PACIFIC SALMON FOUNDATION

NEARSHORE AND ESTUARY PROGRAM

MARINE SCIENCE PROGRAM NEWSLETTER

VOL.3 | September 2024

psf.ca

Photo by Eiko Jones

GREENING THE SALISH SEA: DECISION SUPPORT TOOLS FOR SUCCESSFUL PACIFIC SALMON HABITAT RECOVERY

With the recognition that estuaries and nearshore ecosystems provide vital support to juvenile and adult Pacific salmon, as well as the greater food web, there is growing interest in the 'greening' of our shorelines and nearshore waters. The interest is further heightened by additional opportunities including the potential for carbon sequestration, habitat banking, and kelp aquaculture. However, the success of nearshore restoration projects may be hampered by a lack of: knowledge on optimal site selection, collated and open-access information on the efficacy of methodologies available and appropriate approaches under worsening climate change scenarios, and guidance on priority areas for restoration.

With new funding under DFO's Aquatic Ecosystem Research Fund (AERF), PSF's Marine Science Program is leading a new project that will result in the creation of a Restoration Resource Hub of open-access informative resources and decision-support tools to guide and help co-ordinate adaptive nearshore habitat restoration approaches and strategies. By fostering multi-disciplinary approaches and enhancing education, awareness, and skills, this project will improve conservation efforts and protect valued fish species and habitats.

Photo by Eiko Jones

Cover photos by Mitch Miller (top), Sarina Clay-Smith (left), Isobel Pearsall (centre) and Eiko Jones (right)

WHY A RESTORATION RESOURCE HUB?

Pacific salmon depend on estuarine and nearshore habitats for food and growth, osmoregulation, shelter, and refuge during their early juvenile marine residency and terminal migration. Research findings from the PSF co-led Salish Sea Marine Survival Project (SSMSP), a major transboundary program to assess causes of low marine survival of Chinook, coho, and steelhead, identified the linkages between the availability of quality nearshore habitats, especially in urbanized estuaries, and survival outcomes for salmonids (marinesurvivalproject.org). However, many of our coastal ecosystems have experienced severe habitat degradation, greatly contributing to the vulnerability and decline of salmonids in the Salish Sea and beyond.

The SSMSP recommendations included the vital need for the protection and restoration of eelgrass and kelp habitats to benefit salmon and their prey. However, a recent survey through the Institute for Resources, Environment and Sustainability (IRES) at UBC highlighted a lack of scientific understanding as the major impediment to the success of nearshore restoration initiatives, with secondary concerns including a lack of understanding of appropriate methodologies and inadequate co-ordination. This project aims to address these issues with a Restoration Resource Hub of open-access informative resources and decision-support tools to guide and help co-ordinate adaptive habitat restoration approaches and strategies.

THERE ARE FOUR KEY OBJECTIVES OF THE PROJECT:

1. CREATION OF DECISION SUPPORT TOOLS FOR NEARSHORE EELGRASS AND KELP RESTORATION

Habitat suitability mapping for eelgrass and kelp restoration in the northern Salish Sea

Eelgrass and kelp restoration initiatives in BC can and sometimes do fail due to a lack of prior information available on habitat suitability, eelgrass and kelp environmental requirements, as well as inadequate understanding of anthropogenic stressors, current and future habitat use, land use tenures, and First Nations cultural interests. To help practitioners identify areas most suitable to support eelgrass and kelp habitat, open access eelgrass and kelp habitat suitability models for select Salish Sea estuaries and nearshore regions using ArcGIS software will be developed through an analysis of key environmental, social, and ecological parameters.

The eelgrass models will build on previous work completed for the Cowichan River estuary, where a habitat suitability model, adapted from Short et. al. (2002): Site-selection model for optimal transplant of *Zostera marina* in the northeastern US, was developed and used to select suitable eelgrass transplant sites. Parameters with data suitable for inclusion in this model included sediment, wave exposure, water depth, water quality (i.e. temperature, pH, DO, salinity), current velocity, bed mobility, hydrogen sulfide, active channel classification, and crown land tenures. This model will also incorporate our team's transplant experience to develop a quantitative site-selection model for additional Strait of Georgia estuaries based on scientific criteria.

Kelp forests depend on the presence of rocky substrate, cold waters, and water motion by tides and waves. Other kelp suitability factors include light and nutrient availability and a lack of predatory urchins, and competitive and invasive algae. Key parameters and thresholds for the kelp model will be determined in consultation with subject experts and will include recent satellite-derived information collated under the University of Victoria Spectral lab's Kelp Resiliency Project/Kelp Alliance led by Dr. Maycira Costa. This PSF-supported program has assessed key ecological and environmental parameters associated with kelp persistence, guiding the prioritization and mapping of areas of the Salish Sea where kelp are most likely to recover following marine heat waves and impacts of climate change. We will also work with Dr. Sherryl Bisgrove's Simon Fraser University team, who have been assessing thermotolerance of different bull kelp stocks, another previous PSF supported program.

Parameters will be modelled throughout the focus estuaries and nearshore areas of the northern Salish Sea, where they will be classified as either unsuitable, within acceptable tolerance limits but not optimal, or within optimal tolerance limits. A multiplicative model will be applied such that areas with a higher score will represent areas of higher suitability, and areas with a lower score will represent areas of lower suitability, and a score of zero will represent unsuitable. Where data for key parameters are missing and/or of reduced quality, this project will provide recommendations for future data collection, which can later be incorporated back into the habitat suitability models.

Final deliverables for this work will include raster (mapped) suitability layers for each parameter, an overall habitat raster suitability layer for each species, and a final habitat suitability map identifying areas most likely to support eelgrass and kelp habitat, which may form recommendations for future transplant sites. The models can be ground-truthed against known mapped eelgrass and kelp habitats to ensure the models are accurately depicting suitable habitats, as well as providing information on additional parameters e.g. presence of urchins/early successional competitive algae that should be included. These products can be adapted and scaled up for other regions.

Photo by Mitch Miller

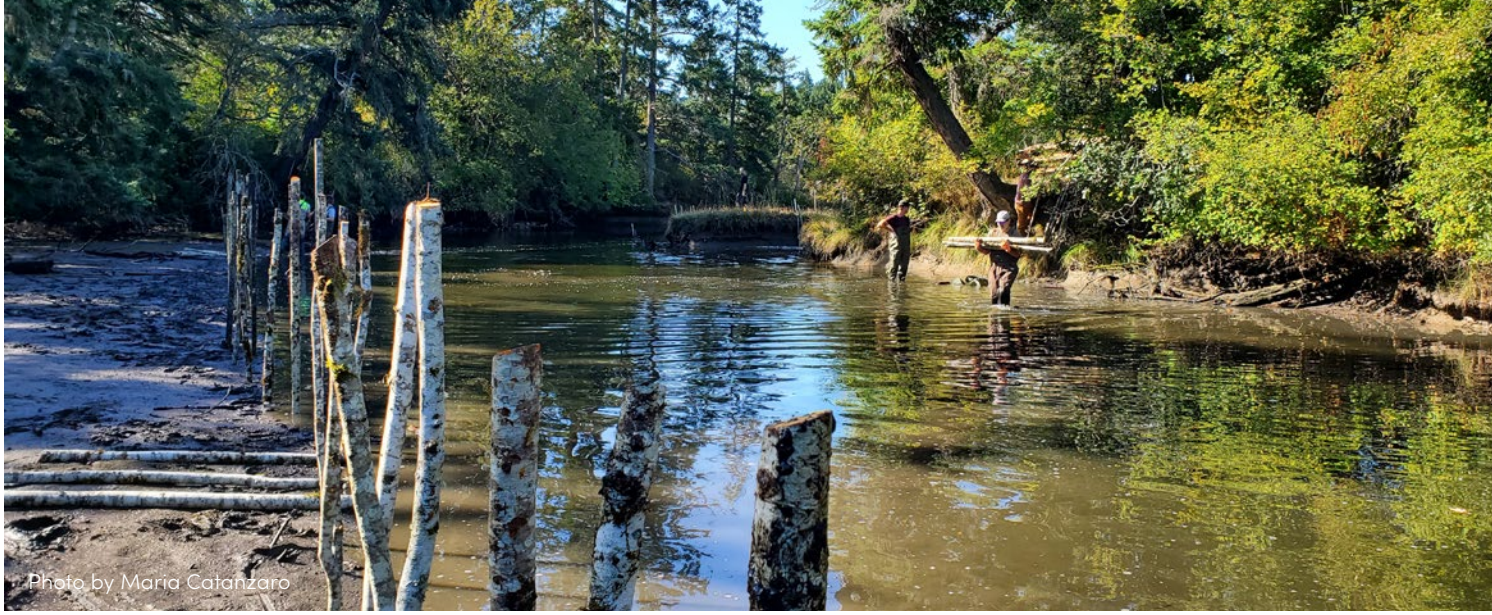
Photo by Maria Catanzaro

Development of an ArcGIS Community Salmon Restoration Atlas

Information is not readily available about restoration methodologies applied around BC and their success, hampering learning from our mistakes, reducing our understanding of optimal strategies, and slowing down the process of adaptive management, which would ensure that the best tools are applied for a particular restoration application. Thus, we will also develop a Community Salmon Restoration Atlas, an ArcGIS map showing the location of restoration projects in both nearshore, estuary, and freshwater environments, providing metadata and data, tools and approaches used, and measures of success. Data will be collated from PSF's Community Salmon Program, West Coast Aquatic's West Coast Vancouver Island projects, and Redd Fish Restoration's projects from Clayoquot Sound, as well as from other stewardship groups around the Strait of Georgia and along the West Coast of Vancouver Island. Examples of restoration projects may include:

- **Uplands:** e.g. removal of fish passage barriers, riparian planting
- **Freshwater:** e.g. connection of rivers and flood-plains, dike and levee setback, revegetation along streams and rivers, placement of large woody debris, wetland restoration
- **Estuary:** e.g. levee setback, eelgrass planting, invasive species removal
- **Marine nearshore:** e.g. removal or softening shoreline armoring, kelp restoration

The Community Salmon Restoration Atlas will provide key words defining the problem statement (e.g. what was the salmon habitat issue addressed?), the location of work, the practitioners involved and outcomes. In many cases, outcomes have not been measured or tracked, so an interview/effectiveness evaluation process will be designed and implemented to determine how well different restoration measures have persisted over time and under climate stressors such as drought, floods, and storm surge, and to assess whether outcomes were positive for Pacific salmon. The resource will be modelled on Washington's Salmon Recovery Portal. Keywords are being created in consultation with DFO so that the Community Salmon Restoration Atlas will be interoperable with similar proposed DFO products. A meta-analysis will assess factors associated with project success, and outline priorities and recommendations for restoration strategies for use in future projects. This analysis and the map together will allow for assimilation of understanding and implementation of adaptive management, will reduce redundancy and will enable future investment in restoration initiatives with highest probability of success.


Photo by Maria Catanzaro

2. DEVELOPMENT OF STATE OF KNOWLEDGE REPORTS & PRACTITIONER HANDBOOKS FOR NEARSHORE HABITATS AND THEIR RESTORATION

Photo by Isobel Pearsall

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Photo by Mitch Miller

State of Knowledge Reports

While there have been recent major advances in our scientific knowledge of nearshore habitat restoration, and a proliferation of researchers working on kelp, eelgrass, and marsh habitat restoration in BC over the past 5-10 years, much of this information remains unassimilated and unavailable to practitioners. To that end, we will collaborate with our broad PSF Community Salmon program members, Hakai, KelpRescue, SeaChange, Guardians of our Salish Estuaries (GooSE), and others, to convene three major symposia and develop three major State of Knowledge reports on BC marsh, eelgrass, and kelp habitats and their restoration. These reports will outline advances in science and understanding of BC marsh, eelgrass, and kelp habitats, anthropogenic stressors, restoration tools, and recommendations for climate adaptation strategies.

The information will be gathered through 1) a series of PSF-led estuary and nearshore workshops convening scientists, GIS specialists, First Nations, and restoration practitioners, 2) systematic literature reviews and 3) information from a series of interviews with researchers and practitioners in both BC and the US working on climate-adaptive methodologies.

Practitioner Handbooks

In addition, four practitioner handbooks will detail eelgrass and marsh mapping, monitoring, and restoration methods, as well as kelp biobanking, and will be showcased to practitioners in the third year of the project through community meetings and outreach workshops. Specifically, the four handbooks will be:

- Guidelines and Tools for Mapping and Monitoring Eelgrass in BC
- A Practical Guide to Eelgrass Restoration Methodologies
- A Compendium of Marsh Habitat Restoration Methodologies
- Kelp Biobanking For Use in Kelp Habitat Restoration


Photo by Nicole Christiansen

3. DEVELOPMENT OF STRAIT OF GEORGIA ESTUARY REPORT CARDS

This program will create concise reports to assess health and condition based on available data for 8-10 important salmon-bearing estuaries in the northern Salish Sea. Reports will be designed as a defensible assessment of scientific knowledge and data in each of the estuary systems and delivered in an approachable style to improve public understanding of issues surrounding health and the importance of estuary ecosystems.

The estuaries that will be reported on include some of those currently making up part of the PSF Bottlenecks to Survival Project as well as some of the smaller estuaries that provide habitat connectivity for salmon within the Strait of Georgia. Estuary state and pressure indicators are currently being developed by MC Wright and Associates Ltd. and DFO and will supplement those originally proposed for the Wild Salmon Policy Strategy 2 by Stahlberg et al. (2009). However, adequate information must be collected prior to indicator development so that indicators with good prospects for long-term monitoring and effective results are selected (EPA Indicator Development for Estuaries).

All data for the Strait of Georgia used in the reports will be collated (historical and current) and mapped (in the Strait of Georgia Marine Reference Guide) and made openly available (in the Strait of Georgia Data Centre). Potential variables include physical, chemical, and biological characteristics e.g. changes in extent of fish habitat (marsh, eelgrass, kelp), presence of forage fish spawning areas including herring, salmon bearing streams, salmon survival and health (from studies done by the PSF Bottlenecks to Survival project and other historical studies), shoreline sensitivity, flood risk, sediments and benthic data, water quality (including any information on contaminants, harmful algae, nutrient inputs), anthropogenic stressors (e.g. shoreline hardening, marine traffic, log boom extent, light pollution, discharges, anchorages, etc.). Information collected in Objective 1 above also will be included in the report cards. This will include work done by Tim Clermont and GooSE to digitize historical aerial imagery of Strait of Georgia estuaries (gathered by Kennedy 1982 and described by Lessard et al. 1996) and compare the data with current ShoreZone imagery gathered from helicopter overflights, to assess the extent of loss and degradation of these marsh habitats over time.


Photo by Ryan Miller

4. TRAINING WORKSHOPS

The final objective of the project will be to raise awareness of the products and techniques resulting from all the other objectives. This will be accomplished through a series of hosted training workshops to share techniques.

There will be a two-part training workshop focused on kelp monitoring, which will target professionals working in kelp restoration, as well local community members and First Nations that are interested in learning the monitoring techniques. The kelp workshops will be held in collaboration with the KelpRescue Initiative and Hakai Institute.

An eelgrass focused workshop will be hosted in collaboration with the Coastal Watershed Institute, and will focus on eelgrass restoration effectiveness monitoring, specifically monitoring salmon and other fish usage of restored beds.

OUTCOMES AND BENEFITS

The creation of a major, open-access Restoration Resource Hub for salmon habitat restoration will provide invaluable support for habitat practitioners engaged in the creation, protection, and restoration of critical habitats for early salmon rearing in the lower river, estuary, and nearshore habitats.

- ✓ The habitat suitability models will equip scientists and practitioners with effective tools to improve transplant efforts for kelp and eelgrass, addressing the need for optimized decision-making in site selection, which will help reduce the overuse and degradation of healthy donor beds for stock, lead to improved transplant success, and guide compensation projects towards the most suitable restoration areas.
- ✓ Additionally, multifaceted GIS-based tools will provide advice on best practices and restoration methodologies, and the practical restoration handbooks and report cards will guide actions that can be implemented in nearshore areas of high salmon conservation values.
- ✓ Information from the Community Salmon Restoration Atlas and associated meta-analysis report will offer insights into restoration methodologies, as well as advice on effectiveness to help practitioners assess method durability under climate change, and whether actions applied have improved salmon outcomes, while also minimizing redundancy and guiding future efforts. The open-access mapping products, manuals and reports will streamline access to information into centralized and accessible locations, facilitating recovery actions in key salmon habitats. This guidance will benefit both juvenile and adult salmon, ultimately enhancing their survival outcomes.
- ✓ Through outreach initiatives to communities of local stewards and First Nations in BC, PSF, SeaChange Marine Conservation Society, and GooSE will promote the State of Knowledge Reports and Practitioner Handbooks. PSF will also produce webinars for widespread dissemination on the utility of the various products, alongside conferences attended by biologists and staff to ensure academic and practitioner outreach.

FOR FURTHER INFORMATION, PLEASE CONTACT:

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The Marine Science Program will work with partners including the University of Victoria (UVic) Spectral Lab, SeaChange Marine Conservation Society, Guardians of Our Salish Estuaries (GooSE), Hakai Institute, MC Wright and Associates Ltd., Kelp Rescue Initiative, West Coast Aquatic (WCA), and Redd Fish Restoration Society.

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Funding for this project is provided by the Aquatic Ecosystems Restoration Fund, a program funded by Fisheries and Oceans Canada