Upper Beaver Watershed Riparian Area Assessment

FINAL REPORT

Project #2132
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Prepared for:

LICA ENVIRONMENTAL STEWARDS

Prepared by:

FIERA Biological Consulting

Photo Credit (Front cover and Acknowledgements page): Mason Unrau

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Acknowledgements

The Lakeland Industry & Community Association (LICA) would like to acknowledge that the Upper Beaver watershed is located within the traditional lands of the Dene, Cree, and Métis on Treaty 6 and 10 Territories and the Métis Homeland. This recognition represents respect and gratitude in sharing this land, and honours our responsibility to truth and reconciliation.

LICA would also like to acknowledge the contribution of the Government of Alberta to the success of this project. The Government of Alberta contributed to the delivery of this project through the Watershed Resiliency and Restoration Program (WRRP), which aims to restore or enhance previously degraded natural habitats, including riparian habitat, within priority watersheds across Alberta. Additionally, the Government of Alberta provided spatial data that was essential for the completion of this project.

LICA would also like to acknowledge contributions from the Counties of Lac La Biche and Smoky Lake, who helped to determine project scope. The North Saskatchewan Watershed Alliance also provided valuable guidance and assisted with this project by providing access to existing riparian assessment data and by providing funding for the completion of the land cover dataset.

LICA ENVIRONMENTAL STEWARDS

Alberta

Executive Summary

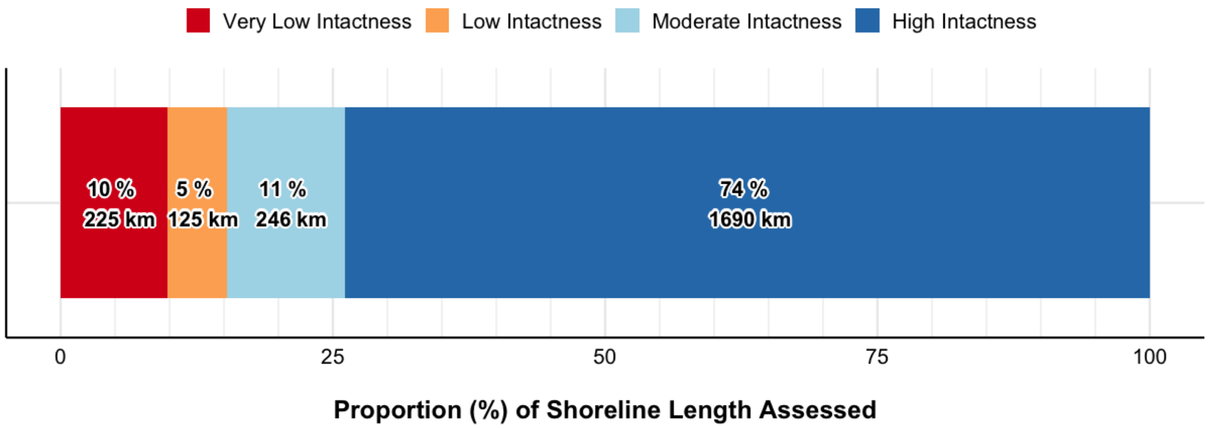
Riparian lands have substantial ecological, economic, and social value; for example, intact riparian habitats stabilize the banks of waterbodies and help modulate water velocities and high water events, thereby improving water quality and protecting surrounding lands from flooding. Intact riparian areas also play a vital role in the exchange of inorganic and organic material between terrestrial and aquatic ecosystems and regulate water temperature and the instream light environment, thereby ensuring suitable habitat for a range of aquatic species. Given the significant role that an intact riparian zone has on providing ecosystem services and supporting healthy and functional aquatic ecosystems, there is a need to effectively manage riparian areas. Thus, understanding the distribution of intact riparian habitat across the landscape, and identifying areas where riparian intactness has been degraded, is essential to improving conservation and management outcomes.

In an effort to better manage riparian habitats within the Upper Beaver watershed, the Lakeland Industry & Community Association (LICA) retained Fiera Biological Consulting to assess riparian habitat along approximately 2,286 km of creek and lake shoreline. The Upper Beaver is a very large (~5,178 km^2) HUC 6 watershed that is located in the east-central portion of the Beaver River (HUC 2) watershed, and is made up of two smaller (HUC 8) subwatersheds: the Upper Beaver River and Amisk River subwatersheds.

Riparian vegetation intactness was assessed along the shorelines of interest using a desktop-based assessment tool that utilizes a current land cover layer derived from satellite imagery. Intactness was assessed within riparian management areas (RMAs) that have a variable length, as determined by major breaks in the proportion of vegetation cover along the shoreline, and a fixed 50 m buffer that extends perpendicular to the shoreline. Within each RMA, intactness was assessed using a number of GIS metrics that quantified the type and extent of vegetation and human disturbance present. Intactness was used as the measure of riparian condition because the relationship between an intact riparian zone and the health or function of the aquatic environment is well established.

In addition to assessing riparian intactness, natural and anthropogenic pressure within local catchments was evaluated to identify riparian areas that may be functionally impaired due to surrounding land use activities. Each RMA within the Upper Beaver watershed was assigned an intactness and pressure score, and these scores were combined using a prioritization matrix that assigned a conservation or restoration priority to each RMA. This allows land managers to target specific areas within the watershed for conservation and restoration, as well as identify areas were more detailed, site-specific field assessments of riparian health or condition may be required.

A total of 127 waterbodies were assessed in the Upper Beaver watershed, including 43 creeks and rivers and 84 lakes. The majority (74%, 1,690 km) of the shoreline assessed was classified as High Intactness, with an additional 11% (246 km) of the shoreline classified as Moderate Intactness. The remaining shoreline was classified as either Low (5%, 125 km) or Very Low (10%, 225 km) Intactness.

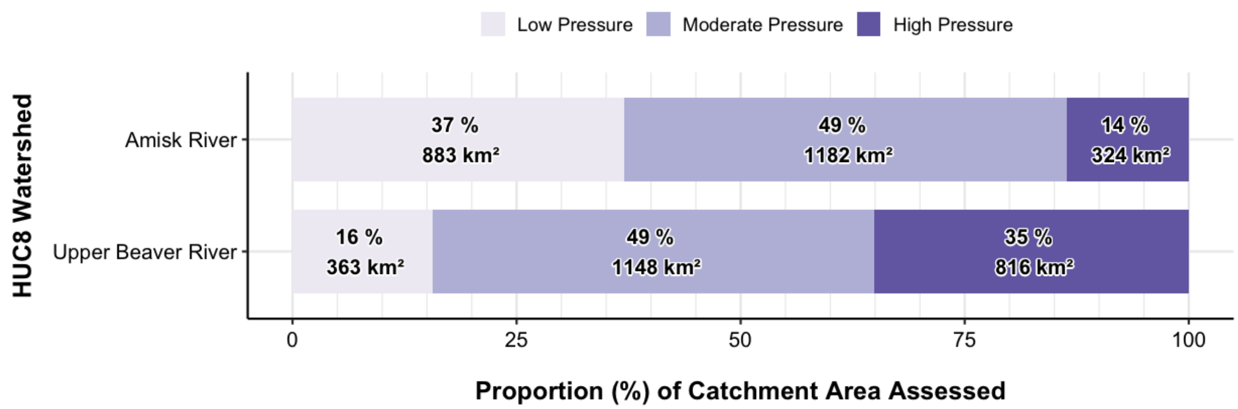


When intactness was compared by subwatershed, both the Amisk River and Upper Beaver River subwatersheds had 80% or more of their shorelines rated as either High or Moderate Intactness, with the Upper Beaver River subwatershed having the greatest proportion of shoreline rated as Very Low Intactness (13%).

When intactness was evaluated for various jurisdictions within the watershed, Thorhild County had 96% of its shoreline classified as High Intactness, whereas the MD of Bonnyville had only 46% of its shoreline classified as High Intactness. Five of the ten jurisdictions had greater than 90% of their shorelines classified as Moderate or High Intactness. The MD of Bonnyville had the greatest proportion of shoreline rated Low and Very Low Intactness (28%), followed by the County of St. Paul (24%), and the Whitefish First Nation (22%).

		Proportion (%) of Shoreline within Intactness Category					
Spatial Extent	**Length Assessed (km)**	**Very Low**	**Low**	**Very Low + Low**	**Moderate**	**High**	**Moderate + High**
Upper Beaver Watershed	2285.8	10	5	15	11	74	85
Amisk River Subwatershed	1551.6	8	5	13	8	79	87
Upper Beaver River Subwatershed	734.2	13	7	20	17	63	80
Athabasca County	234.5	8	3	11	8	81	90
Beaver Lake Cree Nation	13.5	2	3	5	2	93	95
Buffalo Lake Métis Settlement	229.1	2	2	4	6	90	96
County of St. Paul	550.7	15	9	24	15	62	77
Kikino Métis Settlement	342.6	10	7	17	7	76	83
Lac La Biche County	443.0	6	2	8	8	83	91
MD of Bonnyville	202.8	16	12	28	26	46	72
Smoky Lake County	101.3	12	3	15	3	82	85
Thorhild County	103.6	1	1	2	2	96	98
Whitefish Lake First Nation No. 128	65.7	17	5	22	22	56	78

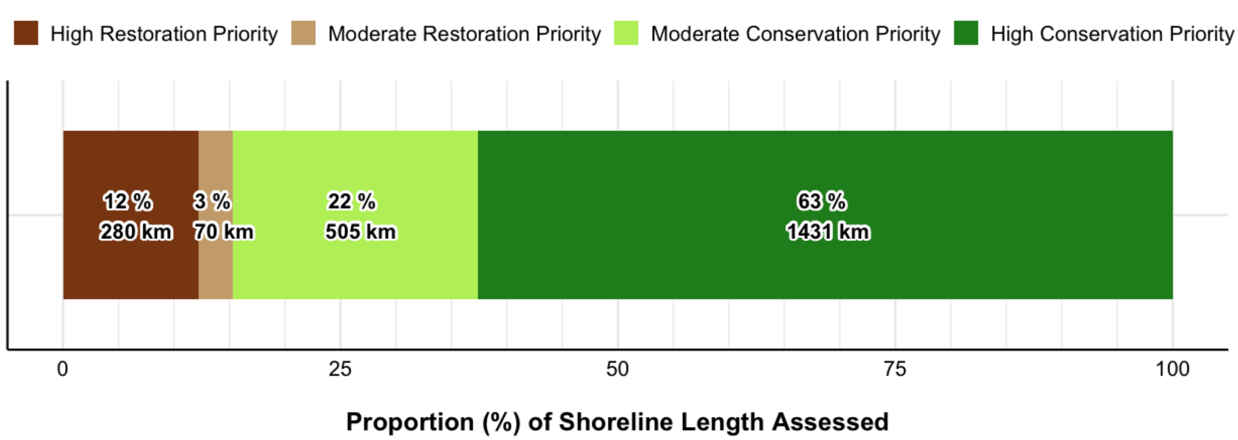
Pressure on riparian system function was assessed for 603 local catchment areas within the watershed. The Upper Beaver River subwatershed had the greatest proportion of its area classified as High Pressure (35%), which was more than two times the area classified as High Pressure in the Amisk River subwatershed.



Within the Upper Beaver watershed, 85% (1,936 km) of the shoreline assessed was classified as either High (63%; 1,431 km) or Moderate (22%; 505 km) priority for conservation. Conversely, 15% of the shoreline was classified as either High (12%; 280 km) or Moderate (3%; 70 km) priority for restoration.

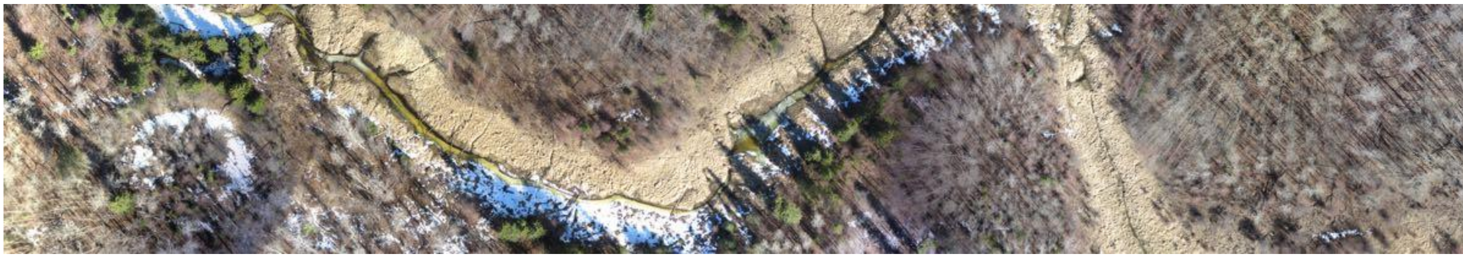
When conservation and restoration priority is compared by subwatershed, the Amisk River had the greatest proportion of shoreline rated as High (70%) or Moderate (16%) Conservation Priority, while the Upper Beaver subwatershed had the greatest proportion of shoreline rated High (17%) or Moderate (3%) Restoration priority.

When conservation and restoration priority was evaluated for jurisdictions within the watershed, Thorhild County, Beaver Lake Cree Nation, and the Buffalo Lake Métis Settlement all had over 95% of their shoreline classified as High or Moderate Conservation priority, while the MD of Bonnyville had the greatest proportion of shoreline classified as either High or Moderate priority for restoration (28%).



Spatial Extent	Length Assessed (km)	Proportion (%) of Shoreline					
		High Restoration	Moderate Restoration	Restoration Priority	Moderate Conservation	High Conservation	Conservation Priority
Upper Beaver Watershed	2285.8	12	3	15	22	63	85
Amisk River Subwatershed	1551.6	10	3	13	16	70	86
Upper Beaver River Subwatershed	734.2	17	3	20	34	46	80
Athabasca County	234.5	9	2	11	11	78	89
Beaver Lake Cree Nation	13.5	2	3	5	2	93	95
Buffalo Lake Métis Settlement	229.1	1	3	4	3	93	96
County of St. Paul	550.7	21	3	24	44	32	76
Kikino Métis Settlement	342.6	11	6	17	10	73	83
Lac La Biche County	443.0	7	2	9	15	77	92
MD of Bonnyville	202.8	23	5	28	45	27	72
Smoky Lake County	101.3	14	1	15	8	77	85
Thorhild County	103.6	1	1	2	2	96	98
Whitefish Lake First Nation No. 128	65.7	20	2	22	42	36	78

This project has generated scientific information that can be used as the basis for the development and implementation of an evidence-based framework for adaptively managing riparian areas within the Upper Beaver watershed. Through the commissioning of this study, LICA, its stakeholders, and Indigenous communities in the region now have an important foundation of scientific evidence upon which to target restoration and conservation activities that will improve water quality, biodiversity, and drought and flood resilience in the watershed. The next step in the advancement of meaningful riparian management and conservation in the Upper Beaver watershed will be to formalize a framework for action that includes a consideration of the current conditions and defining achievable outcomes and measurable targets that can be used by stakeholders to inform management decisions. These actions can then be monitored on a regular basis to provide an evaluation of outcomes that feed into an adaptive and reflexive approach to riparian management over time within the watershed.



List of Terms

Abbreviations

AAFC: Agriculture and Agri-food Canada
ABMI: Alberta Biodiversity Monitoring Institute
AGS: Alberta Geological Survey
ARHMS: Alberta Riparian Habitat Management Society (Cows & Fish)
BMP: Best Management Practice
DEM: Digital Elevation Model
HUC: Hydrologic Unit Code
LICA: Lakeland Industry & Community Association
RMA: Riparian Management Area

Glossary

Aerial Videography: Video captured from a low flying aerial platform, such as helicopter or ultra-light aircraft.

Catchment: Small local drainage areas ranging in size from 0.2 to 36 km^2 that were acquired as part of this study to assess pressure on riparian system function. The catchment data used in this study are freely available from the provincial government as part of Alberta ArcHydro Phase 2 spatial dataset (Government of Alberta 2018).

Conservation Priority: A riparian management area that has been assessed as being moderately to highly intact and is associated with a catchment assessed as having moderate to low pressure. Because these areas are largely in a natural state, they are considered to be targets for conservation and/or protection to maintain their current state of function and ecological value.

Hydrologic Unit Code (HUC): The Hydrologic Unit Code (HUC) Watersheds of Alberta represent a collection of nested hierarchically structured drainage basin feature classes that have been created using the Hydrologic Unit Code system of classification developed by the United States Geological Survey (USGS), with accommodation to reflect the pre-existing Canadian classification system. The HUC Watersheds of Alberta consist of successively smaller hydrologic units that nest within larger hydrologic units, resulting in a hierarchal grouping of alphanumerically-coded watershed feature classes. The hydrological unit codes include HUC 2, HUC 4, HUC 6, HUC 8, and HUC 10, with HUC 2 being the coarsest level of classification and HUC 10 being the finest level of classification.

Indicator: A measurable or descriptive characteristic that can be used to observe, evaluate, or describe trends in ecological systems over time.

Intactness: In reference to the condition of natural habitat, intactness refers to the extent to which habitat has been altered or impaired by human activity, with areas where there is no human development being classified as high intactness.

Left Bank: The bank of a river, stream, or creek that is on the left when facing downstream.

Metric: A qualitative or quantitative aspect of an *indicator*; a variable which can be measured (quantified) or described (qualitatively) and demonstrates either a trend in an indicator or whether or not a specific threshold was met.

Resilience: The capacity of an ecosystem to resist, absorb, and recover from the effects of natural and human-caused disturbance to preserve ecological and hydrological services and functions.

Restoration Priority: A riparian management area that has been assessed as being of low or very low intactness and that is associated with a catchment assessed as high pressure. Because these areas are largely in a modified or disturbed state, they should be targets of restoration to improve their current state of function and ecological value.

Right Bank: The bank of a river, stream, or creek that is on the right when facing downstream.

Riparian Area, Riparian Habitat, Riparian Land, or Riparian Zone: Riparian lands are transitional areas between upland and aquatic ecosystems. They have variable width and extent both above and below ground. These lands are influenced by and/or exert an influence on associated waterbodies, which includes alluvial aquifers and floodplains, when present. Riparian lands usually have soil, biological, and other physical characteristics that reflect the influence of water and/or hydrological processes (Clare and Sass 2012).

Riparian Management Area: As per Teichreb and Walker (2008), and for the purpose of this report, a riparian management area is defined as an area along the shoreline of a waterbody that includes near-shore emergent vegetation zone, the riparian zone, and a riparian protective (buffer) zone.

Strahler Order: A method of classifying and assigning a numeric order to streams in a network based on the number of tributaries. First order streams are dominated by overland flow and have no upstream concentrated flow; whereas higher order streams have a greater number of upstream tributaries. Stream order increases when streams of the same order intersect.

Waterbody: Any location where water flows or is present, whether or not the flow or the presence of water is continuous, intermittent or occurs only during a flood. This includes, but is not limited to lakes, wetlands, aquifers, streams, creeks, and rivers.

Watercourse: A natural or artificial channel through which water flows, such as in creeks, streams, or rivers.

Watershed: An area that, on the basis of topography, contributes all water to a common outlet or drainage point. Watersheds can be defined and delineated at multiple scales, from very large (e.g., thousands of square kilometers, such as the Red Deer River watershed) to very small local watersheds (e.g., square metres, such as a small prairie wetland).

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1.0 Introduction

1.1. Background

Riparian areas are highly complex and dynamic “transitional habitats” that are found along the edge of waterbodies, including rivers, streams, lakes, wetlands, and springs. Riparian areas show steep hydrological and environmental gradients from the water’s edge to the adjacent uplands, and are critical for facilitating the transfer of energy and materials between terrestrial and aquatic ecosystems (NRC 2002). Hydrology (both groundwater and surface water) is the driving force behind the physical, chemical, and biological processes that characterize riparian habitats, and because riparian lands are under the influence of both terrestrial and aquatic processes (e.g. nutrient and sediment transfer), these areas tend to be more biologically productive and have higher levels of biodiversity than other habitats of comparable size (Ibid).

From the perspective of human communities, riparian areas provide a multitude of beneficial ecosystem functions and services, and the relationship between an intact riparian zone and the integrity of the aquatic environment is well established (Pusey and Arthington 2003). For example, intact riparian zones play a vital role in the exchange of inorganic and organic material between the terrestrial and aquatic ecosystems, via the interception of sediments and nutrients that runoff from adjacent upland habitats and through the supply of leaf litter and woody debris. Furthermore, intact riparian vegetation can modulate the transfer of solar energy to the aquatic ecosystem, regulating water temperatures and the instream light environment, ensuring suitable habitat for a range of aquatic species (Ibid). Riparian habitats stabilize the banks of waterbodies and help modulate water velocities and high water events, thereby improving water quality and protecting surrounding lands from flooding (Orewole et al. 2015; Olokeogun et al. 2020). Riparian vegetation also slows floodwater and increases floodplain residence times, which increases recharge to groundwater aquifers (Swanson et al. 2017). In turn, this allows water to seep back into streams during low water or drought periods (Blackport et al. 1995), thereby stabilizing base water flows (Caissie 1991; Blackport et al. 1995).

Despite the importance of these habitats, the loss and impairment of riparian lands in Alberta over the last century has been significant (Clare and Sass 2012), and as a result, recent watershed management efforts throughout the province have been focused on identifying priority areas for riparian restoration and habitat management. In order to efficiently target habitat restoration efforts and resources across large spatial extents, however, there first needs to be reliable information about the location, condition, and function of riparian habitats.

1.2. Methods for Assessing Riparian Areas

1.2.1. Field Assessment

The finest scale and most detailed evaluations of riparian condition come from “boots-on-the-ground” site-specific field assessments and/or inventories of riparian areas. In this type of assessment, such as the Alberta Riparian Habitat Management Society (ARHMS, also known as “Cows & Fish”) Riparian Health Assessment, detailed and local-scale traits of riparian areas are evaluated by trained practitioners, and a comprehensive and thorough assessment of riparian condition is made. Metrics evaluate a wide range of riparian attributes including: vegetation type, structure, and composition; bank characteristics; soil attributes; and land use and disturbance. The final compiled score provides a snapshot of whether a riparian area is “Healthy”, “Healthy, but with problems”, or “Unhealthy”, and gives a land-owner or other interested stakeholders an idea of where to focus management activities. To date, the vast majority of the field-based riparian assessments completed by Cows and Fish have been in central and southern Alberta, and while the site-specific detail offered by this approach cannot be matched, these assessments are limited in their ability to provide information for planning and management at municipal, regional, or larger scales.

Although existing ground-based assessment methods are useful for gathering information about the general condition of riparian habitat at small spatial extents, the site-specific delineation employed for these assessments cannot be scaled up to provide information about riparian condition across larger geographic areas. Further, the results of these assessments are typically not available publicly due to confidentiality agreements with landowners.

1.2.2. Aerial Videography

As an alternative to the highly detailed information required and the substantial time and cost investment associated with field assessments, alternative approaches that utilize recorded video have been applied to assess riparian areas over larger spatial extents. Aerial videography is a tool for assessing riparian habitat where a trained analyst uses spatially referenced continuous video to evaluate a hydrologic system. Instead of walking around and observing the site, the observation takes place through video images acquired from an oblique angle at altitudes of 60 m or less. Riparian condition is assessed within a “riparian management area” (RMA) polygon, and like the field-based Alberta Riparian Habitat Management Society Riparian Health Assessment, the evaluator answers a series of questions about the functional attributes of the riparian lands to derive a score that is then classified according to three health categories that are akin to the field-based approach.

Videography has been applied by various organizations across Alberta using a variety of airborne video platforms (e.g., Mills and Scrimgeour 2004, AENV 2010, NSWA 2015). The benefit of videography is that the entire riparian area of a lake or river can be assessed at one time, while providing a permanent geo-referenced video record of the current status of shoreline. It provides a relatively rapid method to produce a “coarse filter” assessment of riparian health. This approach is not intended to replace field-based assessments, but rather, complement them by allowing larger areas to be evaluated in an approximate fashion, to be followed by more detailed checks on the ground. The goal of the videography assessments is to provide information over larger areas at a lower cost, such that the management of riparian areas at larger scales (i.e. entire lake or river system) can be directed by standardized measurements. In many cases, videography can be very cost-effective per kilometer of shoreline observed. At a certain scale, however, the size of the study area and the width of the stream or river make assessments by videography cost prohibitive. Compared to ground-based methods, aerial videography offers a broader scale and relatively coarse assessment of riparian condition; however, at larger scales, such as for entire watersheds, this method becomes limited in practicality and efficiency (i.e., time and cost).

1.2.3. Satellite Remote Sensing & GIS Assessment

In response to a growing need for an assessment method that could evaluate riparian condition at large spatial extents (i.e., entire watersheds), Fiera Biological developed a Geographic Information System (GIS) method to assess thousands of kilometers of shoreline in a reliable and cost-effective way. This method was developed using metrics comparable to existing ground-based and aerial videography methods, and the results have been validated using both aerial videography (Fiera Biological 2018) and field data (Fiera Biological 2019).

The assessment method uses automated and semi-automated GIS techniques to quantify the intactness of riparian management areas using freely available or low cost spatial data. This method combines imagery from satellites with information about the terrain (e.g., relative differences in elevation, location of depressions, etc.,) to create a land cover dataset that is then used to measure and quantify the amount of natural and human cover types present along the shorelines of a water body. The shoreline is then classified into condition categories along a gradient of how “intact” the vegetation is, with areas that are dominated by natural vegetation being considered highly intact, and areas dominated by human-created land cover types (e.g., roads, houses, agricultural crops) being considered to have very low intactness (Figure 1 and 2). To date, this method has been used to assess over 42,000 km of shoreline across central Alberta (Fiera Biological 2018a-e, 2019, 2020, 2021a-d). This includes 1,169 km of shoreline that has been assessed in the Jackfish-Muriel Creeks subwatershed (Fiera Biological 2021e), which is located in the south-central portion of the Beaver River basin.

Figure 1. Riparian intactness is a measure of how “natural” a shoreline is. Highly intact shorelines are dominated by natural vegetation and other natural cover types, while shorelines classified as very low intactness are dominated by human-build structures, roads, and manicured or disturbed vegetation.

Figure 2. Using a “bird’s eye view”, the satellite-based GIS riparian assessment method measures the type and amount of natural versus human-created land cover types present within 50 m of the shoreline. Shorelines classified as high intactness are almost entirely covered by natural cover. Shorelines that are considered to have very low intactness are dominated by human structures and modified or disturbed vegetation.

1.3. Study Objectives

The overall goal of this project is to contribute to the improvement of watershed health in the Upper Beaver watershed by identifying riparian areas that can be targeted for habitat restoration and/or conservation. In order to achieve this goal, this study had the following primary objectives:

1) Create a recent land cover for the Upper Beaver watershed and use this layer to assess the intactness of riparian areas along major waterbodies.
2) Quantify both natural and anthropogenic pressures within catchments adjacent to riparian areas to generally assess factors that may contribute to the impairment of riparian system function.
3) Provide guidance on how the results from the intactness and pressure assessments can be used in combination to prioritize conservation and restoration efforts within the watershed.

The results of this study provide stakeholders with an overview of the status of riparian management areas within the watershed. This in turn allows organizations throughout the watershed to focus restoration, management efforts, and/or resources in areas of greatest need. Further, this approach has been adapted and applied in other watersheds throughout the province, thereby allowing for a standardization of the methods used to conduct large-scale riparian assessments in Alberta.

1.4. Purpose and Intended Use

This assessment synthesizes data from a variety of sources, with the goal of generally characterizing the current condition of riparian management areas within the Upper Beaver watershed. Readers are asked to consider the following points regarding the scope of this assessment as they review the methods and interpret the results of this study:

- Assessments characterize the relative intactness of riparian areas or pressure within local catchments using a collection of indicators and associated metrics that are measurable in a GIS environment at a pixel resolution of 6 m. These assessments do not provide a statement on the absolute condition of riparian areas or catchments, and do not reflect the influence of factors that were not or cannot be included or considered for analysis. For example, this analysis cannot assess the occurrence or abundance of weeds within a riparian area, given that this type of cover cannot be resolved in a 6 m resolution satellite image. Furthermore, because overhead satellite imagery is used to create the land cover layer used to assess intactness, this assessment is not able to evaluate impacts associated with structures or activities that are obscured by an extensive tree canopy (e.g., small structures, stormwater outfalls, etc.).
- In completing these assessments in a number of watersheds throughout Alberta, we have found that higher riparian intactness scores are more frequently associated with higher-order Strahler streams and rivers, whereas lower-order streams (many of which are unnamed) tend to have a much greater proportion of their shorelines assessed as Low or Very Low condition, particularly in agricultural landscapes. Thus, the overall intactness values for a watershed may be strongly influenced by the order of streams included in the assessment, as well as the dominant land use within the watershed.
- Intactness and pressure ratings are intended to support a screening-level assessment of management and/or conservation priorities across broad geographic areas (e.g., HUC 8 subwatershed, municipality, stream reach). *The tool assessments are not meant to replace more detailed, site-specific field assessments of riparian health or condition*. Instead, intactness and pressure ratings should be used to highlight smaller, more localized areas where field assessments and further validation may be required.

- The provincial hydrography data for streams, creeks, rivers, and lakes was used to delineate the shoreline of the waterbodies included in this assessment. Because waterbodies are dynamic and their boundaries change seasonally and annually, the boundaries for the waterbodies included in this study had to be manually adjusted to ensure that the boundary was reflective of the current location of the shoreline, as well as consistent with the imagery that was used to complete the riparian assessment. Notably, the location of the boundaries used in this assessment may not be representative of the location of these same waterbodies in the future. Further, the spatial boundaries of waterbodies within the watershed that were not assessed as part of this study have not been updated.
- The jurisdictional summaries in this report were based on the boundaries available in the Alberta Base Features dataset and were generated using a spatial intersect rule in the GIS (i.e., if the riparian management area was within a municipality or touched the boundary of a municipality, then it was used to tabulate summaries for that municipality). It should be noted that where a watercourse defines the boundary between two jurisdictions, there is often a substantial spatial offset between the base feature jurisdictional boundary and the water boundary that is digitized as part of this riparian assessment. This is particularly an issue for municipal boundaries, and it is often unclear which municipality is responsible for the management of the left or right bank of a waterbody that defines the boundary of more than one municipality. Editing municipal boundaries to conform with the water boundaries applied in this project was beyond the scope of work, and as such, there may be instances where the spatial intersect rule applied to generate the summaries does not precisely reflect the riparian areas associated with a jurisdiction. Consequently, the jurisdictional summaries provide a *general estimate* of the amount of shoreline that was assessed in the study, as well as the condition of the associated riparian management areas identified for each jurisdiction.

2.0 Study Area

The Upper Beaver is a very large (~5,178 km^2) HUC 6 watershed located in the Boreal Natural Region in east central Alberta (Map 1). The Upper Beaver is composed of two smaller (HUC 8) watersheds: the Amisk River and Upper Beaver River subwatersheds (Map 2).

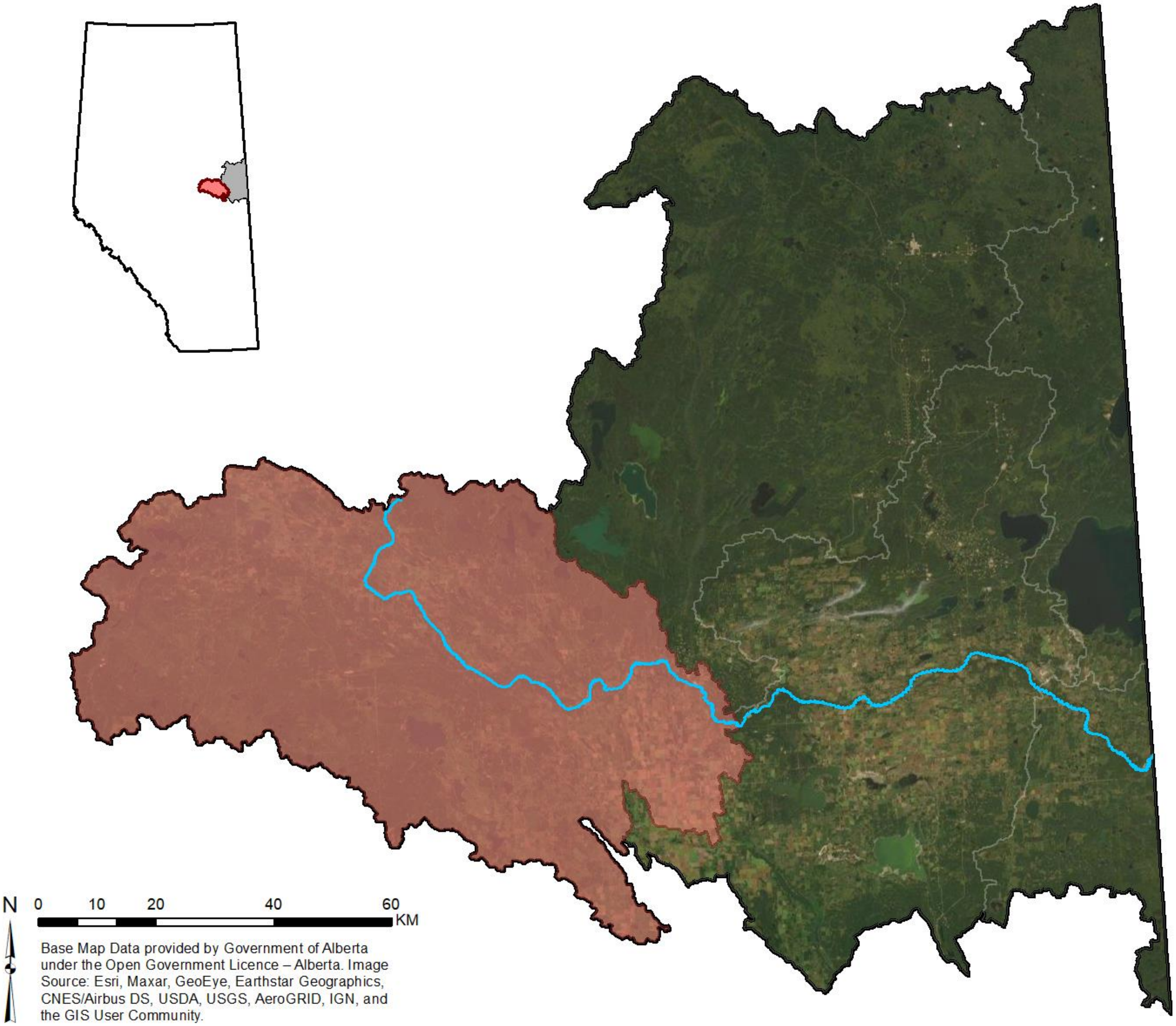
Human activity is relatively limited in this watershed, with only 29% of the lands classified into anthropogenic land cover types (Map 3). Agriculture (cropland and pasture) make up the largest proportion of the lands modified by human activity (26%). The remaining human land cover is comprised of Disturbed Vegetation (2%), Built Up/Exposed (1%), and Human Built (1%). The remaining 71% of the watershed consists of natural land cover types, such as wetlands, forests, open water, and other low and open natural vegetative cover. The predominant wetland land cover types include woody fen (14%), with other wetland land cover types making up roughly 9% of the watershed. Open water accounts for approximately 7% of the land cover in the watershed.

Six rural counties intersect the Upper Beaver watershed, including Athabasca County, Lac La Biche County, Thorhild County, Smoky Lake County, the County of St. Paul, and the MD of Bonnyville. Four first nations communities intersect the watershed as well, including the communities of Beaver Lake Cree Nation and Whitefish Lake First Nation No. 128, and the Métis Settlements of Buffalo Lake and Kikino (Map 4).

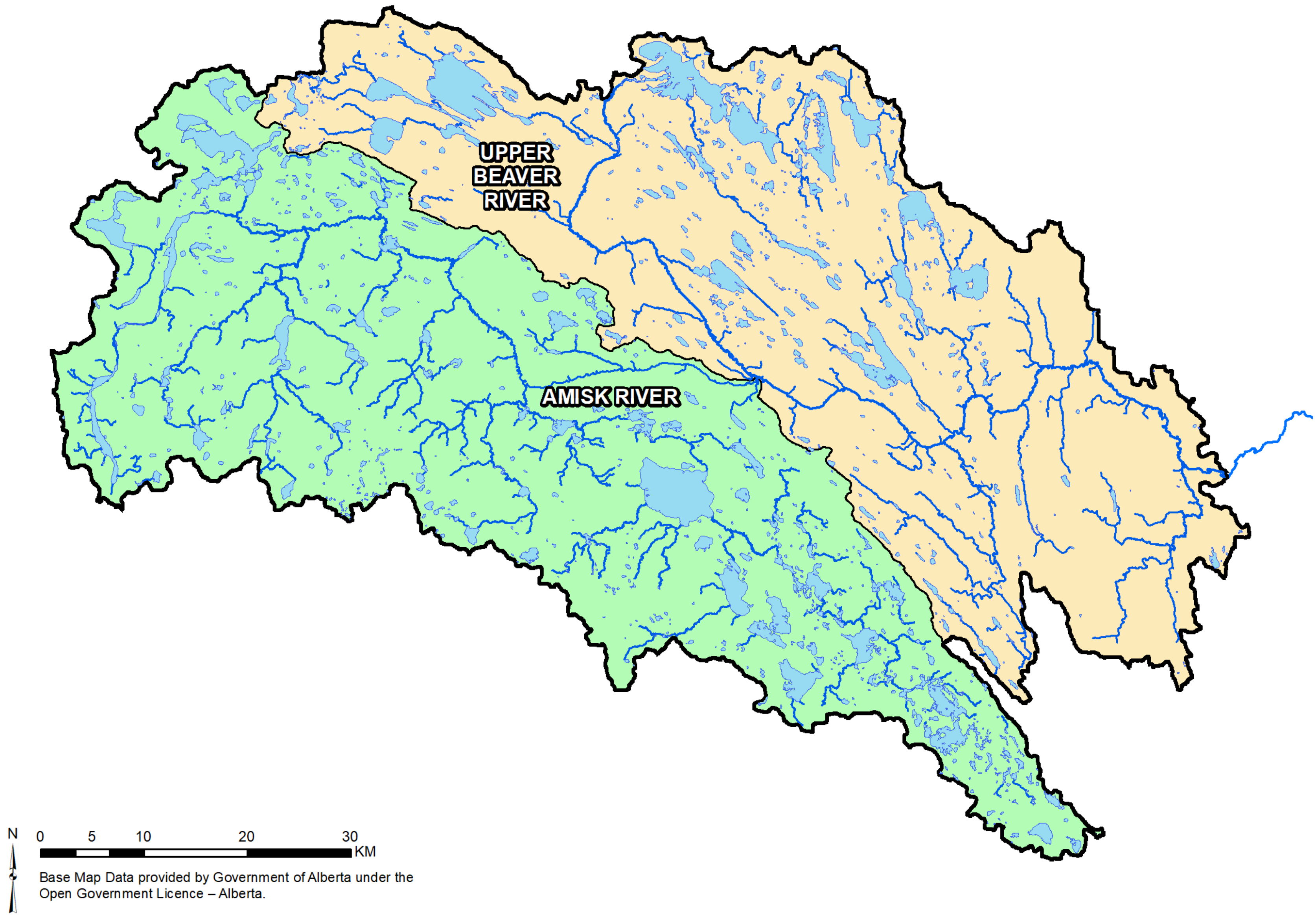
Approximately 2,286 km of shoreline was assessed as part of this study (Table 1), including the left and right banks of 43 watercourses (Map 5) and 84 lakes (Map 6).

Table 1. Waterbodies in the Upper Beaver watershed that were assessed as part of this project. The shoreline length listed for each stream represents the shoreline that was assessed on both the left and right banks.

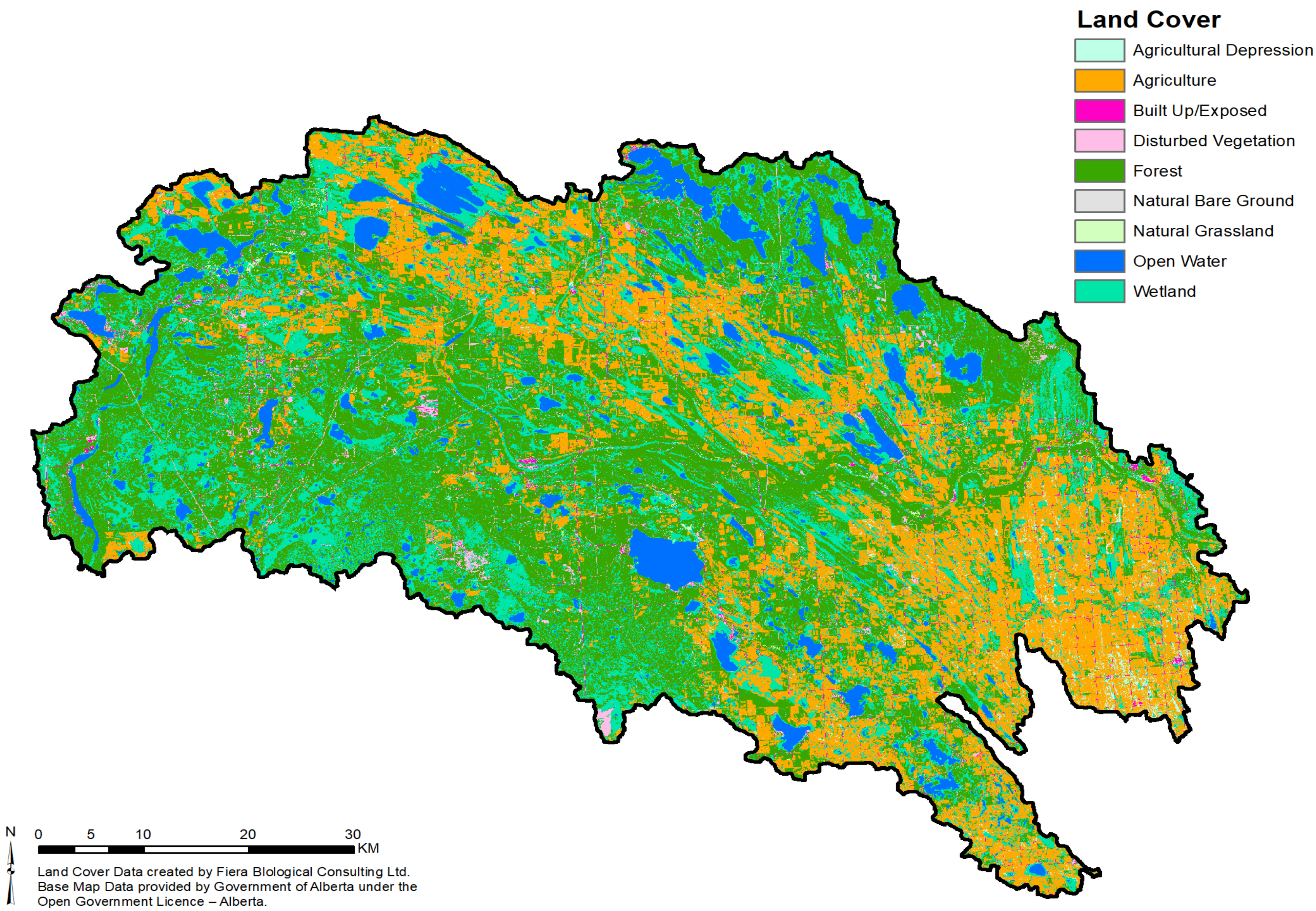
Waterbody Name	Length of Shoreline Assessed (km)
Streams	
Amisk River	207.9
Beaver River	285.3
Bunder Creek	76.5
Columbine Creek	80.4
Fork Creek	16.0
Mooselake River	0.2
St. Lina Creek	89.4
Whitefish Creek	54.0
Unnamed Creeks (35)	629.2
Lakes	
Allday Lake	3.6
Amisk Lake	25.4
Beaver Lake	74.4
Big Johnson Lake	11.3
Buffalo Lake	16.6
Bunder Lake	30.5
Cardinal Lake	5.3
Chappell Lake	8.2
Chota Lake	6.4
Cole Lake	9.2
Denning Lake	8.2
Elinor lake	29.0
Figure Lake	8.1
Floatingstone Lake	17.4
Fork Lake	28.2
Garner Lake	16.6
Goodfish Lake	16.5
Greenstreet Lake	7.9
Little Beaver Lake	9.4
Little Garner Lake	4.1
Lone Pine Lake	8.3
Long Lake	30.5
Lower Mann Lake	19.0
McCullough Lake	5.3
Norberg Lake	15.9
North Buck Lake	49.2
Outlet Lake	5.6
Owlseye Lake	6.7
Reed Lake	20.1
Saturday Lake	3.7
Skeleton Lake	24.8
Snail Lake	6.7
Tompkins Lake	4.5
Upper Mann Lake	17.3
Victor Lake	4.6
Wayetenaw Lake	4.4
Whiskyjack Lake	6.7
Whitefish Lake	26.9
Unnamed Lakes (46)	250.8
TOTAL	**2,286.2**



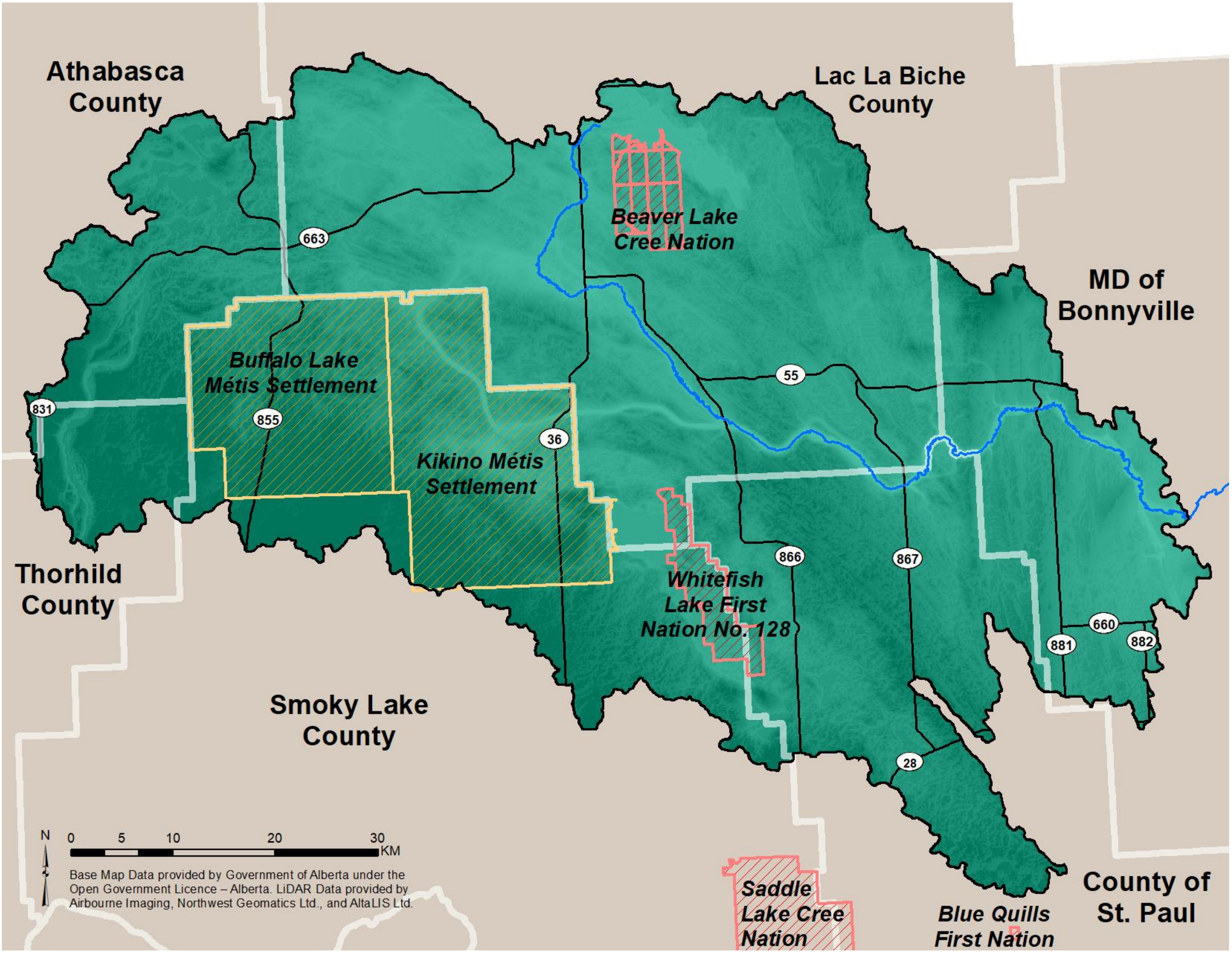
Map 1. The Upper Beaver HUC 6 watershed located within the Beaver River watershed.



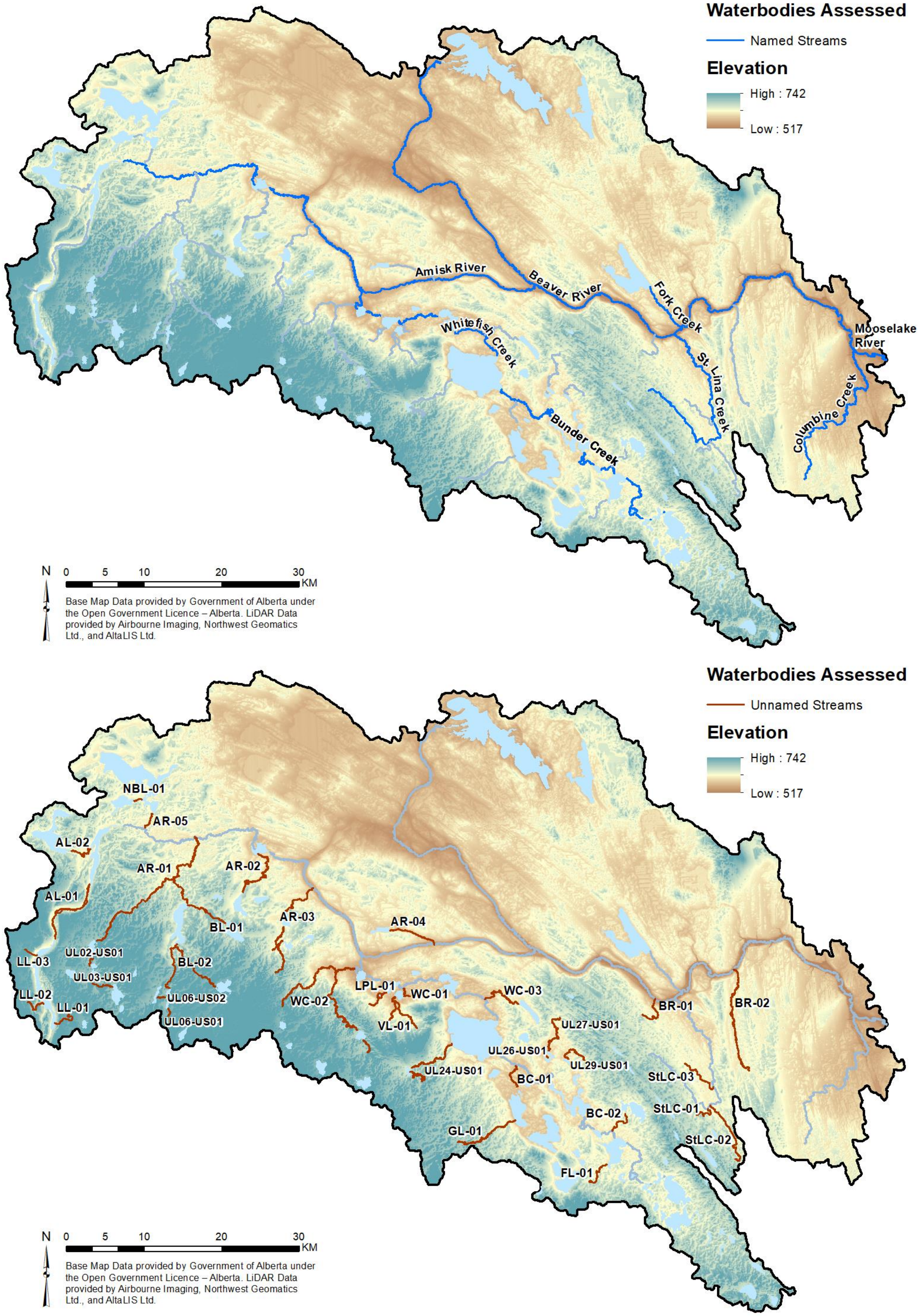
Map 2. The HUC 8 subwatersheds that make up the larger HUC 6 watershed.



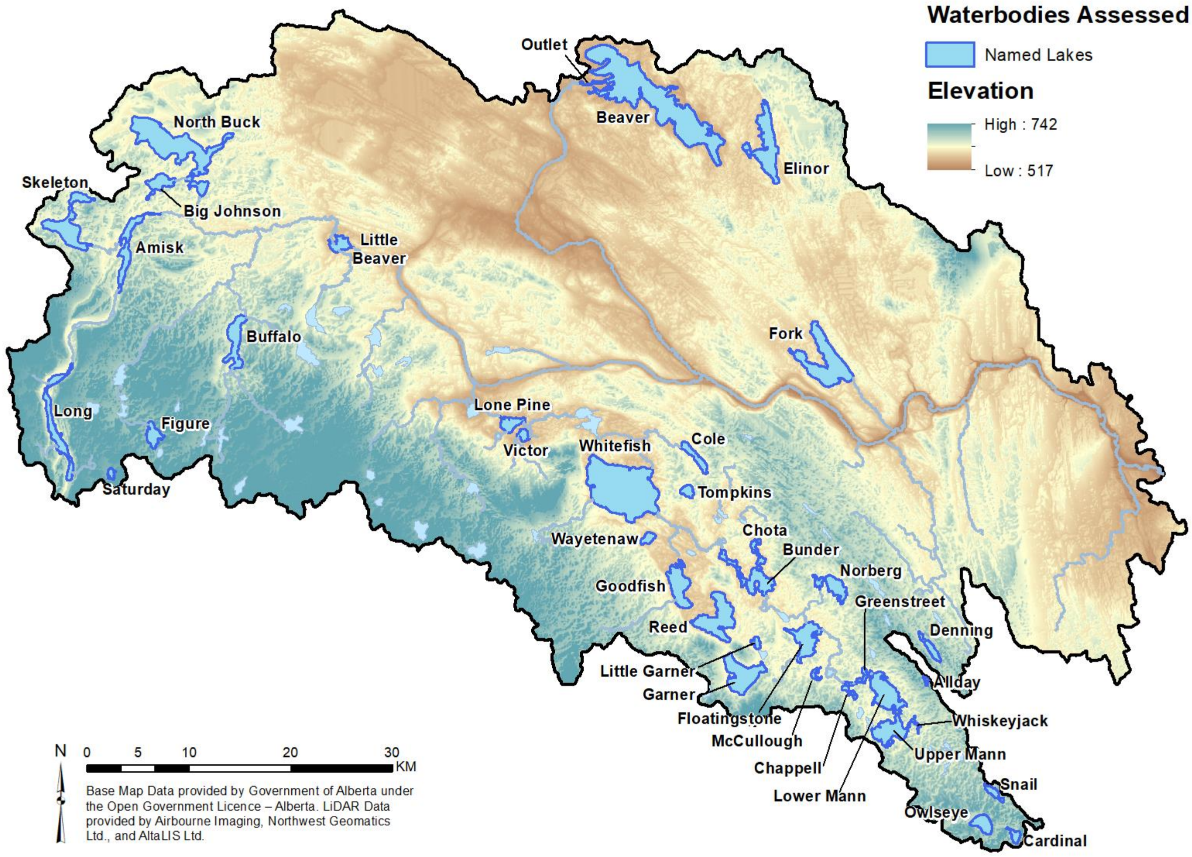
Map 3. Land cover in the Upper Beaver watershed, created using SPOT6/7 imagery from 2017 and 2018.

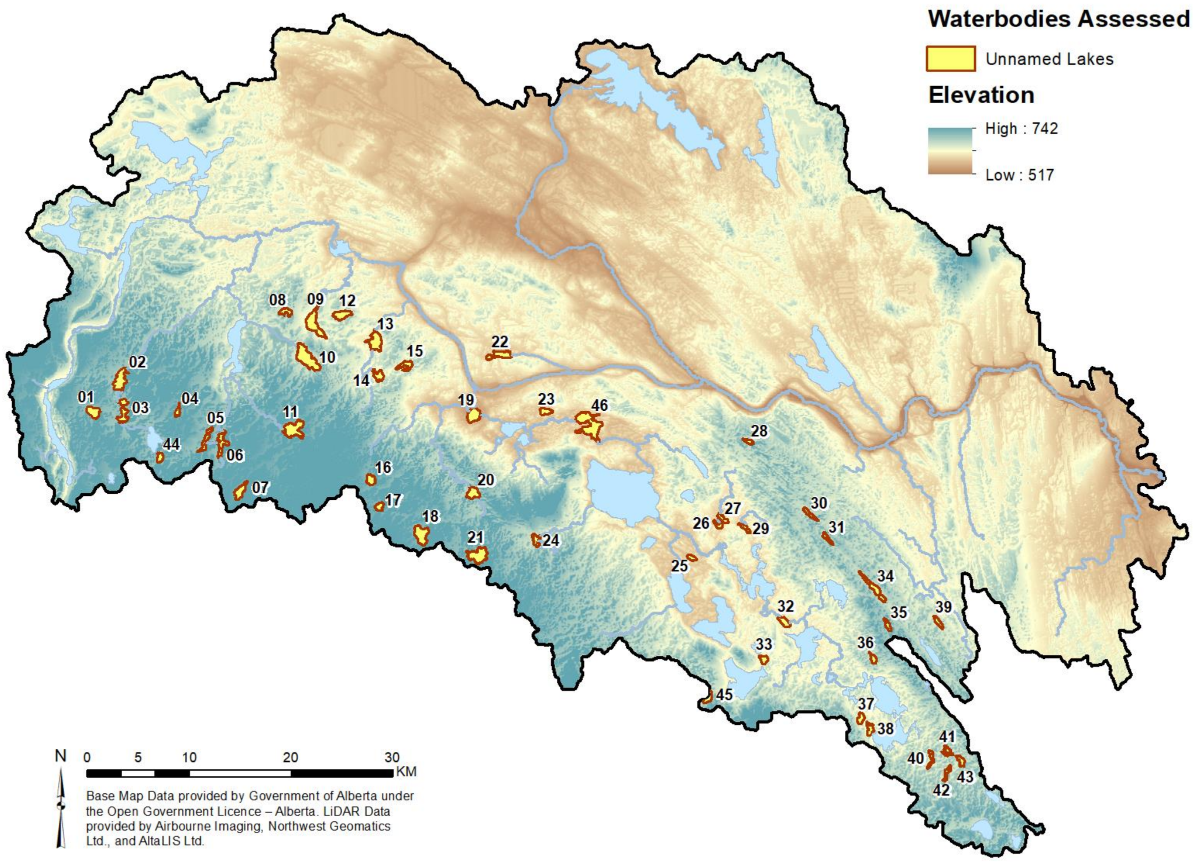


Map 4. Major highways, municipalities, and Indigenous communities located within and surrounding the watershed.



Map 5. Location of named streams and unnamed creeks that were assessed in this study.





Map 6. Location of named and unnamed lakes that were assessed in this study..

3.0 Methods

3.1. Assessing Riparian Intactness

3.1.1. Land Cover Classification

To quantify riparian intactness in a GIS environment, several data sets are required, including a current land cover layer. While a freely available and current land cover layer is available from Agriculture and Agri-Food Canada (AAFC) for this watershed, the resolution of this data (30 m pixel size) is too coarse to accurately assess vegetation within riparian management areas. Consequently, a 6 m pixel resolution land cover layer was created using SPOT 6 and SPOT 7 satellite imagery from 2017, which was obtained by the AWC free of charge from the Government of Alberta.

The 6 m land cover classification was created for the entire watershed and consisted of three separate SPOT 6/7 image scenes. Because of differences in date of acquisition and image quality, each scene was classified individually, but using the same classification methodology. For each satellite image, the four SPOT 6/7 bands were combined with a set of ancillary raster data products that were specifically generated for use in the classification (Table 2). The SPOT 6/7 imagery was used to generate layers for Normalized Difference Vegetation Index (NDVI), Blue Normalized Difference Vegetation Index (BNDVI), Green Ratio Vegetation Index (GRVI), and Iron Oxide Index (IOI), and a 15 m LiDAR DEM was used to derive terrain layers including Probability of Depression, Cost Distance to Water, and Deviation from Mean Elevation. As well, historic image analysis was performed in Google Earth Engine to generate mean summer temperature maps from Landsat 8 imagery and mean and standard deviation maps of NDVI from Sentinel 2 imagery (Table 2). Land cover classes were chosen and organized hierarchically into nested levels to facilitate training data selection and modelling (Table 3). Training data were manually selected for each SPOT 6/7 scene for the following classes: Coniferous; Deciduous; Shrub; Bog; Fen; Marsh; Swamp; Agricultural Depression; Open Water; Agriculture Pasture; Cropland; Human Built; Natural Bare Ground. A random forest classification was performed on each SPOT 6/7 band stack, which included the four SPOT 6/7 bands and additional ancillary layers. Random forest is a classification algorithm that is based on a set of decision trees derived by repeatedly selecting random subsets of training data and applying them to the layers in the band stack to create predictive models. By creating multiple models of decision trees, the best model and combination of information from the information in the band stack is determined and better prediction performance is obtained (Ho 1995). For this classification, 70% of the training data was used to train the classifier and the remaining 30% of the data was held back to validate the preliminary results.

Following the first stage of the classification, decision rules and manual editing were used to fix general classification errors. During this stage, the Natural Grassland class was added to the classification to account for areas of natural, non-woody low cover vegetation, and the Disturbed Vegetation class was added to account for non-agricultural human impacted low vegetation cover and areas with managed or manicured vegetation. Once the quality control and editing for each scene were completed, the seven scenes were mosaicked together to create a complete classified land cover layer for the entire watershed, and the Alberta Base features Roads layer was used to add in a Roads class to complete the 17-class "Level 2" land cover classification (Table 3).

Table 2. Description of the spatial data obtained or derived for use in the assessment of riparian management area Intactness.

Data Layer	Year	Source	Usage
SPOT 6/7 Satellite Imagery	2017	Government of Alberta	Derivation of land cover classification
15 m LiDAR DEM	n/d	Government of Alberta	Derivation of data products for classification
Normalized Difference Vegetation Index (NDVI)	2017/2018	Fiera Biological. Layer was created using SPOT 6/7 satellite data provided by the Government of Alberta	Derivation of land cover classification
Blue Normalized Difference Vegetation Index (BNDVI)	2017/2018	Fiera Biological. Layer was created using SPOT 6/7 satellite data provided by the Government of Alberta	Derivation of land cover classification
Green Ratio Vegetation Index (GRVI)	2017/2018	Fiera Biological. Layer was created using SPOT 6/7 satellite data provided by the Government of Alberta	Derivation of land cover classification
Iron Oxide Index (IOI)	2017/2018	Fiera Biological. Layer was created using SPOT 6/7 satellite data provided by the Government of Alberta	Derivation of land cover classification
Probability of Depression	n/d	Fiera Biological. Layer was created using LiDAR DEM data provided by the Government of Alberta	Derivation of land cover classification
Cost Distance to Water	n/d	Fiera Biological. Layer was created using LiDAR DEM data provided by the Government of Alberta	Derivation of land cover classification
Deviation from Mean Elevation	n/d	Fiera Biological. Layer was created using LiDAR DEM data provided by the Government of Alberta	Derivation of land cover classification
Roads	2014	Alberta Base Features	Derivation of land cover classification
Mean Summer Temperature	2013-2018	Fiera Biological. Layers created using Landsat 8 imagery	Derivation of land cover classification
Mean and Standard Deviation of NDVI	2013-2018	Fiera Biological. Layers created using Sentinel 2 imagery	Derivation of land cover classification
ABMI Human Footprint	2016/2017	Alberta Biodiversity Monitoring Institute	Semi-automated clean-up of classification
6 m Land Cover	2017	Fiera Biological. Layer was created using SPOT 6/7 satellite data provided by the Government of Alberta and derived layers	Derivation of RMAs and quantification of intactness metrics

Table 3. Land cover classes that were used to derive the land cover classification for the Upper Beaver watershed.

Level 1	Level 2	Description
Forest	Coniferous	Coniferous trees (needle-leaf) cover greater than 75% of treed area.
	Deciduous	Broadleaf trees covering greater than 75% of treed area.
	Shrub	Vegetation cover that is at least 1/3 shrub (low/short woody plants), with little or no presence of tress (<10% tree crown closure). Includes upland shrub and riparian shrub (e.g. shrub on gravel bars, shrub around marshes).
Natural Grassland	Natural Grassland	Naturally grassy areas with <1/3 shrub cover and <10% tree cover.
Open Water	Open Water	Any open water (lakes, permanent wetlands, standing water) and flowing water. Includes artificial waterbodies (e.g., dugouts and reservoirs).
Wetland*	Marsh	Low lying areas dominated by emergent or graminoid vegetation and depressional areas adjacent to streams/creeks and lakes.
	Swamp	Depressional areas dominated by deciduous tree or shrub cover.
	Bog	Areas that appear to be dominated by black spruce cover where no water flow is apparent.
	Woody Fen	Depressional areas dominated by woody vegetation cover (trees or shrubs) where surface water flow is apparent.
	Graminoid Fen	Depressional areas dominated by graminoid vegetation cover where surface water flow is apparent.
Agricultural Depression	Agricultural Depression	Human impacted/altered wetland basins in agricultural areas lacking intact emergent vegetation. In croplands these basins are typically cultivated and/or drained, and in pasture these low lying areas may be drained and/or utilized for agricultural purposes such as providing water for cattle.
Natural Bare Ground	Natural Bare Ground	Naturally occurring bare soil, sand, sediment, banks, and beaches.
Agriculture	Pasture	Agricultural areas used primarily as pasture or hayland.
	Cropland	Agricultural areas used primarily as cereal crop. Tilled most years.
Disturbed Vegetation	Disturbed Vegetation	Non-agricultural human-impacted or managed non-woody vegetation.
Built Up/Exposed	Human Built	Human built features and human-caused exposed/bare areas.
	Roads	Paved and unpaved roads.

*NOTE: The wetland class names included in this land cover classification are similar to those used in the Alberta Wetland Classification System; however, this land cover classification should not be considered to be a wetland inventory.

3.1.2. Land Cover Classification Accuracy Assessment

Accuracy of the land cover was assessed using traditional remote sensing techniques, which provide a measure of accuracy for each land cover class, as well as an overall accuracy for all classes combined. Accuracy of the land cover layer was assessed at Level 1 using a stratified validation dataset that was a combination of held back training data points (samples collected at the same time as training data was selected, but were not used to train the random forest model) and randomly selected points that were collected by a trained photo interpreter. A total of 299 samples were used to assess accuracy, with a minimum number of 10 samples validated for each class. The Natural Bare Ground class was not included in the accuracy assessment because it covers less than 0.1% of the study area, and collecting enough samples to validate this class was not feasible.

Overall accuracy at Level 1 for the classification was 94% with a Kappa statistic of 0.92 (Table 4). Class accuracies were high for all classes, with minor confusion between the Forest and Wetland classes in areas where lowland woody cover transitioned to upland woody cover. Some confusion also occurred between the Agriculture, Wetland (marsh), and Agricultural Depression categories, which is expected given the difficulty discerning between these classes without confirmation from a field visit. Confusion between Disturbed Vegetation and Agriculture classes was also noted in transition areas between farmyards and pasture land. Users of this land cover classification should also note that many riparian areas next to streams and rivers have been classified as a wetland cover class (e.g., marsh, graminoid fen, woody fen) throughout many parts of the watershed.

While the land cover and riparian assessment results for the Upper Beaver watershed were not validated using field data, previous riparian assessments completed using this GIS method have been validated using aerial videography data (Fiera Biological 2018a), as well as high resolution imagery and data collected in the field (Fiera Biological 2019). In each case, the riparian assessment results were considered to be very robust when compared against the validation data. When compared to the aerial videography method, overall agreement between the GIS and videography scores was over 75% (Fiera Biological 2018a), and when compared to data collected in the field, the overall agreement between the GIS and field scores was 77% (Fiera Biological 2019). Disagreement between the GIS and field or videography scoring was often related to variability in the interpretation of somewhat “subjective” land cover classes, such as when deciding between natural grassland and pasture or disturbed vegetation.

Table 4. Accuracy assessment results for the Level 1 land cover classes.

	Agricultural Depression	Agriculture	Built Up / Exposed	Disturbed Vegetation	Forest	Natural Grassland	Open Water	Wetland	User Accuracy
Agricultural Depression	8	0	0	0	0	0	0	0	100%
Agriculture	2	60	0	3	1	1	0	0	90%
Built Up / Exposed	0	0	10	1	0	0	0	0	91%
Disturbed Vegetation	0	1	0	6	0	0	0	0	86%
Forest	0	0	0	1	98	0	0	3	97%
Natural Grassland	0	0	0	0	2	9	0	0	82%
Open Water	0	0	0	0	0	0	18	0	100%
Wetland	2	0	0	0	4	0	0	72	95%
Producer Accuracy	80%	98%	100%	60%	93%	90%	100%	96%	94%

NOTE: Producer accuracy measures errors of omission (exclusion) and assesses how well real-world land cover types have been classified. User accuracy measures errors of commission (inclusion), which represents the likelihood of a classified pixel matching the land cover type of its corresponding real-world location.

3.1.3. Editing Water Boundary Data

The provincial hydrography data for the waterbodies of interest were used to delineate the shorelines included in this assessment. Due to the dynamic nature of waterbodies and the vintage of the provincial dataset, the location of the hydrography feature does not always correspond well with shorelines in current satellite imagery. In order to ensure the generation of RMAs and quantification of the intactness metrics were accurate, the hydrography data was manually edited, where necessary, to ensure that the boundaries corresponded with the SPOT 6/7 imagery and the land cover classification. For streams, the edited water boundary represents the approximate centreline of the watercourse. Where the width of a stream or creek was greater than 20 m for a distance of more than 50 m in the SPOT imagery, or the stream passed through an area of open water greater than 1.0 ha, the stream was split and edited to have a unique left and right bank. Lake and open water shorelines were edited to approximate the location of the boundary between the upland and riparian zone. The edited water boundaries for assessed features have an approximate mean accuracy of +/- 5 m relative to their location in the SPOT imagery that was used to derived the land cover layer for this project.

Figure 3. Example of the spatial inaccuracies associated with stream boundaries, where the location of the stream centre line does not match the actual location of the stream and exceeds the 5 m accuracy tolerance in the SPOT imagery. In this example, the yellow lines represent the location of the streamline from the provincial data and the blue line represents the manually edited location of the new stream centre line.

3.1.4. Delineating Riparian Management Area Width and Length

In order to allow for comparisons between watersheds, the GIS methods that were developed to assess riparian areas in the Modeste watershed (Fiera Biological 2018a) were applied in this watershed. As per the GIS method, which was developed to closely match previously developed aerial videography methods (Teichreb and Walker 2008), riparian intactness was assessed within a “riparian management area” (RMA).

RMAs are areas along the shoreline of a waterbody that include the near-shore emergent vegetation zone, the riparian zone, and a riparian protective (buffer) zone (Figure 4). An RMA has two spatial components: width and length. For this assessment, riparian intactness was evaluated within RMAs that had a static 50 m wide buffer that was applied to the left and right banks of each watercourse. For lakes, a single 50 m wide buffer was applied to the shoreline. When assessing riparian condition using aerial videography, RMA length is determined by a change in the score of any single metric, and is thus variable. In order to replicate this approach, we chose to delineate the upstream and downstream extents of each RMA based upon major changes in the proportion of natural cover along the shoreline.

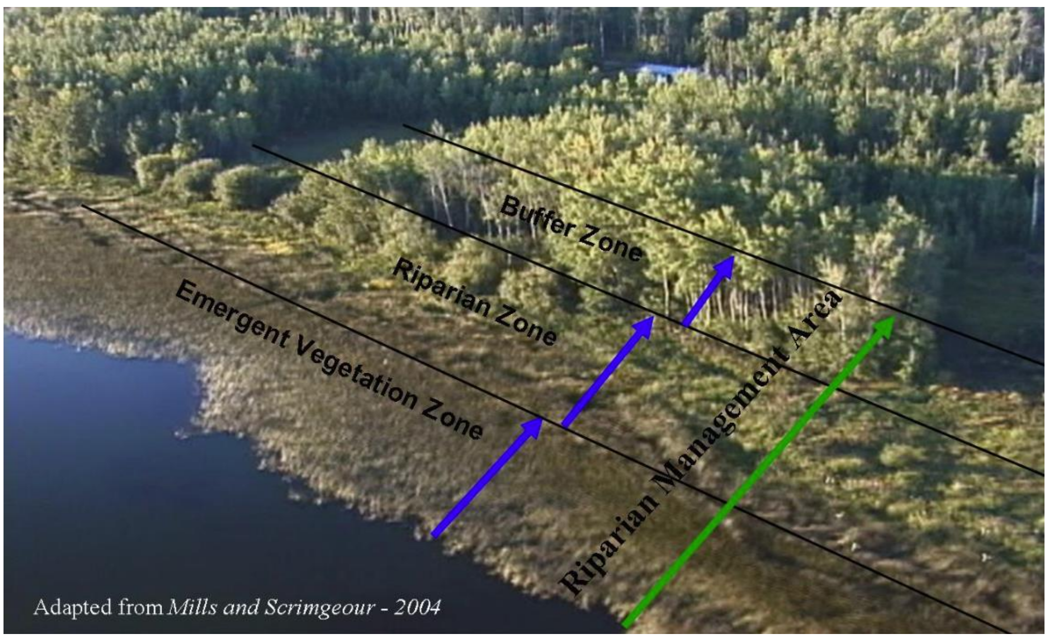


Figure 4. Schematic showing the different shoreline components included in a “riparian management area” (image taken from Teichreb and Walker 2008).

In order to determine the longitudinal extent of each RMA, the proportion of all natural cover types along the shoreline was evaluated, with the start and end points of each RMA corresponding with locations where there were major changes in the proportion of natural cover. To calculate the proportion of natural cover, all natural cover classes in the land cover (i.e., Wetland, Open Water, Natural Grassland, Natural Bare Ground, Forest) were selected and exported as a single layer. The stream layer was then divided into 10-meter segments on the left and right banks and the proportion of natural cover within a 25 m moving window was calculated for each segment. A threshold was used to identify locations along the shoreline within the moving window where there was greater than or less than 55% natural cover. All adjoining homogeneous segments of less than or more than 55% natural cover were then merged to become a single RMA. This threshold value was selected based upon an iterative threshold testing procedure to determine the percent of natural vegetative cover that best approximated the videography RMA boundaries (Fiera Biological 2018a). To reduce error associated with misclassification in the 6 m land cover, very small RMAs (≤10 m) were merged and dissolved with neighbouring segments.

3.1.5. Assigning Unique IDs to Edited Water Boundary Data

Many of the waterbodies in the provincial hydrography data are unnamed features with no unique identification code. Additionally, some names are duplicated several times for features across the province, which can result in confusion and also makes reporting results complicated. As part of this project, a naming schema for newly assessed waterbodies was developed and applied at the HUC 6-level to ensure each waterbody could be identified uniquely and summarized individually. Features were named using the following set of rules:

- **Named Streams** – Streams, creeks, or rivers with an existing name in the Alberta Base Features hydrography dataset or the FWMIS Hydro Arcs dataset retained their existing name. If a name was duplicated in a HUC 6 (e.g., two different streams both named Happy Stream), they were numbered sequentially from west to east (i.e., Happy Stream 1, Happy Stream 2).
- **Named Lakes** – Lakes with an existing name in the Alberta Base Features hydrography dataset or the FWMIS Hydro Arcs dataset retained their existing name. If a named was duplicated in a HUC 6 (e.g., two different lakes both named Pleasant Lake), they were numbered sequentially from west to east (i.e., Pleasant Lake 1, Pleasant Lake 2).
- **Unnamed Lakes** – Lakes with no name in either of the provincial hydrography datasets were assigned a unique ID by combining "UL" with the HUC 6 numeric ID code, along with a number starting at 01 and increasing sequentially moving north to south and west to east (e.g., for unnamed lakes assessed in the Frog HUC 6, the IDs are "UL-110302-01", "UL-110302-02", etc.).
- **Unnamed Creeks** – Streams and creeks with no name assigned in either provincial hydrography datasets were named based on the type of waterbody they flowed into, as follows:
    - **Unnamed Creek into Named Stream** – Unnamed creeks were named based on the Named Stream they flowed into and numbered sequentially starting at the furthest point upstream (e.g., Hooray River-01, Hooray River-02, Hooray River-03). All branches upstream from where a given tributary entered a named stream were considered the same unnamed creek for the purposes of this project.
    - **Unnamed Creek into Named Lake** – Unnamed creeks were named based on the Named Lake they flowed into and numbered sequentially starting at the "12-o-clock" position (e.g., Smiling Lake-01, Smiling Lake -02, Smiling Lake -03). All branches upstream from where a given tributary entered a named lake were considered the same unnamed creek for the purposes of this project.
    - **Unnamed Creek into Unnamed Lake** – Unnamed creeks were named based on the Unnamed Lake they flowed into and numbered sequentially starting at the "12-o-clock" position starting with "US" (e.g., UL-110302-01-US01, UL-110302-01-US02, UL-110302-01-US03). All branches upstream from where a given tributary entered an unnamed lake were considered the same unnamed creek for the purposes of this project .
    - **Isolated Unnamed Creek** – Isolated unnamed creeks (i.e., does not flow downstream into any other water body) were named by combining "US" with the HUC 6 numeric ID code, along with a number starting at 01 and increasing sequentially moving north to south and west to east (e.g., for isolated unnamed creeks assessed in the Paintearth HUC 6, the IDs are "US-090201-01", "US-090201-02", etc.).
    - **Unnamed Creek into Unnamed Creek** – Unnamed creeks were named based on the Isolated Unnamed Creek they flowed into and numbered sequentially starting at furthest point upstream (e.g., US-090201-01-US01, US-090201-01-US02).

3.1.6. Indicator Quantification and Riparian Intactness Scoring

Intactness with each riparian management area was quantified using the following metrics:

Metric 1: Percent cover of natural vegetation;
Metric 2: Percent cover of woody species;
Metric 3: Percent cover of all human impact and development (human footprint).

To quantify Metric 1, all natural cover classes were selected from the land cover layer and the proportion of the RMA covered by those cover classes was calculated. The natural classes used to quantify this metric included: Treed Wetland (Bog, Swamp, Woody Fen), Graminoid Fen, Marsh, Forest, and Natural Grassland. To quantify Metric 2, the percent cover of Forest and Treed Wetland land cover classes was quantified for each RMA. For Metric 3, the percent cover of the following land cover classes were used to calculate human footprint within each RMA: Cropland, Pasture, Agricultural Depression, Disturbed Vegetation, and Built Up/Exposed.

Once each metric was quantified, the values were range standardized and were aggregated using a weighting comparable to the aerial videography methods. The metrics were weighted as follows: Metric 1: 0.15; Metric 2: 0.25; Metric 3: 0.60. The weighted scores were aggregated to derive a final RMA score that ranged between 0 and 100, and these scores were converted into intactness categories using the following categorical breaks:

- High Intactness (≥75-100): Vegetation within the RMA is present with little or no human footprint.
- Moderate Intactness (≥50-75): Vegetation within the RMA is present with some human footprint.
- Low Intactness (≥25-50): Vegetation cover within the RMA is limited and human footprint is prevalent.
- Very Low Intactness (0-25): Vegetation cover within the RMA is mostly cleared and human footprint is the most dominant land cover.

3.2. Assessing Pressure on Riparian System Function

We adapted the Watershed Integrity scoring methodology (Flotemersch et al. 2016) to assess Pressure on Riparian System Function in the HUC 6 watershed. In this method, Watershed Integrity, *WI*, is the product of different watershed functions, with the underlying premise being that *"A high level of integrity exists when all functions are operating at levels that support and maintain the full range of ecological processes and functions essential to the long-term sustainability of biodiversity and ecosystem services" (*Flotemersch et al. 2016, pg. 1660).

With this approach, when any one of the functional components are compromised, the integrity of the watershed is also compromised, and as more functions are compromised, the integrity is compromised in a multiplicative way. We applied this watershed integrity approach to define and calculate Catchment Pressure, *CP*, with the objective of measuring the factors that increase or decrease the ecological and hydrological function of riparian habitats.

In our model, catchment pressure is the product of two functions that describe pressures that may occur within a local catchment area: Natural Resilience (*NR*) and Human Impacts (*HI*). Catchment pressure was calculated using the following equation, with higher scores indicating areas where there may be heightened pressure on riparian system function:

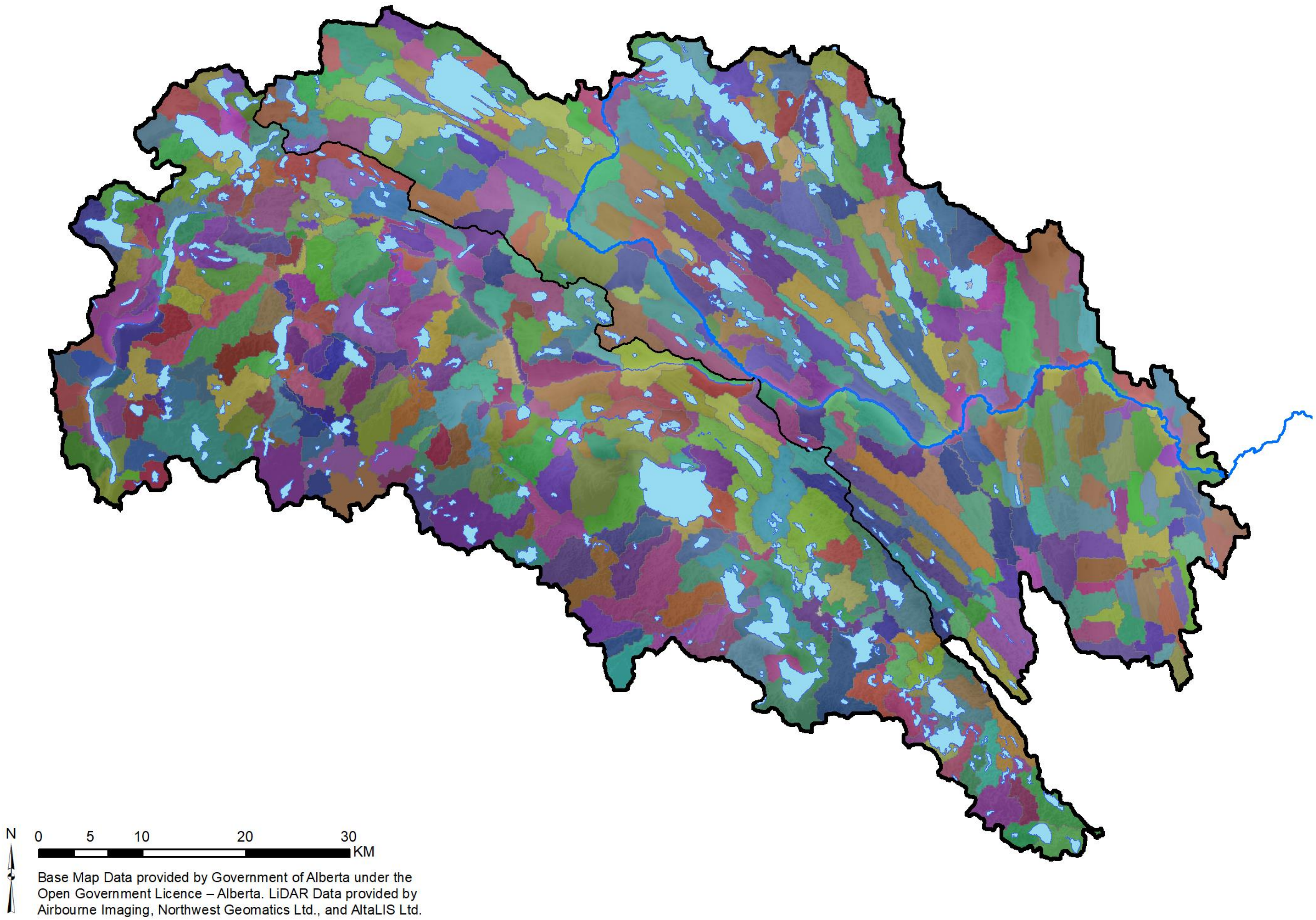
$$CP = CP_{NR} \times CP_{HI}$$

Natural Resilience (*NR*) and Human Impact (*HI*) function scores were calculated from a set of associated stressor metrics (S_i) that are known to affect riparian function and are measurable in a GIS environment. A list of the stressor metrics associated with each function, along with a description of how each stressor was quantified and the data used for the quantification, is provided in Table 5.

Variables that exert pressure on riparian system function range spatially from large-scale to site-specific. We conducted a pressure assessment at a local "catchment" scale, which we considered to be a scale that was meaningful both from the perspective of ecological and hydrological processes, as well as from the perspective of land management. Local catchment areas were identified using the Government of Alberta ArcHydro Phase 2 dataset (GOA 2018; Map 7). Catchments were edited to reflect the left and right contributing areas of the streams in the assessment by splitting them with the streams of interest. Local catchment areas that intersected the RMAs of the waterbodies included in this study were used as the unit of analysis for the pressure assessment.

Table 5. List of metrics used to assess pressure on riparian system function, along with a description of the methods used to assess each metric and the source and vintage of the data used for metric quantification. Each metric was quantified within local catchment areas that were derived specifically for this assessment using LiDAR 15 m data provided by the Government of Alberta.

Function	Stressor Metric	Metric Quantification	Data Source & Date
Natural Resilience (*NR*)	Natural Cover	Percent cover by natural vegetation cover classes	Fiera Biological Upper Beaver watershed Land Cover (2017/2018)
	Slope	Mean cover of steep slopes (>5°)	Fiera Biological, derived from Government of Alberta 15 m DEM
	Landslide Susceptibility	Area weighted average	Alberta Geological Survey (2016)
Human Impacts (*HI*)	Land Use Intensity	Zonal average of land use intensity values	Fiera Biological Upper Beaver watershed Land Cover (2017/2018) and ABMI Human Footprint (2016)
	Stream Crossing Density	Area weighted average of linear features that intersect major streams	Government of Alberta base features (2018)
	Road Density	Area weighted average of roads	Government of Alberta base features (2018)
	Density of Other Linear Disturbance Types	Area weighted average of non-road linear features	Government of Alberta base features (2018)



Map 7. Local catchment areas in the Upper Beaver watershed.

3.2.1. Quantifying Stressor Metrics & Calculating Function Scores

In order to quantify the Land Use Intensity stressor metric, a land use intensity value was assigned to each land cover and human footprint type present in the watershed. To quantify this metric, the SPOT land cover and ABMI human footprint layers were used together, which allowed for intensity characterization by human use type. High intensity of use values were assigned to land cover types that are known to be more impactful on riparian system function, and all values were assigned using best professional judgment informed by a literature review (Donahue 2013). We tested several different schemes for assigning intensity of land use values, and an appropriate range of values and magnitudes was selected by iteratively inspecting output maps and intensity values and ranges. Where the SPOT land cover and ABMI human footprint overlapped, the maximum Intensity of Use value was applied. The final intensity value assignments for land cover in the watershed are provided in Table 6.

Table 6. Intensity of use values assigned to the various land cover classes present in the HUC 6 watershed.

Land Cover Class	Intensity of Use Value
Agriculture – Crop	50
Agriculture – Pasture/Forage	50
Airport	1000
Canals	10
Cultivation (Crop/Pasture/Bare Ground)	50
Cut Block	50
Dugout/Burrow-Pit/Sump	10
Exposed/Barren	1000
High-Density Livestock Operation	1000
Industrial Site (Urban/Heavy Industry)	1000
Industrial Site (Rural)	500
Mine Site	1000
Municipal Water/Sewage	50
Disturbed Vegetation (Other)	25
Peat Mine	100
Pipeline	50
Rail – Hard Surface	100
Rail – Vegetated Verge	50
Reservoir	10
Road – Hard surface	100
Road Vegetated Verge	50
Road/Trail – Vegetated	100
Rural Residential	50
Seismic Line	50
Transmission Line	25
Urban/Developed	1000
Well Site	100

Scores for each of the GIS stressor metrics were calculated using ArcGIS 10.8 in one of two ways. For stressors that have a known measurable biological response, literature-derived thresholds were used to define the maximum feasible value (Table 7). This threshold is the value above which the stressor impairs function beyond a repairable or reversible state. For example, forest cover of at least 25% is required to minimize water quantity/quality issues (Adams and Taratoot 2001), so any catchment with ≤25% of forest cover is under maximum pressure for this stressor. For stressors with a known threshold, scores were calculated as:

$$S_i = 1 - \left(\frac{S_{observed}}{S_{threshold}}\right)$$

For stressors that are physical variables (e.g., slope), or for variables for which the biological response threshold value is not known (e.g., intensity of land use), the catchment stressor values were scored against the maximum value from the stressor's range of values within the watershed (i.e., a range standardized score was calculated). For these stressors, scores were calculated as:

$$S_i = 1 - \left(\frac{s_{observed}}{s_{maximum}}\right)$$

A description of the stressor threshold values used in this assessment, and the method used to derive each threshold, is provided in Table 7.

Once stressors were quantified, the values were compiled within their associated pressure function (CP_{NR} and CP_{HI}) and were combined mathematically to calculate a final catchment pressure score. Previously, the natural cover and terrain (slope, landslide susceptibility) metrics have been weighted equally; however, after reviewing the initial model outputs, it was apparent that because of the high degree of topographic variation in the watershed (i.e., hilliness) the terrain metric was penalizing catchments with high amounts of natural cover and high amounts of topographic variability. Thus, different weightings for these two metrics were tested and adjusted to better capture the relationship between natural cover and terrain in this watershed. The formulas used are as follows:

$$CP = CP_{NR} \times CP_{HI}$$

for which,

$$NR = (1.4 * \%Natural\ Cover) + (0.6 * \min(Slope, Landslide\ Susceptibilty))$$

and,

$$HI = (Intensity\ of\ Use + average(Stream\ Crossing\ Density, Road\ Density, Linear\ Density))$$

Once calculated, the raw catchment pressure scores were scaled to allow for better interpretation of the values. Scaling can be performed and applied in different ways, and for this study, a percentage score was calculated by taking the ratio of the raw catchment pressure score to the theoretical maximum possible score. For the Upper Beaver watershed, there are two stressor scores for each function, and all stressors have a maximum score of 1, so the maximum possible score is (1+1) x (1+1) = 4. Dividing the raw catchment pressure score by the theoretical maximum (4) and multiplying by 100 gives a percent score. In order to have high scores representing areas of High Pressure and low scores representing areas of Low Pressure, values were reversed by subtracting the percentage score from 100.

3.2.2. Assigning Pressure Categories

Catchment integrity was translated into catchment pressure by taking the percent scores and grouping the scores into three pressure categories (Low, Moderate, High) based on the quartile percentile breaks for the distribution of scores. Breaks between categories were adjusted manually slightly up or down to give more meaningful breaks between scores. Catchments in the Low Pressure group roughly correspond to the catchments with the top 25% of scores, catchments in the High Pressure group roughly correspond to the catchments with the bottom 25% of scores, and Moderate Pressure catchments roughly correspond to the remaining 50% of scores (i.e., scores between the 25^{th} and 75^{th} percentiles).

Table 7. Thresholds and scoring types used to calculate stressor scores for pressure metrics.

Function	Stressor Metric	Threshold	Scoring Type	References
Natural Resilience *(NR)*	Natural Cover	Minimum 25% cover	Literature review	Target forest cover of 25% for water quantity/quality (Adams and Taratoot 2001)
				30% cover at watershed scale supports less than one half of the potential species richness and marginally healthy aquatic systems (Environment Canada 2014)
				Target cover of at least 35% for subbasins to prevent moderate extirpation of bull trout (Ripley et al. 2005)
				Threshold of 30% natural cover correlated with riverine ecological condition (Deegan et al. 2010)
				6% loss of aquatic species for every 10% loss of natural land cover (Weijters et al. 2009)
	Slope	Maximum value	Range of values	N/A
	Landslide Susceptibility	Maximum value	Range of values	N/A
Human Impact *(HI)*	Land Use Intensity	Maximum value	Range of values	N/A
	Stream Crossing Density	$0.6/km^2$	Literature review	Stream crossings impede fish passage, affect water flow, and water quality - adapted thresholds from bull trout and general fish road density thresholds of $0.6 km/km^2$ and $0.7 km/km^2$ (Tchir et al. 2004)
	Road Density	$1.0\ km/km^2$	Literature review	Extirpation of bull trout at $1.0\ km/km^2$ (AESRD 2012)
				Large mammals affected at various thresholds: $0.4\ km/km^2$ for grizzly bear; $1.25\ km/km^2$ for black bear (AESRD 2012); $0.62\ km/km^2$ for elk (AESRD 2012)
	Density of Other Linear Disturbance Types	$3.0\ km/km^2$	Literature review	Adapted general density threshold for watershed health, where >3 km/km^2 is used as an indicator for poor health (AESRD 2012)

3.3. Management Prioritization

While riparian intactness and catchment pressure scores on their own provide land managers with important information about riparian condition, combining these scores together to create a prioritization matrix that identifies high priority areas for both conservation and restoration allows land managers to more precisely target areas for management.

Combining intactness and pressure scores results in prioritization matrix with 12 scoring categories, and we assigned a unique score ranging between 1 and 12 to each category (Table 8). The assignment of scores to each prioritization category was informed by numerous discussions with key stakeholders, including a steering committee, during the initial development of the GIS method (Fiera Biological 2018a), and there was general consensus that this scoring approach represented the restoration priorities of the majority of stakeholders. The numeric scores were then combined and assigned to one of four prioritization categories, as follows:

- **High Conservation Priority (Category 1-3):** High/Moderate Intactness and Low/Moderate Pressure
- **Moderate Conservation Priority (4-6):** High/Moderate Intactness and Moderate/High Pressure
- **Moderate Restoration Priority (7-9):** Low/Very Low Intactness and Low/Moderate Pressure
- **High Restoration Priority (10-12):** Low/Very Low Intactness and Moderate/High Pressure

For each riparian management area, the pressure score was determined by intersecting the RMA polygons with the catchment polygons. This ensured that the pressure scores, which were calculated as polygons, could be accurately assigned to the RMA polygons. The resulting prioritization polygons were then scored, and the length of each RMA assigned to each priority category was calculated.

Table 8. Riparian prioritization matrix for RMAs in the Upper Beaver watershed.

		RIPARIAN INTACTNESS			
		High	**Moderate**	**Low**	**Very Low**
CATCHMENT PRESSURE	**Low**	1	3	7	9
	Moderate	2	5	8	11
	High	4	6	10	12

High Conservation Priority (1, 2, 3)
Moderate Conservation Priority (4, 5, 6)
High Restoration Priority (10, 11, 12)
Moderate Restoration Priority (7, 8, 9)

3.4. Data Summaries

All jurisdictional data summaries were generated using a spatial intersect rule in ArcGIS, where the results from each analysis (i.e., intactness, pressure, priority) were intersected with the municipal or first nations community boundary layer. Summarizing the data in this way captures the assessed shorelines that fall within the boundary of the jurisdiction; however, it should be noted that there are spatial discrepancies between the jurisdictional boundary data and the provincial hydrography data that are freely available from AltaLIS. For example, in many instances, jurisdiction boundaries follow the boundary of a waterbody (e.g., the boundary between two Counties follows a creek or river) and often, the boundary topology of these two features do not match. In these instances, some minor edits may have been made to correct the intersection outputs and reassign results from one jurisdiction to another, but in most cases, jurisdictional results were not extensively edited to correct topological errors. As a result, the jurisdictional summaries of shoreline length for intactness and priority are approximate and should be considered estimates that reflect relative differences between jurisdictions.

4.0 Watershed Results

4.1. Riparian Management Area Intactness

Riparian intactness was calculated for approximately 2,286 km of shoreline in the Upper Beaver watershed. Overall, 74% of the shoreline that was assessed was classified as High Intactness, with a further 11% classified as Moderate Intactness (Figure 5). Approximately 15% of the shoreline was classified as either Low (5%) or Very Low (10%) Intactness.

A total of 1,551 km of shoreline was assessed within the Amisk River HUC 8 subwatershed, representing approximately 70% of all of the shoreline that was included in this study (Figure 6). When the length of shoreline is considered, the Amisk River subwatershed had the greatest length of shoreline assigned to the High. Low, and Very Low Intactness categories. When the proportion of shoreline assigned to each intactness category is considered, however, the Upper Beaver subwatershed has a greater proportion of shoreline assessed as Low and Very Low (Figure 7).

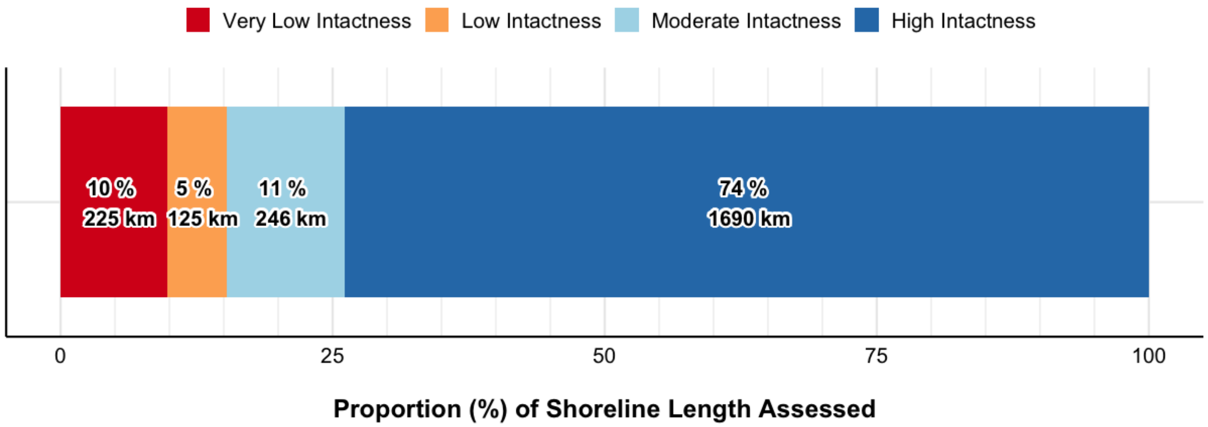


Figure 5. The total proportion of shoreline within the Upper Beaver watershed assigned to each riparian intactness category. Numbers indicate the total length (km) of shoreline associated with each category.

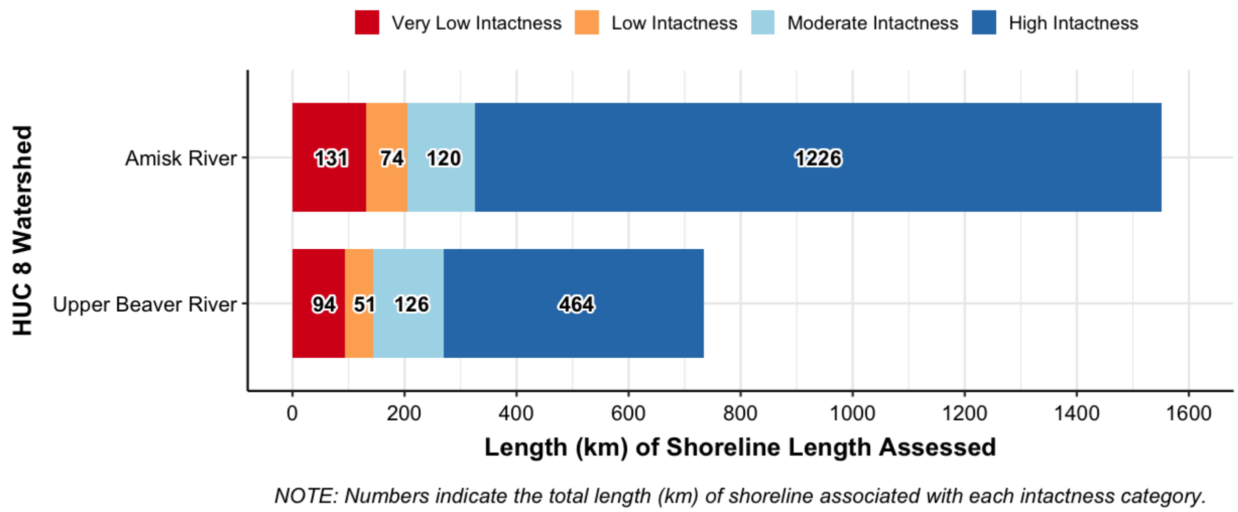


Figure 6. The total length of shoreline within the Upper Beaver watershed assigned to each riparian intactness category, summarized by HUC 8 subwatershed.

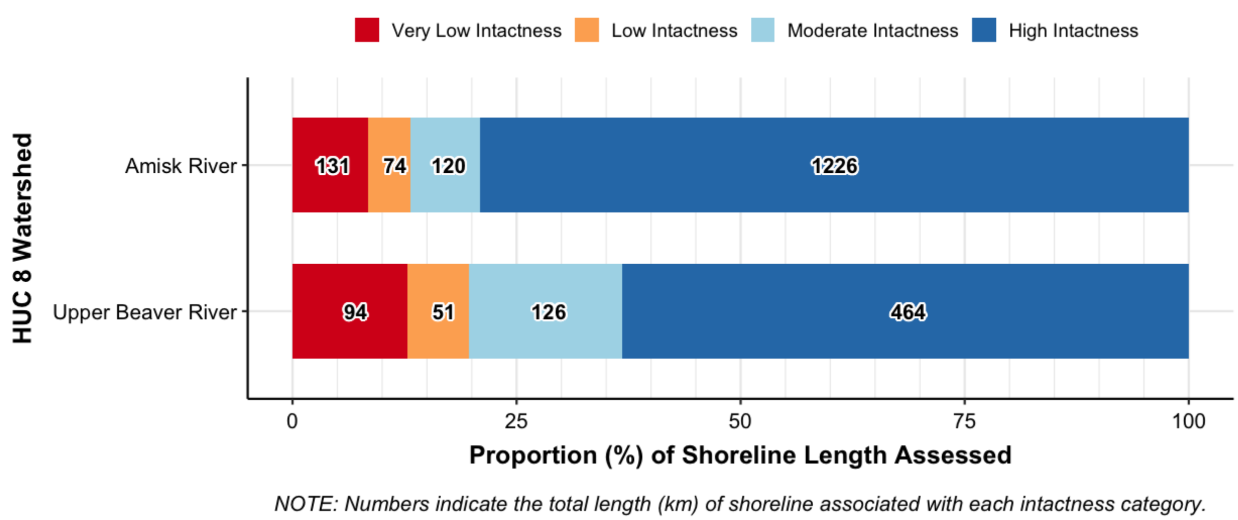


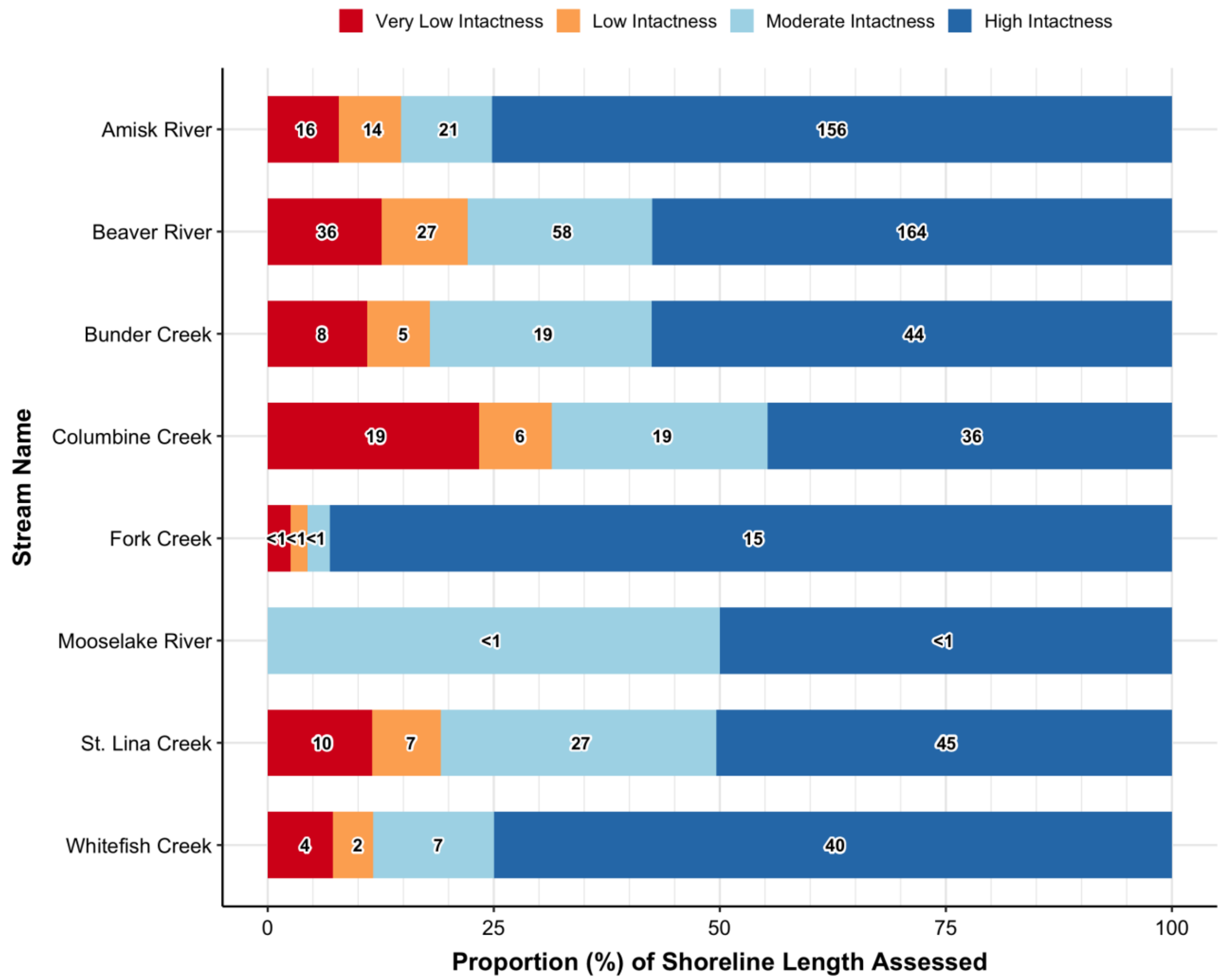
Figure 7. The total proportion of shoreline within the Upper Beaver watershed assigned to each riparian intactness category, summarized by HUC 8 subwatershed.

All of the named streams assessed in this study had more than 65% of their shorelines assessed as either Moderate or High Intactness, with Amisk River, Fork Creek, and Whitefish Creek having the greatest proportion of shoreline assessed as High Intactness (Figure 8). Conversely, Columbine Creek had the greatest proportion of shoreline assessed as Very Low Intactness (23%), while the Beaver River had the greatest length of shoreline assessed as Very Low Intactness (36 km) (Figure 8; Map 8).

Thirty-five unnamed creeks were assessed for intactness as part of this study, and of these, 24 (or 69%) had more than 75% of their shorelines assessed as High or Moderate Intactness (Figure 9; Map 9). In contrast, 11 of the unnamed creeks had more than 25% of their shorelines assessed as Very Low or Low Intactness, and four of these, Bunder Creek-01, Floatingstone Lake-01, St. Lina Creek-02, and St. Lina Cree-03 had greater than 25% of their shoreline assessed as Very Low Intactness. Amisk River-01 had the greatest length (14 km) of shoreline assessed as Very Low Intactness.

A large number of lakes were assessed as part of this study, including 38 named lakes and 46 unnamed lakes (Map 10). Overall, the named lakes were in relatively good condition, with 28 (or 74%) of the named lakes having 75% or more of their shorelines assessed as High or Moderate Intactness (Figure 10). The exceptions to this were Allday, Cole, Denning, Garner, Little Garner, Owlseye, Reed, Snail, and Victor Lakes, which all had more than 25% of their shoreline assessed as Very Low or Low Intactness. Reed Lake had the greatest proportion (61%) and length (12 km) of shoreline assessed as Very Low Intactness. Additional maps illustrating shoreline intactness for Beaver, Elinor, Fork, Garner, and Whitefish Lakes can be found in Appendix B (Maps B-1 to B-5).

Unnamed lakes were also in relatively good condition, with just under half of the lakes having 100% of their shoreline assessed as High Intactness (Figure 11). Only 9 of the unnamed lakes had more than 25% of their shoreline assessed as either Very Low or Low Intactness, with four lakes (UL-120101-25, -33, -43, and -45) all having more than half of their shoreline assessed as Very Low Intactness.



NOTE: Numbers indicate the total length (km) of shoreline associated with each intactness category.

Figure 8. The total proportion of shoreline assigned to each riparian intactness category for named streams assessed in the Upper Beaver watershed.

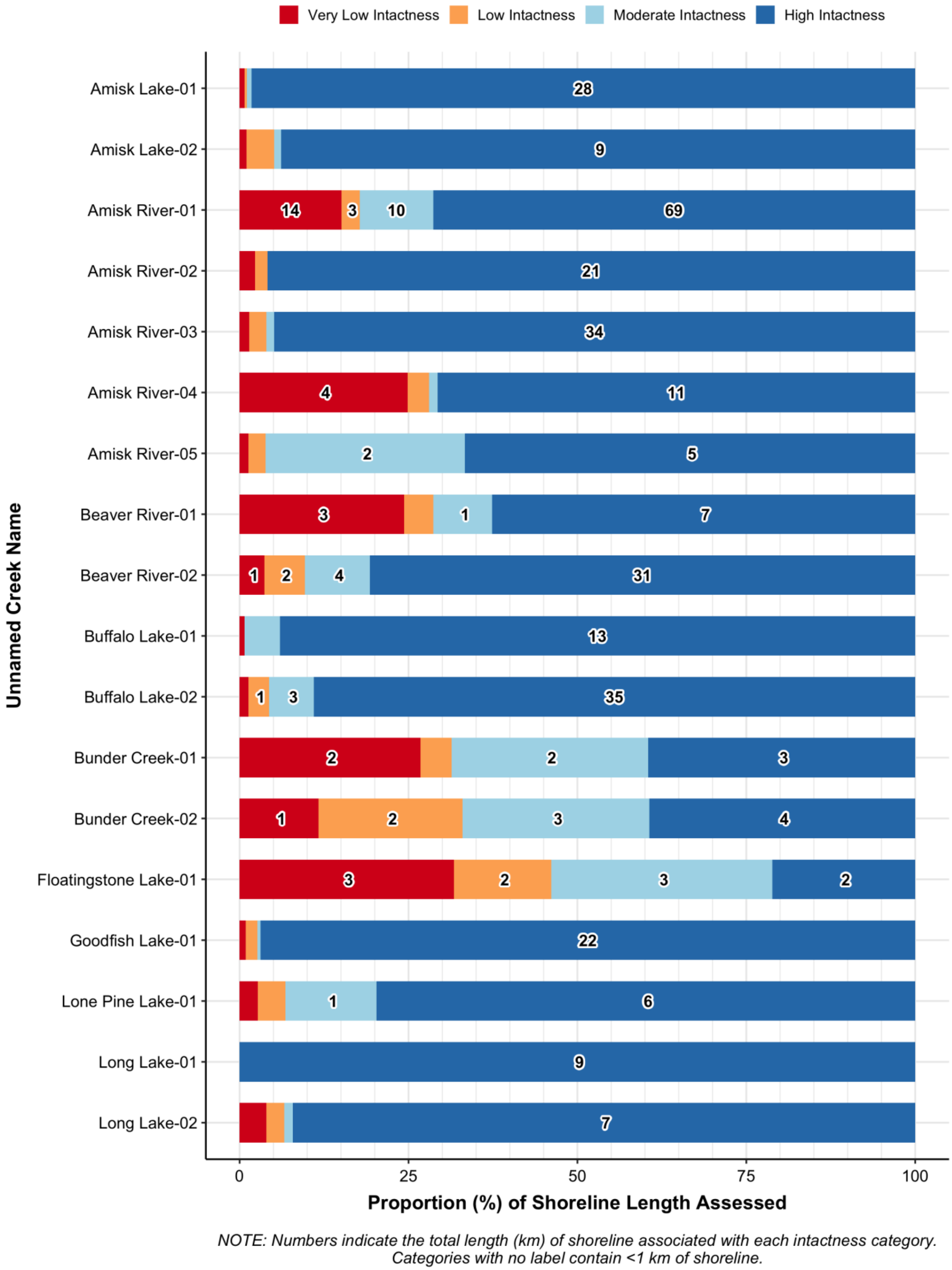
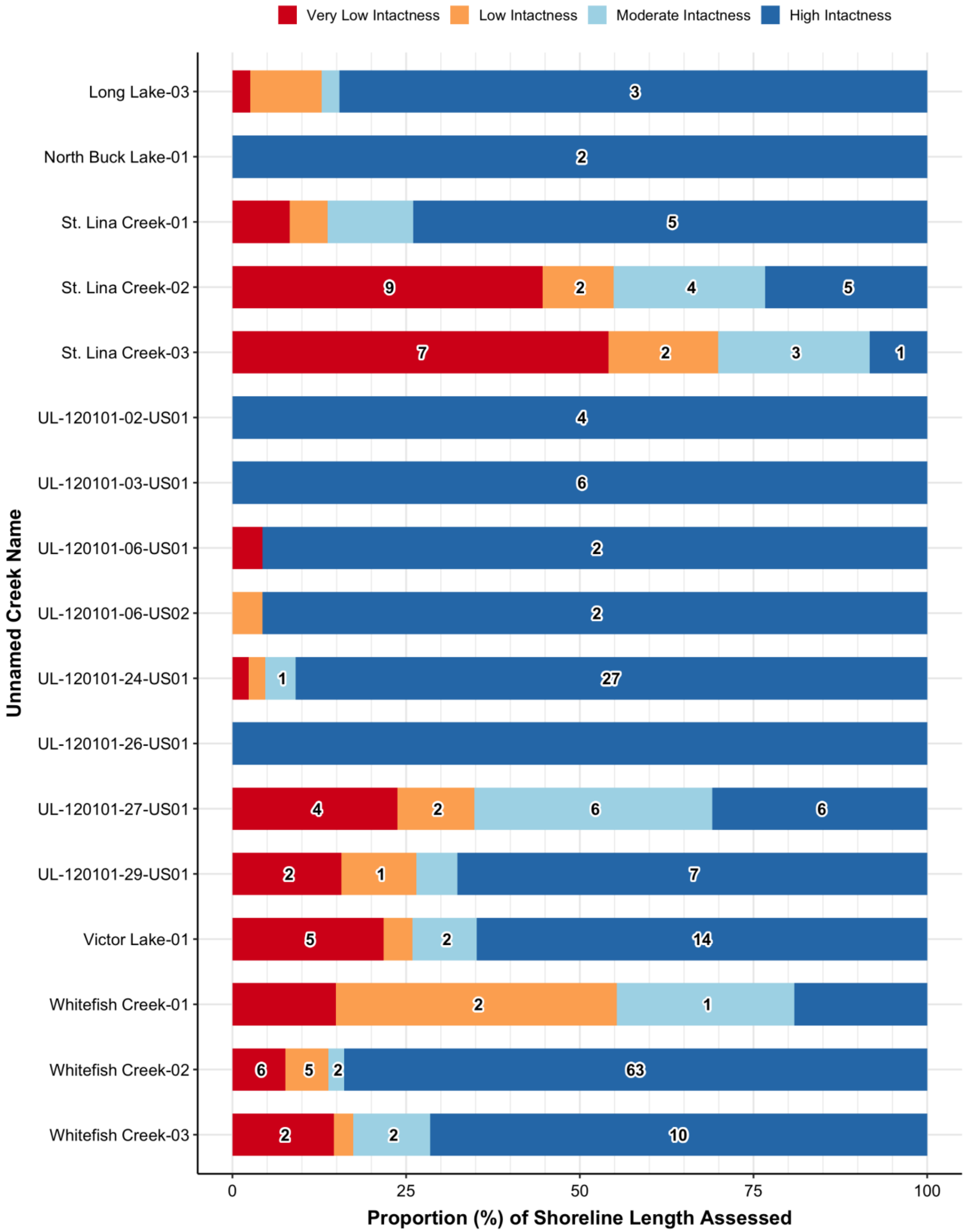


Figure 9. The total proportion of shoreline assigned to each riparian intactness category for unnamed creeks assessed in the Upper Beaver watershed.



NOTE: Numbers indicate the total length (km) of shoreline associated with each intactness category. Categories with no label contain <1 km of shoreline.

Figure 9 *continued*. The total proportion of shoreline assigned to each riparian intactness category for unnamed creeks assessed in the Upper Beaver watershed.

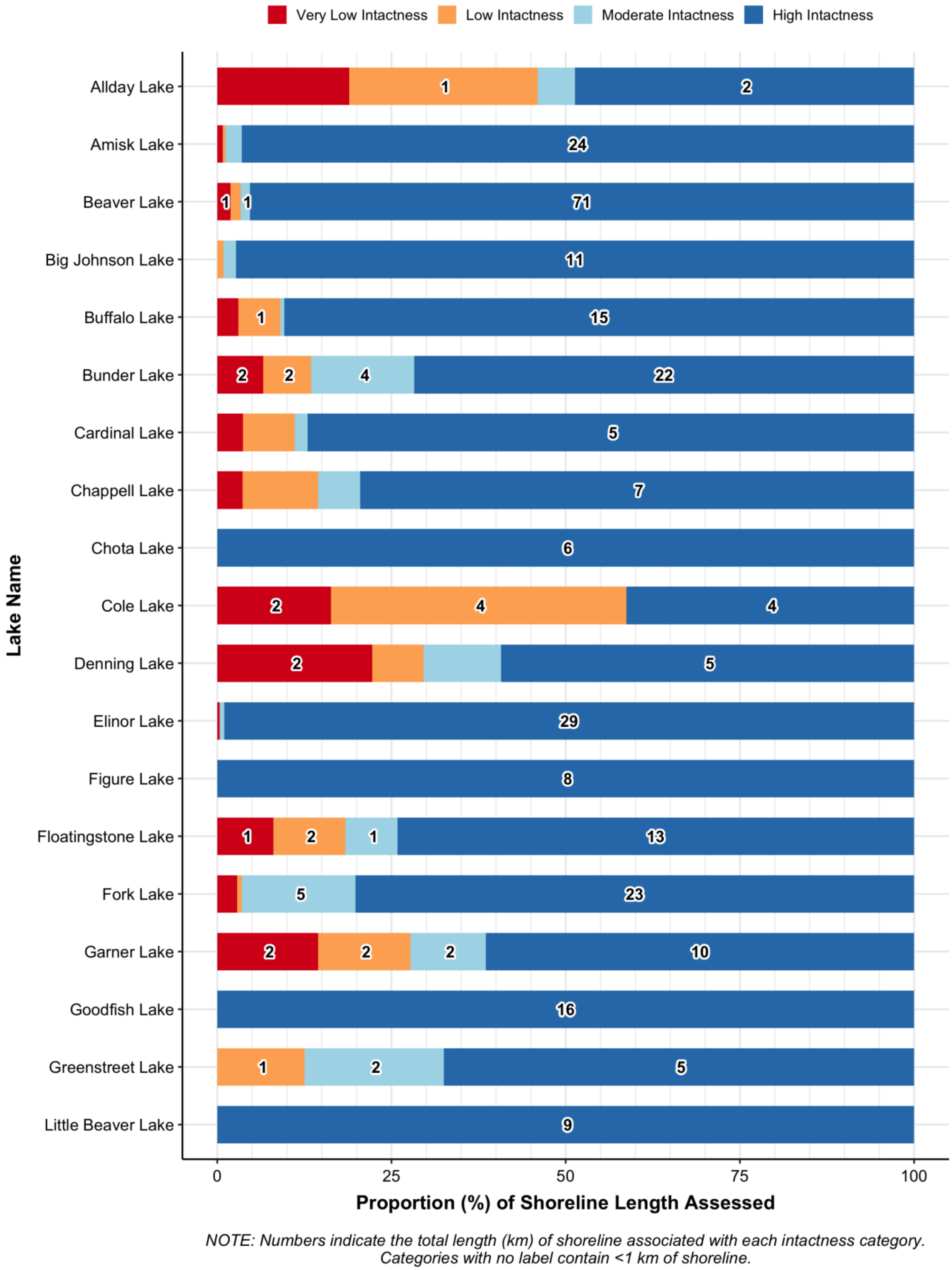
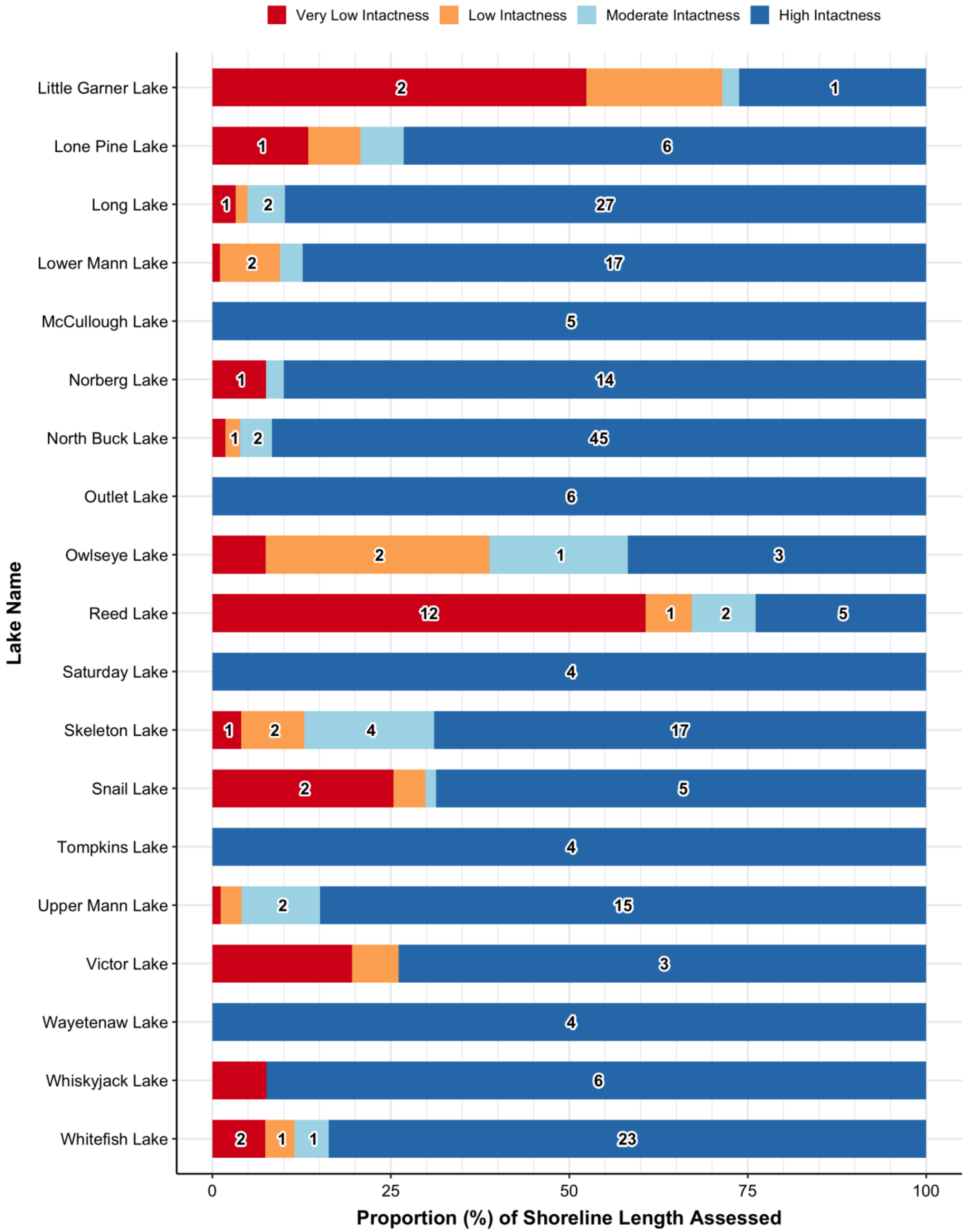
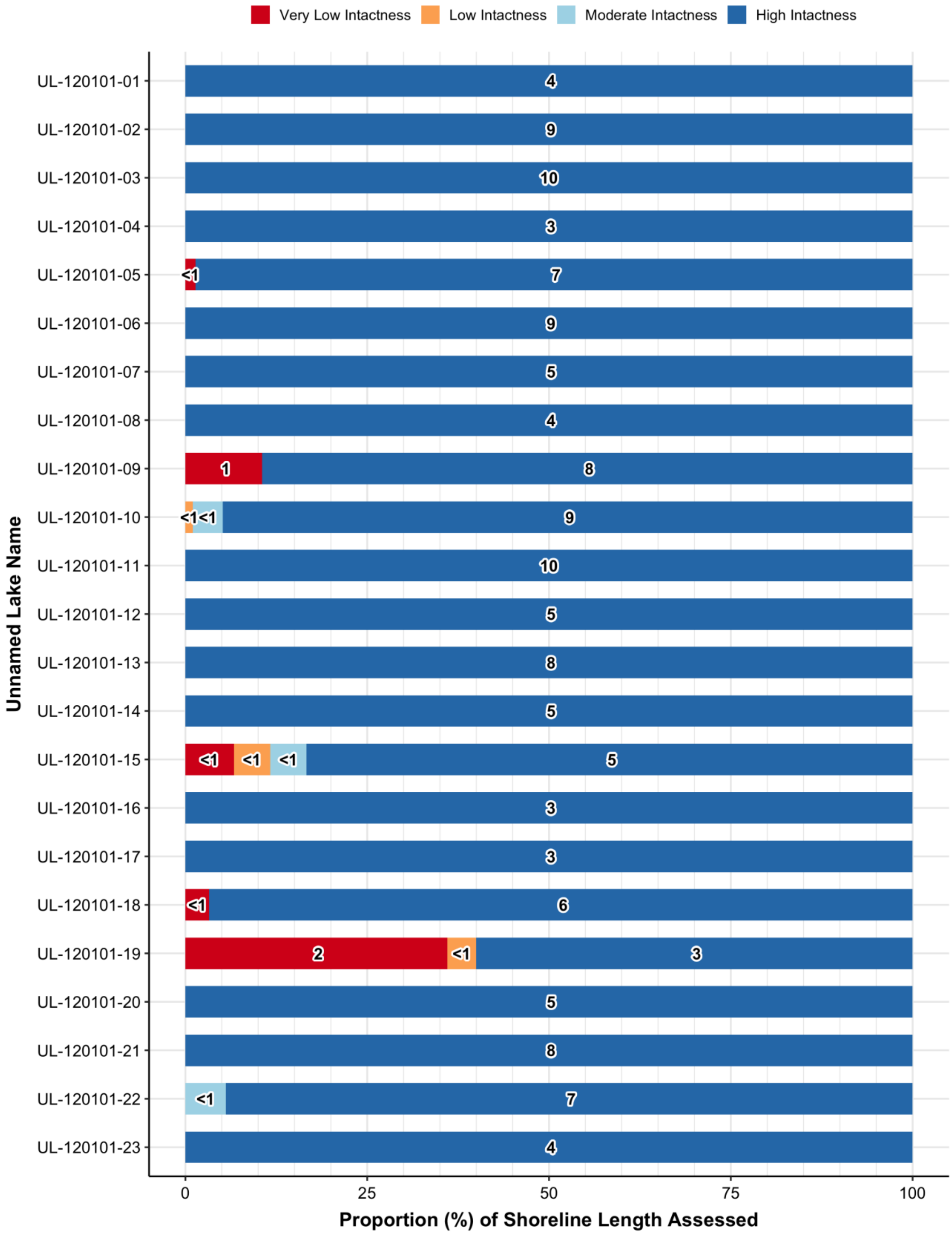


Figure 10. The total proportion of shoreline assigned to each riparian intactness category for named lakes assessed in the Upper Beaver watershed.



NOTE: Numbers indicate the total length (km) of shoreline associated with each intactness category. Categories with no label contain <1 km of shoreline.

Figure 10 *continued*. The total proportion of shoreline assigned to each riparian intactness category for named lakes assessed in the Upper Beaver watershed.



NOTE: Numbers indicate the total length (km) of shoreline associated with each intactness category.

Figure 11. The total proportion of shoreline assigned to each riparian intactness category for unnamed lakes assessed in the Upper Beaver watershed.

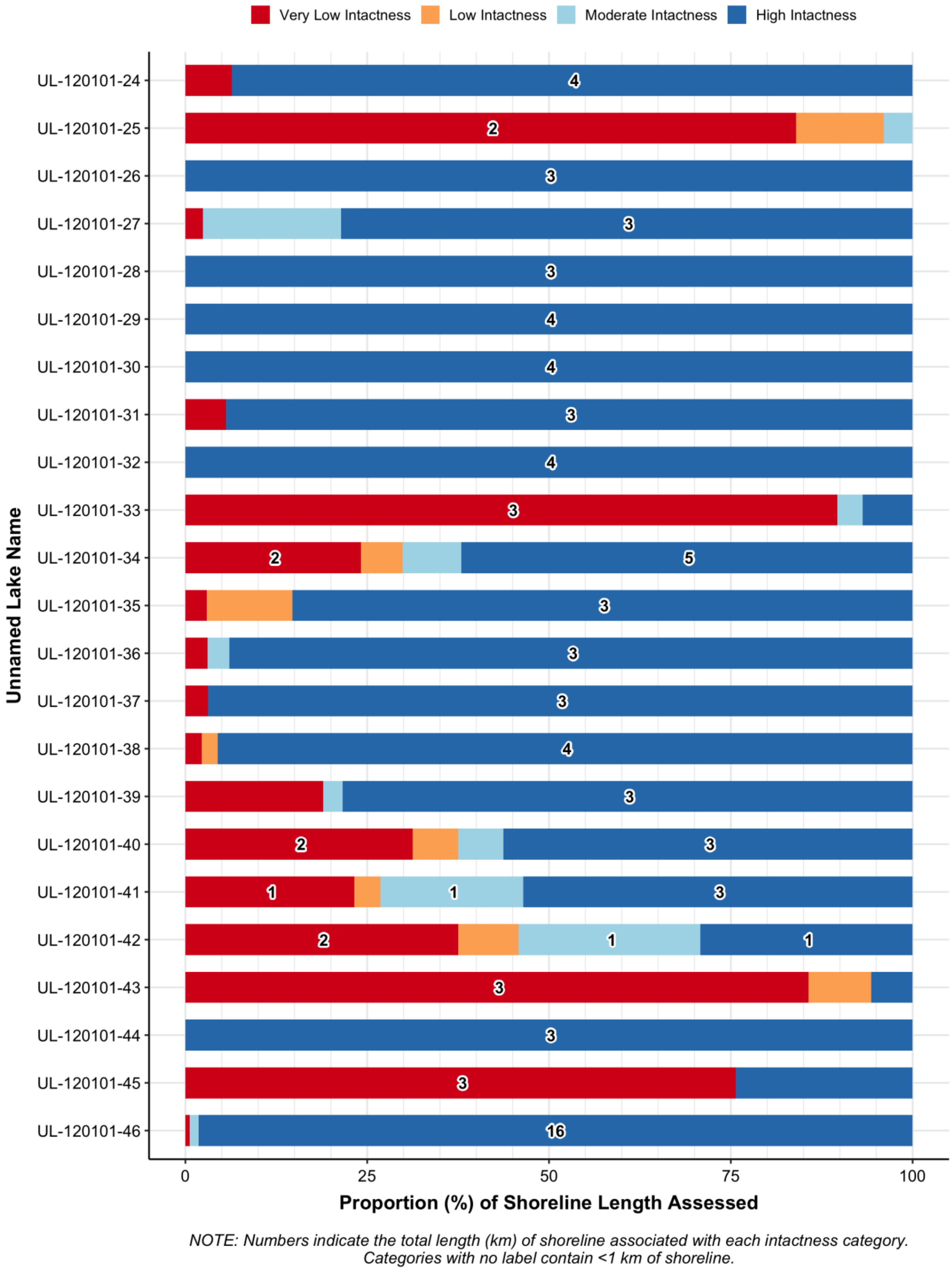
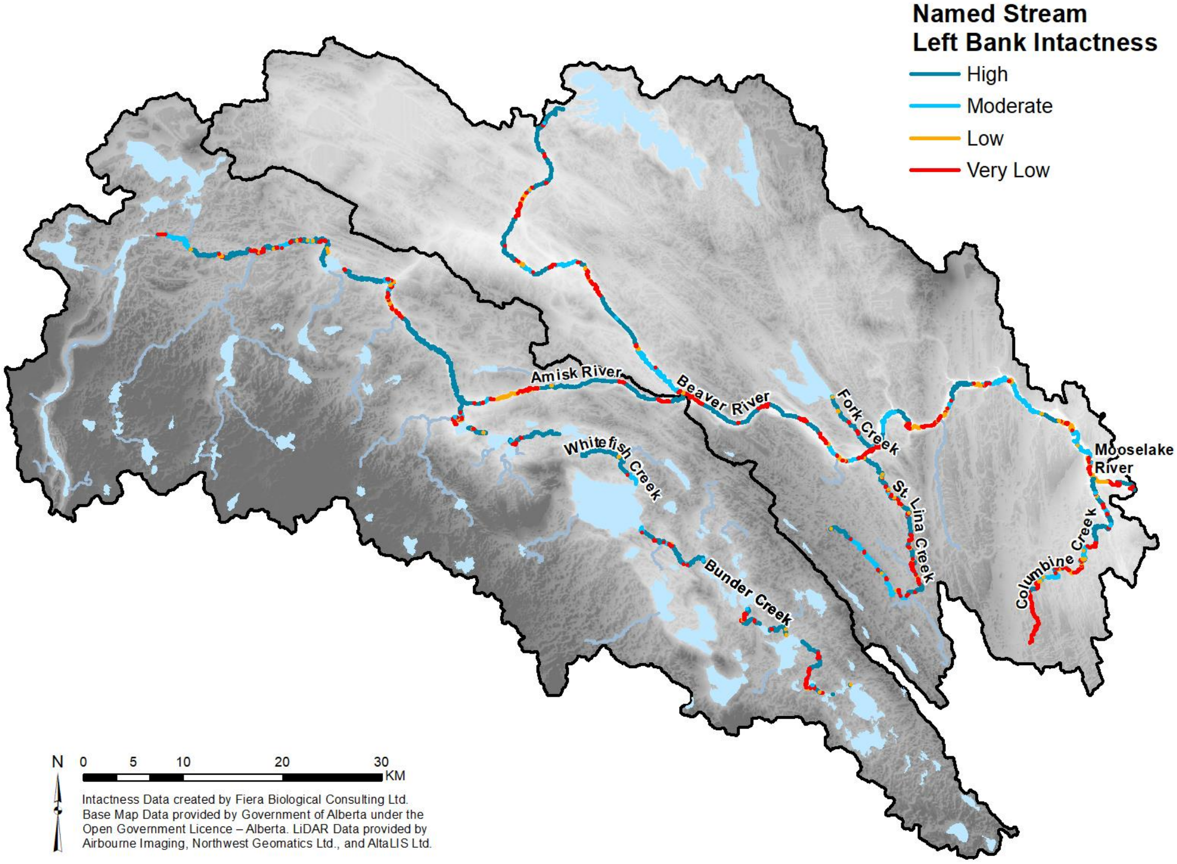
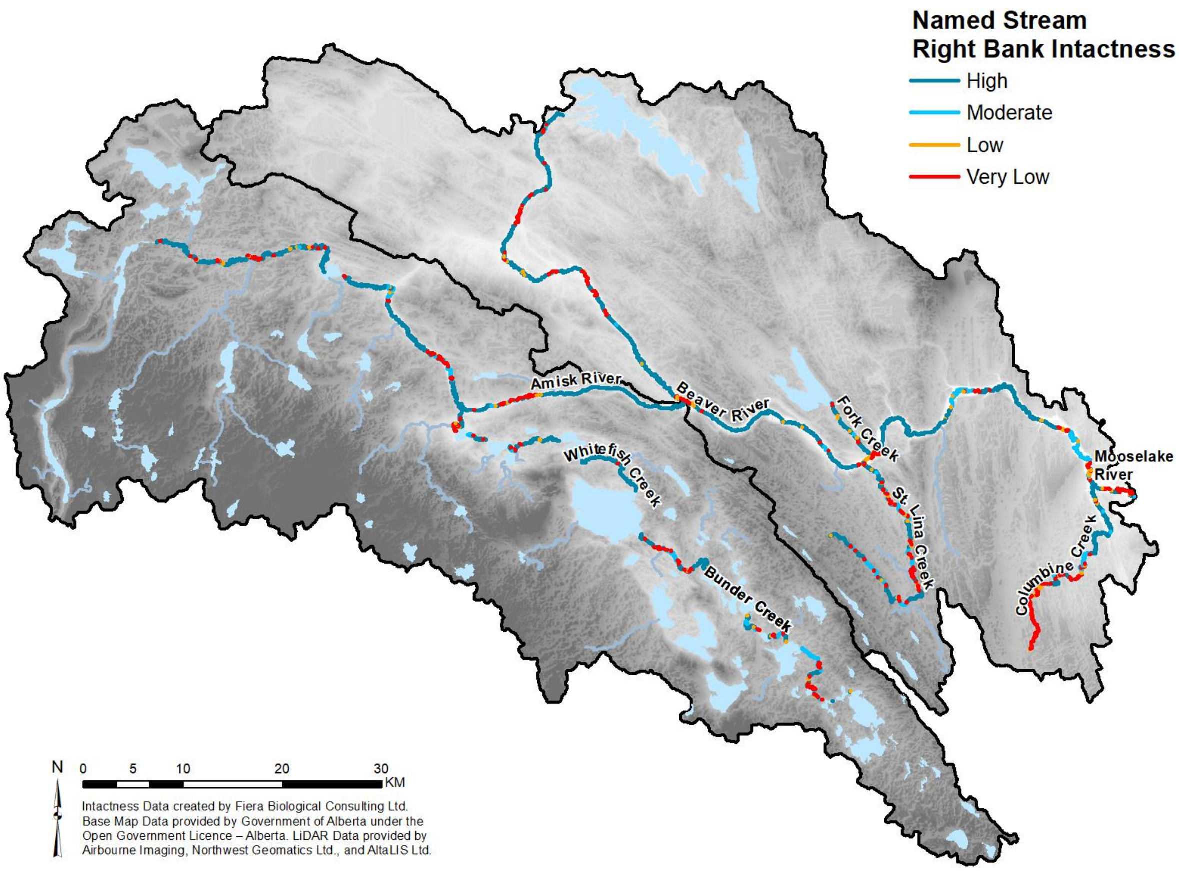
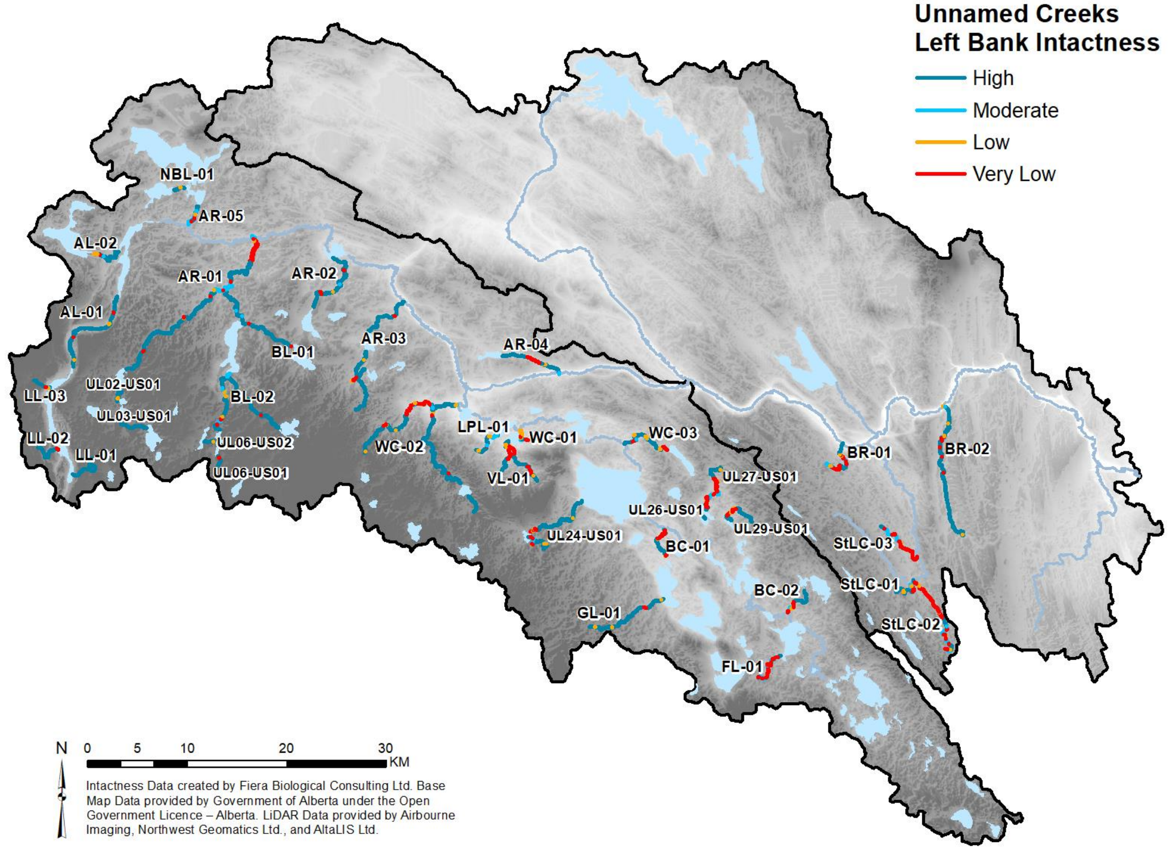


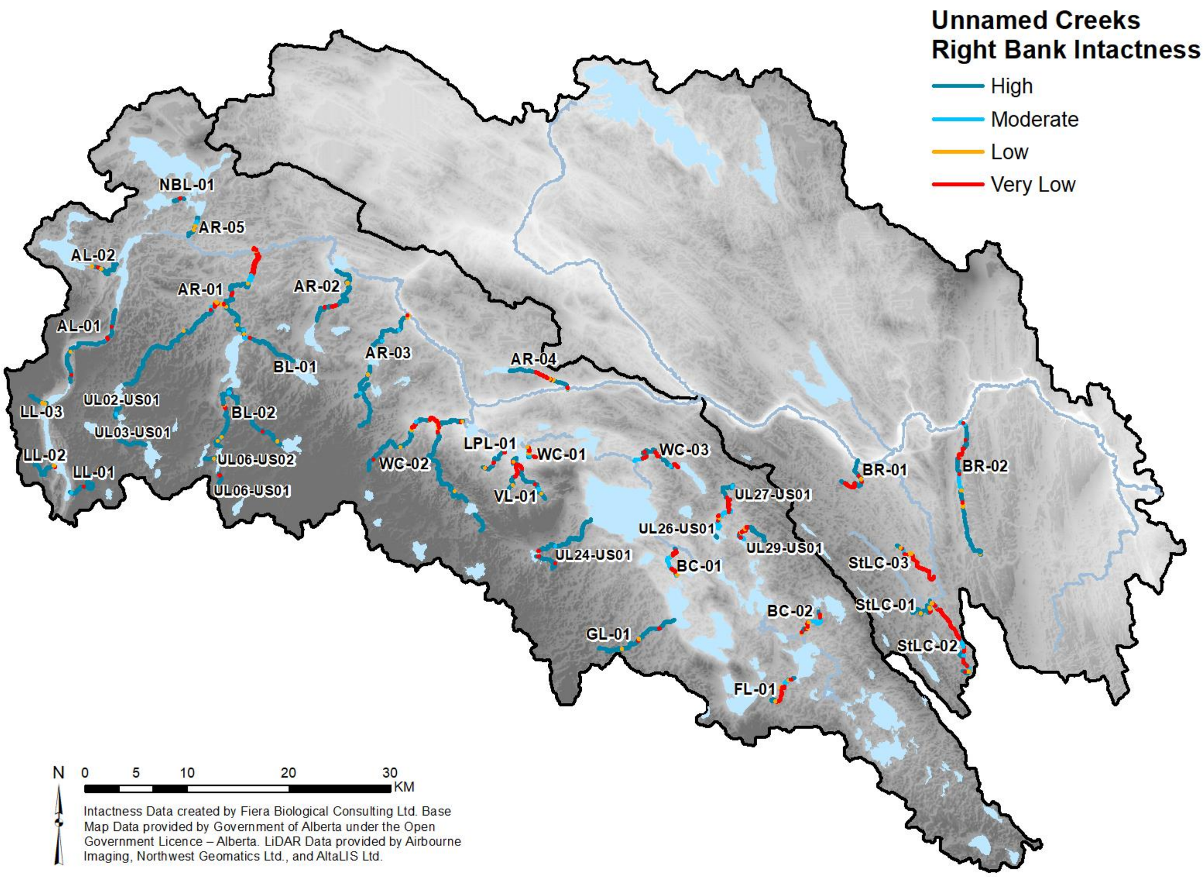
Figure 11 *continued*. The total proportion of shoreline assigned to each riparian intactness category for unnamed lakes assessed in the Upper Beaver watershed.



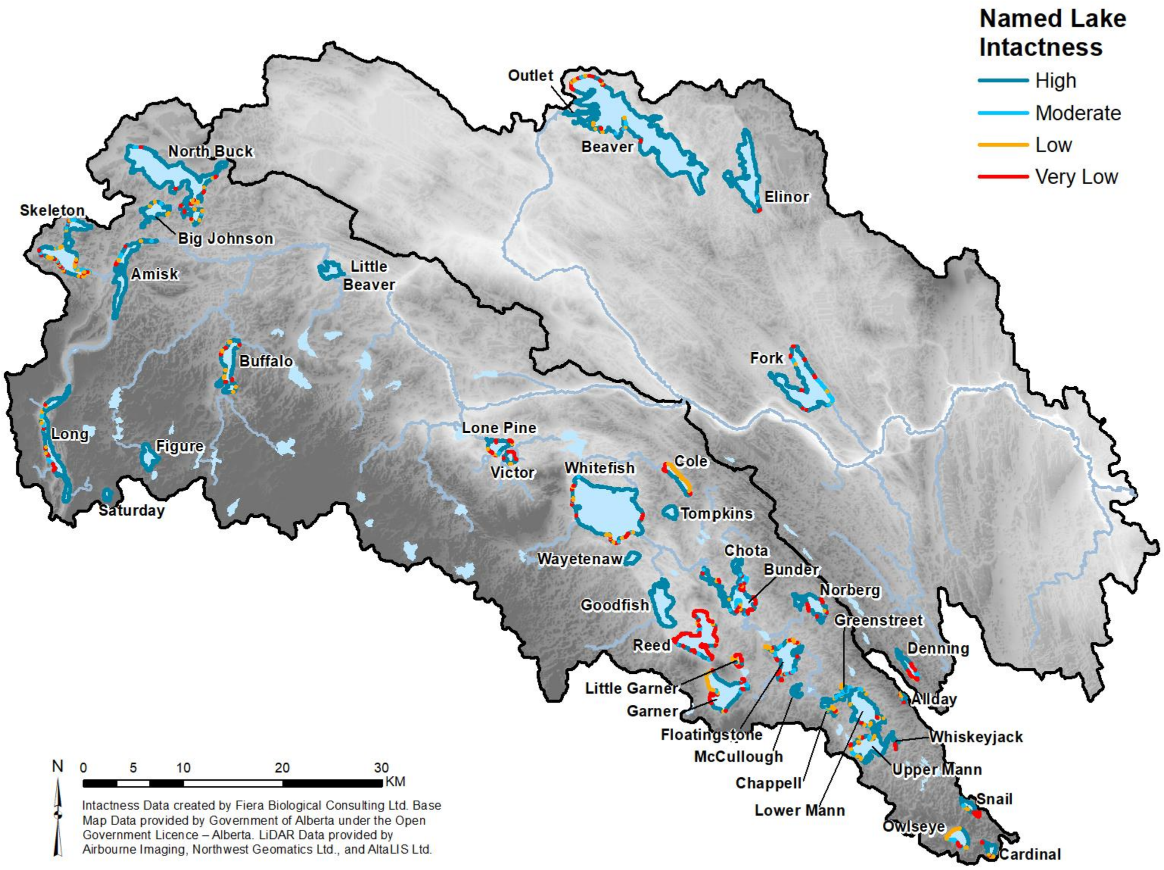


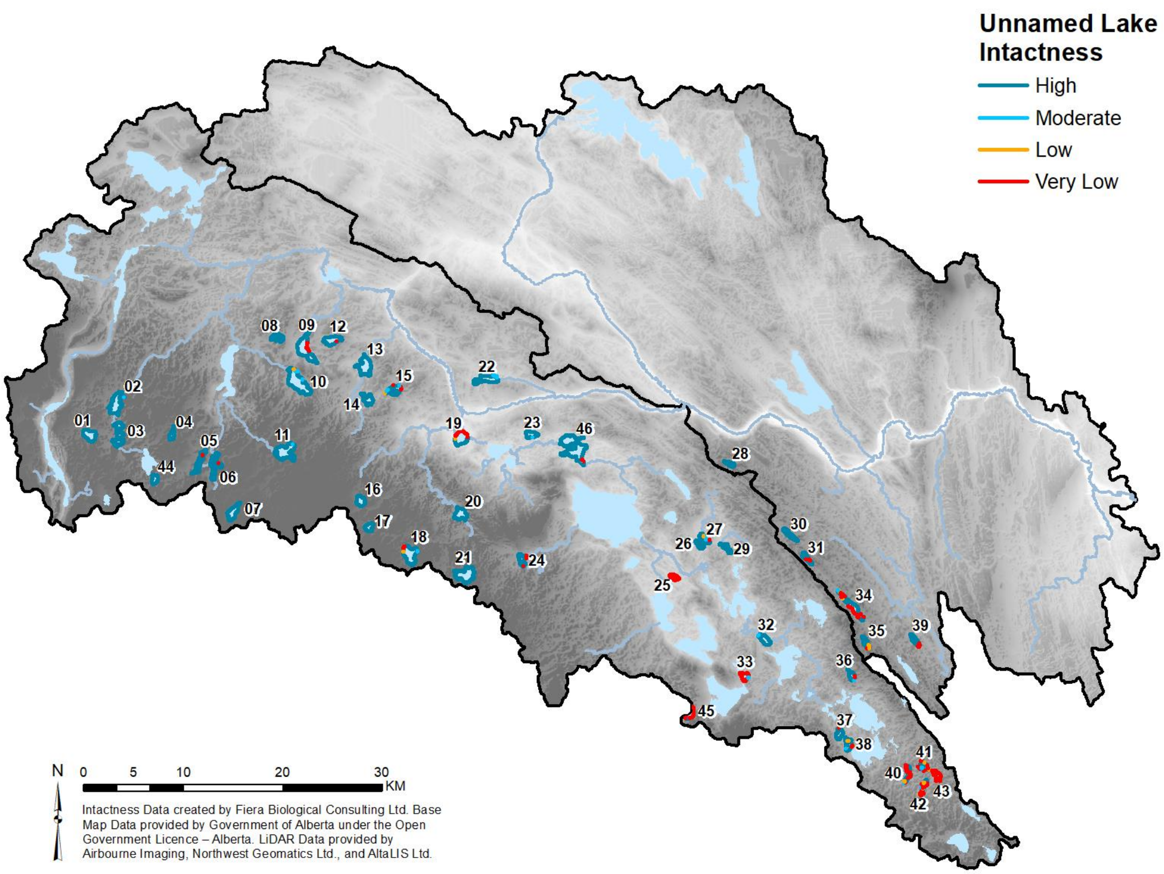
Map 8. Intactness for the left and right banks of named streams that were included in this study. Mooselake River is not shown, as less than 1 km of shoreline was assessed.





Map 9. Intactness for the left and right bank of unnamed creeks that were included in this study.





Map 10. Intactness for the shoreline of named and unnamed lakes that were included in this study.

4.2. Pressure on Riparian System Function

Pressure on riparian system function was assessed for 603 local catchment areas within the Upper Beaver watershed (Map 11). Spatially, areas of High Pressure were concentrated in the eastern portion of the watershed, whereas Low Pressure areas were concentrated along the northern and southern borders of the watershed. Nearly a quarter of the watershed was classified as High Pressure, with the majority (49%) of local catchments being classified as Moderate Pressure and the remaining 26% being classified as Low Pressure (Figure 12). When pressure scores were compared between HUC 8 subwatersheds, the Upper Beaver subwatershed had a greater proportion of its catchment area assessed as High Pressure (35%) than the Amisk River subwatershed (14%) (Figure 13).

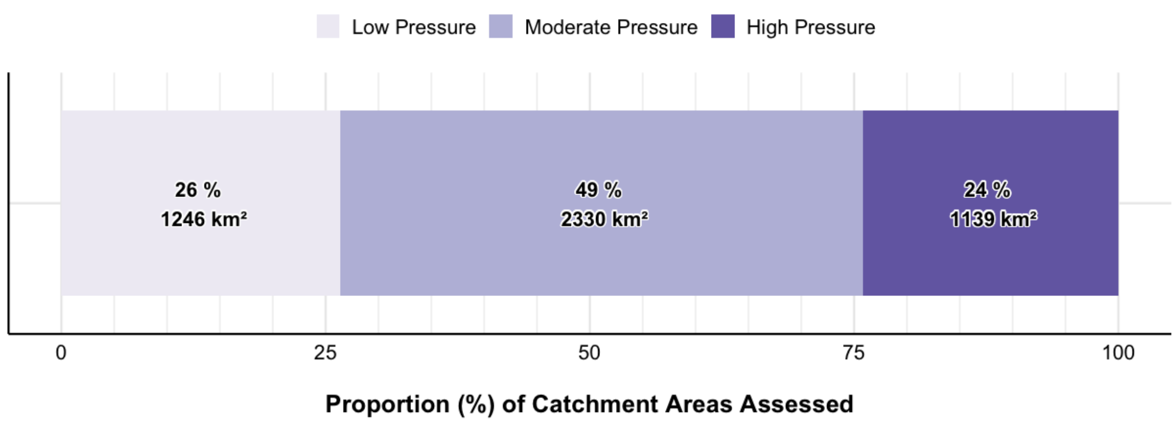


Figure 12. The proportion and area of local catchments within the Upper Beaver watershed assigned to each pressure category.

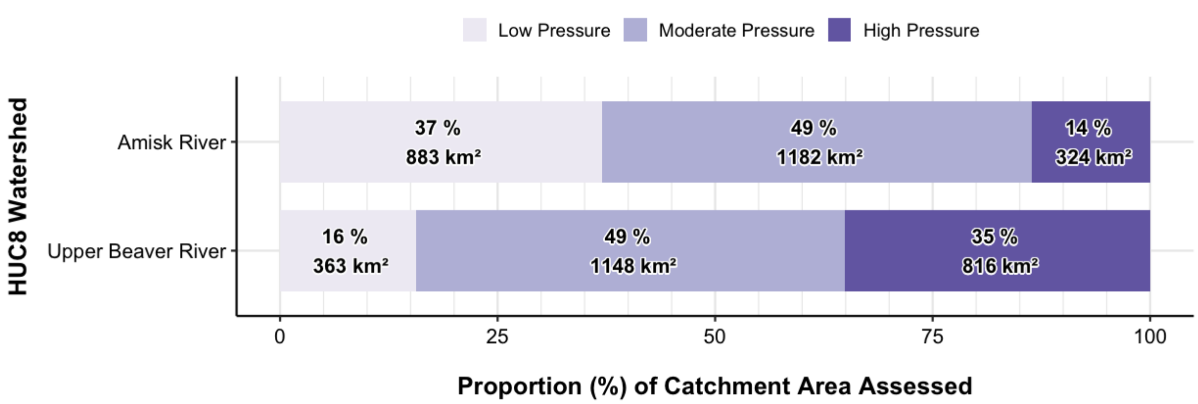


Figure 13. The proportion and area of local catchments assigned to each pressure category, summarized by HUC 8 subwatershed.

Pressure on riparian system function varied widely for the waterbodies assessed in this study (Map 12). For named streams, St. Lina Creek, Columbine Creek, and Fork Creek had the majority of adjacent lands classified as High Pressure (Figure 14). Of the 35 unnamed creeks assessed, six had the majority of adjacent lands classified as High Pressure; however, for most of the unnamed creeks, adjacent catchments were classified as either Low or Moderate Pressure (Figure 15).

Of the 38 named lakes assessed, eight had 100% of their adjacent lands classified as High Pressure, including Allday, Cardinal, Garner, Little Garner, McCullough, Owlseye, Snail, and Victor Lakes (Figure 16). Four other named lakes had a significant proportion of adjacent lands classified as High Pressure, including Bunder, Chappell, Floatingstone, and Reed Lakes. The majority of the unnamed lakes were located in areas where the adjacent land use pressure was Low or Moderate; however, ten of the unnamed lakes had 100% of adjacent lands classified as High Pressure (Figure 17).

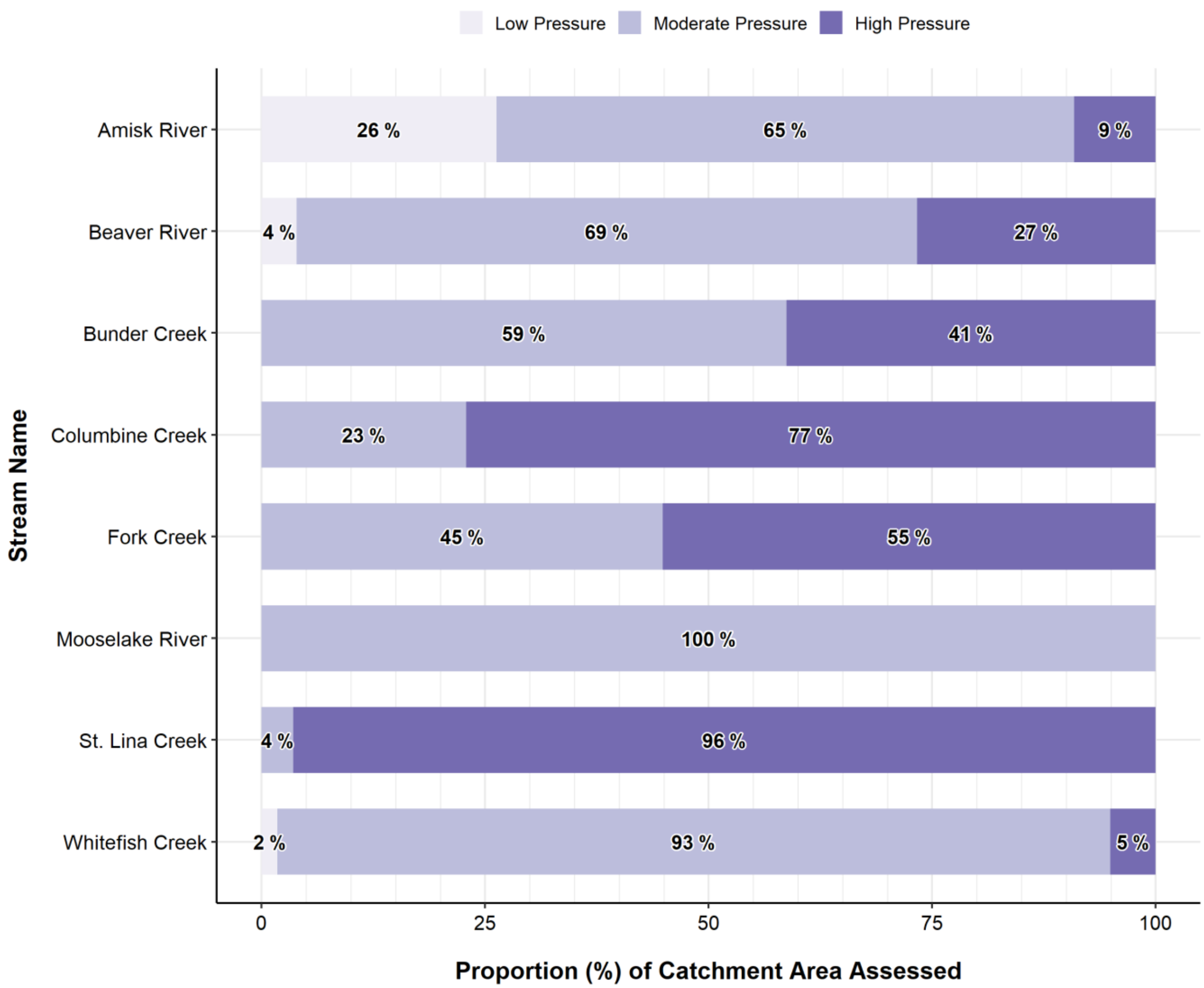


Figure 14. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named streams assessed in the Upper Beaver watershed. Numbers indicate the proportion of area assigned to each category.

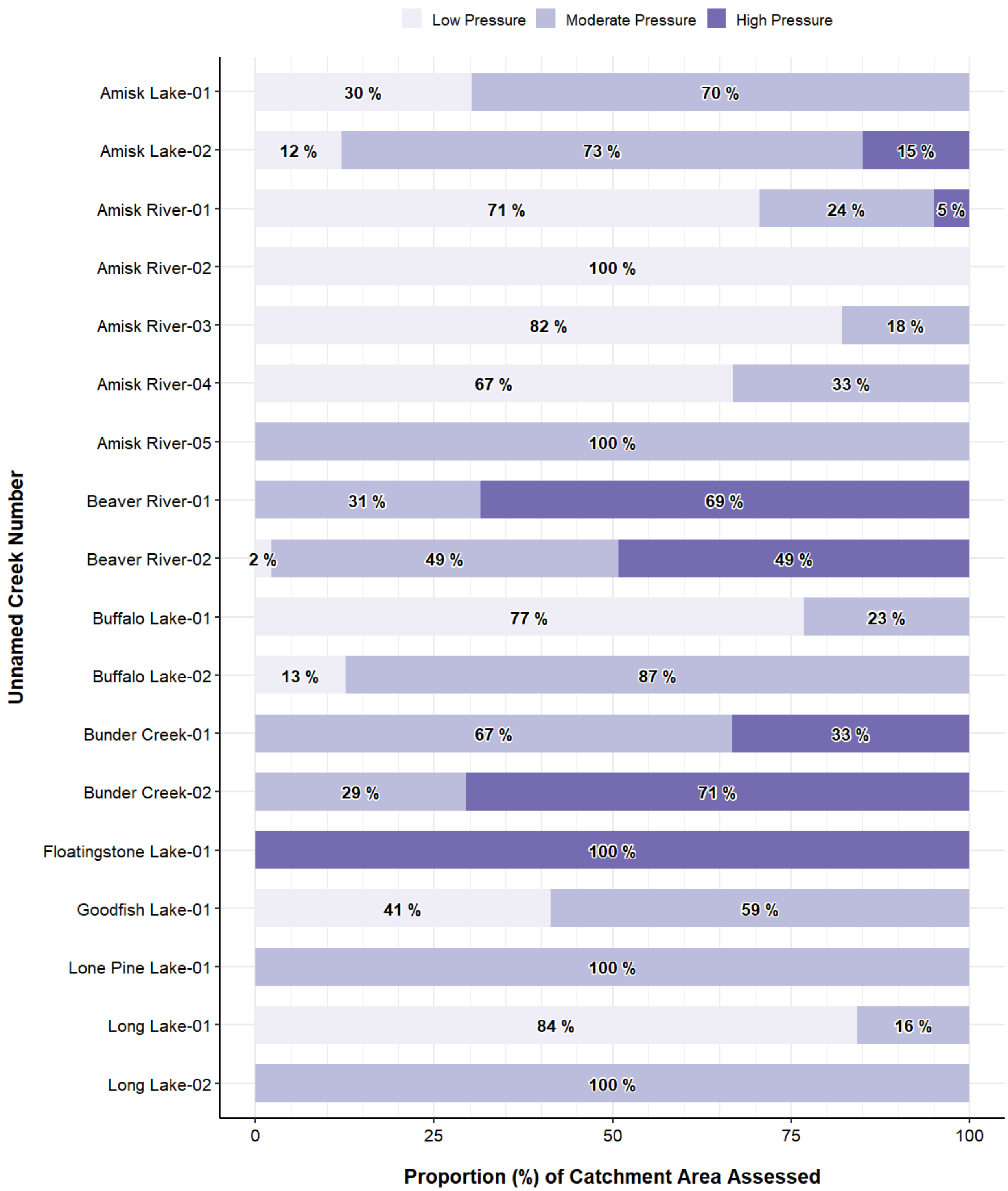


Figure 15. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of unnamed creeks assessed in the Upper Beaver watershed. Numbers indicate the proportion of area assigned to each category.

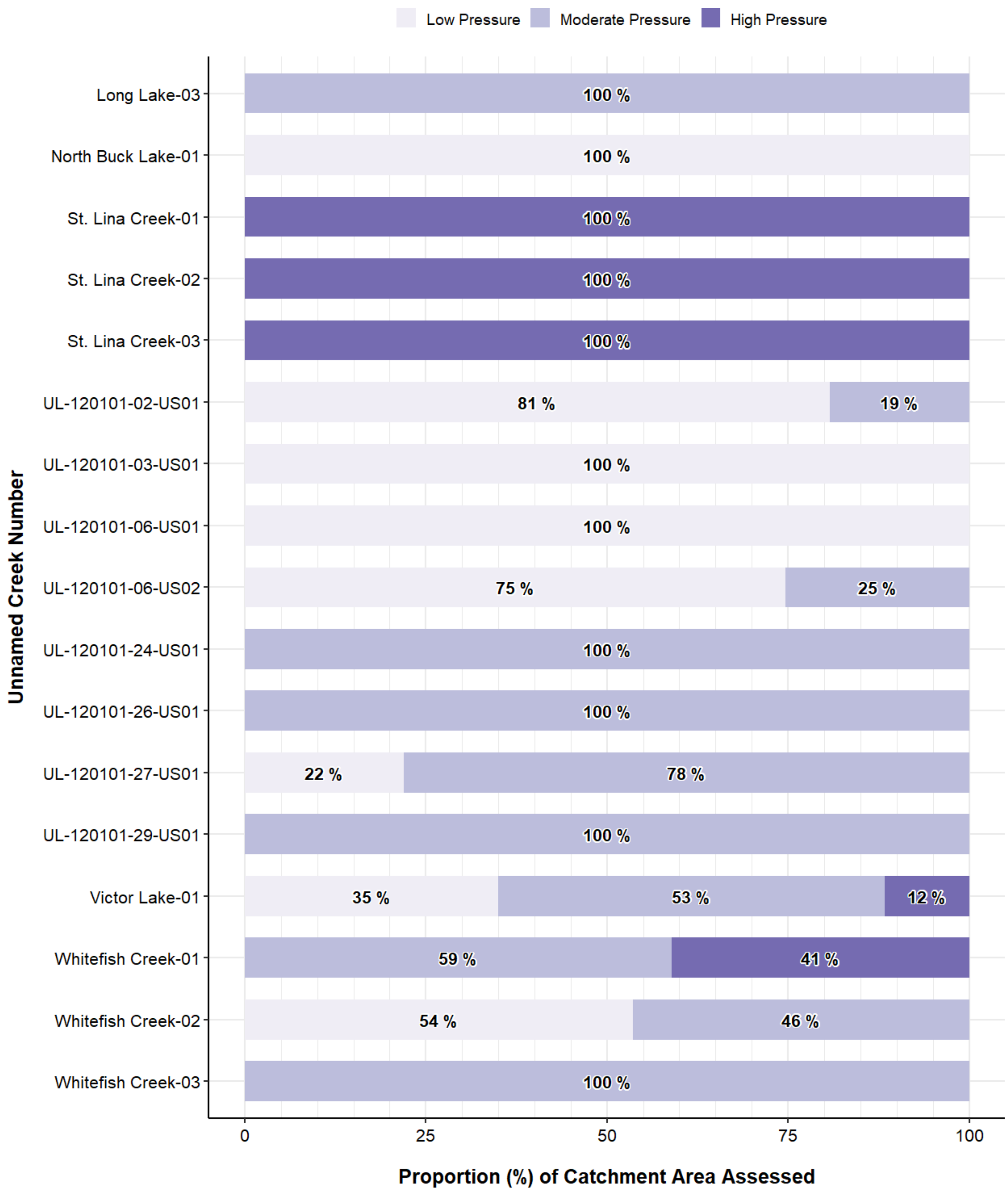


Figure 15 *continued*. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of unnamed creeks assessed in the Upper Beaver watershed. Numbers indicate the proportion of area assigned to each category.

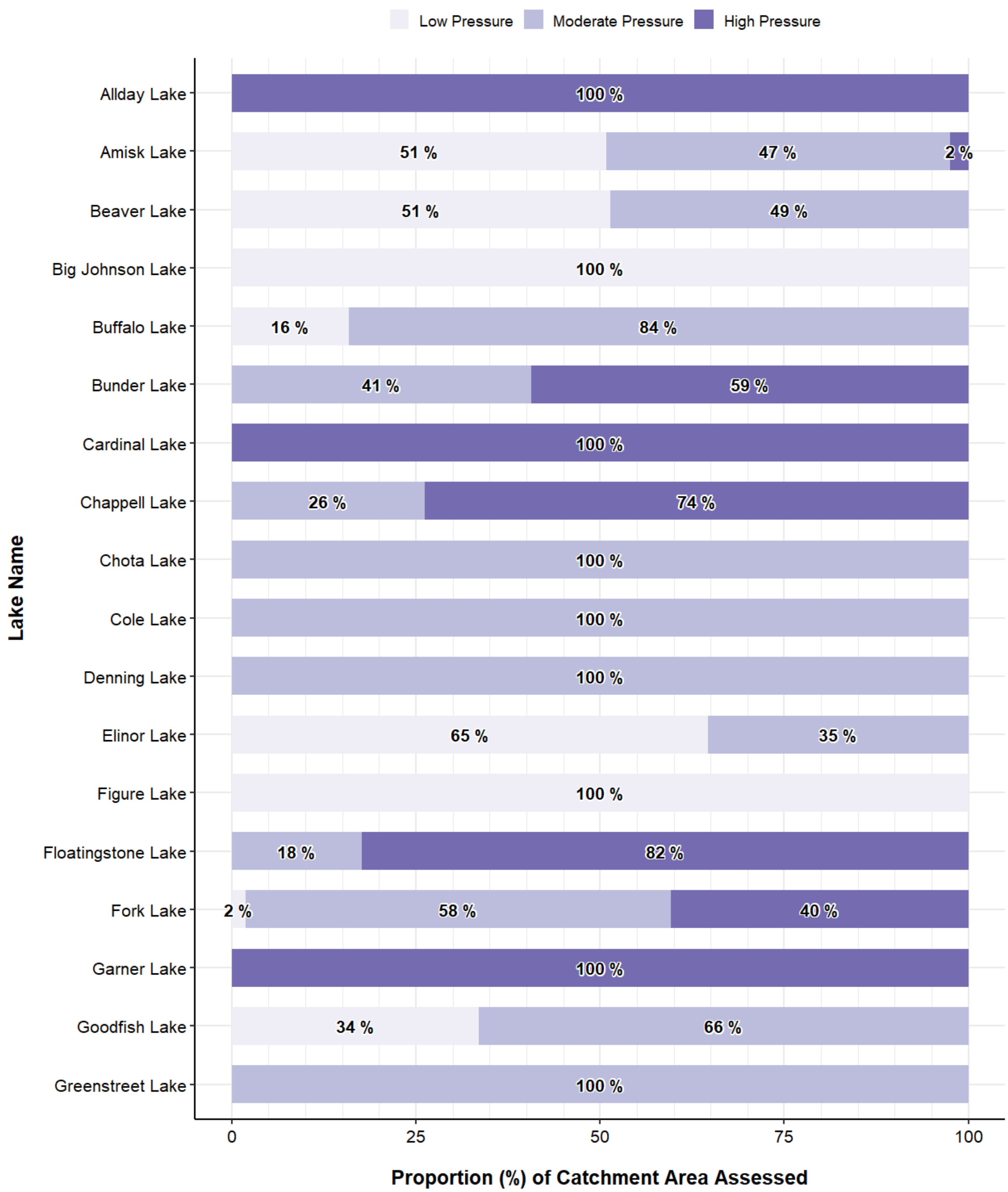


Figure 16. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named lakes assessed in the Upper Beaver watershed. Numbers indicate the proportion of area assigned to each category.

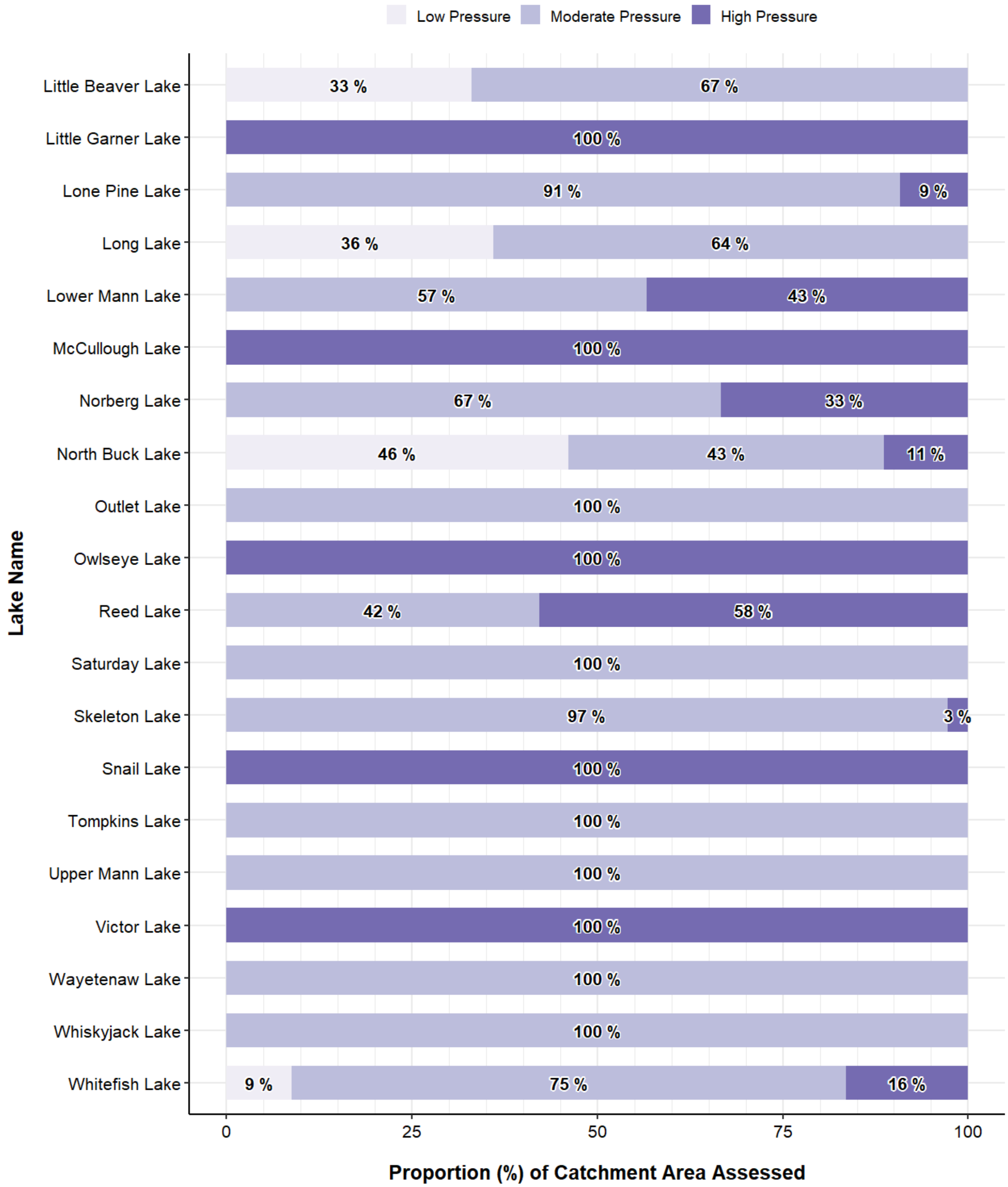


Figure 16 *continued*. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named lakes assessed in the Upper Beaver watershed. Numbers indicate the proportion of area assigned to each category.

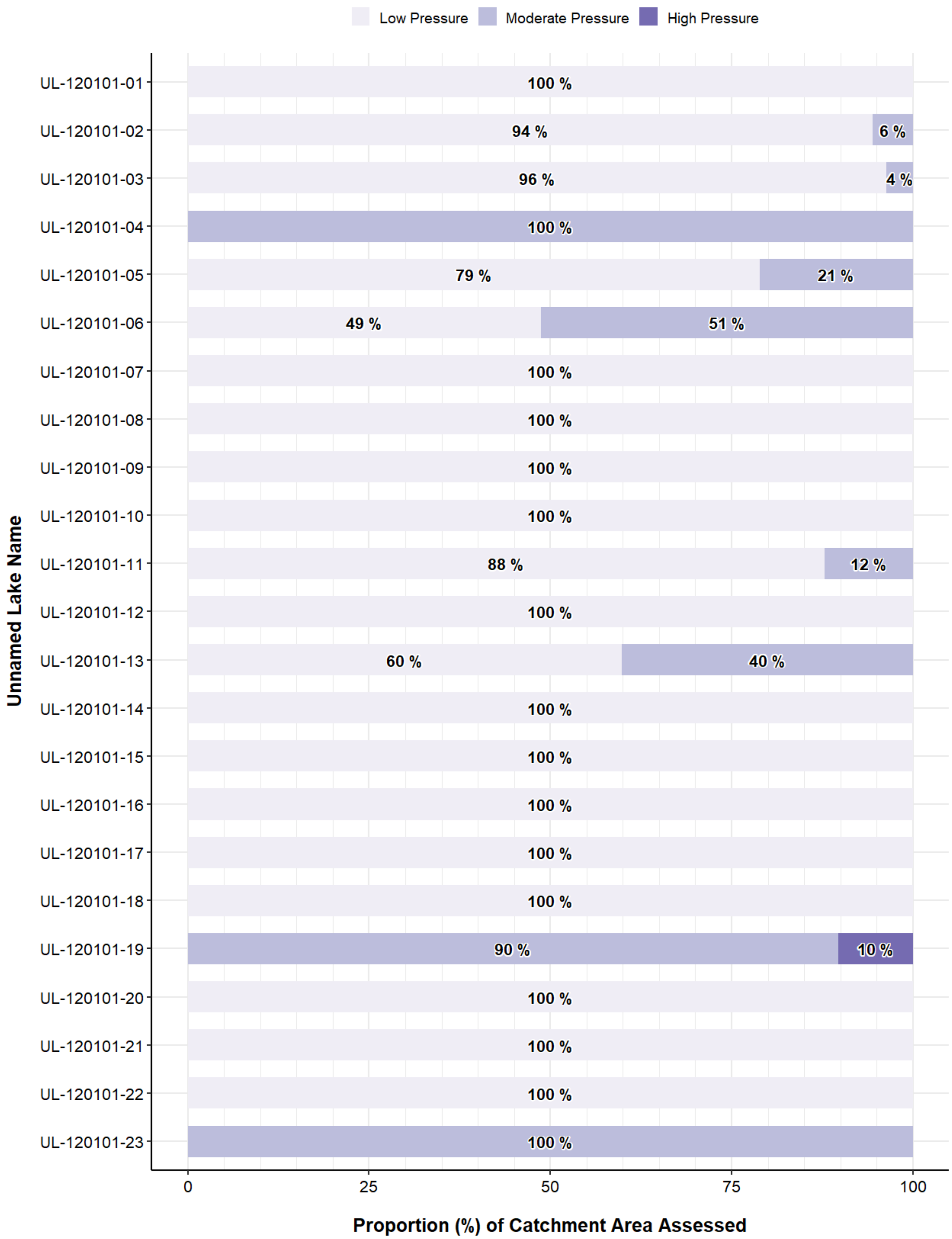


Figure 17. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of unnamed lakes assessed in the Upper Beaver watershed. Numbers indicate the proportion of area assigned to each category.

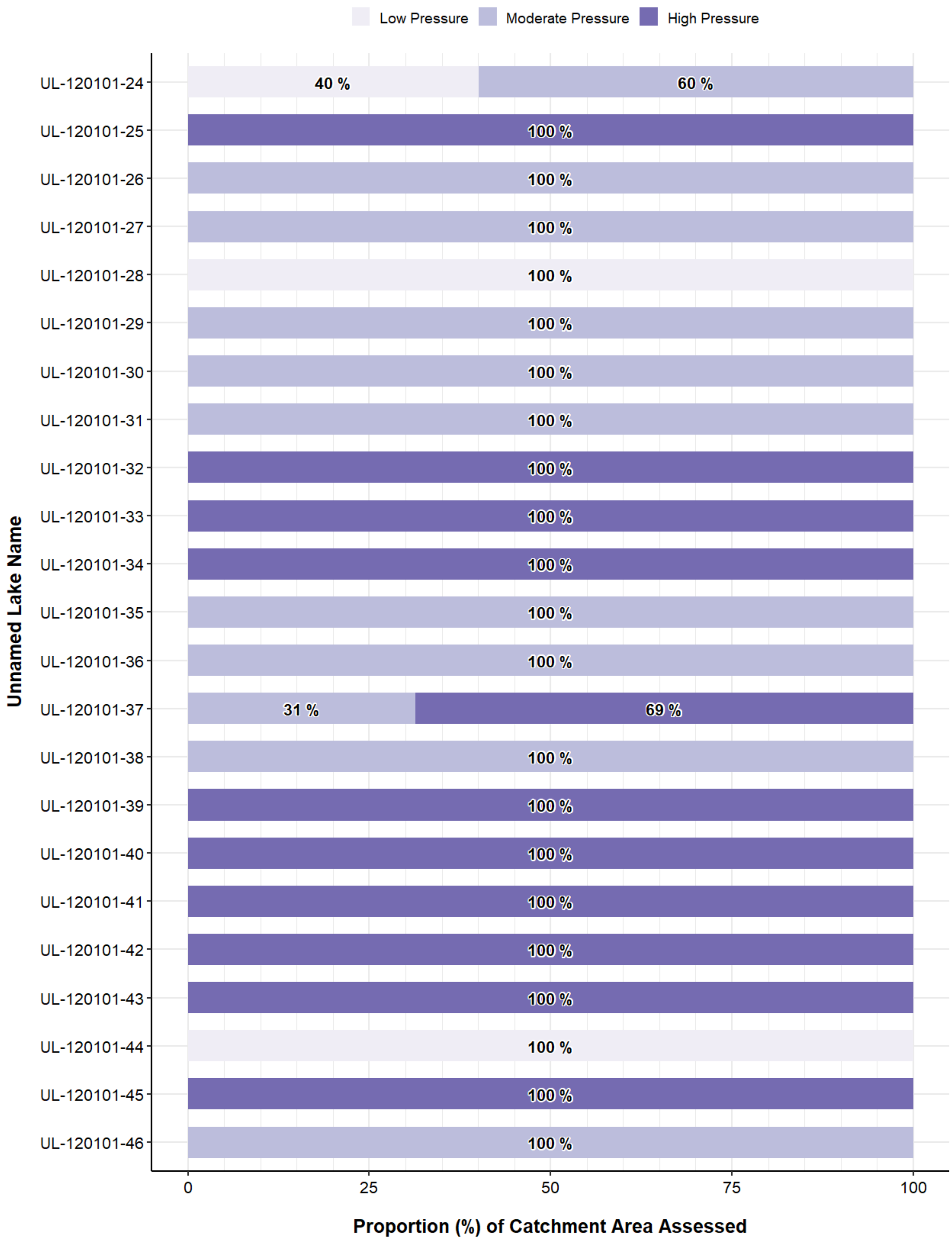
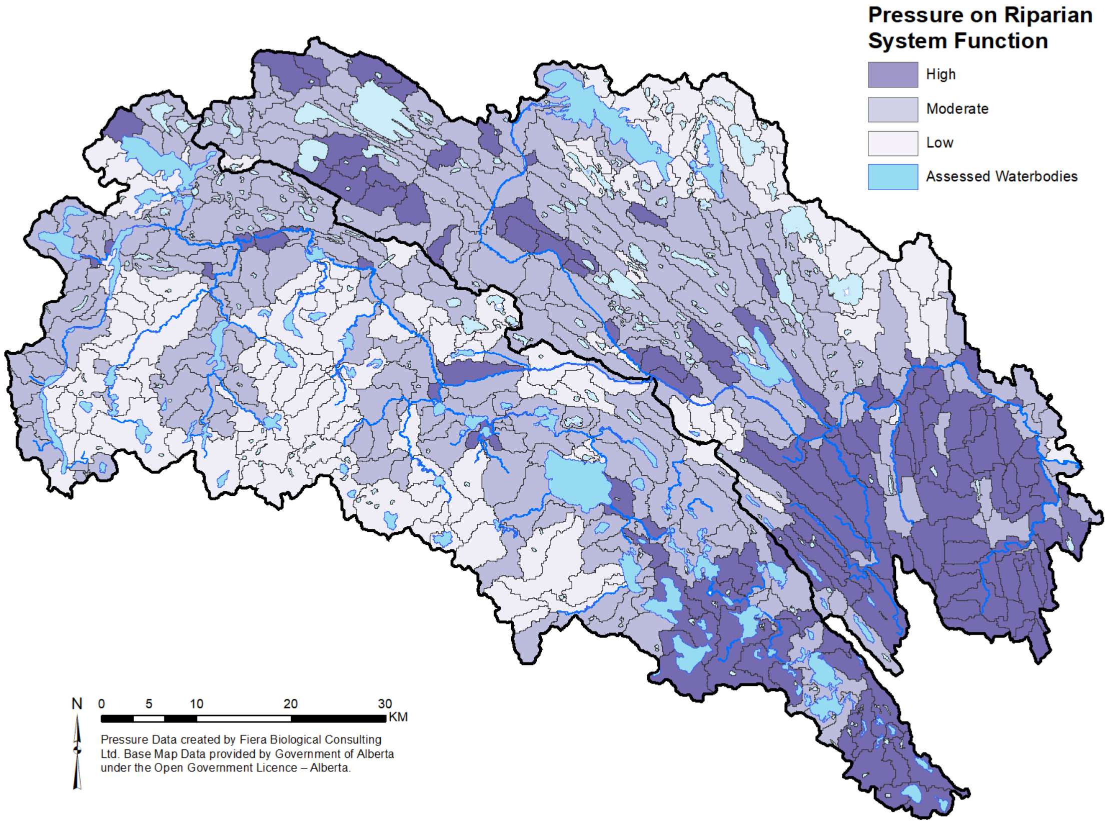
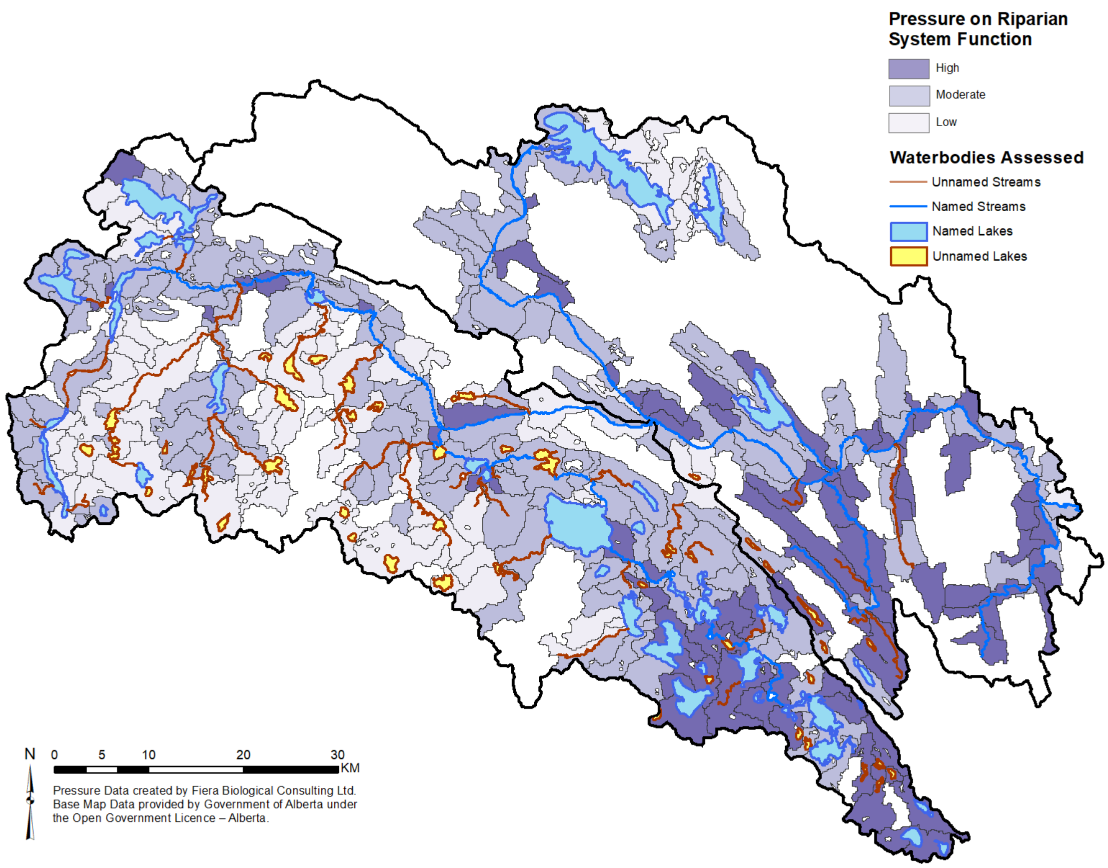


Figure 17 *continued*. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of unnamed lakes assessed in the Upper Beaver watershed. Numbers indicate the proportion of area assigned to each category.



Map 11. Distribution of local catchments classified as High, Moderate, and Low Pressure within the Upper Beaver watershed.



Map 12. Pressure classification for local catchment areas that intersect the RMAs of waterbodies that were included in this study.

4.3. Conservation & Restoration Prioritization

Conservation and restoration priority was assigned to the RMAs of all waterbodies that were assessed in this study, and the results were summarized as the total length of shoreline that has been assigned to each priority category. Within the Upper Beaver watershed, 85% of the shoreline length that was assessed was classified as either High (63%) or Moderate (22%) Conservation Priority, representing approximately 1,936 km of shoreline (Figure 18). Conversely, 15% of the shoreline was classified as either High (12%) or Moderate (3%) Restoration Priority, representing approximately 350 km of shoreline.

When summarized by HUC 8 subwatershed, both the Amisk River and the Upper Beaver subwatersheds had the majority of their shorelines prioritized for conservation (Figure 19). The Amisk River subwatershed had 86% of its shoreline assessed as High or Moderate Conservation, whereas the Upper Beaver subwatershed had 80% of its shoreline assessed as High or Moderate Conservation Priority.

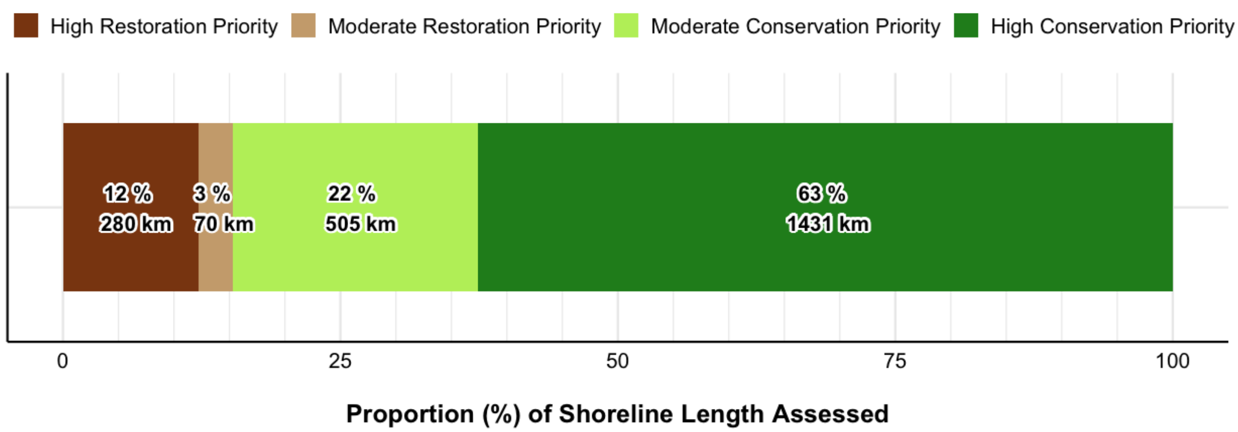


Figure 18. The total proportion of shoreline within the Upper Beaver watershed assigned to each priority category. Numbers indicate the total length (km) of shoreline associated with each category.

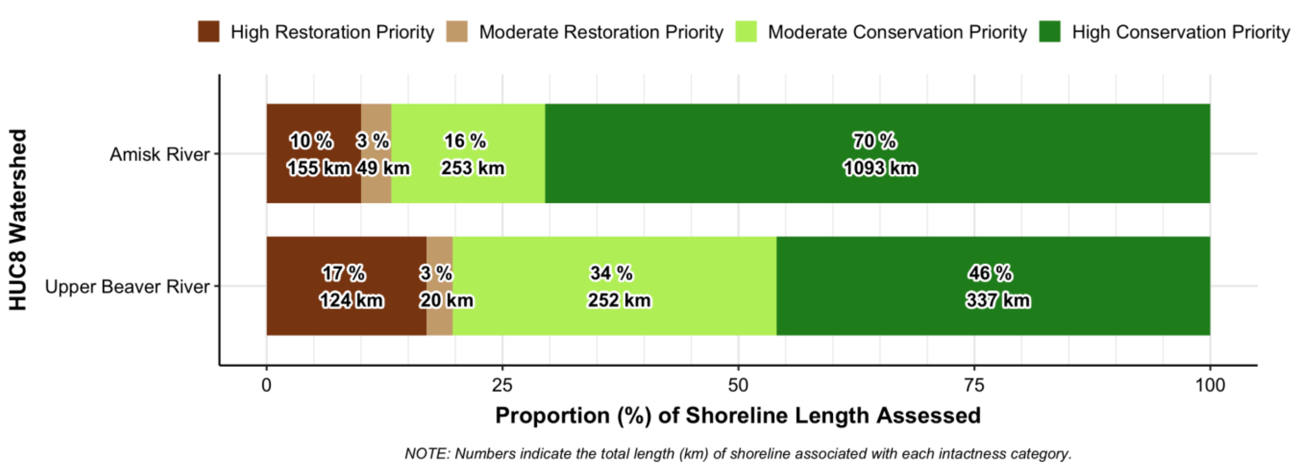


Figure 19. The total proportion of shoreline within the Upper Beaver watershed assigned to each priority category, summarized by HUC 8 subwatershed. Numbers indicate the total length (km) of shoreline associated with each category.

The majority of the shorelines associated with the named streams (Figure 20; Map 13) and the unnamed creeks (Figure 21; Map 14) were classified as either Moderate or High Conservation Priority; however, there were 11 unnamed creeks with 25% or more of their shorelines classified as either Moderate or High Restoration Priority. In particular, St. Lina Creek-02, St. Lina Creek-03, and Whitefish Creek-01 all had more than half of their shorelines assessed as Restoration Priority.

Of the 38 named lakes assessed, all but three had the majority of their shorelines classified as Moderate or High Conservation Priority (Figure 22; Map 15). Cole, Little Garner, and Reed Lakes all had more than half of their shorelines classified as Moderate or High Restoration Priority, while Allday Lake had just under half of its shoreline assessed as High Restoration Priority. Similar to the named lakes, the majority of the unnamed lakes assessed in this study had 50% or more of their shorelines assessed as Moderate or High Conservation Priority (Figure 23; Map 15). In contrast, there were four unnamed lakes that had 75% or more of their shorelines assessed as High Restoration Priority. Additional maps illustrating restoration and conservation priority for the shorelines of Beaver, Elinor, Fork, Garner, and Whitefish Lakes can be found in Appendix B (Maps B-6 to B-10).

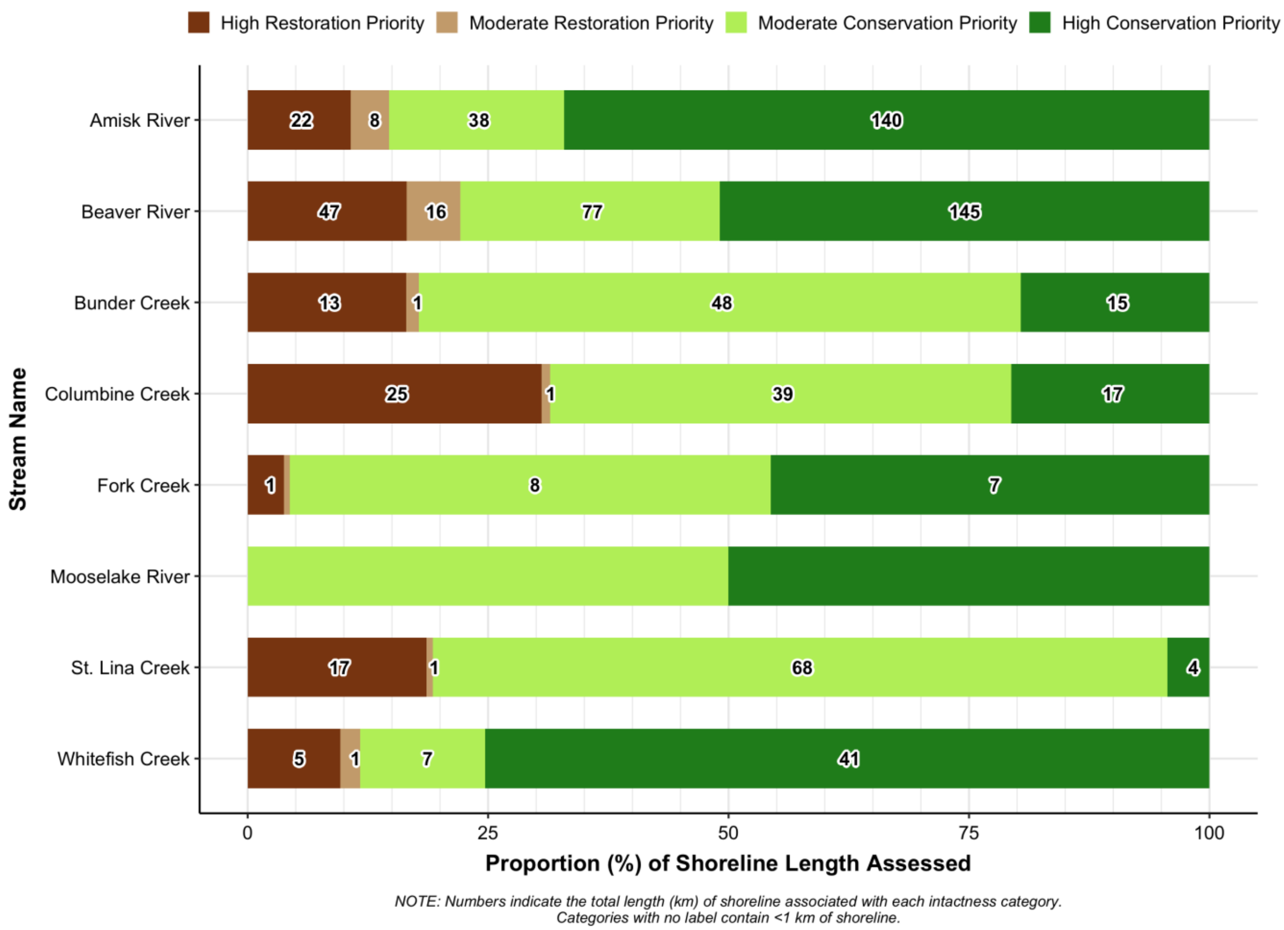


Figure 20. The total proportion of shoreline for named streams assigned to each priority category.

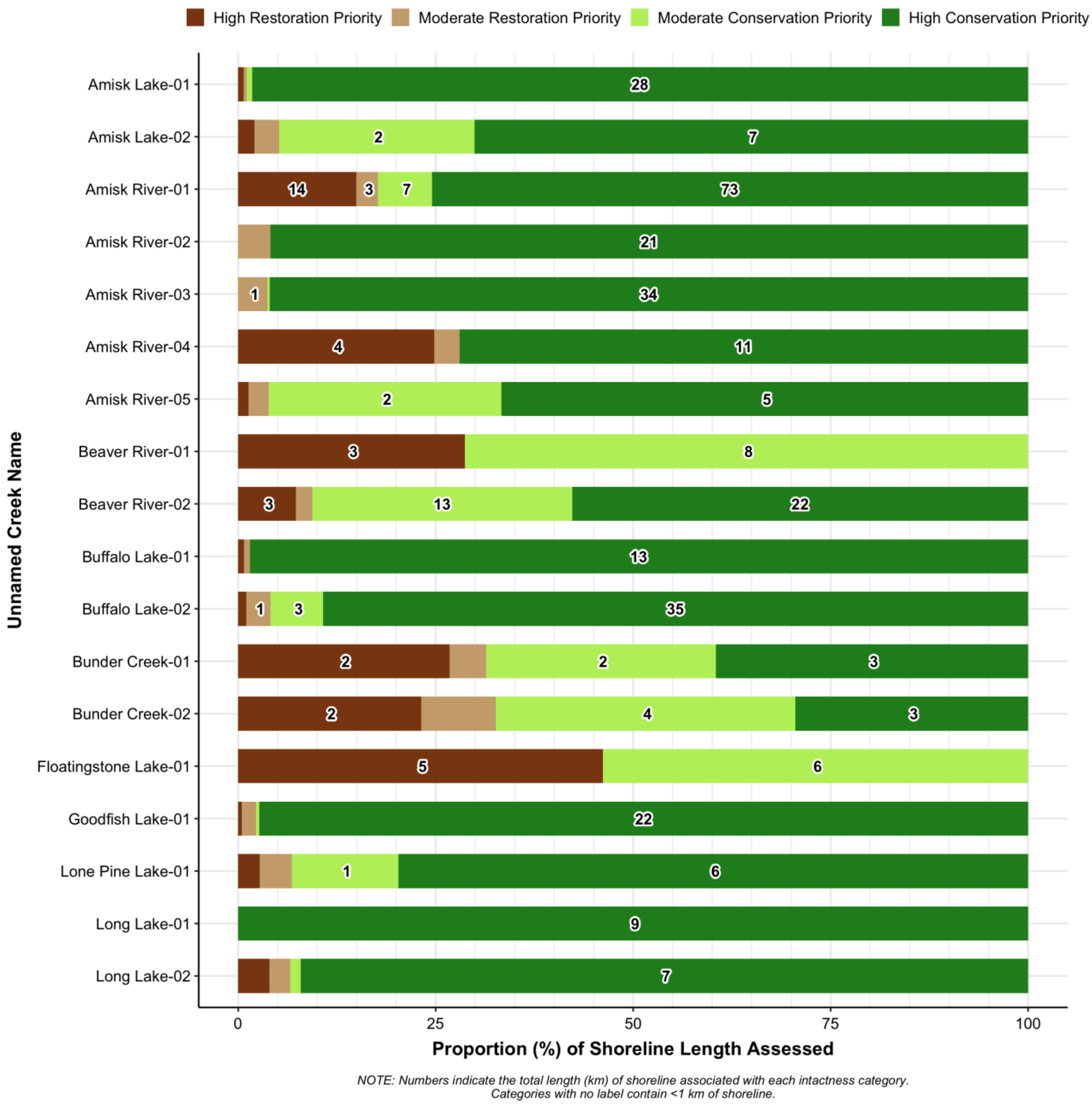


Figure 21. The total proportion of shoreline for unnamed creeks assigned to each priority category.

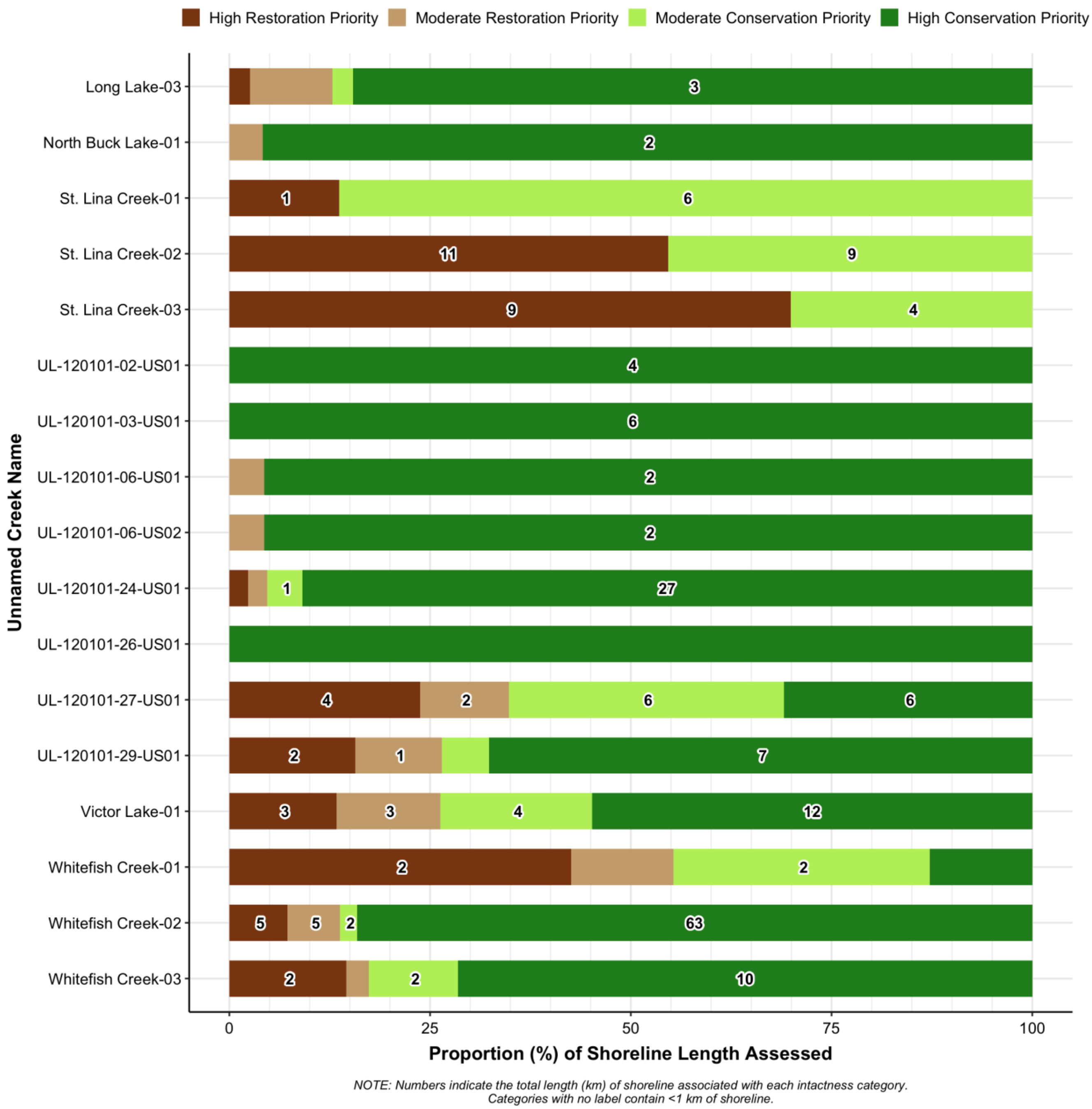


Figure 21 *continued*. The total proportion of shoreline for unnamed creeks assigned to each priority category.

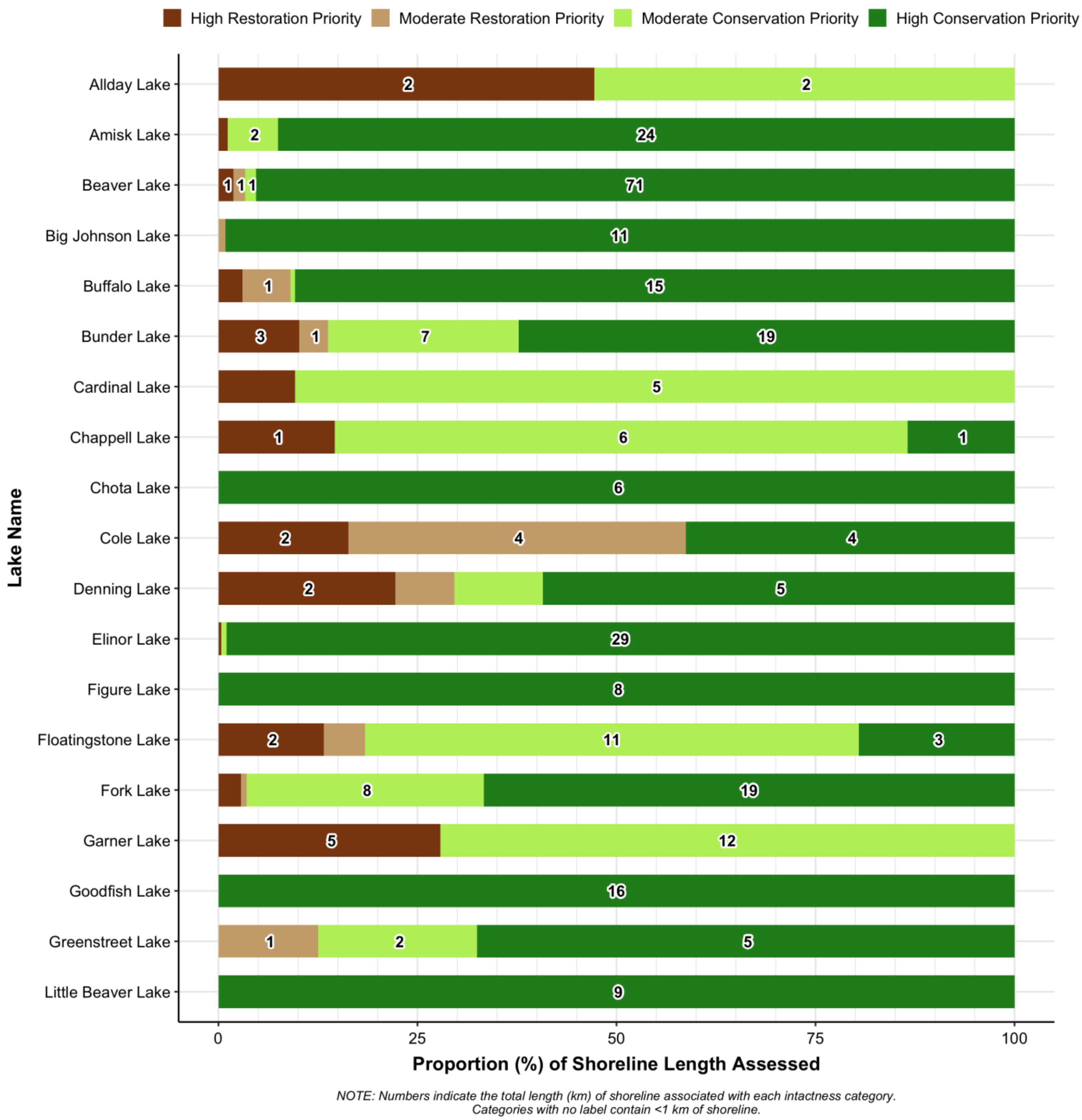


Figure 22. The total proportion of shoreline for named lakes assigned to each priority category.

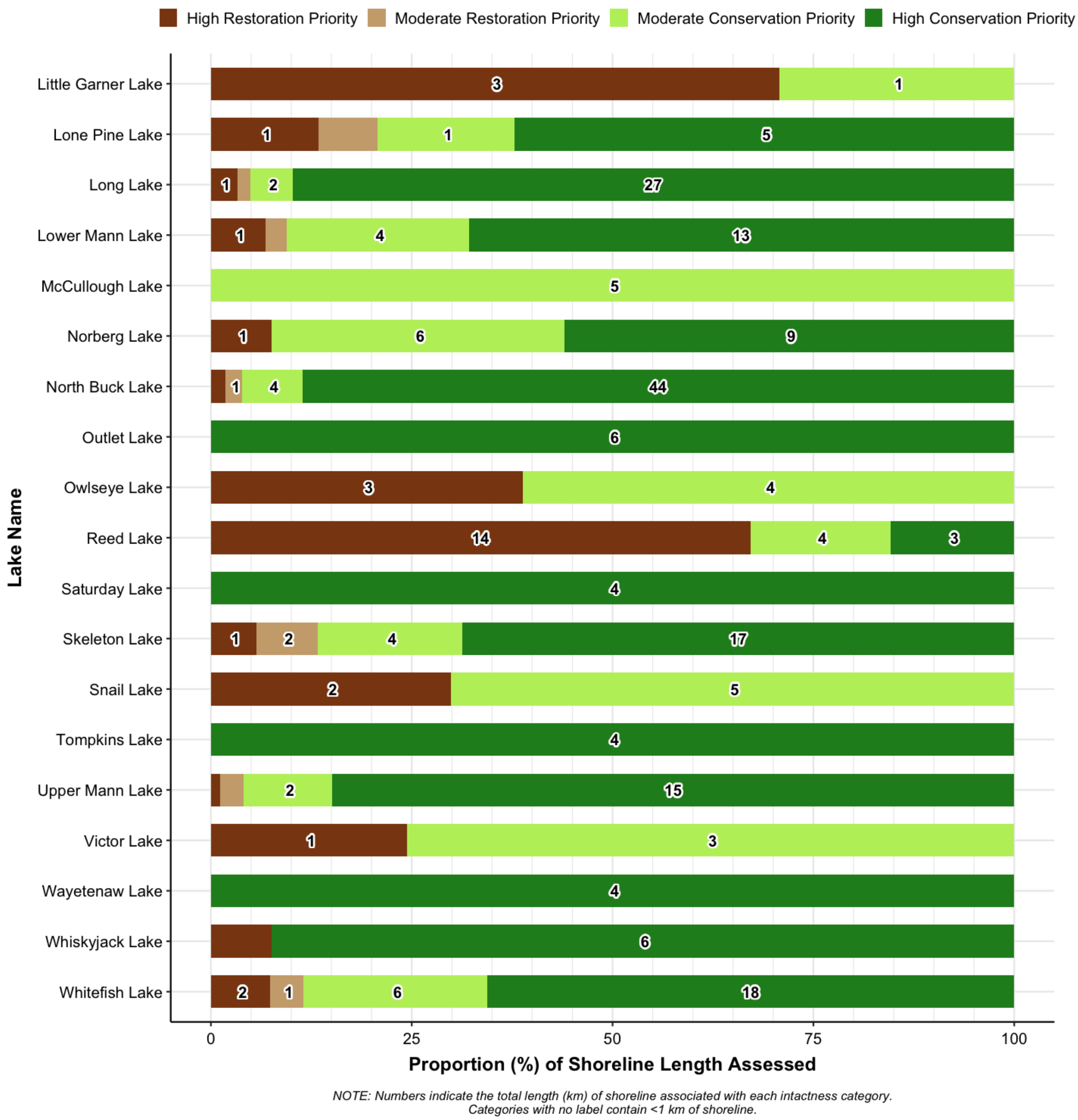


Figure 22 *continued*. The total proportion of shoreline for named lakes assigned to each priority category.

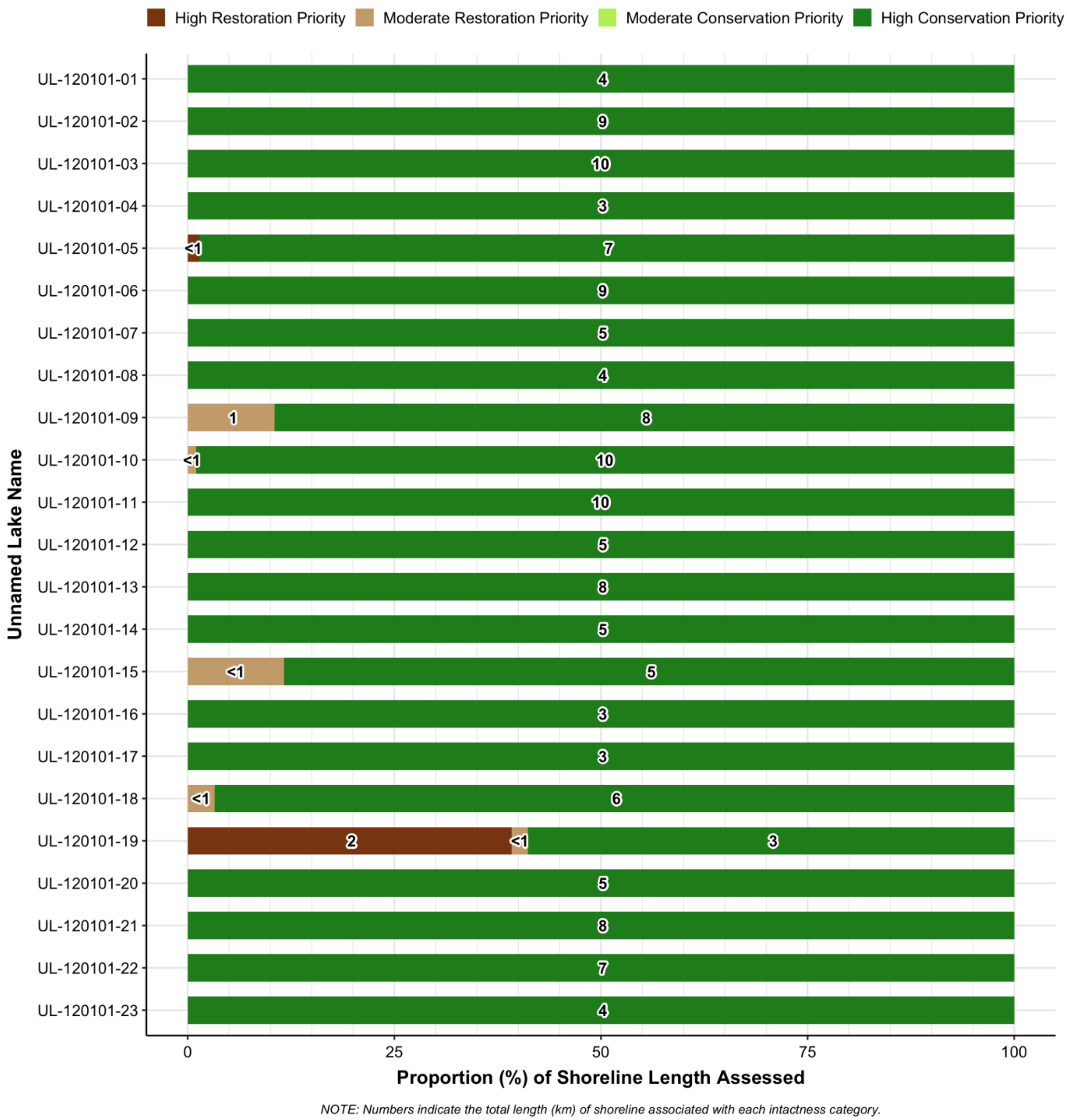


Figure 23. The total proportion of shoreline for unnamed lakes assigned to each priority category.

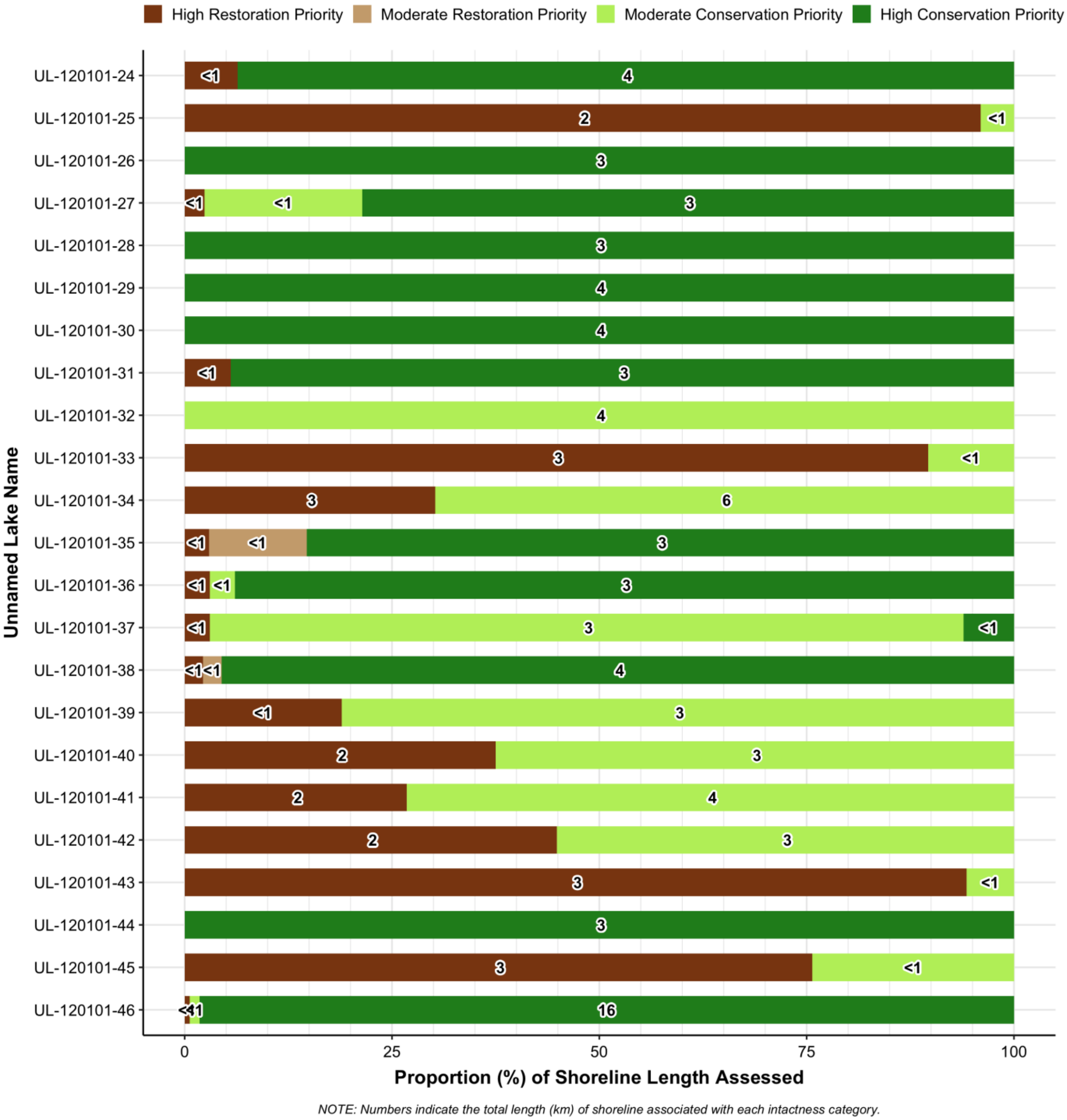
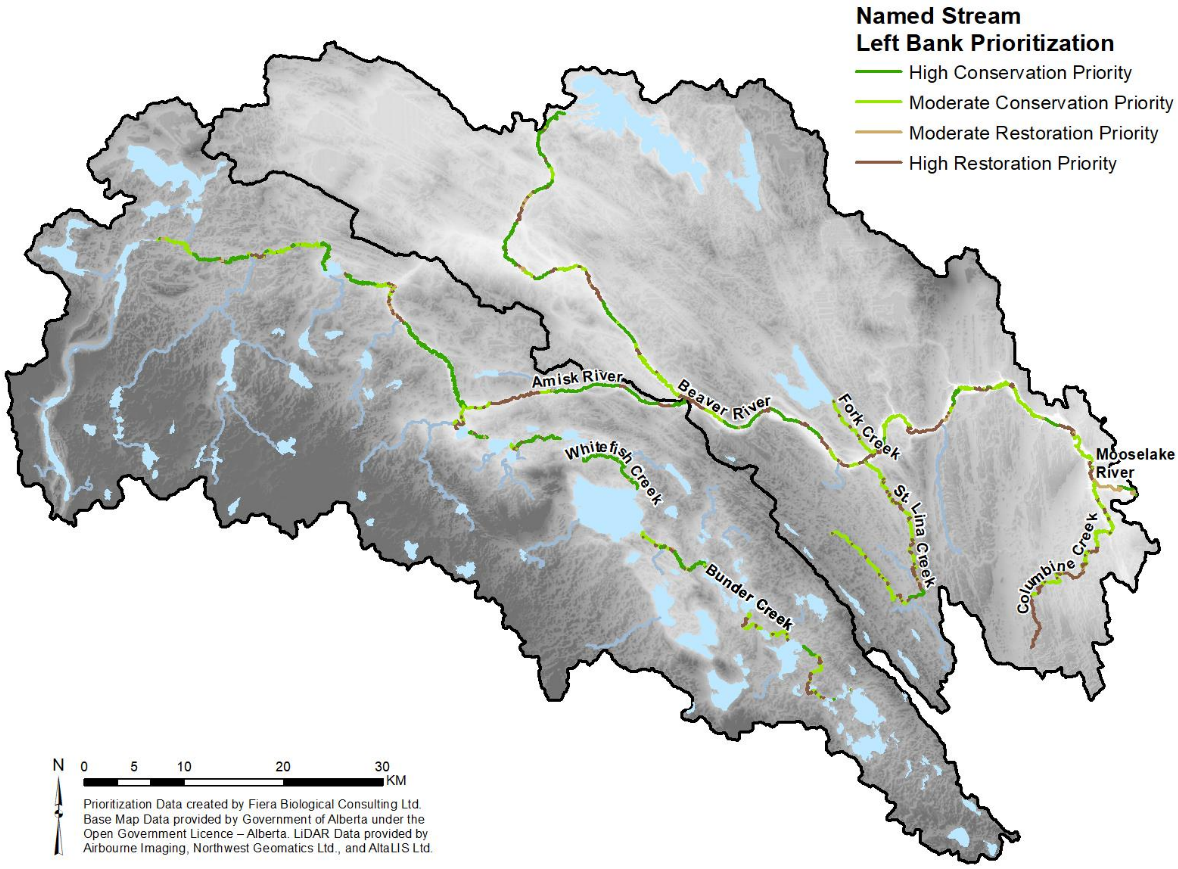
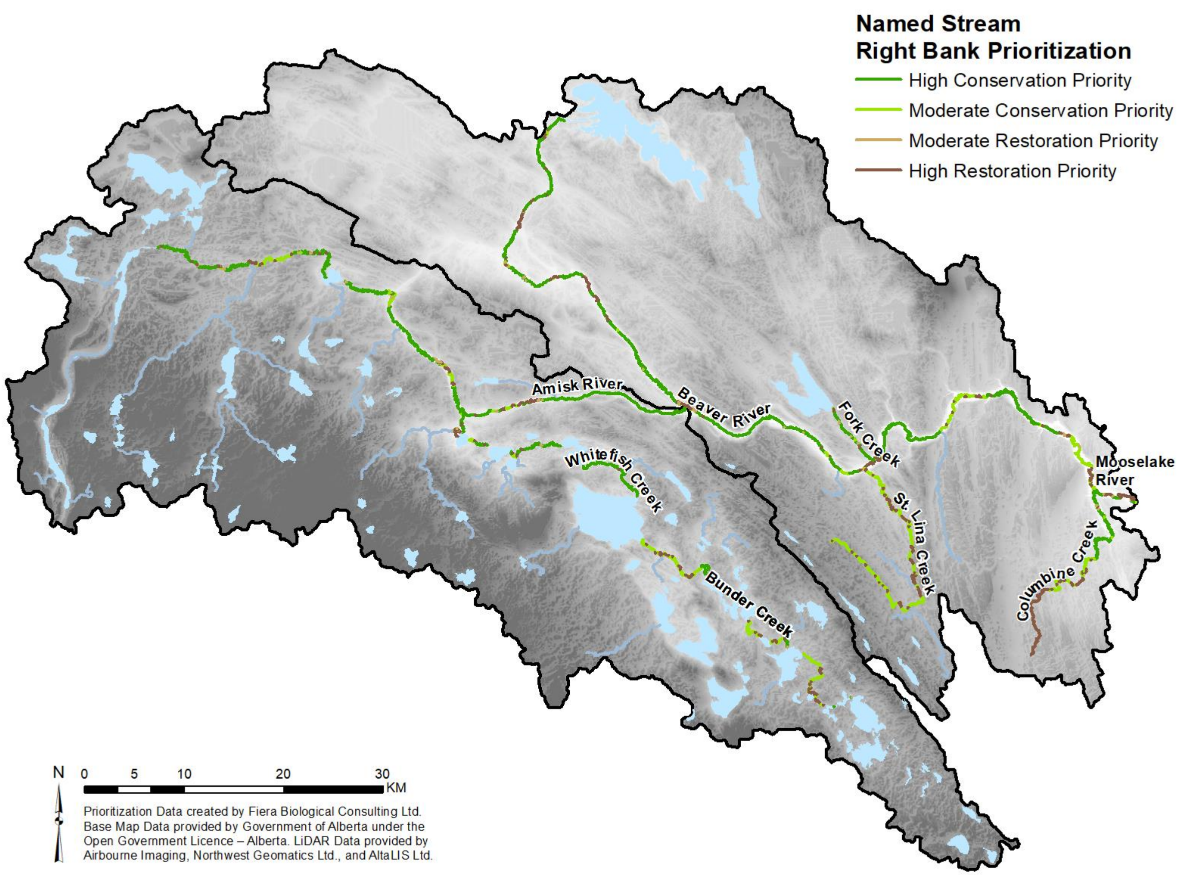
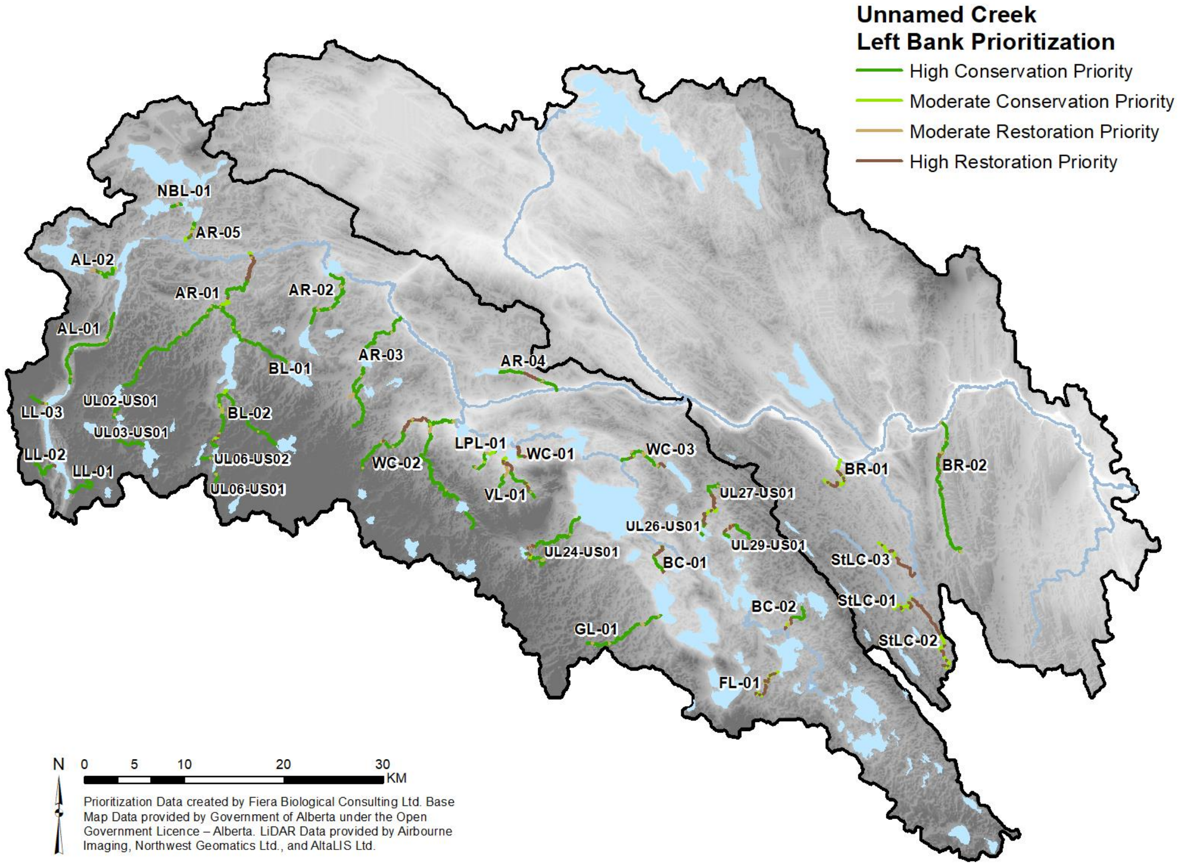


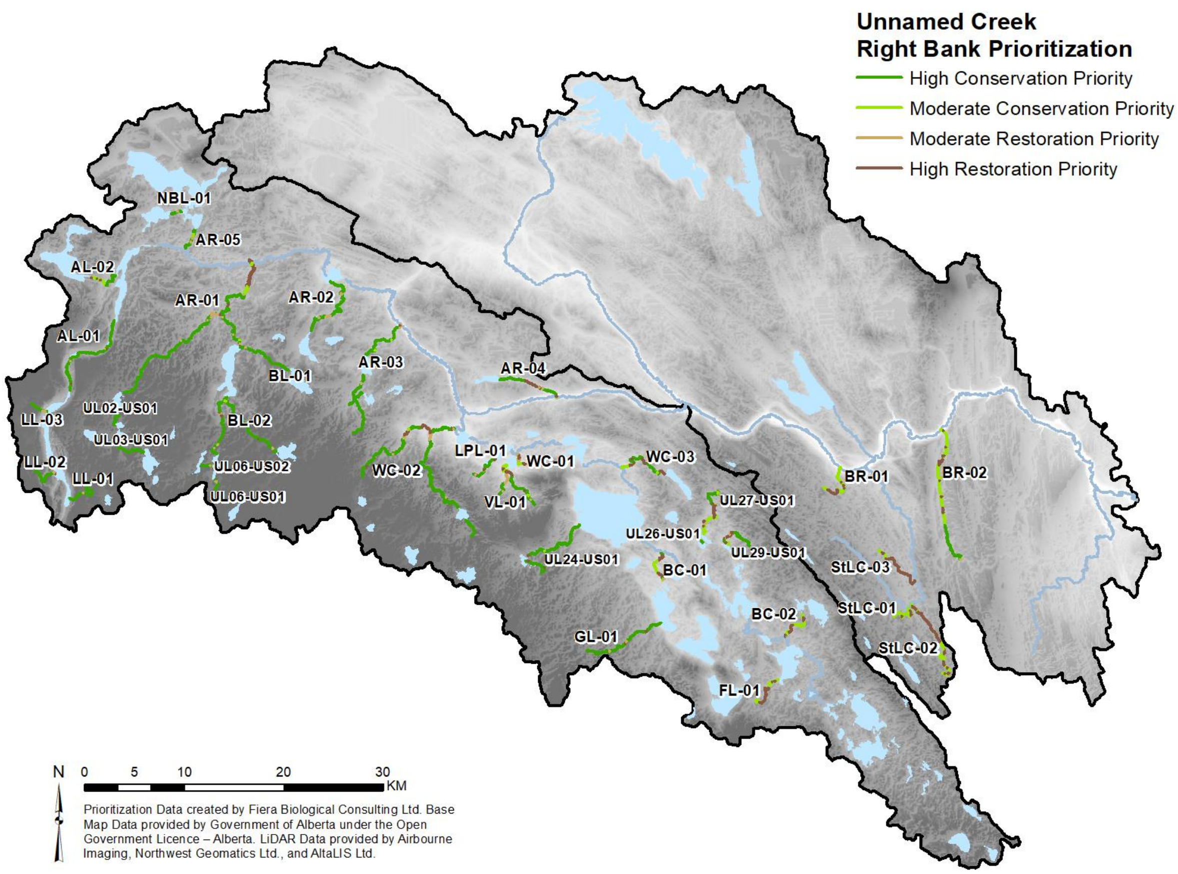
Figure 23 *continued*. The total proportion of shoreline for unnamed lakes assigned to each priority category.



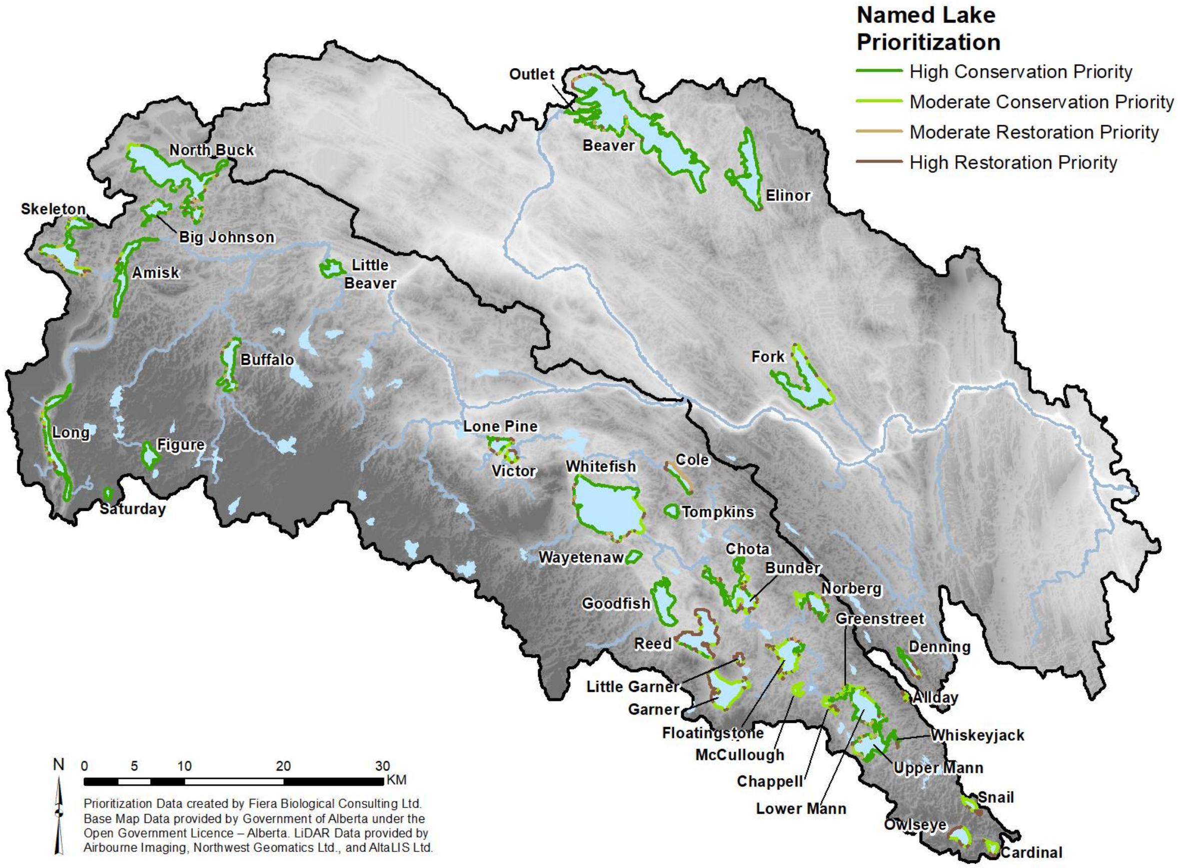


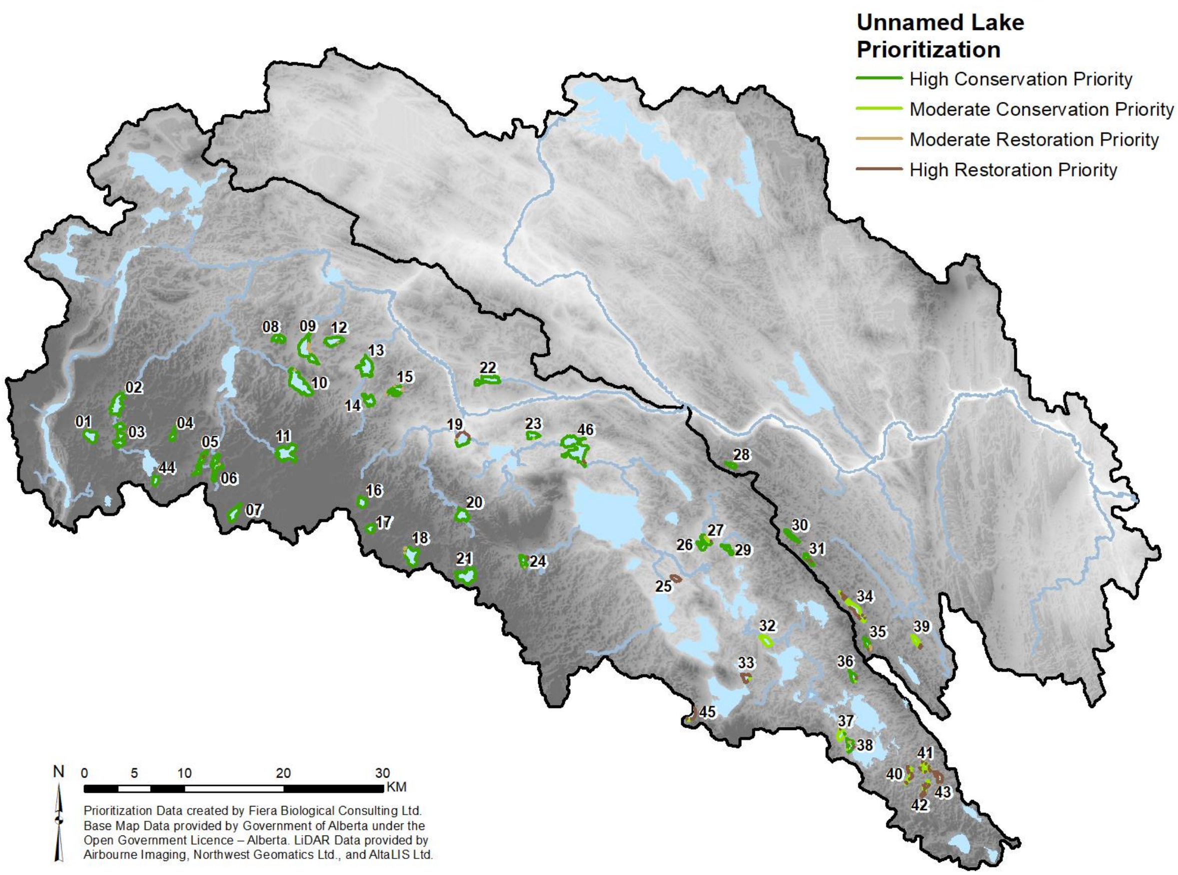
Map 13. Restoration and conservation priority for the left and right bank of named streams included in this study.





Map 14. Restoration and conservation priority for the left and right bank of unnamed streams included in this study.





Map 15. Restoration and conservation priority for the shoreline of named and unnamed lakes included in this study..

5.0 Municipal Results

5.1. Comparison of Intactness, Pressure & Priority

In order to provide riparian assessment information that is relevant from a municipal planning and policy perspective, this section summarizes riparian intactness, pressure on riparian system function, and management prioritization within the Upper Beaver watershed by municipality. Specifically, results are summarized for the rural municipalities of Athabasca County, County of St Paul, Lac La Biche County, MD of Bonnyville, Smoky Lake County, and Thorhild County. The total length of shoreline assessed as part of this study varied considerably by municipality, with the County of St. Paul having the greatest length of shoreline assessed (551 km) and Smoky Lake County having the least (101 km) (Figure 24).

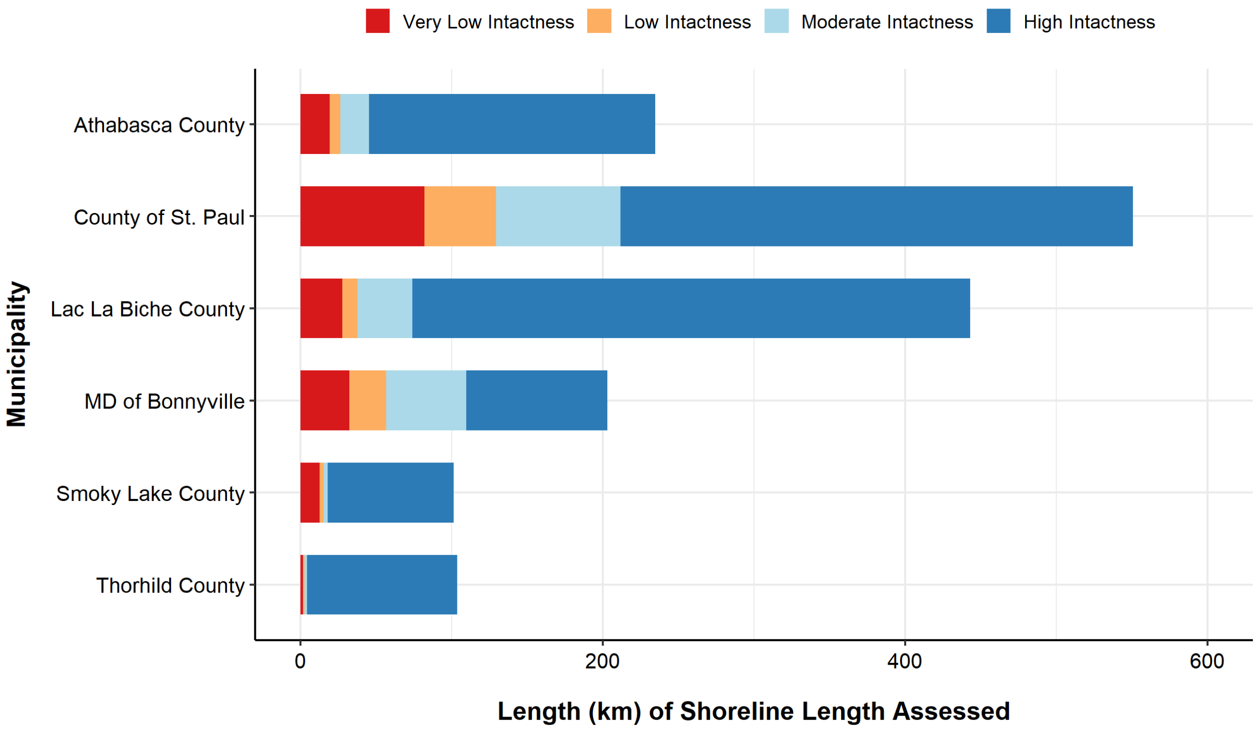


Figure 24. The total length of shoreline assigned to each riparian intactness category, summarized by municipality.

When the proportion of shoreline length assigned to each intactness category was evaluated, all municipalities had 70% or more of their shorelines classified as Moderate or High Intactness, with Thorhild County having the highest proportion of shorelines classified as High Intactness (96%; 99 km) (Figure 25; Maps 16 through 18). Athabasca County, Lac La Biche County, and Smoky Lake County also had a large proportion of shoreline (>75%) classified as High Intactness. Conversely, the MD of Bonnyville had the highest proportion of shoreline classified as Very Low Intactness (16%; 32 km), while the County of St. Paul had the greatest distance of shoreline classified as Very Low (82 km) and Low (47 km) Intactness.

When pressure associated with RMAs was compared between municipalities, the County of St. Paul and the MD of Bonnyville had the greatest proportion of local catchment areas classified as High Pressure (Figure 26; Map 19). Generally, catchments dominated by human disturbance (e.g., agriculture, cutblocks, resource extraction) receive higher pressure scores than catchments with a higher proportion of natural cover. Thorhild County had the greatest proportion of local catchment areas classified as Low Pressure.

The Counties of Athabasca, Lac La Biche, Smoky Lake, and Thorhild all had the majority of their shorelines classified as High Conservation Priority, while the County of St Paul and the MD of Bonnyville had the majority of their shorelines classified as Moderate Conservation Priority (Figure 27). Based on shoreline length, Lac La Biche County had the greatest amount of shoreline classified as High Conservation priority (340 km), and the County of St Paul had the greatest amount of shoreline classified as Moderate Conservation priority (244 km). Conversely, the County of St Paul had 114 km (or 21%) of its shoreline classified as High Restoration Priority, while the MD of Bonnyville had 57 km (or 28%) of its shoreline classified as High or Moderate Restoration priority.

A more detailed breakdown of results by municipality is provided in sections 5.2 through 5.7.

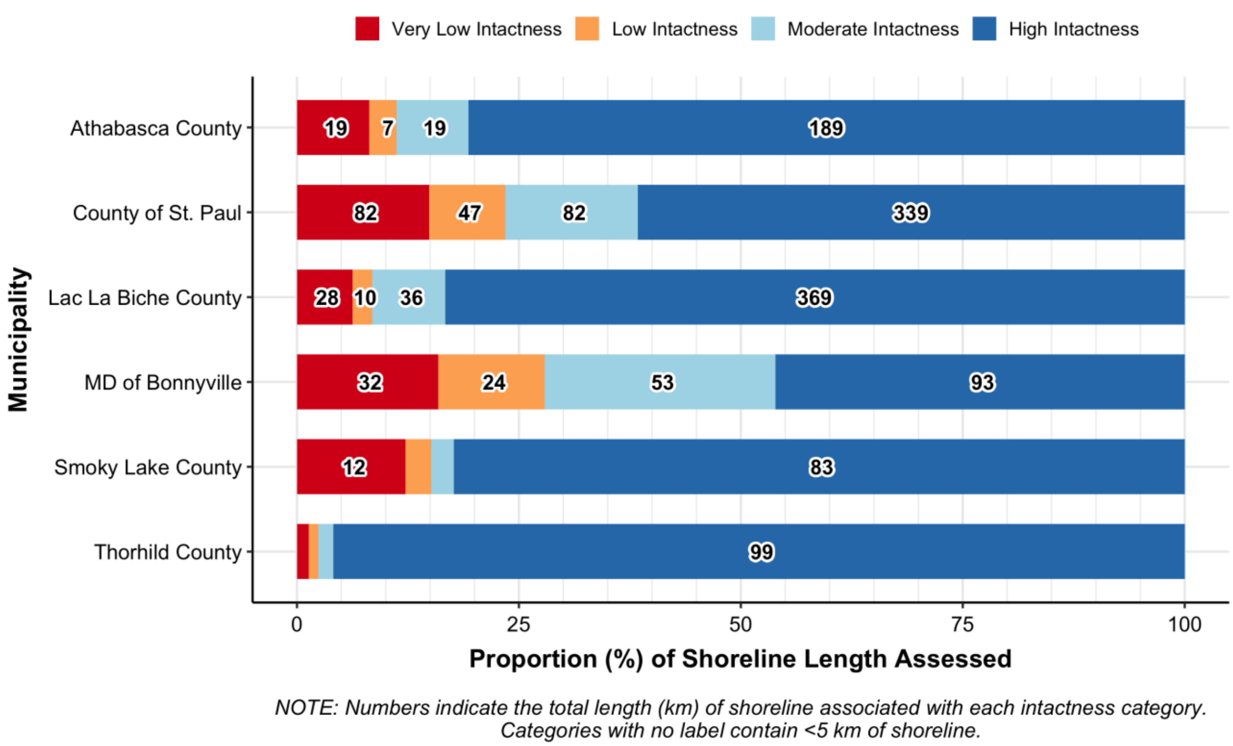


Figure 25. The proportion of shoreline length assigned to each riparian intactness category, summarized by municipality. Numbers indicate the approximate length (km) of shoreline associated with each intactness category.

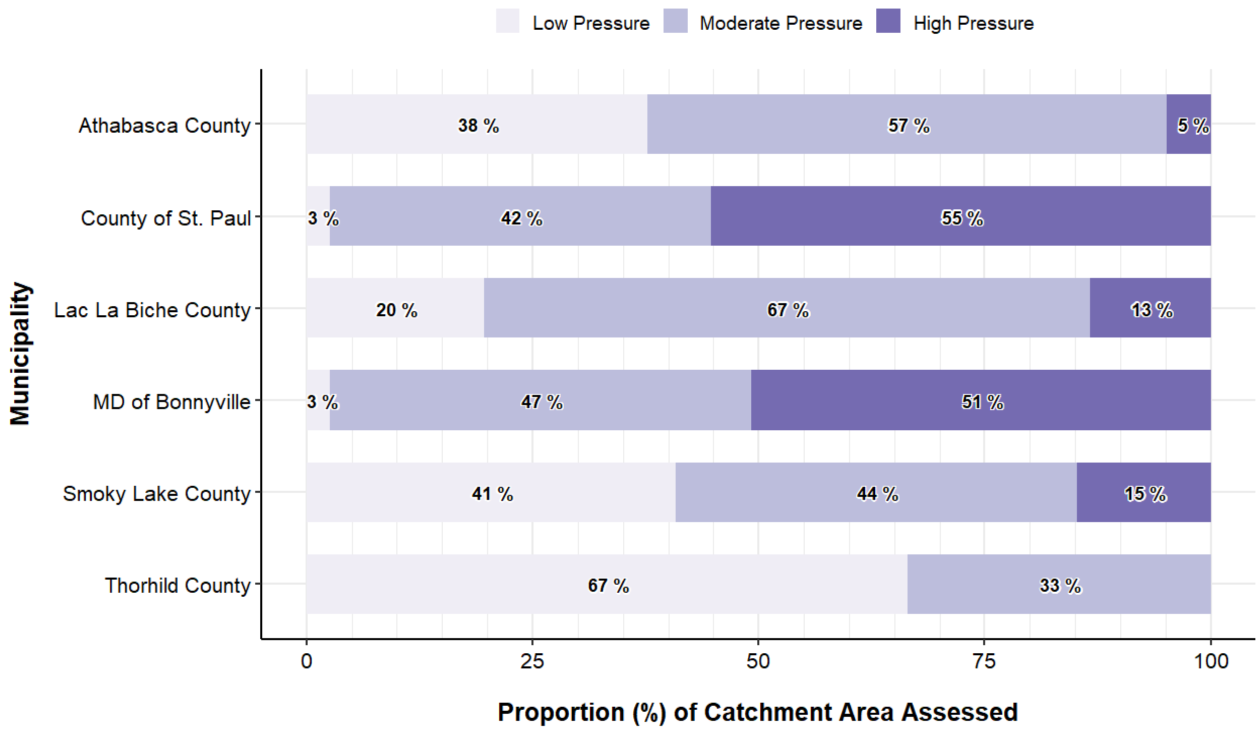


Figure 26. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of waterbodies contained within each municipality. Numbers indicate the proportion of area assigned to each pressure category.

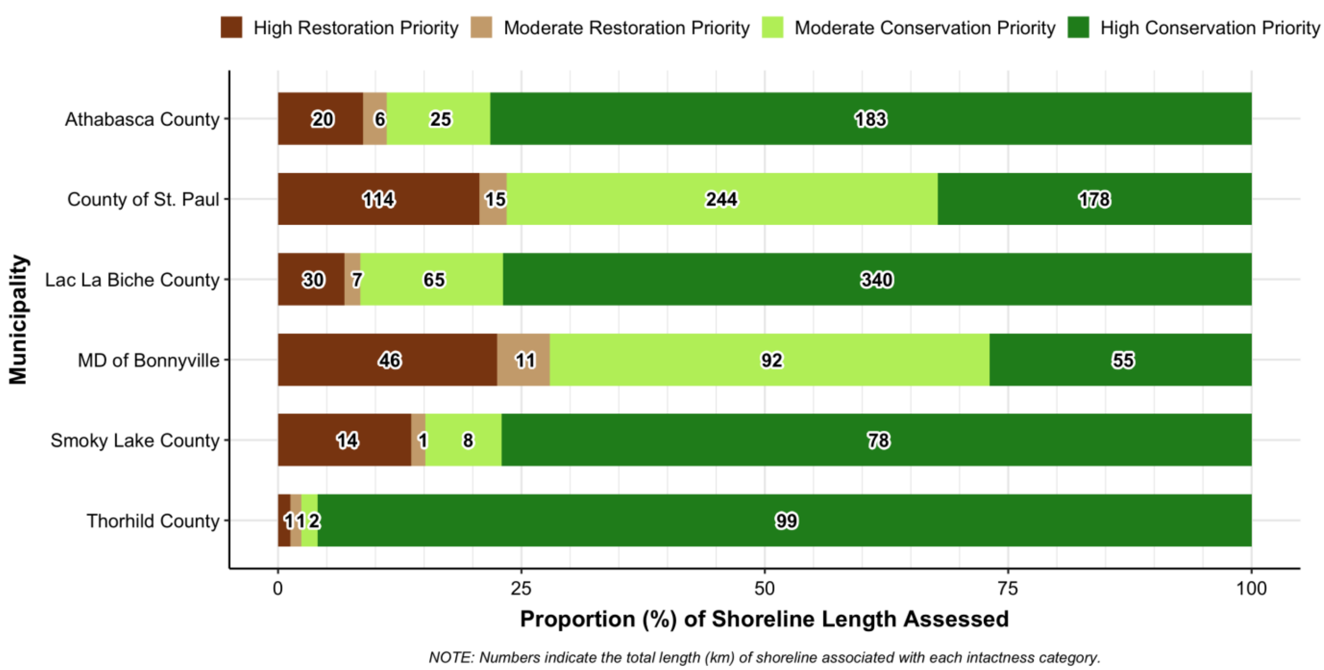
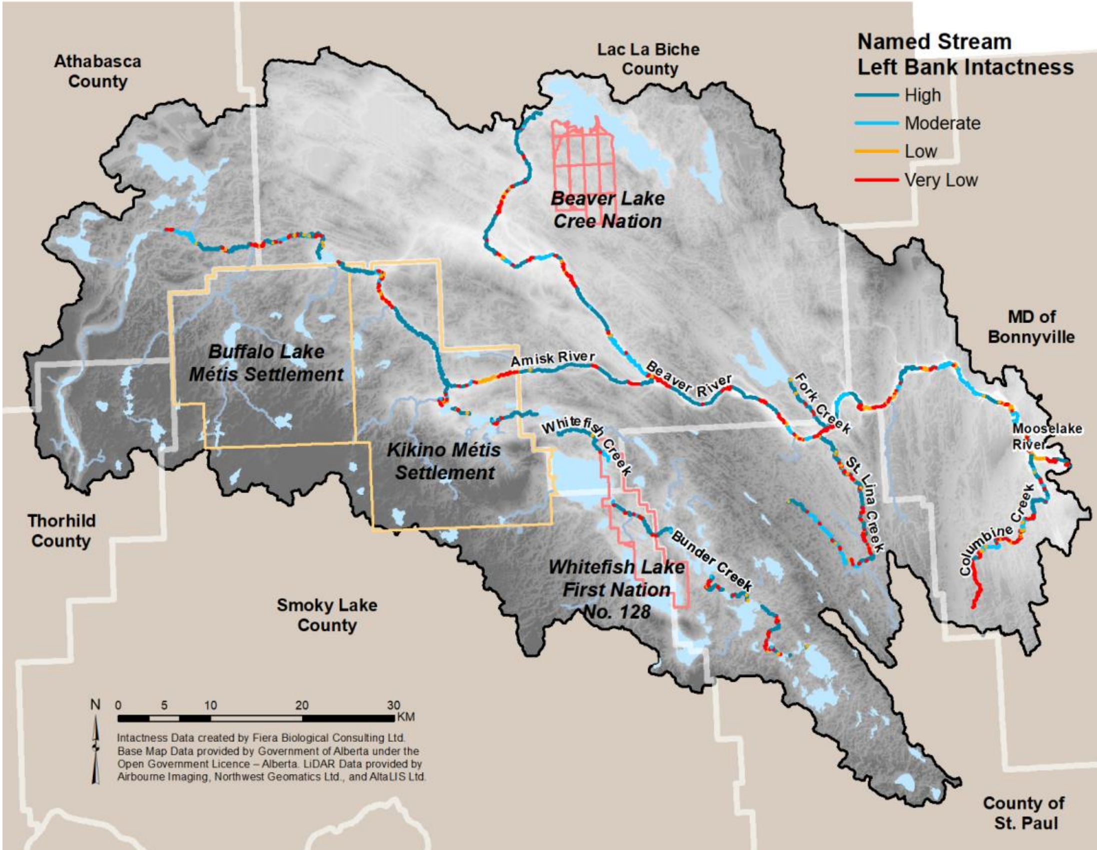
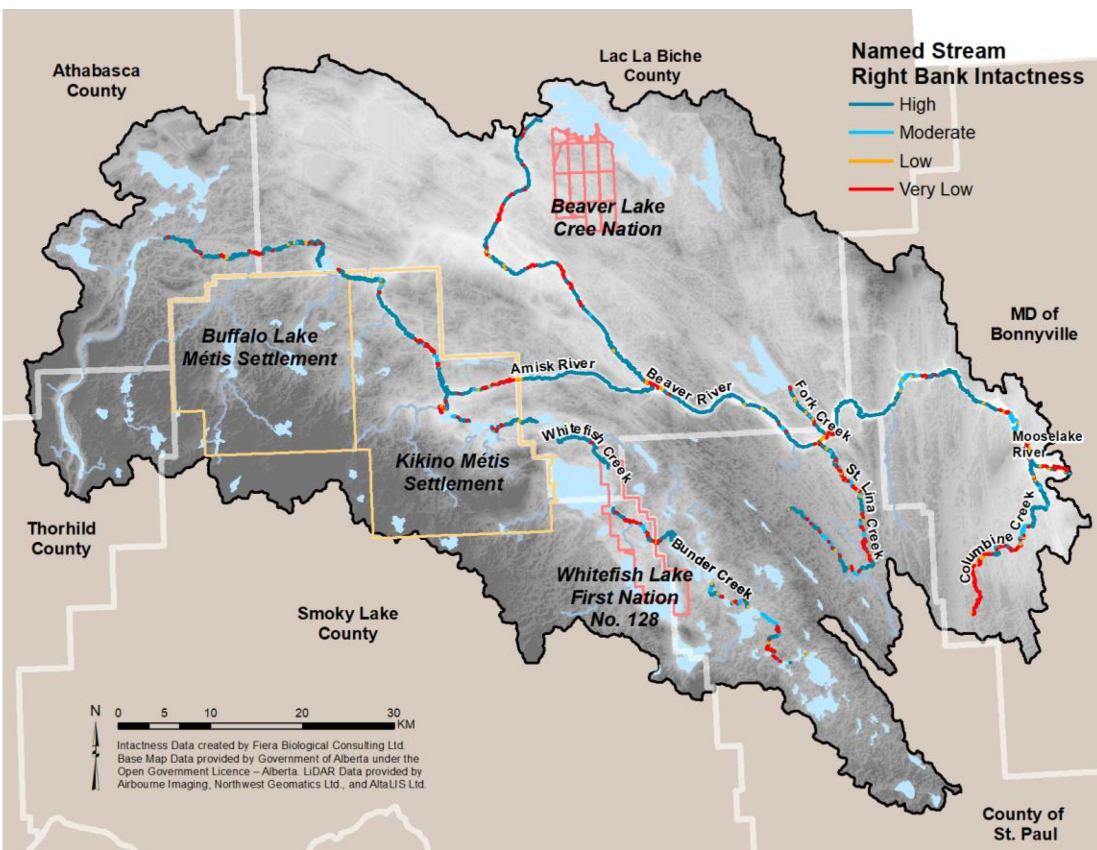
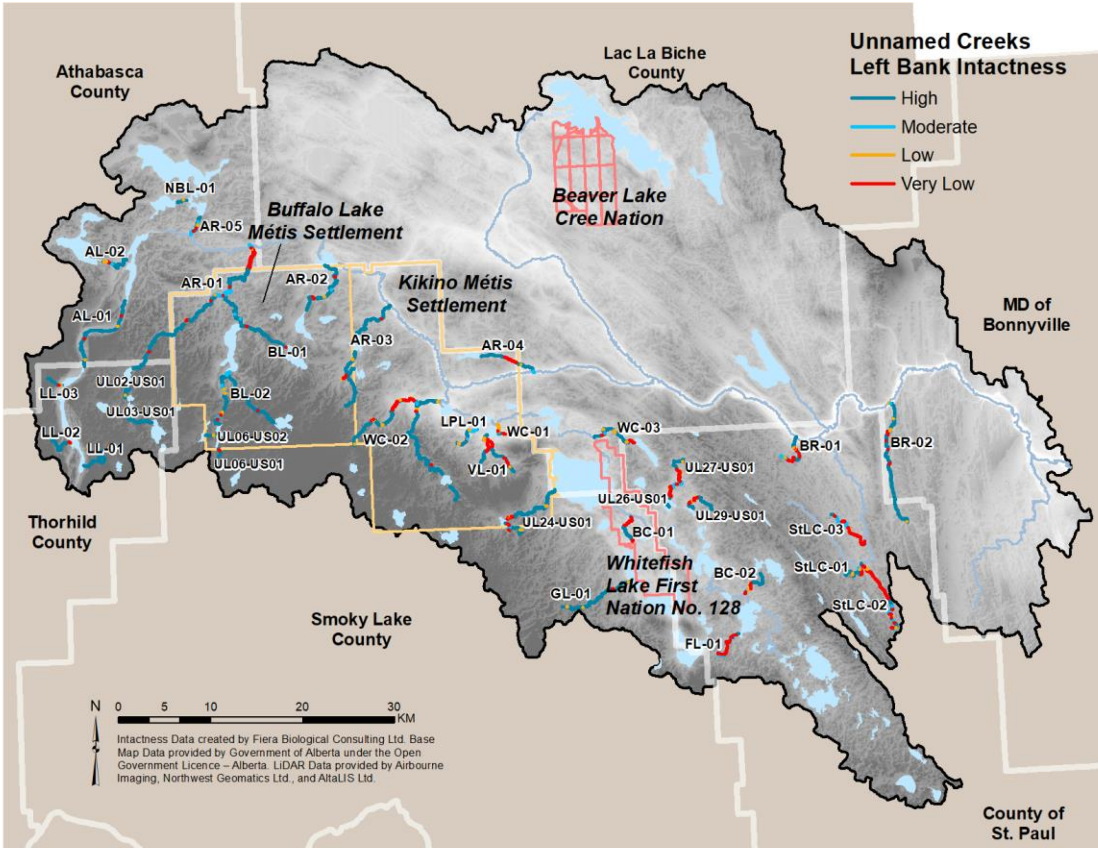


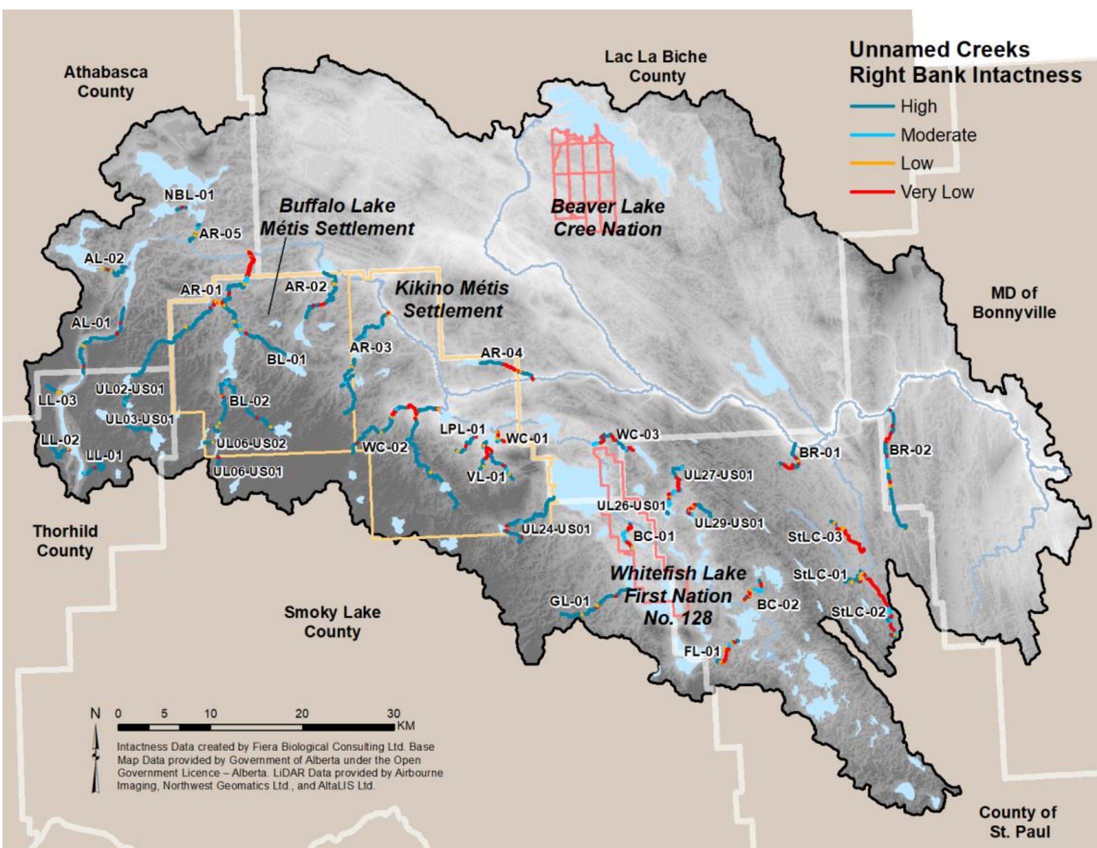
Figure 27. The proportion of shoreline length assigned to each priority category, summarized by municipality. Numbers indicate the approximate length (km) of shoreline associated to each priority category.



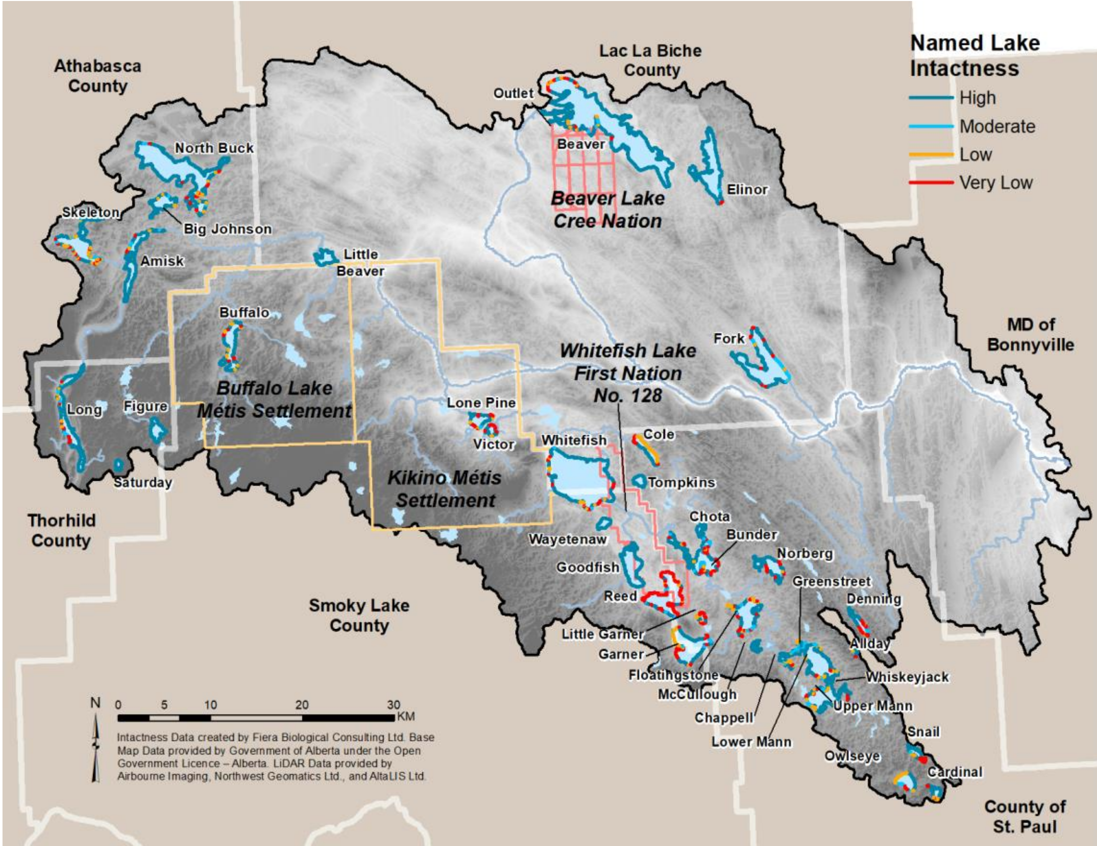


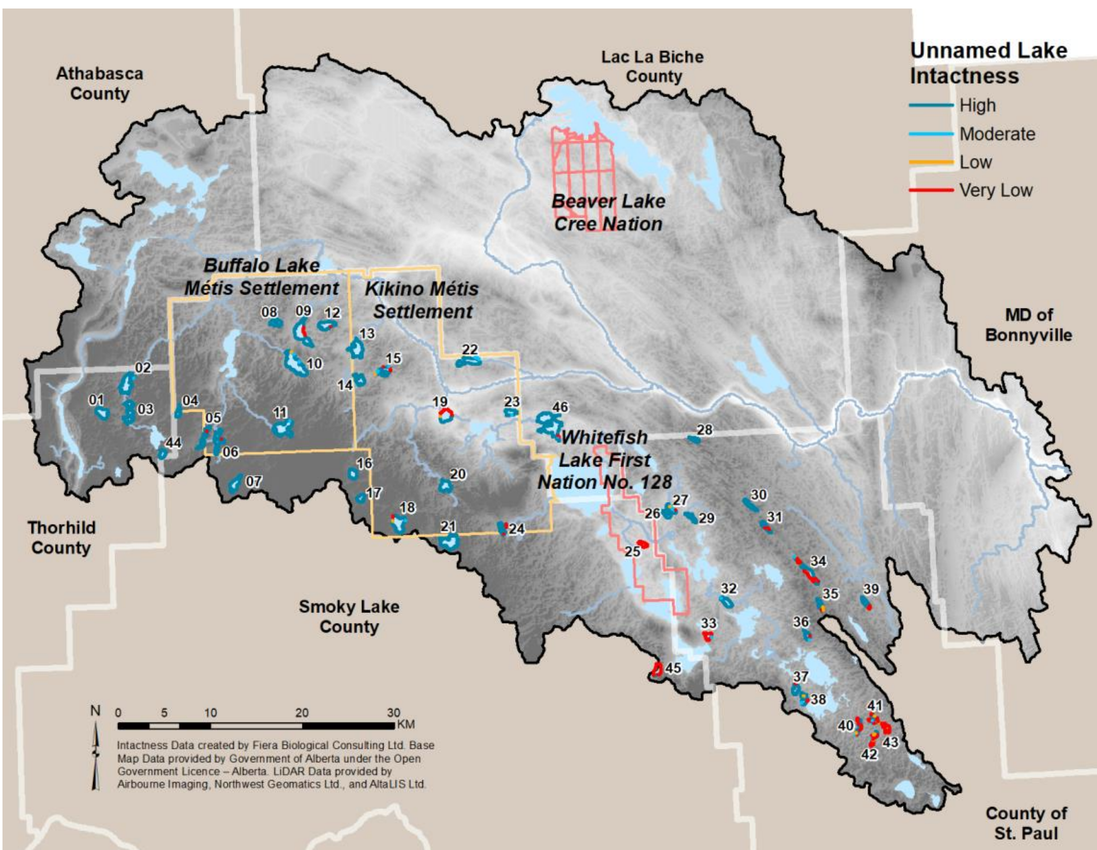
Map 16. Intactness for the left and right banks of the named streams that were included in this study, by jurisdiction.



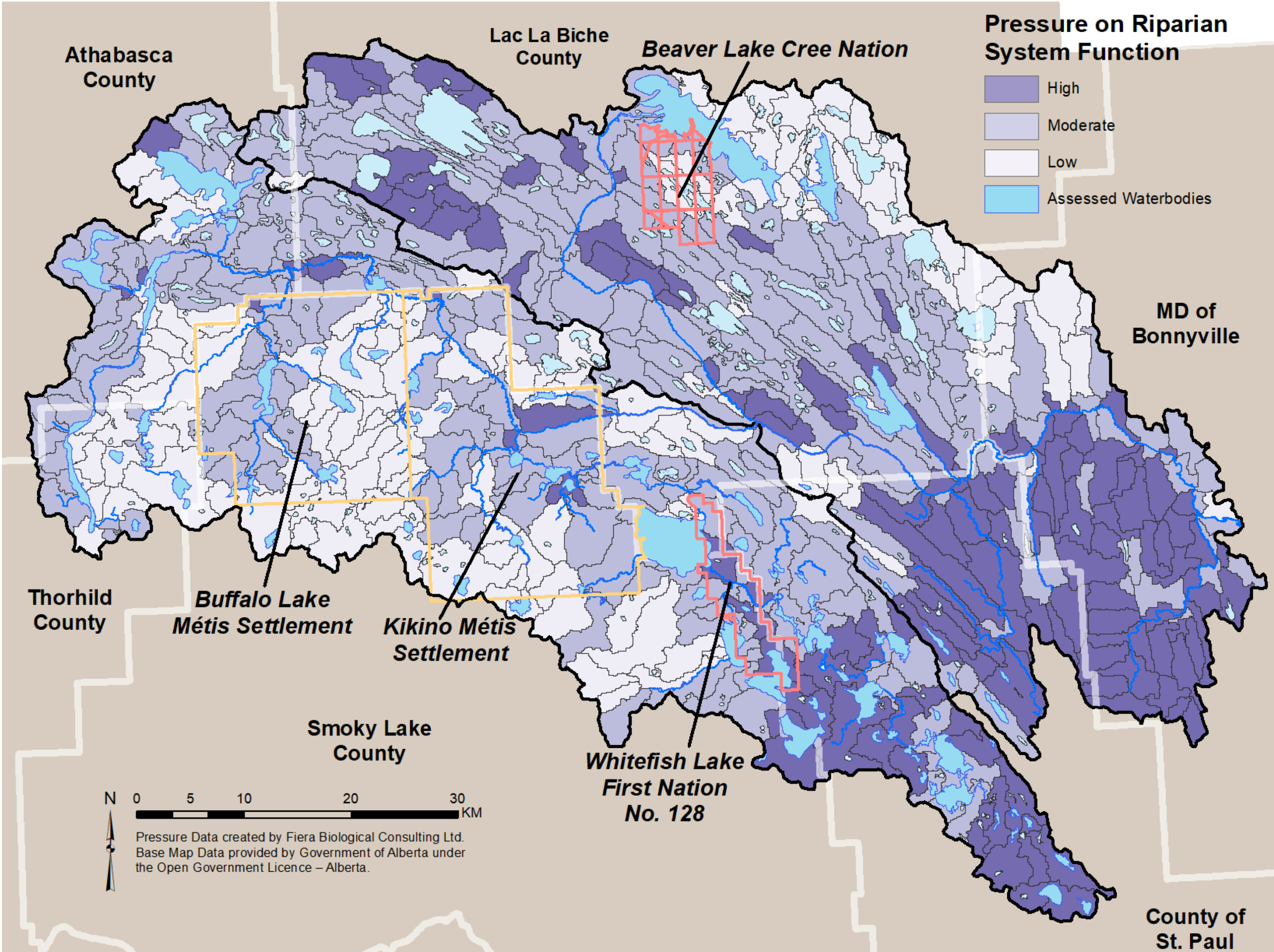


Map 17. Intactness for the left and right banks of unnamed creeks that were included in this study, by jurisdiction.

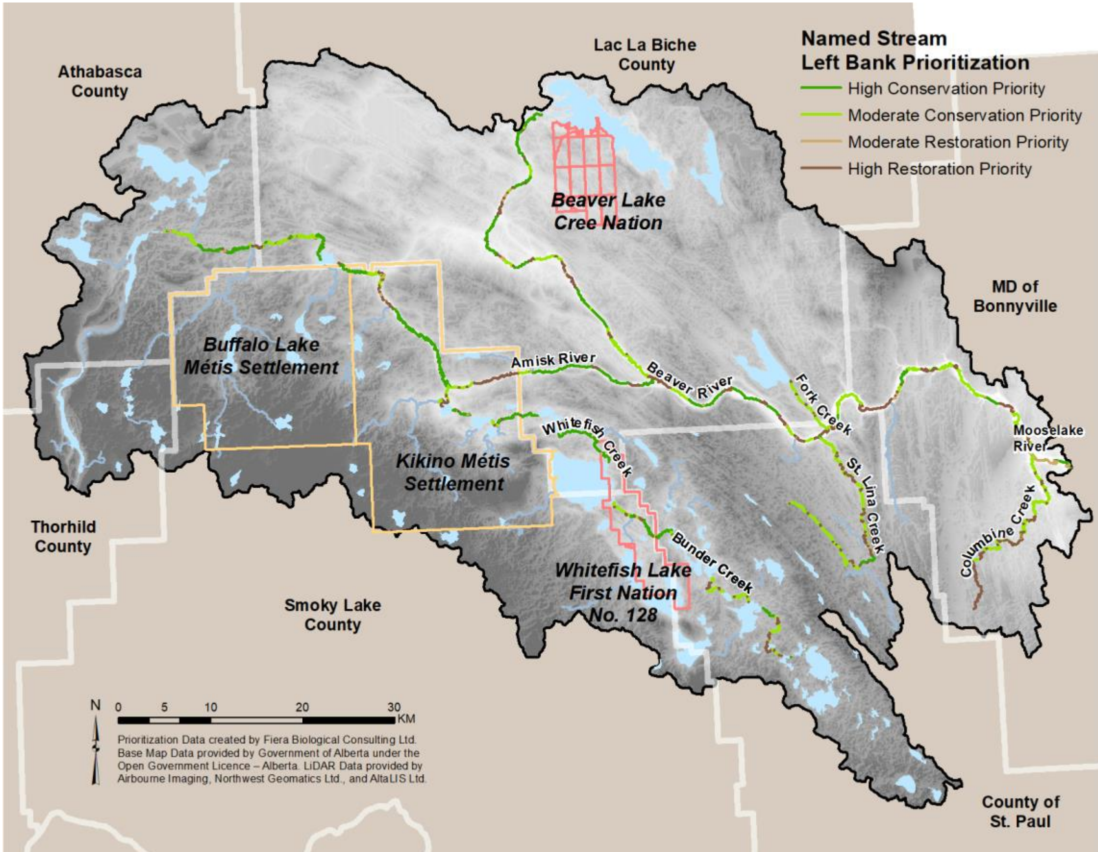


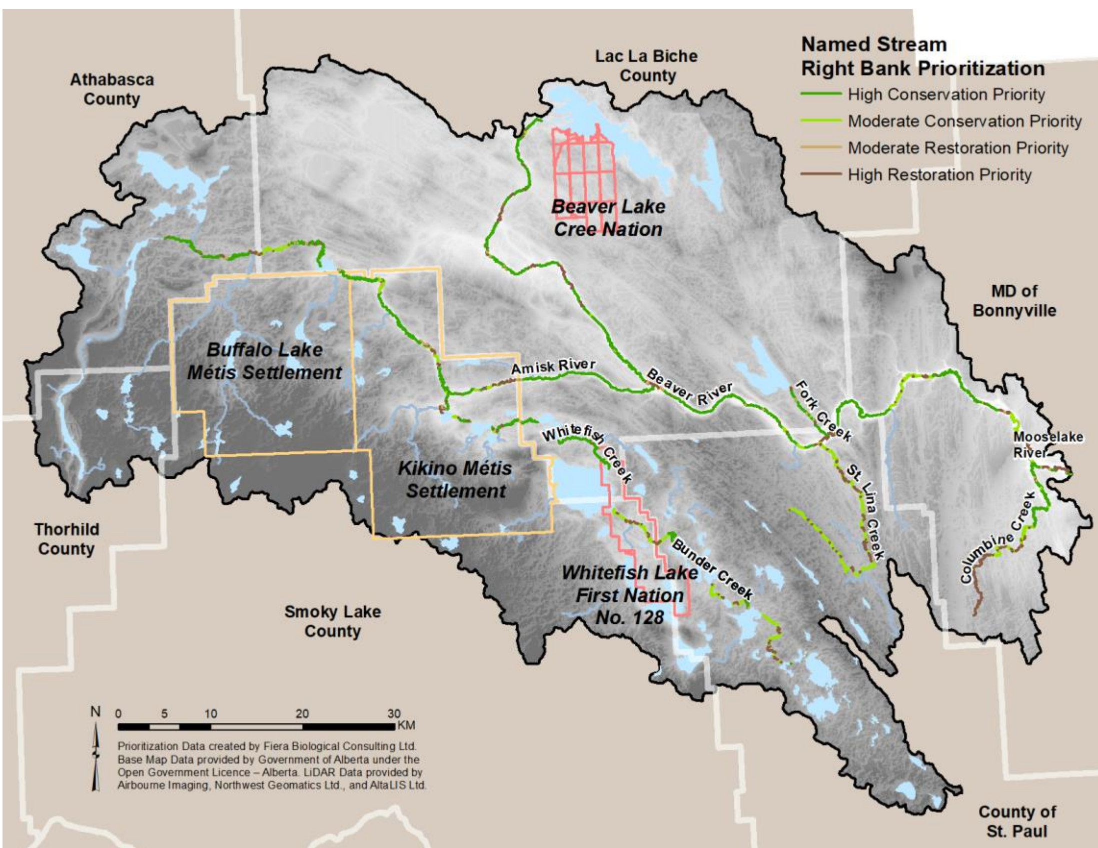


Map 18. Intactness for named and unnamed lakes that were included in this study, by jurisdiction.

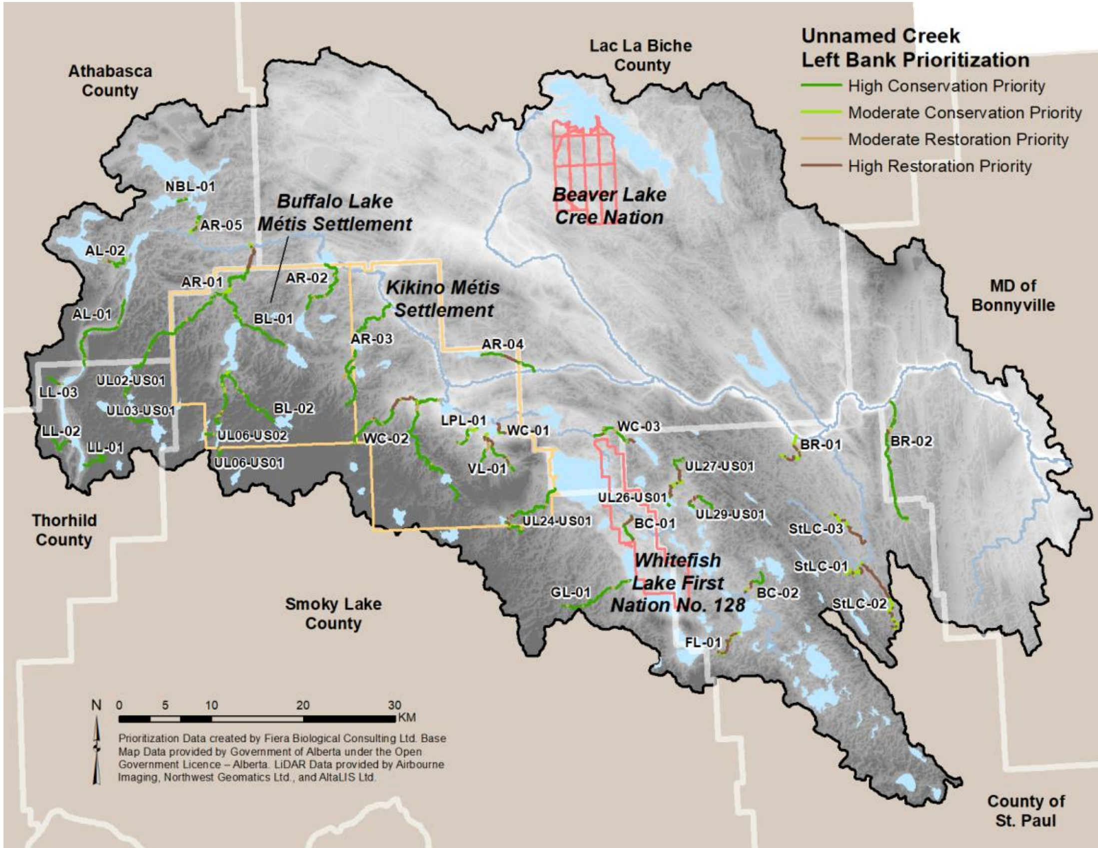


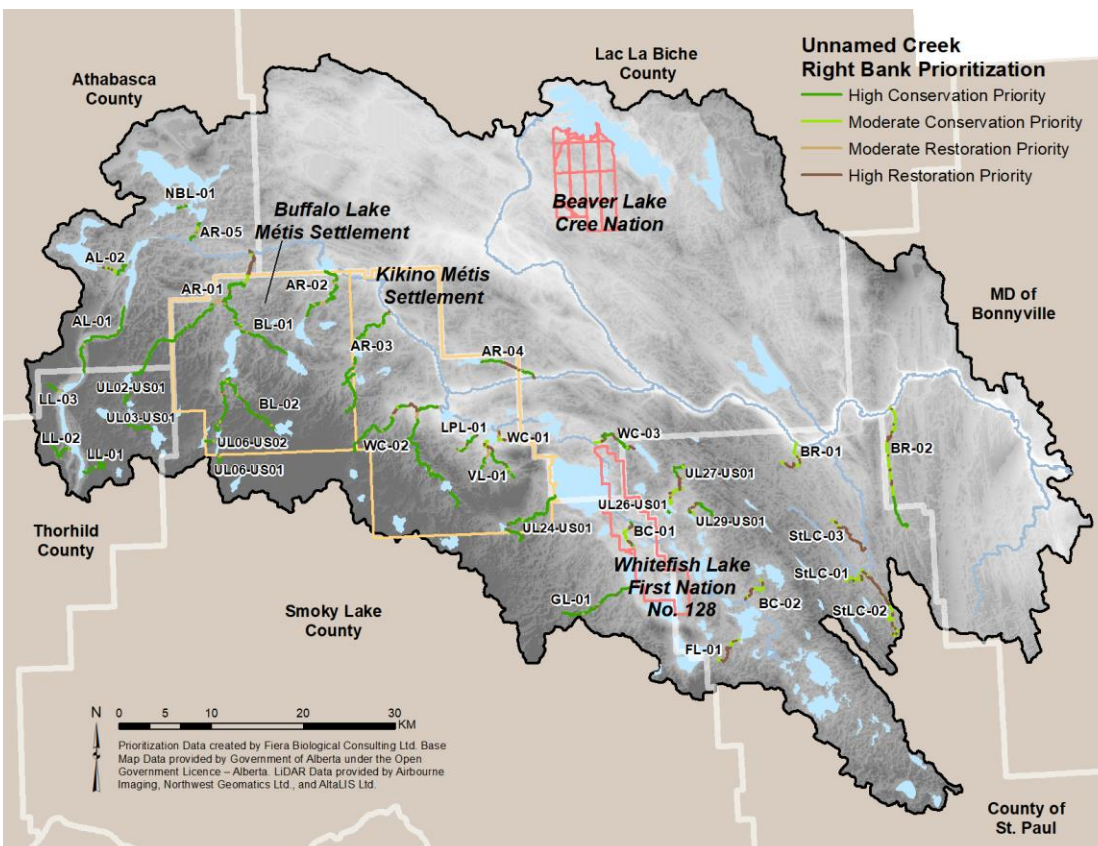
Map 19. Distribution of local catchments classified as High, Moderate, and Low Pressure, by jurisdiction.



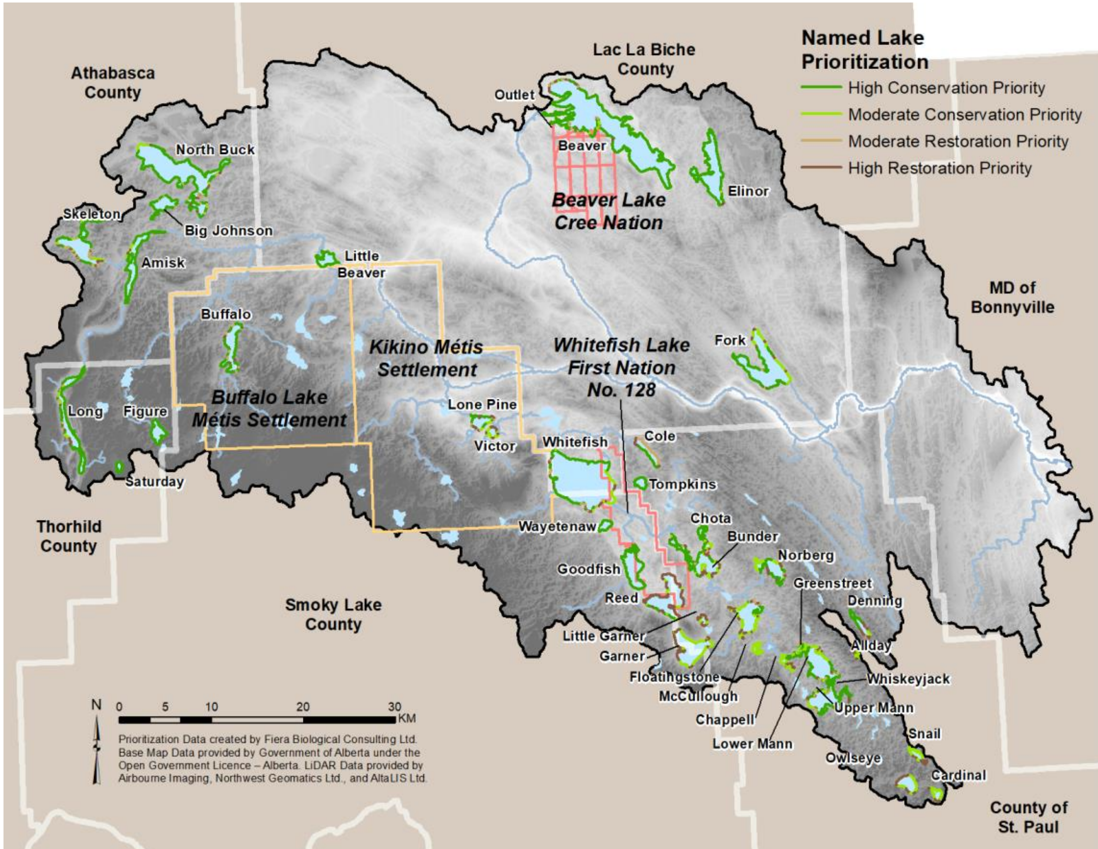


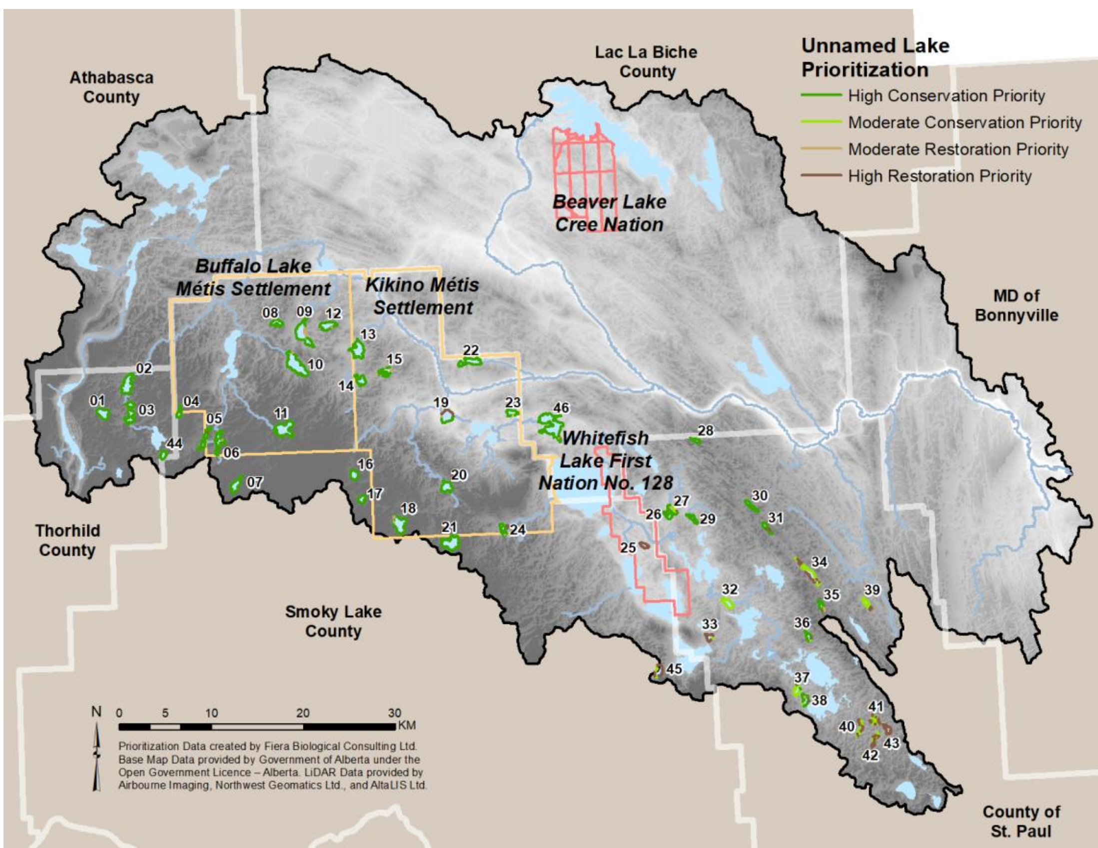
Map 20. Restoration and conservation priority for the left and right bank of named streams included in this study, by jurisdiction.





Map 21. Restoration and conservation priority for the left and right bank of unnamed creeks included in this study, by jurisdiction.





Map 22. Restoration and conservation priority for named and unnamed lakes included in this study, by jurisdiction.

5.2. Athabasca County

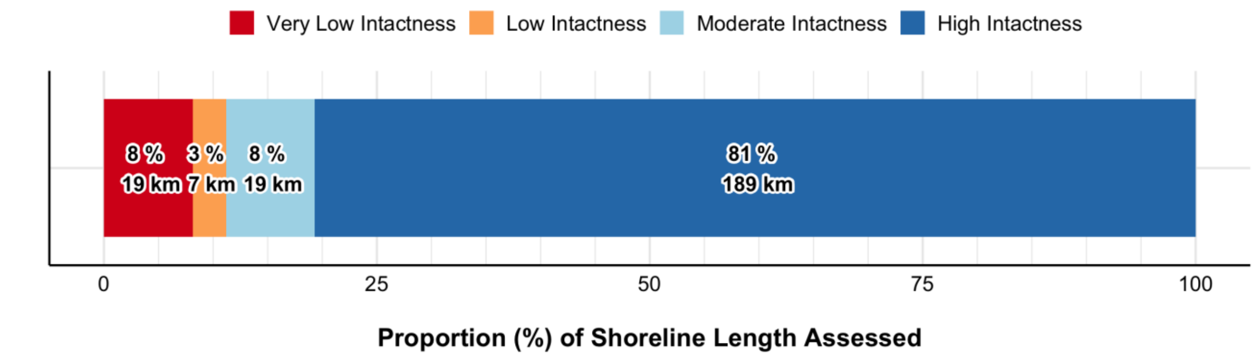


Figure 28. Overall intactness for waterbodies assessed within Athabasca County.

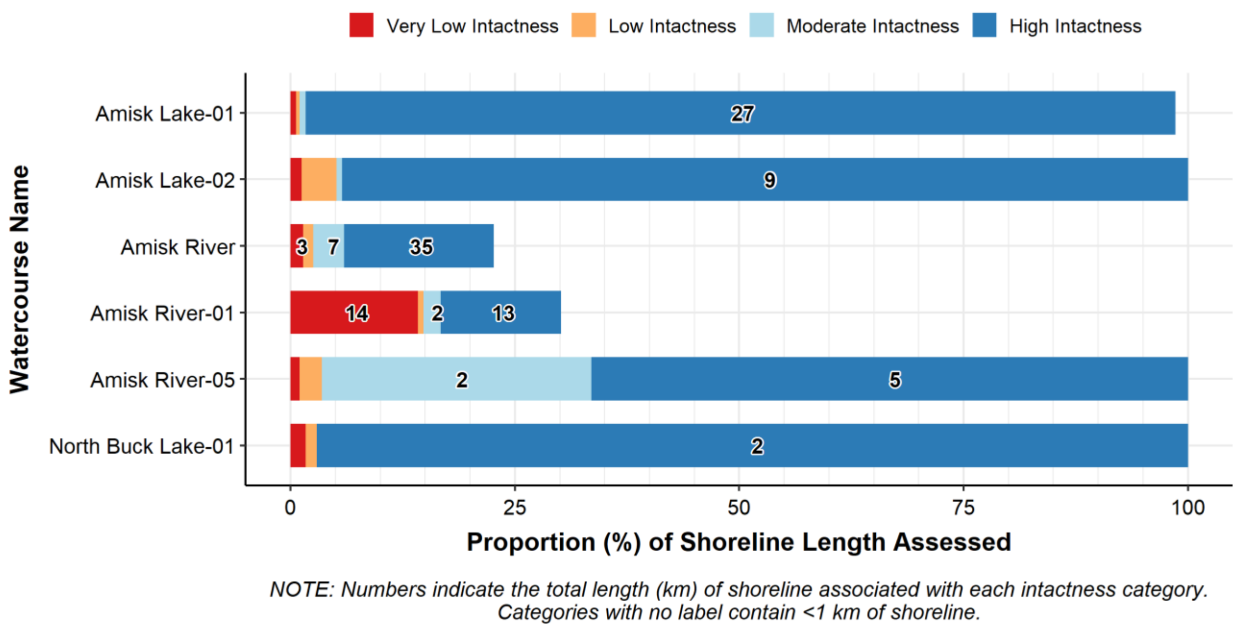


Figure 29. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed watercourses within Athabasca County.

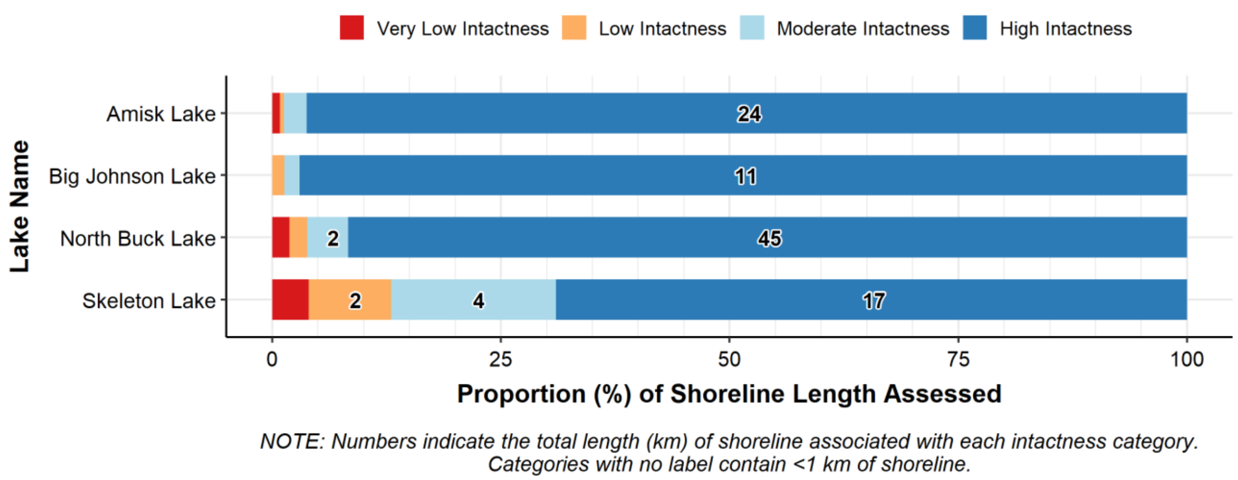


Figure 30. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed lakes within Athabasca County.

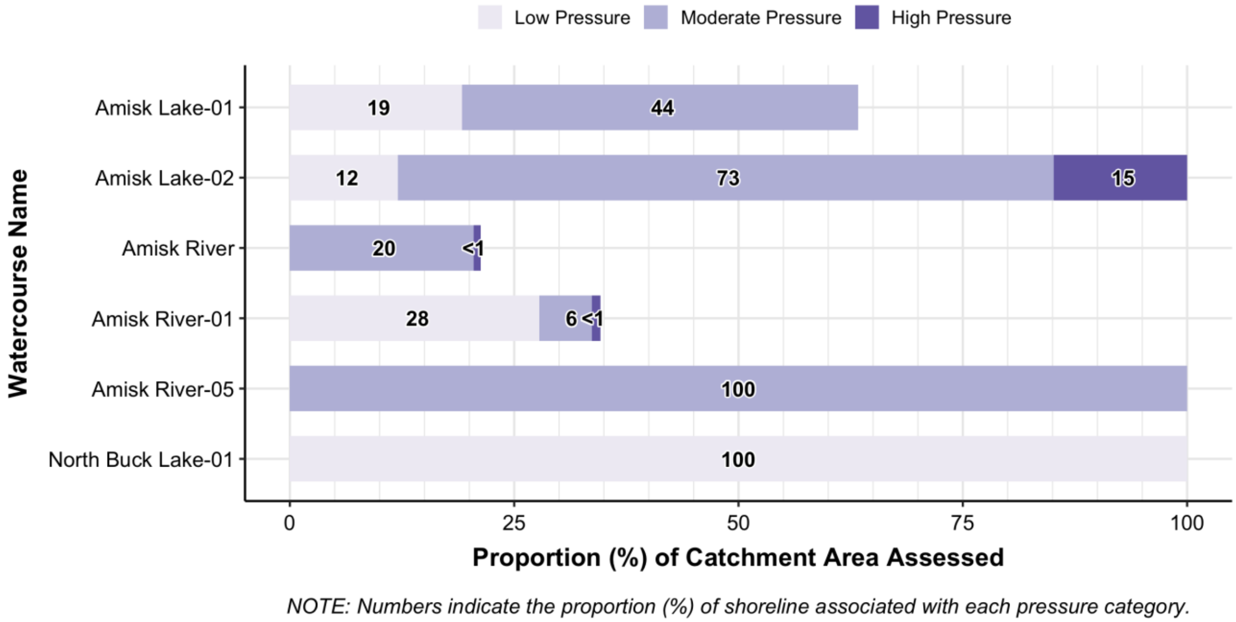


Figure 31. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed watercourses in Athabasca County.

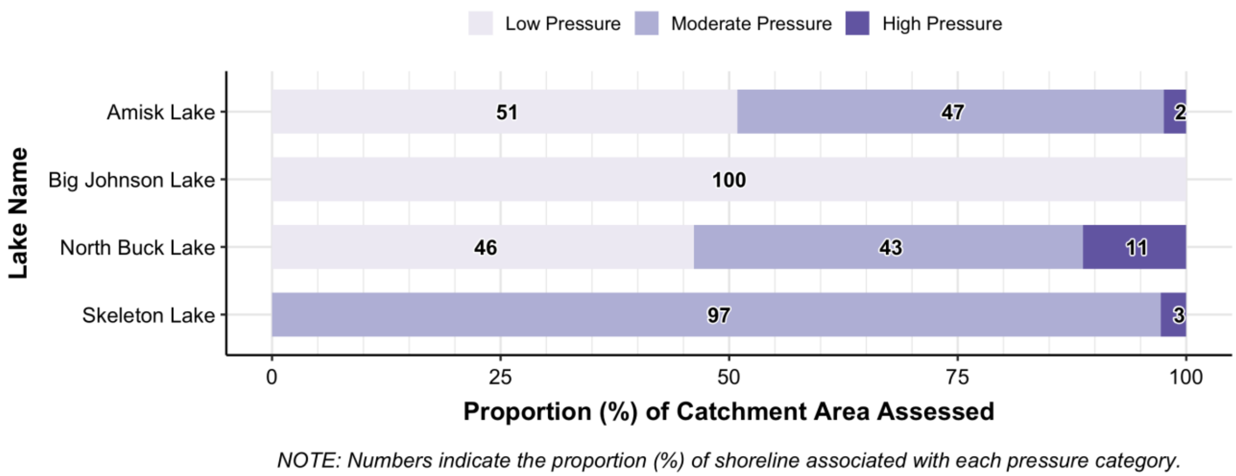


Figure 32. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed lakes in Athabasca County.

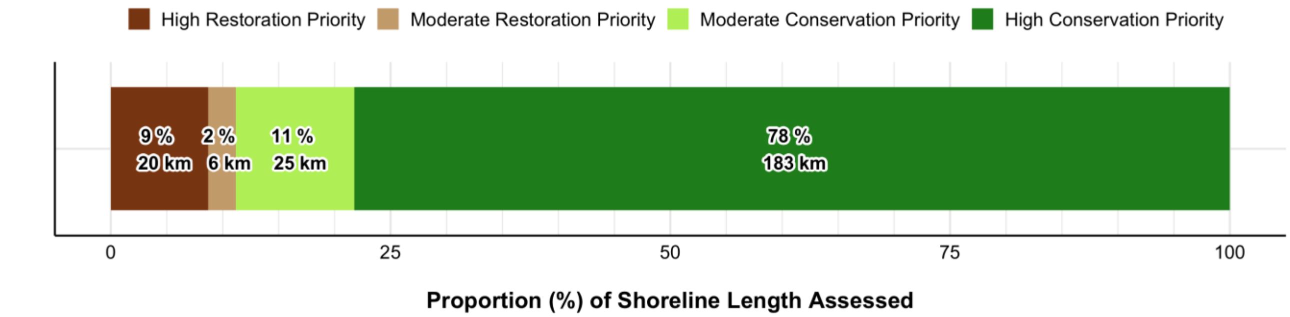


Figure 33. Overall conservation and restoration priority for waterbodies assessed within Athabasca County.

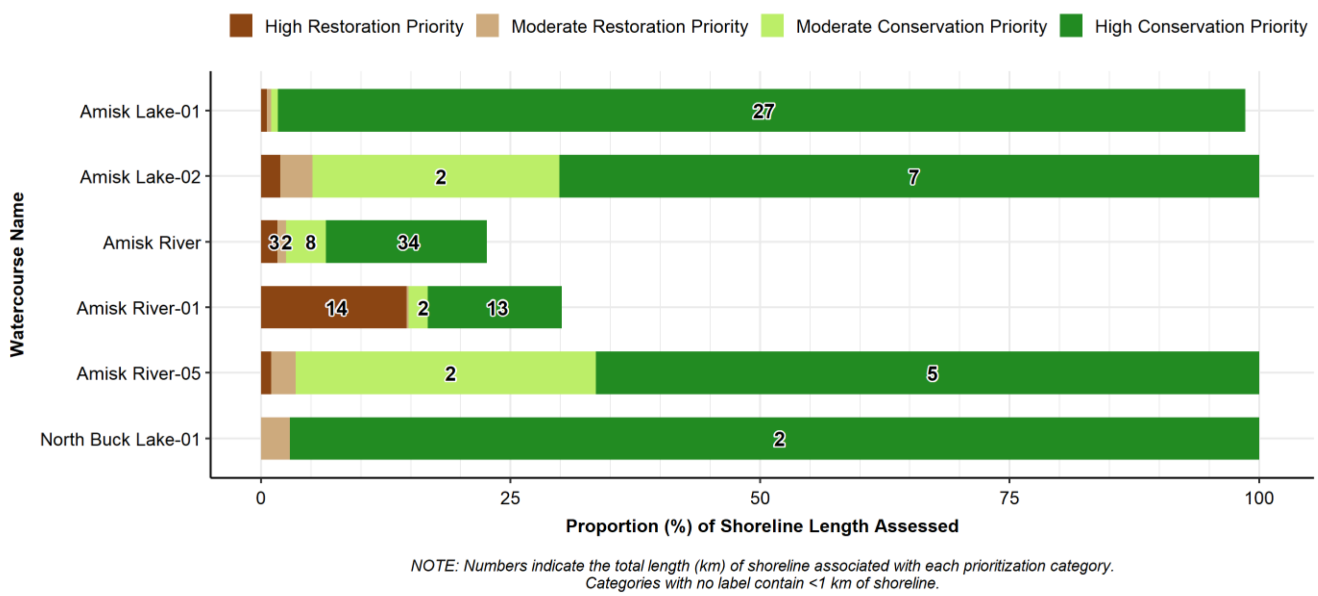


Figure 34. The proportion of shoreline length assigned to each prioritization category for named and unnamed watercourses within Athabasca County.

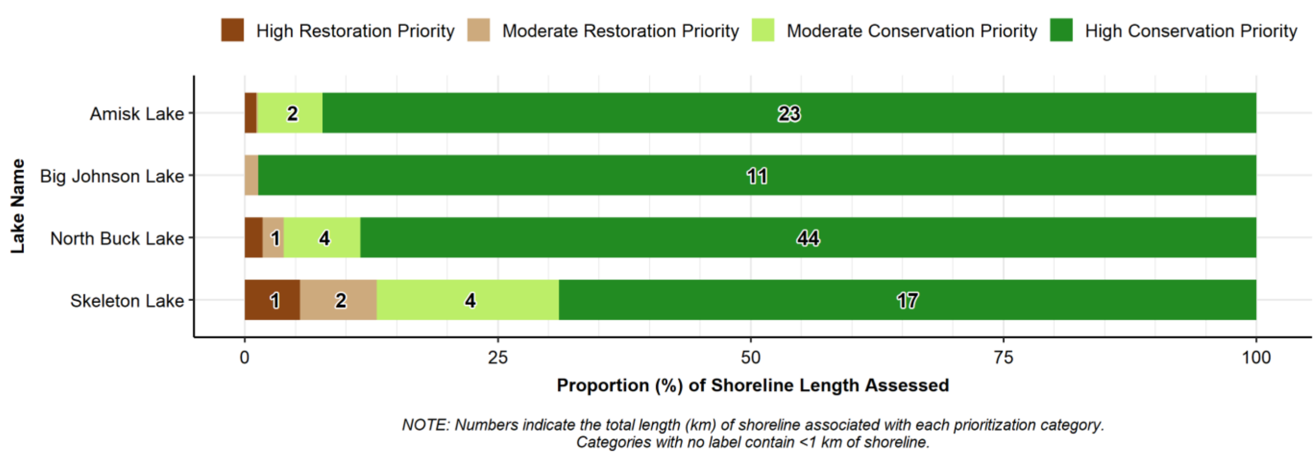


Figure 35. The proportion of shoreline length assigned to each prioritization category for named and unnamed lakes within Athabasca County.

5.3. County of St. Paul

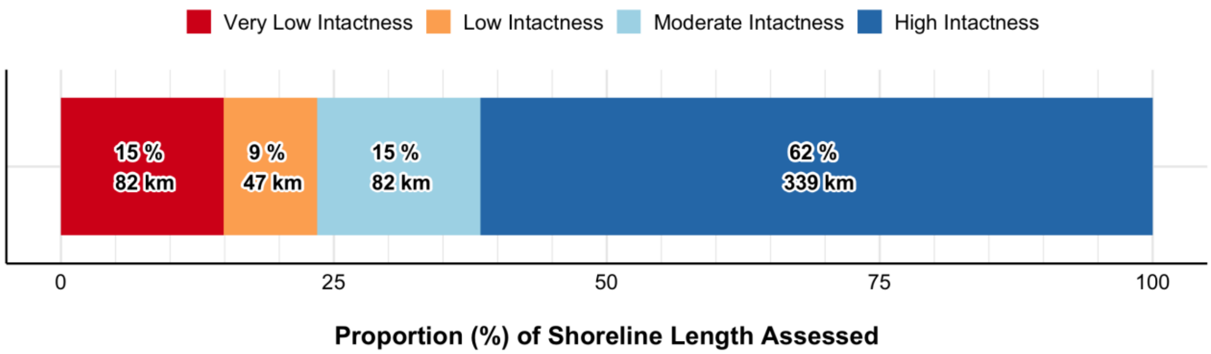


Figure 36. Overall intactness for waterbodies assessed within St. Paul County.

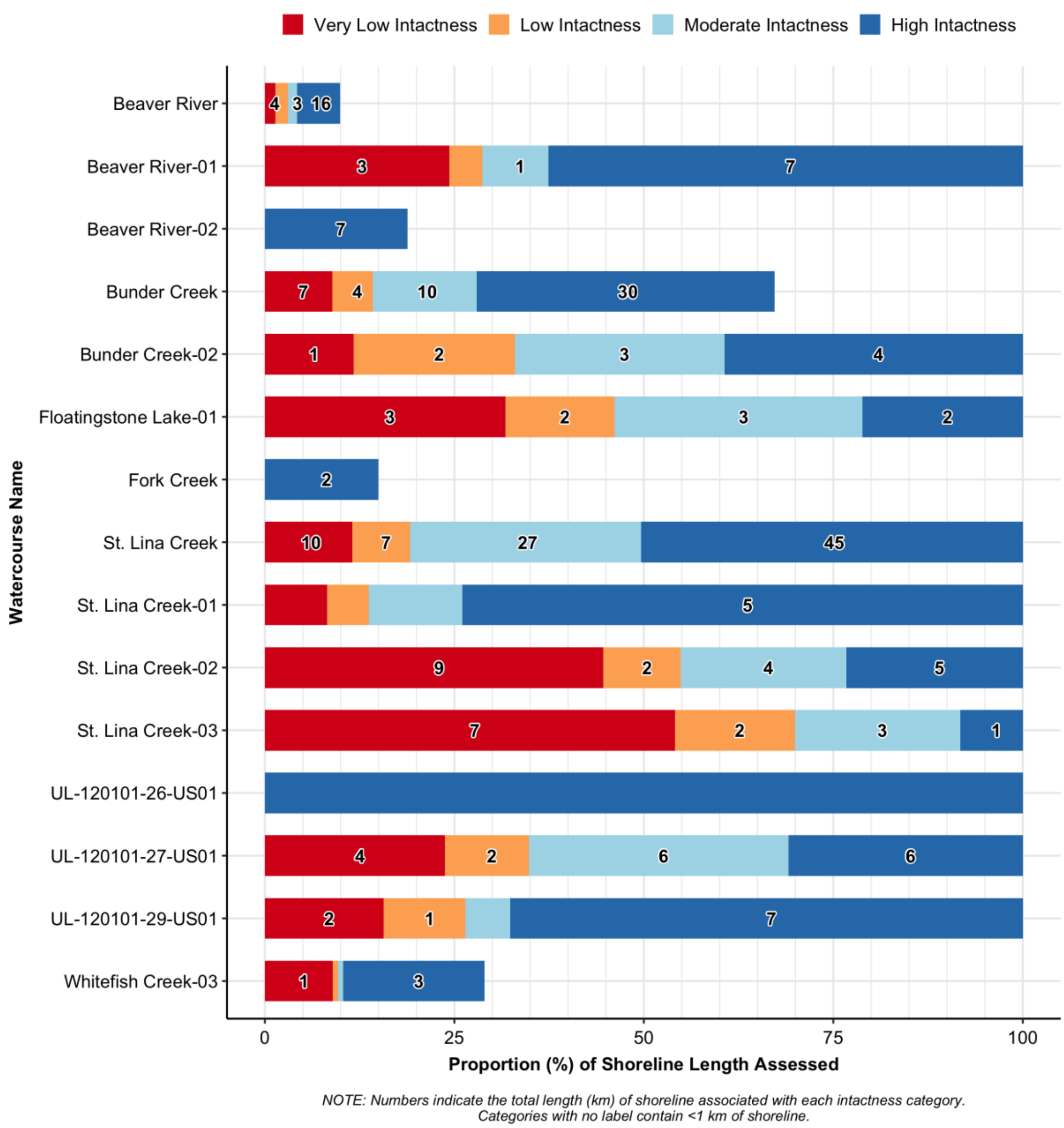
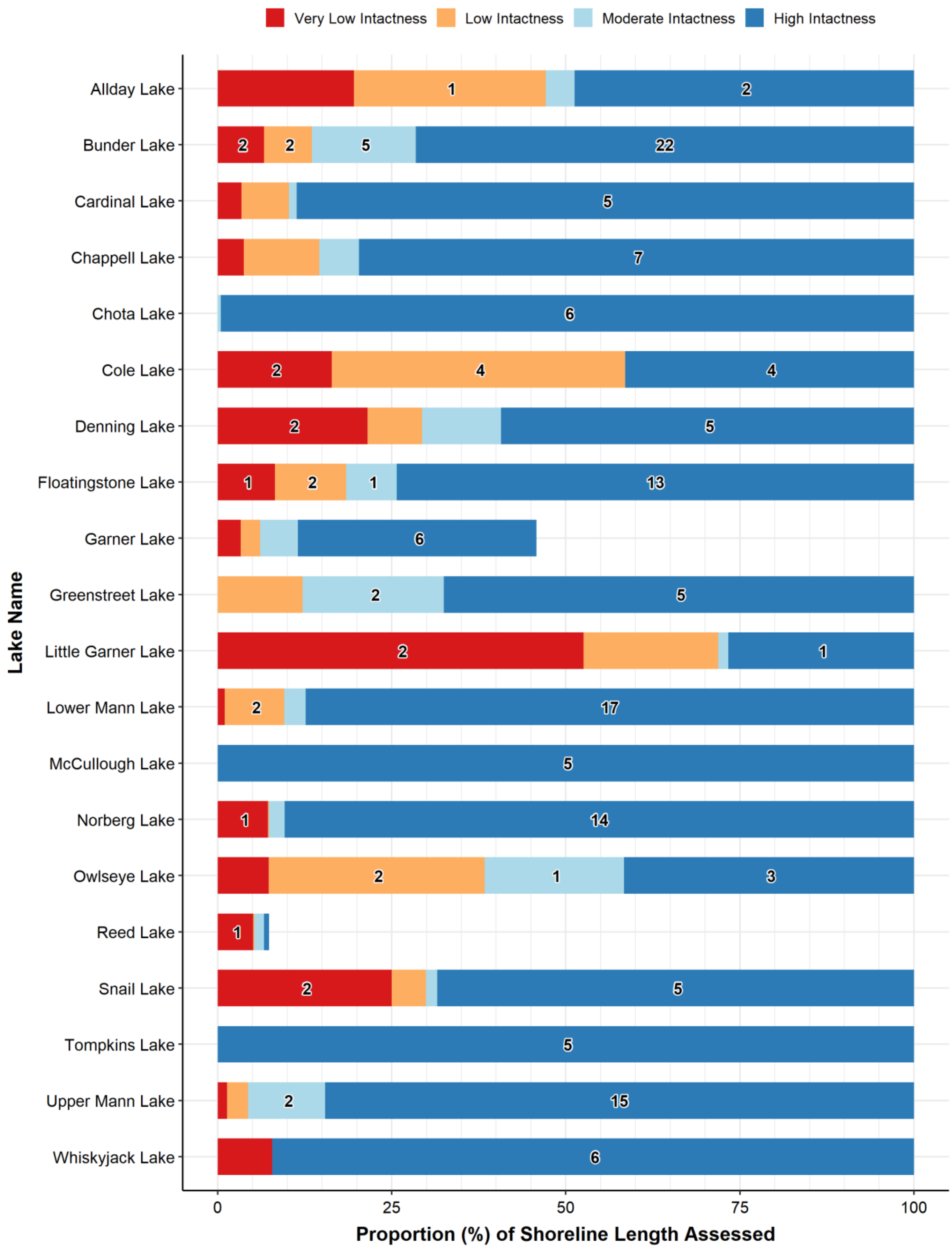


Figure 37. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed watercourses within St. Paul County.



NOTE: Numbers indicate the total length (km) of shoreline associated with each intactness category. Categories with no label contain <1 km of shoreline.

Figure 38. The proportion of shoreline length assigned to each riparian intactness category for named lakes within St. Paul County.

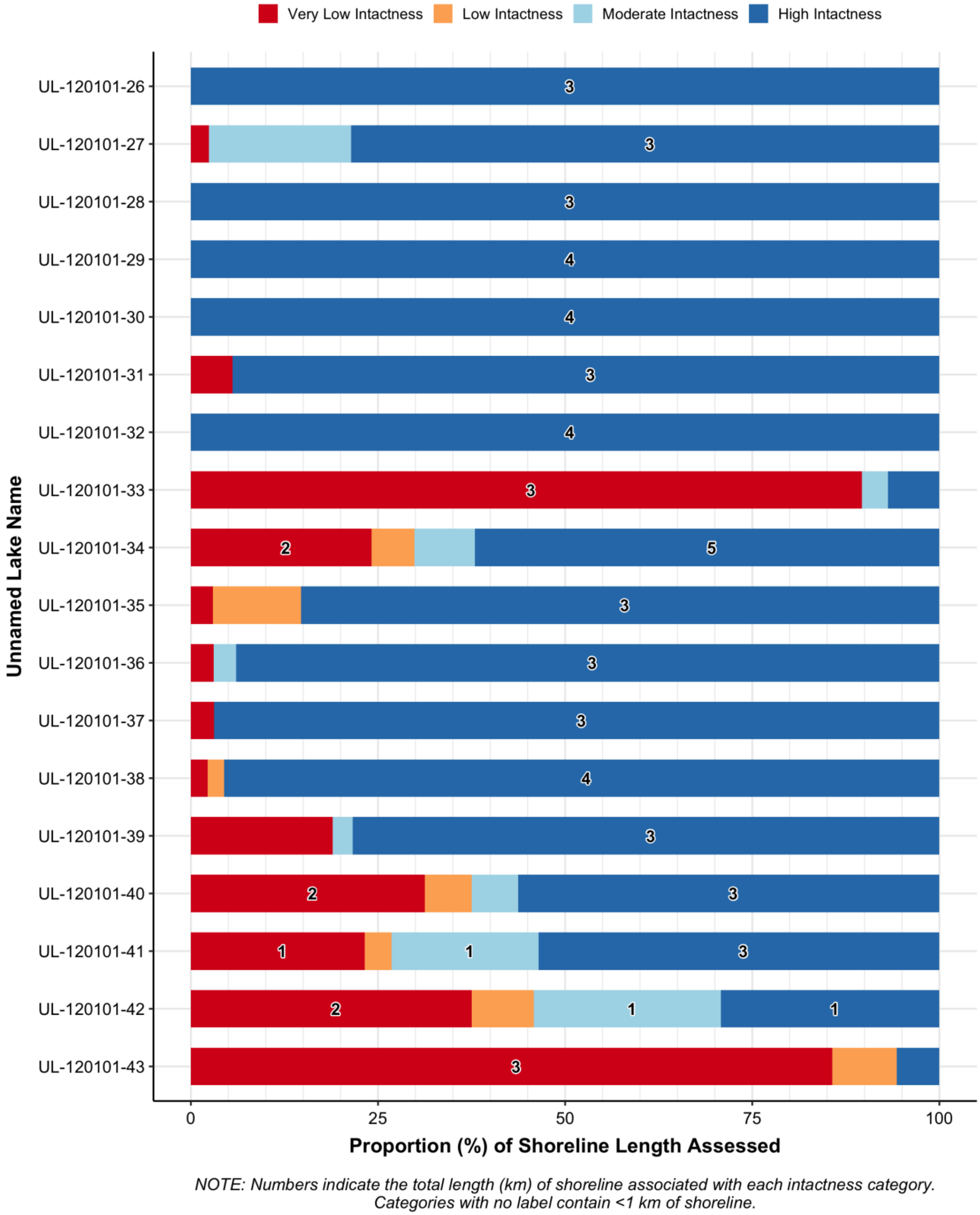


Figure 39. The proportion of shoreline length assigned to each riparian intactness category for unnamed lakes within St. Paul County.

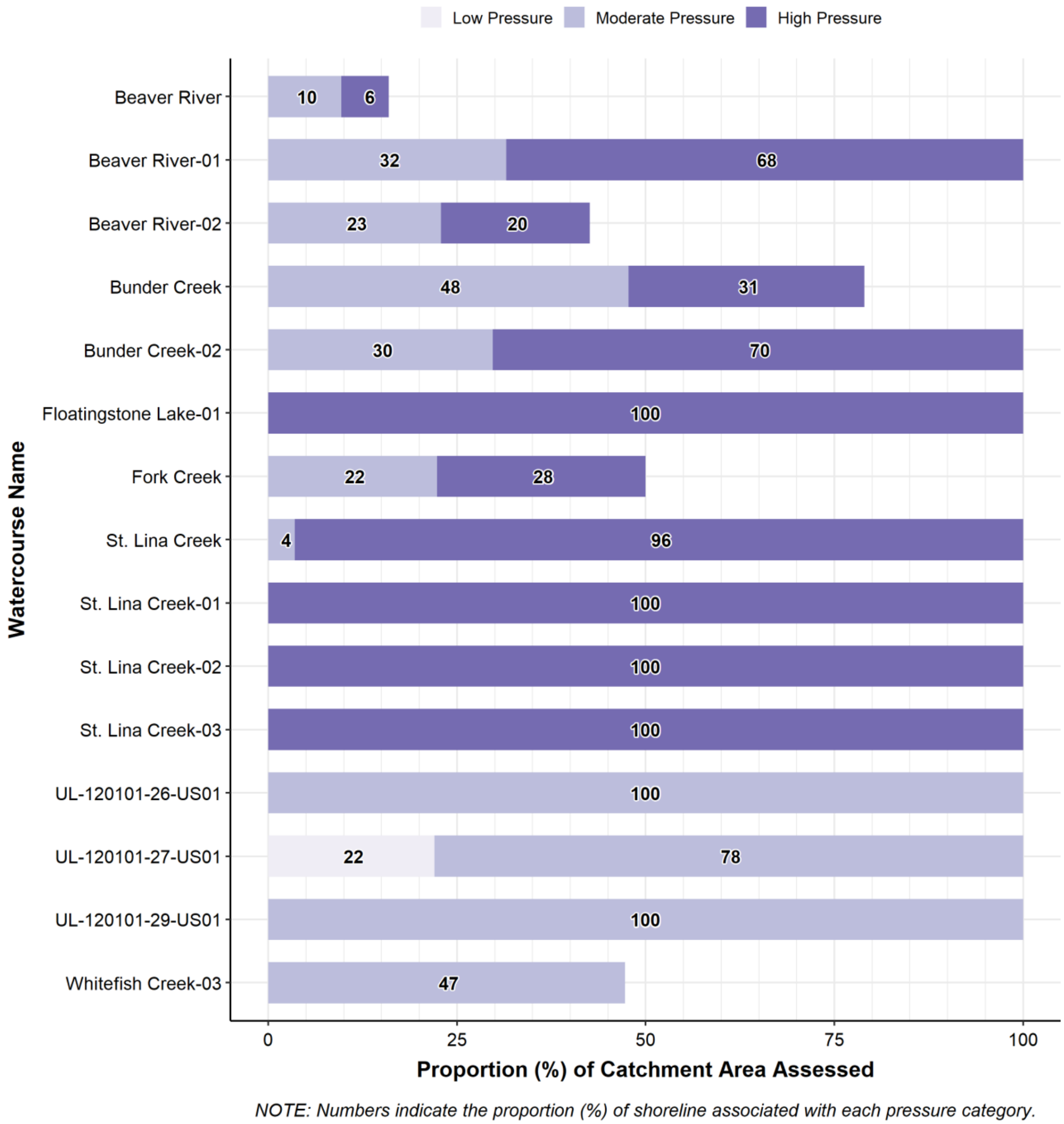


Figure 40. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed watercourses in St. Paul County.

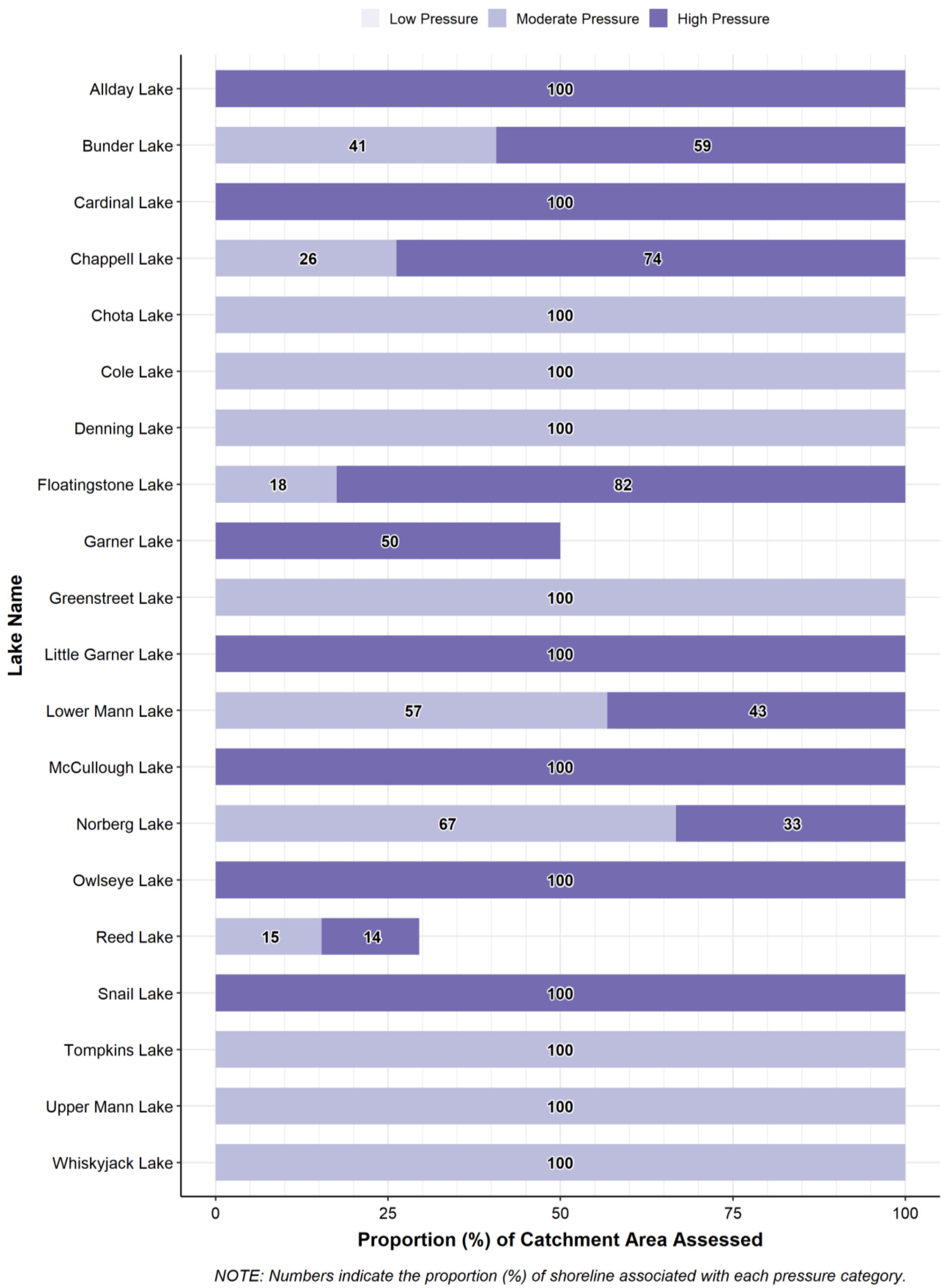


Figure 41. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named lakes in St. Paul County.

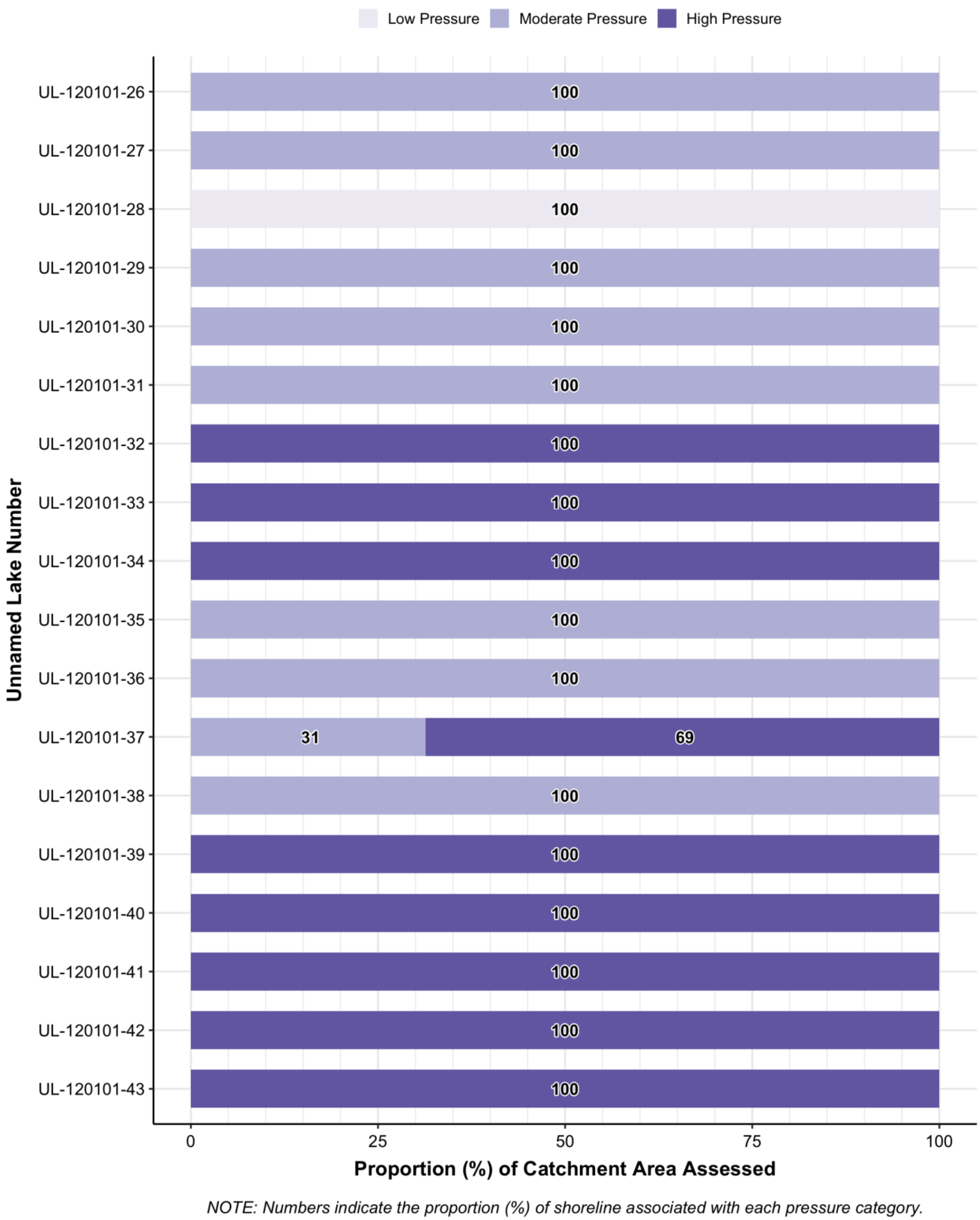


Figure 42. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of unnamed lakes in St. Paul County.

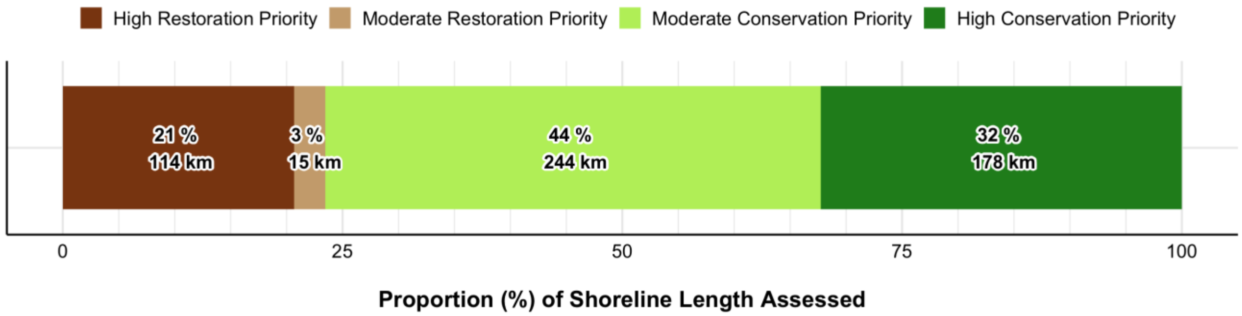


Figure 43. Overall conservation and restoration priority for waterbodies assessed within St. Paul County.

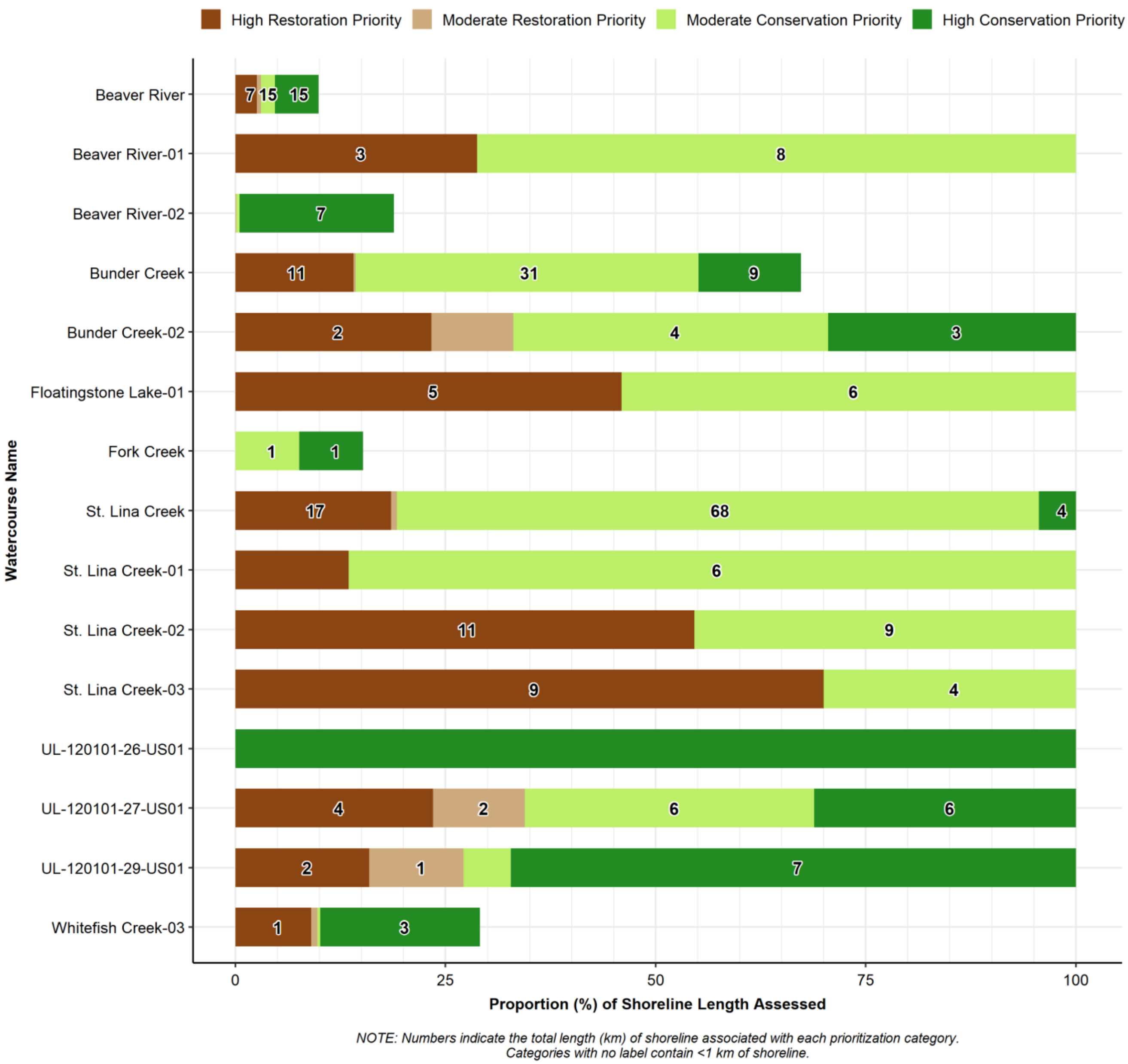


Figure 44. The proportion of shoreline length assigned to each prioritization category for named and unnamed watercourses within St. Paul County.

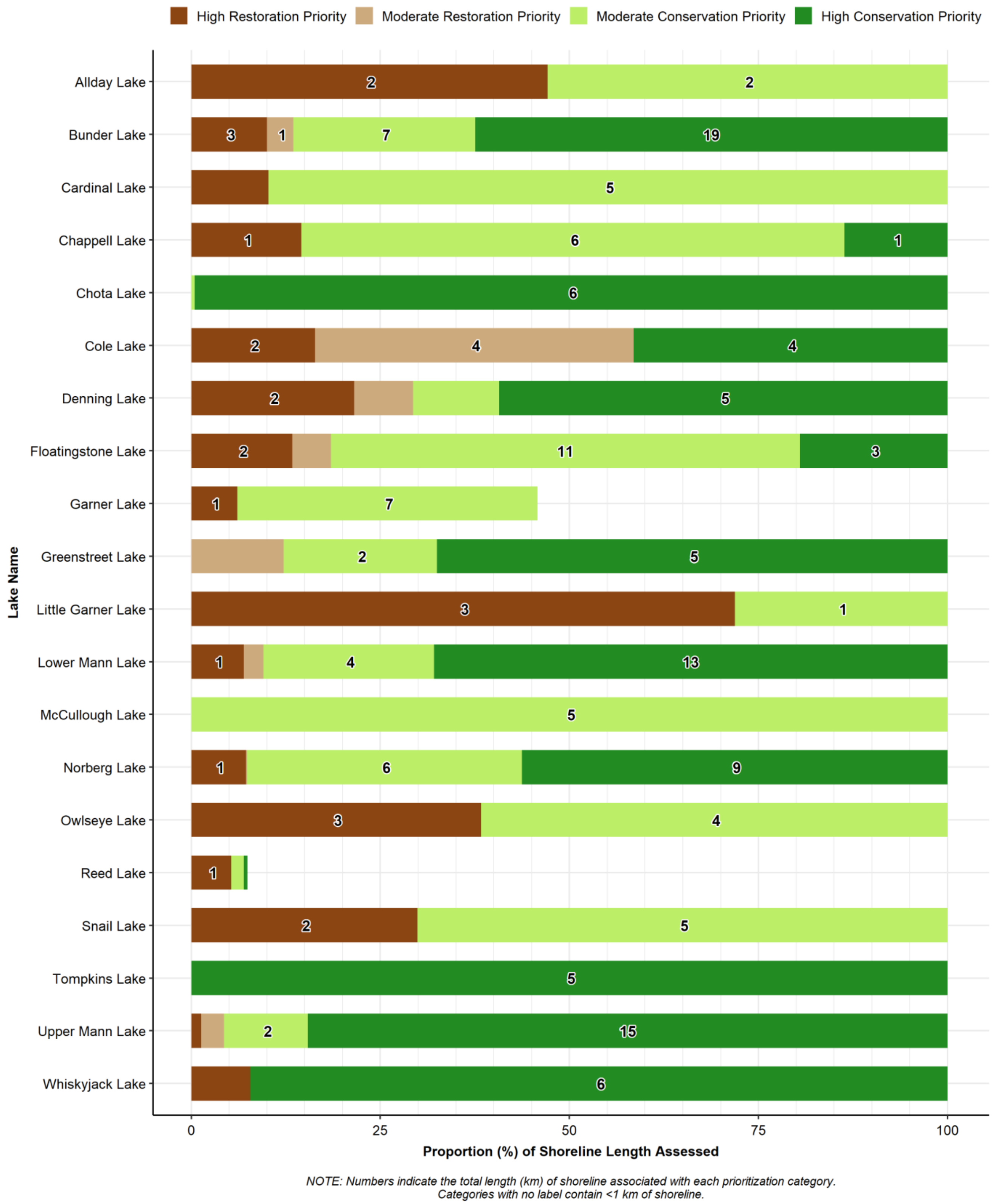


Figure 45. The proportion of shoreline length assigned to each prioritization category for named lakes within St. Paul County.

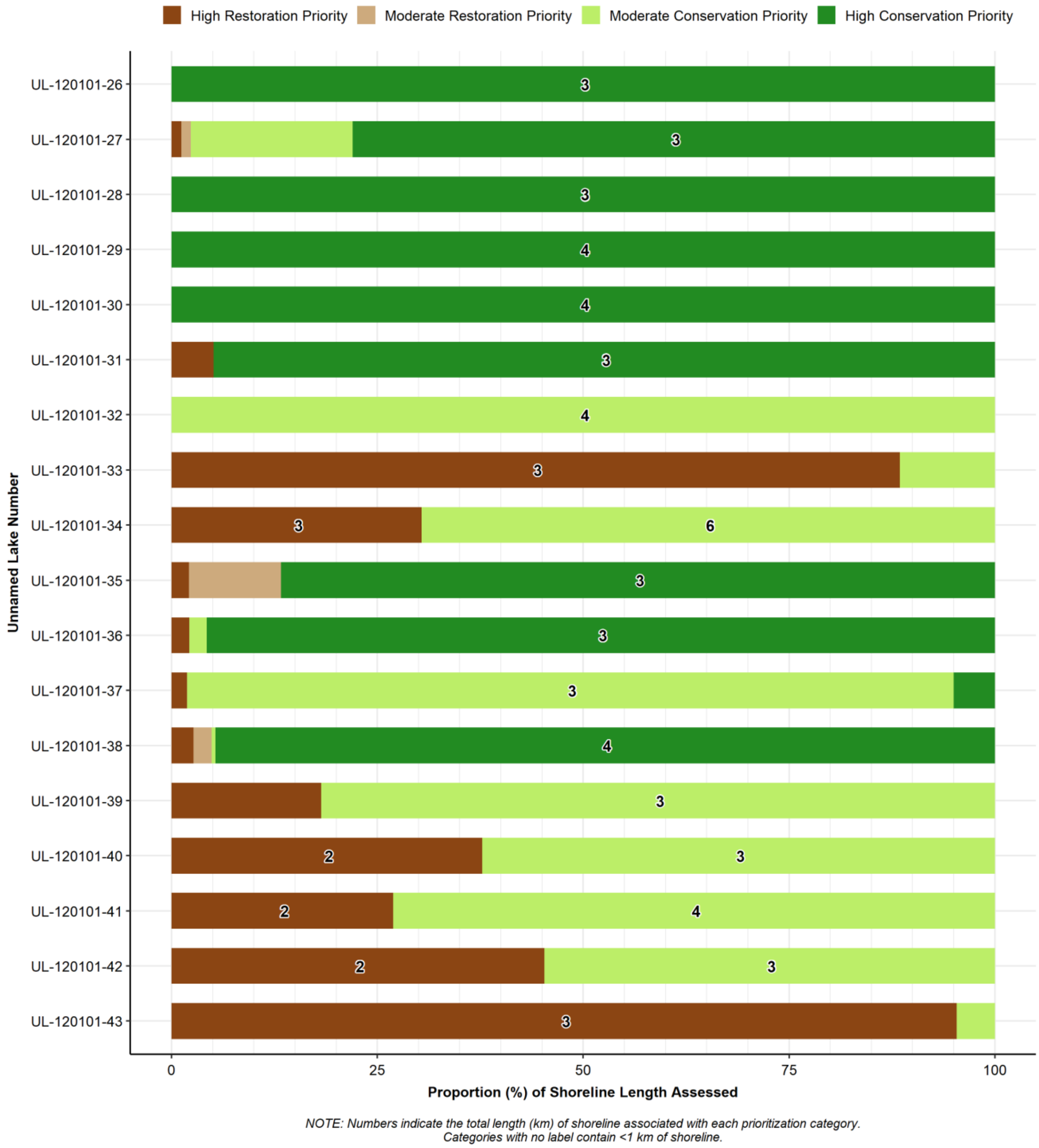


Figure 46. The proportion of shoreline length assigned to each prioritization category for unnamed lakes within St. Paul County.

5.4. Lac La Biche County

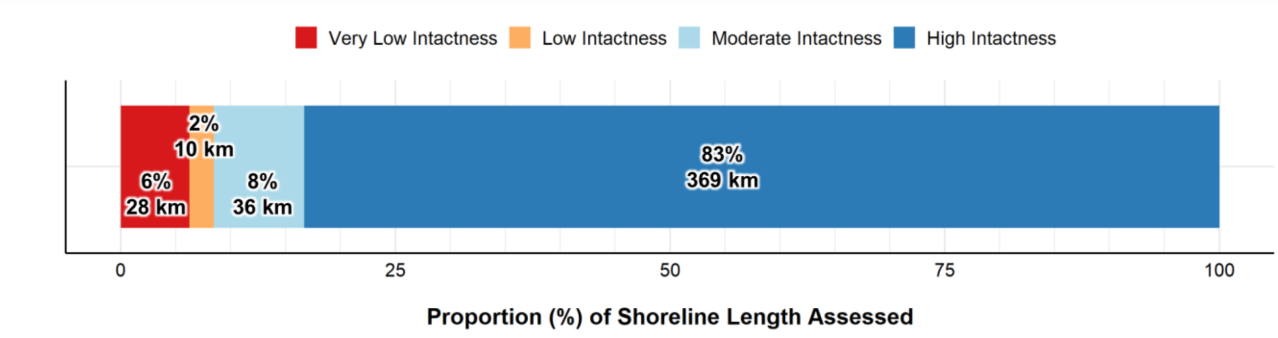


Figure 47. Overall intactness for waterbodies assessed within Lac La Biche County.

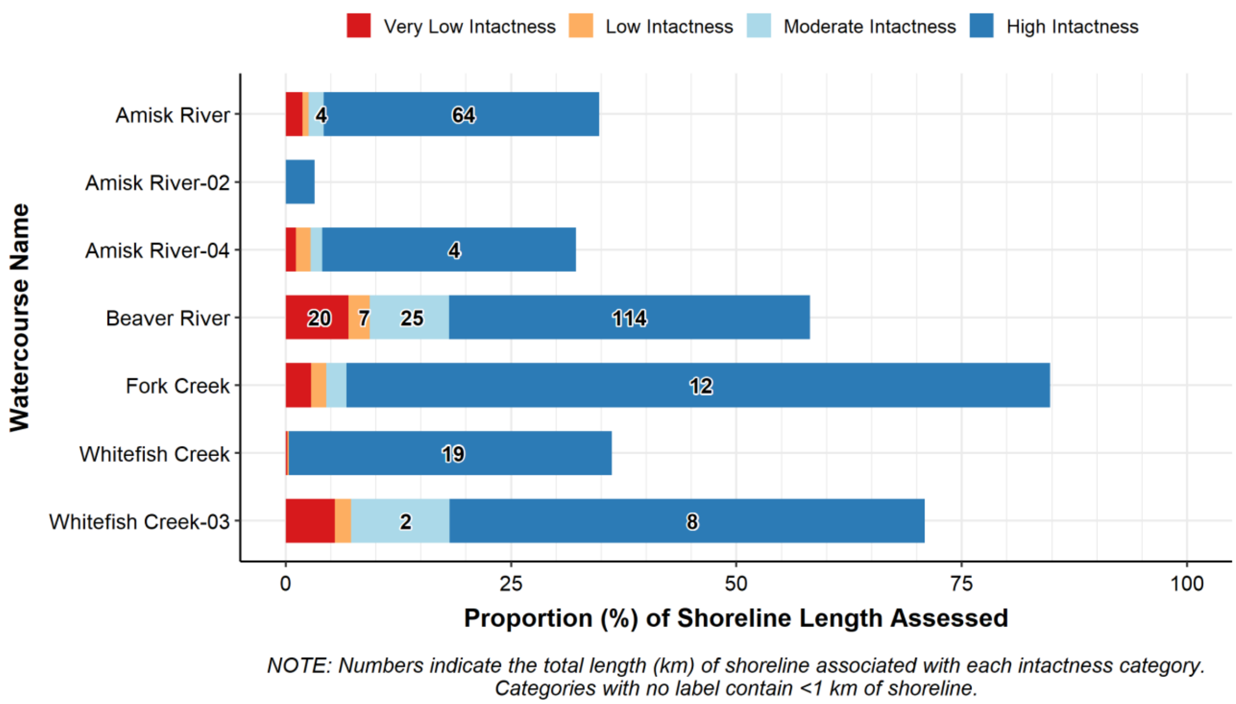


Figure 48. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed watercourses within Lac La Biche County.

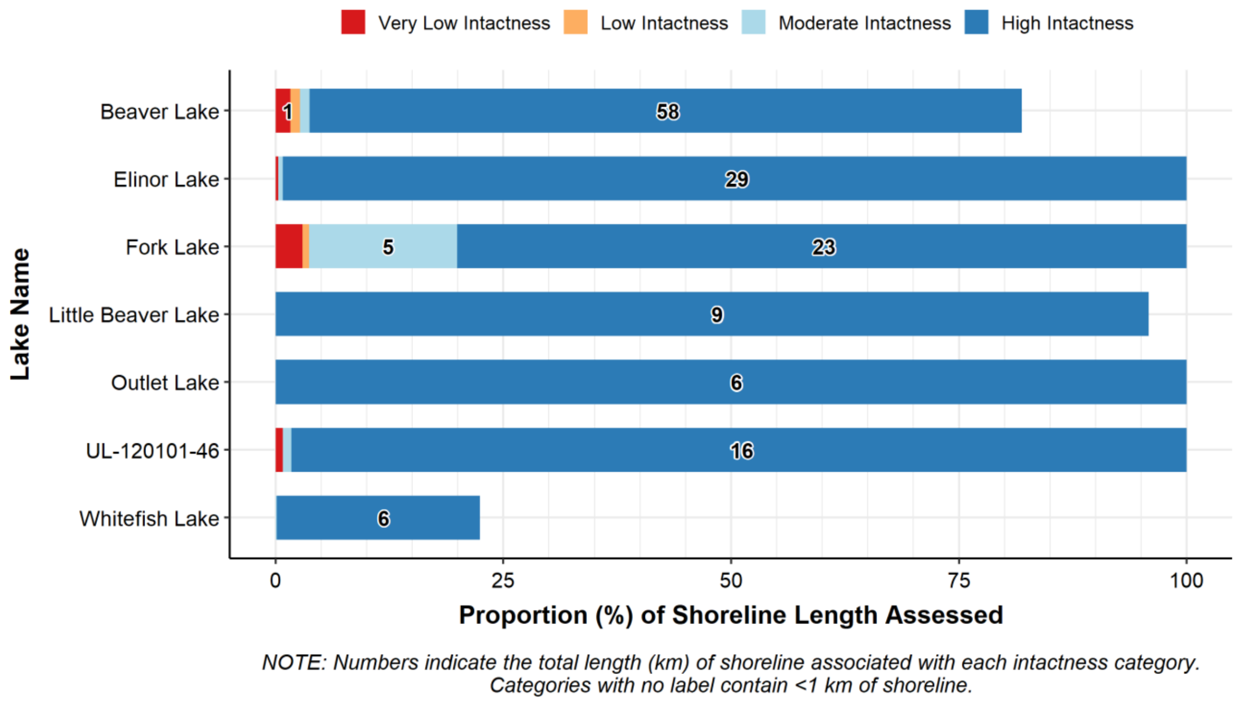


Figure 49. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed lakes within Lac La Biche County.

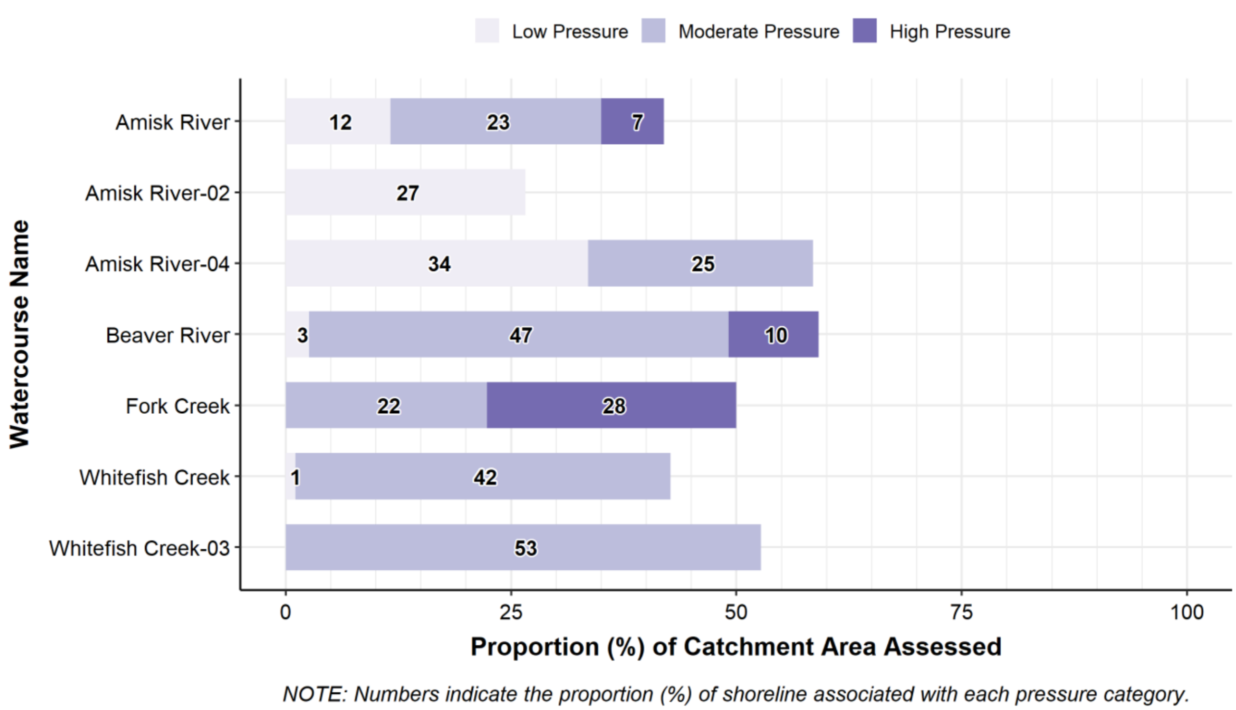


Figure 50. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed watercourses in Lac La Biche County.

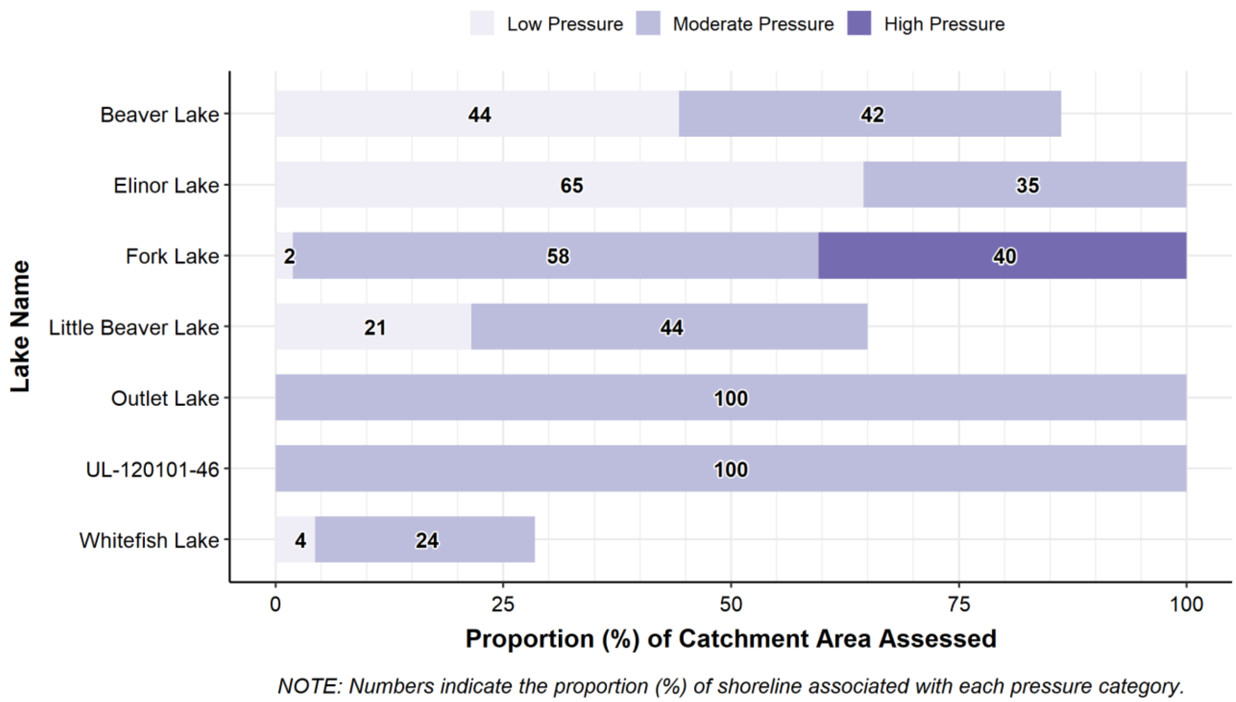


Figure 51. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed lakes in Lac La Biche County.

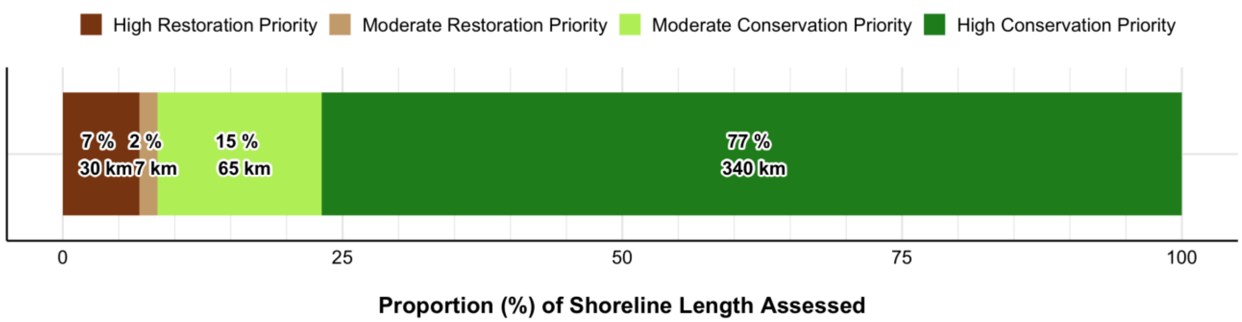


Figure 52. Overall conservation and restoration priority for waterbodies assessed within Lac La Biche County.

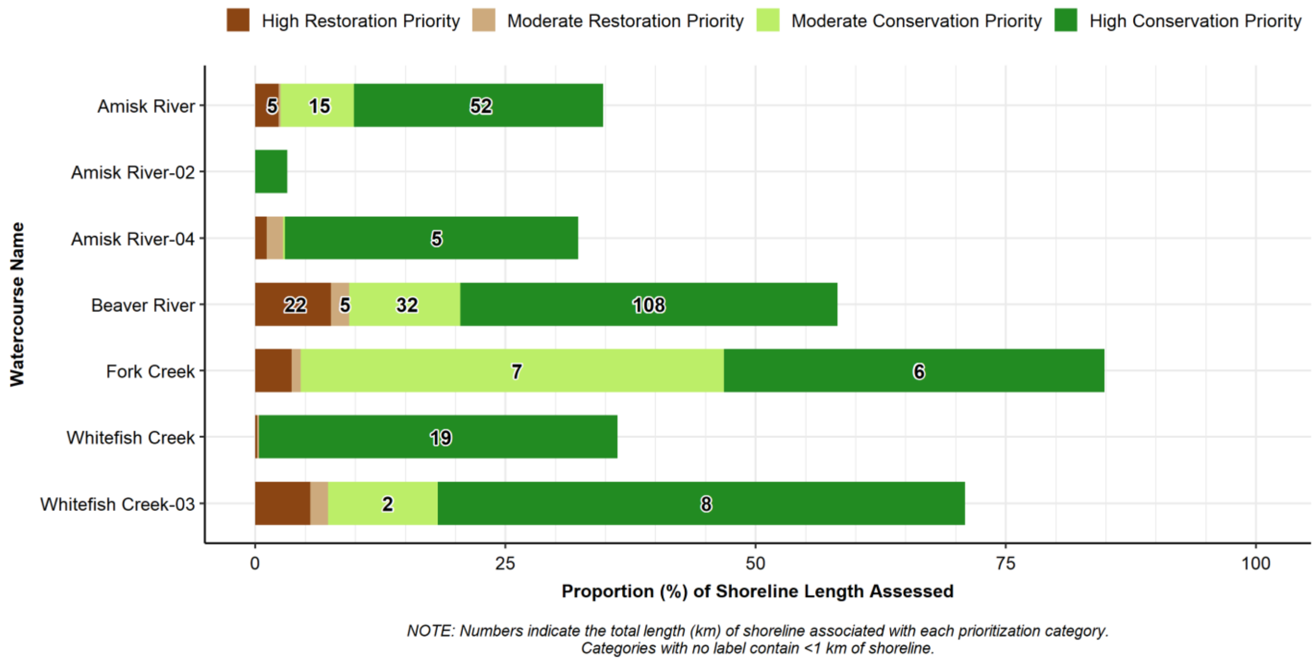


Figure 53. The proportion of shoreline length assigned to each prioritization category for named and unnamed watercourses within Lac La Biche County.

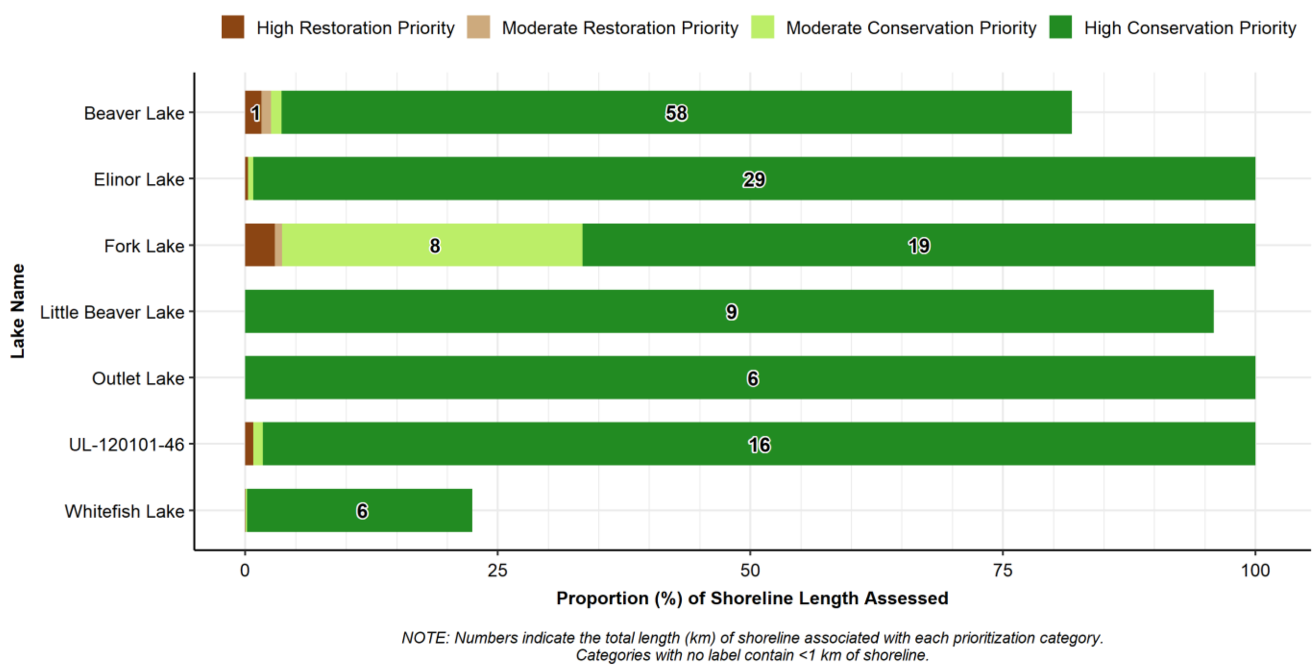


Figure 54. The proportion of shoreline length assigned to each prioritization category for named and unnamed lakes within Lac La Biche County.

5.5. MD of Bonnyville

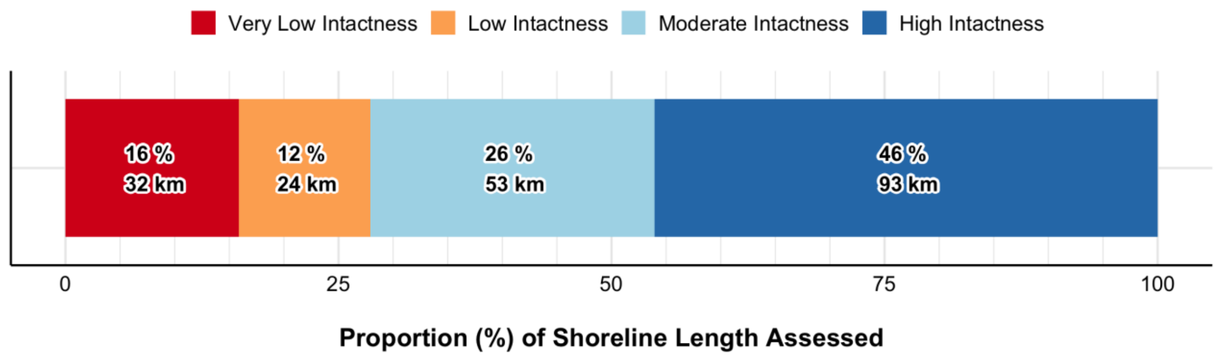


Figure 55. Overall intactness for waterbodies assessed within the MD of Bonnyville.

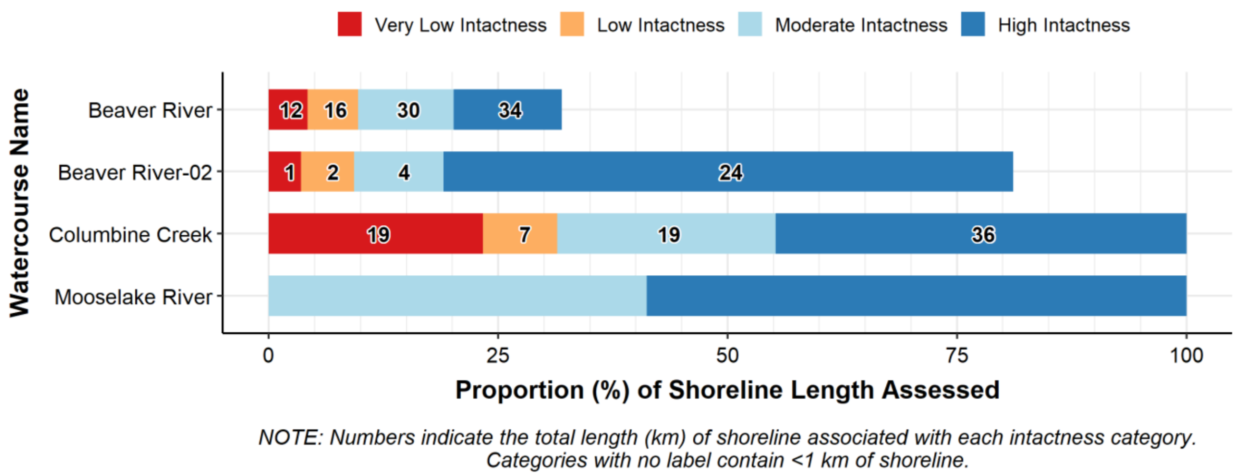


Figure 56. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed watercourses within MD of Bonnyville.

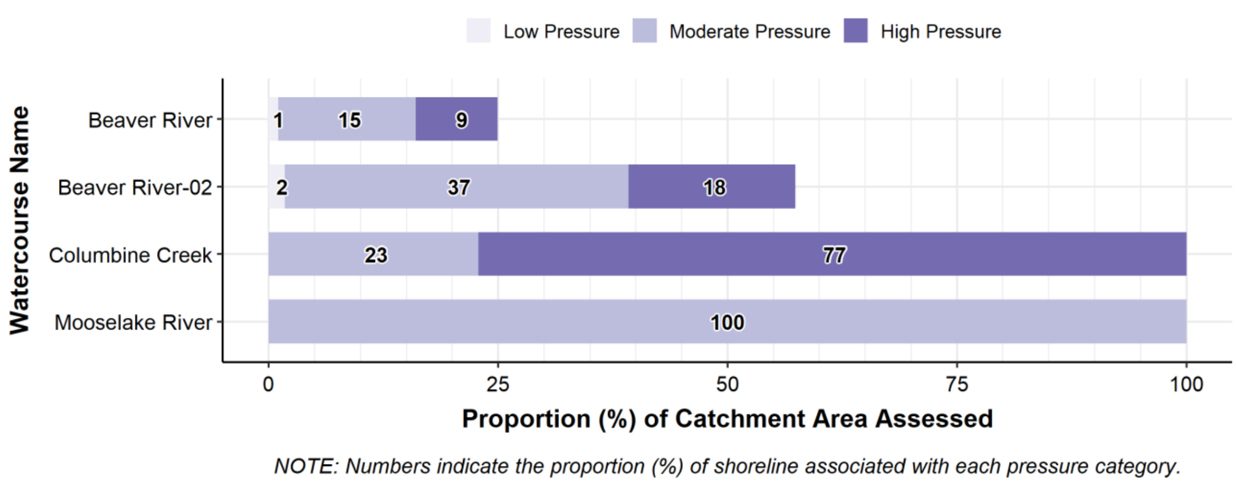


Figure 57. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed watercourses in MD of Bonnyville.

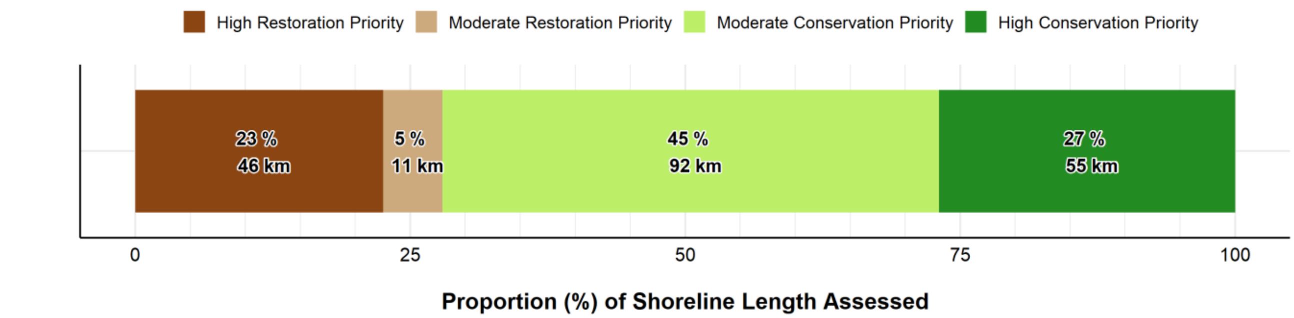


Figure 58. Overall conservation and restoration priority for waterbodies assessed within MD of Bonnyville.

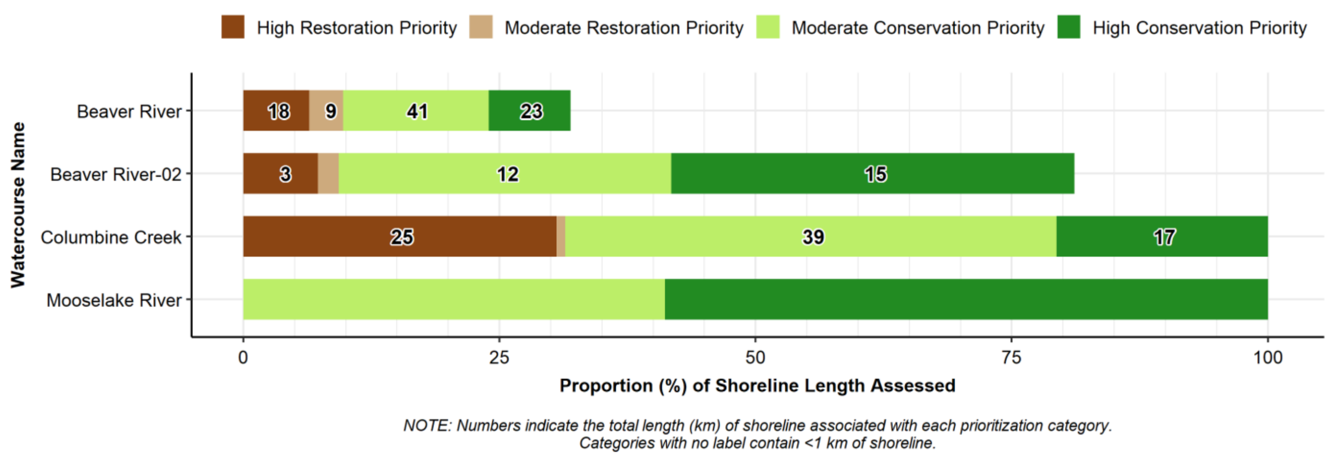


Figure 59. The proportion of shoreline length assigned to each prioritization category for named and unnamed watercourses within MD of Bonnyville.

5.6. Smoky Lake County

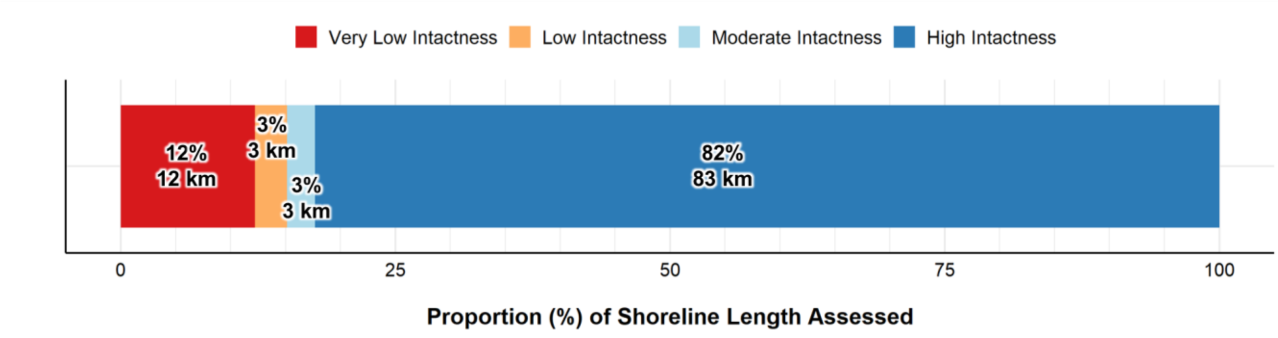


Figure 60. Overall intactness for waterbodies assessed within Smoky Lake County.

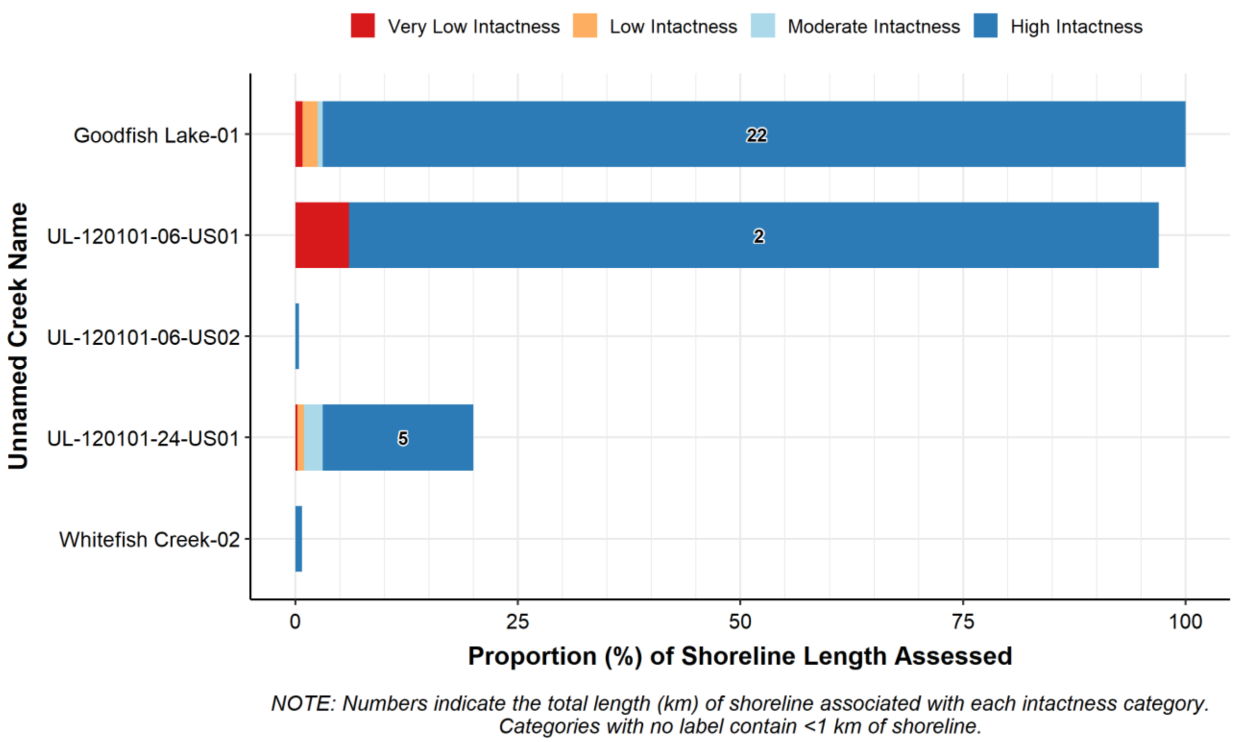
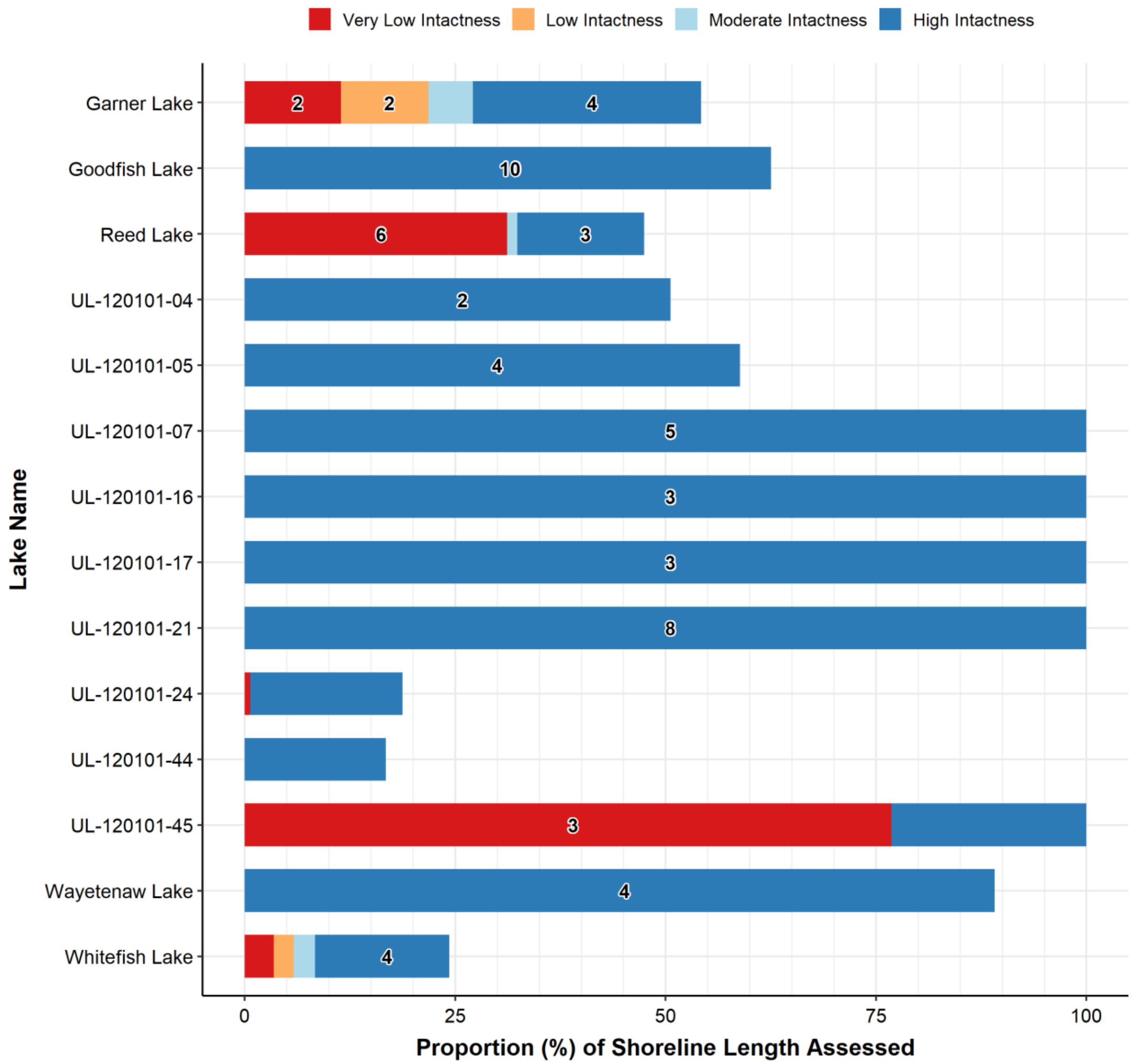


Figure 61. The proportion of shoreline length assigned to each riparian intactness category for unnamed creeks within Smoky Lake County.



NOTE: Numbers indicate the total length (km) of shoreline associated with each intactness category. Categories with no label contain <1 km of shoreline.

Figure 62. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed lakes within Smoky Lake County.

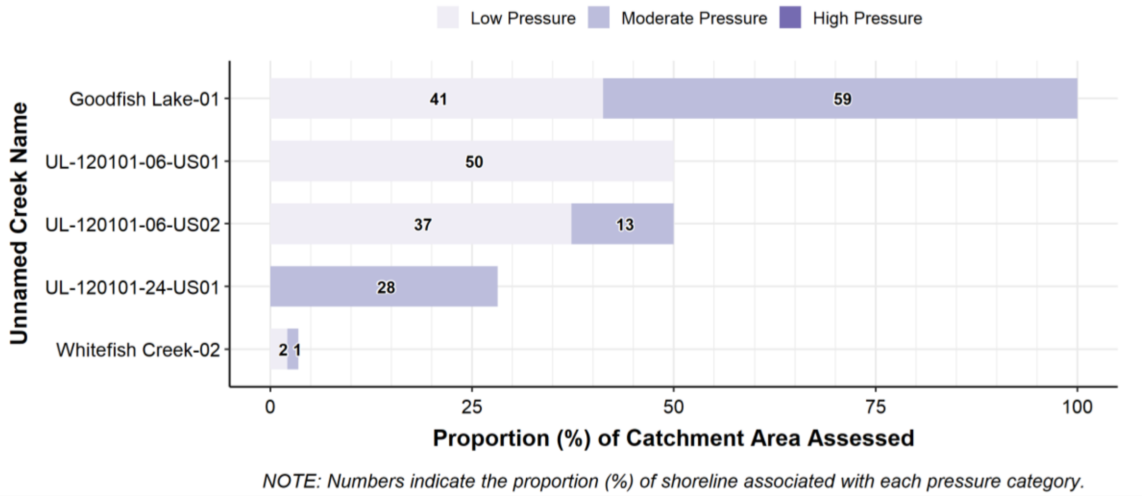


Figure 63. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of unnamed creeks in Smoky Lake County.

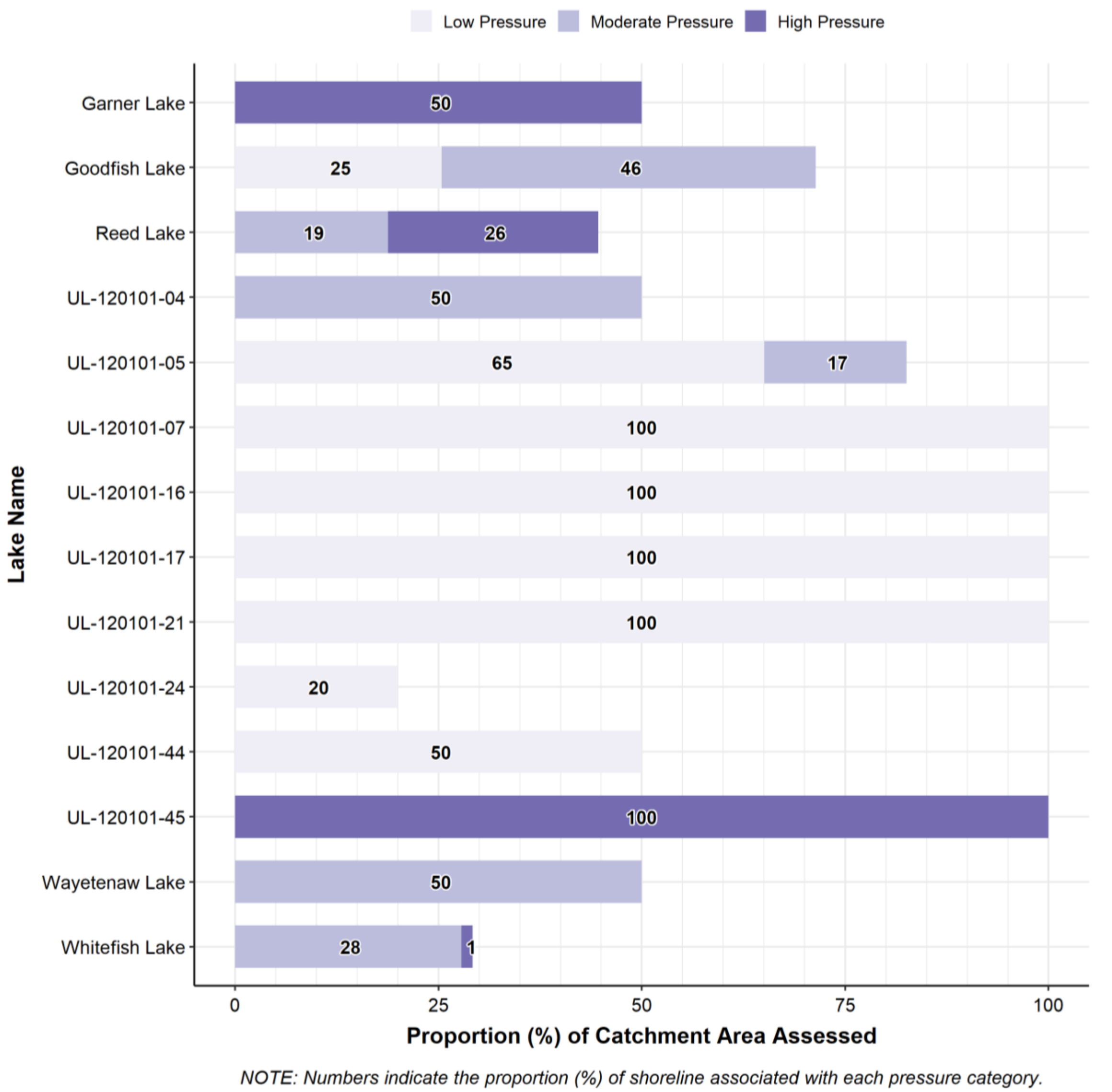


Figure 64. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed lakes in Smoky Lake County.

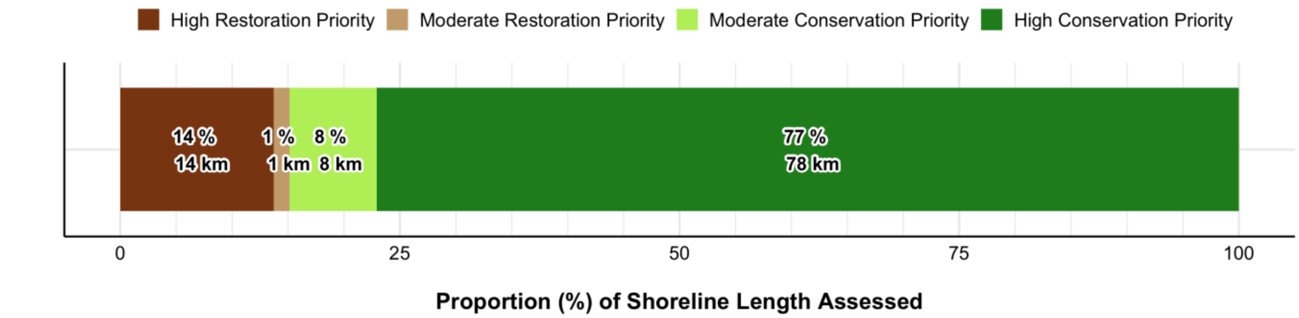


Figure 65. Overall conservation and restoration priority for waterbodies assessed within Smoky Lake County.

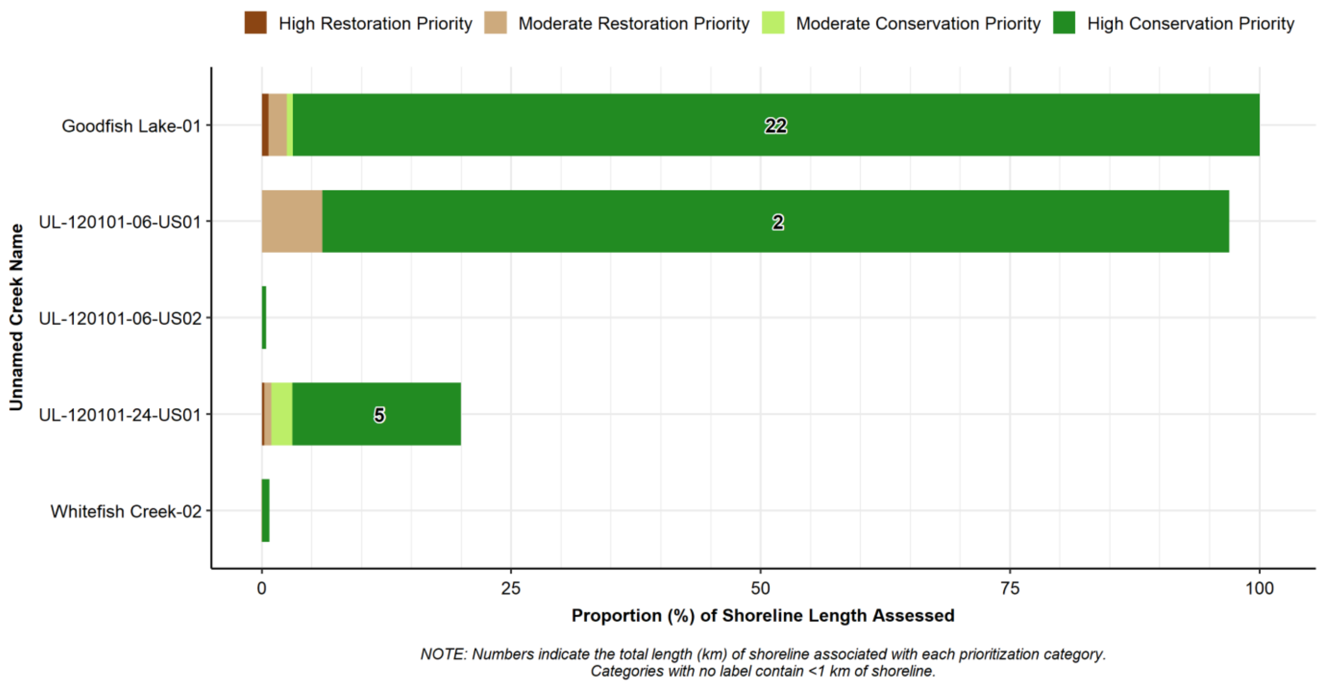


Figure 66. The proportion of shoreline length assigned to each prioritization category for unnamed creeks within Smoky Lake County.

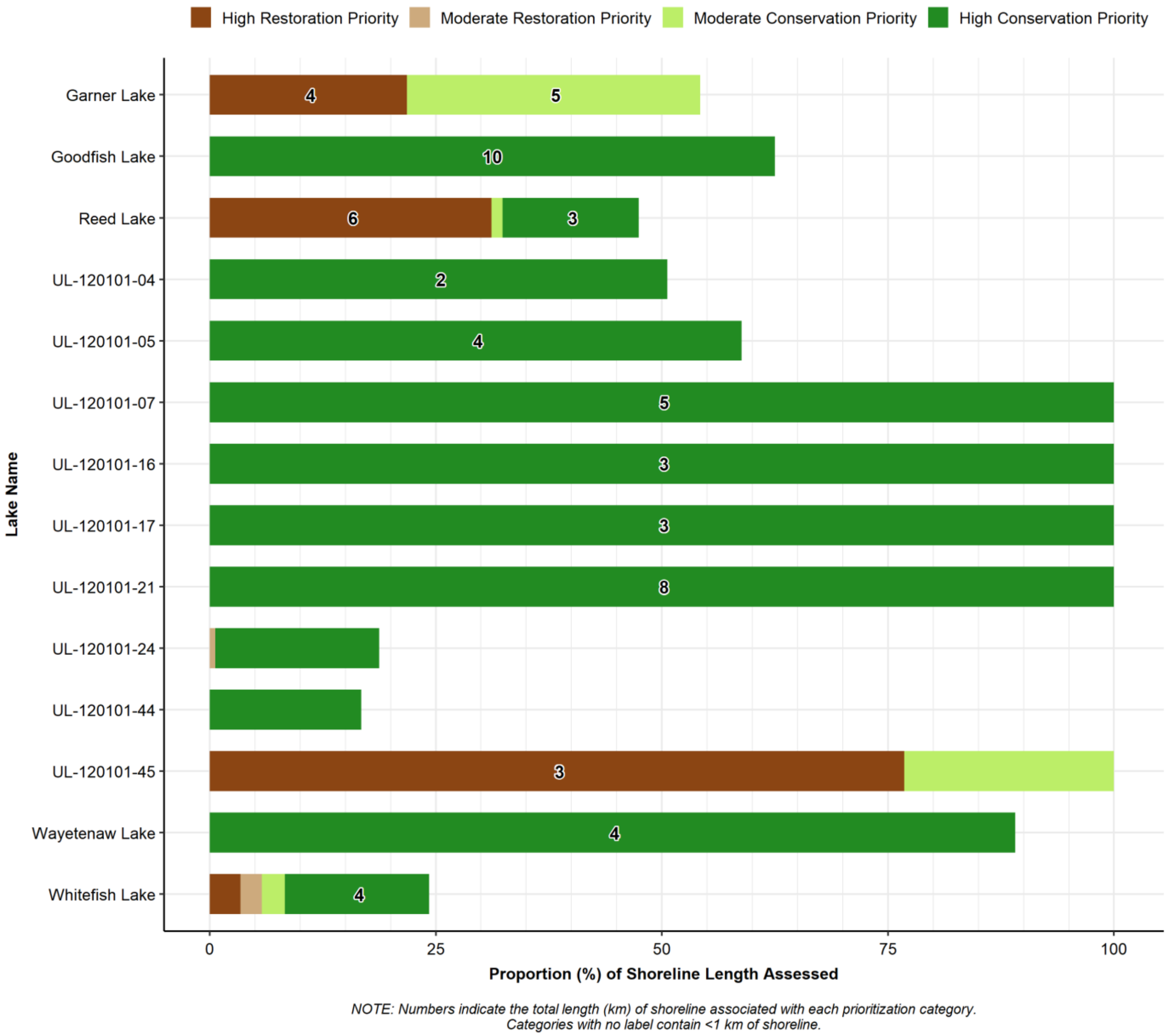


Figure 67. The proportion of shoreline length assigned to each prioritization category for named and unnamed lakes within Smoky Lake County.

5.7. Thorhild County

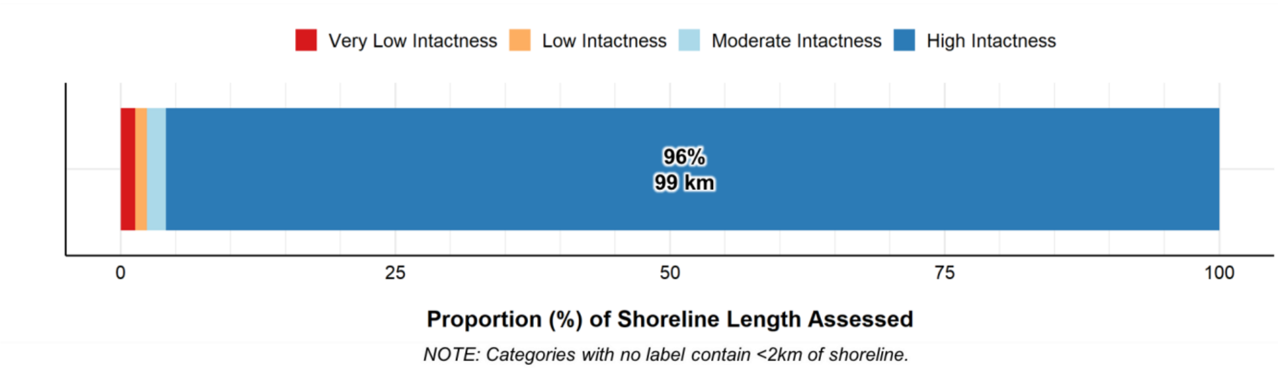


Figure 68. Overall intactness for waterbodies assessed within Thorhild County.

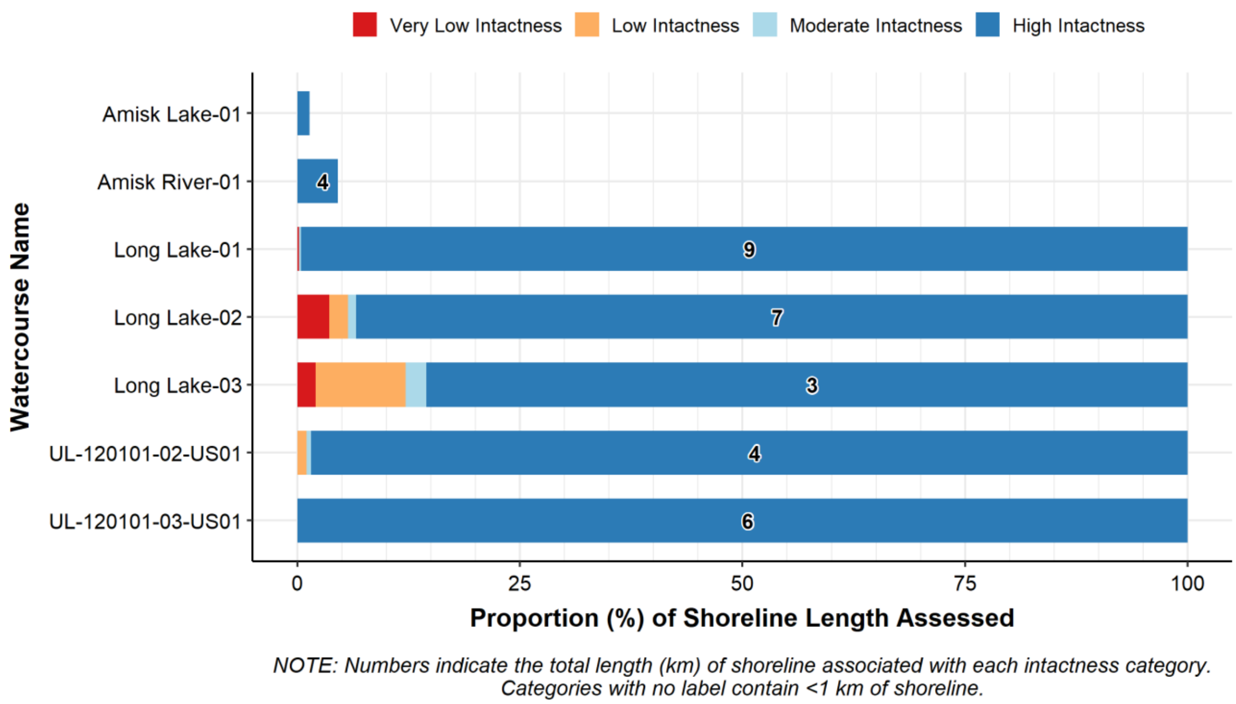


Figure 69. The proportion of shoreline length assigned to each riparian intactness category for unnamed watercourses within Thorhild County.

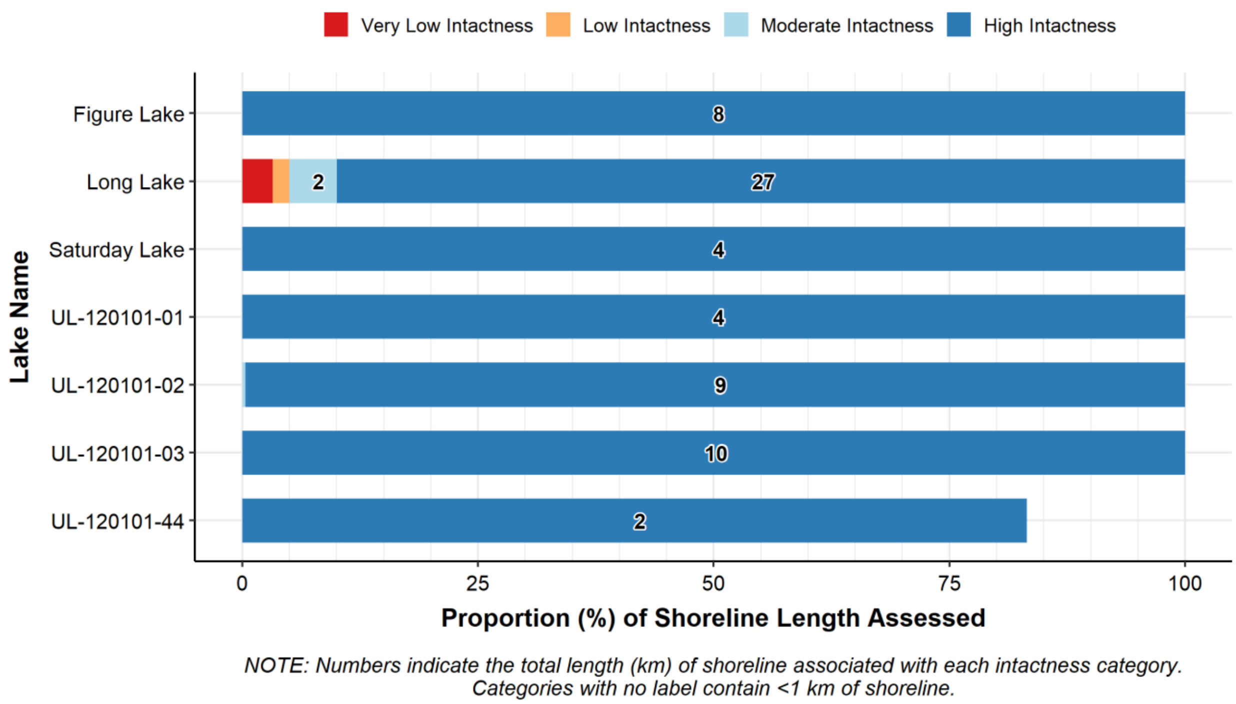


Figure 70. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed lakes within Thorhild County.

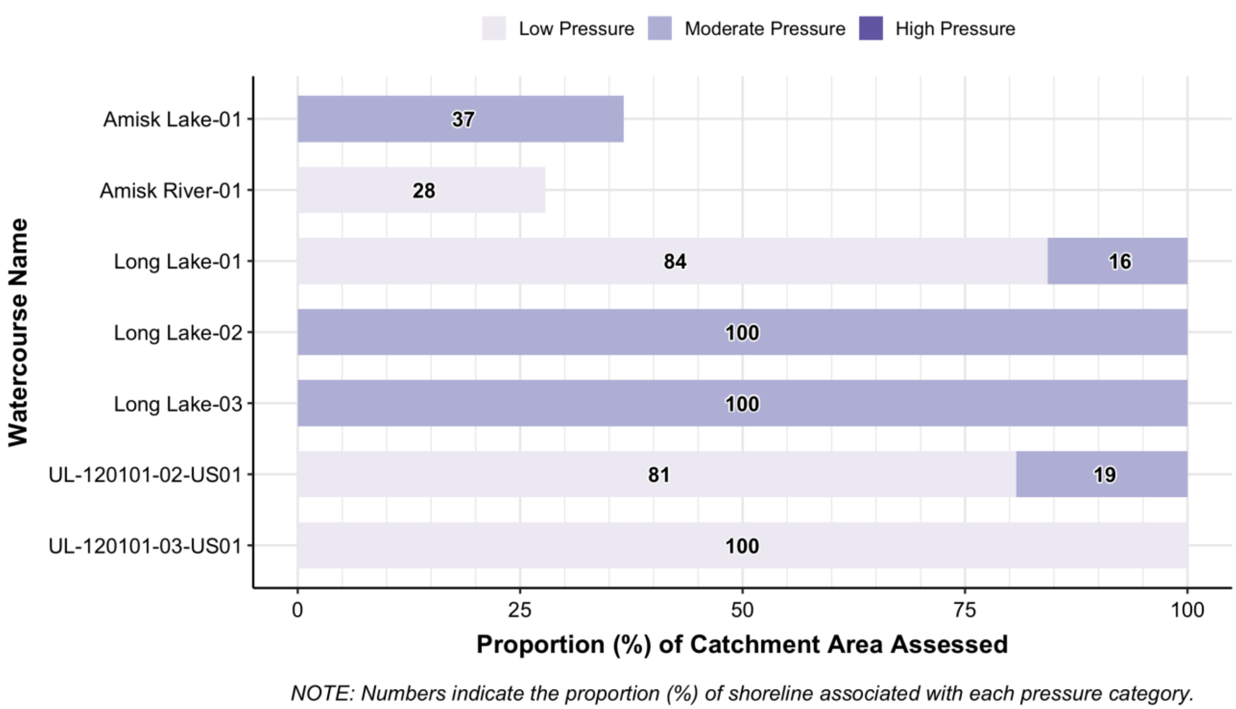


Figure 71. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of unnamed watercourses in Thorhild County.

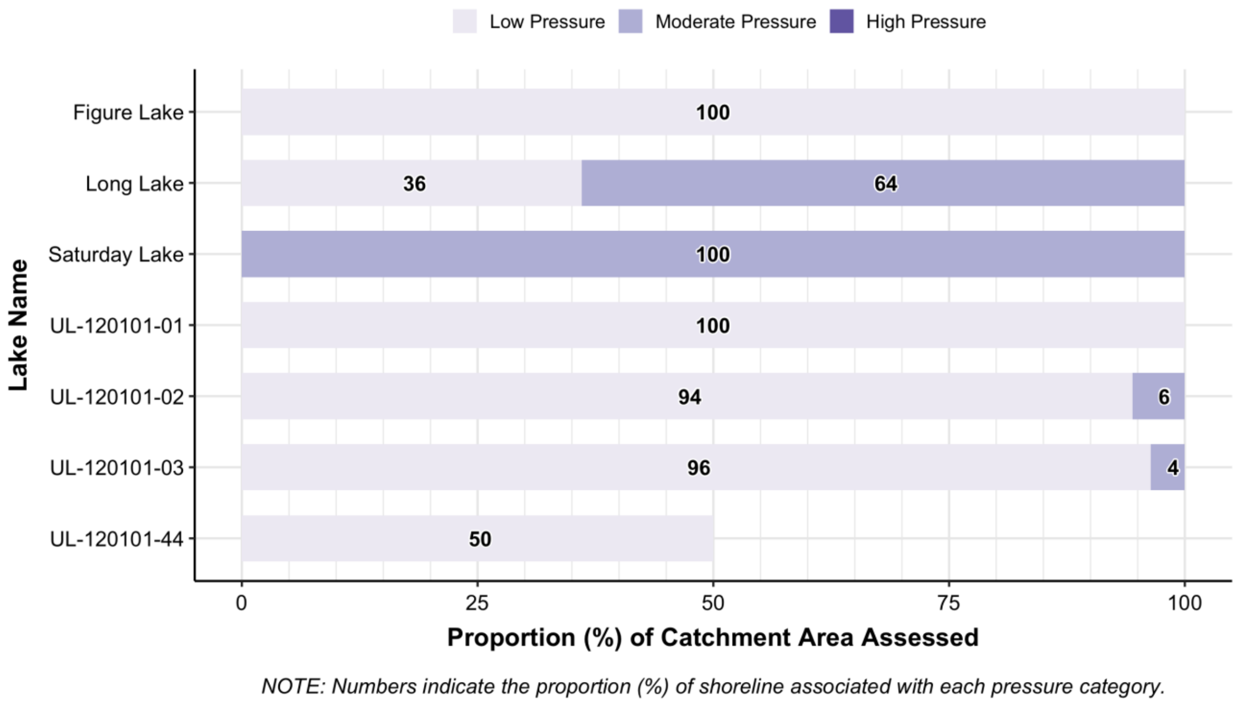


Figure 72. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed lakes in Thorhild County.

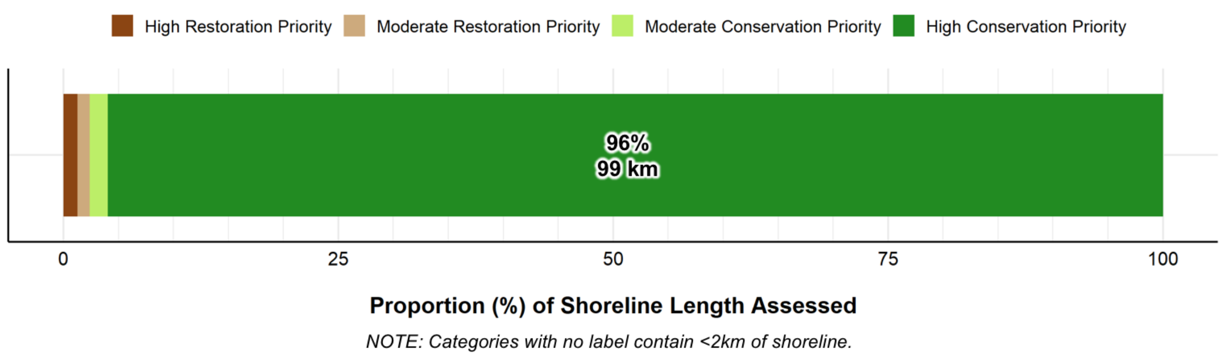


Figure 73. Overall conservation and restoration priority for waterbodies assessed within Thorhild County.

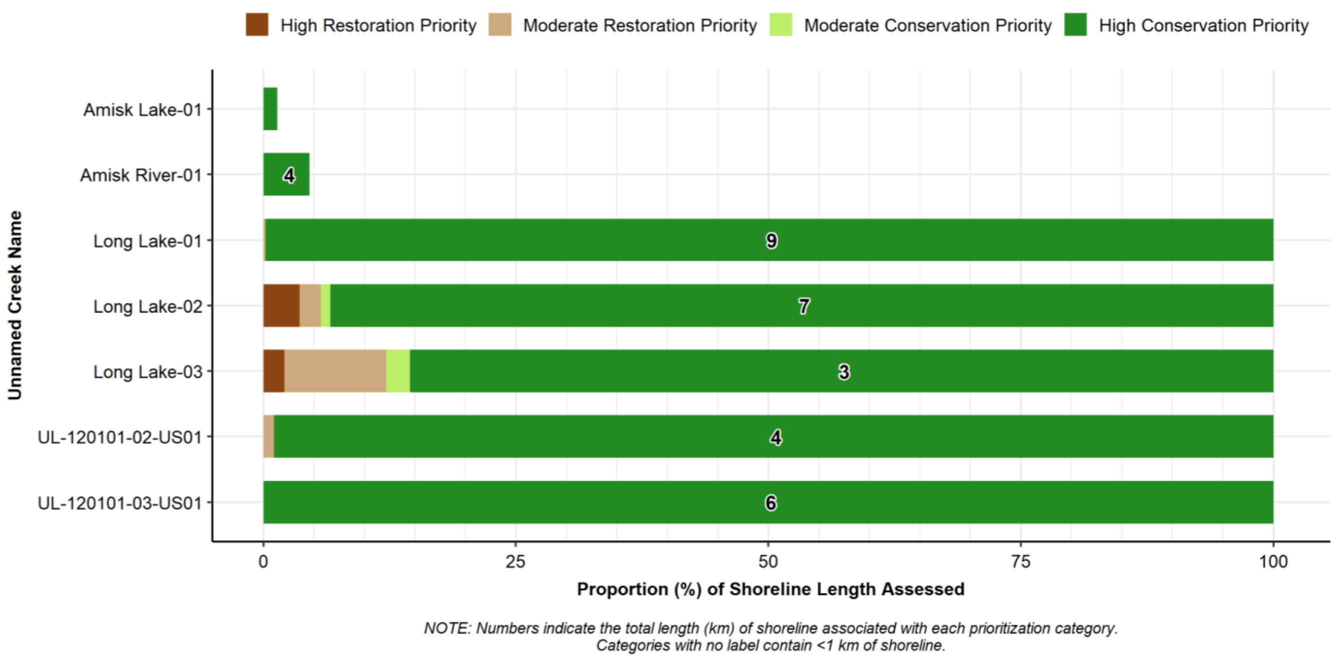


Figure 74. The proportion of shoreline length assigned to each prioritization category for unnamed watercourses within Thorhild County.

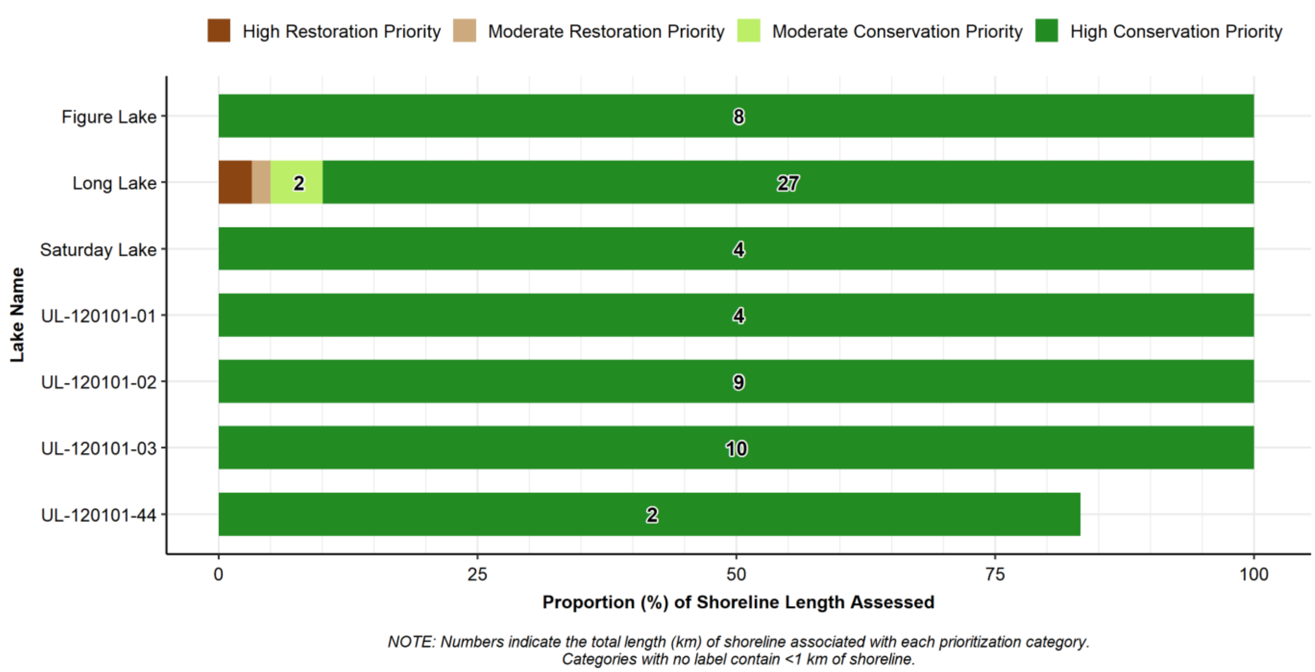


Figure 75. The proportion of shoreline length assigned to each prioritization category for named and unnamed lakes within Thorhild County.

6.0 Indigenous Community Results

The Upper Beaver watershed is located within the Traditional Territories of the Michif Piyii (Métis) and the Nêhiyawak (Cree). The traditional territories of both the Métis and the Cree are vast, with the Métis Nation Homeland covering the prairie provinces and part of British Columbia, Ontario, and the Northwest Territories (Map 23; Government of Canada 2021). The Cree traditional territory stretches from the foot of the Rocky Mountains in the west, to the Hudson-James Bay region in the east (Map 24; Beaver Lake Cree Nation 2021), with the Upper Beaver watershed containing the traditional territories of the Beaver Lake (Wood) Cree and the Nêhiyaw-Askiy (Plains Cree) (Beaver Lake Cree Nation 2021; Native Land Digital 2021). Additionally, a very small portion of the watershed lies within the traditional territory of the Cold Lake First Nations, which is part of the Denesųłiné Nation (Cold Lake First Nations 2017).

There are four distinct Indigenous communities located within the Upper Beaver watershed, including the Buffalo Lake and Kikino Métis Settlements, and the Beaver Lake Cree and Whitefish Lake Cree First Nations. In this chapter, we summarize riparian intactness, pressure, and priority results for each of these Indigenous communities, with results for each individual community presented in Sections 6.2 through 6.5.

6.1. Comparison of Intactness, Pressure & Priority

The total length of shoreline assessed as part of this study varied considerably by Indigenous community, with Kikino Métis Settlement having the greatest length of shoreline assessed (343 km) and Beaver Lake Cree Nation having the least (14 km) (Figure 76).

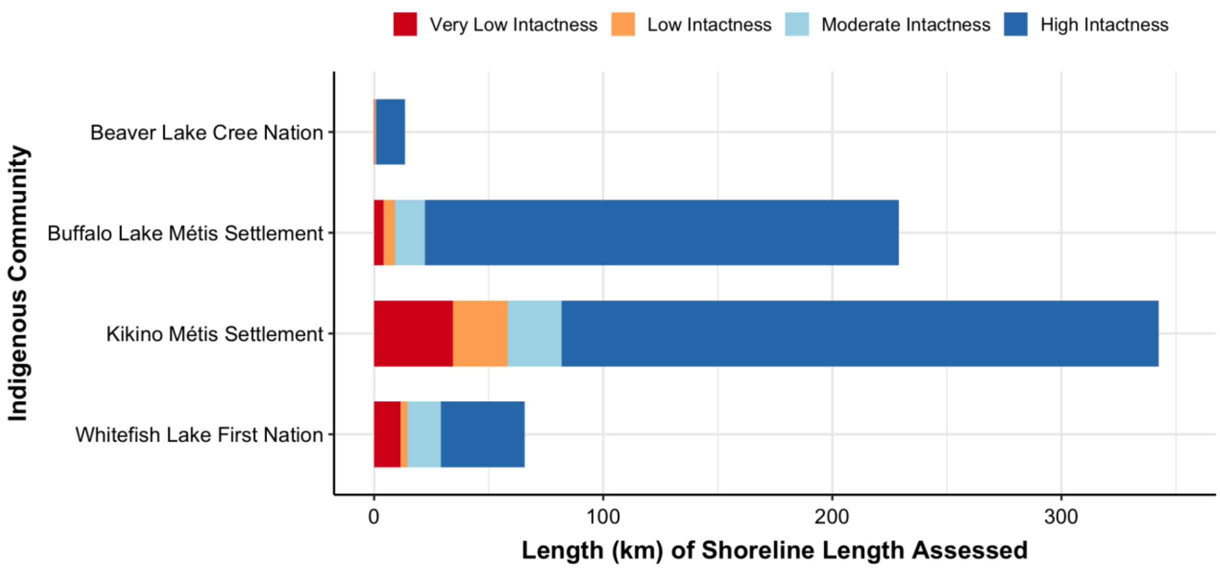


Figure 76. The total length of shoreline assigned to each riparian intactness category, summarized by Indigenous community.

When the proportion of shoreline length assigned to each intactness category was evaluated, all communities had 75% or more of their shorelines classified as Moderate or High Intactness, with Beaver Lake Cree Nation having the highest proportion of shorelines classified as High Intactness (93%; 13 km) (Figure 77; Maps 16-18). Buffalo Lake Métis Settlement and Kikino Métis Settlement also had a high proportion of shoreline classified as High Intactness, with Kikino Métis Settlement having the greatest length of shoreline assessed as High Intactness (261 km). Whitefish Lake First Nation had the highest proportion of shoreline classified as Very Low Intactness (17%; 11 km), while Kikino Métis Settlement had the greatest length of shoreline classified as Very Low (34 km) and Low (24 km) Intactness.

When pressure associated with RMAs was compared between communities, Whitefish Lake First Nation had the greatest proportion of local catchment areas classified as High Pressure, while the Buffalo Lake Métis Settlement had the greatest proportion of local catchment areas classified as Low Pressure (Figure 78; Map 19).

Beaver Lake Cree Nation, Buffalo Lake Métis Settlement, and Kikino Métis Settlement all had the majority of their shorelines classified as High Conservation Priority, while Whitefish Lake First Nation had the greatest proportion of its shorelines classified as Moderate Conservation Priority (Figure 79; Maps 20-22). Based on the shoreline length, Kikino Métis Settlement had the greatest length of shoreline classified as either High (249 km) or Moderate (35 km) priority for conservation. Kikino Métis Settlement also had the greatest length of shoreline classified as High (39 km) or Moderate (19 km) Restoration Priority, and the Whitefish Lake First Nation having the greatest proportion (20%) of shoreline classified as High Restoration priority.

A more detailed breakdown of results for each Indigenous community is provided in sections 6.2 through 6.5.

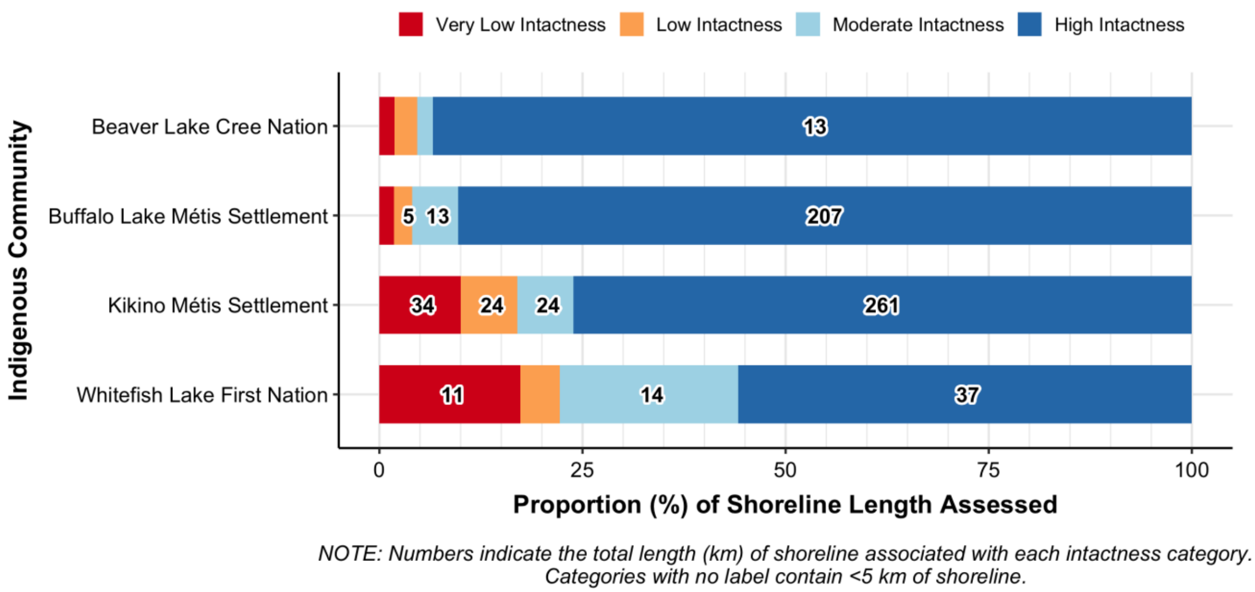


Figure 77. The proportion of shoreline length assigned to each riparian intactness category, summarized by Indigenous community.

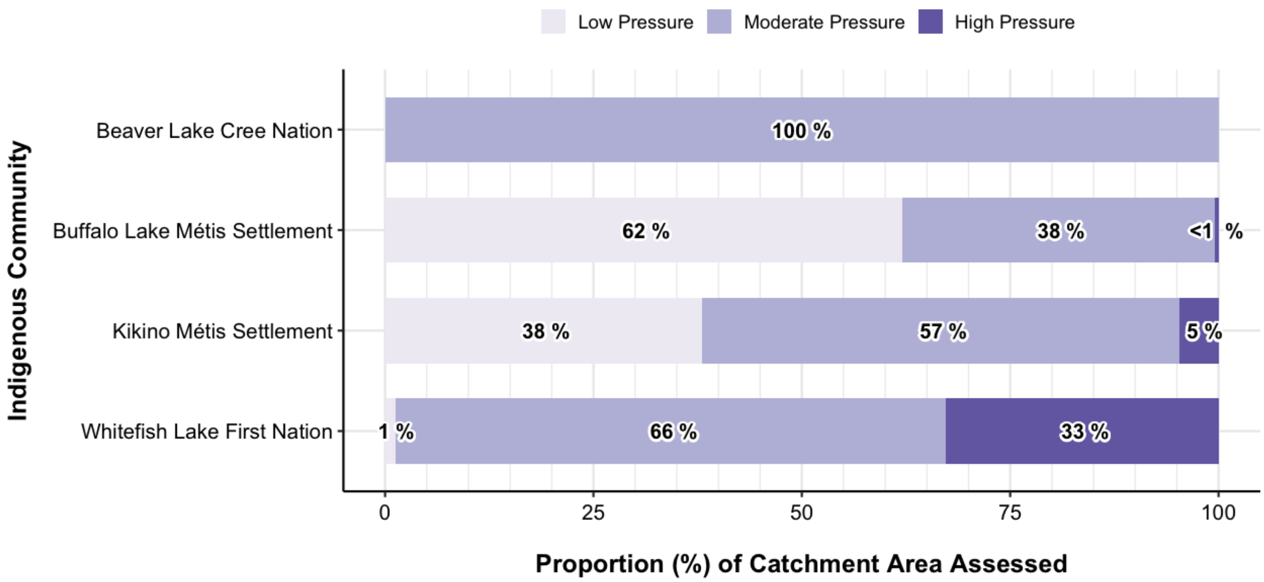


Figure 78. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of waterbodies contained within each Indigenous community. Numbers indicate the proportion of area assigned to each pressure category.

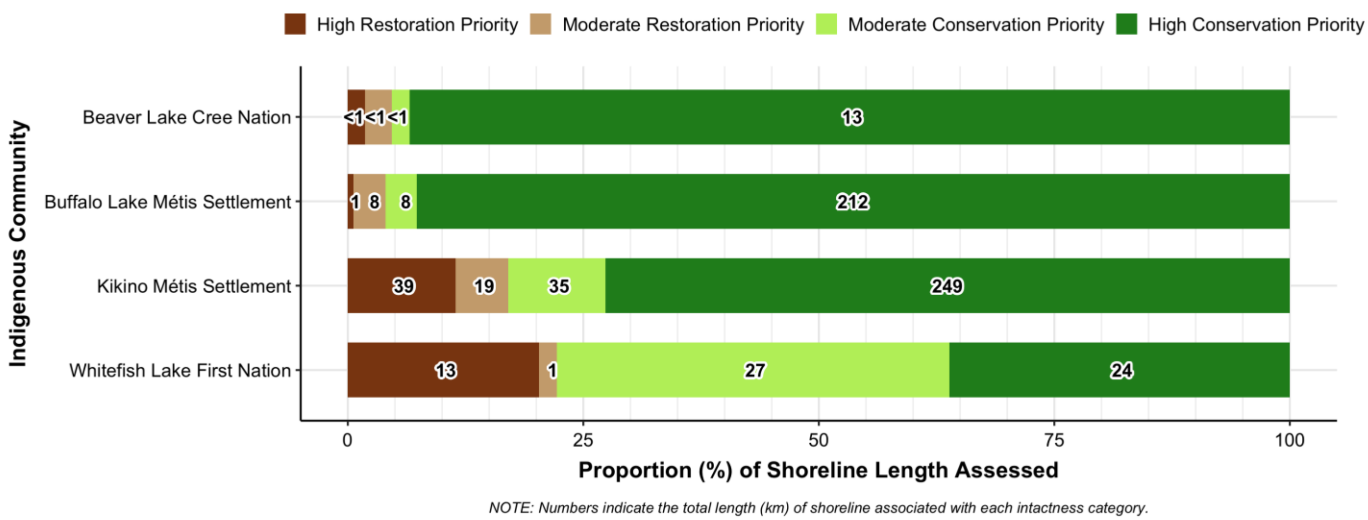
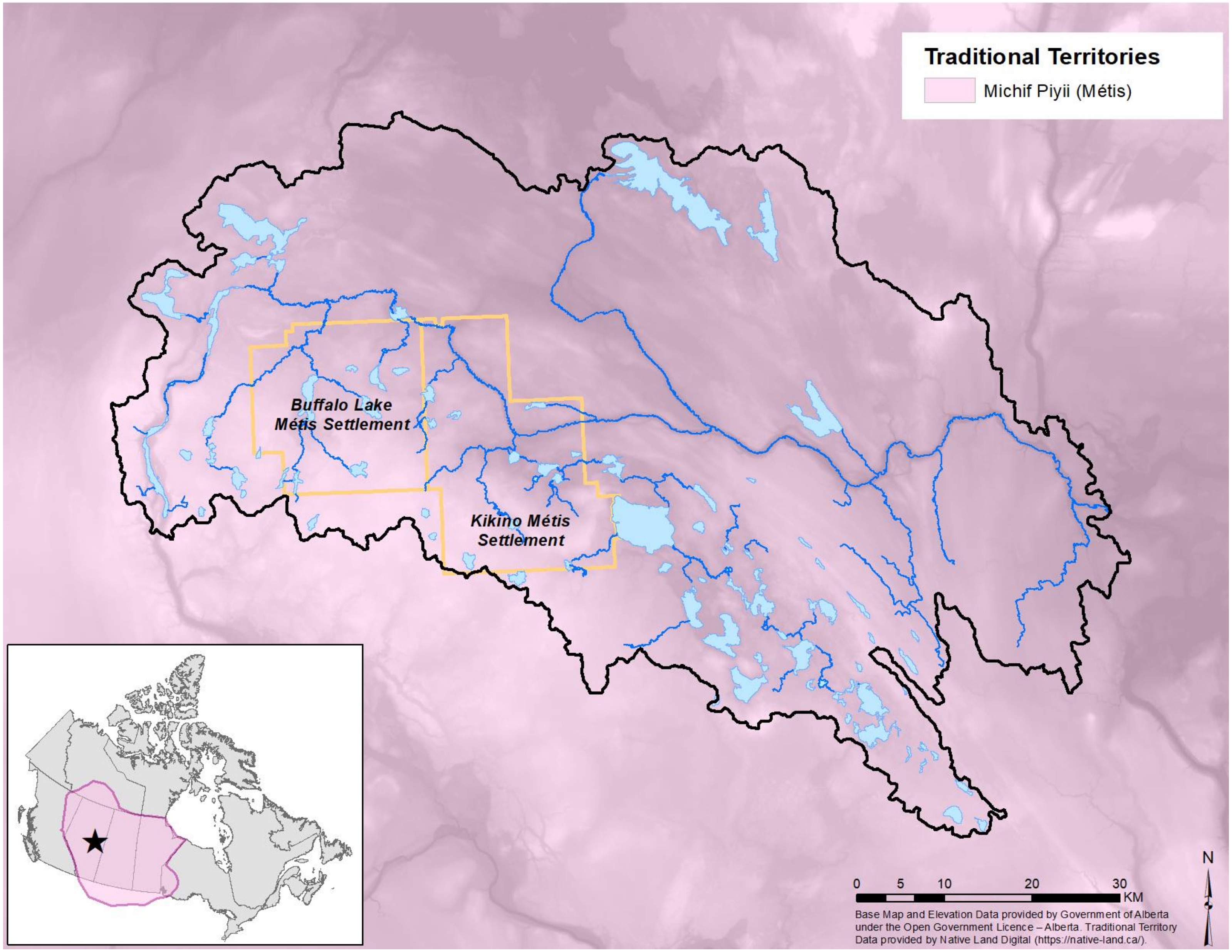
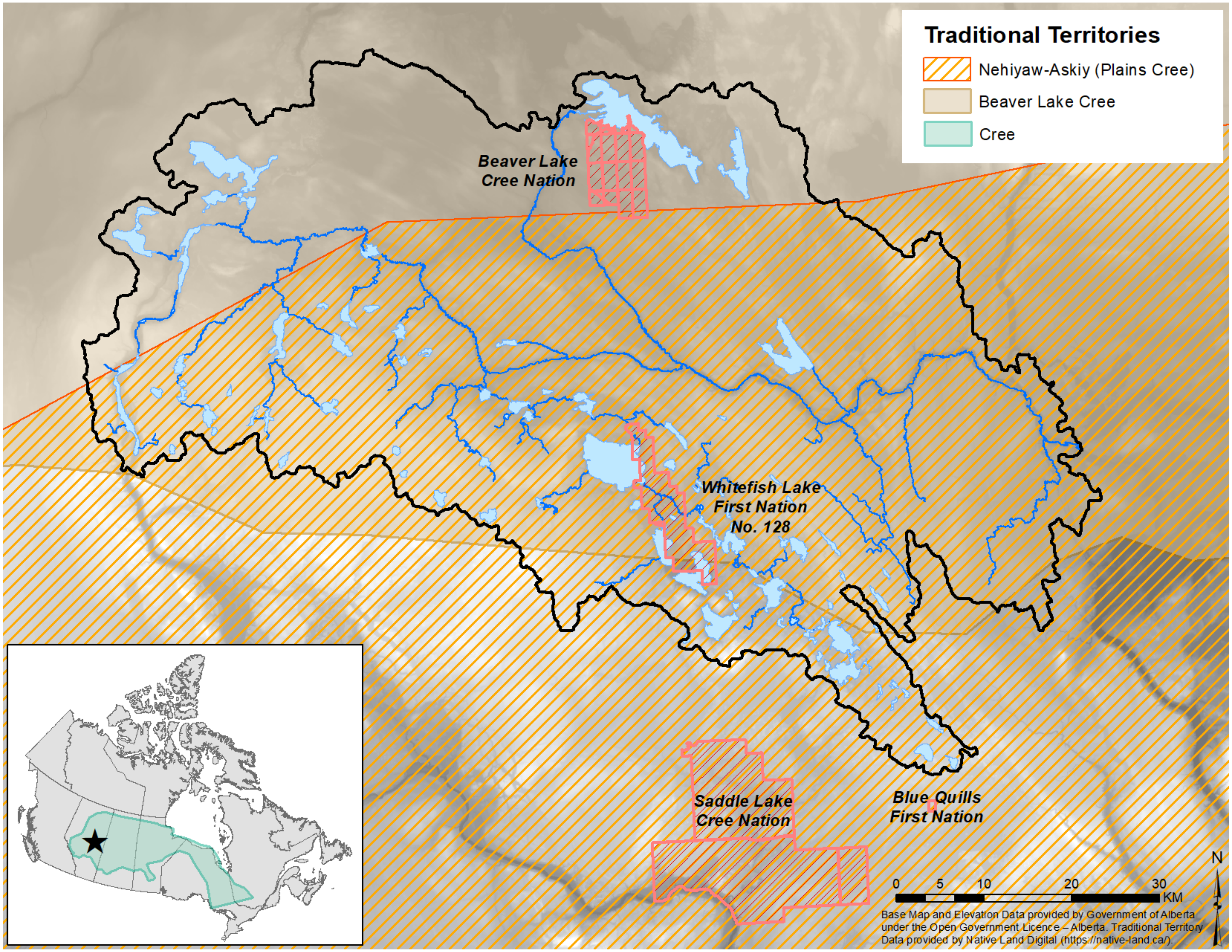


Figure 79. The proportion of shoreline length assigned to each priority category, summarized by Indigenous community.



Map 23. Approximate location of the traditional territory of the Métis Homeland across Canada, as well as the location of Métis settlements within the Upper Beaver watershed.



Map 24. Approximate location of the traditional territory of the Cree across Canada. The Upper Beaver watershed overlaps the traditional territories of both the Plains and Wood (Beaver Lake) Cree, and includes the Beaver Lake Cree Nation and the Whitefish Lake First Nation.

6.2. Beaver Lake Cree Nation

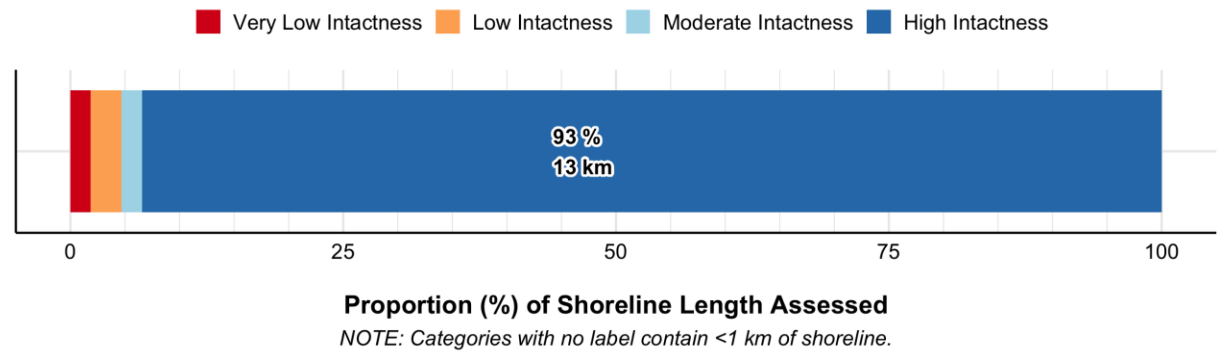


Figure 80. Overall intactness for waterbodies assessed within the Beaver Lake Cree Nation.

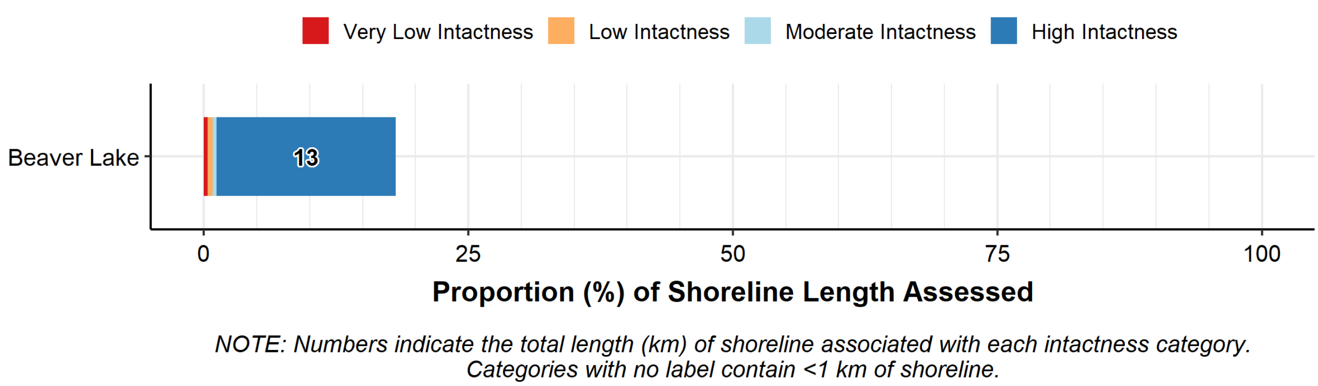


Figure 81. The proportion of shoreline length assigned to each riparian intactness category for the portion of the Beaver Lake shoreline located within the Beaver Lake Cree Nation.

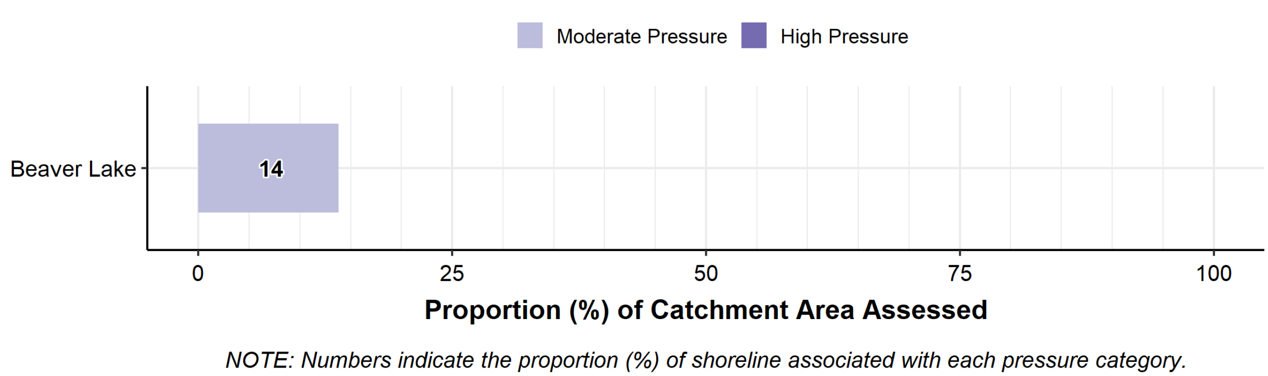


Figure 82. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of Beaver Lake located within the Beaver Lake Cree Nation.

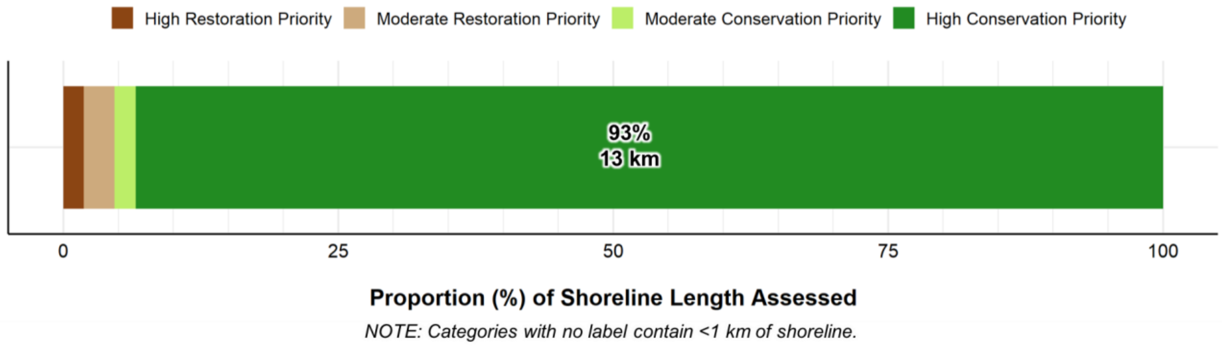


Figure 83. Overall conservation and restoration priority for waterbodies assessed within the Beaver Lake Cree Nation.

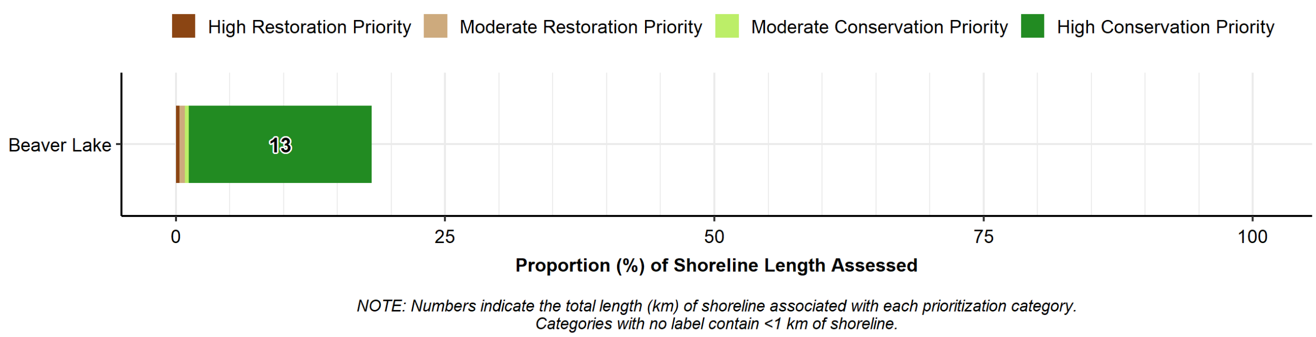


Figure 84. The proportion of shoreline length assigned to each prioritization category for the portion of the Beaver Lake shoreline located within the Beaver Lake Cree Nation.

6.3. Buffalo Lake Métis Settlement

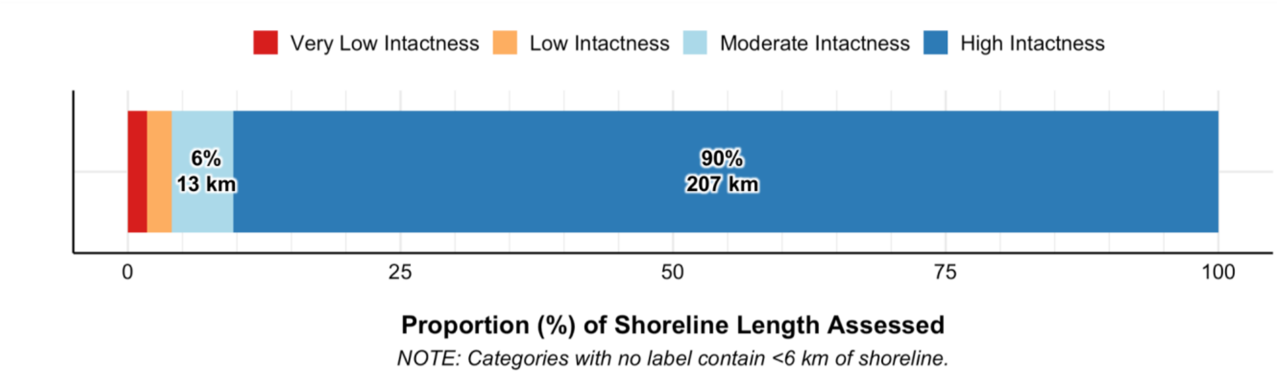


Figure 85. Overall intactness for waterbodies assessed within the Buffalo Lake Métis Settlement.

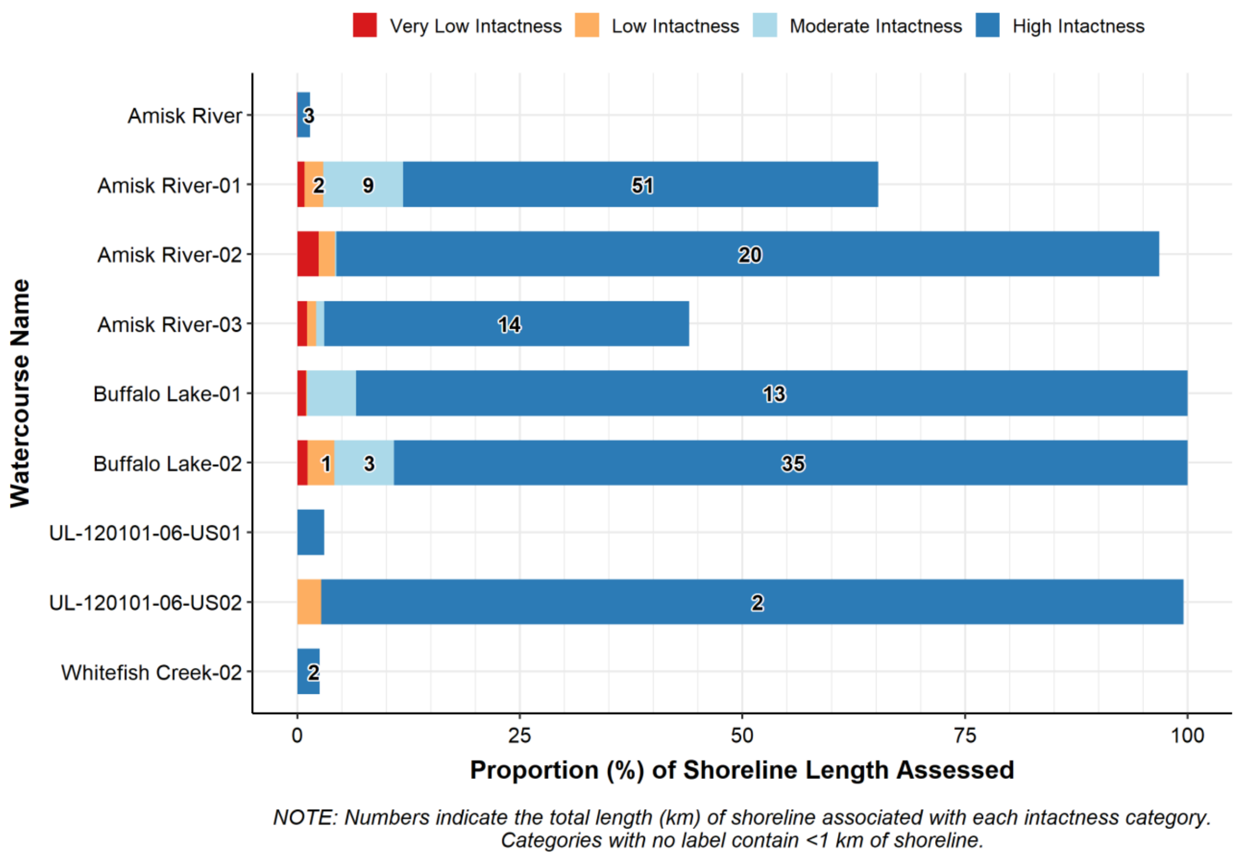
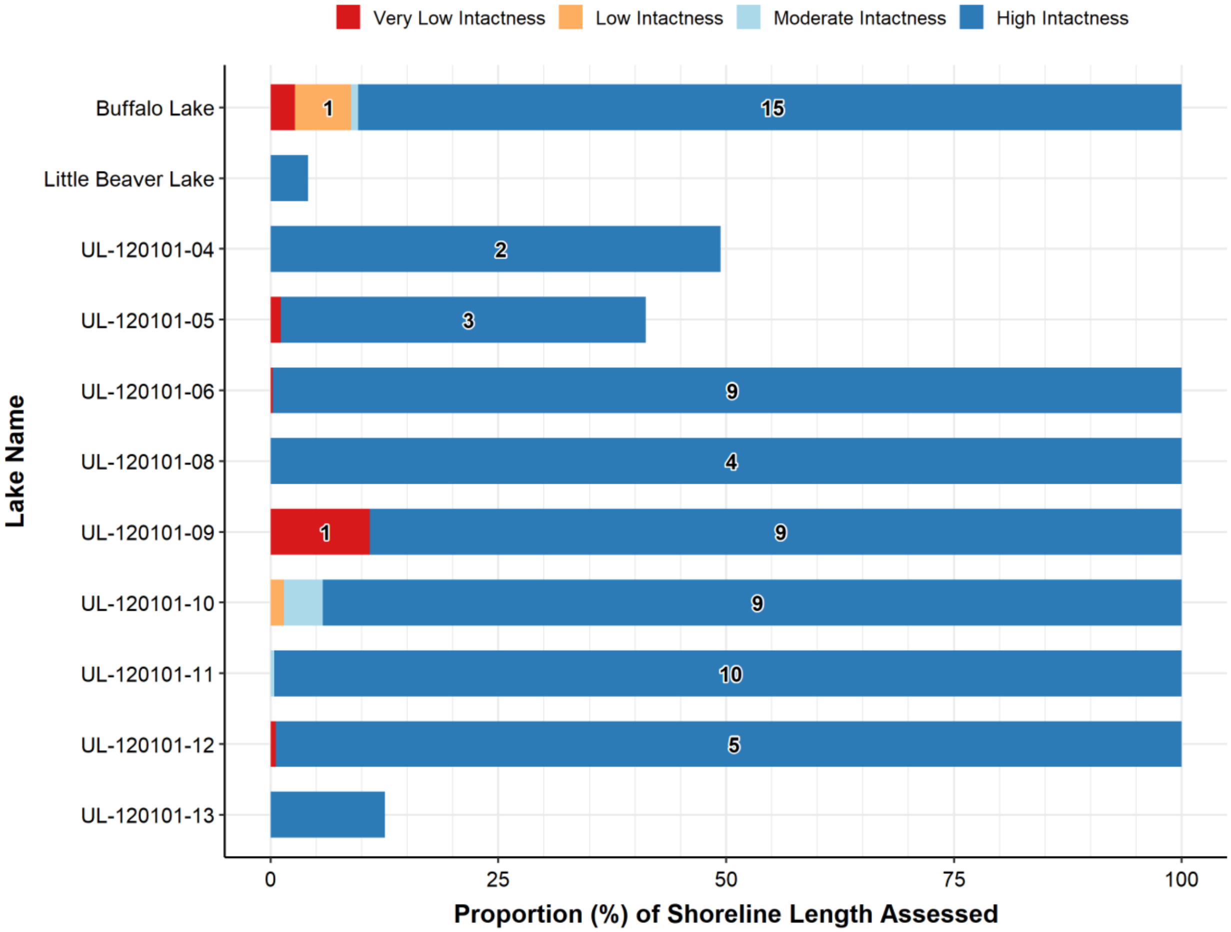


Figure 86. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed watercourses located within the Buffalo Lake Métis Settlement.



NOTE: Numbers indicate the total length (km) of shoreline associated with each intactness category. Categories with no label contain <1 km of shoreline.

Figure 87. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed lakes located within the Buffalo Lake Métis Settlement.

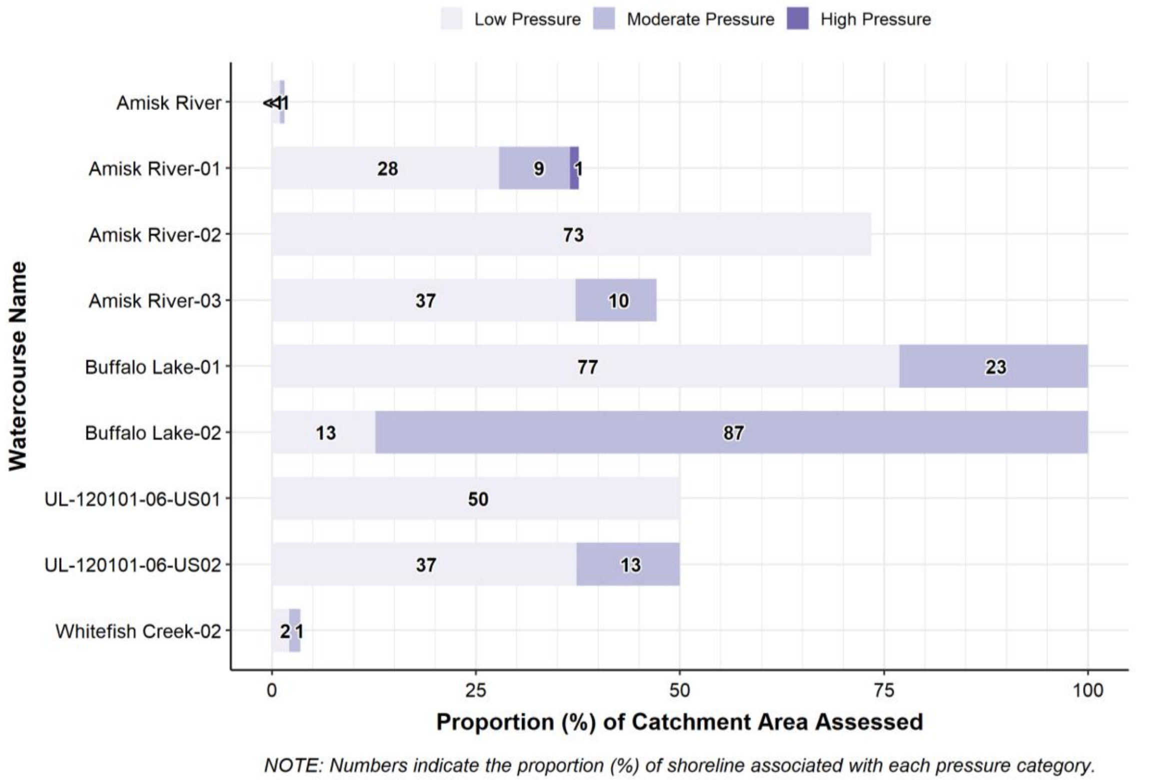


Figure 88. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed watercourses located within the Buffalo Lake Métis Settlement.

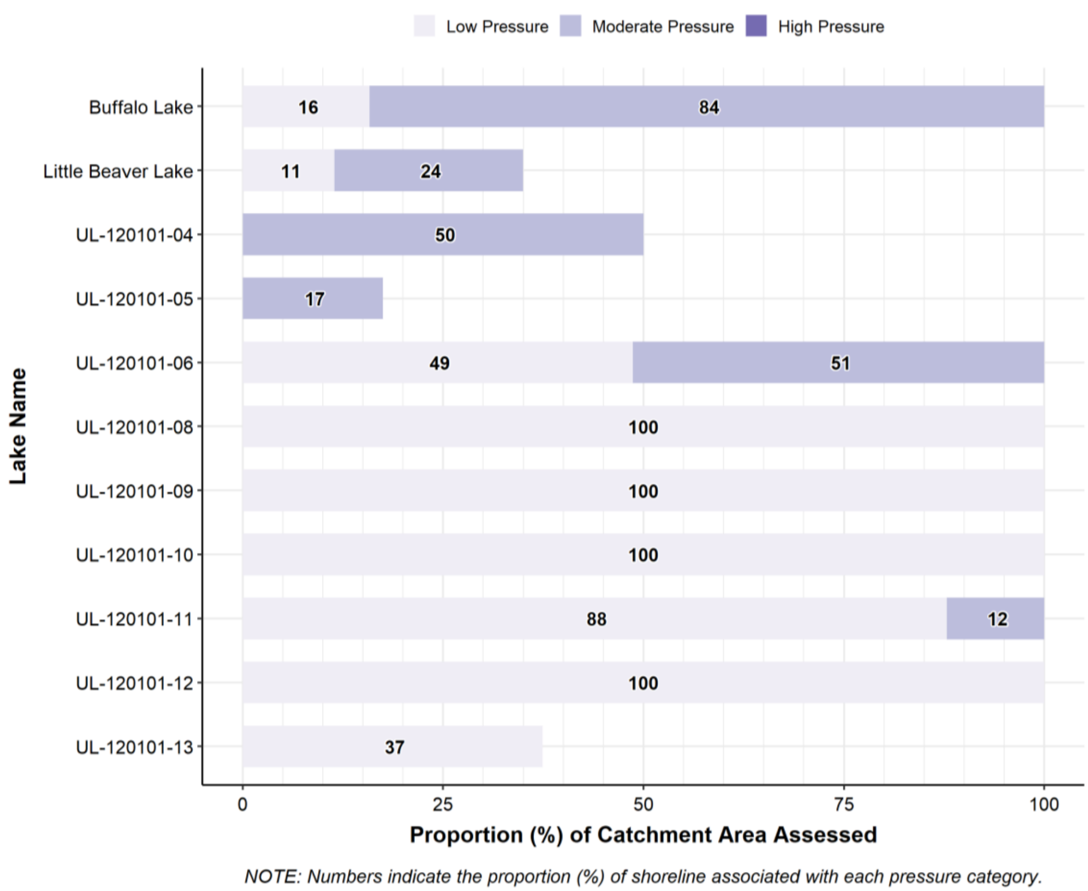


Figure 89. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed lakes located within the Buffalo Lake Métis Settlement.

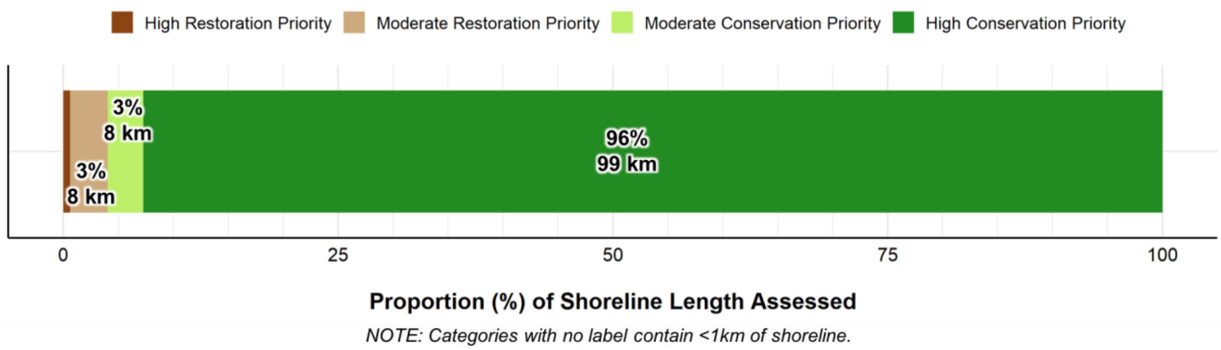


Figure 90. Overall conservation and restoration priority for waterbodies assessed within the Buffalo Lake Métis Settlement.

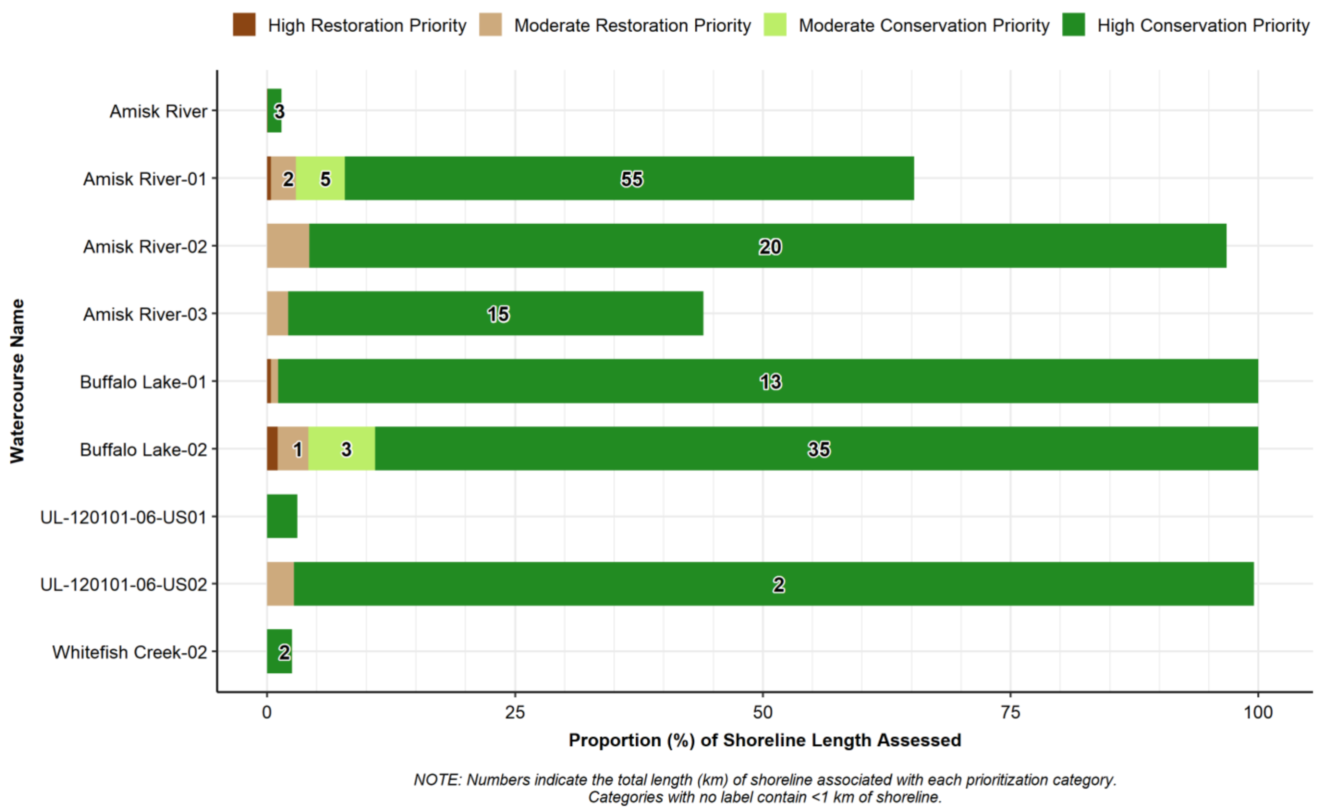


Figure 91. The proportion of shoreline length assigned to each prioritization category for named and unnamed watercourses located within the Buffalo Lake Métis Settlement.

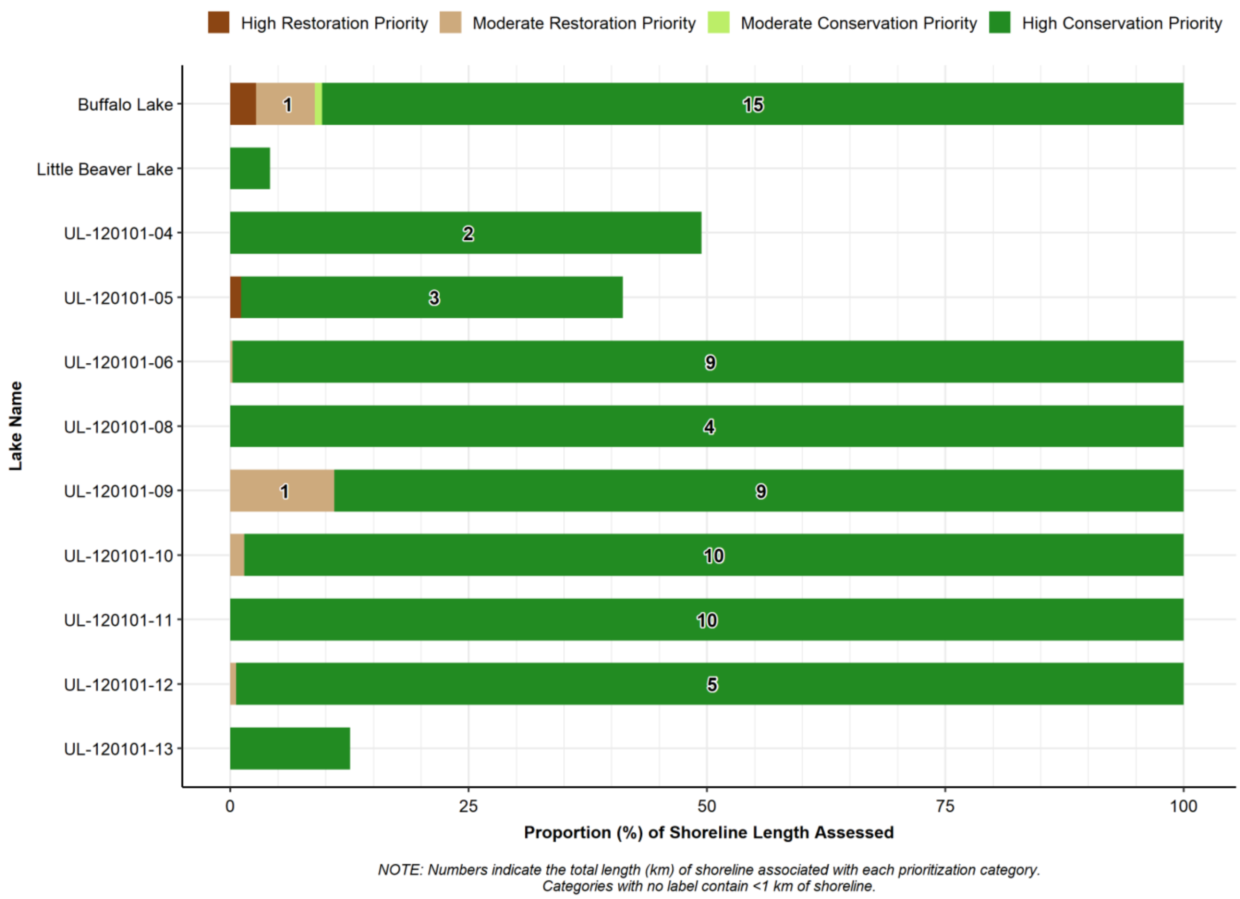


Figure 92. The proportion of shoreline length assigned to each prioritization category for named and unnamed lakes located within the Buffalo Lake Métis Settlement.

6.4. Kikino Métis Settlement

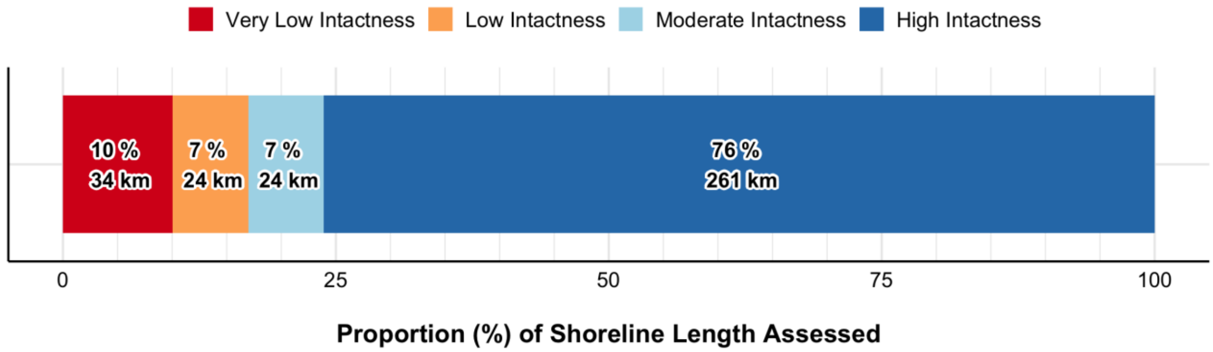


Figure 93. Overall intactness for waterbodies assessed within the Kikino Métis Settlement.

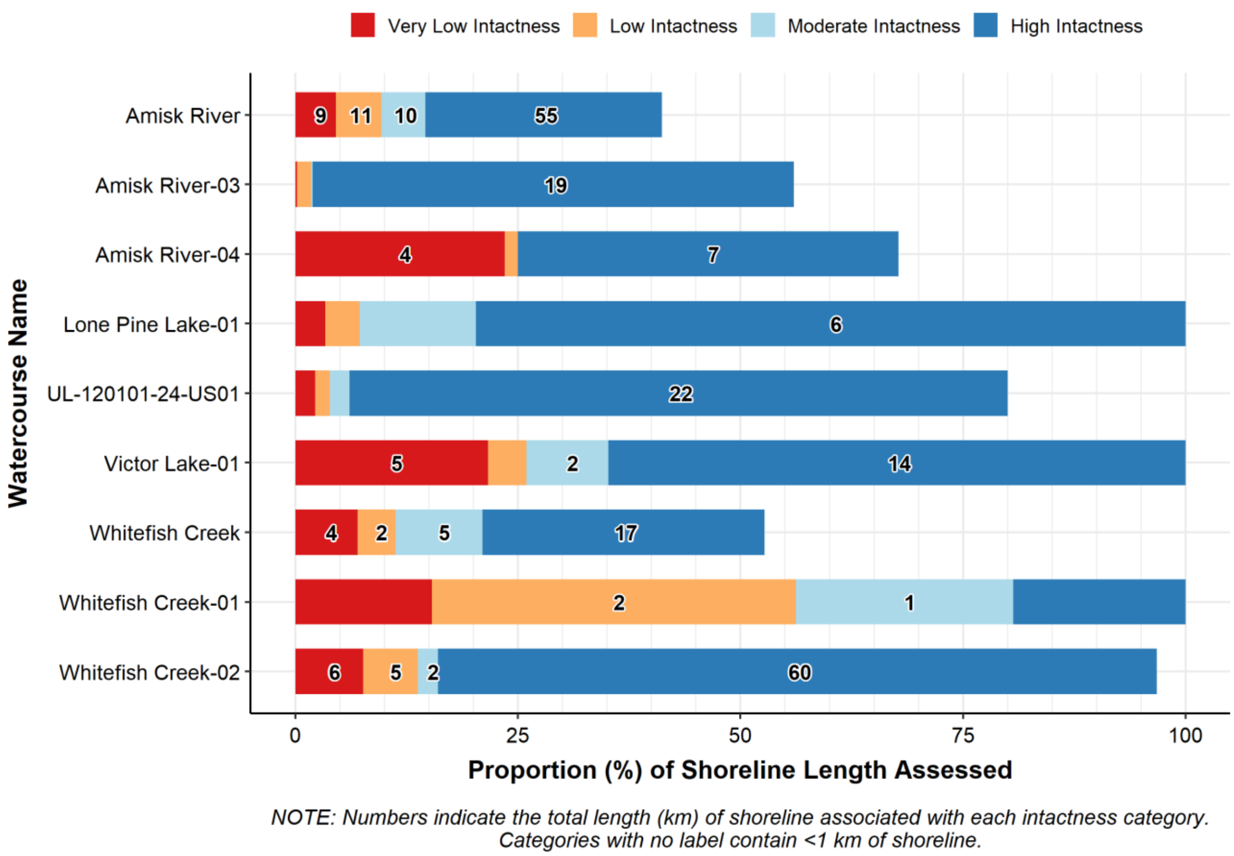


Figure 94. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed watercourses located within the Kikino Métis Settlement.

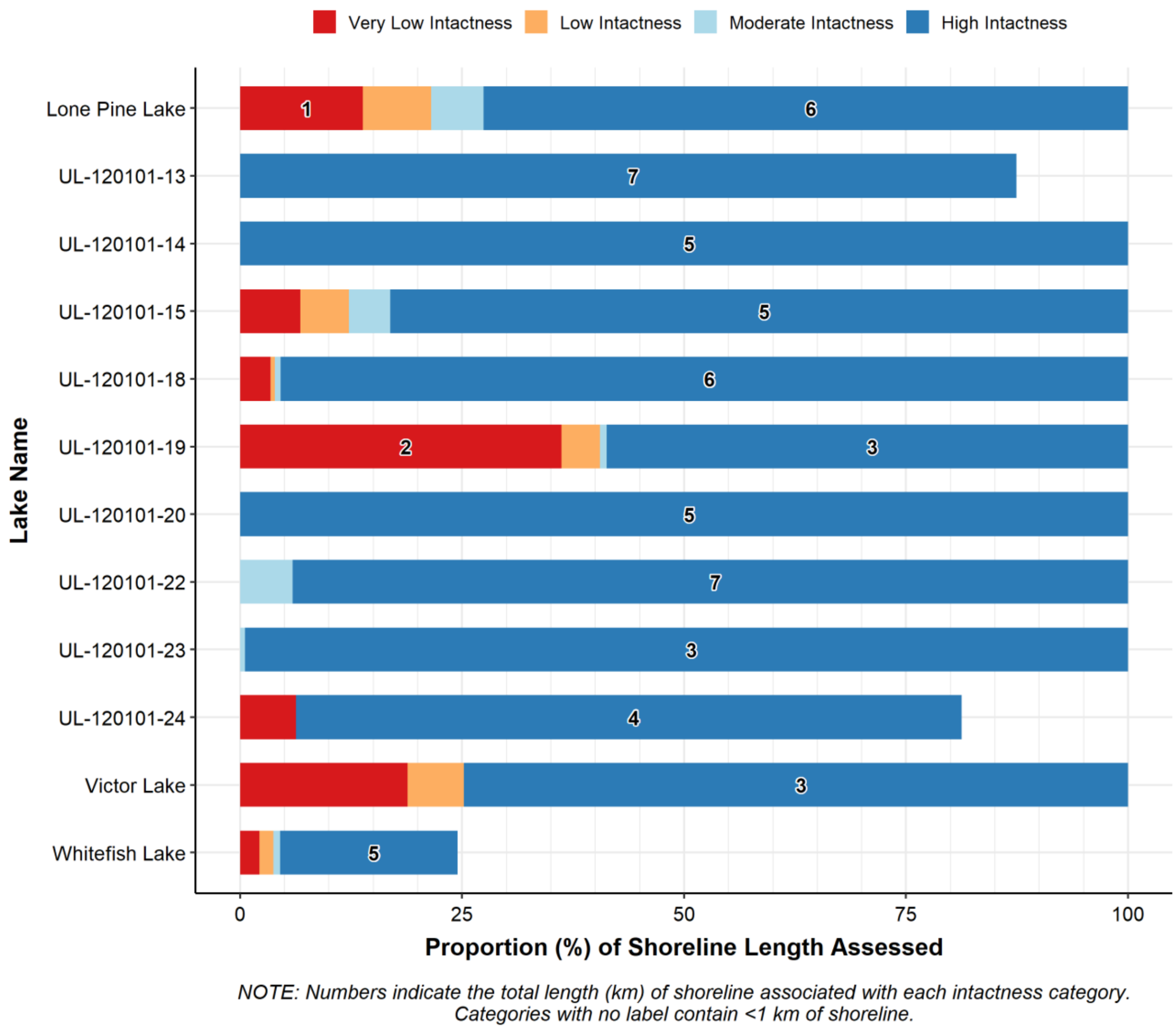


Figure 95. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed lakes located within the Kikino Métis Settlement.

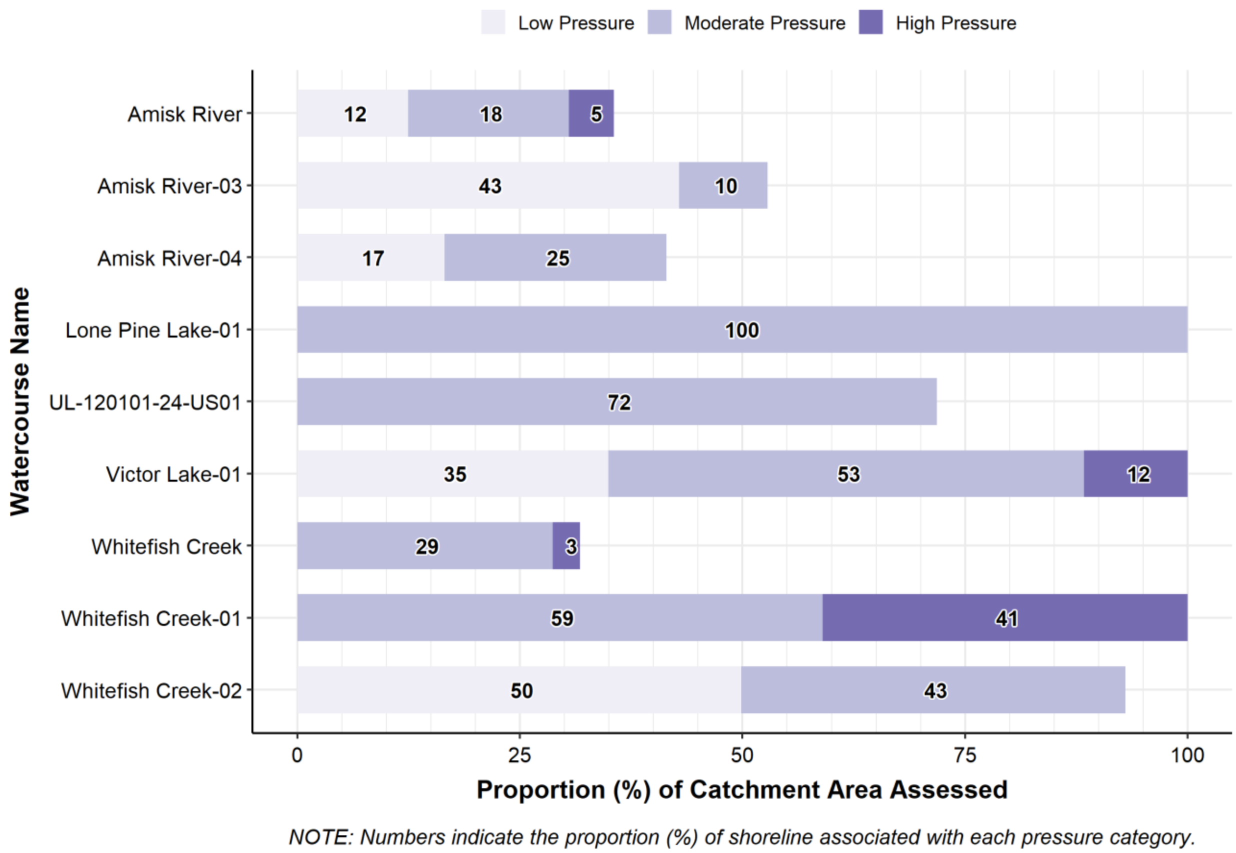


Figure 96. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed watercourses located within the Kikino Métis Settlement.

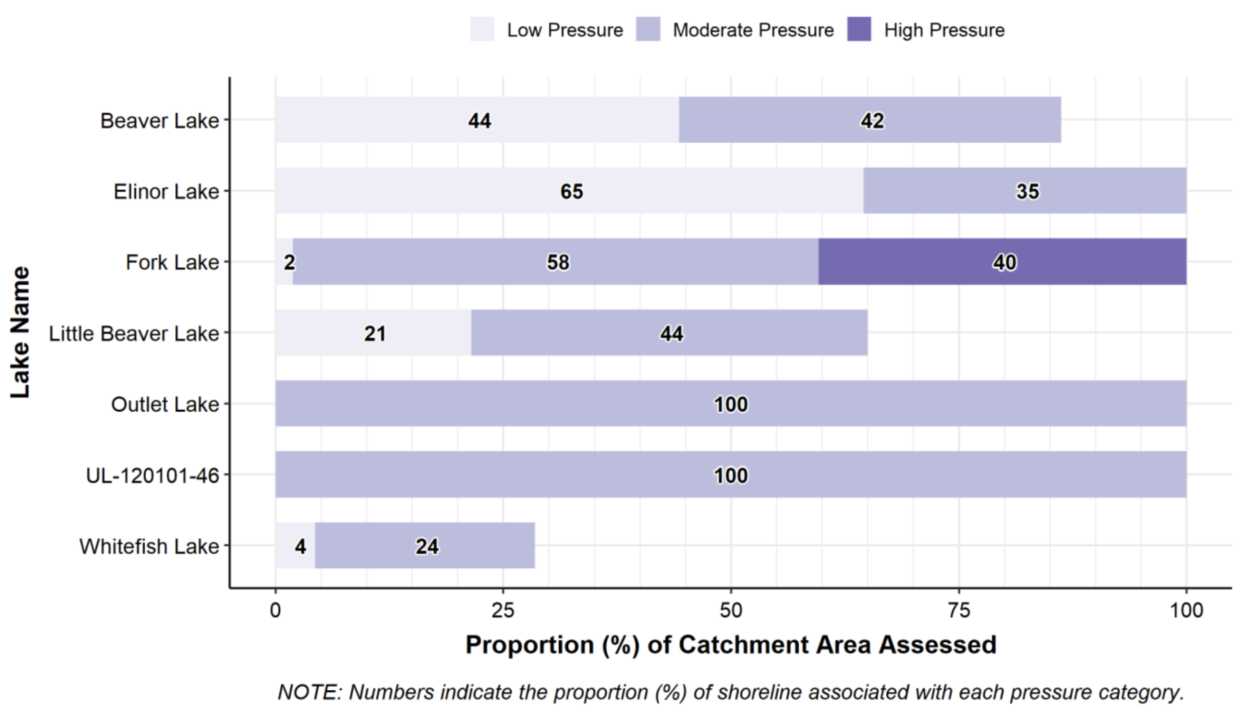


Figure 97. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed lakes located within the Kikino Métis Settlement.

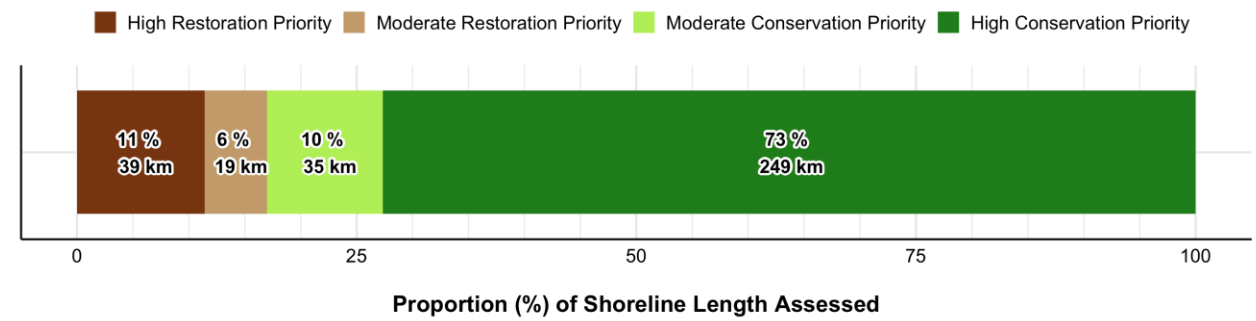


Figure 98. Overall conservation and restoration priority for waterbodies assessed within the Kikino Métis Settlement.

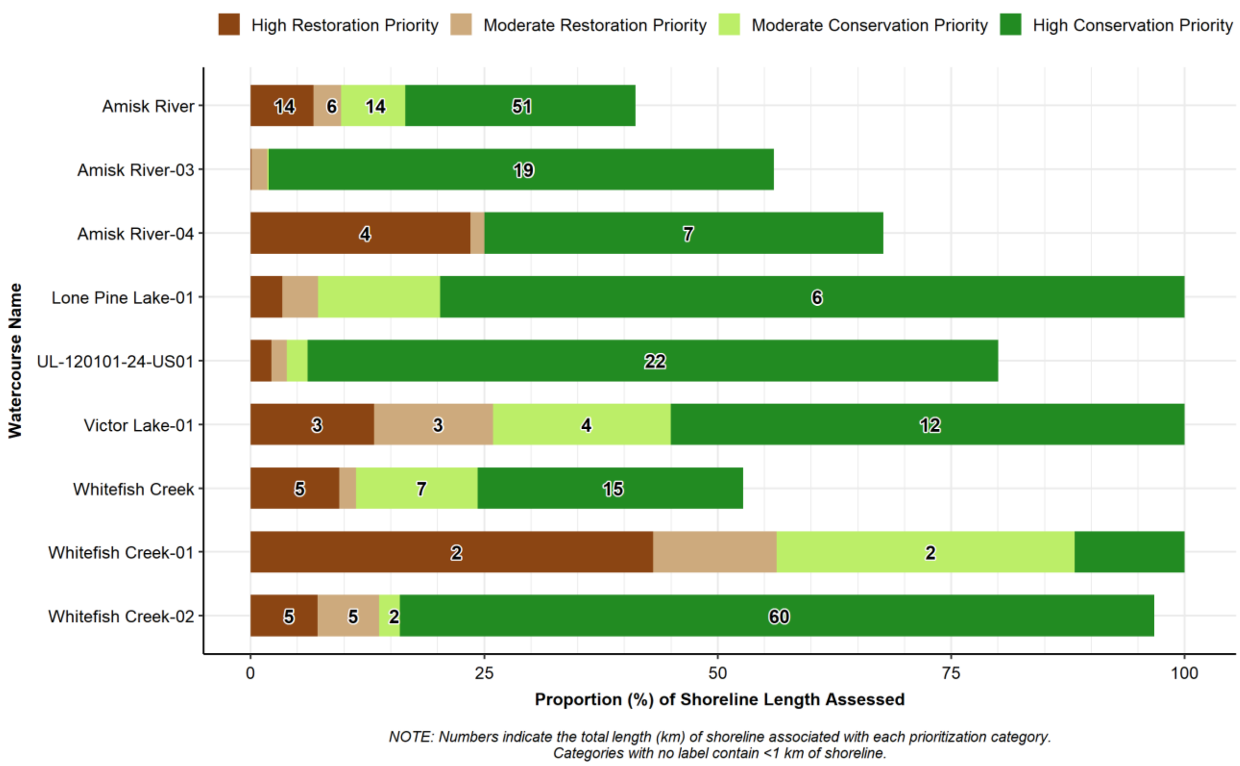


Figure 99. The proportion of shoreline length assigned to each prioritization category for named and unnamed watercourses located within the Kikino Métis Settlement.

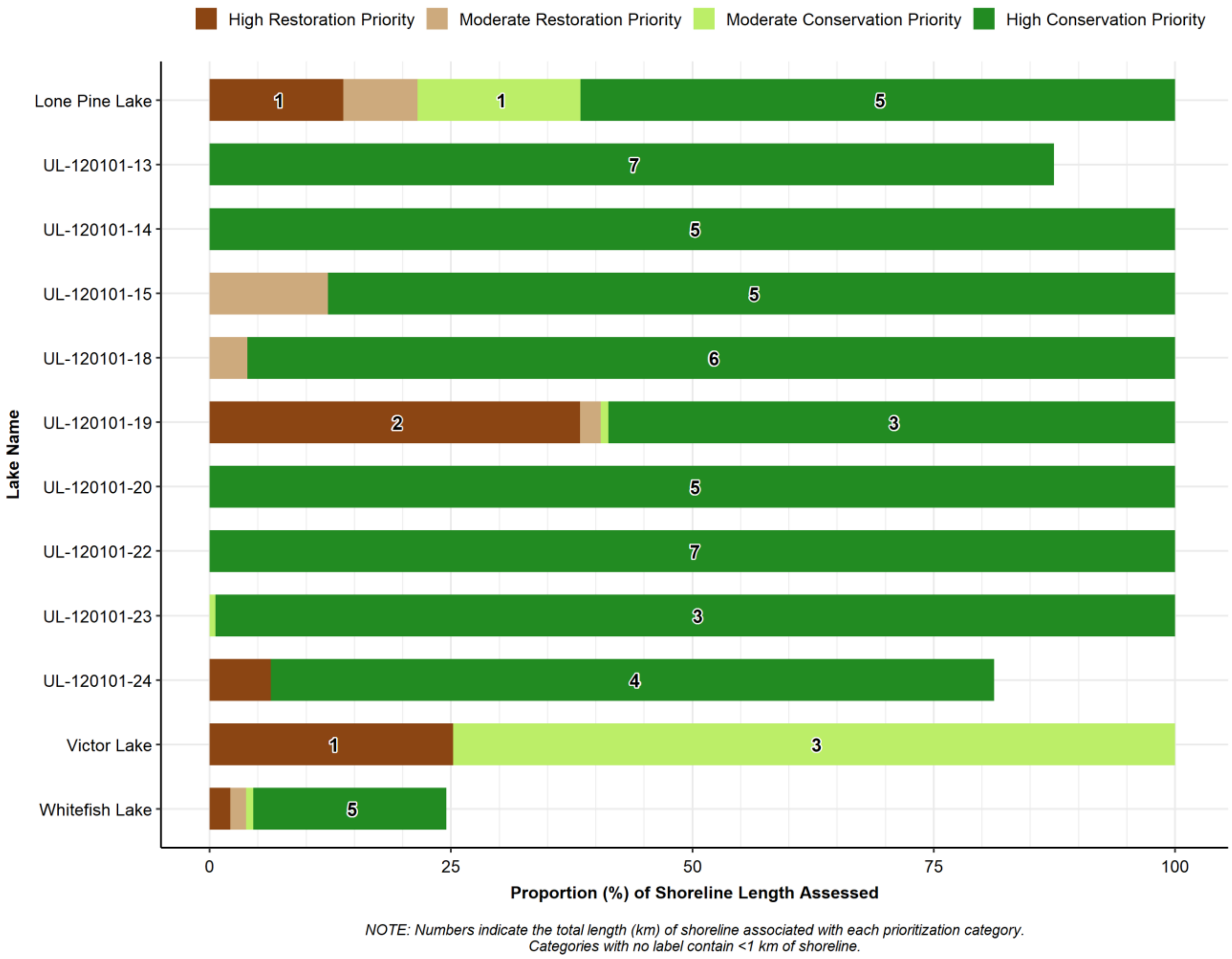


Figure 100. The proportion of shoreline length assigned to each prioritization category for named and unnamed lakes located within the Kikino Métis Settlement.

6.5. Whitefish Lake First Nation No. 128

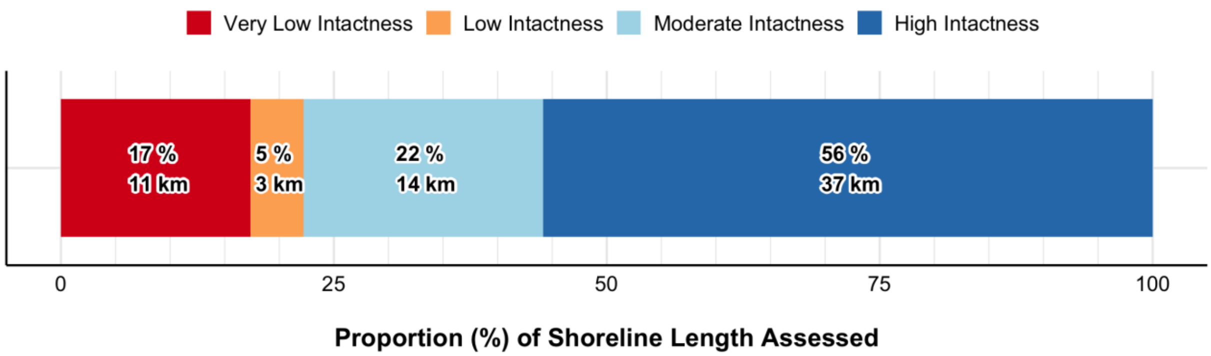


Figure 101. Overall intactness for waterbodies assessed within the Whitefish Lake First Nation.

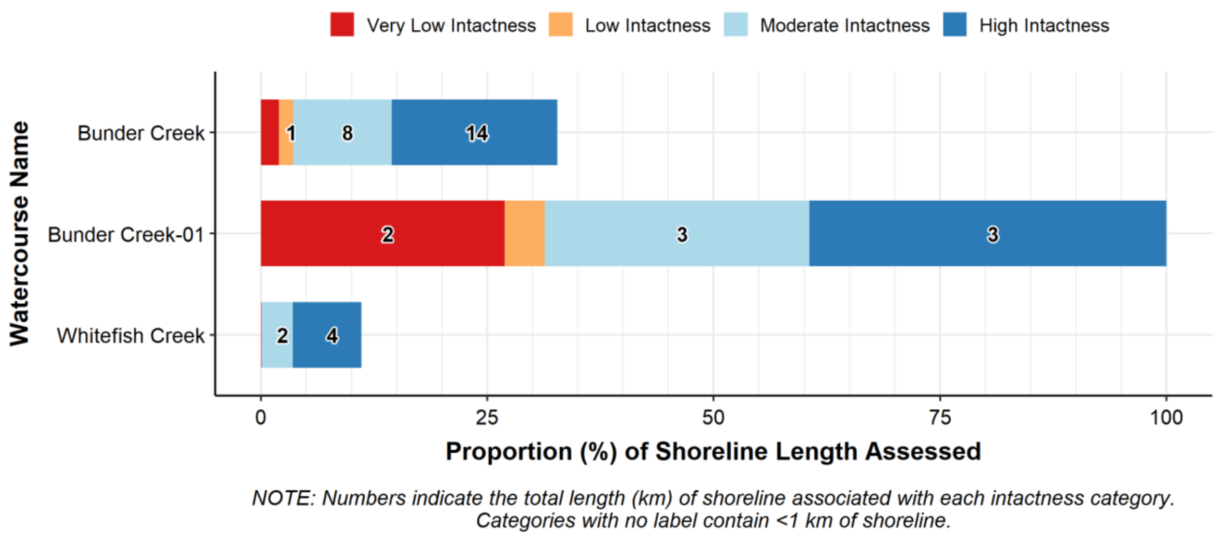


Figure 102. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed watercourses within the Whitefish Lake First Nation.

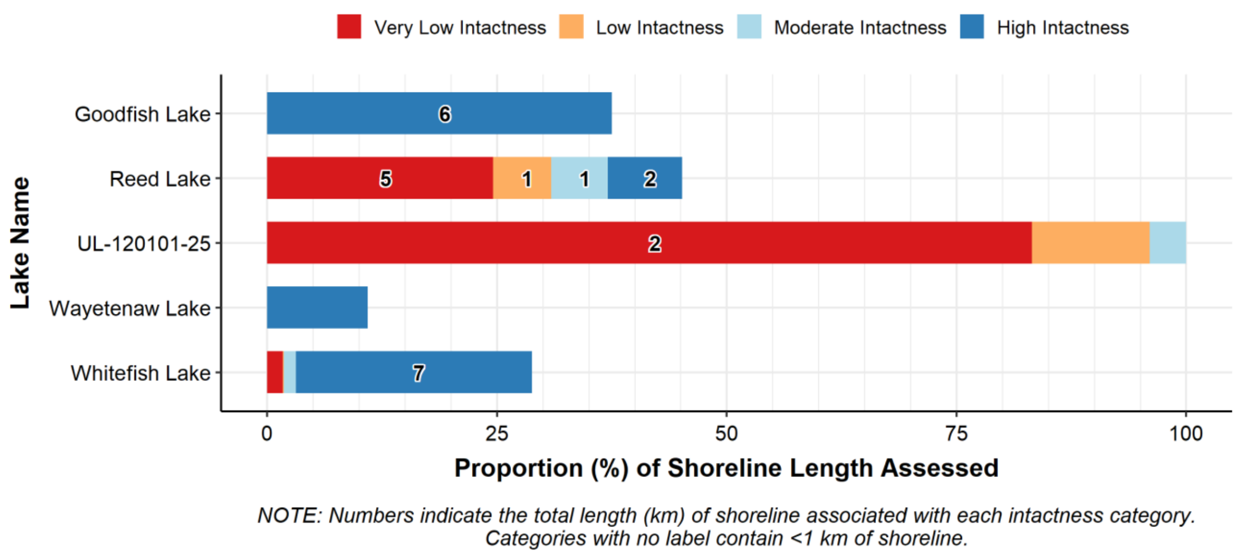


Figure 103. The proportion of shoreline length assigned to each riparian intactness category for named and unnamed lakes within the Whitefish Lake First Nation.

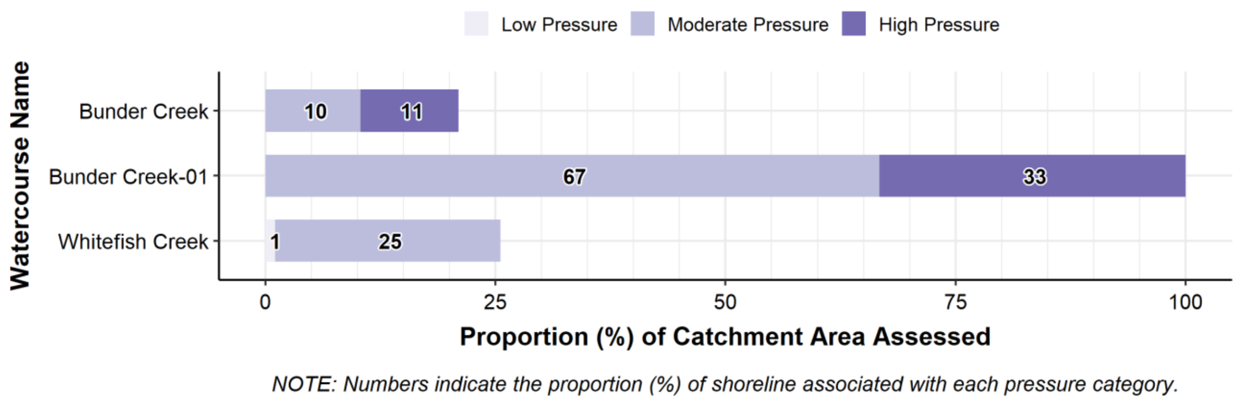


Figure 104. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed watercourses within the Whitefish Lake First Nation.

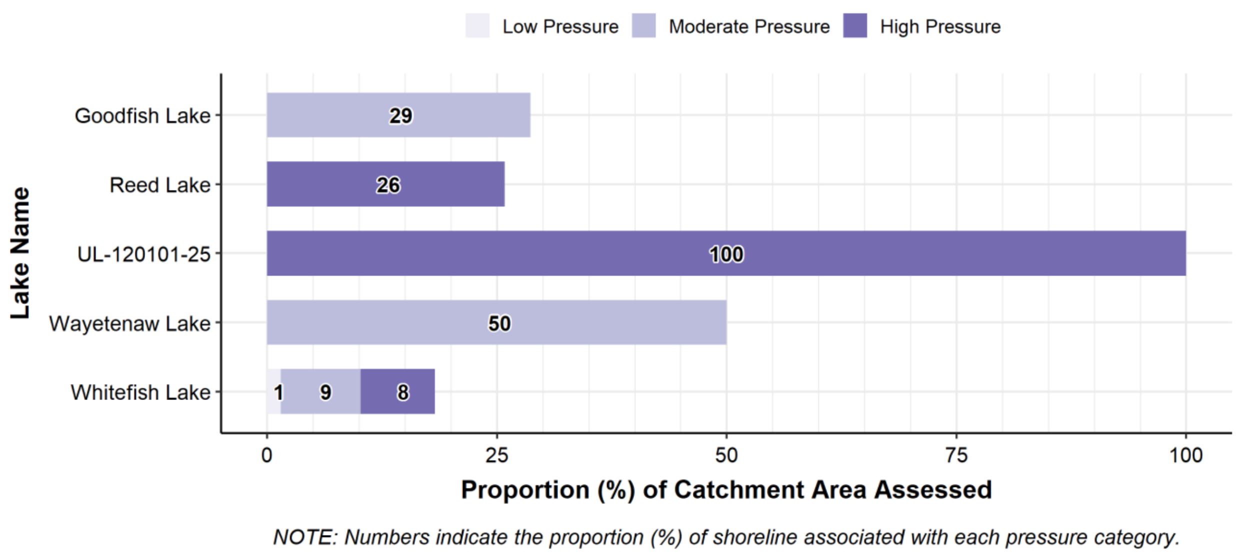


Figure 105. The proportion of catchment area by pressure category associated with RMAs that intersect the shorelines of named and unnamed lakes within the Whitefish Lake First Nation.

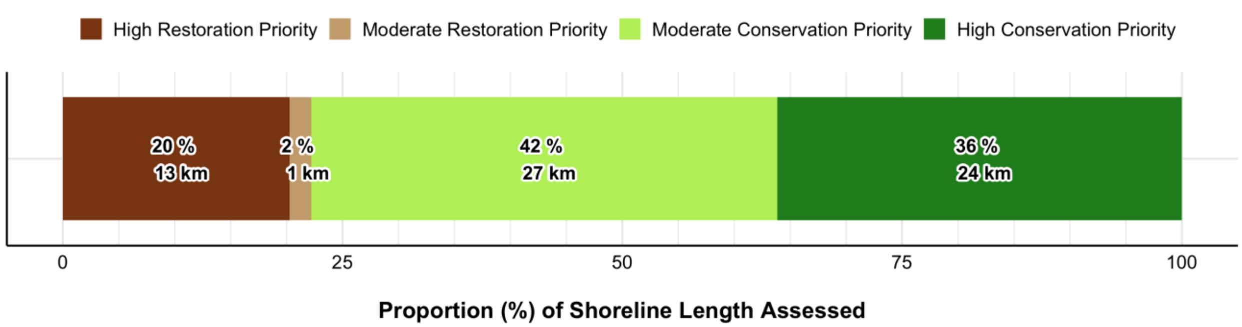


Figure 106. Overall conservation and restoration priority for waterbodies assessed within the Whitefish Lake First Nation.

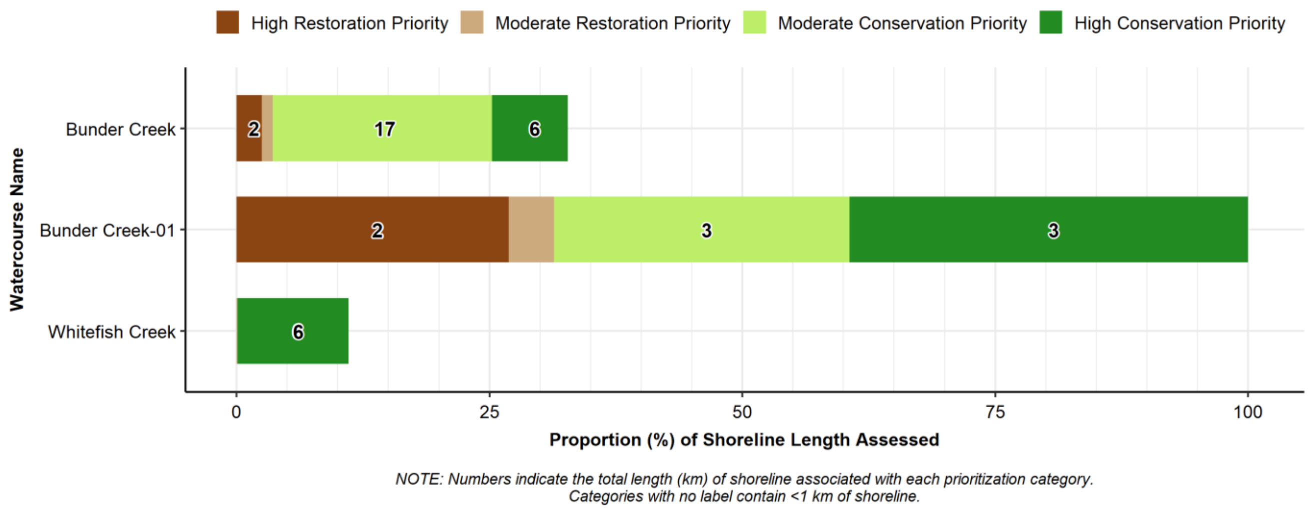


Figure 107. The proportion of shoreline length assigned to each prioritization category for named and unnamed watercourses within the Whitefish Lake First Nation.

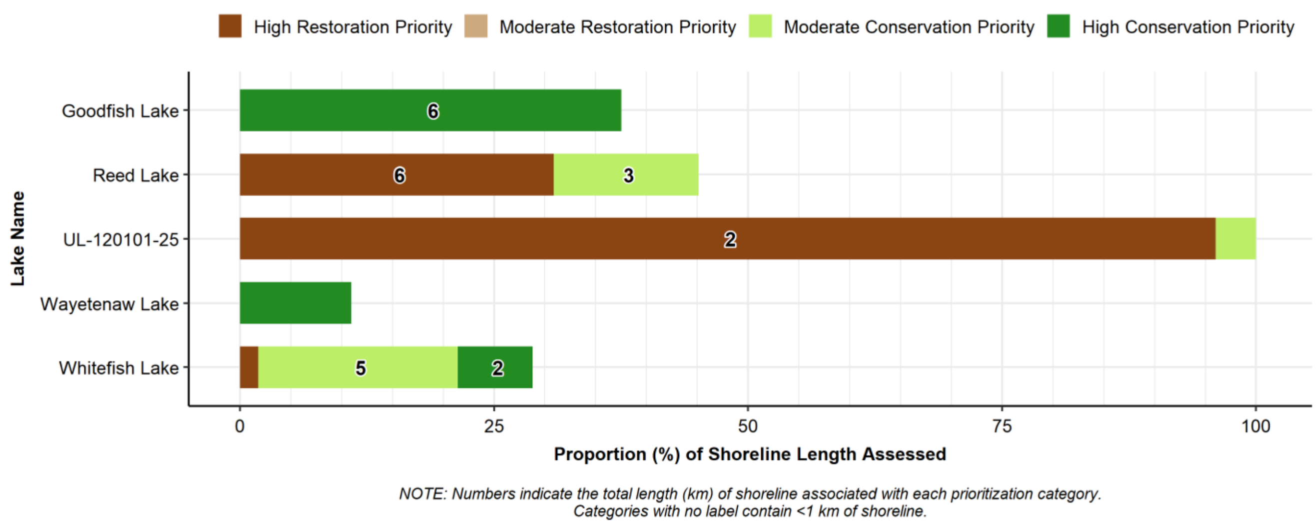


Figure 108. The proportion of shoreline length assigned to each prioritization category for named and unnamed lakes within the Whitefish Lake First Nation.

7.0 Creating a Riparian Habitat Management Framework

Foundational to any conservation planning exercise is the collection and generation of scientific information that can be used as the basis for the development and implementation of an evidence-based adaptive management framework. Through the commissioning of this study, LICA, its stakeholders, and Indigenous communities in the region have an important foundation of scientific evidence upon which to build a systematic and adaptive framework for riparian habitat management in the Upper Beaver watershed.

Importantly, the next step in the advancement of meaningful riparian management and conservation in the watershed will be to formalize a framework for action that includes a consideration of the current conditions (baseline) and defining achievable outcomes and measurable targets, which can then be used to inform relevant collective action by key stakeholders. These actions can then be monitored on a regular basis to provide an evaluation of outcomes that feed into an adaptive and reflexive approach to riparian land management through time.

Central to the goal of improving riparian habitat outcomes in the watershed is the development of a framework with specific objectives for riparian management and conservation. Objectives may address different types of goals, such as environmental (e.g., targets for amount of intact riparian area), social (e.g., increase in awareness), and/or programmatic (e.g., development of municipal policy or application of BMPs). Each defined objective should have associated measures, targets, and actions that are developed to ensure that the associated objective is achievable, and success towards achieving each objective can be measured. A definition for each of the key building blocks for the development of a riparian management framework for the watershed is provided below:

Objective:	High-level statements of desired future conditions (outcomes).
Measure:	Specific metrics that can be quantified to assess the progress towards, and the degree to which, desired future conditions have been achieved.
Target:	Values of measurable items (metrics) that indicate the attainment of a desired condition. In the current context these may be expressed as a single value or as a range to acknowledge the inherent variability of ecosystems.
Action:	Management actions, plans, or policies for achieving stated objectives.

While the development of a riparian management framework and associated objectives should be undertaken collectively by key stakeholders, we provide a number of key recommendations below that should be considered in the development of any riparian management plan.

7.1. Key Recommendations

The development of management objectives must consider ecological, social, and economic factors, and must acknowledge that maintaining functional and resilient ecological and hydrological systems is fundamental to maintaining healthy and vibrant human communities. Below we outline what we consider to be important riparian management objectives for the Upper Beaver watershed, and offer considerations and suggestions for the selection of measures and targets for each objective. We also offer a list of high-level actions for each objective; further discussion about potential actions that can be undertaken to improve riparian habitat management is provided in Section 7. Note that this list of management objectives is not exhaustive, and there may be other important riparian habitat management objectives defined by stakeholders and Indigenous peoples in the watershed.

Objective 1:

- Maintain or improve watershed resilience by conserving high quality riparian habitat.

Measure:

- Proportion (%) of shoreline assessed as Moderate and/or High Intactness.
- Total area of High or Moderate Conservation Priority lands secured through conservation easements or other mechanisms.

This objective can include a measure of conservation at multiple and nested spatial extents. For example, a target for conservation of high quality riparian habitat can be developed for the Upper Beaver watershed as a whole, and/or can also include measures and targets for riparian habitat conservation at the scale of the HUC 8 subwatershed, municipality, Indigenous community, and/or individual water body. Measures for riparian habitat conservation may also be specific to the type (order) and the location (e.g., headwaters) of the stream. For example, riparian vegetation provides proportionately greater benefits to instream habitat along the headwaters of streams specifically as it relates to the regulation of temperature, flow, and sediment regimes (Wipfli and Musslewhite 2004; Anonymous 2007). Because of this, there may be a desire to preferentially target riparian habitat along headwater streams for conservation. Alternatively, retention of riparian habitats along higher order streams could be prioritized in areas where habitat connectivity and biodiversity conservation is a priority.

Targets:

There is no universally accepted scientific target for the total amount of riparian habitat that should be maintained within a watershed; however, there is scientific consensus that the higher the quality and the greater the amount of riparian habitat that is maintained on the landscape, the better the outcomes for biodiversity, water quality, and water quantity. Further, there is no universal consensus on the width of vegetation along streams that should be maintained; however, there is general scientific agreement that factors such as the size (order) of the stream, the steepness of the banks, and the specific management concerns of the local system (e.g., soils, type of adjacent land use and land cover) should all be factors considered when determining the amount (width) of vegetation retained adjacent to a stream. For example, Environment and Climate Change Canada suggests as a riparian management guideline that 75% of a stream's length should be naturally vegetated, and that both sides of a stream should have a minimum 30-meter-wide naturally vegetated zone, while also acknowledging that wider buffers may be appropriate in some circumstances (Government of Alberta 2012; Environment Canada 2014).

Results from this study provide an important baseline that can be used to inform the selection of targets for this objective, as well as to measure improvement and progress towards achieving targets. For example, 74% of the shoreline that has been assessed within the Upper Beaver watershed has been classified as High Intactness, with an additional 11% classified as Moderate Intactness (Table 9). The target for this conservation objective could include specifying an individual target for the desired amount of Moderate and High Intactness at the watershed scale (e.g., ≥20% Moderate and ≥75% High). In addition, or as an alternative, overall targets for this objective can be set for each HUC 8 subwatershed and/or for each municipality and/or Indigenous community. In this case, the Upper Beaver River subwatershed, as well as the MD of Bonnyville and the County of St Paul may be spatially targeted for restoration activities, given that these areas have a lower proportion of Moderate/High Intactness shorelines than other locations within the watershed.

Table 9. Proportion of riparian areas that have been classified in each of the riparian intactness categories, summarised by various spatial extents (HUC 6 watershed, HUC 8 subwatershed, Jurisdiction).

		Proportion (%) of Shoreline within Intactness Category					
Spatial Extent	**Length Assessed (km)**	**Very Low**	**Low**	**Very Low + Low**	**Moderate**	**High**	**Moderate + High**
Upper Beaver Watershed	2,285.8	10	5	15	11	74	85
Amisk River Subwatershed	1551.6	8	5	13	8	79	87
Upper Beaver River Subwatershed	734.2	13	7	20	17	63	80
Athabasca County	234.5	8	3	11	8	81	90
Beaver Lake Cree Nation	13.5	2	3	5	2	93	95
Buffalo Lake Métis Settlement	229.1	2	2	4	6	90	96
County of St. Paul	550.7	15	9	24	15	62	77
Kikino Métis Settlement	342.6	10	7	17	7	76	83
Lac La Biche County	443.0	6	2	8	8	83	91
MD of Bonnyville	202.8	16	12	28	26	46	72
Smoky Lake County	101.3	12	3	15	3	82	85
Thorhild County	103.6	1	1	2	2	96	98
Whitefish Lake First Nation No. 128	65.7	17	5	22	22	56	78

Once watershed or municipal targets have been set, finer scale spatial targets can be set for individual lakes or streams. For example, riparian habitat along creeks in the headwaters of the Upper Beaver and/or each HUC 8 subwatershed could be prioritized for conservation, or as an alternative, riparian areas along creeks with important ecological values, such as threatened or sensitive fish populations, could be prioritized for conservation.

Actions:

There are a number of actions that could be taken to achieve conservation objectives, including (but not limited to):

- Incentivize voluntary conservation of riparian habitat on private land through payment for ecosystem services, changes to tax regimes, or other BMP programs.
- Develop education and outreach programs to encourage stewardship and conservation of riparian habitats on private land.
- Secure high conservation priority riparian habitats through purchase or through other land securement mechanisms available to conservation groups, land trusts, municipalities, or Indigenous communities.
- Develop provincial and/or municipal development setback and riparian land management policies.
- Create a municipal habitat conservation and restoration fund to allow for the securement of high priority riparian conservation areas.

Objective 2:

- Reduce flood risk by restoring riparian habitats that have been impacted or impaired.

Measure:

- Proportion (%) of shoreline assessed as Very Low and/or Low Intactness.

Similar to Objective 1, this measure can include multiple and nested spatial extents, and can also include finer scale spatial targeting of particular regions or high-priority waterbodies.

Targets:

Riparian habitats stabilize the banks of waterbodies and help modulate water velocities and high water events, thereby protecting surrounding lands from flooding (Orewole et al. 2015; Olokeogun et al. 2020). Thus, limiting the amount and extent of riparian habitat that has been severely impacted and restoring these areas should be an important goal for riparian habitat management in the watershed, particularly in areas that are prone to flooding.

For this objective, a target such as having ≥75% of each waterbody's shoreline classified as Moderate or High Intactness could be applied throughout the watershed (Environment Canada 2014). If such a target were to be adopted for the Upper Beaver watershed, data from this study suggests that 76% of the waterbodies assessed in this study meet this target, with only 30 waterbodies falling below this target (Table 10). In this case, it may be a realistic to specifically target these 30 waterbodies for restoration, with the goal of improving the overall intactness of these waterbodies towards the 75% target.

Actions:

There are a number of actions that could be taken to achieve the targets specified under Objective 2, including (but not limited to):

- Incentivize riparian habitat restoration on private land through payment for ecosystem services, changes to tax regimes, or other BMP programs.
- Develop education and outreach programs to encourage private land restoration, particularly for landowners located upstream of flood prone areas.
- Partner with conservation organizations to promote and encourage restoration on private lands.
- Create a municipal or Indigenous community habitat conservation and restoration fund to pay for riparian habitat restoration on public lands, with a specific focus on restoring areas identified as Very Low or Low Intactness.

Table 10. Proportion of shoreline length that has been classified in each of the riparian intactness categories, summarised for individual waterbodies that have less than 75% of their shoreline classified as either Moderate or High Intactness.

Waterbody	Length Assessed (km)	Proportion (%) of Shoreline within Intactness Category					
		Very Low	Low	Very Low + Low	Moderate	High	Moderate + High
Victor Lake-01	21.6	22	4	26	9	65	74
Victor Lake	4.6	20	7	26	0	74	74
UL-120101-29-US01	10.2	16	11	26	6	68	74
UL-120101-41	5.6	23	4	27	20	54	73
Garner Lake	16.6	14	13	28	11	61	72
Amisk River-04	15.7	25	3	28	1	71	72
Beaver River-01	11.5	24	4	29	9	63	71
Denning Lake	8.1	22	7	30	11	59	70
Snail Lake	6.7	25	4	30	1	69	70
UL-120101-34	8.7	24	6	30	8	62	70
Bunder Creek-01	8.6	27	5	31	29	40	69
Columbine Creek	80.5	23	8	31	24	45	69
Bunder Creek-02	9.4	12	21	33	28	39	67
UL-120101-27-US01	18.1	24	11	35	34	31	65
UL-120101-40	4.8	31	6	38	6	56	63
Owlseye Lake	6.7	7	31	39	19	42	61
UL-120101-19	5	36	4	40	0	60	60
UL-120101-42	4.8	38	8	46	25	29	54
Allday Lake	3.7	19	27	46	5	49	54
Floatingstone Lake-01	10.4	32	14	46	33	21	54
St. Lina Creek-02	20.6	45	10	55	22	23	45
Whitefish Creek-01	4.7	15	40	55	26	19	45
Cole Lake	9.2	16	42	59	0	41	41
Reed Lake	20	61	7	68	9	24	33
St. Lina Creek-03	13.3	54	16	70	22	8	30
Little Garner Lake	4.2	52	19	71	2	26	29
UL-120101-45	3.7	76	0	76	0	24	24
UL-120101-33	2.9	90	0	90	3	7	10
UL-120101-43	3.5	86	9	94	0	6	6
UL-120101-25	2.5	84	12	96	4	0	4

Objective 3:

- Manage external pressures on riparian system function.

Measure:

- Pressure score of local catchments adjacent to streams.

As part of this study, pressure scores have been assigned to local catchment areas, which broadly characterizes the existing condition of each catchment as it relates to the type of land cover and the intensity of land use that is present. These catchments and their associated scores offer measures for generally assessing and tracking land use and land cover changes through time.

Targets:

- No net increase in the pressure score of local catchments adjacent to streams.
- Net increase in the cover of natural vegetation (e.g., forest) and/or wetlands within High Pressure catchments adjacent to streams.

Generally, the focus of this objective should be on minimizing the impacts of large scale and cumulative land cover or land use change on riparian areas and associated stream habitats. While it is unlikely that there will be reversals to existing land use or land cover to create an improvement to pressure scores, a realistic goal for this objective would be to identify high priority local catchments where the target for management is a no net increase in the current local catchment pressure score.

An additional target for this objective could include a net increase in the cover of natural vegetation (e.g., forest, shrubs, grassland), and/or wetlands. An increase in the amount of permeable surfaces and low intensity land uses in areas adjacent to riparian habitats will have a net positive effect on the function and condition of riparian and stream habitats.

Actions:

The following is a list of actions that could be undertaken to achieve the targets specified under Objective 3:

- Incentivize voluntary conservation of wetland habitat and natural vegetative cover on private land through payment for ecosystem services, changes to tax regimes, or other BMP programs.
- Develop education and outreach programs to encourage stewardship and conservation of wetlands and other natural vegetation on private land.
- Secure wetland and other natural habitats in high priority catchments through purchase or through other land securement mechanisms available to conservation groups, land trusts, municipalities, or Indigenous communities.
- Create municipal land use bylaws that restrict land clearing or high intensity land use activities in local catchments designated as high priority for conservation.

8.0 Existing Tools for Riparian Habitat Management

Riparian land management in Alberta falls under the jurisdiction of the federal, provincial, and municipal governments. While Alberta does not have legislation or policy that explicitly manages riparian lands, there are a number of laws, regulations, standards, policies, and voluntary programs that can be used to direct the management of riparian lands, or land that directly adjoins riparian lands. The following sections highlights the key legislation, policies, and programs that are currently in place for riparian land management in the province of Alberta. Note that this is not intended to be an exhaustive list; rather, it is intended to highlight legislation, policy, and programs that are considered to be the most relevant and commonly employed to achieve riparian land conservation in the province.

8.1. Guidelines, Policies, and Legislation

Federal jurisdiction over riparian areas in Alberta is somewhat limited in scope. Exceptions to this include the authority to manage natural habitats and associated wildlife on federal land (e.g., First Nation Reserves, National Parks), as well as the authority to regulate migratory birds, fish and fish habitat, navigable waters, and species at risk. A summary of relevant federal laws and regulations that may apply to riparian management in the watershed are listed in Table 11.

At the provincial level, there a number of statutory laws, regulations, and standards that directly or indirectly relate to the management of riparian habitat on both private and public land. The responsibility for managing riparian land falls to a number of provincial ministries and departments, and the mechanisms through which riparian lands are managed varies with respect to whether these habitats are located on private land (White Zone) or public land (Green Zone). In addition, the nature of the disposition and the activities associated with the land use(s) (e.g., forestry, oil and gas, agriculture, or urban development) influences how riparian lands are managed on both private and public land.

In instances of overlapping land use or activities (e.g., forest harvest operating together with oil and gas exploration), the manner in which riparian lands are managed is directed by the laws, regulations, and standards that are specific to that particular land use or activity. In these situations, coordination between the various government ministries responsible for enacting those laws, regulations, or standards is an important aspect of successful riparian management outcomes. Regardless of where the riparian land is located, or what the land use and associated activities may be, the provincial government has jurisdiction over the management of all water in the province under the *Water Act*, as well as all lands that are defined as "public" (regulated under the *Public Lands Act*), which includes the bed and shore of all permanent waterbodies, regardless of whether these waterbodies are located on private land.

In addition to provincial laws and regulations, the Government of Alberta has a wide range of policies, standards, or guidelines that provide direction for the management of natural areas, wildlife, and wildlife habitat. The majority of these policies are voluntary and require the application of best management practices to achieve the desired management goals. One exception to this is the provincial wetland policy. Wetlands are regulated as waterbodies under the *Water Act*, and as such, an approval is required to undertake any works that may impact a wetland. Thus, the principles and goals of the wetland policy and the associated wetland compensation guide are enforced through the *Water Act* application process.

A list and description of provincial laws, regulations, and policies that may apply to the management of riparian areas in the watershed is provided in Table 12.

Table 11. List and description of Federal laws and regulations that may apply to the management of riparian areas in the Upper Beaver watershed.

Federal Law or Regulation	Application to the Management of Riparian Areas
Migratory Bird Convention Act	This legislation is based on international treaty signed by Canada and the United States of America that aims to protect migratory birds from indiscriminate harvesting and destruction on all lands within Canada. Under this Act, efforts should be made to provide for and protect habitat necessary for the conservation of migratory birds, and to conserve habitats that are essential to migratory bird populations, such as nesting, wintering grounds, and migratory corridors.
Fisheries Act	Includes provisions for the protection of fish and fish habitat, and requires an authorization for activities that cause serious harm to fish.
Species At Risk Act	The Federal government has jurisdiction over all SARA-listed species on federally owned lands, including national parks, Department of National Defence lands, and First Nations Reserve lands. Management of SARA-listed species on provincial crown land, or on lands held by private citizens of Alberta, falls under the jurisdiction of the provincial government. In these cases, the provincial government is obligated to protect listed species to the same standards set forth by the Federal government. In cases where provincial governments do not meet these standards, the Federal Minister may issue an order in council to protect federally listed species that occur on provincial or private lands

Table 12. List and description of Provincial laws, regulations, and policies that may apply to the management of riparian areas in the Upper Beaver watershed.

Legislation, Regulation, or Policies	Application to the Management of Riparian Areas
Agricultural Operation Practices Act	Regulates and enforces confined livestock feeding operations planning for siting, manure handling/storage, and environment standards.
Alberta Land Stewardship Act	Creates authority of regional plans and enables the development of conservation and stewardship tools that can be used to acquire and manage natural areas. These tools include conservation easements, conservation directives, conservation offsets, and transfer of development credits.
Alberta Wetland Policy & Wetland Mitigation Directive	Pursuant to the *Water Act*, the provincial wetland policy prohibits the unauthorized drainage or disturbance of wetlands. The stated goal of the policy is to “conserve, restore, protect, and manage Alberta’s wetlands to sustain the benefits they provide to the environment, society, and economy”. If wetland loss or impacts are authorized by the province under the *Water Act*, the permittee is responsible for the replacement of lost wetland habitat at the ratio stipulated by the province. While this policy does not explicitly manage riparian land, there is opportunity within the stated goals and intent of this policy to extend the policy to include riparian lands.
Environmental Protection and Enhancement Act (EPEA)	This legislation aims to protect air, land and water by regulating the process for environmental assessments, approvals, and registrations. In particular, stormwater drainage that is directed to any surface waterbody requires an EPEA approval. Further, the Environmental Code of Practice for Pesticides provides a standard for operating practices that restrict the deposition of pesticides into or onto any open waterbody.
Municipal Government Act (MGA)	Updated in June 2018, the modernized MGA provides municipalities with the authority to adopt statutory plans and bylaws that direct land use and development at subdivision. The MGA also grants limited rights to designate reserves at subdivision that can be used to conserve natural areas, and gives municipalities authority to regulate water on municipal lands, manage private land to control non-point source pollution, and adopt land use practices that are compatible with the protection of the aquatic environment, including development setbacks on waterbodies
Municipal Land Use Policies	Pursuant to Section 622 of the MGA, these Policies were established by Municipal Affairs to supplement planning provisions in the MGA and the Subdivision and Development Regulation, and to create a conformity of standard with respect to planning in Alberta. Section 5 of the Land Use Policies encourages municipalities to identify significant waterbodies and watercourses in their jurisdiction, and to minimize habitat loss and other negative impacts of development through appropriate land use planning and practices. In addition, Section 6 encourages municipalities to incorporate measures into planning and land use practice that minimizes negative impacts on water resources, including surface and groundwater quality & quantity, water flow, soil erosion, sensitive fisheries habitat, and other aquatic resources.

Continued …

Table 12 *continued …* List and description of Provincial laws, regulations, and policies that may apply to the management of riparian areas in the Upper Beaver watershed.

Legislation, Regulation, or Policies	Application to the Management of Natural Areas
Public Lands Act	Regulates and enforces activities that affect the Crown-owned bed and shore of waterbodies, as well as Crown-owned riparian and upland habitats (e.g., forest and grazing leases).
Stepping Back from the Water: A Beneficial Management Practices Guide for New Developments Near Waterbodies	This document provides discretionary guidance to local authorities to assist with "decision making and watershed management relative to structural development near waterbodies", and includes recommendations for development setbacks (buffers) on waterbodies to protect aquatic and riparian habitats.
Soil Conservation Act & Regulations	Regulates activities that may cause erosion and sedimentation of a waterbody.
Surveys Act	Definitions for the "legal bank" of a waterbody, upon which the Crown-owned "bed and shore" is defined. The legal boundary between the bed and shore and the adjacent lands is the naturally occurring high water mark, and may not extend to include the full extent of riparian lands adjacent to a waterbody.
Water Act	The stated purpose of this Act is to support and promote water conservation and management. Under the Act, any activity that causes or has the potential to cause an effect on the aquatic environment requires an approval. Regulations and Codes of Practice under this Act apply to water and water use management, the aquatic environment, fish habitat protection practices, in-stream construction practices, and storm water management.
Weed Control Act	Noxious and prohibited noxious weeds listed under Schedule 1 must be controlled (noxious weed) or destroyed (prohibited noxious weed) by the owner of the land on which the listed weed occurs.
Wildlife Act & Species at Risk Program	Regulates and enforces protection of wildlife species and their habitats, which may include riparian dependent species

While the provincial government holds the authority to regulate water and public land throughout the province, municipalities are given the authority to manage lands within their jurisdiction under the *Municipal Government Act* (MGA), which was modernized and revised in July 2018. Under Part 1, Section 3, the Act outlines the following purposes of a municipality:

1) To provide good governance and foster the well-being of the environment;
2) To provide services that are in the opinion of council to be necessary or desirable;
3) To develop and maintain safe and viable communities; and
4) To work collaboratively with neighbouring municipalities to plan, deliver, and fund intermunicipal services.

A primary power given to municipalities is land use planning and development, which allows municipalities to set the conditions under which lands are subdivided and developed. Further, each municipality must develop statutory planning documents that provide a framework and vision for development and land use within their jurisdictions. Statutory planning documents that are required include:

- Municipal Development Plans
- Intermunicipal Development Plans

- Area Structure Plans
- Area Redevelopment Plans

Within these planning documents, municipalities can provide specific direction for development requirements that may influence the conservation of riparian habitat. In addition to statutory planning documents, municipalities can influence the management of riparian areas by enacting Land Use Bylaws that set forth requirements for development setbacks on environmentally sensitive lands. For example, municipalities can provide specific direction for development requirements in or near riparian habitat, or set forth minimum development setback widths on Environmental Reserve (ER), environmentally sensitive land, or waterbodies and watercourses.

The MGA also gives municipalities the power to enact land use bylaws, as well as the authority to designate land as Environmental Reserve at the time of subdivision. Environmental Reserves are defined in Section 664 as waterbodies or watercourses, lands that are unstable or subject to flooding, and lands “not less than 6 metres in width abutting the bed and shore” of a waterbody or watercourse. While the Act allows municipalities to take a 6 metre (or more) setback on Environmental Reserve lands, the conditions under which this taking is permitted is limited to cases where the setback is required to prevent pollution, provide public access to the bed and shore of the waterbody or watercourse, prevent development of land that presents a significant risk to persons or property if developed, or to preserve natural features that in the opinion of the subdivision authority should be preserved. In addition to the limited opportunities that are available for conserving riparian land as Environmental Reserve, Section 640(4)(l) of the Act allows municipalities to establish development setbacks on lands subject to flooding, low lying or marshy areas, or within a specified distance to the bed and shore of any waterbody.

8.2. Acquisition of Riparian Lands

It is important to note that while there is a wide range of different federal, provincial, and municipal laws and policies that regulate activities within or near riparian areas, these regulations by themselves to do not necessarily result in the conservation of riparian habitat. In many cases, existing laws regulate *activities* that may impact riparian habitats (e.g., the provincial *Water Act*), but do not regulate the habitats themselves. As a result, many of the existing laws result in approvals that allow for the removal or alteration of riparian areas under certain conditions outlined within the approval. In some cases, these regulations require compensation or replacement of impacted habitats (e.g., the Provincial wetland policy and the federal *Fisheries Act*), but typically, existing laws and policies do not prevent land development, and there is very little provision for riparian habitat conservation in existing laws and policies, particularly as it relates to federal and provincial regulation.

At the municipal level, most municipalities have environmental and land use legislation, policies, and guidelines that provide direction for how to target riparian habitats and other natural areas for conservation, as well as guidance for how to integrate these habitats into a neighbourhood post-development. However, there are only a small number of tools or mechanisms available that enable the *acquisition* of lands by the municipality (or a third party) for the purpose of conservation. In some cases, these tools are only available to municipalities at particular times during the development process (e.g., at subdivision). In other instances, there may be restrictions on the amount of land that municipalities can set aside for conservation, as natural area conservation must be considered alongside other land use demands, such as school and park sites. In many cases, municipalities may have undertaken an ecological inventory to identify high priority areas for conservation, and have the appropriate legislation or policies in place to manage these areas, but may lack the appropriate tools (or associated resources) to acquire high priority conservation areas.

One of the most effective conservation mechanisms for aquatic habitats within municipalities is the *Public Lands Act*. Pursuant to this legislation, the Province of Alberta owns the bed and shore of all permanent and naturally occurring waterbodies, including lakes, rivers, streams, and wetlands. Under this Act, all permanent and naturally occurring waterbodies are Crown land, and development must avoid these features. If development cannot be avoided, the Crown determines whether temporary construction or permanent occupation will be authorized, and in many cases, authorized activities that result in the loss of Crown land is subject to compensation. In the case of riparian habitats along streams and rivers and permanent wetlands, the determination of whether riparian areas are considered to be part of the Crown claimed waterbody is contingent on the existence of a legal survey, and the location of the water boundary that is determined by the surveyor, as per the *Surveyors Act*. In this regard there are known inconsistencies with respect to how surveyors determine the location of the water boundary, and this may or may not include riparian habitat.

The second provincial legislation that enables municipalities to develop and implement land conservation and stewardship tools is the *Alberta Land Stewardship Act* (ALSA). Under ALSA, the following tools may be utilized to conserve riparian areas in municipalities:

Conservation Easement:

A conservation easement is a voluntary contractual agreement between a private landowner and a qualified organization, such as a municipality, Land Trust organization, or conservation group. There are only three allowable purposes for a conservation easement under the *Alberta Land Stewardship Act*, and these include the protection, conservation and enhancement of 1) the environment, 2) natural scenic or aesthetic values, or 3) agricultural land or land for agricultural purposes. Under a conservation easement, the landowner retains title to the land, but certain land use rights are extinguished in the interest of conserving and protecting the land. The land use restrictions that apply to the property are negotiated and agreed to at the outset (for example, a restriction on subdivision), and the conservation easement (and the land use restrictions) are registered on title and are transferred to a new land owner if the land is sold. Conservation easements can be negotiated by a private land owner at any time, but the easement must be held by a qualified organization.

Conservation Directive:

A conservation directive allows the Alberta Government to identify private lands within a regional plan for the purpose of protection, conservation, or enhancement of environmental, natural scenic, or aesthetic values. Ownership of the lands is retained by the land owner, and the directive describes the precise nature and intended purpose for the protection, conservation, or enhancement of the lands. A conservation directive must be initiated by the provincial government, and to date, this tool remains largely untested (Environmental Law Centre 2015).

Conservation Offset:

A conservation offset is a tool that allows industry to offset the adverse environmental effects of their activities and development by supporting conservation activities and/or efforts on other lands. In order for conservation offsets to be effective, there must first be guidelines and rules for where offsets can be applied, and provisions for accountability, including monitoring and compliance. While conservation offsets are available as a tool for the conservation of natural areas in the Upper Beaver watershed, work would first have to be done to create a proper framework to create eligibility rules, pricing and bidding rules for selling and buying offsets, and rules for combining buyers and sellers.

Transfer of Development Credits (TDCs):

Transfer of development credits is a tool that creates and incentive to redirect development away from specific landscapes in order to conserve areas for agricultural or environmental purposes. This tool allows land development and conservation to occur at the same time, while also allowing owners of the developed and undeveloped lands to share in the financial benefits of the development activity. A TDC program can be used to designate lands as a conservation area for one or more of the following purposes:

- The protection, conservation and enhancement of the environment;
- The protection, conservation and enhancement of natural scenic or aesthetic values;
- The protection, conservation and enhancement of agricultural land or land for agricultural purposes;
- Providing for all or any of the following uses of the land that are consistent with the following purposes: recreational use, open space use, environmental education use, or use for research and scientific studies of natural ecosystems; and
- Designation as a Provincial Historic Resource or a Municipal Historic Resource under the *Historical Resources Act*.

Before TDCs can be used by municipalities as a conservation tool, they must be established through a regional plan, or they must be approved by the Provincial Government.

Outside of the conservation tools that have been created through the *Alberta Land Stewardship Act*, there are other mechanisms through which municipalities may acquire lands for conservation, most of which rely on voluntary conservation action taken by private land owners. These tools may be utilized at any time during the municipal planning and development process, and include:

Land Purchase:

Municipalities can purchase land from a private land owner at any time for the purpose of conservation. For example, the City of Edmonton established a Natural Areas Reserve Fund in 1999, with the purpose of using these funds to purchase and protect natural areas. While land purchase for conservation is an option that is available, many municipalities do not have the financial resources available to purchase lands within their municipal boundaries, as the market value for these lands can be very high.

Land Swap:

In some cases, a land developer may be willing to "swap" or exchange natural areas for other developable lands that are owned by the municipality. In this case, the municipality and developer enter into an agreement to exchange the lands, such that the natural areas can be conserved.

Land Donation:

Land donation involves the transfer of ownership from a private land owner to the municipality, or to a conservation organization or land trust, who would hold the land for conservation in perpetuity. Lands that are donated to a conservation organization or land trust are eligible for the federal government's Ecological Gifts program which provides donors with significant tax benefits.

The final set of conservation tools are directly available to municipalities, and are the most common and frequently used tools for acquiring riparian areas as part of land development and planning. However, these tools are enabled through the *Municipal Government Act*, which only gives municipalities the authority to use these tools at the time of subdivision. Thus, municipalities can only utilize these tools through formal land development and planning processes.

Environmental Reserve (ER):

Environmental Reserves are defined in the Act as waterbodies, watercourses, lands that are unstable or subject to flooding, and lands "not less than 6 metres in width abutting the bed and shore" of a waterbody or watercourse. While the Act allows municipalities to take a *minimum* of a 6 metre setback on Environmental Reserve lands (with no stated maximum), the conditions under which this taking is permitted is limited to cases where the setback is required to prevent pollution or provide public access to the bed and shore of the waterbody or watercourse. In addition, Section 640(4)(l) of the Act allows municipalities to establish development setbacks on lands subject to flooding, low lying or marshy areas, or within a specified distance to the bed and shore of any waterbody.

Environmental Reserve Easement:

In instances where the municipality and the landowner agree, Environmental Reserve lands may be designated as an Environmental Reserve Easement. An ER Easement serves the same purpose as ER, but differs in that the title of the reserve lands remains with the land owner; however, ER easements are registered on title by caveat in favour of the municipality.

Conservation Reserve:

Under Section 664.2(1), municipalities may designate an area as a Conservation Reserve if the area contains significant environmental features that are not required to be provided as Environmental Reserve. Under the Act, the purpose of taking the Conservation Reserve is to protect and conserve the significant environmental features in a manner that is consistent with other statutory planning documents. In designating a Conservation Reserve, the municipality must compensate the landowner in an amount that is equal to the market value at the time of the subdivision approval application.

8.3. Public Engagement

Public engagement is a critical component to the successful conservation and management of riparian areas. Without the support of the public, successful implementation of restoration and management programs are not possible. Further, many of the acquisition tools outlined above rely on voluntary participation by the public (e.g., land donations and conservation easement). Thus, ensuring that the public are aware of the various voluntary programs that exist for riparian habitat conservation, as well as formulating active partnerships that can capitalize on the public's willingness to participate in such programs, is critical to the conservation and restoration of riparian habitats. Public engagement can take several forms, including the following:

Education, Extension and Outreach:

Increasing public awareness and appreciation for natural areas is a critical component to effective conservation and management. Thus, creating educational opportunities and programs, as well as supporting local conservation and stewardship groups is critical to achieving desired riparian conservation and restoration objectives in the Upper Beaver watershed.

Partnerships:

Given the limited number of tools available to municipalities for the acquisition of riparian areas on private lands, engaging in strategic partnerships to promote voluntary land conservation and management activities is essential. Central to this is developing partnerships with land trusts and conservation organizations, developing strong inter-municipal policies, and partnerships with the provincial government to promote and enhance collaboration and improve conservation outcomes.

All of the tools outlined in this section are currently available to stakeholders in the Upper Beaver watershed for the purpose of conserving and managing riparian habitats; however, in order to focus management action in the watershed, it is essential that the LICA and its partners first define objectives and targets for the conservation, restoration, and management of riparian habitats. Once these objectives and targets have been outlined, specific action and the relevant tools associated with those actions can be identified. In some cases, there may be existing tools in place to achieve the desired management outcomes. In other cases, there may be gaps in the available tools, and new policies, partnerships, or programs may need to be developed in order to achieve the desired management objectives.

9.0 Conclusion

The overall goal of this project was to quantify and characterize the intactness of riparian management areas in the Upper Beaver watershed, and to further assess pressure on riparian system function by evaluating land use and land cover within local catchments immediately adjacent to the waterbodies included in this study. The results of this work provide the Lakeland Industry and Community Association, its stakeholders, and Indigenous peoples in the region with an overview of the status of riparian areas within the watershed, and further provides a foundation of scientific evidence upon which to build a systematic and adaptive framework for riparian habitat management.

In total, approximately 2,286 km of shoreline was assessed in the Upper Beaver watershed as part of this study. Results indicate that 85% of the shoreline assessed is either High (74%) or Moderate (11%) Intactness, with the remaining 15% of the shoreline classified as Very Low (10%) or Low (5%) Intactness. Within the Upper Beaver watershed, the greatest length of shoreline classified as Very Low or Low Intactness was located within the Upper Beaver subwatershed, and primarily within the jurisdictions of the MD of Bonnyville and the County of St Paul.

The next step in the advancement of meaningful riparian management and conservation in the Upper Beaver watershed will be to formalize a framework for action that includes defining achievable management outcomes and measurable targets, which can then be used to inform relevant collective action by key stakeholders and Indigenous peoples. These actions can then be monitored on a regular basis to provide an evaluation of outcomes that feed into an adaptive and reflexive approach to riparian management through time. Importantly, this study contributes to a larger riparian assessment initiative across central Alberta that has included a number of other Watershed Planning and Advisory Councils (North Saskatchewan Watershed Alliance, Battle River Watershed Alliance, Red Deer River Watershed Alliance, Lesser Slave Watershed Council), as well as the Government of Alberta. To date, this initiative has assessed over 40,000 km of shoreline in Alberta, and these riparian assessments will significantly advance watershed planning and stewardship activities within the Beaver River watershed, and elsewhere in the province.

9.1. Closure

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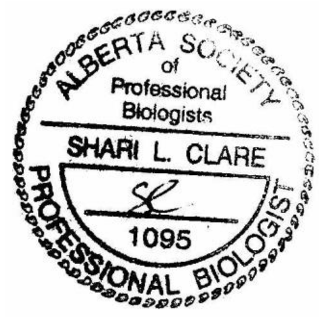
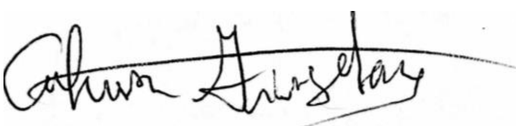


Shari Clare, PhD, PBiol
Director, Sr. Biologist

Shantel Koenig, MGIS, PhD
Sr. Landscape Ecologist and GIS Specialist



Calum Grimshaw, BSc
GIS Specialist

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Appendix A: Intactness & Prioritization Summary Tables

Table A- 1. Length (km) and proportion (%) of shoreline classified into each Intactness category, summarized by waterbody and jurisdiction.

Waterbody Name & Intersecting Jurisdiction	Length Assessed (km)*	Intactness Category							
		Very Low		Low		Moderate		High	
		km*	%	km*	%	km*	%	km*	%
Allday Lake	3.6	0.7	20	1.0	28	0.2	4	1.8	49
County of St. Paul	3.6	0.7	20	1.0	28	0.2	4	1.8	49
Amisk Lake	25.5	0.2	1	0.1	0	0.6	3	24.5	96
Athabasca County	25.5	0.2	1	0.1	0	0.6	3	24.5	96
Amisk Lake-01	28.2	0.2	1	0.1	0	0.2	1	27.7	98
Athabasca County	27.8	0.2	1	0.1	0	0.2	1	27.3	97
Thorhild County	0.4	0	0	0	0	0	0	0.4	1
Amisk Lake-02	9.7	0.1	1	0.4	4	0.1	1	9.2	94
Athabasca County	9.7	0.1	1	0.4	4	0.1	1	9.2	94
Amisk River	207.9	16.4	8	14.3	7	20.9	10	156.4	75
Athabasca County	47.0	2.9	1	2.3	1	7.1	3	34.7	17
Buffalo Lake Métis Settlement	3.0	0.1	0	0	0	0	0	2.9	1
Kikino Métis Settlement	85.6	9.5	5	10.6	5	10.3	5	55.3	27
Lac La Biche County	72.3	3.9	2	1.3	1	3.5	2	63.6	31
Amisk River-01	96.4	14.5	15	2.6	3	10.5	11	68.8	71
Athabasca County	29.1	13.7	14	0.6	1	1.9	2	12.9	13
Buffalo Lake Métis Settlement	62.9	0.8	1	2.0	2	8.7	9	51.4	53
Thorhild County	4.4	0	0	0	0	0	0	4.4	5
Amisk River-02	21.9	0.5	2	0.4	2	0.0	0	20.9	96
Buffalo Lake Métis Settlement	21.2	0.5	2	0.4	2	0.0	0	20.2	92
Lac La Biche County	0.7	0	0	0	0	0	0	0.7	3
Amisk River-03	35.3	0.5	1	0.9	3	0.4	1	33.5	95
Buffalo Lake Métis Settlement	15.5	0.4	1	0.4	1	0.3	1	14.5	41
Kikino Métis Settlement	19.8	0.1	0	0.6	2	0.1	0	19.1	54
Amisk River-04	15.7	3.9	25	0.5	3	0.2	1	11.1	71
Kikino Métis Settlement	10.6	3.7	24	0.2	1	0	0	6.7	43
Lac La Biche County	5.1	0.2	1	0.3	2	0.2	1	4.4	28
Amisk River-05	7.8	0.1	1	0.2	2	2.3	30	5.2	66
Athabasca County	7.8	0.1	1	0.2	2	2.3	30	5.2	66
Beaver Lake	74.8	1.5	2	1.2	2	1.0	1	71.1	95
Beaver Lake Cree Nation	13.5	0.3	0	0.4	1	0.3	0	12.7	17
Lac La Biche County	61.2	1.2	2	0.8	1	0.8	1	58.4	78
Beaver River	285.3	36.0	13	27.1	10	58.2	20	164.0	57
County of St. Paul	28.2	3.9	1	4.8	2	3.4	1	16.2	6
Lac La Biche County	166.0	20.0	7	6.7	2	25.1	9	114.3	40
MD of Bonnyville	91.1	12.1	4	15.6	5	29.8	10	33.6	12
Beaver River-01	11.5	2.8	24	0.5	5	1.0	9	7.2	62
County of St. Paul	11.5	2.8	24	0.5	5	1.0	9	7.2	62
Beaver River-02	38.3	1.4	4	2.3	6	3.7	10	31.0	81
County of St. Paul	7.2	0	0	0.0	0	0	0	7.2	19
MD of Bonnyville	31.1	1.4	4	2.2	6	3.7	10	23.8	62
Big Johnson Lake	11.3	0.0	0	0.2	1	0.2	2	10.9	97
Athabasca County	11.3	0.0	0	0.2	1	0.2	2	10.9	97
Buffalo Lake	16.6	0.5	3	1.0	6	0.1	1	15.0	90
Buffalo Lake Métis Settlement	16.6	0.5	3	1.0	6	0.1	1	15.0	90
Buffalo Lake-01	13.5	0.1	1	0.0	0	0.7	5	12.6	93
Buffalo Lake Métis Settlement	13.5	0.1	1	0.0	0	0.7	5	12.6	93
Buffalo Lake-02	39.2	0.5	1	1.2	3	2.6	7	34.9	89
Buffalo Lake Métis Settlement	39.2	0.5	1	1.2	3	2.6	7	34.9	89

Continued …

Waterbody Name & Intersecting Jurisdiction	Length Assessed (km)*	Intactness Category							
		Very Low		Low		Moderate		High	
		km*	%	km*	%	km*	%	km*	%
Bunder Creek	76.5	8.4	11	5.3	7	18.8	25	44.0	58
County of St. Paul	51.5	6.8	9	4.1	5	10.5	14	30.1	39
Whitefish Lake First Nation	25.0	1.6	2	1.2	2	8.3	11	14.0	18
Bunder Creek-01	8.7	2.3	27	0.4	4	2.5	29	3.4	39
Whitefish Lake First Nation	8.7	2.3	27	0.4	4	2.5	29	3.4	39
Bunder Creek-02	9.5	1.1	12	2.0	21	2.6	28	3.8	39
County of St. Paul	9.5	1.1	12	2.0	21	2.6	28	3.8	39
Bunder Lake	30.5	2.0	7	2.1	7	4.6	15	21.8	72
County of St. Paul	30.5	2.0	7	2.1	7	4.6	15	21.8	72
Cardinal Lake	5.3	0.2	3	0.4	7	0.1	1	4.7	89
County of St. Paul	5.3	0.2	3	0.4	7	0.1	1	4.7	89
Chappell Lake	8.2	0.3	4	0.9	11	0.5	6	6.6	80
County of St. Paul	8.2	0.3	4	0.9	11	0.5	6	6.6	80
Chota Lake	6.4	0.0	0	0.0	0	0.0	0	6.4	100
County of St. Paul	6.4	0.0	0	0.0	0	0.0	0	6.4	100
Cole Lake	9.2	1.5	16	3.9	42	0.0	0	3.8	41
County of St. Paul	9.2	1.5	16	3.9	42	0.0	0	3.8	41
Columbine Creek	80.5	18.8	23	6.5	8	19.2	24	36.0	45
MD of Bonnyville	80.5	18.8	23	6.5	8	19.2	24	36.0	45
Denning Lake	8.2	1.8	22	0.6	8	0.9	11	4.9	59
County of St. Paul	8.2	1.8	22	0.6	8	0.9	11	4.9	59
Elinor Lake	29.0	0.1	0	0.0	0	0.2	1	28.8	99
Lac La Biche County	29.0	0.1	0	0.0	0	0.2	1	28.8	99
Figure Lake	8.1	0.0	0	0.0	0	0.0	0	8.1	100
Thorhild County	8.1	0.0	0	0.0	0	0.0	0	8.1	100
Floatingstone Lake	17.4	1.4	8	1.8	10	1.3	7	13.0	74
County of St. Paul	17.4	1.4	8	1.8	10	1.3	7	13.0	74
Floatingstone Lake-01	10.5	3.3	32	1.5	14	3.5	33	2.2	21
County of St. Paul	10.5	3.3	32	1.5	14	3.5	33	2.2	21
Fork Creek	16.0	0.5	3	0.3	2	0.4	2	14.9	93
County of St. Paul	2.4	0	0	0	0	0	0	2.4	15
Lac La Biche County	13.5	0.5	3	0.3	2	0.4	2	12.5	78
Fork Lake	28.2	0.8	3	0.2	1	4.6	16	22.6	80
Lac La Biche County	28.2	0.8	3	0.2	1	4.6	16	22.6	80
Garner Lake	16.6	2.4	15	2.2	13	1.8	11	10.2	61
County of St. Paul	7.6	0.6	3	0.5	3	0.9	5	5.7	34
Smoky Lake County	9.0	1.9	11	1.7	10	0.9	5	4.5	27
Goodfish Lake	16.5	0.0	0	0.0	0	0.0	0	16.5	100
Smoky Lake County	10.3	0	0	0	0	0	0	10.3	62
Whitefish Lake First Nation	6.2	0.0	0	0.0	0	0.0	0	6.2	38
Goodfish Lake-01	22.6	0.2	1	0.4	2	0.1	1	21.9	97
Smoky Lake County	22.6	0.2	1	0.4	2	0.1	1	21.9	97
Greenstreet Lake	7.9	0.0	0	1.0	12	1.6	20	5.4	68
County of St. Paul	7.9	0.0	0	1.0	12	1.6	20	5.4	68
Little Beaver Lake	9.4	0.0	0	0.0	0	0.0	0	9.4	100
Buffalo Lake Métis Settlement	0.4	0	0	0	0	0	0	0.4	4
Lac La Biche County	9.0	0.0	0	0.0	0	0.0	0	9.0	96
Little Garner Lake	4.1	2.2	53	0.8	19	0.1	1	1.1	27
County of St. Paul	4.1	2.2	53	0.8	19	0.1	1	1.1	27
Lone Pine Lake	8.3	1.2	14	0.6	8	0.5	6	6.0	73
Kikino Métis Settlement	8.3	1.2	14	0.6	8	0.5	6	6.0	73
Lone Pine Lake-01	7.4	0.3	3	0.3	4	1.0	13	5.9	80
Kikino Métis Settlement	7.4	0.3	3	0.3	4	1.0	13	5.9	80

Continued …

Waterbody Name & Intersecting Jurisdiction	Length Assessed (km)*	Intactness Category							
		Very Low		Low		Moderate		High	
		km*	%	km*	%	km*	%	km*	%
Long Lake	30.5	1.0	3	0.5	2	1.6	5	27.4	90
Thorhild County	30.5	1.0	3	0.5	2	1.6	5	27.4	90
Long Lake-01	9.2	0.0	0	0.0	0	0.0	0	9.2	100
Thorhild County	9.2	0.0	0	0.0	0	0.0	0	9.2	100
Long Lake-02	7.5	0.3	4	0.2	2	0.1	1	7.0	93
Thorhild County	7.5	0.3	4	0.2	2	0.1	1	7.0	93
Long Lake-03	3.9	0.1	2	0.4	10	0.1	2	3.3	85
Thorhild County	3.9	0.1	2	0.4	10	0.1	2	3.3	85
Lower Mann Lake	19.0	0.2	1	1.6	9	0.6	3	16.6	87
County of St. Paul	19.0	0.2	1	1.6	9	0.6	3	16.6	87
McCullough Lake	5.4	0.0	0	0.0	0	0.0	0	5.4	100
County of St. Paul	5.4	0.0	0	0.0	0	0.0	0	5.4	100
Mooselake River	0.2	0.0	0	0.0	0	0.1	41	0.1	59
MD of Bonnyville	0.2	0.0	0	0.0	0	0.1	41	0.1	59
Norberg Lake	15.9	1.2	7	0.0	0	0.4	2	14.4	90
County of St. Paul	15.9	1.2	7	0.0	0	0.4	2	14.4	90
North Buck Lake	49.2	0.9	2	1.0	2	2.2	4	45.1	92
Athabasca County	49.2	0.9	2	1.0	2	2.2	4	45.1	92
North Buck Lake-01	2.4	0.0	2	0.0	1	0.0	0	2.3	97
Athabasca County	2.4	0.0	2	0.0	1	0.0	0	2.3	97
Outlet Lake	5.6	0.0	0	0.0	0	0.0	0	5.6	100
Lac La Biche County	5.6	0.0	0	0.0	0	0.0	0	5.6	100
Owlseye Lake	6.7	0.5	7	2.1	31	1.3	20	2.8	42
County of St. Paul	6.7	0.5	7	2.1	31	1.3	20	2.8	42
Reed Lake	20.1	12.2	61	1.3	7	1.8	9	4.8	24
County of St. Paul	1.5	1.0	5	0.0	0	0.3	1	0.2	1
Smoky Lake County	9.5	6.3	31	0	0	0.2	1	3.0	15
Whitefish Lake First Nation	9.1	4.9	25	1.3	6	1.2	6	1.6	8
Saturday Lake	3.7	0.0	0	0.0	0	0.0	0	3.7	100
Thorhild County	3.7	0.0	0	0.0	0	0.0	0	3.7	100
Skeleton Lake	24.8	1.0	4	2.2	9	4.5	18	17.1	69
Athabasca County	24.8	1.0	4	2.2	9	4.5	18	17.1	69
Snail Lake	6.7	1.7	25	0.3	5	0.1	2	4.6	68
County of St. Paul	6.7	1.7	25	0.3	5	0.1	2	4.6	68
St. Lina Creek	89.4	10.3	12	6.8	8	27.2	30	45.0	50
County of St. Paul	89.4	10.3	12	6.8	8	27.2	30	45.0	50
St. Lina Creek-01	7.3	0.6	8	0.4	6	0.9	13	5.4	74
County of St. Paul	7.3	0.6	8	0.4	6	0.9	13	5.4	74
St. Lina Creek-02	20.6	9.2	45	2.1	10	4.5	22	4.8	24
County of St. Paul	20.6	9.2	45	2.1	10	4.5	22	4.8	24
St. Lina Creek-03	13.3	7.2	54	2.1	16	2.9	22	1.1	8
County of St. Paul	13.3	7.2	54	2.1	16	2.9	22	1.1	8
Tompkins Lake	4.5	0.0	0	0.0	0	0.0	0	4.5	100
County of St. Paul	4.5	0.0	0	0.0	0	0.0	0	4.5	100
UL-120101-01	4.3	0.0	0	0.0	0	0.0	0	4.3	100
Thorhild County	4.3	0.0	0	0.0	0	0.0	0	4.3	100
UL-120101-02	8.7	0.0	0	0.0	0	0.0	0	8.7	100
Thorhild County	8.7	0.0	0	0.0	0	0.0	0	8.7	100
UL-120101-02-US01	3.9	0.0	0	0.0	1	0.0	1	3.8	98
Thorhild County	3.9	0.0	0	0.0	1	0.0	1	3.8	98
UL-120101-03	10.3	0.0	0	0.0	0	0.0	0	10.3	100
Thorhild County	10.3	0.0	0	0.0	0	0.0	0	10.3	100

Continued …

Waterbody Name & Intersecting Jurisdiction	Length Assessed (km)*	Intactness Category							
		Very Low		Low		Moderate		High	
		km*	%	km*	%	km*	%	km*	%
UL-120101-03-US01	6.3	0.0	0	0.0	0	0.0	0	6.3	100
Thorhild County	6.3	0.0	0	0.0	0	0.0	0	6.3	100
UL-120101-04	3.4	0.0	0	0.0	0	0.0	0	3.4	100
Buffalo Lake Métis Settlement	1.7	0	0	0	0	0	0	1.7	49
Smoky Lake County	1.7	0.0	0	0.0	0	0.0	0	1.7	51
UL-120101-05	7.1	0.1	1	0.0	0	0.0	0	7.0	99
Buffalo Lake Métis Settlement	2.9	0.1	1	0	0	0	0	2.8	40
Smoky Lake County	4.2	0	0	0.0	0	0.0	0	4.2	59
UL-120101-06	8.8	0.0	0	0.0	0	0.0	0	8.8	100
Buffalo Lake Métis Settlement	8.8	0.0	0	0.0	0	0.0	0	8.8	100
UL-120101-06-US01	2.3	0.1	6	0.0	0	0.0	0	2.2	94
Buffalo Lake Métis Settlement	0.1	0	0	0	0	0	0	0.1	3
Smoky Lake County	2.2	0.1	6	0.0	0	0.0	0	2.1	91
UL-120101-06-US02	2.2	0.0	0	0.1	3	0.0	0	2.2	97
Buffalo Lake Métis Settlement	2.2	0.0	0	0.1	3	0	0	2.2	97
Smoky Lake County	0.0	0	0	0	0	0.0	0	0.0	0
UL-120101-07	5.1	0.0	0	0.0	0	0.0	0	5.1	100
Smoky Lake County	5.1	0.0	0	0.0	0	0.0	0	5.1	100
UL-120101-08	4.2	0.0	0	0.0	0	0.0	0	4.2	100
Buffalo Lake Métis Settlement	4.2	0.0	0	0.0	0	0.0	0	4.2	100
UL-120101-09	9.6	1.0	11	0.0	0	0.0	0	8.5	89
Buffalo Lake Métis Settlement	9.6	1.0	11	0.0	0	0.0	0	8.5	89
UL-120101-10	9.7	0.0	0	0.1	1	0.4	4	9.2	94
Buffalo Lake Métis Settlement	9.7	0.0	0	0.1	1	0.4	4	9.2	94
UL-120101-11	9.7	0.0	0	0.0	0	0.0	0	9.7	100
Buffalo Lake Métis Settlement	9.7	0.0	0	0.0	0	0.0	0	9.7	100
UL-120101-12	5.1	0.0	1	0.0	0	0.0	0	5.1	99
Buffalo Lake Métis Settlement	5.1	0.0	1	0.0	0	0.0	0	5.1	99
UL-120101-13	7.7	0.0	0	0.0	0	0.0	0	7.7	100
Buffalo Lake Métis Settlement	1.0	0	0	0	0	0	0	1.0	13
Kikino Métis Settlement	6.8	0.0	0	0.0	0	0.0	0	6.8	87
UL-120101-14	5.1	0.0	0	0.0	0	0.0	0	5.1	100
Kikino Métis Settlement	5.1	0.0	0	0.0	0	0.0	0	5.1	100
UL-120101-15	6.0	0.4	7	0.3	5	0.3	5	5.0	83
Kikino Métis Settlement	6.0	0.4	7	0.3	5	0.3	5	5.0	83
UL-120101-16	3.4	0.0	0	0.0	0	0.0	0	3.4	100
Smoky Lake County	3.4	0.0	0	0.0	0	0.0	0	3.4	100
UL-120101-17	2.9	0.0	0	0.0	0	0.0	0	2.9	100
Smoky Lake County	2.9	0.0	0	0.0	0	0.0	0	2.9	100
UL-120101-18	6.1	0.2	3	0.0	0	0.0	1	5.9	95
Kikino Métis Settlement	6.1	0.2	3	0.0	0	0.0	1	5.9	95
UL-120101-19	5.1	1.9	36	0.2	4	0.0	1	3.0	59
Kikino Métis Settlement	5.1	1.9	36	0.2	4	0.0	1	3.0	59
UL-120101-20	5.1	0.0	0	0.0	0	0.0	0	5.1	100
Kikino Métis Settlement	5.1	0.0	0	0.0	0	0.0	0	5.1	100
UL-120101-21	8.3	0.0	0	0.0	0	0.0	0	8.3	100
Smoky Lake County	8.3	0.0	0	0.0	0	0.0	0	8.3	100
UL-120101-22	7.3	0.0	0	0.0	0	0.4	6	6.8	94
Kikino Métis Settlement	7.3	0.0	0	0.0	0	0.4	6	6.8	94
UL-120101-23	3.5	0.0	0	0.0	0	0.0	1	3.5	99
Kikino Métis Settlement	3.5	0.0	0	0.0	0	0.0	1	3.5	99

Continued …

Waterbody Name & Intersecting Jurisdiction	Length Assessed (km)*	Intactness Category							
		Very Low		Low		Moderate		High	
		km*	%	km*	%	km*	%	km*	%
UL-120101-24	4.8	0.3	7	0.0	0	0.0	0	4.4	93
Kikino Métis Settlement	3.9	0.3	6	0	0	0	0	3.6	75
Smoky Lake County	0.9	0.0	1	0.0	0	0.0	0	0.9	18
UL-120101-24-US01	29.8	0.7	2	0.7	2	1.3	4	27.0	91
Kikino Métis Settlement	23.8	0.7	2	0.5	2	0.7	2	22.0	74
Smoky Lake County	6.0	0.1	0	0.2	1	0.6	2	5.0	17
UL-120101-25	2.5	2.1	83	0.3	13	0.1	4	0.0	0
Whitefish Lake First Nation	2.5	2.1	83	0.3	13	0.1	4	0.0	0
UL-120101-26	3.3	0.0	0	0.0	0	0.0	0	3.3	100
County of St. Paul	3.3	0.0	0	0.0	0	0.0	0	3.3	100
UL-120101-26-US01	0.7	0.0	0	0.0	0	0.0	0	0.7	100
County of St. Paul	0.7	0.0	0	0.0	0	0.0	0	0.7	100
UL-120101-27	4.3	0.1	1	0.1	1	0.8	20	3.3	78
County of St. Paul	4.3	0.1	1	0.1	1	0.8	20	3.3	78
UL-120101-27-US01	18.1	4.3	24	2.0	11	6.2	34	5.6	31
County of St. Paul	18.1	4.3	24	2.0	11	6.2	34	5.6	31
UL-120101-28	3.0	0.0	0	0.0	0	0.0	0	3.0	100
County of St. Paul	3.0	0.0	0	0.0	0	0.0	0	3.0	100
UL-120101-29	3.8	0.0	0	0.0	0	0.0	0	3.8	100
County of St. Paul	3.8	0.0	0	0.0	0	0.0	0	3.8	100
UL-120101-29-US01	10.3	1.6	16	1.2	11	0.6	6	6.9	67
County of St. Paul	10.3	1.6	16	1.2	11	0.6	6	6.9	67
UL-120101-30	4.1	0.0	0	0.0	0	0.0	0	4.1	100
County of St. Paul	4.1	0.0	0	0.0	0	0.0	0	4.1	100
UL-120101-31	3.5	0.2	5	0.0	0	0.0	0	3.4	95
County of St. Paul	3.5	0.2	5	0.0	0	0.0	0	3.4	95
UL-120101-32	3.8	0.0	0	0.0	0	0.0	1	3.8	99
County of St. Paul	3.8	0.0	0	0.0	0	0.0	1	3.8	99
UL-120101-33	3.0	2.6	88	0.0	0	0.1	4	0.2	8
County of St. Paul	3.0	2.6	88	0.0	0	0.1	4	0.2	8
UL-120101-34	8.7	2.1	24	0.5	6	0.7	7	5.4	62
County of St. Paul	8.7	2.1	24	0.5	6	0.7	7	5.4	62
UL-120101-35	3.3	0.1	2	0.4	11	0.0	0	2.9	87
County of St. Paul	3.3	0.1	2	0.4	11	0.0	0	2.9	87
UL-120101-36	3.3	0.1	2	0.0	0	0.1	2	3.1	96
County of St. Paul	3.3	0.1	2	0.0	0	0.1	2	3.1	96
UL-120101-37	3.2	0.1	2	0.0	0	0.0	0	3.1	98
County of St. Paul	3.2	0.1	2	0.0	0	0.0	0	3.1	98
UL-120101-38	4.5	0.1	3	0.1	2	0.0	0	4.3	95
County of St. Paul	4.5	0.1	3	0.1	2	0.0	0	4.3	95
UL-120101-39	3.6	0.7	18	0.0	0	0.1	1	2.9	80
County of St. Paul	3.6	0.7	18	0.0	0	0.1	1	2.9	80
UL-120101-40	4.8	1.5	32	0.3	5	0.3	6	2.7	56
County of St. Paul	4.8	1.5	32	0.3	5	0.3	6	2.7	56
UL-120101-41	5.6	1.3	24	0.2	3	1.1	19	3.0	54
County of St. Paul	5.6	1.3	24	0.2	3	1.1	19	3.0	54
UL-120101-42	4.9	1.9	38	0.4	7	1.2	25	1.4	30
County of St. Paul	4.9	1.9	38	0.4	7	1.2	25	1.4	30
UL-120101-43	3.4	3.0	88	0.3	8	0.0	0	0.2	5
County of St. Paul	3.4	3.0	88	0.3	8	0.0	0	0.2	5
UL-120101-44	2.9	0.0	0	0.0	0	0.0	0	2.9	100
Smoky Lake County	0.5	0	0	0	0	0	0	0.5	17
Thorhild County	2.4	0.0	0	0.0	0	0.0	0	2.4	83

Continued …

Waterbody Name & Intersecting Jurisdiction	Length Assessed (km)*	Intactness Category							
		Very Low		Low		Moderate		High	
		km*	%	km*	%	km*	%	km*	%
UL-120101-45	3.7	2.9	77	0.0	0	0.0	0	0.9	23
Smoky Lake County	3.7	2.9	77	0.0	0	0.0	0	0.9	23
UL-120101-46	16.6	0.1	1	0.0	0	0.2	1	16.4	98
Lac La Biche County	16.6	0.1	1	0.0	0	0.2	1	16.4	98
Upper Mann Lake	17.3	0.2	1	0.5	3	1.9	11	14.6	85
County of St. Paul	17.3	0.2	1	0.5	3	1.9	11	14.6	85
Victor Lake	4.6	0.9	19	0.3	6	0.0	0	3.4	75
Kikino Métis Settlement	4.6	0.9	19	0.3	6	0.0	0	3.4	75
Victor Lake-01	21.7	4.7	22	0.9	4	2.0	9	14.0	65
Kikino Métis Settlement	21.7	4.7	22	0.9	4	2.0	9	14.0	65
Wayetenaw Lake	4.4	0.0	0	0.0	0	0.0	0	4.4	100
Smoky Lake County	3.9	0	0	0	0	0	0	3.9	89
Whitefish Lake First Nation	0.5	0.0	0	0.0	0	0.0	0	0.5	11
Whiskyjack Lake	6.7	0.5	8	0.0	0	0.0	0	6.1	92
County of St. Paul	6.7	0.5	8	0.0	0	0.0	0	6.1	92
Whitefish Creek	54.0	3.9	7	2.4	5	7.2	13	40.5	75
Kikino Métis Settlement	28.5	3.8	7	2.3	4	5.3	10	17.1	32
Lac La Biche County	19.5	0.1	0	0.1	0	0	0	19.3	36
Whitefish Lake First Nation	6.0	0.0	0	0	0	1.9	3	4.1	8
Whitefish Creek-01	4.8	0.7	15	1.9	41	1.2	24	0.9	19
Kikino Métis Settlement	4.8	0.7	15	1.9	41	1.2	24	0.9	19
Whitefish Creek-02	74.7	5.7	8	4.6	6	1.7	2	62.7	84
Buffalo Lake Métis Settlement	1.9	0	0	0	0	0	0	1.9	3
Kikino Métis Settlement	72.2	5.7	8	4.6	6	1.7	2	60.3	81
Smoky Lake County	0.6	0	0	0.0	0	0	0	0.5	1
Whitefish Creek-03	14.4	2.1	14	0.4	3	1.6	11	10.4	72
County of St. Paul	4.2	1.3	9	0.1	1	0.1	0	2.7	19
Lac La Biche County	10.2	0.8	5	0.3	2	1.6	11	7.6	53
Whitefish Lake	26.9	2.0	7	1.1	4	1.3	5	22.6	84
Kikino Métis Settlement	6.6	0.6	2	0.4	2	0.2	1	5.4	20
Lac La Biche County	6.0	0	0	0	0	0.0	0	6.0	22
Smoky Lake County	6.5	0.9	3	0.6	2	0.7	3	4.3	16
Whitefish Lake First Nation	7.8	0.5	2	0.0	0	0.4	1	6.9	26

*NOTE: All jurisdictional data summaries were generated by using a spatial intersect rule in ArcGIS. Summarizing the data in this way captures the assessed shorelines that fall within the jurisdiction's boundary; however, it should be noted that there are spatial discrepancies between the jurisdictional boundary data and the provincial hydrography data that are freely available from AltaLIS. As a result, the jurisdictional summaries of shoreline length for intactness and priority are approximate and should be considered estimates that reflect relative differences between jurisdictions.

Table A- 2. Length (km) and proportion (%) of shoreline classified into each prioritization category, summarized by waterbody and jurisdiction.

Waterbody Name & Intersecting Jurisdiction	Length Assessed (km)*	Prioritization Category: High Restoration		Moderate Restoration		Moderate Conservation		High Conservation	
		km*	%	km*	%	km*	%	km*	%
Allday Lake	3.6	1.7	47	0.0	0	1.9	53	0.0	0
County of St. Paul	3.6	1.7	47	0.0	0	1.9	53	0.0	0
Amisk Lake	25.4	0.3	1	0.0	0	1.6	6	23.5	92
Athabasca County	25.4	0.3	1	0.0	0	1.6	6	23.5	92
Amisk Lake-01	28.2	0.2	1	0.1	0	0.2	1	27.7	98
Athabasca County	27.8	0.2	1	0.1	0	0.2	1	27.3	97
Thorhild County	0.4	0	0	0	0	0	0	0.4	1
Amisk Lake-02	9.7	0.2	2	0.3	3	2.4	25	6.8	70
Athabasca County	9.7	0.2	2	0.3	3	2.4	25	6.8	70
Amisk River	208.0	22.4	11	8.3	4	37.8	18	139.5	67
Athabasca County	47.0	3.5	2	1.8	1	8.3	4	33.5	16
Buffalo Lake Métis Settlement	3.0	0.1	0	0.1	0	0	0	2.9	1
Kikino Métis Settlement	85.6	14.0	7	6.1	3	14.3	7	51.3	25
Lac La Biche County	72.3	4.9	2	0.4	0	15.3	7	51.8	25
Amisk River-01	96.4	14.4	15	2.6	3	6.6	7	72.7	75
Athabasca County	29.0	14.1	15	0.2	0	1.9	2	12.9	13
Buffalo Lake Métis Settlement	62.9	0.4	0	2.4	3	4.8	5	55.3	57
Thorhild County	4.4	0	0	0	0	0	0	4.4	5
Amisk River-02	21.9	0.0	0	0.9	4	0.0	0	21.0	96
Buffalo Lake Métis Settlement	21.2	0.0	0	0.9	4	0	0	20.3	93
Lac La Biche County	0.7	0	0	0	0	0.0	0	0.7	3
Amisk River-03	35.3	0.0	0	1.3	4	0.1	0	33.9	96
Buffalo Lake Métis Settlement	15.5	0	0	0.8	2	0	0	14.8	42
Kikino Métis Settlement	19.8	0.0	0	0.6	2	0.1	0	19.1	54
Amisk River-04	15.7	3.9	25	0.5	3	0.0	0	11.3	72
Kikino Métis Settlement	10.6	3.7	24	0.2	1	0	0	6.7	43
Lac La Biche County	5.1	0.2	1	0.3	2	0.0	0	4.6	29
Amisk River-05	7.8	0.1	1	0.2	2	2.3	30	5.2	66
Athabasca County	7.8	0.1	1	0.2	2	2.3	30	5.2	66
Beaver Lake	74.4	1.5	2	1.1	1	1.0	1	70.9	95
Beaver Lake Cree Nation	13.5	0.3	0	0.4	1	0.3	0	12.7	17
Lac La Biche County	60.9	1.2	2	0.7	1	0.8	1	58.2	78
Beaver River	285.3	47.1	17	16.0	6	77.0	27	145.2	51
County of St. Paul	28.2	7.3	3	1.4	0	4.7	2	14.9	5
Lac La Biche County	166.0	21.5	8	5.2	2	31.8	11	107.5	38
MD of Bonnyville	91.1	18.3	6	9.5	3	40.6	14	22.8	8
Beaver River-01	11.5	3.3	29	0.0	0	8.2	71	0.0	0
County of St. Paul	11.5	3.3	29	0.0	0	8.2	71	0.0	0
Beaver River-02	38.3	2.8	7	0.8	2	12.6	33	22.1	58
County of St. Paul	7.2	0	0	0.0	0	0.2	0	7.0	18
MD of Bonnyville	31.1	2.8	7	0.8	2	12.4	32	15.1	39
Big Johnson Lake	11.3	0.0	0	0.2	1	0.0	0	11.1	99
Athabasca County	11.3	0.0	0	0.2	1	0.0	0	11.1	99
Buffalo Lake	16.6	0.5	3	1.0	6	0.1	1	15.0	90
Buffalo Lake Métis Settlement	16.6	0.5	3	1.0	6	0.1	1	15.0	90
Buffalo Lake-01	13.5	0.1	0	0.1	1	0.0	0	13.4	99
Buffalo Lake Métis Settlement	13.5	0.1	0	0.1	1	0.0	0	13.4	99
Buffalo Lake-02	39.2	0.4	1	1.2	3	2.6	7	34.9	89
Buffalo Lake Métis Settlement	39.2	0.4	1	1.2	3	2.6	7	34.9	89

Continued …

Waterbody Name & Intersecting Jurisdiction	Length Assessed (km)*	High Restoration		Moderate Restoration		Moderate Conservation		High Conservation	
		km*	%	km*	%	km*	%	km*	%
Bunder Creek	76.5	12.6	17	1.0	1	47.8	62	15.0	20
County of St. Paul	51.5	10.7	14	0.2	0	31.2	41	9.3	12
Whitefish Lake First Nation	25.0	1.9	2	0.8	1	16.6	22	5.7	7
Bunder Creek-01	8.7	2.3	27	0.4	4	2.5	29	3.4	39
Whitefish Lake First Nation	8.7	2.3	27	0.4	4	2.5	29	3.4	39
Bunder Creek-02	9.5	2.2	23	0.9	10	3.6	37	2.8	29
County of St. Paul	9.5	2.2	23	0.9	10	3.6	37	2.8	29
Bunder Lake	30.5	3.1	10	1.1	3	7.3	24	19.0	62
County of St. Paul	30.5	3.1	10	1.1	3	7.3	24	19.0	62
Cardinal Lake	5.3	0.5	10	0.0	0	4.7	90	0.0	0
County of St. Paul	5.3	0.5	10	0.0	0	4.7	90	0.0	0
Chappell Lake	8.2	1.2	15	0.0	0	5.9	72	1.1	14
County of St. Paul	8.2	1.2	15	0.0	0	5.9	72	1.1	14
Chota Lake	6.4	0.0	0	0.0	0	0.0	0	6.4	100
County of St. Paul	6.4	0.0	0	0.0	0	0.0	0	6.4	100
Cole Lake	9.2	1.5	16	3.9	42	0.0	0	3.8	41
County of St. Paul	9.2	1.5	16	3.9	42	0.0	0	3.8	41
Columbine Creek	80.5	24.6	31	0.7	1	38.6	48	16.6	21
MD of Bonnyville	80.5	24.6	31	0.7	1	38.6	48	16.6	21
Denning Lake	8.2	1.8	22	0.6	8	0.9	11	4.9	59
County of St. Paul	8.2	1.8	22	0.6	8	0.9	11	4.9	59
Elinor Lake	29.0	0.1	0	0.0	0	0.2	1	28.8	99
Lac La Biche County	29.0	0.1	0	0.0	0	0.2	1	28.8	99
Figure Lake	8.1	0.0	0	0.0	0	0.0	0	8.1	100
Thorhild County	8.1	0.0	0	0.0	0	0.0	0	8.1	100
Floatingstone Lake	17.4	2.3	13	0.9	5	10.8	62	3.4	19
County of St. Paul	17.4	2.3	13	0.9	5	10.8	62	3.4	19
Floatingstone Lake-01	10.5	4.8	46	0.0	0	5.7	54	0.0	0
County of St. Paul	10.5	4.8	46	0.0	0	5.7	54	0.0	0
Fork Creek	16.0	0.6	4	0.1	1	8.0	50	7.3	46
County of St. Paul	2.4	0	0	0	0	1.2	8	1.2	8
Lac La Biche County	13.5	0.6	4	0.1	1	6.8	42	6.1	38
Fork Lake	28.2	0.8	3	0.2	1	8.4	30	18.8	67
Lac La Biche County	28.2	0.8	3	0.2	1	8.4	30	18.8	67
Garner Lake	16.6	4.6	28	0.0	0	11.9	72	0.0	0
County of St. Paul	7.6	1.0	6	0	0	6.6	40	0.0	0
Smoky Lake County	9.0	3.6	22	0.0	0	5.4	32	0	0
Goodfish Lake	16.5	0.0	0	0.0	0	0.0	0	16.5	100
Smoky Lake County	10.3	0	0	0	0	0	0	10.3	62
Whitefish Lake First Nation	6.2	0.0	0	0.0	0	0.0	0	6.2	38
Goodfish Lake-01	22.6	0.2	1	0.4	2	0.1	1	21.9	97
Smoky Lake County	22.6	0.2	1	0.4	2	0.1	1	21.9	97
Greenstreet Lake	7.9	0.0	0	1.0	12	1.6	20	5.4	68
County of St. Paul	7.9	0.0	0	1.0	12	1.6	20	5.4	68
Little Beaver Lake	9.4	0.0	0	0.0	0	0.0	0	9.4	100
Buffalo Lake Métis Settlement	0.4	0	0	0	0	0	0	0.4	4
Lac La Biche County	9.0	0.0	0	0.0	0	0.0	0	9.0	96
Little Garner Lake	4.1	2.9	72	0.0	0	1.2	28	0.0	0
County of St. Paul	4.1	2.9	72	0.0	0	1.2	28	0.0	0
Lone Pine Lake	8.3	1.2	14	0.6	8	1.4	17	5.1	62
Kikino Métis Settlement	8.3	1.2	14	0.6	8	1.4	17	5.1	62

Continued …

Waterbody Name & Intersecting Jurisdiction	Length Assessed (km)*	High Restoration		Moderate Restoration		Moderate Conservation		High Conservation	
		km*	%	km*	%	km*	%	km*	%
Lone Pine Lake-01	7.4	0.3	3	0.3	4	1.0	13	5.9	80
Kikino Métis Settlement	7.4	0.3	3	0.3	4	1.0	13	5.9	80
Long Lake	30.5	1.0	3	0.5	2	1.6	5	27.4	90
Thorhild County	30.5	1.0	3	0.5	2	1.6	5	27.4	90
Long Lake-01	9.2	0.0	0	0.0	0	0.0	0	9.2	100
Thorhild County	9.2	0.0	0	0.0	0	0.0	0	9.2	100
Long Lake-02	7.5	0.3	4	0.2	2	0.1	1	7.0	93
Thorhild County	7.5	0.3	4	0.2	2	0.1	1	7.0	93
Long Lake-03	3.9	0.1	2	0.4	10	0.1	2	3.3	85
Thorhild County	3.9	0.1	2	0.4	10	0.1	2	3.3	85
Lower Mann Lake	19.0	1.3	7	0.5	3	4.3	23	12.9	68
County of St. Paul	19.0	1.3	7	0.5	3	4.3	23	12.9	68
McCullough Lake	5.4	0.0	0	0.0	0	5.4	100	0.0	0
County of St. Paul	5.4	0.0	0	0.0	0	5.4	100	0.0	0
Mooselake River	0.2	0.0	0	0.0	0	0.1	41	0.1	59
MD of Bonnyville	0.2	0.0	0	0.0	0	0.1	41	0.1	59
Norberg Lake	15.9	1.2	7	0.0	0	5.8	36	8.9	56
County of St. Paul	15.9	1.2	7	0.0	0	5.8	36	8.9	56
North Buck Lake	49.2	0.9	2	1.0	2	3.7	8	43.6	89
Athabasca County	49.2	0.9	2	1.0	2	3.7	8	43.6	89
North Buck Lake-01	2.4	0.0	0	0.1	3	0.0	0	2.3	97
Athabasca County	2.4	0.0	0	0.1	3	0.0	0	2.3	97
Outlet Lake	5.6	0.0	0	0.0	0	0.0	0	5.6	100
Lac La Biche County	5.6	0.0	0	0.0	0	0.0	0	5.6	100
Owlseye Lake	6.7	2.6	38	0.0	0	4.1	62	0.0	0
County of St. Paul	6.7	2.6	38	0.0	0	4.1	62	0.0	0
Reed Lake	20.1	13.5	67	0.0	0	3.5	17	3.1	16
County of St. Paul	1.5	1.1	5	0	0	0.3	2	0.1	0
Smoky Lake County	9.5	6.3	31	0	0	0.2	1	3.0	15
Whitefish Lake First Nation	9.1	6.2	31	0.0	0	2.9	14	0	0
Saturday Lake	3.7	0.0	0	0.0	0	0.0	0	3.7	100
Thorhild County	3.7	0.0	0	0.0	0	0.0	0	3.7	100
Skeleton Lake	24.8	1.4	5	1.9	8	4.5	18	17.1	69
Athabasca County	24.8	1.4	5	1.9	8	4.5	18	17.1	69
Snail Lake	6.7	2.0	30	0.0	0	4.7	70	0.0	0
County of St. Paul	6.7	2.0	30	0.0	0	4.7	70	0.0	0
St. Lina Creek	89.4	16.6	19	0.6	1	68.3	76	3.9	4
County of St. Paul	89.4	16.6	19	0.6	1	68.3	76	3.9	4
St. Lina Creek-01	7.3	1.0	13	0.0	0	6.3	87	0.0	0
County of St. Paul	7.3	1.0	13	0.0	0	6.3	87	0.0	0
St. Lina Creek-02	20.6	11.2	55	0.0	0	9.3	45	0.0	0
County of St. Paul	20.6	11.2	55	0.0	0	9.3	45	0.0	0
St. Lina Creek-03	13.3	9.3	70	0.0	0	4.0	30	0.0	0
County of St. Paul	13.3	9.3	70	0.0	0	4.0	30	0.0	0
Tompkins Lake	4.5	0.0	0	0.0	0	0.0	0	4.5	100
County of St. Paul	4.5	0.0	0	0.0	0	0.0	0	4.5	100
UL-120101-01	4.3	0.0	0	0.0	0	0.0	0	4.3	100
Thorhild County	4.3	0.0	0	0.0	0	0.0	0	4.3	100
UL-120101-02	8.7	0.0	0	0.0	0	0.0	0	8.7	100
Thorhild County	8.7	0.0	0	0.0	0	0.0	0	8.7	100
UL-120101-02-US01	3.9	0.0	0	0.0	1	0.0	0	3.8	99
Thorhild County	3.9	0.0	0	0.0	1	0.0	0	3.8	99

Continued …

Waterbody Name & Intersecting Jurisdiction	Length Assessed (km)*	Prioritization Category							
		High Restoration		Moderate Restoration		Moderate Conservation		High Conservation	
		km*	%	km*	%	km*	%	km*	%
UL-120101-03	10.3	0.0	0	0.0	0	0.0	0	10.3	100
Thorhild County	10.3	0.0	0	0.0	0	0.0	0	10.3	100
UL-120101-03-US01	6.3	0.0	0	0.0	0	0.0	0	6.3	100
Thorhild County	6.3	0.0	0	0.0	0	0.0	0	6.3	100
UL-120101-04	3.4	0.0	0	0.0	0	0.0	0	3.4	100
Buffalo Lake Métis Settlement	1.7	0	0	0	0	0	0	1.7	49
Smoky Lake County	1.7	0.0	0	0.0	0	0.0	0	1.7	51
UL-120101-05	7.1	0.1	1	0.0	0	0.0	0	7.0	99
Buffalo Lake Métis Settlement	2.9	0.1	1	0	0	0	0	2.8	40
Smoky Lake County	4.2	0	0	0.0	0	0.0	0	4.2	59
UL-120101-06	8.8	0.0	0	0.0	0	0.0	0	8.8	100
Buffalo Lake Métis Settlement	8.8	0.0	0	0.0	0	0.0	0	8.8	100
UL-120101-06-US01	2.3	0.0	0	0.1	6	0.0	0	2.2	94
Buffalo Lake Métis Settlement	0.1	0	0	0	0	0	0	0.1	3
Smoky Lake County	2.2	0.0	0	0.1	6	0.0	0	2.1	91
UL-120101-06-US02	2.2	0.0	0	0.1	3	0.0	0	2.2	97
Buffalo Lake Métis Settlement	2.2	0.0	0	0.1	3	0	0	2.2	97
Smoky Lake County	0.0	0	0	0	0	0.0	0	0.0	0
UL-120101-07	5.1	0.0	0	0.0	0	0.0	0	5.1	100
Smoky Lake County	5.1	0.0	0	0.0	0	0.0	0	5.1	100
UL-120101-08	4.2	0.0	0	0.0	0	0.0	0	4.2	100
Buffalo Lake Métis Settlement	4.2	0.0	0	0.0	0	0.0	0	4.2	100
UL-120101-09	9.6	0.0	0	1.0	11	0.0	0	8.5	89
Buffalo Lake Métis Settlement	9.6	0.0	0	1.0	11	0.0	0	8.5	89
UL-120101-10	9.7	0.0	0	0.1	1	0.0	0	9.6	99
Buffalo Lake Métis Settlement	9.7	0.0	0	0.1	1	0.0	0	9.6	99
UL-120101-11	9.7	0.0	0	0.0	0	0.0	0	9.7	100
Buffalo Lake Métis Settlement	9.7	0.0	0	0.0	0	0.0	0	9.7	100
UL-120101-12	5.1	0.0	0	0.0	1	0.0	0	5.1	99
Buffalo Lake Métis Settlement	5.1	0.0	0	0.0	1	0.0	0	5.1	99
UL-120101-13	7.7	0.0	0	0.0	0	0.0	0	7.7	100
Buffalo Lake Métis Settlement	1.0	0	0	0	0	0	0	1.0	13
Kikino Métis Settlement	6.8	0.0	0	0.0	0	0.0	0	6.8	87
UL-120101-14	5.1	0.0	0	0.0	0	0.0	0	5.1	100
Kikino Métis Settlement	5.1	0.0	0	0.0	0	0.0	0	5.1	100
UL-120101-15	6.0	0.0	0	0.7	12	0.0	0	5.3	88
Kikino Métis Settlement	6.0	0.0	0	0.7	12	0.0	0	5.3	88
UL-120101-16	3.4	0.0	0	0.0	0	0.0	0	3.4	100
Smoky Lake County	3.4	0.0	0	0.0	0	0.0	0	3.4	100
UL-120101-17	2.9	0.0	0	0.0	0	0.0	0	2.9	100
Smoky Lake County	2.9	0.0	0	0.0	0	0.0	0	2.9	100
UL-120101-18	6.1	0.0	0	0.2	4	0.0	0	5.9	96
Kikino Métis Settlement	6.1	0.0	0	0.2	4	0.0	0	5.9	96
UL-120101-19	5.1	2.0	38	0.1	2	0.0	1	3.0	59
Kikino Métis Settlement	5.1	2.0	38	0.1	2	0.0	1	3.0	59
UL-120101-20	5.1	0.0	0	0.0	0	0.0	0	5.1	100
Kikino Métis Settlement	5.1	0.0	0	0.0	0	0.0	0	5.1	100
UL-120101-21	8.3	0.0	0	0.0	0	0.0	0	8.3	100
Smoky Lake County	8.3	0.0	0	0.0	0	0.0	0	8.3	100
UL-120101-22	7.3	0.0	0	0.0	0	0.0	0	7.3	100
Kikino Métis Settlement	7.3	0.0	0	0.0	0	0.0	0	7.3	100

Continued …

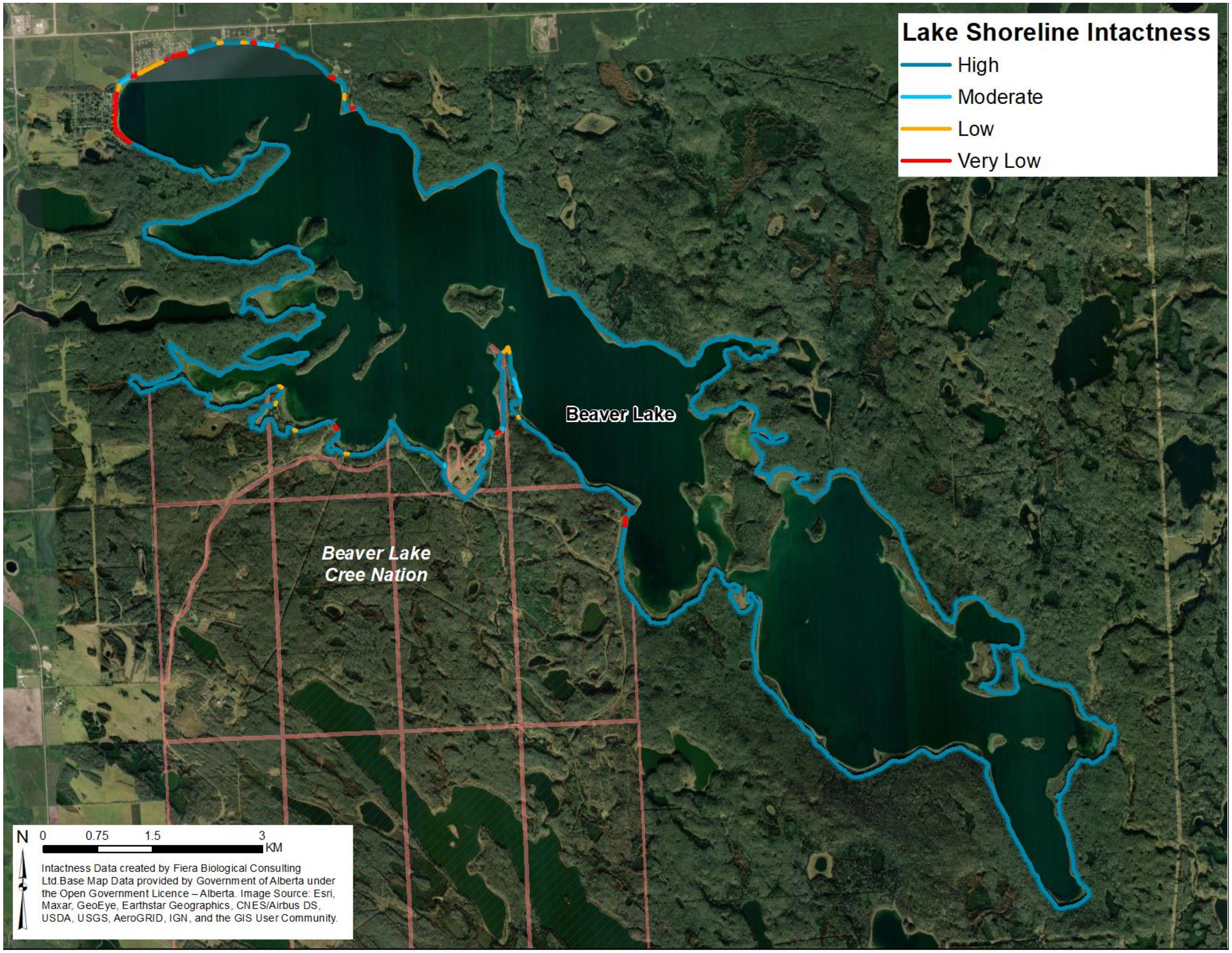
Waterbody Name & Intersecting Jurisdiction	Length Assessed (km)*	Prioritization Category: High Restoration		Moderate Restoration		Moderate Conservation		High Conservation	
		km*	%	km*	%	km*	%	km*	%
UL-120101-23	3.5	0.0	0	0.0	0	0.0	1	3.5	99
Kikino Métis Settlement	3.5	0.0	0	0.0	0	0.0	1	3.5	99
UL-120101-24	4.8	0.3	6	0.0	1	0.0	0	4.4	93
Kikino Métis Settlement	3.9	0.3	6	0	0	0	0	3.6	75
Smoky Lake County	0.9	0	0	0.0	1	0.0	0	0.9	18
UL-120101-24-US01	29.8	0.7	2	0.7	2	1.3	4	27.0	91
Kikino Métis Settlement	23.8	0.7	2	0.5	2	0.7	2	22.0	74
Smoky Lake County	6.0	0.1	0	0.2	1	0.6	2	5.0	17
UL-120101-25	2.5	2.4	96	0.0	0	0.1	4	0.0	0
Whitefish Lake First Nation	2.5	2.4	96	0.0	0	0.1	4	0.0	0
UL-120101-26	3.3	0.0	0	0.0	0	0.0	0	3.3	100
County of St. Paul	3.3	0.0	0	0.0	0	0.0	0	3.3	100
UL-120101-26-US01	0.7	0.0	0	0.0	0	0.0	0	0.7	100
County of St. Paul	0.7	0.0	0	0.0	0	0.0	0	0.7	100
UL-120101-27	4.3	0.1	1	0.1	1	0.8	20	3.3	78
County of St. Paul	4.3	0.1	1	0.1	1	0.8	20	3.3	78
UL-120101-27-US01	18.1	4.3	24	2.0	11	6.2	34	5.6	31
County of St. Paul	18.1	4.3	24	2.0	11	6.2	34	5.6	31
UL-120101-28	3.0	0.0	0	0.0	0	0.0	0	3.0	100
County of St. Paul	3.0	0.0	0	0.0	0	0.0	0	3.0	100
UL-120101-29	3.8	0.0	0	0.0	0	0.0	0	3.8	100
County of St. Paul	3.8	0.0	0	0.0	0	0.0	0	3.8	100
UL-120101-29-US01	10.3	1.6	16	1.2	11	0.6	6	6.9	67
County of St. Paul	10.3	1.6	16	1.2	11	0.6	6	6.9	67
UL-120101-30	4.1	0.0	0	0.0	0	0.0	0	4.1	100
County of St. Paul	4.1	0.0	0	0.0	0	0.0	0	4.1	100
UL-120101-31	3.5	0.2	5	0.0	0	0.0	0	3.4	95
County of St. Paul	3.5	0.2	5	0.0	0	0.0	0	3.4	95
UL-120101-32	3.8	0.0	0	0.0	0	3.8	100	0.0	0
County of St. Paul	3.8	0.0	0	0.0	0	3.8	100	0.0	0
UL-120101-33	3.0	2.6	88	0.0	0	0.3	12	0.0	0
County of St. Paul	3.0	2.6	88	0.0	0	0.3	12	0.0	0
UL-120101-34	8.7	2.6	30	0.0	0	6.1	70	0.0	0
County of St. Paul	8.7	2.6	30	0.0	0	6.1	70	0.0	0
UL-120101-35	3.3	0.1	2	0.4	11	0.0	0	2.9	87
County of St. Paul	3.3	0.1	2	0.4	11	0.0	0	2.9	87
UL-120101-36	3.3	0.1	2	0.0	0	0.1	2	3.1	96
County of St. Paul	3.3	0.1	2	0.0	0	0.1	2	3.1	96
UL-120101-37	3.2	0.1	2	0.0	0	3.0	93	0.2	5
County of St. Paul	3.2	0.1	2	0.0	0	3.0	93	0.2	5
UL-120101-38	4.5	0.1	3	0.1	2	0.0	0	4.3	95
County of St. Paul	4.5	0.1	3	0.1	2	0.0	0	4.3	95
UL-120101-39	3.6	0.7	18	0.0	0	3.0	82	0.0	0
County of St. Paul	3.6	0.7	18	0.0	0	3.0	82	0.0	0
UL-120101-40	4.8	1.8	38	0.0	0	3.0	62	0.0	0
County of St. Paul	4.8	1.8	38	0.0	0	3.0	62	0.0	0
UL-120101-41	5.6	1.5	27	0.0	0	4.1	73	0.0	0
County of St. Paul	5.6	1.5	27	0.0	0	4.1	73	0.0	0
UL-120101-42	4.9	2.2	45	0.0	0	2.7	55	0.0	0
County of St. Paul	4.9	2.2	45	0.0	0	2.7	55	0.0	0
UL-120101-43	3.4	3.3	95	0.0	0	0.2	5	0.0	0
County of St. Paul	3.4	3.3	95	0.0	0	0.2	5	0.0	0

Continued …

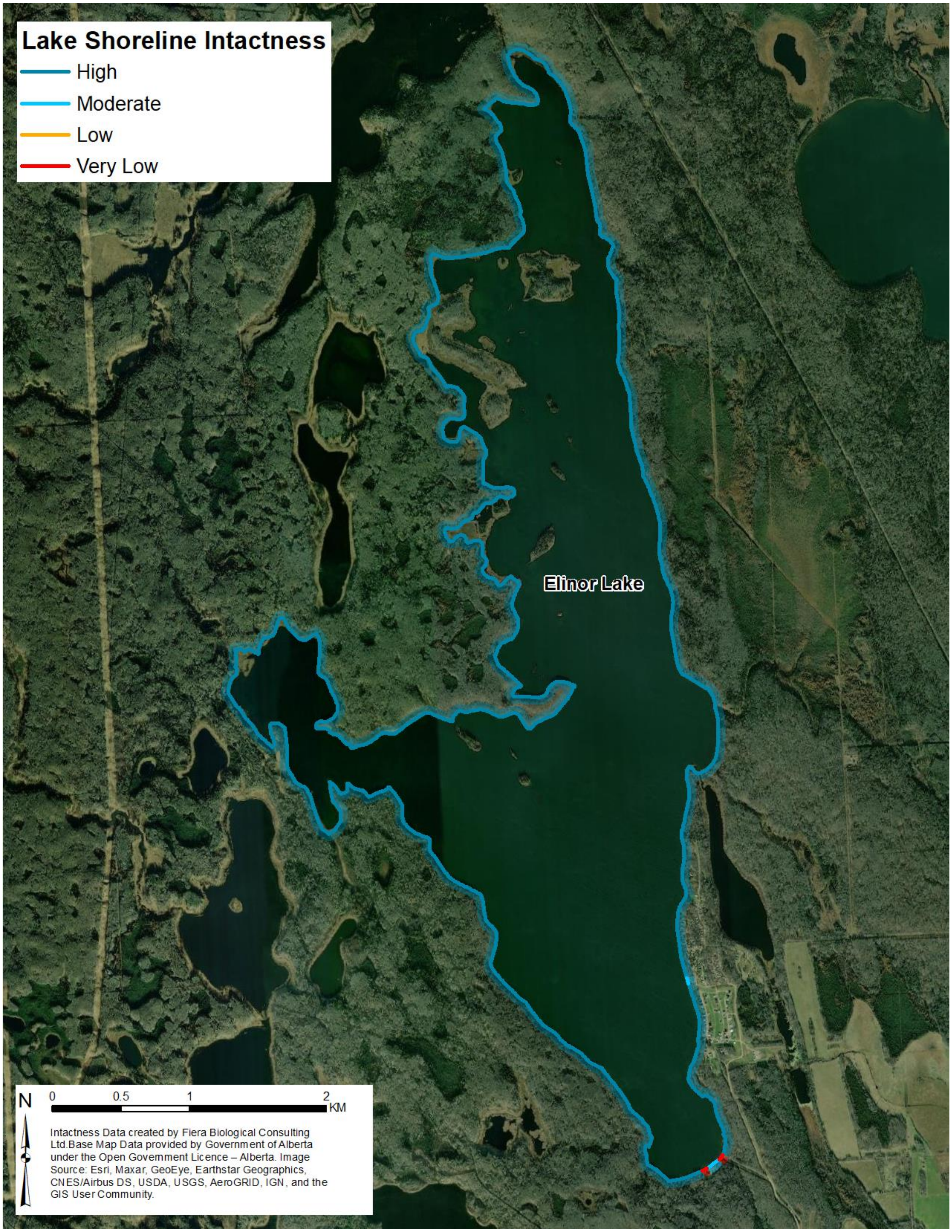
Waterbody Name & Intersecting Jurisdiction	Length Assessed (km)*	Prioritization Category							
		High Restoration		Moderate Restoration		Moderate Conservation		High Conservation	
		km*	%	km*	%	km*	%	km*	%
UL-120101-44	2.9	0.0	0	0.0	0	0.0	0	2.9	100
Smoky Lake County	0.5	0	0	0	0	0	0	0.5	17
Thorhild County	2.4	0.0	0	0.0	0	0.0	0	2.4	83
UL-120101-45	3.7	2.9	77	0.0	0	0.9	23	0.0	0
Smoky Lake County	3.7	2.9	77	0.0	0	0.9	23	0.0	0
UL-120101-46	16.6	0.1	1	0.0	0	0.2	1	16.4	98
Lac La Biche County	16.6	0.1	1	0.0	0	0.2	1	16.4	98
Upper Mann Lake	17.3	0.2	1	0.5	3	1.9	11	14.6	85
County of St. Paul	17.3	0.2	1	0.5	3	1.9	11	14.6	85
Victor Lake	4.6	1.2	25	0.0	0	3.4	75	0.0	0
Kikino Métis Settlement	4.6	1.2	25	0.0	0	3.4	75	0.0	0
Victor Lake-01	21.7	2.9	13	2.8	13	4.1	19	11.9	55
Kikino Métis Settlement	21.7	2.9	13	2.8	13	4.1	19	11.9	55
Wayetenaw Lake	4.4	0.0	0	0.0	0	0.0	0	4.4	100
Smoky Lake County	3.9	0	0	0	0	0	0	3.9	89
Whitefish Lake First Nation	0.5	0.0	0	0.0	0	0.0	0	0.5	11
Whiskyjack Lake	6.7	0.5	8	0.0	0	0.0	0	6.1	92
County of St. Paul	6.7	0.5	8	0.0	0	0.0	0	6.1	92
Whitefish Creek	54.0	5.2	10	1.1	2	7.0	13	40.6	75
Kikino Métis Settlement	28.5	5.1	9	1.0	2	7.0	13	15.4	28
Lac La Biche County	19.5	0.1	0	0.1	0	0	0	19.3	36
Whitefish Lake First Nation	6.0	0	0	0.0	0	0	0	6.0	11
Whitefish Creek-01	4.8	2.1	43	0.6	13	1.5	32	0.6	12
Kikino Métis Settlement	4.8	2.1	43	0.6	13	1.5	32	0.6	12
Whitefish Creek-02	74.7	5.4	7	4.9	7	1.6	2	62.8	84
Buffalo Lake Métis Settlement	1.9	0	0	0	0	0	0	1.9	3
Kikino Métis Settlement	72.2	5.4	7	4.9	7	1.6	2	60.3	81
Smoky Lake County	0.6	0	0	0.0	0	0	0	0.5	1
Whitefish Creek-03	14.4	2.1	14	0.4	3	1.6	11	10.4	72
County of St. Paul	4.2	1.3	9	0.1	1	0.1	0	2.7	19
Lac La Biche County	10.2	0.8	5	0.3	2	1.6	11	7.6	53
Whitefish Lake	26.9	2.0	7	1.1	4	6.2	23	17.7	66
Kikino Métis Settlement	6.6	0.6	2	0.4	2	0.2	1	5.4	20
Lac La Biche County	6.1	0.0	0	0	0	0.0	0	6.0	22
Smoky Lake County	6.5	0.9	3	0.6	2	0.7	3	4.3	16
Whitefish Lake First Nation	7.8	0.5	2	0	0	5.3	20	2.0	7

*NOTE: All jurisdictional data summaries were generated by using a spatial intersect rule in ArcGIS. Summarizing the data in this way assigns the entire length of an RMA that intersects a jurisdictional boundary to a given jurisdiction, even if the RMA extends beyond the jurisdictional boundaries. Consequently, the sum of the shoreline length assessed for each intactness and prioritization category is greater than the values summarized by individual waterbody, HUC 8 and HUC 6.

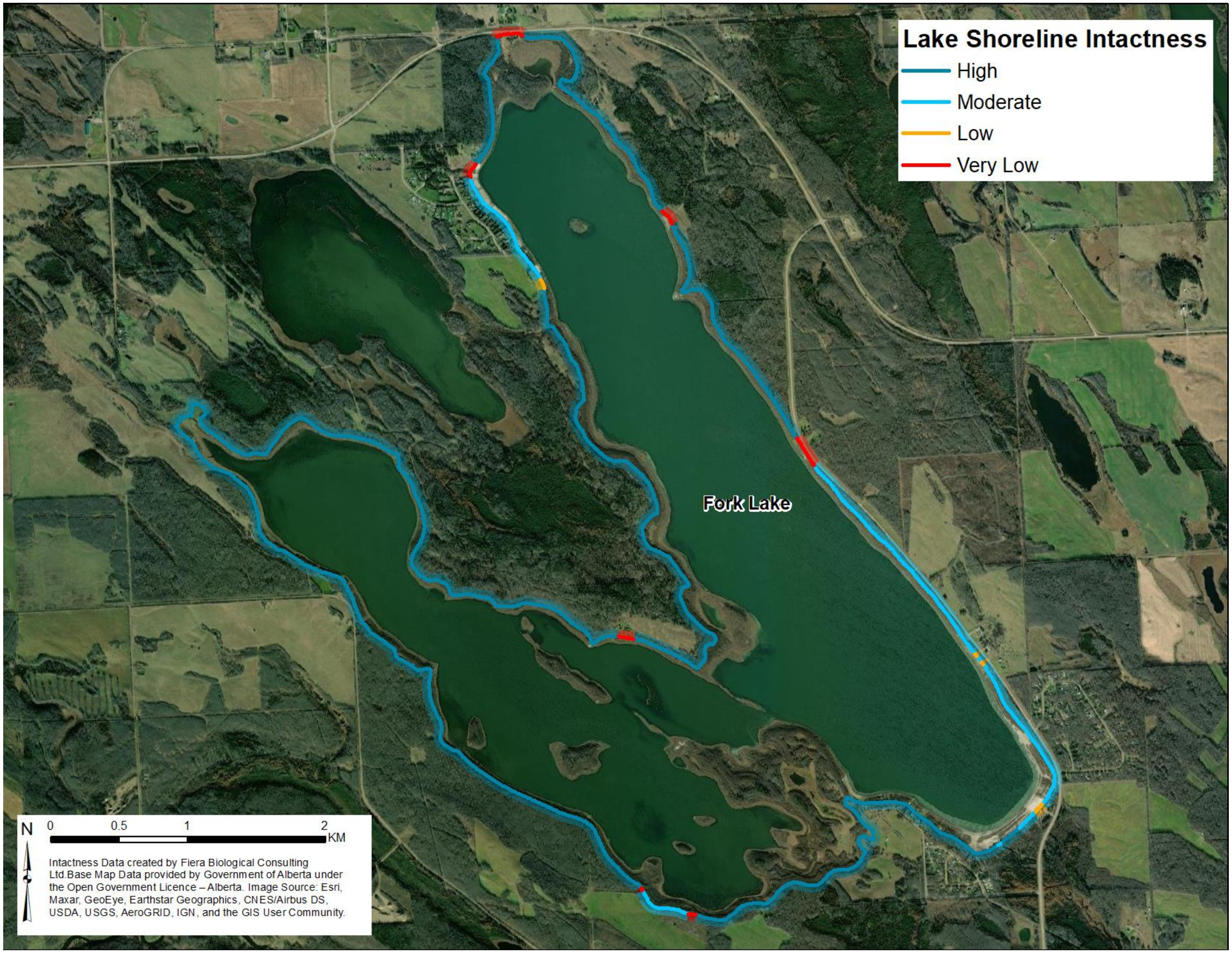
Appendix B: Intactness & Priority Maps for Lakes of Interest



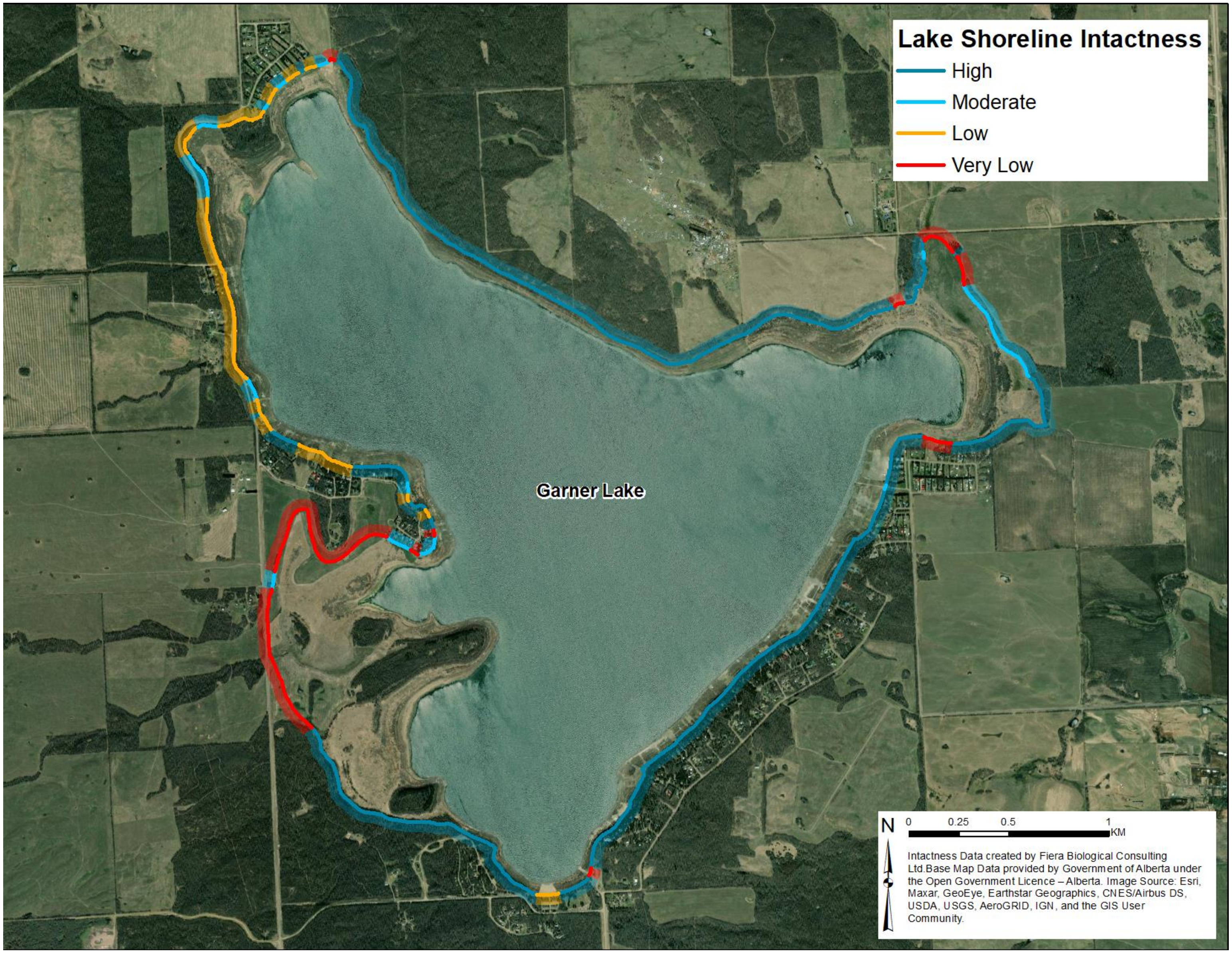
Map B- 1. Intactness for the shoreline of Beaver Lake.



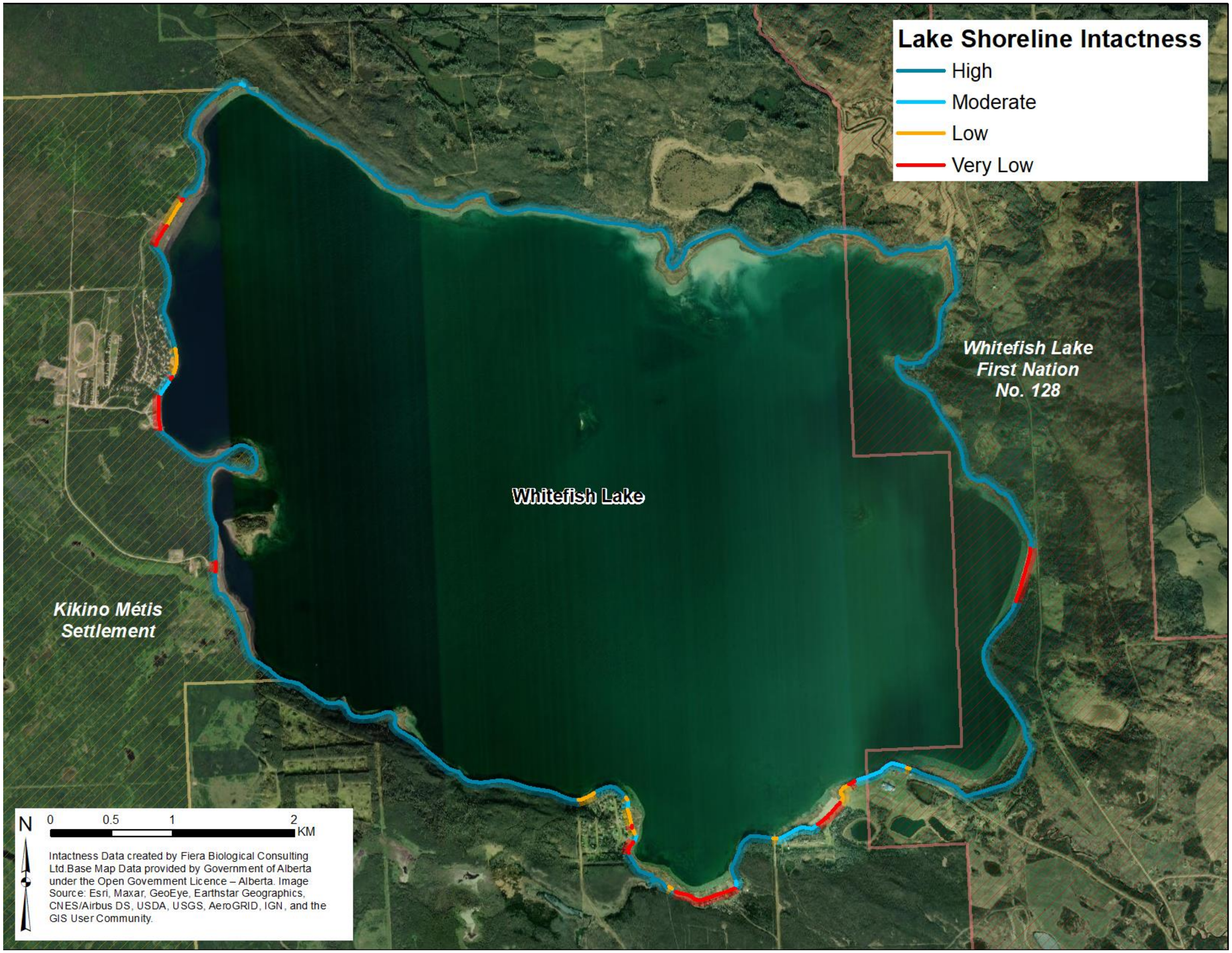
Map B- 2. Intactness for the shoreline of Elinor Lake.



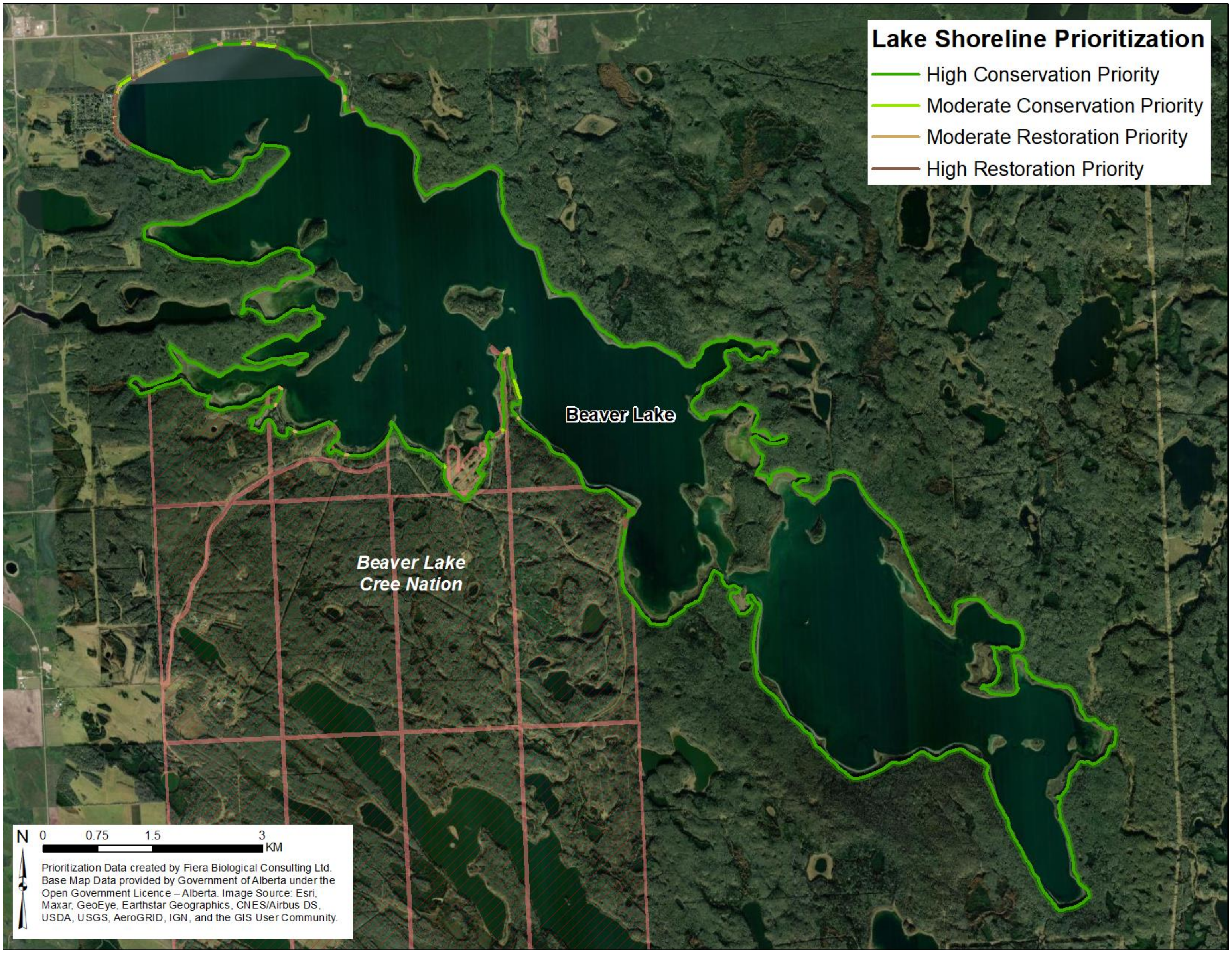
Map B- 3. Intactness for the shoreline of Fork Lake.



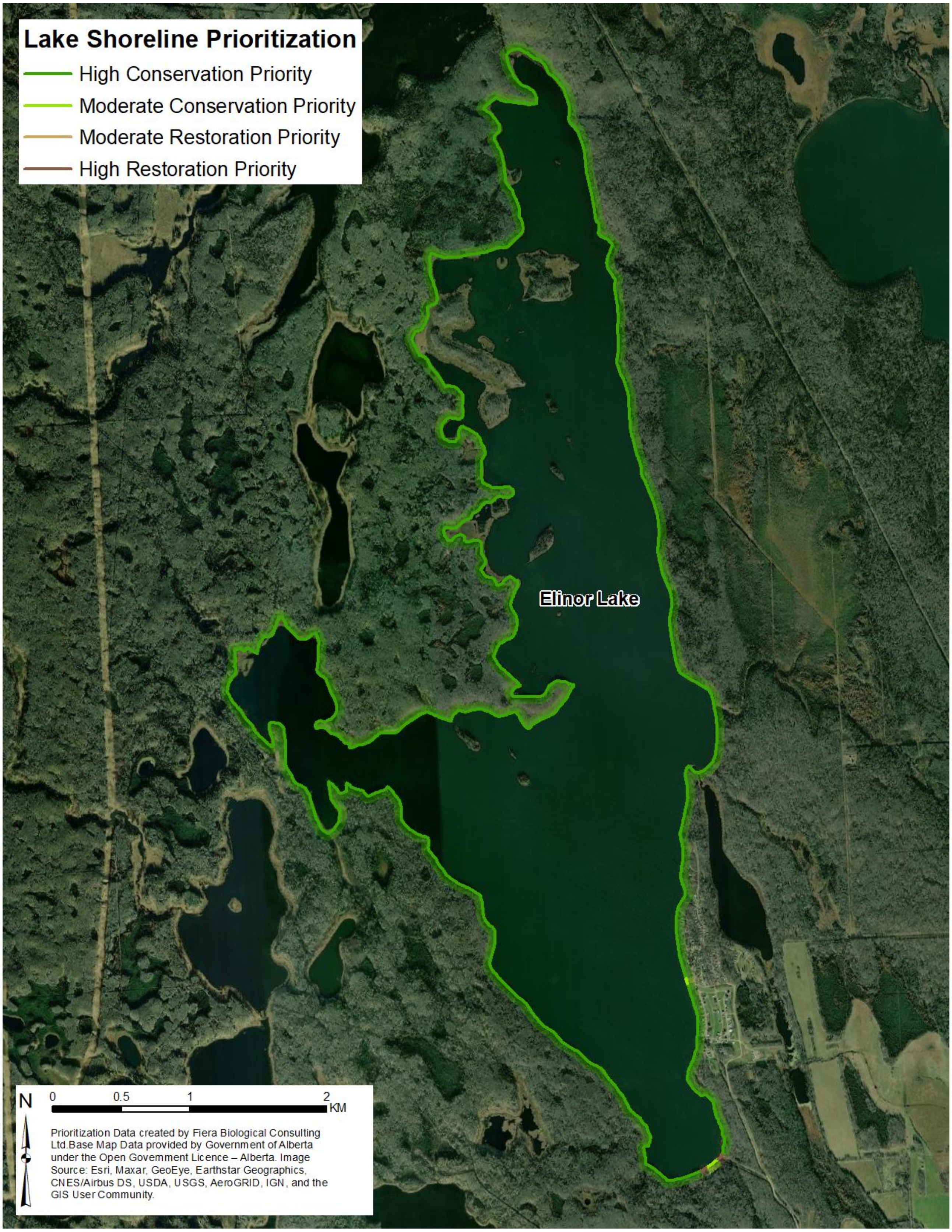
Map B- 4. Intactness for the shoreline of Garner Lake.



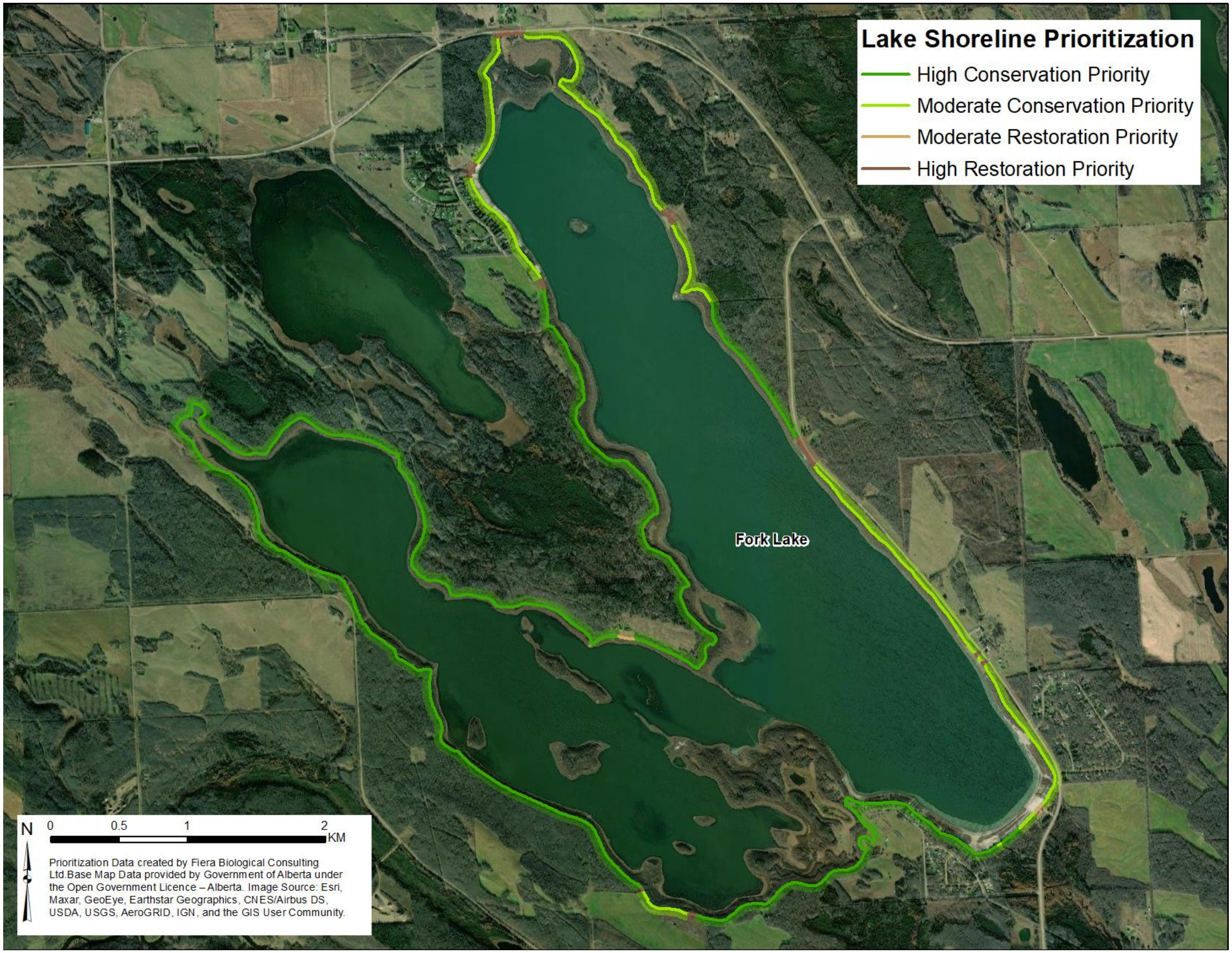
Map B- 5. Intactness for the shoreline of Whitefish Lake.



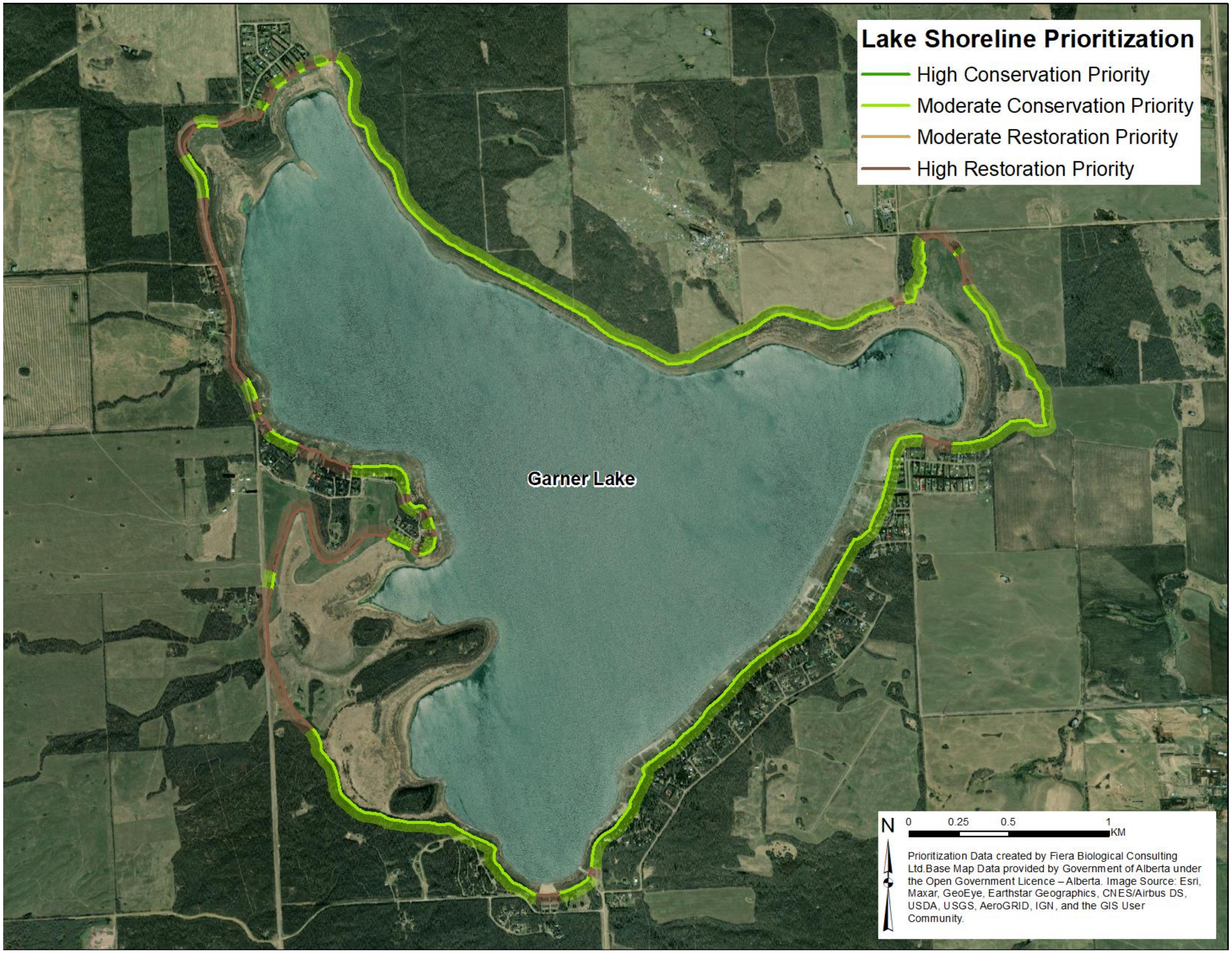
Map B- 6. Conservation and restoration priority for the shoreline of Beaver Lake.



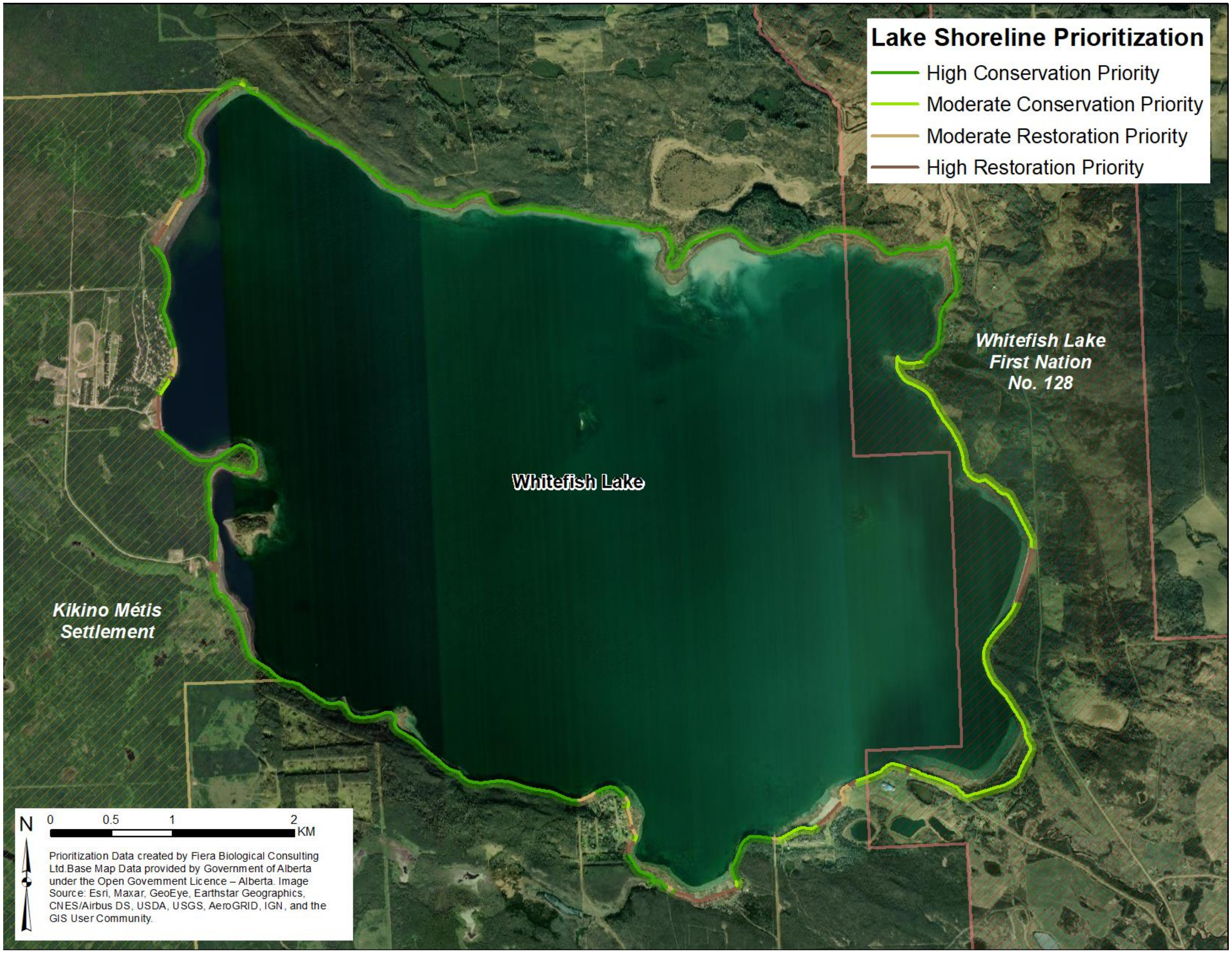
Map B- 7. Conservation and restoration priority for the shoreline of Elinor Lake.



Map B- 8. Conservation and restoration priority for the shoreline of Fork Lake.



Map B- 9. Conservation and restoration priority for the shoreline of Garner Lake.



Map B- 10. Conservation and restoration priority for the shoreline of Whitefish Lake.