PACIFIC SALMON FOUNDATION

MARSH SYMPOSIUM REPORT

A summary of proceedings from the Marsh Symposium

Part of the Greening the Salish Sea: Decision Support Tools for Successful Pacific Salmon Habitat Recovery Project

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ACKNOWLEDGMENT

We acknowledge with deep respect and gratitude that the 2025 Pacific Salmon Foundation Marsh Symposium was held on the traditional and unceded lands of the Lək̓ʷəŋən (Lekwungen) peoples, including the Songhees and Esquimalt Nations, who have stewarded these lands and waters since time immemorial.

We gratefully appreciate the warm opening and cultural sharing by the Songhees, Tsartlip, and Tsawout Nations that commenced the symposium.

We thank the Department of Fisheries and Oceans for their funding support for the project, as well as the Habitat Conservation Trust Foundation for sponsoring our welcome reception. We also thank Dr. Isobel Pearsall, who was instrumental in creating the Greening the Salish Sea Project, Mitch Miller for capturing the symposium with photos and video, Delaney Cox for her incredible graphic recording, and the PSF and GooSE team for their support in making the event a success. A big thanks to all the presenters who shared their work and the attendees who engaged in great discussions and were so open to collaboration. It is through this collaborative and engaged effort that we will be able to make progress in the protection of this vital ecosystem.

Thank you,

Sarina Clay-Smith
PSF Biologist

Cover: Real-time themes and discussions captured as a graphic recording, by Delaney Cox from Draw it Out.

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Please note: The question and answer and the detailed discussion notes (Appendix 3) sections of the report were transcribed as verbatim as closely as possible, with minor edits to provide clarity. The opinions expressed do not necessarily reflect those of the workshop conveners. Care was taken in the preparation of this report, however we acknowledge there may be omissions or misstatements, for which we apologize and will endeavor to correct if brought to our attention.

INTRODUCTION

This report summarizes the 2024 Marsh Symposium that was held from November 20th to 22nd in Victoria, BC. The Marsh Symposium was the second of three symposia organized by the Pacific Salmon Foundation (PSF); the others focused on eelgrass and kelp. These symposia are part of the PSF led project 'Greening the Salish Sea, Decision Support Tools for Successful Pacific Salmon Habitat Restoration' (hereafter called 'Greening the Salish Sea Project'), which is funded by the federal Aquatic Ecosystem Restoration Fund (AERF) within the Department of Fisheries and Oceans (DFO).

The transboundary Salish Sea Marine Survival Project (SSMSP 2014-2020) findings emphasized the importance of healthy, intact nearshore and estuarine environments for Pacific salmon survival. To enable more successful and strategic restoration of key habitats, the Greening the Salish Sea Project is developing a 'Restoration Knowledge Hub' of accessible tools, documents, and other resources to support the recovery of nearshore marine and estuarine ecosystems. The first step towards shaping the resources that will form the Hub was to convene experts in these knowledge-sharing symposia.

The two-day Marsh Symposium was held to inform and guide the State of Knowledge report that will be completed at the end of the second year (Spring 2026) of the AERF grant period. This report will gather and synthesize the key issues, stressors, restoration work, and opportunities with coastal marsh systems throughout the Salish Sea.

The key objectives and desired outcomes of the symposium were to:

1. Identify and assemble key marsh restoration practitioners, government, Indigenous, and academic figures.
2. Gather feedback and input, as well as expand foundational knowledge for the State of Knowledge Report and Practitioners' Handbook.
3. Support actions for the restoration of key marsh habitats, learn about key stressors and potential restoration techniques, and promote climate-adaptive strategies.
4. Understand the value of marsh habitats to important species like the Pacific salmon.
5. Build relationships and strengthen the marsh community by knowledge sharing and networking.

A total of 72 attendees joined the symposium, representing a broad spectrum of stakeholders including Indigenous Nations, Provincial and Federal governments, academia, and NGOs (see Appendix 2 for full list and affiliation). Seven attendees were from the US (Washington and Oregon), with representatives from Tribal Nations, government, and academia.

Structure

The evening before the formal symposium, we hosted a welcome social funded by the Habitat Conservation Trust Foundation. The event included an Indigenous welcoming by a Songhees Nation representative, followed by a speech, drumming, and dancing by members of Tsartlip and Tsawout Nations. To set the stage for the days to come, Dr. Ken Ashley then gave a short plenary talk on the importance of marsh, the work that has been historically done, and the road ahead.

The symposium convened for two days of presentations, panels, and discussions (see Appendix 1 for the full agenda). The presentations, 23 in total, were organized in themed blocks of Regional Case Studies, Restoration Design and Environmental Factors, Climate Resilience and Adaptation, Monitoring and Decision Support Tools, and Overcoming Challenges. In addition, there was a special presentation by Jared Qwustenuxun Williams, who spoke on Indigenous food systems in wetlands. This presentation highlighted the value and opportunity to restore estuarine marsh systems for both Indigenous culture and food sovereignty.

There were two main discussion periods. On the first day, the discussion focused on common stressors on marsh habitats, limiting factors impeding the success of marsh restoration, and how the Practitioners' Handbook could best meet the needs of restoration practitioners. The discussion period on the second day included a transboundary panel of the US-based attendees. The workshop concluded with a discussion about collaboration and the potential for future meetings.

In the following sections, we provide an overview of each presentation, their key themes, and takeaways from discussions. The information and ideas discussed will be used to inform the State of Knowledge report and Practitioners' Handbook on saltmarsh restoration.

Photos from the Evening reception welcoming.

PRESENTATIONS DAY 1

SESSION 1: CASE STUDIES ON VANCOUVER ISLAND

Protecting and Restoring Tidal Marshes from Many Geese

Tim Clermont, Executive Director; Dominic Janus, Darwyn Moffatt-Mallett, Gareth Ashley, Restoration Specialists, Guardians of our Salish Estuaries (GooSE);
Danny Hurry, Guardian Manager, Wei Wai Kum First Nation

Summary:

The GooSE Team, with Danny of Wei Wai Kum First Nation, presented their approaches to restore marsh habitat with a focus on management of non-migrant invasive Canadian geese. Geese feed extensively on *Carex*, which is having a large and devastating impact on marsh habitats.

To rehabilitate marsh habitat, a multi-pronged approach is needed for marsh restoration and goose mitigation:

- Protect the existing marsh from geese:
  - > Eco-cultural fencing has been highly effective. Recommend the use of natural materials for fencing. While it is more labour-intensive than plastic/metal, natural materials are more attractive, biodegradable, and engage people.
  - > Look for opportunities to repurpose natural source materials. For example, GooSE works with the Ministry of Transportation to source trees/branches trimmed along the highways.
- Transplant new marsh:
  - > Currently testing transplant strategies (e.g. donor plugs, native plugs, density levels, etc.) to develop best practices and optimal planting design and environmental conditions.
- Goose control:
  - > Addling eggs to reduce geese numbers over time.
  - > Encouraging Indigenous harvests, which have potential value for participating Nations.

Key Lessons:

- Working with Indigenous Guardians programs has been key to their success.
- There is a need for a broader strategy to combat Canada geese, as they can move and repopulate controlled areas.
- The group is mapping marsh extent through time to understand where habitat has been lost.
- To document the effectiveness of the restoration strategies, GooSE monitors marsh growth (sedge height, stem density, and flowering across) across treatments of passive restoration (protection), active restoration (planting), and control sites.

Outlining Past, Present, and Future Work Comox Valley Project Watershed Society is conducting on marsh around the Comox Area

Caitlin Pierzchalski, Executive Director and Jay Baker-French, Restoration Specialist, Comox Valley Project Watershed Society

Summary:

Caitlin and Jay summarized Project Watershed's various marsh restoration projects from the last decade. Their projects have largely focused on a sediment nourishment approach to facilitate marsh vegetation re-establishment.

- Past Projects:
  - > Royston Wrecks 2014-2018: At two sites, Project Watershed added material to build up the elevation to extend foreshore area. One site was more exposed, and they added cobble around the edge to ensure stability. The sites did not require goose fencing because *Carex* was not present to protect; other salt marsh vegetation that did not attract geese was present.
  - > Ships Point 2019-2024: At this site, they trialed a 'headland berm design'. A large cobble/boulder berm was built to protect marsh sediment nourishment. The site was planted, and the plant community has established well.
  - > Dyke Road Tide Gates 2020: At this more brackish site, they built a platform using finer sediment and the site was protected and planted *Carex*, which established well.
- Current Projects:
  - > Dyke Road Park 2024-2026: A collaborative (Nations, local governments, and NGO) project featuring excavation, nourishment, and 'soft' edge armouring techniques. Canadian geese and historic log sort operations had degraded the site. The project demonstrates proof of concept around elevation restoration assisting plant re-establishment.
  - > Kus-kus-sum 2021-2025: A major restoration of an industrial sawmill site made possible through a land acquisition. After the restoration, the site will be repatriated to K'omoks and City of Courtenay. The restoration is being done over multiple phases: hard surface removal, recontouring, planting, and wall removal to reconnect with Courtenay River.
- Future Projects planned for revegetation and erosion control at Ships Point and Gartley Beach.

Key Lessons:

- Restoring historic elevations is key to achieving desired plant communities.
- Implementing monitoring protocols to track plant community, sediment quality/stability, and wildlife enables learning and adaptive management. Potential future monitoring that could be of value includes soil carbon, sediment accretion, and fish use.
- They recommend leveraging community involvement in monitoring/science, but it must be simple.
- Unique sites need unique solutions.
- There is a lot of community interest in restoring coastal wetlands!

Urban Tidal Marsh Recovery and Monitoring in South Vancouver Island

Jacklyn Barrs, Ecosystem Restoration Specialist at WWF-Canada, presenting on behalf of Peninsula Streams and Shorelines

Summary:

Peninsula Streams and Shorelines' (PSS) restored marsh habitat at Portage Inlet and Hospital Creek in Victoria. These sites are high-value habitat for salmon; however, the marsh area has been degraded by urban impacts (housing and roads pushing into marsh area) and Canada geese grubbing. Jacklyn presented the challenges faced and lessons learned while restoring these urban and culturally significant areas.

- Restoration was accomplished by:
  - > Using goose exclusion methods, this passive restoration strategy was successful where the marsh platform was still elevated.
  - > Replanting marsh species in expanded areas. This was successful in irrigated upper areas; however, edge plantings suffered in summer heat and high salinity conditions, resulting in these areas having to be replanted in the fall.
  - > Re-establishing the elevation of the marsh platform using brushwood dams and reusing organic materials excavated from elsewhere on the site to build up elevation where needed.
- As the marsh platform eroded, evidence of traditional weirs and charcoal was revealed, and so, PSS/WWF-Canada partnered with Songhees Nation to understand the importance of the site.

Key Lessons:

- Education is essential to success: they have created campaigns about not feeding waterfowl, and a restoration project to improve awareness with residents.
- Jacklyn stressed the value and necessity of collaboration with partners and volunteers, and engaging with the community.
- Mermaid Creek (separate project), for example, was placed on hold/stopped due to a permitting issue, which could have been avoided with increased or targeted engagement with residents.

Working with Indigenous Communities to Assess Estuary Resilience to Sea-Level Rise Providing Canadian Context to North American Estuaries

Steven Henstra, Restoration Biologist, and Tom Reid, Land Manager, Nature Trust of British Columbia

Summary:

'MARS' (marsh resilience to sea level rise), a scalable multimetric tool, was developed by the U.S. National Estuary Research Reserve Alliance (NERRA) to understand how resilient estuaries will be to sea level rise and inform management. To understand how BC marshes will fare, Nature Trust of BC has applied MARS to several estuaries in British Columbia for the Estuary Resilience Project. Steve and Tom presented the project's background, results, and restoration projects.

- MARS output compares indicators to thresholds and scores an estuary on its resilience to sea level rise. The results can help inform management strategies (e.g. protection, land acquisition etc.) to achieve the greatest net benefit.
- The project included targeted conservation projects that focused on restoring abiotic processes that give rise to estuary ecosystems:
  - > Snuneymuxw Estuary: Freshwater and Sediment Redistribution — built a freshwater channel to redistribute sediment.
  - > Xwesam Estuary: Reconnecting Tidal Channels — breached old float plane causeway.
  - > Gwa'dzi Estuary: Roadway Breach Tidal Channel Reconnection — breached a road to connect tidal flows.
  - > Cowichan Estuary: Dike removal and Indigenous Food Systems Revitalization — removing a dike and restoring farmland to natural marsh platform and incorporating traditional food/medicinal plantings.

Key Lessons:

- Conservation can be holistic and include Indigenous foods and medicines cultivation. Human connection to the landscape is an essential part of the restoration story.
- Restoration must focus on restoring the abiotic processes that give rise to estuarine systems.
- There is a need for stable, consistent funding, and assessment tools that are scalable across broad landscapes.

Gwa'dzi Estuary: Roadway Breach before and after tidal channel reconnection.

QUESTIONS AND DISCUSSION FOR SESSION 1 PRESENTATIONS:

Q: Is there a way to connect people to monitoring? Encouraging citizen science?

A: **(Tim C)** Trialing the use of an app for monitoring and wildlife cams; City of Nanaimo has a station that overlooks the estuary, the public can take photos and upload them.

A: **(Caitlin P)** We are outsourcing a lot of monitoring to citizen scientists, especially vegetation and pinniped monitoring. Apps like ebird hotspot, for example, can be integrated into bird counts. We used a well-developed citizen science vegetation protocol tool that is easily used by the public with limited plant experience.

A: **(Steven H)** Nature Trust is also working on a citizen science program that will hopefully improve and ensure baseline data is collected, allowing for effectiveness monitoring/adaptive management planning, and before and after comparisons. A simple citizen science solution is a photo point monitoring station with a QR code that leads the public to 'before' pictures, and they can take a photo of the current site and upload it to a website.

A: **(Darwyn MM)** Engaging the public and explaining what you're doing is key.

A: **(Danny H)** Guardians are talking to schools about their work to increase understanding and engagement with youth. We also chat with the public as they go by when in the field.

Q: Have you noticed any changes in the community composition of the marsh following restoration (invasives) and natural recovery?

A: **(Tim C)** Largely no, once the *Carex* returns, it is strong in the lower elevation areas. Invasive grasses at higher elevations can become established, likely brought in by geese. Our original exclosures were a bit too high and we saw different plants establish. There is a tidal sweet spot we had to find to encourage *Carex*. *Carex* is salt tolerant, but it also needs a bit of help to reestablish due to being rhizomal. Stephanie Lang/Tara Martin — planting is good for higher elevation, there you cannot depend on passive recovery.

A: **(Dominic J)** We have not seen many invasives in *Carex* marshes. Generally, plant recovery varies by elevation, where lower elevation leads to *Carex* monoculture (Vancouver Island), but in the Fraser, purple loosestrife is an issue.

A: **(Jay BF)** Some invasives are seen in higher marsh like reed canary grass with higher salinity levels. Reed canary grass requires active management in the Cowichan Estuary. A food plant focus could be a great way to use human management.

Q: How resilient is eco-cultural fencing to weather?

A: **(Tim C)** Site selection is important. The fencing will be susceptible to moving logs or heavy weather in more exposed sites.

A: **(Dominic J)** Ongoing work to assess the longevity and resilience of fencing. So far, it appears to be pretty tough, but not much will survive big logs moving through.

Q: What seems to be working better? Natural colonization or transplant success?

A: **(Tim C)** Where there is still a marsh platform, passive colonization will be successful so long as you remove the stressor, e.g. the geese. We are currently trialing nursery transplants. We are finding that we need stronger protection since the transplants are not as salinity tolerant and more appetizing to geese. We are still assessing the success of transplants.

A: **(Jacklyn B)** In an urban background, you want to select areas with a marsh platform still present and possibly remove sediment from filled areas that have been disconnected from tidal inundation. By building the elevation up and returning tidal processes, you can encourage a marsh platform.

SESSION 2: CASE STUDIES IN THE FRASER RIVER AND WASHINGTON

History of Marsh Creation and Restoration in the Fraser Estuary:

Deering Island Marsh Project from 1990

Mark Adams, Director, Envirowest Consulting Inc.

Summary:

Marsh restoration projects have been implemented for decades in the Fraser Delta, and there are lessons to be learned from how these projects have fared over time. Mark presented an early marsh restoration offsetting project from the 1990s, Deering Island on the North Arm of the Fraser River Estuary.

- The project was initiated in 1990 and was built at the time of active dredging of the North Arm of the river and heavy traffic from barges, log rafts, tugs, created a lot of wake. The design was built to incorporate and withstand this activity.
  - > The activity in the area meant the marsh bench and rock berm couldn't slope too much or blend the elevation, and the platform had to remain outside the navigation channel.
  - > It included a debris boom of piles set in concrete to keep log debris off the marsh.
  - > They built up the platform higher and allowed for sediment to settle over about 3-4 months.
- It was important to understand the habitat composition.
  - > Planted 43% Carex, 20% Juncus balticus, and a mixture of other species. Transplanted donor stock plugs.
  - > Used a substrate mixture of 45% mud, 23% boulders, a mixture of cobbles, and sand.
- A reference site, McDonald Slough, was assessed in 2022 and was found to have very similar vegetation percentage cover and cover class.

Planting plugs of Deerling Island; Monitoring the island in 2022.

CURRENT RESTORATION AND RESEARCH IN THE FRASER ESTUARY:

Fraser River Estuary Tidal Marsh Restoration

Eric Balke, Senior Restoration Biologist, Ducks Unlimited Canada

Summary:

Ducks Unlimited Canada (DUC) has been involved in restoring marsh habitat in the Fraser Estuary since the 1980s. Eric provided a summary of DUC's tidal marsh restoration projects evolving from relatively simple actions to increasing complexity in response to marsh loss, invasive species, and sea level rise.

- An early DUC project (1986) in Boundary Bay removed large woody debris to restore the salt marsh. In 2023 they returned to remove additional woody debris (forestry logs lost from booms/transport).
- In 2012, DUC acquired Sturgeon Bank with the City of Richmond. To restore the site, they excavated channels and trailed piling forestry logs into mounds for wave attenuation and sediment accumulation, rather than removing them. The project had mixed success as new waste logs have arrived, requiring ongoing maintenance to remove them.
- DUC established a *Spartina* Eradication Program in 2003 after invasive *Spartina anglica* was first discovered in Roberts Bank, Boundary Bay. It includes a working group and an annual eradication effort of mapping and treating clones.
- Sturgeon Bank Recession Project – In response to the loss of large areas of marsh (160 ha) since the 80s, DUC began investigating the causes of the recession. Their findings suggest that multiple factors were contributing to marsh decline in the Fraser Estuary: goose grazing, logging, sediment loss, an increase in salinity, and sea level rise.
- DUC acquired funding from the Coastal Restoration Fund to conduct several restoration projects in the South Arm marshes, including:
    - > Three breaches into the Woodward Dam to improve fish access to the marshes;
    - > replacing culverts in Gunn and Williamson Islands to allow fish access to marshes; and
    - > eradication of non-native cattails from Frenchie's Island in collaboration with Raincoast.
- Received British Columbia Salmon Restoration and Innovation Fund (BCSRIF) funding over two rounds to work with partners on the 'Fraser River Estuary Salmon Habitat (FRESH)/ 'Restoration Fraser River Estuary Salmon Habitat (ReFRESH).
    - > Projects include North Arm Jetty Breaches, Marsh Restoration Pilot Projects, and Sturgeon Bank Sturgeon Bank sedimentation addition project, which repurposes sediment dredged from the Fraser River and pumps it via a pipeline to the mudflat to mimic natural processes to build up sediment and help restore marsh losses.
- There is value to raising the intertidal marsh as a nature-based solution to flood protection. This is recognized through a partnership with property and casualty insurance companies called Nature Force. The program invests in nature-based infrastructure areas like the Fraser Delta, which is below sea level.

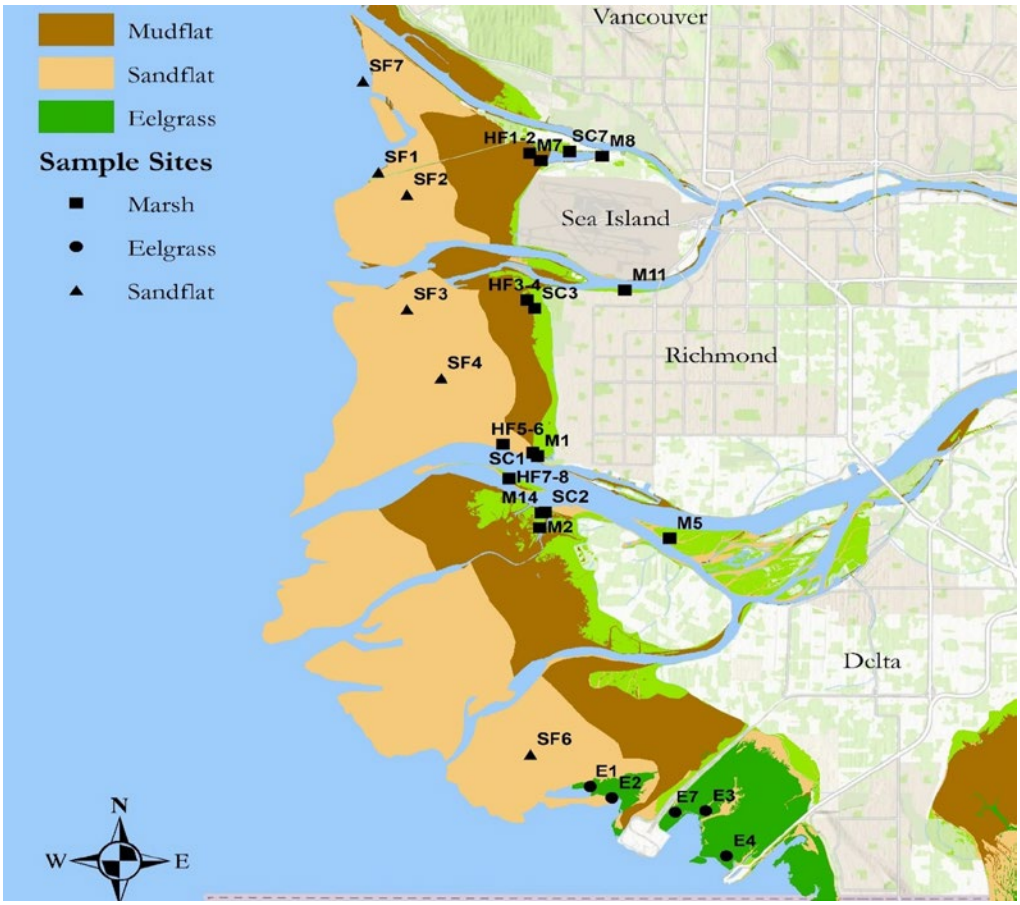
Marsh Habitat Restoration in the Fraser River Estuary, BC

Dave Scott, Biologist, Raincoast Conservation Foundation

Summary:

Significant habitat has been lost or altered in the Fraser River Estuary due to extensive development. Dave presented research and restoration work by Raincoast, looking at how juvenile salmon's access and migration through the estuary has been impacted.

- Since 2016, initially as part of the Salish Sea Marine Survival Project, they have been sampling habitat for salmon usage — abundance, size, DNA, and otolith analysis.
  - > They found that different Chinook populations use the Fraser differently: ocean type from Harrison arrive in early April and spend a long residency in the estuary c.a. six weeks, whereas stream type enter later at a larger size and move through the estuary quickly, and hatchery fish tend not to use estuary habitat.
- Raincoast has been looking at building habitat availability to support salmon migration in built-up areas that are lined with riprap. Using the context of Greg Hood's 'stepping stone' approach and considering the distance between habitat patches and their size to identify priority sites for restoration.
- They have been comparing fish usage in restored 'offsetting sites' to reference sites to understand their value.
  - > Preliminary findings suggest more juvenile salmon use reference sites than the offsetting sites. However, it does vary; Deering Island is one of the best offsetting sites.
- Raincoast has been rehabilitating previously restored sites to make them more supportive habitat for salmon (i.e. cattail removal, debris removal, channel creation, elevation lowering).



Piloting Process-Based Marsh Creation Approaches in the Fraser River Estuary

Daniel Stewart, PhD student, University of British Columbia

Summary:

A Ducks Unlimited Canada (DUC) study reviewed over four decades of marsh creation efforts and visited nearly 80 sites with attention to what factors, such as size and location, contribute to a site's persistence and resilience. Taking inspiration from this project, part of Daniel's PhD project seeks to apply lessons learned to create more resilient and cost-effective restoration. Daniel shared the findings of the DUC and the work of his PhD to date.

- There have been some areas of natural marsh gain in the Fraser Estuary (e.g. Sapperton Bar), where sediment accretion, often due to human influence (log booming and wind dams), resulted in sandbars and marsh plant establishment. Findings lead to the key questions:
  - > What can we learn from locations where there have been gains to inform resilience and longevity?
  - > Can we identify similar accretion zones, already at or approaching the tipping point of marsh establishment to allow for more resilient and lower-cost projects?

- Daniel's current work, ProMEPP — Process-Based Marsh Established Pilot Project, aims to test novel marsh creation methods that can be scaled up. The project has/will:
  - > Gathered data and learn from marsh expansion zones (2023-24)
    - Visiting sites conducted transects of dominant plant species, elevation, and soil properties.
    - Identified pioneer species and the conditions that support them.
  - > Test novel marsh creation methods that can be scaled up (2024).
    - Pre-pilot tests of minor intervention methods (willow stakes, brushwood dams, planting and protecting with exclosures) at Tilbury Island that can be scaled up with greater certainty.
    - Experimented with planting density and diversity, for example, some just sedge, or a mixture with low marsh pioneer species that mimic successional processes.
  - > Upscale to larger marsh creation pilot project (2025-26).

Purple Loosestrife and the Food Web Impacts of Non-Native Plants in PNW Estuaries

Daniel Hennigar, Masters Student, University of British Columbia and Biologist, Raincoast Conservation Foundation

Summary:

Daniel's master's research looks at the food web impacts of nonnative plants in the Fraser River estuary. He has focused on purple loosestrife, an established and expanding invasive plant in the Fraser estuary.

- Purple loosestrife quickly fills in after grazing, log, or wrack disruption. Current control management practices (Provincial Bio Control Program) seem less effective in estuaries.
- Purple loosestrife looks like it is here to stay, so Daniel is seeking to understand the function of an invaded marsh as habitat for juvenile salmon and prey resources.
    - > Sampling benthic invertebrates, terrestrial invertebrates with associated vegetation data, and soil nutrients at ten marsh sites, five with purple loosestrife and five without, with the goal to model juvenile salmon prey abundance related to the presence of purple loosestrife.
    - > Early findings suggest sites with purple loosestrife had lower available N and P compared to the reference sites.

QUESTIONS AND DISCUSSION FOR SESSION 2 — FRASER ESTUARY PRESENTATIONS:

Q: In the original design of Deering Island, I noticed a berm was completely enclosed. Was there talk or an idea of having openings, elevation variability, or drainage channels?

A: **(Mark A)** Back in time, there used to be a marsh at the tip, and we watched it erode. The resiliency of the marsh was taken into account, impacted by large wakes, huge tugs were flying down at 2 am. Deering Slough runs between the marsh and the island. The project had a certain amount of marsh they had to construct (3350 square metres), but they were constrained by navigation channels, property lines. At the time, DFO was simply looking at how many square metres of marsh could be made. Now when you're working with 1000-1500 square metre marshes, you would incorporate a central channel for salmon to access. Channels are also great for harvesting invertebrates, the drift tide takes them out to the river, and the fish are at the mouth. In the 80s/90s, we were more in the dark, DFO only looked at marsh extent, not channels or complexity. By building the elevation up and returning tidal processes, you can encourage a marsh platform.

C: Wanted to highlight that in the 1950s, when the trifurcation happened in the Fraser, bed load in the north arm went from 10-15% to 0, erosion of the salt marsh was exacerbated by lack of sediment supply and wakes.

A: **(Mark A)** The Fraser was heavily dredged, although not anymore, from North Fraser Port to Vancouver Port, not going to prioritize North Arm. In the South arm, they did the dredge cut through layers of mud — 1.5 metre, angle of repose, all the mud flat drops, big chunks fall in like a glacier — sediment load increased with the over dredging. They had navigation depth they have to achieve due to shipping — Panamax vessels, overdredge so they don't dredge as often, all slides into the cut, all of this led to major marsh loss.

Q: Was the erosion of the marsh a combination of wakes and lack of sediment supply?

A: **(Mark A)** high wakes from tugs. We needed to protect from wakes with riprap and were constrained by navigational channels and property lines. Overdredging is a big stressor, but it was needed to achieve a certain depth, so they overdredge to reduce frequency of dredging, marsh falls into the dredge cut.

Q: What's the salinity tolerance of purple loosestrife?

A: **(Daniel H)** It's a wide range, you see it throughout the estuary, early colonizer at low marsh, right down to the delta front. It can tolerate periods of inundation and high salinity.

Q: Does purple loosestrife provide any function? Could it be beneficial in any way?

A: **(Daniel H)** That's to be determined, looking at the positive or negative impact on salmon (prey resources), what does a purple loosestrife dominated habitat benefit salmon in any way, or fish in general (juvenile salmon prey resources).

A: **(Dan S)** very few resources to refer to, monitoring in Fraser in the early 90s (Mark), making uninformed decisions.

Q: Can you talk a little bit about Jamie's exclosure experiment and John McDonalds thesis?

A: **(Eric B)** Been experimenting with marsh recession investigation. Hard to determine post-recession after it has occurred, where they are using trial plots with goose exclosures, marsh is rebounding quickly, strong signal of goose herbivory, especially at delta front. Transplants in the sedimentation addition area — needing to assist vegetation, strong signal, keeping geese out, marsh can regenerate. John McDonald's thesis of the wave sheltering effect of anchored woody debris is being trailed with transplanted veg seaward and landward — failed because woody debris is still moving up and down despite being anchored and causing scouring — lots of lessons learned at Sturgeon Bank, such as under estimating geese appetite, and the impact of logs.

Q: What are the thresholds of appropriate distances between patches? And what do we know about how juvenile Chinook move across the delta between the outlets?

A: **(Dave S)** Adopted right from Greg's paper — it is hard to know how fast they are moving down the river. Chinook show up at the mouth in the south arm a week or two before they come to the north arm. With dredging it can be like a water slide straight down. Tidal marshes are only accessible for a few hours at a time, but salmon shouldn't have to go more than half a tidal cycle before reaching the next patch. Salt wedges extend for tens of kilometres upstream, as the salmon migrate, they duck between fresh and salt waters, influencing how fast they are moving down. The size of the fish also impacts how long they spend in the marsh, a 4-6 cm fish need more fresh water, at 7 cm they move out to the eelgrass, and it is timed as they develop increased salinity tolerance. Hatchery released salmon, typically 8 cm, blow right through the estuary.

Q: The Lower Fraser has a lot of agriculture, and likely lots of nutrient loading, what are the impacts? The east coast is seeing a lot of impacts — energy going to the above ground biomass, rather than the rhizome and this can lead to marsh platform collapse, was that seen that in the golf course area?

A: **(Mark A)** A creek near a golf course drainage contains lots of non-native species growing in the creek near pump stations, lots of species coming from cranberry bogs. Water features in the golf course, outfalls of pump station result in all sorts of strange types of plants

A: **(Eric B)** Sean's PhD thesis looked at nutrient loading from agriculture in marshes — nitrogen dominated fertilizers in bullrush growth. Used two different kinds of fertilizer and found that marsh growth was actually limited by nitrogen.

RESTORATION IN WASHINGTON:

Marsh Restoration in the Snohomish River Delta

Todd Zackey, Field Studies Program Manager, Tulalip Tribes

Summary:

The Snohomish River represents a large and ecologically significant system of Puget Sound. Todd provided an overview of the design, monitoring, and results of four restoration projects in the Snohomish Estuary and highlighted how monitoring results can inform future restoration site design.

- Sites Restored (Qwuloolt, Smith Island, Blue Heron Slough), and future site (Chinook Marsh, in advanced design phase) are large scale projects restoring 142-174 Ha at a cost of of $17-20+ million each. Restoration accomplished by dike breach and setbacks. Took time to settle and learned lessons about number of channels/breaches to ensure appropriate tidal velocities.
- Monitoring to inform restoration design. The group has been monitoring a suite of parameters at different scales (system wide, site-specific). A few study highlights include:
    - > A DNA study on juvenile Chinook found that salmon were not only from the Snohomish basin but found Skagit and Stillaguamish-origin fish utilizing the estuary. Todd commented on the implications for salmon recovery strategies in the marine environment challenges the typical watershed-based approach.
    - > Established a network of water column data loggers to capture the hydrological response to restoration. The data collected showed a change in the salinity dynamics, which impacts the vegetation communities.
    - > A study on toxins in fish revealed that juvenile Chinook had high levels of fire retardant, which can impact their immune system. They were able to deduce the source of the pollution to an industrial laundry facility and are now working with the treatment plant and the city to reduce impacts.
    - > Established sediment elevation tables to understand if sediment accumulation is keeping up with sea level rise (SLR). This information can be incorporated into future project designs.
    - > At Qwuloolt site, they are analyzing soil properties and finding tile drains from agricultural areas cause different revegetation trajectories due to altered salinity pore water. For example, reed canary grass takes longer to die, and native vegetation takes longer to re-establish.

zis a ba Tidal Wetland Restoration

Charlotte Scofield, Fisheries Biologist, Stillaguamish Tribes

Summary:

Charlotte presented the Stillaguamish Tribes' zis a ba tidal wetland restoration projects, which encompass 300 hectares of Stillaguamish Delta and 9 km of shoreline. The area once supported 30,000 returning adult Chinook salmon but has lost 85% of tidal marsh habitat and now only about 1000 Chinook return each year.

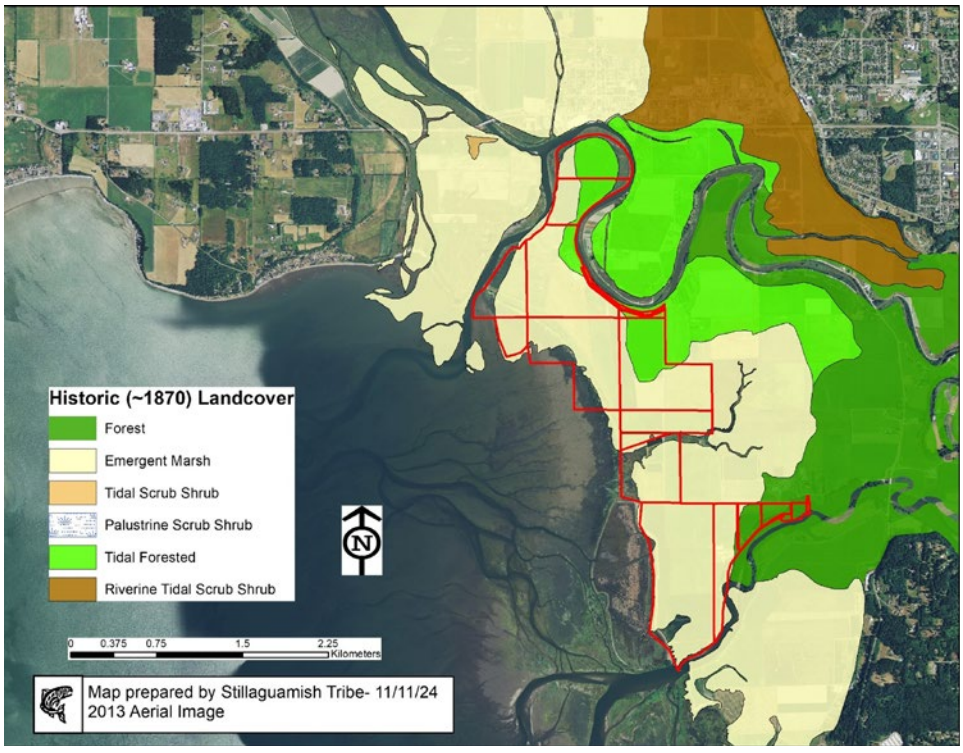
The tribe's approach to restoration has been to:

- Acquire large areas of contiguous land with grant funds to be able to restore over a large area. Having the land protected from development is important for preventing degradation and long-term stewardship.
- Use process-based restoration informed by the best available science to improve the outcomes (e.g. allometry).
- Incorporate community concerns into the design.
- Maintain a commitment to ongoing stewardship.
- Independent Design Review by external consultants to help ensure the success of a project.

The zis a ba projects are being completed in a phased approach over three sites. Each site has/will incorporate breaches, levy setback/flood mitigation, and tidal channel excavation. The cost and extent of restoration for each project varies from $3.2M / 33 Ha to an estimated $36.5M / 174 Ha.

Does it work? zis a ba 1, as an example, has shown the success of channel excavation in slowing down tidal energy to allow natural marsh plant establishment, and early fish monitoring results showed an increase in juvenile fish abundance.

Charlotte closed by highlighting the project's takeaways, including the value of independent design review by external consultants to help ensure a successful project.



The extent of the zis a ba tidal restoration areas.

Using Bioenergetics and Landscape Connectivity to Plan Effective Tidal Delta Restoration Projects for Chinook Salmon Under a Changing Climate

Emily Howe, Aquatic Ecologist, The Nature Conservancy

Summary:

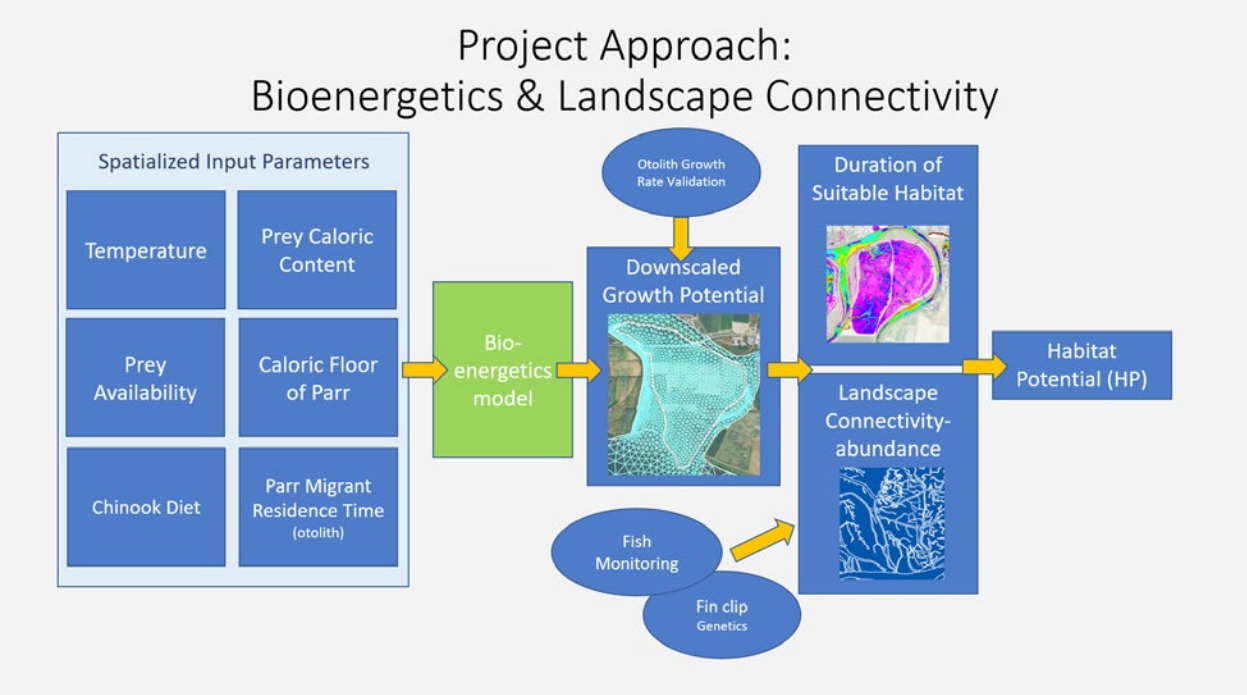
The Nature Conservancy is developing a biological metric to support decision-making and inform better restoration design and outcomes. Emily presented a 'Habitat Potential Index' metric that combines bioenergetics and landscape connectivity to quantify the biological value of habitat and evaluate future habitat quality with climate change.

The project hypothesizes that thoughtful placement and design can enhance the value of the restoration site by increasing connectivity and/or by promoting areas of high growth potential for salmon.

- Well-placed restoration projects support increased juvenile Chinook use beyond the project area by increasing connectivity among sites or by promoting areas with high growth potential.
    - > *How can the restoration site support the reference sites?*
- Climate change will counteract restoration efforts through the additional metabolic stressors, which may be further impacted by poor project placement.
    - > *What is the buffering effect of the restoration actions with climate change?*

To address the project aims, Nature Conservancy has been looking at fish usage of an area; how many fish; how fast can they grow; how much time do they have to grow in a season, and how this will shift under climate change.

They are working on combining various data sources across the Stillaguamish area to develop Habitat Potential (HP) metric, landscape connectivity metric, and fish density metric to input into the model = Habitat Potential Index and use this to see how much of a buffer a restoration project can offer in future climate conditions.



Building a Habitat Potential model with metrics

QUESTIONS AND DISCUSSION FOR SESSION 2 – WASHINGTON PRESENTATIONS:

Q: How are these large parcels of land being acquired? Part of the 20 million dollars?

A: **(Charlotte S)** Our budget did include acquisition. The way that the tribe acquires land was through tribe-built relationships and started with Chinook recovery plan in 2005 identifying habitat limiting factors, which identified this lower delta as a prime area for restoration. It was best to acquire the land and steward it. Washington state has significant grant funds for property acquisition — zis a ba took three grants to acquire the property

Q: How was an Independent Design Review paid for, and how is the reviewer picked?

A: **(Charlotte S)** We incorporated because of a failed project — lesson learned — simple process, reach out to qualified engineers, propose, bid, select the most qualified, grants covered the cost. Tribe is working on such a large scale, that funders see another layer of design review as highly beneficial way to manage risk, it costs a little now, but may save millions if it goes wrong

Q: What was the source of warming? If it was on the freshwater side because of the timing of the hydrology, actual warming of the estuary can you do mitigation in the freshwater? Beaver dam analogs?

A: **(Emily H)** Simple temperature model — temperature is coming down — There is a freshwater warming signal and big mud flat in Port Susan Bay, 3 km of hot mud flats — temperature modelling used is not sophisticated enough to say much detail about this just yet (Todd does). Our climate model shows more what the warming will be, with the fish and monitoring. Early season they go up to zis a ba 1 when it's warm and plants flower and with insects, and then go back down, moving across the delta to the mouth of the river, using the space and temperature gradients quite well. We needed to push back with engineers on the shape of the tidal channels — pushing layback, 45-degree ditch that is impossible to get out of, need to be vertical to grab plants, rebuilt the bucket to dig steeper sides, then groundwater in the marsh can start percolating through. We will leave the issue or importance of beavers to Greg, although we do have one beaver, its impact is not yet known.

A: **(Todd Z)** Multiphase model — hydrodynamic used across the sound once calibrated — Salish sea modelling centre — Integrating a heat flux model (used across the sound) and how much mud heat transfers into the water (solar uptake), there is a Salish Sea Wiki with reports in it — hydrodynamic model being created and calibrated for the sound with seasonal variation and info on interactions of heat and sediments. Multi step. Wiki page.

SESSION 3: RESTORATION DESIGN AND ENVIRONMENTAL FACTORS

Guidance on Effective Use of Marsh Restoration for Coastal Flood and Erosion Risk Management

Enda Murphy, Assistant Professor of Coastal Engineering, University of British Columbia.

Summary:

As coastal flooding, damage, and habitat loss will increase with climate change and sea level rise, it is critical to manage coastal erosion risk. Edna presented guidance resources on risk reduction with nature-based infrastructure and highlights the value of a whole system approach for habitat restoration and risk mitigation.

- Sea level rise is resulting in the loss of coastal wetlands globally (coastal squeeze, SLR exceeds accretion), and contributes to increasing flood hazard risk, which will worsen without coastal wetland habitats (e.g. to reduce wave energy etc.)
  - > In BC, it was estimated that 1 metre of SLR will tip us into a regime of wetland loss
- Coastal wetlands are highly valuable for adaptation; they provide flood water storage, wave attenuation, sediment stabilization, and storm surge attenuation.
  - > Coastal wetlands were estimated to have averted $625M of damage during Superstorm Sandy in the Northeastern US.

Reference guidelines and resources:

- International Guidelines on Natural and Nature-Based Features for Flood Risk Management
  - > Chapter 10 has useful 'rules of thumb' guidance for Coastal Wetlands and Tidal Flats (e.g. natural marshes need low energy under 0.2kW/m waves; Guidance for salt marsh resilience to waves and SLR, design considerations, performance metrics, construction).
- To fill gaps in a Canadian context, a multi-disciplinary team initiated a project to develop Canadian Design Guidance for Coastal Nature-based Infrastructure. Conducted parallel research to create a knowledge base to inform the comprehensive Canadian guide. The resulting document is available for download.
  - > Includes sections on community context, technical solutions, and guidance on predicting and monitoring outcomes.
  - > Chapters 8-10 present guidance and case studies specific to marsh around sediment, plant, and hybrid-based solutions.
- There is an ever-increasing need for accessibility, consistency, transparency, and interdisciplinary collaboration, as well as the need to better communicate the value of the services, natural or nature-based ecosystems can provide.

Restoring Sediment Supply to Sustain Delta Marsh: Role of Waves and Sediment Transport to Inform Restoration in the Nisqually River Delta

Eric Grossman, Research Geologist, U.S. Geological Survey

Summary:

Eric shared lessons from one of the region's largest restoration projects after 15 years. Although the dike removal and restoration served well to reconnect water and fish in the restored section of the Nisqually River Delta, marsh re-establishment has lagged. Modelling sediment supply and exchange demonstrates what would be needed for the habitat to fully reestablish, and what opportunities could improve outcomes.

- The restoration site had substantial subsidence. A large sediment supply is needed to be able to recover a grade suitable for marsh development. They investigated the sediment supply and found:
    - > The hydroelectric reservoir reduced the load.
    - > Wave action was a big factor in sediment exchange and distribution.
- With regional models of hydrodynamics, hydrology, sediment (type and transport properties), and waves, and comparing to historical information, it was estimated it would take 80 years to gain the sediment needed at current rates of sea level rise. With all the sediment that could be routed into the area, it would still require about 20 years.
- Therefore, we need to consider opportunities and adaptive management solutions.
    - > Modelling also showed that by 2040, the I5 causeway would be overtopped during storm events so a solution that helped restore connectivity in the system to help with sediment supply issues could be incorporated in the infrastructure rebuild.
    - > Modelling on broad scales is important to understand the sediment budget with respect to the marsh edge and stability. Results from multiple systems suggest that the combined factors of sea level rise and sediment supply will cause many deltas to experience erosion.
    - > This emphasizes the importance of adaptive management opportunities like connecting historical channels.
        - Nature based approach to improve connectivity, slow waves, and allow for sedimentation.
    - > There is potential to combine regional models that will help with regional planning and priorities for a full Salish Sea perspective.

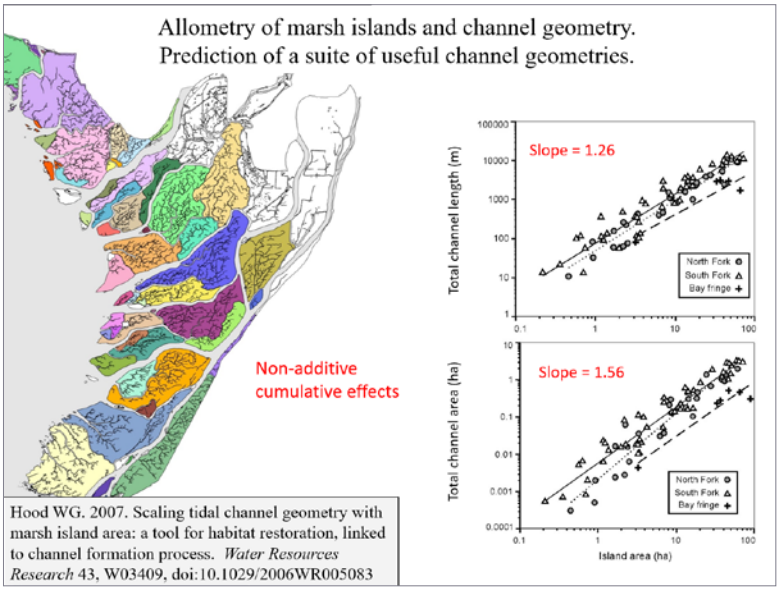
Applying Landscape Allometry to Tidal Marsh Restoration: Predicting Tidal Channel Network Geometry

Greg Hood, Senior Research Scientist, Skagit River System Cooperative

Summary:

Greg explained applying allometry, a mathematical approach, or 'geometry of forms', to determine the design of tidal channels and openings for marsh restoration. Generally, when relying on professional opinion to design channel networks, there has been insufficient channelization incorporated into restoration. The importance of a larger channel network is that it reduces tidal exchange velocity, facilitates vegetation establishment, and creates more accessible habitat.

- Taking the area of a tidal marsh island and charting up the area of the tidal marsh network as a response variable can help predict a suitable design. Puget Sound examples found that:
  - > Response variable slope is greater than one, meaning that the larger the area, the disproportionately more tidal channels there are. There is a greater benefit for restoring larger areas.
  - > The greater the tidal range, the greater the tidal channels.
  - > Fetch reduces the number of tidal channels, which was a surprise.
- Underestimating the quantity and area of channels and dike breaches will limit restoration success. Greg shared lessons from Fir Island Farms and Qwuloolt restoration sites where they deviated from allometry:
  - > High velocity of water coming from a single outlet prevents fish access.
  - > Without channels, tidal exchange energy is focused on the substrate surface, preventing seed retention and marsh plant establishment.
    - Only invasive brass buttons that have very sticky seeds were able to settle and establish.
    - Sites remained mostly unvegetated eight years after restoration; zis a ba, with appropriate allometry, had marsh plant establishment after the second summer.
  - > Tides don't break in a single wave; they come from different angles with many arms into tidal channels and over the bank in different directions that can create null velocity vectors; calm areas where native seeds can settle and create marsh. With more tidal channels, there will be more velocity null zones, and therefore more opportunities for native seeds to settle and establish marsh.



Relationship between the total channel length and total channel area with slopes greater than 1

QUESTIONS AND DISCUSSION FOR SESSION 3 PRESENTATIONS:

Q: For sites that were built with insufficient tidal channels networks, can you adaptively manage by planting certain areas to slow down the velocity or flow?

A: **(Greg H)** Brass buttons could be creating some roughness on the surface, therefore slowing water velocity, leading to more seed drop off and vegetation establishment. It is important to look at sites objectively about what went right/wrong and implement adaptive management.

Q: How do you go about designing something like this, thinking about excavated channels, and ensuring there are an adequate number of channels?

A: **(Greg H)** All the sites we looked at were previously farmed sites, farmed sites that the sediment was subsiding, compressed by tractors, or had clay layers that were 2 m deep. — At zis a ba there was clay all along the face and cut in deep, it would not have naturally carved itself. At best, the tidal channels would have been pretty shallow.

Q: How do you approach this, dig the main arm of the channel and where do you go from there?

A: **(Greg H)** Negotiation with engineers, managers, funders, I'd say excavate as much as you can, otherwise it will take a long time or not happen naturally.

Q: What are the Fir Island site plans? More channels planned or a dike breach?

A: **(Greg H)** There are opportunities for four more outlets; certainly, increase the length and number of tidal channels at the site.

SESSION 4: SPECIAL PRESENTATION

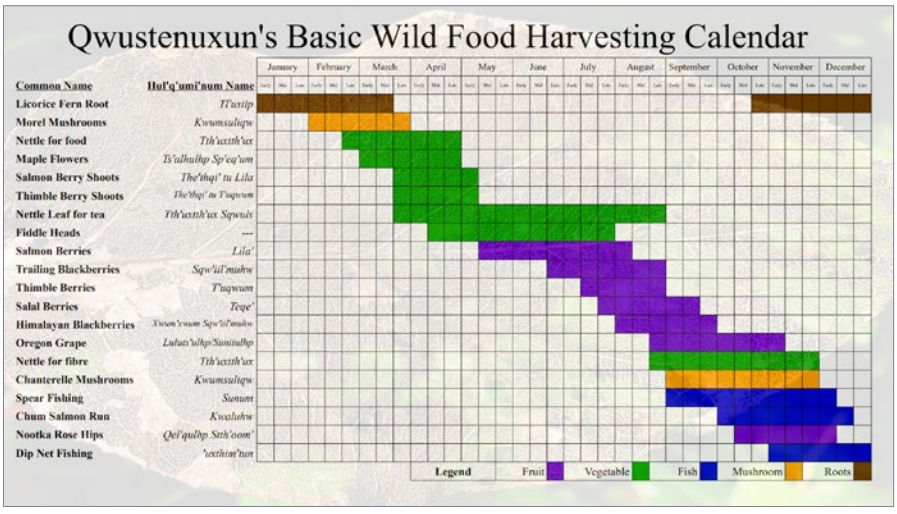
The Language of the Land, a Glimpse into the Indigenous Food Systems in Wetlands

Jared Qwustenuxun Williams, Qwustenuxun Consulting

Summary:

Traditional food is the foundation upon which an entire culture is based. If foods (e.g. smoked salmon) aren't eaten, a diverse set of cultural practices are lost (harvesting cedar, creating tools etc.). Jared shared the deep connection to the land and the rich and complex agriculture that has been fundamental to Indigenous communities for countless generations.

- The connection to land is evidenced by the names of places, which indicate what is harvested and the time of the year when something is there.
- Sophisticated techniques ensured the sustainability of harvest and the improvement of resources for the future. Jared provides intertidal aquaculture and agriculture examples:
  - > Traditional weirs only partially blocked the river and were designed with a small gap to allow selective harvest of weaker male salmon. This allowed maximum reproduction and, over thousands of years, promoted stronger genetics.
  - > Clam beds were created along shorelines for culturing clams. There is evidence that the practices increased the size of butter clams.
  - > Prescribed burns were carried out to promote Camas, even within the estuaries. Camas harvesting was done by turning over a large mat of earth with the bulbs. This allowed for selective harvesting and promoted larger bulbs.
  - > Silverweed and hazelnuts were also similarly managed actively.
- Jared shared a wild food harvesting calendar based on seasonal availability and highlighted the message from Elders that 'what you require is ready when you require it,' and this rhythm provides the nourishment to survive and thrive. For example, more fats and protein in the winter, more fruits and vegetables in the spring and summer.
- Restoration offers an opportunity to reconnect the Indigenous teachings on the connections to the land and to culture.



Harvesting Calendar and Salmon cooked with cedar wood

QUESTIONS AND DISCUSSION FOR SESSION 4 PRESENTATION:

Q: What were the native plantings in the Cowichan Estuary? What species?

A: **(Jared W)** Planted quite a list, including camas, silverweed, salmon, and thimbleberry. Needed to create enough space to plant 128 acres. There has been an epidemic of diabetes in Indigenous communities, camas has been shown to help.

Q: How can we educate people on what was lost through residential schools with respect to these teachings and practices so that they can be brought back?

A: **(Jared W)** It's only a matter of time. We continually hear about the issues with Westernized agriculture and how we need to live with the land. Agriculture run-off is a big issue, Indigenous agriculture does not have that issue. We need to combine our efforts and create a way that we can all thrive — help fix issues of homelessness or starvation.

Q: Was spear fishing done from the bank or also swimming in the water?

A: **(Jared W)** Spears are varied. In the Fraser, it's more of a hook, whereas here we use one that goes through the salmon and ones that release the spear. This is our traditional sea hunting tech; we would have used dip nets because there were so many fish.

Q: How has urbanization impacted the food systems?

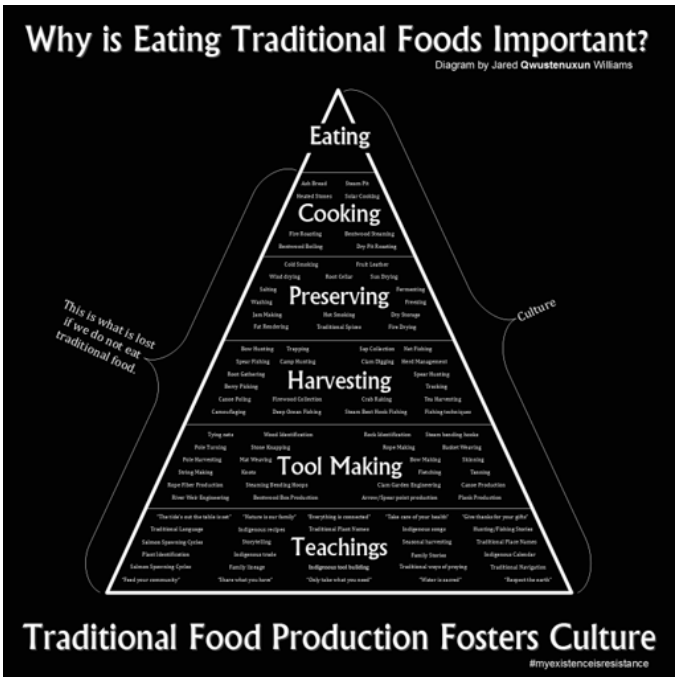
A: **(Jared W)** Upon colonization, cows were moved into Gary Oak meadows which are very important for camas. Important areas were logged and made into areas for agriculture (Duncan). Urban runoff is also killing salmon (tire particles, salt).

Q: People have mentioned draining the swamp to create housing, what are your thoughts?

A: **(Jared W)** There are foods that are no longer here, Labrador tea and soapberry, due to lost land. We need to create more of a balance.

Q: Has there been any success around returning to Indigenous burning practices for forested areas?

A: **(Jared W)** Yes, there is a lot of interest in doing prescribed burns in certain areas, and there are plans for creating a guidebook for this practice.



SESSION 5: CLIMATE RESILIENCE AND ADAPTATION

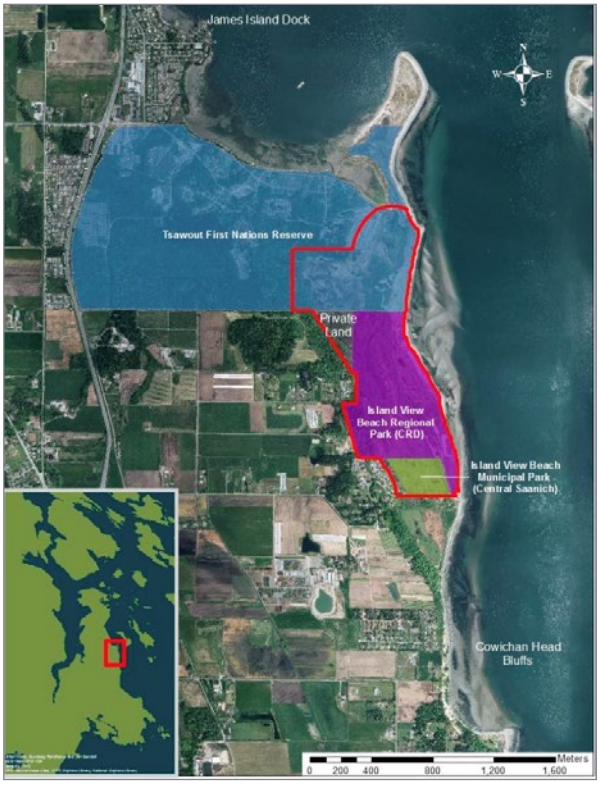
IPCAs and Climate Resilience: Enhancing Conservation and Sustainable Livelihoods: The Tsawout First Nation's Initiative in Creating an Indigenous Protected Area in the Salish Sea

Lais Chaves, Marine Use Planner, Tsawout First Nation, Neil Fowler, Fisheries Biologist, Tsawout First Nation, and Tim Clermont, Executive Director, Guardians of our Salish Estuaries

Summary:

A video was screened on the declaration of the Tsawout First Nation Indigenous Protection Conservation Area (IPCA), which occurred June 21, 2023. The video highlights the traditional importance of the ocean to the Tsawout, who are known as 'Saltwater People'. Since colonization, the Tsawout territory has been degraded, species have been lost, and traditional seafoods are no longer safe to eat. The Tsawout are seeking to turn this around and reestablish the deep connection to a healthy ocean through management and restoration.

- The Tsawout IPCA includes remaining estuary, saltwater lagoon, a diverse sandspit, and foreshore habitat.
- They are working towards a management plan that includes monitoring and restoration and planning to:
  - > Restore drained farmland into productive fish habitat,
  - > Grow seaweed,
  - > Engage youth to be the stewards of the land and pursue a Guardianship program.
- It all started with a goose harvest, a meeting, and ideas. It gathered momentum with the community, sharing knowledge and built up to an IPCA declaration. Tim recommends taking initiative and not waiting for it to happen.



Tsawout First Nation and range of work/scope.

Blue Carbon: Pacific Salt Marshes Current Species Distribution, Carbon Stock, and Projected Distribution Under Climate Scenarios

Vanessa Valenti, Master's Student, University of British Columbia and Blue Carbon Canada

Summary:

Vanessa provided an overview of her master's research goals and her progress. Her research addresses uncertainty in the spatial extent of blue carbon stocks associated with salt marsh habitat and the projected extent and distribution in the future climate.

- In salt marshes, carbon is sequestered and stored in biomass and underlying sediment. There is great uncertainty about the spatial extent of blue carbon ecosystems and where they will exist in future climate conditions. To be able to incorporate blue carbon ecosystems into climate policy and goals this uncertainty needs to be addressed.

Vanessa's work has three overarching goals:

- Model the current and future distribution of Pacific salt marshes.
    - > Develop species distribution models of the key marsh species with existing data and incorporate future climate scenarios.
- Determine Pacific salt marsh below-ground carbon stocks.
    - > Analyze soil core samples from diverse marsh habitats and apply to the extent.
- Analyze the variation across marsh condition factors.
    - > With the metadata from core samples and coastal data to explain observed variance.

Data availability, quality, and spatiotemporal consistency for the model imports have proved challenging.

Blue Carbon: Assessing the Blue Carbon Value of Marshes: Small but Mighty

Marianne Fish, Senior Specialist, Coastal Ecosystems WWF – Canada

Summary:

Despite their small area, salt marshes have high carbon storage potential and represent an important blue carbon habitat. Carbon stocks and sequestration rates in a marsh vary due to many abiotic and biotic factors and can be influenced by stewardship actions. Marianne described the work of WWF-Canada's Blue Carbon Project to monitor, understand and share knowledge on carbon sequestration.

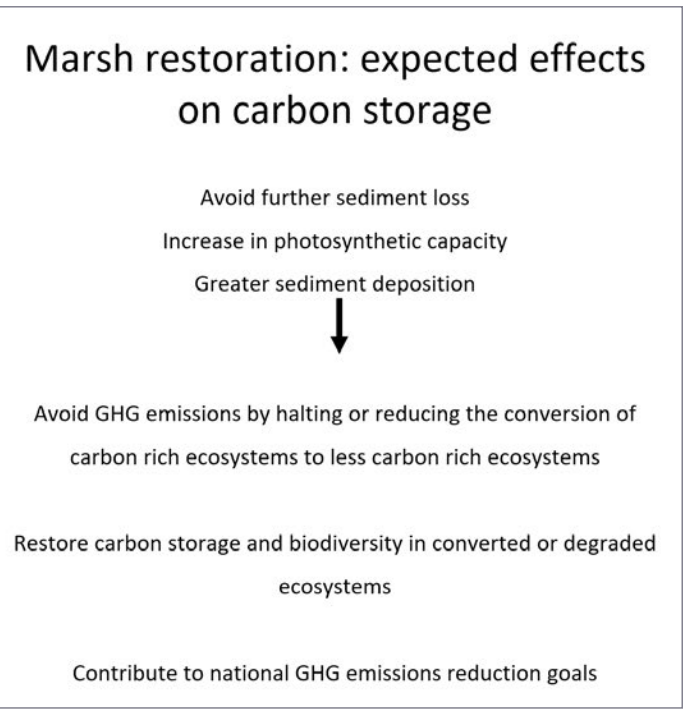
Looking at the carbon stocks and sequestration rates helps us understand the effects of stewardship actions.

- For example, goose fencing prevents future sediment loss, plantings increase photosynthetic capacity, and with increased structure sediment deposition will be greater, resulting in more stored carbon potential.

The work that WWF–Canada has done:

- Support Indigenous led work to monitor, restore, and protect blue carbon habitats including capacity building workshops held in collaboration with Hakai.
- Support testing of innovative techniques.
- Create and disseminate information, a state of knowledge report on blue carbon in Canada is available on the WWF-Canada Website.
- Facilitate a community of practice and knowledge exchange.

Marianne closed by encouraging those wanting training opportunities or to participate in the community of practice to get in contact with her.



QUESTIONS AND DISCUSSION FOR SESSION 5 PRESENTATIONS PART 1:

Q: What's the best carbon sequestering plant?

A: **(Vanessa V)** Not really one species in particular, more about the vegetation being present to capture sediment and build up the marsh platform. The underground biomass is important and varies between species.

Q: What's the timeline of the WWF Project?

A: **(Marianne F)** 2022–2026.

Q: What's the spatial resolution?

A: **(Vanessa V)** It depends on the data source. There was resampling at the finest layer, but they're hoping for 20m for eelgrass, but most likely 500m overall.

Q: A big data gap is knowing the depth of the peat layer, in certain places it can be 8m, is that incorporated?

A: **(Vanessa V)** Agreed, that would be great to know, not currently able to incorporate right now

Q: One of the slides was about carbon accumulation in eelgrass and kelp latitude differences moving away from the topics. Is there similar behaviour with salt marsh where C accumulation is more or less based on global location?

A: **(Vanessa V)** We don't know yet, but something we hope to figure out.

Tsleil-Waututh Nation Estuary Restoration at the Indian River Watershed

Benji Eisenberg, Coastal Adaptation Consultant, and Graham Nicholas, Senior Environmental Specialist, Tsleil-Waututh First Nation

Summary:

Since colonization, there has been tremendous ecological change in Burrard Inlet, resulting in habitat loss and the loss of the way of life. Tsleil-Waututh Nation (TWN) is working to move back to traditional food systems through restoration and rehabilitation. Benji and Graham described their recent efforts in their marsh habitats.

- TWN has created a Burrard Inlet Action Plan and Indian River Watershed Plan to improve the health of the inlet with the overarching goal of reconnecting the community to traditional foods.
- Despite being a largely intact system there are legacy issues and marsh loss in the estuary.
- TWN took part in an exchange with GooSE/ K'omoks, sharing knowledge, food, and experiences across the Salish Sea.
    - > From the lessons and skills learned, TWN created a goose exclosure in their territory in a highly accessible location for the community to be involved. The exclosure was planted with *Carex* and they plan incorporate traditional foods for future harvest and cultural revitalization. There is also interest in goose harvest.
    - > Benji described a pilot exclcosure project of a small 4x6 m exclosure paired with a control plot that will be monitored for how the marsh vegetation responds.

QUESTIONS AND DISCUSSION FOR SESSION 5 PRESENTATIONS PART 2:

Q: Is the goal of these seed projects to give people living on the reserve the chance to engage with restoration projects?

A: **(Benji E)** Yes, they're 300 m from the reserve so members can see the site firsthand.

Q: Is there any harvest plan in the larger project areas?

A: **(Graham N)** There is a big elk hunting community, there is an appetite to get food plants harvested in these areas as well, so yes.

PRESENTATIONS DAY 2

SESSION 1: MONITORING AND DECISION SUPPORT TOOLS

Longer Time and Spatial Scales: Evaluating Vegetation, Carbon Accumulation, and Elevation Capital in Legacy Tidal Marsh Restoration Projects on the West Coast of the United States

Christopher Janousek, Researcher, Oregon State University

Summary:

Efforts to restore estuaries have occurred since the early 1900s on the US West Coast. Understanding the outcomes of 'mature' restoration sites can inform current restoration designs and decisions. Chris summarized the MAREA (Mature Restoration Assessment) project, which assesses the long-term function of salt marsh restoration projects with respect to vegetation communities, elevation, and carbon sequestration.

- Studying 16 paired sites at nine estuaries along the west coast of the US, the project evaluated three tidal marsh attributes: vegetation development, elevation capital, carbon sequestration in older restoration projects (c.a. 22-62 years since restoration), and reference sites. Restoration was generally dike removal and passive vegetation colonization, some sites had fill added. Key results include:
  - District regional patterns (southern California compared with Pacific Northwest).
  - Salinity and elevation were greater drivers of plant communities than restoration/reference status.
  - Both restored and reference sites had high vegetation cover.
  - Reference sites tended to have higher plot-scale diversity and were more likely to have rare species.
  - Restored sites that did not have elevation manipulated (e.g. not filled) were lower than reference sites; restored sites that had fill added had better elevation capital.
  - Soil cores revealed that reference and restored sites had similar carbon sequestration rates.
- Chris's recommendations from the study for restoration include:
  - Elevation and salinity are key considerations in restoration design and management.
    - If elevation is too low, it is vulnerable to SLR; if too high, there will be poor channel development and reduced carbon sequestration.
    - Low salinity leads to non-native species, which may require additional management.
  - Planting may be needed to boost plant community diversity.
  - Long-term monitoring is a critical component of restoration.

Mapping Marsh in the Fraser Delta with Remote Sensing

Bing Lu, Assistant Professor, Simon Fraser University

Summary:

Remote sensing, using images collected by satellites, drones, and helicopters, is a powerful tool to capture spatial and temporal changes over a large area and can serve as a method of long-term monitoring of estuarine systems. Bing has been applying techniques to study marsh die-off and vegetation communities in marsh systems.

- Satellite imagery was used to track trends in marsh extent. With analysis from remote sensing models, areas where marsh is stable, lost, or gained can be delineated. With this information, the causes (i.e. geomorphological, ecological) behind the changes can be explored.
- With high-resolution satellite imagery (resolution can be as fine as 30 cm), different colours and patterns can reveal details of the plant community. With field surveys and machine learning models, vegetation maps can be generated.
    - > An application is to identify locations of invasive species to inform management and track spatial and temporal change.
- Ultra-high resolution imagery from a drone can be as fine as 2 cm, which allows for more detailed mapping.
    - > An application example includes identifying vegetation density and biomass in relation to environmental factors (topographic conditions, water availability, anthropogenic impacts) to better understand dynamics through time.
- Bing highlights the importance of a multi-disciplinary team to fully realize the great value of remote sensing tools and applications.

Wetland Ecosystem Services Protocol (WESP) and Marsh Mapping

Neil Fletcher, Director of Conservation Stewardship, BC Wildlife Federation

Summary:

Neil outlined the Wetland Ecosystem Services Protocol (WESP), a standardized rapid assessment tool that can provide relative estimates of functions and benefits that a wetland provides. WESP was designed for freshwater wetlands, but it could be adapted for those working on tidal and salt marshes.

- WESP is concerned with functions and benefits rather than ecosystem health.
    - > Functions are defined as the physical, chemical, and biological processes supported by the wetland.
    - > Benefits qualify the importance of a given function to human society based on surrounding land uses and landscape characteristics.
- WESP is designed so that someone with 4-5 days of training can collect data for wetland function and benefits assessments in a single site visit.
    - > 66 field indicators with 45 GIS calculated indicators are combined to provide a measure on functions.
    - > Can be used to make 'report card' style outputs of relative function values.
- This tool standardizes assessment of wetland habitats and functions to support mitigation or offsetting, protection decisions, as well as economic evaluation.

QUESTIONS AND DISCUSSION FOR SESSION 1 PRESENTATIONS PART 1:

Q: Is there training available for the WESP tool?

A: **(Neil F)** Right now, there is training for the fieldwork. They are currently working on training for the desktop portion, which should be available by spring 2025.

Q: Was there any correction for introduced species when doing the plant cover analysis?

A: **(Chris J)** No, for the total plant cover, all species were lumped together, there are some species that are ambiguous as to whether they are native/non-native in PNW.

Q: Did you see an overgrowth of Ulva in the marshes?

A: **(Chris J)** Algae and vascular plants have a complicated relationship. They both compete for light and nutrients, but algae help to stabilize sediment. Watersheds with agricultural runoff may have persistent algal cover problems (N). In places that don't have elevation gradient for vascular plants, nutrients favour algae blooms.

Q: How do the elevations of the restored sites compare to other metrics (elevation and salinity being important factors), how much did they skew the results?

A: **(Chris J)** Vegetation community, carbon sequestration, and elevation are all tightly related. Low elevation sites subsided a lot and have relatively poor plant cover and high algal cover. Lower elevation sites may have higher accretion, so that could result in higher carbon sequestration rates.

Q: Was there an overall difference in performance that would lead you to recommend low or high elevation in restoration across all factors?

A: **(Chris J)** I don't have the data pulled together to properly answer. Including remote sensing data, pulling that info together to see how sites group together to map based on different functions is still a work in progress.

Q: Are there examples of WESP protocols applied to marshes; would you use it in BC to provide info on species assemblages?

A: Oregon and Atlantic Canada are using WESP. It would be a first pass on these systems rather than in depth. Wetlands of BC classification guide does have some species assemblages, but would need updating.

Q: One of the deliverables of this project (AERF) is to create report cards for estuaries. Hopefully, together we can discuss what those look like, stay connected, and come up with a plan that really informs the report cards (e.g. Nature Trust etc.).

A: **(Chris J)** This is a nested approach; all our work is complementary, so we can pull together different systems and approaches.

A: **(Bing L)** We can pull together different features using remote sensing to evaluate ecosystem health and define it in a more concrete way. Some indicators can come from the field, some from remote sensing to generate more of a complete picture of the wetland. Remote sensing has been widely used for wetland classification throughout North America (lots done in Alberta).

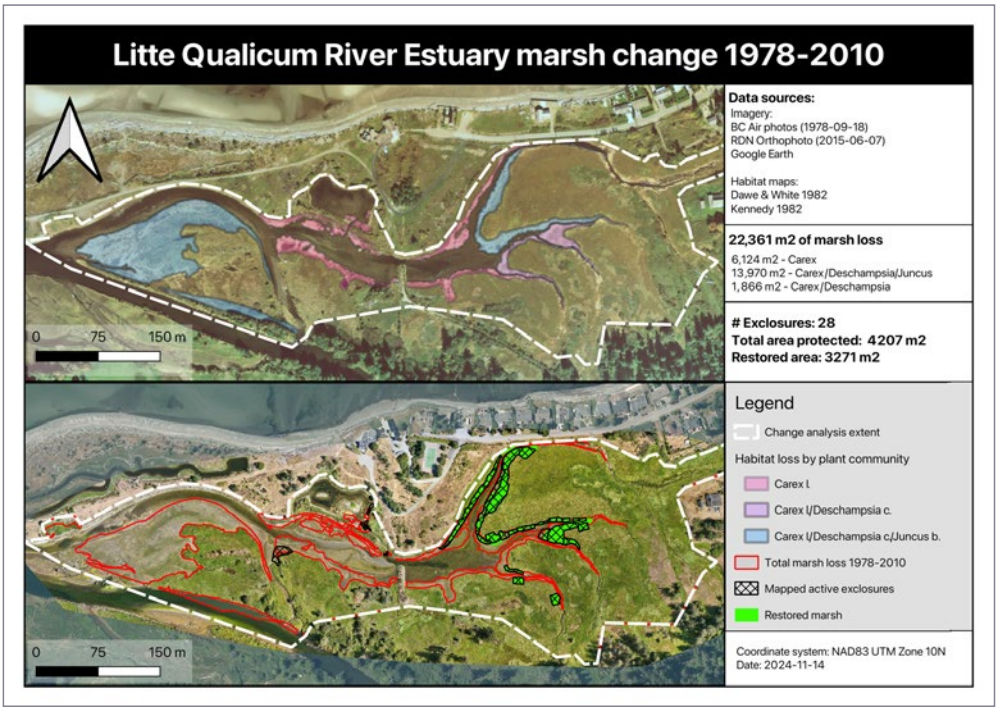
Tools to Scale Up Restoration and Monitoring with Limited Resources

Dominic Janus, Restoration Program Manager, Guardians of our Salish Sea Estuaries,
Liam Irwin, Researcher, University of British Columbia

Summary:

Using historical satellite or helicopter imagery provides us with a benchmark to understand changes in marsh extent over the last 40+ years. Dominic and Liam presented opportunities for raising awareness of marsh issues or informing restoration potential, from being able to demonstrate where marsh extent has changed.

- Part of the PSF 'Greening the Salish Sea' project includes an estuary marsh habitat change analysis.
  - > By mapping and comparing historic air photos (c.a. 1980) and recent satellite imagery of estuaries based on recent imagery, they are identifying areas of loss or gain in select estuaries.
  - > Showed example of loss of the *Carex* edge, which is an important habitat for rearing salmon, and speculated on causes such as geese grubbing, lower freshwater inputs, or SLR.
- They describe the potential to use drone and LiDAR technology to monitor the effectiveness of restoration activities.
- On a broader scale (Salish Sea or BC wide), Landsat data provides regular imagery since 1984. This long time series could be used to assess changes in marsh extent and condition, noting that the resolution is not as high in the older imagery.
- Collaboration towards common goals and combining efforts and resources has potential to improve our understanding of marsh habitat, its value, and our collective ability to convey this.



Change analysis of the Little Qualicum River Estuary

QUESTIONS AND DISCUSSION FOR SESSION 1 PRESENTATIONS PART 2:

Q: Who will be continuing to collect the data?

A: **(Liam I)** The province of BC has committed to collecting LiDAR data for the entire province in the next 2 years.

Q: What long term data sets are available? We don't want to assume 1980 is the 'real' baseline if we don't know what changes have occurred prior to then.

A: **(Dominic J)** For sure, but we have to use what we have and have to set a baseline somewhere.

Q: Where would the funding come from and where is the data to be stored for your proposed project?

A: **(Dominic J)** Data would be made publicly available, probably by PSF, and NSERC may be able to match funding from other sources, which would allow for a grad student or postdoc to work on the project.

Q: How can we incorporate future human movements and impacts into future modelling scenarios?

A: **(Neil F)** Models with similar parameters have been made in Chesapeake Bay, could use a similar approach.

SESSION 3: OVERCOMING CHALLENGES

The Campbell River Estuary Was Rehabilitated in the 1980s and 1990s... Until You Know Who Showed Up!

Sean Boyd, Research Scientist Emeritus, Environment and Climate Change Canada

Summary:

Four islands supporting marsh habitat were built in the Campbell River Estuary in the 1980s to offset habitat loss from industrial forestry activities under the DFO policy of the time of 'No Net Loss of Fish Habitat.' The built islands supported healthy *Carex* meadows until Canadian geese took up residence. Sean shared the lessons learned from the project.

- In the Campbell River Estuary, BC Forest Products built a dry land sorting facility and was required to compensate for the loss of 0.4 ha of intertidal marsh. The project consisted of:
  - > Cleaning up debris and pilings from the estuary.
  - > Four islands being built using sediment additions and planting with *Carex* transplants (23,000 15x15 cm plugs) from a nearby donor marsh.
    - Sediment included rocks and cobbles, which helped provide stability.
    - Unplanted blocks had similar vegetation cover after c.a. 5 years compared with blocks with transplants and reference sites. Sean suggests that as long as the substrate is stable and at a suitable elevation, planting may not be necessary; natural recruitment can work.
  - > The sites were monitored periodically.
- Sites supported productive *Carex* until heavy grazing by Canada geese began, with major losses observed by 2009 due to grubbing and grazing activity. *Carex* was lost or replaced by the less palatable *Juncus balticus*.
  - > Goose populations increased about 15% from 1990-2009.
  - > Roundup began in 2017 (GooSE and Nation) over 5 years removing 2,630 (130K goose days of foraging pressure).

Lessons Learned:

- Monitor for as long as possible!
- Marsh creation is a poor substitute for protecting the natural system. And ensure compensation does not replace other productive/valuable habitat (i.e. don't create marsh over eelgrass).
- Not managing geese, is itself a management decision.

Campbell River estuary prior to work and during planting

Troubleshooting a Non-Functioning Salt Marsh: Case Study Juskatla, Haida Gwaii

Morgan Tidd, Geomorphologist, Department of Fisheries and Oceans

Summary:

Morgan summarized a salt marsh restoration project on the north island of Haida Gwaii that failed to achieve its intended outcomes due to design flaws, and what we can learn from it.

- The site, Juskatla, is at the end of a long sound and has been used as a logging camp. Degradation to the site included extensive infill and wood debris, which impacted the eelgrass and salt marsh habitats.
- The restoration included reinstating natural depth/elevation profiles of the shoreline, capping over wood debris, and restoring eelgrass and marsh.
  - > The reference area also showed subsidence due to goose herbivory, a high river flow event, and other dynamics. More research is needed to understand what is happening.
  - > Used harvested seeds for revegetation of the marsh.
- After restoration, the site had issues with drainage/pooling water, invasive plants.
  - > The infill was dug over and fine grain material was placed over top, which did not allow proper drainage.
  - > An armoured toe was added to the design. This was unnecessary in the low-energy site and may be impeding tidal and freshwater flushing and redistribution of sediments, which may in turn be affecting the gradient.
  - > The erosion at the reference site indicates there are many issues at play that will need to be considered.
- It is important to plan for adaptive management and assess what features are required – seek input from a coastal geomorphologist.

Photo of the site showing poor drainage and elevation

Data Accessibility: PSF Marine Data Centre

Paulina Salinas Ruiz, Biologist, Pacific Salmon Foundation

Summary:

Paulina summarized the goals and products of the PSF Marine Data Centre, which aims to be a 'one stop shop' for connecting people to data through a long-term secure open access data portal and educational resources. Products are designed to increase awareness of environmental issues salmon face and improve decision-making.

- The Data Centre is working to secure and improve access to data, and creates many data products that bring information to life in a centralized location.
  - > House data from different sources and help direct to datasets housed elsewhere (e.g. government data).
  - > Map-based displays of data (StoryMaps, interactive maps, static maps, dashboards).
  - > Marine Ecosystem map, and interactive map featuring over 400 layers of spatial data.
  - > Generate atlases and knowledge hubs from accessible data.
- As part of this 'Greening the Salish Sea' project, the Data Centre will host a 'Restoration Knowledge Hub' containing resources and including a 'Restoration Atlas', which is an interactive map with a digital inventory of Community Salmon Program habitat restoration projects.
  - > These products will allow practitioners to see the latest techniques, where projects have been done and their outcomes, and will facilitate communication and collaboration across salmon restoration work.

QUESTIONS AND DISCUSSION FOR SESSION 3 PRESENTATIONS:

Q: Do you know anything about biomass data collected and published in 2000? Does sediment size affect plant biomass in the habitat?

A: **(Sean B)** We have to refer to published papers; I don't know why biomass would be lower in restored sites? Maybe because of salinity?

Q: In the photo, *Juncus* is remaining — planted into a rocky substrate which is an interesting type which could have been a result of the dam and geese likely chipped away at the sediment, then high flows from the river eroded away and the marsh platform disappeared

A: **(Sean B)** Could have done an elevation survey to figure out how much has declined. Some areas in the middle of the island have sunken and they have pooled. We want marsh islands to be rounded so they drain (with the highest point in the middle). It is a good idea to add sediment before this area is replanted in the future.

Q: Could juncus be used as a goose exclosure?

A: **(Sean B)** Maybe, but the better solution would be getting rid of the geese

Q: For the Haida Gwaii project, was there allometry modelling?

A: **(Morgan T)** Super small scope of a project should start with morphological changes, and it should work itself out. Carving channels is unlikely to be needed.

Q: Does anybody at PSF talk about herring recovery?

A: **(Paulina SR)** Yes, PSF has a BCSRIF herring project.

Q: Do you work with citizen scientists or First Nations data?

A: **(Paulina SR)** We do work with them and ensure that data is securely protected

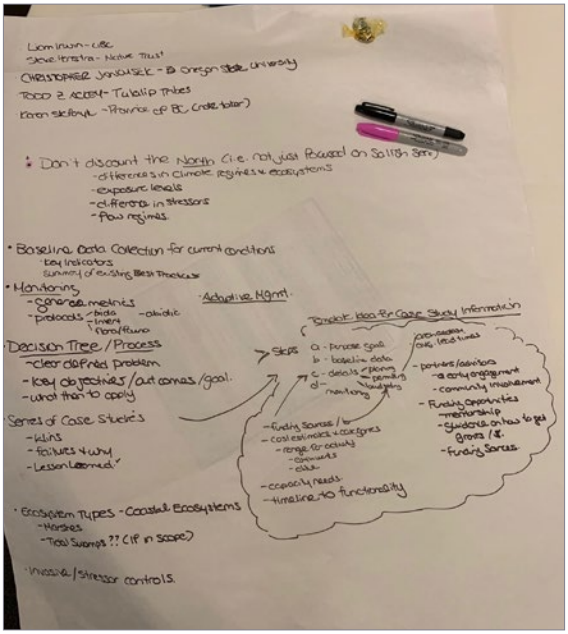
GROUP DISCUSSIONS

Day 1: Feedback on State of Knowledge and Practitioner Guide Content

In this session, Dominic Janus and Sarina Clay-Smith introduced the Practitioner Handbook and Table of Contents for the State of Knowledge report for feedback and engagement. In groups, ideas for what the Practitioner's Handbook should include were discussed, written down on poster paper, and presented. For the State of Knowledge document, the draft table of contents was posted in the room on a large poster, and attendees were invited to write content ideas and suggestions for resources. A summary of key ideas follows below, and more comprehensive notes can be found in Appendix 3.

Comments from Discussion:

- As marsh restoration is a developing field, the Practitioner Handbook would benefit from being a 'living document' that can be updated as new techniques are tested and resources are created. Being in an App format could be useful.
- Include case studies that highlight successes, failures, and lessons learned.
- Considerations for climate change must be included.
- Create decision trees to guide users to the best approach, and tools for their needs and take a 'toolbox approach' key topics include:
    - > Site selection,
    - > Permitting,
    - > Standardized monitoring,
    - > Building meaningful First Nation engagement,
    - > Communication guidance,
    - > Funding opportunities,
- Incorporate Indigenous knowledge and Indigenous-led projects. A food production/security lens should be highlighted.
- Have a section of linked resources.



One of the papers presented during the discussion period on the Practitioners' Handbook.

Attendees discussing ideas during the first day discussion session.

Day 2: Transboundary Collaborative Panel Discussion

Much of the discussion during the US panel session focused on the challenges of the arbitrary wall that is the border. We all acknowledge that ecosystems extend beyond borders, and fish do not have passports! So, how we can work together and share knowledge and funding was discussed. Verbatim notes are available in Appendix 3. The following is a summary of this panel discussion.

- Habitat protection needs whole watershed thinking in Canada and the US — funding restrictions and borders make this difficult, but some strategies could be explored.
    - > Look at past and current transboundary projects to see how we can continue to build partnerships. Examples that were brought up include Pacific Bird Habitat Joint Venture, American Friends of Canadian Conservation, SSMSP.
    - > Be creative in our way of thinking about funding — MakeWay and Coastal Funds work with Indigenous groups and are with more flexible funding.
    - > Work directly with states/provinces, or on a more local level, rather than through Federal government.
    - > There may be opportunities to share funds from private sources, which are not subject to as many jurisdictional issues as government-issued funding would be. During the last Trump Administration, there was an outpouring of private funding.
- Other habitats (kelp and eelgrass) and their ecosystem services (e.g. blue carbon) benefit from a higher profile. Marsh is arguably as important for habitat value and carbon sequestration potential. We need to learn from other systems to figure out how to make marsh 'more sexy' and thereby increase awareness and attract more funding.
    - > Use existing tools that are focused on other habitats and apply them to marsh — like kelp report cards with long-term monitoring.
    - > How can the Coastal Marine Strategy be leveraged? We need to be a loud, strategic, and united voice!
- The representatives on the US side did not report the same level of Canada goose population and herbivory problems but have observed snow geese and swans grubbing on marsh vegetation. The panel appreciated gaining awareness of the issue and learning about the solutions that are employed here, which could be applied if needed.

Photo of our US Panel (left to right) Todd Zackey, Emily Howe, Charlotte Scofield, Greg Hood, Christopher Janousek

Day 2: Closing Symposium Group Discussion

Led by Tim Clermont, a final discussion wrapped up the symposium. Topics such as future meeting formats, topics to cover, as well as ongoing priorities were discussed. Overall, the group expressed appreciation for the event and considered it highly valuable. Acknowledging that this scale of a symposium is unlikely to occur regularly, there could be opportunities for smaller, regular virtual discussions. These could be focused on specific themes (e.g. sea level rise, or a particular restoration technique, monitoring), with shared organization responsibilities that would not require as much cost/capacity to any single entity. Several participants expressed that the discussion periods were most valuable. Future meetings would benefit from increased time dedicated to breakout sessions and panel discussions. Tim closed by sharing the graphic recording of the meeting.

Tim Clermont recapping with a partially completed graphic recording.

KEY THEMES AND TAKEAWAYS:

Protection over restoration

- Existing marsh habitat should be protected, and this should be prioritized over offsetting projects. While restoration or marsh creation is preferred over net habitat loss, natural marsh has inherent values that are not easily replicated in restored habitats, even several years post-restoration.

Action item:

- Advocate for marsh protection and look for opportunities and funding to protect areas.

Marsh restoration

- Marsh restoration can be successful by creating the correct abiotic conditions and removing pressures (e.g., goose herbivory, dike, etc.) that led to a site's degradation. Having the correct elevation and salinity will support natural revegetation. Also important is having an appropriate number of channels and breaches (allometry) in the site design. Projects with too few channels experience concentrated tidal flows, which prevent natural plant recruitment. Multiple channels/ breaches slow tidal flows across the system and provide greater habitat access for fish.
- Marsh habitats are a rich cultural and nutritional resource for Indigenous communities around the Salish Sea. Restoring that connection should also be a priority.

Action item:

- Continue implementing and experimenting with restoration projects. Marsh restoration is inherently experimental, so testing different treatments and evaluating mechanisms governing marsh assembly/formation can help develop best practices and inform other projects.
- Share results from restoration projects, including successes, failures, and lessons learned.
- Work with local Nations to restore marshes for opportunities to cultivate traditional foods and support sovereignty.

Addressing pressures

- In the Canadian Salish Sea, herbivory by introduced and hyperabundant geese has caused losses of swaths of *Carex* meadow. Not addressing grazing geese is a 'management decision'. Several presentations focused on this issue and solutions. Methods such as eco-cultural fencing can protect *Carex*, along with population control measures. Involving Guardian programs has been fundamental to the success of these efforts.
- Protecting and rehabilitating large-scale projects can have great net benefit. Also consider how a restoration can support intact reference areas in the vicinity.

Action item:

- Continue taking actions to reduce impacts from resident geese and look for additional opportunities to reduce cumulative pressures on marsh habitats.

Climate change

- Climate change will pose a challenge to marsh habitat and the species that depend on it.
- Sea level rise will have a dramatic impact on coastal ecosystems globally. Depending on sediment supply, elevation, and backshore topography, marsh area may be lost due to subsidence or coastal squeeze, or it may migrate landward. It is critical to take steps to understand how a marsh will be affected (e.g. MARS tool) and apply strategic management decisions that will support resiliency.
- It was also acknowledged that marsh habitat value for salmon and other species will shift with climate change. For example, as tidal areas experience warmer temperatures, they will not be supportive to salmon growth as long. Restoration can buffer these impacts, and it will be important to understand the value of restoration when making decisions.

Action item:

- Apply estuary resilience to sea level rise monitoring and lessons learned from the project broadly.

Raise the profile of marsh

- Marsh habitats and their ecosystem services have been undervalued. Products that quantify and highlight the values of marsh would help advocate for protection and restoration.
- Marsh provides climate mitigation and adaptation services. Salt marsh globally has a high potential for blue carbon storage. Work is actively being done to help understand blue carbon potential for BC's marshes. Marsh provides storm and wave attenuation services and can serve as nature-based climate adaptation infrastructure that can be worth millions of dollars. Raising awareness of these values could prove to be a valuable lever for federal protection and policy.

Action item:

- Develop products that can quantify marsh values to support funding decisions.
- Disseminate information on marsh values via channels that will reach and engage the community.

Monitoring

- Monitoring provides the foundation for adaptive management and informed decision making.
- Remote sensing can support ongoing monitoring, and there are innovative ways, such as machine learning mapping, to apply this technology. Historical imagery, albeit at lower resolution, can provide a baseline of marsh extent that can be compared to the current extent. Recent high-resolution imagery (30 cm^2 satellite, 2 cm^2 drone) can be used to delineate plant communities, invasive species, and track responses to management actions or pressures.
- Monitoring the effectiveness of restoration projects and comparing their state and condition to reference habitat can inform future interventions and contribute to adaptive management.

Action item:

- Explore innovative techniques to assist with monitoring marsh extent and health on various scales.
- Use data to inform where intervention is needed and evaluate the effectiveness of actions.

Collaboration opportunities

- Interdisciplinary and transboundary collaboration will be key for the future of successful marsh habitat protection and restoration. Biologists, geomorphologists, engineers, policy-makers, and Traditional Knowledge Holders have valuable perspectives, experience, and knowledge.
- Work towards cultivating an engaged community needs to be prioritized so that the public can become advocates as well.
- Continuing conversations and leveraging an informed and united voice are necessary.

Action item:

- Host more gatherings, learning opportunities, knowledge exchanges, and opportunities for groups to network. Include practitioners, First Nations, governments, and researchers from different disciplines.
- Make information on Salish Sea restoration projects accessible and centrally available to all practitioners and researchers.
- Learn from previous transboundary projects and be creative with funding approaches to work around the border.

The GooSE and PSF Team at the end of the Symposium — Dominic Janus, Nicole Christiansen, Tim Clermont, Sarina Clay-Smith, Paulina Salinas Ruiz, Liam Coleman, and Romina Barbosa

APPENDIX 1: AGENDA

6:30 pm - 7 pm	Registration
7 pm to 9 pm	Welcome by Songhees, Tsawout & Tsartlip drumming & singing, keynote speech by Dr. Ken Ashley, poster session, drinks & appetizers, mix & mingle

NOVEMBER 21ST, DAY 1, MERINO ROOM

8:00 am - 9:00 am	Breakfast & Registration	
Time	Description	Presenter
9:00 am	AERF Project, How this All Fits Together	Nicole Christiansen
9:10 am	Why We're Here, Intentions, Bigger Picture	Tim Clermont
9:20-10:35 am	Session 1: Case Studies: Vancouver Island	
9:20 am	Guardians of our Salish Estuaries	Tim C, Dominic J, Darwyn MM, Gareth A, Danny H
9:40 am	Project Watershed	Caitlin Pierzchalski
9:50 am	Peninsula Streams & Shorelines with WWF	Jacklyn Barrs
10:05 am	Nature Trust	Steven Henstra, Tom Reid
10:15 am	Q/A panel with Presenters	All
10:35 am	Break	
10:45 am - 12:15 pm	Session 2: Case Studies: Fraser River & Washington	
10:45 am	History of Marsh Creation/Restoration in Fraser Estuary	Mark Adams
10:55 am	Current Restoration&Research in the Fraser Estuary	Eric Balke, Daniel Hennigar, Dave Scott
11:20 am	Q/A panel with Presenters	All
11:35 am	Restoration in Washington	Todd Zackey, Charlotte Scofield, Emily Howe
12:05 pm	Q/A panel with Presenters	All
12:15 pm	Lunch	
1:00 pm - 1:45 pm	Session 3: Restoration Design & Environmental Factors	
1:00 pm	Guidance on Effective Use of Marsh Restoration for Flood & Erosion Risk Mitigation	Enda Murphy
1:10 pm	How Waves & Sediment Transport can Inform Marsh Restoration	Eric Grossman
1:20 pm	Tidal Channel Allometry to Marsh Restoration	Greg Hood
1:30 pm	Q/A panel with Presenters	All
1:45 pm	Break	
1:55 pm - 2:45 pm	Session 4: The Language of the Land, a Glimpse into Indigenous Food Systems in Wetlands	Jared Qwustenuxun Williams

2:45 pm	Break	
2:55 pm - 3:50 pm	Session 5: Climate Resilience & Adaptation	
2:55 pm	IPCAs & Climate Resilience	Lais Chaves, Neil Fowler, Tim C
3:10 pm	Blue Carbon	Marianne Fish, Vanessa Valenti
3:35 pm	Tsleil-Waututh Shoreline Adaptation Project	Benji E, Graham Nicholas
3:50 pm	Break	
4:00 pm - 4:50 pm	Session 6: Group Discussion & Practitioners Handbook	
4:00 pm	Questionnaire Responses	Dominic Janus, Sarina C-S
4:30 pm	Discussion: Designing a Practitioner's Handbook	Dominic Janus, Tim Clermont
4:50 pm - 5:00 pm	Graphic Recording Review & Closing Song	Jared Qwustenuxun Williams
6:00 pm	Evening Social at the Swan Pub	

NOVEMBER 22ND, DAY 2, MERINO ROOM

8:00 am to 9:00 am	Breakfast	
9:00 am	Recap of day 1	
9:10 am - 11:00 am	Session 1: Monitoring & Decision Support Tools	
9:10 am	Monitoring Restoration Outcomes: Longer Time & Larger Spatial Scale	Christopher Janousek
9:25 am	Mapping Marsh in the Fraser Delta with Remote Sensing	Bing Lu
9:35 am	Wetland Ecosystem Services Protocol & Marsh Mapping	Neil Fletcher
9:45 am	Q/A panel with Presenters	All
10:00 am	Break: Time to checkout if needed	
10:15 am	Tools to Scale Up Restoration & Monitoring with Limited Resources	Dominic Janus, Liam Irwin
10:35 am	Discussion Panel with Monitoring Experts	All
11:10 am - 12:00 pm	Session 2: Transboundary Collaboration Panel Discussion	US attendees
12:00 pm	Lunch	
12:45 pm - 1:45 pm	Session 3: Overcoming challenges	
12:45 pm	Challenges in Restoration Efforts in the Fraser & Campbell River Estuaries	Sean Boyd

1:05 pm	Restoration Failures & Challenges in Physical & Planting Prescriptions	Morgan Tidd
1:20 pm	Data Accessibility	Paulina Salina Ruiz
1:35 pm	Discussion	All
1:50 pm	Break	
2:00 pm - 2:50 pm	Session 4: Priorities going forward & focused topics	Group Discussion
2:30 pm	Breakout Sessions	All
2:50 pm	Graphic Recording & Meeting Recap & Wrap-Up	Tim Clermont, Delaney Cox
3:00 pm	Symposium Closes	

APPENDIX 2: PARTICIPANT LIST

Name	Organization	Role
Alexandra Kosmides	Songhees Nation	Land and Environment Officer
Angela Spooner	DFO	Nearshore Restoration Biologist
Benjamin Eisenberg	Tsleil-Waututh Nation	Consultant
Bing Lu	SFU	Researcher
Caitlin P	Project Watershed	Executive Director
Camille Andrews	Greenways Land Trust	Habitat Management Coordinator
Charlotte Scofield	Stillaguamish Tribe of Indians	Fisheries Biologist
Christopher Janousek	Oregon State University	Researcher
Cosmo Roemer	Halalt First Nation	Biologist
Dan Buffett	Habitat Conservation Trust Foundation	CEO
Daniel Hennigar	Raincoast	Biologist
Daniel Stewart	University of British Columbia, Asarum Ecological Consulting	PhD Biologist
Danny Hurry	Wei Wai Kum FN	Guardian Manger
Darwyn M	Guardians of our Salish Estuaries	Biologist
David Scott	Raincoast Conservation Foundation	Biologist
Delaney Cox	Drawing It Out	Graphic Recorder
Dominic Janus	Guardians of our Salish Estuaries	Restoration Program Manager
Dr. Ken Ashley	BCIT	Retired Professor
Emily Fulton	Redd Fish Restoration Society	Marine Manager
Emily Howe	The Nature Conservancy Washington	Aquatic & Estuarine Ecologist
Enda Murphy	University of British Columbia	Research Engineer
Eric Balke	Ducks Unlimited Canada	Senior Restoration Biologist
Eric Grossman	U.S. Geological Survey	Research Geologist
Gareth Ashley	Guardians of our Salish Estuaries	Biologist
Graham Nicholas	Tsleil-Waututh Nation	Senior Environmental Specialist
Greg Hood	Skagit River System Cooperative	Senior Research Scientist
Isobel Pearsall	Independent Consulting	Biologist
Jacklyn Barrs	WWF-Canada	Ecosystem Restoration Specialist
Jacques Sirois	Canadian Wildlife Service	Retired Biologist
James Reynolds	Canadian Wildlife Service	Biologist
Jamieson Atkinson	British Columbia Conservation Foundation	Program Manager

Jasmine Muncaster	Squamish River Watershed Society	Restoration Technologist/ Assistant Program Manager
Jay Baker-French	Comox Valley Project Watershed Society	Ecological Restoration Specialist
Josh Bryce	Songhees Nation	Land and Marine Guardian
Karen Stefanyk	Province of BC	Wetland Biologist
Katie Lavoie	Greenways Land Trust	Executive Director
Kieran Wilson	Musqueam Indian Band	Coordinator
Kyla Sheehan	Pacific Salmon Foundation	Program Manager
Lais Chaves	Tsawout First Nation	Marine Use Planner
Lia Chalifour	North Coast Stewardship Program	Coastal Conservation Lead
Liam Coleman	Pacific Salmon Foundation	Kelp Biologist
Liam Irwin	University of British Columbia	Researcher
Lorne Underwood	W̱SÁNEĆ Nation	Marine Manager
Maria Catanzaro	Pacific Salmon Foundation	Biologist
Marianne Fish	Coastal Ecosystems, WWF-Canada	Senior Specialist
Mark A. Adams	Envirowest Consultants Inc.	Director
Morgan Tidd	Federal Government - DFO	Geomorphologist
Neil Fletcher	BC Wildlife Federation	Director of Conservation Stewardship
Neil Fowler	Tsawout First Nation	Fisheries Biologist
Nicole Christiansen	Pacific Salmon Foundation	Program Manager
Patty Menning	Department of Fisheries and Oceans - AERF	Biologist
Paulina Salinas Ruiz	Pacific Salmon Foundation	Biologist
Romina Barbosa	Pacific Salmon Foundation	Biologist
Sarina Clay-Smith	Pacific Salmon Foundation	Biologist
Scott Northrup	Department of Fisheries and Oceans - AERF	Team Lead
Sean Boyd	Environment & Climate Change Canada	Scientist emeritus
Steven Henstra	The Nature Trust of British Columbia	Restoration Biologist
Susan Anthony	SeaChange Marine Conservation Society	Researcher/Project Manager
Tanis Gower	Fernhill Consulting	Biologist
Tim Clermont	Guardians of our Salish Estuaries	Executive Director
Tom Reid	West Coast Conservation Land Management Program	Land Manager
Vanessa Valenti	University of British Columbia - Blue Carbon Canada	PhD Researcher
W. Todd Zackey	Tulalip Tribes Natural & Cultural Resources Dept	Field Studies Program Manager

APPENDIX 3: DETAILED DISCUSSION NOTES

Feedback on Practitioner Guide Content Discussion Day 1:

A breakout session with small groups discussing ideas and reporting out to everyone.

- The Practitioner Handbook should be a living document that is adaptive and changes over time. An app with live links that are updated, would be useful.
- It should be housed in a secure location outside of a government entity to protect it from changes that may occur due to changes in political priorities. PSF is a good choice.
- Take a 'toolbox approach' — different tools, methods, and resources depending on the needs of restoration. Example of toolbox tools:
    - > Site selection, tool prescription guidelines
    - > Ballpark cost estimate of work (qualitative, scale)
    - > Permitting, legislative framework (difference between Canada/US)
    - > Standardized monitoring protocols (long-term scales)
    - > Step by step checklists
    - > Building meaningful First Nation engagement — map and protocols
- Provide guidance on long-term monitoring (best practices) including baseline monitoring prior to work (both abiotic/biotic). As well as where to store the data.
- Include case studies, looking at the entire west coast (more of a PMEP approach).
- Include links to International guides and projects.
- Indigenous knowledge and Indigenous-led projects that incorporate a food production/security lens should be highlighted.
- Consideration of climate change is a necessity.
- Establish a distinction between the purpose of tidal marsh restoration and the appropriate actions to take to achieve those purposes
- Create flow charts that can be used to connect a project's objectives to appropriate actions, or to assist in identifying permits needed.
- A list of funding opportunities that can be updated regularly.
- Marsh plant ID guide.
- Make the handbook in a 'choose-your-own-adventure' style — issue, scale of issue, current state of knowledge related to issue, funding and cost estimates based on project size, who to contact, etc.
- Provide guidance on communicating projects to the public, engaging the community.

Feedback on State of Knowledge Table of Contents:

The proposed table of contents for the State of Knowledge report was made into a poster and placed in the meeting room. Throughout the symposium, attendees provided feedback, notes, and ideas on sticky notes directly on the table of contents. Below is each section with the transcribed comments.

Section 1: Tidal marsh in the Salish Sea and importance to salmon ecology from Indigenous and Western science perspectives

- Ask Lia for references from her thesis for this section. Melanie Davis has excellent papers especially for natural vs restored marsh.
- Marsh plants as food sources and historic marsh conditions under cultivation.
- Estuaries are ancestrally one of the most nutrient dense areas/ ecosystems in BC (weirs, stone fish traps, root gardens, forest gardens, waterfowl hunting...). How do we centre restoration around bringing access to nutritional foods/cultural foods?
- Understanding how different marsh plant species vary in value to juvenile salmon
- Understanding density goals for juvenile salmon and carrying capacities and bottlenecks
- Incorporate Indigenous stories about species throughout. Reach out to communities for their knowledge

Section 2: Distribution and extent of estuaries and tidal marsh habitat within the Salish Sea– What are the changes revealing?

- Habitat Potential Index vs Risk Index categories. Consider money required to restore habitat and the probability of success
- What are important biotic vs abiotic drivers of change? Ecological drivers and predicting future conditions
- Address idea of natural cycles/ variation in accretion and erosion of marsh platform over time. Common question that comes up from the public when history photos show variation
- Basic information re: range of marshes relative to tidal range, e.g. mean water, MHW, MHHW
- Mapping tidal swamp — forested and scrub-shrub tidal wetlands would also be great. They are a rare but very cool ecosystem!

Section 3: Comparison of methods for mapping and monitoring tidal marsh: Benefits and drawbacks of each

- Consider multiple tiers of possible monitoring — quick vs intensive data collection
- Streamline efforts coast wide — MARS, remote sensing, condition metrics
- Suggestion for standard attributes, classification systems, etc.
- Further discuss the potential applications of remote sensing and challenges
- Importance of field data collection for remote sensing-based monitoring and mapping

Section 4: Anthropogenic and biological stressors: Impacts at watershed levels to climate change

- Include upriver impacts such as forestry (include legacy), fire, mining, agriculture, urban development, stochastic events linked to climate change
- Containments — methods to study and mitigate
- Impacts of water quality on marsh growth potential contaminants
- Groundwater withdrawal in urban estuaries

Section 5: Restoration: What we have learned from failures and success so far and what that means for future work

- Information on past projects, including motivation, goals, and monitoring
- Prioritization of restoration — development of holistic assessment and decision support that is accessible to smaller groups
- Permitting environment — who has to be consulted, what are the design requirements for any given project/site
- Planting effectiveness vs natural recruitment
- Mark comments re: transplanting — commercial transplant — Conservation Organizations not applying best practices — important to take small plugs and pinch sediment for increased donor site recovery
- Where to start? How do you know where to go when you are starting a project?
- Integrate tidal marsh restoration and resilience with coastal flood adaptation planning — integrate marshes into flood protection
- Restoration priorities — criteria, most impactful, where to focus resources
- Essential to have appropriate marsh texture for restoration success

Section 6: Monitoring: Assessing the impact and success of different restoration techniques

- Long-term data collection utilizing citizen science and hubs for long-term data storage/collation (like the Marine Data Centre)
- Pre and post monitoring of juvenile salmon at restoration and reference sites
- Long-term monitoring with both ground surveys and air photos
- Consider potential impacts to non-target species (juvenile flatfish, forage fishes like eulachon)

Section 7: Addressing knowledge, data, and capacity gaps for protection and restoration with First Nations and other coastal communities

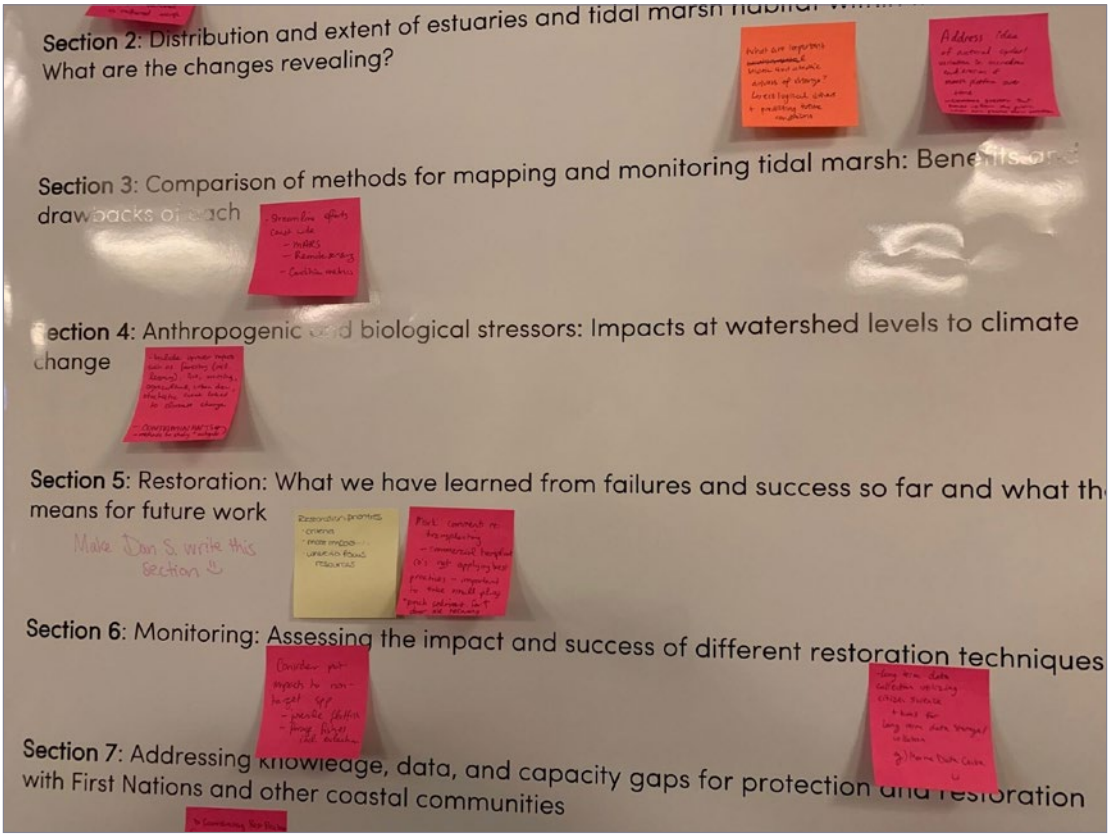
- Coordinating Best Practices for a variety of contexts – budgets, environmental conditions, anthropogenic impacts, predicted resilience (i.e. If you have an exposed site subject to forestry impacts and recession with high sediment input and medium SLR projects, here are your options...
- Permitting lens best practices for decision makers and regulators for permit requirements (eg Independent Design Review)
- How to tap into community (citizen) science for monitoring

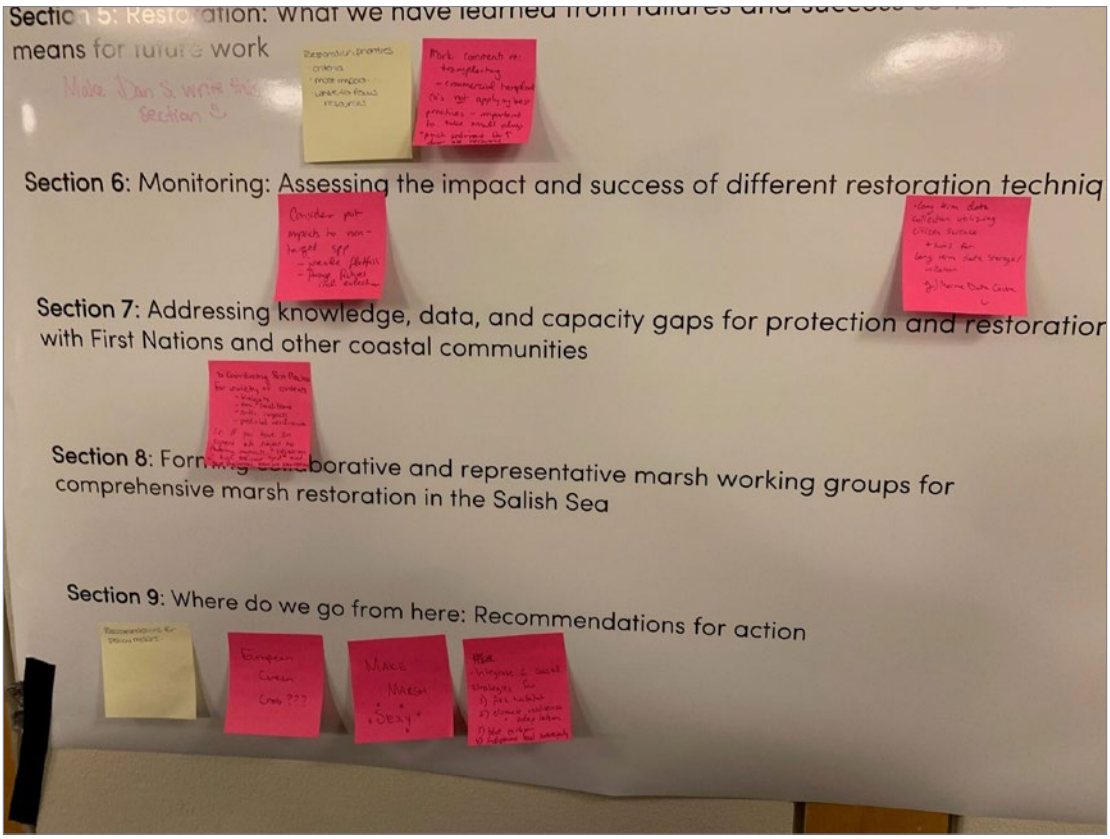
Section 8: Forming collaborative and representative marsh working groups for comprehensive marsh restoration in the Salish Sea

- There was interest to have working groups for different topics — develop protocols and best practices — meet often to update
- Could look at model working groups in other regions for ideas. For example, WRMP (wetlands regional monitoring program) in San Francisco Bay
- Focused sessions on relevant topics ~ 30% presentation/background and 70% discussion of participants questions and working through project ideas

Section 9: Where do we go from here: Recommendations for action

- "Make marsh sexy" — referring back to previous discussions about getting public interest in marsh like eelgrass and kelp
- Management strategies and actions for/by estuary importance class
- Recommendations for policy makers
- Integrate with coastal strategies for 1. Fish habitat 2. Climate resilience and adaptation 3. Blue carbon 4. Indigenous food sovereignty 5. Watershed security
- European green crab?





The State of Knowledge Table of Contents with the sticky notes that are outlined above.

Transboundary Collaborative Discussion Day 2:

Participants: Charlotte Scofield, Emily Howe, Greg Hood, Christopher J, Todd Zackey (all US attendees)

Questions and Discussion:

Q: Are you all a mixture of academics? State and Federal employees?

A: **(Greg H)** Yes, we're a mix of researchers, NGO, tribal, and government.

C: **(Scott N)** We've been hosting Knowledge Exchanges through a DFO/PSF collaboration. Would be great to build on the present event and have one themed on estuary restoration. Would be beneficial to have input from those on the panel, as they have advanced experience — if interested, please reach out.

Q: What's the rough amount invested in the mature marsh monitoring project?

A: **(Chris J)** For data collection we have a 2-year grant from NERRS Science Collaborative, which includes 15 people with 4-5 people doing the bulk of the data collection and analysis — San Diego to Puget Sound.

Q: How does the border impact your work?

A: **(Emily H)** There has been a lack of focus in urbanized areas, and tribes and ecosystems being left behind by Nature Conservancy (one of the largest NGOs with US and CA branches). Heard a lot more whole watershed thinking yesterday — in the US space, funding and agency wise it gets all chopped up, not sure about Canada, but really feel that 'wall' funding-wise and project-wise (can't make it across the border). Political situation is a challenge, however, there may be opportunities. During Trump's first term, there was an outpouring of private funding, which may be more nimble to flow across the border where as, government funding would be more limited.

C: **(Lia C)** MakeWay and Coast Funds work with Nations and various groups, and are doing this work. We need to be a bit more creative. This collaboration has not been applied in the Salish Sea — local politicians are aware that the Salish Sea is connected, so working at this level may be an attainable next step. There is a mention of marsh in the Coastal Marine Strategy, but needs to be more prominent. Kelp is flashy, eelgrass is sexy, marsh can be sexy too. Existing tools for other higher profile habitats that we can apply to marsh, e.g. kelp report cards with long-term monitoring — Puget Sound Partnership.

A: **(Chris J)** PNW Blue Carbon Working Group has focused on Oregon for the last eight years, but they are now working in Washington and starting to bring in BC through a subcommittee meeting at PERS (March). The idea is to build a database (southern Mexico to Alaska) incorporating tidal swamps including those shown to be high carbon sinks — Craig Cornu, Institute for Applied Ecology, who is now handing it off to Chris J and Heida Diefenderfer. Once/year meetings on Zoom and network — community of practice. Increase work on tidal swamps — super cool rare ecosystem with high carbon stocks, ramp up studies and restoration around those systems.

A: **(Jacklyn B)** WWF Canada runs a national community of practice and database partnering with Hakai, there is potential for collaboration between the two.

Q: How can we work with Greg to implement his allometric design in our restoration sites?

A: **(Greg H)** Wall for his work — working for Tribes, get nervous when he starts work outside his place. It has to have good justification, just makes it tricky. It's important to collaborate and work together, we would have to negotiate across particular boundaries.

Q: What is the impact of goose herbivory south of the border (it's such a huge issue for BC)?

A: **(Greg H)** In Skagit there are snow geese and swans. Not really seeing a huge presence of Canada geese but keeping an eye out for them. We have noticed swans grubbing on restoration sites, but we are not sure what the impacts are on reference marshes. Have seen grub pits. Learning from Canada and the warning, keeping an out.

A: **(Emily H)** Swans have been seen grubbing in the northern end of the Stillaguamish Delta, where we have been seeing pedestals. Combined with the high wave energy (South facing bay), once the hole has started, the waves run up it and it erodes out from the back. It's a very exposed system so exclusion fencing would not be as effective, they just disappeared, not sure if the alder/willow would be better, maybe dogs. Maybe just make a lot more habitat?

A: **(Greg H)** Maybe we need to encourage more hunting in Washington, coordinate with hunting management, seems like a win-win.

A: **(Charlotte S)** Tribes have acquired new properties and have taken the lead on harvesting geese and administering permits for harvesting.

Q: There are studies in the US that encompass multiple estuaries but stop at the Canadian border, which is not good. If there are levers to collect the data on the Canadian side to contribute to those large-scale projects, what would those be? Representation on both sides increases the power of the study. How do we foster that going forward?

A: **(Chris J)** Concept of an idea – California, through the University of California, works with Baja, Mexico, their salt marshes are very similar. This shows potential to working directly with the state or provincial governments (a little bit more opportunistic/dynamic) rather than at a federal level. There may be an opportunity to fund joint research — forget the federal gov — BC and Washington State, or Oregon. Washington is still blue.

A: **(Tom R)** The MARS is an American developed tool by NERRA. In applying it to BC, worked with a science advisory council — NERRS and BC folks to collect the same data, cross boundary. Pacific bird habitat joint venture — certain habitats — link into cross — functions of these habitats on what they provide — funding mechanism through north American waterfowl conservation act, American friends of Canadian land — send it across the border — Cowichan project — US forest service wanted to contribute — don't be afraid to ask and call someone up — NERRS research directors came to Vancouver Island — we took them to sites and talked about ideas building offshore oyster reefs, higher level joint venture. Linked in with BC and John Rybczyk — knowledge exchange and partnering — tons of opportunity, not so much for funding. Report card — bird numbers, salinity, elevation profile, what's more important — make data available for projects, how does this feed into monitoring

A: **(Karen S)** BC has joined the joint venture, sitting on technical committee, major drivers to influence the investment into restoration work, treaty, and acknowledgement of Indigenous rights, legit and policy that you've had

A: **(Todd Z)** It has been done, SSMSP as an example. Tribes are co-manager of the fisheries in Washington — management of the salmon goes across the border — there is precedent. You could do more — Salish Sea ecosystem conference — smaller scale with focused groups much better (PSF) lots of extra that's not interesting — PMEP — whole coast putting datasets together — is PSF going to be that lead — the repository for the data like PMEP — what's of concern and what needs to be known. Tribes have lobbyists — casinos provide money and ability — tribes have treaties — supreme law of land — trust obligation to the land

A: **(Charlotte S)** Endangered Species Act — Chinook is listed, main priority for tribe and salmon recovery — in the watersheds — salmon recovery plan, id habitat issues and how to address them to recover Chinook in watershed — 2005 — long process.

A: **(Greg H)** southern fund — fish management, help with cross-border. Differences — Columbia River estuary vs. Puget Sound — motivated by a federal judge against power — federal court order to mitigate industry impacts — good governors too

A: **(Chris J)** A lot is happening at the state level. All three western states have passed legislation for climate change. They want blue carbon to be a part of the policy, In CA the emissions reduction taking natural blue carbon ecosystems along with forests. In California, 30% of lands in CA will be preserved by 2030.

Closing Symposium Group Discussion Day 2:

Priorities and moving forward:

- **(Susan A)** Participate in a meeting series where we have monthly discussions on whatever topics people want with regular attendance. Found that frequent, but short meetings help with capacity it puts less pressure on people.
- **(Eric B)** Presentations are great, but when we have everyone here, more focused discussions seem more worthwhile. We would like a focused talk on sea level rise adaptation and expanding the MARS tool to other areas — incorporating tidal marsh resilience into local flood adaptation (infrastructure protection). Re-use of dredge sediment (Fraser Delta) — scoping a road map for this topic
- How to leverage infrastructure protection, insurance, climate adaptation and protection/rehab of marsh
- **(Neil Fr)** The format of the meeting has been good, people may be more willing to participate in the reports if there is something in it for them ie: publication
- Increase the cost of the salmon stamp!
- **(Dom J)** Are there topics that we missed that we can capture in a future meeting or follow up?
    - > How salt marshes form
    - > More about tidal swamps
    - > Focused discussion on legislation and policy
    - > Invasive cattail and errant logs
    - > Sea level rise adaptation, incorporate tidal marsh resilience into coastal flood adaptation
    - > How to secure funding
    - > Different pressures on different estuaries with different needs
    - > What is the legacy and how to maintain the data and structure without the funding for it
    - > How can we deliver money differently
    - > Plant assemblages that provide best habitat for juvenile salmon
- Structure of meetings moving forward
    - > Shorter presentations and more brainstorming time

APPENDIX 4: GRAPHIC OF SYMPOSIUM PROCEEDINGS

by Delaney Cox

PACIFIC SALMON FOUNDATION

Delaney Cox with DRAWING IT OUT

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GUARDIANS OF OUR SALISH ESTUARIES

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