ÁTL'ḴA7TSEM
HOWE SOUND
BIOSPHERE REGION

Knowing Our Streams

A review of knowledge and stewardship programs of fish-bearing streams within the Átl'ḵa7tsem/Howe Sound UNESCO Biosphere Region.

PREPARED FOR ÁTL'ḴA7TSEM / HOWE SOUND BIOSPHERE REGION INITIATIVE
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Acknowledgements

Compiling a robust inventory on fish-bearing streams and the stewardship programs that have been carried out in Átl'ka7tsem/Howe Sound would not have been possible without the generous contributions of time and knowledge from all participants. This Project is the results of collaboration and information sharing through active members within Átl'ka7tsem/Howe Sound.

The geographic scope of this Project falls within the traditional territory of the Sḵwxwú 7mesh Úxwumixw (Squamish Nation). We recognize and honour the Sḵwxwú 7mesh Úxwumixw as the traditional custodians of this land and pay our respects to their elders, past, present, and emerging. Thank you to the Sḵwxwú 7mesh Úxwumixw for their participation and collaboration on this Project. We look forward to continuing to learn and share more information on valuable fish-bearing streams of Átl'ka7tsem/Howe Sound.

Thank you to the Howe Sound Biosphere Region Initiative Society for the opportunity to carry out this Project and to Environment and Climate Change Canada for providing the funding to complete this project. A special thanks to Mike Stanford for giving time to this Project as a knowledgeable and resourceful supervisor.

Finally, thank you to all of the participants to this project who contributed immensely to this project and made it possible - Tim Pardee from the Bowen Island Fish & Wildlife Club, Shirley Samples at the Sunshine Coast Streamkeepers Society, Colin Levings, Zoe Blue at the Squamish Streamkeepers, Lora Tryon at Lake Trail Environmental, Edith Tobe at the Squamish River Watershed Society, Greg Weary and Keith Pelletier at West Vancouver Streamkeepers, Dianna Sanford and Angela Kroning at Sunshine Coast Conservation Association, Julie Aeyelts and Aaron Marchant from Squamish Nation, Nikki Kroetsch at DFO, Malcolm Wigham at DFO, and Peter Scholefield from Gambier Island Conservancy.

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Executive Summary

The complex, intertwining relationship between stream and forest ecosystems is indisputably one of the key characteristics of coastal British Columbia. Within these freshwater streams, there are a myriad of species, including ecologically, culturally, and economically significant anadromous species. These ecosystems have felt the ongoing effects of land use in the form of resource extraction, human occupation, road expansion, and climate change. There is a clear understanding that stream restoration and protection is paramount to maintain the health of these coastal ecosystems and the livelihoods of those who depend on them. Capacity and funding limitations hinder the ability for stewardship organizations to spend time identifying areas of potential restoration and what activities would maximize the benefit for these fish species. In addition, a lack of data to provide baseline information to guide stewardship efforts further limits the work that these organizations carry out.

The streams within Átl'ka7tsem/Howe Sound are no strangers to the aforementioned environmental degradation, yet various stewardship groups have worked tirelessly over the previous decades to restore and protect these sensitive ecosystems and to protect high priority fish species. The Howe Sound Biosphere Region Initiative Society contracted Grace Mackie in November 2022 to assess existing data gaps within the Marine Reference Guide and to determine the current state of stream stewardship within Átl'ka7tsem/Howe Sound. The results for 94 priority streams identified in this project are summarised in the following report.

The report is split into two parts – Part 1 data gaps in the Marine Reference guide; and Part 2 Current State of Stewardship.

Part 1 was completed through a desktop analysis where data layers in the Marine Reference guide were compared to five relevant sources on fish bearing streams. This analysis showed that there are multiple issues with the data currently displayed in the Marine Reference Guide. These included:

- Streams completely missing from the guide since the application uses the BC Freshwater Atlas which lacks this crucial information on stream locations
- Outdated data or incomplete fields
- No reference to any spawning channels.

It is suggested that these inconsistencies be addressed for the Marine Reference Guide to fulfill its full potential of being a decision support tool that users can reference when making land-use decisions. The most effective way to do so is to collaborate with stewardship organizations mentioned in this report, or to develop monitoring activities that would fill these data gaps.

Part 2 involved identifying stewardship groups currently operating within Átl'ka7tsem/Howe Sound and an interview, as well as a survey, to create a record of stewardship activities that have been carried out in the past or will be carried out in the near future. This information was then assessed to identify overlaps and gaps in stewardship efforts and create guidance on potential stream restoration and monitoring opportunities that would benefit priority fish species. The results from this assessment indicated that there are various opportunities to develop projects that would benefit freshwater

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ecosystems and anadromous fish species within each Marine Unit (from the Marine Reference Guide) including:

- Culvert replacement
- Temperature logging
- Riparian re-planting
- Water quality monitoring
- Re-evaluation of rearing ponds affected by summer droughts

The results of the report serve both to indicate where gaps exist in data and stream stewardship, but also to highlight and recognize the positive impact these stewardship organizations have had on the landscape. The findings in this report can now be used to guide those who are conducting stewardship towards projects of high importance. It is our hope that through this guidance the strain on capacity within each organization will be diminished. It is also our hope that this report works to convene existing stewardship knowledge into one document to highlight successes and foster collaborative effort in future endeavours that each group carries out.

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Table of Contents

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1 How to Use This Document

This report was compiled with the main objective of sharing information on the subject of fish-bearing streams within the Átl'ḵa7tsem/Howe Sound Biosphere. This report consists of three main sections: Background and Context; Part I: The Marine Reference Guide; and Part II: State of Stewardship in Átl'ḵa7tsem/Howe Sound. A breakdown of the information found in each section is provided below.

Background and Context:

- Introduction and background information relevant to understanding the purpose and methodology of this Project
- Scope and objectives of this study

Part I: The Marine Reference Guide:

- List of all the currently documented fish-bearing streams, according to the Marine Reference Guide
- Comparison to other relevant resources on fish bearing streams in order to provide a gap analysis on fish-bearing streams in Átl'ḵa7tsem/Howe Sound.

Part II: State of Stewardship in Átl'ḵa7tsem/Howe Sound

- A summary of the stewardship societies operating within the project scope
- Documented and potential fish-bearing streams
- Potential future restoration and monitoring activities.

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2 Introduction

Átl'ḵa7tsem/Howe Sound is the southernmost fjord in North America. It is an inlet of the Salish Sea found between the Lower Mainland and Sunshine Coast of British Columbia and is surrounded by rugged mountains, dense forests, and rocky shores. This stretch of ocean extends 42 km from West Vancouver to Squamish and is home to many islands and island clusters, such as Bowen and Gambier Island.

Designated a UNESCO Biosphere Region in 2021, this mountainous coastal ecosystem is home to diverse watersheds that have served the Sḵwx̱wú7mesh Úxwumixw for thousands of years (howesoundbri.org/atlka7tsem-howe-sound). Fed by several freshwater systems from over 40 watersheds, Átl'ḵa7tsem/Howe Sound supports various fish and wildlife species, including at least 9 species of salmonids (Roberge et al., 2002).

This region is an important habitat for salmon, trout, and herring. These species are important socially and culturally to the Sḵwx̱wú7mesh Úxwumixw and economically overall in Átl'ḵa7tsem/Howe Sound (Bodtker, 2017). Many of these valued fish species depend on freshwater systems to complete a portion of their life cycle. Salmon species such as pink, chum, Chinook, sockeye, and coho use streams to spawn. Other species, like sea-run coastal cutthroat trout and steelhead trout, will stay in streams an average of 2-3 years to spawn, incubate, and rear offspring before migrating to the sea. More permanent residents of Átl'ḵa7tsem/Howe Sound streams include resident cutthroat trout, rainbow trout, Dolly Varden, char, eastern brook trout, and kokanee salmon. Salmonids in streams also carry out important ecosystem services such as acting as a source for marine-derived nitrogen when adult salmon decompose after spawning (Levings, 2017).

Population decline of anadromous fish species has been noted in Átl'ḵa7tsem/Howe Sound since the 70's; this decline is due to over-fishing, habitat degradation, pathogens, and climate change (Levings, 2017; Dearden, 2020). Habitat degradation of streams is the result of human activities such as commercial and residential developments, forestry operations, and pollution from mining activities (Bodtker, 2017; Levings et al*.,* 2004). The at-risk salmonid species protected under the Species at Risk Act (SARA) include but are not limited to coho salmon (threatened), steelhead (endangered), cutthroat trout (special concern), sockeye salmon (endangered), and Chinook salmon (threatened, endangered and special concern for its fall, summer, and stream populations respectively) (COSEWIC, 2016). However, efforts have been underway to help these fish populations by restoring the habitats vital to these fish populations. Through the protection of these salmonids and their habitat since the mid 1900's, stewardship societies and citizen science groups have built a rich history within the Átl'ḵa7tsem/Howe Sound biosphere region and have been at the centre of ongoing enhancement and management. Within Átl'ḵa7tsem /Howe Sound Biosphere Region, there is currently no central data source providing information on past and present stewardship society programs in fish-bearing streams.

Fish-bearing streams in Átl'ḵa7tsem/Howe Sound are vulnerable to several threats, including habitat loss and degradation, pollution, overfishing, and shifting environmental conditions due to climate change. With ongoing land usage surrounding these streams, including highway development, railway crossings, logging, provincial parks, and other linear development (FIDQ), it is important to acknowledge

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the threats these watersheds and fish species face. As of 2018, riparian zone disturbance and road density near streams showed high risk of impacting to the surrounding watersheds in Howe Sound (MNRF, 2018). There are 2300 km of road in the Átl'ka7tsem/Howe Sound area. Sixty-five percent of these roads are logging roads, both active and inactive (Juthans, 2018). These roads can produce a downstream impact on aquatic ecosystems, affecting both water quality and quantity (Juthans, 2018). Átl'ka7tsem/Howe Sound has also been home to various pulp mills, some still active today (Miller, 2020). Historically, these logging mills have posed threats to fish bearing streams as well as downstream communities that rely on drinking water, as seen in the Chapman Creek watershed on the Sunshine Coast (Hume, 2007). In addition to logging mills, there are 13 mines in 12 watersheds within the Howe Sound area, as of 2016 (Juthans, 2018). Britannia Mine, known for one of the worst incidences of water pollution in North America, is just one of many mines in the Sound, some of which are still developed prospects (Alava and Bodtker, 2017; Juthans, 2018).

Taking into consideration the cumulative impacts on streams in Átl'ka7tsem/Howe Sound, it is important to continue and expand the assessment of the health of fish-bearing streams.

With enhancement efforts like riparian restoration, educating students about salmon conservation, or even running hatcheries, stewardship societies have been able to play a key role in salmon conservation (Dearden, 2020). Citizen science data not only provides an opportunity for a large amount of data over a broader spatiotemporal scale, but, when completed within a controlled observation and survey process, becomes a valuable tool for studying the conservation and ecology of a given species (Johnston et al., 2020). With a coordinated approach to stewardship, the value of information sharing in Átl'ka7tsem/ Howe Sound could play a key role in enhancing salmon conservation and restoration.

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3 Context

The goal of this report is to assess the current involvement of stewardship societies active within the scope of this Project. Stream stewardship efforts in the context of this Project include the monitoring, restoration, public education, and programs created and organized by stream stewardship societies. It is the management of streams, riparian zones, and watersheds that foster sustainable growth of fish populations and other species of interest. In the case of this report, the focal point will be on stewardship societies whose goals are to enhance and restore fish-bearing streams and support the conservation and growth of anadromous fish populations in Átl'ka7tsem/Howe Sound. The species of interest in this report include chum, coho, Chinook, pink, and sockeye salmon as well as cutthroat trout, coastal cutthroat trout, steelhead, and Dolly Varden.

The stewardship efforts of the following societies will be analyzed to determine the current state of stewardship efforts as well as highlight potential areas for future monitoring and restoration work:

- Squamish River Watershed Society
- Squamish Streamkeepers
- Squamish Nation
- West Vancouver Streamkeepers
- Sunshine Coast Streamkeeping Society
- Bowen Island Fish and Wildlife Club
- Gambier Island Conservancy

Currently, the need for information on fish-bearing streams poses a key challenge for continued efforts to protect and restore these habitats. Citizen science groups like stewardship societies play a vital role in conserving anadromous fish habitats by providing data for under-researched areas (Turner & Husby, 2017). These groups can address a wide range of ecological research questions and increase the scope and volume of available data (Johnston et al., 2020; Peters et al., 2015). Creating a comprehensive inventory of stewardship efforts for the fish-bearing streams of Átl'ka7tsem/Howe Sound will be a useful tool for highlighting knowledge gaps and showcasing opportunities for preventative action in conserving fish-bearing streams.

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4 Objectives

The main objectives of this report are as follows:

1. Execute a gap analysis of the information presented on the Marine Reference Guide about fish-bearing streams.
2. Undertake a comprehensive inventory on past and present stewardship programs occurring in fish-bearing streams within Átl'ḵa7tsem/Howe Sound Biosphere Region.
3. Present an analysis of potential gaps (or overlaps) of stewardship programs in fish-bearing streams within Átl'ḵa7tsem/Howe Sound in terms of:
    a. Identifying fish-bearing streams that would benefit from stewardship programs.
    b. Recommending where preventative action could be taken to preserve fish-bearing streams.
4. Disseminate the inventory to stewardship societies and other interested parties to increase information sharing and collaboration in future effort

5 Project Scope

5.1 Geographic Scope

Documented fish-bearing streams included in this report must lie within the boundary of the of the Átl'ḵa7tsem/Howe Sound Biosphere Region boundary. The boundary contains over 218,723 hectares and includes part of the Sunshine Coast, West Vancouver, Squamish, and all the islands within Howe Sound. The Marine Reference Guide divides the Átl'ḵa7tsem/Howe Sound Biosphere Region into six units called the Marine Units. These units are divided within the Sound, as seen in Figure 1. For the purpose of this report, streams will be categorized based on the Marine Unit that they outflow into. However, an exception to this will be the islands within Átl'ḵa7tsem/Howe Sound; these islands (Gambier Island, Bowen Island, Keats Island, Bowyer Island, and Anvil Island) will studied be independent to the Marine Units.

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Marine Units Within the Átl'ka7tsem / Howe Sound UNESCO Biosphere Region

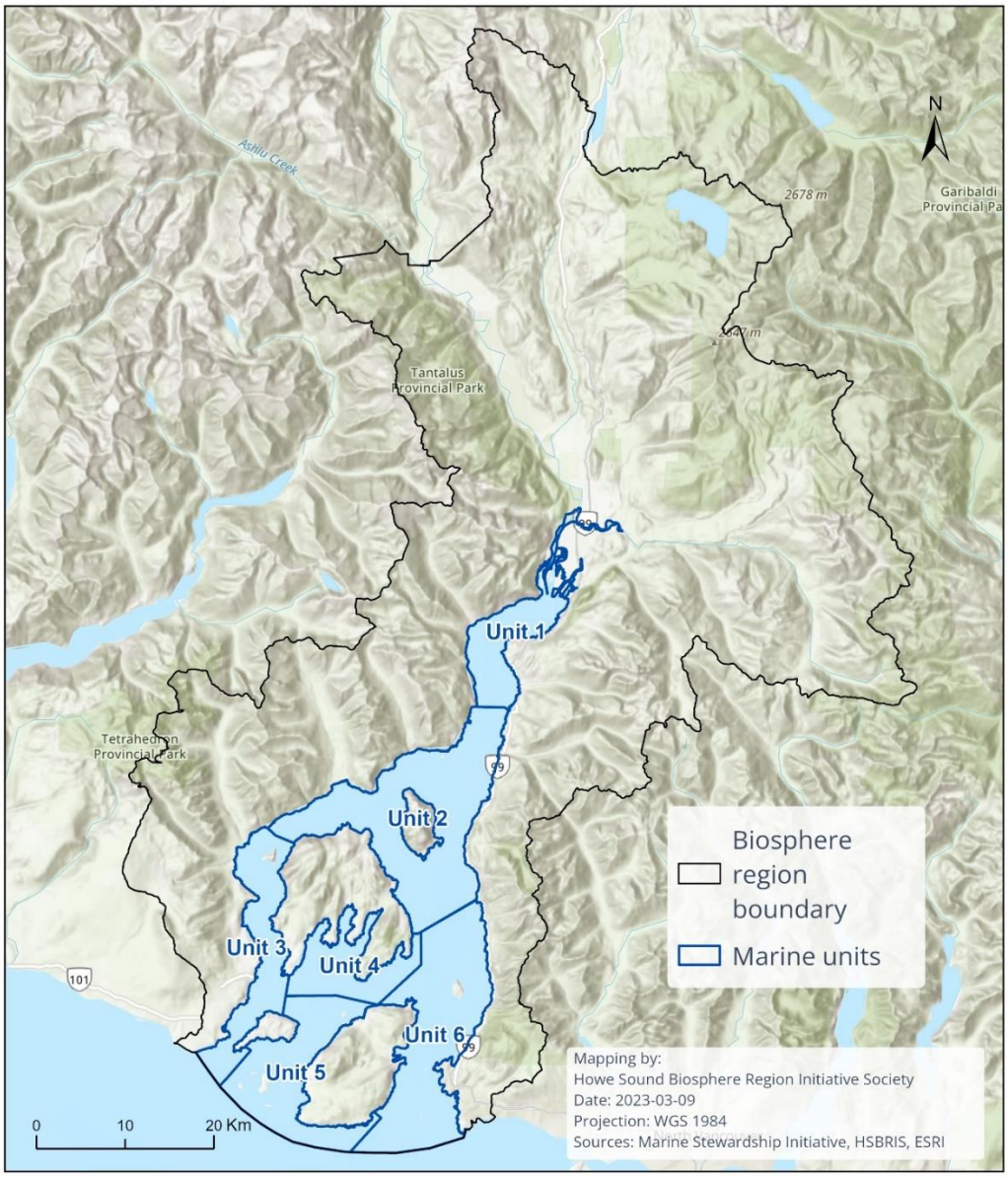

Figure 1: A map of the geographic scope of the area as defined by the boundary of the Biosphere Region and showing the 6 Marine Units.

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5.2 Stewardship Societies

This report focuses on the activities and programs carried out only by stewardship societies that have worked or are currently working with the Átl'ka7tsem/Howe Sound Biosphere Region.

This report focuses on local environmental stewardship with the specific lens of conserving and enhancing fish-bearing streams. Local environmental stewardship refers to the actions taken by individuals or groups to protect and responsibly use the environment with an overall aim of achieving specific environmental goals (Bennett et al., 2018). This can be a range of activities as individuals may have different capabilities, resources, and motivation.

The stewardship societies included in the report all have programs that involve the stewardship of fish-bearing streams. This may include restoring local stream habitats and fish populations, organizing community events to promote understanding of fish-bearing streams, facilitating community-based conservation and management of fish-bearing streams, advocating for the conservation of fish-bearing streams, and carrying out citizen science monitoring projects that contribute data to environmental monitoring efforts. Hereafter, these programs will be simply referred to as stewardship efforts.

5.3 Fish-bearing Streams

This Project will include fish-bearing streams that meet a specific criterion in order to be included. The criteria are as follows:

1) All streams with documented fish observations on the Marine Reference Guide, BC Public Records, Habitat Wizard, or from active stewardship societies will automatically be included.
2) Second order and higher streams will be included – when assessing state of stewardship efforts in fish-bearing streams, these streams will be referred to as potential fish-bearing streams.

Streams of second order and higher without any documented fish observations will be considered potentially fish-bearing because as stream order increases, so does depth and width (Platts, 1979). This increases habitat available to anadromous fish. Species of interest in this Project are unlikely to inhabit first order streams, therefore first order streams without documented fish observations will not be included (Platts, 1979).

5.4 Species of Interest

The main focus of this report is to understand the current state of knowledge on fish-bearing streams that provide habitats for anadromous fish species. This includes coho, chum, Chinook, pink, and sockeye salmon, as well as Dolly Varden and Coastal Cutthroat trout.

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6 Methods

This study is divided into two sections:

- Part I: The Marine Reference Guide
- Part II: The State of Stewardship in Átl'ka7tsem/Howe Sound

The methods used for each section are described below.

6.1 Part I: The Marine Reference Guide

Part I of this report consist of a desktop analysis to determine the current state of knowledge on fish-bearing streams in the Átl'ka7tsem/Howe Sound Biosphere according to the Marine Reference Guide (hereafter referred to as MRG). Information compiled in Part I of this Project will go on to support objectives for Part II.

Using the data from the MRG, an inventory of documented fish-bearing streams in the Howe Sound Biosphere was created. The streams included in the inventory were considered to be fish-bearing so long as the stream included data which demonstrated that the stream was fish-bearing.

When looking for information in the MRG on fish-bearing streams, 17 layers categorized as FISH layers can be found. For the purpose of this study, two layers were chosen in order to classify a stream a fish-bearing for the purposes of this Project:

1. "Fish Observation Points"; Known BC Fish Observations from Data BC, 2020.
2. "Salmon bearing streams" from OceanWise, Ocean Watch Howe Sound Edition, 2017

These data layers were selected because they contain information that documents the presence of fish species that fall under the scope of the species of interest; salmon species, Dolly Varden, Cutthroat trout, and Coastal cutthroat trout.

Taking from the attribute table of the two data layers on the MRG, a list was created that represents all the documented fish-bearing streams according to the MRG. This list included the stream name, stream order, and Marine Unit associated with the stream.

The list of documented fish-bearing streams from the MRG was compared to other relevant resources on fish-bearing streams to determine any gaps in the current data on fish-bearing streams in the Marine reference Guide, supporting the first objective of this Project.

Resources used during the desktop analysis include:

- Habitat Wizard
- FIDQ
- EcoCat
- Fisheries Information Summary System
- Community Mapping Network

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6.2 Part II: The State of Stewardship in Átl'ḵa7tsem/Howe Sound

Part II of this report focused on understanding the current state of stewardship efforts within Átl'ḵa7tsem / Howe Sound. Stream stewardship societies were identified to be included in the report if they have been or are currently active within Átl'ḵa7tsem/Howe Sound and focus on the conservation and enhancement of fish-bearing streams. The groups included in the analysis are:

- Squamish River Watershed Society
- Squamish Streamkeepers Society
- Sunshine Coast Streamkeepers Society
- Bowen Island Fish and Wildlife Club
- West Vancouver Streamkeeper Society
- Gambier Island Conservancy
- Squamish Nation

A Complete list of participants of this Project is provided in the Appendix.

Background research was conducted to compile available information on which streams the societies work in as well as any publicly available information on past and present stewardship efforts being conducted by these groups. Representatives for each society were contacted and asked to participate in this study. If the representatives chose to participate in the study, both interviews and surveys were used to collect more information on overall goals, future projects, and other relevant information from the group.

Using information collected, an inventory was created that included all fish bearing streams, general information on the streams, fish observations, and a summary of the stewardship efforts conducted within. This inventory has been provided as a pairing document called "Stream Reports". The stream reports will be a detailed and easily accessible resource for stewardship societies to look up a stream to find recent fish observations, active and past stewardship efforts, location, and other relevant information (Figure 2).

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Stream Inventory Report

General Info			
Name:			
UTM			
Watershed Code:		Waterbody ID:	

Land Use	Details	Source
N/A		

	Marine Reference Guide	**Habitat Wizard**
Stream Order:		
Stream Length (km):		
Stream Magnitude:		
Salmon Bearing:		

Comparison of Most Recent Documented Fish Observation Points:			
Marine Reference Guide		**Habitat Wizard**	
Fish Species	*Observation Date*	*Fish Species*	*Observation Date*

Spawning Site	Details	Source
N/A		

Stewardship Monitoring and/or restoration work			
Society	Project Name/Description	Date	Source
Enhancement/Management			
Activity	Description	Date	Source

Figure 2: A blank Stream Report. These reports were used to create summaries of all relevant and available information of general stream information, land use, a comparison of classification and fish observations between the Marine Reference Guide and HabitatWizard, stewardship efforts and previous notable enhancements and management of the stream.

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7 Results

7.1 Part I

The desktop analysis revealed that there are a total of 98 documented fish-bearing streams in Átl'ka7tsem/Howe Sound, 45 of which are categorized as salmon-bearing. A final inventory of all documented fish-bearing streams from the Marine Reference Guide has been provided in the accompanying document called Stream Reports.

The data layer for streams on the MRG is provided by Data BC from the Freshwater Atlas Stream Network. This database provides the stream name, order, and shapefile for the Marine Reference Guide. The version of the Freshwater Atlas used on the guide was originally published March 9th, 2011, and was most recently updated on the 18th of March 2021. A limiting factor of using the Freshwater Atlas Stream Network is that many streams are missing information; for example, a stream may simply be missing its associated gazetted name or local name. A more significant example of missing information is that many existing streams have no data at all and therefore do not appear to exist on the Freshwater Atlas (Table 1). This issue exists on the MRG and HabitatWizard as both resources use the Freshwater Atlas for stream and creek layers. The base map provided on the MRG includes streams and stream names but is not an interactive layer like the Freshwater Atlas layer; therefore, analysis on this layer is not possible. Additionally, the base map is replaced by satellite imaging once viewing the map at a 1:20,000 scale. When attempting to do a primary desktop evaluation for stream inventories, it is recommended to inspect maps at a minimum scale of 1:20,000 (USDA, 2020). Since the base map changes to satellite view at this scale on the MRG, users must rely solely on the stream data provided by the Freshwater Atlas Stream Network. Streams that exist that are not included in this data source would therefore be missed if this guide were to be used as a primary resource on streams in Átl'ka7tsem/Howe Sound.

Table 1: Streams that are currently undocumented or missing from the MRG.

Area	Missing/Undocumented Streams
Squamish Area	Newport Creek Horse Creek Tenderfoot Creek (Figure 4) Thunderbird Creek (**Error! Reference source not found.**) W Meighan Creek (**Error! Reference source not found.**) E Meighan Creek (**Error! Reference source not found.**) L Stawamus River Thyestes Creek Brackendale Creek Brennan Channel Tiempo/Tiampo Creek and Channel (Figure 6) Harris Slough (Figure 3)
West Vancouver	Larson Creek (Figure 5) Wood Creek (Figure 5)
Sunshine Coast	Charman Creek

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A solution for this issue would be collaborating with stewardship societies to map and upload the missing streams.

Stream order of streams on the MRG and Habitat Wizard conflict. Both map applications use the Freshwater Atlas for streams and creek networks, however stream order for HabitatWizard is provided by Stream Reports associated with the stream. The Stream Reports on HabitatWizard were updated more recently than the data from the Freshwater Atlas attribute table and reflect information given on FIDQ Query. This discrepancy could lead to incorrect assessment and assumptions when carrying out desktop analyses.

Fish observations points are provided by the Knowledge Management Organization within Data BC. This dataset is called Known BC Fish Observations and was published on October 9th, 2020, and was most recently update on December 10th, 2020. This dataset contains reported fish sightings dating back to December 31st, 1904. The dataset includes the name of the agency that reported the fish, the species, activity and life stage of the fish, the date, and relevant information on the waterbody and location of sighting. The fish observation points in this dataset are predominantly sourced from reports published by consulting firms or government agencies. There is currently a lack of information from citizen scientists, such as stewardship societies, for fish observations points. There are multiple stewardship societies active within Átl'ka7tsem/Howe Sound but recorded observations from these groups are not reflected in the MRG. A potential source that could be used to enhance fish observation points would be through collaboration with the Pacific Streamkeepers Federation who run the Streamkeepers Database. This database compiles surveys from stewardship societies that include Salmonid Spawner Surveys and Juvenile Trapping and Identification. Surveys uploaded by stewardship societies include location information. This could be included in the MRG in the future for a more robust display of fish observations.

The OceanWise data provided for the layer "Salmon bearing" on the MRG is sourced from an OceanWise Ocean Watch publication. It is mentioned in the report that the list of salmon bearing streams is not a complete list (Levings, 2017). The original list was of 35 streams that are potentially streams used for salmon spawning. Since the publication of this report, 10 streams have been added as salmon bearing. Based on spawning surveys[1] from the stewardship societies, there are more salmon bearing streams versus what is reported on the MRG Salmon Bearing data layer. Sourcing from data collected by stewardship societies uploaded to the Streamkeepers Database (https://www.streamkeepers.info/) could enhance and extend knowledge of salmon bearing streams on the MRG. This could lead to a more accurate representation of distribution of salmon-bearing streams.

There is a current gap regarding the names and locations of important spawning channels on the MRG. Overall, spawning channels throughout Átl'ka7tsem/Howe Sound are not reflected in the MRG. Creating a layer to demonstrate the location, along with the name, and observed species using the channel would be a beneficial layer to contribute to public access and understanding of these important habitats.

[1] Spawning Surveys published by West Vancouver Streamkeepers, Squamish Streamkeepers, the Sunshine Coast Streamkeeping Society, and Bowen Island Fish and Wildlife Club have all published Salmonid Spawner Surveys accessible at: https://www.streamkeepers.info/

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Collaborating with stream stewardship societies would be a possible option to gather more information on confirmed and active spawning channels. Further documentation of these spawning channels can then go on to inform future restoration or enhancement programs as well as helping best inform decision making processes for land use.

The Marine Reference Guide is a great resource to for visualizing and investigating documented fish bearing streams. A key limit in the knowledge on fish-bearing streams of this application is a lack of representation of stewardship initiatives in the area. Citizen science groups like stewardship societies can address a wide range of ecological research questions and increase the scope and volume of available data (Johnston et al., 2020; Peters et al., 2015). Enhancing the MRG with information from a comprehensive inventory of stewardship efforts for the fish-bearing streams of Átl'ka7tsem/Howe Sound would give a more robust representation that reflects goals and motivations of the local citizen scientists active in the region.

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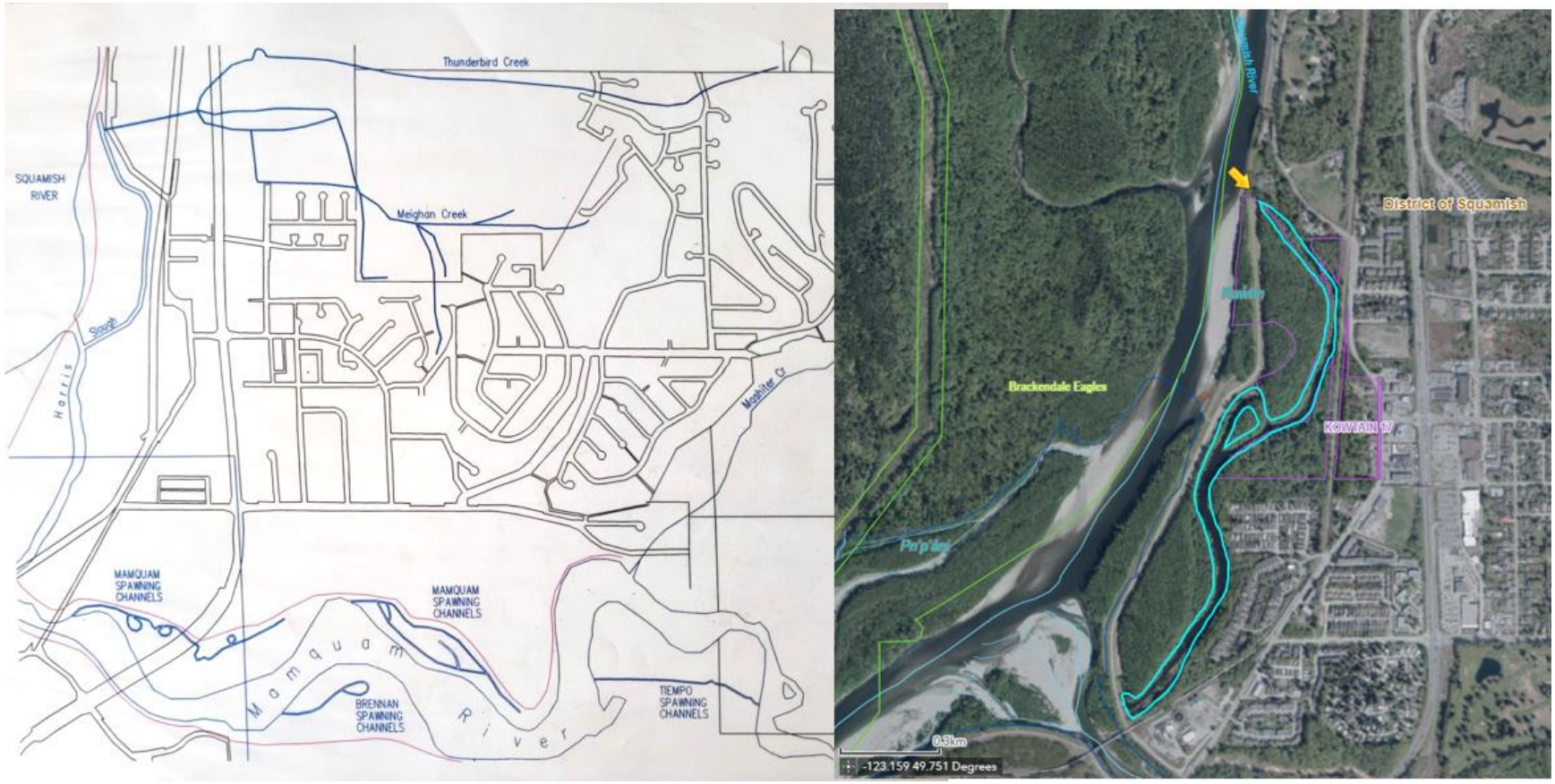

Figure 3: A comparison of mapped streams between a map (left) provided by Edith Tobe (SRWS, EB Tobe Enterprises) and a screenshot from the Marine Reference Guide (right). These maps both show Harris Slough - note that gazetted name is not included on MRG. Streams missing from the MRG map include Thunderbird Creek and Meighan Creek.

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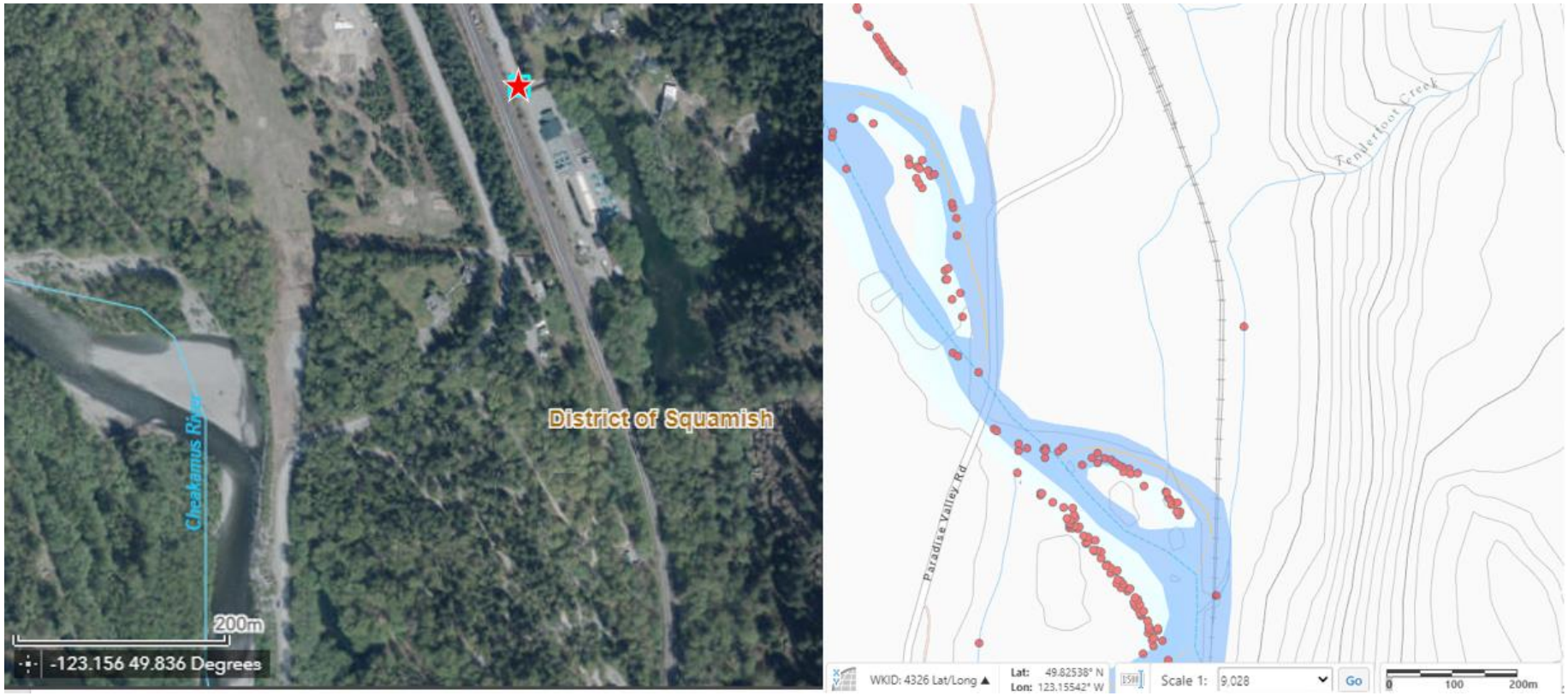

Figure 4: A comparison between the Marine Reference Guide (left) and Habitat Wizard (right). The red star in the left image marks the Tenderfoot Creek Hatchery. A line mapping Tenderfoot Creek is apparent on HabitatWizard; however, this exists only on the base map. A data layer that users can interact with for Tenderfoot Creek does not exists on either resource.

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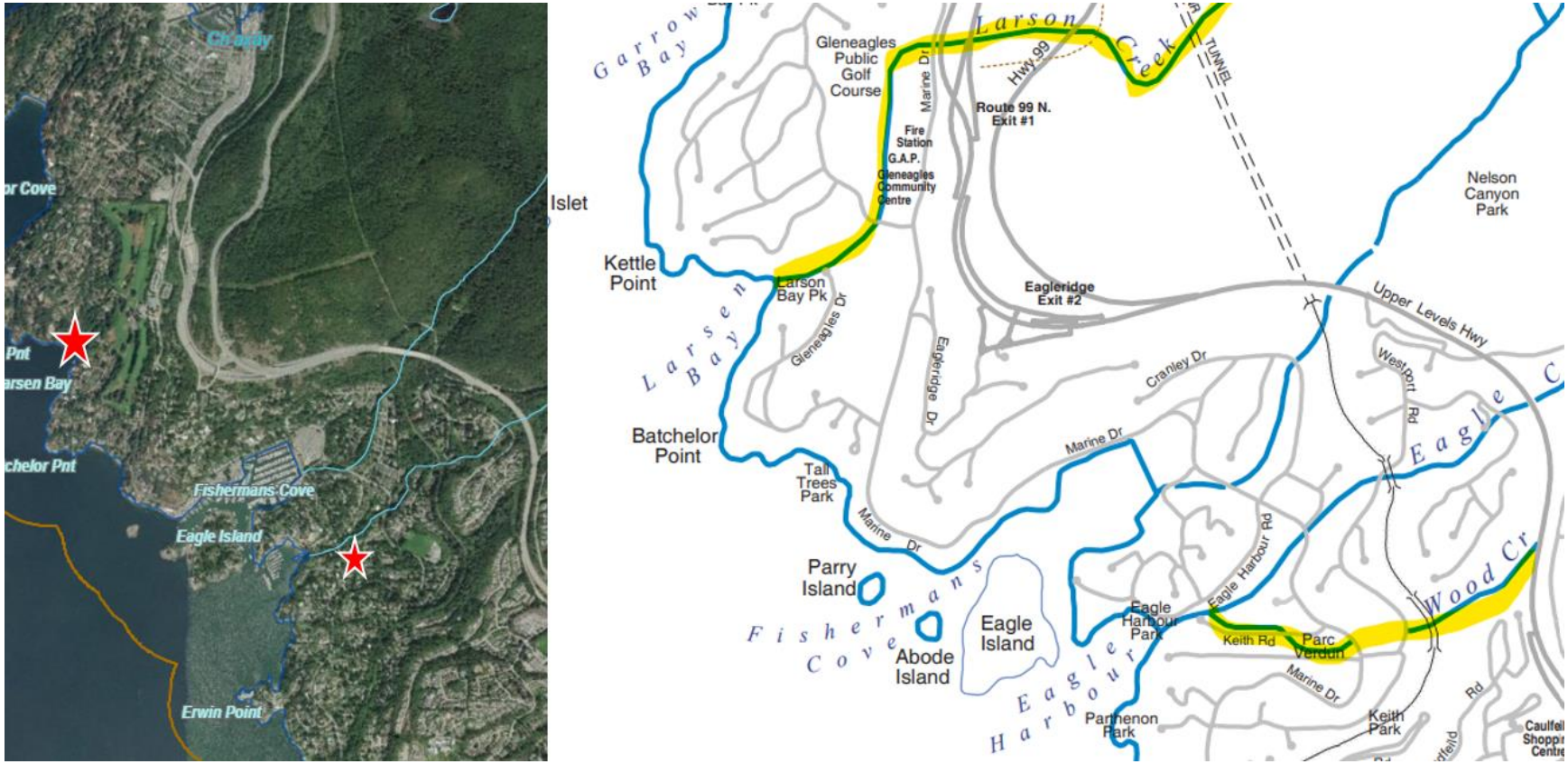

Figure 5: A comparison between the Marine Reference Guide and a map by the West Vancouver Streamkeepers Association (https://www.westvancouverstreamkeepers.ca/creek-data). Larson Creek and Wood Creek has been mapped by the West Vancouver Streamkeepers, however no data at all exists for the creeks on the Marine Reference Guide. Red stars in the left image indicate around where steam mouths should be.

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Figure 6: A comparison of mapped streams between a map provided by Edith Tobe (right) (SRWS, EB Tobe Enterprises) and a screenshot from the Marine Reference Guide (left). These maps both show the Mamquam River at Tiampo Creek- note that gazetted name is not included on MRG. The spawning channel is not properly mapped and there is no current data on Tiampo Creek/Spawning Channel on the MRG.

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8 Part II – State of Stewardship in Átl'ḵa7tsem/Howe Sound

This section is dedicated to reporting the past and present stewardship activities carried out by these groups and recommendations for future monitoring and restoration. The gap analyses will be separated into sections based on Marine Unit, save for Bowen Island and Gambier Island who have been given their own unit for the sake of simplicity.

Stewardship Societies and Programs in Átl'ḵa7tsem/Howe Sound

There are currently 7 stewardship societies working within the Átl'ḵa7tsem / Howe Sound with a focus on salmon enhancement in fish-bearing streams.

- Squamish River Watershed Society
- Squamish Streamkeepers
- Squamish Nation
- West Vancouver Streamkeepers
- Sunshine Coast Streamkeeping Society
- Bowen Island Fish and Wildlife Club
- Gambier Island Conservancy

Squamish River Watershed Society

The Squamish River Watershed Society (SRWS) has been conducting extensive habitat restoration projects in the Squamish area (SRWS-1, 2023). In 2005, Golder Associates Ltd. reported that the SRWS to have created over 160,000 m^2 of rearing and spawning habitats for coho, Chinook, pink, chum, and steelhead (Golder, 2005). This society takes a science-based approach to restoration and management activities (Tobe, 2023). SWRS works closely with the Squamish Nation, Tenderfoot Hatchery, Squamish Streamkeepers, DFO, local and provincial government and the community. SRWS frequently partners with the Squamish Nation and the Squamish Streamkeepers to carry out key physical restoration programs. Projects include the Elaho River Restoration Project partnered with Squamish Nation in 2017, Evans Creek re-watering in 2014, The Mamquam Reunion Project in 2005, and currently the Central Estuary Restoration Project (SRWS-1). Since 1998, SRWS volunteers have worked with the DFO to restore habitats that were altered by the installation of the Squamish River training dyke.

SRWS has worked in almost all Squamish River and Lillooet River watersheds to assess, map, and restore streams since it first started in 1993 (SRWS-1, 2023). This is formally documented in the Forest Renewal BC's Water Restoration Program which ran from 1995-1998. This effort identified priority areas for restoration and carried out in-stream restorations.

Education and community involvement is also taken on by volunteers of SRWS. Recently, SRWS has partnered with the Squamish Streamkeepers to create a Community Conservation Program that started in 2022. The SRWS Community Outreach Program educates students from Grade 2 to 6 where the students learn more about salmon and release salmon fry at coho and Cottonwood Park with support from the Tenderfoot hatchery (SRWS-1, 2023).

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Squamish Streamkeepers

The Squamish Streamkeepers is a charitable non-profit founded in 2000 with the Squamish River Watershed Society and became and independent society in 2006. Since then, the volunteer-based society has been focused on monitoring and restoring salmon populations within the Squamish River Watershed. Funding acquired by the Streamkeepers supports salmon stock assessment, public stewardship, habitat restoration/enhancement. The Squamish Streamkeepers operate in smaller salmon-bearing streams, spawning channels in Furry Creek, 29.5 Mile Creek and Swift Creek in Paradise Valley[2]. A significant success to be noted from the Squamish Streamkeepers is their work on Pacific Herring spawning recovery. In 2009, the society worked to improve herring spawning habitats by wrapping creosote piling that are lethal to herring eggs in in HDPE covers. This led to an increase in herring spawn and survival[2]. These findings were then shared and applied to pilings at Vancouver's False Creek Harbour. The Squamish Streamkeepers are actively involved in restoring herring populations. In 2021 the Streamkeeper's transferred herring eggs to Coal Harbour, a location where herring historically spawned. Squamish Streamkeepers work installing nets to help spawning herring in Senakw (False Creek), installing about 170 nets in the water in 2022[2].

Squamish Streamkeeper volunteers have been surveying salmon bearing creeks for over 20 years and have recently begun uploading the results of these surveys to their Facebook page and the Pacific Streamkeepers Federation Database. Reports from spawning surveys are also compiled annually and sent to DFO in the fall[3].

Squamish Nation

Sḵwx̱wú7mesh Úxwumixw, the Squamish Nation, has been active as a government since 1923. Territory of the Squamish People include Howe Sound watersheds, False Creek, English Bay, and Burrard Inlet[4]. As part governing activities, the Squamish Nation is active in conducting physical restoration of fish-bearing streams, for example working to open the Elaho River by blasting impassable rock features (GeoBreak, 2019). In partnership with Golder Associates, Squamish Nation has been carrying out enumerator data collection and surveys in Squamish Watersheds to track coho and Chinook populations for over 20 years. Data collection on fish-bearing streams relates to community engagement and supports rights and title in keeping restoration activities accountable to community needs and values. Squamish Nation trains and certifies members in monitoring techniques and is actively engaged with the community to identify key sites for restoration. A program run by Squamish Nation is the Capilano River Guardians.

West Vancouver Streamkeepers

The West Vancouver Streamkeepers (WVS) is a non-profit established in 2001 with the intention to foster and promote best practices in the protection of Pacific salmon populations. This organization is

[2] From Squamish Streamkeepers Website, accessed Jan 2023 at https://www.squamishstreamkeepers.org/what-we-do/pacific-herring-restoration/
[3] Squamish Streamkeeper Survey results accessed at https://www.streamkeepers.info/profile.php?user=3080
[4] From https://www.squamish.net/about-our-nation/

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volunteer based and actively conducts surveys and measures parameters in 22 creeks and tributaries in the District of West Vancouver[5].

WVS works with the Nelson Creek Hatchery to incubate chum and coho eggs annually. Volunteer members carry out all steps necessary to run the hatchery with supervision from the DFO. The hatchery has been operational since 1997[5]. Recorded fry releases run from 2006 to 2022. Coho and chum fry have been released in Cypress Creek, Nelson Creek, Eagle Creek, Wood Creek, Hadden Creek, Larson Creek, and West Brothers Creek. From September to December, WVS volunteers conduct spawner surveys (counting salmon returns in local creeks). Surveys are then conducted in the spring to count fry emerging.

This society has been successful in carrying out major physical restoration projects including the Rodgers Creek Estuary Enhancement in 2020, installation of fish ladder and debris racks in Nelson Creek in 2020 and repairing fish ladder and culverts in Lawson Creek in 2019 and 2020[5].

Community Outreach Programs are run by WVS including guiding school field trips, guiding high school students in conducting annual spawner surveys, and organizing storm drain painting. Other activities include invasive plant removal, native plant re-planting, and community clean-ups along shores and creeks.

Sunshine Coast Streamkeeper Society

The Sunshine Coast Streamkeeper Society is a recently formed streamkeeping society on the Sunshine coast. This volunteer-based program currently monitors 12 streams along the sunshine coast.

Following Pacific Streamkeepers methods, the SCSS has conducted Introductory Stream Habitat Assessments, Water Quality Surveys, Salmonid Spawning Surveys, and Streamside Planting. Results from these projects are uploaded and available on the Pacific Streamkeepers Federation database. Survey have been uploaded annually since 2018[6].

In partnership with the Pacific Salmon Foundation, the SCSS is taking part in the Climate Change & Salmonids Project. This involves the installation of air and water temperature loggers in streams that are downloaded every 3 to 6 months. Temperature loggers are installed in Roberts Creek, Malcolm Creek, Chaster Creek, Langdale Creek, Hutchinson Creek, Dakota Creek, Wilson Creek, and Angus Creek (S. Samples, Report Survey, 2023).

Monthly invasive species plant removals and native re-planting days are organized by the SCSS. On these days volunteers can be seen in Malcolm Creek, Roberts Creek, Chapman Creek, or Charman Creek actively working to restore the riparian zones.

The SCSS has been carrying out Salmon Spawn Surveys from 2018 to 2022. Data collected from these surveys are published on the SCSS website[7]. An overall motivation for the SCSS is to compile baseline data on salmon presence in streams along the Sunshine Coast. Working with the Ministry of

[5] From West Vancouver Streamkeepers Website, accessed https://www.westvancouverstreamkeepers.ca/about
[6] Surveys are accessible on the Streamkeepers Database, https://www.streamkeepers.info/profile.php?user=3035
[7] https://sunshinecoaststreamkeepers.com/spawning-counts-for-creeks-fall-2021/

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Transportation, SCSS is also working with the DFO to map culverts in the area that need replacement (S. Samples, Report Survey, 2023).

Bowen Island Fish and Wildlife Club

Bowen Island is home to the Bowen Island Fish and Wildlife Club, a volunteer organization that is dedicated to the conservation and enhancement of fish populations on the island, with a strong focus on restoring local salmon populations.

Tim Pardee, who has worked on the Bowen Island Fish and Wildlife Club (BIFWC) and is the head of the organization, offered information on the activities and responsibilities carried out by the organization. Bowen Island Fish and Wildlife Club has been successful in carrying out habitat restoration projects such as re-creating spawning areas and calming ponds in Davies Creek, building climbing pools in Explosives Creek, rebuilding spawning beds in the freshwater Lagoon, and removing sediment that has accumulated behind Carter Dam on Terminal Creek. These efforts were made possible by a strong resource of volunteers and funding from the Pacific Salmon Federation and Fisheries & Oceans Canada. Reports on each project are summarized in the corresponding document labelled Stream Reports and are also available in full on the Bowen Island Fish and Wildlife website.

Working with the Pacific Streamkeepers Federation, BIFWC carries out surveys using the Streamkeepers methodology and upload the data they collect to the Streamkeepers Central Database. In 2011 and 2014 BIFWC did Introductory Stream Habitat Surveys, Advance Stream Habitat Surveys, Water Quality Surveys, and Salmonid Spawning Surveys in Davies Creek and Terminal Creek. Between 2019 and 2022, these surveys were repeated, along with Juvenile Fish Trapping and Identification Surveys in Terminal Creek[8]. The data for these surveys can be accessed on the Pacific Streamkeepers Database.

BIWFC is mainly focused on salmon enhancement and works closely with the DFO to brood and release salmon fry from the Terminal Creek Hatchery. This hatchery produces chum and coho releases annually and will release pink salmon fry on odd years (Dearden, 2020). Data on salmon fry releases and brood results from 2015 to 2021 can be found on the Bowen Island Fish and Wildlife Club's website[9]. Fry are released in Upper Terminal, main and Lower Terminal Creek, Killarney Lake, Killarney Creek, Grafton Creek, Explosives Creek and up until recently Davies Creek. BIFWC made the decision to stop releasing salmon fry into Davies Creek in 2018 as mortality rates were too high. One theory of low success of fry release in Davies Creek is that the temperature of the creek has increased beyond the threshold of the fry. In 2021, there were no coho fry released into Killarney Creek due to increased temperatures. According to Pardee, Grafton Creek and Killarney Creek no longer seem to be a viable option for fry release because of an increase in water temperatures.

A new undertaking for the BIFWC is the Trap and Transport Program. In October of 2022, salmon traps were installed in Mannion Bay (BIWFC, 2023). The traps will act as a bypass to bring spawning salmon up to spawning habitats in Terminal Creek as the fish can no longer migrate up the fish ladder at Bridal Falls. The aim is to allow coho and chum to relocate above the impasse and spawn in Terminal Creek.

[8] Accessed March 2023: https://www.streamkeepers.info/
[9] BIFWC accessed at: https://bowenhatchery.org/

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The following results look at each Marine Unit and islands in Átl'ḵa7tsem/Howe Sound and repot on the documented and potential fish-bearing streams, the active stewardship efforts within the section, and some potential opportunities for future stewardship efforts. Each section contains a summary table including a list of documented and potential fish-bearing streams, whether the stream is salmon-bearing or not according to the MRG, and which species of interest have been observed in the streams. The columns for the species of interest are labelled as follows:

- CHI: Chinook salmon
- COHO: coho salmon
- CHUM: chum salmon
- CCT: coastal cutthroat trout
- CT: cutthroat trout
- PINK: pink salmon
- SS: sockeye salmon
- ST: steelhead
- UN: unidentified species

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8.1 Marine Unit 1

Documented and Potential Fish-Bearing Streams

Marine Unit 1 is the largest of the Marine Units in terms of number of watersheds and streams that are present in it. This marine unit includes streams outflowing into the Squamish Harbour from Britannia Beach up into the Squamish Valley.

Based on information gathered from public records, the MRG, and information shared by stewardships societies within Marine Unit 1, there are at least 65 fish bearing streams in Marine Unit 1. Of the 65, 19 streams are classified as salmon-bearing according to the MRG. The classified salmon-bearing streams in Marine Unit 1 are listed in the box below.

There are at least 65 fish-bearing streams in Marine Unit 1, but only 43 of these streams are listed as fish bearing by the MRG, as seen in Table 2. Table 3 summarises which of these streams have documented observations of any of the species of interest for this Project. In total, 39 of the 43 fish-bearing streams have records of any Chinook, coho, chum, cutthroat trout, coastal cutthroat trout, pink salmon, sockeye, steelhead, or Dolly Varden (Table 3).

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Table 2: This table includes a list of all documented and potential fish-bearing streams in Marine Unit 1. Included in this table is the stream name, order, and watershed code.

Creek Name	Stream Order	Watershed Code
Daisy Creek	2	900-086800
Thistle Creek	2	900-086900
Britannia Creek	3	900-087400
Gonzales Creek	2	900-089700
Shannon Creek	2	900-090400
Stawamus River	3	900-091000
Ray Creek	2	900-091000-34500
L Stawamus Creek	N/A	N/A
Unnamed	N/A	N/A
Sky Pilot Creek	2	900-091000-74100
Omer Creek	2	900-091000-77500
Loggers Lane Creek	2	900-091900
Unnamed Creek	1	900-091900-34004
Cattermole Creek	2	900-093500
Squamish River	6	900-097600
Monmouth Creek	2	900-097600-01100
Fries Creek	2	900-097600-09200
Lewis/Evans Creek	1	900-097600-15000
Thyestes Creek	2	900-097600-15100
Cheakamus River	5	900-097600-12900
Alpha Creek	1	900-097600-12900-53800-3480
22-Mile Creek	N/A	N/A
Serratus Creek	3	900-097600-22100
Tantalus Creek	3	900-097600-26800
Pilchuck Creek	3	900-097600-28400
Cloudburst Creek	1	900-097600-28400-20200
Spring Creek	2	900-097600-56300
Zenith Creek	2	900-097600-32400
Mawby Creek	2	900-097600-36600
Madden Creek	2	900-097600-37200
Ashlu Creek	3	900-097600-38300
Judd Slough	1	900-097600-11300
Cheakamus River	5	900-097600-12900
Cheekye River	4	900-097600-12900-03600
Brohm River	3	900-097600-12900-03600-1780
Hut Creek	N/A	900-097600-12900-12700
Swift Creek	1	900-097600-12900-11500
Culliton Creek	4	900-097600-12900-15400
Tenderfoot Creek	N/A	900-097600-12900-07804
Chance Creek	2	900-097600-12900-28100
Garibaldi Creek	2	900-097600-12900-28900
Rubble Creek	3	900-097600-12900-30100

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Table 2: (continued) This table includes a list of all documented and potential fish-bearing streams in Marine Unit 1. Included in this table is the stream name, order as well as whether or not the stream listed has been documented as fish-bearing on the MRG.

Creek Name	Stream Order	Watershed Code
Roe Creek	3	900-097600-12900-33800
Dryden Creek	1	900-097600-07500-11900
Brackendale/Cottonwood Creek	N/A	N/A
Hop Ranch Creek	2	900-097600-07500
Newport Creek	N/A	900-097600-09263-05849
Horse Creek	N/A	N/A
Mamquam River	5	900-097600-05100
W Meighan Creek	2	900-097600-07100
E Meighan Creek	N/A	N/A
Harris Slough	N/A	N/A
Thunderbird Creek	N/A	900-097600-08811
No-Name Creek	N/A	N/A
Mashiter Creek	4	900-097600-05100-08900
Ring Creek	3	900-097600-05100-12500
Raffuse Creek	3	900-097600-05100-26200
Skookum Creek	4	900-097600-05100-37500
Martin Creek	1	900-097600-05100-55000
Crawford Creek	3	900-097600-05100-60000
Tiampo Creek/Spawning Channel	N/A	N/A
Mill Creek	3	900-100100
Woodfibre Creek	3	900-100300
Foulger Creek	3	900-100800
Brennan Spawning Channels	N/A	N/A

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Table 3: A summary of the species presence within the documented fish-bearing streams of Marine Unit 1. This table also indicated if the stream is classified as salmon bearing according to the MRG.

	Salmon	Observed Fish Species									
Stream Name	**Bearing**	**CHI**	**CHUM**	**COHO**	**CCT**	**CT**	**PINK**	**SS**	**ST**	**DV**	**UN**
Daisy Creek	**Y**	X	X	X	Y	X	X	X	X	X	X
Thistle Creek	N	X	X	X	Y	X	X	X	X	X	X
Britannia	**Y**	X	X	X	Y	X	Y	X	X	Y	X
Shannon Creek	**Y**	Y	Y	Y	Y	X	X	X	X	Y	X
Stawamus River	**Y**	Y	Y	Y	Y	X	Y	X	Y	Y	X
Ray Creek	N	Y	X	Y	Y	X	X	X	Y	X	X
Loggers Lane Creek	**Y**	X	X	Y	X	X	X	X	X	X	X
Unnamed	N	X	X	Y	X	X	X	X	X	X	X
Squamish River	**Y**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Monmouth	**Y**	X	X	Y	X	X	X	X	Y	X	X
Mamquam River	**Y**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Mashiter Creek	**Y**	Y	Y	Y	Y	X	Y	Y	Y	Y	X
Ring Creek	N	Y	X	Y	Y	X	X	X	Y	Y	X
Raffuse Creek	N	X	X	X	X	X	X	X	X	Y	X
Skookum Creek	N	X	X	X	X	X	X	X	X	Y	X
Unnamed	N	X	X	X	X	X	X	X	X	Y	X
Crawford Creek	N	X	X	X	Y	X	X	X	X	X	X
Meighan Creek	N	X	Y	Y	Y	X	X	X	Y	Y	X
Thunderbird Creek	N	X	X	Y	X	X	X	X	X	X	X
Hop Ranch Creek	**Y**	X	Y	Y	Y	X	Y	X	Y	X	X
Dryden Creek	**Y**	X	Y	Y	Y	X	X	X	Y	X	X
Judd Slough	N	X	Y	Y	X	X	X	X	X	X	X
Fries Creek	N	X	X	Y	X	X	X	X	Y	X	X
Cheakamus River	**Y**	Y	Y	Y	Y	X	Y	Y	Y	X	X
Cheekye River	**Y**	X	X	Y	Y	X	X	Y	Y	Y	X
Brohm River	**Y**	Y	X	Y	Y	X	X	Y	Y	Y	X
Chance Creek	N	X	X	X	Y	X	X	X	X	X	Y
Garibaldi Creek	N	X	X	X	X	X	X	X	X	X	Y
Evans Creek	N	X	Y	X	Y	X	X	X	Y	X	X
Thyestes Creek	N	X	X	Y	X	X	X	X	Y	X	X
Tantalus Creek	N	X	X	Y	X	X	X	X	Y	X	Y
Pilchuck Creek	**Y**	Y	Y	Y	Y	X	Y	X	Y	Y	X
Cloudburst Creek	**Y**	X	X	Y	Y	X	X	X	Y	X	X
Mawby Creek	**Y**	X	X	Y	X	X	X	X	X	X	X
Madden Creek	N	Y	X	Y	X	X	X	X	Y	X	X
Ashlu Creek	**Y**	Y	Y	Y	Y	X	Y	Y	Y	Y	Y
Mill Creek	**Y**	X	X	Y	X	X	X	X	Y	Y	Y
Woodfibre Creek	N	X	X	X	Y	X	X	X	X	X	Y
Foulger Creek	N	X	X	X	X	X	X	X	X	X	Y

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Stewardship Efforts within Marine Unit 1

Squamish River Watershed Society, Squamish Nation, and the Squamish Streamkeepers are all active in streams within Marine Unit 1 (Table).

Table 4: A summary of stewardship activities within the Marine Unit 1 based on publicly available information, published reports, interviews with active members, and survey reports.

Creek Name	Project Name	Description	Date	Stewardship Society
Ashlu Creek	Log Jam Removal	Volunteers went to Ashlu Creek N and opened log jams	Jul-21	Squamish Streamkeepers
Ashlu Creek	Chinook and coho Enumeration	Enumeration of salmon present collected for internal use.	1996 - Present	Squamish Nation
Brackendale Creek	Enhancement	Added spawning material into head pond.	2013	Squamish Streamkeepers
Brackendale Creek	Salmonid Spawner Surveys	Volunteers conduct counts of spawning salmon	2000 -Present	Squamish Streamkeepers
Brennan Channel	Chinook and coho Enumeration	Enumeration of salmon present collected for internal use.	1996-Present	Squamish Nation
Brennan Spawning Channels	Salmonid Spawner Surveys	Volunteers conduct counts of spawning salmon	2000 -Present	Squamish Streamkeepers
Britannia Creek	Monitoring Water Temperature	Water temperature loggers installed to collect data. Project no longer active.	2020-2021	SRWS
Britannia Creek	Chinook and coho Enumeration	Enumeration of salmon present collected for internal use.	1996 - Present	Squamish Nation
Brohm River	Brohm River Watershed Restoration Program	Enhancement and Restoration	Sep-98	SRWS
Cheakamus Creek	Chinook and coho Enumeration	Enumeration of salmon present collected for internal use.	1996 - Present	Squamish Nation
E Meighan Creek	Salmonid Spawner Surveys	Volunteers conduct counts of spawning salmon	2000 -Present	Squamish Streamkeepers
Furry Creek	Chinook and coho Enumeration	Enumeration of salmon present collected for internal use.	1996 - Present	Squamish Nation

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Table 4: (continued) A summary of stewardship activities within the Marine Unit 1 based on publicly available information, published reports, interviews with active members, and survey reports.

Creek Name	Project Name	Description	Date	Streamkeeping Society
Horse Creek	Enhancement	Added spawning material to Creek.	2013	Squamish Streamkeepers
L Stawamus River	Salmonid Spawner Surveys	Volunteers conduct counts of spawning salmon	2000 -Present	Squamish Streamkeepers
L Stawamus River	Chinook and coho Enumeration	Enumeration of salmon present collected for internal use.	1996 - Present	Squamish Nation
Loggers Lane Creek	Beaver Baffle Installation	Beaver Baffle installed at Loggers Lane Creek by Streamkeepers.	July 9 2020	Squamish Streamkeepers
Loggers Lane Creek	Salmonid Spawner Surveys	Volunteers conduct counts of spawning salmon	2000 -Present	Squamish Streamkeepers
Mamquam Blind Channel	Community Clean up	Removed 13 derelict vessels from the channel.	2014	Squamish Streamkeepers
Mamquam River	Chinook and coho Enumeration	Enumeration of salmon present collected for internal use.	1996 - Present	Squamish Nation
Mamquam River Watershed	Mamquam River Reunion	Flood gate installed through Mamquam River Dyke.	2005	SRWS
Mamquam Spawning Channel	Coho salmon fry rescue	Approximately 700 Coho fry rescued	Aug-20	Squamish Streamkeepers
Mamquam Spawning Channel	Coho salmon fry rescue	Approximately 900 coho fry rescued and relocated to Mashiter Spawning Channel.	Jul-21	Squamish Streamkeepers
Mamquam Spawning Channel	Coho salmon fry rescue	Approximately 300 coho fry rescued and relocated to Mashiter Spawning Channel.	Jul-21	Squamish Streamkeepers
Mamquam Spawning Channel	Salmonid Spawner Surveys	Volunteers conduct counts of spawning salmon	2000 -Present	Squamish Streamkeepers
Mashiter Creek	Chinook and coho Enumeration	Enumeration of salmon present collected for internal use.	1996 - Present	Squamish Nation

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Table 4: (continued) A summary of stewardship activities within the Marine Unit 1 based on publicly available information, published reports, interviews with active members, and survey reports.

Creek Name	Project Name	Description	Date	Streamkeeping Society
Shovelnose Creek	Chinook and coho Enumeration	Enumeration of salmon present collected for internal use.	1996 - Present	Squamish Nation
Squamish River Estuary	Restore the Shore	Modifying lower training berm to open up over 144 hectares of estuary habitat.	Jan-23	SRWS
Squamish River Estuary	The Blue Carbon Project	Generating off-set funding for estuary restoration.	2014	SRWS
Squamish River Estuary	Central Estuary Restoration Plan	Developed to improved Chinook salmon stocks.		SRWS and Squamish Nation
Squamish River Estuary	Southern Training Berm Removal (Phase 2)	Beginning of the removal of Southern Training Berm	2020-2022	SRWS
Squamish River Estuary	Central Estuary Restoration Plan - Biophysical Monitoring by LTEC	LTEC monitored sediment accretion, water levels and quality, and wetland vegetation growth. Project no longer active.	2018-2020	SRWS
Squamish River Estuary		Tidal channel restoration in Squamish River Estuary	2005	SRWS
Squamish River Estuary	Central Estuary Fisheries Monitoring Program	Monitoring Chinook, chum, and coho.	2020-2021	SRWS, Stephanie Lingard
Squamish River Estuary		Replaced 2 culverts that were too small and replaced with larger box culverts to allow fish passage.		SRWS
Squamish River Estuary	Squamish Estuary Marsh Transplant	Restoring fish passage	May-00	SRWS
Squamish River Estuary	Squamish Estuary Wood Debris Removal	Excess woody debris removed and replanting or riparian zone	Mar-00	SRWS
Squamish River Estuary	Watershed Restoration Program 1998-1999 Squamish Valley Projects	Mamquam pond restoration, Cheakamus Pond restoration, and Squamish River Estuary Channel Restoration	Jan-99	SRWS
Squamish River Watershed	Chinook and coho Enumeration	Enumeration of salmon present collected for internal use.	1996 - Present	Squamish Nation

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Table 4: (continued) A summary of stewardship activities within the Marine Unit 1 based on publicly available information, published reports, interviews with active members, and survey reports.

Creek Name	Project Name	Description	Date	Streamkeeping Society
Squamish River Watershed	Squamish River Watershed 1998 Riparian Monitoring Project	Longterm project for monitoring and restoration within the Squamish River Watershed.	Jan-98	SRWS
Stawamus River	Monitoring Water Temperature	Temperature logger installed to collect water temperature. No longer active.	2020-2021	SRWS and LTEC
Stawamus River	Chinook and coho Enumeration	Enumeration of salmon present collected for internal use.	1996 - Present	Squamish Nation
Swift Creek	Coho salmon fry rescue	Approximately 1000 Coho fry rescued near second bridge.	Aug-22	Squamish Streamkeepers
Swift Creek	Walking Survey	Pink salmon reported by Streamkeeper Jack Cooley.	2019	Squamish Streamkeepers
Swift Creek	Walking Survey	Reported as drying quickly and endangering Coho fry.	Jul-20	Squamish Streamkeepers
Swift Creek	Coho salmon fry rescue	Approximately 500 coho fry rescued from Swift Creek	Jul-20	Squamish Streamkeepers
Swift Creek	Coho salmon fry rescue	Approximately 1100 coho fry rescued from Swift Creek	Aug-20	Squamish Streamkeepers
Swift Creek	Coho salmon fry rescue	Approximately 1000 coho fry rescued from lower Swift Creek.	Jul-21	Squamish Streamkeepers
Thunderbird Creek	Salmonid Spawner Surveys	Volunteers conduct counts of spawning salmon	2000 -Present	Squamish Streamkeepers
Tiampo Creek	Salmonid Spawner Surveys	Volunteers conduct counts of spawning salmon	2000 -Present	Squamish Streamkeepers
Tiampo	Tiampo Coho Refuge Habitat Restoration Project	Enhancement of Tiampo Spawning pools	2014	SRWS
Tiampo		Digging Tiampo refuge pools.		SRWS
Tiampo	Salmonid Spawner Surveys	Annual Spawn Surveys		Squamish Streamkeepers
W Meighan Creek	Fence Building	Installed a split rail fence protecting W Meighan Creek spawning salmon.	21-Aug	Squamish Streamkeepers
W Meighan Creek	Salmonid Spawner Surveys	Volunteers conduct counts of spawning salmon	2000 -Present	Squamish Streamkeepers

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Potential Areas for Restoration/Monitoring

Stream Mapping

Many streams that the SRWS and Squamish Streamkeepers monitor have no data present in the Freshwater Atlas and therefore no information on the streams is available on the MRG. A potential future project would be to map the missing streams in order to create a data layer that can be used on the MRG. Unmapped streams include:

- Thunderbird Creek
- W Meighan and E Meighan Creek
- Horse Creek
- Brackendale/Cottonwood Creek
- Brennan Spawning Channels
- Tiampo Creek/Spawning Channels
- Newport Creek
- Magnolia Creek
- Harris Slough
- Tenderfoot Creek

Tiampo Spawning Channel

Ponds have been dug previously to create year-round refuge for coho in t the Tiampo spawning channel (SRWS, 2014). However, this spawning channel has been reported to dry out every summer by Squamish Streamkeeper Jack Cooley[10]. Chum and coho were reported to be seen on the Squamish Streamkeeper Facebook page in 2020, showing this spawning channel is still of important use for the two species. As the area is recently reported as drying out, there is a need to re-evaluate the current state of the rearing ponds. There may be an opportunity to further restore this spawning channel and avoid any waterless periods.

Swift Creek

Squamish Streamkeepers have reported rescuing coho salmon fry in 2020, 2021, and 2022. Swift Creek has been drying out for the past 3 summers between July and August[10]. An assessment to determine if there is any restorative work that can be carried out or preventative action that can be taken in 2023 prior to the creek drying out is recommended.

Revisiting Urban Water Courses in the District of Squamish

During an interview for this report, Edith Tobe, president of the Squamish River Watershed Society and professional biologist, mentioned that it is worth revisiting urban water courses such as Brohm Creek, Dryden Creek, Harris Slough, North and South Mamquam River, Stawamus River, and L Stawamus River, and Magnolia Creek. Tobe reported that SRWS is not currently monitoring these creeks and that newer information on the current state of these creeks would be beneficial.

[10] Anecdotal, Facebook Post by Jack Cooley on https://www.facebook.com/groups/721286331781408/

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Ashlu Creek

Jack Cooley, a Squamish Streamkeeper, reported sightings of pink salmon in Ashlu Creek. Additionally, a 2006 report by Golder Associates for the Pacific Salmon Foundation highlighted a lack of information regarding salmonid populations in Ashlu Creek (Golder, 2006). SRWS recommended possible enhancements for Ashlu including fry planting and barrier removals (SRWS-4, 2002). Squamish Streamkeepers were able to remove log jams from Ashlu in 2021.

Cheekye River

Cheekye River has recorded presence of sockeye, coho salmon, steelhead, cutthroat trout, dolly varden, and rainbow trout. Triton reported that the confluence of Cheekye River and Cheakamus River has been elevated which may stop fish passage, as well as a barrier to fish passage at 6 km from this point (1993). A report by the SRWS suggests fish habitat is limited in the in this river as a result of low habitat complexity and an unstable watershed (SRWS-4, 2002). A more recent Level 1 Assessment to determine the functional conditions of this water course may be beneficial to determine is measures can be taken to increase fish passage.

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8.2 Marine Unit 2

Documented and Potential Fish Bearing Streams

Marine Unit 2 focuses on streams that flow into Howe Sound from the east and west sides of the Sound. Islands present within this Marine Unit will be analyzed independently. In total, there are 18 documented fish bearing streams, 6 of which are classified as salmon-bearing streams, as seen in Table 5 and Table 6 (MRG; FIDQ; HabitatWizard). There are 4 creeks in Marine Unit 2 that are not documented as fish bearing but fall within the scope of this Project. These streams are Downing Creek, Bain Creek, Stolterfoht Creek, and an unnamed stream (Watershed Code: 900-107200, Waterbody ID: 265245).

Table 5: This table lists the documented and potential fish-bearing streams for the east side of Marine Unit 2. Streams are included if they have previously been documented as fish-bearing or if they met the criteria of a fish-bearing stream as defined by this Project. The second column indicates if the stream is classified as salmon-bearing according to the MRG. Observed fish species found from the MRG, HabitatWizard, and FIDQ.

Stream Name	Salmon Bearing	Observed Fish Species									
		CHI	CHUM	COHO	CCT	CT	PINK	SS	ST	DV	UN
Loggers Creek	**Y**	X	X	Y	X	X	X	X	X	X	X
Deeks Creek	N	X	X	X	Y	Y	X	X	X	X	X
Bertram Creek	N	X	X	X	X	Y	X	X	Y	X	X
Kallahne Creek	N	X	X	X	X	Y	X	X	X	X	X
Porteau Creek	N	X	X	X	X	Y	X	X	X	X	X
Furry Creek	**Y**	X	Y	Y	Y	Y	X	X	Y	Y	Y
Phyllis Creek	N	X	X	X	X	X	X	X	X	X	X
Cyrtrina Creek	N	X	X	X	X	X	X	X	X	Y	X
Unnamed Creek #9	N	X	X	X	X	Y	X	X	X	X	X
Downing Creek	N	X	Y	Y	Y	Y	X	X	Y	Y	X
Bain Creek	N	X	X	X	X	X	X	X	X	X	X
Stolterfoht Creek	N	X	X	X	X	X	X	X	X	X	X
Unnamed Creek	N	X	X	X	X	X	X	X	X	X	X

Table 6: This table lists the documented and potential fish-bearing streams for the west side of Marine Unit 2. Streams are included if they have previously been documented as fish-bearing or if they met the criteria of a fish-bearing stream as defined by this Project. The second column indicates if the stream is classified as salmon-bearing according to the MRG. Observed fish species found from the MRG, HabitatWizard, and FIDQ.

Stream Name	Salmon Bearing	Observed Fish Species									
		CHI	CHUM	COHO	CCT	CT	PINK	SS	ST	DV	UN
Ellesmere Creek	**Y**	X	X	Y	X	Y	X	X	X	Y	X
Potlatch Creek	**Y**	Y	Y	Y	Y	Y	X	X	X	Y	X
McNab Creek	**Y**	Y	Y	Y	Y	Y	Y	X	Y	X	X
Harlequin Creek	N	X	X	X	X	Y	X	X	X	X	X
Unnamed Creek	N	X	Y	Y	X	Y	X	X	X	X	X
Box Canyon Creek	N	X	X	Y	Y	Y	X	X	Y	X	X

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Stewardship Efforts within Marine Unit 2

Most creeks within this unit are less easily accessible by the public, which is apparent when compiling a history on stream stewardship efforts within them. However, there is some activity within these creeks, conducted by the Squamish Nation and the Squamish River Watershed Society.

The Squamish Nation has been conducting enumeration data collection and surveying with Golder Associates in Furry Creek and data collected is used internally (Squamish Nation, Report Survey, 2023).

From 2020 to 2021, the Squamish River Watershed Society worked with Lake Trail Environmental to install underwater temperature loggers to monitor the following streams: Potlatch Creek, McNab Creek, Furry Creek, and Porteau Cove (L. Tryon, personal correspondence, 2023). This program has since ceased but based on the use of waterproof epoxy to attach loggers at site, it may be possible that the loggers are there and ready for future use. Data from these loggers are currently unpublished.

Potential Streams for Future Monitoring and Restoration Efforts

Downing Creek and Phyllis Creek

As of 2022, Black Mount Logging Inc. has active cut blocks on either side of Phyllis Creek and Downing Creek. Phyllis Creek has recorded sightings of Rainbow trout and, although it has no documented sightings of fish, it is worth looking into Downing Creek (FIDQ; Habitat Wizard). Both creeks are tributaries of Furry Creek, which has several observed fish sightings and is classified as salmon-bearing (MRG; FIDQ; Habitat Wizard). The Furry Creek watershed has also had extensive upslope restoration and enhancement throughout the nineties (SRWS-3, 2002). Logging roads near Downing Creek were reported to be unstable and a threat to the watershed in a 1996 report by the Squamish Forest District (SRWS-3, 2002). As logging practices continue in the area the creeks, should be assessed to ensure present logging practices do not pose a threat to the watershed.

Porteau Cove

In an email correspondence for this report, local fish biologist Colin Levings reported seeing coho fry in the small creeks surrounding Porteau Cove. In addition to these reported coho fry, cutthroat trout have been observed in Porteau creek in 2002 (MRG; FIDQ). Porteau Cove is an active campground and boat launch, meaning that human disturbance in the area is relatively high. These potential and documented fish sightings merit a closer look at fish activity in Porteau Cove. As an actively used site for camping, windsurfing, and boating, there is likely potential restorative measures to be taken to increase potential presence of coho in the system.

Restarting/Expanding Temperature Logging Activities

The Squamish River Watershed and Lake Trail Environmental set up temperature loggers in Potlatch Creek, McNab Creek, Porteau Cove, and Furry Creek in Marine Unit 2. Restarting this data collection and expanding it to documented fish-bearing streams like Loggers Creek, Deeks Creek, Phyllis Creek, Ellesmere Creek, and the unnamed creek could inform future stewardship activity. This data can provide insight into temperature variability, finding thermal refuges for sensitive species, and highlighting the

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effectiveness of management actions to mitigate impacts of climate change on streams (Liang et al., 2013).

Bertram Creek

During the Sea to Sky Highway Improvement Project, streams that cross the Sea to Sky Highway underwent fish surveys and biophysical inventory and assessment (FIDQ). Provincial record states that, during the assessment of Bertram Creek, low densities of Cutthroat trout were present and rock material was found that may be generating acid (FIDQ). Another significant report on Bertram Creek is the installation of a culvert 7.5 km downstream during highway improvement (FIDQ). Further research into Bertram Creek surveying and monitoring did not reveal any follow up on any potential generation of acid from rock material in the stream.

McNab Creek and Surroundings Streams

McNab Creek has 10 tributaries that are documented as fish bearing, all of which can be found in the Stream Report document provided with this report. McNab Creek flows into a large estuary that receives water from Harlequin Creek and an unnamed salmon-bearing creek (Watershed Code: 900-107200, Waterbody ID: 265245). Land use in the McNab watershed is predominantly forestry use ad there are currently active cut blocks being logged by Black Mountain Logging Inc. and Fortis BC (FIDQ). There are retired cut blocks surrounding the upper reaches of McNab Creek. Public records on FIDQ report extensive landslides in the area suggesting unstable bank from logging practices as well as reported thinning of riparian vegetation which can lead to increased stream temperatures.

A significant reason to focus on McNab Creek is the development of the gravel mine proposed by BURNCO Rock Products Ltd. The McNab estuary is one of three remaining intact estuaries in Átl'ka7tsem/Howe Sound.

Finally, John Buchanan, a local Streamkeeper, has published recorded footage of McNab Creek from 2017 compared to 2022[11]. The footage shows clips of the creek filled with salmon in September of 2017 followed by footage of the creek, completely dry in October of 2022. This was a drastic change noted by Buchanan and it would be worth following up in the fall to see if this was an anomaly or if it there has been a significant shift in flow in McNab Creek leading to increased events of drying out.

McNab and Potlatch Creek

An audit released in 2009 by the Forest Practices Board investigated British Columbia Timber Sales (BCTS) program and timber sale licence holders in Powell River Business Unit where Potlatch Creek and McNab Creek are located. It was reported that BCTS agreed to carry out road maintenance activities to reduce risks to fisheries on forest service road near Potlatch Creek and McNab Creek (Forest Practices Board, 2009). The Board also discovered 81 crossing structures (mainly wooden box culverts) had been identified by BCTS to have been structurally unsound but had not taking any action towards fixing these crossing points. Follow up on any maintenance of insufficient road crossings is unavailable, suggesting the need for assessing and fixing crossings in the area.

[11] Accessed at: https://www.youtube.com/watch?v=cL-FSi9tMVY

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8.3 Marine Unit 3

Documented and Potential Fish Bearing Streams

Marine Unit 3 is located on the west side of the Howe Sound, on the Sunshine Coast. For simplicity, this section focuses on the watersheds flowing into the Marine Unit from Sunshine Coast only. Islands that fall within Marine Unit 3 will be analyzed independently (Bowen Island, Gambier Island, Keats Island). Over 8 watersheds flow into Marine Unit 3 from the Sunshine Coast. There are 12 streams with documented fish observations in this unit and 9 of those streams are classified as salmon-bearing, according to the MRG (Table 7).

The text box below lists the documented fish-bearing streams within Marine Unit 3. Creek names listed in bold are also classified as salmon-bearing.

Table 7: This table lists the documented and potential fish-bearing streams that are found within Marine Unit 3. Streams are included if they have previously been documented as fish-bearing or if they met the criteria of a fish-bearing stream as defined by this Project. The second column indicates if the stream is classified as salmon-bearing according to the MRG. Observed fish species found from the MRG, HabitatWizard, and FIDQ.

Stream Name	Salmon Bearing	Observed Fish Species									
		CHI	CHUM	COHO	CCT	CT	PINK	SS	ST	DV	UN
Gibson Creek	N	X	Y	Y	X	Y	X	X	Y	X	Y
Soames Creek	**Y**	X	Y	Y	X	Y	X	X	X	X	X
Langdale Creek	**Y**	X	Y	Y	Y	Y	X	X	Y	X	Y
Hutchinson Creek	**Y**	Y	Y	Y	Y	Y	Y	X	X	X	X
Ouillet Creek	**Y**	Y	Y	Y	Y	Y	Y	X	Y	X	X
S Twin Creek	**Y**	X	Y	Y	Y	Y	X	X	X	X	X
N Twin Creek	N	X	Y	Y	Y	Y	X	X	X	X	X
Bear Creek	**Y**	X	X	Y	X	Y	X	X	X	X	Y
Dakota Creek	**Y**	Y	Y	Y	X	Y	Y	X	Y	Y	X
McNair Creek	**Y**	X	Y	Y	Y	Y	X	X	Y	Y	X
Mohawk Creek	N	X	X	X	X	Y	X	X	X	X	X
Rainy River	**Y**	Y	Y	Y	Y	Y	Y	X	Y	Y	X

Stewardship Efforts within Marine Unit 3

Sunshine Coast Streamkeepers Society (SCSS) monitor creeks along the Sunshine Coast and are active within this Marine Unit. Shirley Samples, the current president of the society, offered insight into the activities and responsibilities of the SCSS.

The SCSS have conducted surveys following the Pacific Streamkeeper methodology in streams since 2018. Within the scope of this Project, the SCSS has conducted surveys in 6 fish-bearing streams, as seen in Table 8. These streams are Langdale Creek, Gibson Creek, Hutchinson Creek, Ouillet Creek, Dakota Creek, and Charman Creek. Volunteers carrying out the surveys are trained by representatives from the Pacific Streamkeepers Federation.

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Table 8: A summary of the Pacific Streamkeeper Federation Modules conducted by the SCSS since 2018. Results from survey have been uploaded and are accessible on the Streamkeepers Database.

Stream Name	Pacific Streamkeeper Federation – Module Type Conducted in Stream
Langdale Creek	Water Quality Survey Juvenile Fish Trapping and ID Salmonid Spawner Survey
Gibson Creek	Water Quality Survey Streamside Planting Salmonid Spawner Survey
Hutchinson Creek	Water Quality Survey Juvenile Fish Trapping and ID Salmonid Spawner Survey
Ouillet Creek	Water Quality Survey Juvenile Fish Trapping and ID Salmonid Spawner Survey
Dakota Creek	Water Quality Survey Juvenile Fish Trapping and ID Salmonid Spawner Survey
Charman Creek	Water Quality Survey Streamside Planting Salmonid Spawner Survey

In partnership with the Pacific Salmon Federation, the SCSS has set up both air and temperature loggers in 8 streams, bolded stream names fall within project scope:

- Roberts Creek
- Malcolm Creek
- **Langdale Creek**
- **Hutchinson Creek**
- **Dakota Creek**
- Wilson Creek
- Chapman Creek
- Angus Creek – to be moved to Gray Creek

Data from these loggers are downloaded every 3 to 6 months and will soon be uploaded to the SCSS website to be made publicly available.

From 2018 to 2022, the SCSS conducted spawning counts in 7 streams, 3 of which fall within the scope of this study. Data from the spawning counts is accessible through the SCSS website. All streams surveyed by the SCSS are listed below, streams within scope are listed in bold font:

- Roberts Creek
- Chaster Creek
- **Gibson Creek**
- **Langdale Creek**
- Malcom Creek
- Angus Creek
- **Ouillet Creek**

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The SCSS runs a monthly Invasive Plant Removal/Native Plant Re-Planting initiative. SC Streamkeepers started this program in 2020 and have worked to remove invasive plants from riparian zones at Malcolm Creek, Roberts Creek, Chapman Creek, and Charman Creek. Charman Creek is the only stream included in this program that falls within the scope of the study.

A challenge mentioned by Samples regarding creek monitoring was that some creeks are not being monitored because they do not have someone in the area who can be accountable for monitoring. Of the 12 streams in Marine Unit 3 that fall within the scope of the project, only 6 of these creeks are involved in stewardship monitoring efforts. The 7 unmonitored streams are as follows:

- Soames Creek
- N Twin Creek
- S Twin Creek
- Bear Creek
- McNair Creek
- Mohawk Creek
- Rainy River

Access to these streams may be a limiting factor for stewardship societies as they are further away from residential areas however monitoring these streams would be valuable as the forests surrounded the creeks are heavily logged. The mouths of Ouillet Creek, Twin Creeks, and Bear Creek have lumber yards and log booms present, and the mouth of the Rainy River is the site for the Port Mellon Pulp Mill.

Potential Streams for Future Monitoring and Restoration Efforts

Accumulate Baseline Data in Creeks

Interviews with three representatives from the SCSS and the Sunshine Coast Conservation Association highlighted an overall need for baseline data on fish presence in streams on the Sunshine Coast. Historical data on fish presence and escapement for the area is hard to come by; Angela Kroning mentioned during an interview that certain reports on streams in the area are missing or have no written record, leaving the Sunshine Coast with no realistic baseline. Samples later reaffirmed this knowledge gap, mentioning an overall need for baseline data to prove streams are fish-bearing (Interview, March 8, 2023).

To ameliorate this situation there are two recommendations for future work to put forward:

1. Continue Salmonid spawner surveys in the streams currently included in these efforts and add more streams to the schedule. The recommended streams to add include Twin Creek, Bear Creek, Soames Creek, McNair Creek, Rainy River, and Mohawk Creek. Most of these streams are classified as salmon bearing on the Marine Reference Guide.
2. Using Traditional Ecological Knowledge from local First Nations and Local Ecological Knowledge to extend the historical baseline on fish populations in streams along the Sunshine Coast. One method to close the gap in knowledge on historical baselines is to interview and collect anecdotal data from locals to gain further insight into historical baselines. An example of this is a research article published by Eckert and colleagues where traditional ecological knowledge was

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collected on yelloweye rockfish populations and was used to extend the historical baselines for the population (Eckert et al., 2017).

Dakota Creek/Rainy Creek

Land use surrounding Dakota Creek and Rainy Creek is primarily consists of forestry. In 2019, logging roads in Dakota Valley were constructed. As a community watershed, Dakota Creek should be closely monitored for impacts due to these practices as run off from forest service roads may impact water quality.

Culvert Replacement

It was brought forward by Samples that many culverts in the area are old and act as barriers to fish passage (Interview, March 8, 2023). In a future project, the SCSS will be working with the DFO to map and potentially replace old and non-functional culverts.

Increasing scope of Temperature Logging

Adding temperature loggers to the outlying creeks would be a low effort method to increase baseline data; it is pertinent to understand the rate of stream temperature increases, as it impacts salmon spawning.

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8.4 Marine Unit 6

Documented and Potential Fish Bearing Streams

West Vancouver is the predominant landmark for Marie Unit 6. Watersheds from West Vancouver and Bowen Island flow into this Marine Unit. For simplicity islands within the project scope will be analyzed independently.

This unit contains 5 streams that have documented fish observation, 2 of which are classified as salmon bearing (see **Error! Reference source not found.**). In Marine Unit 6, there are 4 streams that meet the stream criteria of this study but are not documented as fish bearing. Theses streams are Montizambert Creek, Charles Creek, Harvey Creek, and Wood Creek.

Table 9: This table list the documented and potential fish-bearing streams that are found within Marine Unit 6. Streams are included if they have previously been documented as fish-bearing or if they met the criteria of a fish-bearing stream as defined by this Project. The second column indicates if the stream is classified as salmon-bearing according to the MRG. Observed fish species found from the MRG, HabitatWizard, and FIDQ.

Stream Name	Salmon bearing	Observed Fish Species									
		CHI	CHUM	COHO	CCT	CT	PINK	SS	ST	DV	UN
Eagle Creek	Y	X	Y	Y	Y	Y	X	Y	X	X	X
Nelson Creek	Y	Y	Y	Y	Y	Y	Y	X	Y	X	X
Larson Creek	N	X	X	X	X	X	X	X	X	X	Y
Magnesia Creek	N	X	X	X	X	Y	X	X	X	X	X
Yahoo Creek	N	X	X	X	X	Y	X	X	X	X	X
Charles Creek	N	X	X	X	X	X	X	X	X	X	X
Harvey Creek	N	X	X	X	X	X	X	X	X	X	X
Wood Creek	N	X	X	X	X	X	X	X	X	X	X

Montizambert Creek and Charles Creek were sampled in 2002 and 2003, during the Sea to Sky Highway Improvement Project, and showed no presence of fish (FIDQ). During a biophysical survey in 2003, it was determined that Charles Creek is unlikely to have any fish presence near Highway 99, due to a concrete aggregate channel, but it is suggested that there is the potential of fish presence near the railway that crosses the creek (FIDQ). However, no follow-up on Harvey Creek was found that can confirm this.

Stewardship Efforts within Marine Unit 6

The group West Vancouver Streamkeepers is active in Eagle Creek, Nelson Creek, Larson Creek, and Wood Creek (a tributary of Eagle Creek). Annual spawner surveys have been conducted in these creeks since 2018[12]. When carrying out these surveys, the Streamkeepers collect count on chum, coho, Chinook, and pink salmon. Based on Salmon Survey reports published on the West Vancouver Streamkeepers website, chum and coho are the predominant species with pink and Chinook being observed in smaller numbers from 2019 to 2022.

[12] West Vancouver Streamkeeper Spawner Surveys are accessed at https://www.westvancouverstreamkeepers.ca/spawner-surveys

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The temperatures of Eagle Creek and Larson Creek were recorded in 2016 and 2017 using automated instream loggers and there have been tests of the water quality twice a year, during this period, looking at dissolved oxygen, pH, and turbidity. In 2021, Nelson and Eagle Creek each had over 10 traps in each creek for a Fry Survey.

The Department of Fisheries and Oceans Canada Pacific Science Enterprise Center Community Stream Monitoring project is also currently active in West Vancouver. This Project is ongoing, collecting water temperature from Nelson Creek, Larson Creek, and Eagle Creek (DFO, 2013).

Potential Streams for Future Monitoring and Restoration Efforts

Larson Creek

Currently there is no information on Larson Creek in the MRG. This creek is included in West Vancouver Streamkeepers spawner surveys and the society recorded the temperature of the stream, via a temperature logger, from 2016 to 2017. From 2006 to 2017, volunteers from West Vancouver Streamkeepers released chum fry into Larson Creek. In 2018, the fish population of Larson Creek was nearly wiped out by a cement operation which killed over 80 Cutthroat trout (Richter, 2022). A follow up assessment of the current state of Larson Creek is therefore recommended. It would be beneficial to understand the state of water quality in Larson Creek and if there is potential to restart releasing salmon fry into the creek. John Barker, former president of West Vancouver Streamkeepers was quoted in a CBC interview saying that cutthroat trout population is roughly recovered to 50% of its original size (Baker, 2022). This creek therefore may be an ideal candidate to be surveyed more closely to track the recovery of the Cutthroat population.

Harvey Creek

During the Sea to Sky Highway Improvement Project in 2003, Harvey Creek was reported as having the potential to be fish-bearing below the railway crossing. No follow surveys or fish sightings have been reported. Local knowledge provided by Colin Levings adds that there have been sightings of adult pink salmon in the low reaches of Harvey Creek (e-mail correspondence, December 22, 2022). Levings also reported there could have been spawning activity, however the creek bed appears unstable. This creek therefore shows potential to be fish-bearing and may benefit from a proper habitat assessment with the potential to restore the creek bed to enhance spawning if it shows to be unstable. Harvey Creek is a water source for the Village of Lions Bay which means water quality (turbidity, bacteria, metals, and chemical levels) are monitored and managed by Public Works.

Yahoo and Magnesia Creek

Currently no stewardship efforts are active in these two creeks.

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8.5 Bowen Island

Documented and Potential Fish Bearing Streams

Bowen Island has a strong history of fishing for salmon, herring, trout, and cod as they were popular and culturally valued fish to catch. The streams on Bowen Island are relatively small, and only a few are known to be salmon-bearing.

The provincial record lists 22 streams that drain from Bowen Island (FIDQ). Recorded fish observations gathered from the provincial record, the MRG, and Habitat Wizard suggest that 8 of these streams are fish bearing with observations including chum, coho, coastal cutthroat trout, and Kokanee. Also observed were Rainbow trout, Brook trout, and Sculpin (Table 10).

There were no other streams on Bowen Island that fit the criteria to be potentially fish-bearing.

Table 10: This table list the documented and potential fish-bearing streams that are found on Bowen Island. Streams are included if they have previously been documented as fish-bearing or if they met the criteria of a fish-bearing stream as defined by this Project. The second column indicates if the stream is classified as salmon-bearing according to the MRG. Observed fish species found from the MRG, HabitatWizard, and FIDQ.

Stream Name	Salmon Bearing	Observed Fish Species									
		CHI	CHUM	COHO	CCT	CT	PINK	SS	ST	DV	UN
Josephine Creek	N	X	X	X	X	X	X	X	X	X	X
Explosives Creek	N	X	X	X	Y	Y	X	X	X	X	X
Malkin Creek	N	X	X	X	Y	X	X	X	X	X	X
Grafton Creek	**Y**	X	X	X	Y	Y	Y	X	X	X	X
Killarney Creek	**Y**	X	X	Y	Y	Y	Y	X	X	X	X
Terminal Creek	**Y**	X	Y	Y	Y	Y	X	X	X	X	X
Davies Creek	**Y**	X	X	X	X	X	X	X	X	X	X
Lee Creek	**Y**	X	X	Y	Y	Y	X	X	X	X	X

Stewardship Efforts on Bowen Island

Bowen Island Fish and Wildlife Club (BIWFC) is active on Bowen Island. Out of the 8 fish-bearing streams, BIFWC is active in 5 of them (Table 11). BIWFC conducts annual fry release of coho and chum salmon, and on odd years they will release pink salmon. These species are the priority species of this group, and the volunteers manage fry at the Terminal Creek Hatchery. A more detailed summary of stewardship efforts performed on Bowen Island can be found in the accompanying document labelled Stream Reports.

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Table 11: Summary of stewardship efforts on Bowen Island performed by the Bowen Island Fish and Wildlife Club.

Stream	Project/Activity
Explosives Creek	Tunstall Beach Habitat Rehabilitation Project Climbing Pool Installation Annual Fry Release
Grafton Creek	Annual Fry Release
Killarney Creek	Annual Fry Release
Terminal Creek	Carter Pond Sediment Removal Pacific Streamkeeper Surveys Annual Fry Release
Davies Creek	Davies Creek Rehabilitation Pacific Streamkeeper Surveys

The Department of Fisheries and Oceans Canada Pacific Science Enterprise Center Community Stream Monitoring project is also currently active on Bowen Island. This Project is ongoing, collecting water temperature from Terminal Creek, Killarney Creek, Explosives Creek, and the Bowen Island Lagoon (DFO, 2013).

Potential Streams for Future Monitoring and Restoration Efforts

Based on the available data, online resources, and anecdotal data from Tim Pardee, the following includes recommendations on where future restoration and monitoring could take place. Overall, there is a need to increase baseline data on fish presence in streams to demonstrate the value of the streams and help properly inform decision making processes.

Riparian Vegetation Enhancement Along Fish-Bearing Streams

Coho and chum salmon have not been released into Davies Creek for the past 5 years and, more recently, they are no longer released to Grafton Creek and Killarney Creek. A factor influencing the decision to stop fry release in these streams is an increase in stream temperature. Effective re-establishment of riparian vegetation can lower the input of solar radiation of the streams surface and could help reduce the maximum stream temperature (Bowler et al., 2012; Trimmel et al., 2018). Priority streams for riparian vegetation restoration include Killarney Creek, Terminal Creek, Davies Creek, and Grafton Creek.

Private properties along creeks may have denuded valuable riparian vegetation. For example, Grafton Creek lies on land zoned as Rural Residence 1 (RR1) which allows single dwellings on 10-acre parcels and Terminal Creek has sections that are RR1 as well (Schaefer and Page, 2015). In addition to habitat loss from urban development and habitat fragmentation, most creeks fall on designated Park Zones, which can be degraded through human activities from trail building and use. Therefore, there is the potential that streams on Bowen Island have been impacted by overall development and use that has resulted in degradation of riparian vegetation. It is recommended that these streams be surveyed for areas of riparian vegetation loss, documented, and restored. In the case where streams are on private property

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and cannot be accessed, efforts to increase public awareness of the benefits of a healthy riparian ecosystem should be put in place via public forums, brochures, and signage.

Collecting A More Comprehensive Baseline Data on Terminal Creek

The fish ladder from the Lagoon to Terminal Creek is no longer a viable option for spawning salmon to climb. To help acquire funding to rebuild the ladder, there is a need for baseline data that proves spawning salmon are returning with intent to reach spawning habitats in Terminal Creek. Volunteer members have already been collecting Salmonid Spawning Surveys for Terminal Creek for the Pacific Streamkeepers Federation; however, the surveys are not being done frequently enough to create a baseline. A challenge in creating a more comprehensive baseline for spawning salmon returns has been that there have not been enough volunteers to collect and upload surveys more consistently.

Lee Creek

Currently, the BIWFC is not active in Lee Creek. According to the MRG, Lee Creek is a salmon-bearing stream. This suggests that Lee Creek may be a salmon-bearing, and it could be worth monitoring the stream to either remove the classification of salmon-bearing or restore the creek to become salmon bearing once again.

Josephine Creek and Lee Creek

Metro-Vancouver recently purchased forested and waterfront land on Bowen Island to create a campground with 100 sites. With the addition of the campground comes the potential for habitat degradation due to an increase in stress on the land from human activity. The proposed area is a kilometer square piece of land adjacent to Josephine Creek. To ensure proper protection is placed on the streams who could potentially be impacted by this increase in human activity, there is a need for baseline data that will show if the stream is considered fish-bearing.

8.6 Gambier Island

Documented and Potential Fish-Bearing Streams

The provincial record lists 27 streams on Gambier Island and has recorded fish observations in 5 of those streams (BC Catalogues, accessed 2023). Combined with information from the Marine Reference Guide, Habitat Wizard, and a report from Oscar Gustafson prepared in 1997, it is suggested that there are at least 7 streams that may be fish-bearing on Gambier Island, and 4 of those streams are classified as salmon-bearing according to the MRG (Table 12).

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Table 12: This table list the documented and potential fish-bearing streams that are found on Gambier Island. Streams are included if they have previously been documented as fish-bearing or if they met the criteria of a fish-bearing stream as defined by this Project. The second column indicates if the stream is classified as salmon-bearing according to the MRG. Observed fish species found from the MRG, HabitatWizard, and FIDQ.

Stream Name	Salmon Bearing	Observed Fish Species									
		CHI	CHUM	COHO	CCT	CT	PINK	SS	ST	DV	UN
Long Bay Creek	**Y**	Y	Y	Y	X	X	Y	X	X	X	X
Centre Creek	**Y**	X	Y	Y	Y	X	Y	X	X	X	X
Whispering Creek	**Y**	Y	Y	Y	Y	X	Y	X	X	X	X
Mannion Creek	**Y**	Y	Y	Y	X	Y	Y	X	X	X	X
Gambier Creek	N	X	X	X	X	X	X	X	X	X	Y
Grennon Creek	N	X	X	X	X	X	X	X	X	X	X
McDonald Creek	N	X	X	X	X	X	X	X	X	X	X

Stewardship Efforts within Gambier Island

Gambier Island Conservancy operates on Gambier Island and along with Gambier Island Trust. There is currently no stewardship group on the island with a focus on the stewardship of fish-bearing streams. However, the Gambier Island Conservancy initiated some projects relating to streamkeeping. From 1997 to 2002 Lois Kennedy spearheaded an operation to provide accurate information on Gambier Island streams and to foster objective and sustainable practices for land use planning based on findings. Streams were mapped for the Community Mapping Network. This Project confirmed Gambier Creek, Grennon Creek, Long Bay Creek, Mannion Creek, McDonald Creek, and Whispering Creek as the major fish-bearing streams of Gambier Island. Gambier Island Conservancy is currently taking water samples from streams on Gambier Island in order to determine the presence of the Coastal Tailed Frog. Monitoring in Whispering Creek has restarted, and temperature of the creek will be monitored before and after a planned cut block on Whispering Creek is logged.

Potential Streams for Future Monitoring and Restoration Efforts

Grennon Creek

Grennon Creek is not documented as fish-bearing on the MRG and is not documented on HabitatWizard. An RAR Stream Identification Report from 2015 states the presence of a culvert that is considerably long and may be limiting fish-passage (Willmott and Lange, 2015). At the time of the report, a log was placed across the channel as well as a wooden weir structure to aid fish passage. Based on these findings it was suggested to remove the culvert and replace it with a more suitable structure for fish-passage such as a clear-span bridge. Local fish biologist Mike Stamford confirmed the presence of coastal cutthroat trout in the creek, however there are currently no formally documented sightings on any online resources. The RAR Stream Identification report suggest there is plenty of restoration activity that can be done at Grennon Creek, including re-planting riparian areas that have been fragmented by private properties. Additionally, it was reported that there is a culvert at the confluence of tributary 1 in Grennon Creek that should be replaced as of 2015. Follow up assessments to confirm whether or not these recommendations have been carried out is suggested.

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Whispering Creek

Whispering Creek is classified as a salmon-bearing stream and has documented fish observations of Chinook, chum, coho, and pink salmon, as well as coastal cutthroat trout (MRG, Data BC). During a 2001 RAR Stream Identification report by Madrone Environmental Services Ltd., Whispering Creek outflows into West Bay via a sloping cobbled beach. Local knowledge included in the report suggest a decrease in returns of chum salmon, but as of 2014 locals reported an increase in pink salmon returns. A waterfall acts as a barrier near where Wilderness Road crosses the creek. The RAR assessment suggest spawning in this creek is limited due to type of channel and the size of substrate within. Whispering Creek was assessed by Ecologic Consultants to determine the impacts of a planned cut block surrounding Whispering Creek (2021). The assessment did not include any information on fish presence in the stream but mentioned risk of bank instability and increased run-off. Temperature is being monitored presently at Whispering Creek, however additional surveying is recommended to monitor any increase in surface pollution run-off entering the stream and areas of the bank which may become unstable throughout the logging.

Mannion Creek

Mannion Creek is classified as salmon-bearing and has documented fish observations of Chinook, chum, coho, and pink salmon as well as cutthroat trout. Land use surrounding the estuary is an operating woodlot with log booms at the mouth of the stream as well as linear development along the stream. The bed of Mannion Creek is reported to be too coarse for spawning which suggests there may be an opportunity to restore the channel bed. An assessment of the creek is suggested to determine if there is a chance to improve spawning habitats in this creek. Due to land use surrounding the creek, it is also recommended that the creek be monitored in order to prevent any significant damages to the stream.

8.7 Remaining Islands in Átl'ka7tsem/Howe Sound

Keats Island, Anvil Island, and Bowyer Island did not contain any documented fish bearing streams or potential fish-bearing streams that met the scope of this Project. These islands were therefore not included in this report. Watersheds on these islands have low potentials to be fish bearing (Willmott and Lange, 2015).

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10 Appendix

Participants and Contributors to this Report:

Shirley Samples – Sunshine Coast Streamkeepers Society Lead

Colin Levings – Fisheries Biologist

Zoe Blue – Interim Communications and Outreach Coordinator, Squamish Streamkeepers

Lora Tryon – Lake Trail Environmental

Edith Tobe – President of Squamish River Watershed Society

Greg Weary – West Vancouver Streamkeeper

Keith Pelletier – President of West Vancouver Streamkeepers

Dianne Sanford – Sunshine Coast Conservation Association

Julie Aeyelts – Squamish Nation

Aaron Marchant – Squamish Nation

Peter Scholefield – Gambier Island Conservancy

Mike Stanford

Tim Pardee – President of the Bowen Island Fish & Wildlife Club

Angela Kroning – Sunshine Coast Conservation Association

Malcolm Wigham – Community Advisor at DFO for Howe Sound

Nikki Kroetsch – Data Steward for DFO PSEC Community Stream Monitoring (CoSMo)

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Blank Survey

Survey – Prepared for:

The following survey is a part of the Inventory and Gap Analysis of Stewardship Efforts in Fish-Bearing Streams project conducted via the Átl'ka7tsem/Howe Sound Biosphere Region Initiative. If you are receiving this email you have agreed to collaborate and share relevant information on behalf of [name here], your contributions are greatly appreciated and thank you for your participation.

This survey is made up of 15 open ended questions to be answered.

Once completed, please email the complete survey to gracemackie@howesoundbri.org in PDF format.

1. Are there new streams to be included in monitoring and restoration efforts this year? Which ones?
2. Are there fish-bearing streams where this organization is not active but would benefit from monitoring or restoration?
3. Is there a protocol to follow when selecting a fish-bearing stream to include in X's programs
4. What are the main goals of this group related to the stewardship of fish bearing streams for 2023? (i.e., education goals, restoration goals, funding goals
5. What types of projects and programs are resources most directed to? (i.e. fish surveys, building fish ladders, streams restoration, etc.
6. What are the main uses of the monitoring data collected? (Click box of those that apply)

☐Reporting back to funders

☐Supporting funding application

☐Contributing to larger research projects, led by science providers, universities, etc.

☐Supporting submissions on environmental matters

☐General results to provide to municipalities, science providers …

☐Testing/measuring efficacity of new methods/equipment/materials

☐Other – please note

7. Please rank the following based on the priorities of this organization for monitoring in fish-bearing streams. For simplicity, please highlight the corresponding answer High, Medium, or Low.

Community involvement and education	High	Medium	Low
Guide future restoration projects	High	Medium	Low
Funding accountability	High	Medium	Low
Support/contribute wider research	High	Medium	Low
Support funding applications	High	Medium	Low
Influence decision making	High	Medium	Low

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8. What are the priority fish species of this organization when monitoring?
9. Where does funding for your organization come from?
10. Which databases are fish survey data uploaded to?
11. What protocols are followed when conducting surveys of fish-bearing streams?
12. Are surveys carried out by volunteers? How many volunteers does this organization have on average?
13. What has been a key limiting factor in monitoring efforts if any?
14. What has been most successful during the operation of this organization?

Thank you for your participation in this survey from all of us at the Átl'ka7tsem/Howe Sound Biosphere Region Initiative, we appreciate your time given to this inventory project. Once analysis is done, there will be a final report disseminated to all survey participants.

Any follow up questions on this survey or the project can be directed to gracemackie@howesoundbri.org along

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