RESTORATION OF RIVERS: A PROVINCIAL OUTLOOK TO SUSTAINING NEWFOUNDLAND AND LABRADOR RIVERS

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Abstract

Concerning river restoration efforts, there is little information available about the relationship between restoration, the extent to which proposed actions have been implemented, and the resulting impact on desired conservation outcomes. The following research, drew upon information from the Newfoundland and Labrador River Restoration Database (NLRRDB) to implement a survey of restoration project managers/practitioners to assess river restoration project motivations, the metrics used to evaluate the success of projects, and the proportion of projects that set and meet criteria for ecologically successful river restoration. This project resulted in practitioners stating the need for an accessible and constantly updated database of historical counts, transparency, and a focus on making provincial and federal funds more equally distributed. This thesis also reviewed previous research to provide interested parties with recommendations to help inform future project planning and associated resource allocation priorities.

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Dedication

Dedicated to the memory of my mother, Susannah Skinner, and my grandmother, Catherine Eavis, who always believed in my ability to be successful in academia. You may be gone, but your courage, strength, and determination have made this journey possible.

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Chapter 1: General Introduction

General Introduction

The abundance of freshwater species in the province of Newfoundland and Labrador has contributed to the province in social, economic, and ecologic ways. As such, each species brings different attributes including the cycling of nutrients from one ecosystem to another, increasing the predator-prey relationship, adding to the view, and even the recreational fishery. One of the province's key species for recreational fishery and restorative projects is the Atlantic salmon, which is the main focus of this study due to the current media coverage and vested interest of the public.

Salmon need pristine habitats to reproduce and thrive. Due to current trends in society, that result in pollution, forest harvesting processes, and cottage development, these creatures are rapidly losing areas that they once called home. As mentioned by (Thorstad, et al., 2020, p.2659) "salmon populations are sensitive to freshwater habitat loss and alteration from a range of human activities … transport, and forestry". This illustrates that salmon are vulnerable species that need to be protected via properly planned projects. Salmon not only benefit the ecosystem surrounding them but also bring wealth to society in monetary and psychological ways, which is why we must save their environment.

One such way that salmon habitat has been improved is through river restoration, a concept involving multiple techniques that "restore or improve conditions" (Beechie & Roni, 2012, p. 2). Many techniques can be used in various scenarios, all of which, if adopted properly, will mitigate the loss of habitat caused by natural or human impacts. Some of these techniques include channelization, dam retrofits, addition or removal of vegetation, and construction of fishways. The restored habitats produce economic, ecological, and social benefits that outweigh the monetary and labor costs needed to adopt these techniques.

Restoration is a complicated process, but without it, ecosystem services and ecosystems would be lost, hindering the well-being of the society, economy, and ecology of the region. Modifications to river systems by humans have damaged many aspects of the ecosystem. As people may not fully understand the purpose of restorative projects, it becomes often overlooked as to what the outcome will bring to the ecosystem, such as new infrastructure, fragmented landscapes from roads, increase in sedimentation, decrease in nutrient flow, or, positive increase with fish passage, stream water quality, rejuvenation of the surrounding area, and that the projects completed reduce the human interference for many years.

With the ever-evolving technology in the modern age, developing safe and beneficial systems to aid in deteriorated ecosystems becomes easier and more efficient. With proper implementation and design, rivers may return to their regular state and provide benefits to humans and animals alike.

River restoration is somewhat underrepresented in the scientific literature. As such, there are few regionally or nationally recorded databases. This begs the question how many rivers are perceived as healthy in the eyes of scientists? And where are the dollars being spent on this conservational effort? If not conservational, what political, economic, or social aspects are being affected?

As the concept of river restoration became more evident in the scientific literature in the past few decades, practitioners began to release more information about the work completed, as it was beneficial to the public as well as to scientists who monitor the region. While some documents were short on details, the general summary of the projects became evident, allowing for inferences to be made. Due to the increasing popularity in academia, peer-reviewed literature is limited but ever-evolving, making the research important and currently niche which in turn reduces the number of papers that could be drawn upon here.

Restorative efforts involve many aspects, from design to implementation, to equally important monitoring and evaluation practices. Each step involves many different players and tools, which makes the strategy both collaborative and lengthy. The design stage involves looking at the scope of the area, the type of technique needed, funding, and land rights. Implementation needs the plans created for the technique, the funds for materials, a labor force to complete the work, and approval from the government. Monitoring and evaluation, which does not always occur, requires practitioners to obtain tools and a labor force to complete the scientific process, as well as the funds to fix any damaged structures. With so many actors at play, they all must collaborate and express opinions and develop objectives for the project, as they provide necessary insight, which can subsequently reduce the cost and increase the effectiveness and efficiency of their work.

Problem Statement

Successful restoration of rivers is essential to the salmon population as well as other species that roam the ecosystem. This action requires collaboration among governments, the public, and non-governmental organizations. Without the collaboration of each group, managers and practitioners cannot function successfully. Determining what is considered successful in river restoration is dependent on those involved, those who live in the area, as well as the fish who spawn and live there. Each group has varying objectives, which makes understanding each group crucial. The area in question, the province of Newfoundland and Labrador, has many adventure tourists and recreational fishers, so a decline in freshwater species due to the decline in river health would decrease tourism and may deter future anglers or recreationists from visiting. The first article presented in this thesis draws upon definitions of success from practitioners familiar with many of the restoration projects identified in the Newfoundland and Labrador River Restoration Database (NLRRDB) (Appendix B) and is focused on both understanding what constitutes a successful restoration project and providing recommendations for future framework design. The second paper provides general insight into the factors that may have contributed to the restoration process of the last few decades; it examines the geographical distribution of restoration projects within the province. Overall, this thesis describes the perceptions, opinions, and values of practitioners of river restoration projects in the province and examines the factors contributing to the geographical distribution of projects.

General Methodology

Data collected for this study was retrieved from a convenience sampling (n=5) of practitioners who have aided in the restoration of Newfoundland and Labrador rivers. Probability sampling was not possible due to there being limited active groups and personnel with the knowledge of the timespan of the group's involvement with the projects. The lack of samples was due to the pandemic and the willingness to participate in an online setting. Despite being based on a small sample size, the results still produce important information. Each practitioner provided insight into decades of work sometimes spanning many individual restoration projects and programs thus providing general insight into the restorative practices within the province. Convenience sampling is a non-probability form of sampling in which "participants are selected by the researcher, are referred to the researcher, or self-select to participate in a study" (Stratton, 2021, p. 373). While the technique is beneficial for smaller studies looking for specific information, the strategy does suffer some shortcomings, such as the inability to make generalizations about the larger population and the potential for biases or under or over-representation of specific groups (Qualtrics, 2022).

To overcome the shortcomings of the sampling technique, the sampling technique was modified. The modification follows a similar tactic to stratified sampling, as it "increases the estimation of an unknown population (Yasmeen et al., 2021, p. 174). The 170 projects listed in the NLRRDB were led by 40 proponent organizations. This database is a collection of restoration projects in Newfoundland and Labrador since the 1940s. The NLRRDB is comprised of project descriptions, contact information, costs, and locations and is further explained in section 2.3 below. The stratified sampling was completed by ensuring that each of the project proponent groups (i.e., government, non-governmental organizations, and academics) was represented in the sample. Each of the study participants held specialized knowledge of the projects and project types and was also able to share more general perspectives on the history of provincial river restoration efforts and speak to multiple separate projects included in the NLRRDB. Regardless of the sampling, this study was not meant for statistical representation of the practitioners of Newfoundland and Labrador. It was designed to gain an understanding of the perspectives, opinions, and values of a sample of practitioners regarding their perceptions of success regarding river restoration efforts in the province.

This research was reviewed and approved by Memorial University's Grenfell Campus Research Ethics Board on September 22nd, 2020. The reference number 20210539 was assigned to the project. These manuscripts included here present data using basic descriptive analyses of the data sets, along with an analysis of answers provided by open-ended survey questions. Basic mapping via Arc GIS was employed to display datasets to showcase the geographic distribution of projects throughout the province.

Survey Structure and Analysis

Data were collected using a researcher-administered survey comprised of 47 questions as seen in Appendix C. Questions included items about the river restoration process, such as who funded the project? Was monitoring completed? and What factors lead to the final design of the project? Some questions also focused on indicators of project success and whether global climate change was considered in the project's design, implementation, or monitoring. The survey was modified from Palmer et al. (2005). Response options varied throughout the survey but mainly consisted of binary responses (true/false or yes/no), five-point Likert-scales (with Not at all 1; Somewhat 2; neither mostly present nor mostly absent 3; mostly present 4; substantially (5)), select all that apply, and open-ended questions. The survey was administered through workshops held on October 26, 2021, and November 23, 2021.

Geographic Information System Data

Map files were sourced from various organizations, including the government of Newfoundland and Labrador, the Government of Canada, the Department of Fisheries and Oceans (DFO), the Environmental Systems Research Institute (ESRI), and the NLRRDB. These files were datasets for various indicators, including demographics, watersheds, economics, and politics. Locational data, such as names and points, were sourced from Cartesian coordinates listed in the NLRRDB and exported through Google Maps. Mapping these aspects was essential in making comparisons between the types and costs of projects as well as making comparisons between political parties, economic zones, and watersheds.

Conclusion

The information presented here can help identify the project types and management processes deemed most successful by project proponents. Such information can be used to help inform a more effective and efficient allocation of resources to future restoration efforts. Understanding the factors that influence the geographical distribution of projects – and whether there is a connection with ecological or habitat needs – can also help inform a more effective allocation of projects and associated resources in the future. This project is highly important in representing the provincial river restoration efforts. As such, this project created the previously non-existent NLRRDB, by reviewing the government and academic database of projects in the province, as well as by talking to various actors in the industry. As seen in Appendix A, the database was created through a screening process that reviewed all hits found through the search terms which included “stream” “river”, “brook”, or “wetland” with categorical terms of NRRSS categories and locational terms of “Newfoundland and Labrador”. Once screened by reviewers on an abstract and title basis by reviewers it was either included or excluded based on results and content, thus creating a database with the project type, group involved, title, duration, start date, location, funding, and contact information. The resulting database provides detailed documentation on projects since the province joined Canada in 1949. Without a historical record, many projects would be unknown, and future projects would not be able to benefit from past lessons.

The first article defines and describes the perceptions, opinions, values, and knowledge of provincial practitioners that have worked on river restoration projects over the past few decades. The survey revolved around the concept of restoration as it happened throughout the years in the province. Looking at design, implementation, monitoring, and evaluation helps researchers decipher the strengths and weaknesses of a lengthy and costly process. Without such analysis, the process cannot improve, making success harder to come by.

The second article analyses the factors that may have limited or enhanced the success of restoration over the past few decades. Through using Arc GIS, the second manuscript illustrates how the government, economy, and environment work together and how each can independently affect restorative efforts. This analysis brings to light the need for collaboration among each silo, allowing for new opportunities to emerge.

Chapter 2: Assessing Motivations and Success of Restoration Projects

Introduction

River Restoration Basics

Globally, rivers are diminishing in quality, as seen by the decrease in dissolved oxygen, dissolved organic carbon, total phosphorous, and total suspended solids as illustrated by (Virro et al., 2021 which negatively affects biodiversity. As a result, ecological services also become degraded and less resilient. Without restorative measures, rivers will never return to a beneficial state for both humans and animals. There are many ways to restore a river, each of which has its costs, and its advantages and disadvantages.

Governments, nongovernmental organizations, stakeholders, and concerned citizens restore rivers through channel meandering, riffle and pool creation, fishway, and ladder installations, dam removals, flow modifications, bank stabilizations, riverbed re-naturalization, and clean-ups, among other things. The types of restorative measures chosen will depend on the needs of the river, the goals of the restorative team, and the resources available. There are many benefits to each technique, including a balance of flow, a decrease in sedimentation, an increase in flora and fauna types, an increase in water quality, and a decrease in pollution and debris (Allan and Palmer, 2006).

The Government of Canada has spent 24 million dollars since 2013 on 440 projects under the Recreational Fisheries Conservation Partnerships Program (DFO, 2016). Many more projects were funded before and during this program period; however, Annual investment totals $10,000,000 and participating organizations must match the amount they request. All projects are examined by DFO and must align with the protection of a vulnerable species (Bird, 2014).

While it was a beneficial program, there have been many other federally funded projects, for example, the Miawpukek First Nation's river restoration project in Newfoundland and Labrador, received $400,000 to restore a riverbank and carry out stabilization, while others, such as the Surf Inlet Watershed and Dam Salmon restoration in British Columbia, received $100,000 to complete a feasibility study and make an informed decision (Department of Fisheries and Oceans Canada, 2022).

When installing structures and employing techniques, the planners work through the outcomes they want to achieve and how to do so in an effective manner. However, this process is complicated by the fact that there appears to be no agreed-upon way to measure the success of projects. Depending on the agency and the project objectives, the definition of success will change. What is good for one project may not be good for another. While some scholars have created site- or context-specific ways of determining what they deem as successful and effective, there is no internationally, or even nationally, accepted system to gauge the effectiveness of restoration efforts. Without a standard set of criteria, it is impossible to evaluate the merits of projects that are being awarded significant financial investment. Palmer et al. (2005) stated that "although there is growing consensus about the importance of river restoration, agreement on what constitutes a successful restoration project continues to be lacking" (p. 5). A unified system would allow groups to focus on strategies that are deemed successful, resulting in greater efficiency and effectiveness, and consequently, greater confidence for stakeholders and funders.

Establishing criteria of success and conducting a systematic evaluation of success is essential for ensuring that restoration efforts are effective. However, a wide range of criteria for success can be identified. Unfortunately, minimum expenditure of available funds is often seen as a metric of success. Such a misguided focus can result in a lack of funding for more ecologically important, longer-term, or complex restoration projects. Scholars examining standards for successful river restoration have, more appropriately, focused on the importance of ecological criteria. As mentioned by Wohl et al., (2005), "A key distinction between river restoration and other management actions is the intent to re-establish "natural" rates of certain ecological and chemophysical processes and/or to replace damaged or missing biotic elements" (p.2). It is important to determine the criteria that restoration project proponents have adopted for their projects and to what extent these criteria have been met. The need to develop a more unified understanding of river restoration efforts, including definitions and levels of success, is perhaps nowhere more obvious than in the province of Newfoundland and Labrador, where, to date, a synthesis of restoration efforts and measures of success have not been completed, despite there being almost $30,000,000 invested in 170 river restoration efforts over the last 72 years (NLRRDB, 2022).

Since joining the confederation, Newfoundland and Labrador has completed river restoration work in several regions. Newfoundland and Labrador, unlike some Canadian jurisdictions, has a large fiscal crisis, one that is limiting funds for certain projects due to more urgent matters (i.e., balancing a budget). Newfoundland and Labrador have a long history of fishing, it has indigenous populations that continue to practice subsistence activities, and it has a large tourism sector of recreational fishing, all of which make effective and successful restorative efforts particularly valuable to the province. One of the goals of this research is to help identify motivations and criteria for the success of river restoration efforts in the province. Such information is critical for making more well-informed and effective recommendations and for allocating funding for future projects.

Impacts of Restorative Projects

While rivers normally have provided benefits to both humans and animals, restorative projects have also led to changes in how humans and organisms interact with rivers and river ecosystems. Managing the benefits of what can be achieved through restoration is complicated, as

> river restoration generates different types of benefits, which can sometimes be conflicting. For example, an increase in ecological benefits can lead to a decrease in recreational benefits and vice versa, meaning that it might be difficult to reach the maximum benefits in both categories simultaneously. (Logar et al., 2019, p. 1084)

Estimating the costs and benefits of these efforts fall into three categories: biological, economic, and social. Each of these categories is important in determining which technique to use; depending on the river condition, as well as the issue that is being addressed, certain techniques would be better to use than others. The following paragraphs will, in general, discuss the importance of each category of benefits.

Biological.

The biological condition of the river is generally understood to be the basis for river restoration. Restoration projects are designed to contribute to a more sustainable future on rivers that are in peril. The ecological impact that humans have placed on rivers has threatened biodiversity and ecological services in rivers and riparian ecosystems. Restorative projects are therefore used to increase and restore what was lost, which unfortunately is often unnoticed or unprotected by the public. In restoring the river to a sustainable status, practitioners not only save fish populations but also decrease climate change impacts (Battin, et al., 2007, p. 6723). By allowing streams to recover to some degree, fish populations recover, and carbon can be sequestered and stored more effectively. Stream restoration efforts also help support other ecosystem components, such as riparian vegetation and sedimentation transport. With the use of connectivity "practitioners can ensure that other processes, such as gene flow, through fragmented landscapes or species range shifts under climate change scenarios will also be restored" (Baldwin, et al., 2012, p. 274). Piecing together a fragmented area restores not only habitat but the natural processes that flow within them, making it just as important when restoring an area.

Economic Costs.

While biological remediation is the goal of the project, economics often dictate what gets done. Success in restorative projects is heavily weighed on how much is spent and whether the resources were spent effectively and efficiently. One of the most crucial aspects when implementing a project is the planning stage as it outlines how the project will run and what it needs and what the outcomes will be. Without criteria surrounding biological success, decisions could end up being based solely on what is least expensive rather than what is ecologically sound. As each technique incurs different costs, and certain projects are needed more than others, success cannot be defined solely on this measure. Economic impacts also involve whether the economy will benefit. When looking at the economics of rivers, scholars often attain a willingness to pay (WTP) of concerned citizens, and this allows people to value the river based on what they would pay to fix it. Collins et al. (2005) looked at two rivers in the United States and found that people are willing to pay more for a fully sustainable fishery than a moderate change. On average, between "$12 and $16 per month per household … estimated to be about $1,900,000 million annually" (p. 9).

Social.

Humans are essentially the cause of river degradation as well as a beneficiary of economic impacts through fishing. Societal impacts look at the human relation to the projects. In saying that, impacts include recreational and psychological impacts, as well as experiences. According to Wohl and colleagues, “societal perceptions and expectations of ecosystem performance ultimately determine whether restoration is a viable management option.” (Wohl et al., 2005, p.3). Rivers are essential ecosystems for pleasure as well as for subsistence. Fishers fish either for the experience or to feed their families. The way people view rivers often depends on their livelihood and lifestyle. Rivers provide a vast number of opportunities to humans including water sports such as kayaking and canoeing, as well as providing a view to see while hiking or watching fish jump upstream. Overall, they can be used as a remedy for a psychological condition known as Nature Deficit Disorder, “The loss of opportunity to interact with the natural environment” (Warber et al., 2015, p.1) as they provide mental relief as well as the much-needed fresh air. As such, changes to its management will ultimately change the way people interact.

Defining Success

Success is defined as “the attainment of a favored or desired outcome” (Webster, 2022, Definition B). While this definition fits most perceptions of success, it is rather vague. One must ask: what defines success? There are many criteria to choose from, so there is no universally accepted definition of success. As such, it is important to see what motivates success in different contexts.

Success depends on the achievement of set goals, goals that are obtainable yet unique to each sector, making project definitions of success hard to replicate. In the case of a fish ladder, for example, success could be defined simply as constructing an effective fish passage. This goal is unique to the technique and would not be applicable, for example, to a stream channel requiring bank stabilization via vegetation restoration. Continuing with the fish passage example, objectives would include maintaining a safe passage route upstream, maintaining ideal water quality, flow and temperature, and ease of access if a problem were to occur. While the goal is to ease fish passage and construct a safe, efficient, and effective structure. The dilemma, therefore, is to find qualities and traits that will carry over from project to project, such as water quality, and population numbers.

Research Objectives

Concerning the province of Newfoundland and Labrador river restoration efforts, there is little information available about the relationship between restoration project motivations, the extent to which proposed actions have been implemented, and the resulting impact on desired conservation outcomes. This research, which is funded by the Atlantic Salmon Conservation Foundation (ASCF), has drawn upon information from the NLRRDB, to survey restoration project managers/practitioners with the goals to assess river restoration project motivations, to determine the metrics used to evaluate the success of projects, and to identify the proportion of projects that set and met criteria for ecologically successful river restoration. The objective of this project is to outline what success in river restoration should look like, as well as to determine how successful the province of Newfoundland and Labrador is when it comes to river restoration.

Literature Review

History of Rivers

Rivers have shaped the Earth for millions of years. Forming from precipitation and landscape runoff, these physical landforms contribute to the diversity and prosperity of the planet. Fluvial systems have changed the Earth in many ways. While contouring the landscape of the earth's crust, the land is flooded, and nutrients and rocks have been relocated as part of the process of fluvial geomorphology (Environment and Climate Change Canada, 2013). Rivers provide access for many species to reproduce and connect ecosystems around the planet, keeping biodiversity strong. Rivers, however, change with time. Velocity is constantly changing due to the amount of water available, leading to channels becoming wider, and streams potentially drying up, while this may seem detrimental, some rivers rejuvenate in dry and wet cycles which allows still water and moving water organisms to thrive (Datry et al., 2014. Because of this, proper management of maintaining water levels is crucial to both still and moving water animals.

Benefits of Healthy Rivers

While often unnoticed by the public, rivers sustain habitats and livelihoods for aquatic and terrestrial organisms, including humans. Rivers are often only thought of as a body of water, while in fact, they "provide a broader set of ecosystem services that deliver immense benefits to people, economies, and nature, which include, but exceed, the value of the water they carry" (Opperman et al., 2018, p. 5). The benefits are not only for the Instream ecosystem. Because of the transportation and deposition of sediment and nutrients throughout a river, nutrient-rich deltas form in low-lying areas that can sustain fruitful agricultural productivity. The interconnectedness between rivers and the landscape whether it be abiotic or biotic stems from “the physical attributes [that surround the] terrestrial area” (Doretto et al., 2020, p. 1855). This suggests that climatic conditions and organisms present will alter the way the stream functions, if for example, trees are present there will be more oxygen allowing for biotic growth.

Throughout history, many civilizations developed around rivers, as humans found out that they provide access to food and water as well as electricity, transportation, and societal well-being. In fact, “rivers and lakes are linked to human activity for thousands of years and the first prehistoric settlements were created on their banks” (Vavili & Gkounta, 2015, p. 20). Rivers were harnessed throughout the years, but as urbanization began to unfold, so did the degradation of the world’s most undervalued and beautiful ecosystems. Fluvial features have shaped the Earth in many ways. According to Wilson and Carpenter (1999),

> goods and services may be divided into two categories: (1) the provision of direct market goods or services … and (2) the provision of nonmarket goods or services which include things like… satisfaction people derive from knowing that a lake or river ecosystem exists. (p.772)

Geographically speaking, channels altered the landscape and aided in agricultural practices through sediment and nutrient deposits. Animals of surrounding biomes benefit through having breeding grounds and sources of food and water. Particularly in Newfoundland and Labrador, rivers were used as transportation systems for the logging industry. The river drive “was [done] to float the pulp wood over water to the mill site or railway depot” (Higgins, 2007). During times of settlement, rivers were a source of food for settlers. For example, Rennie’s River like many other rivers in Newfoundland and Labrador provided fish for the residents. However, Rennie’s River became developed, which led to its degradation as “the surrounding area became farmland and the home of a flour mill” (CBC News, 2020, para. 2). More recent developments of rivers in this province include the hydroelectric dams that connect residents to the electrical grid.

One of the most recent developments, Churchill Falls Power Station, “uses the vast water resources of the Churchill and Naskaupi rivers” (Crabb, 1973, p. 331). These systems also extend to the current and future benefits of humanity. While economic benefits may come easily to mind, many hidden services are provided, most of which will be unnoticed until the river can no longer deliver such services as access to education opportunities focused on conservation and diversity, aesthetics, and recreation from fishing, rafting, kayaking, and walking on boardwalks and along the riverbanks, among others. Psychologically, humanity benefits from the fresh air, and the calming sounds of water flowing, as well as being connected with nature and being societally connected with other people who enjoy the resource.

Current Issues

While there are undoubtedly many benefits to rivers, the degradation caused by anthropogenic activities and developments led to many issues that threaten the health of rivers. According to Everard and Moggridge (2012) “Negative impacts on freshwater ecosystems have become more severe and widespread. The ecosystem impacts of urbanization also extend further than the immediate urban area” (p. 295). With the increase in urbanization, rivers become polluted by chemical spills, discarded plastic and garbage, or even cut off, dried up, or rechanneled due to land use changes. As human populations grow, the problem grows too, as Karr (1999) stated, “Society, oblivious either to human-health risks or to the ecological risks of radically altering rivers, has chronically undervalued rivers' biological components” (p.225). It is because of this lack of education and other actions, like an increase in angling, that fish populations decline. Dams, while good for electrical generation as seen in Churchill and Muskrat Falls examples from Newfoundland and Labrador, have been detrimental, as they alter water flow, increase sedimentation, decrease nutrient flow, as well as cut off important breeding grounds for spawning fish (US Energy Information Administration, 2020). These issues are commonly known by the public and by officials who can make a difference. However, without prioritization of ecological considerations and a lack of funds, these problems are still without solution. River restoration has been described as prioritizing the goal of "[increasing] the ecological and cost-effectiveness of restoration strategies" (Bernhardt et al., 2007, p.490). By doing so, the process fosters ecological resilience both instream and the surrounding areas allowing for environmental processes and services to return.

Valuation of Techniques

There are multiple ways to restore a river to a more sustainable and beneficial state. While costly, the following techniques have been used on a variety of rivers throughout Newfoundland and Labrador, and around the world. While all methods have benefits that affect the ecosystem and anthropogenic surroundings, some are, of course, more suitable to the desired outcomes for particular river systems. Each of the techniques described below in Table 1 is defined by Bernhardt et al. (2007). These techniques can be categorized as follows: human-centric, ecosystem-centric, and planning and research.

> The most commonly stated goals for river restoration in the United States are to enhance water quality, to manage riparian zones, to improve in-stream habitat, for fish passage, and for bank stabilization. Projects with these goals are typically small in scale with median costs of <$45,000. (Bernhardt et al., 2005, p. 636)

While this seems to be a low cost for a high reward, one must account for the number of projects that are carried out, the time and materials expended, as well as the more expensive larger projects. Table 2 below, created by Bernhardt et al., (2005) illustrates the median cost for each type of river restoration technique defined in their case study of rivers in the United States.

Table 1 NRRSS Working Group List of Goal Categories and Operational Definitions

NRRSS Operational Categories	Definitions
Dam Removal/Retrofit	Removal of dams and weirs or modifications/retrofits of existing dams to reduce negative ecological impacts. Excludes dam modifications that are simply for improving fish passage.
Floodplain Reconnection	Practices that increase the flood frequency of floodplain areas and/or promote flux of organisms and material between riverine and floodplain areas.
In-Stream Habitat Improvement	Altering structural complexity to increase habitat availability and diversity for target organisms and provisions of breeding habitat and refugia from disturbance and predation.
Aesthetics/Recreation/Education	Activities that increase community value; use, appearance, access, safety, and knowledge.
Water Quality Management	Practices that protect the existing water quality or change the chemical composition and/or suspended particulate load.
Land Acquisition	Practices that obtain lease/title/easements for streamside land for the explicit purpose of preservation or removal of impacting agents and/or to facilitate future restoration projects.
In-Stream Species management	Practices that directly alter aquatic native species distribution and abundance through the addition (stocking) or translocation of animal and plant species and/or removal of exotics. Excludes physical manipulations of habitat/breeding territory.
Bank Stabilization	Practices designed to reduce/eliminate erosion or slumping of bank material into the river channel. This category does not include stormwater management.
Stormwater Management	A special case of Flow Modification that includes the construction and management of structures (ponds, wetlands, and flow regulators) in urban areas to modify the release of storm runoff into waterways from watersheds with elevated imperviousness into waterways. These practices/structures generally aim to reduce peak flow magnitude and extend flow duration.
Flow Modification	Practices that alter to timing and delivery of water quantity. Typically, but not necessarily, associated with releases from impoundments and constructed flow regulators.
Channel Reconfiguration	Alteration of channel plan form or longitudinal profile and/or day-lighting (converting culverts and pipes to open channels). Includes stream meander restoration and in-channel structures that alter the thalweg (lowest elevation) of the stream.
Fish Passage	Removal of barriers to upstream/downstream migration of fishes. Includes the physical removal of barriers and also the construction of alternative pathways. Includes migration barriers placed at strategic locations along streams to prevent undesirable species from accessing upstream areas.
Riparian Management	Revegetation of riparian zone and/or removal of exotic species (cattle, weeds). Excludes localized planting only to stabilize bank areas.

Note 1 Adapted from Bernhardt et al., (2007).

Table 2 Median Costs for Goal Categories

MEDIAN COSTS FOR GOAL CATEGORIES		
NRRSS PROJECT CATEGORIES	MEDIAN COST	EXAMPLES
Aesthetics/Education/Recreation	$63,000	Cleaning (E.G., Trash Removal)
Bank Stabilization	$42,000	Revegetation, Bank Grading
Channel Reconfiguration	$120,000	Bank Or Channel Reshaping
Dam Removal/Retrofit	$98,000	Revegetation
Fish Passage	$30,000	Fish Ladders Installed
Floodplain Reconnection	$207,000	Bank Or Channel Reshaping
Flow Modification	$198,000	Flow Regime Enhancement
In-Stream Habitat Improvement	$20,000	Boulders/Woody Debris Added
In-Stream Species Management	$77,000	Native Species Reintroduction
Land Acquisition	$812,000	Buy Land Permits
Riparian Management	$15,000	Livestock Exclusion
Stormwater Management	$180,000	Wetland Construction
Water Quality Management	$19,000	Riparian Buffer Creation/Maintenance

Note 2 Table from Bernhardt, et al., (2005).

Success Criteria

Measures of success, as previously discussed, are very important when it comes to planning, implementing, managing, and especially evaluating restoration projects. Despite success being so important, the criteria for success are often unclear. According to Bernhardt et al., when considering river restoration efforts, "goals are not clearly linked to objective success criteria, and data collected to evaluate projects are either not directly relevant to project goals or not utilized in evaluating project effectiveness" (Bernhardt et al., 2007, p. 491). Because of this, restoration projects are often lacking the checks and balances that can ultimately change the outcome for the better. Defining the criteria for specific projects will help create guidance on which restoration approaches are most successful when developing and implementing the technique. Likewise, success criteria will allow for more projects to run effectively and efficiently, making project costs lower, and ecosystem services much higher.

Criteria.

Success criteria seem to differ from project to project based on technique, location, as well as access to funds and labor. While most practitioners agree that success is important, their projects each have different criteria of success while some others do not have criteria at all. One such group of authors that tried to solve this problem for the benefit of rivers and practitioners alike, is Palmer et al. (2005). In their paper, they discussed the various types of indicators to determine success and placed them into a matrix that describes how rivers can be restored in the most effective way possible, depending on their needs. As seen below in Table 3, the matrix outlines the indicators in five distinct and important categories. These categories include the various indicators (most of which are ecological) that will aid in determining the success of each project.

Table 3 Provisional Summary of Guidelines that could be used to evaluate the Five Criteria for Ecologically Successful River Restoration

Criteria	Evaluation Guidelines	Indicators
Guiding Image of Dynamic State	The guiding image should take into account not only the average condition or some fixed value of key system variables (hydrology, chemistry, geomorphology, physical habitat, and biology) but should also consider the range of these variables and the likelihood they will not be static. It should explicitly recognize human-induced changes to the system, including changes in the range of key variables. Ideally, this plan should consider local as well as watershed-scale stressors and should consider how much local restoration can contribute to watershed-level restoration.	Presence of a design plan or description of desired goals that are not orientated around a single, fixed, and invariable endpoint (e.g., static channel, temporally invariant water quality).
Ecosystems are Improved	Appropriate indicators of ecological integrity or ecosystem health should be selected based on relevant system attributes and the types of stressors causing impaired ecological conditions. The expected rate of improvement will vary with the degree of impairment, the degree to which restoration reduces key stressors, and the sensitivity of the selected indicators to changes in stressor levels. Change may be relative to a reference site or away from a degraded state.	Water quality improved, a natural flow regime was implemented, increase in population viability of target species, the percentage of native vs. non-native species increased, the extent of riparian vegetation increased, increased rates of ecosystem functions, the bioassessment index improved, improvements in limiting factors for a given species or life stage (e.g., decrease in percentage fines in spawning beds or decrease in stream temperature).
Resilience is Increased	Systems should require minimal ongoing intervention and have the capacity to recover from natural disturbances such as floods and fires, and to recover from further human encroachment.	Few interventions are needed to maintain the site, the scale of repair work required is small, and documentation that ecological indicators stay within a range consistent with reference. conditions over time
No Lasting Harm	Pre- and Post-project monitoring of selected ecosystem indicators (see 2 above) should demonstrate that the impacts of the restoration intervention did not cause irreversible damage to the ecological properties of the system.	Little native vegetation was removed or damaged during implementation, vegetation that was removed has been replaced and shows signs of viability (e.g., seedling growth), and little deposition of fine sediments because of the implementation process.

Criteria	Evaluation Guidelines	Indicators
Ecological Assessment is Complete	Ecological goals for the project should be clearly specified, with evidence available that post-restoration information or data were collected on the ecosystem variables of interest. The level of assessment may vary from simple pre- and post-comparisons to rigorous statistically designed analyses (e.g., using before-after, treatment-control, or both types of comparison) but results should be analyzed and disseminated.	Available documentation of preconditions and post-assessment.

Note 3 Table Adapted from Bernhardt et al., 2005

While these are general indicators of success, they are not universal for each project around the world, making the process of defining success across jurisdictions difficult. To make strides in creating sustainable and effective projects, as well as healthy ecosystems, practitioners and governing bodies must adopt a strategy that is as clear and easily managed as that presented in Table 3 above.

Provincial Outlook

The province of Newfoundland and Labrador has a vast landscape, with numerous rivers, lakes, bogs, and forests. Being surrounded by the ocean, our economy, historically, has been related to the fishery. The well-documented decline of the northern cod stocks in the province, eventually lead to a large-scale commercial fishing moratorium which still exists today. (Smellie, 2021), presents a cautionary tale of how economically significant species can be depleted if effective recovery strategies are not implemented. Likewise, the recreational fishery for salmon is steadily declining. The DFO (2020a) states that “14 assessed rivers showed declines in total returns, and eight of these involved declines of greater than 30% compared to their previous generation mean” (p. 5). As such, to keep fish habitats and stocks stable, we must focus on restoring and protecting our river systems. While it may seem like a high price tag and a lengthy process, biodiversity and economic and social prosperity depend on it.

Geography.

Newfoundland and Labrador encompass many types of ecosystems. Being more than three times, the size of the Maritime provinces combined (Government of Newfoundland and Labrador, 2018), at roughly 406,000 square kilometers, the province takes pride in its geographic variety. With a large number of rivers throughout Newfoundland and Labrador, the resources seem endless; however, with the urbanization and resource development of the province, these regions are becoming less resilient. The island portion of the province has approximately 4,404 rivers (Porter, et al., 1974, p. 5) while the Labrador portion has approximately 120 rivers (Anderson, 1985, p. iv). Overall, according to Anderson (1985), the drainage area of the rivers in Labrador totals 237,081km^2. Likewise, Porter et al., (1974), claim that insular Newfoundland has a drainage area of 103,413km^2 for a province-wide total drainage area of 340,494km^2.

Recreational Demographics.

While the province's population of 510,550 (Statistics Canada, 2022). people are mostly an aging population, there is quite an active group of people that utilize the environments. Whether it be for fishing, hiking, or water sports, people look forward to using the pristine waters of the province. According to DFO (2015), "Resident angler participation rates have consistently been the highest in Newfoundland and Labrador" (p. 9). The rate of fishing in the province has been generally stable, with the DFO reporting the 2015 rates at 110,772 resident anglers. While fishing may be one of the more lucrative and economically beneficial uses of rivers, hiking, and watersports are also gaining a reputation in the province. Rafting, kayaking, and hiking have provided a gain in revenue for the tourism industry, with angling at $10,000,000 and 500 jobs alone (Dean-Simmons, 2023). as there are thrill seekers from around the world that want to experience the breathtaking scenery and action that Newfoundland and Labrador have to offer. Financial gain comes from paying for excursions or buying/renting related equipment. For instance, according to the Department of Culture, Tourism Arts and Recreation (2022), 9% of the surveyed 247 participants participated in kayaking while traveling the province in 2021. Likewise, hiking and angling proved to be popular in the province with 59% and 8% respectively (Department of Culture, Tourism, Arts and Recreation, 2022). The province also has many different guiding and outfitting companies that assist tourists and residents alike in finding a successful hunting or fishing spot for their expedition, representing 6% of the surveyed population (Department of Culture, Tourism, Arts and Recreation, 2022).

Methods

The following section outlines the application of the National River Restoration Science Synthesis as described and utilized by Palmer et al. (2005). Modifications were made where necessary, as the original application of this tool did not include queries on climate change. The system used by Palmer et al., fits well into the broad systems and projects that Newfoundland and Labrador have to offer. The provincial and national standards for reporting on such projects are limited and vary accordingly. With a lack of useful tools for checking the effectiveness of these projects, Palmer’s framework proves to be the most effective and efficient in answering the essential questions. By utilizing Palmer’s methods, we can ensure that replication can occur, which allows for a much-needed comparison, especially for governing bodies of both the United States and Canada, as well as for scholars in the field.

To employ Palmer's framework, it was necessary to find participants who have worked on projects within the province and were willing to provide information on project rationale, goals, contributors, etc. We developed and utilized a database (See Appendix A and B) that included all of the projects as well as their contact information. This step is essential because, to date, the province has not compiled a list of projects or provided proof of their success.

Study Area

Stream restoration has been provincially and nationally adopted, with large financial and time investments throughout the years. However, many of the restoration strategies have changed and improved as our technology and understanding of restoration ecology have grown. This led to increased rates of restorative development, as the materials used become more durable and the restoration strategies become more effective. The current physical, chemical, and biological techniques that are used are effective in retaining ecological health. However, biological systems are more efficient as they cost and pollute less (GE, et al., 2019).

Database Overview

The database titled "Newfoundland and Labrador River Restoration Database" (NLRRDB) as seen in Appendix B was specifically compiled for this project. The database, created in Microsoft Excel, outlines in detail all of the documented river restoration projects in the province since Newfoundland and Labrador joined the confederation in 1949. While some of the projects listed have few details, they remain important for many reasons. Projects with less information could show the less-than-ideal transparency of projects to the public and/or the lack of data available. Having all projects listed, no matter the amount of information available also illustrates the work done throughout the province over time. For most of the 170 projects listed, there is an organization (40 in all), that implemented the project, the year the project was completed, the cost of the project, the location of the project, and a National River Restoration Science Synthesis (NRRSS) classification (See Table 1). A research assistant compiled all of the data by searching government documents, articles, and other academic sources. In total, $28,000,000 was spent on these projects in 72 years.

Data Collection

Data for the project were obtained through the NLRRDB. This database was compiled by a systematic review. The identification and compilation of literature for this archive consisted of two stages. Similar to that of Costillo et al. (2016), our process included a standard literature review consisting of search terms that would pick up any document and or article that outlined river projects in the province. This was then followed by a ‘snowballing sample, which consisted of finding practitioners with familiarity with the projects identified. Similar to Costillo, this process led to many new articles and contacts, as requests for restoration data were sent to the restoration professionals on this list, along with a request for additional contacts. The results of this search were exported to Microsoft Excel and categorized into project types, which were defined by Bernhardt et al. (2007). Details on the exclusion process and the database searches are included in Appendix A under the Systematic Review Protocol. This project was approved by the Grenfell Campus Research Ethics Board (GC-REB) under application number 20210539.

Recruitment.

After the database was compiled and finalized, the contacts provided by the snowball effect and the articles were asked via email to partake in a half-day workshop to discuss their role and the projects, perceptions of success, and other project-related topics in more detail. This allowed for more in-depth and varied information regarding the restoration projects that have happened in the province. Eligible participants were those that had been involved with any stream restoration project in the province of Newfoundland and Labrador. After reviewing the database, it was noted that out of the 170 documented projects, only five people could be contacted. Because of this, participants were asked to complete the survey multiple times, depending on how many projects they have worked on, leaving us with a detailed description of over 50 projects. The participants, therefore, are representatives of more than just a single project or group. Out of our five interviewees, nine provincial, federal, and non-governmental organizations were represented out of the 40 groups listed in the NLRRDB. Participants were also very knowledgeable about their organization's history in restorative projects. Most of the data was retrieved from the 1980s onwards, as documentation for projects before then was very limited and incomplete. The extensive experience of the participants, therefore, beneficially serves the research, as they represented many different projects and roles over a long period.

Workshop.

To answer the questions set out in this project, our focus was on finding out to what extent project components were successful in achieving project objectives. Workshop questions, found in Appendix C, focussed on the type or source of funding, the location, and duration of the project, and whether proponents felt the project was effective and successful. Respondents were presented with various response formats to allow for various data analysis techniques. Following the success of Palmer et al. (2005), our workshop nearly replicated this early survey instrument to allow for a comparison of findings between studies. The current research, however, also incorporated questions about whether project proponents accounted for inevitable climate change impacts on their projects, or if climate change-related outcomes were among the goals identified.

Our workshop comprised of categorizing projects into human-oriented (i.e., dam removal/retrofit, structures, education, recreation, aesthetics), ecologically-oriented (i.e., water quality, channel reconfiguration, species, and habitat quality), or research and planning. Due to such categorization, the questionnaire had to be completed three times, one for each category of project. The workshop was administered through WebEx, which included an interactive, real-time survey created on PollEverywhere that was given to the participants via an internet link or through text message. Users had 20-30 minutes per questionnaire. This polling software allows users to create various polls using multiple choice, written, ranking, and select all that apply formats to collect and decipher the information. It can be used on various platforms including phones, web browsers, and presentation software.

Data Analysis

Data analysis commenced shortly after the half-day collection process, as the data was time-sensitive due to the constraints of the software used. We exported the collected data and used the analysis toolset on PollEverywhere. This analysis revealed the criteria for restoration project success, as identified by participants. The data was presented in a visual format with graphs and charts, which were provided to participants who had indicated a desire to receive study summaries after completion of the study. Descriptive statistics were also used in showing results from selected answers.

Results

While this study focused on 170 different projects spanning the provincial history, there was some difficulty, sometimes owing simply to time passed since some projects were completed, in securing interviews with those practitioners having sufficiently close knowledge of the projects. We were, however, able to interview five practitioners who knew information about a large variety of projects listed in the database. While we were not able to secure as many interviews as initially planned, these individuals worked on all of the types of projects listed, meaning they had a wealth of knowledge on each technique and were thus able to provide a near-complete picture of stream restoration considerations in the province.

The interviewees completed the same survey three times. Each time they completed the assessment, they were asked to focus their answers on their experiences with working on ecological projects, human-oriented projects, and finally research and planning projects. The focus on each of these categories led to a generalized result based on the projects they completed. While the results are not conclusive to specific projects, the overall result is representative of what has happened to the provincial rivers since the initiation of restoration projects.

Provincial Database

Comprising 170 projects spanning the course of the provincial history since confederation, the NLRRDB highlights, the restorative projects completed throughout the province. When looking at restoration project intent listed for projects in the NLRRDB, the top three categories, as seen in Figure 1, were Fish Passage (29%), In-Stream Habitat Improvement (21%), and Aesthetics, Recreation, and Education (16%). Similar to the original database, the interview subset, which is the group of projects that participants shared information about, categorized the intent of their projects as Fish Passage (19%), In-Stream Habitat Improvement (15%), and Dam Removal and Retrofit (14%) as seen in Figure 2. There is a difference between fish passage and dam removal in this analysis as dams were excluding fish passage modifications as mentioned by Bernhardt, referenced in Table 1 above Dams in this case refer to modifications to the dam itself, whether it be demolished or revised. Fish passage, on the other hand, is referring to any means of adjusting rivers to allow for easy relocation of fish. As such, fish ladders are an add-on to a dam but do not affect the way dams operate, and are therefore excluded from dam retrofit in the analysis. Over the last 72 years, over 27 million dollars has been spent on river restoration in the province. Of these projects, 84% have utilized federal funding, with the remaining 16% receiving funding from volunteers, contractors, and NGOs. Project costs ranged from $2,965 up to $2,900,000 million. Of the projects assessed in the database, the average stream restoration project cost was found to be $199,455.86. An overview of the project type and the amount of spending has been provided in Figure 3 below.

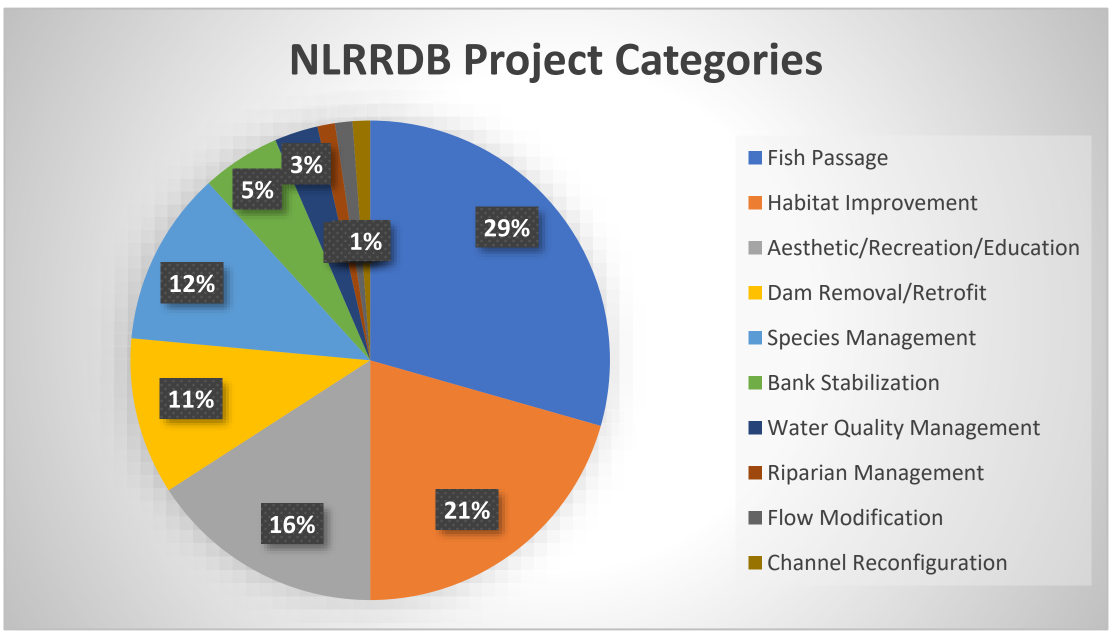

Figure 1 NLRRDB Project Techniques

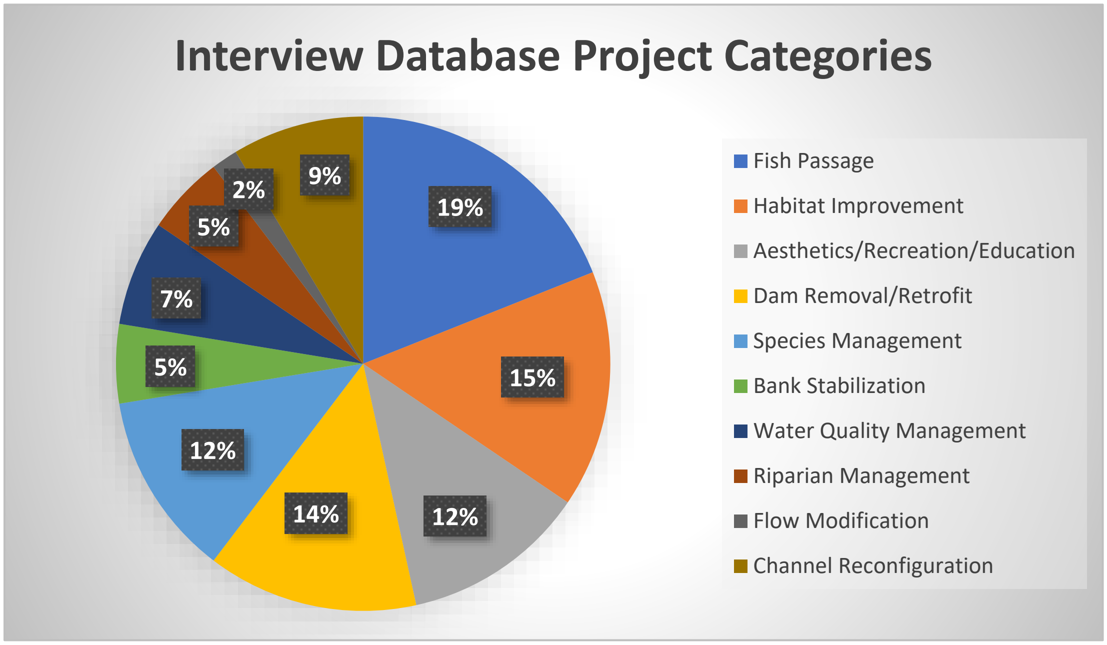

Figure 2 Interview Database of NRRSS Project Techniques

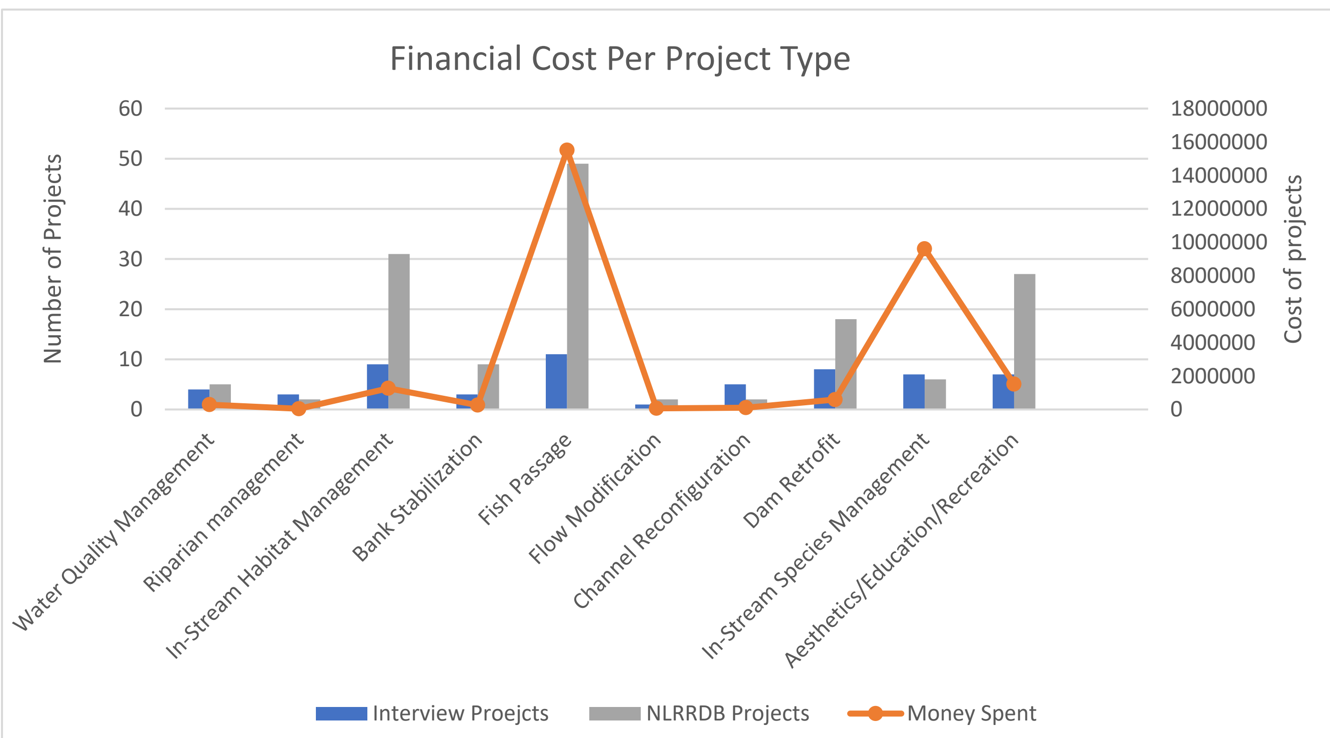

Figure 3 Total Number of Projects and Costs

Interview Results

Participant Demographics.

Of the five participants in our survey, three identified themselves as non-governmental organization members, one identified themselves as a government worker, and the other one was an academic. Based on the provincial database, the backgrounds of participants were ideal for our study, as no project category was not represented by participants. While the practitioners surveyed may not have been working on the project at that time, they were considered the most well-informed people for the projects in the NLRRDB.

Project Distribution.

While the projects were distributed throughout the province, there seems to be a cluster forming in the Kittiwake economic region, (Economic Zone 14) of the province as seen in Figure 4 below. Furthermore, a breakdown of projects has been provided in Table 4. Projects were mainly developed on provincial (crown) lands with a few exceptions of private ownership and municipal lands.

Project location and Economic Zones

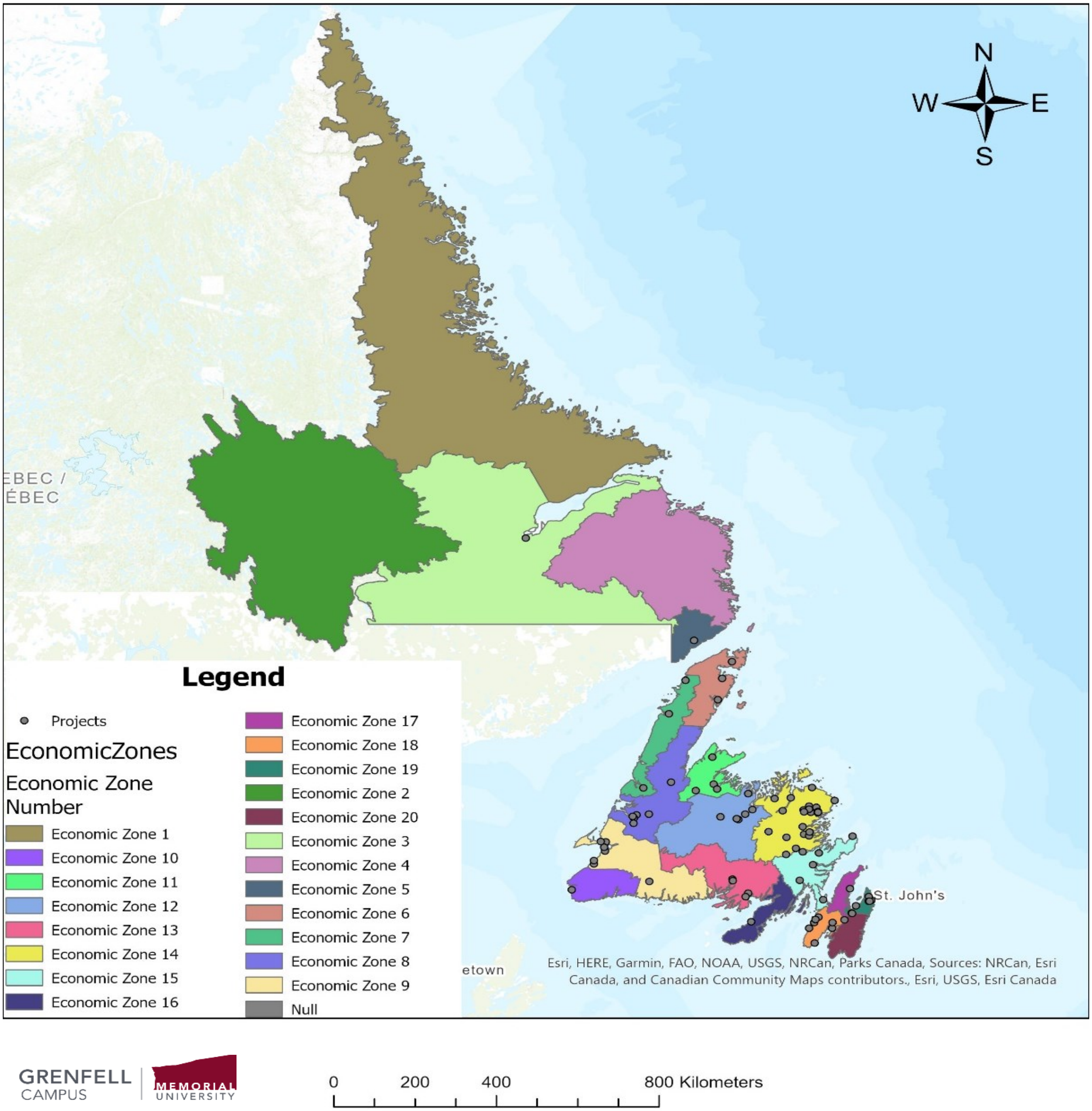

Figure 4 Provincial Economic Zones and NLRRDB Projects

Note 4 Projects were grouped as one dot if projects overlapped (maintenance, monitor etc.) Source: Author Content - data from ESRI, NLRRDB, and Government of Newfoundland and Labrador

Table 4 Economic Zones and Project Totals

Economic Zone Number	Economic Zone Name	Number of Projects
1	Nunatsiavut Government	0
2	Hyron Regional Economic Corps.	0
3	Central Labrador Regional Economic Corps.	1
4	Southeast Aurora Development Corps.	0
5	Labrador Straits Development Corps.	1
6	Nordic Economic Development Corps.	2
7	Red Ochre Regional Board	4
8	Humber Economic Development Boards Inc.	13
9	Long Range Regional Economic Development Board	8
10	Southwestern Marine and Mountain Zone Corps.	1
11	Emerald Zone Corps.	5
12	Exploit Valley Economic Development Corps.	11
13	Coast of Bays Corps.	3
14	Kittiwake Regional Economic Development Corps.	48
15	Discovery Regional Development Board	5
16	Schooner Regional Development Corps.	1
17	Mariners Resource Opportunities Inc.	1
18	Avalon Gateway Regional Economic Development	11
19	Northeast Avalon Regional Economic Development	14
20	Irish Loop Regional Development Board	2

Note 5 Economic zones retrieved from Government of Newfoundland and Labrador, Project totals retrieved from NLRRDB

Motivations.

While every project has different reasons for its implementation, some reasons are more often cited than others. In Newfoundland and Labrador, the projects were mainly incentivized by the available funding (35%). They were also implemented due to river degradation (20%). Projects were varied throughout the province; however, some types were more common than others. In our survey, participants indicated that fish passage was implemented the most, at 20%, followed by in-stream habitat management, and dam retrofit, at 15% and 14%, respectively. The provincial database has very similar results, the only difference being aesthetics, recreation, and education, which fall slightly behind dam retrofits at 12% of the total projects.

Project Design and Implementation.

Participants were asked about the relevance of their project to a larger watershed plan. Seventy-two percent of the responses reported that the projects were part of a watershed plan. Surprisingly, however, when asked what influenced the project site, only six percent claimed that watershed plans were important factors. Ecological concerns, available funding, and scientific interests were the most often cited choices with 18%, 18%, and 15% of the responses, respectively.

When looking at the design aspect of projects, we asked participants what influenced the final design of their project. As seen in Figure 5 below, the responses gravitated towards the cost and experience choices, with 29% choosing costs and 21% choosing experience. Stakeholders and location tied in last with 10% of the responses each. Surprisingly, only 14% of projects were designed to address ecological impacts. The implementation of the projects plays a major part in how well a project is designed and, as such, if a project is effectively implemented it can be assumed that the project was designed properly. Based on the results of the final design influences, it can be assumed that stakeholders and the location are not as influential as other factors, as they had been briefly mentioned in the influences listed in the design question. When asked who implemented the project, 50% of the projects were completed by non-governmental organizations, while 23% were provincially or federally led, and nine percent were privately or voluntarily implemented or through the assistance of stakeholders.

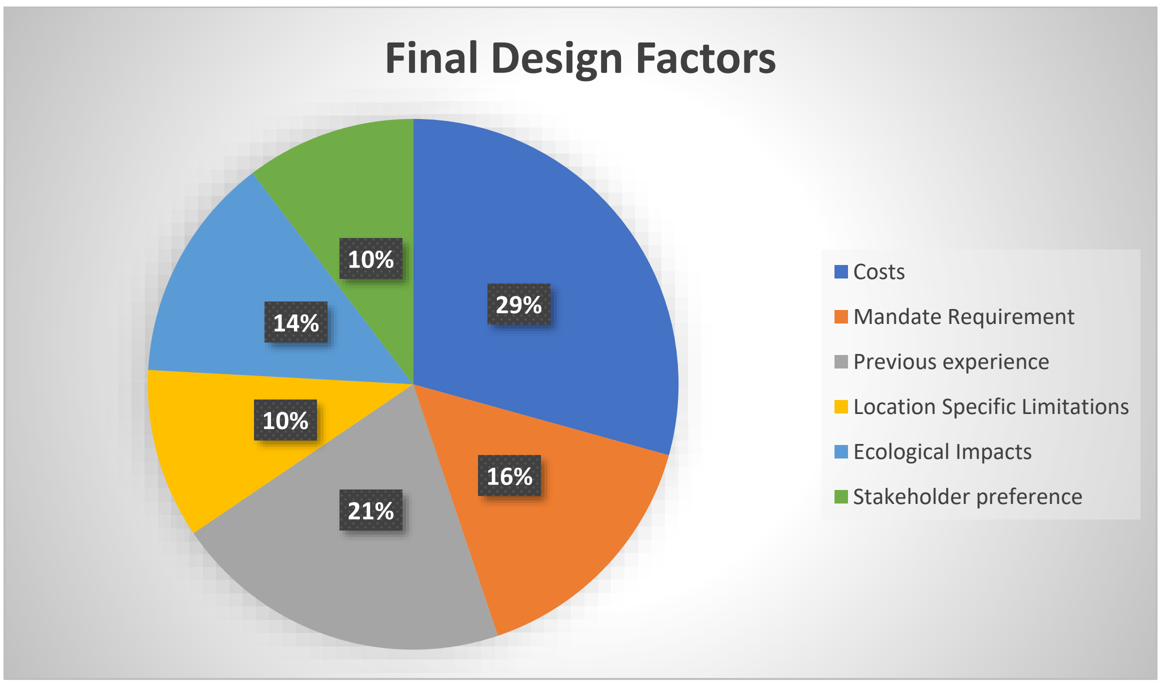

Figure 5 Final Design Factors for Practitioner Projects

The influence of citizens is important in maintaining a socially acceptable, and participative approach to transparency. As such, we asked participants if citizens were involved in the implementation process. Responses spanned from not having any interaction to having complete interaction. Most of the responses (30%) stated that citizens were somewhat involved, whereas 22% said there was no involvement, and 14% said they were completely involved.

While the answers vary, citizen participation can depend on the type of work needed as well as how comfortable people were with doing specific tasks. However, with most of the responses pointing towards citizens assisting, it goes to show that the public has an interest in the health and well-being of our river systems.

Monitoring.

Monitoring is very important to projects, as it allows the practitioners and other concerned individuals to see if they have made any progress with restoring the ecosystem or reached other project goals. Only two of the projects covered by interviewees did not include some sort of monitoring – both of which were human-oriented projects (education, aesthetics, and recreation). Monitoring in these cases may not have occurred, as it did not affect the ecosystem, only the way the citizens perceive it. An important objective of our study was to determine whether climate change received more attention over time. This, however, was deemed impossible due to the choice of method. Based on the low sample size, our data had to be clumped based on project type and not year. In our survey, 25% of the projects monitored indicators that pertained to climate change, which may or may not coincide with more recent projects due to the evolution of climate change science. Alongside these indicators, 26% of our projects monitored indicators biologically, physically, and with photomapping. The monitoring did not stop there, as there were also projects covering chemical indicators (nine percent).

Development for the monitoring strategies and techniques for the project has been determined by various factors. In our survey, we asked what enabled monitoring to happen. Our survey concluded that the availability of funds, volunteer interests, and academic interests had the biggest impact. Each of these factors represented 21% of the total interview database, followed closely by personal interests, regional interests, and a funding mandate at 10% each.

Monitoring techniques were often defined by the protocols set in place. When asked how they came to monitor their project, practitioners responded by using federal protocols (22%), expert advice (22%), previous data (20%), and academic literature (20%).

Evaluation.

None of the projects were considered poorly implemented based on design, as participants ranked the projects as at least somewhat successful. Despite these positive appraisals, success criteria were only identified in half of the projects detailed by participants. The surprising aspect is that each participant stated at least some success in their projects, even though no criteria of success were identified. When asked what made the project successful, a further understanding of rivers was an often-cited indicator, with 31% of the practitioners. Seeing positive results with rivers and humans followed close behind, with each having 17% of the practitioners, and Improvement with the success indicators ranked the least, at a two percent share. On the other hand, we asked what would have prevented a project's success, and the responses pointed to a lack of funding (25%). Close behind was natural disturbances at 20%. With the amount of money spent on projects in the province, it is important to note that participants flagged inadequate funding as a barrier to success. While natural disturbances can be minimized, they cannot be prevented. Money, on the other hand, could be more effectively allocated if ecological criteria were set, making the ecological benefit per unit of expenditure increase.

Conclusion

Globally, rivers are diminishing in quality, creating a less biodiverse ecosystem for salmon and other animals as well as plants. Through improper planning and implementation of development, we are left with fewer ecosystem services and more cabins, and forest roads that fragment the ecosystem and pollute the water. Our research aimed to find out which projects were deemed successful and why they were successful, while also determining a strategy that can be used to determine success in future projects.

Our research employed a modified survey created by Palmer et al. (2005). Our modified version added questions about climate change to make it more relevant to more contemporary ecological restoration considerations; Due to the clumping based on small sample sizes, trends on climate change data were impossible. By clumping by category, we could not distinguish projects by date, therefore assuming whether climate change has received more attention over time became impossible. This step-by-step guide by Palmer et al. (2005) aided in our data collection via online surveys with experts, and while different than their approach, this strategy was successful in gathering essential data. The analysis of the results concluded that the criteria of success for restoration projects in Newfoundland and Labrador were not, for the most part, based on ecological indicators. Motivations of project design were mainly focused on access to funding. Several limitations and shortcomings are noted in this study. The analysis can be considered a stepping-stone for future projects to determine ways to measure success in provincial river restoration projects. Future studies can work on delineating the factors (economic, political, or social) that contribute most to project design and distribution.

In summary, the results of the present study illuminate a fraction of the problems faced in Newfoundland and Labrador rivers. Before this study, there were, in fact, no measures of evaluating success in Newfoundland and Labrador rivers, leaving the governing bodies and practitioners with even less useful information for deciding the location and need for future projects. While the current study begins to decipher what caused the non-ecological restorative projects to be implemented as well as how they decided to build them it does not identify what initiated the need for restoration. From a planning and decision-making perspective, however, the results from the interviews are crucial for guiding future decisions in the province. After talking to our five experts, it was concluded that the findings are essential for focusing future resources on effective and ecologically justified projects. This paper thus highlights the key findings of the issues faced by the practitioners in hopes of an immediate change, allowing for a more collaborative and efficient approach. Effectively, it would be beneficial to create a committee comprised of elected members of interested parties who would then decide on how to allocate the funding based on an agreed-upon set of criteria including monitoring, ecological, societal, and economic factors, along with climate change. The group should also incorporate the NLRRDB and maintain its relevancy as well as provide insight on how things should be completed based on previous models and historical maps. This change would improve our conservation efforts immensely, as it would improve the quality of projects completed. With climate change and resource development continually on the rise, river restoration and proactive management are certainly needed. Without changing our current approach, rivers may cease to provide humanity and the surrounding environment the ecosystem services they once did.

Chapter 3: Geographic Distribution of River Restoration Projects

Introduction

While there are more than 700,000km² of rivers worldwide (Allen and Pavelsky, 2018), much of this area has been degraded to the point where there are no ecological, social, or economic benefits to be obtained. Because of this, many regions are suffering from a loss of ecosystem services. Thankfully, it is not too late for these systems, as conservation practitioners have developed a series of techniques to facilitate river restoration. These techniques can theoretically be employed to allow the river to recover and bring the ecosystem services to a state like that of the natural unaltered river, However, in practice this becomes difficult to achieve. By looking at ecological indicators, such as water quality, pollution levels, flow rate, water level, temperatures, and others, we can easily determine which rivers need immediate attention. Further research on these indicators in the watershed would be ideal and beneficial for future projects.

The Importance of River Restoration

Degradation of a river can result from overfishing, pollution, urban sprawl, dam construction, and recreational watersports, among others. While these may increase satisfaction for the economic and social well-being of communities, it decreases the overall quality and health of the river and the surrounding ecosystems. While these activities can be scaled back to alleviate the strain, it is most beneficial to re-establish the river's natural state. While restorative techniques are beneficial, construction and maintenance can be costly. By utilizing the ecological indicators on rivers in the pre-planning stage, much of the cost can be invested into ecological benefits, making it more acceptable to society. Studying the conditions of rivers will lower the chances of creating unneeded projects and increase those that benefit the ecology of rivers.

Focusing on the ecology of rivers has never been more important. As previously mentioned, river restoration is not solely based on ecology or ecological indicators. Relating to this study is the Natural Flow Regime paradigm which monitors and evaluates streamflow and the response of biotic elements in the ecosystem. Based on a study by Nguyen et al., (2021) ecological elements such as fish abundance, and spawning have increased based on the stream flow changes. The authors state that streamflow magnitude, frequency, rate of change, timing, and duration play a role in impacting the restoration of river health (Nguyen et al., 2021). Each factor has been proven to be beneficial, which, in turn, adds to the question of what ecological indicators should be monitored when calculating success in restoration.

Techniques.

Restorative efforts on rivers are essential to maintain the health and prosperity of river systems. There are many restorative techniques to use, including but not limited to, channel reconfiguration, revegetation, fish ladders, and bank stabilization. As illustrated in Table 5 below, rivers can be restored by many different means. Costs vary for each method, making it a tough choice to decide how to spend scarce resources and gain as many benefits as possible. As seen in Table 6 below, project types range between a mere few thousand dollars to a few hundred thousand dollars, meaning the project needs to be carefully planned economically, yet more importantly, ecologically. River restoration benefits both nature and humanity, as "[w]aters provide places and activities urban dwellers and their families can enjoy together" (Hasse, 2015, p. 78). Remediating rivers restores habitats, and humans benefit by having a social place to connect with family, friends, and nature.

Table 5 Restorative Techniques

NRRSS Operational Categories	Definitions
Dam Removal/Retrofit	Removal of dams and weirs or modifications/retrofits of existing dams to reduce negative ecological impacts. Excludes dam modifications that are simply for improving fish passage.
Floodplain Reconnection	Practices that increase the flood frequency of floodplain areas and/or promote flux of organisms and material between riverine and floodplain areas.
In-Stream Habitat Improvement	Altering structural complexity to increase habitat availability and diversity for target organisms and provisions of breeding habitat and refugia from disturbance and predation.
Aesthetics/Recreation/Education	Activities that increase community value; use, appearance, access, safety, and knowledge.
Water Quality Management	Practices that protect the existing water quality or change the chemical composition and/or suspended particulate load.
Land Acquisition	Practices that obtain lease/title/easements for streamside land for the explicit purpose of preservation or removal of impacting agents and/or to facilitate future restoration projects.
In-Stream Species management	Practices that directly alter aquatic native species distribution and abundance through the addition (stocking) or translocation of animal and plant species and/or removal of exotics. Excludes physical manipulations of habitat/breeding territory.
Bank Stabilization	Practices designed to reduce/eliminate erosion or slumping of bank material into the river channel. This category does not include stormwater management.
Stormwater Management	A special case of Flow Modification that includes the construction and management of structures (ponds, wetlands, and flow regulators) in urban areas to modify the release of storm runoff into waterways from watersheds with elevated imperviousness into waterways. These practices/structures generally aim to reduce peak flow magnitude and extend flow duration.
Flow Modification	Practices that alter to timing and delivery of water quantity. Typically, but not necessarily, associated with releases from impoundments and constructed flow regulators.
Channel Reconfiguration	Alteration of channel plan form or longitudinal profile and/or day-lighting (converting culverts and pipes to open channels). Includes stream meander restoration and in-channel structures that alter the thalweg (lowest elevation) of the stream.
Fish Passage	Removal of barriers to upstream/downstream migration of fishes. Includes the physical removal of barriers and also the construction of alternative pathways. Includes migration barriers placed at strategic locations along streams to prevent undesirable species from accessing upstream areas.
Riparian Management	Revegetation of riparian zone and/or removal of exotic species (cattle, weeds). Excludes localized planting only to stabilize bank areas.

Note 6 Adapted from Bernhardt et al., 2007

Table 6 Median Costs for NRRSS Techniques

MEDIAN COSTS FOR GOAL CATEGORIES		
NRRSS PROJECT CATEGORIES	MEDIAN COST	EXAMPLES
Aesthetics/Education/Recreation	$63,000	Cleaning (E.G., Trash Removal)
Bank Stabilization	$42,000	Revegetation, Bank Grading
Channel Reconfiguration	$120,000	Bank Or Channel Reshaping
Dam Removal/Retrofit	$98,000	Revegetation
Fish Passage	$30,000	Fish Ladders Installed
Floodplain Reconnection	$207,000	Bank Or Channel Reshaping
Flow Modification	$198,000	Flow Regime Enhancement
In-Stream Habitat Improvement	$20,000	Boulders/Woody Debris Added
In-Stream Species Management	$77,000	Native Species Reintroduction
Land Acquisition	$812,000	Buy Land Permits
Riparian Management	$15,000	Livestock Exclusion
Stormwater Management	$180,000	Wetland Construction
Water Quality Management	$19,000	Riparian Buffer Creation/Maintenance

Note 7 Adapted from Bernhardt et al., 2005

Ecosystem Services.

Ecosystem services are the benefits people obtain from ecosystems (Constanza et al., 1998). Benefits received from ecosystems affect society, humanity, and the ecology of the surrounding areas. When degraded, these benefits diminish and are often hard to get back. Often, the benefits are overlooked by the public when a project is being implemented nearby, as they have a not in my back yard (NIMBY) concern. Our study highly recommends utilizing ecosystem indicators to delineate which rivers need help. Interestingly, a new project in the Northern Peninsula, on the Northwest coast of Insular Newfoundland, seen in economic zones 6,7, and 8 in Figure 4 above, is doing just that. The Parker's Brook restoration, funded by the World Wildlife Federation (WWF), is planning on dredging and re-establishing the Parker's Brook area due to ecological concerns of charr and salmon populations lowering. The group "examined the physical conditions [to] establish an understanding of the cause(s) of charr mortality … established a general understanding of fluvial habitat and geomorphic conditions/processes in Parker's Brook" (Nelson et al., 2021, p. 2). By doing so, the company proved the need for restoration and can mitigate costs by planning accordingly. Ecosystem services can be divided into four groups: Provision, Regulation, Support, and Culture. Each of these affects life in many ways, including water purification, carbon sequestration, decomposition, photosynthesis, psychological impacts, and food and water access (The National Wildlife Federation, 2022). While each of these is important to maintain, it can become difficult to achieve all in one project, which is why planning should be completed before undertaking such a task.

River Ecosystem Services.

Every ecosystem has a unique range of what it can offer humanity and ecology. For rivers, one instantly thinks of the obvious provisional and support services such as water, food, and their contributions to life cycles. However, there are many other important benefits such as fresh air, access to a view scape, a place for recreational activities, and monetary gains. When it comes to rivers, all ecosystem service groups are met. It is important to note that when developing a project, planning should be a component, with the factors of "a river's hydrogeomorphic state in the past, and possible future; and costs and benefits of incremental rehabilitation" duly considered (Thorp et al., 2010, p. 72). Getting a fuller picture of maximum benefits allows for a wiser decision to be made.

Provincial Aspect

With more than 30,000 km^2 of water and towering Appalachian and Torngat mountains surrounding the rocky and boggy barrens, the impressive landscape contains many valuable natural resources that make up a vast portion of the provincial economy. The province is highly productive in resource extraction and boasts many rural communities. Developing around the water, residents made good use of the resource. Fisheries have led to most if not all the settlements, and, additionally, loggers used the water to bring wood to the mill for processing. Eventually, development led to communities being supplied with electricity generated from large-scale hydroelectric dams harnessing the rushing waters of surrounding rivers.

The province is a region well-known for fishing and outdoor recreation, so people spend a lot of time on the water throughout the year. Whether on the ocean or at a river, residents and tourists alike take advantage of what the province has to offer. The waters of the province cover 31,340 km^2 (Statistics Canada, 2016). These rivers are used for resources, fishing, watersports, and, in general, relief from everyday stresses. While the province still relies on the once-declined commercial ocean fishing industry, recreational salmon fishing provides a substantial amount of money to the provincial economy through licensing, guides, and accommodations. According to the Department of Fisheries and Oceans (DFO), salmon expenditures totaled $20,000,000 in 2010, which is the most current data available. Of this $20,000,000, $3,500,000 is contributed by non-resident anglers (DFO, 2020b). Similarly, recreational watersports are a boost in adventure and adrenaline tourism with tours, accommodations, and rentals or purchases of equipment, making the freshwater just as important as the saltwater in our province. While isolating these costs is difficult, it can be noted that Newfoundland and Labrador have been classified as an environmental playground for Canada, with an emphasis on hiking, rafting, fishing, and kayaking (Stoddart and Graham, 2016).

Introduction to GIS

Geographic information systems (GIS) are computer tools that produce maps using real-life data. Environmental System Research Institute (ESRI) defines GIS as software that "creates, manages, analyzes, and maps all types of data. GIS connects data to a map, integrating location data (where things are) with all types of descriptive information (what things are like there)" (ESRI, 2023, para. 1). This modern technology can predict and model any scenario, and map any topic of interest. By utilizing GIS, statistics and ideas can be visualized, clearly making decision-making and planning easier. GIS has become so popular in contemporary research that businesses use the technology for "the autonomous car industry, ride-hailing services (location-based services), aviation/shipping navigation, and business decision-making" (Muenchow et al., 2018, p.2). There is much to be modeled and depicted using this advanced software, including climate change adaptation, projections of the future, and even just a simple comparison of various indicators. By plotting indicators such as those pertinent to ecological success (i.e., water quality, temperature, flow, etc.), we can easily make projections as to what areas need assistance. Plotting data is powerful and insightful in many ways. Geographic distribution compares regions based on the data entered. In the case of the current study an introduction to river restoration in Newfoundland and Labrador, a geographic distribution based on ecological indicators, is needed to determine the past and current distribution as well as the future need of projects on rivers. Our general model of delineating factors at play is simply not enough. Our findings indicate areas of concern but lack detail on what causes the concern. Due to the time constraints and scope of this project, there was simply not enough time to evaluate the ecological indicators for restoration in the province. There is, however, ample evidence that would suffice for the analysis through water quality monitoring stations. Ideally, this would be sought after in subsequent academic papers. Mapping these variables would be like the analysis that we have completed in this study, plotting stations that monitor ecologic conditions such as water temperature or quality on a map and spatially joining them with the locations of where restorative projects are to compare them statistically based on climate variables to see if they create patterns.

Research Objective

The process of determining what affects the motivation of developing and implementing a river restoration project is complicated, as it involves many different aspects. While looking at the political, ecological, economic, and social factors, there is potential for some overlap, which would indicate whether these are suitable indicators to describe the rationale for project location. This aspect of the current study employed GIS to better understand the distribution of river restoration projects in the province. This information was then used to examine the extent to which the ecological health of rivers influenced project distribution.

Methods

Study Design

We mapped the geographical distribution of restorative projects encompassing the four regions (Western, Central, Avalon, and Labrador) of the province of Newfoundland and Labrador. When examining the social and ecological contexts within the province, we looked at several factors, including the number of scheduled salmon rivers, as defined by the Department of Fisheries and Oceans; the economic zones; the human population density; the elected political party; the number of restorative projects; and the financial expenditure of projects, among others. We utilized a watershed layer file provided by ESRI Canada to conduct our GIS analysis. We then clipped each of the data sets into the watersheds to complete a comparative analysis of the watershed to economic or political zone as well as the amount of spending and projects within each of the zones or watersheds. This provided a region-based comparison, allowing us to see which areas received more attention concerning project allocation.

Data Collection

Geographic information systems (GIS) data was compiled through various datasets provided by federal and provincial government open data, as well as through the Newfoundland and Labrador River Restoration Database (NLRRDB). These datasets include the economic zones of 2014, the provincial watersheds, the scheduled salmon rivers, the project areas, and the population (census). The projects were classified using a modified National River Restoration Science Synthesis (NRRSS) system, which is a system created to gather data on all river restoration projects in the United States (Bernhardt et al., 2005). To further the analysis, we grouped each technique based on the intent of the project, through reading titles and descriptions. As defined below in Table 7, there were three categories of restoration project foci. Ecological benefits included projects that affected the biological, chemical, or physical condition of the river and its ecosystem; for instance, a fish passage improvement. Human benefits were classified as recreational, educational, or aesthetic, such as walking trails or podcasts. Finally, the research and planning category focussed on projects that plan or alter current and future projects, such as watershed management plans or updating previous fishways.

Table 7 NRRSS Project Category Groups

Category	Project Type	Example
Ecological	Fish	Fish passage, Species management
	Water	Water Quality, Flow Modification
	Habitat	Dam removal, Bank Stabilization, Floodplain Connection, Habitat Management
Human	Services	Boardwalks, Aesthetics, Public Access, Roads
	Outreach	Podcasts, Education, Public Events
Research	Planning	Designing Plans, Research, and Models
	Maintenance	Upgrades, Rebuilding, Monitoring

Note 8 NRRSS Technique Groups Adapted from Bernhardt et al., 2005

We compiled the data points of each restoration project by utilizing the reports and plotting an approximate location based on the river name. When multiple projects on the same river were recorded, we plotted them together as projects that had upgrades and checkups throughout the years. Plots were separated on the same river if the projects did not match up with each other based on the reports. After plotting the points, we used a pairwise join to compare how many points were in each watershed, giving us descriptive statistics of both the number of projects and the funding per watershed.

We then used pairwise intersects to combine features to illustrate ecological, economic, and social aspects. This tool creates a feature class that comprises of features that intersect with each other in two separate layers (ERSI, 2023). Ecologically, the data for watersheds was modified with an addition of the number of scheduled salmon rivers, as provided by the DFO. After ascertaining how many rivers were in each watershed, we developed a density model by dividing the number of rivers by the area of each watershed, resulting in the amount of watershed used for scheduled salmon rivers. While there are many other species of interest for conservation and economic gains, such as trout or charr, our proxied use of salmon covered a large portion of the recreational freshwater fishing industry. After compiling this data, we combined the watershed layer with the economic zone layer to find out how much of the watershed was used for salmon rivers in economic areas. We then further described the statistics by determining how many rivers were in each economic zone. Finally, we took a look at the social factors that were involved. We added demographic data to our map, as provided by the federal and provincial governments. We compiled unemployment data, population data, political data, and income to determine how many rivers were in wealthy and populated areas; this was done with pairwise joins and descriptive statistics.

Statistical Analysis

All descriptive statistics were created using the tool sets provided in ArcGIS Pro. We looked at various factors, including the number of projects in the watershed and economic zones, category types, and funding per project per economic zone and watershed. Likewise, we compiled statistics of election results to explore how they related to river project distribution. Data were summarized in attribute tables within the ArcGIS application, from which we calculated averages and totals.

Results

When compiling results for river project allocations, we utilized the NLRRDB as seen in Appendix B, as well as the scheduled salmon rivers of Newfoundland and Labrador, as provided by the DFO, along with the economic zones, election results, and watershed boundaries as obtained from the provincial government. The sections below explore how these factors may have impacted the allocation and geographical distribution of river restoration projects throughout the time captured by the NLRRDB.

Watersheds

River systems influence and are influenced by the surrounding typography. The area that contributes water quantities to a river is known as a drainage basin, catchment area, or watershed (National Oceans and Atmospheric Administration (NOAA), 2021). Watersheds are very important to the health and longevity of a river's lifecycle. Without a steady flow of water from the watershed, rivers would eventually dry up. Thankfully, watersheds provide water through runoff, snowmelt, and precipitation, and they can influence rivers through seepage or direct flow. While these areas can encompass large masses of land, rivers are often left in good shape when these important areas are undisturbed.

Provincial Watersheds.

The province of Newfoundland and Labrador has a hilly topography, allowing for many watersheds to form. Due to the vast number of hills and several rivers within the province, there are many small watersheds. Because of this, our analysis took a more general approach by looking at the overarching larger watersheds that encompassed the smaller ones. The 12 watersheds analyzed included the Northern Newfoundland, Southern Newfoundland, Southern Labrador, Central Labrador, Northern Labrador, Petit Mécatina and Strait of Belle Isle, Moisie and St Lawrence Estuary, Romaine, Natashquan, Eastern Ungava Bay, Churchill, and Caniapiscau. Due to the number of projects in each region, insular Newfoundland was reclassed into two major watersheds, "Northern Newfoundland" comprising of 26 sub-watersheds, and "Southern Newfoundland" comprising of 19 sub-watersheds. Labrador was split into 10 other watersheds where Caniapiscau has six minor watersheds, five in Central Labrador, five in Churchill, six in Eastern Ungava Bay, five in Natashquan, three in Romaine, three in Moisie and

St Lawrence estuary, eight in Northern Labrador, four in Petit Mécatina, and two in Southern Labrador as defined by ERSI Canada and depicted in Figures 6 and 7 below.

Project and Salmon Rivers.

While there are many rivers within the province of Newfoundland and Labrador, not all of them are monitored frequently or used for salmon fishing. Because of this, certain rivers get more help than others. To compare our project rivers with the rivers used for salmon fishing, the project utilized the NLRRDB as well as the scheduled rivers document created by the DFO. Both sets of data are similar in numbers but very few overlap with each other. The DFO states that there are 186 scheduled rivers throughout the province. However, there are more that are unmonitored. The dataset for river restoration projects sits at 170. Looking at unique sites, the number of 170 rivers lowered to 88 rivers. As seen in Figures 6 and 7 below, projects of the NLRRDB were indicated and separated into category types by the yellow (Ecosystem), red (Human), and blue (Research) dots, while scheduled salmon rivers were illustrated through orange circles. We utilized salmon as a proxy for our analysis. While other species who need help, help the economy such as trout, and charr, Salmon seem to be more popular in the media, allowing for more information to be sourced. The comparison between rivers that were restored and scheduled salmon rivers is noticeable due to the color distinction. While there is some overlap, the majority of the restored rivers are not covering the salmon habitat. Therefore, risking the health of the salmon population as well as the recreational fishery. Illustrating that ecosystem health in terms of fish, is not looked at enough.

As represented in Table 8 below, restorations occur in the province's northern watershed more than any other watershed. While there is some overlap, the majority of the restored rivers are not covering the scheduled salmon rivers. This discrepancy, therefore, calls into question the criteria used in determining where restoration projects are implemented and whether other, non-ecosystem health-related criteria impact the geographical distribution of projects.

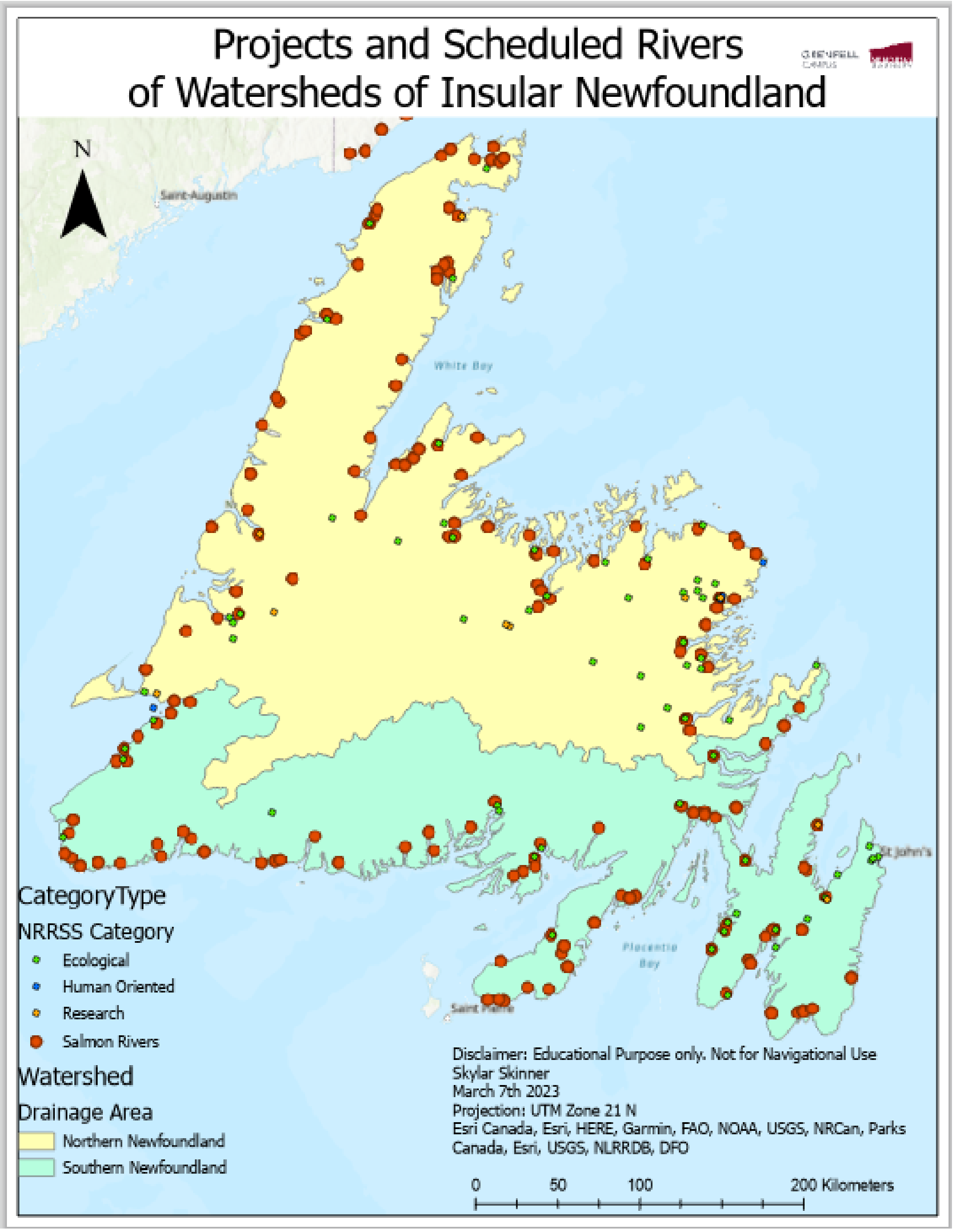

Figure 6 NRRSS Project Groups, Salmon Rivers, and Insular Newfoundland Watershed

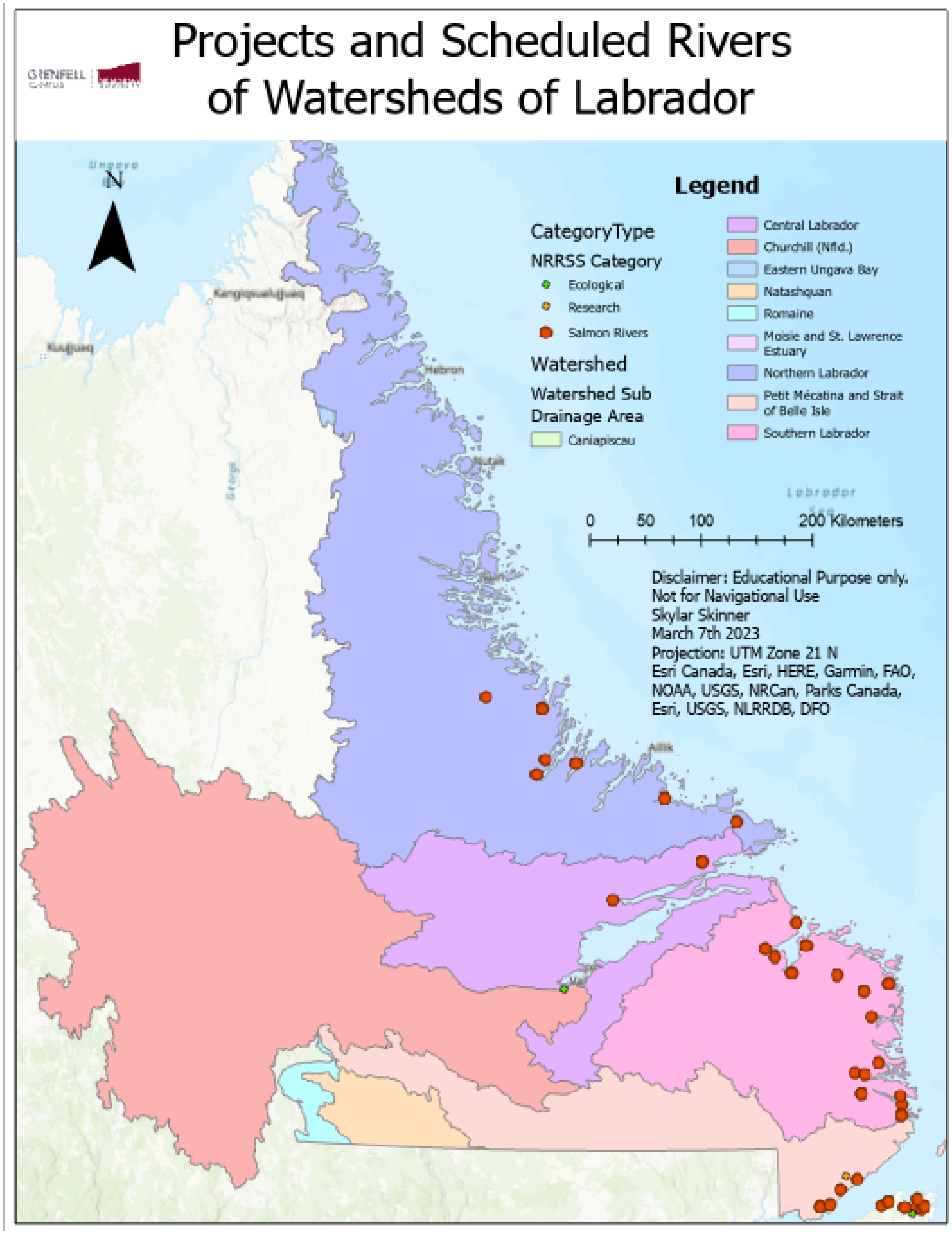

Figure 7 NRRSS Project Groups and Salmon Rivers of Labrador Watersheds

Table 8 Project and Salmon River Watershed Comparison

Watershed	Project River Total	Project Percentage	Scheduled River Total	Scheduled Percentage
Caniapiscau	0	0	0	0
Central Labrador	0	0	0	0
Churchill	1	0.58	0	0
Eastern Ungava	0	0	0	0
Moisie	0	0	0	0
Natashquan	0	0	0	0
Northern Labrador	0	0	18	9.67
Northern Newfoundland	120	70.58	60	32.25
Romaine	0	0	0	0
Southern Labrador	0	0	5	2.68
Southern Newfoundland	48	28.23	87	46.77
Strait of Belle Isle	1	0.58	16	8.6
Total	170	100	186	100

Economic Zones

Economic zones are areas that are delineated to illustrate the amount of money earned and spent within a year. Often used in census data, these districts provide clear detail about how the population deals with money. In terms of our research, we utilized the boundaries outlined by the provincial government to see if there is any correlation between river restoration and funding of projects in terms of proximity to an economic center and the amount of money spent.

Funding.

To compare the amount of money spent on each project throughout the province, we utilized the data collected within the NLRRDB to illustrate the difference between each project. After spending a total of $27,000,000 on 170 projects in 71 years, the province shows an uneven distribution of funds among districts. Some projects cost more due to materials and labor used, but a more just distribution based on ecological need seems warranted. Depicted in Table 9 below is a comparison of project funding totals per economic zone as well as an analysis of how much of the $27,000,000 has been spent in each region. As shown in Figures 8 and 9 below, most if not all projects are classified between one and three percent of the $27,000,000 illustrating that projects in the province are at similar costs; however, by looking at Table 9 below, one can see that due to having multiple projects located within certain economic zones, a loss in balance occurs. This loss of balance shows the unequal distribution of projects, as some regions have an abundance of restored rivers while others have very little to show. Because of this, certain areas will more than likely have a healthier ecosystem and better societal benefits than others due to the implementation of actions to restore and improve the area.

Table 9 Economic Zone Project Funding Totals

Zone	Project Total	Funding Total	Percentage of Funding
Nunatsiavut Government	0	0	0
Hyron Regional Economic Corps.	0	0	0
Central Labrador Regional Economic Corps.	1	20,000	0.072
Southeast Aurora Development Corps.	0	0	0
Labrador Straits Development Corps.	1	126,350	0.45
Nordic Economic Development Corps.	14	905,404	3.23
Red Ochre Regional Board	7	2,780,911	10.10
Humber Economic Development Board Inc.	16	152,391	0.55
Long Range Regional Economic Development Board	11	1,585,254	5.76
Southwestern Marine and Mountain Zone Corps.	1	17,000	0.062
Emerald Zone Corps.	5	2,821,000	10.25
Exploit Valley Economic Development Corps.	19	7,561,284	27.47
Coast of Bays Corps.	4	23,000	0.084
Kittiwake Regional Economic Development Corps.	47	5,769,801	20.96
Discovery Regional Development Board	7	90,567	0.33
Schooner Regional Development Corps.	1	43,000	0.16
Mariners Resource Opportunities Inc.	2	205,760	0.75
Avalon Gateway Regional Economic Development	14	3,828,904	13.91
Northeast Avalon Regional Economic Development	16	1,033,882	3.76
Irish Loop Regional Development Board	0	0	0
Province Wide	5	560,995	2.04
Total	170	27,524,909	100

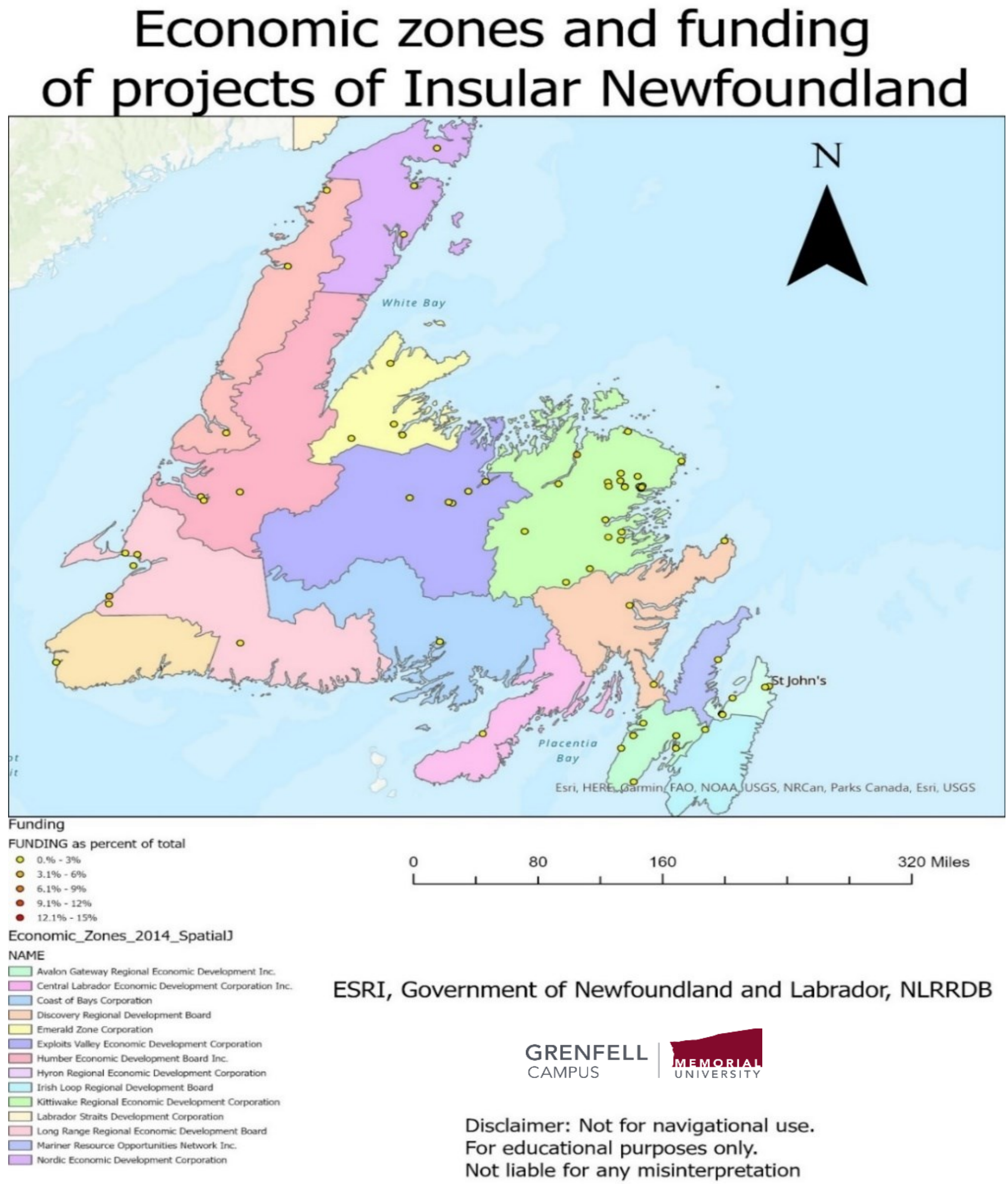

Figure 8 Economic Zone Project Funding of Insular Newfoundland

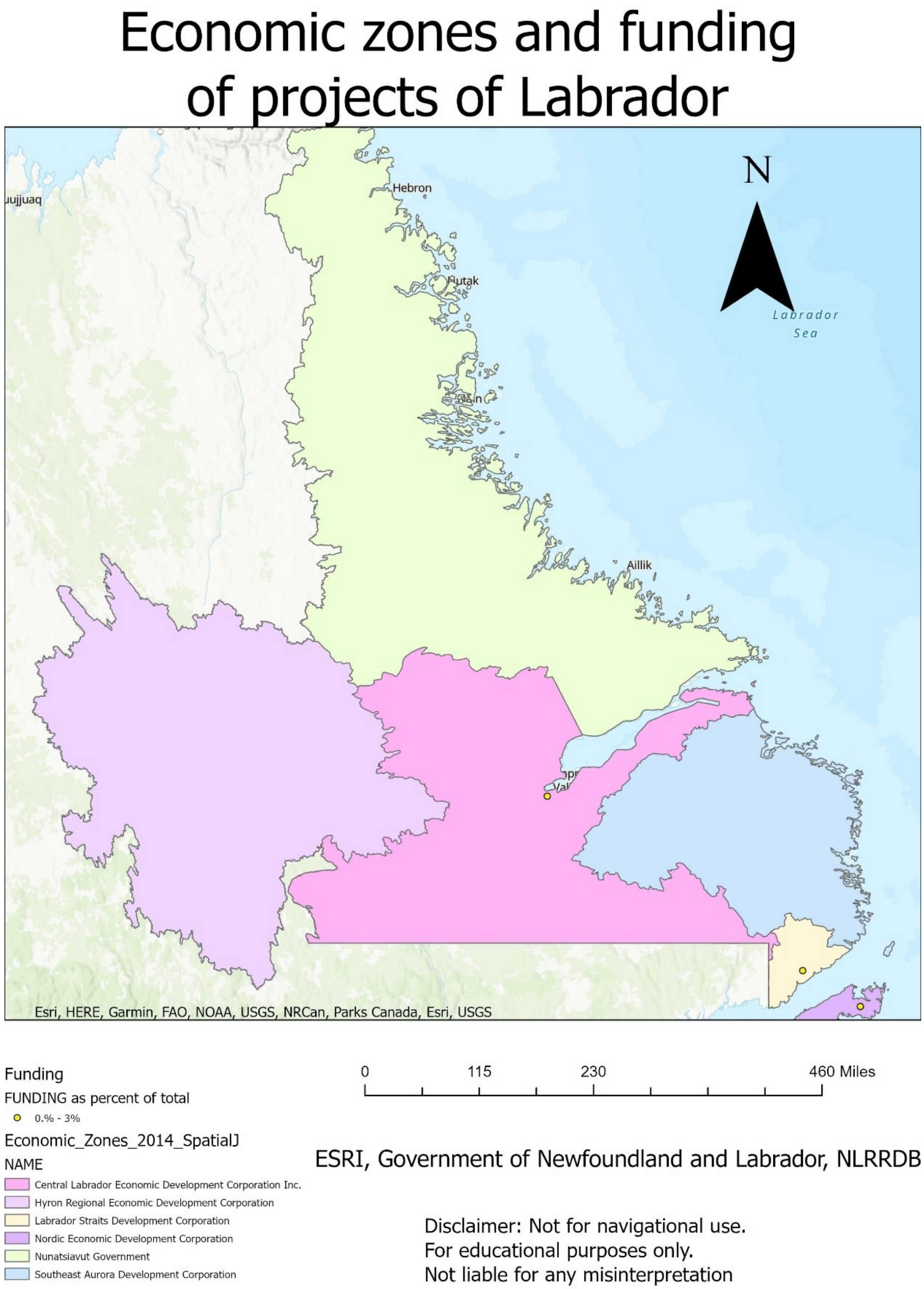

Figure 9 Economic Zone Project Funding of Labrador

Proximity to Regional Center.

Regional economic centers are the hubs for economic activity for the district. Usually, these represent the vigor of working citizens. The farther you go from the center of the economic zone, the less connected you become to the economy. As seen in Figures 10 and 11 below, which show how close in proximity the river restoration projects are to the economic center, illustrate that regional activity can lead to changes. The proximity is indicated with graduated shading, where the darker hue (2) is farthest from the center, and the lightest shade (5) is closest. In the case of the Humber River, as well as those projects along the Exploits River and the Kittiwake Coast, economic centers are not far from restoration projects, meaning there is a population and economy that utilize and affect the river system either beneficially or otherwise.

Proximity to Economic Center and funding of projects of Insular Newfoundland

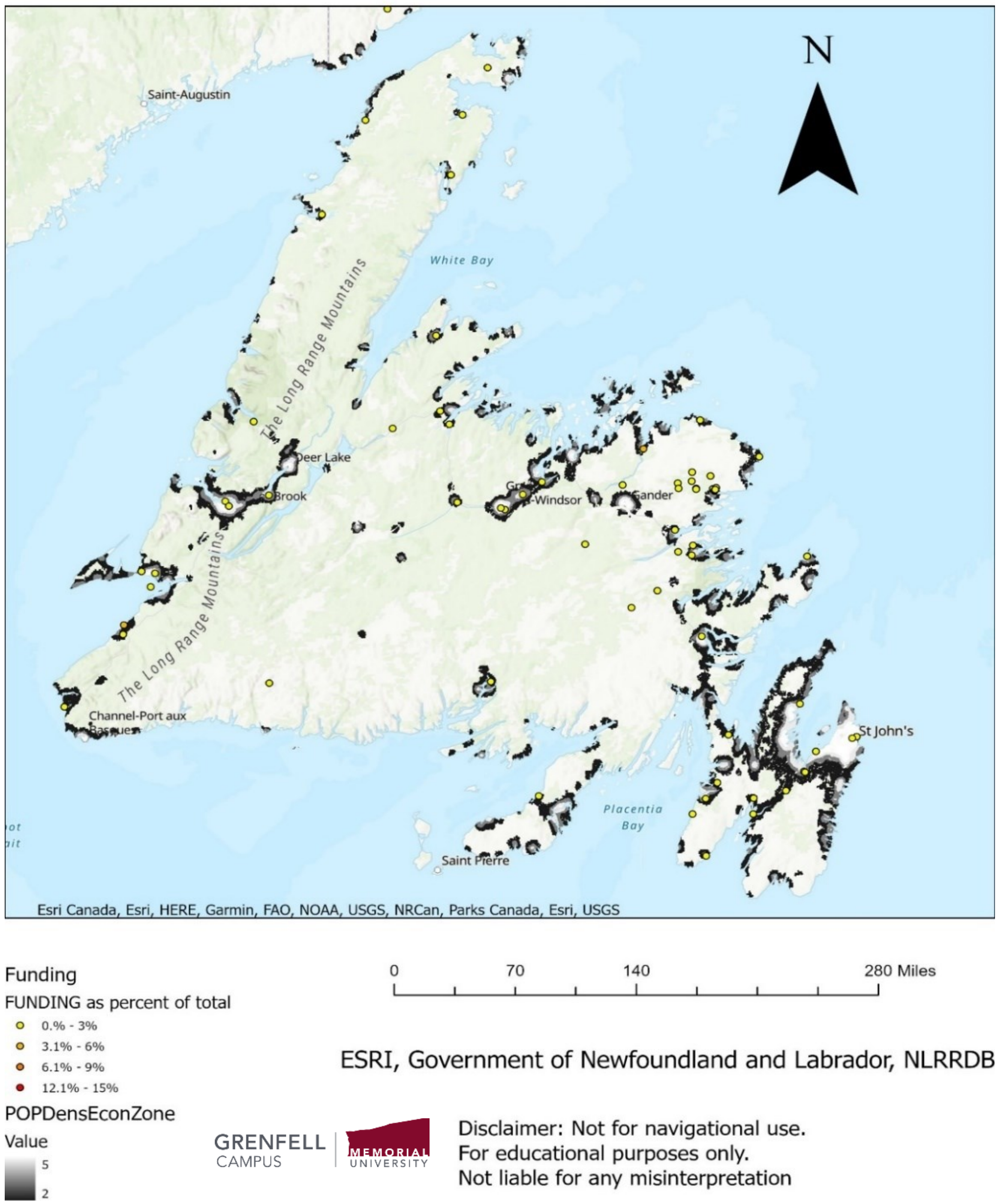

Figure 10 Project Proximity to Economic Center of Insular Newfoundland

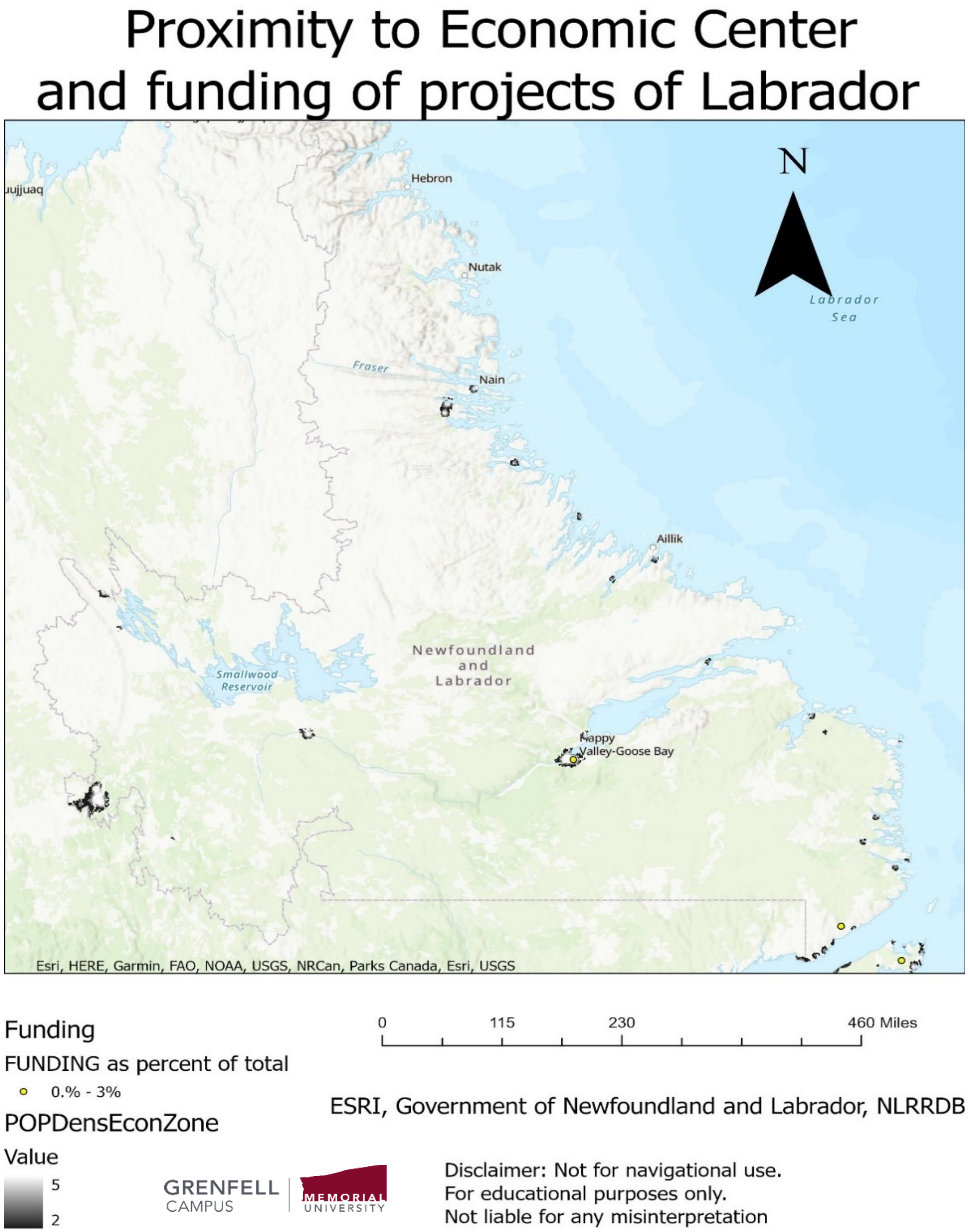

Figure 11 Project Proximity to Economic Centers of Labrador

Politics

Politics can be very influential in how things are done within regions of the province as a whole. In our research, we utilised the political boundaries and electoral results, provided by the government of Newfoundland and Labrador, to date back to 1949 to get a full picture of how politics may have impacted the distribution of river restoration projects within the province. After an analysis of the electoral data, we can see which parties have reigned in districts that have completed projects. This can indicate whether politics has been influential in how many projects were completed and how much money was spent completing them.

Political Parties.

After a careful interpretation of the 21 provincial elections since 1949, we averaged the winning parties based on districts. In Figure 12 below, we have illustrated the winning party based on how successful they were in polls since every election starting in 1949. Alongside this data, we have included the projects completed since 1949, therefore illustrating that the electoral party that was in power in that region may have some relationship to the amount of funding or the number of projects completed within their district. Obviously, politicians and their mandates change frequently, and some districts may have lost their seats for a brief number of years, but overall, it can be said with confidence that the Liberal party has held some responsibility in pursuing the completion of river restoration projects in many areas of the province. However, when combining the maps, there is a distinction to be made that boundaries do not align, meaning that the party in charge of a specific region may not have full access to a watershed or economic zone. Because of this, it becomes difficult to confirm the actions of a government or agency, thereby illustrating the need for collaboration and a unified system of outlining certain aspects such as ecological needs to be met, societal and economic impacts to be mitigated and improved upon, and jurisdictional barriers to overcome such as who governs what areas, especially in terms of watersheds. The collaboration would have to include indigenous people, governments, and agencies that are involved in the areas as they each have a large role to play in how the land is used and maintained.

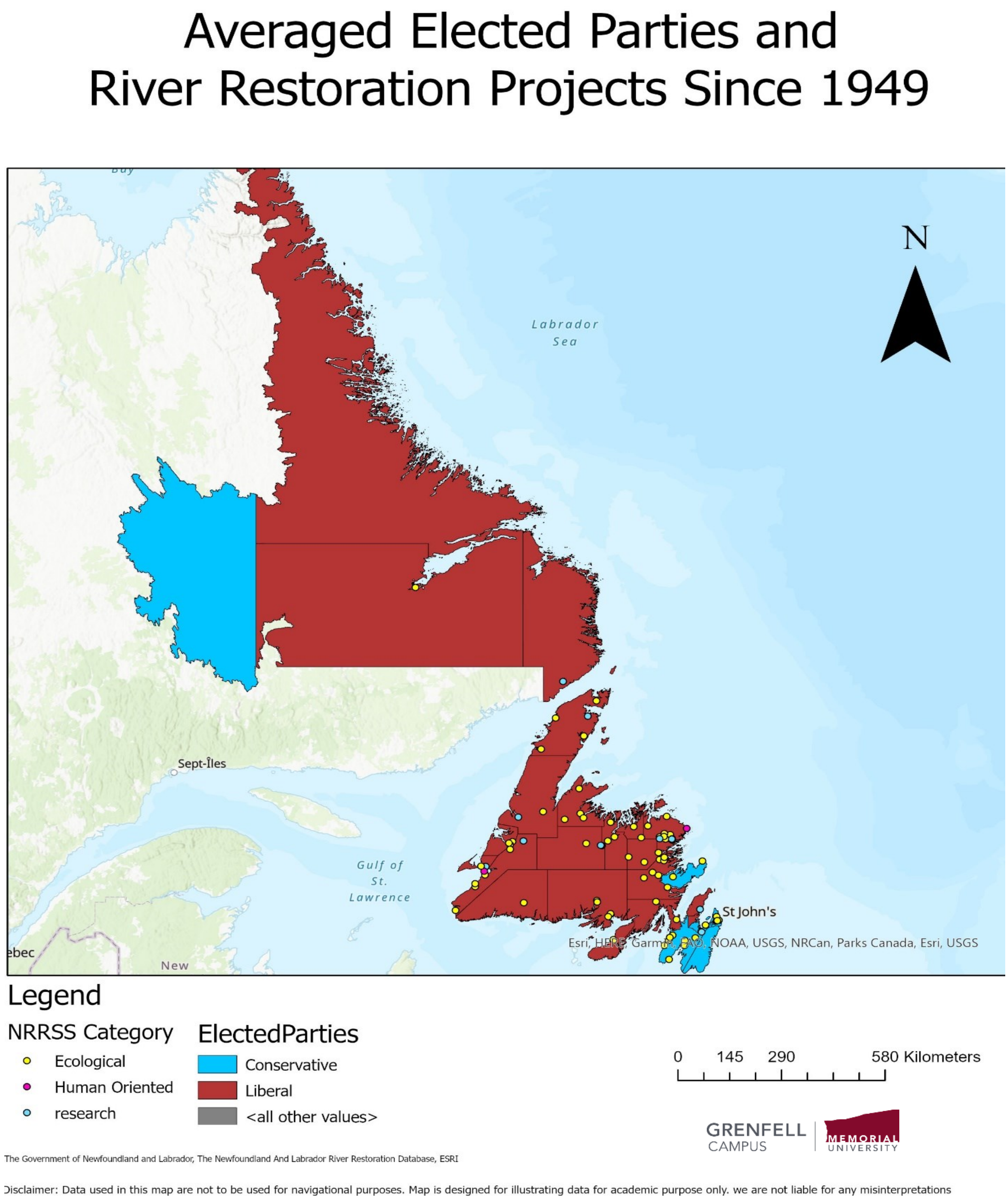

Figure 12 Average Elected Party and Project Groupings

Conclusion

The application of GIS is a common way to present planning challenges and other geographic information. By utilizing maps, one can visualize every aspect that is pertinent to one's study, as well as plan for the issues that may lie ahead. While looking at the aspects of watersheds, economic zones, and elected parties, we get clear insights into their relationship with project areas. The DFO has provided the locations of scheduled rivers for salmon fishing allowing us to compare our results to the rivers. In general, it can be concluded that each of these aspects can be influential in how restoration projects have been implemented, government, scientists, practitioners, and the public are not on the same page. Different boundary systems make it hard to compare and contrast each region, and there is difficulty surrounding which jurisdiction a project falls in or how much control certain groups and agencies have. However, it has been determined that projects mostly fall within the northern watershed of Newfoundland, the economic zone 14, and have been in general, near economic centers, and governed by Liberals. As such, there is uneven an distribution of projects not based on ecological need, allowing for certain regions to benefit more than others. Thus, the question remains how can officials determine an effective successful strategy for allocating restorative projects? Our findings conclude that further in-depth analysis of geomatics is needed on each factor (economic, political, and environmental) to determine the most important factors as only descriptive statistics were used. Site suitability analyses are one ideal solution of many for determining locations for future projects as well as the use of tools such as buffers

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Chapter 4: General Conclusion

Conclusion

The findings of this study outline several important facts when it comes to restoring rivers. The practitioners seem to agree that provincial river restoration projects are somewhat successful. Through lengthy interviews and numerous conversations during workshops, it became evident that practitioners also supported a collaborative effort between the government and practitioners so they can share much-needed information. While a collaborative approach was a major change needed for success to occur, so too was the need for financial stability. Practitioners stated unanimously that money is often lacking or poorly shared among groups requesting assistance. While the need for assistance is evident, so too is the need for collaborative effort. The GIS mapping illustrated the divide between the economy, the environment, and politics. With certain areas receiving more money or more projects than other jurisdictions, and the difference between watershed, economic zones, and electoral boundaries, it becomes clear that the three sectors do not align with equal project distribution and associated funding, whether it is from favoritism or randomness. The analysis concluded that the Liberal jurisdiction of economic zone 14 has more sway than other regions with similar political alignment. Also, there are more projects in the northern Newfoundland watershed, which could be in response to it being the largest watershed. Nonetheless, projects should be spread evenly based on a set of criteria to ensure all regions are benefiting instead of one. Without proper alignment and collaboration, there will always be unevenness, and the balance is essential for a transparent government, a fair and just society, and the well-being of the environment, economy, and society.

The current study met with some obstacles that are worth noting. One of the first major setbacks was the Covid-19 pandemic. Because of the pandemic, data collection became more difficult. When the project started, the interviews were supposed to happen in person. However, as things switched to online, people became busy, and/or emotionally and physically drained from online activity, lessening our responses. A technological error occurred when collecting data as well. As creating a project report outlining the steps of project development and implementation was not made to be transparent to the public, much of the necessary data was missing, meaning that there could be money unaccounted for, projects unlisted, and so on, creating an inaccurate track record of the province. The final obstacles we faced were time and financial constraints. For instance, the second article of the manuscript can be further investigated, especially to identify what caused the province to act the way it has towards the distribution of restoration projects. Due to the time and financial parameters for this study, however, we could only generally observe the topic, allowing for inferences to be made but lacking sufficient concrete evidence to conclude anything certain.

By way of concluding this paper, a strong recommendation for continued research and development can be made, specifically a more thorough analysis of this paper in terms of testing ecological, economic, and societal factors along with a more open and collaborative approach to governing river restoration between federal and provincial governments with investors. This study and its findings will be made available through MUN’s online archives to stay transparent and encourage open access to research.

Recommendations

Ecological restoration is a growing field of research and practice, much can be said about what needs to be done in the future of restorative actions in the province of Newfoundland and Labrador. Based on this research a few main points need to be considered in the recommendations for a more effective allocation of restoration projects.

First and foremost, the development of nonarbitrary criteria including ecological, climate change and economic, and societal would be beneficial as it is the basis of how restoration should be completed to be successful. The process would encourage scientists, researchers, and other affiliated individuals to come forward with criteria and how to best gauge them. The most effective gauges for success would define the checklist for future projects to use. Some criteria could include a list of benefits for the river, plans for recovering from natural disturbances, a system to monitor ecological attributes such as water quality periodically, sources of funding, and citizen affiliation where they become involved with the process.

Secondly, it would be beneficial to see future development in overall project management. It was noted by participants that each group involved is separated and not communicating properly, leading to confusion on what needs to be done and how to do it successfully. This is why I would like to propose a regulatory board. By establishing a committee of like-minded individuals and stakeholders funding can be allocated effectively based on ecological concerns, interested groups can be represented at proposal meetings as well as hired to complete the work. This would lead to higher transparency as those who are interested are directly involved. Electing members can also be done through public nominations ensuring that the right ideas are brought forward. Ideally, this group would include members that were involved in creating the nonarbitrary criteria, or this committee can be used to create the same criteria.

In reference to establishing a clear criterion for ecological success, it would be ideal for future projects to ensure that monitoring is in place. Currently, this is not the case as the funding mandate does not require it. Further research into why it was omitted would be ideal for academic literature.

Furthermore, the NLRRDB, being a holistic representation of projects completed within the province, would need to be updated frequently as more projects get completed. By doing so, transparency would be maintained and there would be a plethora of information to be used in future research.

In terms of geomatics, an in-depth analysis of potential influences should be done, as this research just scratched the surface of possibilities. These analyses would ideally include ecological monitoring aspects, economics, and societal influences as well as site suitability.

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Appendix A

Methods

Search Terms

A list of relevant search terms was generated by the supervisory committee/ with other experts and the graduate student and divided into four components population, agents of change, intervention and outcome combined with Boolean operations "AND" and /or "OR" (Table 1)

Search String

Subject Terms	"Stream "OR "River" OR "Brook" OR "Wetland"
AND	
Categories (NRRS operation definition)	aesthetics/recreation/educational; OR channel configuration; OR dam removal; OR fish passage; OR flow modification; OR instream habitat improvement; OR species management; OR land acquisition; OR riparian management; OR stormwater management; OR water quality management
AND	
Geographic Terms	Newfoundland and Labrador
AND	
Intervention	Restoration; OR Improvement; OR Rehabilitation

Abbreviated search: When a complex search string is not accepted by the search engine, the help menu will be consulted and the search terms will be modified. The search terms will be recorded in the article databases in order to preserve all metadata associated with the search.

Article type: The search will include a variety of article types, including primary literature in peer-reviewed journals and grey literature. The search strategy will strive to minimize publication biases by focusing efforts equally on each article type, and all articles will be equally critically appraised to ensure validity.

Article/file formats: The search will not have any article type restrictions (e.g., PDF vs. PowerPoint vs. MS-Word). All formats will be acquired and if specialized software is required, alternative formats will be requested for ease of file transferability. Where books are identified, digital copies will be sought (either through internet searches for availability or requests to authors) in order to ensure that all obtainable records are made available as an output from this review. The Review Team will use interlibrary loans or contact authors of unobtainable articles in an attempt to gain access to every article in full form.

Computer settings: The browsing history and cookies will be disabled on all computers used to conduct the search. The members of the Review Team will not access any electronic accounts (e.g., email, website) during the search period and will use "private mode" (Safari) for web browsers to reduce the possibility of user-specific search results.

Language: English search terms will be used to conduct all searches in all databases. All references that are returned will be included in the database. When articles in other languages are returned using the search strategy, those records will be reported in the database.

Publication databases

1. ISI Web of Science core collection—Multidisciplinary research topics including journals, books, proceedings, published data sets, and patents
2. Scopus—Abstract and citation database of peer-reviewed literature including journals, books, and conference proceedings
3. ProQuest Dissertations and Theses Global—International depository of graduate dissertations and theses
4. Waves (Fisheries and Oceans Canada)—Canadian government books, reports, government documents, theses, conference proceedings and journal titles
5. Science.gov—US Federal Science

Search engines: Search terms will be entered into Google Scholar and the first 1000 hits (sorted by relevance) will be screened for the appropriate fit for the review questions.

Specialist websites: Specialist organization websites listed below will be searched using search terms. Page data from the search results will be extracted, screened for relevance, and searched for links or references to relevant publications and data and grey literature. The list of websites was narrowed to the following 104 organizations in 4 groups NGO, Aboriginal, Government and Municipality. after consulting with our Advisory Team for relevance. These have been restricted to English websites, primarily in North America, due to the scope of our review question.

1. St. Anthony Economic Development
2. Argentia Management Authority
3. Town of Bay Roberts
4. Mariner Resource Opportunities Network Inc. - Carbonear
5. Southeastern Aurora Development Corporation - Cartwright
6. Town of conception Bay South
7. Economic Development- Deer Lake
8. Humber Economic development Board. Corner Brook
9. Avalon Gateway Regional Economic Development Inc.-Dunville Placentia
10. Nordic Economic Development Corporation - Flowers Cove
11. Labrador Straits Development Corporation-Forteau
12. Gander and Area Chamber of Commerce
13. Kittiwake Economic Development Corporation-Gander
14. Exploits Valley Economic Development Corporation
15. Town of Grand Falls Windsor
16. Central Labrador Economic Development Board Inc.
17. Huron Regional Economic Development Corporation-Lab City

18. Town of Lab City
19. Inukshuk Economic Development Corporation-Makkovik
20. Schooner Regional Development Corporation- Marystown
21. City of Mount Pearl
22. Red Ochre Regional Board Inc.-Parsons Pond
23. Port au Port Econ Dev Association PAPEDA
24. Marine and Mountain Zone Corporation -Port aux Basque
25. Town of Springdale
26. Coast of Bays Corporation-St. Albans
27. City of St. John's Department of Economic Development & Tourism
28. NATI - Newfoundland and Labrador Association of Tech.
29. Long Range Regional Economic Development Board
30. Irish Loop Regional Economic Development Board-Trepassy
31. Indian Bay Ecosystem Development
32. White Bay Central Development Association
33. Freshwater-Alexander Bay Ecosystem Corporation
34. Bay St. George South Development Association
35. Ramea Economic development Corporation
36. St. Barbe Development Association/Nortip
37. Port Aux Basques Economic Development Office
38. Burnt Island Economic Development Board
39. Johnson GeoCentre
40. CPAWS-NL
41. Conservation Corps CCNL
42. Friends of Pippy Park
43. Grand Riverkeeper Labrador Inc GRKL
44. Kelligrews Ecological enhancement program KEEP
45. Nature Conservancy of Canada
46. Nature Newfoundland and Lab
47. Newfoundland and Lab enviro network NLEN
48. Petty Harbour Mini Aquarium
49. Port aux Port Bay Fisheries Committee
50. Quidi Vidi/Rennie's River Development Foundation (QVRRDF)
51. Ducks Unlimited Canada
52. Western Environmental Centre (WEC)
53. Coastal Connections Ltd.
54. Northeast Avalon ACAP
55. World Wildlife Fund Canada WWF
56. Salmon and Trout Restoration Association of conception bay central
57. SPAWN
58. SAEN
59. Salmonid Council of NL
60. NL Wildlife Federation. CWF
61. IBEC
62. GRMA
63. Atlantic Salmon Federation

64. Newfoundland and Labrador Outfitters Association
65. The Salmon Anglers of Newfoundland Guild (TSANG)
66. Newfoundland fisherman's Forum
67. Salmon and Trout fishing Newfoundland
68. Newfoundland hunting and angling Junkies
69. Newfoundland Association of Hunters and Anglers
70. Labrador Hunting and Fishing Association
71. NEIA
72. Newfoundland & Labrador Wildlife Federation
73. QLF
74. Stewardship Association of Municipalities SAM
75. Environment Resources Management Association
76. Burin Peninsula Association for Salmon Enhancement
77. Torrent river Salmon enhancement project
78. ACAP Humber Arm
79. Friends of Shoal Harbour River
80. Corner Brook Stream Development organization
81. The town of Hughes Brook
82. Canadian Wildlife Federation
83. Salmon and Trout Restoration Association of Conception Bay Central
84. Atlantic Salmon Conservation Foundation
85. Freshwater-Alexander Bay Ecosystem Corporation
86. Eco-Action Community Funding Program
87. CAEE Canadian Council for Ecological Areas
88. Atlantic Ecosystems Initiatives
89. Recreational Fisheries Conservation Partnerships Program
90. Fisheries and Land Resources - Canadian Heritage rivers system
91. City of St. Johns
92. Town of Clarenville
93. Town of Corner Brook
94. Town of Deer Lake
95. Town of Gander
96. Town of Grand Falls Windsor
97. Town of Holyrood
98. Town of Rocky Harbour
99. Town of St. Anthony
100. Town of Stephenville
101. Town of port aux basque
102. Town of Churchill Falls
103. Happy Valley Goose Bay
104. Labrador City Wabush

Other literature searches: Reference sections of accepted articles, reports and relevant reviews will be hand searched to evaluate relevant titles, symposium papers, and other articles that have not been found using the search strategy. Authors of any unpublished references will be contacted to request access to the full article. We will also use social media and email to alert the community of this systematic review and to reach out to area experts for research articles that are difficult to obtain, or for suggestions of articles to include. The Advisory Team will be consulted for insight and advice for new sources of information. Any article provided will also be used to test the comprehensiveness of our search strategy and, where appropriate, adjustments will be made to the search strategy to ensure it is comprehensive and inclusive. Any changes made to the search strategy will be justified and documented in the final review.

Search record database: All articles generated by each of the search strategies will be exported into separate databases. After all searches have been completed and references found using each different strategy have been compiled, the individual databases will be exported into EXCEL as one database. Duplicates will be identified and merged. All references regardless of their perceived relevance to this systematic review will be included in the database. This database will act as the archive and will remain unchanged throughout the review process, since it is the direct product of the search strategy and will be useful in the future when updating the systematic review archive (general updating timeframe is currently every 5 years).

Screening process and inclusion criteria: Articles found using the search criteria will be imported into EXCEL and screened at title, abstract and full text, and included/excluded based on criteria outlined below.

Before the screening process begins, two reviewers using a subset of 10% of all articles or 100 abstracts (whichever is bigger) will undertake consistency checks to ensure consistent and repeatable decisions are being made in regards to which articles are screened out and which go on in the process for further review. The two reviewers will use a Kappa test to determine consistencies in screening decisions. A Kappa score of ≥ 0.6 indicates substantial agreement between reviewers and will be required before any further screening is conducted for the review. The results from the consistency check will be discussed and discrepancies will be reviewed by both reviewers to understand why the choice was made to include/exclude the article.

All article screening decisions will be included in the database, so it will be clear at what level any article was excluded. If the decision to include or exclude a specific article is unclear, that article will be retained and will go on to the next level of screening. If there is further doubt, the Review Team will discuss those articles and reach a decision as a group. If there are any further disagreements on inclusion of articles based on the outline criteria, the Advisory Team will be consulted. Any articles that do not have abstracts (as is the case for some grey literature), will automatically be screened at the full text level. Justification of the reason for inclusion or exclusion of an article will be recorded using EPI reviewer, and all articles excluded at the full text level will be included with the review, in compliance with Collaboration for Environmental Evidence (CEE) guidelines. Only English-language literature will be included during the screening stage.

Articles will be included based on the following pre-defined inclusion criteria developed in consultation with the Advisory Team:

Relevant subjects

Any river restoration effort as defined by the categorial descriptions (NRRSS working group definitions (Bernhardt, et al. 2007)).

Relevant outcomes

Only direct outcomes in the form of an identified project (s)

Relevant types of projects

Refer to NRRSS working group categorial definitions

Study quality assessment

Each of the documents that pass the full text screening level will be classified and coded in the article database using a number of parameters including (but not limited to):

Data extraction strategy

Meta-data will be extracted from the included studies by the Review Team and will be recorded in a MS-Excel database that will be made available with the published systematic review, as additional supporting files. The extracted information will be used to assess the overall effectiveness of each intervention strategy, and when sufficient, good quality data exist, the information will be used in a meta-analysis. Some of the outcome data that will be recorded will include: outcome means, measures of variation (e.g., standard deviation, standard error, confidence intervals), and sample sizes. When data are presented in tables or graphs, all information will be extracted and recorded. If it is not possible to decipher information from graphs, the main contact author for the article will be contacted (via email or phone) by the Review Team to request the information. During that request, the Review Team will also solicit the author to suggest any grey literature that they may know of related to the systematic review topic. Where only raw data are provided in the article, the Review Team will calculate summary statistics. In those instances, we will record how the calculations were conducted and with what information. To ensure that data are being extracted in a consistent and repeatable manner, two reviewers will extract information from ten of the same articles. Afterwards, the information will be compared. Any inconsistencies will be discussed amongst the Review Team members, and if any disagreement occurs, they will be discussed with the entire Review Team to ensure all reviewers are extracting and interpreting data in the same manner.

Potential effect modifiers and reasons for heterogeneity

The Review Team will extract data on potential effect modifiers from articles that are included at the full-text level of screening. All information will be recorded in the database. Potential effect modifiers that will be recorded for all included studies, given the data is available, include but are not limited to:

- Location (including geographical coordinates)
- Waterbody (freshwater/marine, lake/stream/river, etc.)
- Outcome

Data synthesis and presentation

A narrative synthesis of data from all articles included in the systematic review will be generated. The synthesis will aim to be as visual as possible, summarizing information in tables and figures. The ultimate goal of this review is to assess is to provide an evidence-based synthesis of the nature and extent of river restoration activities in Newfoundland and Labrador to provide representative database for research and policy and development. The discrete questions are: Where are the major sources of stream restoration data? What types of stream restoration are occurring? Are there spatial and/or temporal trends in the practice of restoration? How much money is spent on restoration? How does this amount compare to national and NA restoration expenditures? All efforts will be made to provide quantitative assessments and meta-analysis of the articles included in this review, when the study designs and evidence-base allow. Where studies report similar outcomes, meta-analysis will be performed. In these cases, effect sizes will be standardized and weighted appropriately.

Summary of Activities

- 216 projects identified thus far
- 44 groups contact for data verification – 18 responded. Second round of call-backs contact January to finalize the data.
- 60 web sites searched
- 1500 documents in 4 search engines examined, 392 reports, peer reviewed manuscripts, book chapter and other literature identified in the first scan.

Appendix B

Group Type	Organization	NRRSS WG Category	Project Title	Location	Year Started	Duration (Years)	Funding	Source
CG	Indian Bay Ecosystem Corporation	Bank Stabilization	Adurt Brook conservation and restoration project	Adurt Brook Indian bay river	2016	31	$ 63,896	IBEC
CG	Indian Bay Ecosystem Corporation	Bank Stabilization	Spurrells Brook Restoration Project	Spurrells Brook	2016	1	$ 26,861	IBEC
CG	Indian Bay Ecosystem Corporation	Bank Stabilization	Moccasin Pond Brook enhancement project	Moccasin Pond	2014	1	$ 9,800	IBEC
CG	Indian Bay Ecosystem Corporation	Channel Reconfiguration	Indian Bay Watershed Ecosystem Health Assessment: Benthic Biomonitoring, Water Quality and Salmon Stock Analysis	Indian Bay Brook	2017	1	$ 16,000	IBEC
CG	Indian Bay Ecosystem Corporation	Dam Removal/ Retrofit	Moccasin Pond Brook enhancement project	Moccasin Pond	2014	1	$ 9,245	IBEC
CG	Indian Bay Ecosystem Corporation	Dam Removal/ Retrofit	Spurrells Brook Restoration Project	Spurrells Brook	2016	1	$ 6,000	IBEC
CG	Indian Bay Ecosystem Corporation	Dam Removal/ Retrofit	Bonavista North Stewardship & Enhancement Project	Bonavista North	2015	1	$ 33,567	IBEC
CG	Indian Bay Ecosystem Corporation	Riparian Management	Moccasin Pond Brook enhancement project	Moccasin Pond	2015	1	$ 19,958	IBEC
CG	Indian Bay Ecosystem Corporation	Water Quality Management	Indian Bay Watershed Ecosystem Health Assessment: Benthic Biomonitoring, Water Quality and Salmon Stock Analysis	Indian Bay Brook	2017	1	$ 11,000	IBEC
CG	Indian Bay Ecosystem Corporation	Water Quality Management	Wing Brook Enhancement Project	Wings Brook	2017	1	$ 17,500	IBEC
CG	Indian Bay Ecosystem Corporation	In-Stream Habitat Improvement	Jim Steady's Restoration Project	Jims Steady	2017	1	$ 13,300	IBEC
CG	Indian Bay Ecosystem Corporation	In-Stream Habitat Improvement	Number One Brook Restoration Project	Number One Brook	2016	1	$ 20,000	IBEC
CG	Indian Bay Ecosystem Corporation	Dam Removal/ Retrofit	Skippers Brook Restoration Project	Skippers Brook	2016	1	$ 20,000	IBEC
CG	Indian Bay Ecosystem Corporation	Dam Removal/ Retrofit	bridges and culvert retrofits	Indian Bay Watershed	2001	1	$ 87,000	IBEC
CG	Indian Bay Ecosystem Corporation	Aesthetics/ Recreation/ Education	Indian Bay River Salmon Identification & Population Health	Indian Bay River	2019	3	$ 21,618	IBEC
CG	Indian Bay Ecosystem Corporation	In-Stream Habitat Improvement	Jim Steady's Restoration Project	Jim's Steady	2018	1	$ 24,701	IBEC
CG	Indian Bay Ecosystem Corporation	Aesthetics/ Recreation/ Education	Watershed Podcast	Indian Bay Watershed	2019	1	$ 2,965	IBEC
CG	Indian Bay Ecosystem Corporation	Aesthetics/ Recreation/ Education	Conserving & Understanding the Species at Risk of Cape Freels	Cape Freels & Queen's Maide (Newtown)	2019	1	$ 200,000	IBEC

Group Type	Organization	NRRSS WG Category	Project Title	Location	Year Started	Duration (Years)	Funding	Source
CG	Indian Bay Ecosystem Corporation	Aesthetics/ Recreation/ Education	Black Duck Pond Observation Deck (Ducks Unlimited Canada)	Black Duck Pond (Indian Bay Watershed)	2019	1	$ 4,500	IBEC
CG	Indian Bay Ecosystem Corporation	Aesthetics/ Recreation/ Education	Obstruction Database Collection (DF)	Bonavista North	2019	1	$ 9,610	IBEC
CG	Indian Bay Ecosystem Corporation	Aesthetics/ Recreation/ Education	Indian Bay Watershed Stream Survey Report	Indian Bay Watershed	1996	1	$ 24,700	IBEC
CG	Humber Arm Environmental Association	Bank Stabilization	Fish Habitat Restoration: Stream Bank Stabilization to Reduce Siltation on South Brook, Pasadena, NL	South Brook, Pasadena	2017	2	$ 53,732	ASCF Website
CG	Humber Arm Environmental Association	Aesthetics/ Recreation/ Education	Salmon habitat conservation : A comprehensive management plan for South Brook Newfoundland and Labrador	South Brook, Pasadena	2018	1	$ 24,300	ASCF Website
CG	Humber Arm Environmental Association	In-Stream Habitat Improvement	Restoring Aquatic Connectivity in the Humber River Watershed	Humber River	2019	1	$ 42,000	ASCF Website
CG	Norris Arm & Area Economic Development Committee	Fish Passage	Rattling Brook Salmon Restoration Project	Great Rattling Brook or the Grand Falls Fish way	2014	2	$ 170,000	ASCF Website
CG	Norris Arm & Area Economic Development Committee	Water Quality Management	Rattling Brook Salmon Restoration Project	Great Rattling Brook or the Grand Falls Fish way	2012	2	$ 183,000	ASCF Website
CG	Norris Arm & Area Economic Development Committee	Channel Configuration	Rattling Brook Salmon Restoration Project	Great Rattling Brook or the Grand Falls Fish way	2017	1	$ 90,000	ASCF Website
CG	White Bay Central Development Assoc.	Fish Passage	Salmon River Habitat Restoration Project - barrier removal	Salmon River, Main Brook	2018	1	$ 81,215	WBDCA
CG	White Bay Central Development Assoc.	In-Stream Habitat Improvement	Salmon River Habitat Restoration Project - dams and log sills	Salmon River, Main Brook	2017	1	$ 111,009	WBDCA
CG	White Bay Central Development Assoc.	In-Stream Habitat Improvement	debris removal pulp wood	Salmon River, Main Brook	1991	1	$ 123,000	WBDCA
CG	White Bay Central Development Assoc.	Aesthetics/ Recreation/ Education	Planning	Salmon River, Main Brook	1992	1	$ 27,800	WBDCA
CG	White Bay Central Development Assoc.	Dam Removal/ Retrofit	Removal of pulp wood dams	Salmon River, Main Brook	1993	1	$ 72,000	WBDCA
CG	White Bay Central Development Assoc.	In-Stream Habitat Improvement	debris removal pulp wood	Salmon River, Main Brook	1994	1	$ 72,000	WBDCA
CG	White Bay Central Development Assoc.	In-Stream Habitat Improvement	habitat improvement boulder clusters, dams ad half log covers	Salmon River, Main Brook	1995	1	$ 70,000	WBDCA
CG	White Bay Central Development Assoc.	In-Stream Habitat Improvement	Project Monitoring and Evaluation	Salmon River, Main Brook	1995	1	$ 42,000	WBDCA
CG	White Bay Central Development Assoc.	In-Stream Habitat Improvement	Bide arm brook pulpwood removal	Bide Arm Brook	1995	1	$ 23,000	WBDCA
CG	White Bay Central Development Assoc.	Fish Passage	Removal of Obstructions	Salmon River, Main Brook	1992	1	$ 119,300	WBDCA

Group Type	Organization	NRRSS WG Category	Project Title	Location	Year Started	Duration (Years)	Funding	Source
CG	White Bay Central Development Assoc.	Fish Passage	Bridge Reconstruction	Salmon River, Main Brook	1992	1	$ 48,000	WBDCA
CG	Exploits River Management Authority	Fish Passage	Restoration on the tributaries of the Exploits River, including removing complete and partial obstructions	Exploits River	2010	3	$ 119,000	ASCF Website
CG	Exploits River Management Authority	In-Stream Habitat Improvement	Exploits River Tributaries Restoration	Exploits River	2014	5	$ 196,503	ASCF Website
CG	Exploits River Management Authority	In-Stream Habitat Improvement	Habitat Restoration Survey- Tributaries of the Exploits River	Exploits River	1993	1	$ 40,000	https://www.tandfonline.com/doi/pdf/10.1577/1548-8659(1987)7<207%3AASEITE>2.0.CO%3B2?needAccess=true
CG	Exploits River Management Authority	In-Stream Species Management	Salmon Ranching in Little River	Little River	1987	7		https://waves-vagues.dfo-mpo.gc.ca/Library/197911.pdf
CG	Exploits River Management Authority	In-Stream Species Management	Salmon Ranching in Romaines	Romaines River	1993	2		https://waves-vagues.dfo-mpo.gc.ca/Library/197911.pdf
CG	Exploits River Management Authority	In-Stream Species Management	Stock Augmentation in Piper Hole	Piper's Hole River	1989	6		https://waves-vagues.dfo-mpo.gc.ca/Library/197911.pdf
CG	Exploits River Management Authority	In-Stream Species Management	Stock Augmentation in Flat Bay Brook	Flat bay brook, Pipers Hole	1993	6		https://waves-vagues.dfo-mpo.gc.ca/Library/197911.pdf
CG	Exploits River Management Authority	Flow Modification	Flow Diversion in Panmahec Brook	Exploits River	1995	2	$ 47,000	CASEC/DFO D Scruton
CG	Bay St Georges Development Assoc.	Bank Stabilization	Develop Habitat Conservation Plans and Restoration for Rivers in Bay St. George	Bay St. George; Middle Barachois, Little Barachois, and Flat Bay Brooks	2018	1	$ 25,000	ASCF Website
CG	Bay St Georges Development Assoc.	Fish Passage	Develop Habitat Conservation Plans and Restoration for Rivers in Bay St. George	Bay St. George; Middle Barachois, Little Barachois, and Flat Bay Brooks	2018	1	$ 33,250	ASCF Website
CG	Bay St Georges Development Assoc.	Dam Removal/ Retrofit	Habitat Conservation Plan Restoration - inventory and barrier removal	Little Crabbes river	2019	1	$ 129,542	ASCF Website
CG	Bay St Georges Development Assoc.	Dam Removal/ Retrofit	Habitat Improvement, Obstruction Removal, Little Crabbes River.	Little Crabbes river	1994	1	$ 66,500	ASCF Website
CG	Town of Holyrood	Fish Passage	Mahers River Fishway	Maher River	2017	1	$ 75,145	ASCF Website
CG	Town of Holyrood	Fish Passage	Mahers River Fishway	Maher River	2018	1	$ 133,000	ASCF Website
CG	Town of Holyrood	Aesthetics/ Recreation/ Education	Adaptations in Atlantic salmon juvenile behaviour and health related to long-term habitat alterations	Holy Cross Park (Mahers River)	2016	2	$ 41,400	ASCF Website
P	DFO	In-Stream Species Management	Mollyguajeck fall adult transfers and stocking	terra nova	1985	17	$ 247,000	https://waves-vagues.dfo-mpo.gc.ca/Library/273922.pdf
CG	Freshwater Alexander Bay Ecosystem Corp	Fish Passage	Evaluation of Habitat Expansion Outcomes on Upper Terra Nova River.	Mollyguajeck Falls fishway/TERRA NOVA	2015	4	$ 283,453	ASCF Website

Group Type	Organization	NRRSS WG Category	Project Title	Location	Year Started	Duration (Years)	Funding	Source
CG	Freshwater Alexander Bay Ecosystem Corp	In-Stream Habitat Improvement	debris removal pulp wood	Northwest Brook	1995	1	$ 32,000	www.fabec.org/contact-us.html
CG	Freshwater Alexander Bay Ecosystem Corp	In-Stream Habitat Improvement	Dam removal	Gull Pond	1996	1	$ 24,000	www.fabec.org/contact-us.html
CG	Freshwater Alexander Bay Ecosystem Corp	In-Stream Habitat Improvement	debris removal pulp wood	Wyatt and Pennie Brook	2010	1	$ 18,700	www.fabec.org/contact-us.html
CG	Freshwater Alexander Bay Ecosystem Corp	in-stream Habitat Improvement	Woody debris obstructions	Northwest Brook	1995	1	$ 15,000	https://www.tandfonline.com/doi/pdf/10.1577/1548-8659(1987)7<207%3AASEITE>2.0.CO%3B2?needAccess=true
CG	Freshwater Alexander Bay Ecosystem Corp	In-Stream Habitat Improvement	debris removal pulp wood	Northwest Brook	2006	1	$ 15,500	www.fabec.org/contact-us.html
IG	Gander Bay Indian Band Council	Riparian Management	Salmon Tracking and Stock Assessment	Salmon Brook	2015	1	$ 22,700	ASCF Website
IG	Gander Bay Indian Band Council	Water Quality Management	Operate Salmon Fishway, Glenwood, NL	Gander	2017	1	$ 43,671	ASCF Website
IG	Gander Bay Indian Band Council	Water Quality Management	Salmon Brook Fishway	Salmon Brook	2018	1	$ 33,000	ASCF Website
IG	Gander Bay Indian Band Council	Dam Removal/ Retrofit	Removal of 8 Beaver Dams and existing Beaver from 3 tributaries of Gander River	Gander	2015	1	$ 33,000	ASCF Website
IG	Gander Bay Indian Band Council	Fish Passage	Salmon Brook Fishway	Salmon Brook	2017	2	$ 76,921	ASCF Website
CG	Gander River Management Association	In-stream Habitat Improvement	Northwest Gander River Restoration and Demonstration Project. Restore bridges and culverts	Gander	1993	1	$ 50,000	https://waves-vagues.dfo-mpo.gc.ca/Library/274574_Pt1.pdf
CG	Gander River Management Association	In-Stream Habitat Improvement	Report on Work Done as Recommended by Gander Habitat Study Salmon Enhancement Project for Tributaries of the Gander River System.	Gander	1994	1	$ 52,750	https://www.tandfonline.com/doi/pdf/10.1577/1548-8659(1987)7<207%3AASEITE>2.0.CO%3B2?needAccess=true
IG	Miawpukek Ferst Nation	Fish Passage	Miawpukek South East Brook Enhancement (MSEBE)	South East Brook	2017	1	$ 23,000	ASCF Website
NGO	SAEN	Aesthetics/ Recreation/ Education	Salmon Conservation Public Education and Awareness	Province Wide	2017	1	$ 8,800	ASCF Website
NGO	SAEN	Aesthetics/ Recreation/ Education	Videos on Habitat Improvement	Rennies River	2018	1	$ 33,000	ASCF Website
NGO	SAEN	In-Stream Species Management	Egg incubation and planting	Rennies River	2016	2	$ 50,692	ASCF Website
NGO	SAEN	Flow Modification	Falls Remediation – Quidi Vidi	Rennies River and Virginia River	2013	1	$ 20,000	ASCF Website
NGO	SAEN	In-Stream Species Management	Rennies River Watershed management Survey & salmon spawning bed enhancement	Rennies River	2014	1	$ 17,750	ASCF Website

Group Type	Organization	NRRSS WG Category	Project Title	Location	Year Started	Duration (Years)	Funding	Source
NGO	SAEN	In-Stream Habitat Improvement	Rennie's River Restoration Project	Rennies River	1993	1	$ 30,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
NGO	SAEN	Dam Removal/ Retrofit	Remedial Work Carried Out on St. Mary's Bay North Rivers.	St Mary's Bay River	1993	1	$ 24,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
NGO	SAEN	Aesthetics/ Recreation/ Education	Videos on Habitat Improvement	Rennies River	1993	1	$ 23,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
NGO	SEAN	In-Stream Species Management	Fish Friends Education Program – Purchase of nechiller units	Rennies River	2009	1	$ 10,300	ASCF Website
NGO	SAEN	Aesthetics/ Recreation/ Education	Videos on Habitat Improvement	Rennies River	1994	1	$ 23,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
ACA	MUN	Aesthetics/ Recreation/ Education	Implementation and evaluation of habitat improvement structures on tributaries of the Salmon River Watershed, Main Brook Newfoundland and Labrador	Salmon River Watershed	2014	2	$ 65,835	ASCF Website
ACA	MUN	Aesthetics/ Recreation/ Education	Development of River Restoration Planning and Analysis Tool	Province Wide	2015	3	$ 208,996	ASCF Website
ACA	MUN	Aesthetics/ Recreation/ Education	Salmon gametes as a source for research, restocking and public engagement	Exploits River	2016	3	$ 139,650	ASCF Website
ACA	MUN	Aesthetics/ Recreation/ Education	Long term evaluation of Ecological Restoration Plan Salmon River Watershed	Salmon River Watershed	2015	1	$ 35,245	ASCF Website
ACA	MUN	Aesthetics/ Recreation/ Education	Incubation sensitivity to winter temperatures in four DUs of Atlantic salmon in Canada	Labrador, Northeast Newfoundland, South NL, Northwest NL	2015	1	$ 126,350	ASCF Website
ACA	MUN	Aesthetics/ Recreation/ Education	Assessing the impact of instream barriers and climate change on Atlantic salmon population persistence and productions	Province Wide	2017	4	$ 147,300	ASCF Website
ACA	MUN	Aesthetics/ Recreation/ Education	Evidence synthesis and analysis of river restoration effort in Newfoundland and Labrador	Province Wide	2019	3	$ 195,899	ASCF Website
ngo	SPAWN	In-Stream Habitat Improvement	Clear up a blockage on the Upper Humber Brook for Atlantic salmon with the use of excavator	Humber River	2010	1	$ 16,359	ASCF Website
NGO	Qalipu First Nation	Aesthetics/ Recreation/ Education	Aquatic Conservation Plan for Warm Brook	Stephenville	2019	1	$ 19,950	ASCF Website
NGO	Intervale	Aesthetics/ Recreation/ Education	Education and awareness for the conservation of wild Atlantic salmon and salmon habitat in the Bay St. George area of Newfoundland	Bay St. George River	2018	2	$ 101,012	ASCF Website

Group Type	Organization	NRRSS WG Category	Project Title	Location	Year Started	Duration (Years)	Funding	Source
NGO	Friends of the Salmonier Nature Park	Aesthetics/ Recreation/ Education	Salmonier Nature Park's Atlantic Salmon Ecology Awareness Project	Salmonier	2019	1	$ 21,300	ASCF Website
CG	Kelligrews Ecological enhancement program	Dam Removal/ Retrofit	Removal of Impediment to Fish Passage in Lower Gullies River	Lower Gullies River	1993	1	$ 11,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Central Development Association	Dam Removal/ Retrofit	Improving access to river	Bound Brook	1993	1	$ 12,100	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	ELEDA	In-stream Habitat Improvement	Habitat Restoration/Conservation Project.	Exploits River	1993	1	$ 43,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	White Bay North Dev Assoc.	Fish Passage	Pinsents Brook Salmonid Enhancement Program.	Pinsent Brook	1993	1	$ 15,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Corner Brook Stream Corp	Aesthetics/ Recreation/ Education	Corner Brook Stream Feasibility Survey for Salmonid Enhancement.	Corner Brook Stream	1993	1	$ 16,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Branch River Improvement Committee, Branch, NF	in-stream Habitat Improvement	Branch River Enhancement Project: Project Results and Recommendations.	Branch River	1994	1	$ 15,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Isthmus Area Development Association, Bellevue, NF	in-stream Habitat Improvement	Trout Brook River Restoration and Improvement.	Trout River	1994	2	$ 35,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Mokami Regional Development Association, Happy Valley-Goose Bay, Lab.	Bank Stabilization	Smiths Brook Habitat Enhancement Project.	Smiths Brook	1994	1	$ 20,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Gander Bay-Hamilton Sound Development Association, Carmanville, NF	Dam Removal/ Retrofit	Ragged Harbour River Project; Building of Dam.	Ragged Harbour River	1994	1	$ 29,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Penguin Area Development Association, Burgeo, NF	Bank Stabilization	Top Pond Brook Restoration Project #3145.	Top Pond Brook	1994	1	$ 33,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Burin Peninsula Development Association	Dam Removal/ Retrofit	Eastern Black River Salmonid Enhancement Program.	Garnish River	1994	1	$ 43,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Bonne Bay Development Association, Woody Point, NF	In-Stream Habitat Improvement	Lomond River Habitat Restoration and Improvement Program Final Report.	Lomond River	1994	1	$ 11,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Port aux Port Indian Band Council	Dam Removal/ Retrofit	Removal of beaver dams	Romaines River	1994	1	$ 17,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Great Lamaline Development Association	In-stream Habitat Improvement	stone weir and boulder removal clean up	Salmonier River	1993	1	$ 28,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Shaol Harbour Development Rotary Club	In-Stream Habitat Improvement	addition of low head dams	Shoal Harbour River	1995	1	$ 22,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	Codroy River Valley Development Association	In-Stream Habitat Improvement	addition of low head dams	Little Codroy River	1995	1	$ 17,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
IND	Bowater's	Fish Passage,	Indian River Bay Verte-artificial channel construction	Indian River	1963	2	$ 65,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	FLOW	In-stream habitat improvement	Enhancing stream invertebrates in south brook	South Brook Avalon	1995	2	$ 27,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf

Group Type	Organization	NRRSS WG Category	Project Title	Location	Year Started	Duration (Years)	Funding	Source
CG	Newfoundland and Labrador Env Agency	Bank Stabilization	Erosion Control and debris removal	Great Barasway River	1993	1	$ 30,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	St Barbe Development Association	In-stream habitat improvement	St. Genevieve River Watershed Habitat Restoration Project	St Genevieve River	1995	1	$ 35,000	https://waves-vagues.dfo-mpo.gc.ca/Library/212119.pdf
CG	North Shore Bay of Islands Development Association	Dam Removal/ Retrofit	Hughes Brook Salmon Enhancement Project	Hughes Brook	1983	1		http://publications.gc.ca/collections/collection_2012/mpo-dfo/Fs97-6-2051-eng.pdf
CG	North Shore Bay of Islands Development Association	in-stream species management	Hughes Brook Salmon Enhancement Project	Hughes Brook	1986	8		http://publications.gc.ca/collections/collection_2012/mpo-dfo/Fs97-6-2051-eng.pdf
CG	North Shore Bay of Islands Development Association	in-stream species management	Hughes Brook Salmon Enhancement Project	North and Bound Brook	1987	5		http://publications.gc.ca/collections/collection_2012/mpo-dfo/Fs97-6-2051-eng.pdf
CG	North Shore Bay of Islands Development Association	Aesthetics/ Recreation/ Education	Hughes Brook Salmon Enhancement Project	Hughes Brook	1983	2		http://publications.gc.ca/collections/collection_2012/mpo-dfo/Fs97-6-2051-eng.pdf
CG	North Shore Bay of Islands Development Association	Aesthetics/ Recreation/ Education	Hughes Brook Salmon Enhancement Project	Hughes Brook	1988	4		http://publications.gc.ca/collections/collection_2012/mpo-dfo/Fs97-6-2051-eng.pdf
CG	North Shore Bay of Islands Development Association	Aesthetics/ Recreation/ Education	Hughes Brook Salmon Enhancement Project	North brook	1987	4		http://publications.gc.ca/collections/collection_2012/mpo-dfo/Fs97-6-2051-eng.pdf
CG	North Shore Bay of Islands Development Association	Dam Removal/ Retrofit	Hughes Brook Salmon Enhancement Project	North brook	1986	4		http://publications.gc.ca/collections/collection_2012/mpo-dfo/Fs97-6-2051-eng.pdf
NGO	Ducks Unlimited Canada	Bank Stabilization	Torbay Gully Wetland Enhancement	Torbay	2019	1		Ducks Unlimited
NGO	Ducks Unlimited Canada, Corner Brook Pulp and Paper	In-Stream Habitat Improvement	Corner Brook Marsh	Corner Brook	1996	1		Ducks Unlimited
NGO	Ducks Unlimited Canada, Corner Brook Pulp and Paper	Dam Removal/ Retrofit	Birchy Basin	Birchy Basin, Upper Humber River	1992	1		Ducks Unlimited
NGO	Ducks Unlimited Canada	Fish Passage	Lethbridge Gully	Lethbridge	1992	1		Ducks Unlimited
NGO	Ducks Unlimited Canada	Instream Habitat Improvement	Jumper Brook	Resource road in Loon Bay area	1981	1		Ducks Unlimited
NGO	Ducks Unlimited Canada	Instream Habitat Improvement	Otter Pond	Lewisporte	1982	1		Ducks Unlimited
NGO	Ducks Unlimited Canada, Corduroy Brook Enhancement Association	Fish Passage	Corduroy Brook	Grand Falls - Windsor	1998	1		Ducks Unlimited
NGO	Ducks Unlimited Canada, Pippy Park	Instream Habitat Improvement	Fogarty's Wetland	St. John's	2000	1		Ducks Unlimited

Group Type	Organization	NRRSS WG Category	Project Title	Location	Year Started	Duration (Years)	Funding	Source
NGO	Ducks Unlimited Canada	Fish Passage	Cooks Marsh	Logger School Road area	1983	1		Ducks Unlimited
NGO	Ducks Unlimited Canada	Instream Habitat Improvement	Burnt Hill	St Johns	1988	1		Ducks Unlimited
P	DFO	Fish Passage	Lomond River Fishway	Lomond River	1948	72		https://waves-vagues.dfo-mpo.gc.ca/Library/36894.pdf
P	DFO	Fish Passage	Fishway Torrent River	Torrent River	2018	1	$ 121,917	Buyandsell.gc.ca/procurement-data/tender-notice/PW
P	DFO	Fish Passage	Fishway	Exploits (GF, GRB, BF & RIL FW)	1959	61	$ 2,900,000	https://waves-vagues.dfo-mpo.gc.ca/Library/40706680pt1.pdf
P	DFO	Fish Passage	Stocking	Humber River	1982	15	$ 800,000	
P	DFO	Fish Passage	Fishway	Terra Nova (MJF) two	1955	65	$ 278,000	
P	DFO	in-stream species management	Adult Transfers & Fry Stocking	Indian Brook Enhancement	1982	15	$ 594,000	
P	DFO	Fish Passage	Fishway	Robinsons River	1982	28	$ 1,160,000	
P	DFO	in-stream species management	Stocking	South Brook	1982	15	$ 720,000	
P	DFO	in-stream species management	Adult Transfers & Fry Stocking	Gander Bay Brook	1982	15	$ 950,700	
P	DFO	Fish Passage	Fishway	Torrent River	1966	54	$ 1,961,000	
P	DFO	in-stream species management	Pond Rearing & Adult Transfers & Fry Stocking	Black Brook	1982	15	$ 762,000	
P	DFO	Fish Passage	Fishway	Rocky River	1966	1	$ 100,000	https://waves-vagues.dfo-mpo.gc.ca/Library/9984.pdf
P	DFO	In-stream Species Management	Pond Rearing & Adult Transfers & Fry Stocking	Exploits River	1957	36	$ 3,600,000	
P	DFO	In-stream Species Management	Stocking Fry & Adult transfers	Rocky River	1984	4	$ 340,000	
P	DFO	In-stream Species Management	Egg incubation and planting	Rocky River	1989	9	$ 640,000	
P	DFO	In-stream Species Management	Pond Rearing	Indian/Black Brook	1980	14	$ 680,000	
P	DFO	In-stream Species Management	Pond Rearing and Adult Transfer	Torrent River	1972	4	$ 430,000	
P	DFO	In-stream Species Management	Egg transfer and Incubation Reintroduction of Salmon	Rennies River	2012	4	$ 565,000	Buyandsell.gc.ca/procurement-data/tender-notice/PW
P	DFO	Fish Passage	New Fishway	Indian River, NE Placentia	2017	1	$ 155,681	
P	DFO	Fish Passage	New Fishway	Indian River, NE Placentia	2019	1	$ 630,200	
P	DFO	Fish Passage	Fish Enhancement	Salmon Brook	2018	1	$ 573,850	

Group Type	Organization	NRRSS WG Category	Project Title	Location	Year Started	Duration (Years)	Funding	Source
P	DFO	Fish Passage	Fishway	Lower Terra Nova River	2017	1	$ 149,173	
P	DFO	Fish Passage	Fishway	Salmon Brook, Gander	2016	1	$ 158,200	
P	DFO	Fish Passage	Fishway Replacement	Salmon Brook, Gander	2016	1	$ 1,203,970	
P	DFO	Fish Passage	Fish Enhancement	Salmon Brook, Gander	2018	1	$ 573,850	
P	DFO	Fish Passage	Fishway	Colinet River	2014	1	$ 1,411,370	
P	DFO	Fish Passage	Fishway	Exploits River	2015	1	$ 452,000	
P	DFO	Fish Passage	Fishway Upgrade	Bishops Falls Exploits	2015	1	$ 275,472	
P	DFO	Fish Passage	Fishway	Bishops Falls Exploits	2016	1	$ 165,715	
P	DFO	Fish Passage	Fishway	Grand Falls Lower Fishway	2016	1	$ 1,686,243	
P	DFO	Fish Passage	Fishway Upgrade	Lomond River	2016	1	$ 221,994	
P	DFO	Fish Passage	Fishway Upgrade	Middle Brook Fishway	2016	1	$ 284,606	
P	DFO	Fish Passage	Fishway Upgrade	Great Ratting Brook - Grand Falls	2016	1	$ 218,000	
P	DFO	Fish Passage	Fishway Upgrade	Grand Falls Lower Fishway	2016	1	$ 135,700	
P	DFO	Fish Passage	Fishway	Rocky River Fishway	2017	1	$ 406,353	
P	DFO	Fish Passage	Fishway Replacement	Salmon Cove River	2017	1	$ 205,760	
P	DFO	Fish Passage	Fishway	Indian Brook	1958	62		https://waves-vagues.dfo-mpo.gc.ca/Library/36894.pdf
P	DFO	Fish Passage	Fishway	Salmon Brook, Gander	1957	63		https://waves-vagues.dfo-mpo.gc.ca/Library/36894.pdf
P	DFO	Fish Passage	Fishway	Middle Brook	1956	64		https://waves-vagues.dfo-mpo.gc.ca/Library/36894.pdf
P	DFO	Fish Passage	Fishway	Northwest River Port Blanfford	1948	72		https://waves-vagues.dfo-mpo.gc.ca/Library/36894.pdf
P	DFO	Fish Passage	Fishway	North East River Placenta	1973	47		https://waves-vagues.dfo-mpo.gc.ca/Library/36894.pdf
P	DFO	Fish Passage	Fishway	Smokey fall Bay d Nord	1949	71		https://waves-vagues.dfo-mpo.gc.ca/Library/36894.pdf
P	DFO	Fish Passage	Fishway	Riverhead Brook, Notre Dame Bay	1956	64		https://waves-vagues.dfo-mpo.gc.ca/Library/36894.pdf
P	DFO	Fish Passage	Fishway	Salmon River South Coast, Bay D'Espoir	1949	71		https://waves-vagues.dfo-mpo.gc.ca/Library/36894.pdf

Appendix C

Q1) Which group best represents where you are from

- Provincial Government
- Federal Government
- Academia
- Non Governmental Organisation
- Concerned Citizen

Q2) How would you categorize the projects you worked on

- Ecological
- Human Oriented
- Research and Planning

Q3) Which of the following was the primary focus for the project

- Water Quality Management
- Riparian Management
- In-Stream Habitat Management
- Bank Stabilisation
- Fish Passage
- Flow Modification
- Channel Reconfiguration
- Dam Removal/Retrofit
- Land Acquisition
- In-Stream Species Management
- Aesthetics/Education/Recreation

Q4) Why was the previous answer considered the main focus for the project

- Greatest factor influencing river degradation
- Legal Requirements
- Focus for which funding was available
- Public demand or safety
- Problem that could be most easily addressed
- Other

Q5) Was climate change adaptation identified as part of the rational for this project

- Yes
- No
- Unsure

Q6) What role did you play while working on the project

- Manager/Coordinator

- Consultant
- Designer
- Implementer
- Evaluator
- Funder

Q7) What and/or who motivated this project?

- Project was part of a larger management plan
- Priorities/preference of agency staff
- Watershed council
- Environmental NGO
- Citizen Interest
- Regulatory Mandate
- Mitigation Project
- Other

Q8) Who funded the project?

- Private contractor
- City agency
- Local or regional authority
- Provincial agency
- Federal agency
- Volunteers
- Non Governmental/ Not for profit organisation

Q9) Was the project part of an organised watershed management plan for the catchment?

- Yes
- No
- Unsure

Q10) Has a watershed assessment been completed on the river/stream?

- Yes
- No
- Unsure

Q11) Do the goals for the project overlap with the goals for the watershed?

- Not at all
- Somewhat
- Mostly
- Completely

Q12) What factors led to the prioritization of this site over other possible sites?

- Funds available

- Public interest
- Scientific interest
- Political interest
- Ecological concern
- Infrastructure concern
- Legal requirement
- In the watershed plan
- Recreation

Q13) Which factors were most influential in determining the final project design?

- Costs
- Requirements or mandates
- Previous experience
- Location specific limitations
- Ecological impacts
- Stakeholder preferences
- Other

Q14) were citizen groups involved in the projects initiation stage?

- Not at all
- 2
- Somewhat
- 4
- Substantially

Q15) were citizen groups involved in the projects implementation stage?

- Not at all
- 2
- Somewhat
- 4
- Substantially

Q16) were citizen groups involved in the projects evaluation stage?

- Not at all
- 2
- Somewhat
- 4
- Substantially

Q17) what was the status of land ownership on which the project was implemented?

- Private
- City
- Provincial

- Federal
- Indigenous
- Other

Q18) what resources were used in creating and evaluating the design plan that was selected?

- Manual/book/report/guide
- Peer reviewed journal
- Model or project site analysis
- Individual opinion
- Past experiences
- other

Q19) was there any particular influential workshop, course, paper, talk, expert, or demonstration project that influenced the way in which the project was completed?

Q20) an advisory committee was associated with the project?

- True
- False
- unsure

Q21) was the project implemented as designed?

- Not at all
- 2
- Somewhat
- 4
- completely

Q22) funding was available for project maintenance?

- True
- False
- unsure

Q23) follow up maintenance occurred?

- True
- False
- unsure

Q24) an organisation collected monitoring data specific to the project, in order to evaluate its implementation?

- True
- False
- unsure

Q25) How did you choose how to monitor the project?

- Protocol for previously collected data
- Federal protocol
- Provincial protocol
- Local/regional conservation group protocol
- Book/manual/report/scientific literature
- Expert advice
- Other
- Not applicable

Q26) who performed the monitoring and evaluation component of the project?

- Agency Scientist
- Volunteer
- University student/professor
- Non-profit organisation
- Consultant/for profit
- Other
- Not applicable

Q27) What enabled your team to monitor this project?

- Pursuit of additional funds
- Funding mandate
- Local volunteer interest
- Academic researcher involvement
- Ongoing regional effort
- Legal requirement
- Personal commitment
- Other
- Not applicable

Q28) what type(s) of monitoring were conducted?

- Chemical
- Physical
- Biological
- Photo monitoring
- Other
- Not applicable

Q29) Climate change was monitored and/or evaluated

- True
- False
- Unsure

Q30) Previously collected monitoring information was used as baseline data for the project evaluation

- True
- False
- Unsure

Q31) The monitoring component was part of a regional monitoring effort

- True
- False
- Unsure
- Not applicable

Q32) Someone analysed the data

- True
- False
- Unsure

Q33) What sort of analysis was used to summarize the data?

- Graphical
- Statistical
- Comparative (tabular)
- Modeling
- Unsure
- None

Q34) Success criteria were explicitly stated in the design plan?

- True
- False
- Unsure

Q35) Rate the success criteria accomplishment from 1 (not at all) to 5 (completely)

- Not at all
- 2
- Somewhat
- 4
- Completely
- Too soon to tell
- Not applicable

Q36) Do you consider the project successful?

- Not at all
- 2

- Somewhat
- 4
- Completely
- Too soon to tell

Q37) what made/would make the project successful
- Overall positive effects on river
- Overall positive effects on wildlife
- Positive effect on humans
- Increased understanding of river systems
- Capacity building
- Ecological indicators are positive
- Success criteria was met

Q38) What kept/would keep this project from being successful?
- Exotic weeds
- Structure failure
- Public disapproval
- Human disturbance
- Natural disturbance
- Inadequate funding
- Inadequate design
- No increase in measures of success
- Poorly implemented
- Plants died
- other

Q39) Monitoring data was used to evaluate success
- true
- false
- unsure

Q40) what were the additional benefits of the project?
- Ability to do more restorative projects
- Increase in property value
- Community awareness
- New partnerships with industry and community
- Learned new information about the ecosystem and its species
- Other
- none

Q41) if you had the opportunity, what changes if any would you make to any aspect of the project?

Q42) if you were to redesign the project, would you make any changes due to climate change consideration?

- Yes
- No
- maybe

Q43) information about the project has been made available to others

- true
- false
- unsure

Q44) the project could have been done less expensively

- true
- false
- unsure

Q45) Climate change should be considered in the future

- true
- false
- unsure

Q46) Funding and/or project support has been distributed according to ecological needs of river systems

- true
- false
- unsure

Q47) is there anything else you feel we should know about your project?