3.0 Watershed Characteristics

3.1 General Description

Antler Lake is a small, shallow lake located in central Alberta, about 35 km east of the City of Edmonton, at the eastern end of Strathcona County. The closest population center is the Hamlet of Antler Lake, located along the eastern and south-eastern shore of the lake. There are cottage residences along the eastern and southern shores, as well as residential development on Hazelnut Island, located on the south end of the lake. The Antler Lake watershed is part of the Cooking Lake system in the Beaverhill sub-watershed, one of twelve sub-watersheds of the NSR watershed (**Figure 11**). The Beaver Hills Moraine is a distinct geomorphological feature, representing an island of Boreal Forest and hummocky, knob-and-kettle topography, supporting numerous wetlands, lakes, and creeks (**Figure 12**; Strathcona County, 2018).

The land area, whose surface runoff drains to a particular point or body of water (lake, stream course, etc.), is called the drainage area, catchment area, or watershed. There are many variables that can alter the flow of water in the watershed. For instance, the level or gently undulating landscape of the surrounding Canadian Prairies, the local landforms and climatic conditions, and the portions of a watershed contributing and non-contributing to the surface runoff can cause significant and variable differences in how and where water collects, or drains, during each event and from year to year (Figliuzzi and Associates, Ltd., 2018).

The functional and specific hydrologic boundary of the Antler Lake watershed is difficult to define because of the hummocky landscape surrounding the lake. The "gross drainage area" is defined by the height of land, but the watershed contains a few non-contributing areas, which may only connect to the lake during above average flow years. The delineation of the "effective drainage area" is critical to understanding the hydrology of the basin (see further discussion in **Section 4.2**).

The delineation of the watershed boundary and contributing versus non-contributing areas for Antler Lake vary slightly, depending on the perspective and methods of the delineator. For this report, the delineation was provided by Sal Figliuzzi and Associates (2018) whom calculated the Water Balance for the Antler Lake watershed. The drainage areas were calculated as follows:

- The gross drainage area (including the lake surface area) for Antler Lake was estimated at 21.10 km^2 (**Figure 8**).
- The effective drainage area, the area contributing surface runoff to Antler Lake during a 1:2-year event, when the lake is at its average elevation of 738.28 m, was estimated at 11.25 km^2 (**Figure 12**) (Figliuzzi and Associates, Ltd., 2018).

For more detailed information regarding the calculations of the drainage area for the Antler Lake watershed, refer to **Appendix 1**.

The rolling, hilly terrain of the Beaver Hills Moraine is inherently poor for agricultural crops and, as a result, much of the area within the Antler Lake watershed remains naturally vegetated. However, some areas have experienced development pressures due to the proximity to the City of Edmonton (**Section 3.6**). In areas with suitable land, natural vegetation has been converted to agriculture and, increasingly, rural residential neighborhoods (Spencer Environmental, 2005). The Antler Lake watershed offers many natural, undisturbed, land features which provide valuable habitat for wildlife and recreational opportunities (**Sections 3.3 and 3.9**). Development in the watershed has resulted in anthropogenic disturbances occurring across approximately 29% of the watershed (**Section 3.6**). Climate in the region may also be shifting, which could alter features of the watershed and exacerbate anthropogenic disturbance in the area (**Section 3.2**).

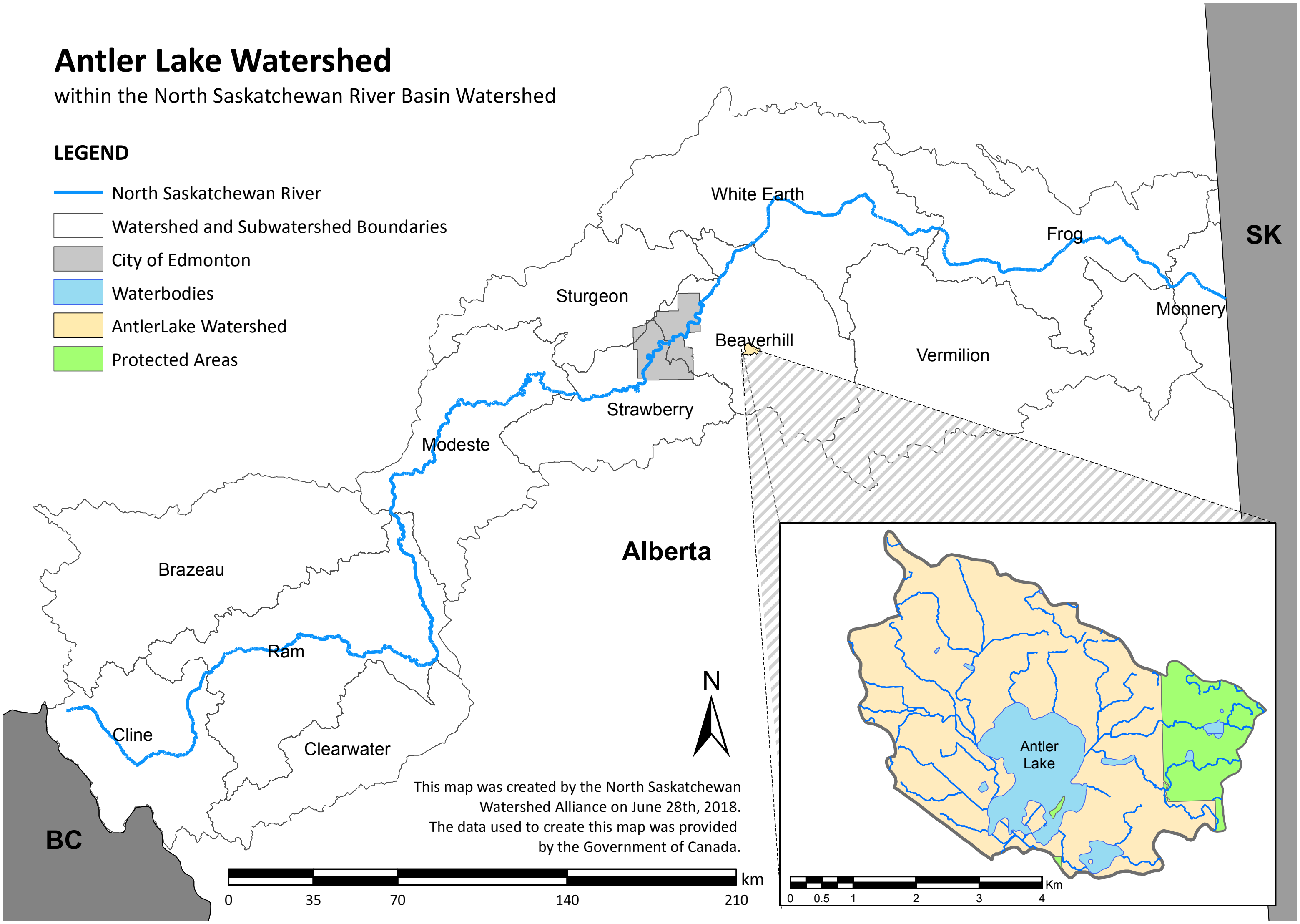


Figure 11. Location of the Antler Lake Watershed in the Beaverhill Sub-Watershed, One of Twelve Sub-Watersheds of the North Saskatchewan River Basin.

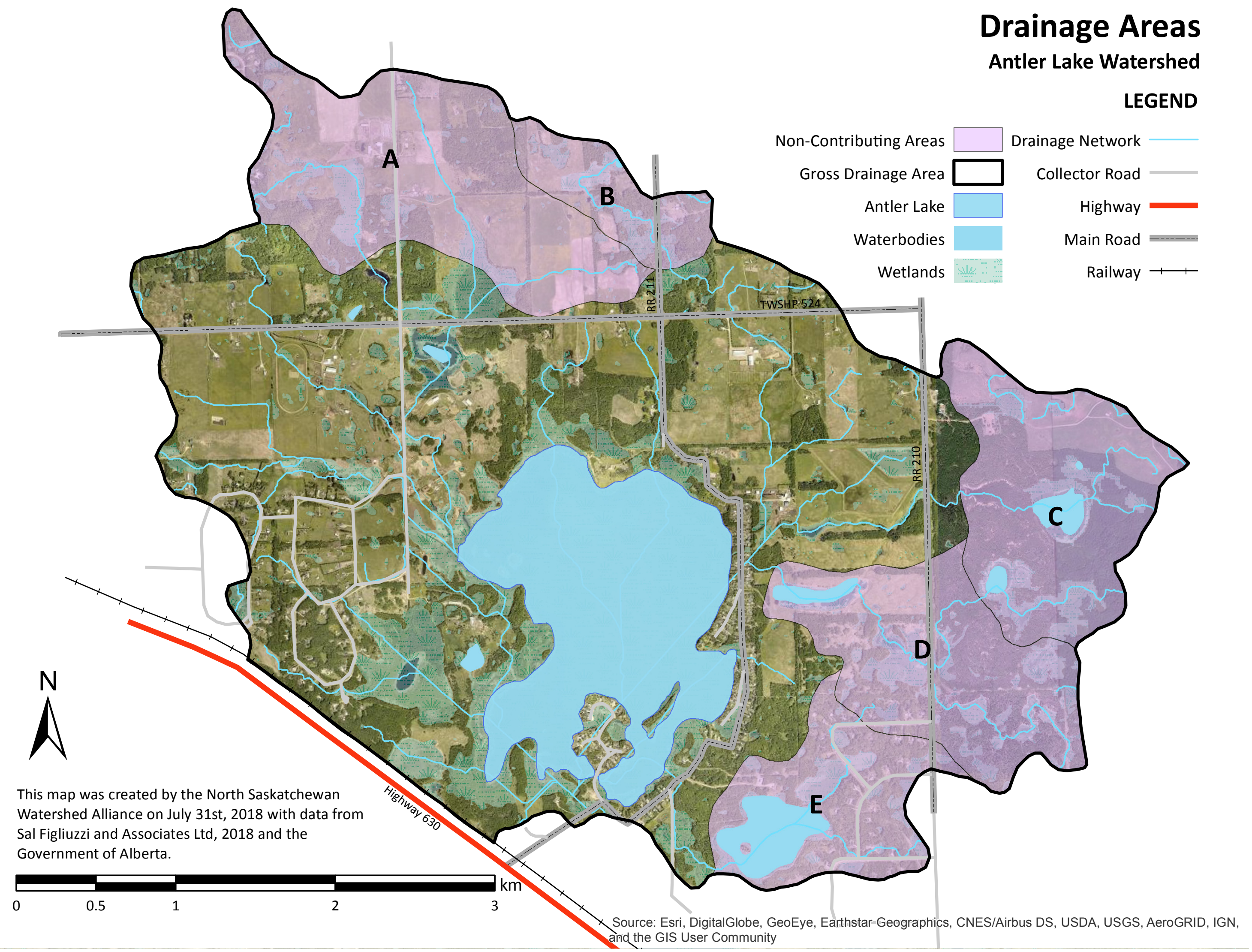


Figure 12. Gross and Non-Contributing Drainage Areas and Surface Water Features for the Antler Lake Watershed.

3.2 Climate

Understanding historical climatic variability within the watershed, and how it is affected by global climatic oscillations, is important in determining the potential implications of future climate variability on the hydrology of local lakes. Two drivers of climate cycling predominate in the western Canadian provinces: El Niño Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO). ENSO cycles every 2 to 7 years (with each cycle lasting 6–18 months) and refers to the warming or cooling of surface water temperatures of the equatorial Pacific Ocean, accompanied by a change in overlying atmospheric pressure (NOAA, 2016; SCONC, 2016). PDO cycles occur on a longer timescale of 20 to 30 years and are like ENSO, except that the shift in surface water temperature and overlying atmospheric pressure occurs in the Northern Pacific Ocean (SCONC, 2016). ENSO and PDO have two phases that produce different climatic responses: both El Niño and a warm phase (positive) PDO bring warm dry conditions to western Canada, whereas El Niño's sister phase, La Niña, and a cold phase (negative) PDO, result in cool, wet conditions for the region (ECCC, 2016a; 2016b). Climatic effects of ENSO can be amplified or diminished by the PDO depending on the cycling phase. For example, during a positive (warm) PDO, the climatic effects of El Niño may be amplified because they both result in warm, dry conditions.

Regional impacts of PDO and ENSO can be difficult to understand and predict. For example, in the early 2000s, the region experienced warmer and drier weather than normal, even though the PDO was primarily in a negative (cold) phase (**Figure 13**). Variability also exists within cycles, with each phase producing slightly different results. Prior to the winter of 2016, forecasters predicted that with a combined positive PDO and strengthening El Niño, North America would see a mild winter with minimal snowfall (NOAA, 2015), whereas others argued a strong, high-pressure ridge along the west coast would create an interaction that would bring more snow than anticipated in an El Niño year during the latter winter months (Gillham, 2015; Thompson, 2015). The former prediction turned out to be correct when, from March 2015 to May 2016, a strong El Niño and a positive (warm) phase PDO aligned to produce drought-like conditions in the region. Globally, the 2015 winter was the warmest year on record (ECCC, 2016a).

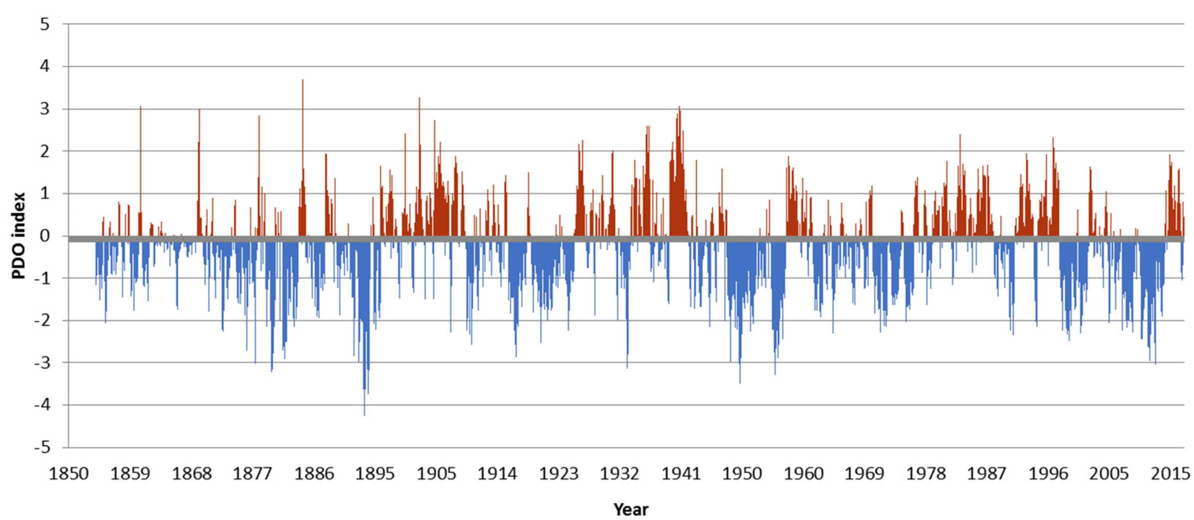


Figure 13. Positive (warm) and Negative (cold) Phases of Pacific Decadal Oscillation (PDO) Over the Past 162 years, 1854 – 2016 (NOAA, 2017).

Natural Region classifications are used to characterize ranges of the landscape to help determine patterns reflective of features that are driven by climate, geological, and soil differences. The Antler Lake watershed is located within the Dry Mixedwood Subregion of the Boreal Forest Natural Region (**Figure 14**). The climate of this region is characterized by a mean, annual temperature of 1.1 °C and 461 mm of mean, annual precipitation (NRC, 2006). Approximately 70% of annual precipitation in this subregion occurs between April and August. Peak precipitation occurs in June and July, generated by convective storms (NRC, 2006).

More specifically, Antler Lake falls within the Beaver Hills Moraine, which experiences a cool, continental climate, like the surrounding region. The Beaver Hills Moraine is characterized by peak precipitation in the summer and a long winter, with 5 months of permanent snow cover. The mean annual precipitation is slightly higher than the larger, natural sub-region, at 474 mm, and 76% of it falling between April and October, when land surfaces are free of snow (Caiazza, et al., 1978). Mean annual temperature and precipitation around Antler Lake are slightly higher than the sub-region, but in alignment with climate characteristics of the Beaver Hills Moraine, with long-term averages of 2.9 °C and 473 mm (1961 to 2017), respectively. Approximately 79% of precipitation in the Antler Lake watershed falls from April to October, with the highest amount of precipitation in July (**Figure 15**; AAF, 2016).

Over a longer timescale, climate cycling within the region follows a pattern of wet and dry periods that persist for at least a decade in length. This climate pattern was documented in the North Saskatchewan River region, using data reconstructed from tree rings dated to the 1100s (Sauchyn, et al., 2011). The same pattern is evident in historical precipitation and temperature records for the watersheds; conditions were wetter and cooler in the late 60s, 70s, and early 80s, followed by a transition into drier and warmer conditions by the late 90s and into the 21st century (**Figure 16**). Collectively, the evidence suggests that conditions in the watershed are generally warmer and drier than normal and have been since the mid-1990s.

With a shift in 2014 to a positive (warm) phase PDO, warm and dry winter conditions in the region may persist for several years, and these conditions may be amplified during El Niño winters (Bonsal and Shabbar, 2011). Over several decades, it is anticipated that global climate change could induce prolonged dry and warm periods, and the Dry Mixedwood Subregion in Alberta may experience a shift from forested land cover to grasslands (Schneider, 2013), which would have implications for regional lakes.

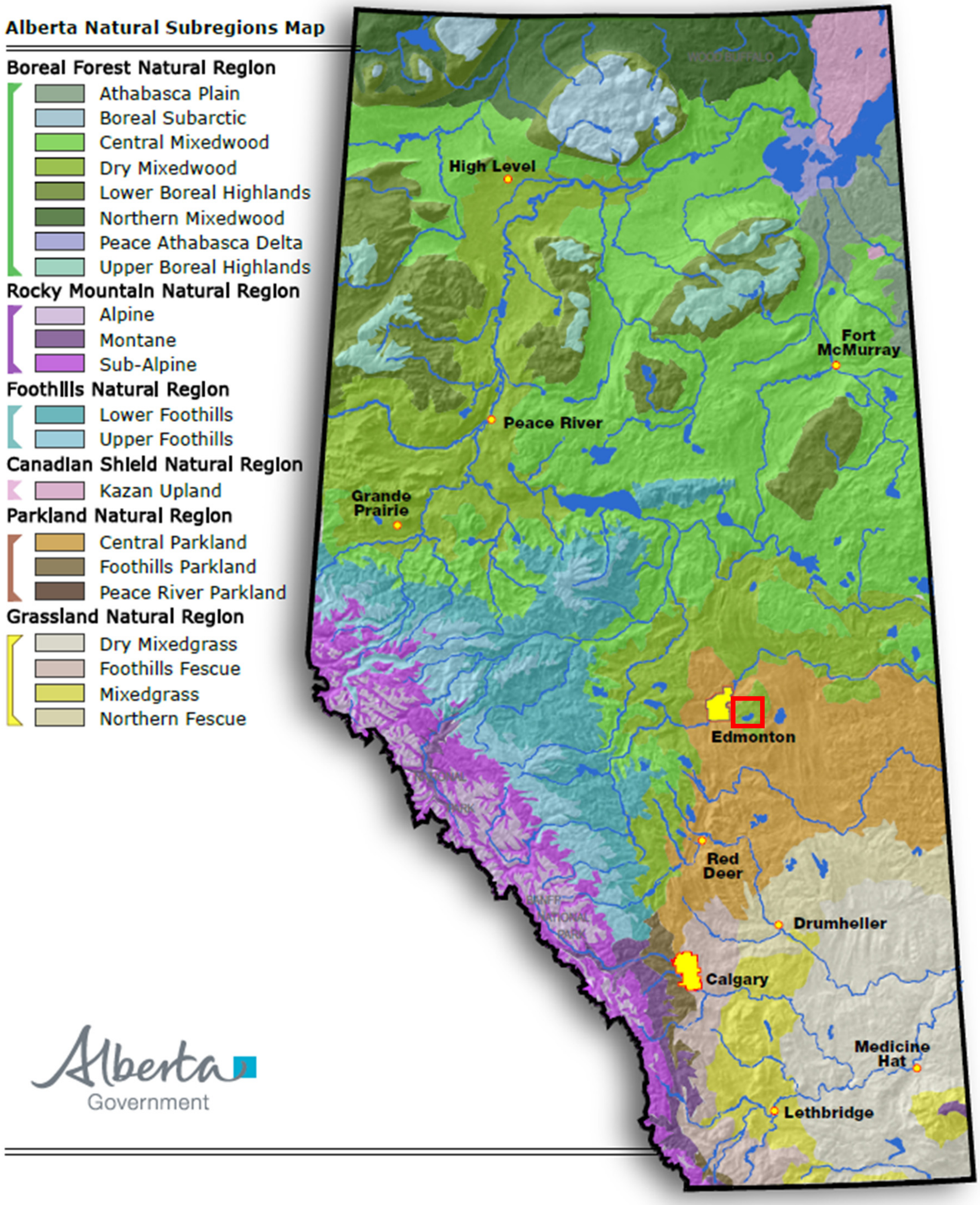


Figure 14. Natural Subregions of Alberta. The red box indicates the approximate location of the Antler Lake watershed, in the Dry Mixedwood Subregion (AEP, 2015).

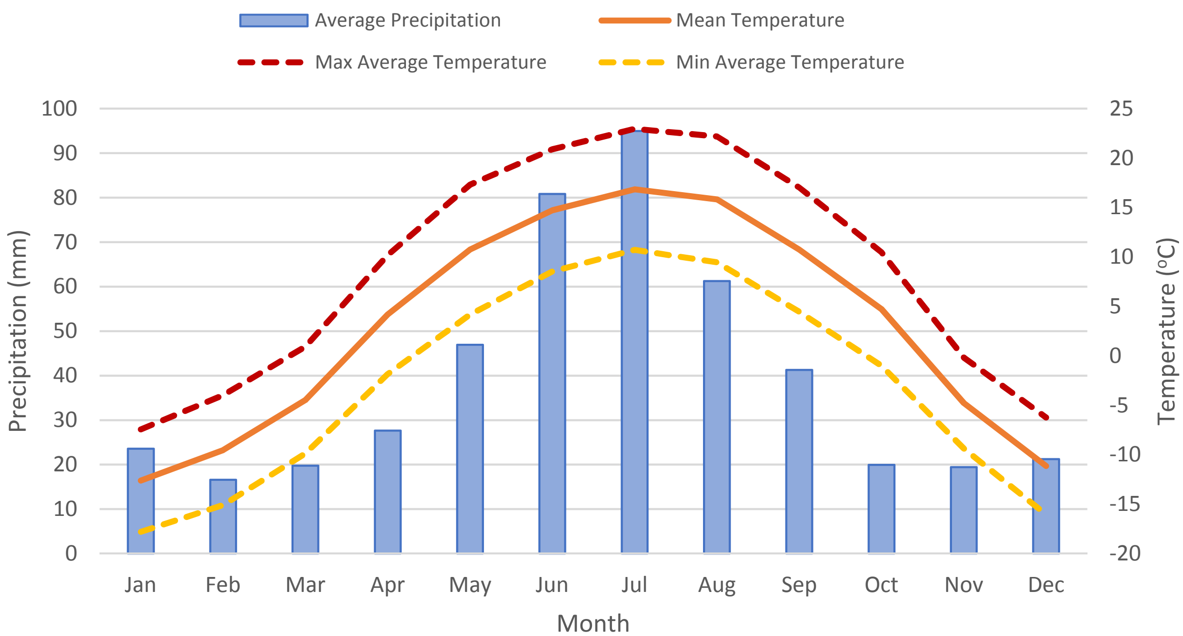


Figure 15. Average Monthly Precipitation and Temperature for the Region (T052R21W4) Surrounding Antler Lake (1961 - 2018) (AAF, 2016).

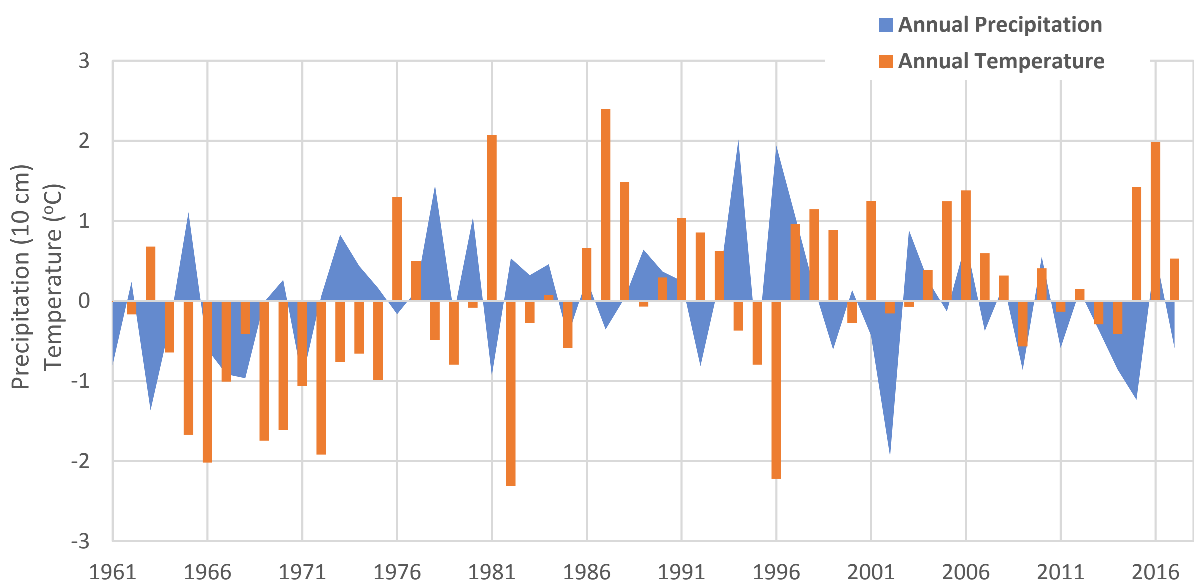


Figure 16. Relative Annual Average Accumulated Precipitation and Temperature for the Region Surrounding the Antler Lake Watershed (1961 - 2017)(AAF, 2016).

Key Messages:

- Antler Lake watershed lies within an ecoregion island of Dry Mixedwood Boreal Forest.
- Since the 1990's, temperatures have been above average and precipitation below average.
- Climate predictions anticipate longer dry and warm periods, which could alter the local vegetation and have implications for lake levels, particularly shallow lakes in the region.

3.3 Geological History

Regional geology is an important factor in determining viable land use activities within a watershed and factors that may contribute to a lake's hydrology, function, and health. The watershed's underlying bedrock and surficial deposits determine the types of soils found atop them. The characteristics of soils will determine the type of vegetation and other land use features available within the watershed.

3.3.1 Regional Geology

Antler Lake lies within the Beaver Hills Moraine, a 1,500 km^2, distinct, geomorphological feature, strongly influenced by historical patterns of glaciation and deposition. The Beaver Hills Moraine is a "dead-ice" or stagnant moraine, formed during the retreat of the glaciers about 9,000 years ago (Geowest, 1997). This landscape is comprised of hummocky, "knob and kettle" terrain, with aspen-dominated forests in upland areas, and wetlands and small lakes in lowland areas (**Figure 17**; NRC, 2006; AMEC, 2015). Antler Lake is characterized as one of these wetland depressions occurring throughout the area.

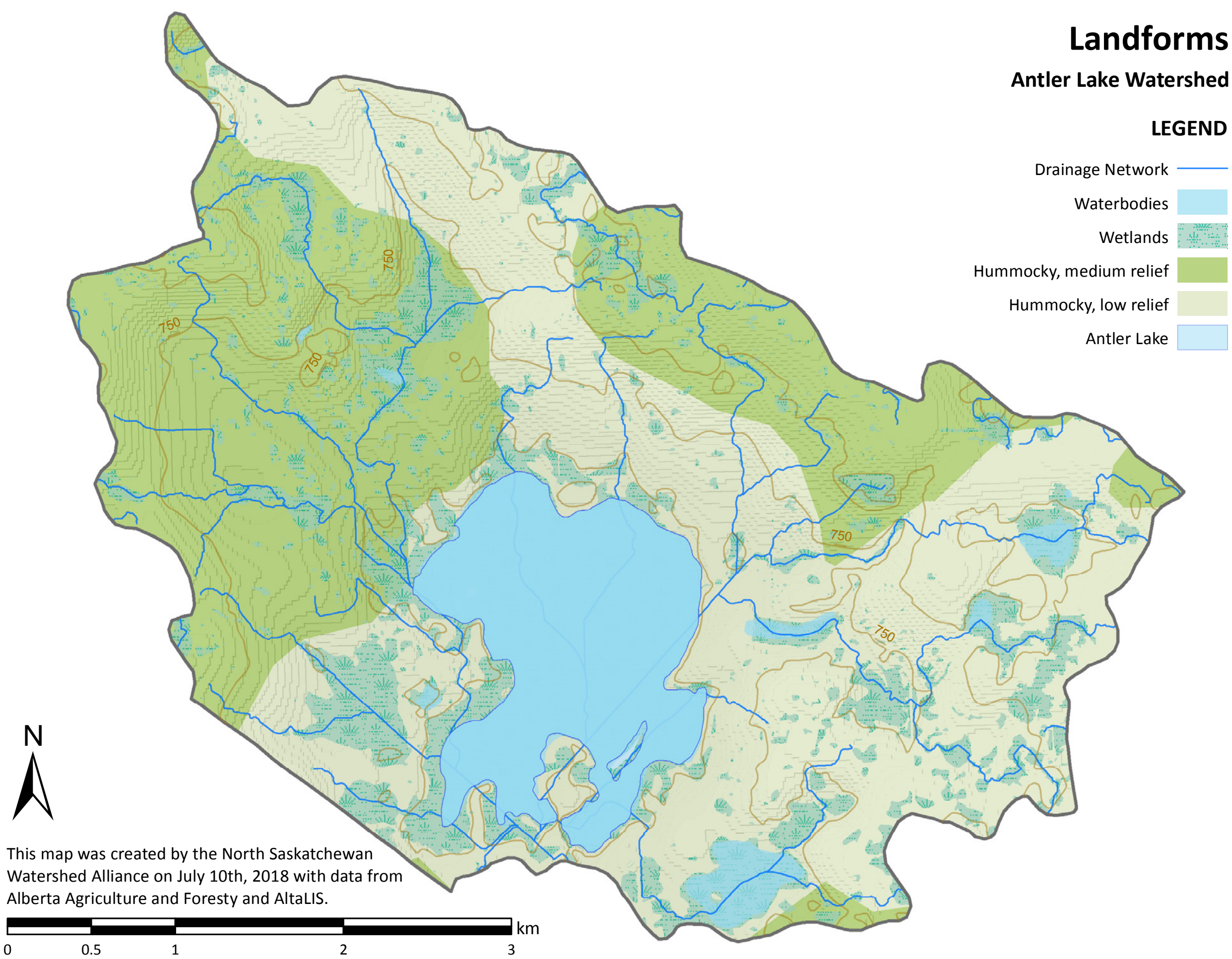


Figure 17. Landforms of the Antler Lake Watershed (data obtained from AAF, 2016; AltaLis, 2016).

Bedrock is the hard rock underlying the loose surficial material (clay, sand, silt) and soils. In the Antler Lake watershed, the bedrock is of the Horseshoe Canyon formation of the late Cretaceous period (**Figure 18**; NRC, 2006; Mossop and Shetsen, 1994). The Horseshoe Canyon formation has a maximum thickness of 350 meters and has three separate units: Upper, Middle, and Lower. The Lower Horseshoe Canyon, which can be up to 170 m thick, is less than 130 m thick within Strathcona County. The composition of the bedrock here consists of deltaic and fluvial sandstone, siltstone, and shale, with interbedded coal seams, bentonite, and thin, nodular beds of limestone and ironstone (HCL, 2001). Some of this bedrock contains water-saturated rocks that are permeable enough to transmit groundwater (HCL, 2001).

Overlying the bedrock are the loose surficial materials deposited by retreating glaciers. The type of landform in this area, created by the retreating glacier, is called a moraine. Moraines are created when dirt and rocks trapped on the glacier surface accumulate or get pushed by the glacier (NSIDC, 2019). The predominate surficial materials in the region are moderately fine-textured to moderately calcareous, glacial till consisting of an unsorted mixture of clay, silt, sand, and gravel, with local, water-sorted material, and bedrock (NRC, 2006; Prior, et al., 2013). Surficial deposits lie throughout the region and are generally greater than 25 m thick on uplands and may reach 100 m thickness in buried valleys (Prior, et al., 2013). Additionally, a substantial component of surface material (10%) contains glaciofluvial sands and organic deposits with minor inclusions of glaciolacustrine materials (NRC, 2006).

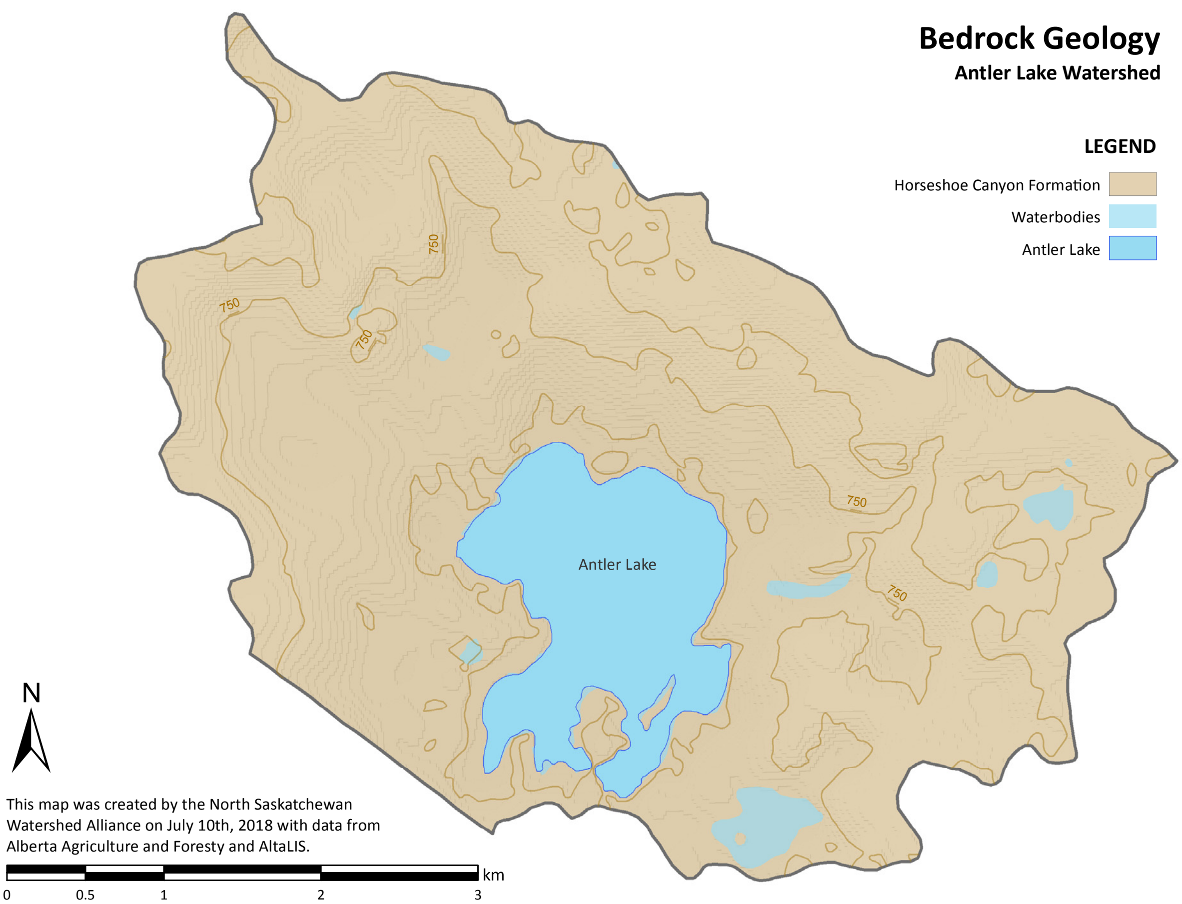


Figure 18. Bedrock Geology of the Antler Lake Watershed (data obtained from Prior, et al., 2013).

3.3.2 Soil Characteristics

Soil development is influenced by underlying parent material (in this case, glacial till), drainage, and overlying vegetation. Soils help regulate watershed health through nutrient cycling, water absorption, groundwater recharge and contaminant transport. The types of soils present in a watershed will dictate the plant cover and wildlife present in the area, as well as agricultural potential. In this region of Strathcona County, the agricultural potential is not as much dependant on soil type as it is on the underlying land formation and climate. The agricultural potential here is much lower than surrounding regions, due to the hummocky terrain and wet depressions, which make it difficult to manage annual crops (Toma, Bouma, and Stantec, 2015). The lack of agricultural suitability is one reason why the Beaver Hills have retained extensive natural woodland habitat, while the adjacent lands have largely been cleared (BHI, 2018). Dominant soils in the region are medium-to-fine textured gray and dark gray luvisols (**Figure 19**; NRC, 2006). Luvisolic soils develop under forested areas and range from moderate to well-drained. Cultivation in the region occurs primarily on dark gray luvisols, whereas orthic gray luvisols have severe agricultural limits because of their high clay content and anoxic properties (Mitchell and Prepas, 1990).

Depending on the soil type and the degree of soil disturbance, watersheds may be more or less susceptible to soil erosion (by wind or water) and pollutant runoff, and have a varying capacity to store water and provide adequate site productivity (Schoonover and Crim, 2015). The soils around Antler Lake are graded at a “high risk” for water erosion, however, are rated as “low risk” for wind erosion risk (AAF, 2005a; 2005b). This rating is likely due to the hummocky shape of the land and how water moves and collects within the watershed, while at the same time blocking the wind from the low, depression areas in combination with climatic factors. The high-risk rating for water erosion is of concern, because it can lead to a reduction in soil quality by removing soil particles and nutrients. Additionally, erosion can reduce water quality if particles are carried into nearby water bodies (AAF, 2005a).

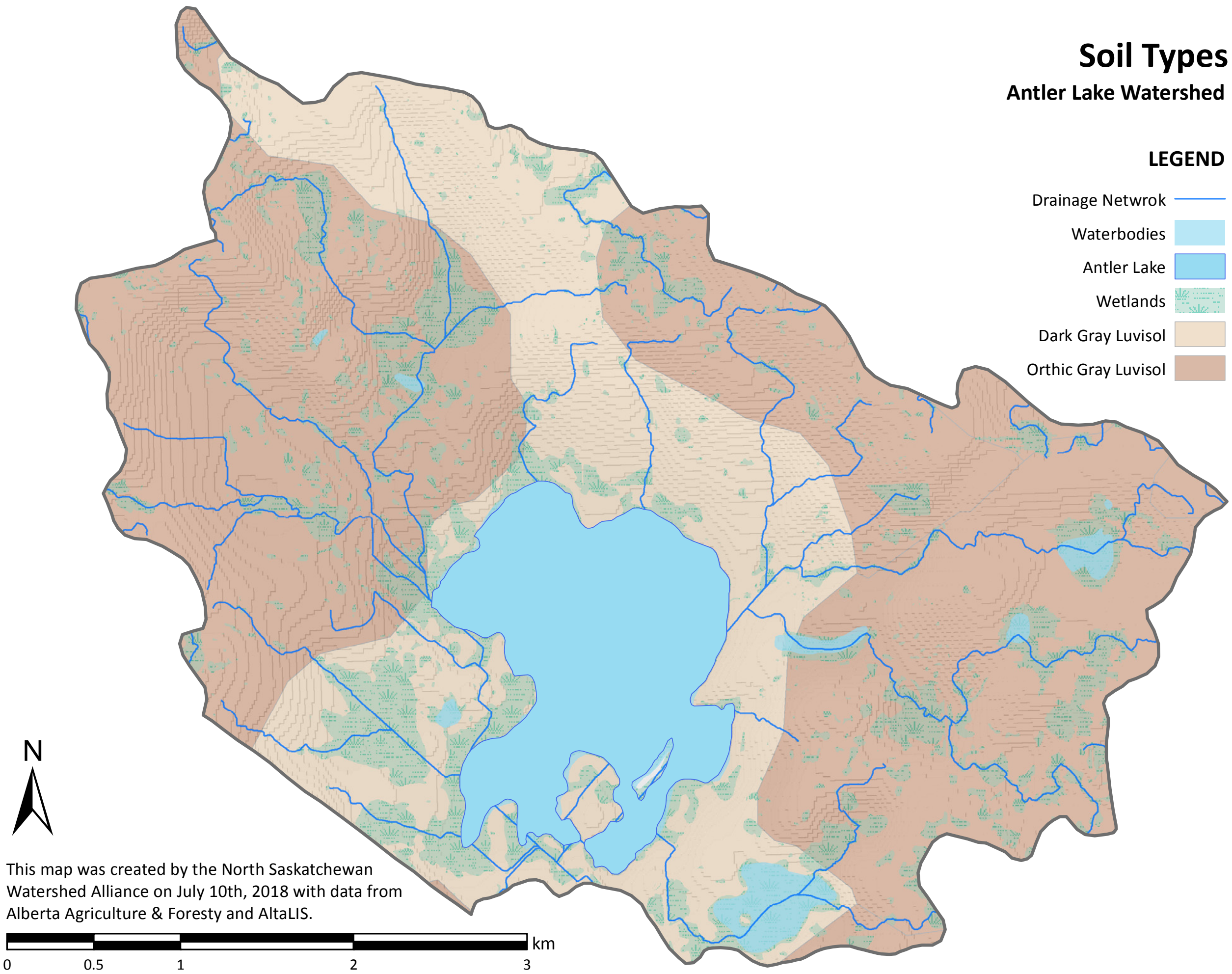


Figure 19. Soil Types in the Antler Lake Watershed (AAF, 2016).

3.4 Groundwater

3.4.1 Groundwater Recharge

Groundwater and surface water are intricately linked, through movement of groundwater to the surface (discharge area) and through movement of surface water into the ground (recharge area) (Spencer Environmental, 2007). Through this interaction, groundwater quantity and quality have the potential to affect surface water quantity and quality and vice versa (Council of Canadian Academics, 2009). The Beaver Hills Moraine plays a critical regional role in groundwater recharge and is an important source of both surface and ground water. Groundwater recharge areas are located throughout the Moraine, in areas where the groundwater table is near the ground surface, and there is a hydraulic gradient supporting downward groundwater flow (HCL, 2001). These sites are usually waterbodies where surface water percolates through underlying sediment layers to resupply shallow and deep aquifers (Spencer, 2007). This slow and continual recharge process is therefore a critical element of the water cycle.

Groundwater recharge/discharge for Strathcona County was calculated by comparing water levels in the region to land surface elevation. The results show that for most of the County, there is a downward hydraulic gradient from the surficial deposits to the bedrock. The Antler Lake watershed is comprised of a mix of both recharge and transition areas (**Figure 20**; HCL, 2001).

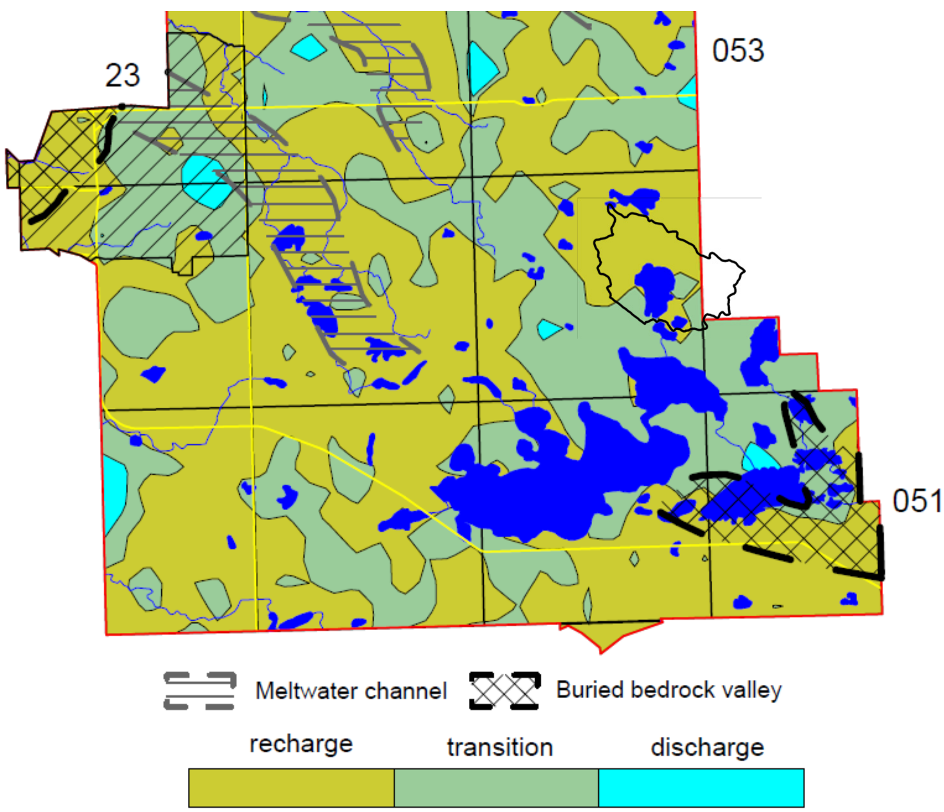


Figure 20. Recharge/Discharge Areas between Surficial Deposits and Upper Bedrock Aquifer(s) within the Southern Region of Strathcona County. The approximate location of Antler Lake watershed is delineated in black (Figure modified from HCL, 2001).

Regional observation wells are used to provide updated information on groundwater levels. In the 2001 *Regional Groundwater Study for Strathcona County*, areas of groundwater decline in aquifers were determined by comparing changes in water-level before major development began in 1970 and after 1984 (HCL, 2001). Within Strathcona County, 51% of the areas where there had been a water-level decline of more than five metres in upper bedrock aquifer(s) corresponded to where the estimated water well use was between 10 and 50 m^3/day (HCL, 2001). The northern area of the Antler Lake watershed is an area of high groundwater decline, whereas the southern region of the lake is rated to have low groundwater decline. The rest of the watershed is in an area of low groundwater rise (**Figure 21**; HCL, 2001).

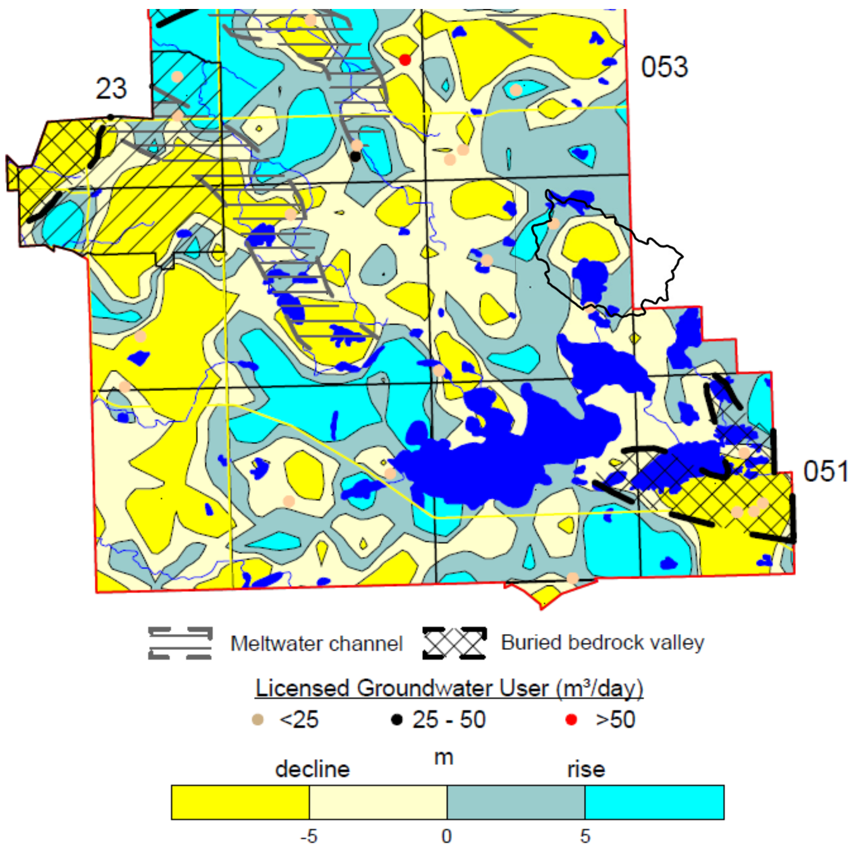
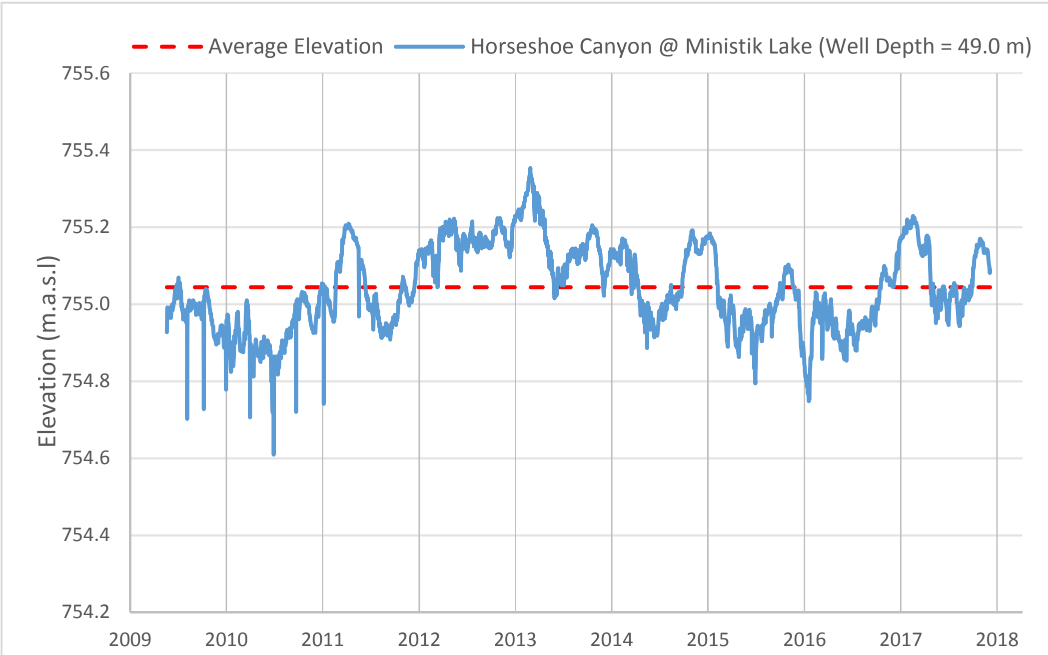


Figure 21. Changes in Water Levels in Upper Bedrock Aquifer(s) within the Southern Region of Strathcona County. The approximate location of Antler Lake watershed is delineated in black (Figure modified from HCL, 2001).

The nearest observation wells to the Antler Lake watershed are located at Ministik Lake station (approximately 14 km south of Antler Lake) and Cooking Lake (approximately 15 km southeast of Antler Lake). Both wells are in the Horseshoe Canyon formation. Water level recordings at Ministik Lake station began in 2009. Water levels at this station have undergone periodic fluctuations, with the highest peak recorded in 2013. Cooking Lake station has historic water-level records beginning in 1974, showing substantial periodic fluctuation, with highest levels recorded in the early 1970s and a large period of rise between 1988-1990, followed by a long period of decline from late 1990s until 2018 (**Figure 22**; HCL, 2001). Changes in groundwater levels in this region could be related to regional climate cycling and/or to changes in land cover/use in the region. Further investigation is warranted to identify groundwater level trends in the region and to characterize the relationship between groundwater and surface water quantity and quality for Antler Lake.



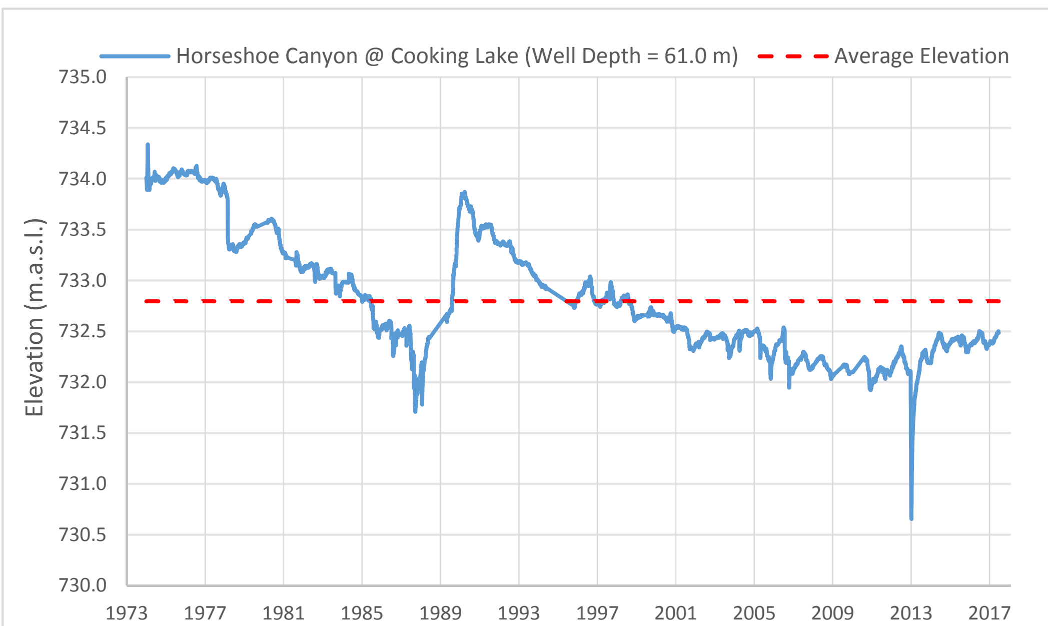


Figure 22. Groundwater Levels from 1973 - 2016 at Ministik Lake (Top: Station # 05EBG018) and Cooking Lake (Bottom: Station # 05EBG013) from 2009 – 2018 (AEP, 2016).

3.4.2 Water Wells

Data retrieved from Alberta Water Well Information Database, found 312 water well, drilling reports, which included 145 domestic water wells in the Antler Lake watershed (**Figure 23**; AEP, 2018c). Well density, the concentration of wells within a defined space, is moderate-to-high, relative to the surrounding region. The highest density of domestic wells is within the Hamlet of Antler Lake, accounting for 42 of the recorded water wells, 8 of which are licensed (AEP, 2018c). The highest allocation of 24 m^3 /day is for a well labelled as an "Antler Lake Water Conservation water supply well" in 01-14-052-21 W4M (HCL, 2001).

All wells within the Antler Lake watershed are located within bedrock (HCL, 2001). Most bedrock wells in the region are in the Lower Horseshoe Canyon aquifer, which is comprised of the porous and permeable parts of the Lower Horseshoe Canyon formation that underlies the southern half of Strathcona County (HCL, 2001). In the county, the main aquifers are found in fractured coal seams within the bedrock. If the coal layers are not fractured, the aquifers are found within clayey and/or bentonitic sandstones. Groundwater from the bedrock aquifers are frequently, chemically soft, with generally low concentrations of dissolved iron and high concentrations of sodium. Water quality in the Lower Horseshoe Canyon aquifer is generally good but can be high in total dissolved solids and sulphate as a result of the water's interaction and time spent with the bedrock materials (HCL, 2001).

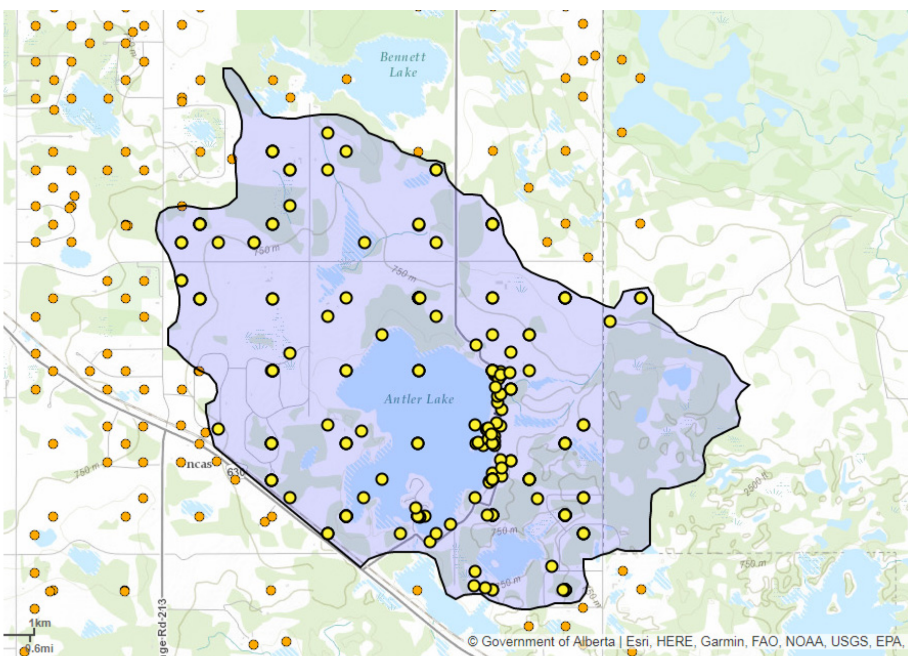


Figure 23. Map of Water-well Drilling Reports Documented within the Antler Lake Watershed. Data retrieved from Alberta Water Well Information Database, Alberta Environment and Parks. (AEP, 2018c)

Water well density and abandonment can correlate directly to potential groundwater contamination risk and can reflect pressure (through usage) on groundwater resources within a region (Government of Alberta, 2018). The density of water wells, however, will also be controlled by groundwater potential in the surrounding region and suitability. As such, areas of suitable groundwater resources with comparatively higher water well density may reflect increased development demands, compared to areas with similar groundwater potential and lower well density (BHI, 2015).

3.4.3 Groundwater Contamination Risk

Groundwater contamination risk in the Beaver Hills Moraine and across Strathcona County was completed using a GIS model designed to identify areas of high sensitivity, where potential for linkage between surface and groundwater was highest and most permeable (Spencer Environmental, 2006). This model considered that groundwater sensitivity is higher where the surface lands and underlying groundwater are relatively well-connected (recharge and discharge areas). Potential, point-source, release features that lie near a discharge or recharge zone, porous soils (sand and organic matter), or waterbodies, increase the potential for groundwater contamination (Spencer Environmental, 2006). Across the Antler Lake watershed, 95% of the area was a high-to-medium sensitivity risk for groundwater contamination. A significant area around Antler Lake was rated as a high risk, covering most of the Hamlet of Antler Lake. This area has overlapping sensitivity factors including surface water, coarse soils, and groundwater recharge and discharge zones (**Figure 24**). In addition, this area has a high density of wetlands along with concentrated shoreline, residential development which greatly increases the potential for groundwater contamination.

The intent of this analysis was to provide information that could be used to identify appropriate locations for operations and land uses with potential for point-source release of contaminants. The concern with such activities, with respect to groundwater, is the potential for contaminants to enter groundwater reserves, percolating through surface water or permeable soils. In addition, because the model is directly tied to recharge and discharge locations, the model can be used to identify lands where those functions

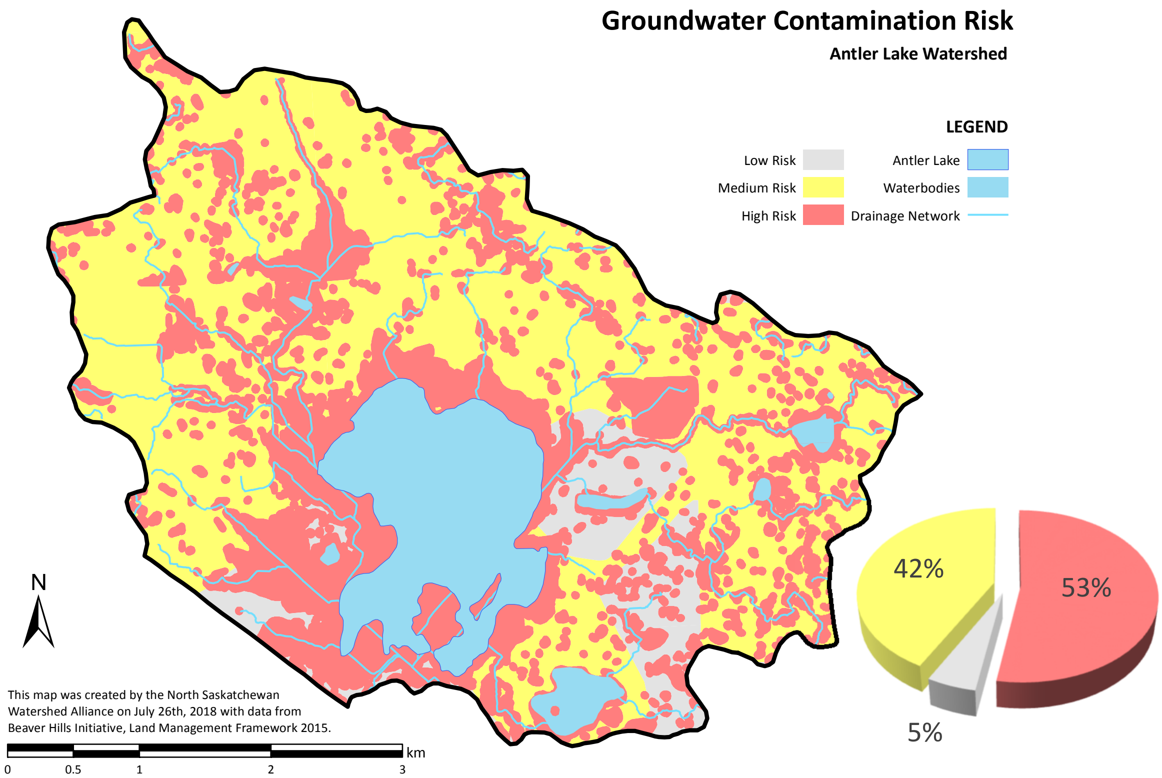


Figure 24. Groundwater Contamination Risk in the Antler Lake Watershed (BHI, 2015).

could be impaired by certain other land management activities (e.g., wetland infilling, placement of impervious surfaces) (Spencer Environmental, 2006).

Key Messages:

- Soils on the landscape are at high risk for water erosion.
- The watershed is a regional groundwater recharge area.
- Further investigation is needed to understand the groundwater/surface water relationship.
- Moderately high water well density in the watershed, all lying within the bedrock.
- 95% of the watershed is of medium-to-high sensitivity for groundwater contamination risk.

3.5 Land Cover

Much of our natural landscape in Alberta has been affected by our human footprint. The ideal solution for land use planners, such as municipalities, is to create a balance between human land use and natural, ecosystem functions. To do this, we must first understand the current state of the natural landscape, how people have influenced its composition and function, and then we can address areas in need of improvement or protection.

Land cover is a term used to describe how much of a region is covered by forests, wetlands, impervious surfaces (roads and parking lots), agriculture, and other land and water types. Water types include wetlands or open water. Land use is a term to describe how people use the landscape – whether for development, conservation, or mixed uses (NOAA, 2018).

Below, we will discuss some of the natural landscape features, which largely focus on vegetation in both types and amounts of vegetation (i.e. forest, wetland, etc.). This section will focus on the natural environment first, followed by land cover types that represent our human footprint, i.e. land use, which will discuss agriculture, development, and zoning. Antler Lake lies in an area distinctly different from the surrounding lands in terms of their soils, terrain, extent, and type of natural vegetation present. Mixedwood forests interspersed with wetland depressions on the Moraine add considerable topographic and ecological variety to a part of the province dominated mostly by Parkland vegetation. The high levels of biodiversity (plants, invertebrates, vertebrates) known to inhabit the Beaver Hills Moraine reflect this considerable variation in landform. Approximately 61% of the Antler Lake watershed area consists of forested land, scrubland, grassland, open water, and wetlands (**Table 1**; **Figure 25**; BHI, 2015).

3.5.1 Forested Land

Land cover in the Dry Mixedwood subregion consists of aspen-filled (*Populus tremuloides*), boreal forests with scattered stands of white spruce (*Picea glauca*), fen wetlands, and an underbrush of beaked hazelnut (*Corylus cornuta*), prickly wild rose (*Rosa acicularis*), wild sarsaparilla (*Aralia nudicaulis*), wild sweet pea (*Lathyrus ochroleucus*), purple peavine (*Lathyrus nevadensis*) and bluejoint grass (*Calamagrostis canadensis*). Land cover within the watershed is typical of the subregion. Forested areas consist predominantly of trembling aspen on well-drained sites and scattered stands of paper birch (*Betula papyrifera*), white spruce, and balsam poplar (*Populus balsamifera*) on poorly drained sites (Mitchell and Prepas, 1990). However, it is important to note that forests of the area are predominantly young, in a sessional sense, from disturbance by grazing and residential development. Very few spruce or mature mixedwood stands can be found due to extensive forest fires in the area in the early 1900s (Westworth and Knapik, 1987).

Within the Beaver Hills Moraine, terrain and soil conditions have limited the extent of past, largescale, agricultural clearing which has resulted in much of the area remaining extensively forested with aspen, and in some areas, spruce woodlands (BHI, 2004). These factors have played an essential part in preventing extensive clearing and helping to retain this area's natural features.

3.5.2 Wetlands

Wetlands are important features on the landscape, providing water and carbon storage, groundwater recharge, wildlife and waterfowl habitat, and removal of excess nutrients and contaminants from surface water (Mitsch and Gosselink, 2007). Wetlands account for 52,073 hectares or 33% of the total area of the Beaver Hills (BHI, 2004). Of the classified wetlands, 'shallow open water' and 'ephemeral waterbody' wetland classifications make up the greatest proportion of wetland types within the Antler Lake watershed (66% of total wetland area) (**Figure 26**).

Agricultural and urban activities in Alberta have adversely impacted wetlands and wetland complexes; in the regions surrounding Edmonton, approximately 75% of wetlands have been drained or destroyed by building roads nearby (Wray and Bayley, 2006). In response to the severe wetland loss throughout the region, Strathcona County has developed a *Wetland Conservation Policy* which has the goal of "No Net Loss" of wetlands within the urban and rural areas of the County. The policy aims to balance the loss of wetland functions, through rehabilitation of former degraded wetlands or enhancement of healthy, functioning wetlands (Strathcona County, 2009b).

3.5.3 Agricultural Land

Land suitable for cultivation and grazing is also dispersed throughout the subregion. Approximately 23% of the Antler Lake watershed area consists of agricultural (cropland and pasture) land cover (**Figure 25**; BHI, 2015). 'Developed' and 'Exposed' land cover (see classification in **Table 1**) is quite high within the watershed, accounting for 16% of the total watershed area*,* relative to other small watersheds within the Beaver Hills Moraine (BHI, 2015).

Changes in land cover within the watersheds have occurred over time, reflecting agricultural and other human development in the region. Based on historical records, cultivation of the area began in the late 1800s as Europeans settled in the region (Peterson, 2015). Anecdotal evidence and historical records indicate that land cultivation involved deforestation, but the extent of deforestation cannot be evaluated due to a lack of land cover data predating the 1950s. A coarse evaluation of land cover/use was conducted in the 1990s and 2000s. Historical land cover can be compared to present day data to evaluate land cover change over the last 20 years. This data should be ***interpreted with caution*** due to differences in resolution and classification of the land cover data.

Agricultural land cover has decreased by approximately 11% from 1990 to 2015 (7.17km^2 to 4.88 km^2). 'Developed' and 'Exposed' land has doubled from 1.16 km^2 to 3.34 km^2, with increased urban development on the east shore of Antler Lake. Natural cover has remained relatively the same over time, when considering the combined total of scrub vegetation, forested land, open water, and wetlands in 1990 compared to 2015. The main difference in land cover from 1990 to 2015 is the conversion of 'Agricultural' land classification into 'Exposed' land classification.

Table 1: Comparison of Land Cover Classification by Total Area for the Antler Lake Watershed in 1990, 2000, and 2015 (AAFC, 2016; BHI, 2015).

General Land Cover Classification	1990 AAFC			2000 AAFC			2015 BHI		
	Land Cover Class	Area (km²)	%	Land Cover Class	Area (km²)	%	Land Cover Class	Area (km²)	%
Agriculture	Total Agriculture	7.17	**34%**	Total Agriculture	7.37	**35%**	Total Agriculture	4.88	**23%**
		-					Annual Crops	0.29	
		-					Pasture	4.59	
Scrub	Total Scrub	N/A		Total Scrub	0	**0%**	Total Scrub	1.50	**7%**
							Grassland	0.96	
							Shrub	0.54	
Forested	Total Forest Cover	8.58	**41%**	Total Forest Cover	8.48	**40%**	Total Forest Cover	8.18	**39%**
		-					Deciduous Trees	7.39	
		-					Coniferous Trees	0.22	
							Trees	0.56	
Developed	Developed - Urban/Built-Up	1.16	**5%**	Developed - Urban/Built-Up	1.07	**5%**	Developed	1.21	**6%**
Exposed	Bare Earth/Fallow	0		Bare Earth/Fallow	0.01	**0%**	Bare Earth/Fallow	2.13	**10%**
Wetland	Wetland	0.92	**4%**	Wetland	0.89	**4%**	Total Wetland	1.10	**5%**
							Ephemeral Water Body - Dry	0.63	
							Ephemeral Water Body - Wet	0.47	
Water	Open Water	3.35	**16%**	Open Water	3.35	**16%**	Shallow Open Water	2.18	**10%**

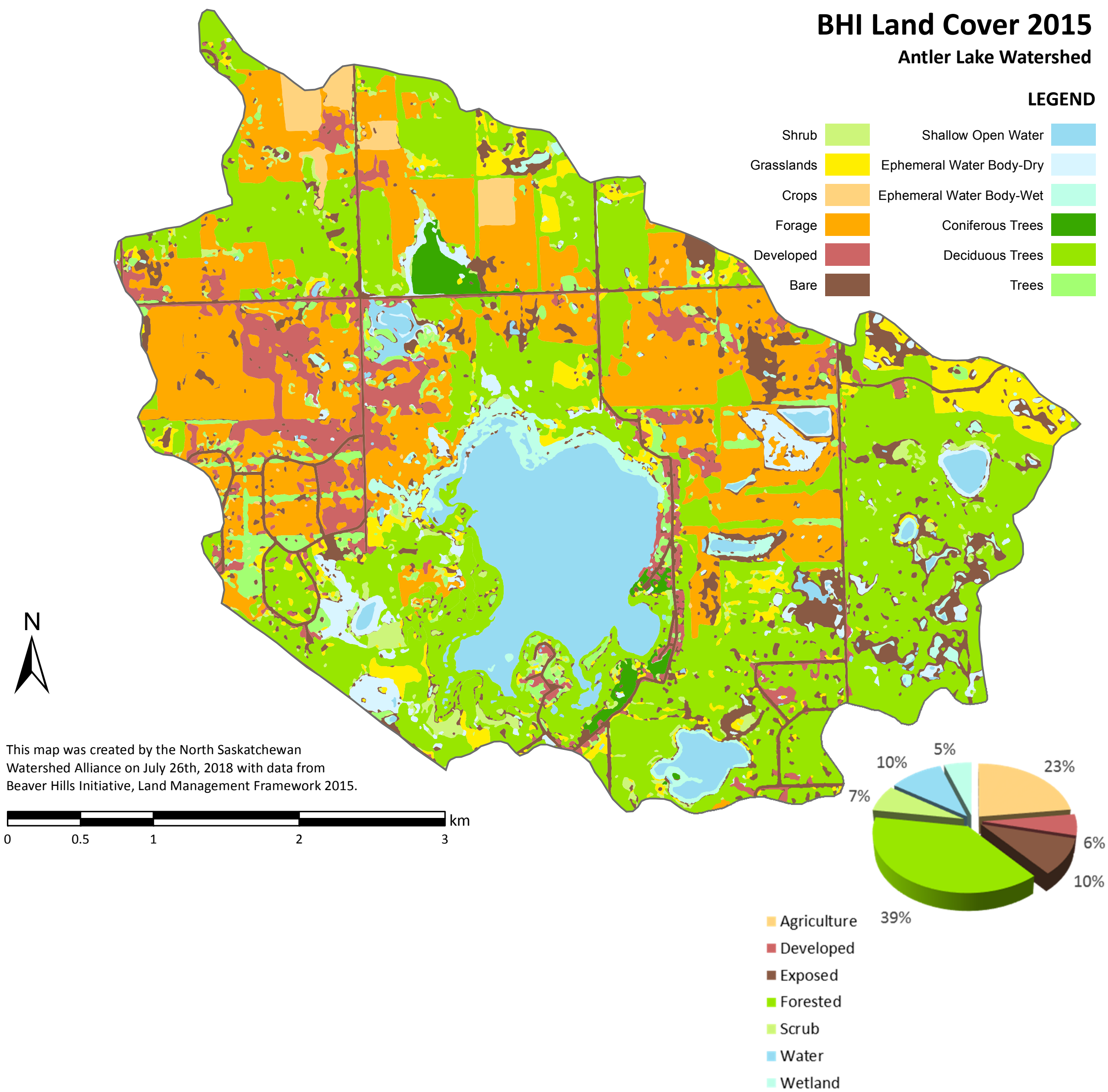


Figure 25. Land Cover of the Antler Lake Watershed in 2015 (map) with Percent of Land Cover Per Area (pie-chart; BHI, 2015).

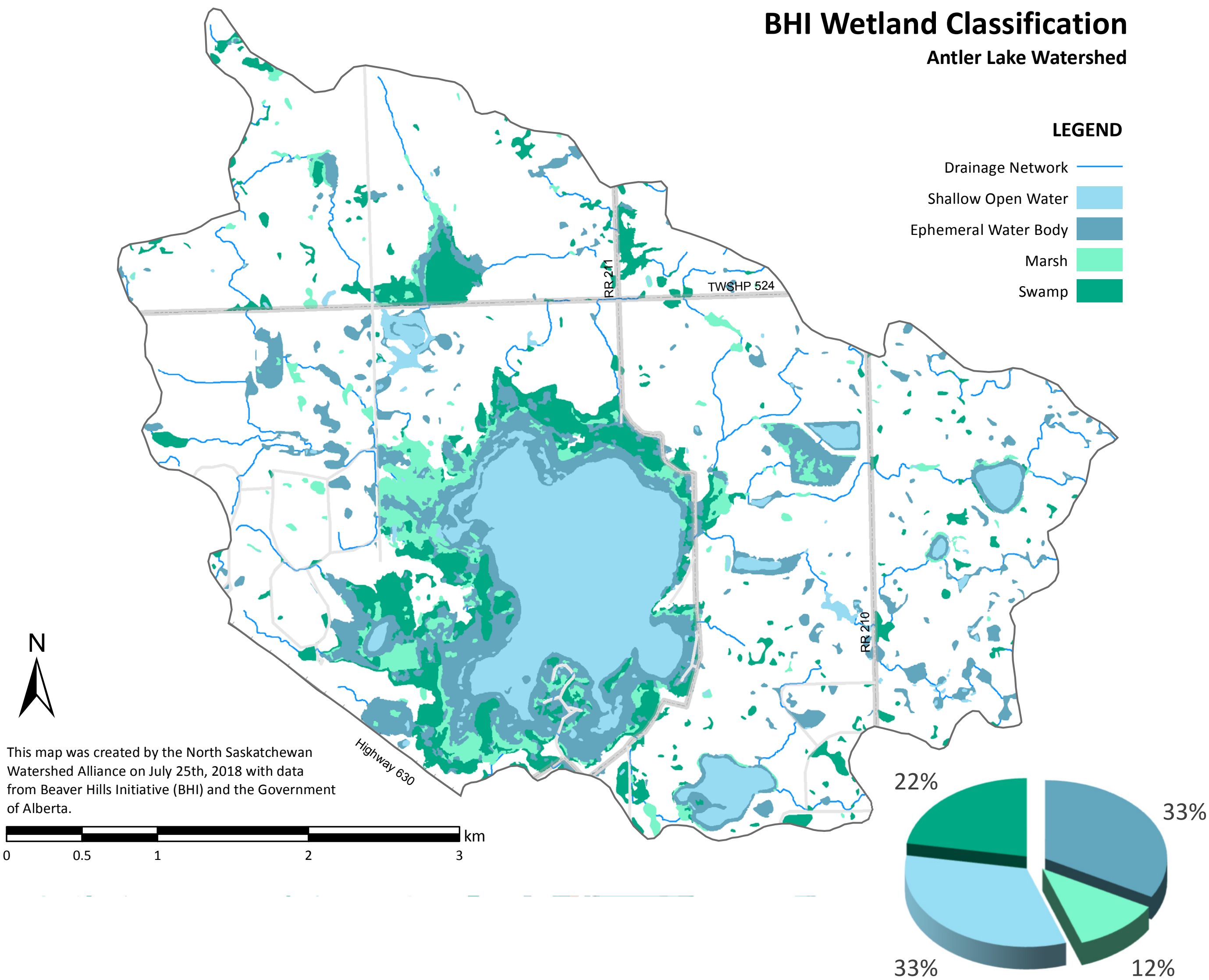


Figure 26. Wetland Classification and Distribution within the Antler Lake Watershed (data obtained from BHI, 2015).

Key Messages:

- 61% of the Antler Lake watershed is composed of natural vegetation and wetlands.
  - Forested/Scrub: 46%
  - Wetland: 5%
  - Lake: 10%
- 29% of the watershed has been developed or used for agriculture.
  - Agriculture: 23%
  - Developed: 6%

3.5.4 Landscape Connectivity

Biodiversity is essential to our quality of life; it is the foundation of ecological processes that provide free, beneficial services, on which, we rely. We call these services, "Ecosystem Services" or "Ecological Goods and Services", as clean air and water, climate moderation, medicines, even our food sources rely on the biological actions that are carried out by a wide array of microbial, plant, and animal species (**Figure 27**).

Large areas of useful habitat maximize biodiversity; however, these areas often lie within a matrix of lands less beneficial to these organisms. As a result, connected habitat corridors are essential for plants and animals to move between suitable habitat areas (BHI, 2015). Connectivity is a measure of the extent to which plants and animals can move between patches of habitat (Hilty, et al., 2006).

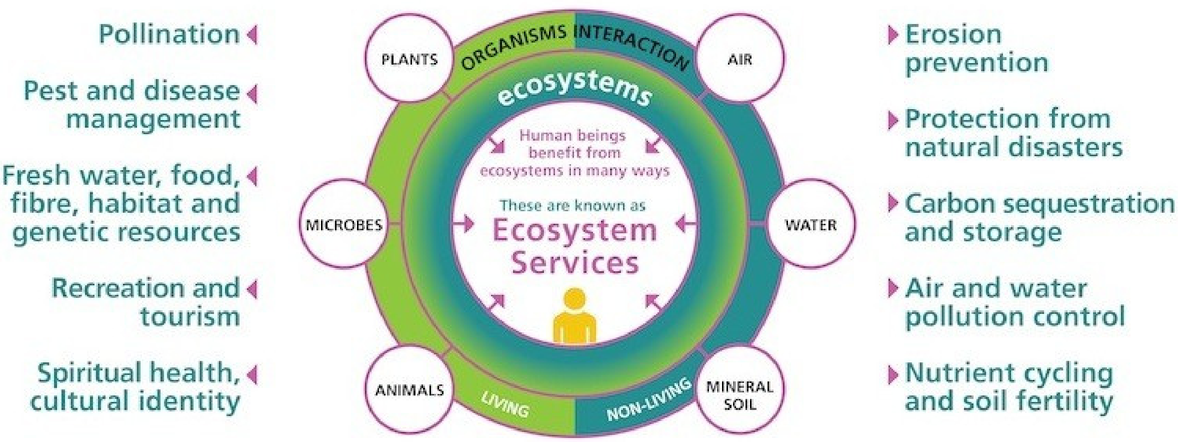


Figure 27. Ecosystem Services (Bioversity International, 2019).

In the 2014 *BHI Land Management Framework* update project, a landscape connectivity modelling analysis was completed that incorporated both structural and functional connections within the Beaver Hills Moraine. The model described the distribution of habitat and level of structural connectivity across the watershed, identifying critical linkages within this area that help to sustain biodiversity (BHI, 2015). The model was designed to consider the effect of habitat patches and corridors and the isolation imposed by barriers or by impassible land uses in the matrix. Overall, the model shows that the Antler Lake watershed provides important habitat and corridors to sustain a high level of biodiversity within the Beaver Hills Moraine (**Figure 28**).

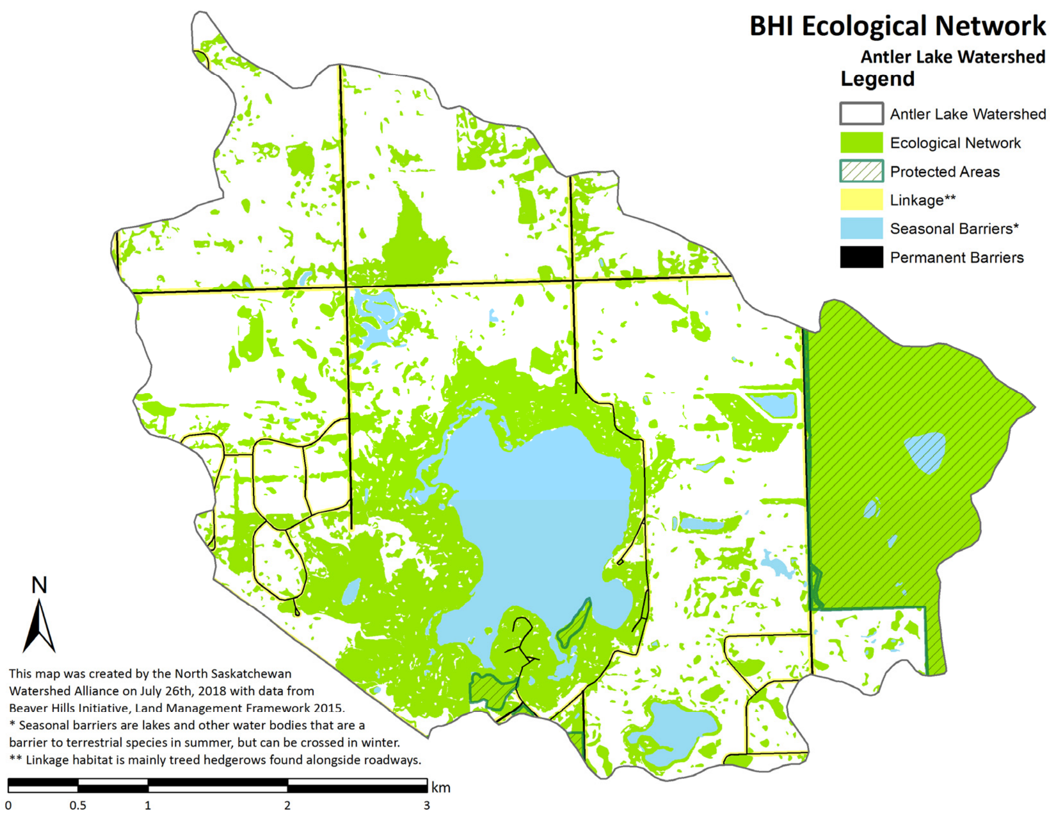


Figure 28. Beaver Hills Initiative (BHI) 2015 Ecological Network of the Antler Lake Watershed. Data obtained from the BHI Land Management Framework (BHI, 2015).

3.6 Land Use

Like many areas of Alberta, the Beaver Hills is experiencing increasing land use pressure from recreation, urban and country residential development, industry, and agriculture, placing increasing demands on the area's ecosystems. This pressure has the potential to result in significant, ecological deterioration and biodiversity loss. This, in turn, could affect the social and economic well-being of local communities and the quality of life of residents and visitors to the Moraine (BHI, 2015). Much of the development in the Antler Lake watershed took place decades ago, and recent changes to policies for the Beaver Hills Biosphere have put a limited new developments within the area (Strathcona County, 2018a). Therefore, a look at land use across the watershed is most informative towards understanding current use and provides a perspective on the effects it may have on landscape connectivity.

Agriculture, transport, and housing are the main land uses that occur within the Antler Lake watershed. The Alberta Biodiversity Monitoring Institute (ABMI) tracks land use in Alberta through the Human Footprint Inventory, which characterizes anthropogenic disturbance on the land (ABMI, 2016). According to the Human Footprint Inventory in 2014, anthropogenic disturbances (all activities) have occurred across approximately 47% of the watershed (ABMI, 2016). Agriculture activity accounts for the greatest land use in the area (29%), followed by housing (12%) and transport (6%) (**Figure 29**). These numbers are slightly different than those reported by the BHI land cover inventory, which combined shows agriculture and developed areas to take up about 39% (including "bare" land). These discrepancies can be explained by many potential causes including different researchers using different methods for surveying as well as different characterizations of features across different years of information. A finer scale assessment may provide more accurate numbers, but both data sets provide a similar story in the end: human development has impacted the landscape, yet much natural area still remains in the watershed.

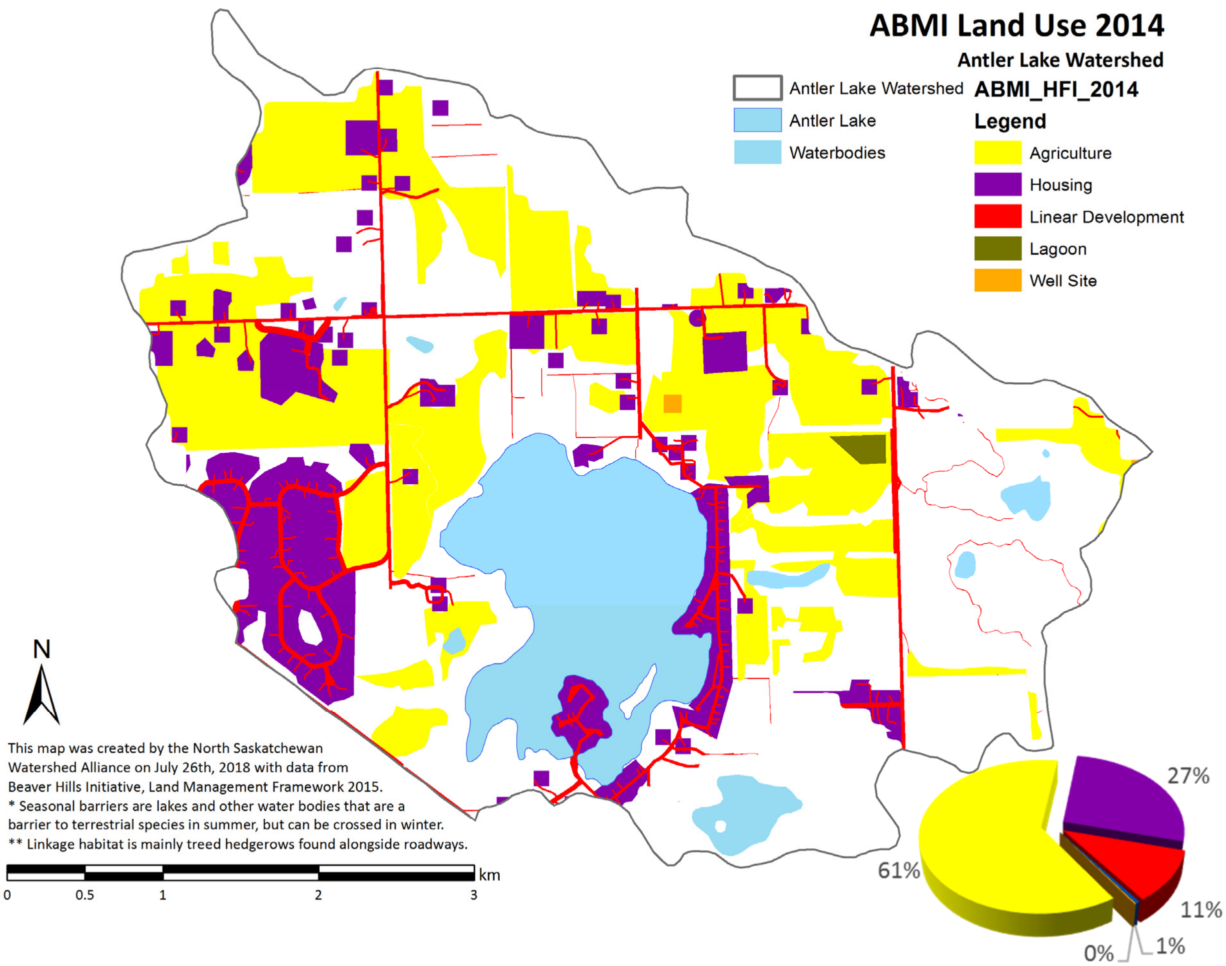


Figure 29. Land Use in the Antler Lake Watershed Based on the Human Footprint Inventory 2014 (map) and Percent of Land-Use Class Per Land-Use Area (pie-chart; ABMI, 2016).

3.6.1 Agriculture

Agriculture is the predominant anthropogenic activity within the watershed (**Figure 29**). Agricultural activity has the potential to impact watersheds by increasing nutrient and pesticide loading to nearby waterbodies or watercourses and by altering water quantity through water withdrawals and changes in land cover (Palliser Environmental Services Ltd. and AARD, 2008).

The Antler Lake watershed has limited agricultural capacity due to the natural terrain, climatic conditions, and a frost-free period often less than 90 days (AMEC, 2015; Toma, Bouma, and Stantec, 2015). This area is restricted to forage crops and coarse grains, as the hilly area and wet depressions make it more difficult to manage annual cropping, but it does support hay and pastureland suitable for beef cattle and other grazing livestock. The area is also suitable for horticultural uses and small livestock holdings (Toma, Bouma, and Stantec, 2015).

An Agriculture Capability analysis has been completed for the Antler Lake watershed as part of BHI Land Management Framework update in 2014 (**Figure 30**; BHI, 2015). The resulting GIS layer highlights larger areas of land more suitable to large-scale cereal production, as well as smaller parcels capable of supporting smaller scale forage crops. Only 20% of the Antler Lake watershed is assessed as Class 2 & 3 (moderate-to-severely moderate limitations, restricting the range of crop productions and requiring conservation efforts; Government of Canada, 2013) agricultural potential with most of the area (37%)

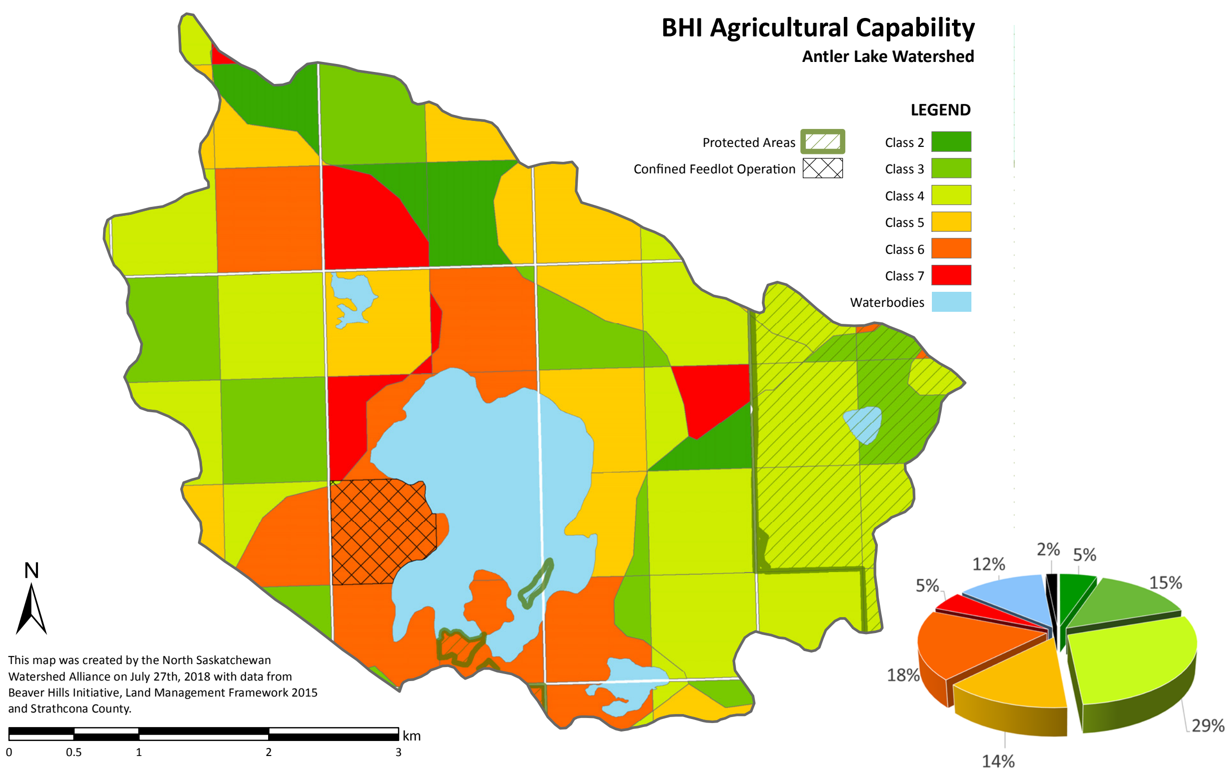


Figure 30. Agriculture Capability within the Antler Lake Watershed. Data obtained from Beaver Hills Initiative, Land Management Framework (BHI, 2015).

having a very low (Class 6 & 7: soils capable of permanent or annual crops; Government of Canada, 2013) or no (Waterbody) agriculture capacity.

Within the Antler Lake watershed, forage crops and pastureland are the predominant agricultural land-uses in the area. Of the cultivated land in the watershed, 83% is pasture/forage crops and 17% is annual cropland (AAFC, 2016). Of the annual crops planted in the watershed, spring wheat, canola/rapeseed, and barley are most common, representing 92% of annual crops (AAFC, 2016).

Livestock in Strathcona County include cattle, poultry, pigs, sheep/lambs, horses and ponies, goats, bison, elk, llamas, and alpacas. Cattle are the predominant livestock kept in the area, followed by horses and sheep (AAF, 2011). Within Strathcona County, cattle numbers have decreased from 32,879 in 2001 to 14,781 head in 2011, a 55% decrease, most likely due to urban expansion within the County (Toma & Bouma and Stantec, 2015). Livestock density data for the Antler Lake watershed is unavailable, so it is unknown if a similar decline in livestock density has occurred within this area. As of 2018, a single "high-density livestock operation" or Confined Feedlot Operations (CFO) is approved within the watershed boundary, which is adjacent to Antler Lake, located on the west side of the lake (Strathcona County, 2018d). Prior to 2002, licensing and compliance monitoring of CFOs were the responsibility of Alberta's municipalities. The Natural Resources Conservation Board CFO database shows the high-density livestock operation located within the Antler Lake watershed to have had a CFO Development Permit approved by Strathcona County on Dec 18, 1980 (NRCB, 2018). Visual analysis of 2018 satellite imagery of this area confirms the presence of an agricultural operation within this parcel, with the barns located 150 m from the closest shoreline. Because this feedlot existed before the Beaver Hills Policy Area was established, it has been grandfathered in, and allowed to remain. Any new or expanded feedlots will have to be built outside the Beaver Hills Policy Area (Strathcona County, 2018a).

Agricultural practices across Alberta have improved over the last few decades to maximize efficiency and productivity while minimizing environmental impacts. Alberta Agriculture and Forestry have created a guide for beneficial management practices for Alberta farmers, which includes improved practices for manure applications, soil erosion control, and reduced nitrogen and phosphorus losses (AAF, 2004). There are also regulations in place to minimize nutrient runoff from farm operations; *the Alberta Operation Practices Act* regulates manure management in the province by setting standards and regulations for manure collection, storage, and application (AAF, 2017). New programs at the municipal level, such as agricultural stewardship, promoted through ALUS Canada (https://alus.ca/), will also help to reduce agricultural impacts in the watersheds.

3.6.2 Environmentally Significant/ Sensitive Areas

In the 1989 *Strathcona County Environmental Significant Areas* report, Antler Lake is listed as a locally significant area for the production, moulting, staging, and migration of waterfowl. The major features of Antler Lake identified in this report included:

- good waterfowl and waterbird habitat,
- island has secure nesting sites,
- good muskrat habitat, and
- some shorelines had not been impacted.

The report identified that the islands of the lake offer secure nesting opportunities for waterbirds. Notable breeding species mentioned included: Eared Grebe (*Podiceps nigricollis*), Red-necked Grebe (*Podiceps grisegena*), Horned Grebe (*Podiceps auratus*), Ring-necked Duck (*Aythya collaris*), and Black Tern (*Chlidonias niger*). The report highlights the high sensitivity to disturbance of the remaining unimpacted shoreline vegetation and that any further development might be highly detrimental to the remaining waterfowl habitat (Griffiths, 1987; Girvan, 1989).

The most recent Environmental Sensitivity mapping was completed as a component of the *Beaver Hills Initiative Land Use Planning and Land Management Framework*. A geographic information system (GIS) analysis of biophysical features was performed, resulting in the Land Management Areas (LMA) map (2007), which was updated to an Environmental Sensitivity Areas (ESA) map in 2014. The map identifies areas of High, Moderate, and Low Sensitivity along with Protected Areas. High Sensitivity Areas contain several sensitive features including natural water, high biodiversity, and wildlife corridors. Moderate Sensitivity Areas are lands with some natural features but low biodiversity. The Antler Lake watershed contains 28% High, 20% Moderate, and 42% Low sensitivity areas (**Figure 31**).

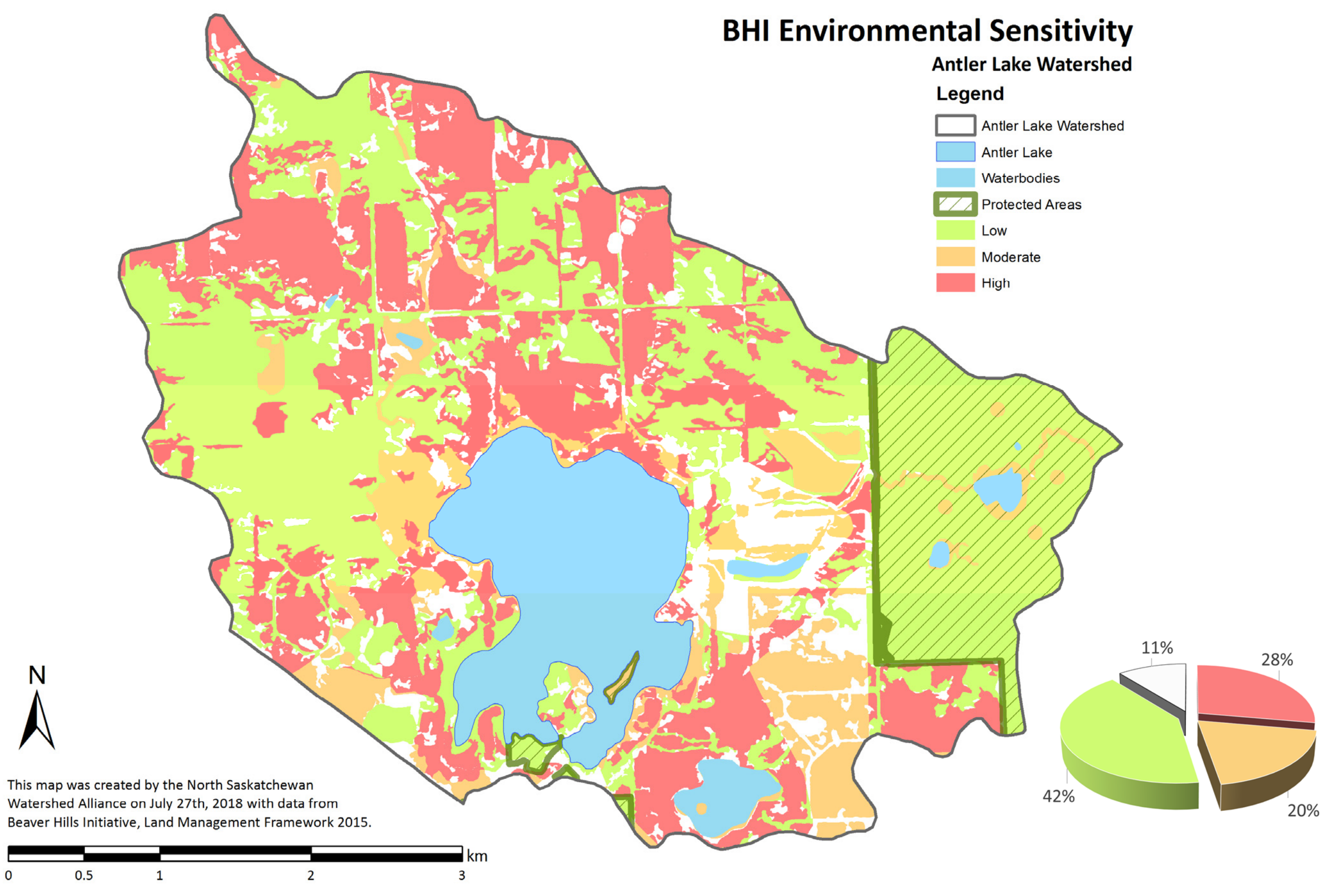


Figure 31. BHI Environmental Sensitivity Areas mapping within the Antler Lake watershed (BHI, 2015). White areas were not rated.

3.6.3 Protected Areas

Parks and protected areas are not only the anchors for biodiversity protection, but they are also important destinations and settings for a wide variety of outdoor recreation and sustainable tourism activities and experiences (**Section 4.7**). Through the *BHI Land Management Framework*, protected areas managed for conservation by federal, provincial, municipal, or environmental organizations across the Beaver Hills Moraine were compiled (BHI, 2014).

Active conservation within the Beaver Hills Moraine dates to the end of the nineteenth century. In 1899, Alberta's first forest reserve, the Cooking Lake Forest Reserve, was opened. It included all the present-day Elk Island National Park and the Cooking Lake-Blackfoot Grazing, Wildlife, and Provincial Recreation Area (Mitchell and Prepas, 1990). These large blocks of protected areas are located directly east of Antler Lake (**Figure 32**). There are also smaller protected areas surrounding the watershed, including North Cooking Lake Natural Area (south), Strathcona Wilderness Centre (north), and other small areas protected by a diversity of environmental organizations. In addition, Antler Lake Island was designated a protected natural area in 2001. In total, 25% of Antler Lake Watershed falls within protected areas (**Figure 32**; BHI, 2015).

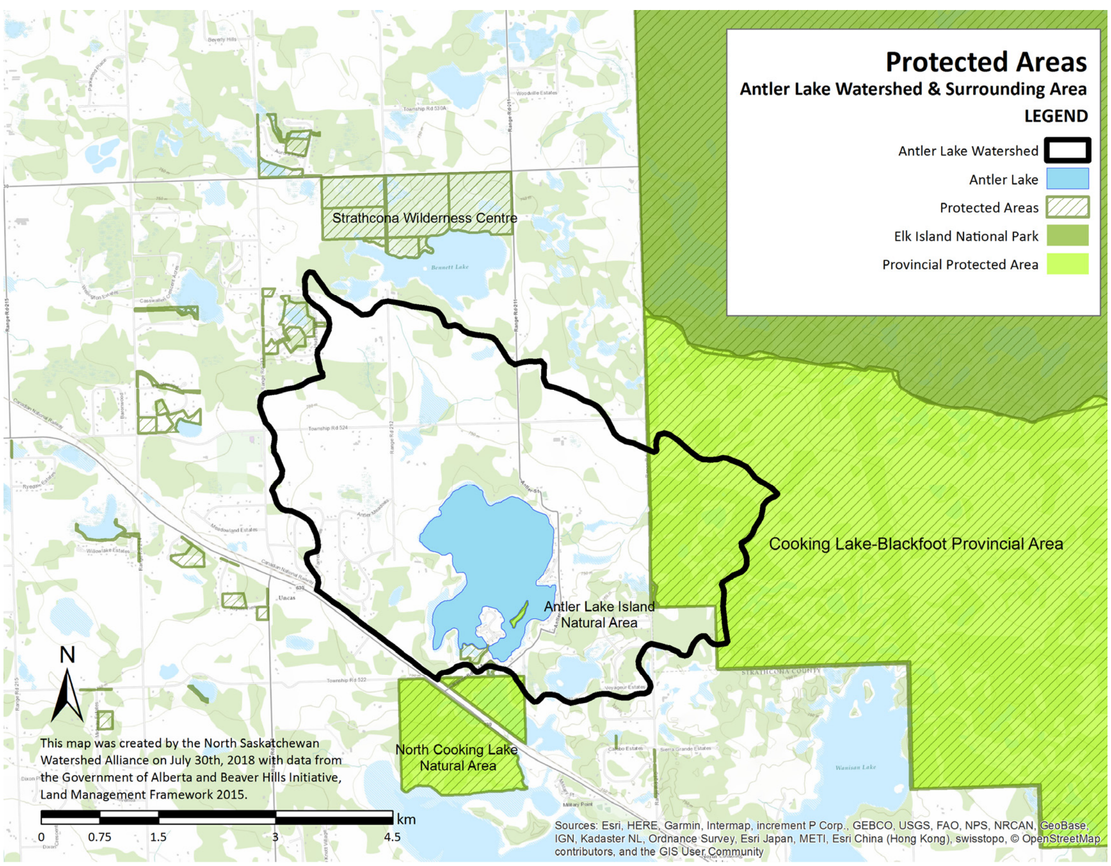


Figure 32. Protected areas within the surrounding area of the Antler Lake watershed. Data obtained from Beaver Hills Initiative, Land Management Framework (BHI, 2015).

3.6.4 The Human Population: Land and Water Use

Strathcona County is strongly influenced by the City of Edmonton, providing numerous economic opportunities for businesses, and County residents whom frequently travel to and from Edmonton for work, recreation, health care, and a wide range of other metropolitan services (Strathcona County, 2005). This has resulted in a 49% population growth within the County in the past 30 years (**Figure 33**). Strathcona County has experienced a 4.68% annual, average growth rate per year from 1955 to 2017 (Alberta Municipal Affairs, 2018; Statistics Canada, 2018).

Urbanization around Antler Lake has increased substantially since the 1950s. Historical, aerial photographs (orthophotos) for the Antler Lake watershed are available, dating back to the 1950s. When compared with modern day satellite imagery, increased urbanization surrounding the lakes is evident (**Figure 34**). Antler Lake is currently the largest Hamlet in Strathcona County, with a population annual, average growth rate of 3.5% per year from 1981 to 2015. Population records for the Hamlet begin in 1971, where rapid growth occurred until 1981. Since then, the population has only experienced slight fluctuations, ranging from 275 (1991) to 469 people (2015) (**Figure 33**; Strathcona County, 2018f). As of 2016, 484 properties were reported within the vicinity of the greater Antler Lake area, with a year-round population of 1,209 persons (**Table 2**). This area has experienced a substantial growth rate of 4% per year since 2011, which is much higher than the average growth within the County as a whole (2.2%) in the same time-period.

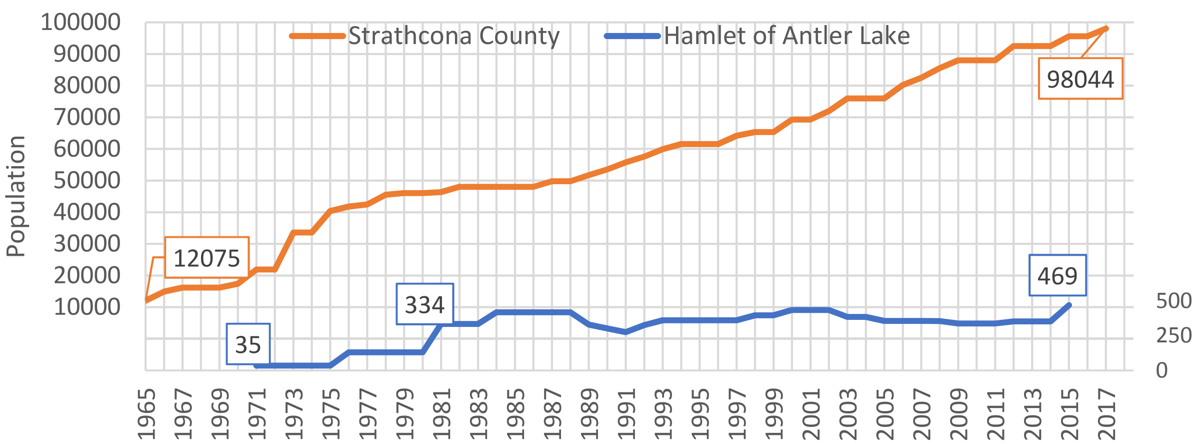
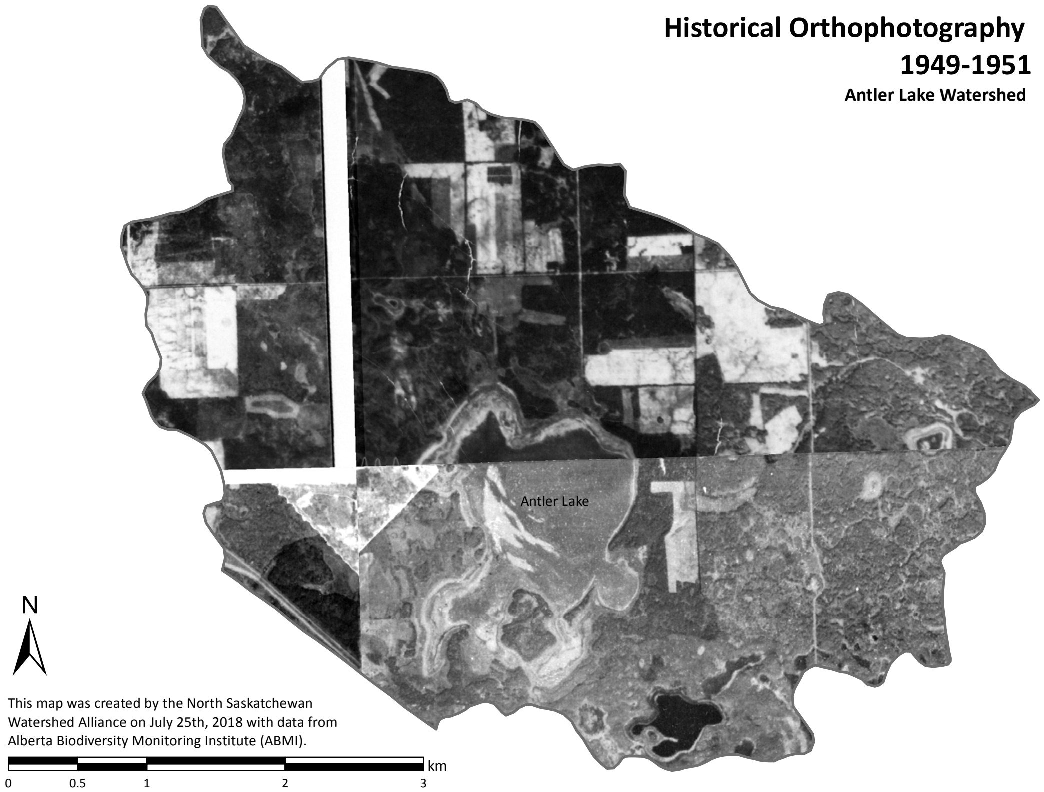


Figure 33. Population Growth in Strathcona County and the Hamlet of Antler Lake (data from Alberta Municipal Affairs, 2018; Strathcona County 2018f).

Table 2. Population and Property Counts of Communities Located around Antler Lake (Statistics Canada, 2018). Note: population and dwelling counts for "other rural subdivisions" are estimates.

Community	Properties	Population 2011	Population 2016	Growth Rate (per year)
Rural Subdivisions*	304	552	767	
Hamlet of Antler Lake	180	454	442	
TOTAL Antler Lake:	484	1006	1209	4%

*Property and population counts estimated using dissemination areas (designated by Statistics Canada) surrounding Antler Lake (48112076; 48111676; 48100201; 48111679; 48111677). Population and dwelling numbers were calculated based on area percentage within the watershed boundary of these 5 dissemination areas.



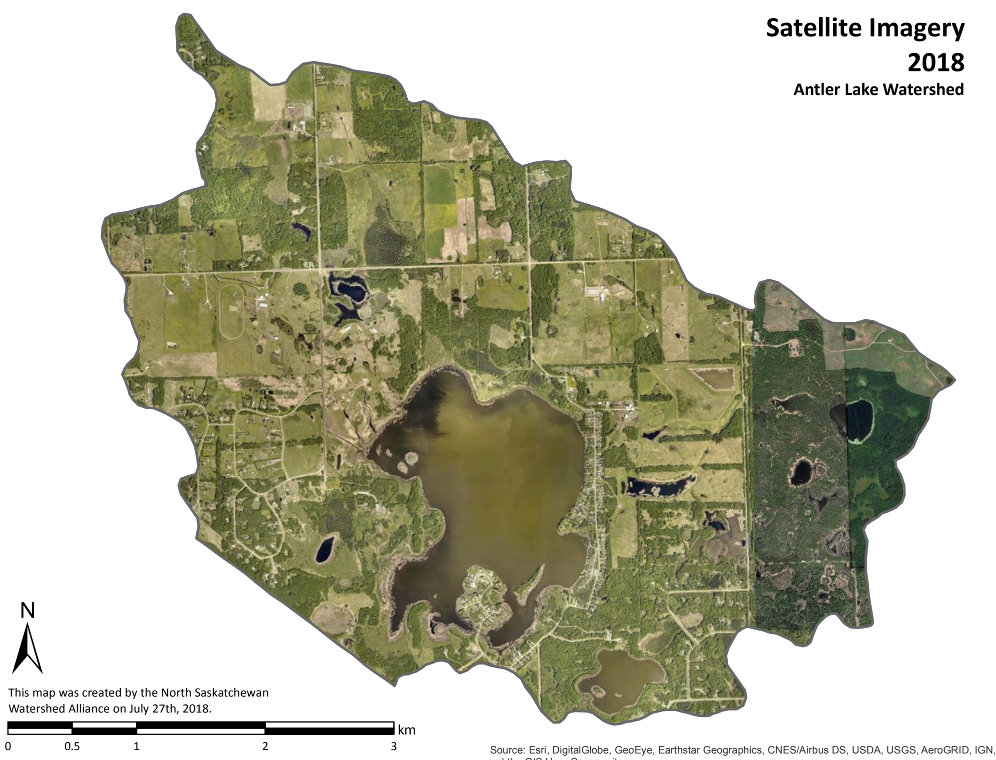


Figure 34. Historic Aerial Photographs 1949 - 51 (top) and Satellite Imagery 2018 (bottom) Depicting Development Areas around the Antler Lake Watershed (ABMI, 2015).

3.6.5 Land Use Zoning

Municipalities regulate land use by designating land-use zones. Most land within the Antler Lake watershed is zoned for agricultural use (56%), followed by residential (15%) (**Figure 35**). Within the Agricultural General (AG) Zoning District, Strathcona County permits agriculture (general, intensive horticulture, minor intensive agriculture, minor equestrian centers) and dwellings (single, secondary, and minor uses like minor home businesses). Discretionary uses (which may be permitted depending on specific site circumstances) include some agriculture (garden stands, major intensive agriculture, greenhouses and plant nurseries, major equestrian centers), some associated agricultural uses (veterinarians), and other uses, such as agricultural dwellings, collective communal dwellings, religious assemblies, and private airports, all of which require discretionary approval from the Developmental Authority (Strathcona County, 2015).

There are three residential zoning districts that fall within the Antler Lake watershed including: Rural Residential/Agriculture (RA), Low Density Country Residential (RCL) and Hamlet (RH) accounting for 15% of the total watershed area (**Figure 36**). RA and RCL Zoning Districts permitted uses are similar, including agriculture (general, intensive horticulture) and dwellings (single detached dwellings and minor uses like minor home businesses). Discretionary uses include some agriculture (garden stands, minor intensive agriculture, animal breeding and boarding, greenhouses and plant nurseries, equestrian centers), some associated agricultural uses (veterinarians), and bed and breakfasts. The difference lies within the allowable subdivisions per quarter section: the maximum density in the RA Zoning District "shall be eight (8) parcels per quarter section", whereas RCL Zoning District's subdivision regulations specifies the maximum density "shall not exceed 50 lots per quarter section". Hamlet Zoning Districts permit dwellings (single detached dwellings and minor uses like minor home businesses) but does not allow for agriculture activities (Strathcona County, 2015). The Hamlet of Antler Lake accounts for approximately 3% of the total watershed area.

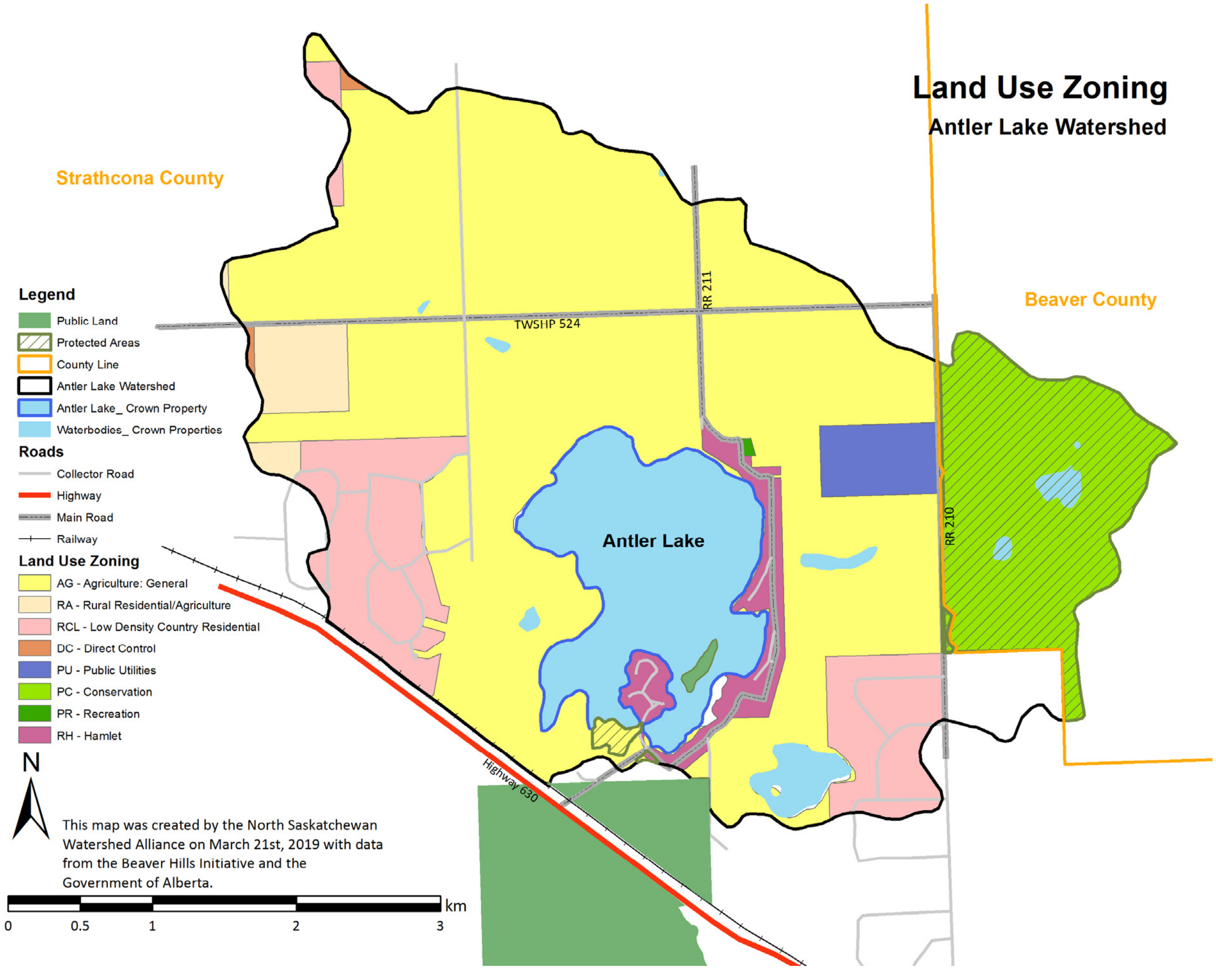


Figure 35. Land Use Zones in the Antler Lake watershed (data from Strathcona County GIS Services, 2018a).

3.6.5.1 Utilities

Strathcona County Utilities operates and maintains all utilities, including drinking water and wastewater services for the Hamlet of Antler Lake. Strathcona County's drinking water comes from the North Saskatchewan River, which originates at the Saskatchewan Glacier in the Rocky Mountains, 500 km southwest of Edmonton. Strathcona County receives its water from EPCOR Water, which operates two water treatment plants in Edmonton, producing a total capacity of 530 million liters of water per day (**Figure 35**).

Figure 36. EPCOR Potable Water Service System Map (Strathcona County, n.d.). The blue line represents the potable water service line from the City of Edmonton to Beaver County.

Wastewater is collected by homeowners with STEP collection systems (septic) that pump into a pressure system owned and operated by Strathcona County (Lockhart, 2018). From there, the wastewater makes its way to the Antler Lake Lift Station which pumps to the Lagoon (**Figure 37**). Strathcona County follows the "Code of Practice for Wastewater System Using a Wastewater Lagoon" (2003) made under the *Environmental Protection and Enhancement Act, RSA 2000, c.E-12* and the *Wastewater and Storm Drainage Regulation, A.R. 119/93*.

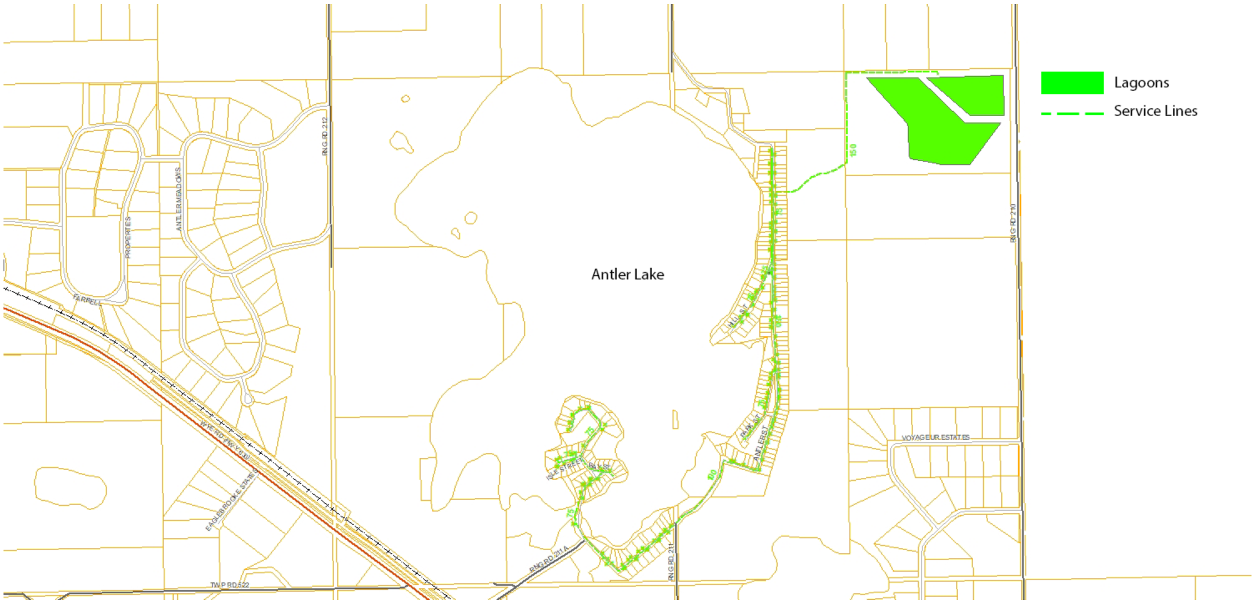


Figure 37. Wastewater Service System Map for the Hamlet of Antler Lake.

It is important to note that the Hamlet of Antler Lake was provided with municipal servicing after development. As such, there may be some homes that have not connected to the municipal system to date, in which case, would likely have a water cistern and a septic tank that would need regular pump out maintenance (Lockhart, 2018).

Key Messages:

- The Hamlet of Antler Lake and surrounding area experiences a 4% annual population growth rate.
- Strathcona County operates the utilities in the area, providing infrastructure for water through EPCOR, and pumps wastewater out to a nearby lagoon.
- The surrounding area of the Beaver Hills Moraine has a long history of conservation.
- Most land in the Antler Lake watershed is zoned for agriculture, also making up the largest component of human footprint, followed by housing and roads.
- Agricultural land has decreased in the recent decade, and is now primarily forage crops and pastureland, with some crops and livestock.

3.7 Riparian Health

Riparian habitat maintains watershed health by preventing erosion, cycling nutrients, maintaining biodiversity, reducing energy created by waves, filtering and buffering water, and recharging aquifers (AEP, 2015). Retaining riparian areas, or permanent vegetation adjacent to waterbodies, is important for maintaining their functionality within the ecosystem.

In general, waterbodies not impacted by human development are typically healthier in terms of water quality and habitat functions than waterbodies with a substantial amount of human development immediately adjacent to, or near, the shorelines (AMEC, 2015). Tracking the length of shoreline with adjacent human development provides an indication of waterbody protection and can be a proxy for waterbody health. Lakefront development and agricultural activities adjacent to Antler Lake can result in deterioration of riparian areas, impairing their function and adversely affecting lake health.

Though the NSWA has now developed a tool for assessing riparian intactness (relative health indicators), the Beaverhills sub-watershed has not yet been assessed with aerial or on-the-ground methods. Therefore, no official assessment of riparian intactness or health has yet been completed for Antler Lake.

For the purpose of this report, the NSWA developed a coarse shoreline assessment to estimate the amount of shoreline with adjacent human development for Antler Lake, along with four other lakes, located within the Beaver Hills Moraine, by calculating shoreline lengths that occur within anthropogenic areas. For this analysis, anthropogenic areas were identified (using 2018 2.5m SPOT Imagery) with satellite imagery of lakefront properties with modified riparian areas. The analysis also viewed agricultural lands directly adjacent to lake shorelines as "developed" and areas observed with intact vegetation as "vegetation cover". Riparian lengths used in this analysis are extremely coarse, warranting verification in future studies. This analysis was performed over the entire Beaver Hills Moraine for comparison purposes. For the entire Beaver Hills Moraine, on average, less than two percent of watercourse streambanks and waterbody (lakes and wetlands) shorelines overlapped with developed areas. In comparison, 46% of Antler Lake shorelines are adjacent to developed areas (**Figure 38**). In addition, Antler Lake has the largest percent of total shoreline length adjacent to anthropogenic development compared to other lakes close to the Antler Lake watershed (**Table 3**). The shoreline assessment of the Beaver Hills Moraine shows that a substantial portion (73%) of the watercourse streambanks and waterbody shorelines within this area are protected by permanent vegetation cover. Proportionally, a higher percentage of watercourse streambanks are protected by permanent vegetation cover (75% of total) as compared to waterbody shorelines (68% of total lake shoreline) (AMEC, 2015). In comparison, Antler Lake has only 54% of the shoreline in vegetated cover without adjacent development.

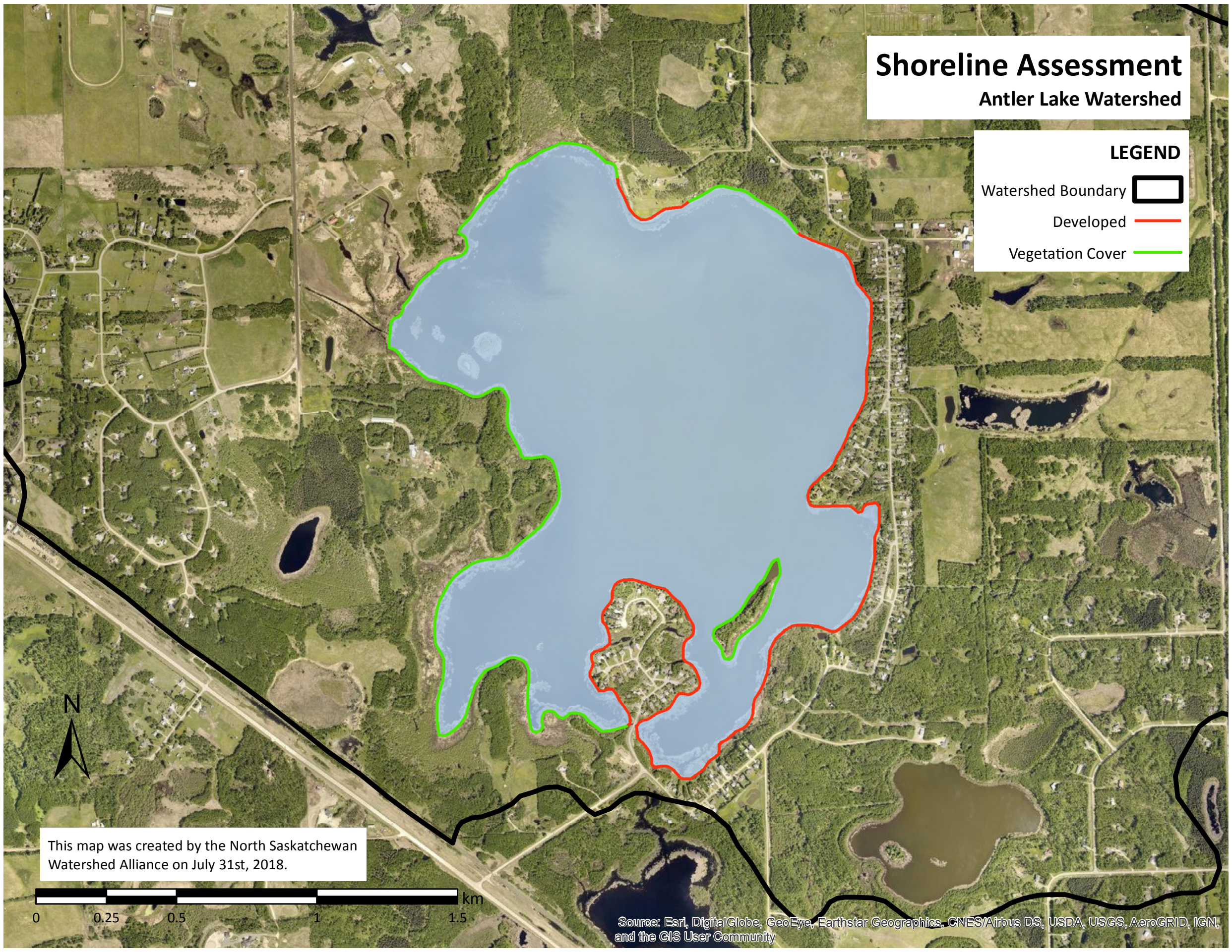


Figure 38. Shoreline Assessment of Antler Lake. Map and data created by NSWA.

Table 3. Summary of Shoreline Length with Development and Vegetation Cover for Antler Lake and Nearby Lakes.

		Antler Lake	Cooking Lake	Hastings Lake
	Total Shoreline length (km)	10.9	69.2	38.4
Developed	Shoreline Length (km)	5.0	25.9	10.8
	% of total shoreline length	**46%**	**37%**	**28%**
Vegetation Cover	Shoreline Length (km)	5.9	43.4	27.6
	% of total shoreline length	54%	63%	72%

Key Messages:

- A coarse approximation of riparian intactness indicates 54% of the Antler Lake shoreline to have vegetated cover, which is lower than other regional lakes with human development surrounding them.
- A detailed riparian assessment is warranted to better understand the health of the riparian zone and to provide conservation and restoration priorities.
- General recommendations for conservation and restoration could be made based on best management practices.

3.8 Wildlife

The Dry Mixedwood Subregion is a transitional zone between the Southern Central Aspen Parkland and the Boreal Forest subregion to the north, making it one of the most productive areas of the boreal subregions for wildlife, mainly because of the diversity of habitats available (Strong and Leggat, 1992). This island of boreal forest means that both boreal animal species (moose, black bear, Canada lynx) and grassland animal species (sharp-tailed grouse, mule deer) live in the region (Geowest, 1997). The uniqueness of geographical features and biodiversity of the Beaver Hills Moraine has earned it a place as the primary Priority Natural Area in the Edmonton region for Canada's Nature Conservancy, Ducks Unlimited, and the Alberta Conservation Association.

The abundance and diversity of plant and animal life within the Beaver Hills Moraine is a result of the relatively undisturbed habitat of this area. This is due in part to the several federal and provincially protected areas located entirely within the Beaver Hills Biosphere, including Elk Island National Park, the Ministik Bird Sanctuary, the Cooking Lake Blackfoot Recreational Area, Miquelon Lake Provincial Park, and several smaller provincial natural areas (BHI, 2004).

Within the watershed, Antler Lake Island is a designated Natural Area, encompassing 1.6 acres of land, making it Beaver Hills' smallest natural area (Husby and Fast, n.d.). Waterbirds use this island for nesting, as it is covered with low, aquatic and riparian vegetation. However, in the past 50 years, the shoreline of Antler Lake has undergone intense development pressure, with nearly half of the shoreline developed into low-density, residential lots. This has resulted in a significant decrease in shoreline. It has been predicted that the high levels of human activity on and around the lake will likely reduce the biodiversity of Antler Lake Island and the lake itself (Husby and Fast, n.d.).

3.8.1 Biodiversity

Biodiversity (biological diversity) describes the variety of life on Earth. "This term describes multiple levels of complexity that make up our natural world, including: all animals, plants, insects, and micro-organisms (species diversity), not just the ones we see or even know about; where they live, connect and interact (ecosystem diversity); and, the very genetic make-up of each living being (genetic diversity)" (ABMI, 2018a). Maintaining biodiversity is important for healthy, functioning ecosystems and the services they provide us.

The number of species (species richness) estimated by the Alberta Biodiversity Monitoring Institute (ABMI), representing common, native birds, mammals, vascular plants, bryophytes (non-vascular plants like mosses), lichen, and soil mites is moderately high for the Antler Lake watershed. The species richness index is calculated for 1 km^2 grids across Alberta, and estimates for species richness are made based on habitat types (ABMI, 2018b). By comparing **Figure 39** to **Figure 24**, it is evident that species richness estimates are highest in areas with greater forest cover, and this is important for connected habitats and ecological networks within the watershed.

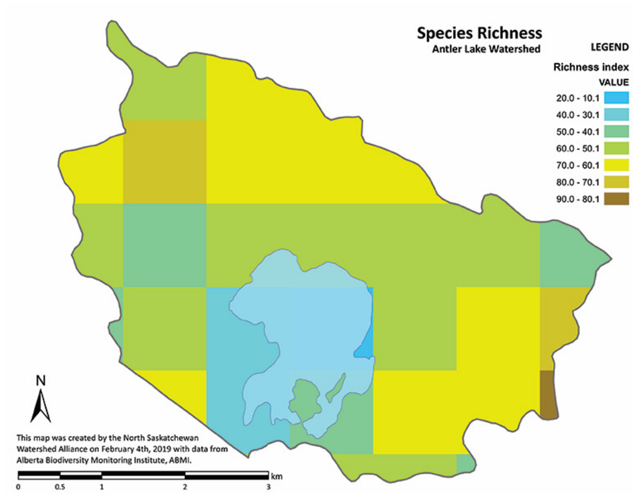


Figure 39. Species richness within the Antler Lake watershed. Data are derived from the Alberta Biodiversity Monitoring Institute (ABMI).

3.8.2 Birds

Cooking Lake-Blackfoot Provincial Recreation Area, located 1 km east of Antler Lake, is home to more than 200 species of birds. Two pairs of nesting Trumpeter Swans (*Cygnus buccinator*), the largest and rarest swan species in the world, reside in this area (Mitchell and Prepas, 1990). The large, irregularly shaped lakes in Strathcona County, such as Cooking, Hastings, Wanisan, Antler, Twin Island, and Bennett lakes, are a few of the many stop-over, or staging sites along both autumnal and vernal migratory pathways (Geowest, 1997). Wetlands ringed with cattails and willow are nesting and feeding habitat for Red-winged Blackbirds (*Agelaius phoeniceus*) and many types of waterfowl, including Blue-winged Teal (*Spatula discors*), and Northern Shoveler (*Spatula clypeata*) (AMEC, 2015).

Along with being an important stop-over location for migrating waterfowl, a variety of birds occupy the Antler Lake watershed, with the lake providing important breeding, nesting, and staging habitats. Sheltered bays along the northwest, west, and southwest shores support dense beds of emergent vegetation that provide the critical wetland habitat for these species. This area is used by breeding and non-breeding gulls for temporary feeding during mass emergence of midges and damselflies, which is a common occurrence on most lakes and many large sloughs (Griffiths, 1987).

The lake provides a sizable area of open water available to moulting, staging, and migrating waterbirds, as well as two very small islands in the northwest bay that may be suitable for nesting/loafing. In 1987, Antler lake was rated a critical wetland with local importance due to the significant value of importance as a waterbird breeding and migration stopover (Griffiths, 1987). Waterbird breeding species of noteworthy significance included Eared Grebe, Red-necked Grebe, Horned Grebe, Ring-necked Duck, Black Tern and Marsh Hawk (a.k.a. Northern Harrier) (*Circus hudsonius*). A more recent aerial survey, in 2003, observed Red-necked Grebes and Mallard Ducks (*Anas platyrhynchos*) at Antler Lake (Found and Hubbs, 2004). In addition, the report identified the presence of Great Blue Herons (*Ardea herodias*), Black Tern, American Coot (*Fulica americana*), Lesser Scaup (*Aythya affinis*), Canada Goose (*Branta canadensis*), and the Green-winged Teal (*Anas crecca*) for nearby Cooking Lake.

3.8.3 Mammals

Upland, aspen forests provide habitat for deer, moose, snowshoe hare and weasel (SAPAA, 2011). In 2015, the *Moraine Mesocarnivores Project* detected 17 species of wildlife including: Moose (*Alces alces*), Fisher (*Pekania pennanti*), White-tailed Deer (*Odecoileus virginianus*), Mule Deer (*Odocoileus hemionus*), Red Fox (*Vulpes vulpes*), Coyote (*Canis latrans*), Wolf (*Canis lupus*), Least Weasel (*Mustela nivalis*), Stoat (a.k.a. Short-tailed Weasel) (*Mustela erminea*), Long-tailed Weasel (*Mustela frenata*), Common Porcupine (*Erethizon dorsatum*), Striped Skunk (*Memphitis memphitis*), Wood Bison (*Bison bison* *athabascae*), Plains Bison (*Bison bison bison*), Elk (*Cervus canadensis*), Black Bear (*Ursus americanus*), and Cougar (*Puma concolor couguar*) within the Beaver Hills Moraine (Stewart and Fisher, 2016).

3.8.4 Other

Because of the colder climate in which the Antler Lake watershed experiences, the presence of amphibians and reptiles is rare within the Beaver Hills Moraine, and no specific records of their presence in the Antler Lake watershed can be found. Within the Moraine, only 5 amphibian and 3 reptile species have been recorded. Likewise, our knowledge of insect species is limited in the area, and only 15 species of butterfly are known to occur in the Moraine (UNESCO, 2016), with no specific details for the Antler Lake watershed.

No records of native fish populations could be found for Antler Lake. In nearby Cooking Lake, low numbers of Brooke Stickleback were recorded in the early 1960s (Mitchell and Prepas, 1990). It was noted that it may have been possible for them to migrate up to Antler Lake during times of high flow (Griffiths, 1987), but there has been no direct evidence of this.

3.8.5 Fisheries

Fish and Wildlife Information Management System has one record of fish culture stocking at Antler Lake which took place in 1958 of 17,000 yellow perch minnows. In 2006, Alberta Environment and Parks performed a fish survey on the lake using trap nets, minnow traps and dip nets and found no fish (AEP, 2019). Anoxic conditions during winter are the major limitation to fish survival, explained within a comprehensive study of shallow prairie lakes in the 1970s, which concluded that lakes with an average depth under 2 m are in a regular winterkill mode (Barica and Mathias, 1979). Antler Lake's average mean depth has been calculated as 1.8 m, which does not allow for fish populations to survive over winter, due to the lack of oxygen.

3.8.6 Species at Risk

Several, provincially rare plants and wildlife species live within the Beaver Hills Moraine. Rare species presence is likely related to the natural habitat available relative to that in adjacent, agricultural lands. The protected areas that run the length of the Beaver Hills are also a major factor to the presence of these species, which is demonstrated by their clustered presence in a band between the protected areas of Elk Island National Park and Miquelon Provincial Park. In addition, the lower level of human use in these zones helps provide secure habitat for these species. These lands are also providing colonial nesting sites for pelicans and herons, which is significant for their protection, due to the sensitivity of these breeding birds to disturbance (BHI, 2018). In 2015, a total of 65 species were identified to be listed on one or more of the federal or provincial lists of species of conservation concern. A total of 37 bird species, six mammals, three amphibians and three reptiles were reported as occurring within the Beaver Hills by the Fisheries and Wildlife Management Information System (FWMIS) (**Table 4**; AEP, 2018d).

Table 4. Listed Species of Conservation Concern within the Beaver Hills Moraine (Table modified from AMEC, 2015; see Appendix 1 for complete list)

	ESRD General Status of Alberta Wild Species	Wildlife Act	COSEWIC	SARA	Total
Birds	37	2	11	4	**37**
Mammals	6	0	3	0	**6**
Amphibians	3	1	3	2	**3**
Reptiles	3	2	7	4	**3**
Plants	16	0	0	0	**16**

Notes: Species listed as 'Secure', 'undetermined' or not listed under the General Status of Alberta Wild Species were not included in total species counts. For COSEWIC counts, species listed as 'not at risk' or not listed by COSEWIC were not included; species listed on priority assessment lists were included *(AMEC, 2015).*

Key Messages:

- There is high, overall biodiversity within the watershed, with several rare and at-risk species.
- Waterfowl represent the most diverse group of wildlife, followed by mammals.
- Records of native fish, reptiles, amphibians, and insects in the Antler Lake watershed cannot be found. It is possible that a small number of yellow perch may still reside in the lake after their introduction, but this is unlikely.
- Conservation and restoration opportunities should be pursued to enhance the landscape connectivity and provide better quality habitat space for wildlife in the Antler Lake watershed.