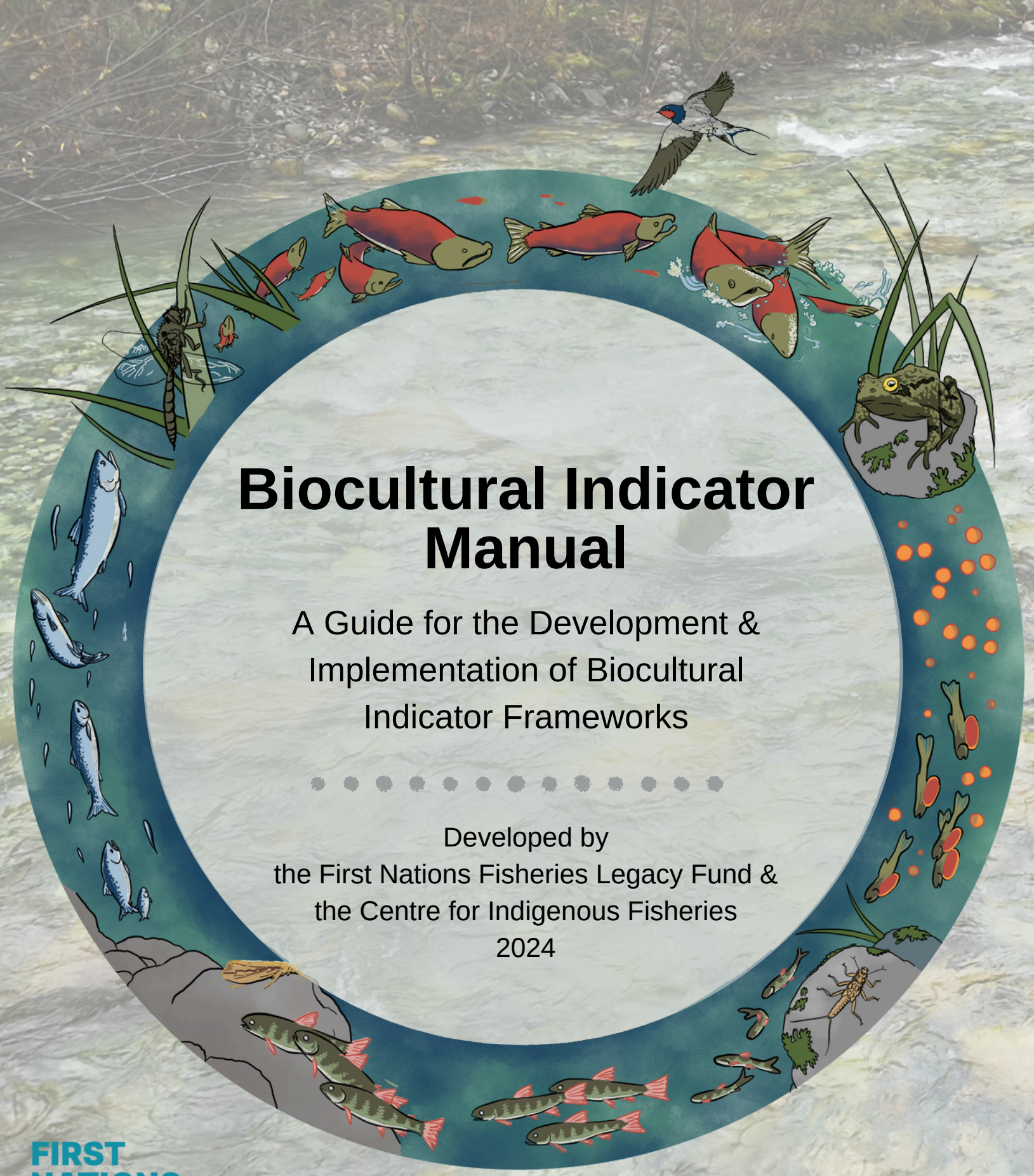


Biocultural Indicator Manual

A Guide for the Development & Implementation of Biocultural Indicator Frameworks

Developed by
the First Nations Fisheries Legacy Fund &
the Centre for Indigenous Fisheries

2024

FIRST NATIONS FISHERIES LEGACY FUND

Centre for Indigenous Fisheries

Illustration by nicole marie burton, Petroglyph Studios

“I knew this had promise when we first began, but in no way anticipated this wonderful outcome. It was a career pleasure working on this with such caring and talented people, and I hope this has “legs” in helping others.”

“I am amazed at the amount of work and effort that went into this, and I hope this is just the start of more frameworks driven by Indigenous knowledge. Would love to see more initiatives like this in the future.”

“I appreciate being a part of this work and I am grateful you all included the First Nations on the lower stalew (river). What I can see ….it will be extremely helpful to other nations in the future especially with the climate change which we are in the midst of…even now the river is low flow and changes to the river temperature changed the run for eulachon (ooligan) this past spring.”

Why Did We Make This?

The Biocultural Indicator Manual was developed to support First Nations communities in leading culturally relevant water stewardship activities in their territories.

The manual and methods contained within it incorporate Indigenous Knowledge and values through the use of biocultural indicators, which consider the health of aquatic systems through Indigenous Peoples' values and experiences.

- This manual documents the processes, methods, and lessons learned during the Lower stáĺəẃ (Fraser River) pilot project to develop a biocultural indicator framework for water assessment.
- This manual has been shared with the intention that First Nations across Canada can use it to bridge Indigenous Knowledge and Western science in their own water and fish habitat stewardship work.
- This is a living document that can be adapted over time to meet the unique needs of each user.

This manual can benefit First Nations; specifically, those that deal with lands, waters, stewardship, and referrals. First Nations organizations and not-for-profits can also benefit from using this resource.[1]

This manual was developed through collaboration between the **First Nations Fisheries Legacy Fund** (FNFLF), community members and staff from the six FNFLF First Nations (see page 3), and University of British Columbia **Centre for Indigenous Fisheries** (CIF) graduate students Kasey M. Stirling and Kate Mussett, and supervisor Dr. Andrea Reid.

Reconsideration, reshaping, and renewal of these methods for the purposes of new work, while maintaining goals of centering and upholding Indigenous Peoples and their knowledge systems is encouraged.

By carrying out this work to weave Indigenous Knowledge Systems with Western science, the project team aspired to decolonize Western science practices and enable Indigenous Peoples to lead the management of aquatic ecosystems in their traditional territories.

[1] While the focus of this manual is on BC First Nations, it is not mean to exclude Métis or Inuit Peoples. These groups may face similar realities to First Nations in BC and as such, may find utility in this manual.

Contributions and Acknowledgments

The success of this project has hinged on the complex, dynamic, and culturally rooted Indigenous Knowledges of partners from q̓iċəy̓, q̓ʷaːn̓ƛ̓ən̓, kʷikʷəƛ̓əm, xʷməθkʷəy̓əm, sc̓əwaθən məsteyəx, and səlilwətaɬ First Nations. Despite shared histories and overlapping territorial boundaries, the lived experiences of the individuals that the project team has had the pleasure of learning from and with are unique. The project team is grateful for the time, knowledge, and ideas shared by community collaborators for this project.

The project team is grateful for the táməxʷ (lands), waters, and other-than-human relations who allowed us to conduct our research in relation with them.

The First Nations Fisheries Legacy Fund (FNFLF) comes to this work as a collaboration of the q̓iċəy̓ (Katzie), q̓ʷaːn̓ƛ̓ən̓ (Kwantlen), kʷikʷəƛ̓əm (Kwikwetlem), xʷməθkʷəy̓əm (Musqueam), sc̓əwaθən məsteyəx (Tsawwassen), and səlilwətaɬ (Tsleil-Waututh) First Nations working together in the spirit of snəẃeyəɬ (traditional teachings with a central focus on sustainability and long-term planning). FNFLF came to this work in order to exercise responsibilities to protect, conserve and restore the health of aquatic ecosystems and species of collective concern in the Lower stal̓əẃ.

The University of British Columbia Centre for Indigenous Fisheries (CIF) comes to this work as academic partners committed to conducting equitable research for fish, people, and place in ways that are useful and relevant to Indigenous partners. CIF strives to generate collaborative science that is *with* and *for* Indigenous Peoples to reimagine what healthy university-community relationships can look like. We are majority Indigenous scholars, as well as allies, that place the needs and interests of Indigenous Peoples at the heart of all that we do.

The project team would also like to acknowledge Donna Robins of q̓ʷaːn̓ƛ̓ən̓ for her help translating key ideas into the Həńq̓əmiń̓əm̓ language of the FNFLF First Nations.

Contents

Context & Background

The six FNFLF First Nations sought to develop a water assessment tool that would address knowledge gaps in water management by incorporating First Nations values and perspectives.

This tool would weave Indigenous Knowledge Systems with Western science to develop a holistic water assessment methodology. Weaving or braiding knowledge systems is often referred to as the process of bringing together both Indigenous Knowledge and Western science as distinct knowledge systems with equal value. The knowledge systems can interact to create new solutions but remain separate.

Given the complexity and uniqueness of Indigenous Knowledges, there is no one way to weave Indigenous Knowledge with Western science. **Each case must be approached with respect, reciprocity, relationality, and responsibility.**

Biocultural Indicators

One way to weave knowledge systems is through the use of *biocultural indicators*. Biocultural indicators consider the health of aquatic systems through cultural values, experiences, and place-based relationships contained in Indigenous Knowledge Systems (1). Biocultural indicators have been used by Indigenous Peoples to monitor, understand, and steward their lands for millennia (1). **Biocultural indicators can be used as a type of "data" in complement to Western science in exercises of weaving knowledge systems.**

Biocultural indicators are rooted in the ecological knowledge of local peoples; as a result, they will be different for each region and community. Biocultural indicators, in practice, can be any variety of things. Examples can be as specific as the bloom timing of a culturally significant plant or as broad as a sense of place (1).

Lower stál̓əw̓ (Fraser River) Pilot Project

The FNFLF and the CIF collaboratively developed a Biocultural Indicator Framework to assess the health and status of water and fish habitat in the Lower stál̓əw̓ (Fraser River) and Burrard Inlet. The Framework offers a culturally relevant and comprehensive approach for communicating values and priorities to promote social, cultural, economic and ecological resilience.

The Biocultural Indicator Framework was developed in collaboration with community members and staff from the six FNFLF First Nations. The project spanned three years (2020-2023) and involved scoping, planning, development, implementation, and reporting on results. Framework development was shaped by conversations with community collaborators at workshops, interviews, and site visits. The Biocultural Framework was implemented at sixteen pilot sites across the traditional territories of the six FNFLF First Nations.

The FNFLF and CIF found that weaving together knowledge systems provided the most complete understanding of water health at each site, more than Western science methodologies alone. **The involvement of communities at every stage of the project was central to its success, as was the commitment to uplift Indigenous Knowledge Systems and First Nations cultural values in the holistic water health assessment framework.**

Photo: Andrea Reid

Inspirations: Cultural Health Index

The development of a Biocultural Indicator Framework was largely influenced by work previously done by the Māori Nation in Aotearoa (New Zealand) to develop a Cultural Health Index (CHI). Through collaborative research, Māori Peoples and the New Zealand Ministry for the Environment developed the CHI to assess freshwater systems based on Māori cultural values and knowledge (2). The CHI provides a framework for Māori to apply traditional methods and perspectives in assessing the overall health of waterways in their area, thereby empowering Māori to participate meaningfully in freshwater management (3).

Photo: Andrea Reid

Part 1: Project Planning

Project Planning was a critical foundation for work on the Biocultural Indicator Framework project to occur. This included scoping and planning project goals, acquiring funding to do the work, and developing a research agreement between the First Nations Fisheries Legacy Fund and Centre for Indigenous Fisheries.

- [ ] **1.1 Set project goals and develop a plan.**
- [ ] **1.2 Develop a funding strategy.**
- [ ] **1.3 Build foundations for partnerships and relationships.**

1.1 Setting Project Goals

Project planning and goal setting were key first steps to take in the development of a biocultural indicator framework for water health assessment. Project planning and goal setting will likely be carried out differently within each community or region, and community priorities and needs should guide the process for every initiative. Below are some steps that can be followed before project activities occur. This is not a comprehensive list and should be adjusted as needed.

Key considerations for project planning and goal setting:

- Meet with First Nations community members and staff to **determine community priorities and goals** in regards to a community-led water monitoring framework.
- **Determine if there are ongoing relevant projects** that this work can be added to or that it can be built upon.
- Reach out to academic institutions or non-profit organizations to **develop potential partnerships.** Ensure that in depth conversations take place to determine if a partnership is suitable.
- If deciding to work in partnership with an organization, **hold a meeting to determine shared goals and interests.** This will help ensure that everyone is on the same page prior to the start of the project.
- **Set a short list of measurable goals** that can be transferrable to a work plan at a later date.

1.2 Funding Strategy

Funding for the Lower stáĺəw̓ pilot project occurred in two stages. The first stage of funding supported the *scoping and planning* phase of the project and the second phase supported *framework development and implementation*. Receiving funding for the scoping and planning phase allowed time for sufficient planning and research to occur prior to project implementation.

Step 1:
Speak with First Nations community members and staff to determine priorities and support needed to develop a biocultural indicator framework.

Step 2:
Develop a work plan and budget for the proposed initiative, including as much detail as possible.

Step 3:
Scope potential partnerships and sources of funding. Send introductory emails and request meetings to begin building relationships.

Step 4:
Prepare project proposals and funding applications while prioritizing multi-year funding opportunities with non-burdensome reporting requirements.

Grant Guidance/Tips:

- Build relationships with funders before and during application phases.
- Cleary describe how the proposal matches the purpose of the grant and the values of the funder.
- Use your proposal to tell a compelling story about a need you will meet.

Partnering with academic institutions (or other organizations) in this work can offer many benefits including, but not limited to: access to additional tools, resources and expertise, increased capacity, strengthened project proposals, increased funding opportunities through academic-specific funding, creation of space for Indigenous-led research in academic scholarship, empowerment of Indigenous researchers, and enabling academic institutions to form meaningful relationships with local communities.

See Appendix A for more information about funding.

1.3 Ethical Practices

Ethical practices, governed by co-created research protocol agreements, were critical to this work. The research agreement for this project was signed by representatives of all involved groups (CIF Principal Investigator and FNFLF President). This allowed everyone in the project team to get on the same page in terms of goals, methods, values, and expectations at the beginning of the project.

In addition, team members from the CIF (Kate Mussett, Kasey M. Stirling, and Dr. Andrea Reid) successfully completed UBC's Behavioural Research Ethics Board (BREB) application with input from the FNFLF partners before engaging in knowledge exchange or 'data collection' with First Nations project participants. The BREB application outlined UBC's expectations of ethical work and allowed research planning to be in line with university and community ethics protocols.

Components of our Research Agreement

- Agreed-upon timelines
- Desired outcomes and deliverables
- Stated commitments to data sharing
- Publication and data storage requirements
- Privacy considerations
- Processes for project termination

See Appendix B for more information about our Research Agreement.

The following page demonstrates how a project like this can be understood during any phase of the work. Conventional Western academic research projects are linear and often lack the capacity for reflexivity and cyclical work. The flexible way of thinking presented below allows the entirety of a project to be malleable to community needs. Within the overarching ethical practices agreed upon by both partners are the phases of the project. Each phase supports the next while also allowing space to reflect on lessons learned before moving ahead. No phase of the work can exist within the realm of ethical practices without building a strong foundation in the previous stage. No phase truly ends but continues to inform all consecutive actions over the duration of the work.

1.3.1 Phases of Ethical Practices

1. The first phase of ethical practices is **Funding & Planning**. Considerable time should be spent on this part to lay the foundation for all next steps.

2. The second phase is **Relationship Building**. Good and ethical work can only be accomplished when goals and methods are clarified and trust is built within a project team.

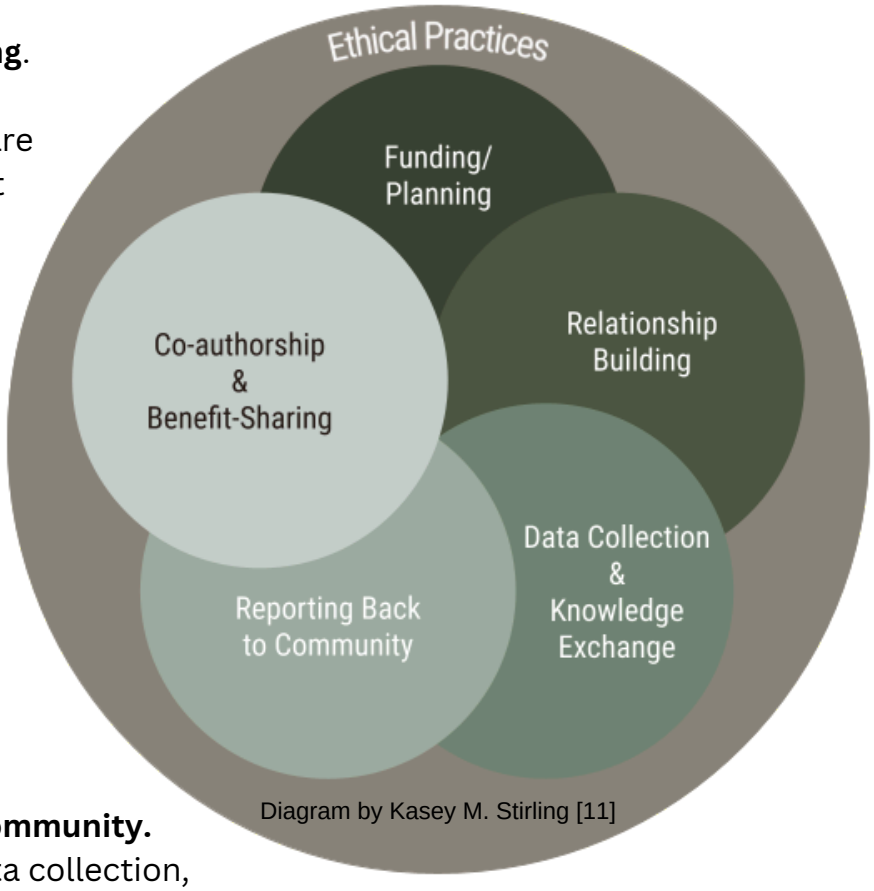


Diagram by Kasey M. Stirling [11]

3. The third phase is **Data Collection & Knowledge Exchange**. This should only begin once trust is established and methodologies are agreed upon. At any decision-making point in the data collection process, next steps should be planned collaboratively.
In this phase, the project team also made a point to ask the water for permission to take our samples and offered sacred medicines in return.

4. The fourth phase is **Reporting Back to Community.** Reporting back about the progress of data collection, obstacles, problems, and decisions to be made situates decision-making power within First Nations communities and supports their agency in the project.

5. The fifth phase is **Co-Authorship & Benefit Sharing**. Co-authorships among all project contributors is encouraged, should they wish to participate in sharing of results. Reporting does not and should not consist of only academic outputs like scholarly articles or institutional reports; be creative in the ways you communicate your project to a wide variety of audiences that may benefit from the work. This stage of the project should also not be considered the last; **let it be the springboard from which next steps and actionable outcomes allow this process to renew.**

Photo: Kate Mussett

Part 2: Knowledge Exchange

Ongoing collaboration and knowledge exchange with the FNFLF First Nations communities was integral to the Biocultural Indicator Framework project. The project team facilitated a series of virtual workshops, small group interviews, site visits, and surveys with FNFLF First Nations community members and staff to develop the Biocultural Indicator Framework.

- [ ] **2.1 Hold a workshop series to elicit locally relevant knowledge.**
- [ ] **2.2 Hold interviews to refine understanding of culturally significant elements of water health.**
- [ ] **2.3 Share progress with communities by reporting back.**
- [ ] **2.4 Develop a locally-informed biocultural indicator framework.**

2.1 Workshop Process

Knowledge exchange, facilitated by a workshop series, served as the basis for choosing indicators and developing a Biocultural Indicator Framework. The workshop series brought together community members and staff from the six FNFLF First Nations who held knowledge and experiences relating to water health in their traditional territories. The workshop series also provided opportunities for community collaborators to discuss ideas and provide input at each stage of the project. The workshop series was a successful effort to engage and collaborate with the FNFLF First Nations communities to develop a Biocultural Framework. Community collaborators were offered honoraria in recognition of the time and knowledge they shared with the project team.

Ideally, all engagement activities would have been hosted in person to facilitate connectedness and open discussion. Most were hosted virtually to accommodate the COVID-19 pandemic and public health orders at the time.

Workshop #1

Begin identifying community values and themes of water health.
Provide relevant background information to introduce the initiative.

Workshop #2

Identify sites of interest where the initiative should focus efforts.

Workshop #3

Rank themes from previous workshops to select the most important 3-5, which will form the basis of the biocultural indicator framework.

Workshop #4

Share the proposed biocultural indicator framework with community collaborators for feedback.

See Appendix C for sample workshop questions.

Lower stál̓əw̓ Workshop Series

In the first workshop, community collaborators identified values and indicators of health related to water and fish habitat. Indicators that emerged from those conversations were grouped into five overarching themes.

In the second workshop, community collaborators identified sites of interest within their traditional territories and categorized each site based on healthy and unhealthy characteristics. A digital map of locations of interest and descriptions of each place was created through a virtual community mapping exercise. The research team selected sixteen pilot sites from the co-created map to implement the Framework and test the assessment process.

The third workshop focused on ranking the biocultural indicators, ecological priorities, and overarching themes that emerged in the first two workshops.

Reflections

- Ongoing engagement with the First Nations communities was integral to this work.
- Workshops were a critical step in developing relationships with the First Nations communities. They fostered trusting relationships that paved the way for collaborative future work on the project.
- Workshops may be improved if hosted in-person to facilitate more effective and flowing conversations between community collaborators and the project team.
- Categorizing sites as only healthy or unhealthy was challenging. Collaborators were encouraged to categorize sites by having more healthy or unhealthy characteristics.

Recommendations

- Facilitate ongoing collaboration and discussion with First Nations partners through workshops to co-develop indicators and co-select pilot sites.
- Take time in workshops to listen and foster trusting relationships with community collaborators.
- Prioritize in-person engagement with community collaborators.
- Identify culturally-appropriate ways to recognize collaborators for their contributions.

2.2 Small Group Interviews

In order to facilitate further knowledge exchange and relationship building, small group interviews were held with community collaborators from the six FNFLF First Nations. Two interviews were facilitated virtually with up to five participants each to discuss a set of open-ended questions. The interviews revisited previous discussions to assess continued relevance and elicited more detail on biocultural indicators.

Themes of Small Group Interview Discussions

- Participants' relationships to aquatic health.
- How participants assess aquatic health.
- How participants' home waters have changed over time.
- How changes in home waters affected participants' relationships to the previously identified biocultural indicators: Ways of Engaging, Care Taking, and Access to a place.

Interviews were integral to understanding the intricacies of each biocultural indicator. They also provided further insights into how components of the Framework may hold varying importance for each individual and First Nations community. The workshops and interviews brought to light similar responses about declines in the health of important ecosystems as well as the ecological and biocultural elements that indicated those changes.

Reflections

- The information shared in the interviews was critical to this work.
- Interviews enabled the project team to increase their understanding of each biocultural indicator and the methods to measure them.

Recommendations

- Facilitate interviews that encourage open discussion about the use of biocultural indicators.
- Incorporate culturally important places or practices into interviews.
- Interviews may be improved if hosted in person over a meal or at a location of significance for community collaborators.

See Appendix D for sample interview questions.

2.3 Site Visits and Reporting Back

Photo: Nicole Jung

In the spring of 2022, **two site visits were organized to bring together community collaborators to share their thoughts informally while visiting the pilot sites.** These visits, while not yielding any formal data, were very valuable to the process of knowledge exchange and feedback to guide the development of the Framework, the methods of assessment, and the eventual outcomes of the pilot project.

Two additional workshops were held throughout the remainder of the project during and following fieldwork data collection, surveys, and initial data analysis for the sixteen pilot assessment sites. **These workshops offered another opportunity for the project team to check in with community collaborators and elicit feedback** on the framework, how the project was progressing, how it should be presented, and what directions it might take in the future.

Reflections

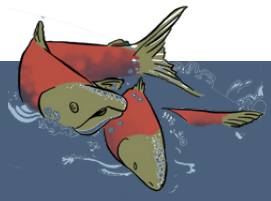
- Site visits and reporting back activities were very beneficial to the development and implementation of the Biocultural Indicator Framework.
- It was essential that the project team was flexible to ideas and feedback from community contributors. Adaptability ensured that the Framework was a living concept that met the needs of the First Nations communities.

Recommendations

- Prioritize frequent in-person engagement with First Nations communities, within their community spaces and territories when possible.
- Build adaptability and flexibility to feedback into any new or ongoing biocultural indicator framework initiatives.

2.4 Developing a Framework

The development of a biocultural indicator framework enables different knowledge systems and ways of seeing to come together equally. The processes and recommendations in this manual can support the development of biocultural indicator frameworks elsewhere. However, it is essential that each First Nations community chooses their own culturally relevant indicators and shapes the framework to assess water health in their territories.



Key Considerations in Framework Development:

- **Take time to gain clarity about the data or knowledge the project will seek before beginning framework development.** A biocultural indicator framework is a tool for understanding and organizing information.

- **Select biocultural indicators that are relevant to the project.** The number of indicators to include depends on the project's objectives, context, and contributors.

- **Choose a number of indicators that is realistically attainable.** Consider that different types of indicators will require different methods of measurement. Group similar indicators into overarching themes and limit the number of indicators in the framework to between five and eight.

- **Outline the meaning of each indicator, the ways that it is measured, and its relationships to other components of the framework**. Biocultural indicators are greater than a single data point.

- **Refer back to the biocultural indicator framework and make revisions as the project progresses.** A working framework will help to center objectives and Indigenous Knowledge in the work as well as provide a point of reference for key ideas.

Biocultural Framework for the Lower stáĺəẃ

This Biocultural Framework reflects the unique ecological knowledge and relationships held by the q̓iċəy̓ (Katzie), q̓ʷa:ńƛ̓əń (Kwantlen), kʷikʷəƛ̓əm (Kwikwetlem), xʷməθkʷəy̓əm (Musqueam), sc̓əwaθən məsteyəx (Tsawwassen), and səlilwətaɬ (Tsleil-Waututh) First Nations communities and individuals whom the project team interacted with. This Framework is closely tied to the Lower stáĺəẃ (Fraser River).

Illustration by nicole marie burton, petroglyph studios

Lower stál̓əw̓ Biocultural Framework

The Lower stál̓əw̓ Biocultural Framework is composed of five broad indicators. Three Indigenous Knowledge-informed indicators emerged in the workshop series as a reflection of the themes that FNFLF First Nations community members and staff brought forward. Two Western science-based indicators were based on the conventional methods used in Canada and the expertise of the CIF graduate students. As represented in the illustration on the previous page, **the five indicators are interwoven in a "basket" of knowledge**. No single piece can form a holistic understanding of water health without the others. This Biocultural Indicator Framework was developed for, and in collaboration with, the FNFLF First Nation community members.

Access is the overarching indicator of water health which encompasses all of the rest. Access, for this Framework's purposes, had many definitions. Access for people, animals, and scéɬən (salmon) to a place were considered, as well as access to resources, capacity, and equipment to carry out research.

Ways of Engaging indicates how First Nations Peoples can and do interact with rivers and streams. Categories of šxʷʔəy̓kʷs ctaməɬ (doing good things in a good way with a good heart) included harvest, ceremony, transportation, spiritual connection, and rest.

Care-Taking is an assessment of the involvement of First Nations in stewardship and decision-making for rivers and streams. xixáɬəḿəɬ ct tə ḿa təməxʷ (caring for our land) is an essential cultural value for the six Nations and involves education, physical and spiritual maintenance, and culturally-appropriate governance.

Physical Health is a measure of the in-river and riparian ecological characteristics such as benthic macroinvertebrates, channel characteristics, vegetation presence, water flow, and water chemistry.

Biological Health is a representation of biotic (living) communities in a river or stream; examining algal communities via environmental DNA (eDNA) monitoring was a primary focus.

Photo: John Francis Lane

Part 3: Data Collection

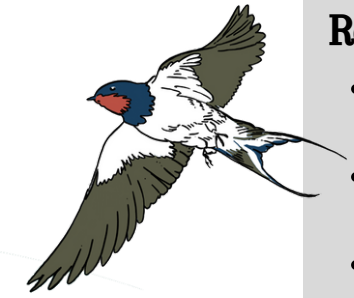
A survey was distributed to gather more information on the biocultural indicator components of the framework. Ecological data collection was carried out to inform water health assessments through the Biological and Physical indicators in the Biocultural Framework. Ecological health assessments also tested the usefulness of specific methods and technologies for First Nations communities. Data collection methodologies will vary depending on the indicators chosen; these are the methodologies that were deemed appropriate for this project's purposes.

- [ ] **3.1 Distribute surveys to quantify biocultural indicators.**
- [ ] **3.2 Choose tools for data collection that will answer your questions.**
- [ ] **3.3 Collect physical environment data via riparian sampling.**
- [ ] **3.4 Collect biological data via sampling environmental DNA.**

3.1 Surveys

A survey was selected for assessing the culturally-informed indicators of aquatic health, based on the methods used to quantify biocultural indicators by the Māori Cultural Health Index. Biocultural indicators were quantified into numerical scores in order to analyze data across Framework components within a similar format. Surveys were selected because they recorded information in the way that participants wanted to present it and allowed for individuals to respond at a time that was most convenient to them. Open-ended survey questions were a flexible method that best fit Indigenous Knowledge Systems and the needs of the project.

The survey sought to quantify the aquatic health of sites of interest using questions directed at Access, Care-Taking, and Ways of Engaging. The surveys were shared with community collaborators to assess as many of the pilot sites as were relevant to their knowledge and experience. The survey asked quantitative (numerical scales) and qualitative (short answer) questions to facilitate knowledge sharing with context. The survey provided a wealth of knowledge and information to assess the health of pilot sites through culturally-informed indicators. It was created and housed through *Qualtrics XM* survey software.



Reflections

- The types of questions posed within the survey ultimately restricted analysis because the focus was on changes in site health as opposed to solely on current conditions.
- Numerical or categorical answers did not provide as much detail as written responses, which made quantitative analysis difficult.
- The large number of pilot locations also made quantitative analysis difficult.

Recommendations

- Keep survey questions clear, concise, and relevant.
- Focus survey questions on a small number of locations (less than 16) in order to gather more information about the nature of biocultural indicators at each site.
- Utilize a group response format or work through the surveys with respondents to ensure collective understanding of questions, intentions, and processes.

See Appendix E for more information about the survey.

3.2 Ecological Data Collection Tools Used

Personal Protective Equipment (PPE)

- Personal Flotation Device
- Whistle
- InReach (or satellite phone)
- Radios
- First Aid kit
- Water helmets
- Clothing for changing weather conditions

Consumables

- Calibration solutions
- pH buffer solution
- Wash bottles (500mL & 1000mL)
- Kimwipes
- Forceps
- Bug sample bottles (500mL)
- Antifreeze preservative
- Parafilm(R)
- Paper towels & garbage bags

Data Collection Equipment

- Kicknet (400 um mesh sieve)
- Turbidity Meter
- Thermometer
- pH/Conductivity Meter
- Dissolved Oxygen Meter (e.g., YSI)
- Survey rod, meter stick, & 30 cm ruler
- Hand level
- Measuring tape
- Sterile Falcon(R) tubes (50 mL)
- Sterile Syringes (25 mL)
- Aquarium water chemistry test kits (nitrate, nitrite, phosphorus, chlorine, etc.)

See Water Rangers details on pg. 24 for details on alternatives to these tools

Bio-Safety Equipment

- Quat Plus (decontamination from whirling disease)
- Spray bottles:
  - 70% Ethanol (EtOH)
  - Bleach (NaClO)
  - distilled water (dH2O)
- Scrub brushes
- Safety glasses
- Nitrile gloves
- Liquid waste container

General Equipment

- Large tote bins
- Throw rope and bag
- Buckets
- Chest waders
- Wading boots
- Wading pole or stick
- Scissors
- Pencils & pens
- Waterproof & UV-resistant markers
- Water jugs
- Insulated cooler
- Tarp
- Ice packs
- Clipboard
- Flagging tape
- Tube Racks
- Waterproof paper
- Sealable plastic containers
- Scotch & masking tape

3.3 Physical Health Data Collection

The physical health of riparian ecosystems can be measured through several methods. Depending on the tools available, specific project goals, capacity and funding availability, and desired outcomes, you may choose to use these tools alone or in tandem with one another.

Sequencing the Rivers for Environmental Assessment and Monitoring (STREAM)

To assess the health of riparian ecosystems, STREAM methodologies examine variables from within the water column, the water's edge, and surrounding land use. For our pilot study, these variables included: surrounding land use assessment, location data, reach data (habitat types, aquatic organisms, and vegetation), water chemistry data, channel characteristic data, an assessment of surrounding natural material for habitat availability, as well as a collection of benthic macroinvertebrate samples. More information can be found here: https://stream-dna.com/

Pilot site benthic macroinvertebrate samples were sent to the STREAM partner lab at the University of Guelph to be sequenced for the presence or absence of particular bioindicators of stream health, particularly in reference to pollutants. Some macroinvertebrates have a greater tolerance for polluted water, whereas others do not, resulting in a greater understanding of stream pollution given the presence or absence of these species. Other variables were analyzed by our project team.

To participate in the STREAM program, training through the Canadian Rivers Institute led by Living Lakes Canada was completed.

Photos: Nicole Jung and Andrea Reid

Water Rangers

Water Rangers is a water quality assessment program which offers low-cost supply kits with instructions for carrying out basic water sampling. Water Rangers test kits are a less costly option (in comparison to traditional water monitoring tools) for water sampling for pH, turbidity, conductivity, total dissolved solids, dissolved oxygen, air temperature, and water temperature. They are commonly used as tools for youth science education.

Water Rangers test kits include a protocol program to simplify their use for a range of purposes and levels of expertise. The program explains how to select water testing sites, develop water testing schedules, use the field guide and test kit equipment, and log observations on the Water Rangers online database. The test kits are designed to be used on-site and repeatedly at regular intervals to determine water quality and changes over time, in order to produce data for aquatic health management. These tools can be used to get high-level results of aquatic ecosystem data.

More Information about Water Rangers can be found here:
https://www.waterrangers.ca/tour

Photo: Nicole Jung

Water Rangers test kits were used in tandem with other methods to compare their effectiveness as tools for biocultural indicator frameworks. Water Rangers freshwater test kits were used to assess water quality at pilot locations alongside STREAM and eDNA methods during sampling activities.

Reflections on Aquatic Data Collection for Physical Riparian Health

Riparian and aquatic data collection was, overall, successful. Participation in the STREAM program played a large role in shaping which data were collected, how they were collected, and how they were analyzed. The STREAM program's established field guide and data collection parameters, as well as the Water Rangers protocol program, helped us to repeat consistent and similar data collection protocols across the pilot sites.

The use of STREAM in the context of biocultural indicator frameworks can be a significant asset. The STREAM program is accompanied by a high level of support from STREAM project partners including sample analysis and metabarcoding from the Hajibabaei Lab at the University of Guelph, data analysis support from academic partners, and access to the Canada-wide STREAM database.

Our experiences with Water Rangers testkits were very positive. The testkits were easy to use, compactable, and accurate. Water Rangers could be used on its own or in tandem with other tools to determine the condition of a specific aquatic ecosystem. The choices for each different biocultural framework project will depend on their specific objectives and tools available. The water quality results from the Water Rangers program were high-level and general, so supplementing them with a more intensive tool is recommended if more specific results are needed.

See Appendix F for more information about physical health data collection.

Recommendations

- Choose riparian health and water quality assessment tools based on capacity and resources available, level of expertise, project objectives, and the data results needed.
- Follow consistent data collection and sample collection protocols over time and across test sites in order to create comparable data sets.
- Utilize all of the support resources available to complement your chosen tools.

3.4 Biological Health Data Collection

Environmental DNA (eDNA) analysis is becoming a common technique of aquatic sample collection in ecological fieldwork as the technology becomes more precise and its applications are standardized across varying fields and ecosystems. Aquatic benthic diatoms have been shown to be good indicators of the chemical, physical, and biological parameters of their ecosystems (4). When diatom species present in a sample are identified, a representation of the aquatic environment at the time of sampling can be determined. This data can fill gaps in quantifiable metrics for sites not often accessed or sites not easily accessible to First Nations, technicians, and biologists. The collection of aquatic benthic diatoms from field sites over time and subsequent laboratory analyses provide a promising opportunity for weaving together Western science and Indigenous Knowledge.

Aquatic benthic diatoms were collected monthly from pilot sites over a four month period for the biocultural indicator project. The European Committee For Standardization protocols were followed to collect algal biofilm samples for the Biological Health indicator. Ecological fieldwork involved sterilizing and using equipment, collecting algal biofilm samples, and storing and transporting the samples to a university laboratory. Water Rangers test kits were also used, to establish basic environmental parameters and collect meta-data at the time of sampling to be later associated with the sequencing results. Aquarium water testing kits were purchased in place of more expensive field meters for measuring nitrate, phosphate, and ammonia concentrations to explore more accessible options for water quality monitoring as well as to add to the meta-data.

Photo: John Francis Lane

See Appendix G for more information about biological health data collection.

Reflections on Environmental DNA Data Collection for Biological Health

eDNA data collection offers a critical opportunity for understanding the biotic landscape of an ecosystem and the unseen inhabitants within. Sample collection requires some initial training to ensure sterilization of equipment is done effectively and that site-to-site contamination does not occur. After this initial training, collection is quite simple and quick.

Most biochemistry labs were not experienced at working in partnership with Indigenous Peoples, but were willing to learn. Biochemistry labs that can help sequence eDNA samples often assume that Indigenous Peoples will only perform the task of sample collection, not analysis. However, there are increasing numbers of Indigenous students and early career researchers in the fields of biochemistry, bioinformatics, and other related disciplines. To be able to support these projects wherein Indigenous biochemists are involved in the analyses, labs are beginning to be open to re-thinking their workflows. Reach out to biochemistry labs near you to start these kinds of conversations and plan out work that is beneficial to your community!

Work between Indigenous researchers and biochemical labs is becoming more common, but still has its difficulties. Some lab practices that are considered standard practice were obstacles in this project, but are easy to overcome. The most significant of these obstacles included timeline constraints, lack of understanding of the need for Indigenous data sovereignty and data sharing agreements, the assumption that the lab would handle all analyses on their own and not involve First Nations in the lab process, and bioinformatics that reflect significance testing that might conflict with Nations' perspectives.

Recommendations

- Ensure that timelines are flexible.
- Co-develop data sovereignty and ownership agreements.
- Arrange lab space and training or mentorship upon request.
- Ensure that analyses accurately reflect the questions that First Nations are seeking to address with eDNA data.

Photo: Nicole Jung

Part 4: Data Analysis and Sharing Results

Data analysis was carried out not to prove or validate Indigenous Knowledge processes but to instead highlight how Indigenous Knowledges and Western science together can help us view water health in a more holistic way. Data analysis tools and processes can be adjusted to fit First Nations community's needs, objectives, and budgets.

- **4.1 Choose tools for data analysis.**
- **4.2 Analyze data collected.**
- **4.3 Share and refine findings based on community feedback.**

4.1 Overview of Data Analysis Tools

Trint AI Transcription Software:

- Accurate but tends to favour deeper, English-speaking, male voices.
  - Take note of Indigenous words and places in real-time as it can misinterpret Indigenous voices and languages.
- Moderate pricing and user-friendly.
- Allows multiple team members to work collaboratively.
- Has servers in Canada, which supports Indigenous data sovereignty.

NVivo 11 Coding Software:

- Can be difficult to learn to use.
- Facilitates coding and qualitative analysis to meet a variety of project goals.
- Provides high-level visualizations and reports on data.

eDNA Analysis tools:

- Biopython and similar packages offer user-friendly functions to analyse DNA sequences and datasets.
- Multiple Sequence Alignment (MSA) tools like Clustal can help to assess species similarity when identifying species via eDNA.
- BLAST can provide quick sequence-based searches across worldwide databases.
- For smaller datasets or those with some basic processing, R and RStudio can help to visualise trends in the data.

R + RStudio (v.2022.07.01):

- Software for statistical and quantitative analysis.
- No cost.
- Can be complicated to learn for the first time.
- A wide array of analytical and visualization tools depending on desired outputs.

Other options:

- Python, etc. offer more computational power than R, if needed (i.e. with large datasets).

Data visualization packages:

- ggplot2
- Base R

Data analysis packages:

- tidyverse
- factoextra
- biopython

Statistical analysis methods:

- Principal Component Analysis (PCA)

Other options:

- Nonmetric Multidimensional Scaling (NMDS)
- Analysis of Variance (ANOVA)

4.2 Data Analysis Details

Workshop Analysis

Audio recordings from the workshops were transcribed with *Trint artificial intelligence* software and saved and referenced throughout the project to identify details and specifics for shaping the foundations of the work. Following the transcription of each workshop, results were thematized by the research team and presented to community participants for feedback. This process of analysis and data sharing is based on discussion, collaboration, and manual coding or thematizing of the results of each workshop, rather than software-based analysis utilized throughout the rest of the project. For example, following our pilot site selection workshop, data collection locations were chosen based on accessibility, habitat or ecosystem type, size, territory, and reasoning associated with site selection. This form of manual coding or organizing was driven by the types of ecological methodologies (physical and biological health) employed, as well as project timelines, team size, equipment, and goals.

Reflections:

- Despite not initially using formal data analysis methodologies for workshop data, this iterative process was critical to our research agreement and collaborative development of research processes and timelines.
- Regular conversation and results sharing ensured accuracy and accountability.

Recommendations:

- Discuss methods of analysis throughout the workshop process in order to ensure that the knowledge shared is respected and honoured.
- Center flexibility and adaptability in your process, as data analysis for the workshop series will inform how you will move through other forms of data collection.

Interview Analysis

Interviews were transcribed from *Zoom* recordings using *Trint AI* software. Indigenous words, names, and places were transcribed in real time and, if missed, participants were contacted to confirm words, definitions, and accurate spellings.

The interview questions took a deductive approach to determine critical aspects of identified biocultural indicators. The subsequent qualitative analysis took an inductive approach to allow specific dimensions and qualities of each indicator to arise in the raw data outside of the confines of traditional analytical frameworks (5). Initial coding of high-level themes began during the transcription process in order to maintain familiarity with the data and teachings from key informant conversations (6). This ultimately informed the framework applied during coding and thematizing of interview transcripts in the *NVivo* qualitative analysis software *(v.11.4.1)*.

The coding framework first identified a series of initial nodes relating to definitions of and experiences with Access, Care-Taking, and Ways of Engaging. Throughout this process, some of these nodes were removed or consolidated, and several additional nodes were added. The second iteration of coding identified emerging themes under the 'umbrella' of each indicator, specifically relating to experiences over time (past, present, and future), as well as experience or story type (positive or negative). This would allow for a discussion of results rooted in change over time and effects of change across response types.

Reflections:

- Analysis benefited from using a coding framework focused on the three biocultural indicators, but the strongest results arose naturally from interview discussions.

Recommendations:

- Improvements to the interviews could be made by planning them in person over a meal or at a location of significance to participants.

Survey Analysis

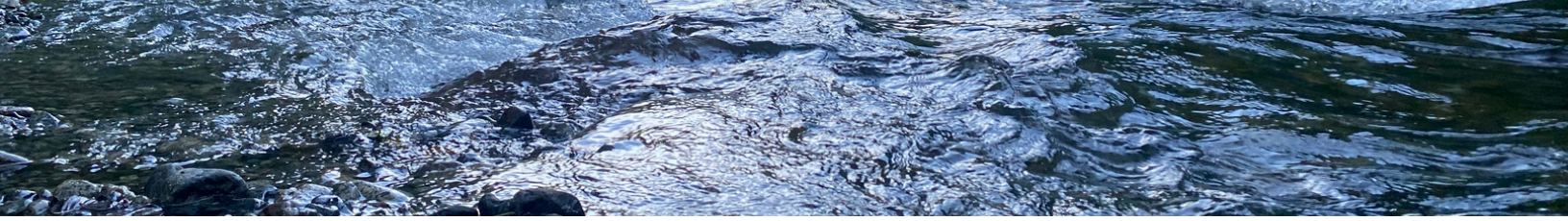
Initial discussions were held with community partners prior to quantitative analysis to share high-level results, after which analyses were performed and quantitative and qualitative survey results were brought in. Scores were provided for each indicator (Access, Ways of Engaging, and Care-Taking) and were exported from *Qualtrics XM* into *Excel* for inspection of initial patterns. To support quantitative findings, qualitative coding was performed using the written survey responses in *Excel*. Responses were sorted according to the indicator the responses were in reference to, as well as into positive or negative associations. Specific attributes of health for each indicator were outlined in order to depict major themes for results.

Reflections:

- Analysis of quantitative survey results was made difficult due to the way questions were asked and the nuance in response types.
- Small sample sizes made discerning patterns in data from statistical analysis in R challenging.
- Ultimately, qualitative coding and sorting of attributes provided the greatest amount of detail and description.

Recommendations:

- If the number of responses is small, opt for qualitative analysis over quantitative analysis.
- Collaborate with project partners to organize categories into which to sort or code attributes (e.g., Healthy and unhealthy, positive and negative, past and present, etc.).
- Use a survey platform that ensures data confidentiality, provides reports, and allows for different question types (e.g., scales, numerical, categorical, maps, etc.).
- Make questions clear and easy to understand, especially in conversations about change over time. Consider desired evaluation and analysis before deciding how questions will be asked (e.g., numerical or categorical).



Physical Health: STREAM Analysis

To facilitate community interpretation of results, and due to our small sample sizes, visual and multivariate analytical tools were selected instead of significance testing.

The following steps were taken during the analysis process:

- Visual inspection and descriptive statistics for collected aquatic and riparian data were performed and generated in *RStudio (v.2022.07.01)* using the *ggplot2* package to investigate patterns between sites.

- Optimal condition thresholds based on the *British Columbia Water Quality Guidelines for Aquatic Life, Wildlife, and Agriculture* were included in these visualizations to understand the health status of sites based on Western ecological standards (7).

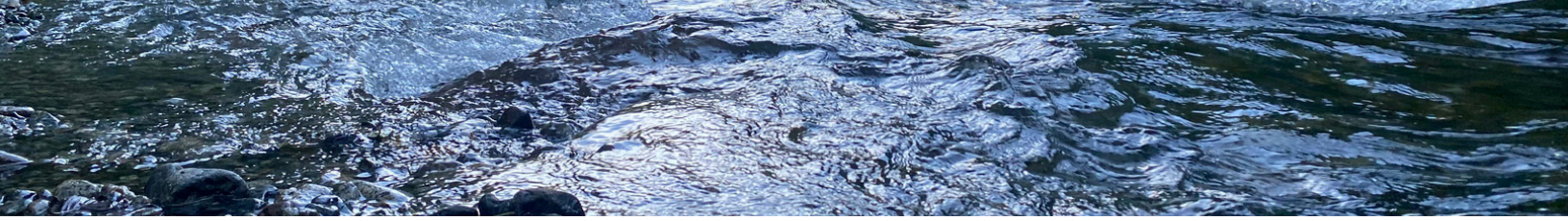
- Analyses included six variables common within STREAM and other aquatic ecosystem assessment models: water temperature, turbidity, velocity, dissolved oxygen, specific conductance, and bank height.

- Principal component analysis (PCA) was selected as an appropriate method for multivariate data analysis given the multidimensional nature of our dataset (8).
  - PCA finds relationships and correlations amongst a large set of variables, creating a smaller number of combined and uncorrelated variables (principal components) that can be used to draw inferences about the larger dataset, helping us here to make comparisons across sites (8).
  - This reduces the number of variables while retaining as much information as possible by articulating patterns and relationships within the data (8).

- Before initiating the PCA, missing values were imputed via mean calculations of variable values across all other sites.

- The function *prcomp* from the *R* package *factoextra was used* to run the PCA to discern the ability of STREAM variables to define, or differentiate, the health of sites accurately.

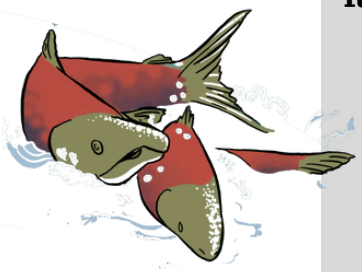
- The resulting principal component scores were then plotted within 95% confidence ellipses in *ggplot2*.



Physical Health: STREAM Analysis (continued)

Benthic macroinvertebrate data underwent similar assessments within community health categories to visualize differences in presence-absence data of 126 species, as well as species richness, across 13 sites. Macroinvertebrates themselves are commonly used as bio-indicators of aquatic ecosystem condition and change, given their sensitivity to biological, physical, and chemical changes (10).Three orders in particular are commonly used as a metric of assessment known as **EPT** richness: mayflies (***E****phemeroptera*), stoneflies (***P****lecoptera*), and caddisflies (***T****richoptera*) (10). These orders are of special significance given their inclusion in STREAM, as well as their repeated mention as ecological indicators within workshops. Presence-absence data were transformed into a presence-absence metric figure using the *geom_tile* function in *ggplot2*. The metric was reduced to include only EPT indicators across Healthy and Unhealthy sites. Additionally, species richness was calculated using the *tidyverse* package, and plotted for each site in *ggplot2*.

Analysis results can be viewed in detail in Kate Mussett's published thesis paper [9].



Reflections:

- Much of the physical health variable analysis was informed and supported by STREAM program partners and commonly used methodologies from other STREAM users.
- Assessing the efficacy of STREAM variables using a Healthy vs. Unhealthy framework helped to identify which variables held the most explanatory power, as well as specific ecosystem aspects in need of care, stewardship, or restoration.

Recommendations:

- Use a data analysis framework that is relevant to project goals, locations, knowledge types, and methodologies.
- Use a variety of analytical methods (e.g., ANOVA, PCA, NMDS), as some may reflect results more efficiently than others.
- Choose data visualization tools that are user-friendly and easy to understand for those who may not have knowledge of statistical methodologies. This is also critical for results sharing and overall communication with project partners.

Biological Health: eDNA Analysis

eDNA samples collected were isolated for total genomic DNA (gDNA) to be able to prepare the samples for amplification via PCR (polymerase chain reaction) and next-generation sequencing (NGS). However, due to the fact that this preparation took place in a teaching lab that was not solely a sequencing lab with more stringent protocols, there were difficulties in amplifying the samples without contamination. This reflected what many First Nations would likely experience should they take similar samples and run similar analyses on their own.

The strategy, therefore, was shifted to look into the processes involved in sending samples to a sequencing lab within and outside of BC and what sorts of data-sharing agreements and file outputs are commonly shared in those spaces. This shift in planning allowed us to examine how principles of Access and additional obstacles in sequencing genetic samples might manifest themselves in similar projects. In this way, the project team was able to evaluate the standard practices of private sequencing labs and offer suggestions to the laboratories for how to work better and be better prepared for working with Indigenous Peoples while also clarifying and describing options available to Indigenous Peoples when deciding where to send their samples and what analyses they might consider.

Reflections:

- eDNA analysis in labs not purely setup for sequencing can result in contamination of samples.
- Not all labs are prepared to enter into data sharing agreements.

Recommendations:

- Discuss your project and goals with a potential lab before collecting or sending eDNA samples.
- Know that procedures can be flexible to your concerns and needs.

Options for eDNA Analysis:

- Send samples to academic or private labs.
- Find an Indigenous-owned and operated lab and partner with them to sequence your samples.
  - There aren't many, but they will be excited to work with you!

Additional information on eDNA Analysis can be viewed in detail in Kasey Stirling's published thesis paper [11]

4.3 Community Centered Results Sharing

Centering the goals and needs of the FNFLF First Nations community members and staff was a critical component of the Lower Fraser pilot project. Results sharing focused on returning knowledge and data to the hands of the six FNFLF First Nations communities. **Results and data sharing adhered to the central purpose of this project: to develop a tool for the FNFLF First Nations to use.**

Throughout the project, FNFLF First Nations community members and staff were given updates on processes and results through workshops and in-person visits to pilot sites. Feedback was encouraged and welcomed at every engagement activity. Feedback from community collaborators was critical for reimagining the framework illustration and ensuring that framework components, data collection, and data analysis continued to be useful and appropriate.

All of the ecological data and Indigenous Knowledge compiled through this project belongs to the FNFLF First Nations. Recordings, samples, analyses, and transcripts were stored securely on UBC and FNFLF servers during the project and will be returned to the FNFLF First Nations upon project completion.

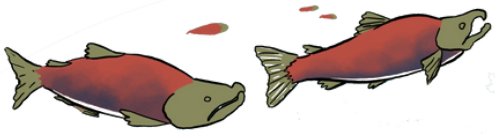
Reflections:

- The needs and priorities of biocultural frameworks may differ for each community or organization.
- Open communication and adaptability to feedback were key to success in developing and implementing a biocultural indicator framework.
- Indigenous data sovereignty is an ongoing conversation and is very important to the FNFLF First Nations.

Recommendations:

- Focus on community needs and priorities at every stage of developing a biocultural indicator framework.
- Dedicate time and resources to facilitate open dialogue to elicit feedback and guidance.
- Protect confidential information and obtain permission for external data sharing.

Photo: Nicole Jung



Outcomes

This Biocultural Manual was developed to share the FNFLF and CIF's processes and lessons learned for developing and implementing a biocultural indicator framework. The Framework developed during the pilot project is specific to the needs, concerns, and context of the six FNFLF First Nations. It is not intended to be a one-size-fits-all solution for the incorporation of Indigenous Knowledge in water and fish stewardship. The FNFLF and CIF hope this manual is used as a tool for First Nations throughout BC and Canada to develop biocultural indicator frameworks that fit their unique needs and goals.

Biocultural indicator frameworks:

- Center Indigenous Knowledge Systems in water health assessments.
- Address knowledge gaps in water management.
- Offer a structure for weaving Western science with Indigenous Knowledge.
- Build capacity in First Nations communities to lead water stewardship work.

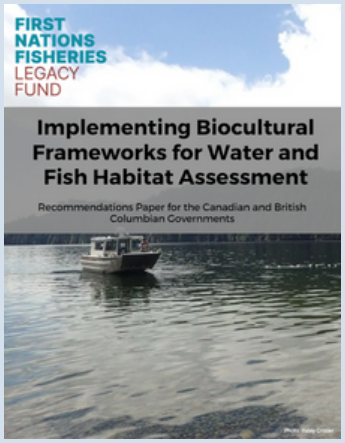
This project does not stand alone: several First Nations and First Nations-led organizations across British Columbia are working to develop tools for the incorporation of cultural values and Indigenous Knowledges in water stewardship. This work to develop a biocultural indicator framework for water stewardship contributed to broad efforts to ensure the health of ecologically and culturally important aquatic ecosystems for syəẃenəɬ (generations) to come.

Further Reading

Additional resources regarding biocultural indicator work are outlined below.

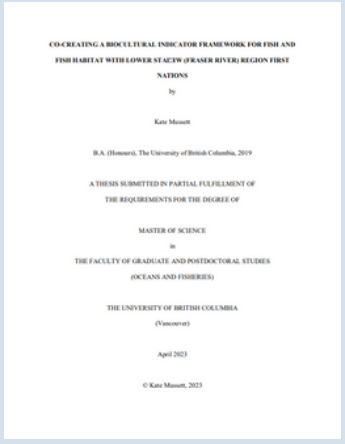
***Implementing Biocultural Frameworks for Water and Fish Habitat Assessment: Recommendations Paper for the Canadian and British Columbian Governments* [12]**

- This paper identifies ways in which the Canadian and BC governments can meaningfully incorporate Indigenous Knowledge Systems in water and fish habitat management, by integrating biocultural indicators into water health assessment practices through the use of biocultural indicator frameworks.



***Co-creating a biocultural indicator framework for fish and fish habitat with Lower staɬaw (Fraser River) region First Nations* [9]**

- This research aimed to address the growing concerns of how the health of aquatic ecosystems is measured using indicators based in Western scientific understandings alongside Indigenous Knowledge Systems. This research identified limitations of using Western scientific tools alone to measure fish habitat health and identify restoration goals, as well as identify the strengths of weaving together multiple knowledge systems in defining a more complete picture of aquatic health.


CO-CREATING A BIOCULTURAL INDICATOR FRAMEWORK FOR FISH AND FISH HABITAT WITH LOWER STAɬAW (FRASER RIVER) REGION FIRST NATIONS

by

Kate Mussett

B.A. (Honours), The University of British Columbia, 2019

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE
in
THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES
(OCEANS AND FISHERIES)

THE UNIVERSITY OF BRITISH COLUMBIA
(Vancouver)

April 2023

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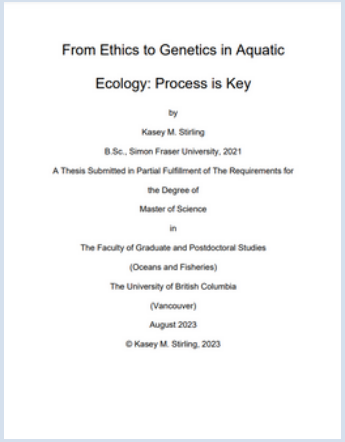
From ethics to genetics in aquatic ecology: process is key [11]

- Research with Indigenous Peoples is encouraged in many fields, including the natural sciences. Yet, ethical practices essential to such work, like obtaining free, prior, and informed consent from Indigenous Peoples, are not always considered by researchers and scientists. In this thesis, ethical practices in partnered research with Indigenous Peoples are detailed in three studies within the fields of aquatic ecology, Indigenous research methodologies, and community-based environmental research.


From Ethics to Genetics in Aquatic Ecology: Process is Key

by

Kasey M. Stirling

B.Sc., Simon Fraser University, 2021

A Thesis Submitted in Partial Fulfillment of The Requirements for the Degree of

Master of Science

in

The Faculty of Graduate and Postdoctoral Studies

(Oceans and Fisheries)

The University of British Columbia

(Vancouver)

August 2023

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Appendices

Appendix A: Funding Resources

Tips for Finding Funding and Grant Resources:

The **Government of Canada** operates many granting programs for a range of areas of concern, which can be found at:

- Federal government opportunities www.canada.ca/en/government/grants-funding.html
- Active funds for ocean stewardship are listed here: https://www.dfo-mpo.gc.ca/oceans/funding-financement/index-eng.html
- Active funds for fisheries stewardship are listed here: https://www.dfo-mpo.gc.ca/fisheries-peches/index-eng.html

There are many **regional funding programs** through government and nonprofit organizations. Some significant fund distributors in British Columbia are:

- BC Government: www.bcbid.gov.bc.ca
- Pacific Salmon Foundation: https://psf.ca/
- Real Estate Foundation of British Columbia: https://refbc.ca/grants/
- Local Community Foundations of Canada: https://communityfoundations.ca/find-a-community-foundation-map
- Watershed Security Fund: https://watershedsecurityfund.ca/funding-opportunities/

Information about funders can be found at:

- Foundations in Canada: www.charityvillage.com/canadian-foundations
- Corporate funding programs in Canada: www.charityvillage.com/corporate-funding-programs

Tips for Finding Partner Organizations:

Partnerships can be a very effective way to access financial support. Many grant programs will give preference to applications that involve partnerships between eligible organizations to increase the overall impact of funding.

- Scope potential partner nonprofit organizations, First Nations organizations, and academic institutions in your region. Look for strategic and value alignment and reach out to learn about ongoing and potential future initiatives.
- Academic institutions have their own internal funding programs that may support graduate students to work with you.

The Lower stál̓əw̓ (Fraser River) pilot project was funded and supported by the DFO Indigenous Habitat Participation Program. The project also indirectly received support from the following grants, bursaries, and scholarships secured by the UBC CIF students:

- Mitacs Accelerate Grant
- Pacific Salmon Foundation
- UBC Ocean Leaders
- UBC Aboriginal graduate fellowship
- New Relationship Trust Foundation
- Indspire
- Irving K. Barber Scholarship Society
- BC Scholarship Society
- Richard J. and Julia Krejsa Scholarship in Oceans and Fisheries

Appendix B: Research Agreement

The following Research Agreement template was developed by the Indigenous Research Support Initiative (IRSI) at the University of British Columbia. This template was used as the basis for the Research Agreement between FNFLF and CIF with some information changed or altered to meet the needs and goals of the project for both parties.

RESEARCH PROTOCOL

BETWEEN:

THE UNIVERSITY OF BRITISH COLUMBIA, a corporation continued under the University Act of British Columbia with offices at 103 – 6190 Agronomy Road, Vancouver, British Columbia, V6T 1Z3

("UBC")

AND:

<@>, with a corresponding address at <@>

(the "Indigenous Community")

WHEREAS:

UBC has committed in its Strategic Plan, “Shaping UBC’s Next Century”, to prioritize partnerships with Indigenous peoples and communities;

UBC has launched its new Indigenous Strategic Plan 2020 and commits UBC to taking a human rights-based approach to its Indigenous strategic framework. The plan represents a university-wide response to the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), and the National Inquiry into Missing and Murdered Women and Girls’ Calls for Justice. It also represents the UBC Vancouver campus’ response to the the Truth and Reconciliation Commission’s Calls to Action;

Guidance regarding the developing practices and interpretations of Free, Prior and Informed Consent (FPIC) described in UNDRIP has been provided by the Expert Mechanism on the Rights of Indigenous Peoples (https://undocs.org/A/HRC/39/62) and UBC acknowledges its obligations with respect to abiding by the principles, spirit and intent of FPIC;

The research program contemplated by this Agreement is of mutual interest to UBC and to the Indigenous Community, and may derive benefits for both through new knowledge and discoveries; and

UBC and Indigenous Community have agreed to enter into this agreement (the "Agreement") to set out their rights and obligations with respect to the research project carried out by UBC in a manner which is mutually respectful, beneficial and acceptable to both Parties.

The Parties also acknowledge and agree that this Agreement has been drafted and informed by OCAP™ and that this Agreement and its principles are not static but will continue to develop and change as the framework for reconciliation between Canada and Ingenious people continues to evolve

Appendix B: Research Agreement Continued

THE PARTIES AGREE AS FOLLOWS:

1. DEFINITIONS

1.1 In this Agreement:

1.1.1 **"Confidential Information"** means all information of a culturally or community sensitive nature, regardless of its form that has been identified as such and disclosed in confidence by the Indigenous Community to UBC, except that "Confidential Information" does not include: (a) information that is received, possessed, or independently by UBC prior to receipt from the Indigenous Community, other than through prior confidential disclosure by the Indigenous Community; and (b) information that has been, or becomes, published or available to the general public, other than as a result of a disclosure by UBC in violation of this Agreement.

1.1.2 **"Contract Period"** means the period commencing on the Start Date and ending <@> months thereafter.

1.1.3 **"Data"** means facts and figures, qualitative (e.g. an interview recording or transcript) or quantitative (e.g. health metrics, a wildlife count, geospatial data, or forest cover inventory), which communicate something specific but may not have yet been categorized, contextualized, calculated or condensed to provide patterns, context, or information and knowledge, which was collected, acquired or transferred, incidentally or otherwise, by one or both Parties during the performance of the Project;

1.1.4 **"Final Report"** has the meaning set forth in Article 2.3.

1.1.5 **"Investigator"** means Dr. <@> of the Department of <@> at UBC.

1.1.6 **"Moral Rights"** are the rights of the Indigenous Community, to the integrity of the Indigenous Knowledge, and the right of the Indigenous Community to be associated with the Indigenous Knowledge and ensure the accuracy and the cultural sensitivity of interpreting the Indigenous Knowledge.

1.1.7 **"OCAP™"** refers to First Nations principles of Ownership, Control, Access and Possession, which represent the assertion of First Nations rights to govern information collected from and pertaining to First Nations. OCAP™ mandates that First Nations control why, how and by whom information is collected, used or shared.

1.1.8 **"Project"** has the meaning set forth in Article 2 herein.

1.1.9 **"Receiving Parties"** has the meaning set forth in Article 4.1 herein.

1.1.10 **"Results"** means the research results from the Project developed by UBC, the Investigator, or the research team.

1.1.11 **"Start Date"** means <@>.

Appendix B: Research Agreement Continued

1.1.12 **"Indigenous Knowledge"** means the accumulated body of knowledge, observations, understandings, skills, practices, innovations and philosophies that an Indigenous Community develops, sustains, and passes on from generation to generation. It can include a wide variety of subject matters, such as ecological, medicinal, agricultural, and health-related knowledge. Indigenous knowledge tends to be placed-based and arise from the Indigenous people's intimate relationship with their natural world. It can be embedded in community practices, teachings, institutions, laws, relationships, and rituals. Although it is rooted in the traditional way of life of the people who hold it, it is dynamic and evolves over time. Indigenous Knowledge can take whatever form or media such knowledge is provided, including all discussions, analysis, compilations, studies, reports or other materials in a variety of media containing or generating from, in whole or in part, the Indigenous Community. Indigenous Knowledge can include, but is not limited to:

a) The manifestations of the Indigenous Community's sciences, technologies and culture, (including environmental knowledge, use of natural resources, land use and occupation, systems of land tenure and self-management);
b) Governance and laws;
c) Spiritual knowledge including creation stories;
d) Protocols (including values and ethics governing human use and behaviour, as well as site-specific protocols);
e) Immoveable cultural property (including sacred and historically significant sites and burial grounds);
f) Culturally significant areas (which may include cultural heritage and/or archaeological sites which are not public);
g) Special ecological places, (including but not limited to salmon spawning grounds, wildlife breeding and wintering areas);
h) Knowledge of fauna and flora, seeds, medicines, water, soils, weather, solar and lunar effects, processes and cycles;
i) Abundance and habitat information (including historic trends and base line information);
j) Oral traditions, literatures, and visual performing arts (including songs, dances, music, stories, ceremonies, symbols and designs); and
k) Culturally significant practices and locations, that may be confidential and are generally not made public unless aggregated so as to protect identity of informants, specific sites, locations, species etc., and approved through internal processes;
l) Management Plans (including protected area or special management plans, forestry management plans and supporting Data);

2. RESEARCH PROJECT

2.1 UBC will perform the research project as described in Schedule "A" (the "Project") under the direction of the Investigator in collaboration from the Indigenous Community, during the Contract. Period. The Indigenous Community and UBC may at any time amend the Project by mutual written agreement.

Appendix B: Research Agreement Continued

2.2 During the Contract Period, UBC will:

2.2.1 Adhere to the principles of OCAP™,

2.2.2 Adhere to the principles and practices of FPIC;

2.2.3 respect the rights of individuals of the Indigenous Communities collaborating on the Project, including the rights to privacy and to fully informed consent in accordance with appropriate research ethics guidelines and standards for the Project, including any research ethic committee of the Indigenous Community and Canada's federal research funding agencies of Canadian Institutes of Health Research; Natural Sciences and Engineering Research Council; and Social Sciences and Humanities Research Council;

2.2.4 respect any written principles of engagement for the Project co-developed between the Parties related to dealing with the Indigenous Knowledge and engaging individual members of the Indigenous Community, which may be affixed hereto;

2.2.5 carry out research in a manner consistent with this Agreement;

2.2.6 maintain all the Data and the Indigenous Knowledge gathered from the Indigenous Community during the Project according to the wishes of the Indigenous Community, and make the Data freely available to the Indigenous Community; and

2.2.7 provide the Indigenous Community with regular progress reports of the Project as agreed to between the Parties.

2.3 UBC will submit a draft final report of the Results to the Indigenous Community within 90 calendar days after the conclusion of the Contract Period or early termination of this Agreement, whichever is sooner. The Indigenous Community will be afforded the opportunity to provide proposed amendments or feedback on the draft final report, within 90 days after delivery of the draft final report from UBC. UBC will use all reasonable efforts to include all provided amendments or feedback from the draft into the final report (the "Final Report"). The Indigenous Community may use the Final Report and the Results prepared by UBC for their own purposes provided that the Indigenous Community acknowledge the contributions of UBC, the Investigator and their research team, as applicable.

3. INDIGENOUS KNOWLEDGE AND DATA

3.1 As between the Parties, the Indigenous Community retains exclusive ownership of, and the sole right to reproduce the Indigenous Knowledge and the Data shared with, or identified by the Investigator and their research team during the Project.

3.2 The Indigenous Community grants UBC the rights to use the Data and the Indigenous Knowledge solely for the purposes of carrying out the Project identified in Schedule A during the Contract Period and a period of 5 years thereafter, in order to allow for the completion of the student thesis and publication of findings arising from the Project.

Appendix B: Research Agreement Continued

3.3 UBC shall not infringe the Moral Rights of the Indigenous Community by modifying or adapting the Indigenous Knowledge without the prior written consent of the Indigenous Community and UBC shall further attribute ownership of the Indigenous Knowledge to the Indigenous Community in all publications thereof.

4. USE OF DATA

4.1 Within a period of 6 months following the completion of the research Project, or early termination, the Investigator will provide a final, annotated copy of the Data to the Indigenous Community. Following a period of 5 years from the completion of the Project the Investigator will delete their research copies of the Data. Should the Investigator wish to access the Data in the future, the Indigenous Community may provide access through a new research agreement.

5. CONFIDENTIALITY

5.1 All Confidential Information provided to UBC, the Investigator and their research team (the "Receiving Parties") by the Indigenous Community under this Agreement and the Project will be held by the Receiving Parties, in confidence and will not be disclosed except: (a) with the written consent of an authorized representative of the Indigenous Community; and (b) if required by law. If any of the Receiving Parties become legally obligated to disclose any of the Confidential Information, the Receiving Parties will provide the Indigenous Community with prompt written notice (except where prohibited by applicable law) and use good faith efforts to provide the Indigenous Community an opportunity to seek a protective order or other appropriate remedy to protect the disclosure of the Confidential Information. The Receiving Parties will be permitted to only disclose Confidential Information to their employees, agents, and representatives with a need to know for the purposes of this Agreement or the Project and who are subject to the same duties of confidentiality.

5.2 UBC will obtain written consent from each Indigenous Community member who shares Data during this project. UBC will develop a participant consent form in partnership with the Indigenous Community.

6. PUBLICATION OF RESULTS

6.1 UBC, as an academic institution, and the Investigator, as an academic, will be able to publish the final Results from the Project in peer-review journals or other academic publications, and to present such Results at symposia and conferences (the "Proposed Disclosure"), subject to the Indigenous Community being provided with copies of the Proposed Disclosure at least 90 days before the presentation or publication date.

6.2 The Indigenous Community may object to the Proposed Disclosure on the grounds that: (i) it contains Confidential Information that was disclosed to the Receiving Parties by the Indigenous Community; or (ii) that it discloses Indigenous Knowledge in a manner that conflicts with the Indigenous Community's Moral Rights. If the Indigenous Community makes an objection on the grounds that the Proposed Disclosure contains Confidential Information, UBC will remove such Confidential Information from the proposed disclosure, after which UBC is free to present and/or

Appendix B: Research Agreement Continued

publish the Results. If the Indigenous Community makes an objection on the grounds that the proposed disclosure of the Results conflicts with their Moral Rights with respect to Indigenous Knowledge, then UBC will delay the Proposed Disclosure until UBC and the Indigenous Community have addressed any issues regarding the proper representation of the Indigenous Knowledge such that it does not conflict with the Indigenous Community's Moral Rights.

6.3 Indigenous Community members and staff who contribute to collaborative research projects with UBC and provide analysis and interpretation of Data may be attributed co-authorship in peer-review journals or other academic publications, and at symposia and conferences. UBC and Indigenous Community will determine at the outset of each project if attributing co-authorship is expected or not.

7. DISCLAIMER OF WARRANTY

7.1 Neither UBC, nor the Indigenous Community make any representations or warranties, either express or implied, regarding Data or other results arising from the Project, or any Confidential Information that is disclosed, or Indigenous Knowledge. Each Party specifically disclaims any implied warranty of non-infringement or merchantability or fitness for a particular purpose and, in no event, will either Party be liable for any loss, whether direct, consequential, incidental or special or other similar damages arising from any defect, error or failure to perform even is a party has been advised of the possibility of such damages. Each Party acknowledges that the Project is of an exploratory nature, that no particular results can be guaranteed, and that each Party has undertaken its own due diligence with respect to all matters arising from this Agreement.

8. TERMINATION

8.1 This Agreement may be terminated:

8.1.1 by either Party giving the other Party not less than 30 calendar days advance notice of termination; or

8.1.2 following a material breach of this Agreement by the non-breaching Party, where the breaching Party fails to correct the material breach within 15 calendar days of receiving written notification from the non-breaching Party.

8.2 No termination of this Agreement will release the Parties from their rights and obligations under Articles 3 (Indigenous Knowledge), 4 (Confidentiality), and 5 (Publication of Results).

9. NOTICES

9.1 All reports and notices or other documents that a Party is required or may want to deliver to any other Party will be delivered in writing by either personal delivery or registered/certified mail to the address of the receiving Party who is authorized to act and make decisions on behalf of the Parties set out below:

to **UBC**: _____

to **Indigenous Community**: _____

Appendix B: Research Agreement Continued

9.2 Indigenous Community may direct questions of a research nature or regarding financial matters to UBC through the following contacts: _____

10. GENERAL

10.1 Nothing contained in this Agreement is to be deemed or construed to create between the Parties a partnership or joint venture. No Party has the authority to act on behalf of any other Party, or to commit any other Party in any manner at all or cause any other Party's name to be used in any way not specifically authorized by this Agreement. No Party may use the other Party's name, trademarks or insignia for any advertising or any promotional purposes, including but not limited to media releases, without the other Party's prior written consent.

10.2 Subject to the limitations in this Agreement, this Agreement operates for the benefit of and is binding on the Parties and their respective successors and permitted assigns.

10.3 No condoning, excusing or overlooking by any Party of any default, breach or non-observance by any other Party at any time or times regarding any terms of this Agreement operates as a waiver of that Party's rights under this Agreement. A waiver of any term or right under this Agreement will be in writing signed by the Party entitled to the benefit of that term or right, and is effective only to the extent set out in the written waiver.

10.4 No exercise of a specific right or remedy by any Party precludes it from or prejudices it in exercising another right or pursuing another remedy or maintaining an action to which it may otherwise be entitled either at law or in equity.

10.5 Part or all of any Article that is indefinite, invalid, illegal or otherwise voidable or unenforceable, may be severed from this Agreement and the balance of this Agreement will continue in full force and effect.

10.6 This Agreement and Schedule "A" set out the entire understanding between the Parties and no changes to this Agreement are binding unless in writing and signed by the Parties to this Agreement. The Parties will be bound by Schedule "A", except to the extent that it may conflict with the terms and conditions contained in this Agreement, in which case the terms and conditions of this Agreement will govern.

10.7 This Agreement may be executed in counterpart by the Parties, either through original copies or by facsimile or electronically each of which will be deemed an original and all of which will constitute the same instrument.

SIGNED FOR AND ON BEHALF of **<THE UNIVERSITY OF BRITISH COLUMBIA>**

_____

SIGNED FOR AND ON BEHALF of **<INDIGENOUS COMMUNITY>**

_____

Appendix C: Workshop Series Sample Questions

The following questions were developed by Kasey M. Stirling and Kate Mussett (University of British Columbia's Centre for Indigenous Fisheries) for the FNFLF Biocultural Framework project for use in the workshop series.

Workshop 1: Identifying Indicators

What makes a healthy watershed?
What do I see in a healthy watershed? What do I smell? How do I feel?
What makes an unhealthy watershed?
What criteria should we consider in the development of biocultural indicators?
What are some biocultural indicators we might use to assess and monitor watershed health?

Workshop 2: Mapping Pilot Sites

What is the name of the place?
Can you describe the place?
What makes this place healthy or unhealthy?
How is this place connected to other places?
Has this place changed?
Is this place accessible?
How can this place be improved?
On a scale of 1 (most unhealthy) to 5 (most healthy), how would you rank the health of this place?

Appendix D: Small Group Interview Sample Questions

The following questions were developed by Kasey Stirling and Kate Mussett (University of British Columbia's Centre for Indigenous Fisheries) for the FNFLF Biocultural Framework project.

Associated questions that may be asked to guide the conversation if needed are bulleted and italicized under the related main questions below. Questions 3-6 are inspired by the Cultural Health Index for assessing aquatic health developed by the Māori in conjunction with the New Zealand Government (Tipa and Tierney, 2006).

1. *What do you consider to be your home waters or watershed? Why is it important to you?*
    - What does the water/place give you?
    - What does the water/place ask of you?
    - Is this a place that is significant to your family?
2. *What changes have you noticed in this place over your lifetime/in your relationship with this place over time?*
    - How did you gauge/measure these changes?
    - Share main themes from community workshops as examples.
    - What are some of the indicators of change you have witnessed?
3. *What has impacted the health of streams and rivers, and their access?*
4. *What traditional monitoring techniques have you heard of – specific to water?*
5. *What could Traditional Knowledge add to the current water management processes?*
6. *What are the barriers that stop First Nations Peoples from participating in this management?*
    - How do you feel that “science” is carried out within your home lands and waters?
7. *What do you think scientists and researchers need to know before participating in water research or management that impacts Indigenous communities?*

Appendix E: Biocultural Indicator Survey

The following survey was developed by Kasey Stirling and Kate Mussett (University of British Columbia's Centre for Indigenous Fisheries) and FNFLF staff for the FNFLF Biocultural Framework project.

General Questions:
Would you like to remain anonymous?
If 'yes', move to site selection and the next set of questions.
If 'no':
What is your name?
What is your age?
What First Nation(s) do you belong to?
Which site would you like to speak to? (Drop down menu of 16 sites)
If you chose another site, would you classify this site as healthy, unhealthy, or other?

Care-Taking:
Are you and/or your community involved in the care-taking of this site? Please indicate on the slider:
0 = Not involved
1 = Conditionally involved
2 = Fully involved
Please elaborate on your response below, to whatever degree you feel comfortable.

Ways of Engaging:
What is this place currently used for? Select all that apply.
Harvest / Ceremony / Transportation or travel / Spiritual connection / Education / Home or rest / Other (please describe)
Please elaborate on your response below, to whatever degree you feel comfortable.

Access:
How accessible is this site? Please indicate on the slider:
0 = Not accessible
1 = Conditionally accessible
2 = Very accessible
Please elaborate on your response below, to whatever degree you feel comfortable.

Additional Comments:
Is there anything else you'd like to share, or feel would be important for us to know?

Appendix F: Aquatic and Riparian Data Collection Resources

The Physical Health section of the Biocultural Manual included the recommended use of a series of data collection resources, depending on project goals, team size and type, and resources at hand. These resources can be used individually, or in tandem with one another given the context of your work.

Water Rangers

A variety of Test Kits are available from the Water Rangers Store, including the following:

1. Freshwater Explorer Testkit (full size and compact available)
2. Ocean Explorer Testkit (full size and compact available)
3. Education Testkit (made for hands-on approaches to science education)

Refills and replacements can also be ordered through the Store:
https://www.waterrangers.ca/shop/

STREAM

Participation in the STREAM program involves both in-person and online training. Depending on your project's context, you may choose between 4 main certifications:

1. Project Manager (online and in-person field training required)
2. Field Technician (online and in-person field training required)
3. Data Analyst (online training only)
4. Data Entry Technician (online training only)

Discounted rates apply for full-time students and Indigenous Peoples/groups. Further information on certifications, registration, and Canada-wide course offering dates can be found at:
https://www.canadianriversinstitute.com/training/cabin

The STREAM program follows CABIN data collection protocols, which are detailed here:
https://publications.gc.ca/collections/collection_2012/ec/En84-87-2012-eng.pdf

More information on the STREAM program, partners, publications, and resources can be found here: *https://stream-dna.com/*

Appendix G: eDNA Field Sampling

The Benthic Diatom eDNA Sampling Field Sheet was developed by Kasey M. Stirling (MSc student from CIF) for this project based on recommendations from the European Committee for Standardization's 2014 report, basic environmental parameters also being assessed, and lessons learned on the ground during fieldwork.

Benthic Diatom eDNA Sampling Field Sheet

Site Name: _____ Date: _____/_____/20_____

Site Code: _____ Crew Initials: _____

Sample #: _____ Elevation: _____ m

Coordinates: _____°_____'_____" N, Air temp.: _____ °C

_____°_____'_____" W Water temp.: _____ °C

Weather: (Select all that apply)

- ☐ Sun
- ☐ Clouds
- ☐ Overcast
- ☐ Rain
- ☐ Heavy Rain
- ☐ Freezing Rain
- ☐ Snow
- ☐ Hail
- ☐ Wind
- ☐ Fog
- ☐ Other: _____

Dissolved Oxygen: _____ % sat. Phosphate: _____ ppm

D.O.: _____ mg/L Bromine: _____ ppm

pH: _____ Chlorine: _____ ppm

Conductivity: _____ µS/cm Alkalinity: _____ ppm

Total Dissolved Solids: _____ ppm Hardness: _____ ppm

Nitrate: _____ ppm Turbidity: _____ NTU

Nitrite: _____ ppm Canopy Coverage: _____ m

Ammonium: _____ ppm Depth Sampled: _____ cm

Number of stones sampled:

- ☐ Pebbles (< 65 mm): _____
- ☐ Cobbles (> 65 mm): _____
- ☐ Vertical surface sampled (ie. wall / bridge)? (circle) Y / N

Time when 70% EtOH added to sample: ____:____ AM / PM (circle one)

Notes:

Photos from the Field


Photo: Andrea Reid


Photo: Kate Mussett


Photo: Andrea Reid


Photo: Andrea Reid


Photo: Kate Mussett


Photo: Jenna Duncan


Photo: Kate Mussett

Photo: Andrea Reid

Photo: Brunswick Point, Kate Mussett & Kasey Stirling

Contact Us

First Nations Fisheries Legacy Fund
Email: info@fnfisherieslegacy.ca
Website: https://fnfisherieslegacy.ca/

University of British Columbia
Centre for Indigenous Fisheries
Email: cif@oceans.ubc.ca
Website: https://www.cif.fish/