

Indicators to Assess Watershed Health in British Columbia

Draft Discussion Paper
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A. Advancing Watershed Sustainability in BC

The BC Wildlife Federation (BCWF), in conjunction with funding from the Gordon & Betty Moore Foundation is undertaking a project to advance watershed conservation and sustainability throughout BC. BCWF is delivering the project in partnership with the Fraser Basin Council (FBC). In addition, many other organizations and individuals, representing a diversity of perspectives, experiences and expertise, were engaged in various ways throughout year-one (Fall 2013 – Spring 2014) of this three-year project.

This initiative arose from a concern, shared by many, that watershed ecosystems in BC are losing their resilience and sustainability. The long-term health of watersheds is key to ensure the sustainability of the ecosystems, communities and economies that depend upon them. However, over the years, land and water use decisions and activities have resulted in the gradual loss of ecological function in watersheds including degradation of habitat, declining water quality, inadequate flows for environmental values, and conflict among different sectors that depend upon water. Though there are many diverse organizations and jurisdictions working on the stewardship, management, planning and governance of watersheds and water resources, there is still a need for enhanced coordination and collaboration among these efforts.

The goal of this project is to educate British Columbians on the importance of watershed sustainability and protecting BC's diverse and unique aquatic resources. It also aims to help strengthen capacity in BC to achieve healthy watersheds by considering watershed health and sustainability through several different lenses, or sub-projects. The focus of the sub-projects facilitated by the Fraser Basin Council include the following:

1. Vision of Watershed Sustainability – Develop a unifying vision of sustainability for watersheds and landscapes through a collaborative process that engages First Nations organizations and non-governmental conservation organizations.
2. Watershed Management Actions – Conduct research on the roles, responsibilities and actions required to effectively manage the health and sustainability of BC's watersheds, including an assessment of capacity, challenges and opportunities.
3. Funding and Delivery Models – Conduct research and develop recommendations on funding and delivery models needed to advance watershed health and sustainability at local and regional scales throughout BC.
4. Capacity and Accountability for Shared Decision-Making = Conduct research and develop recommendations regarding capacity requirements and accountability mechanisms for shared decision-making at local, regional and watershed scales.

5. Natural Resource Practices Board – Conduct research and develop recommendations regarding a Natural Resource Practices Board to provide advice on effective, science-based management of natural resources including independent performance audits and reporting.
- 6. Indicators of Watershed Health – Conduct research and develop a set of indicators to measure the health of watershed and estuarine ecosystems throughout BC.**
7. Workshop for Advisors and Practitioners – Plan, deliver and co-host a workshop to present key findings to date and facilitate dialogue and feedback.

Each of the projects outlined above are intended to focus on a particular aspect of watershed management. (e.g. vision, management, governance, capacity, oversight, funding, etc.). However, these different aspects can also be seen as distinct pieces of a more complex and interconnected puzzle. The following is intended to illustrate how the different pieces fit together.

1. **Vision** – What are our needs, aspirations and goals for our watersheds?
 - Project - Vision of Watershed Sustainability
2. **Implementation** – What actions do we take to achieve our vision?
 - Project – Watershed Management Actions
 - Project – Capacity and Accountability for Shared Decision-Making
3. **Resources** – What human and financial resources do we allocate – and how – to most efficiently and effectively manage watersheds and achieve our vision?
 - Project – Funding and Delivery Models
4. **Evaluation and Performance Management** – How can we best assess progress towards achieving our vision of healthy watersheds and what auditing and reporting mechanisms can assist?
 - **Project – Indicators of Watershed Health**
 - Project – Natural Resources Practices Board

Note: the highlighted project above indicates the focus of this particular discussion paper.

Acknowledgements

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B. Introduction to Indicators of Watershed Health

1. Purpose of Discussion Paper

This paper provides an overview of a framework of indicators that could potentially be used by one or more organizations at a local or regional scale to assess the health of one or more watersheds (Watershed Indicators Framework). The paper briefly outlines how indicator data can be utilized within decision-making processes and provides recommendations on further refining the list of indicators through piloting the Watershed Indicators Framework “on the ground”. Although significant research was undertaken and advice was received from numerous experts, there remains much uncertainty regarding the breadth, depth, and accessibility of data in relation to assessing the state and trends in watershed health across a wide range of relevant issues, at a relevant watershed scale, to support priority decisions.

2. Why Assess Ecosystem Health at a Watershed Scale?

Watersheds are a useful geographic unit to measure ecosystem health¹ because of the numerous interconnections within watersheds:

- Ground and surface water connections
- Land and water connections
- Upstream and downstream connections
- Human community and ecosystem connections

The appropriate geographic scale for assessing watershed health remains an issue for further discussion. Numerous advisors highlighted that watersheds are context-specific. The priority issues, available data, need and capacity to measure watershed health likely vary over time and across different regions of BC. Although a singular specific scale of watershed was not agreed to through the advisory process, a suggested starting point was characterized as:

- Third order watershed
- 1 : 50,000 map scale

Depending on the key issues, interests, capacity and available resources, the optimal geographic scale would be adjusted accordingly for each particular context.

3. Audience and End Users of the Watershed Indicators Framework:

It is anticipated that this discussion paper and the attached Framework of Watershed Health Indicators will be of interest to a wide range of local, regional, watershed, and/or province-wide organizations that may be interested in measuring the health of their watersheds. A variety of end-users may benefit from the information presented in a Watershed Health Assessment. This could include, but is not limited to local, regional and First Nations governments, community-based organizations, provincial and federal management agencies and other organizations.

¹ It is acknowledged that watersheds are not necessarily the best unit to measure all aspects of ecosystem health.

A number of partners will likely be involved in the implementing and testing the efficacy and relevance of the Framework, with one or more groups as the lead coordinator or organizing body. This partnership approach would be considered on a case-by-case basis as watersheds and regions across BC have different needs, interests and capacities. A collaborative partnership approach is suggested to strengthen capacity and combine areas of expertise and interest. It is also a useful way to combine limited resources, build institutional and organizational knowledge and can help to develop working relationships that will last beyond the indicator / assessment process.

The attached watershed indicators framework provides a relatively comprehensive list of available and relevant indicators at the watershed or regional scale. It is not an exhaustive list and it is expected that additional information sources will be available at the local or regional scale. The user(s) of this framework are encouraged to identify the highest priority issues within their watershed and utilize some – or all – of the indicators from the Watershed Indicator Framework, along with supplementary data specific to the region or watershed of interest. It is expected that users of the Framework will organize and present the selected indicator information in way that is most relevant or suitable for their needs. It is also expected that an indicators framework and watershed assessments that utilize the framework will be reviewed and updated on a semi-annual (e.g. 5 year) basis to identify trends and changes over time as well as identifying emerging or shifting priorities.

4. What are Indicators?

Indicators are specific pieces of statistical information that can be used to help build a better understanding of the health, or state, of a resource or overall ecosystem. When assessed over time, they are useful tools to measure critical trends in environmental health.

The common definition of indicators is:

“Statistical data that can be selected and observed to gain insight into the functioning of a complete system”

There are a wide range of goals and objectives related to measuring and reporting on ecosystem or environmental health. Common goals for the use of indicators include:

- To identify critical issues or trends and responses that could improve those issues;
- To increase public awareness and understanding about environmental or ecosystem health;
- To inform decision making and planning processes and influence action to improve environmental health;
- To advance sustainability and sustainable use of resources.

Indicators are inherently an over-simplification of reality to help us understand current status and trends. It is important to understand this critical limitation of indicators. However, this is, in part, the appeal of indicators. We simply do not have the breadth and depth of knowledge to provide a comprehensive understanding of complex systems such as watersheds. Therefore indicators can be helpful to provide signals about specific aspects of the state of watersheds,

the pressures that are impacting on watersheds, and the responses that organizations and individuals are undertaking to manage the health and sustainability of watersheds.

Indicators are tools that can be applied at many different geographic scales or units. Many local governments use indicators to measure and report on their particular community. Provincial and federal government agencies some times develop a range of environmental, economic, or social indicators and related reports. Some non-governmental organizations use indicators to help profile specific issues related to their mandate.

5. What Are Watershed Indicators?

For the purposes of this paper, “watershed indicators” are specifically selected to help assess the health of watersheds. If our goal is to manage human activities to protect, conserve and sustain the wealth of features and functions provided by watersheds, then it is appropriate to collect and analyze data and information at the geographic scale of watersheds. Conservation Authorities in Ontario and Watershed Planning and Advisory Councils in Alberta have some experience with developing watershed report cards or state of the watershed reports. In BC, the Fraser Basin Council and Columbia Basin Trust have prepared “State of the Basin” reports. However, there has been relatively little work undertaken to collate indicator data to assess the health of local and regional watersheds in BC.

Watersheds are geographic units that are highly integrated. Watersheds reflect the connections between land, water and other resources. Watersheds include interactions between groundwater and surface water. Watersheds connect features, functions, activities and impacts between upstream and downstream parts of watersheds. The most appropriate watershed scale will be defined by the end-user of the Watershed Indicators framework depending on issues of highest priority and intended use of the indicator data. Some indicators are well suited for public education purposes while others may be more appropriate to inform decision-makers.

C. Scope and Approach to Developing Watershed Indicators for BC

This discussion paper and the associated framework of watershed indicators was developed through the following process:

- Fraser Basin Council experience in the development and use of indicators
- Review of other relevant literature on watershed-related indicators, cumulative effects assessment and other relevant issues;
- Input from a wide range of technical advisors with experience in the development and use of data, information, knowledge and indicators relevant to watersheds.
- Additional input from a diversity of watershed practitioners at a multi-interest workshop in March 2014.
- Research and validation of best available data and data access at a geographic scale and time period that is relevant to watersheds and watershed organizations in BC.

1. Scope and Structure of a Watershed Indicators Framework for BC

At this time, based on the literature review, advisor input and current knowledge about data availability, the following scope and structure of watershed-scale information has been included:

Three Types of Information:

1. **Baseline or Contextual Information** – This information is less likely to change over time and may be illustrated as mapped data. Where appropriate / available / relevant this information can help to indicate trends over time and high priority areas or issues of concern.
2. **Indicators** – Depending on the watershed of interest, not all issues are of concern and indicator data may or may not be available across most watersheds. Traditional knowledge, citizen science and source of information should also be considered.
3. **Future Context / Pressures** – Data or information sources that indicate expected future scenarios.

Specific indicators have been organized five topics / themes of information:

1. Fresh Water Quality and Quantity
2. Fish and Wildlife
3. Ecosystems
4. Resource Use and Impacts
5. Resource Conservation

The attached Watershed Indicators Framework includes details regarding specific indicators and information sources to populate the indicators within each of these themes. A list is also included at the end of this discussion paper.

2. Recommended Criteria for Indicator Selection

The following criteria were used to identify and select the most appropriate indicators to assess watershed health in BC.

General Criteria:

- **Relevancy to Watershed Health Assessment:** The indicator is relevant to some aspect of a state, pressure, or management response in a watershed.
- **Credibility:** Data are likely to be available from credible sources.

Indicator Selection

- **Relevancy:** The issue measured by the indicator is likely relevant in many watersheds in BC.
- **Geographic Scale:** Data are likely to be available for many local / regional-scale watersheds across BC (approximately 1:50,000 map scale).
- **Time Period / Trend Analysis:** Data may be available for a period of time sufficient to analyze trends and are likely to be updated on a semi-regular basis in the future.

3. Recommendations for Next Steps:

The attached Watershed Indicator Framework has been developed and refined with input from a wide range of technical experts and watershed practitioners. To further test the relevance and appropriateness of the framework, it would be helpful to apply the framework within a specific watershed context through a partnership with local watershed or government organizations. This will help to further refine the indicator development process and make the end result more relevant “on the ground”.

Pilot Project

It is recommended that an implementation partner be identified in one or more watersheds in BC. Once a partner is identified, the steps identified in the Implementation section of this report (below) provide guidance on how the Watershed Indicators Framework could be put into practice.

Traditional Knowledge and Citizen Science

Further research and scoping of potential data and information sources from traditional knowledge will need to take place at the watershed scale in collaboration with the implementation partner. In addition, identification of existing citizen science networks and data at the watershed scale will assist in the watershed assessment process and may inform additional indicators that can be utilized to assess and track local watershed health overtime.

Cumulative Effects

There is a growing interest in cumulative effects assessment and management (CEAM) in BC, which likely presents emerging challenges and opportunities for watershed health indicators. This was identified as an important area for further consideration in future phases of the project. Watersheds are relevant geographic units for measuring certain types of cause-effect relationships. Legal requirements to address cumulative effects in BC may also compel the provincial government to improve information related to particular values that may be impacted by cumulative effects. However, to truly assess and manage cumulative effects we need to deepen our knowledge beyond correlation to causation. We need to understand in more depth how different pressures influence watershed health individually and in combination. There may also be an opportunity to share the learnings about CEAM (process, challenges, must-do items) between organizations and agencies throughout different regions of BC. Further work is required regarding diagnostic indicators. What metrics are best suited to tell us what mechanisms are driving change and what are the effects.

Tool Kit

The next phase of work could help develop a toolkit for “how to” develop and use indicators for a wide range of purposes in a wide range of watershed contexts across BC. For example, what guidance could be offered on how to use indicators to assess cumulative effects, enhance biodiversity conservation, adapt to climate change, restore priority aquatic habitats, etc.?

4. Implementing the Watershed Indicators in BC

As multiple data sources are required to populate the watershed indicators set out in the attached framework, a collaborative approach will be required to determine specific high-priority watershed components that need to be assessed and how this information can be utilized to inform decision making processes that lead to improved outcomes on the ground.

Implementation of the Watershed Indicators framework may include:

- Dialogue and input from potential implementers and users of the proposed watershed indicators framework to further refine needs and expectations;
- Establishing a collaborative approach with a local watershed organization or regional/local government as the coordinating body;
- Determine an appropriate and accessible framework to compile and present the watershed indicator data – this may include utilization of an open standards approach to data management as well as visual representation to illustrate trends or high priority issues (e.g. traffic light green-orange-red, or dash board etc.).
- Identification of how data and information gathered during watershed assessment process will be applied and utilized to inform decision-making and prioritize actions.
- Identification of roles and responsibilities for the various groups and organizations involved in the collaborative process to identify, gather and apply watershed indicator data and information. This may include establishing a Memorandum of Understanding (MOU), a Terms of Reference (TOR) or a common set of principles to guide the process.

D. Appendix: List of Proposed Watershed Indicators

1. Fresh water quantity and quality

CONTEXT:

- Mean annual discharge
- Sensitive Stream Classification – number and names of sensitive streams in watershed (as a % of the overall number of streams within specified watershed)
- Aquifer Vulnerability Rating

INDICATORS:

- Surface water quality – achievement of Water Quality Objectives;
- Surface water quality - water quality index for Surface Water Bodies in BC
- (pH, Dissolved Oxygen, temperature, metals, hydrocarbons
- Benthic Invertebrates – fresh water quality and aquatic ecosystem condition
- Surface water quantity – low flow advisories
- Groundwater Levels
- Marine Water Quality – attainment of marine water quality objectives

FUTURE CONTEXT:

- Projected changes to seasonal and annual precipitation and temperature
- Projected changes in stream / river hydrology

2. Fish and Wildlife

CONTEXT:

- Species at Risk (trend reporting)

INDICATORS:

- Salmon Escapement – Sockeye, Coho, Pink, Chum and Steelhead
- PROPOSED: Run size & catch + harvest rate. TRENDS & THREATS: Trend in Population, Trend in Distribution Threats to population Threats to habitat
- Status of Pacific Salmon Conservation Units
- Health of Recreational Fisheries
- Status of Key Wildlife Populations
- Habitat Vulnerabilities and Pressures

3. Ecosystems

CONTEXT: (*Baseline – changes in % over time)

- Variation and extensiveness of ecosystems – land area by type and biogeoclimatic Zones
- Ecologically Intact Ecosystems – area and type
- Wetlands and estuaries – area, classification*

INDICATORS:

- Riparian Disturbance
- Invasive Species (area, type, rate of spread)
- Habitat status / condition – water temp, flow, physical habitat quality, area
- Conservation Framework – Status Rankings species & ecosystems at risk
- Change in land use / land cover, ecosystem conversion overtime

FUTURE CONTEXT:

- Projected Changes by biogeoclimatic zones due to changing climate

4. Resource Use and Impacts

CONTEXT: (*Baseline – changes in % over time)

- Population density
- Land use and land cover – total area and % of watershed in different land cover types / land use (including urban density)
- Forest cover
- Existing resource development projects

INDICATORS:

- Water use (demand) – allocation by sector; number of large water users by volume; stream status by water allocation
- Riparian forestry practices - # of streams by stream condition classification
- Road density and stream crossings – number of road crossings; road density, length of roads per watershed
- Forestry – equivalent clear cut area; volume of timber harvested; forest restocking rates; area of forest disturbed and restocked in BC
- Impervious surfaces - % of impervious surfaces within watershed
- Agricultural Land Use – livestock density, total hectares of irrigated land, % of total land with agricultural Chemical Units applied, etc.
- Hydro / Energy Sector – number of energy or hydro development sites per stream / watershed
- Linear Development – density of linear development / construction: roads, utility corridors, pipelines, right-of-way, railways etc.
- Oil and Gas sector – water licenses by volume; density of wells per watershed
- Mining Sector – mine development – total number of mines per watershed, footprint of mining activity; water license by volume
- Urban impacts: municipal wastewater effluent, industrial effluent, spills and releases, urban land development, urban runoff
- Industry (impacts of discharges on water bodies & habitats): industrial effluent, spills and releases
- Climate change - precipitation: changes in snow pack, rainfall levels. Seasonal variability etc.

FUTURE CONTEXT:

- Projected population growth
- Proposed resource development projects by sector/type

5. Resource Conservation

CONTEXT:

- Protected areas (ha, classification)

INDICATORS:

- Watershed stewardship and restoration activities (type, length or area of fish habitat restored, length of fencing per stream corridor etc.)
- Sustainable Forest Management operations – area of % of sustainable certified forest operations
- Agricultural conservation or stewardship practices (buffer zones, soil conservation, rotational grazing)
- Water and Watershed planning activities
- Agricultural Environmental Farm Plans
- Species at Risk Recovery Efforts
- Implementation of riparian area regulations