

ALBERTA WATER COUNCIL



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Healthy Aquatic Ecosystems — A WORKING DEFINITION

Preamble

This document presents a working definition for Healthy Aquatic Ecosystems along with explanatory and contextual information to understand, interpret and apply the definition. The definition and supporting materials are a single package that, if separated, may lead to interpretations outside the original intent of the authors.

The definition package is a *working definition* or *living draft* that should be regularly reviewed and updated to reflect our changing understanding of aquatic ecosystems and their health and allow for adaptation of the definition to accommodate the future needs of its users. The working definition presented here was arrived at through a consensus process with a multi-stakeholder group with expertise in Alberta water issues.

Healthy Aquatic Ecosystems — A working definition:

A healthy aquatic ecosystem is an aquatic environment that sustains its ecological structure, processes, functions, and resilience within its range of natural variability.



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Introduction

Alberta's *Water for Life* strategy recognizes the importance of healthy aquatic ecosystems, safe drinking water and reliable, quality water supplies. Inherent in the strategy is the understanding that our aquatic ecosystems are the source for all existing and potential uses of water, including the sustainability of the ecosystem itself.

Arising from the goal of healthy aquatic ecosystems in the *Water for Life* strategy is a need to define the term *healthy aquatic ecosystems*. This definition will provide a direction and foundation for future work so we can collectively strive towards healthier aquatic ecosystems. This definition will do so by:

- improving our understanding of aquatic ecosystems and their health,
- providing a consistent and common language from which to improve our data collection and research efforts,
- providing a benchmark for understanding and measuring aquatic ecosystem health,
- guiding the development of new or improved management tools and practices, and
- supporting planning, management, and decision-making.

The working definition of *healthy aquatic ecosystems* depicts the components of an aquatic system operating within its range of natural variation. In this context, the definition provides a benchmark for understanding and measuring aquatic ecosystem health that can inform water management and decision-making by describing the current state of the aquatic ecosystem. This information can then be considered along with other environmental, social and economic requirements when making management decisions.

The working definition of *healthy aquatic ecosystems* can be applied at any scale, from local to provincial, as it contains elements that are relevant to aquatic ecosystems at all scales. The application of the working definition at the major basin or provincial scale will enable balanced decisions within a broader landscape approach, thereby facilitating the achievement of the three goals of Alberta's *Water for Life* strategy.

Perspectives

Aquatic ecosystem — aquatic environment

Ecosystems are naturally complex. Ecological units exist at varying scales, such that an ecosystem can be an individual water body and also a collection of interacting water bodies. But regardless of their scale, these systems share common elements. All have biological, chemical, and physical components that interact and react to one another and to other influences over time. Aquatic ecosystems are those ecosystems occurring in or on water or its beds and shores, including its biological organisms and communities.

Aquatic environment is defined by Alberta's *Water Act* and is intentionally referenced in the working definition of *healthy aquatic ecosystems* to link existing legislation, policy, and understanding to the strategic goals in the *Water for Life* strategy. This linkage should facilitate integration and alignment of existing policies and planning for water and land that are already underway in Alberta. The *Alberta Water Act* defines *aquatic environment* as the "components of the earth related to, living in, or located on water or its shores, including its organic and inorganic matter, living organisms and their habitats, and their interacting natural systems." The definition includes any type of aquatic ecosystem, such as lakes, wetlands, rivers, streams, aquifers, and riparian areas.

Sustainability

An aquatic ecosystem is *sustainable* when it has the ability to meet the needs of the present without compromising the ability to meet the needs of the future. The key consideration of sustainability is to ensure future opportunities are not precluded by today's actions and tomorrow's generations are afforded the opportunities of today.



Ecological structure, process and function

Ecological functions are the effects of ecological processes on the physical and chemical conditions of their environment. Aquatic ecosystem functions include sediment storage, water filtration, biodiversity maintenance, carbon storage, and groundwater recharge, among many others. Note that “functioning” does not imply that ecosystems perform purposeful roles. Ecological functions can provide services and benefits to humans such as the production of wild game, seafood or flood mitigation. However, ecosystem functions may also have no human value.

These ecological functions are accomplished by processes. Ecological processes are the activities and sequences of observable changes in the structural elements of an ecosystem. Examples of aquatic ecological processes include transporting sediment, capturing nutrients, and absorbing floodwater.

Ecosystems can be described in terms of their structure or the form and organization of their constituent parts. These parts are typically characterized as physical, chemical, and biological with descriptors such as feature type and location, species composition, abundance, trophic level, and biodiversity.

For example, cattails and other aquatic plants (structure) uptake and absorb nutrients and pollutants (process) leading to water purification (function). These three elements are closely related, as process describes the interaction between the structural parts of an ecosystem that result in ecological functions. Collectively, ecological structures, processes and functions in their natural state can be described as having ecological integrity.

Range of natural variability

The working definition uses *range of natural variability* to acknowledge that “healthy” is typically a range of condition, as opposed to an absolute condition.

Ecosystems are naturally dynamic within a certain range over space and time. The ecological structure and functions are influenced by the current environment as well as past environmental fluctuations and disturbances. Ecosystems are always responding to past changes, including relatively predictable daily and seasonal variation, less predictable changes in weather, and other disturbances (e.g. fire, insect outbreaks, etc). Spatial variation within and among ecosystems is critical to the function of individual ecosystems and of entire regions. For example, riparian ecosystems may filter sediment and other pollutants that would otherwise move into water bodies. Ecosystem variation across the landscape stems from environmental variation, population and community processes and disturbance.

Observations about natural temporal and spatial variability in ecosystem structure, process, function and resilience can inform management decisions by providing clues about the degree to which an induced change may affect the ecosystem and its potential response. For example, historical records of hydrologic flows are used in science-based in-stream flow needs determinations to assess the degree of effect of proposed water withdrawals on an aquatic system.



Resilience

Resilience is the ability of an ecosystem to recover from a disturbance so as to retain essentially the same structure, processes and functions. When an ecosystem is disturbed and can still remain within the natural range of variability, it can be described as *resilient*. Aquatic ecosystems vary greatly in their inherent resilience to disturbance; some ecosystems are very robust while others are fragile. The ability of an ecosystem to respond to change is dependant upon the properties of the ecosystem itself, such as water quality and water depth, its intactness, species composition and diversity. For example, prairie streams are usually less resilient than parkland or boreal streams because of lower precipitation and a more variable climate, among other factors.

The ability of an ecosystem to respond to change is also dependant upon the degree of disturbance and the rate of change. Ecosystems may be less resilient to rapid and extensive changes than those where changes are slower or less widespread.

In simplest terms, *disturbance* is a disruption of existing conditions that causes the structure, processes and functions of an ecosystem to change. Many ecological processes and functions require natural disturbances such as fire, flood, drought, and weather to persist. For example, flooding drives channel formation, as well as the extent of riparian area, and nutrient movements in aquatic systems. Typically, disturbance can be described in terms of its frequency, size, intensity, and biotic response.

Anthropogenic disturbances also occur on the landscape and may have ecological effects that are similar to those of natural disturbances. However, the impacts of natural and anthropogenic disturbance can overlap and accumulate on the landscape. A good understanding of both natural and anthropogenic disturbances, and their interaction, is imperative for assessing and managing cumulative effects in aquatic ecosystems.

Resilience is an inherent feature of healthy aquatic ecosystems and varies considerably from one ecosystem to another. Resilience is included in our definition because it is an important attribute of aquatic ecosystem health and an important consideration in natural resource management. However, great care should be taken in the application of the term resilience. While it is important to understand that resilience is a key factor in ascribing the 'health' of aquatic ecosystems, it is equally important to recognize that ecosystem resilience is finite. Identifying an ecosystem as highly resilient should not be interpreted to mean that an ecosystem either can or should be disturbed.



Opportunities

Measures of aquatic ecosystem health

There are a number of opportunities and challenges in attempting to use a broad definition of *healthy aquatic ecosystems*. Perhaps the most obvious of these is that different types of aquatic ecosystems including rivers, lakes, streams, wetlands and groundwater, will have different measures of health.

Alberta's aquatic ecosystems are complex and interconnected ecological units containing various waterbody types, biological organisms and communities that interact with their physical and chemical surroundings. In addition to this complexity, these systems can be characterized, measured, and managed at a variety of scales using an assortment of tools and techniques.

Measures of ecosystem health must assess the health of individual water bodies as well as the overall health of aquatic ecosystems across a landscape. For example, numerous wetlands on the landscape work in combination to provide a variety of functions, including wildlife habitat, groundwater recharge, nutrient assimilation, removal of contaminants and sediment, and flood attenuation. These functions require the cumulative health of wetlands as an aquatic ecosystem type. A reduced number, area or variety of wetland types could constitute an unhealthy state for the wetland ecosystem even if the remaining wetlands exhibited conditions that would signify that those individual wetlands were otherwise healthy.

In particular, many aspects of ecosystem resilience are difficult to describe and measure because of the complex nature of the concept. This poses a significant challenge to the development of appropriate metrics; however the potential benefits of undertaking this work are significant.

Data requirements

Data and information required to make healthy ecosystem assessments at the regional or major-basin scale may not be readily available. There is a significant opportunity to collect data pertinent to large scale assessment while also fulfilling more routine site-level assessment requirements. Additional information will also be needed to properly assess the natural range of variability inherent in Alberta's ecosystems.

