6.0 Conclusions

Antler Lake is a small, shallow, hypereutrophic waterbody that is sensitive to climate and development pressure. The land that contributes runoff to the lake is relatively small and contains concentrated urban and country residential development and many agricultural lands. Water levels have dropped significantly (between 1–2 m) since the 1990's, and water quality has decreased, with increased plant and algal growth, high nutrient levels, and more concentrated salts and heavy metals, indicating the lake is far along in its natural life cycle. Nevertheless, the lake continues to function as an important habitat for wildlife and provides many natural benefits related to ecosystem functioning, water storage and filtration. The Antler Lake watershed is an important feature within the surrounding region of the Beaver Hills Moraine, acting as a habitat corridor and allowing for connectivity within habitat space for nearby protected areas.

The long history of conservation within the Beaver Hills reflects recognition for the uniqueness of the landscape and the strong connection people have with the surrounding environment. Strathcona County has clearly identified their priorities for environmental conservation and stewardship for the Beaver Hills in their Municipal Development Plan, which is an important first step. Antler Lake is a small lake within the region but may tell us much about what nearby lakes may be experiencing, especially considering their hydrological connectedness.

Although much information is available about the land within the Antler Lake watershed, and the surrounding region, Antler Lake itself lacks historical water quality data, among other data gaps that would improve the overall understanding of watershed functioning and ecosystem health. Below, we discuss some of the knowledge gaps that would help complete the picture. However, beyond more detailed assessments, the greatest improvements will likely come from enhanced stewardship and collaboration to ensure future land management decisions are made with the state of the Antler Lake watershed in mind.

7.0 Knowledge Gaps

This report has identified several data gaps for evaluating the health of the Antler Lake watershed, including:

1. Long-term water quality data, as well as measurements during winter months.

    a. Only three years of data on water quality is available for Antler Lake. On-going water quality sampling is useful for long-term, trend analysis and for monitoring changes to water quality that may be indicative of climate, pollution, or other local changes to the surrounding environment. This work can also involve residents around Antler Lake, engaging them to help build awareness about water quality and in identifying local solutions to improve water quality.

2. A detailed riparian health assessment.

    a. A riparian intactness assessment has been initiated for Antler Lake, within the Beaverhill sub-watershed, as a part of the *Riparian Health Action Plan: Phase I* project by the NSWA, expected to be completed by December 2021. Riparian intactness assessments are useful to help direct management efforts for restoring lost riparian habitat through the evaluation of their intactness and characteristics of the watershed. This information combined with support from other non-profit groups such as Cows and Fish, Alternative Land Use Services (ALUS), and the Agroforestry and Woodlot Extension Society of Alberta (AWES) can provide opportunities for local residents to revegetate the shoreline and re-establish a healthy riparian buffer to help improve the water quality, aquatic health, and biodiversity at Antler Lake.

3. An assessment of groundwater hydrology and connections to surface water.

    a. Recent information is not available to fully evaluate groundwater trends in the Antler Lake watershed. Further investigation is warranted to characterize the relationships between groundwater and surface water, especially considering the high levels of groundwater contamination risk estimated for the area. This work could be done in partnership between the Antler Lake Stewardship Committee, Strathcona County, and Alberta Environment and Parks. Regarding hydrological connectivity, it could be beneficial to monitor stream flow, as this is not currently monitored, from Antler Lake into downstream lakes and creeks that drain into the North Saskatchewan River, but this may require significant investment in infrastructure.

4. Surveys of aquatic biodiversity, including invasive species.

    a. Currently, there are no known detailed aquatic biodiversity surveys available for Antler Lake. Additional information on phytoplankton, zooplankton, benthic invertebrates and aquatic macrophytes would provide a direct assessment of ecosystem conditions. These assessments would also be beneficial towards understanding the importance of the lake, in its current condition, as habitat space for migratory waterfowl and other species that rely on these organisms as a source of food or shelter. The only invasive species that have been surveyed for in the watershed are invasive Quagga and Zebra mussels. There is the potential for other aquatic invasive species to enter the Antler Lake watershed and cause further degradation, particularly due to the development along the shoreline. Specific species that should be surveyed for are invasive aquatic plants such as Flowering Rush, Purple Loosestrife, Himalayan Balsam, Phragmites, and Pale-Yellow Iris.

5. A local, specific, phosphorous budget.

    a. Lastly, a detailed phosphorus budget would be a valuable diagnostic tool to quantify pollution sources and determine if any external sources are still contributing to the high levels of nutrients in the lake. The preliminary phosphorus budget (**Appendix 3**) revealed a significant contribution from internal loading that may have been caused by past land-use practices, such as waste disposal before the sewer installment. However, the sediments in the area naturally contain phosphorus and nitrogen. The purpose of a more detailed assessment would not be to determine past contributions, but rather to determine if any changes to current land-use practices are needed. For instance, if agricultural lands or the feedlot near the lake were found to be significant sources, best management practices could be utilized to reduce the flow of nutrients from these areas.

Future research initiatives in these areas could help address data gaps (**Table 15**) and provide the information necessary to verify the condition of the watershed. These projects could also inform targeted restoration strategies to improve watershed health. Research initiatives could be carried out by watershed partnerships formed among the local community, lake stewardship groups, local governments, non-governmental organizations, and the Alberta Government.

Table 13. Data Gaps and Potential Future Projects for the Antler Lake Watershed.

Data gaps	Future Projects	Potential Leads	Relative Cost	Estimated Timeframe
Water Quality	Long-term lake monitoring	ALMS, ALSC	$	Short
Aquatic Biology	Surveys for: Phytoplankton, Zooplankton, Benthic Invertebrates and Aquatic Macrophytes	ALMS, AEP, Invasive Species Council	$-$$	Short-Mid
Riparian Health	Riparian health assessment	NSWA	$$	Mid
Phosphorus Budget	Point-Source Phosphorus Budget for the Lake	AEP, Environmental Consulting Company	$-$$	Long
Updated Groundwater Hydrology	Regional groundwater assessment	Strathcona County, AEP, AGS	$-$$	Long
Stream flow in watershed tributaries	Streamflow monitoring project	AEP	$$-$$$	Long

$ = 0-25,000 ; $$ = 25,000 – 50,000 ; $$$ = 50,000 – 100,000

8.0 General Recommendations

Antler Lake we have some general recommendations:

- The Antler Lake Stewardship Committee, in partnership with Strathcona County and local non-profit organizations, ***enhance stewardship activities*** around the lake and watershed to help inform residents about the condition of the lake, and to provide a sense of community and ownership that invigorates responsible land management practices. This could be delivered in the form of several outreach events through the year that focus on various watershed topics: riparian health, living on the waterfront, ecosystem services, the water cycle, Christmas bird count and other biodiversity surveys with the NatureLynx app, planting native species, pollinators and building bee condos, etc.

- All residents in the Antler Lake watershed and Strathcona County work to conserve and restore the riparian area around the lake, as it functions to prevent erosion, filter out contaminants from runoff, and provides important habitat for wildlife. Following the completion of the riparian intactness survey of the Beaverhill sub-watershed by the NSWA, recommendations will be in place to help inform Strathcona County and the public about where conservation and restoration projects would best be implemented. Local NGOs, like Cows and Fish and Nature Alberta, may be consulted on best approaches for restoration projects and best management practices for conservation. Residents may consult *Living on the Waterfront: The Alberta Guide for Shoreline Living* from the Nature Alberta's website as a tool for assessing their personal property as well.

- Property owners of the Hamlet of Antler Lake and nearby residents should adopt natural landscaping on lakeshore properties, incorporating native plant species, reducing lawn clearing, and the use of chemical pesticides and fertilizers that can leach into the lake.

- Country residential landowners should closely monitor personal ground wells and septic systems to ensure they are functioning properly and serviced when needed.

- Agricultural property owners should use best management practices (BMPs) to prevent the runoff of pesticides and fertilizers into the lake, such as the installation of catch basins or berms to prevent run-off from reaching water bodies, rotational grazing, off-stream watering, and portable shelters, reducing tillage practices, install grassed water ways, and change the frequency of manure application and rates (Ormann and Baruma, 2016).

9.0 Addressing Specific Concerns

Here, we present our recommendations in the context of the public's concerns expressed during consultation and reference the specific sections within this document for further reading.

- **Blue green algae (cyanobacteria) blooms and the toxicity of these events**
  - Residents around Antler Lake expressed they wanted to learn ways in which to manage blue green algae bloom events as well as methods for prevention and strategies for decreasing phosphorus levels in the lake. To date there have not been any recorded health advisories for cyanobacteria blooms at Antler Lake. Generally, Antler Lake is below the recreational limits for microcystin (cyanotoxin) levels, though one past measurement in 2017 was above this limit.
  - ***Regular water quality monitoring is recommended to test for high microcystin concentrations during the summer months.***
    - **References:** Sections 4.4, 4.6, and 4.7.

- **Health of the fish population**
  - Some residents believe that there were fish in the lake, historically, and want to know more about the status of the fishery.
  - In 1958, stocking the lake with Yellow Perch was attempted, but failed as a long-term program. Recent surveys did not find fish, though it is possible for small populations of Perch to exist, considering their tolerance for low-oxygen environments.
  - ***It is not recommended to use resources towards trying to establish new fisheries, as the lake is too shallow to support fish over the winter.***
    - **References:** Section 4.5.

- **Water quality**
  - The 2016 water quality testing by ALMS identified high levels of phosphorous and lead which was troubling to some landowners.
  - The Total Phosphorus (TP) in Antler Lake is, on average, very high and the lake is classified as Hypereutrophic, as are many shallow lakes in Alberta.
  - The amount of Lead detected (0.356 µg/L) was well below the recommended guidelines (7.0 µg/L) for heavy metals.
  - ***It is recommended that the ALSC collaborate with the Alberta Lake Management Society (ALMS) to conduct regular water quality monitoring.***
  - ***It is recommended that property owners reduce or eliminate their use of fertilizers and pesticides that may leach into the lake and contaminate it.***
  - ***It is recommended that everyone within the Antler Lake watershed work together with Strathcona County to conserve and repair (where needed) the riparian zone around the lake to help reduce the contamination of the lake from runoff.***
    - **References:** Sections 4.4 and 4.7.

- **Lake dredging as an in-lake treatment for phosphorus**

- Lake dredging is the process of removing silt and sediment from the lake bottom in hopes of removing blockages, contaminants, or increasing lake depth.
- Dredging of a natural water body such as Antler Lake would not likely receive approval from the federal, provincial or municipal government agencies particularly since it is considered an important biodiversity link within the Beaver Hills Biosphere.
- All lakes, including bed and shore are owned by the Crown and managed by the province. There are multiple layers of policy that govern the waterbody and any potential modifications to it. Any modifications presented, such as dredging, would have to undergo approval of the federal *Public Lands Act*, the *Water Act*, and the *Fisheries Act*. It is likely that other provincial or municipal policies may also be considered.
- ***It is not recommended to pursue in-lake treatments for phosphorus, including lake dredging, as the cost is high, and the evidence of previous success is very low.***
    - **References:** Bormans, et al., 2016; Government of Alberta, 2014; 2019.

- **<u>Identification of harmful land use practices</u>**
    - Potential, harmful land-use practices within the Antler Lake watershed could be identified as anything that contributes pollutants to the lake, removal of natural features like vegetation, changes to the shoreline that could cause erosion, or developments that disrupt or alter water flow, habitat linkages, or otherwise harm the environment and the natural functioning of the ecosystem.
    - There have been no official surveys of the Antler Lake watershed to specifically identify harmful land-use practices.
    - ***It is recommended that residents around Antler Lake consult with Nature Alberta to assess their properties for harmful land-use practices, so they may be advised in how to make positive changes to their property to help protect the lake from further degradation.***
    - ***It is recommended that the ALSC collaborate with environmental NGOs, Alberta Environment and Parks, and Strathcona County to provide public education to residents and visitors about harmful land-use practices and encourage change within the community.***
        - **References:** Sections 3.5, 3.6, 3.8, and 4.4.

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11.0 Glossary

A

Air entrainment
The entrapment of air bubbles within a substance.

Alkaline/alkalinity
The acid-neutralizing capacity of water.

Anoxic
The absence of oxygen, as in bodies of water, lake sediments, or sewage. Anoxic conditions generally refer to a body of water sufficiently deprived of oxygen to where zooplankton and fish would not survive.

Anthropogenic[1]
Involving the impact of man on nature; induced, caused, or altered by the presence and activities of man, as in water and air pollution.

Aquifer
An underground water-bearing formation that is capable of yielding water. Aquifers have specific rates of discharge and recharge. As a result, if groundwater is withdrawn faster than it can be recharged, the underground aquifer cannot sustain itself.

B

Basin[1]
A geographic area drained by a single major stream; consists of a drainage system comprised of streams and often natural or man-made lakes. Also referred to as Drainage Basin, Watershed, or Hydrographic Region.

Bathymetry[1]
(1) The measurement of the depth of large bodies of water (oceans, seas, ponds and lakes). (2) The measurement of water depth at various places in a body of water. Also the information derived from such measurements.

Bedrock[1]
(Geology) The solid rock beneath the soil (Zone of Aeration or Zone of Saturation) and superficial rock. A general term for solid rock that lies beneath soil, loose sediments, or other unconsolidated material.

Biodiversity (Biological Diversity)[2]
The variability among living organisms from all sources and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems.

Biological productivity[3]
The rate of production of living material produced or energy utilized by organisms within a given period in a specified habitat.

C

Calcareous[1]
Formed of calcium carbonate or magnesium carbonate by biological deposition or inorganic precipitation in sufficient quantities to effervesce carbon dioxide visibly when treated with cold

0.1 normal hydrochloric acid. Calcareous sands are usually formed of a mixture of fragments of mollusk shell, echinoderm spines and skeletal material, coral, foraminifera, and algal platelets.

Catchment area[1]

(1) The intake area of an aquifer and all areas that contribute surface water to the intake area. (2) The areas tributary to a lake, stream, sewer, or drain. (3) A reservoir or basin developed for flood control or water management for livestock and/or wildlife. See also Drainage Area; Watershed. (4) The land (and including the streams, rivers, wetlands and lakes) from which water runs off to supply a particular location in a freshwater system. In North America, the term watershed is often used instead of catchment area.

Climate[3]

The pattern of weather in a particular region over a set period of time, usually 30 years. The pattern is affected by the amount of rain or snowfall, average temperatures throughout the year, humidity, wind speeds and so on.

Conductivity

A measure that indicates water's ability to conduct an electrical current. It provides an indication of the amount of dissolved substances in the water. When conductivity is high, the concentration of dissolved material is also high.

Connectivity[4]

The concept of connectivity is used to describe how the spatial arrangement and quality of other elements in the landscape affect the movement of organisms among habitat patches (Merriam 1984,1991; Taylor et al. 1993; Forman 1995 in Bennett 2003). In an urban context, connective landscapes are described in terms of relatively permeable habitat patches and linkages, separated by a less permeable matrix and barriers.

Corridor[4]

Any space, usually linear in shape, that improves the ability of organisms to move among patches of their habitat (Hilty et. al 2006). Although naturally-vegetated linear strips can also be corridors (Bennett 2002), for this assessment we identified only disturbed grass corridors, primarily transportation rights-of-way (i.e., linear greenspace, such as hedgerows, were not specifically identified as corridors in this assessment).

Culvert

A pipe or concrete structure that allows water to flow under a road, railroad, or other obstruction, allowing it to flow from one side to the other.

D

Discharge area[1]

(1) An area in which ground water is discharged to the land surface, surface water, or atmosphere. (2) An area in which there are upward components of hydraulic head in the aquifer. Ground water is flowing toward the surface in a discharge area and may escape as a spring, seep, or base flow, or by evaporation and transpiration.

Dissolved oxygen

A measurement of the amount of oxygen available to aquatic organisms. Temperature, salinity, organic matter, biochemical oxygen demand, and chemical oxygen demand affect dissolved oxygen solubility in water.

Drainage area[1]

That area, measured in a horizontal plane, enclosed by a topographic (drainage) divide from which direct surface runoff from precipitation normally drains by gravity into the stream above the specified point.

E

Ecological network[5]
Ecological networks are representations of the interactions that occur between species within a community. The interactions include competition, mutualism and predation, and network properties of particular interest include stability and structure.

Ecosystem
A community of interdependent organisms together with the environment they inhabit and with which they interact.

Ecosystem services[6]
All the direct and indirect benefits that people obtain from nature and natural processes. Examples include water storage and flood control, provision of water supplies, provision of genetic resources, raw materials, and food, pollination of crops and native vegetation, and fulfillment of people's cultural, spiritual, recreational, and educational needs.

Effective drainage area[7]
A portion of the gross drainage basin that can be expected to contribute surface runoff to a body of water during a flood with a return period of two years. The effective drainage area excludes portions of the gross drainage area that drain to peripheral marshes, sloughs and other natural depressions that prevent runoff from reaching the water body in a year of average runoff.

El Niño Southern Oscillation[8]
El Niño was initially used to describe a warm-water current that periodically flows along the coast of Ecuador and Perú, but has since become identified with a basin-wide warming of the tropical Pacific east of the International Dateline. This oceanic event is associated with a fluctuation of a global-scale tropical and subtropical surface pressure pattern, called the Southern Oscillation. This coupled atmosphere-ocean phenomenon, with preferred time scales of 2 to about 7 years, is collectively known as El Niño–Southern Oscillation (ENSO). During an ENSO event, the prevailing trade winds weaken, reducing upwelling and altering ocean currents such that the sea-surface temperatures warm, further weakening the trade winds. This event has great impact on the wind, sea-surface temperature and precipitation patterns in the tropical Pacific, with effects throughout the Pacific region and in many other parts of the world, through global teleconnections. The cold phase of ENSO is called La Niña.

El Niño[9]
El Niño is Spanish for little boy and it is what local South American fisherman call a warmer than usual current along the western coast of that continent at Christmas time. Most years, the strong and prevailing trade winds blow westward dragging the warmest surface waters across the Pacific to Australia and Indonesia. But every 2 to 7 years, these trade winds weaken or change direction. This allows the warm waters to change direction and head toward the coast of South America, increasing water temperatures there as much as 5°C. This causes changes in atmospheric pressure which, in turn, trigger a shift in global weather patterns.

Environmentally Significant Areas[10]

Areas that are important to the long-term maintenance of biological diversity, physical landscape features and/or other natural processes, both locally and within a larger spatial context.

Ephemeral stream[1]

A stream that flows only in direct response to precipitation, and thus discontinues its flow during dry seasons. Such flow is usually of short duration. Most of the dry washes of more arid regions may be classified as ephemeral streams.

Erosion[1]

The wearing away and removal of materials of the earth's crust by natural means. As usually employed, the term includes weathering, solution, corrosion, and transportation. The agents that accomplish the transportation and cause most of the wear are running water, waves, moving ice, and wind currents. Most writers include under the term all the mechanical and chemical agents of weathering that loosen rock fragments before they are acted on by the transportation agents; a few authorities prefer to include only the destructive effects of the transporting agents.

Euphotic depth/zone[3]

The lighted region of a body of water that extends vertically from the surface to the depth at which photosynthesis fails to occur because of insufficient light penetration.

Eutrophication

The process by which lakes and ponds become enriched with dissolved nutrients, either from natural sources or human activities. Nutrient enrichment may cause an increased growth of algae and other microscopic plants, the decay of which can cause decreased oxygen levels. Decreased oxygen levels can kill fish and other aquatic life.

Evaporation[11]

The change of the state of a liquid, like water, into a vapour.

F

Flushing rate[12]

The volume or percentage of dissolved particles stored in a lake that, on average, flows out of the lake (is flushed) in a given year. It is estimated as the mean annual outflow from the lake which can carry the dissolved particle divided by the volume of storage in the lake.

Fluvial[1]

Of or pertaining to rivers and streams; growing or living in streams ponds; produced the action of a river or stream.

G

GIS (Geographic Information System)[1]

A computer information system that can input, store, manipulate, analyze, and display geographically referenced data to support the decision-making processes of an organization. A map based on a database or databases. System plots locations of information on maps using latitude and longitude.

Glaciation[1]

(1) Alteration of the earth's solid surface through erosion and deposition by glacier ice. (2) To cover with ice or a Glacier; to subject to or affect by Glacial Action. (3) To freeze.

Glaciofluvial deposits[1]

Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces.

Glacial till[13]

An unsorted and unstratified accumulation of glacial sediment, deposited directly by glacier ice. Till is a heterogeneous mixture of different sized material deposited by moving ice (lodgement till) or by the melting in-place of stagnant ice (ablation till). After deposition, some tills are reworked by water.

Glaciolacustrine deposits[13]

The transportation of glacier sediment away from the ice margin by icebergs. Sediment transported by floating ice and deposited in lakes in called glacial-lacustrine sediment.

Gross drainage area[7]

Is the land surface area that can be expected to contribute surface runoff to a given body of water under extremely wet conditions. It is defined by the topographic divide (height of land) between the water body under consideration and the adjoining watersheds.

Groundwater recharge

Inflow of water to a groundwater reservoir (zone of saturation) from the surface. Infiltration of precipitation and its movement to the water table is one form of natural recharge. Also, the volume of water added by this process.

H

Headwaters

The source and upper tributaries of a stream or river. (BRBC)

Hummocky terrain

An area of land characterized by hills and depressions of various sizes and shapes that typically occur in areas that have been glaciated.

Hydrologic cycle (water cycle)

The process by which water evaporates from oceans and other bodies of water, accumulates as water vapour in clouds, and returns to oceans and other bodies of water as rain and snow or as runoff from this precipitation or groundwater.

Hydraulic gradient[1]

The gradient or slope of a water table or Piezometric Surface in the direction of the greatest slope, generally expressed in feet per mile or feet per feet. Specifically, the change in static head per unit of distance in a given direction, generally the direction of the maximum rate of decrease in head. The difference in hydraulic heads (h1 - h2), divided by the distance (L) along the flowpath, or, expressed in percentage terms:

I = (h1 - h2) / L X 100 I = (h1 - h2) / L X 100

A hydraulic gradient of 100 percent means a one-foot drop in head in one foot of flow distance.

Hydraulic residence time (chemical residence time)[12]

The average amount of time that a dissolved substance entering the lake stays in the lake before it flows out.

Hydrology[1]
The science of waters of the earth, their occurrence, distribution, and circulation; their physical and chemical properties; and their reaction with the environment, including living beings.

Hypereutrophic
Pertaining to a lake or other body of water characterized by excessive nutrient concentrations such as nitrogen and phosphorous and resulting high biological productivity. Such waters are often shallow, with algal blooms and periods of oxygen deficiency.

I

Impervious[1]
A term denoting the resistance to penetration by water or plant roots; incapable of being penetrated by water; non-porous.

Impervious Surfaces
Land where water cannot infiltrate back into the ground such as roofs, driveways, streets, and parking lots. Total imperviousness means the actual amount of land surface taken up with impervious surfaces, often stated as a percentage. Interestingly, a site with a total imperviousness of 60% can act like a site with only 10% imperviousness if strategies such as channeling roof runoff into a garden and using swales to capture rainwater are used.

Ion
Removing or adding electrons to an atom creates an ion (a charged object very similar to an atom).

L

Land cover[14]
The observed physical and biological surface of the Earth and includes biotic (living, such as natural vegetation) and abiotic (non-living, such as rocks) surfaces. Land cover can be determined by field assessment and using aerial and satellite imagery.

Land use[14]
Describes the economic and social functions of land to meet human demands, including activities and institutional arrangements to maintain or restore natural habitats. Typical land use classes include agriculture, settled areas and managed areas.

Landscape connectivity[15]
A measurement of the continuity of a landscape corridor (riparian corridor, etc.). Connectivity promotes valuable natural functions, such as movement of animals through their habitat, transport of materials and energy, which help maintain the integrity of natural communities.

Landscape sensitivity[17]
Landscape sensitivity is regarded as the potential for and the probable magnitude of change within a physical system in response to external effects and the ability of this system to resist the change.

La Niña[11]
Every four to five years or so, a pool of cooler than normal water replaces the warmer than normal El Niño current off the west coast of South America. This pool of water is called La Niña

or “girl child” and may be as much as 2°C lower than the average sea surface temperature of 28°C. In contrast to El Niño, La Niña brings colder winters to western Canada and Alaska and drier, warmer weather to the American south-east.

Luvisol[18]

A group of soils that are generally fertile and widely used for agriculture.

M

Microcystin[21]

A type of liver toxin produced by cyanobacteria. Microcystins have been responsible for illness and death of livestock, pets, and wildlife following the consumption of cyanobacteria-infested water. Microcystins have also been linked to incidences of gastrointestinal illness in humans.

Moraine[1]

An accumulation of boulders, stones, or other debris carried and deposited by a glacier. Moraines, which can be subdivided into many different types, are deposits of Glacial Till. Lateral Moraines are the ridges of till that mark the sides of the glacier's path. Terminal Moraines are the material left behind by the farthest advance of the glacier's toe. Each different period of glaciation leaves behind its own moraines.

N

Non-contributing/dead drainage area[12]

An area of land within the gross drainage area from which there is no surface outflow, even under very wet conditions. This situation is common in the Canadian Prairies, where major depressions having sloughs and shallow lakes with no outlets are usually associated with dead drainage.

O

Orthophotography

Aerial photographs that are geometrically corrected to provide true-to-scale measurements of geographical features, as in a map.

P

Pacific Decadal Oscillation[8]

A statistical measure of coupled decadal to interdecadal variability of the atmospheric circulation and underlying ocean in the Pacific Basin. It is most prominent in the North Pacific, where fluctuations in the strength of the winter Aleutian Low pressure system covary with North Pacific sea-surface temperatures and are linked to decadal variations in atmospheric circulation, sea-surface temperatures and ocean circulation throughout the Pacific Basin. Such fluctuations have the effect of modulating the El Niño–Southern Oscillation cycle.

pH

A measure of the intensity of the acid or base chemistry of the water. A pH of 7 is neutral, while below 7 is acidic and above 7 is basic. pH in surface water is regulated by the geology and geochemistry of an area and is affected by biological activity. The distribution of aquatic organisms and the toxicity of some common pollutants are strongly affected by pH.

Phytoplankton[22]

The portion of the plankton community (living at or near the surface) composed of tiny plants, algae, and diatoms.

Polymictic lake[19]

A type of holomictic lakes that are too shallow to develop thermal stratification; thus, their waters can mix from top to bottom throughout the ice-free period.

Precipitation[9]

Precipitation is any form of water -- liquid or solid -- that falls from the atmosphere and reaches the earth. Forms of precipitation include snow, ice pellets, freezing rain, freezing drizzle, rain and drizzle.

R

Riparian

Pertaining to the banks of a river, stream, waterway, or lake.

Riparian Area

The area of water-loving vegetation beside a stream, river, lake, or pond. Riparian areas are critical in reducing the negative effects of various land-uses on adjacent waters.

S

Scrubland[20]

An area of land where the dominant vegetation types are shrubs, often also including grasses, herbs, and geophytes.

Secchi disk[1]

A circular plate, generally about 10-12 inches (25.4-30.5 cm) in diameter, used to measure the transparency or clarity of water by noting the greatest depth at which it can be visually detected. Its primary use is in the study of lakes.

Secchi depth[1]

A relatively crude measurement of the turbidity (cloudiness) of surface water. The depth at which a Secchi Disc (Disk), which is about 10-12 inches in diameter and on which is a black and white pattern, can no longer be seen.

Site productivity

The perceived amount of production potential of a resource at a particular site (e.g. agriculture or timber)

Species richness[24]

Species richness is simply a measure of the number of species within a defined region. The ABMI has created an index of species richness for Alberta that is a relative measure of the number of common native species within 1-km^2 grid cells across the province.

Surficial

Relating to the Earth's surface.

T

Thermal stratification[1]
The vertical temperature stratification of a lake or reservoir which consists of: (a) the upper layer, or Epilimnion, in which the water temperature is virtually uniform; (b) the middle layer, or Thermocline, in which there is a marked drop in temperature per unit of depth; and (c) the lowest stratum, or Hypolimnion, in which the temperature is again nearly uniform.

Thermocline[1]
(1) The region in a thermally stratified body of water which separates warmer oxygen-rich surface water from cold oxygen-poor deep water and in which temperature decreases rapidly with depth. (2) A layer in a large body of water, such as a lake, that sharply separates regions differing in temperature, so that the temperature gradient across the layer is abrupt. (3) The intermediate summer or transition zone in lakes between the overlying Epilimnion and the underlying Hypolimnion, defined as that middle region of a thermally stratified lake or reservoir in which there is a rapid decrease in temperature with water depth. Typically, the temperature decrease reaches 1°C or more for each meter of descent (or equivalent to 0.55°F per foot).

Tropic/Trophic status
The overall level of biological productivity (or fertility) of a lake. It is usually defined by the concentrations of key nutrients (phosphorous and nitrogen) and the algae present. Alberta is a province with very diverse ecoregions and as a result our lakes vary widely in trophic state. Some lakes, such as those in the foothills and mountains, tend to have low nutrient concentrations, while others, like those in the central plains area, tend to have very high nutrient and algal concentrations. Lakes in Alberta are categorized into four trophic levels: Oligotrophic (low productivity), Mesotrophic (moderate productivity), Eutrophic (high productivity), and Hypereutrophic (very high productivity).

V

Vernal migratory path
The path taken by migratory birds during the spring.

W

Water balance/budget[1]
(1) (Hydrology) An accounting of the inflows to, the outflows from, and the storage changes of water in a hydrologic unit or system.

Watershed
The area of land that catches precipitation and drains into a larger body of water such as a marsh, stream, river, or lake. A watershed is often made up of a number of sub-watersheds that contribute to its overall drainage. For instance, the North Saskatchewan River watershed is made up of 12 sub-watersheds, including the Sturgeon River sub-watershed that contains within it the Hubbles Lake and other lake watersheds.

Weather (NRC)
State of the atmosphere at a given time and place with regard to temperature, air pressure, humidity, wind, cloudiness and precipitation. The term is mainly used to describe conditions over short periods of time.

Wetland
Land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, water-loving vegetation, and various kinds of biological activity which are adapted to a wet environment.

Wetland complex[25]
Consists of two or more palustrine basins occurring in close proximity; often but not always hydrologically linked.

Winterkill[3]
The death of fishes in a body of water during a period of prolonged ice and snow cover; caused by oxygen exhaustion due to respiration and lack of photosynthesis.

Z

Zooplankton[1]
Small, usually microscopic animals found in lakes and reservoirs that possess little or no means of propulsion. Consequently, animals belonging to this class drift along with the currents.

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1.0 Appendix 1: Species Of Conservation Concern

11.1 Vascular and non-vascular plant species

Species		Provincial Status
Common Name	**Scientific Name**	**ESRD Status (2010)**
Ascending grape fern	*Botrychium ascendens*	May be at Risk
Blunt-leaved pondweed	*Potamogeton obtusifolius*	Sensitive
Carolina wild geranium	*Geranium carolinianum*	Sensitive
Clinton's bulrush	*Trichophorum clintonii*	May be at Risk
Crested shield fern	*Dryopteris cristata*	May be at Risk
Dwarf grape fern	*Botrychium simplex*	May be at Risk
Fox sedge	*Carex vulpinoidea*	May be at Risk
Golden saxifrage	*Chrysosplenium iowense*	Sensitive
Lakeshore sedge	*Carex lacustris*	May be at Risk
Lance-leaved grape fern	*Botrychium lanceolatum*	Sensitive
Northwestern grape fern	*Botrychium pinnatum*	Sensitive
Pale blue-eyed grass	*Sisyrinchium septentrionale*	Sensitive
Pale moonwart	*Botrychium pallidum*	May be at Risk
Round-leaved bryum	*Bryum cyclophyllum*	Sensitive
Slender naiad	*Najas flexillis*	May be at Risk
Watermeal	*Wolffia columbiana*	Sensitive
Widgeon-grass	*Ruppia cirrhosa*	Sensitive

Notes: May be at Risk = any species that "May be at Risk" of extinction or extirpation and is therefore a candidate for detailed risk assessment; Sensitive = any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming "At Risk" (AESRD, 2010).

11.2 Wildlife

Species		Provincial Status	
Common Name	**Scientific Name**	**ESRD Status (2010)**	**Wildlife Act**
	Birds		
American bittern	*Botaurus lentiginosus*	Sensitive	
American kestrel	*Falco sparverius*	Sensitive	
American white pelican	*Pelecanus erythrorhynchos*	Sensitive	
Bald eagle	*Haliaeetus leucephalus*	Sensitive	
Barn swallow	*Hirundo rustica*	Sensitive	
Barred owl	*Strix varia*	Sensitive	
Black-crowned night heron	*Nycticorax nycticorax*	Sensitive	
Black tern	*Chlidonias niger*	Sensitive	
Broad-winged hawk	*Buteo platypterus*	Sensitive	
Chestnut-collared longspur	*Calcarius ornatus*	Sensitive	
Common nighthawk	*Chordeiles minor*	Sensitive	
Common yellowthroat	*Geothylpis trichas*	Sensitive	
Eastern Phoebe	*Sayornis phoebe*	Sensitive	
Forster's tern	*Sterna forsteri*	Sensitive	
Grasshopper sparrow	*Ammodramus savannarum*	Sensitive	
Great blue heron	*Ardea herodias*	Sensitive	
Great gray owl	*Strix nebulosa*	Sensitive	
Horned grebe	*Podiceps auritus*	Sensitive	
Least flycatcher	*Empidonax minimus*	Sensitive	
Lesser scaup	*Aythya affinis*	Sensitive	
Northern goshawk	*Accipiter gentilis*	Sensitive	
Northern harrier	*Circus cyaneus*	Sensitive	
Northern pintail	*Anas acuta*	Sensitive	
Northern pygmy owl	*Glaucidium gnoma*	Sensitive	
Piping plover	*Charadrius melodus*	At Risk	Endangered
Purple martin	*Progne subis*	Sensitive	
Pileated woodpecker	*Dryocopus pileatus*	Sensitive	
Short-eared owl	*Asio flammeus*	May be at Risk	
Sora	*Porzana carolina*	Sensitive	
Sprague's pipit	*Anthus spragueii*	Sensitive	
Swainson's hawk	*Buteo swainsoni*	Sensitive	
Trumpeter swan	*Cygnus buccinator*	At Risk	

Western grebe	*Aechmorphorus occidentalis*	Sensitive	Endangered
Western tanager	*Piranga ludoviciana*	Sensitive	
Western wood-pewee	*Contopus sordidulus*	Sensitive	
White-winged scoter	*Melanitta fusca*	Sensitive	
Mammals			
American badger	*Taxidea taxus*	Sensitive	
Fisher	*Martes pennanti*	Sensitive	
Hoary bat	*Lasiurus cinerus*	Sensitive	
Northern long-eared bat	*Myotis spetentrionalis*	May be at Risk	
Silver-haired bat	*Lasionycteris noctivagans*	Sensitive	
Amphibians			
Boreal toad	*Anaxyrus boreas*	Sensitive	
Canadian toad	*Bufo hemiophrys*	May be at Risk	
Northern leopard frog	*Lithobates pipiens*	At Risk	Endangered
Reptiles			
Plains garter snake	*Thamnophis radix*	Sensitive	
Red-sided garter snake	*Thamnophis sirtalis*	Sensitive	
Wandering garter snake	*Thamnophis elegans*	Sensitive	

Notes: ESRD Status: May be at Risk = any species that "May be at Risk" to extinction or extirpation, and is therefore a candidate for detailed risk assessment; Sensitive= any species that is not at risk of extinction or extirpation, but may require special attention or protection to prevent it from becoming "At Risk" (AESRD, 2010).