catching, I was guiding full time down there, I was catching hundreds of shad, and they wanted me to take the time to mark each shad. But the same guy who wanted me to do this was the same guy who was shitting all over me for clubbing an environmental ramble for shooting cormorants. So, I said well, you want to pick and choose what you want to do, that's fine. I choose to shoot cormorants. I have a permit, now go away and leave me alone, and by the way, I'm not tagging any fish. I'm not going to do your papers for you. You know, it's kind of like, they want your help, they also want some input to know what to do. So... I don't know how the study went. I'd be the last person to give them a second quarter. But it doesn't really matter.

The Nictaux could stand more water during spawning season for shad, and rearing time for trout. No reason why it shouldn't be coming back. The Falcourt Inn would feel better about it; tourism would feel better about it. Uh, there's hiking trails – they could make hiking trails in Nictaux, and maintain and develop the upper falls. It has potential of being a wonderful river. It is actually one of the biggest tributaries on the system, the smaller one. When I was a kid growing up in Lawrencetown, every brook had salmon fry, every brook had trout.

I was talking this morning to a writer from the south shore, and he was doing an article, and he wants some information. I was talking to him and I was saying, you know, I'm going through some data – it wasn't that great in the past. I mean, I fished 4 or 5 days to catch a salmon, now I go up, some of the rivers I go to I catch 2. So, and then there were some that were better than others. So… I don't know about how good the past is, how wonderful it all was. Because… it was good, better than now in some cases. But, you know, if the Nictaux was to provide any fish at all, habitat… it's not just fish, beavers, muskrats – that river's full of wildlife. Not a day goes by there that I don't see numerous muskrats, and uh… ducks. Mergansers. Mergansers with a daycare. Have you seen mergansers with a day care?

Lindsey: I've seen lots of mergansers

Perry: They will… the broods will combine, and one duck will take the brood and the other ducks will take off to get food. You'll see this duck with a flurry of little ducks... *laughs* it's kind of funny…. Yeah, it's full of wildlife. Pheasants, deer, I mean, it's a wonderful river, but it's pathetic when there's no water in it. And it shouldn't be that way. Should be a nice river, and a hiking trail up the whole damn thing.

Lindsey: Yeah, a lot of people I think hike up the railbed right now, the ATV tracks.

Perry: Yeah, and uh, right up to the falls. Some of it is marked. If you go online, I don't know if it's there now, but I remember two years ago I went online for a couple on vacation, and they went up, they wanted maps. I found a map of a trail online. There's also a wonderful book on the Annapolis and Nictaux – more the Annapolis. The lady who developed it put out a map of canoe routes, which was well done.

Looking at maps, general map discussion

Lindsey: So you've mostly been trout and shad fishing on the Nictaux River system?

Perry: When I was a kid growing up in Lawrencetown, the community all fished salmon. I'd sit around and watch them, and now, I fish shad in the same place.

Lindsey: So, whereabouts did they usually have more luck? The upper reaches, or the lower reaches?

Perry: Salmon were in the pools of the main river. In Nictaux, uh, there were pools; all those places were pools, all the way up through, where shad are now. All were salmon runs, and *laughs*, there was, they call it "Nictaux Fly" – they used to thread a worm on a hook, on a fly and then throw it out, until the warden came along, then they'd snap the worm off. But anyways, salmon fishing was done in the salmon pools, in fact I used a lot of the pools and eddies on the main stem of the Annapolis, nursery pools. They were for salmon, and now we have shad laying in those pools. I don't doubt there's a few salmon. The last one I saw laying in a pool nearby… pool, they had a couple up by a ladder one day. Very small.

Lindsey: And have you done a lot of fishing for shad in the lower part too?

Perry: Yes, the lower part of the Nictaux. A lot. One of my favourite places. They never went above Martyn's Mill. I suspect they weren't going up through that. It's a very awkward, difficult place to be around inexperienced people, because there's a lot of poison ivy. I have to be very careful where I take people. There's another place upstream from Middleton that's bad for poison ivy – it's called 'Mosquito Hellhole'. There's a bridge comes across the river. I've never seen so many mosquitos in my life, and downstream, poison ivy. But it's a beautiful river to canoe. I've canoed up and down it in my 26ft.

One of the things about it that people don't often understand is that you can be awfully close to civilization and be absolutely remote. It's a beautiful river, I love the river.

Looking at maps again

It seems like Waterloo Lake and the Shannon River have a lot of browns, but they don't seem to migrate anywhere else. Seems to be those two places, around Squirreltown, and I'd thought I'd go up around there. A friend of mine used to fish speckled up by a pool at McGill Lake dam, they used to pool there. Looking at this, it makes sense now what they were saying and all the things I read on the Nictaux River. They never gave a specific date on the dam. It's always the '30s. Which means they were captives for 10 yrs.

Lindsey: Well, I think I may actually have the date of installation for this one (pointing at map).

Perry: That would be the one that hurt the most. I don't remember anyone ever talking about fishing up here (pointing at map).

Lindsey: This one re-diverts the water to the powerhouse, via the man-made canal here (pointing at map). I wonder whether fish still travel down the canal here and get stuck at the power house.

Perry: They probably do. They go through the powerhouse. The big danger there is the pressure. You see how low the turbine is below the top, they get the bends coming out. Either they survive getting the turbine hits, they come out the bottom. We've lost salmon at the Gaspereau to the bends. Sometimes the turbine at the powerhouse, it will sit there idle. And, uh, fish will come up, get the pressure of the water coming in, there's always some water. And then, they'll just turn the switch on, and water comes flying in the pool, and then the water there coming in has different levels of oxygen, so then the fish get the bends and die – they float dead downstream, eyes popped. So that's something that you have to watch for, depending on how deep the water is. So I've no idea what the entrance of the top of the water down. Once you enclose the turbine, the water in a pipe, when it comes down as a pipe, the height of it is the generating capacity of the turbine, but it's also the height, it's the same as if we took the hole from 60 feet down and inch from the top. Now there's a standard operating procedure that instigated over something that happened over here one time. It blew up on them – it destroyed a bunch of salmon, and they had to pay a lot. And so, what we did was say, ok, from this point on, you can only bring your turbines up in stages, and work your way up, don't instantly bring it on. And I think they've been doing it. I don't know they do it on all the rivers, but they do it on this river for sure.

It's not as if I look for problems, it just happens that they happen. Every year, around power stations, turbines and dams, you're confronted with a whole list of problems. I'd love to see a watershed managed. I'd love to see somebody take this watershed, this whole watershed, all the time, and manage this for speckled trout and brown trout. Single hook, barbless, no live bait, retention of one fish over 13 inches. And work it as a management watershed. Because right now, it's fished, but not a lot. It has potential – hard to get people to change. That's a big watershed. But it doesn't produce the water for that dam down here (pointing at map). That's the problem as I understand it. That's why you get the low water in the summer. So, you have to increase the water velocity down here, and somehow tell people more about this, you know, say this is a beautiful watershed.

The Annapolis River itself, the main stem, it's gotten a lot better too. I mean, people say its dirty now, they didn't see it thirty years ago. It was an open sewer, and uh, Greenwood, they were no help. And the headwaters, full of salt…

Lindsey: And Middleton had the sewage treatment plant that was discharging directly into the river

Perry: And the hospital. I mean, I remember going down there one day fishing, and the Nictaux was running clean, but the Annapolis was running all cloudy. So I went upstream, and got to the hospital outflow, and there it was. Directly into the river. So, we started blowing the whistle on it, and the next thing I knew, it was corrected. Then, we did the same thing, and there was a group, maybe it was the Clean Annapolis, did that same thing that we did on the Cornwallis, where we went down and identified sewage outflows, leachates from different hookups. And reported all of them. We got results, sometimes not what you'd expect. The Cornwallis is a very prolific river, full of fish, it's just scandalous. But it's because Berwick is putting nutrients in the river, and farmers are putting lime on their fields, and are pumping up the nutrient levels all the time. And as long as it doesn't go above a certain level –it's crooked. That's the battle.

Lindsey: That's the tipping point.

Perry: The tipping point, yes that's right. And that tipping point is very fragile. But right now, if you go down to the Cornwallis River, you can look into 6 ft of water and count the pebbles. All it would take would be a little too much more nutrients than we had algae, then we'd have a whole bunch of problems. I was saying one time if we could take the pollution, the sewage from the valley, and take it out south of the lakes and manage to put it in the lakes to increase the fertility back on the south mountain, we'd have wonderful fishing. Because the limiting factor back there is, there's no nutrients, the water is basically voided, it doesn't have any nutrient base at all. We went through with measurements, ah, what did we look at… electric conductivity, just to see what stuff was in the water. The water was clean pure, but there was nothing in it. You could turn over rocks but there were no bugs. Just mud and rocks. When we were doing mapping of it, we came up the valley floor, it just dropped off the charts. pH was higher, not unacceptable, but nutrient levels were. If we could just get the nutrient levels up… We thought about approaching the government – they had a plan in place, for reforestation, when you cut, a certain amount of money was set aside for reforestation. We believed, a bunch of us believed, you'd be better off fertilizing the forest. In other words, instead of just taking trees out and replacing them with a new tree, you were taking nutrients out with that tree, so we had to replace the nutrients for the tree. So we suggested to them that the aerial spray nutrients on the forest that had been cut. It would be a dual edged sword, because you'd also increase the fertility in the watershed. Instantly. But they wouldn't buy it. Pulp. Lumber companies wouldn't buy into it. Even if it wouldn't cost them anything, they wouldn't buy into it. But that would still work. If we just had some way of saying – I have a, on my power bill, there's a certain amount that goes into watershed, you know, environmental stuff. It's their way to make people feel warm and fuzzy about their operation. All in all, you could tap into that money.

You could tap in and put fertility, take a lake, any lake, and put in fertilizer, and lime. And then see how that stream improves. See, there's a liming thing down on West River, down on the other end of the province. That was done by private people, and the government said it wouldn't work. Surprise, surprise it did, they just didn't want it to work. But that's working fine. They got a 100% increase in productivity in the streams they put the limer on.

People, they take control, do it, and it can work. But you've got to decide what you want. That's the part that's sometimes hard. They'll say, well, do I want salmon. Well that's nice, but it will cost so many millions of dollars to put a plan in place to save the Atlantic salmon. And they'll probably never reach the numbers that we would need to fish them. So you won't derive any benefit other than the fact that you have salmon that you can see once in a while. If you had an observation deck you might see one. Is that worth the effort? Or is it better to say, let's do this as brown trout, start working, increasing fertility, producing more food, you know, uh, biomass – rebuild a food chain and then have speckled trout and brown trout. You know, something in there. And then put regs in to protect it. But I don't think that's the purpose of Clean Annapolis River.

Lindsey: No, we're not a regulatory agency.

Perry: Your aim and focus is not on a specific salmon, it's the overall health of the river.

Lindsey: Basically, the mission of the organization is to achieve healthy watersheds. So, our mission statement that-

Perry: That we're not working your mandate, because her mandate is to maintain, as close to, under naturalist conditions. Your mission statement says that you want to make any help to watershed base, and your baseline criteria is what it was like before all this crap happened to it.

Lindsey: But, we don't have that kind of baseline information.

Perry: Pretty near, you do. On the south mountain side, and the north mountain, to a degree, side. The valley floor is … but the south mountain is slight different. Brooks that come into the Cornwallis River, their pH is high, they're not as purple, but they do buffer the potential high fertility in the river. I always like the concept of uh – we were at a meeting one time and somebody talked about pollution. I said well, I know the easiest way to get rid of pollution. It's simple, it's easy. Get rid of pollution, end of problem end of story. He said, "What do you do?". "You stop testing for it".

Lindsey: That doesn't get rid of it, that just doesn't recognize –

Perry: No, the public doesn't care anymore. See, a few years ago, the Friends of the Cornwallis River were doing pH and all that, and studying pollution along the river. And the E. coli count was high, so they went to the press and said that the E. coli count was through the roof, and you shouldn't swim in it, do anything with it – it was toxic. The farmers of course irrigated from there and they didn't want the general public to know that they were having toxic water sprayed on their strawberries… So they lobbied hard to have the testing stopped. Not to have the pollution taken care of, but the testing stopped. So, it went on like that for a while, and then there was a major fish kill, up around Berwick. And, of course, where are the water tests? Well, we don't have any - Why? Their department of environment, they knew it had the potential to be polluted. Now we have a big OD problem. Oxygen demand. No oxygen in the first so many miles of the river. Nothing can live there, even eels can't live there. Well it's just oxygen. I said "I know, there's no aeration, no treatment. Test it."

So they started testing it, and Berwick cleaned it up. They did clean it up. And then after that, they don't test for years. The Dept. of Environment has given more water rights to the Cornwallis River than the Cornwallis River has. In other words, they give the farmers the right to remove water for irrigation more than the river can produce. The reason it works is because they all don't use it.

But we did do something in the Cornwallis that was kind of interesting.

58:46 – 1:05:00

Further discussion about the Cornwallis River and the Annapolis River Guardians program

Well, if there's anything I can do for you guys just give me a holler – do you have a fundraiser? Why don't you tap into something you have? Go back to doing the shad tournament. Years ago the Annapolis Fly Fishing Association put it on. They funded themselves that way. The dept. loved it. At the time I was assigned to come out – wrote articles for magazines. And they wanted me to come out and cover it… *general commentary about shad sportfishing and the tournament*

Lindsey: So far, we haven't gotten into that sort of thing a lot, but we've started partnering with the Nova Scotia Marathon Canoe Racing Association and put on the Annapolis River Canoe Race. This year was the second year.

Perry: Oh, that's a good idea.

Lindsey: Yeah, the goal behind it is basically to help people realize the recreational potential of the river.

Perry: A race would be fun; a scavenger hunt would be good too. Only a photo one, where you don't have to pick anything up, but would have to find a certain flower for example, and take a picture, with the date on it. I took some guys fishing, and they were taking photos with their phones, and they were good photos. Another trick, you must never charge a fee – free will offering. That will always get you more than a fee. Someone will come along, who had a great time with their family, and think nothing of dropping a bunch of $ into the pot.

…

It's funny, I have fished the Nictaux watershed numerous times, and never knew it. That's another thing too, you asked people say, have you fished on the river, and they'll say, yeah – for shad, for trout. Most wouldn't recognize a lot of these other places as part of the watershed. So instead of saying, have you fished the Nictaux River, a more meaningful question would be have you fished the Nictaux watershed? Because to most people, the Nictaux River is from the power dam down.

Discussion about old turbine on the Fales River There was salmon in that stream – the Fales. And at one spot was crazy. We inventoried all of that. We were classifying pools, A, B, and C. What we were after was a map, to proceed how to include habitat. Then the program all fell apart / funding. It takes a lot of money to do that.

Lindsey: Are there other people you'd recommend I meet with to discuss the Nictaux sub-watershed?

Perry: … people have all died. Nothing was written down, they've all died. If I think of something I will give them your information. Most people have a spot, and they don't know where the water comes from, or what affects it (i.e. acid rain, etc.) they just have their favourite spot, and don't tend to move very far from it… Ron Barteaux in Paradise. Ronny's a good man. *laughs* I have a list in my mind, going down it, and trying to think who's died. But Ronny would know too. He's the only person left I can think of. It's a good thing someone's taking this down! Because soon Ronny will be gone, and we'll all be gone, and none of this will have been recorded. I just like passing this on to somebody else.

If you ever decide to have a banquet or a fundraiser or something, just give me a holler. I do a lot of sculptures. I did an 8ft high salmon for a guy last year, but I usually give paintings or things away for fundraisers. We have a club once a month, to help people learn to tie, as most of us have been tying forever.

I did one once in the states and we made up little pill bottles for kids with all the materials to tie a fly. It worked out very well.

…

Lindsey: Thank you very much for meeting with me today.

Perry: My pleasure. Always like to see someone doing something.

10.F Appendix F: Interview with Hal Elliott

Lindsey: Basically, we would like to know if you have had past experiences fishing in the Nictaux sub-watershed, and if you have stories you would like to share with us.

Hal: We used to put in here (pointing at map), down near Squirreltown, and take canoes down and blow the Scotsman. And make canoe trips down there, fishing. I never had much luck. Although, just before it gets to where it runs down into the headpond of the dam, there's a couple of big pools it runs into before it starts to go down. The fish I had on that thing, when he rolled off, he rolled off right by the canoe in front of my – and the guy sitting in front said "My god, the eyes are as big as mine". He was a big fish, but uh, I never had much luck out there.

Lindsey: What were you fishing for?

Hal: Whatever would take, basically. Well, we were after trout. There's some brown trout out there that are really big. A couple of the fellas fish them a lot. Old Doug Feener, he used to …

(Discussion of Feener's relation to Levi)

But anyway, it's always been good fishing out there. I was out at the headpond there before I even started fly fishing. I went out there one night with a little spinning rod, just as it come down, and I was maybe two hundred, two hundred and fifty feet away – there's a little point there, I was around there. Brian's mother always said, you just take a big gob of worm, and you put on there, and just let it float down. So I had a big bobber and down there about four or five feet, and I just let the gob of worm float down, and all of a sudden it stopped, and it come down a bit further, then it stopped. Then it come down a bit further and it stopped, and come down a bit further and it stopped again. Then started to go upstream, and by jeez it was a big fish. But of course, with my luck it just goes down there, and jumps up in the air, looks at me, and spits it out. That night, while I was there, a mother otter and two pups come down, and she went and got a trout about this long (showing with hands), and took it up on the bank across from me and started eating it. The pups would come along and look at her eating it, and she'd growl at them, and they'd jump back in the water. Then they come across and looked at me. And then when she finished, they went away down the river.

It's always been good fishing out through there, 'round McGill, Curl Hole – been out there fishing a lot. But I've never gone in and used a boat that much, only canoed down here (pointing) a couple of times.

Levi: Yeah, Doug was telling me last fishing season that he hooked a brown right by the Curl Hole in the up side, right by Molly, and uh, he must've fought that thing for 45 minutes, and it was the biggest one he's ever caught. In the end it wrapped itself around one of those root balls. He went out an tried to unwrap it, but it took off and, was spooked enough it snapped the line. But he said it looked like a salmon.

Hal: Well, I have always heard that that's why they put browns in there. Is when they put the dam in, they put browns in there to replace the salmon. And, uh, because everyone was really upset about the salmon not being able to get up past the dam and all. But, I don't know, I've read somewhere, on some information that Diane gave me – there was an engineer, or a fisheries officer that came down to go over the Nictaux, and he said there was five dams on that river.

Levi: On the main stem?

Hal: Yeah.

Levi: Martyn's Mill, Nictaux Falls, Nixon dam, um that one's wide open though.

Hal: This was way back, this was in the early 1900s.

Levi: Yes, I've seen reference to that.

Hal: And it said something about a woman, who owned the mill, and something was happening to the dam, and they were wondering if they should fix it or not. Anyway, they were saying that there was a couple of sawmills on it that they used to take the sawdust and spread it on the land to, uh, to more or less mulch the land. I guess he said that instead of just dumping the sawdust in the river like a lot of them old mills used to do. But this was a long time ago.

Levi: Yes, it seems to me like I've seen some old documentation, I can't remember where, but somebody had excerpted something. Like where, even back in the 20s or 30s, someone had claimed that there were dams on the river that the salmon couldn't get up anyhow. But I've been talking to Doug, talking to my grandfather, and Earl Saunders, and uh, Bill Nixon, and they all said, they had the Nixon's monuments, and they had their mill up where the big dam was built….

(reminiscing)

Doug was telling me he remember going down with his father, Ernest, and the salmon were making their way up the sluices of that dam, and making their way upstream, well above where the sawmills were. And they'd grab one, bring it home, and cook it for supper. But he said there were plenty coming up through. You could almost reach your arm in and…

Hal: Yeah. Well, you see, when they put that dam in, the plant down there, the pool down there, the salmon just colonated down there for a few years afterward, and they just forked them out. They'd go down there with pitchforks, and just fork them out and take them home in baskets.

Lindsey: Have you seen any salmon anywhere on the river recently? Even below the dam?

Hal: I haven't. I haven't fished there very much. Dougie Coleman might have. He works up there, he's Greenwood's guy up at the mall.

(Levi and Hal reminiscing about the mall and fishing rods)

Yep, he's full of stories, Dougie is, but a lot of them are just stories, I think. I've known him long enough, that you take whatever he says.

Lindsey: We are working on coming up with a restoration plan to do some work on the Nictaux River system, so if you had any ideas of work you'd like to see done –

Hal: Well, we did uh, how many rock sills did we put in? 20? I think that's basically right there, that's the best thing to happen for any salmon, because right there, that gives them places for, to spawn. You'll never get them up above the dam, the power plant.

Levi: No, you'd need tens of millions of dollars to do anything there.

Hal: No you wouldn't, you'd just need more water. And they wouldn't give you any more water, because they'd want it for the power plant.

Levi: I've had conversations with Ken. He was the one that told me that the falls, just below the dam, there's no point in looking at doing anything with that dam because there's already a natural barrier to fish migration downstream, and the fish never got up there because there's a waterfall. There's a channel, that uh, the waterfall's up here, and the old channel is down here, and I just shook my head. Yeah, flow regulation is something that has come up in the past. I mean, in some ways, I'd like to dream and believe we could take that dam out of there. See things move up to Waterloo River and start spawning again.

Hal: Yeah, that'll never happen.

Levi: No, not realistically. But looking at the stretch downstream, in where the rock sills are, between there, and uh, even the dam at Nictaux Falls, they could probably jump. With a good flow, you think? You'd have to put a ladder in there, and I don't know if there's much point in doing that.

Hal: Uh, I've never walked down from the dam to the falls. But I've walked up to that Nixon dam, that's a big dam. Holy jumping, that held a lot of water. Sawmill, or grist mill, it was… I don't know, that was a big dam.

Levi: I don't know who put it in, I don't know, my great grandfather had a sawmill, but I don't know if they could have afforded to put in a structure like that.

Hal: It drops pretty fast from up there. I don't know if there's much spawning up through there, but once you can get up above a little bit further, up the Shannon and that, there's really good spawning up around there.

Levi: Yeah, there's some really good gravel beds up around Squirreltown and that.

Hal: I don't know if you've ever heard, but the Annapolis River salmon is a different than any other salmon in Nova Scotia, especially the ones that spawn here and grow in the river, like the Fales River. Those there, that they are used to slower water, and will hide in the weeds, because there's no rapids and stuff like in the Margaree.

Hal: And they had the instincts to survive in that type of environment compared to… and when they left the Annapolis Basin they turned left and went out to sea, to Greenland, right. Where most of the others are inner bay, and where the Gaspereau and all those, they stayed in the Bay of Fundy, and that's what made them different.

Levi: Ok, yeah, I know DFO doesn't classify the Annapolis system as an inner bay river, although a lot of its neighbours would be. And that its more of a southern uplands stock.

Hal: And that's the reason why they're not doing anything with the Annapolis salmon anymore.

Levi: Well, they're reviewing the southern uplands stocks right now. So, all the other ones, the Greenland stocks –

Hal: The Salmon River, down in uh,

Levi: Yep, and all the way up, like to the South Shore. The Mersey…

Hal: What's his name, Roy LeBlanc…

Levi: The salmon river association? Yeah.

(Discussion of Salmon River Association activities and outreach)

The whole thing about flow regulation – been thinking about where those rock sills are, digging pools, potentially creating spawning areas. I always wonder what the up and down, in terms of the flow regulation, is doing to juvenile survival, and that sort of thing.

Hal: Oh, you can go in there and catch salmon fry anytime.

Levi: They're still there?

Hal: Oh yeah. You can get them up in, well my sons caught them up in Walker Brook, up in Wilmot. Walker Brook, and Wiswal Brook. And those ones there. He's fished down at the bottom of them and he's caught salmon. So, they're in the river. There's lots of salmon in the river.

Levi: Yeah, well, In the Nictaux itself, I guess I wonder what the flow regulation does just in that stretch.

Hal: You should be able to find out from Gaspereau, because they do the same thing. And they got that fish ladder going. I don't know if they can count fish there, or have a trap in it, or…

Levi: I don't know if they do counts. I know they regulate according to the time of year that fish are coming up through.

Hal: Yeah, there's gaspereau, there's striped bass. I don't know if they go up very far, but they would need to spawn in the lower part of it, don't they?

Levi: I would think so.

(Discussion about Gaspereau and Lake George and Kings County Lake monitoring)

Hal: Ken went and put that halbunger valve on the end of, on the side of the power plant in the fall. Basically all it is is a fire hose nozzle about this big around (showing with hands), and uh, they'd open that up and it would oxygenate the water, and be a big spray, and they thought they were doing great things. Until, we went fishing one day – and everywhere you looked there was eels laying there.

Levi: Dead ones.

Hal: Yeah. What was happening was, uh, I called Ken up, it was a Saturday, and he come down Sunday morning, and looked at them and said, "They're going through that valve". And the valve, I don't know how they even got through it, because you'd think it would just mutilate them. But it didn't. They went through a hole, and they'd come out, and their eyes would be all bloodshot, and everything because of the pressure that squeezed them through. It just squeezed them through.

Levi: And they were coming down from up top on the canal?

Hal: Yeah. Yeah, you know, its in the fall, and that's when their migration is. Like in the spring, where we had the fishway going there, and you could see the little eels, they'd be climbing right up the walls of the fishway, just to get that further, to go out to the water. They'll crawl across land those eels will.

Levi: Oh, they're incredible. I've seen them at Crystal Falls, just clinging to the rocks and making their way up.

Lindsey: They get through the smallest cracks. So are they still using that valve?

Levi: I don't think.

Hal: Yeah, well, like, he could use it at certain times of the year, like summer time would be alright. You know, when eels start going back, you'd just shut it off.

Levi: I wonder what happens when the eels that get into the canal system have to make their way down somehow, I wonder if they're still going down the pipeline though.

Hal: Oh yeah.

Levi: Are they making it through alive?

Hal: Well they must be, they're coming back. There's always lots of eels. People have said there's lots of eels. You know, an eel don't just go to whatever river it comes from.

(discussion about eels).

Levi: Yeah, because you don't see a lot of dead eels floating downstream on a regular basis. And we were in the river this fall, trying to see what we could catch.

Hal: You'll never have a salmon river without lampreys. … You have lampreys, because they keep the rocks and everything turned up. So the sediment don't impact them. I've seen them over there above the rock sills.

Lindsey: We caught some down in… here (pointing) below the 201, behind Fred's field. Where we also caught a bunch of smallmouth bass when we were electrofishing.

Levi: Yeah, there's enough of those around in that stretch. You were fishing the riffles too, which made a big difference. I've caught them down in that same area, a little bigger. They're still fun to catch.

(discussion about tv fishing shows)

Hal: There's a dam on Trout Lake.

Levi: Zwicker's got a little thing too, just to hold the water up.

Hal: I think they'd put sandbags across that at one time, to raise and lower the level of the lake. It's the only reason I can think they'd put a dam there. ….

We even had Greenwood do aerial photos of this area here. Those would be in the file. They weren't that good though, because they had a hydraulic leak, and it was leaking all over the lens, so… they didn't come out real good, but they did them for us. That's something you could ask them to do again, if you knew somebody. The fellow that we got to do it for us, he's a retired airforce and he's up in Port Williams now.

(Discussion about friends and neighbours in the Auroras)

Levi: So, what's floating around in our mind, we've gotten one of the new DFO grants for a Recreational Fisheries Conservation Partnership Program and we get funding from Aopt A Stream, but there's, uh, $7000 left over from the Annapolis River Fly Fishers, and we were hoping to do something in the Nictaux. We're just trying to, kind of prioritize of where we could work. What's kind of crossed my mind, maybe I can bounce it off you, is around where the rock sills are. You've got the pools, and some structure around where the rock sills are there, but in between, its still kind of wide and flat, not a lot of cover in the areas between the rock sills. So, its crossed my mind to have some people come out and think about what we can do in between those areas, to improve the habitat, by maybe putting some boulder clusters, or some root wads or things to provide more cover in between the pools, for the juveniles and that, to break up the current a little bit for when it flashes up. Give them a place to rest. Do you think there'd be much value in doing that?

Hal: Oh, I do – Have you talked to Amy?

Levi: Yeah, I've talked to Amy specifically; she's going to come out in January. And then Mike Parker. And, uh Andy Sharpe, who used to work here but now works for him, at East Coast Aquatics. They've done some work up in Sackville River which also kind of flashes quite a lot and can have some pretty high flows, so was hoping to have them come out and go out with Amy and kind of bounce some ideas off them to see what they can do, and what Amy thinks about it. Because I mean, we've been talking for a while about that area and walked it, and thinking, well, all this work already went into it – why couldn't' we do a little more in that area?

Hal: The only thing is, is that it'll ruin – you got to watch where you put 'em, because you don't want to ruin your beds. Because if you put rock in, you know what happens behind the rock – it makes a hole.

Levi: No, it would be like- say you had a rock sill here and a rock sill here, and your pools, it'd be the areas in between, and it wouldn't be huge structures, you know, it would be a couple, two or three big boulders here, two or three big boulders there, because it's all pretty much well sorted medium-sized cobble, and it's as flat as this table.

Hal: Yeah, like I say, you put a rock in, doesn't matter if it's a rock this big or a rock this big (gesturing), there's going to be a hole. So, you don't want anything too big, but if it's not big enough, it's not going to stay there.

Levi: Yes, exactly, it has to be appropriately sized for sure.

Hal: You might have to dig a hole and put a rock in, so it just comes up above.

Levi: Embed it a little bit, yeah.

Hal: You watch the buggers with the four wheelers – that first sill. They cross it all the time, the four wheelers.

Levi: Yeah, there's almost like a roadway going across the whole river.

Hal: My son and I was fishing there one day, and we were talking to a guy, and he said it was the first time he'd ever seen shad up below the power plant.

Levi: Ted Kiatus, I ran into him on the river. He might've been telling me that too. That just a couple of years ago, they wound up by the power plant, all the way up there. That's good news too.

Hal: Oh yeah. The only problem is, I've got a $40,000 fishway there that's not even working anymore. And I don't know what to do with it. It probably should be filled in, because nobody's ever going to fix that breach.

Levi: Who's land is that on?

Hal: That's part of the Mill property. I think they own about 2 or 3 acres right along Fred's land there.

Levi: Yeah, Fred owns the field, so they have that swath in behind the field I guess.

Hal: Well, yeah. From the field to the river. It's not that big. We were going to buy it, and try to build a place there or something, on stilts so it wouldn't get washed away… Nah. It's too.. you'd have to have it awful high. And we keep having winters like this, this may be one of those winters where it really floods too.

(Talking/Reminiscing about snow)

Lindsey: Jim was telling me that you'd probably be the best person to know about who used to be on the Fly Fishing Association.

Hal: Glen Stilwell, Terry Wilkins, uh… Bob Cronin (sp?). It was basically he and I that worked on the rock sills with the DFO. That's one thing, you'll have to go through the DFO to do the rock sills.

Levi: Yeah, that's another bunch we'll have to have come down. Because the work we're doing, well its funded in part through them. I asked them if they wanted to come down and give us an idea about what we should do, and they told me, well, you're better off just talking to Amy. They've lost all that capacity. They used to have Jane and Anita and neither one of them are with them. Jane passed away.

Lindsey: What happened to Anita?

Levi: She's either lost her job completely when they restructured DFO or moved on to another area. There's not habitat branch anymore anyway. So now its fisheries conservation/protection, and habitat's not their thing anymore.

Hal: Yeah, well, Amy's done a lot more work. You've got to talk to Leblanc, and Roy down in there, some of the work that's being done on that river. He'd be a good one to talk to. Stutters a little bit. He's a good guy.

Levi: I remember watching when they installed – this was before Nictaux, when they installed rock sills on the Salmon River too.

Hal: Yeah, yeah, that's where we got the idea. He told us we should be doing it up there. And then, I went to Amy, and Amy said go to DFO. Anyway, that was… 2001? And 2002. We did it 3 years in a row.

(Levi talking about where he grew up in Nictaux Falls)

Lindsey: What was it like before?

Hal: Flat. It was flat, just nothing. Well, there was about this much water. When they had the power plant shut off, there was just about that much water (showing with hands)….how wide is it?

Lindsey: About 25m

Levi: Yeah, 25 to 30 m depending where you are.

(Discussing rock sill spacing)

Levi: Another thing we've thought about doing is adding larger wing deflectors on the back end of them to concentrate the flow and dig a little stronger. Might dig them out a little deeper even.

Hal: Yeah, that'd be a good idea. You'd want, you'd want two wouldn't you?

Levi: Yeah, you'd want a substantial one on the upstream side of the angle, then a smaller one on this side to help direct a little bit. What it does, is ramps, kind of forces the water in toward, in to the pool a little more. I mean, it's kind of there a little bit anyway, but I was wondering if there was any value in coming out farther and narrowing it up even more.

Hal: Well, you don't want to – you want to deflect it so it's through the center, you don't want to deflect it so it goes through one side, because you're going to dig that bank out.

Levi: In theory, it should kind of cut through to the next one. If you get the deflector right, it should bounce off one and into the other, hopefully not blow out the opposite bank.

Lindsey: It'd be a challenge for high flows.

Hal: Yeah, that's it.

Levi: Yeah, well, at high flows there's not a lot you're going to do. I mean, it's still, that would follow the pattern of the thalweg, so hopefully it would stay contained under all the water, I don't know. So, you haven't been fishing around Martyn's Mill, or those sills in quite some time?

Hal: Last time we went down there, the water was shut off.

Levi: Ok. When do you think the last time was you actually fished?

Hal: I haven't fished for over a year because my knees won't let me. Waiting to have my knee replaced. I can't go in the water anymore.

Levi: So you think in the last five years you've been through that area?

Hal: I've been down there, yeah.

Levi: Were you still catching juvenile salmon? Like salmon fry or anything like that?

Hal: No, I didn't catch anything. No... my son has been though. He's walked down there quite a ways and back, and he's pretty good at it. And Dougie fishes it all the time.

Levi: Maybe we need to talk to him. You used to go shad fishing down by the bridge, and it was hard to keep them off your hook. But now, you don't tend to get them. The last time I got a silvered smolt, 3 or 4 years ago.

Hal: Travis got a bunch at the swimming hole.

Lindsey: Where's the swimming hole?

Levi: Uh, Nictaux Falls.

Hal: Just above the dam. At the top end of Fred's field.

Levi: Where the rope swing is. Several years ago, probably around 2001, in Nictaux Falls, right at the foot of the dam I saw something jumping. Was flicking a fly over the top to see if I could get it, and got about a 14 inch silvered smolt sitting at the base of the dam.

Hal: The river's got lots of salmon in it. To me, I think that they should be a catch and release fishery for salmon. There's lots of trout. When Travis was catching them he thought they were brown trout. I said no Travis, those aren't brown trout, they're salmon. Because they have the stripes on the side he thought they were brown trout. But there used to be, I used to live on Bridge Street and old guy Syke Joudry used to live there, next door, and he was a salmon fisherman. He used to go down, walk down below the old railroad bridge, and he would come back with a salmon every once in a while form down there. There's a pool down there that they hang in, and then there's a pool down behind the cemetery that they fish them in. Burt Balcom, if you talk to him, he could tell you a lot about fishing below the bridge for salmon in the spring, because he says you used to have to take your cigarette lighter and tap your eyelet on your rod because they'd ice up, pulling your line through. He'd be a good guy to talk to, to get a hold of him.

Levi: Burt Balcolm, yeah, he's in Nictaux.

Hal: Right across from the Old Nictaux West school there.

(Talking about folks from Nictaux)

Burt fished salmon in that river a lot, back in the day, if you don't mind sitting there listening to them old stories.

Lindsey: Not at all.

(Discussion about Aylesford Road fishing, random topics)

Handing out surveys to Hal.

Levi: Does anybody still get together to do any fly tying? I know there was in Wilmot…

Hal: Not anymore, not anymore. We used to – that's how we got started with this salmon thing, restoration projects and stuff. I saw you had one there.

(Talking about craft fair in Annapolis)

Lindsey: We're thinking of holding another workshop up towards Nictaux in January at some point. So we'll keep in touch and let you know when that's going on.

(Discussion of what will be tied and general fly tying discussion, shad tournament, fishing technique, fishing stories).

Levi: We've got some of the best shad fishery right here, and it's not used enough.

Hal: Yeah, right from Lawrencetown to Middleton. Paradise, I guess you can catch shad in Paradise when they first start coming out. But it goes right up to Aylesford. That's one people like, because it's easy.

…

Anyway, I gotta go next door and pick up a baby spoon. (Baby discussion ensues)

Lindsey: Thanks for coming down.

10.G Appendix G: Document from Perry Munro

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Preface

This report has been sponsored by the Atlantic Salmon Association, a body interested in the conservation of the resources of Atlantic Salmon in Canada. The Association wished to know the economic value of the Atlantic Salmon fishery to the Province of Nova Scotia. This study for the year 1964 makes a beginning to answer the question.

The conduct of this study has, among other things, strengthened:

(1) recognition of the need for close liaison between different disciplines, in particular between biology and economics, in the search for solutions to certain complex questions. Certainly the economist is being forced into new areas of inquiry of both an empirical and theoretical nature as our society demands more recreational facilities in numerous forms. The economist must take a new look at what is called the "tertiary sector" of the economy. Many of the questions arising here involve other disciplines too, each confronted with its own set of variables, but the economic aspects also are so complex that anything short of powerful analysis is inadequate. While this study cannot claim to be an example of powerful economic analysis, such analysis is nevertheless implicit in the report;

(2) appreciation of the vital role of the public administrator.

Thanks are expressed for the assistance of officials in the Federal Department of Fisheries in Halifax, St. Andrews, and Ottawa, and in the Provincial Department of Lands and Forests, Halifax; of the officers of the Nova Scotia Salmon Anglers Association, the Nova Scotia Fish and Game Association, and the Atlantic Salmon Association. In particular, thanks are expressed for encouragement and assistance given by Messrs. T. B. Fraser, President of the Atlantic Salmon Association; the late J. F. Donly, who was a member for Nova Scotia on the Executive of the Atlantic Salmon Association; and Evan Lloyd, Executive Director of the Cape Breton Tourist Association. The Acadia University Institute provided facilities and assisted in the planning and administration of the study.

N. H. Morse

PART I

COMMERCIAL AND SPORT FISHERY

BACKGROUND OF THE SALMON FISHERY

If the origins, habits and life cycle of the remarkable fish, the Atlantic Salmon—*salmo salar*—are not familiar to the reader, a general description can be found in Wooding's article on Canada's Atlantic Salmon.[1] This anadromous species ranges in the waters of the North Atlantic and spawns in rivers of northwestern Europe, the British Isles, and northeastern North America. In one important sense, however, the species does not comprise a homogeneous stock since as a rule spawning fish return to the river (or to the spawning grounds) of their parents. Pollution of a river, the erection of barriers such as hydro-electric power dams, and the cutting of forests which affects the flow of water, or run-off, especially in spring or summer, are obstacles to the maintenance of a salmon run native to any given river since they impede both the movement of spawning salmon ascending a river and the escape of young smolts when ready to return to the sea.

It is recorded that when settlers first came to this continent, Atlantic Salmon ". . . were common as far inland as Lake Ontario and were known, in fact, to spawn in the headwaters of the Don River, not far from the present city of Toronto."[2] In New England, salmon runs existed in the Hudson, Connecticut, and virtually every river of Maine flowing into the sea.[3] Today, the runs in these rivers no longer exist and, so far as the St. Lawrence river system is concerned, salmon do not ascend much beyond the Saguenay.

The records of early salmon fishing are rather incomplete and the fishery in Nova Scotia was but a small part of the total fishery in the waters of the eastern seaboard of the Continent, including the Gulf of St. Lawrence. The fishery was, of course, primarily commercial. MacEachern and MacDonald[4] have summarized some aspects of it in Nova Scotia. For example, the diary of Simeon Perkins shows that the salmon runs in the Mersey River were a factor leading to the selection of Liverpool as a townsite. The runs were heavily exploited, and the product was sold in England. Depletion of stocks caused fishermen to go to the Gulf, Newfoundland, and even to Labrador, for salmon.

It can be assumed that heavy exploitation of salmon runs was not confined to the Mersey in Nova Scotia. In any event, the runs restored themselves over the years so that by the late 1700's and 1800's, commercial salmon fishing provided a source of revenue for many fishermen. Records of catch date back to 1870, and, although the figures may not be very accurate, show a commercial salmon fishery in Nova Scotia yielding 2-2½ million pounds. Although the catch declined to less than ½ million pounds in 1881, it rose to nearly 1¾ million pounds in 1887. Between 1896 and 1930 there was a general upward trend in commercial production in Nova Scotia which, apart from the low years of 1889, 1900, and 1928, rose from around ¾ million pounds annually to well over one million pounds. After 1930, the trend of the commercial catch was downward, reaching a low level of 128,000 pounds in 1955.[5] Landings have remained above this figure since that date.

The annual commercial catch of Atlantic Salmon in Nova Scotia is given in Table I for the years 1953 to 1964 inclusive. Also landings for the Maritime region[6] are shown for the period 1958 to 1964. Details respecting the geographical location of the commercial catch in Nova Scotia are given in Appendix A. The location of the commercial catch for the whole of the Maritime region in terms of the three areas—Gulf, Atlantic, and Fundy—is given in Appendix B.

Table I shows that the commercial catch in Nova Scotia fell from 271,000 pounds in 1953 to

1. F. H. Wooding, Canada's Atlantic Salmon, Second Edition, (Ottawa, 1956). The article was published originally in the *Canadian Geographic Journal.*
2. *Ibid.*, p. 7.
3. *Loc. cit.*
4. N. E. J. MacEachern and J. R. MacDonald, *The Salmon Fishery in Nova Scotia*, (Ottawa, 1962), reprinted from *The Canadian Fish Culturalist*, No. 31, October, 1962.
5. *Ibid.*, p. 45.
6. The Maritime region includes three areas—Gulf, Atlantic, and Fundy. "The Gulf Area includes Quebec landings on the Gaspe coast as far north as Cape Gaspe and extends around the Gulf of St. Lawrence to Fourchu on the east coast of Cape Breton Island. The Atlantic Area extends from here around the outer coasts of Nova Scotia to Cape Sable. The Fundy Area goes from Cape Sable around the whole Bay of Fundy to Grand Manan Island, N.B." C. J. Kerswill, "The Research Program, Part I," Report of the Scientific Sub-Committee, Federal-Provincial Co-ordinating Committee on Atlantic Salmon, *Trade News*, April, 1956, p. 5.

Table I. Commercial Salmon Landings, Nova Scotia 1953-1964, and for Maritime Region 1958-1964

Year	Nova Scotia Landings lbs.	Nova Scotia Value $	Rest of Maritime Region Landings lbs.	Total Maritime Region Landings lbs.
1953	271,000	117,300		
1954	228,000	103,800		
1955	128,000	63,700		
1956	136,000	70,700		
1957	146,000	76,600		
1958	204,000	103,600	685,200	889,200
1959	210,000	111,400	949,300	1,159,300
1960	240,000	131,900	753,100	993,100
1961	279,000	157,300	731,100	1,010,000
1962	312,000	183,900	887,700	1,199,700
1963	301,155	173,915	709,045	1,010,200
1964	251,533	164,311	1,058,579	1,310,112

Sources: *Fisheries Statistics of Canada, Nova Scotia*; Department of Fisheries, Halifax, Nova Scotia.

128,000 pounds in 1955,[7] a year of low landings of salmon in all the Maritime region. After 1955, landings in Nova Scotia rose annually to 312,000 pounds in 1962, at which time the commercial catch for the Maritime region was 1,199,700 pounds. In 1964, commercial landings in Nova Scotia had fallen to 251,533 pounds whereas those for the Maritime region as a whole had risen to 1,397,334 pounds, the highest for any year in the period 1958 to 1964. In general, landings in Nova Scotia have been running around 20-25 per cent of the total commercial landings of salmon in the Maritime region.

Appendix B shows the importance of the Gulf area for commercial production of Atlantic Salmon in the Maritime region. In 1964, for example, the Gulf area, which included eastern New Brunswick, yielded 1,070,829 pounds compared to 65,027 pounds for the Atlantic, and 174,256 for the Fundy area. Appendix A shows that commercial landings in Nova Scotia also are highest in the Gulf area and lowest in the Fundy area. In the Gulf area, Victoria County and eastern Inverness yield relatively large quantities along with Antigonish and eastern Pictou. Between 1953 and 1964, the lowest landings in the Gulf area of Nova Scotia were 91,100 pounds in 1957 and the highest were 199,000 pounds in 1962. In the Atlantic area, which yields perhaps half as much as the Gulf area of Nova Scotia, landings are rather evenly distributed by geographical districts, with eastern Halifax and Guysborough County accounting for one-third of the volume. Lunenburg and Queens counties also account for about one-third of the catch in the area. For the Atlantic area as a whole, the lowest yield was 24,000 pounds in 1956 and the highest was 88,000 pounds in 1961. Kings County has the heaviest landings of any of the fisheries districts included in the Fundy area of Nova Scotia. The lowest catch in the Fundy area between 1953 and 1964 was 2,000 pounds in 1956 whereas the highest was 56,000 pounds in 1962. Generally, two thirds or more of the commercial catch of salmon in Nova Scotia is reported from fisheries districts in the Gulf and Atlantic areas from east Pictou around to east Halifax, that is, fisheries districts 12 to 19 respectively, including all districts in Cape Breton Island.

The value of landings of salmon depends upon the volume landed and the price per pound. Statistics on landed values, by districts, are given in Appendix A. Table I only summarizes the figures of landed value of commercial salmon in Nova Scotia. Landed value follows closely the movement in the volume of landings. Between 1953 and 1964, landed value of salmon in Nova Scotia fell from $117,300 in 1953 to $63,700 in 1955 and rose steadily thereafter to $183,900 in 1962. Because of progressively lower catches in 1963 and 1964 without compensating changes in price, landed value of salmon in Nova Scotia declined to $173,915 in 1963 and to $164,311 in 1964. The commercial salmon fishery is a wholly inshore fishery ac-

7. MacEachern and MacDonald report 127,000 pounds in 1955.

counting for .5% of 1% of the total value of landings of sea fish in Nova Scotia.

The commercial salmon catch, like that of angling, depends both upon environmental factors, which determine the size of the available salmon stock,[8] and upon the fishing effort in any given year.[9] MacEachern and MacDonald reported in 1962 on the number of traps, gill nets, and drift nets licensed in Nova Scotia from 1929 at 10-year intervals. "Before this period there was no breakdown of nets given in the annual reports. According to the licenses issued, the number of gill nets is at the same level as 1929 but traps have decreased almost 65 per cent from the 1929 figure. Similar decreases may have taken place in the gill net fishery, but this is not indicated by the licenses issued. Many people take out a license to hold their berth but may not fish during the year. Others fish only part time or in the evenings while holding other jobs to make their living."[10]

The number of trap and net licenses issued in Nova Scotia is shown in Table II. The number of trap licenses decreased from 478 in 1929 to 178 in 1959, whereas the number of licenses issued for nets in 1929 was 693 and had fallen only to 669 in 1959. The number of licenses increased during the thirties and stood at 1,672 in 1939,[11] declining nearly 50 per cent to 870 in 1949, with further decreases during the fifties. Available evidence indicates an increase in the number of traps after 1959 to 339 in 1964 and a decrease in the number of nets from 669 to 397. Commercial landings of salmon in the first half of the 1960's have been above those of the last half of the 1950's, signifying either no diminution of fishery effort, in some sense, or increased efficiency of nets and traps, or increased availability of fish, or some changed combination of all three factors.

Table II. Trap and Gill Net Licenses Issued in Nova Scotia for Selected Years, 1929-1964*

Year	*Traps*	*Nets*
1929	478	693
1939	499	1,672
1949	376	870
1959	178	669
1964	339	397

*Statistics for 1964 are comprised of the average number of traps and nets employed in Protection District No. 2, the seven eastern mainland counties, from 1960 to 1965, together with the actual number in use in the remainder of the Province. Deep sea trap nets are not included, but weirs along the Bay of Fundy are included.

Sources: N. E. J. MacEachern and J. R. MacDonald, *The Salmon Fishery in Nova Scotia*, (Ottawa, 1962); and Department of Fisheries, Halifax, Nova Scotia.

Sport Fishery

There are no official records of angling catches in Nova Scotia prior to 1923, although some angling had been done in earlier years. "At the turn of the century the number of salmon anglers in the province was small. Many of the older guides, when asked about the number of fly fishermen for salmon, stated that you could count on the fingers of one hand the number of local residents following the sport, and the number of outsiders visiting the streams was also small, with a few exceptions like the Margaree and Medway

8. Although not an estimate of the salmon stock, an analysis of the total catch of salmon from what was called the "Atlantic Pool" was given in a Brief presented by the Atlantic Salmon Association to the Tourist Council, Province of Quebec, June 13, 1963, Appendix A. The "Atlantic Pool", estimated to be 760,000 salmon, represented the number of fish caught by rods and nets in the four Atlantic Provinces and Quebec in a typical year (1959). "Newfoundland nets obtain 500,000, by far the major share of the crop, and the rods of the province are credited with 20,000. This leaves 240,000 fish as the "pool" for Quebec, New Brunswick and Nova Scotia. From this pool, New Brunswick and Nova Scotia nets take 150,000 with 25,000 caught by rods. There then remains a pool of 65,000 (out of 760,000) to accommodate Quebec's harvest of 55,000 by commercial fishermen, and 10,000 by Quebec anglers." (p. 10). The figures, of course, are intended to be suggestive mainly and not necessarily to be an accurate accounting for any given year.

9. It can be argued also that the available salmon stock in any given year depends not only on environmental factors but also on the extent of exploitation (fishery effort) of the preceding years.

10. N. E. J. MacEachern and J. R. MacDonald, *op. cit.*, p. 44.

11. Owing to the absence of alternative opportunities for employment in the thirties, there was "crowding" in the fisheries generally. The increase in the number of net licenses issued in the 1930's is a manifestation of the "crowding" in this branch of the fishery.

ECONOMIC VALUE

Table III. Angling Catch of Salmon, Nova Scotia and Maritime Region, 1958-1964 Inclusive

Year	Nova Scotia			Rest of Maritime Region			Maritime Region		
	No. Fish	Weight lbs.	No. Rod-Days*	No. Fish	Weight lbs.	No. Rod-Days*	No. Fish	Weight lbs.	No. Rod-Days*
1958	5,188	37,300	71,892	59,860	380,212	85,956	65,048	417,512	157,848
1959	5,145	35,041	55,631	27,885	189,942	69,096	33,030	224,983	124,727
1960	2,211	13,386	48,262	21,284	157,670	101,111	23,495	171,056	149,373
1961	3,767	23,902	63,778	22,720	141,553	62,983	26,487	164,455	126,761
1962	4,998	32,202	76,580	26,927	178,846	86,716	31,925	211,048	163,296
1963	3,080	21,164	40,434	72,900	350,354	84,986	75,980	371,518	125,420
1964	4,743	25,595	32,932	54,106	272,321	90,286	58,849	296,916	123,218

Source: Department of Fisheries, Halifax, Nova Scotia.

*Rod-day is a day or part(s) thereof spent fishing on one river whether a catch is made or not by the angler.

Rivers."[12] However, the gradual increase in angling in the first quarter of the century was quickly accelerated during the 1930's. It is reported that angling declined during World War II but in the post-war period the extent of angling greatly increased in Nova Scotia.[13] Perhaps 3,000 persons fish salmon for sport in Nova Scotia now.[14]

Statistics on the catch of salmon by anglers in Nova Scotia and the Maritime region[15] for the years 1958 to 1964 inclusive are given in Table III. The same information is also presented in Appendix C which shows the angling catch in terms of the Gulf, Atlantic, and Fundy areas which cut across provincial boundaries. The importance of the Gulf area, which includes the relatively large angling catch of the Miramichi River in New Brunswick, is readily apparent for the Gulf area tends to yield about five-sixths of the total angling catch of the Maritime region.

The number of salmon taken by anglers varies from year to year, but during the seven years, 1958 to 1964 inclusive, the lowest angling catch in Nova Scotia occurred in 1960 when only 2,211 salmon were reported taken. This number was slightly less than 10 per cent of the total angling catch for the Maritime region in that year. In the same period, the largest catch in Nova Scotia occurred in 1958, with a total of 5,188 fish reported—about 8 per cent of the total for the Maritime region. In 1964, anglers in Nova Scotia are reported to have taken 4,743 salmon, having a total weight of 25,595 pounds, and to have fished 32,932 rod-days. Again, in 1964, the angling catch in Nova Scotia was about 8 per cent of that for the whole Maritime region. Anglers in Nova Scotia fished about 7 rod-days per salmon taken. The figures show a disproportionately large number of rod-days in Nova Scotia per fish taken compared to the rest of the Maritime region. This situation probably is a reflection of the number, size, location, and accessibility of waters to anglers in Nova Scotia compared to New Brunswick.

Additional statistics on salmon angling in Nova Scotia are given in Appendix D which records, as far as statistics are available, the angling catch of salmon in Nova Scotia since 1923. The figures are considered to be more complete and more accurate for the later years than for the earlier. Statistics of angling catches have been recorded for as many as 67 rivers, but the regular list comprises 56 rivers of which the Margaree, St. Mary's, Moser, Sheet Harbour West, La Have, and Medway are the best yielders.[16] In the period since World War II, the smallest angling catch in Nova Scotia

12. MacEachern and MacDonald, *op. cit.*, pp. 46-47.

13. *Ibid.*, pp. 47-48.

14. See below, p. 18, for a discussion of the reliability of this figure.

15. See above, p. 3, footnote 6, for a statement of the boundaries of the Maritime region.

16. There are nine scheduled rivers in Nova Scotia on which only fly fishing is permitted during the salmon angling season. These rivers are: Margaree, North, St. Mary's, Moser, Musquodoboit, La Have, Medway, Gold, and Petite Riviere.

occurred in 1957 when only 1,599 salmon were taken. In the same period the largest angling catch was 7,544 fish taken in 1948. Thus, in the period 1945 or 1948 to 1957, there has been a wider fluctuation in the salmon angling catch in Nova Scotia than has occurred in the period 1958 to 1964.

Summary of the Salmon Fishery in Nova Scotia —Commercial and Sport

During the last seven years, 1958 to 1964 inclusive, commercial salmon fishermen in Nova Scotia have taken annually, on the average, from 20 to 25 per cent of the total commercial catch for the Maritime region. In 1964, commercial landings of salmon in Nova Scotia were 251,533 pounds with a landed value of $164,311. Anglers in Nova Scotia, on the other hand, have tended to take from 8 to 10 per cent of the total angling catch of the Maritime region. In 1964, the angling catch in Nova Scotia was reported at 4,743 fish with a total weight of 25,595 pounds.

In terms of weight, the commercial catch of salmon in Nova Scotia in 1964 was ten times as large as the angling catch. Since 1958, commercial landings in Nova Scotia has been from 6 to 18 times as large as the angling catch.

PART II

VALUE OF SPORT FISHING

In this century, particularly in the last three decades, as a consequence of the rate of exploitation of the resources of Atlantic Salmon in the face of the encroachments, in one form or another, of civilization on the habitat of salmon, questions have been asked about the future of the resource. In Canada, as in other countries concerned with the problem, there has been initiated a rather extensive biological research program to assist in the formulation of effective measures for conservation of salmon resources. In addition, since the expenditure of public monies is involved, individuals, groups, and government, with an interest in the maintenance of the resource, have been confronted with the problem of its evaluation in economic terms so that criteria may be evolved to assist in making decisions respecting the expenditure of monies.

It is an understatement to say that the valuation of a resource, such as that of Atlantic Salmon is difficult.[17] Nevertheless, a number of studies have been made,[18] and the Atlantic Salmon Association itself has sponsored two others in Canada, one in Quebec[19] and one in New Brunswick.[20] Both these latter studies are, basically, examples of the application of what is known as the expenditures method of evaluation.[21] Maheux used expenditures in the angling and commercial branches of the fishery as a basis for calculating revenues from which an estimate of the associated "personal income" was derived for the Province of Quebec. Maheux concluded that the ". . . combined rod and net fishing for salmon brings each year to the residents of this Province (Quebec) in personal income $2,085,850, or 80% of the total received from the salmon resource. Of this sum, the 12,000 fish caught by line and rod (less than one-fifth of the commercial catch) contributed nearly 75%.[22]

Grasberg sought ". . . to ascertain the econ-

17. See: J. A. Crutchfield, "Valuation of a Fishery," Twenty-Seventh North American Wildlife Conference, or his article in *Land Economics*, May, 1962.

18. See, for example, William G. Brown, Ajmer Singh, and Emery N. Castle, "Net Economic Value of the Oregon Salmon—Steelhead Sport Fishery," *Journal of Wildlife Management*, Volume 29, No. 2, April, 1965; and also W. C. Ballaine, & Seymour Fiekowsky, *Economic Values of Salmon and Steelhead Trout in Oregon Rivers*, School of Business Administration, University of Oregon, August, 1953.

19. Georges Maheux, *Atlantic Salmon in the Economy of Quebec*, (Quebec, 1956).

20. Eugene Grasberg, *Economic Benefits of the Atlantic Salmon to the Province of New Brunswick* (Fredericton, 1956).

21. Four methods have been suggested, or used: namely, expenditures, costs, Hotelling, and non-monetary methods. See, W. R. D. Sewell, et. al., *Guide to Benefit-Cost Analysis*, (Ottawa, 1962), pp. 29-30. R. A. Spargo, in a study entitled *Evaluation of Sport Fisheries, An Experiment in Methods*, (Ottawa, 1964), which is concerned with a particular river system employs the expenditures method, Hotelling method, personal valuation method, and alternative fishing area method. Consideration of the fishery on a particular river is a different problem in certain respects than consideration of a fishery generally within a province, for example.

Table IV. No. of Salmon Anglers, Nova Scotia, 1964, and Response to Questionnaire

Total number of names of anglers on usable mailing list	2,671
Number of anglers who replied to questionnaire	1,006
Number of replies rejected	47
Number of replies used	959
Number of replies showing expenditures outside Nova Scotia	144
Number of replies from Nova Scotians with expenditures outside Nova Scotia	70
Number of respondents who intended to do more angling in 1965	799
Number of respondents who intended to do less angling in 1965	91
Number of respondents who made no comment about intentions for 1965	116
Unusable or incomplete names and addresses not included on mailing list	580

omic benefits derived by the people of New Brunswick from both commercial and rod fishing of Atlantic Salmon." The measure of "economic benefits" was defined as ". . . the amount of income (accruing to the residents of the Province) which is attributable to the occurrence of salmon and which could not reasonably be expected to exist if the fish disappeared permanently."[23] The conclusions of the study were that New Brunswick income accruing in an average year in the mid-fifties from sport fishing for salmon would be $1,144,125; from commercial fishing, processing and retailing $478,875; and from federal expenditures on research and protection $376,900; or a total of $1,999,900.[24]

In any of these studies, as in the present one, a number of conceptual difficulties arise with respect to the delineation of the boundaries of the problem, and the selection of the quantity or magnitude to be measured. In addition, there are questions respecting the method of evaluation to be adopted. There are also the practical aspects of the case, including such matters as the existing institutional arrangements which govern both the conditions under which salmon waters are available to the public and the availability of information.

In Nova Scotia, in contrast to Quebec and New Brunswick, there are no private angling clubs and no privately owned or leased waters. Consequently all (salmon) rivers and streams are open to the public during the fishing season. Moreover, a very great deal of the angling is done without guides. Also, outfitters are not an identifiable group in the Province that can provide useful information on sales to salmon anglers. Therefore, some sources of information found in other provinces are not existent in Nova Scotia. Nevertheless, in virtue of the Atlantic Salmon Association's interest in knowing ". . . what the value of the sport fishing is as well as the commercial salmon fisheries,"[25] the expenditures method, despite its limitations, seemed the most feasible one to adopt in the search for an answer. And, so far as sport fishing is concerned, it was apparent that anglers themselves were the only source of useful information. An estimate of expenditures was far more feasible than an estimate of employment as a measure of the value of the sport fishery for salmon.

The Province of Nova Scotia for the first time instituted salmon angling licenses for all salmon anglers in 1964, and the records made available as a consequence of this innovation, although rather incomplete, facilitated greatly the compilation of a workable list of names and addresses of salmon anglers. In addition, federal Fisheries Officers provided the names of 1,600 persons who fished in Nova Scotia for salmon in 1964. A list of 2,671 names of salmon anglers eventually was compiled from all sources of information—although it is possible that some trout fishermen were also included—and a survey by questionnaire was undertaken, along with a number of interviews. There were two mailings of the questionnaire and some distribution through the Nova Scotia Salmon Anglers Association. The Cape Breton Tourist Association kindly undertook the task of publicity and mailing in Cape Breton Island.

The results of the survey can be summarized. Table IV shows some information respecting the number of anglers who fished for salmon in Nova Scotia in 1964 and the number who responded to the questionnaire.

It should be pointed out that there is no way of determining with complete accuracy the total number of anglers who fished for salmon in Nova Scotia in 1964; and in virtue of the problem of distinguishing trout from salmon fishermen in the source material, it is possible that the total number of salmon anglers in Nova Scotia could be

22. Georges Maheux, *op. cit.*, p. 28.

23. Eugene Grasberg, *op. cit.*, p. 2.

24. *Loc. cit.*

25 Correspondence dated April 6, 1964.

smaller than the figure given in the Table. Of the 47 replies rejected, one was clearly inaccurate and the remainder indicated that the respondents either had salmon licenses but did not fish or were trout fishermen only. If the same ratio of non-anglers and trout fishermen to the number of respondents applies to the whole list of 2,671 names, the effective or active list would be reduced to approximately 2,500 anglers in 1964. On the other hand, if allowance is made for unusable names and addresses, 580 altogether, the total number of anglers who fished in Nova Scotia could well exceed 3,000 persons.

A summary of the fishing effort and the success of the respondents in catching salmon is given in Table V. These figures are based on the 959 replies that were used in the compilations. The estimated number of rod-days reported was 19,695. The reported number of salmon caught was 3,462 and the total weight 25,164 pounds. On the average, each salmon represented approximately 6 rod-days of effort and had an average weight of 7.3 pounds.

Table V. Fishing Effort and Catch of 959 Salmon Anglers in Nova Scotia, 1964

Estimated Number of Rod-days	19,695
Number of Salmon	3,462
Total Weight	25,164 lb.
Number of Rod-days per Salmon	6 (approx.)
Average Weight per Salmon	7.3 lb.

It is possible to speculate about these figures. The official estimate of the number of salmon taken by anglers in 1964 is 4,743,[26] whereas 959 respondents reported 3,462 fish. If the total number of anglers was around 3,000, and if all anglers were, on the average, as successful in making a catch as the respondents to the questionnaire, the total number of salmon caught in Nova Scotia by sport fishermen in 1964 could have been in excess of 10,000, about twice the largest number reported for sport fishing in Nova Scotia for any year to date. Perhaps respondents reported too high a catch. On the other hand, official estimates may be low owing to the unlikelihood of fisheries officers having knowledge of all salmon caught by anglers and to some confusion as to whether grilse are reported.

A comparison of two sources of information does not resolve the matter but is of interest. The Department of Fisheries collected rather detailed information of an economic nature from salmon anglers on the Medway in 1964.[27] The Department's list of 280 fishermen (not all the fishermen who fished the Medway) included 27 persons whose names or addresses were incomplete and who could not be reached in this study. However, of the 253 names remaining, 102 responded to the questionnaire and 151 did not. On the Department's list, the respondents are reported as having caught 181 salmon altogether, or 1.77 fish per angler. On the other hand, the non-respondents are shown on the Department's list as having caught a total of 252 salmon, or 1.67 per angler, slightly below the average catch per respondent.

If the actual catch of all non-respondents was as large, on the average, as that of non-respondents on the Medway in relation to respondents who fished the Medway, the total salmon angling catch in Nova Scotia (including grilse?) would be 8-10,000 salmon. However, informed opinion is that such a figure is unrealistic. Fortunately, resolution of this question is not crucial to the purposes of this study, but there will be another reference to it again in the discussion below respecting the economic aspects of the survey of anglers which is the crux of this report.

Expenditures reported by respondents are summarized in Table VI. The section of the questionnaire (Appendix E) pertaining to value of investment in gear, or any equipment—boats, camps, trailers, camping equipment—used for salmon fishing generally was not answered; but answers were much more complete for the section on current expenditures.

For activities associated with salmon angling, the 959 respondents whose replies are used in this study travelled 816,245 miles in Nova Scotia and 179,074 miles outside Nova Scotia. The latter figure is comprised of the mileage of persons coming to Nova Scotia and of Nova Scotians going outside the Province. Mileage figures are converted to dollars at the rate of ten cents per mile. Other expenses for travel include mainly, bus, plane, train fares, and arrangements made with friends.

Food and accommodation is the largest category of expenditure in Nova Scotia. Expenditures on meals may seem high, but they include family expenses. The figure of $83,268 may also seem large for the item enttiled "purchase of camp," but it involves a few transactions involving reasonably large sums. Total expenses on food and accommodation, including miscellaneous items not designated as separate categories in Table VI, were $191,554 in Nova Scotia and $22,100 outside Nova Scotia. Expenditures on tackle, clothing, purchase and rent of boat and such items designated as equipment and supplies were $80,599 in Nova Sco-

26. See above, Table III, p. 10; and Appendix D.

27 Department of Fisheries, Halifax, Nova Scotia.

Table VI. Expenditures of 959 Salmon Anglers (and Their Families) who fished in Nova Scotia in 1964

	In Nova Scotia	Outside Nova Scotia
Travel: Own car—miles	816,245 mi.	179,074 mi.
@ 10c mile	$ 81,625	$17,907
Other (train, bus, plane, friends)	13,054	4,925
Total	$ 94,679	$22,832
Food and Accommodation:		
Purchased meals	$ 31,553	$ 8,000
Beverage	13,247	1,448
Lodging	14,862	5,169
Camping fees	1,917	—
Maintenance of Camp or Trailer	12,948	—
Purchase of camp, trailer, tent, etc.	83,268	—
Total (incl. Miscellaneous)	$191,554	$22,100
Equipment and Supplies:		
Tackle, clothing, purchase or rent of boat, other	$ 80,599	$10,751
Other Expenses: Guide, group or club fees, other	$ 9,536	$ 4,818
Total (All Items)	$376,368	$60,501
Average expense per respondent	$392	$63

tia and $10,751 outside Nova Scotia. Expenditures for the hiring of guides, the payment of group and club fees, and for any other relevant purpose were $9,536 in Nova Scotia and $4,818 outside. Total expenditures reported in Nova Scotia were $376,368 and those incurred outside the Province were $60,501. Average expenditure per respondent in Nova Scotia was $392 and $63 outside Nova Scotia, an average of $455 for both geographical areas.

These results can be compared to other studies. Spargo's[28] estimate (using the expenditure method) of expenditures or costs of anglers fishing the Margaree River in 1962 were:

Average expenditure or cost per respondent $222.52

Average expenditure or cost in Canada per respondent 183.74

Average expenditure or cost in the Margaree area per respondent 97.51

Department of Fisheries information on the Medway River in 1964 estimates expenditures at $100 per angler.[29] This figure includes costs of accommodation (meals, lodging, guides); costs of travel (fares, car expenses); and costs of equipment (20 per cent depreciation on total value of equipment of $38,332). Although the average expenditure per freshwater fisherman probably is lower than that

28 R. A. Spargo, *Evaluation of Sport Fisheries: An Experiment in Methods,* (Ottawa, 1964), Tables 4, 5, and 6.

29 Department of Fisheries, Halifax, Nova Scotia.

Table VII. Comparison of Replies of 18 Respondents to Questionnaire with Information Obtained from interviews with 25 Non-Respondents, Nova Scotia, 1964

	18 Respondents	25 Non-Respondents	Summary
Total no. salmon	42	50	92
No. fish per angler	2.2	2.0	2.1
Total no. rod-days	477	522	999
No. rod-days per angler	26.1	20.9	23.2
No. rod-days per salmon	11.4	10.4	10.9
Total expenditures	$5,952	$625	$6,577
Average expenditures per angler	$ 331	$ 25	$ 153

per salmon angler, Benson's estimate[30] of expenditures per freshwater sport fisherman in Canada in 1961 is $138.30. A comparable figure for the United States in 1960 is $95.25.[31]

It can be seen that all these estimates are considerably below the figure obtained for the average expenditure per salmon angler in Nova Scotia. The accuracy of the figures depends upon the respondents on each of whom fell the burden of deciding what expenses to include and what to exclude. A more detailed questionnaire that would leave less to the discretion of the respondent might have been more satisfactory, but in virtue of the difficulties in compiling a satisfactory list of anglers, the timing of the survey, and the likelihood of a low response to an elaborate questionnaire, the decision was made to restrict its length and to strike a compromise on the information sought. A number of checks along with comments returned with the replies, were used to assess the figures returned by respondents.

If the answers from the 959 respondents are accepted as reasonable, and if it is accepted that the pattern of fishing of non-respondents was similar to that of respondents, and if it is assumed that the number of anglers was around 3,000 persons, total expenditures incurred by anglers in the course of salmon fishing in Nova Scotia in 1964 could have been as large as $1,129,000.[32] If, on the other hand, there are grounds for presuming that the figures are too high to be applied on the average to all fishermen, they can be scaled down. But this process soon degenerates into a guessing game. However, according to the references cited above, it would seem that the minimal average expenditure for all anglers would not be below $100, and perhaps a figure nearer $200 per angler[33] would be more realistic. On these bases, that is, considering ranges of expenditure between $100 and $200 on the average per angler for all anglers, the total expenditure of, say, 3,000 salmon anglers in the course of salmon fishing in Nova Scotia in 1964 would range between $300,000 and $600,000.

As a check on the whole survey, 50 names were selected by random sample procedures from the total list of 2,671 names. The random sample included the names of 18 respondents and of 32 non-respondents. The latter group included one name whose address was in the United States and this was the only name outside Nova Scotia. Of the 31 non-respondents in Nova Scotia, 26 were found for interview and 25 replies were received from them.[34] A comparison between the replies of the 18 respondents and the information obtained from interviews with 25 non-respondents in Nova Scotia on the random sample list is given in Table VII.

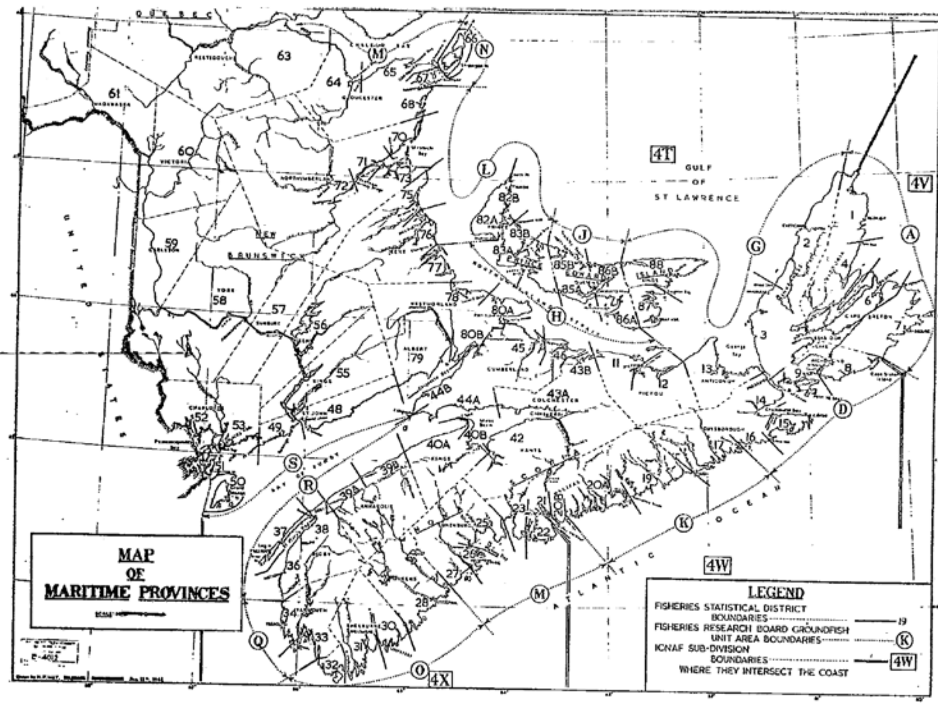
30 D. A. Benson, *Fishing and Hunting in Canada, 1961*, (Ottawa, 1961), Table 8.

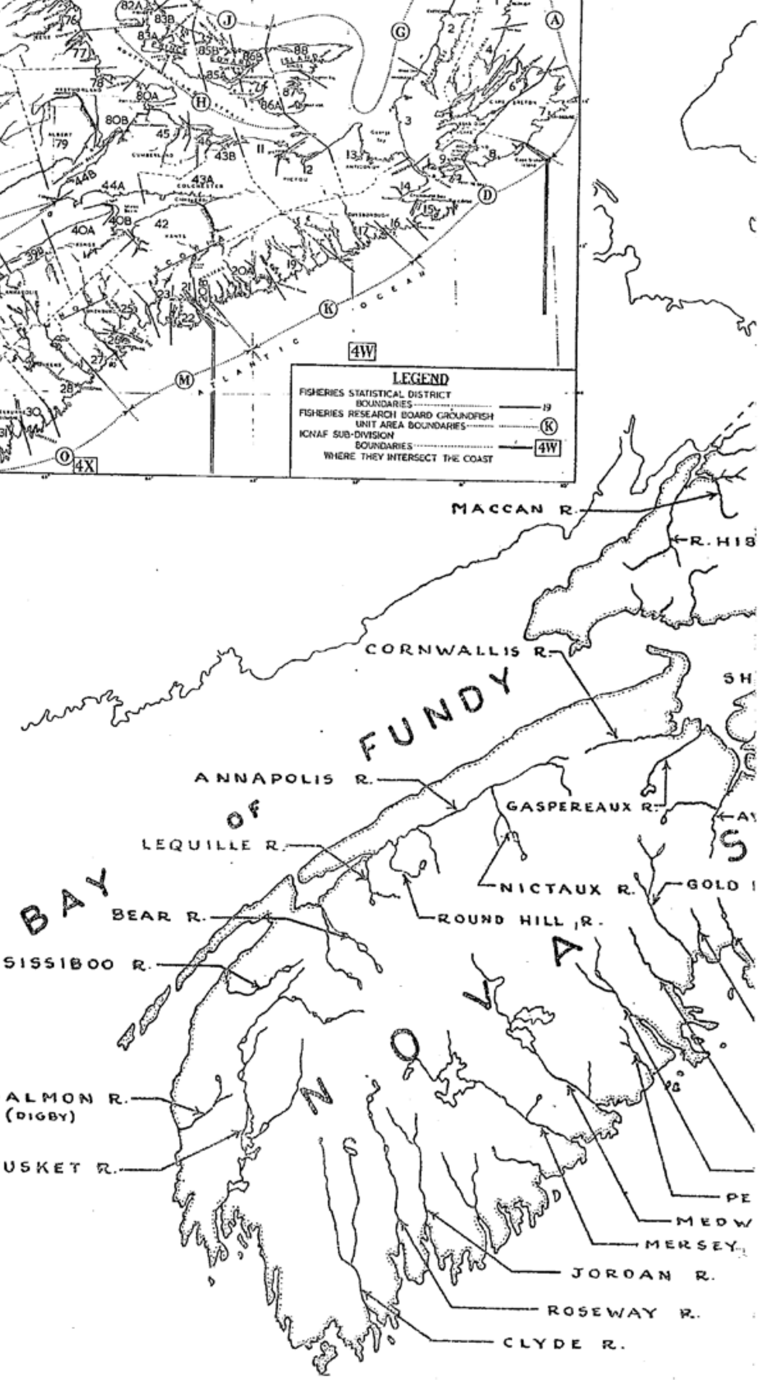
31 U. S. Department of the Interior, *National Survey of Hunting and Fishing, 1960,* (Washington, D.C., 1960), Table 3.

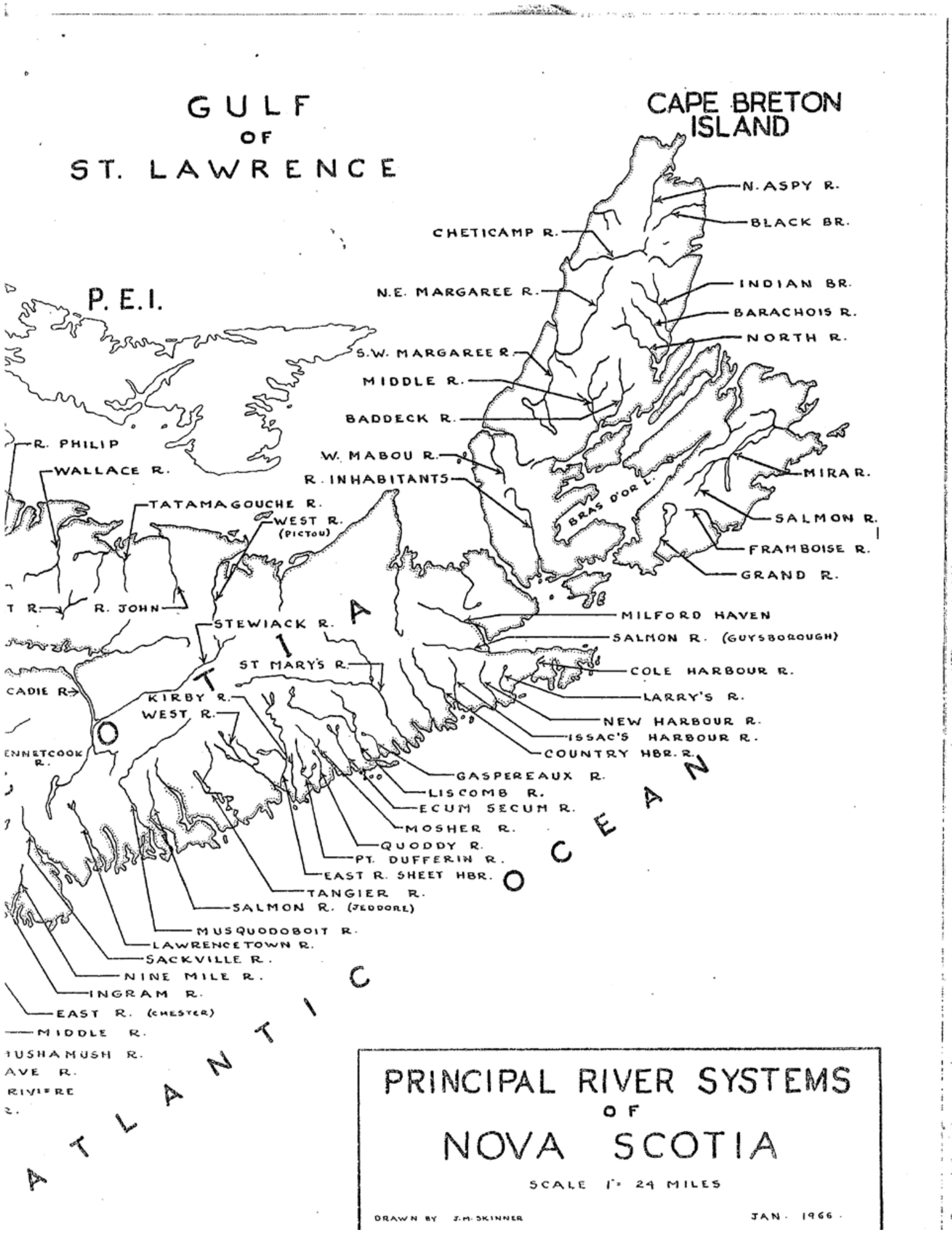
32 $376,368 multiplied by 3 and rounded to the nearest thousand.

33 Cf. R. A. Spargo, *op. cit.,* Table 5.

34 One angler wished to mail his reply. This has not been received at time of writing. Actually it was not the intention to wholly complete a random sample owing to the great likelihood of its containing the name(s) of person(s) in a distant place. Rather it was the objective to start with a random sample and to gather as much information as resources and time permitted from the sample list. Non-completion of the sample probably means a wider range of error than the existence of any particular bias that might be introduced apart from the dropping of the names of non-residents.


MAP
OF
MARITIME PROVINCES
LEGEND
FISHERIES STATISTICAL DISTRICT BOUNDARIES
FISHERIES RESEARCH BOARD GROUNDFISH UNIT AREA BOUNDARIES
ICNAF SUB-DIVISION BOUNDARIES WHERE THEY INTERSECT THE COAST
GULF OF ST LAWRENCE
4T
4V
4W
4X


MACCAN R.
CORNWALLIS R.
BAY OF FUNDY
ANNAPOLIS R.
GASPEREAUX R.
LEQUILLE R.
NICTAUX R.
GOLD
BEAR R.
ROUND HILL R.
SISSIBOO R.
NOVA S
SALMON R. (DIGBY)
TUSKET R.
MERSEY
JORDAN R.
ROSEWAY R.
CLYDE R.


GULF
OF
ST. LAWRENCE
CAPE BRETON ISLAND
P. E. I.
N. ASPY R.
BLACK BR.
CHETICAMP R.
INDIAN BR.
N.E. MARGAREE R.
BARACHOIS R.
NORTH R.
S.W. MARGAREE R.
MIDDLE R.
BADDECK R.
W. MABOU R.
R. INHABITANTS
MIRA R.
BRAS D'OR L.
SALMON R.
FRAMBOISE R.
GRAND R.
R. PHILIP
WALLACE R.
TATAMAGOUCHE R.
WEST R. (PICTOU)
R. JOHN
STEWIACK R.
MILFORD HAVEN
SALMON R. (GUYSBOROUGH)
ST MARY'S R.
COLE HARBOUR R.
LARRY'S R.
KIRBY R.
WEST R.
NEW HARBOUR R.
ISSAC'S HARBOUR R.
COUNTRY HBR. R.
GASPEREAUX R.
LISCOMB R.
ECUM SECUM R.
MOSHER R.
QUODDY R.
PT. DUFFERIN R.
EAST R. SHEET HBR.
TANGIER R.
SALMON R. (JEDDORE)
MUSQUODOBOIT R.
LAWRENCETOWN R.
SACKVILLE R.
NINE MILE R.
INGRAM R.
EAST R. (CHESTER)
MIDDLE R.
ATLANTIC OCEAN
PRINCIPAL RIVER SYSTEMS OF NOVA SCOTIA
SCALE 1" = 24 MILES
DRAWN BY J.M. SKINNER
JAN. 1966.

The table indicates that the great difference between respondents and non-respondents to the questionnaire relates to expenditures. Non-respondents frequently stated that expenses were so small a reply to the questionnaire seemed unnecessary. In most cases, non-respondents fished only in a nearby river at little or no expense to themselves. The average expenditure of 18 respondents in the sample was $331 and of 25 non-respondents interviewed was $25, or an average of $153 per angler for the total of 43 anglers. Non-respondents seemed to do as much fishing as respondents and to be about as successful in making a catch.[35]

It is taken (as an educated guess) that the average expenditure per salmon angler in Nova Scotia in 1964 was between $100 and $160. On the assumption there were 3,000 anglers, the range of values for the total expenditure of anglers in the course of salmon fishing in Nova Scotia lies between $300,000 and $480,000. The latter figure being 160 per cent of the former brings to mind Clawson's warning that an estimate that is more than twice the true figure—however the latter is defined—introduces more error than a zero estimate.[36] Scaling down the minimum figure to $300,000, which is below the reported expenditures of 959 respondents, is not intended to indicate lack of confidence in their replies but rather to recognize the problem of determining the boundaries of the problem and difference in point of view as to what expenditures may rightly be included. In any event, in virtue of the institutional arrangements in Nova Scotia in 1964, it is impossible to achieve a higher degree of accuracy, to apply other methods of measurement, and to advance to more sophisticated levels of analysis.

35 Cf. above, p. 20.

36 Marion Clawson, *Methods of Measuring the Demand for, and the Value of, Outdoor Recreation,* Resources for the Future Incorporated, (Washington, D.C., 1959), p. 3.

Summary: Value of the Sport and Commercial Salmon Fishery in Nova Scotia, 1964.

As explained in the report, the value of the sport and commercial salmon fishery in Nova Scotia in 1964 was as follows:

Sport Fishing:

Expenditures of 959 anglers who responded to questionnaire	$376,368
Estimated minimum and maximum level of aggregated expenditures on the assumption of a total of 3,000 anglers with average expenditures between $100 and $160	$300,000-$480,000

Commercial Fishery:

Landed value	$164,300

The estimated range of aggregate expenditures of anglers in Nova Scotia is perhaps conservative and the higher figure may be reasonably realistic.

If there is a desire to compare sport fishing values with marketed values, the comparison is difficult, or even pointless, since marketed value statistics include the selling value of salmon purchased from fashermen or suppriels outside Nova Scotia but marketed by Nova Scotian shippers.

PART III

CONCLUDING REMARKS

It is impossible to trace money flows through successive rounds of payments and to estimate the total income accruing in Nova Scotia in any given year from salmon resources as a consequence of expenditures of salmon anglers in Nova Scotia and the expenditures of consumers for salmon marketed commercially by Nova Scotian suppliers. There would be an effect, known as the "multiplier" effect, stemming from the initial expenditure flow. But how much income would accrue in Nova Scotia as a consequence of this effect, and how much in other geographical areas, cannot be determined without much more information than is now available. In any event, the relative size of the initial expenditure stream presumably is an indication of the relative size of its over-all effects. This study has made certain estimates respecting the size of the sport in relation to the commercial fishery for salmon in Nova Scotia, and the reader may draw his own conclusions.

It is impossible in Nova Scotia to estimate values as has been done in Quebec[37] and in New Brunswick[38] owing to the institutional and jurisdictional arrangements in the Province and to the open and diffuse nature of the sport fishery. Also, no mention has been made of government expenditures for research and conservation owing in part to the practical difficulty of obtaining a realistic figure for Nova Scotia and also to certain conceptual questions respecting the boundaries of the problem of estimating the value of a fishery.

Serious consideration of the economic feasibility of artificially maintaining or increasing the resources of Atlantic Salmon in Nova Scotia, or eastern Canada, as is done in certain European countries would require both more economic information about the fishery than is presently available and probably different institutional arrangements respecting harvesting. The economics of the supply of, and demand for, salmon is complex. On the supply side, the Atlantic Salmon is a species that responds to fish cultural practices, but the expansion of such a program raises questions concerning the multiple use of resources, if one considers both fish and habitat. Also, the more a resource is depleted probably the more difficult becomes the economic justification of its restoration from the point of view of costs. On the demand side, on the other hand, there are numerous questions pertaining to the harvesting of the resource, and these include the prevailing institutional arrangements with both their domestic and international aspects. But such questions should not be pushed into the background, however, for it is along these lines that further study of an interdisciplinary nature is needed if existing conditions are to be changed wisely and at least partial answers are to be found to some interesting issues in political economy.

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37 See: Georges Maheux, *op. cit.*

38 See: Eugene Grasberg, *op. cit.*

APPENDIX A

Geographical Locations of Nova Scotia Commercial Salmon Catches, 1953-1964

	1953		1954		1955		1956		1957		1958	
Gulf Area												
Districts:	Quant	Val	Quant	Val	Quant	Val	Quant	Val	Quant	Val	Quant	Val
1 —Victoria Co.	23	9.10	28	11.00	10	4.30	12	5.50	22	10.40	36	14.00
2 —Inverness Co.	58	23.00	42	19.50	23	11.30	18	8.60	11	5.40	20	9.90
3 — " "	2	.90	3	1.40	3	1.50	3	1.30	—	—	—	—
4 —Victoria Co.	13	5.50	9	4.50	4	2.00	2	1.20	—	—	3	1.50
6 —Cape Breton Co.	3	1.20	3	1.40	1	.20	—	—	1	.40	1	.30
7 — " " "	10	4.90	7	3.10	3	1.30	3	1.00	2	.80	2	1.30
11 —Pictou Co.	1	.20	1	.40	1	.20	—	—	—	—	—	—
12 — " "	6	2.70	10	4.70	6	3.30	9	4.60	9	5.00	25	11.60
13 —Antigonish Co.	63	28.50	57	25.80	44	22.20	44	24.40	46	24.90	55	30.00
43B—Colchester Co.	—	—	—	—	—	—	—	—	—	—	—	—
45 Cumberland Co.	—	—	—	—	—	—	—	—	—	—	—	—
46 — " "	—	—	—	—	—	—	—	—	—	—	—	—
Total	179*	75.00*	160	70.80	95	46.30	92	46.60	91	46.90	142	68.60

*These values are in '000's of dollars and '000's of pounds, respectively.

	1953		1954		1955		1956		1957		1958	
Atlantic Area												
Districts:												
8 —Richmond Co.	1	.60	1	.30	1	.40	1	—	—	—	1	.50
9 — " "	7	2.40	6	2.20	2	.70	2	—	—	—	2	.70
14 —Guysborough Co.	14	5.60	8	3.40	4	1.90	2	1.20	3	1.70	2	1.10
15 — " "	2	.70	2	.70	—	—	1	.70	2	.80	2	1.00
16 — " "	2	1.10	3	1.20	2	.90	1	.60	1	.60	2	.80
17 — " "	12	4.80	7	2.90	4	1.70	2	.80	4	1.40	5	2.30
19 —Halifax Co.	12	5.80	6	2.80	4	2.30	3	1.00	5	1.60	5	2.20
20A— " "	4	1.50	2	1.00	2	.80	—	—	—	—	1	.50
20B— " "	—	—	—	—	—	—	—	—	—	—	—	—
21 — " "	1	.50	—	—	—	—	1	.70	—	—	—	—
22 — " "	7	3.00	4	2.00	1	.60	2	1.00	1	1.00	2	1.00
23 — " "	1	.60	2	.90	2	.90	2	1.00	1	.80	2	.90
25 —Lunenburg Co.	5	2.40	5	1.90	2	.90	1	.50	2	.80	2	1.10
26 — " "	2	1.00	2	1.10	1	.70	1	.70	1	.40	2	2.00
27 — " "	5	2.70	5	2.60	2	1.00	3	1.30	1	.50	2	1.30
28 —Queens Co.	3	1.90	4	2.40	1	1.00	1	.70	1	.90	5	3.20
30 —Shelburne Co.	1	.20	—	—	—	—	1	.30	—	—	1	1.70
31 — " "	1	.40	—	—	—	—	—	—	—	—	—	—
Total	80	34.70	57	25.60	28	13.80	24	10.50	22	10.50	37	20.30

	1953		1954		1955		1956		1957		1958	
Fundy Area												
Districts:												
32 —Shelburne Co.	—	—	—	—	—	—	—	—	—	—	—	—
33 —Yarmouth Co.	—	—	—	—	—	—	—	—	—	—	—	—
34 — " "	—	—	—	—	—	—	—	—	—	—	—	—
36 —Digby Co.	—	—	—	—	—	—	—	—	—	—	—	—
37 — " "	—	—	—	—	—	—	—	—	—	—	—	—
38 — " "	—	—	—	—	—	—	—	—	—	—	—	—
39A—Annapolis Co.	—	—	—	—	1	.30	1	.40	—	—	—	—
39B— " "	—	—	—	—	—	—	—	—	—	—	—	—
40A—Kings Co.	4	2.10	5	3.30	3	2.10	—	—	5	3.50	8	5.20
40B— " "	—	—	—	—	—	—	—	—	—	—	—	—
42 —Hants Co.	2	1.10	2	1.00	—	—	1	.60	9	3.80	6	3.00
43A—Colchester Co.	4	1.80	3	1.40	—	—	—	—	8	3.60	6	2.80
44A—Cumberland Co.	2	.60	1	.30	—	—	—	—	1	.40	4	2.60
44B— " "	—	—	—	—	—	—	—	—	2	1.40	1	.50
Total	12	5.60	11	6.00	4	2.40	2	1.00	25	12.70	25	14.10
Nova Scotia Total	271	117.30	228	103.80	128	63.70	136*	70.70*	146	76.60	204	103.60

*These values given here may be too high. Also note that the Nova Scotia total may not necessarily be the exact sum of the sub-totals given at the end of each area.

APPENDIX A

Geographical Locations of Nova Scotia Commercial Salmon Catches, 1953-1964

	1959		1960		1961		1962		1963		1964	
	Quant	Val	Quant	Val	Quant	Val	Quant	Val	Quant	Val	Quant	Val
Gulf Area Districts:												
1 —Victoria Co.	16	7.10	64	35.60	26	12.70	48	29.80	38.2	22.80	41.3	26.40
2 —Inverness Co.	26	13.20	24	12.30	24	12.80	28	15.70	23.7	15.10	22.9	15.40
3 — " "	—	—	—	—	2	1.60	4	2.30	3.4	2.20	2.3	1.70
4 —Victoria Co.	3	1.50	2	1.00	4	2.30	3	1.90	3.2	2.20	4.5	3.40
6 —Cape Breton Co.	3	1.10	2	.60	4	2.00	4	2.40	3.8	2.00	5.3	3.10
7 — " " "	1	.30	—	—	1	.60	2	1.30	1.7	1.10	2.2	1.70
11 —Pictou Co.	—	—	—	—	—	—	—	—	1.3	.20	.1	—
12 — " "	19	9.50	25	13.40	26	14.30	47	26.10	48.6	27.90	34.3	22.30
13 —Antigonish Co.	60	32.40	45	23.30	51	27.60	63	37.50	62.5	33.60	56.0	36.30
43B—Colchester Co.	—	—	—	—	—	—	—	—	—	—	—	—
45 —Cumberland Co.		—	—	—	—	—	—	—	—	—	—	—
46 — " "	—	—	—	—	—	—	—	—	—	—	—	—
Total	128*	65.10*	162	86.20	138	73.90	199	117.00	185.4	107.10	168.9	110.30
Atlantic Area Districts:												
8 —Richmond Co.	2	1.00	2	1.00	1	.60	1	.50	1.4	.70	.8	.40
9 — " "	1	.60	1	.40	6	3.20	9	4.60	8.3	4.10	5.6	3.10
14 —Guysborough Co.	2	.90	13	7.30	10	5.80	6	3.80	2.1	1.20	2.7	1.70
~~15 — " "~~	~~4~~	~~1.70~~	~~2~~	~~1.00~~	~~2~~	~~.80~~	~~1~~	~~.70~~	~~2.1~~	~~1.20~~	~~1.6~~	.90
16 — " "	2	1.00	2	1.10	2	1.00	1	.50	1.2	.60	.6	.30
17 — " "	4	2.00	4	2.20	12	5.90	10	4.90	8.7	4.40	4.1	2.70
19 —Halifax Co.	6	3.00	9	5.30	10	5.90	13	7.40	6.1	3.80	5.7	3.60
20A— " "	3	1.60	2	1.30	6	3.20	6	3.70	5.4	3.30	4.5	2.90
20B— " "	—	—	—	—	—	—	—	—	—	—	—	—
21 — " "	3	1.40	1	.80	4	2.50	4	2.70	4.4	2.80	5.4	3.70
22 — " "	12	7.00	1	.50	6	3.20	5	3.20	2.6	1.50	2.6	1.90
23 — " "	1	.70	5	2.70	6	4.30	5	2.50	3.8	2.20	3.6	2.20
25 —Lunenburg Co.	2	1.30	4	1.70	2	1.30	5	2.50	2.9	1.60	2.4	1.30
26 — " "	2	1.20	2	1.20	4	2.70	3	2.10	3.3	2.30	2.5	1.90
27 — " "	5	2.60	2	1.40	7	3.60	9	5.30	5.6	3.50	4.7	3.20
28 —Queens Co.	4	2.50	4	2.70	4	2.50	6	4.30	3.5	2.40	1.5	1.10
30 —Shelburne Co.	—	—	—	—	3	1.40	1	.30	.9	.50	.2	.10
31 — " "	—	—	—	—	—	—	—	—	—	—	—	—
Total	53	29.10	54	30.60	88	47.90	85	49.00	62.3	36.10	48.5	31.00
Fundy Area Districts:												
32 —Shelburne Co.	—	—	—	—	—	—	—	—	—	—	—	—
33 —Yarmouth Co.	—	—	—	—	—	—	—	—	—	—	—	—
34 — " "	—	—	—	—	1	.80	—	—	—	—	.2	.20
36 —Digby Co.	—	—	—	—	—	—	—	—	—	—	—	—
37 — " "	2	1.10	—	—	2	1.30	—	—	—	—	—	—
38 — " "	1	.70	—	—	2	1.10	—	—	.4	.20	.7	.50
39A—Annapolis Co.	—	—	—	—	1	.50	—	—	.9	.60	2.3	1.70
39B— " "	2	1.30	4	2.10	9	5.20	—	—	7.8	4.70	3.1	1.20
40A—Kings Co.	19	11.40	13	8.20	37	24.00	18	11.00	34.9	19.80	23.0	15.10
40B— " "	—	—	—	—	—	—	—	—	—	—	—	—
42 —Hants Co.	1	.20	2	.80	—	—	4	2.10	3.6	2.00	1.7	.90
43A—Colchester Co.	1	.60	1	.60	1	.30	2	1.30	1.5	.90	—	—
44A—Cumberland Co.	3	1.90	4	2.40	3	1.80	4	2.20	4.1	2.50	2.8	1.90
44B— " "	—	—	—	—	—	—	—	—	—	—	.2	.10
Total	29	17.20	24	14.20	56	35.00	26	17.00	53.2	30.70	33.8	21.60
Nova Scotia Total	210	111.40	240	131.90	279	157.30	312	183.90	301.1	173.90	251.5	164.30

*These values are in '000's of dollars and '000's of pounds, respectively.

Note that the Nova Scotia total may not necessarily be the exact sum of the sub-totals given at the end of each area.

Sources: Dominion Bureau of Statistics; Fisheries Statistics of Canada, Nova Scotia, 1954-62. Department of Fisheries, Halifax, Nova Scotia.

APPENDIX B

Commercial Salmon Catch — Maritimes Area, 1958-1964

	Gill Nets	Drift Nets	Trap Nets	Trap Nets or Weirs	Total	N.S. Total
1964						
Gulf	15,870*	492,915	548,176	13,868	1,070,829	168,900
Atlantic	27,894	181	15,718	21,233	65,027	48,500
Fundy	7,454	111,439	24,544	30,819	174,256	33,800
Total	51,218	604,535	588,439	65,920	1,310,112	251,500
1963						
Gulf	44,800	281,000	457,200	19,800	802,900	185,400
Atlantic	27,200	400	35,000	24,100	86,700	62,300
Fundy	27,000	41,700	500	51,500	120,200	53,200
Total	99,000	323,100	492,700	95,400	1,009,800	301,100
1962						
Gulf	44,100	299,300	606,800	27,300	977,500	199,000
Atlantic	30,300	100	38,700	32,900	102,000	85,000
Fundy	19,200	74,600	—	26,400	120,200	26,000
Total	93,600	374,000	645,500	86,600	1,199,700	312,000
1961						
Gulf	5,600	318,200	381,900	11,700	717,400	138,000
Atlantic	29,700	200	44,500	18,700	93,100	88,000
Fundy	21,800	116,200	—	61,500	199,500	56,000
Total	57,100	434,600	426,400	91,900	1,010,000	279,000
1960						
Gulf	10,600	249,900	484,000	9,300	753,800	162,000
Atlantic	19,600	900	19,200	16,000	55,700	54,000
Fundy	29,400	129,900	—	24,300	183,600	24,000
Total	59,600	380,700	503,200	49,600	993,100	240,000
1959						
Gulf	9,700	352,800	486,300	6,200	855,000	128,000
Atlantic	20,600	—	31,900	10,000	62,500	53,000
Fundy	42,100	172,200	—	27,500	241,800	29,000
Total	72,400	525,000	518,200	43,700	1,159,300	210,000
1958						
Gulf	3,000	121,100	478,700	12,300	615,100	142,000
Atlantic	22,700	—	7,500	11,400	41,600	37,000
Fundy	39,000	178,900	—	14,600	232,500	25,000
Total	64,700	300,000	486,200	38,300	889,200	204,000

*The values given for the "Nova Scotia total" may not necessarily add up to the given total.
Source: Department of Fisheries, Halifax, Nova Scotia.

ECONOMIC VALUE

APPENDIX C

Sports Salmon Catch, Maritimes Area, 1958-1964

	Rod-Days	Number of Fish	Weight
1964			
Gulf	79,343	50,769	251,167 lbs.
Atlantic	28,280	4,086	22,179 lbs.
Fundy	18,595	3,994	23,570 lbs.
Total	123,218	58,849	296,916 lbs.
1963			
Gulf	70,442	68,451	330,353 lbs.
Atlantic	33,047	2,426	15,466 lbs.
Fundy	21,931	5,103	25,609 lbs.
Total	125,420	75,280	371,518 lbs.
1962			
Gulf	63,038	25,943	174,401 lbs.
Atlantic	71,917	4,318	25,583 lbs.
Fundy	28,341	1,664	11,064 lbs.
Total	163,296	31,925	211,048 lbs.
1961			
Gulf	43,569	21,526	131,649 lbs.
Atlantic	60,868	3,445	21,421 lbs.
Fundy	22,324	1,566	11,385 lbs.
Total	126,761	26,487	164,455 lbs.
1960			
Gulf	46,427	18,748	144,448 lbs.
Atlantic	46,039	1,909	10,812 lbs.
Fundy	56,907	2,838	15,796 lbs.
Total	149,373	23,495	171,056 lbs.
1959			
Gulf	56,368	25,499	173,572 lbs.
Atlantic	47,999	4,564	29,234 lbs.
Fundy	20,360	2,967	22,177 lbs.
Total	124,727	33,030	224,983 lbs.
1958			
Gulf	74,383	56,764	362,424 lbs.
Atlantic	66,468	4,500	31,258 lbs.
Fundy	16,997	3,784	23,830 lbs.
Total	157,848	65,048	417,512 lbs.

Source: Department of Fisheries, Halifax, Nova Scotia.

APPENDIX D

	River	County	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
1.	Margaree	Inverness	1066	699	363	489	868	509	274	248	484	167	470	144	527
2.	Cheticamp	"	—*	—	69	100	138	121	95	146	122	62	116	3	53
3.	North	Victoria	—	—	—	—	—	—	4	6	9	37	74	95	252
4.	Baddeck	"	—	—	—	—	—	—	—	—	—	—	—	—	—
5.	Middle	"	—	—	—	—	—	—	—	—	—	—	—	—	—
6.	Grand	Richmond	—	—	—	—	—	—	—	—	5	30	19	6	13
7.	St. Mary's	Guysborough	—	—	—	—	518	189	444	245	305	140	127	64	241
8.	Gaspereau	"	—	—	—	—	—	20	35	22	15	8	12	8	—
9.	Liscomb	"	—	—	—	—	—	—	—	—	18	15	14	6	51
10.	Ecum Secum	"	—	—	—	—	250	55	72	57	75	35	32	51	71
11.	Milford Haven	"	—	—	—	—	—	—	—	—	—	—	—	—	—
12.	Salmon	"	—	—	—	—	—	—	—	—	—	—	—	—	—
13.	Cole Harbour	"	—	—	—	—	—	—	—	—	—	—	—	—	—
14.	New Harbour	"	—	—	—	—	—	—	—	—	—	—	—	—	—
15.	Isaac Harbour	"	—	—	—	—	—	35	40	26	—	—	—	—	—
16.	Country Harbour	"	—	—	—	—	50	15	23	16	21	5	—	—	—
17.	Moser	Halifax	—	—	—	—	—	—	—	—	—	—	—	—	—
18.	Quoddy	"	—	—	—	—	—	—	—	—	—	—	—	—	—
19.	Sheet Harbour East	"	—	—	—	—	—	—	—	—	—	—	—	—	—
20.	Sheet Harbour West	"	—	—	—	—	—	—	—	—	—	—	—	—	—
21.	Tangier	"	—	—	—	—	—	—	—	—	—	—	—	—	—
22.	Ship Harbour	"	—	—	—	—	—	—	—	—	—	—	—	—	—
23.	Musquodoboit	"	—	—	—	—	—	—	—	—	—	—	—	—	—
24.	Salmon	"	—	—	—	—	—	—	—	—	—	—	—	—	—
25.	Sackville	"	—	—	—	—	—	—	—	—	—	—	—	—	—
26.	Nine Mile	"	—	—	—	—	—	—	—	—	—	—	—	—	—
27.	Kirby	"	—	—	—	—	—	—	—	—	—	—	—	—	—
28.	Port Dufferin	"	—	—	—	—	—	—	—	—	—	—	—	—	—
29.	Ingram	"	—	—	—	—	—	—	—	—	—	—	—	—	—
30.	Lawrencetown	"	—	—	—	—	—	—	—	—	—	—	—	—	—
31.	East	Lunenburg	—	—	—	—	—	—	—	—	—	50+	—	—	20
	Middle	"	—	—	—	—	—	—	—	—	—	20	—	—	125
	Gold	"	—	—	—	—	—	—	—	—	—	50+	—	—	20
34.	La Have	"	—	—	—	—	—	—	—	—	—	—	—	—	150
35.	Petite Riviere	"	—	—	—	—	—	—	—	—	—	—	—	—	110
36.	Medway	Queens	—	—	—	500	—	—	—	—	—	487	—	—	474
37.	Mersey	"	—	—	—	1200	—	—	—	—	—	600	—	—	662
38.	Jordan	Shelburne	—	—	—	—	—	—	—	—	—	—	—	—	—
39.	Tusket	Yarmouth	—	—	—	—	—	—	—	—	—	—	—	—	80
40.	Clyde	Shelburne	—	—	—	—	—	—	—	—	—	—	—	—	30
41.	Salmon	Digby	—	—	—	—	—	—	—	—	—	—	—	—	28
42.	Annapolis	Annapolis	—	—	—	—	—	—	—	—	—	—	—	—	30
43.	LeQuille	"	—	—	—	—	—	—	—	—	—	—	—	—	4
44.	Round Hill	"	—	—	—	—	—	—	—	—	—	—	—	—	20
45.	Nictaux	"	—	—	—	—	—	—	—	—	—	—	—	—	13
46.	Gaspereau	Kings	—	—	—	—	—	—	—	—	—	106	—	—	—
47.	Cornwallis	"	—	—	—	—	—	—	—	—	—	—	—	—	—
48.	River Phillip	Cumberland	—	—	—	—	—	—	—	—	—	—	—	—	—
49.	Stewiacke	Colchester	—	—	—	—	—	—	—	—	—	—	—	—	—
50.	Barrachoise	Victoria	—	—	—	—	—	—	—	—	—	—	—	—	—
51.	North Aspy	"	—	—	—	—	—	—	—	—	—	—	—	—	—
52.	Framboise	Richmond	—	—	—	—	—	—	—	—	—	—	—	—	—
53.	Jeddore	Halifax	—	—	—	—	—	—	—	—	—	—	—	—	—
54.	~~Larry's River~~	~~Guysborough~~	—	—	—	—	—	—	—	—	—	—	—	—	—
55.	Shubenacadie	Hants	—	—	—	—	—	—	—	—	—	—	—	—	—
56	Maccan	Cumberland													
	Totals		1066	699	432	2289	1824	944	987	766	1054	1812	867	377	2974

*The dash, in most places, does not indicate "no catch", but rather that the values are simply unavailable.

ECONOMIC VALUE

River	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951
1. Margaree	286	312	488	314	474	812	391	348	510	507	443	406	836	427	462	553
2. Cheticamp	99	66	86	95	35	80	37	16	45	59	53	90	149	69	56	79
3. North	126	309	349	302	308	318	211	204	198	239	148	200	155	135	181	140
4. Baddeck	6	42	26	1	31	46	9	2	8	4	6	35	24	45	—	19
5. Middle	—	—	—	—	—	16	6	—	2	—	—	2	18	33	—	14
6. Grand	37	40	41	45	37	34	1	2	1	—	—	2	6	12	16	43
7. St. Mary's	930	375	441	262	617	301	208	1005	651	806	207	237	1063	336	264	1070
8. Gaspereau	19	31	24	7	26	20	3	42	13	10	3	1	—	4	2	7
9. Liscomb	105	45	17	77	61	23	19	60	86	115	18	69	250	16	18	197
10. Ecum Secum	82	78	48	30	150	78	43	148	111	80	48	17	130	51	52	112
11. Milford Haven	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
12. Salmon	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	4
13. Cole Harbour	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	—
14. New Harbour	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	9
15. Isaac Harbour	29	96	20	13	28	—	—	—	—	—	—	—	—	—	1	2
16. Country Harbour	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
17. Moser	—	253	280	30	219	33	77	153	94	241	25	23	239	34	120	177
18. Quoddy	19	—	—	—	7	3	—	9	9	12	—	4	30	4	40	18
19. Sheet Harbour East	—	—	—	19	48	47	31	94	14	30	28	—	—	14	69	37
20. Sheet Harbour West	—	65	54	51	174	63	69	272	78	221	106	—	—	49	396	166
21. Tangier	282	246	114	51	88	65	51	64	133	27	7	12	65	11	35	57
22. Ship Harbour	29	45	40	—	—	40	125	85	95	100	120	40	85	7	31	72
23. Musquodoboit	74	240	100	46	75	100	99	110	100	300	110	69	192	50	92	134
24. Salmon	—	—	—	—	—	—	—	—	—	—	—	—	—	28	29	16
25. Sackville	—	—	—	—	—	—	—	—	—	—	—	—	—	5	7	7
26. Nine Mile	—	61	20	21	81	17	12	19	12	20	10	10	27	5	5	1
27. Kirby	—	—	—	45	36	25	63	—	—	—	—	—	66	64	93	46
28. Port Dufferin	5	69	64	45	217	43	26	50	36	45	35	9	92	4	70	114
29. Ingram	175	478	174	166	187	51	25	76	13	31	32	59	191	50	93	89
30. Lawrencetown	168	168	80	—	45	25	23	23	21	30	70	15	—	—	—	—
31. East	41	28	59	32	44	58	25	48	42	57	36	52	64	30	32	36
32. Middle	68	50	27	46	56	59	29	42	37	58	45	83	84	21	33	42
33. Gold	65	91	73	110	142	149	77	97	80	187	91	108	178	51	60	96
34. La Have	200	344	125	250	239	251	263	493	662	998	393	750	1255	137	705	375
35. Petite Riviere	200	238	60	150	83	37	85	138	69	380	153	88	348	18	68	40
36. Medway	715	613	312	412	712	586	597	1165	456	1156	465	408	985	317	612	697
37. Mersey	993	637	278	510	498	339	301	388	167	215	133	153	228	163	356	99
38. Jordan	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—
39. Tusket	114	60	20	10	66	81	51	187	49	280	142	83	174	98	54	11
40. Clyde	97	30	18	4	33	18	55	81	33	41	8	31	134	7	12	10
41. Salmon	30	43	38	32	37	41	42	34	27	79	51	63	137	45	49	28
42. Annapolis	114	139	78	63	9	346	111	91	129	265	318	79	14	148	45	116
43. LeQuille	78	19	19	23	33	77	32	74	44	59	77	15	44	63	38	40
44. Round Hill	106	99	100	47	49	—	—	—	—	—	—	—	—	75	44	150
45. Nictaux	58	253	37	10	13	—	—	—	—	—	—	—	—	168	—	139
46. Gaspereau	55	48	14	52	7	32	6	13	21	20	36	30	56	35	—	20
47. Cornwallis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
48. River Phillip	—	—	—	30	108	166	163	364	480	250	237	156	225	135	313	161
49. Stewiacke	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
50. Barrachoise	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
51. North Aspy	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
52. Framboise	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
53. Jeddore	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
54. Larry's River	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
55. Shubenacadie	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
56 Maccan	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	5405	5711	3724	3354	5073	4480	3362	5997	4525	6922	3654	3399	7544	2969	4566	5250

	River	1952	1953	1954	1955 Rod-Days	1955 No. Fish	1955 Wt.	1956 Rod-Days	1956 No. Fish	1956 Wt.	1957 Rod-Days	1957 No. Fish	1957 Wt.
1.	Margaree	325	385	440	1650	345	3645	1380	152	1298	1215	185	1491
2.	Cheticamp	116	61	170	—	82	—	—	80	—	—	51	—
3.	North	356	177	198	8625	81	684	435	91	711	400	27	246
4.	Baddeck	12	32	31	400	12	103	8	2	18	18	2	17
5.	Middle	29	23	1	60	—	—	18	2	20	—	—	—
6.	Grand	66	90	52	1825	65	267	2798	84	343	479	50	199
7.	St. Mary's	820	1163	415	5050	253	2659	8230	425	3187	1440	143	1157
8.	Gaspereau	—	4	12	300	27	108	608	14	66	87	6	30
9.	Liscomb	85	181	53	1000	62	300	1091	21	111	85	11	55
10.	Ecum Secum	62	148	125	2000	131	550	6400	97	535	410	17	85
11.	Milford Haven	—	—	—	—	—	—	—	—	—	—	—	—
12.	Salmon	45	11	—	103	15	70	51	14	79	60	4	27
13.	Cole Harbour	—	3	2	130	1	10	—	—	—	—	—	—
14.	New Harbour	19	1	3	15	2	9	45	4	42	—	—	—
15.	Isaac Harbour	13	—	—	15	5	22	—	—	—	27	3	18
16.	Country Harbour	1	2	1	—	—	—	20	2	15	28	1	6
17.	Moser	311	271	155	9560	185	980	7680	177	781	4690	81	337
18.	Quoddy	14	29	20	1490	59	315	1180	38	185	1925	19	81
19.	Sheet Harbour East	114	51	114	2070	24	119	1350	18	69	1105	6	24
20.	Sheet Harbour West	340	405	167	12920	523	2755	12105	232	1119	9480	288	1122
21.	Tangier	61	56	11	2635	32	195	3540	43	221	2300	6	30
22.	Ship Harbour	192	110	50	3085	64	432	7525	110	653	5140	9	45
23.	Musquodoboit	102	83	40	4000	17	215	1460	10	130	1850	17	199
24.	Salmon	5	44	—	—	—	—	—	—	—	—	—	—
25.	Sackville	—	2	—	—	—	—	—	—	—	—	—	—
26.	Nine Mile	14	4	3	—	—	—	—	—	—	—	—	—
27.	Kirby	16	43	30	1265	15	82	1395	20	96	—	19	—
28.	Port Dufferin	89	173	148	3160	125	690	3300	96	442	3300	34	138
29.	Ingram	51	71	50	700	70	240	566	41	270	—	14	—
30.	Lawrencetown	—	—	2	500	3	30	3500	9	105	600	1	8
31.	East	11	15	8	90	2	8	25	7	63	40	7	65
32.	Middle	37	16	17	175	10	55	111	3	19	95	4	20
33.	Gold	88	130	115	415	72	411	286	85	695	162	18	125
34.	La Have	357	608	402	759	94	683	1112	289	2157	952	118	817
35.	Petite Riviere	45	90	33	275	41	209	425	66	399	253	21	105
36.	Medway	487	801	532	3065	275	2258	7280	504	3376	4992	295	1855
37.	Mersey	106	113	30	200	23	265	510	30	195	360	15	67
38.	Jordan	—	4	16	—	—	—	—	—	—	—	—	—
39.	Tusket	101	210	45	282	33	265	627	92	750	451	45	413
40.	Clyde	17	91	17	—	—	—	720	7	40	650	7	36
41.	Salmon	45	43	46	1267	19	164	1352	37	328	623	4	42
42.	Annapolis	41	143	56	2453	104	930	557	75	688	531	31	265
43.	LeQuille	10	40	30	560	18	149	184	19	155	32	2	18
44.	Round Hill	33	44	67	749	26	216	247	50	411	32	17	146
45.	Nictaux	55	157	122	1662	71	536	794	87	729	—	13	—
46.	Gaspereau	15	35	25	295	22	128	1002	29	272	152	4	35
47.	Cornwallis	—	2	4	50	4	28	58	2	16	—	—	—
48.	River Phillip	111	17	—	1	—	—	20	6	31	126	15	62
49.	Stewiacke	—	—	—	—	—	—	—	—	—	—	—	—
50.	Barrachoise	—	—	—	—	—	—	—	—	—	—	—	—
51.	North Aspy	—	—	—	—	—	—	—	—	—	—	—	—
52.	Framboise	—	—	—	—	—	—	150	33	15	—	4	34
53.	Jeddore	—	—	—	—	—	—	—	—	—	—	—	—
54.	Larry's River	—	—	—	—	—	—	—	—	—	—	—	—
55.	Shubenacadie	—	—	—	—	—	—	—	—	—	—	—	—
56.	Maccan	—	—	—	10	—	—	20	6	24	—	—	—
	Totals	4818	6182	3859	75676	3012	20681	80175	3170	20175	44087	1599	9390

APPENDIX D

River	1958 Rod-Days	1958 No. Fish	1958 Wt.	1959 Rod-Days	1959 No. Fish	1959 Wt.	1960 Rod-Days	1960 No. Fish	1960 Wt.	1961 Rod-Days	1961 No. Fish	1961 Wt.
1. Margaree	1275	334	3699	1110	225	2689	1050	140	1343	1035	147	1110
2. Cheticamp	—	60	—	—	55	—	—	8	—	—	26	—
3. North	236	45	338	975	162	1330	307	52	462	481	67	519
4. Baddeck	9	8	60	58	15	132	32	5	45	—	—	—
5. Middle	9	19	245	32	4	35	—	—	—	5	2	17
6. Grand	—	117	417	—	162	846	—	112	554	172	65	292
7. St. Mary's	4392	735	6161 (8.3)	2970	550	5048 (9.0)	2284	278	2285 (8.2)	2749	451	4061 (9.0)
8. Gaspereau	337	18	60	107	20	90	193	10	41	248	22	95
9. Liscomb	555	14	70	400	60	300	572	49	262	491	33	188
10. Ecum Secum	918	103	459	614	89	435	849	64	260	708	102	450
11. Milford Haven	—	—	—	4	2	16	—	—	—	—	—	—
12. Salmon	45	4	23	141	17	89	198	1	5	179	7	57
13. Cole Harbour	—	5	25	5	3	15	—	—	—	—	—	—
14. New Harbour	30	2	18	105	1	10	—	—	—	98	4	17
15. Isaac Harbour	99	10	54	261	38	199	128	4	27	130	8	42
16. Country Harbour	20	3	14	26	1	5	—	—	—	—	—	—
17. Moser	6475	207	984	4030	392	1645	7635	207	885	11090	250	1085
18. Quoddy	2185	21	121	450	9	38	1555	15	73	1220	5	24
19. Sheet Harbour East	5080	131	540	1610	79	35	1205	16	73	2230	23	103
20. Sheet Harbour West	9865	237	1091	6550	376	1540	8510	151	640	12375	310	1405
21. Tangier	2595	24	133	1720	50	215	2560	22	85	1725	9	44
22. Ship Harbour	6895	113	561	2220	48	245	—	—	—	240	20	180
23. Musquodoboit	1790	69	725	3375	69	693	—	—	—	—	68	600
24. Salmon	—	—	—	—	—	—	—	—	—	—	—	—
25. Sackville	45	12	55	—	—	—	—	—	—	—	—	—
26. Nine Mile	186	32	143	—	—	—	—	—	—	—	—	—
27. Kirby	2470	67	280	1555	36	155	2370	44	185	1155	23	97
28. Port Dufferin	4660	146	634	2660	152	655	3715	50	215	6150	89	440
29. Ingram	2298	124	642	2324	149	634	1376	23	176	1170	76	578
30. Lawrencetown	1200	11	105	950	32	267	180	3	16	96	21	214
31. East	10	6	65	43	6	53	129	7	34	193	5	48
32. Middle	126	31	195	125	16	70	206	16	72	218	12	61
33. Gold	445	148	955	778	237	1393	280	11	95	888	117	1482
34. La Have	2265	807	5455	2005	639	4542	1347	81	559	4695	646	3333
35. Petite Riviere	292	94	516	566	96	476	435	56	246	439	84	362
36. Medway	7668	1038	9337	9975	1023	7210	8468	551	3018	10314	819	5364
37. Mersey	1660	62	496	738	14	89	560	24	154	960	23	109
38. Jordan	12	5	54	—	—	—	—	—	—	—	—	—
39. Tusket	559	117	934	363	64	492	387	50	400	270	19	179
40. Clyde	660	18	130	120	2	14	200	18	95	375	18	160
41. Salmon	1317	60	544	1976	81	764	848	28	314	1045	27	313
42. Annapolis	672	28	213	383	38	319	175	5	35	135	1	5
43. LeQuille	66	6	47	143	30	256	96	4	40	210	49	353
44. Round Hill	141	65	565	309	109	869	188	21	167	156	36	255
45. Nictaux	522	18	126	86	1	8	—	—	—	—	—	—
46. Gaspereau	378	46	338	184	30	257	96	15	78	110	24	191
47. Cornwallis	23	3	20	32	2	7	26	2	12	—	—	—
48. River Phillip	159	9	76	175	14	116	240	68	275	103	19	86
49. Stewiacke	450	7	25	—	—	—	—	—	—	—	—	—
50. Barrachoise	—	—	—	—	—	—	—	—	—	—	—	—
51. North Aspy	—	—	—	—	—	—	—	—	—	—	—	—
52. Framboise	—	1	5	—	8	40	—	5	22	—	—	—
53. Jeddore	—	—	—	—	—	—	—	—	—	—	—	—
54. Larry's River	5	1	7	—	—	—	—	—	—	—	—	—
55. Shubenacadie	—	—	—	—	—	—	—	—	—	—	—	—
56 Maccan	—	—	—	—	—	—	—	—	—	—	—	—
Totals	71892	5188	37300	55631	5145	35041	48262	2211	13386	63778	3767	23902

ATLANTIC SALMON FISHERY IN NOVA SCOTIA 31

APPENDIX D

	River	1962 Rod-Days	1962 No. Fish	1962 Wt.	1963 Rod-Days	1963 No. Fish	1963 Wt.	1964 Rod-Days	1964 No. Fish	1964 Wt.
1.	Margaree	1240	505	5155	1190	335	3160	2243	416	3729
2.	Cheticamp	—	—	—	—	—	—	—	—	—
3.	North	1100	145	984	589	63	466	379	59	460
4.	Baddeck	45	12	95	140	27	285	—	—	—
5.	Middle	35	16	130	81	16	85	—	—	—
6.	Grand	215	152	802	149	94	426	960	111	474
7.	St. Mary's	4930	869	6306 7.2	4445	480	4460 9.2	3918	994	6728 6.7 AVE - 8.3lb
8.	Gaspereau	496	80	348	248	7	28	396	41	164
9.	Liscomb	732	143	794	493	52	294	507	42	252
10.	Ecum Secum	990	165	698	708	129	629	827	126	622
11.	Milford Haven	—	—	—	—	—	—	—	—	—
12.	Salmon	190	1	8	63	3	16	315	16	102
13.	Cole Harbour	—	—	—	—	—	—	—	—	—
14.	New Harbour	64	—	—	73	5	25	12	1	8
15.	Isaac Harbour	260	33	167	76	9	44	222	38	228
16.	Country Harbour	55	6	36	38	4	26	191	12	87
17.	Moser	9525	263	1165	4050	245	1095	1748	334	1795
18.	Quoddy	1420	50	255	350	20	85	441	76	380
19.	Sheet Harbour East	2445	103	430	1015	14	65	1990	59	235
20.	Sheet Harbour West	19050	346	1615	2146	290	1367	3020	405	1663
21.	Tangier	1950	20	90	1690	17	105	580	59	271
22.	Ship Harbour	—	32	202	—	10	63	295	34	182
23.	Musquodoboit	—	42	314	—	23	183	442	42	273
24.	Salmon	—	—	—	2700	169	755	—	—	—
25.	Sackville	—	—	—	—	—	—	—	—	—
26.	Nine Mile	—	—	—	—	—	—	—	—	—
27.	Kirby	2180	35	155	2820	23	102	2640	52	220
28.	Port Dufferin	7310	119	553	—	169	—	1579	229	1350
29.	Ingram	424	57	272	565	37	214	709	29	153
30.	Lawrencetown	—	20	180	—	4	26	55	6	36
31.	East	130	—	—	115	4	16	110	6	22
32.	Middle	105	2	8	70	3	12	40	12	130
33.	Gold	770	149	777	560	74	419	590	112	491
34.	La Have	5582	546	3595	4167	200	1609	2407	589	2715 5.4 lb avg.
35.	Petite Rivière	423	50	288	360	42	174	557	120	518
36.	Medway	9636	830	5126	3842	426	2949	3085	504	2961
37.	Mersey	1662	28	108	1366	26	186	435	23	92
38.	Jordan	—	—	—	3	1	6	—	—	—
39.	Tusket	192	14	138	230	21	270	270	14	120
40.	Clyde	—	—	—	150	6	40	35	1	5
41.	Salmon	519	12	104	678	25	218	282	10	66
42.	Annapolis	247	9	69	595	5	39	329	6	45
43.	LeQuille	290	26	205	336	13	109	184	13	105
44.	Round Hill	138	3	33	155	3	26	90	3	24
45.	Nictaux	—	—	—	—	—	—	—	—	—
46.	Gaspereau	88	14	113	141	18	119	313	16	109 7.5 Avge
47.	Cornwallis	32	1	6	36	9	36	111	4	12
48.	River Phillip	300	47	404	210	31	360	170	12	71
49.	Stewiacke	1720	59	402	3420	90	600	298	99	555
50.	Barrachoise	72	2	20	24	1	6	4	2	15
51.	North Aspy	—	—	—	2	1	16	90	5	50
52.	Framboise	20	5	51	35	6	30	4	4	36
53.	Jeddore	—	—	—	—	3	16	—	—	—
54.	Larry's River	—	—	—	240	5	30	85	9	63
55.	Shubenacadie	—	—	—	20	6	30	—	—	—
56.	Maccan									
	Totals	76580	4998	32202	40434	3080	21164	32932	4743	25595

10.H Appendix H: Document Excerpt from Veith, 1884

REPORT

UPON THE CONDITION OF THE

RIVERS IN NOVA SCOTIA

IN CONNECTION WITH THE

FISHERIES IN THAT PROVINCE.

Printed by Order of Parliament

OTTAWA:
PRINTED BY MACLEAN, ROGER & CO., WELLINGTON STREET.
1884.

RETURN

(134)

To an ADDRESS of the SENATE, dated 22nd February, 1884;—For Copies of all Reports made to the Department of Marine and Fisheries, between the 1st day of March, 1881, and the last day of December, 1882, by F. N. D. Veith, Esq., an Officer appointed to inspect and report upon the condition of the Rivers in Nova Scotia, and to perform other duties in connection with the Fisheries in that Province.

By Command,

J. A. CHAPLEAU,

Secretary of State.

Department of the Secretary of State,
2nd April, 1884.

DIARY.

IN PURSUANCE OF MINISTER OF MARINE AND FISHERIES ORDER OF 7th MARCH, 1881.

1881.—17*th March.*

Received in the afternoon my commission from the Minister of Marine and Fisheries to inspect the rivers throughout Nova Scotia, and to communicate with Mr. Rogers respecting it. Wrote to Mr. Rogers, asking his opinion whether or not, being at New Ross, Lunenburg County, I had better begin with the rivers from Gold River westerly.

18*th March.*

While awaiting Mr. Rogers reply, being on the spot, determined to visit the head waters of the Gold River and ascertain whether the outlets from the different lakes above New Ross, flowing into the main river, were open for salmon to ascend. Spent the day in getting all the information possible concerning the dams and falls to visit, and in making memoranda of their locality and ownership.

19*th March.*

Visited Larder's River, half-way between Lance's mill and its junction, with Gold River, and found it much choked with *debris* from freshets. It wants clearing out thoroughly. Larder's River, a tributary of the Gold River, flowing out of Lake Ramsay, was once a very famous stream for salmon, and no doubt, from reliable information received from Mr. Ross, a resident on the Gold River for nearly forty years, was very much sought after by these fish, who ascended it in hundreds to spawn in Lake Ramsay, a very sandy and gravelly bottomed sheet of water. Larder's River is now completely stopped by a dam at Lance's Mill.

20*th March.*

Sunday.

21*st March.*

Visited a portion of the river above the cross-roads, then round the Lake to Ross's Falls a very heavy pitch or rapid about 16 miles from the sea; it is quite passable for fish and free from any stoppage. I have been told a mill is about to be erected here and a dam placed entirely across. It might be deemed necessary that when the dam is building a fishery officer should inspect its construction, so that a

134—1

. . .

I must, perforce, not take this quite literally, for Mr. John Fitzgerald, the Overseer, and Francis Tolson, the Warden and Assistant Caretaker at the hatchery, visited these mills and down stream below them, only a day or two previous to my being there myself, and Tolson reported to me, at Bedford, and Fitzgerald, when I met him a day or two after in Halifax, that everything was quite satisfactory when they saw it. A small quantity of mill refuse will escape, no matter how much care be taken; but there is a marked improvement in the condition of the river this year, compared with last. I would earnestly recommend, while speaking of these mills, that a ladder be placed this season, while the water is low, at Hefler's dam, to allow the fish to reach the lake and small streams above, where they could find spawning grounds unpolluted by any sawdust whatever. The want of one has long been felt, and the dam at this mill, debarring the fishes' progress, has much to do with the deterioration of the river complained of. I strongly advocated a ladder being built here, in my report of last year (July 19th)

10th August.

In Halifax; weather unfit to attempt inspection.

11th August.

I again went to the Sackville River, as I wished to learn whether it be true that the mill refuse is, as stated to me since my visit on the 9th, in the day time saved, when people are on the watch, only to be thrown in at night, when the fishery officer is not expected, and there is no one about to see. To do this I was there at daylight in the morning, and travelled for some miles along the bank up towards the mills, in search of fresh signs, but everything was, apparently, satisfactory enough, although Mr. Jack, and a Mr Black, both living a short distance from the river, mentioned to me that they suspected the evasion of the law, just before daylight, to be really the case frequently. I wrote a brief note to these gentlemen on my return, telling them my instructions were to prosecute any of the millers against whom proof could be brought of actually putting the sawdust in, and begged of them if they were able to have any of these millers caught in the act, they would at once let me know, and I would see that the offenders were brought to book and punished.

I find it necessary, owing to the owners of these mills being very poor, to ask that assistance may be given, by a grant of money to build the ladder, I have before alluded to, at Hefler's dam, which is the uppermost on the river below the lake (the other dams are easily surmounted). I have no doubt they would all join in contributing the wood material, were only part of the labor and spikes, nails, &c., provided them free of expense.

I find a great many salmon and grilse have been seen in the Sackville River during the past two months, especially the latter, which says something for it, after all, in spite of so many dismal prognostications; and, although the fishermen in the Bedford Basin still complain of the dearth of the salmon, compared with former years, yet with constant watching, combined with Mr. Wilmot's yearly adding fresh stock, I believe even this complaint will, in a year or two, no longer be made.

12th August.

Last year I visited only the lower part of the Annapolis River and its tributaries; but I went no higher than the Lawrencetown Mills. I had been called away to King's County, and intended to return and visit the upper portion, together with its magnificent tributary, the Nictaux, but was prevented, and went to other counties and to Cape Breton, and so never reached my purposed destination there. I, this day, took passage in train for Middleton, near which is the junction of the Nictaux with the Annapolis, but found the train went no further than Kentville Station that night, so I was obliged to remain until Monday morning before I could proceed.

13th August.

Sunday.

14th August.

I arrived at Middleton Station in the afternoon and, after driving across to the hotel, on the post road, some distance away, I set about gaining all the information possible to facilitate my inspection, and made arrangements for conveyance, &c., the following morning.

15th August.

The junction of the Nictaux and the Annapolis River is about 9 miles from the tide-way. I began to-day at this point and found the Nictaux quite clear of edgings and sawdust, up to and about the first mill, which is situated 1½ miles from the confluence. The dam here is not a high one, being only 3 or 4 feet in time of heavy freshet, and salmon and grilse have been observed jumping over it, but as both this tributary of the Annapolis, and the Annapolis River itself, are frequented by shad, a ladder of simple and inexpensive structure would be of much benefit to assist these valuable fish. The conformation of the bank on the south-east side is admirably adapted for such a purpose. I should mention that the water falls here very rapidly, and at no other time than the high freshet do salmon and grilse succeed in getting over.

A resident here informed me that this season, when the water fell some 2 feet, he saw the fish trying to jump it; but most of them fell back, unable to do so, and became an easy prey to the night poachers with their sweep-nets. This mill and dam is owned by a widow, whose husband, J. Rogers, died a short time ago. She is in very indifferent circumstances, and barely ekes out a living in trying to conduct her late husband's business, and it would be a charity if some assistance were given her to enable her to have this ladder erected.

I proceeded upwards from here, and 1 mile above, came upon the dam where Chipman and Beale's mill stood. It was destroyed some little time ago by fire, but the dam remains intact. It is situated at the Nictaux Falls, so called, from which the settlement near here takes its name. These falls are about 200 feet long, and in time of freshet, must be very formidable for fish to attempt ascending. They could be much improved by a small outlay in blasting. Two or three good shots, judicially placed, would be all that is necessary to remedy their abruptness. The dam is 10 or 12 feet in height, and I saw, in the centre, the remains of an old ladder, now broken, decayed and useless. Indeed, it must have been always the latter, for, on measurement, I found the grade was only about 1 foot in 4 or 5, at the outside, which is, notably, too steep for any description of fish. It appeared almost upright. A good ladder is much needed here—one of the new patent would be the best in a dam of such height.

I then went on to Ward & Gate's grist, carding and shingle machine mill. It has a dam 10 feet in height, and has never been supplied with a ladder. But, on crossing over the dam to the west side, I found a gate cut in it, and a small, most inefficient, channel cut round into the bank, and joining the river some 10 or 15 feet below. It is possible that, were this much widened and deepened, it might be made to answer; but it is too accessible to poachers. I learn this firm is very well to do, and, I should say, could not well object to build a proper ladder in the centre of the dam, which would last for many years and open up this formidable barrier to both salmon and shad. I fear their run round, as it is called, was never sufficiently large to have been of any service. Some considerable distance up, I should say over a mile, I reached Samuel and Robert Nickson's saw mill, with a dam about 10 feet in height. There is here no provision made for fish to get above it—neither fish-pass nor ladder. Should a proper one be erected, there would be then a clear run of nearly 7 miles of good water, without any hindrance to shad and salmon, until they reached the gang saw mills belonging to Freeman & Mitchell, formerly owned by Pope, Voce & Co. I may mention here, that gaspereaux are unknown to either the Nictaux or the Annapolis, at least so far up as this, from the latter's junction with the salt water. But besides the shad and salmon, there is a very large species of trout, attaining sometimes 4 and 5 lbs. in weight. I observed, at all the mills I have just described, that a great deal of care seems to be taken in keeping the water free from mill rubbish. Edgings, &c., are carted away for the residents' firewood, and the sawdust is in some cases taken away and spread as manure over the fields, and in others, piled in great heaps, sufficiently far away from the river's bank to ensure its not falling in. At the grist mill, which was not working when I arrived there, they told me they make a compost heap of the shells on husks, and they find them too valuable to top-dress their land with, to allow them to be thrown in the river; a in practice too common in many other grist mills throughout the Province, and which is more fatal to the fish than even sawdust. Rain setting in, I was obliged to return to the inn, deferring my inspection of Freeman & Mitchell's mills, 7 miles above Nickson's, the last mill visited.

16th August.

Before going up any further on the Nictaux, I determined to see the main river at Lawrencetown mills, which are 6 miles below the mouth of the Nictaux, to ascertain in what condition the dam was, for it would be necessary to make this barrier accessible to fish, before it became necessary to open up its tributary. I visited this place on the 29th April, 1881, and then found the mills in disuse, the gear all removed from them, and everything about them out of repair, whilethe dam remained intact, and totally obstructing the river. I determined then to make this inspection to-day, and so drove over. I found that a great change had taken place since I had last been there. The property had fallen into other hands, and Mr. Brown had become the purchaser, and intending to run these mills again, had begun to repair them and refit them with new waterwheels and other gear. He had rebuilt and raised the dam some feet, and I found was then employed, when I arrived, in making a cutting or sluice-way on the side nearest the south shore. He contemplated making it 5 feet in width, and proposed driving piles at intervals on either side, which would not only act as braces to secure the dam, but also make breaks, something after the manner of a ladder's buckets. The idea was an ingenious one, and I could not help approving of this measure, assisting, as it would undeniably, the fall run of salmon. I remained all day here, advising him as he proceeded, and by night fall we had the job nearly completed. A false dam had to be made above the cutting as there was a good head of water on. I left him, with a promise to return next day and superintend the finishing, and returned to Middleton.

17th August.

Immediately after breakfast I started again for the Lawrencetown dam, and with Mr. Brown, the miller, and a couple of his men, we made the following work complete, as follows:—The sluice was cut 5 feet in width down to the actual bed of the river (we allowed no flooring), five piles being driven in on either side of the interior to brace everything. Finding the piles did not succeed in checking or breaking the water sufficiently, I directed that one large piece of rock, of suitable shape, should be carried on a raft he worked with and dumped just at the entrance. It settled firmly at the botsom and was a great succes, making a considerable eddy and back water, and allowing a passage for fish to pass on either side. This done and acting on the same principle, we here and there, all down the sluice, placed very heavy, irregularly shaped rocks, which broke up the rapid course of the water into innumerable little eddying pools, and at the foot we threw in a pile of rock which made a breakwater into the sluice and so completed a very reliable fish-pass, rigging a boom as well round its upper end to stop all dirt and *debris* from stopping it up and to keep it clear. I further directed that in case of too much water, in high freshets, rushing through and in danger of displacing the stones, that the upper end should be planked across, leaving only a 14 inch aperture at one side. Next year, when the mill is in operation and he is able to saw the material, Mr. Brown will, I am sure, if called upon to do so, erect at this place a good wooden ladder as a fixture. I returned to Middleton in the evening.

18th August.

I drove, to-day, to Freeman & Mitchell's mills, 10 miles above Middleton, on the Nictaux River. There is here a large gang saw mill, and extensive operations are carried on. I found that they burned their sawdust and edgings, and the river about and down from the mill is cleanly kept. The dam is 12 feet in height, and has no ladder or fish pass. I did not go beyond this place; but I learn that the river is clear above for 11 miles, and that then one reaches a rolling dam at the foot of McGill's Lake, which is of great extent. By small streams into the Nictaux empty, also, respectively, Shannon's and Waterloo Lakes, into which, also, run a number of good-sized brooks, affording good spawning grounds.

19th August.

Returned to Halifax.

20th August.

Sunday. In Halifax.

21st August.

In Halifax, writing up reports, accounts, correspondence, &c.

22nd August.

I visited again, to-day, the Sackville River, reaching the mills by conveyance from Bedford. I found that Hefler, the miller, had permitted the bin which I instructed him to prepare for the reception of the sawdust beneath the mill, to be removed, while some men were carting the rubbish out, and this had not been replaced. He excused himself by saying that he had not been sawing nor near his mill for some days, and that he had given strict orders that it should be put back on the completion of the job of removing the sawdust. However, I saw none falling from his floors, and I left him with a caution, that the receptacle must, positively, be a permanent one, and if I saw any more of this neglect, he would have to incur the full penalty.

This was all that appeared at all wrong. I left instructions with the Warden to visit this place again in a few day, in my absence at Hubbard's Cove, and see that Hefler complied with his directions.

23rd August.

In Halifax.

24th August.

I took coach this morning to proceed to Hubbard's Cove, St. Margaret's Bay, in order to carry out Mr. Rogers' request, that I should supervise the erection of a fish-ladder at Shankle's mill, the old ladder, running up under the mill, not having proved as serviceable as at first considered; the new ladder to be built, as much as possible on Mr. Rogers' principle, at the north-west side of the mill, Mr. Rogers furnishing me with a model to guide me in the work. On reaching my destination, I immediately saw Mr. Shankle, who at once, as the water was in a most favorable condition, gave orders for his men to make the cutting in the dam, remove the old ladder, and commence the foundation of the new.

25th August.

Still at Hubbard's Cove. I find the building of the ladder and ballasting its upper end with heavy stone, in the mill pond, will occupy some time. I shall, however, unless directed to the contrary, remain on the spot to supervise its erection daily.

26th to 31st August.

At Hubbard's Cove, superintending the ladder and writing up my reports, disbursement accounts, &c., &c.

Hon. Minister Marine and Fisheries. FRED H. D. VEITH.