The Nictaux Sub-watershed: A Restoration Management Plan

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

PUBLIC VERSION

Clean Annapolis River Project
314 St. George Street, P.O. Box 395
Annapolis Royal, NS, B0S 1A0
1-888-547-4344; 902 532 7533
carp@annapolisriver.ca
www.annapolisriver.ca

This page was intentionally left blank.

The Nictaux Sub-watershed: A Restoration Management Plan

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

PUBLIC VERSION

Prepared by:

Lindsey Freeman, Habitat Ecologist
March, 2014

1st Revision:

Amber Stoffer, Fisheries Technician
March, 2017

NSLC Adopt A Stream, Fisheries and Oceans Canada

This page was intentionally left blank.

Table of Contents

List of Figures VII
List of Tables VIII
Acknowledgements X
Executive Summary XI
1.0 Introduction 1
2.0 Restoration Plan Objectives 2
3.0 The Nictaux Watershed – Introductory Information 3
3.1 Background 3
3.2 Labeled Topographic Maps 9
4.0 Additional Monitoring Data 21
4.1 Fish Population Surveys 21
4.1.1 Electrofishing 21
4.2 Habitat Suitability Assessments 22
4.2.1 2013 HSI Assessments 22
4.2.2 2016 HSI Assessment 25
4.3 Canadian Aquatic Biomonitoring Network Results 29
4.4 Water Quality Results 32
4.5 Habitat Connectivity Assessments 33
5.0 Public Outreach and Information Gathering 36
5.1 Community Outreach 36
5.1.1 Presentations 36
5.1.2 Fly Tying Workshops 37
5.2 Information Gathering 37
5.2.1 Survey Results 38
5.2.2 Meetings 42
6.0 Habitat Descriptions and Restoration Opportunities 43
7.0 Restoration Plan Summary 44
8.0 Summary 46
9.0 References 47
10.0 Appendices 49
10.A Appendix A: HSI Tables 49
10.B Appendix B: 2013 HSI Data 50
10.C Appendix C: Culvert Classification and Prioritization Tables 51
10.D Appendix D: Nictaux River Angler Survey 54
10.G Appendix G: Document from Perry Munro 56

10.H Appendix H: Document Excerpt from Veith, 1884 84

List of Figures

Figure 1. Labeled topographic map of the entire Nictaux sub-watershed, subdivided into stream sections. 10
Figure 2. Feature labels for Section 1 of the Nictaux River. 11
Figure 3. Feature labels for Section 2 of the Nictaux River. 12
Figure 4. Feature labels for Section 3 of the Nictaux River. 13
Figure 5. Feature labels for Section 4 of the Nictaux River. 14
Figure 6. Feature labels for Section 5 of the Nictaux River. 15
Figure 7. Feature labels for Section 6 of the Nictaux River. 16
Figure 8. Feature labels for Section 7 of the Nictaux River. 17
Figure 9. Feature labels for Section 8 of the Nictaux River. 18
Figure 10. Feature labels for Section 9 of the Nictaux River. 19
Figure 11. Feature labels for Section 10 of the Nictaux River. 20
Figure 12. HSI monitoring sites on the Nictaux River system. 23
Figure 13. HSI monitoring sites on the Nictaux River system for 2016 (sites surveyed in 2016 were half the length of sites surveyed in 2013). 27
Figure 14. Family Biotic Indices for the Nictaux River 2013 CABIN sites. 31
Figure 15. Fly-tying workshop at the Middleton Lion's Hall in Nictaux. 37
Figure 16. Species that have been observed or caught by respondents on the Nictaux River system. 38
Figure 17. Locations where respondents like to fish in the Nictaux River sub-watershed. 39
Figure 18. Percentage of survey respondents who have caught Atlantic salmon as bycatch while fishing the Nictaux River system. 39
Figure 19.The percentage of survey respondents that caught an Atlantic salmon as bycatch, and the life stage they caught. 40
Figure 20.The decade(s) in which survey respondents caught Atlantic salmon in the Nictaux River system. 40
Figure 21.Percentage of individuals who have noticed a change in the Nictaux system. 41
Figure 22. Flowchart for classification of barriers. 51

List of Tables

Table 1. Fish population survey locations within the Nictaux River sub-watershed. 21
Table 2. Summary of HSI assessment survey results at NICHSI2. 24
Table 3. Summary of HSI assessment survey results at NICHSI3. 25
Table 4. Summary of HSI assessment survey results at NICHSI4. 25
Table 5. Summary of HSI assessment survey results for brook trout at NICSW before and after fine sediment removal. 27
Table 6. Summary of HSI assessment survey results for Atlantic salmon at NICSW before and after fine sediment removal. 28
Table 7. Summary of HSI assessment survey results for Brook trout at NICCON before and after fine sediment removal. 28
Table 8. Summary of HSI assessment survey results for Atlantic salmon at NICCON before and after fine sediment removal. 29
Table 9. CABIN sampling sites within the Nictaux River sub-watershed. 30
Table 10. Evaluation of water quality using the Family Biotic Index. 30
Table 11. Water quality guidelines listed by parameter. 32
Table 12. Range of tolerated water quality values for species of salmonids. (Adapted from DFO, 2006). 32
Table 13. Range of tolerated pH values (DFO, 2006). 32
Table 14. Watercourse crossing assessment results for the Nictaux River sub-watershed. 33
Table 15. Barrier type and criteria for determining fish passage. 52
Table 16. Barrier culvert remediation options for culverts that do not meet provincial guidelines. 52
Table 17. Road watercourse crossing prioritization index. 53
Table 41. Prioritization categories for culverts based on prioritization scores. 53

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

Acknowledgements

CARP would like to thank the following for their support in the completion of the Broken Brooks project:

- Fisheries and Oceans Canada's Recreational Fisheries and Conservation Partnerships Program.
- Nova Scotia Salmon Association's NSLC Adopt A Stream program.
- The Province of Nova Scotia and the Government of Canada for their financial and in-kind support.
- The Nova Scotia Youth Conservation Corps program.
- Amy Weston (Project Manager), Bob Rutherford (Committee Chair) and Will Daniels (Field Technician) of NSLC Adopt A Stream for their continued project support, guidance and expertise.
- Current and past CARP management staff for their in-office support and guidance, as well as CARP field staff, summer staff, and past project leaders for their in-field support.
- NSLC staff for their in-field assistance.

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.

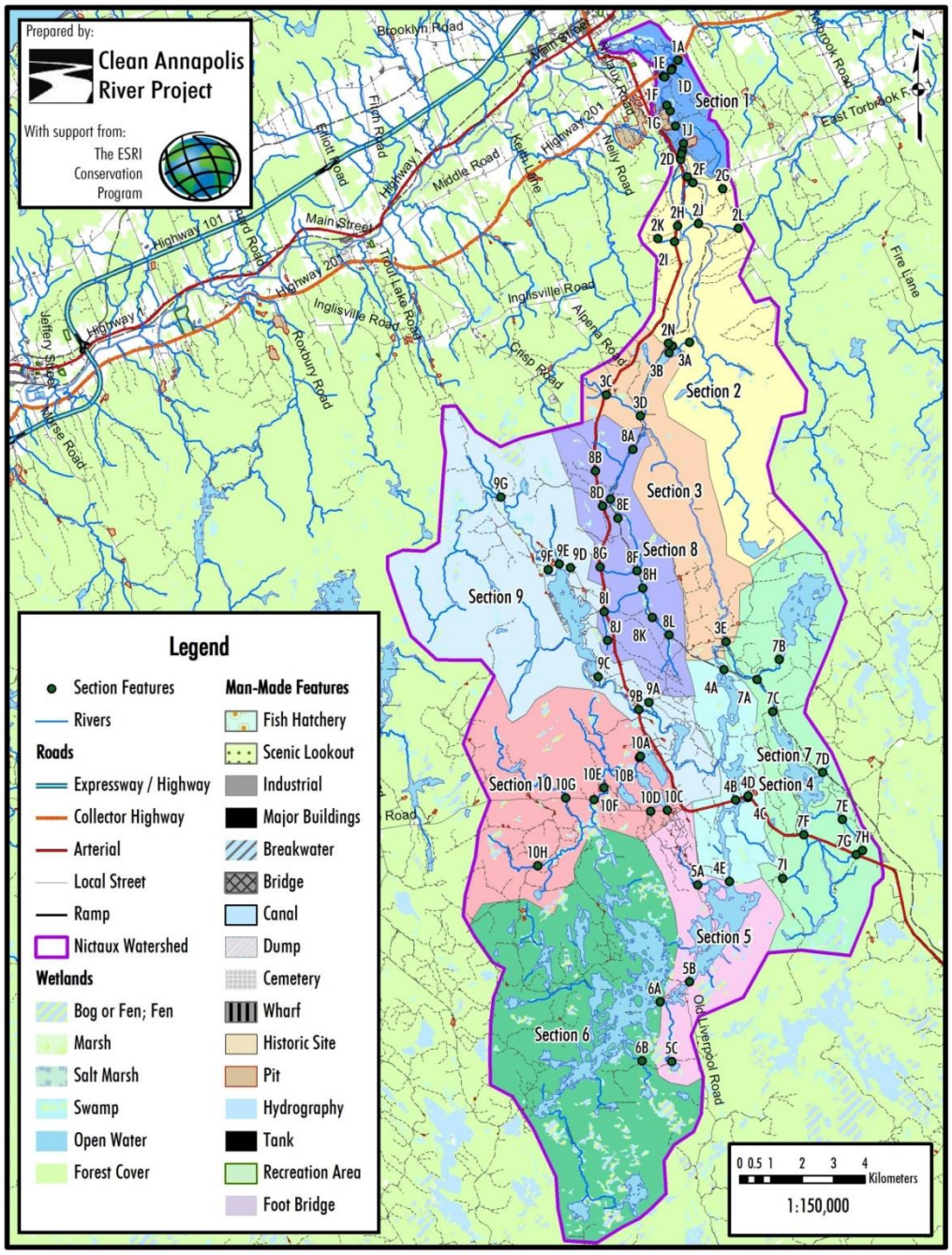


Figure 1. Labeled topographic map of the entire Nictaux sub-watershed, subdivided into stream sections.

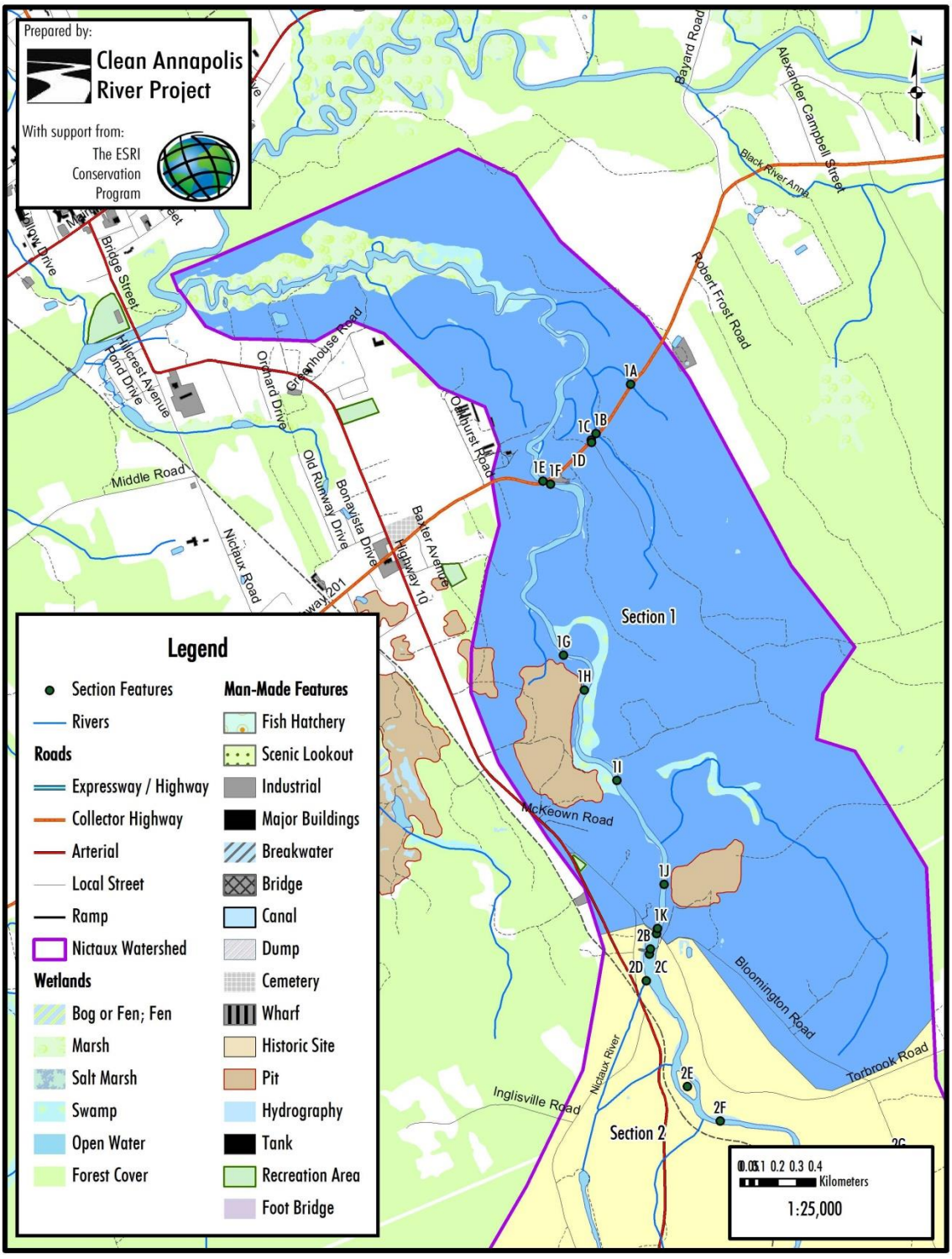


Figure 2. Feature labels for Section 1 of the Nictaux River.

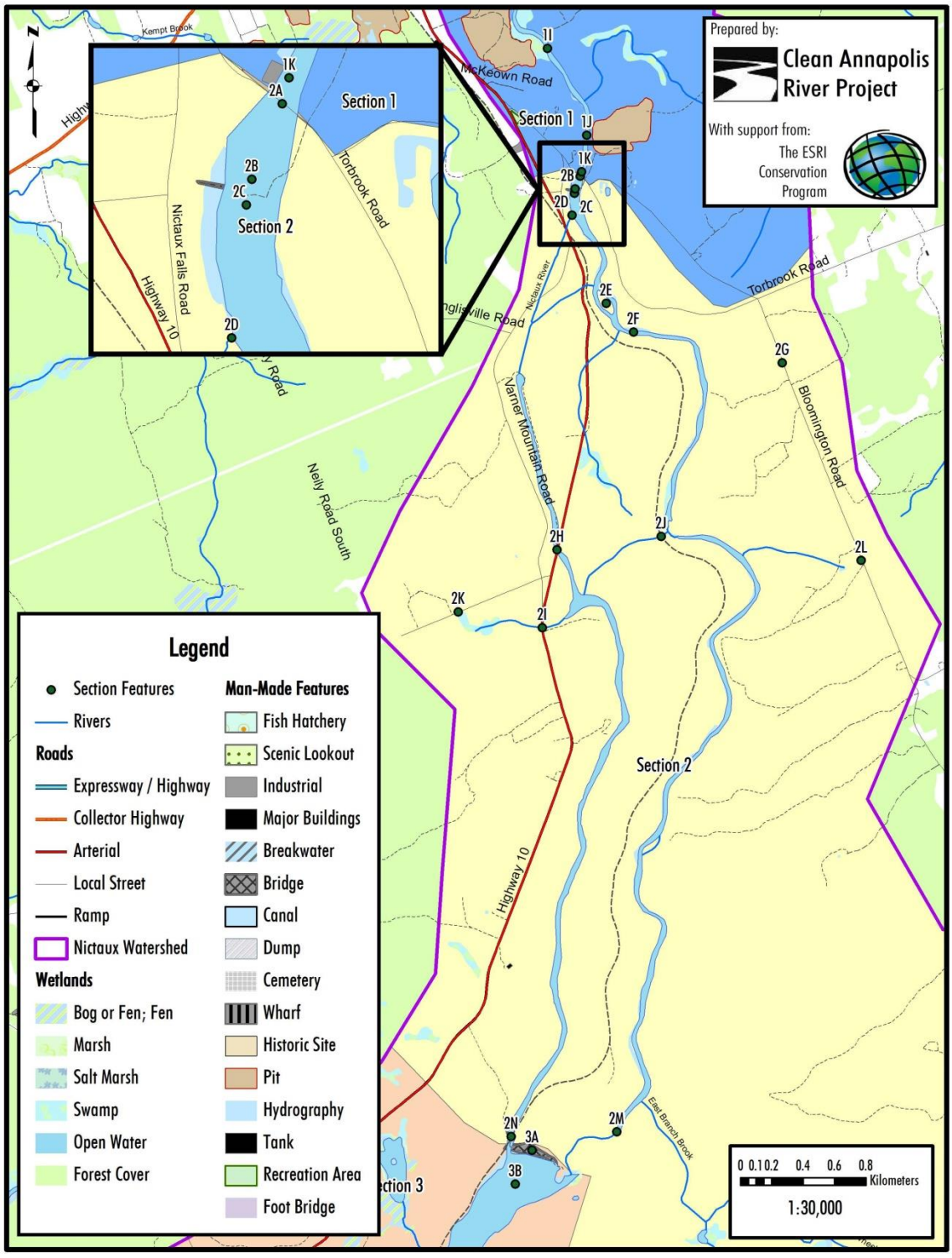


Figure 3. Feature labels for Section 2 of the Nictaux River.

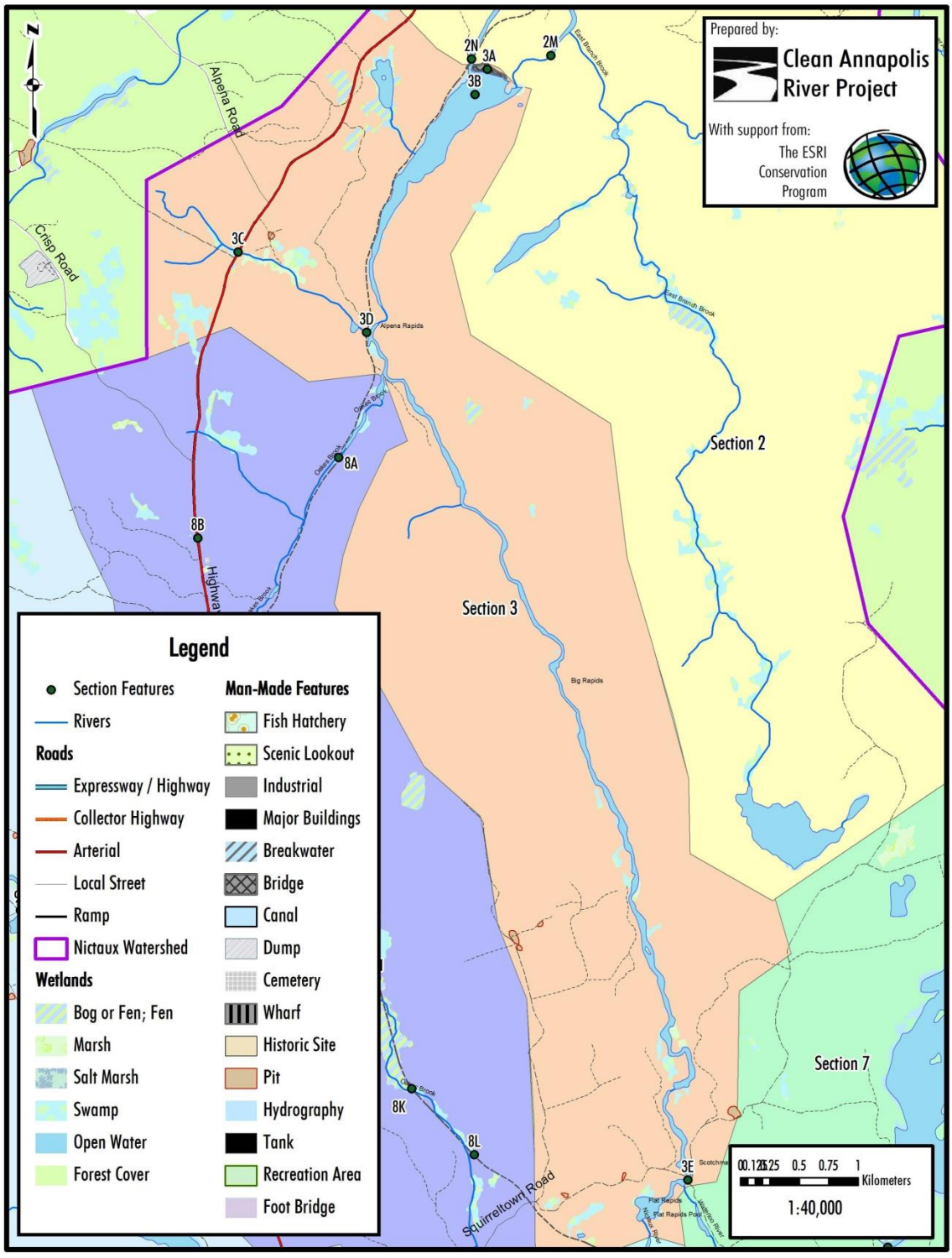


Figure 4. Feature labels for Section 3 of the Nictaux River.

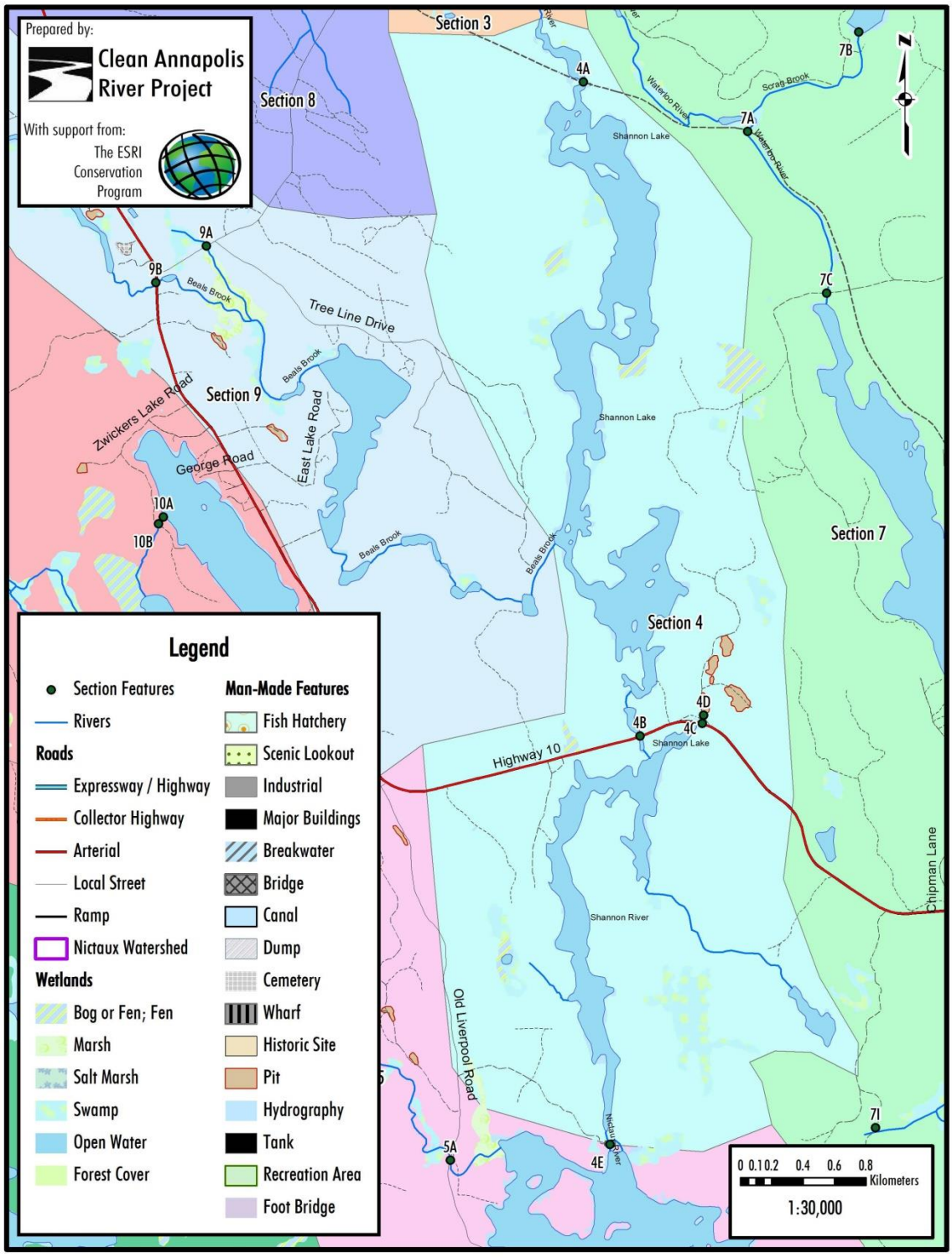


Figure 5. Feature labels for Section 4 of the Nictaux River.

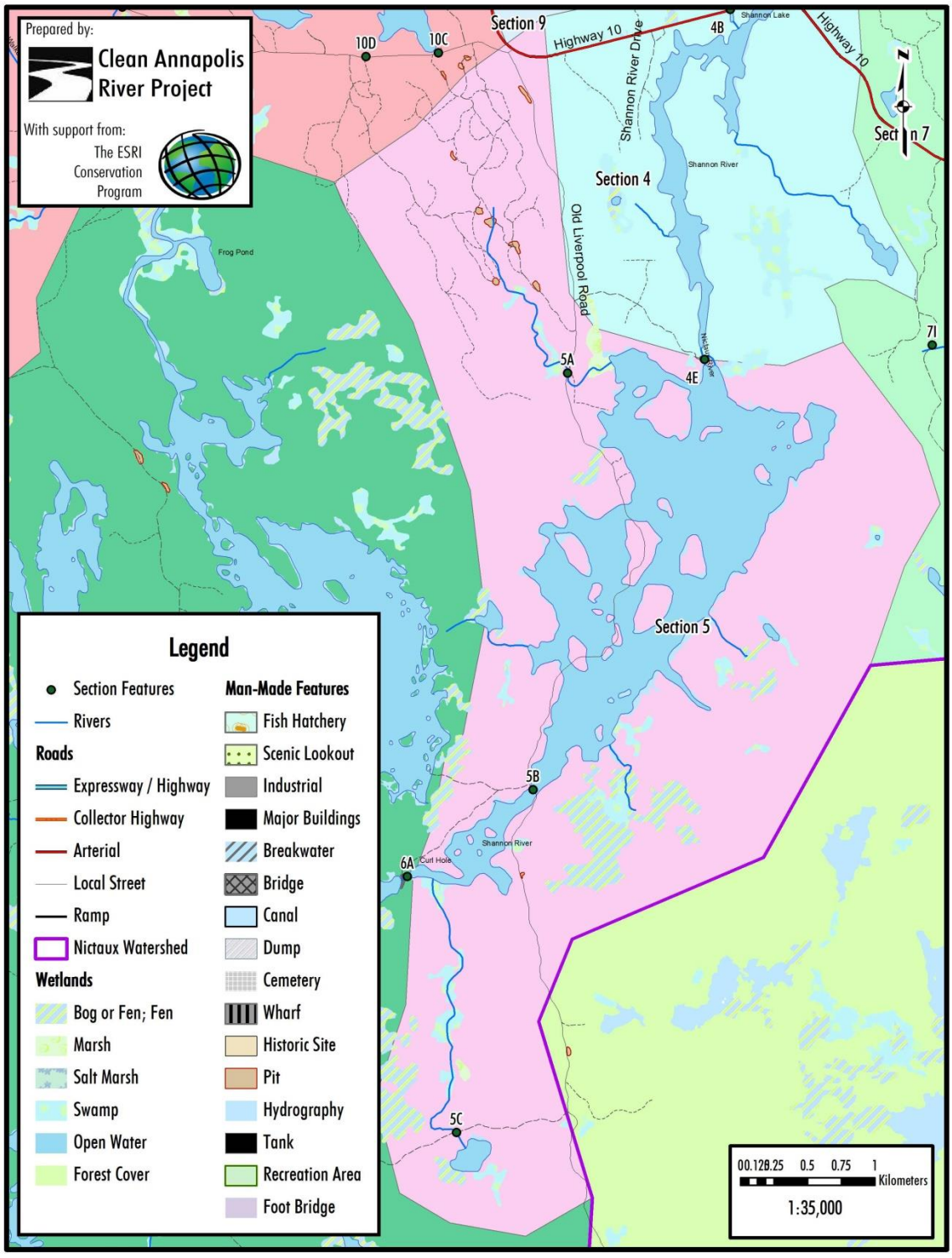


Figure 6. Feature labels for Section 5 of the Nictaux River.

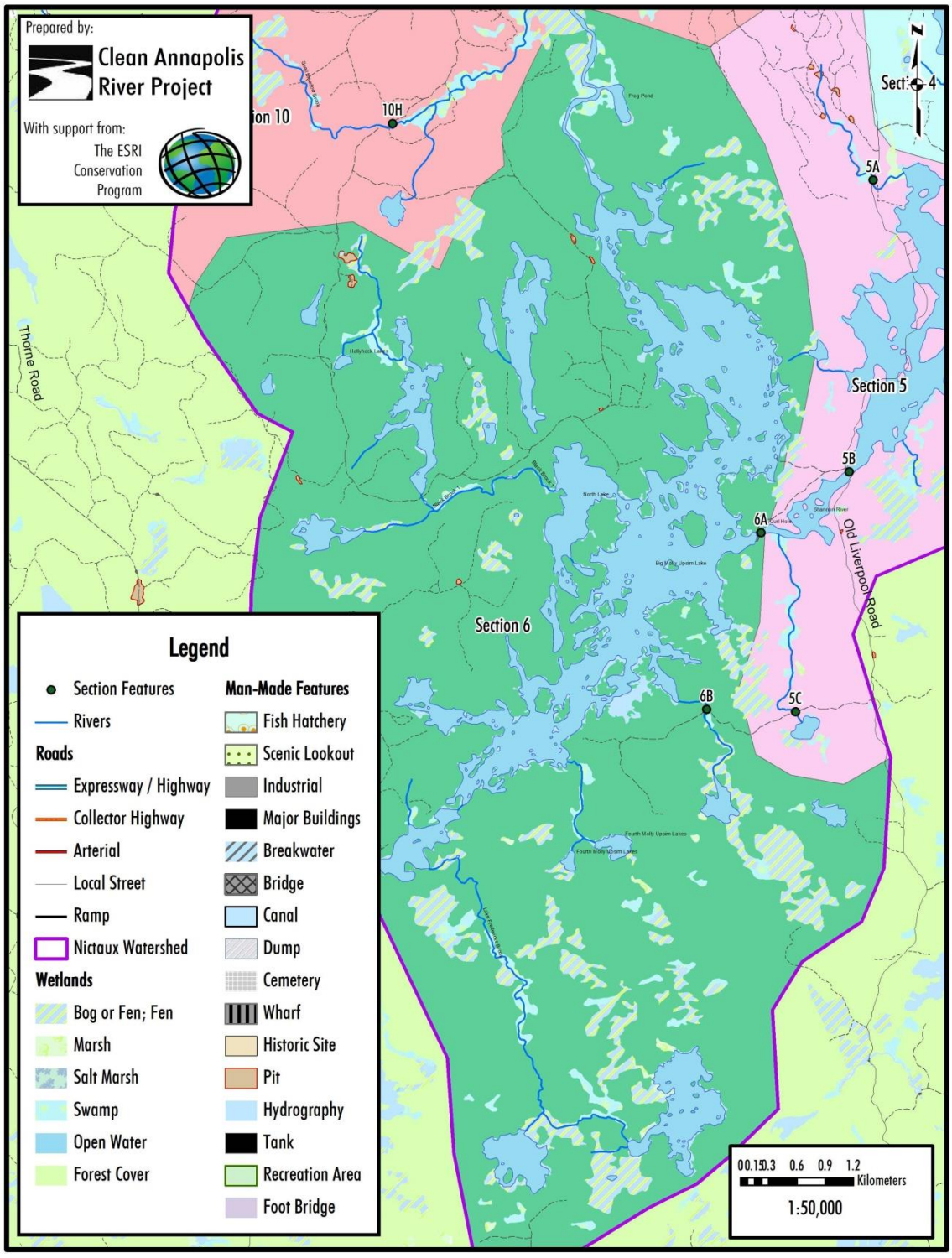


Figure 7. Feature labels for Section 6 of the Nictaux River.

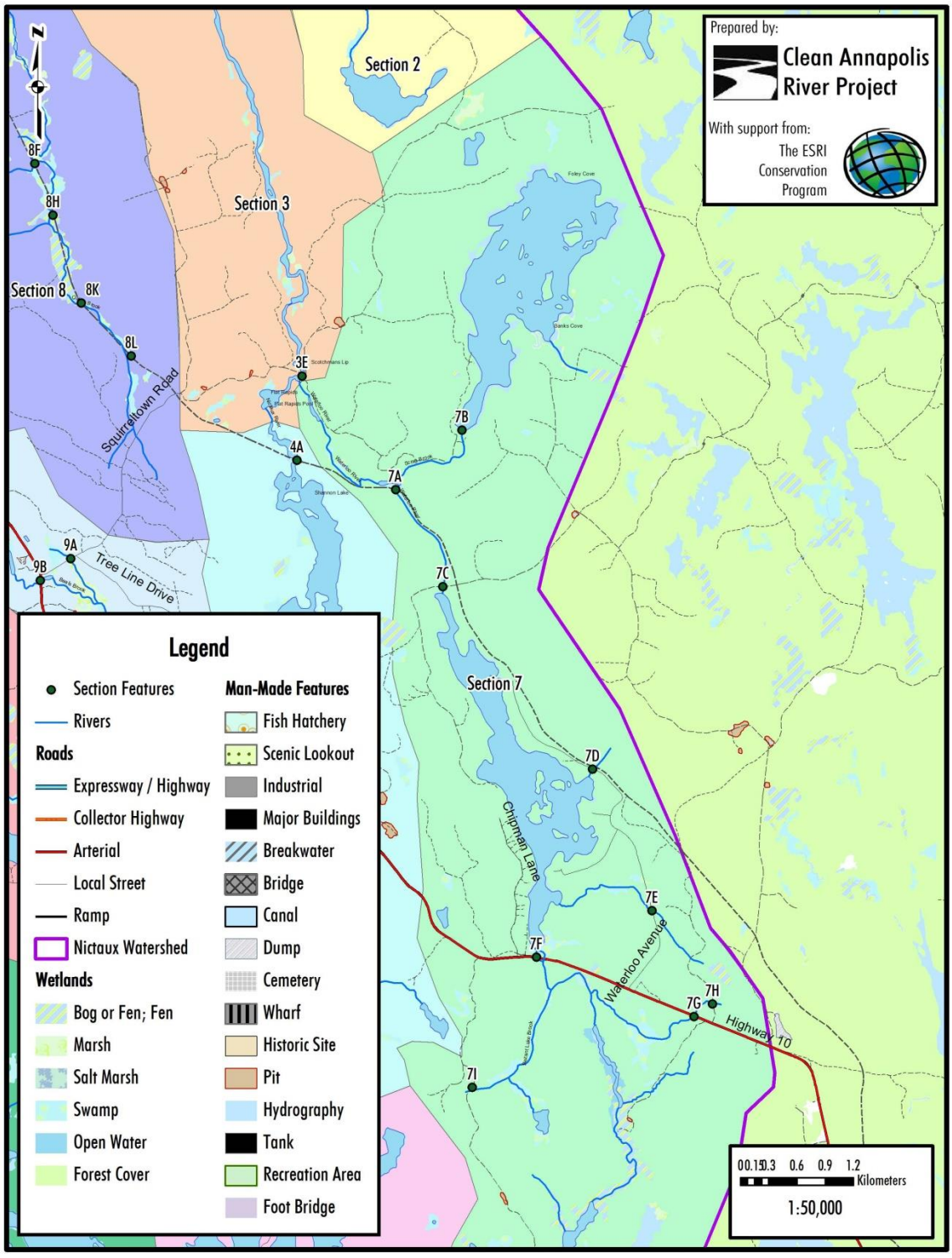


Figure 8. Feature labels for Section 7 of the Nictaux River.

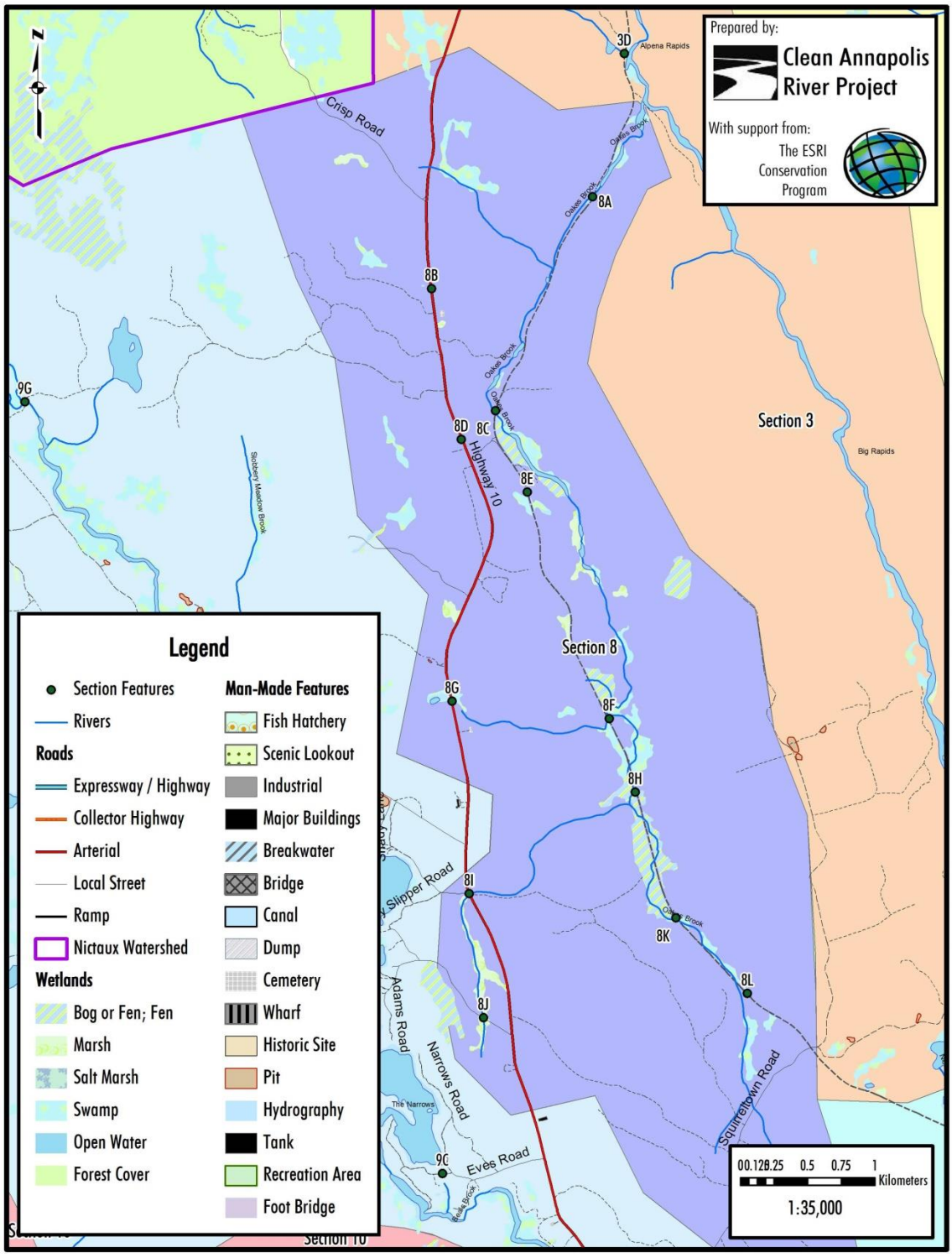


Figure 9. Feature labels for Section 8 of the Nictaux River.

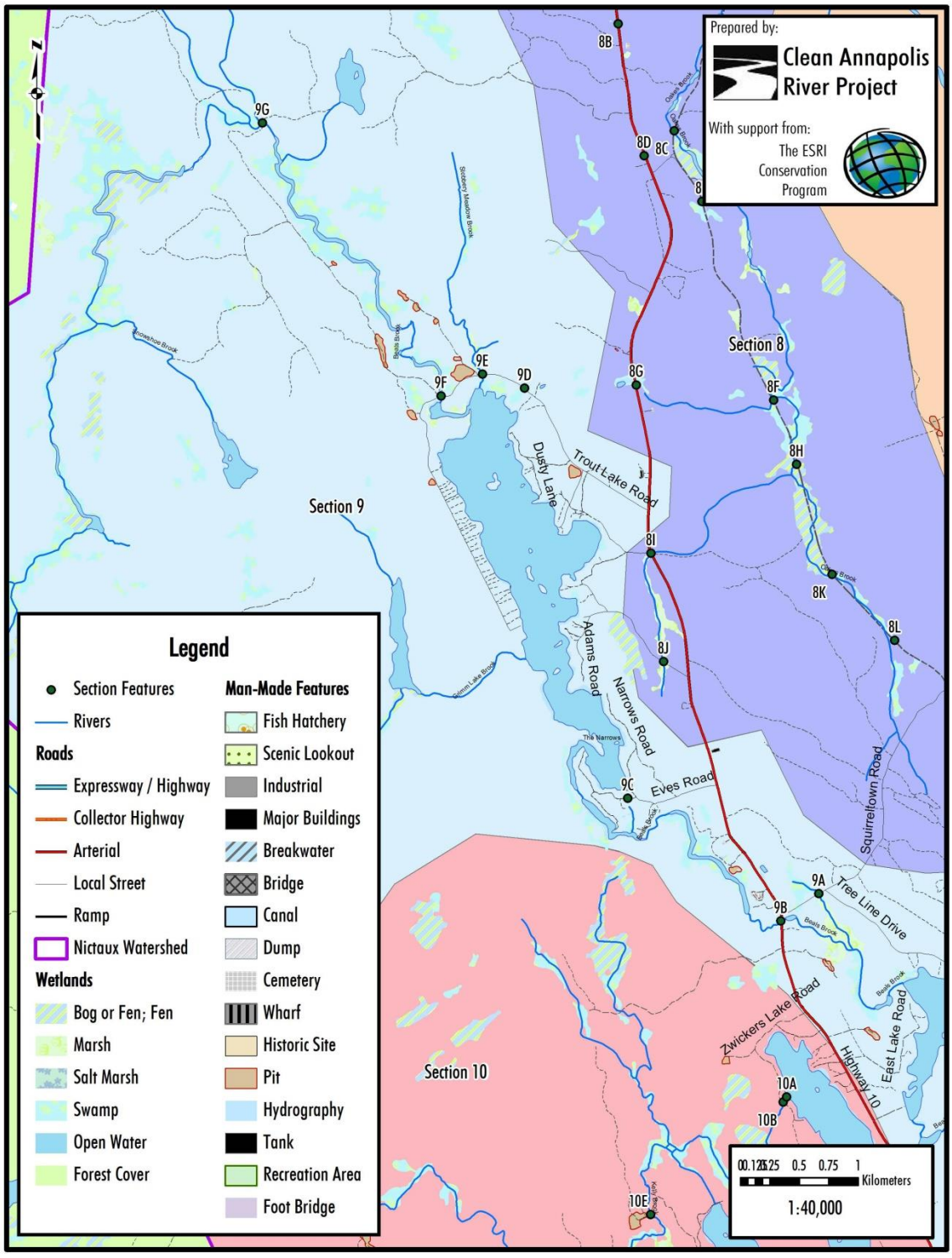


Figure 10. Feature labels for Section 9 of the Nictaux River.

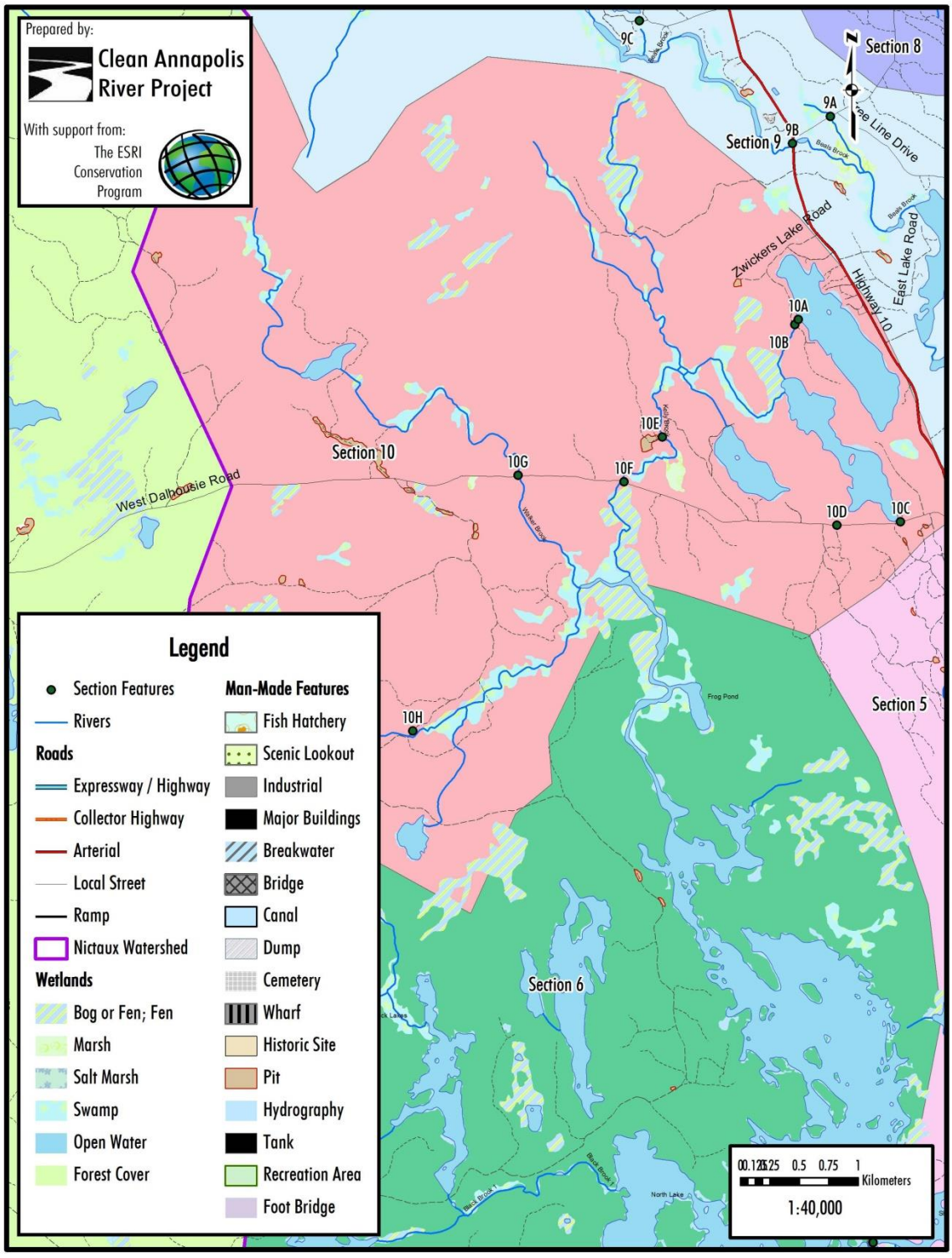


Figure 11. Feature labels for Section 10 of the Nictaux River.

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	omitted	omitted	Electrofishing	19-Sep-13
NIC01F	Nictaux River	omitted	omitted	Fyke Net	06-Oct-13
NIC01M	Nictaux River	omitted	omitted	Minnow Trap	06-Oct-13
NIC02E	Nictaux River	omitted	omitted	Fyke Net	05-Oct-13
NIC02F	Nictaux River	omitted	omitted	Minnow Trap	05-Oct-13
NIC02M	Nictaux River	omitted	omitted	Electrofishing	20-Sep-13
NIC03E	Nictaux River	omitted	omitted	Electrofishing	18-Sep-13
NIC03F	Nictaux River	omitted	omitted	Fyke Net	04-Oct-13
NIC03M	Nictaux River	omitted	omitted	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. Results have been omitted from this version of the report.

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 assessed 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 12. Full assessment data and habitat quality values for brook trout have been omitted from this version of the report.

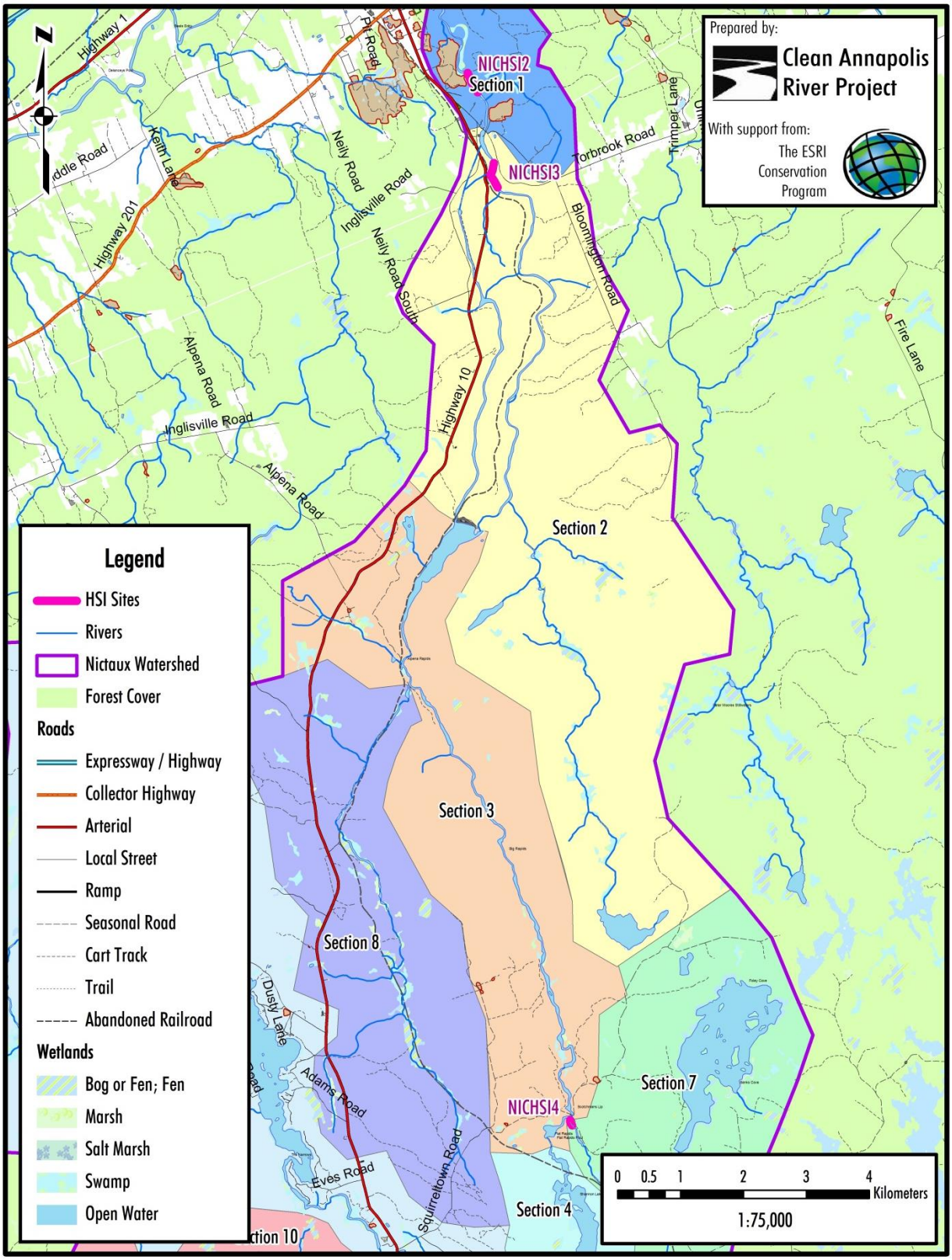


Figure 12. HSI monitoring sites on the Nictaux River system.

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.

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 2-4 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 2. 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 3. 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 4. 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

HIS Assessment data has been omitted from this version of the report. 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). The intent of these HSI surveys was to evaluate restoration activities on in-stream habitat quality.

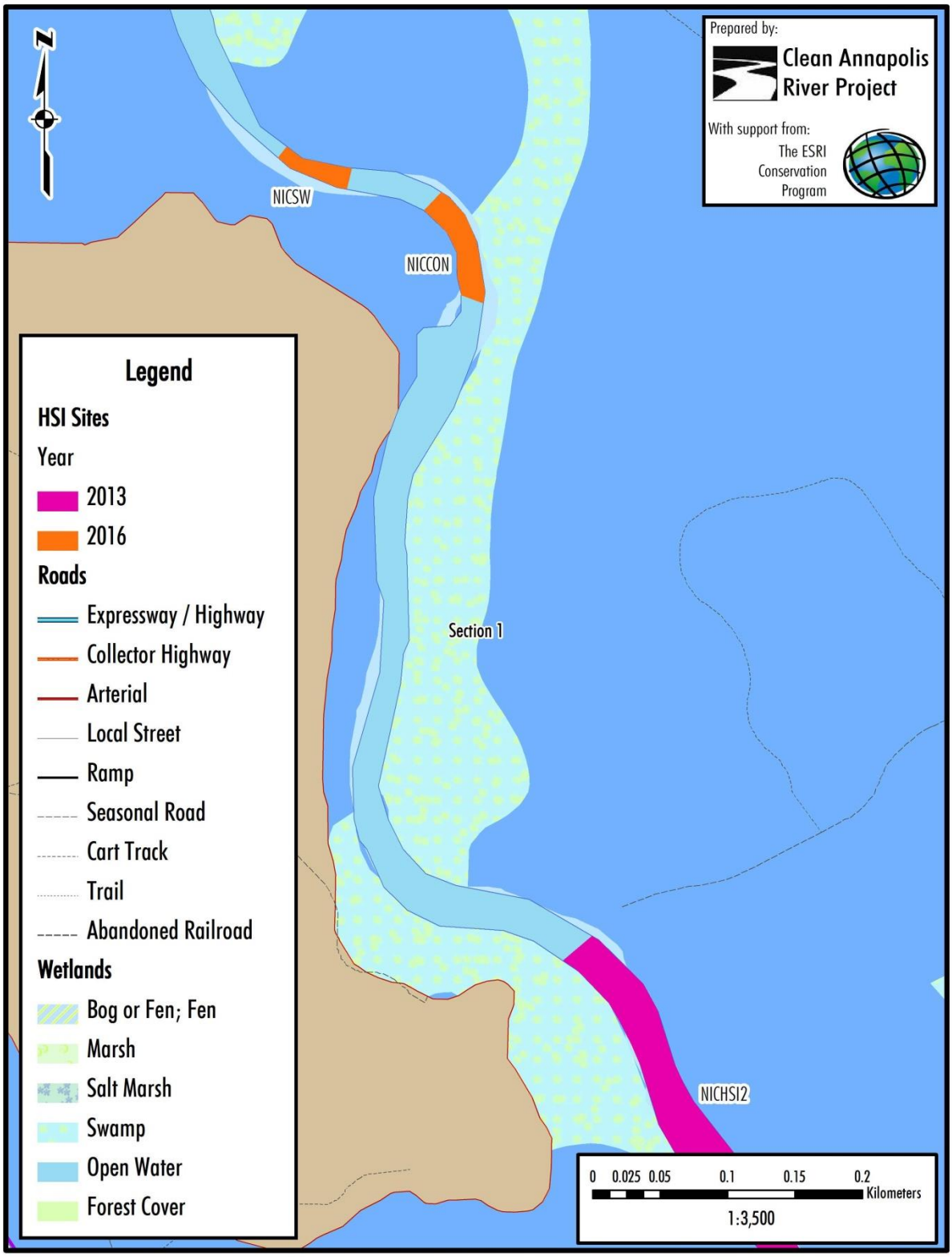

N
Prepared by:
Clean Annapolis River Project
With support from:
The ESRI Conservation Program
NICSW
NICCON
Section 1
NICHSI2
Legend
HSI Sites
Year
2013
2016
Roads
Expressway / Highway
Collector Highway
Arterial
Local Street
Ramp
Seasonal Road
Cart Track
Trail
Abandoned Railroad
Wetlands
Bog or Fen; Fen
Marsh
Salt Marsh
Swamp
Open Water
Forest Cover
0 0.025 0.05 0.1 0.15 0.2
Kilometers
1:3,500

Figure 13. 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 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. In addition, a decrease in overall pool quality could have resulted from the extremely dry conditions experienced during the summer of 2016.

These results only show a snapshot of impacts to the physical habitat, and whether the treatment will have long term benefits is still 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 2017 field season to document the long term impacts of restoration activities.

Table 5. Summary of HSI assessment survey results for brook trout at NICSW before and after fine sediment removal.

Variable	Before			After		
	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 6. Summary of HSI assessment survey results for Atlantic salmon at NICSW before and after fine sediment removal.

Variable	Before			After		
	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 7. Summary of HSI assessment survey results for Brook trout at NICCON before and after fine sediment removal.

Variable	Before			After		
	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 8. Summary of HSI assessment survey results for Atlantic salmon at NICCON before and after fine sediment removal.

Variable	Before			After		
	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 9 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 9. CABIN sampling sites within the Nictaux River sub-watershed.

Site ID	Watercourse Name	Easting	Northing	Assessment Type	Date Assessed
NIC01	Nictaux River	omitted	omitted	CABIN Sampling	7-Oct-2013
NIC02	Nictaux River	omitted	omitted	CABIN Sampling	7-Oct-2013
NIC03	Shannon River	omitted	omitted	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 10.

Table 10. 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 14 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.

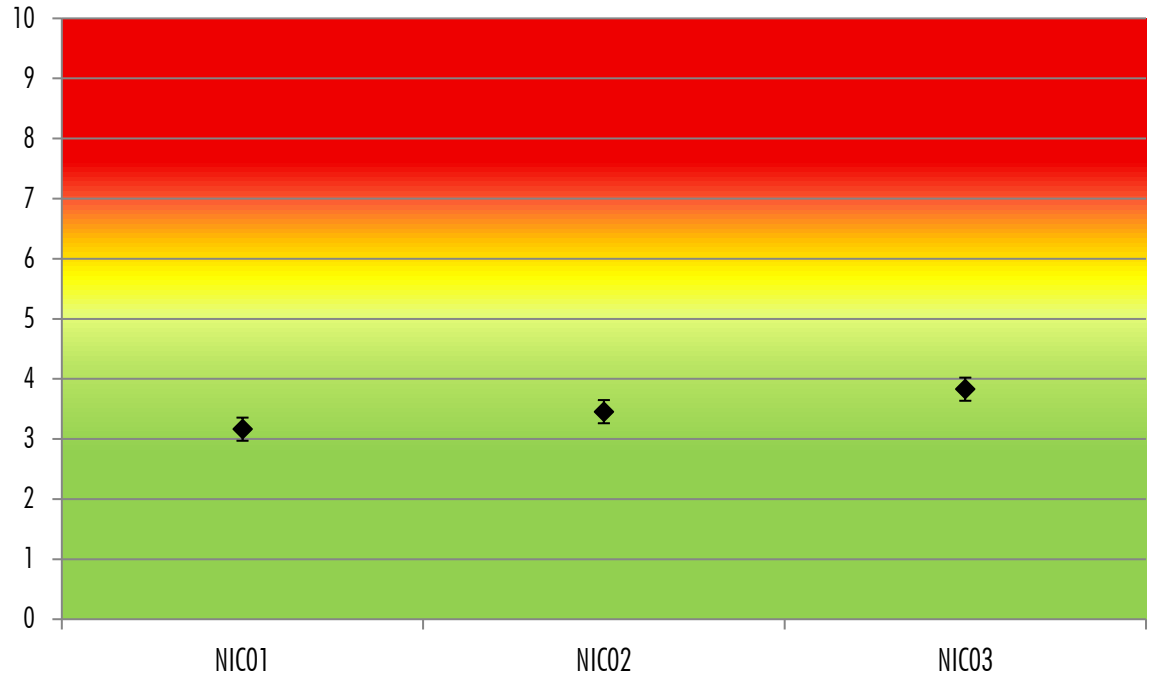


Figure 14. Family Biotic Indices for the Nictaux River 2013 CABIN sites.

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. Results have been omitted from this version of the report.

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 11 outlines the general water quality guidelines for some commonly measured water parameters, and Tables 12 and 13 denote acceptable values described by the DFO.

Table 11. 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 12. 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 13. 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. Water quality data has been omitted from this version of the report.

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 14 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 14. 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	omitted	omitted	Bridge				
BEL005	Beals Brook	omitted	omitted	Partial Barrier	6.99	-0.083	Low	Tailwater control
BEL006	Beals Brook	omitted	omitted	Bridge				
BEL007	Beals Brook	omitted	omitted	Not Fish Habitat				
BEZ001	Bezant Lake Brook	omitted	omitted	Bridge				
BEZ002	Bezant Lake Brook tributary	omitted	omitted	Partial Barrier	0.59		Low	Tailwater control
BEZ004	Bezant Lake Brook tributary	omitted	omitted	Partial Barrier	8.9	0.16	Low	Tailwater control
BEZ005	Bezant Lake Brook	omitted	omitted	Full Barrier	2.6	3.09	Low	Baffle installation
KEL003	Kelly Brook tributary	omitted	omitted	Not Fish Habitat				
KEL004	Kelly Brook	omitted	omitted	Bridge				
KEL013	Kelly Brook tributary	omitted	omitted	Not Fish Habitat				
NIC001	Nictaux River	omitted	omitted	Bridge				
NIC002	Nictaux River tributary	omitted	omitted	Full Barrier	12.5	5.21	Medium	Baffle installation and tailwater control

Culvert ID	Stream Name	UTM Easting	UTM Northing	Barrier Type	Outflow Drop (cm)	Slope (%)	Priority	Recommendations
NIC003	Nictaux River tributary	omitted	omitted	Full Barrier	6.9	4.21	Medium	Baffle installation and tailwater control
NIC004	Nictaux River tributary	omitted	omitted	Full Barrier	30.2	6.20	Medium	Baffle installation and tailwater control
NIC006	Nictaux River	omitted	omitted	Bridge				
NIC008	Nictaux River tributary	omitted	omitted	Partial Barrier	8.2	1.15	Low	Tailwater control
NIC009	Nictaux River tributary	omitted	omitted	Not Fish Habitat				
NIC010	Nictaux River tributary	omitted	omitted	Partial Barrier	2.2	0.91	Low	Tailwater control
NIC011	Nictaux River tributary	omitted	omitted	Full Barrier	66.1	1.93	Low	Removal of structure/ fish ladder
NIC012	Nictaux River tributary	omitted	omitted	Partial Barrier	-9	1.01	Low	Debris removal
NIC013	Nictaux River tributary	omitted	omitted	Not Fish Habitat				
NIC014	Nictaux River tributary	omitted	omitted	Full Barrier	10.6	-0.63	Low	Tailwater control
NIC015	Nictaux River tributary	omitted	omitted	Not Fish Habitat				
NIC016	Shannon River	omitted	omitted	Bridge				
NIC017	Shannon River tributary	omitted	omitted	Full Barrier	18.1	-0.09	Low	Tailwater control
NIC018	Shannon River tributary	omitted	omitted	Full Barrier	1.9	12.08	Low	Removal of structure/ fish ladder
NIC021	Shannon River tributary	omitted	omitted	Not Fish Habitat				
NIC024	Nineteen Mile Lake drainage	omitted	omitted	Full Barrier	19	-1.84	Low	Tailwater control
NIC026	Little Cranberry Lake drainage	omitted	omitted	Bridge				
NIC027	Nictaux River	omitted	omitted	Bridge				
NIC028	Nictaux River tributary	omitted	omitted	Full Barrier	43	1.77	Medium	Removal of structure/ fish ladder
NIC029	McGill Lake	omitted	omitted	Bridge				
NIC030	McGill Lake tributary	omitted	omitted	Full Barrier	10.7	-0.757	Medium	Debris removal
NIC035	Quilty Lake tributary	omitted	omitted	Partial Barrier	-23.2	1.67	Low	Tailwater control
NIC036	Quilty Lake tributary	omitted	omitted	Partial Barrier	-0.5	1.11	Low	Tailwater control

Culvert ID	Stream Name	UTM Easting	UTM Northing	Barrier Type	Outflow Drop (cm)	Slope (%)	Priority	Recommendations
NIC037	Connell Lake tributary	omitted	omitted	Not Fish Habitat				
NIC038	Walker Brook	omitted	omitted	Passable	-36.1	0.32		
NIC039	Beals Brook tributary	omitted	omitted	Not Fish Habitat				
NIC040	Beals Brook tributary	omitted	omitted	Not Fish Habitat				
NIC041	Beals Brook	omitted	omitted	Partial Barrier	0.9	-1.17	Low	Tailwater control
NIC042	Trout Lake tributary	omitted	omitted	Not Fish Habitat				
NIC043	Trout Lake tributary	omitted	omitted	Full Barrier	-61.6	3.38	Low	Baffle installation
NIC044	Trout Lake tributary	omitted	omitted	Not Fish Habitat				
NIC045	Oakes Brook tributary	omitted	omitted	Not Fish Habitat				
NIC046	Oakes Brook	omitted	omitted	Bridge				
NIC047	Oakes Brook tributary	omitted	omitted	Not Fish Habitat				
NIC048	Oakes Brook tributary	omitted	omitted	Partial Barrier	7.7	1.71	Low	Tailwater control
NIC049	Zwicker's Lake tributary	omitted	omitted	Full Barrier	24.7	-3.63	Low	Baffle installation and tailwater control
NIC052	Walker Brook	omitted	omitted	Bridge				
NIC053	Walker Brook	omitted	omitted	Not Fish Habitat				
NIC054	Walker Brook tributary	omitted	omitted	Not Fish Habitat				
NIC057	Snell Meadow Brook tributary	omitted	omitted	Not Fish Habitat				
NIC058	Big Mud Lake tribuary	omitted	omitted	Not Fish Habitat				
NIC060	Oake's Brook tributary	omitted	omitted	Partial Barrier	1.6	-1.33	Low	Tailwater control
NIC061	Oake's Brook	omitted	omitted	Bridge				
NIC062	Oake's Brook tributary	omitted	omitted	Bridge				
NIC063	Oake's Brook	omitted	omitted	Bridge				
NIC064	Oake's Brook	omitted	omitted	Bridge				
NIC065	Nictaux River	omitted	omitted	Bridge				
NIC066	Nictaux River	omitted	omitted	Bridge				
NIC067	Nictaux River tributary	omitted	omitted	Full Barrier	58.8	7.031	Low	Removal of structure/fish ladder

Culvert ID	Stream Name	UTM Easting	UTM Northing	Barrier Type	Outflow Drop (cm)	Slope (%)	Priority	Recommendations
NIC068	Wambolt Lake Drainage	omitted	omitted	Not Fish Habitat				
NIC069	Nictaux River tributary	omitted	omitted	Full Barrier	18.9	-4.450	Low	Tailwater control
OAK005	Oakes Brook tributary	omitted	omitted	Passable	-31.9	-0.24		
OAK006	Oakes Brook tributary	omitted	omitted	Partial Barrier	-52.8	1.46	Low	Tailwater control
OAK007	Oakes Brook tributary	omitted	omitted	Passable	-0.114	-0.39		
OAK009	Oakes Brook tributary	omitted	omitted	Full Barrier	30.7	0.52	Low	Tailwater control
OUT002	Trout Lake tributary	omitted	omitted	Not Fish Habitat				
SLB002	Slobbery Meadow Brook	omitted	omitted	Bridge				
WLC001	Waterloo Lake tributary	omitted	omitted	Partial Barrier	-2.49	2.49	Low	Debris removal
WLC002	Waterloo Lake tributary	omitted	omitted	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 15. 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 15). 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 16 shows the percentage of respondents that caught various fish species in the Nictaux sub-watershed, and Figure 17 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.

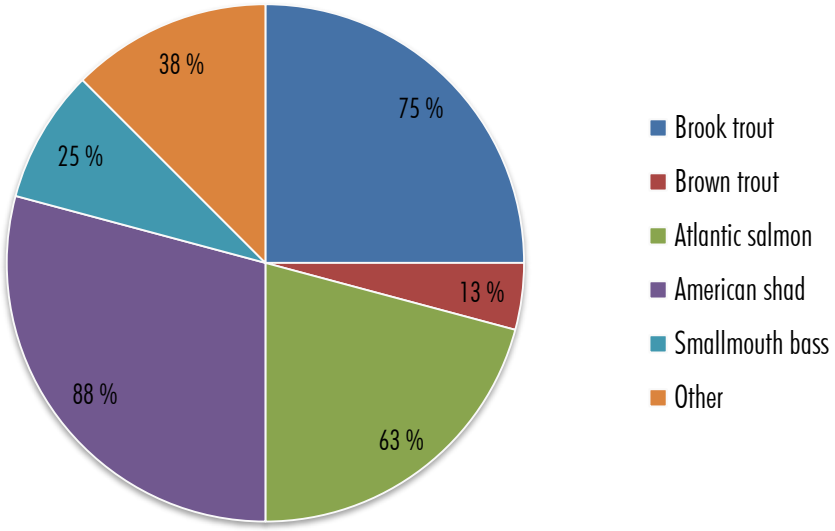


Figure 16. Species that have been observed or caught by respondents on the Nictaux River system.

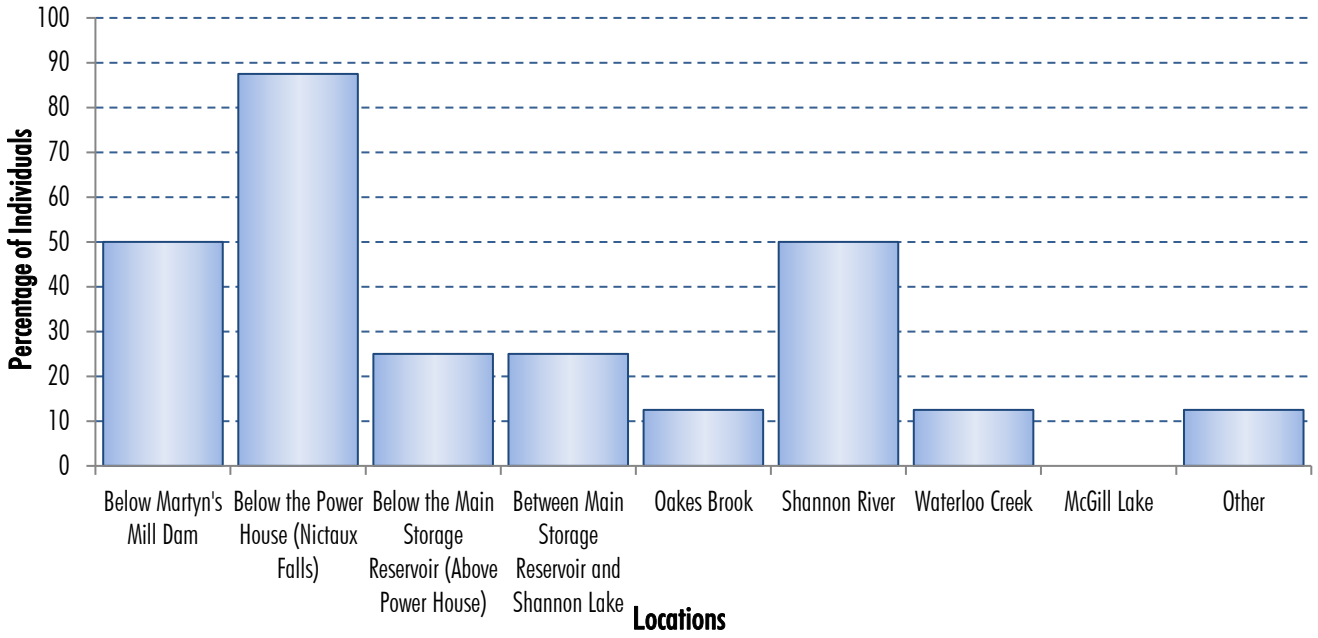


Figure 17. Locations where respondents like to fish in the Nictaux River sub-watershed.

Of the survey respondents, 50% had reported having caught an Atlantic salmon as bycatch while out fishing (Figure 18). Of these individuals, 75% had caught an adult, 50% had caught a smolt, and 25% had caught a salmon parr (Figure 19).

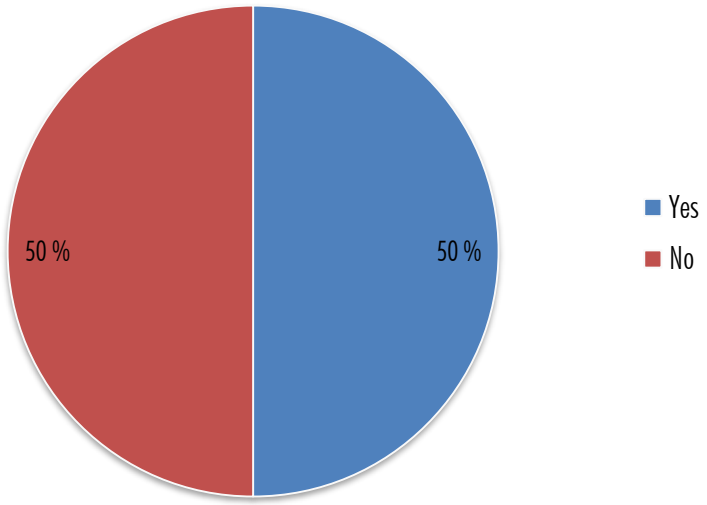


Figure 18. Percentage of survey respondents who have caught Atlantic salmon as bycatch while fishing the Nictaux River system.

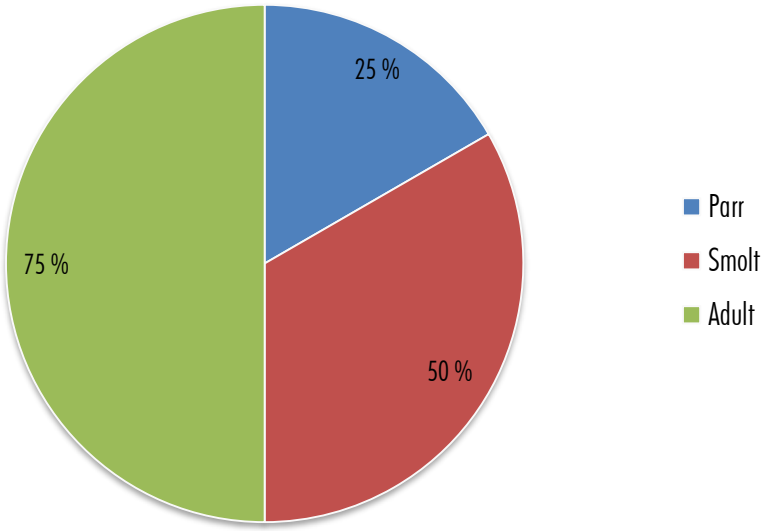


Figure 19. The percentage of survey respondents that caught an Atlantic salmon as bycatch, and the life stage they caught.

Figure 20 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.

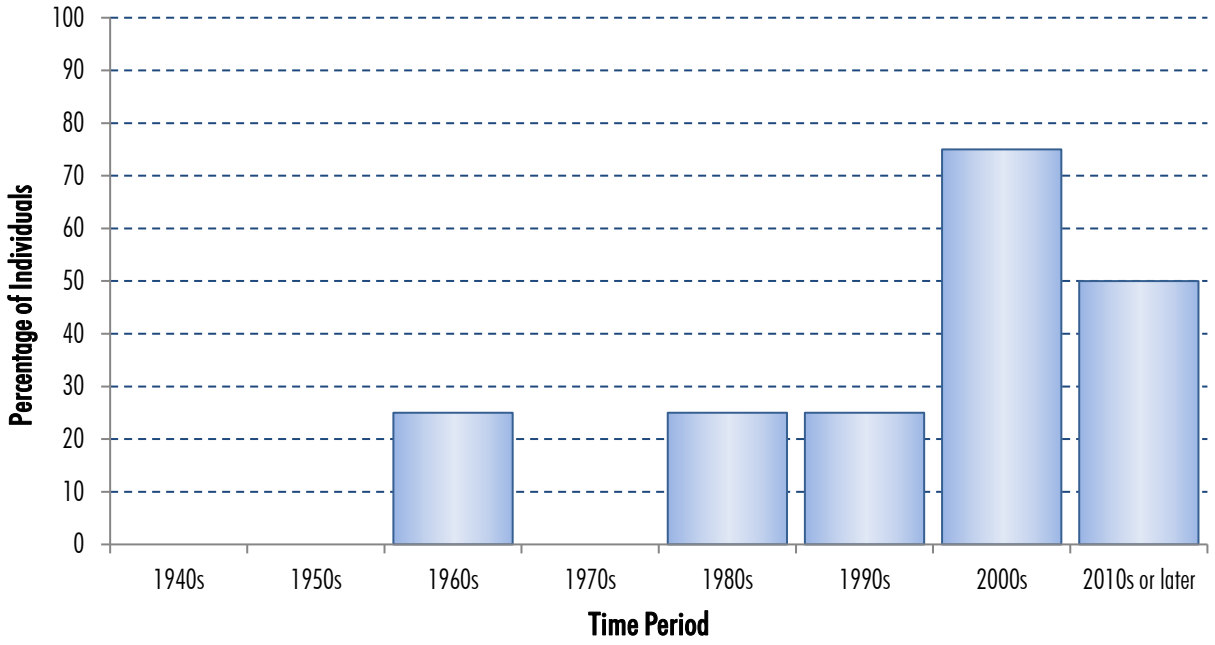


Figure 20. The decade(s) in which survey respondents caught Atlantic salmon in the Nictaux River system.

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

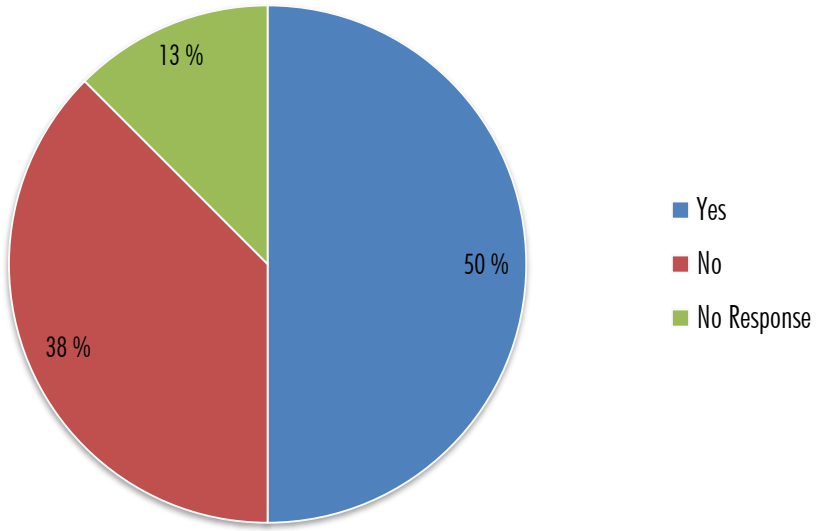


Figure 21.Percentage of individuals who have noticed a change in the Nictaux system.

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.

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.

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. Data and maps have been omitted from this version of the report.

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 ($>20^{\circ}C$), 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

[AAS] NSLC Adopt A Stream. 2016. The Nova Scotia Fish Habitat Assessment Protocol: A field methods manual for the assessment of freshwater fish habitat. Version 1.4.

Bardonnet, A. and J.-L. Baglinière. 2000. Freshwater habitat of Atlantic salmon (Salmo salar). *Canadian Journal of Fisheries and Aquatic Sciences, 57:* 497-506.

Bjorn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. In: Meehan WR (ed). *Influences of forest management on salmonid fishes and their habitats.* American Fisheries Society, Bethseda.

Bohn, B.A., and J.L. Kershner. 2002. Establishing aquatic restoration priorities using a watershed approach. *Journal of Environmental Management, 64:* 1-9.

Bouchard Jr., R.W. 2004. Guide to Aquatic Invertebrates of the Upper Midwest. 4th Edition, Chironomidae Research Group, University of Minnesota, Saint Paul, Minnesota.

Brunner, J.W. 2012. The Nova Scotia Fish Habitat Assessment Protocol: A field methods manual for the assessment of freshwater fish habitat. Version 1.1. Clean Nova Scotia.

[CCME] Canadian Council of Ministers of the Environment. 2003. Water Quality for the Protection of Aquatic Life: Nitrate. Retrieved June 15, 2011, from http://st-ts.ccme.ca/?lang=en&factsheet=140.

[DFO] Fisheries and Oceans Canada. 2006. Ecological Restoration of Degraded Aquatic Habitats: A Watershed Approach. Fisheries and Oceans Canada, Gulf Region. CAT# Fs104-4/2006E. 180pp.

Freeman, L. 2013. Annapolis River 2012 Annual Water Quality Monitoring Report. Clean Annapolis River Project. Annapolis Royal, Nova Scotia.

Freeman, L. 2014. Brook Brooks 2014: Improving in-stream fish habitats through restoration. Clean Annapolis River Project. Annapolis Royal, Nova Scotia.

Gibson, R.J., Haedrich, R.L., and C.M. Wernerheim. 2005. Loss of fish habitat as a consequence of inappropriately constructed stream crossings. *Fisheries, 30(1):* 10-17.

Hendry, K. and D. Cragg-Hine. 2003. Ecology of the Atlantic Salmon. Conserving Natura 2000 Rivers Ecology Series No. 7. English Nature, Peterborough.

Kauffman, J.B., Beschta, R. L., Otting, N., and D. Lytjen. 1997. An ecological perspective of riparian and stream restoration in the Western United States. *Watershed Restoration, 22(5):* 12-24.

Klemetsen, A., Amundsen, P.-A., Dempson, J.B., Jonsson, B., Jonsson, N., M.F. O'Connell, and E. Mortensen. 2003. Atlantic salmon Salmo salar L., brown trout Salmo trutta L. and Arctic charr Salvelinus alpinus (L.): a review of aspects of their life histories. *Ecology of Freshwater Fish, 12:* 1-59.

Mackie, G. 2004. *Applied Aquatic Ecosystem Concepts*. 2nd Edition, Kendall/Hunt Publishing Company, Dubuque, Iowa.

MacMillan, JL., D. Cassie, J.E. LeBlanc, and T.J. Crandlemere. 2005. Characterization of water temperature for 312 selected sites in Nova Scotia. Canadian Technical Report of Fisheries and Aquatic Sciences, 2582.

McCamon, J. 2015. Fish Habitat Restoration and Enhancement: Addressing habitat fragmentation and productivity in the Annapolis River watershed. Clean Annapolis River Project. Annapolis Royal, Nova Scotia.

Savoie, R. and Haché, D. 2002. Design criteria for fish passage in new or retrofit culverts in the Maritime provinces, Canada. Department of Fisheries and Oceans Canada, Habitat Management Section, Oceans and Sciences Branch. Moncton, New Brunswick.

Stoffer, A. 2017. Fish Passage Restoration and Habitat Enhancement: A project to address fish habitat fragmentation and degradation in the Annapolis River watershed. Clean Annapolis River Project. Annapolis Royal, Nova Scotia.

Taylor, B.R., MacInnes, C., and T.A. Floyd. 2010. Influence of rainfall and beaver dams on upstream movement of spawning Atlantic salmon in a restored brook in Nova Scotia, Canada. *River Research and Applications, 26:* 183-193.

Wagner, K. 2013. Broken Brooks 2012: Salmonidae Outreach, Accessibility and Restoration. Clean Annapolis River Project. Annapolis Royal, Nova Scotia.

10.0 Appendices

10.A Appendix A: HSI Tables

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

This appendix has been omitted from this version of the report

10.C Appendix C: Culvert Classification and Prioritization Tables

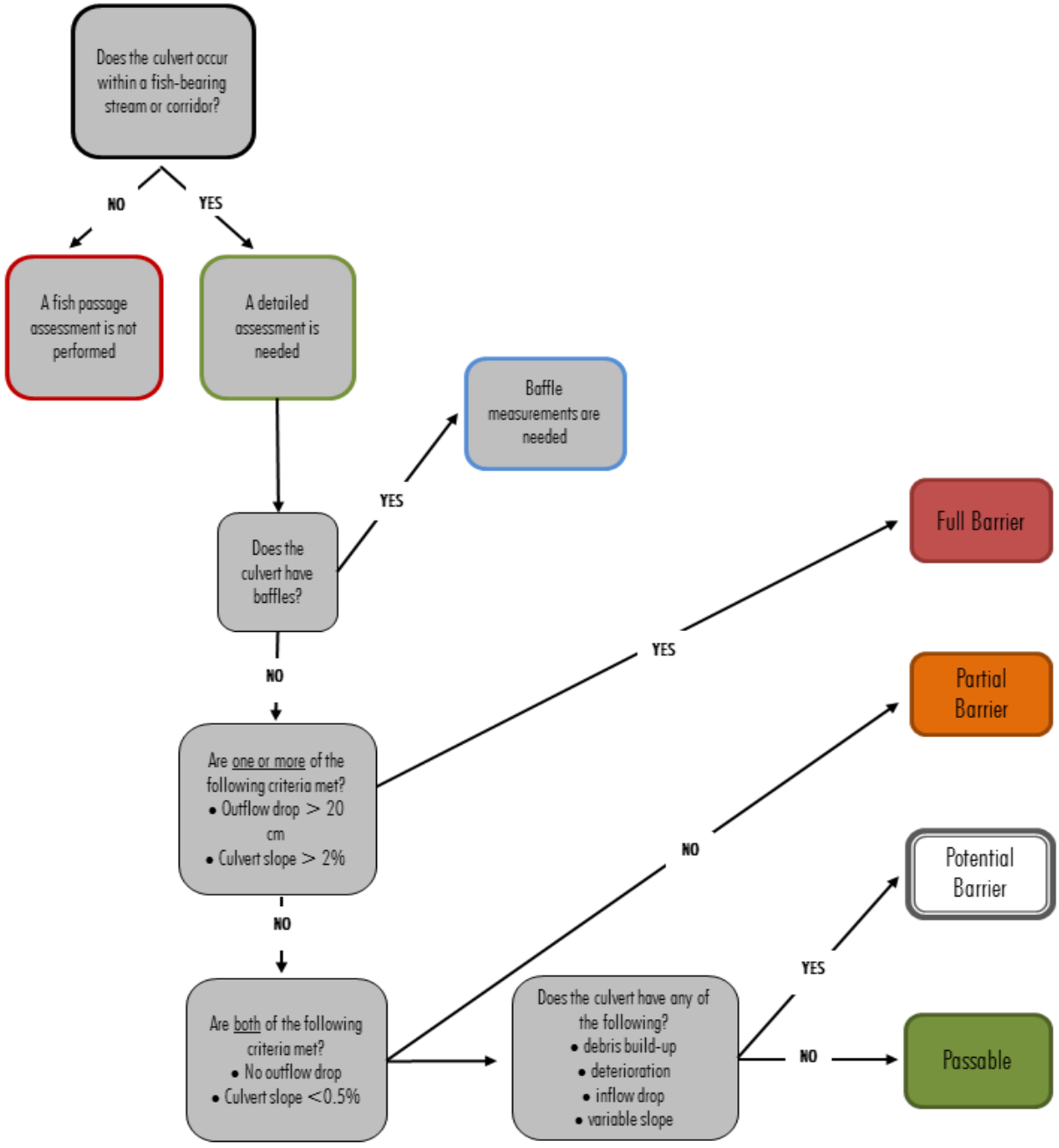


Figure 22. Flowchart for classification of barriers.

Table 15. 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 16. 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 17. 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 18. 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
☐ American shad
☐ Brown trout
☐ Smallmouth bass
☐ Atlantic salmon
☐ 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.G Appendix G: Document from Perry Munro

TABLE OF CONTENTS

PREFACE 5

LIST OF TABLES 4

PART I COMMERCIAL AND SPORT FISHERY 7

Background of the Salmon Fishery 7

Sport Fishery 9

Summary of the Salmon Fishery in Nova Scotia—
Commercial and Sport 11

PART II VALUE OF SPORT FISHING 11

PART III CONCLUDING REMARKS 19

APPENDICES

Appendix A—Geographical Locations of Nova Scotia
Commercial Salmon Catches 23

Appendix B—Commercial Salmon Catch, Maritimes
Area, 1958-1964 25

Appendix C—Sport Salmon Catch, Maritimes Area, 1958-1964 ... 26

Appendix D—Salmon Angling Record, Province of
Nova Scotia, 1923-1964 27

BIBLIOGRAPHY 32

LIST OF TABLES

Table		Page
I	Commercial Salmon Landings, Nova Scotia, 1953-1964 and for Maritime Region 1958-1964	8
II	Trap and Gill Net Licenses Issued in Nova Scotia for Selected Years, 1929-1964	9
III	Angling Catch of Salmon, Nova Scotia and Maritime Region, 1958-1964 inclusive	10
IV	Number of Salmon Anglers, Nova Scotia, 1964 and Response to Questionnaire	12
V	Fishing Effort and Catch of 959 Salmon Anglers in Nova Scotia	13
VI	Expenditures of 959 Salmon Anglers (and Their Families) Who Fished in Nova Scotia in 1964	14
VII	Comparison of Replies of 18 Respondents to Questionnaire with Information Obtained from Interviews with 25 Non-Respondents, Nova Scotia, 1964	15

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.

ECONOMIC VALUE

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.

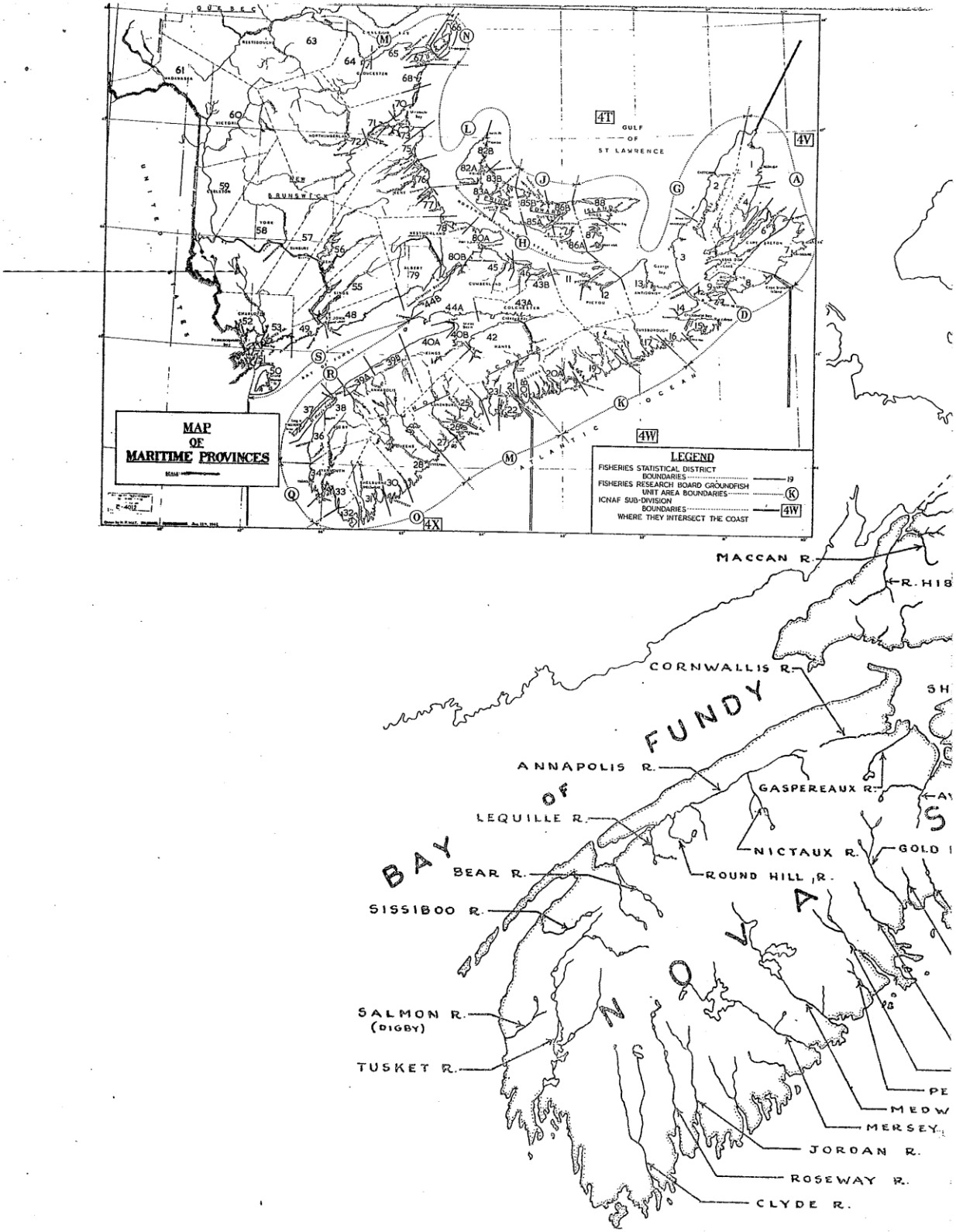
30 D. A. Benson, *Fishing and Hunting in Canada, 1961*, (Ottawa, 1961), Table 8.

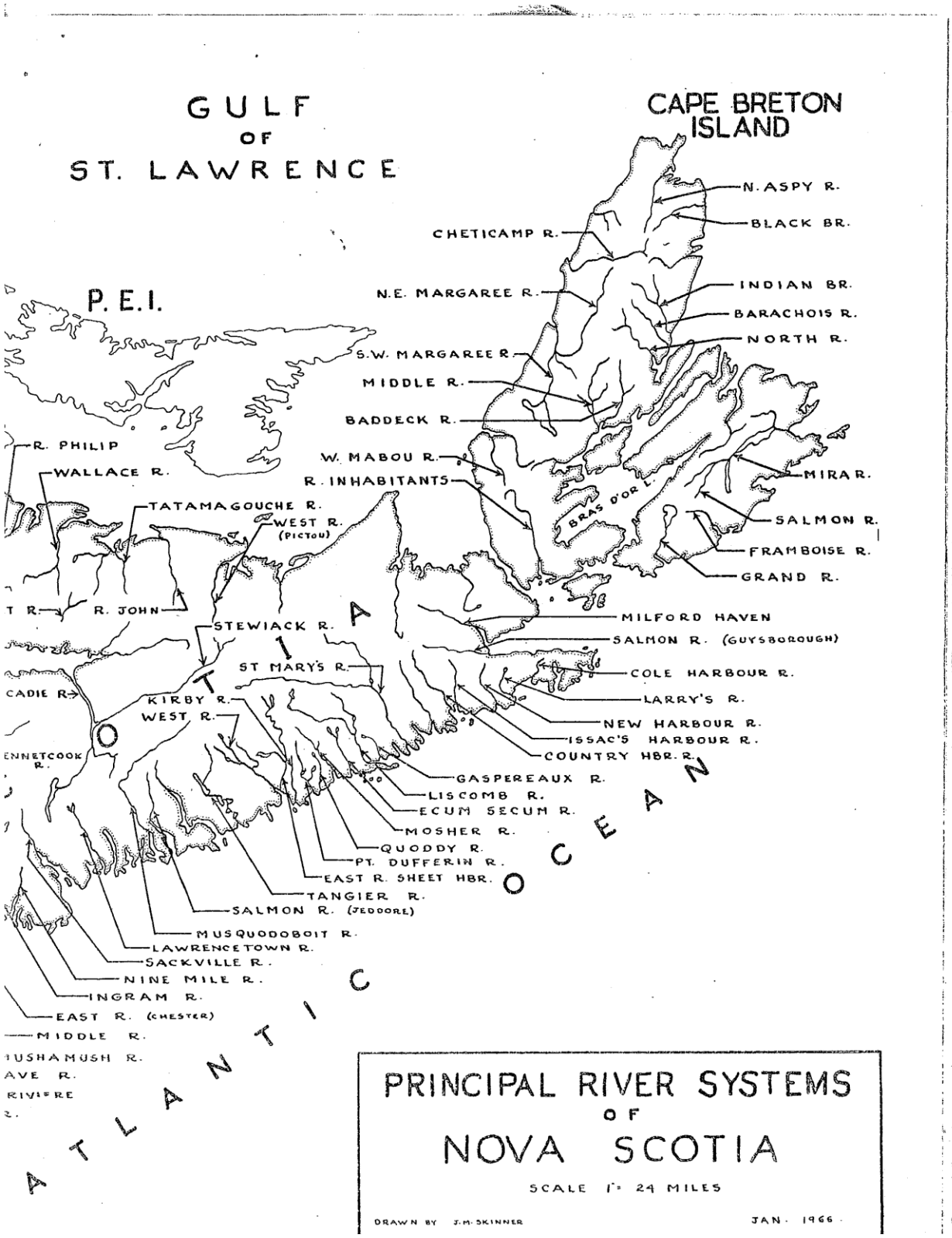
31 U. S. Department of the Interior, *National Survey of Hunting and Fishing, 1960,* (Washington, D.C., 1960), Table 3.

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
4T
4V
4W
4X
GULF OF ST LAWRENCE
ATLANTIC OCEAN
NEW BRUNSWICK
MACCAN R.
CORNWALLIS R.
FUNDY
ANNAPOLIS R.
GASPEREAUX R.
LEQUILLE R.
BAY OF
NICTAUX R.
BEAR R.
ROUND HILL R.
SISSIBOO R.
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.
R. PHILIP
W. MABOU R.
MIRA R.
WALLACE R.
R. INHABITANTS
BRAS D'OR L.
TATAMAGOUCHE R.
WEST R. (PICTOU)
SALMON R.
FRAMBOISE R.
GRAND R.
R. JOHN
MILFORD HAVEN
STEWIACK R.
SALMON R. (GUYSBOROUGH)
ST MARY'S R.
COLE HARBOUR R.
KIRBY R.
LARRY'S 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.

---

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.

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

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.

ECONOMIC VALUE

APPENDIX A

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

	1959		1960		1961		1962		1963		1964	
Gulf Area Districts:	Quant	Val	Quant	Val	Quant	Val	Quant	Val	Quant	Val	Quant	Val
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

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

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

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.

28

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

ECONOMIC VALUE

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	2970	550	5048	2284	278	2285	2749	451	4061
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

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 9.2	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	1387	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,

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

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

. . .

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 an 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.

18*th 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.

19*th August.*

Returned to Halifax.

20*th August.*

Sunday. In Halifax.

21*st August.*

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

22*nd 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.

23*rd August.*

In Halifax.

24*th 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.

25*th 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.

26*th to* 31*st 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.