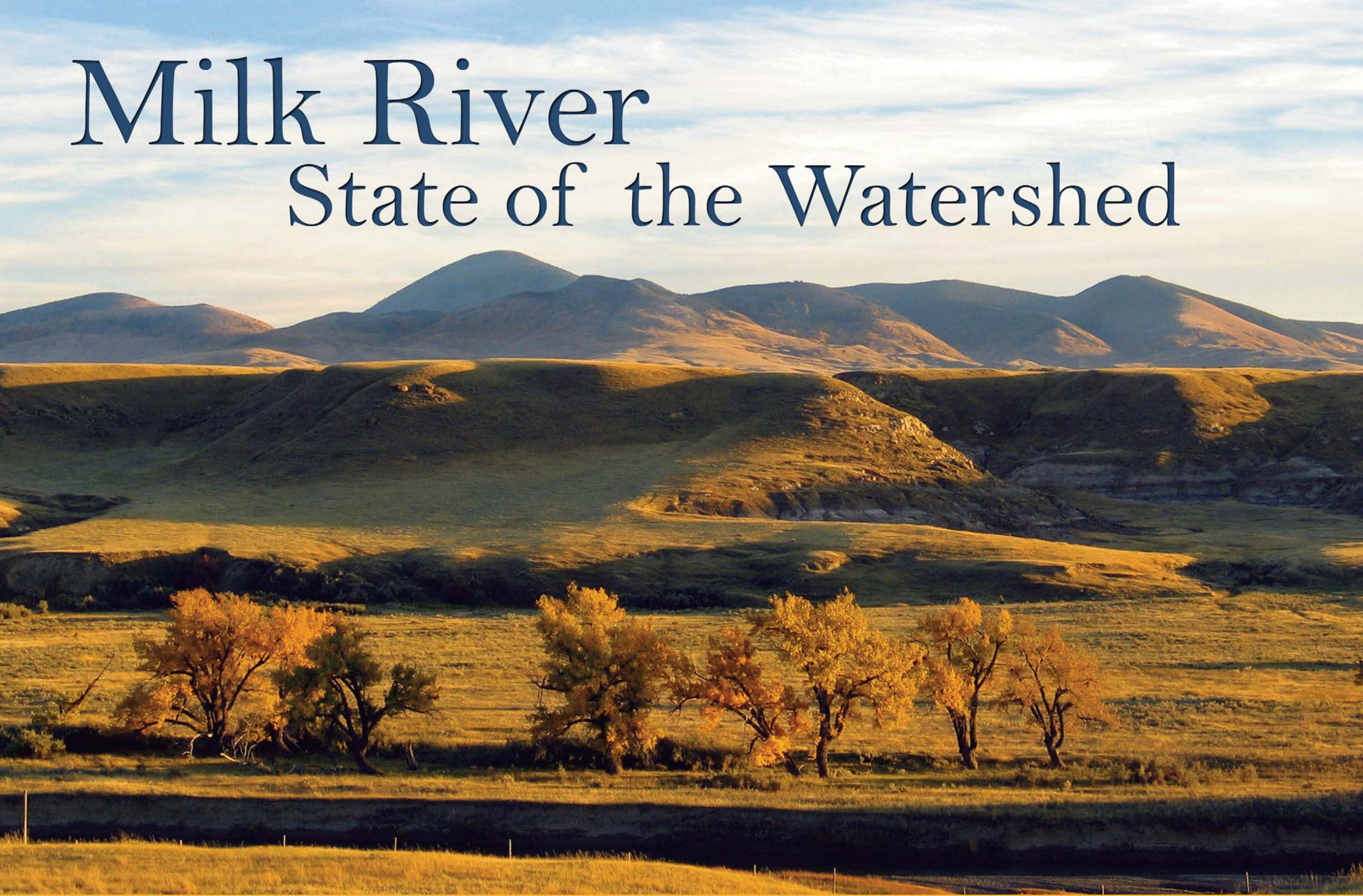
Milk River
State of the Watershed



Milk River Watershed Council CANADA

2008

Dear Ellie,

Because the picture of you playing in the river at Writing-on-Stone Provincial Park is on the cover of the first publication of our Milk River Watershed Council, I wanted to tell you a little about the next publication, the State of the Watershed Report. This story covers many of the things that are building blocks for the life of people and nature's things in the Milk River watershed that stretches from Onefour in the east to Whiskey Gap in the west. Those building blocks will become more important to you and your friends as you grow up, complete your education and then take an active role in shaping your communities year by year.

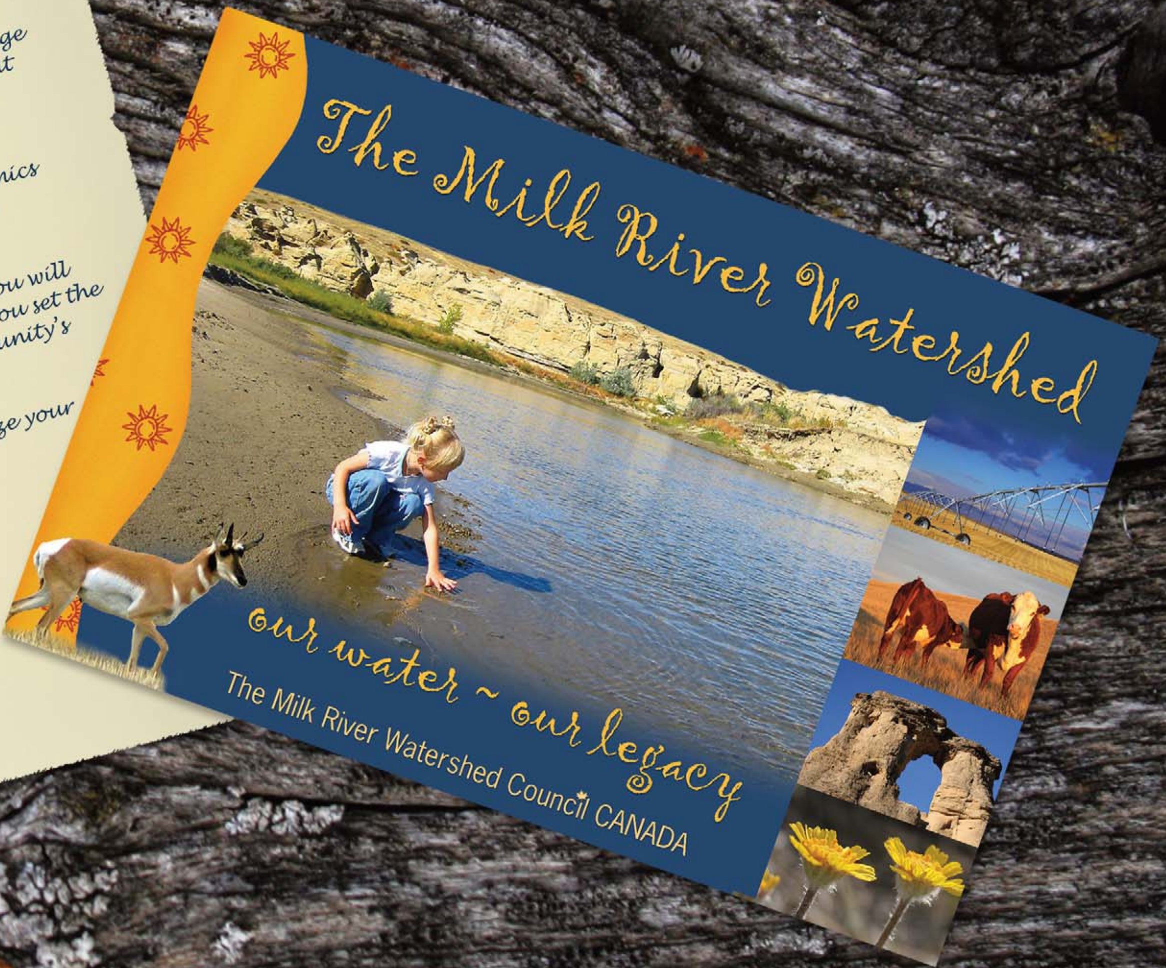
Don't forget that young people like you, as residents of the watershed, will have the opportunity and the great challenge to understand the economic and environmental issues that will become important to you as you take your place in society. I hope that you and your friends will seize the opportunity to apply your knowledge and ingenuity to improve your quality of life that will be based on economics and the preservation and enhancement of the natural environment that you like so much.

This watershed story will serve as a benchmark that you will be able to look back on to measure your progress as you set the goals and carry out the work to improve your community's quality of life.

Please take up the challenge so that you can realize your dreams.

Good luck Ellie.

Love
Grandpa



Milk River State of the Watershed Report 2008

Milk River Watershed Council Canada

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Box 313, Milk River, AB TOK 1MO
www.milkriverwatershedcouncil.ca
ISBN: 0-980-9707-0-8

An electronic version of this report is available at: www.milkriverwatershedcouncil.ca

This document should be cited as: Milk River Watershed Council Canada. 2008. Milk River State of the Watershed Report 2008. Milk River Watershed Council Canada. Milk River, Alberta. 155 pp.

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Other Acknowledgements
Thank-you to all of the landowners in the watershed for their role in environmental stewardship and participation in programs that have helped us prepare this report.

Report printed on 100% recycled paper.

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1.0 Introduction

1.1 The Milk River Watershed

The Milk River is the smallest of Alberta's seven major river basins, encompassing an area of 6,664 km^2 (Map 1.1). The Milk River is also the northern most tributary of the Missouri River. The Milk River watershed is transboundary, spanning areas in the provinces of Alberta and Saskatchewan, as well as the State of Montana, U.S.A.

The Milk River is about 1,173 km long and flows through Montana and Alberta. The headwaters originate in northwestern Montana on the Blackfeet Reservation (Map 1.1). It then enters Alberta, flows through the Town of Milk River, eastward through the southern portion of the province, prior to looping back into Montana.

The eastern tributaries (i.e., Lodge Creek, Battle Creek and Bare Creek) originate in the eastern part of the watershed and flow through Saskatchewan and south into Montana before joining the Milk River just east of Chinook, Montana (Map 1.1).

In Alberta, the Milk River watershed is unique in terms of size, climate, water supply, vegetation and wildlife.

1.2 Milk River State of the Watershed Report

The Milk River Watershed Council Canada (MRWCC) is a non-profit Society designated as a Watershed Planning and Advisory Council under the provincial Water for Life Strategy (GOA 2003). The vision of the MRWCC is a watershed where community well-being is supported by a vibrant economy and sustained by a healthy environment that will endure as our legacy for future generations. This vision will be accomplished through activities that:

- Foster the sustainable use and integrated management of land and water resources,
- Promote quality water supplies for aquatic health and domestic water use,
- Promote beneficial management practices that conserve wildlife and plant diversity,
- Increase community knowledge and involvement in conservation initiatives, and
- Develop programs to asses and monitor the state of the watershed.

In 2006, the MRWCC's State of the Watershed Report Team, a multi-disciplinary group of people representing government agencies, non-government agencies, industry and landowners developed a suite of indicators to measure the state or health of the Milk River watershed. Indicators are components of the watershed that reflect land use and changes to environmental conditions. These indicators establish benchmarks and targets that can be used to monitor and evaluate change in the watershed and help direct watershed management planning to ensure the long-term health of the region. In general, the State of the Watershed Report is a report card that lets us know how well the watershed is being managed.

The State of the Watershed Report is a comprehensive document that integrates many aspects within the watershed to determine its status in terms of environment, social and economic well-being. Indicators range from statistics on road networks, agricultural production and oil and gas activity, to riparian health, upland range health and wildlife. The indicators are intricately connected such that all are necessary to understand and manage the watershed. Table 1.1 summarizes the indicators that were developed by the State of the Watershed Report Team, in consultation with the public, and subsequently used in this report. The State of the Watershed Report brings together research from a number of different resource managers and individuals who work and live in the watershed.

The findings of this report will enable the Milk River Watershed Council Canada and its partners to assess our current understanding of the watershed in preparation for the development of a Watershed Management Plan. This report will be used as a tool to help make informed water and land management decisions in the Milk River watershed for the benefit of all who rely on its resources, including people and wildlife.

State of the Watershed Report Organization

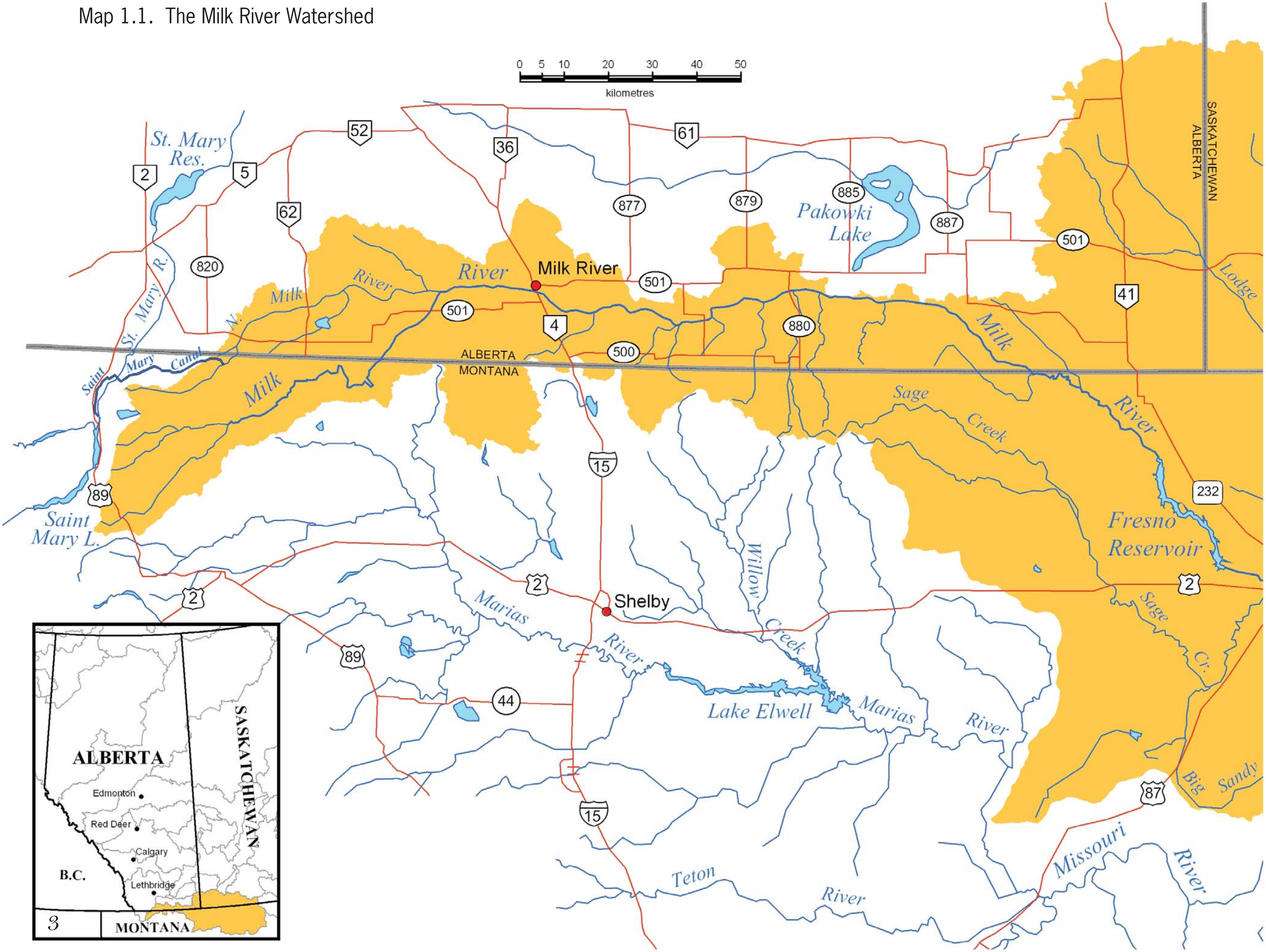
This report is organized into two sections. The first section, Chapters 2 and 3, provide an overview of the natural history and landscape within the Milk River watershed, including bedrock and surficial geology, soils, natural regions, land cover and social history. These form the fundamental basis of how the watershed developed on a physical and social level.

The second section, Chapters 4 through 10, describes the State of the Watershed and measures our footprint in terms of land use (e.g., parks and protected areas, agriculture, oil and gas activity), surface and groundwater supply and quality, riparian areas, wetlands and wildlife. This section identifies data gaps and provides recommendations to help define future direction for the MRWCC and its partners.

Table 1.1. Summary of indicators developed by the State of the Watershed Report Team.

Watershed Component	Indicators	Description	Watershed Linkages
Aquatic Ecosystems	Surface Water	Water supply, water allocation and use, water quality	Land use, aquatic health
	Groundwater	Water supply, water allocation and use, water quality	Land use, aquifer depletion
	Fisheries	Species composition, species at risk	Water quantity and quality
	Invertebrates	Invertebrates	Water quality, fish habitat
	Streambank stability & erosion	Rate of streambank erosion	Channel stability, sediment transport, water supply and quality
Riparian Ecosystems	Wildlife	Loggerhead Shrike, Northern Pintail	Associated with shrub cover and wetlands
		Amphibians	Riparian health, wetlands, and water quality
	Vegetation	Preferred tree and shrubs, cottonwoods, invasive plant species	Land use, flow regime
	Wetlands	Number of wetlands, number of drained wetlands, classification by type	Land use
Upland Ecosystems	Wildlife	Sharp-tailed Grouse	Upland health (shrub communities i.e. snowberry, rose, etc.)
		Sage Grouse	Endangered species (health of silver sagebrush communities)
		Grassland birds (Sprague's Pipit/Long-billed Curlew)	Range health
		Ferruginous Hawk	Bird of prey (pest control)
		Ungulates (pronghorn/mule deer/elk)	Large grazers associated with fragmentation of the landscape
		Richardson ground squirrel	Significant prey species
		Burrowing Owl	Upland health (open prairie)
		Prairie rattlesnake	Correlated to roads and social tolerance
	Vegetation	Invasive plant species	Land management
	Land use	Development, roadways, agriculture, oil and gas activity	Associated with fragmentation of the landscape
Community	Economics	Recreation, tourism, agriculture, oil and gas activity	Population and human health
	Watershed Awareness and Involvement	Participation in programs that promote the health of the watershed.	Awareness leads to better management decisions

Map 1.1. The Milk River Watershed




Eastend
Cypress Lake
Frenchman
River
Battle
Creek
13
18
4
37
2
24
Frenchman
River
SASKATCHEWAN
MONTANA
Whitewater
River
Creek
Rock
Creek
Line
Porcupine
Creek
Battle
Creek
Cottonwood
Cr.
Assiniboine
Cr.
241
242
Havre
Chinook
Cr.
Beaver
Creek
Clear
Snake
Creek
Milk
River
Malta
L.
Bowdoin
Peoples
Creek
66
191
Beaver
Creek
Larb
Creek
Willow
Creek
Glasgow
Missouri
River
Fort
Peck
Res.
Cr.

2.0 Geography

2.1 Climate

The climate within the Milk River watershed is similar to that of the western plains, having short warm summers and cold winters with occasional to frequent mild periods. Winter conditions are influenced by the Rocky Mountains and Chinook winds. The local climate is further modified by the Milk River Upland, the Sweetgrass Hills and the Cypress Hills (Klohn Crippen Consultants Ltd. 2003).

Precipitation. Precipitation ranges between 316 mm and 450 mm annually from east to west. Mean precipitation at Del Bonita is 397 mm and further east at Onefour it is 353 mm (Adams et al. 2003; Adams et al. 2005). Most rainfall occurs during the growing season (May through September), accounting for more than 50% of the annual total. There is a high yearly variability and uneven distribution of rainfall within the watershed (Kjearsgaard et al. 1986).

The areas of highest elevation, the Cypress Hills and Sweetgrass Hills, receive a greater amount of precipitation compared to the surrounding points. Greenlee (1981) reported precipitation of about 460 mm annually at 1,400 m in the Cypress Hills. Dormaar (2003) noted that the Sweetgrass Hills rise abruptly from the surrounding plains and force moist air masses, advancing from the northwest, upwards as they approach the northern slopes resulting in orographic (mountain weather) rainfall.

The highest average snowfall occurs in January, however, the greatest single snowstorm events often occur in March or April (Klohn Crippen Consultants Ltd. 2003). Snow contributes about 30% to the annual precipitation.

Temperature. The mean annual temperature in the area ranges from 5.8^{0}C at Aden to 3.8^{0}C at Whiskey Gap. The frost-free period on the plains is generally greater than 120 days. The last spring frost occurs about mid-May and the first fall frost comes about mid-September. The shorter frost-free period on the Milk River Upland, which is less than 90 days, makes the area more suitable for coarse grains and grazing than for wheat production (Kjearsgaard et al. 1986).

Areas higher in elevation are characterized by lower mean annual temperatures. Greenlee (1981) reports a mean annual temperature of 2^{0} to 3^{0} celsius for the Cypress Hills.

Drought conditions occur frequently in the Milk River watershed. Historical records show that periods of below average precipitation (drought) were greater in severity and duration prior to European settlement of the region.

The driest reconstructed 12-month period occurred from August 1793 to July 1794 (Dormaar 2003).

Late spring to early summer bring high winds and short, heavy rains (Graspointer 1980). Data for the Lethbridge airport show that there are only 15 calm days annually, compared to 27 recorded for Medicine Hat. Prevailing westerly winds are most evident during the period from October to December. The average annual wind speed is 20.4 km/hr with maximum hourly speeds of 120 km/hr and maximum gusts of 170 km/hr. Wind erosion is a very real concern in this watershed (Kjearsgaard et al. 1986).

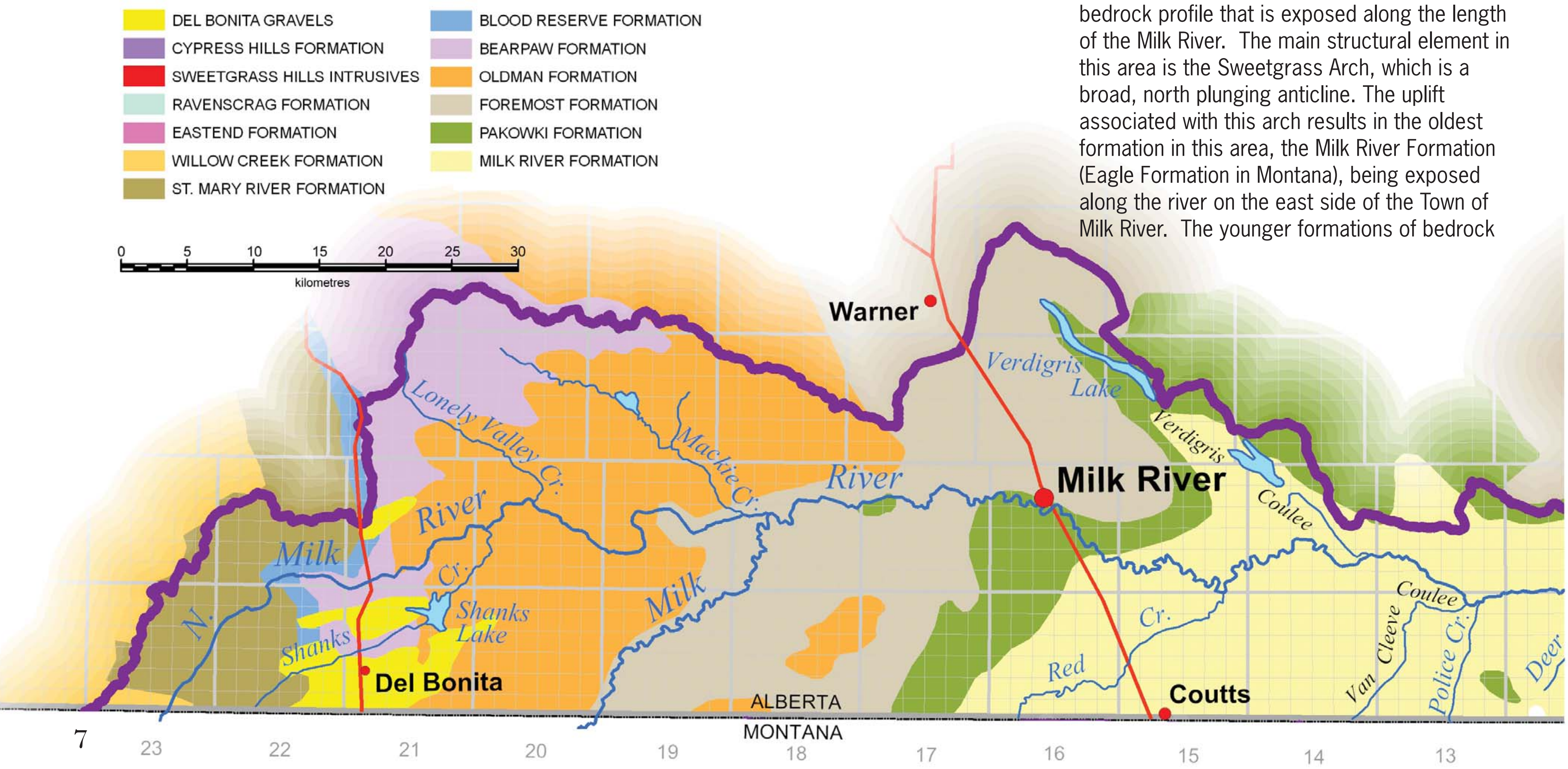
Wetland soils impacted by drought.

2.2 Bedrock Geology

Bedrock geology for the Milk River watershed is illustrated in Map 2.1. The watershed is characterized by a series of eroded upland plateau draining into the present day river basin. The plateau are remnants of pre-glacial fluvial terraces and typically range in elevation from 1,200 m to 1,400 m. Two of the most significant plateau in this area of Alberta are the Del Bonita Plateau and the Milk River Ridge. The Del Bonita Plateau consists of an unglaciated and a glaciated portion. The unglaciated area is level to gently inclined, about three townships in size and occurs at and elevation of about 1,300 m (Adams et al. 2003a). The Milk River Ridge, rises about 300 m above the adjacent plains on the north boundary of the watershed, and serves as a divide between the Milk River watershed and the South Saskatchewan River basin. Similar age plateau are located on the south side of the Milk River in Montana. In addition, there are three major igneous plugs in northern Montana referred to as the Sweetgrass Hills that rise above the surrounding terraces to an elevation of almost 2,000 m (Klohn Crippen Consultants Ltd. 2003).

Erosion and uplift have resulted in a variable bedrock profile that is exposed along the length of the Milk River. The main structural element in this area is the Sweetgrass Arch, which is a broad, north plunging anticline. The uplift associated with this arch results in the oldest formation in this area, the Milk River Formation (Eagle Formation in Montana), being exposed along the river on the east side of the Town of Milk River. The younger formations of bedrock

Map 2.1. Bedrock Geology

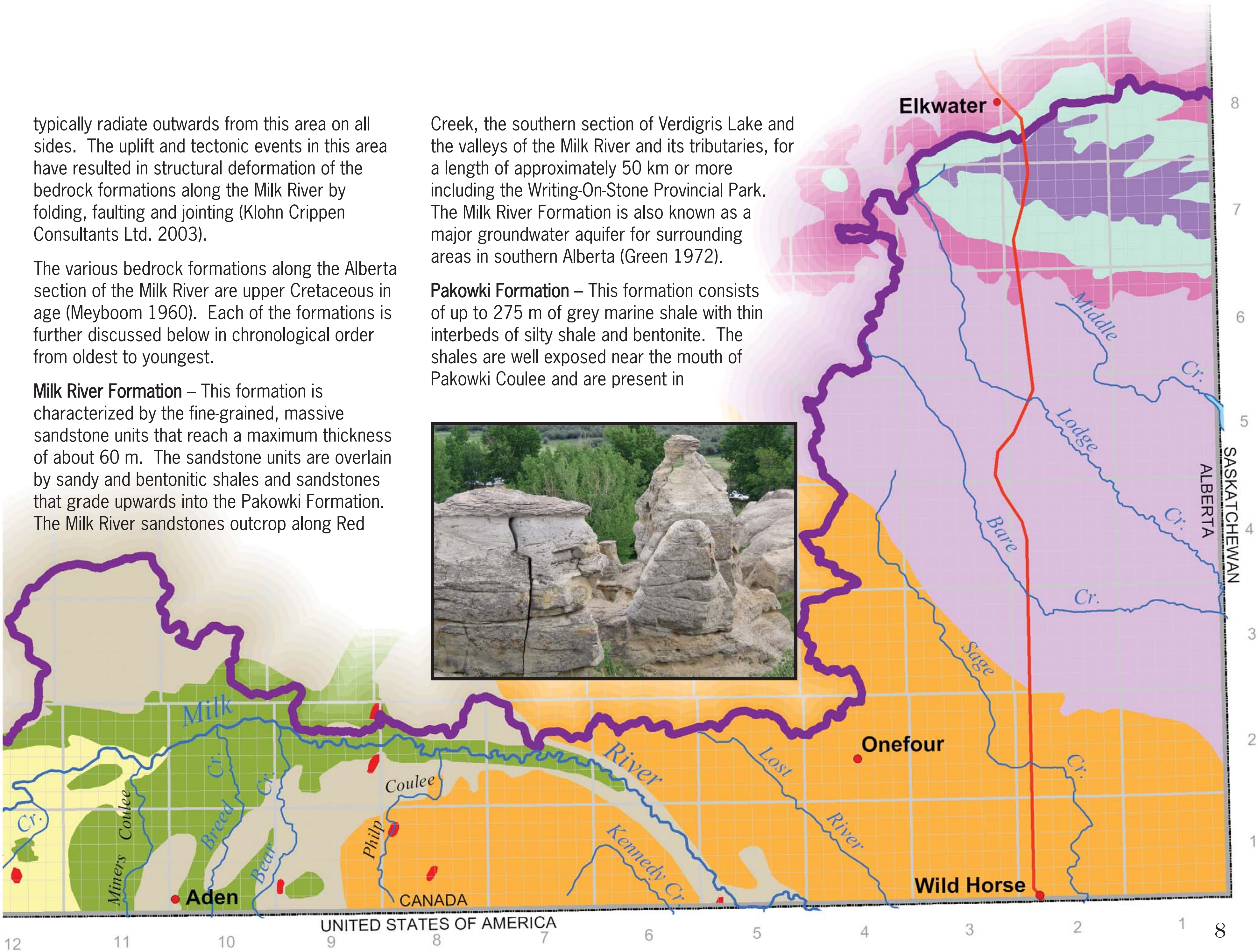


typically radiate outwards from this area on all sides. The uplift and tectonic events in this area have resulted in structural deformation of the bedrock formations along the Milk River by folding, faulting and jointing (Klohn Crippen Consultants Ltd. 2003).

The various bedrock formations along the Alberta section of the Milk River are upper Cretaceous in age (Meyboom 1960). Each of the formations is further discussed below in chronological order from oldest to youngest.

Milk River Formation – This formation is characterized by the fine-grained, massive sandstone units that reach a maximum thickness of about 60 m. The sandstone units are overlain by sandy and bentonitic shales and sandstones that grade upwards into the Pakowki Formation. The Milk River sandstones outcrop along Red Creek, the southern section of Verdigris Lake and the valleys of the Milk River and its tributaries, for a length of approximately 50 km or more including the Writing-On-Stone Provincial Park. The Milk River Formation is also known as a major groundwater aquifer for surrounding areas in southern Alberta (Green 1972).

Pakowki Formation – This formation consists of up to 275 m of grey marine shale with thin interbeds of silty shale and bentonite. The shales are well exposed near the mouth of Pakowki Coulee and are present in



surrounding sections of Milk River as well as underlying Verdigris Lake. In the eastern extent of the Canadian part of the watershed, the formation outcrops in the Milk River canyon. The upper beds are gradational into the overlying Foremost Formation.

Foremost Formation (Member of the Judith River Formation) – This formation is a series of fresh and brackish water deposits consisting of up to 150 m of pale grey feldspathic sandstone, grey and green siltstone and dark grey, carbonaceous shale. Coal and oyster beds are present in this formation as well as thin beds of bentonite. The Foremost Formation is exposed along the Eastern canyon sections of the Milk River and along the North branch of the Milk River, and also in the Milk River canyon (Roberston and Hendry 1982).

Oldman Formation (Member of the Judith River Formation) – This unit is comprised of 60 m to 185 m of pale grey, thick bedded, medium to coarse-grained feldspathic sandstone, grey, clayey siltstone and dark grey and brown carbonaceous shale. The Oldman Formation is exposed along upstream sections of the Milk River and North Milk River (Roberston and Hendry 1982).

Bearpaw Formation – This unit consists of up to 200 m of dark grey, marine clay shale with clayey sandstone beds, ironstone concretions and bentonite layers. It is located in the highlands, adjacent to the plains to the far west of the watershed and the far east.

The Bearpaw formation is also composed of younger Cretaceous strata. In the Cypress Hills region, the Bearpaw formation is overlain by a series of shale, sandstone, bentonite and coal beds, which comprise the Eastend, Whitemud, Battle, and Frenchman formations. Their stratigraphic equivalents, the Blood Reserve and St. Mary Formations, also consist of shales and thin sandstones on the sides of Milk River Ridge (Meyboom 1960).

Eastend Formation – This unit overlies the Bearpaw shale and is confined to the foot of the main escarpment of the Cypress Hill (Borneuf 1976).

Ravenscrag Formation – This unit is confined to a narrow rim around the highest parts of the Cypress Hills (Borneuf 1976).

Cypress Hills Formation – The Tertiary deposits in the watershed have been removed by erosion except in the Cypress Hills, which are topped by a thick conglomerate of likely Oligocene age, overlying the Ravenscrag Formation which consists of sandstones and shales likely of the Paleocene age (Meyboom 1960). Although most of the area is covered by glacial drift, the Cypress Hills were not affected by glacial activity. This formation consists of pebble and cobble conglomerate with some sandstone lenses (Borneuf 1976).

Blood Reserve Formation – This unit consists of grey to greenish grey, thick bedded, feldspathic sandstone on the western edge of the watershed.

St. Mary Formation – The non-marine St. Mary Formation consists of pale grey and green, fine to medium grained calcareous sandstone and green and grey siltstone. The St. Mary Formation is located on the western edge of the watershed.

Willow Creek Formation – This unit consists of grey, green and pink, bentonitic mudstone with interbeds of pale grey, fine-grained calcareous non-marine sandstone. The Willow Creek Formation is located in the northwestern area of the watershed, near Lonely Valley.

Del Bonita Gravels - Extensive gravel deposits of pre-glacial age are located within upland areas in the Del Bonita area. In the vicinity of Del Bonita, pre-glacial gravel covers an area of approximately 50 km^2. The material varies in thickness from 3 to 5 m and generally has less than 3 m of overburden. These pre-glacial deposits are not being widely utilized at present but may become an important source of granular material in the future (Shetson 1980).

Sweetgrass Hills Intrusives – This unit was formed by plutonic (i.e., deep igneous) activity associated with primary tectogenesis. These intrusions together with more deeply seated intrusions, disturbed the regional dip in the area and created a radiating pattern of nose and dome-like structures extending from Montana into Alberta (Meyboom 1960).

2.3 Pre-glacial Topography and Buried Valleys

The major pre-glacial drainage basins in southern Alberta consisted of the Lethbridge and Whisky River systems. The Whisky River system encompasses most of the current Milk River watershed and was separated from the Lethbridge system by the Milk River Ridge. At the upstream end, the Whisky and North Whisky rivers followed similar alignments to the current modern day river systems; however, the alignments are not coincidental and there are many areas where the alignments cross each other. Downstream of the Town of Milk River the pre-glacial Whisky River and current Milk River are more or less coincidental for a significant length. Unlike the modern day Milk River which flows south into Montana, the pre-glacial Whisky River flowed northeastward near Pakowki Lake towards the Medicine Hat pre-glacial valley.

The pre-glacial valleys are typically very mature and are infilled at the bottom of valley with Saskatchewan gravels. In many areas, the pre-glacial valleys were eroded to lower elevations below the current river valleys. This is the case near the confluence of the Milk River and North Milk River where the pre-glacial buried Whisky valley is greater than 30 m below the existing Milk River ((Klohn Crippen Consultants Ltd. 2003).

The North Milk River and much of the upper Milk River flow in a stream cut valley that follows along the course of the much older pre-glacial drainage channel. The valley is generally wide (up to 2 km) and has walls composed of glacial till or other valley-fill sediments, underlain at depth by sandstone. The modern day valley is steep walled and narrow in areas where the river has been deflected outside the course of the pre-glacial channel (Klohn Crippen Consultants Ltd. 2003).

2.4 Surficial Geology

A large portion of the Milk River watershed topography was influenced by the Laurentide glaciation and post-glacial activity. Most areas adjacent to the Milk River valley were covered

Map 2.2. Surficial Geology
(adapted from Shetsen 1987)

CRETACEOUS AND TERTIARY, UNDIVIDED

- 16 BEDROCK
- Surface modified by lake and stream erosion and deposition
- End moraine ridge
- Linear feature parallel to ice movement
- Linear feature transverse to ice movement
- Ice-thrust ridge
- Ice-thrust block
- Esker
- Major meltwater channel
- Minor meltwater channel
- Meltwater channel partly buried by glacial deposit
- Alluvial fan

PLEISTOCENE AND HOLOCENE, UNDIVIDED

- 1 EOLIAN DEPOSIT
- LACUSTRINE DEPOSIT
  - 2a Coarse sediment
  - 2b Fine sediment
- FLUVIAL DEPOSIT
  - 3a Coarse sediment
  - 3b Fine sediment
- 4 STREAM AND SLOPEWASH ERODED DEPOSIT

PLEISTOCENE

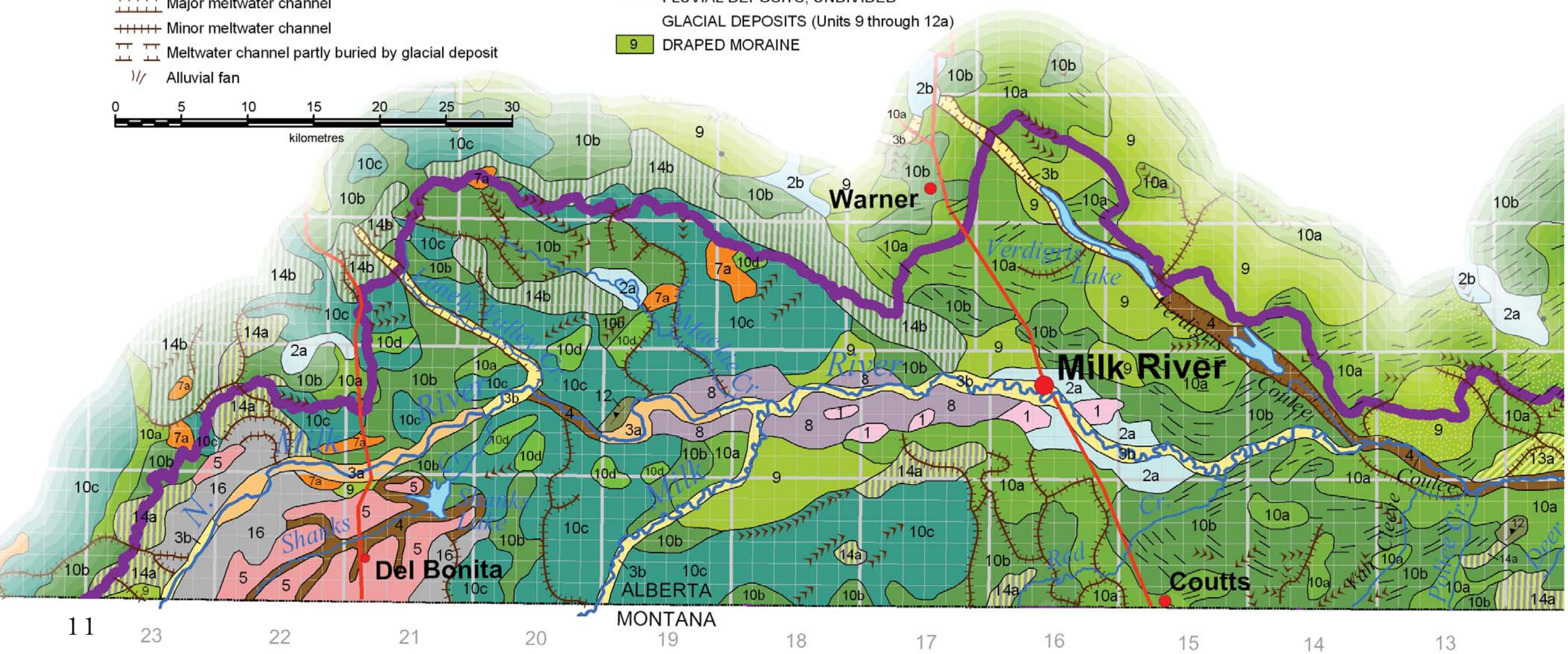
- 5 CRYOTURBATED EOLIAN AND FLUVIAL DEPOSIT
- ICE CONTACT LACUSTRINE DEPOSIT
  - 6a Coarse sediment
  - 6b Fine sediment
- ICE CONTACT FLUVIAL DEPOSIT
  - 7a Coarse sediment
  - 7b Fine sediment
- 8 ICE CONTACT LACUSTRINE AND FLUVIAL DEPOSITS, UNDIVIDED
- GLACIAL DEPOSITS (Units 9 through 12a)
- 9 DRAPED MORAINE
- STAGNATION MORAINE
  - 10a Undulating topography
  - 10b Hummocky topography moderately to weakly developed
  - 10c Hummocky topography strongly developed
  - 10d Mixed hummocky and moraine plateau topography
- 11 RIDGED END MORAINE
- 12 ICE - THRUST MORAINE
- 12a ICE THRUST AND STAGNATION MORAINE, UNDIVIDED
- GLACIAL AND FLUVIAL DEPOSITS, UNDIVIDED
  - 13a Draped moraine interspersed with fluvial deposit
  - 13b Stagnation moraine interspersed with fluvial deposit

CRETACEOUS, TERTIARY AND PLEISTOCENE, UNDIVIDED

- BEDROCK AND GLACIAL DEPOSIT, UNDIVIDED
  - 14a Draped moraine on bedrock uplands and plains
  - 14b Stagnation moraine on bedrock uplands

LATE TERTIARY AND EARLY PLEISTOCENE

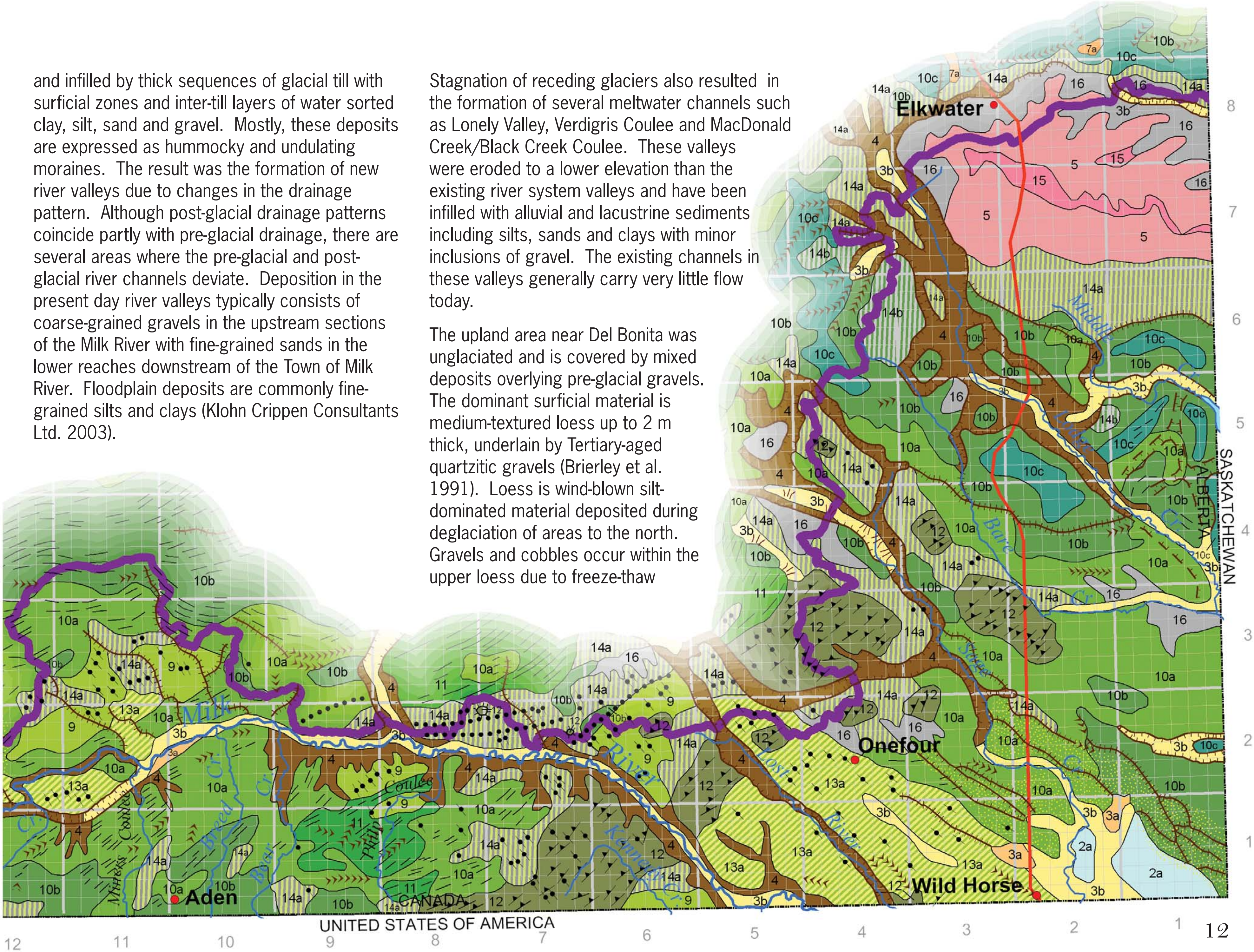
- 15 FLUVIAL DEPOSITS



and infilled by thick sequences of glacial till with surficial zones and inter-till layers of water sorted clay, silt, sand and gravel. Mostly, these deposits are expressed as hummocky and undulating moraines. The result was the formation of new river valleys due to changes in the drainage pattern. Although post-glacial drainage patterns coincide partly with pre-glacial drainage, there are several areas where the pre-glacial and post-glacial river channels deviate. Deposition in the present day river valleys typically consists of coarse-grained gravels in the upstream sections of the Milk River with fine-grained sands in the lower reaches downstream of the Town of Milk River. Floodplain deposits are commonly fine-grained silts and clays (Klohn Crippen Consultants Ltd. 2003).

Stagnation of receding glaciers also resulted in the formation of several meltwater channels such as Lonely Valley, Verdigris Coulee and MacDonald Creek/Black Creek Coulee. These valleys were eroded to a lower elevation than the existing river system valleys and have been infilled with alluvial and lacustrine sediments including silts, sands and clays with minor inclusions of gravel. The existing channels in these valleys generally carry very little flow today.

The upland area near Del Bonita was unglaciated and is covered by mixed deposits overlying pre-glacial gravels. The dominant surficial material is medium-textured loess up to 2 m thick, underlain by Tertiary-aged quartzitic gravels (Brierley et al. 1991). Loess is wind-blown silt-dominated material deposited during deglaciation of areas to the north. Gravels and cobbles occur within the upper loess due to freeze-thaw



processes over the last 18,000 years since the glacial maximum. Glaciofluvial sands and gravels also cover the upland area surrounding the Milk River near the confluence with the North Milk River.

The combination of low rainfall, limited vegetation growth and presence of erodible valley deposits has resulted in the formation of extensive areas of badlands which contribute large quantities of silt and sand-sized sediments to the Milk River (Borneuf 1976).

2.5 Regional Hydrogeology

Regional hydrogeology in the Milk River watershed is characterized by the groundwater conditions in the surficial Quaternary deposits, pre-glacial alluvial deposits and the underlying bedrock. The groundwater flow patterns in the Quaternary deposits trend in the same manner as the existing drainage basin. The drainage basin serves as a groundwater sink and shallow or near-to-surface groundwater flows are typically towards adjacent river and creek drainage channels. Groundwater levels are generally perched on or within zones of glacial drift, seepage zones and springs are observed along valley slopes at the contacts of different geologic deposits (Klohn Crippen Consultants Ltd. 2003).

Pre-glacial valleys in the Milk River watershed generally drain eastward. Groundwater pressures in the pre-glacial alluvium are maintained by recharge from higher topographical areas in the west. Generally the pre-glacial alluvium is below the existing valley bottom although groundwater pressures are often higher.

Groundwater pressures in the upper bedrock formations are influenced by the near surface and pre-glacial drainage patterns and trend towards these drainages. The Milk River sandstone formation is thought to be recharged from areas exposed or subcropping sandstone, from surrounding bedrock and buried valleys, and from the Sweetgrass Hills. Flows in this formation are towards the northeast and north resulting in flowing artesian pressures in some areas as the land surface drops in elevation. The influence of local topography is not readily noticeable, except along some of the coulees, where depression of the piezometric surface may be due not so much to the effect of topography as to a lowering of water levels by strong flowing wells located in the coulees (Tokarsky 1974).

2.6 Watershed Hydrology

Many small tributaries, most of which flow northward from the Sweetgrass Hills of Montana, feed the Canadian reach of the Milk River. Many of these streams are intermittent. Once the Milk River re-enters Montana, it is joined by numerous southward flowing tributaries from the Cypress Hills area of Alberta and Saskatchewan and northward flowing streams from the Bearspaw Mountains of Montana (Winhold and Quazi 1987). Throughout most of the Milk River watershed, the topography consists of gently rolling prairie, vegetated by grassland suitable for grazing and ranching. The area is arid, with most of the precipitation occurring between April and August.

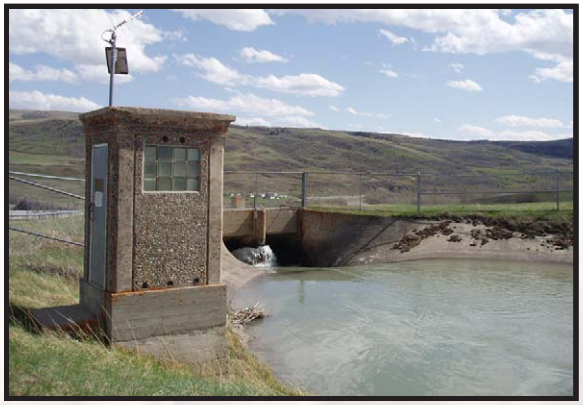
The St. Mary River also originates in Montana and drains the catchments west of the Milk River watershed. The St. Mary River flows northward into Alberta where it eventually flows into the South Saskatchewan River. In order to utilize its share of the water in the St. Mary River system, the United States, between 1906 and 1911 constructed storage works and a diversion canal, known as the St. Mary canal, in northern Montana to divert flows from the St. Mary River to the North Milk River. This canal is normally operated during the irrigation season of each year from April to October and during some periods provides the majority of flow in the river.

Mean annual runoff from the Canadian portion of the Milk River watershed ranges from approximately 45 mm on the western ends to 15 mm at the eastern end of the watershed. Most of the runoff occurs during snowmelt (Klohn Crippen Consultants Ltd. 2003).

St. Mary River - A Part of Milk River Watershed Hydrology

1. St. Mary River, Montana.

2. St. Mary - Milk River diversion headworks.



3. Gauging station upstream of syphon.

4. Syphons delivering water to the Milk River into Canada from Montana.

5. St. Mary canal in Monanta by the Alberta border.

2.7 Physiography, Relief and Drainage

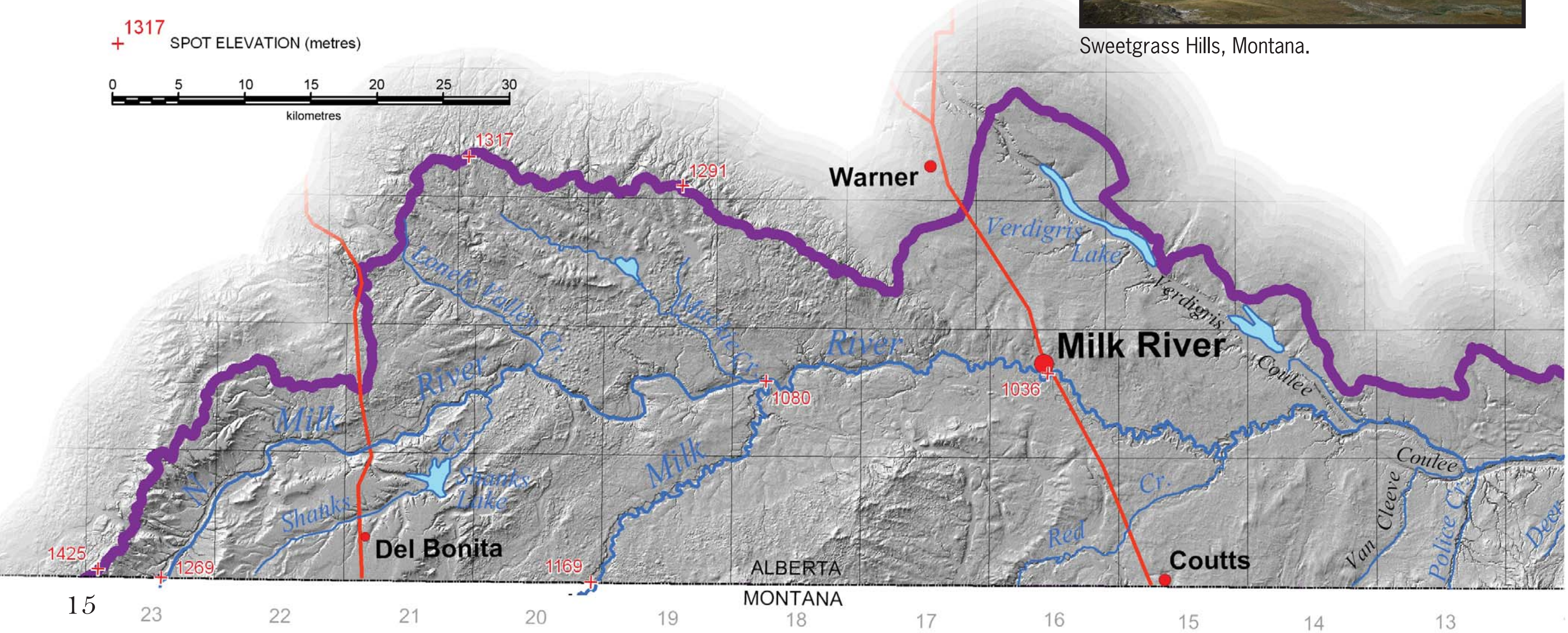
The Milk River watershed encompasses two physiographic regions: Western Alberta Plains and Southern Alberta Uplands. These regions are further divided into sections and districts. The Verdigris Plain (920 m – 1,070 m) ecodistrict is part of the Western Alberta Plain, and the Milk River Ridge (1,070 m – 1,340 m), Milk River Plain (1,040 m – 1,340 m), and Sweetgrass Upland (1,040 m – 1,290 m) ecodistricts are part of the Southern Alberta Uplands (Kjearsgaard et al. 1986).

The Verdigris Plain is characterized by a partially dissected landscape of morainal material overlying rolling bedrock. Significant areas of lacustrine veneer overlying till also occur. A local high of 1,000 m occurs approximately 2 km east of Coutts on the 49th parallel (Kjearsgaard et al. 1986). At the point where the Milk River flows out of Canada the elevation is 819 m, the lowest elevation in Alberta.

Hummocky morainal landforms as well as undulating and terraced fluvial materials characterize the Milk River Plain. Elevations in this district are significantly lower than those of the Milk River Ridge (Kjearsgaard et al. 1986).

Sweetgrass Hills, Montana.

Map 2.3. Physiography, Relief and Drainage

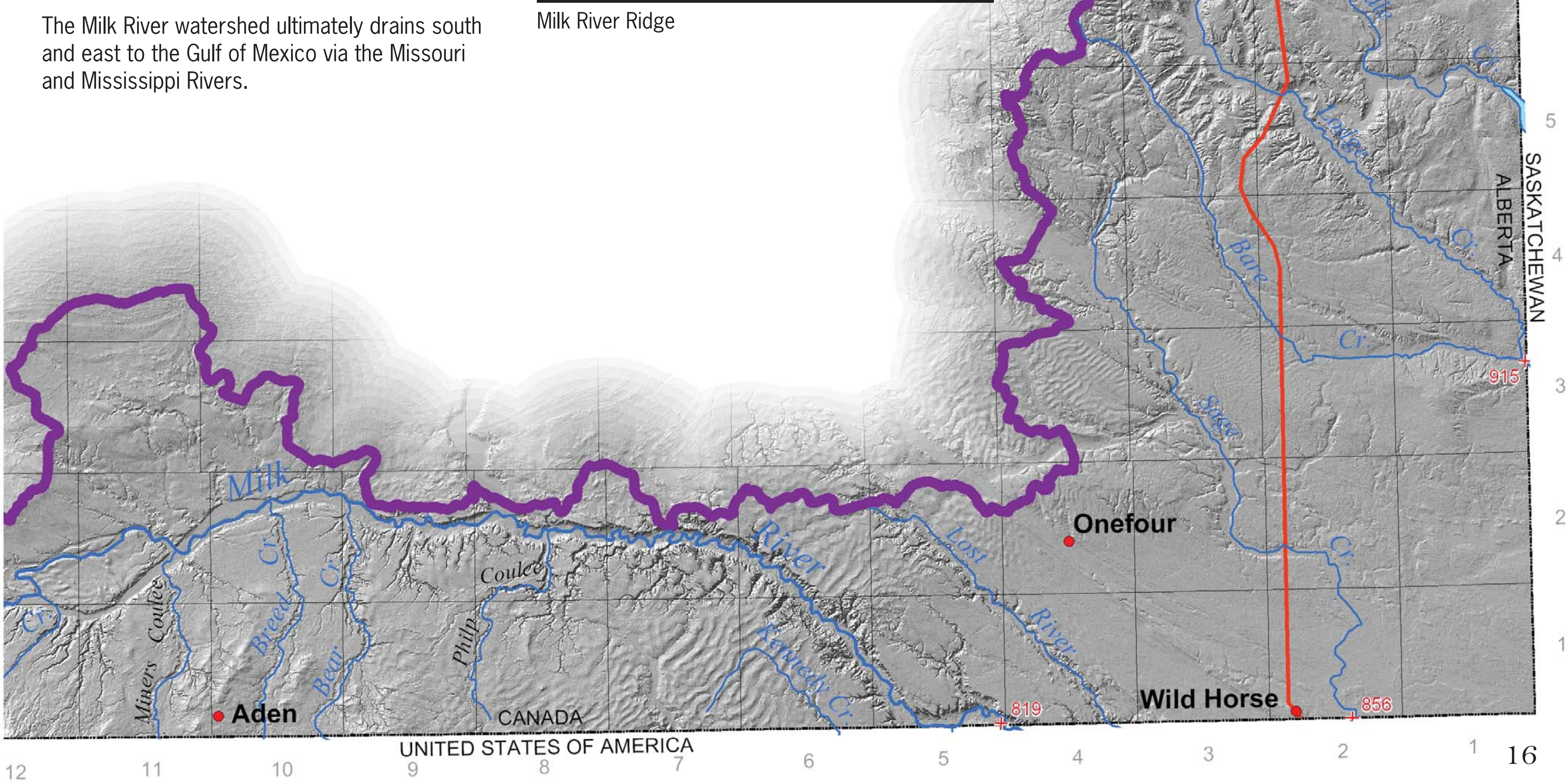


Hummocky and dissected morainal landforms overlying inclined bedrock, typifies the Sweetgrass Upland. It forms the north shoulder of the Sweetgrass Hills, which reach an elevation of 2,100 m in Montana.

Generally going from northeast to southwest, elevations and relief gradually increase until the Milk River Ridge is reached. There, an abrupt increase occurs in both elevation and relief. These changes are reflected in the slopes that prevail in various parts of the watershed.

The Milk River watershed ultimately drains south and east to the Gulf of Mexico via the Missouri and Mississippi Rivers.

Milk River Ridge



2.8 Soils

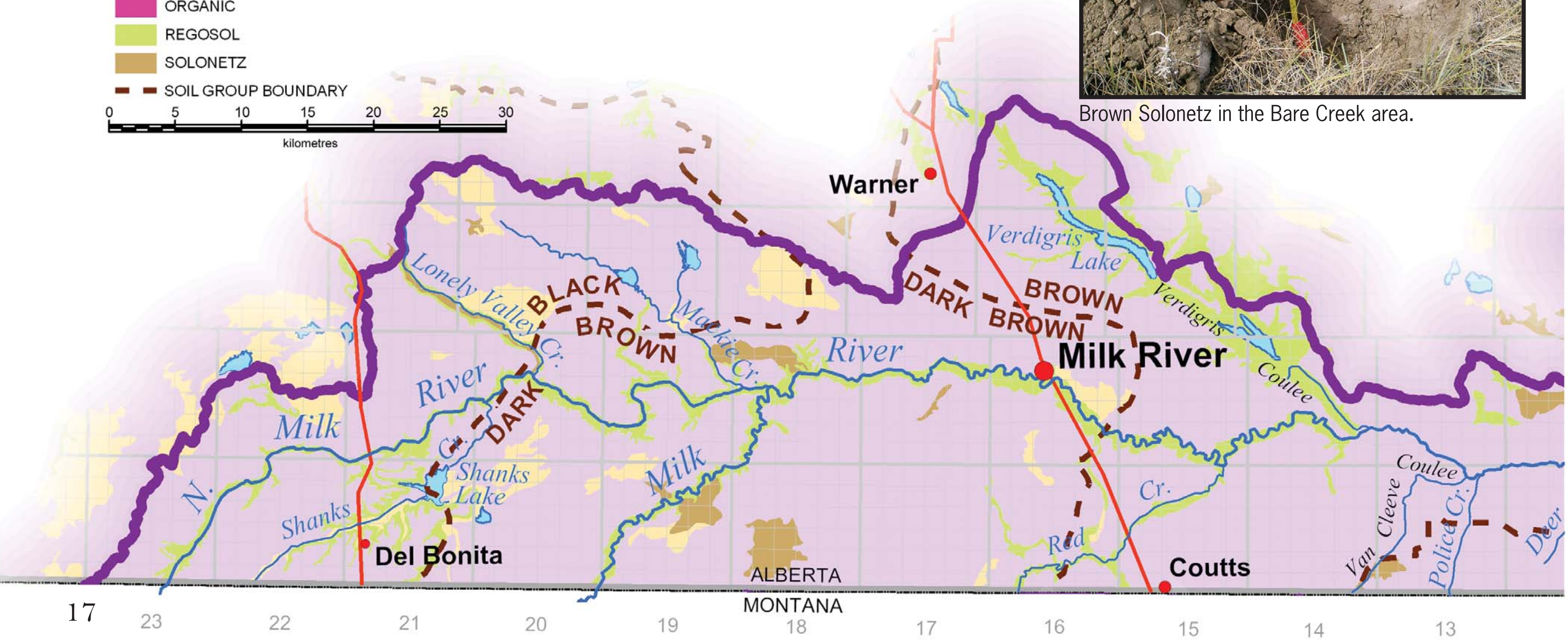
Soils are the foundation of the watershed, providing minerals for plants, absorbing rainwater and releasing it at a later date to prevent floods and droughts, and providing habitat for microorganisms. Soils in the Milk River watershed reflect changes in climate that can be seen in the surface colours of soils. These colours range from Brown to Dark Brown to Black (Kjearsgaard et al. 1986; McNeil et al. 1994).

Soils of the Black soil zone dominate in the western portion of the watershed and on the Cypress Hills Plateau where precipitation is slightly greater and temperatures slightly cooler than most of the eastern and southern portions of the watershed. Soils in the eastern portion of the watershed are dominated by the Brown soil zone and soils between these two extremes are of the Dark Brown soil zone.

Climatic, topographical, and parent material conditions have resulted in the development of Orthic Black, Orthic Dark Brown, and Orthic Brown Chernozems, which are the dominant soils that persist throughout the watershed, McNeil et al. 1994). These soils typically contain an A-horizon (topsoil layer) that is approximately 10 cm to 15 cm thick, over a Bm horizon (subsoil). The parent material in the area is typically a medium to moderately fine textured glacial till or a veneer (< 100 cm) of glaciolacustrine or

Brown Solonetz in the Bare Creek area.

Map 2.4. Soil Orders

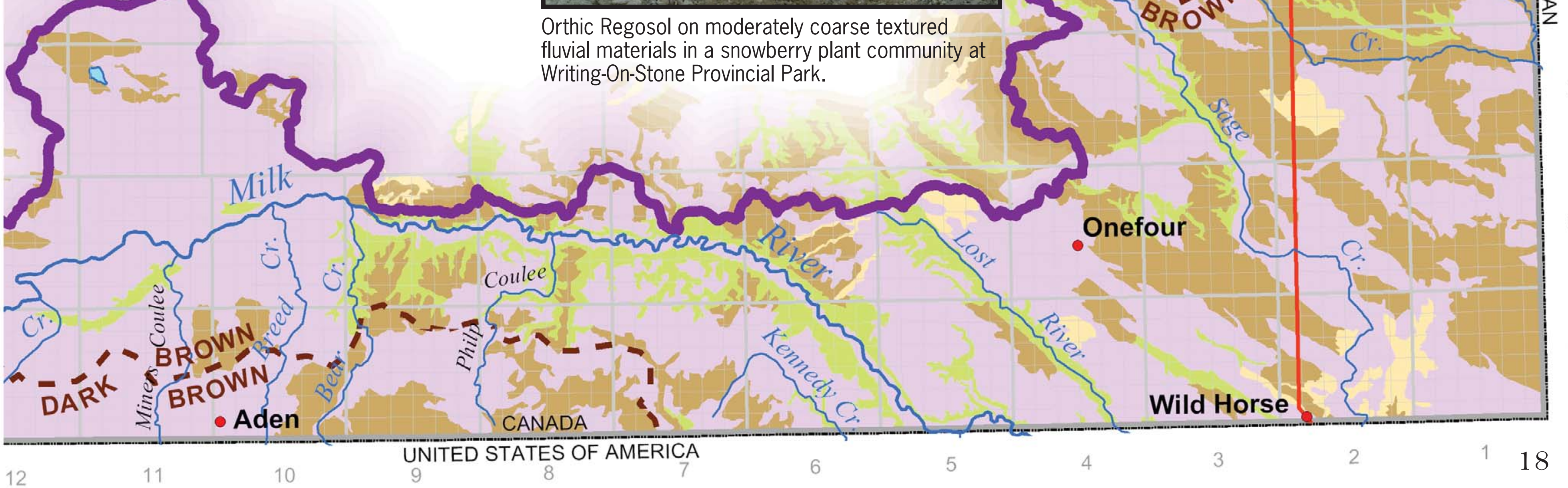


glaciofluvial material over medium textured, moderately calcareous till. Undulating and hummocky terrain and slopes between 2% and 9% predominate in these areas. Where soils have developed on more sodic or saline materials, Solonetzic soils and saline phases of Chernozemic soils occur.

Gleyed and Gleysolic soils are typically found in the poorly drained depressions associated with hummocky terrain and medium to fine-textured till or lacustrine veneers over till. If groundwater discharge occurs in these areas, localized salinization may be evident.

Regosols are poorly developed soils. These soils are primarily found in two locations: 1) on eroded knolls, as minimal infiltration of precipitation retards soil development, resulting in a Regosol; and 2) floodplain areas, frequent flooding disrupts profile development, either by deposition of sediment or scour (removal) of material, resulting in a Regosol.

Orthic Regosol on moderately coarse textured fluvial materials in a snowberry plant community at Writing-On-Stone Provincial Park.



2.9 Natural Subregions

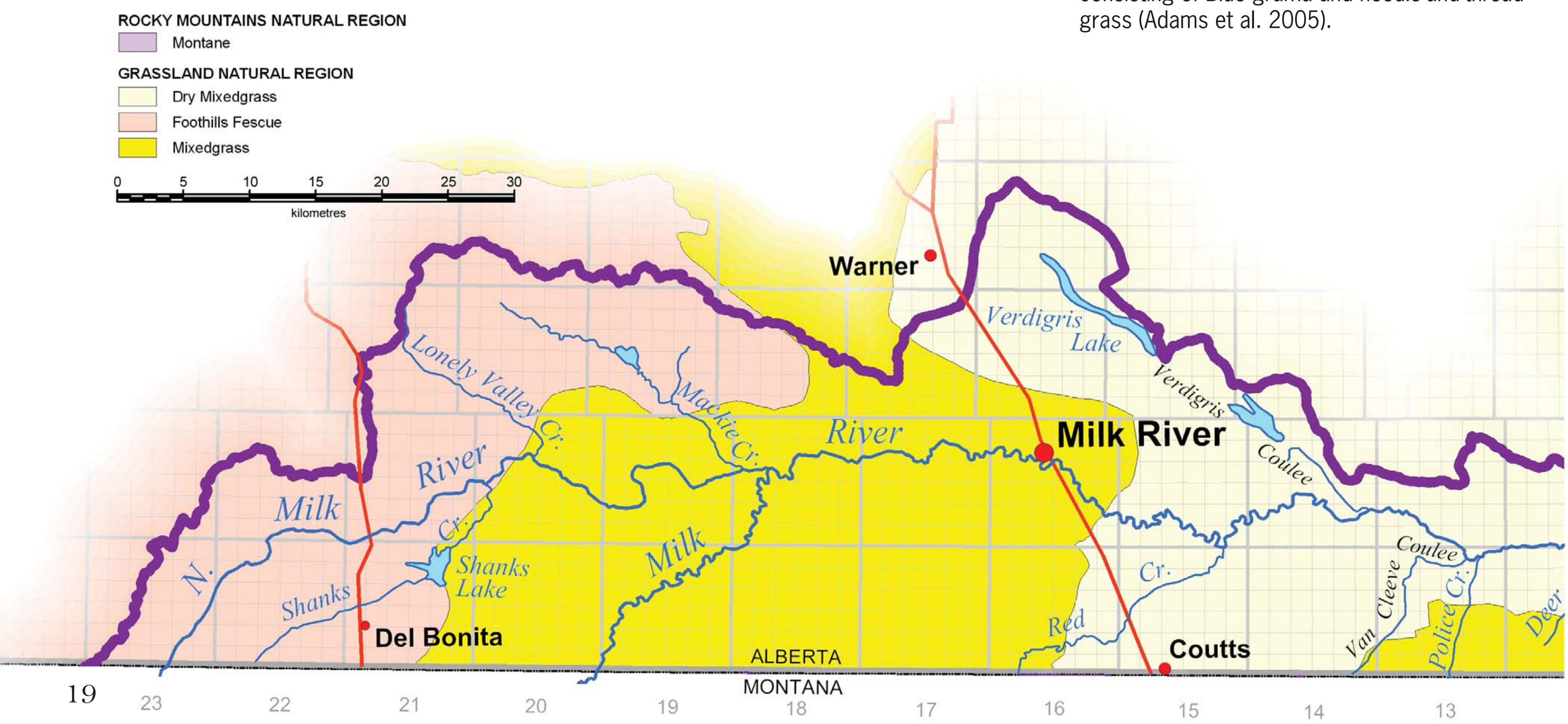
There are two natural regions represented in the Milk River watershed; these are the Rocky Mountains Natural Region and the Grassland Natural Region. The Grassland Natural Region contains four subregions. Only three of these subregions are represented in the Milk River watershed; these are Foothills Fescue, Mixedgrass and Dry Mixedgrass.

The Foothills Fescue subregion covers 10.4% of the Milk River watershed. This natural subregion is dominated by Black Chernozemic soils and a vegetation community dominated by foothills rough fescue *(Festuca campestris)* (Adams et al. 2003).

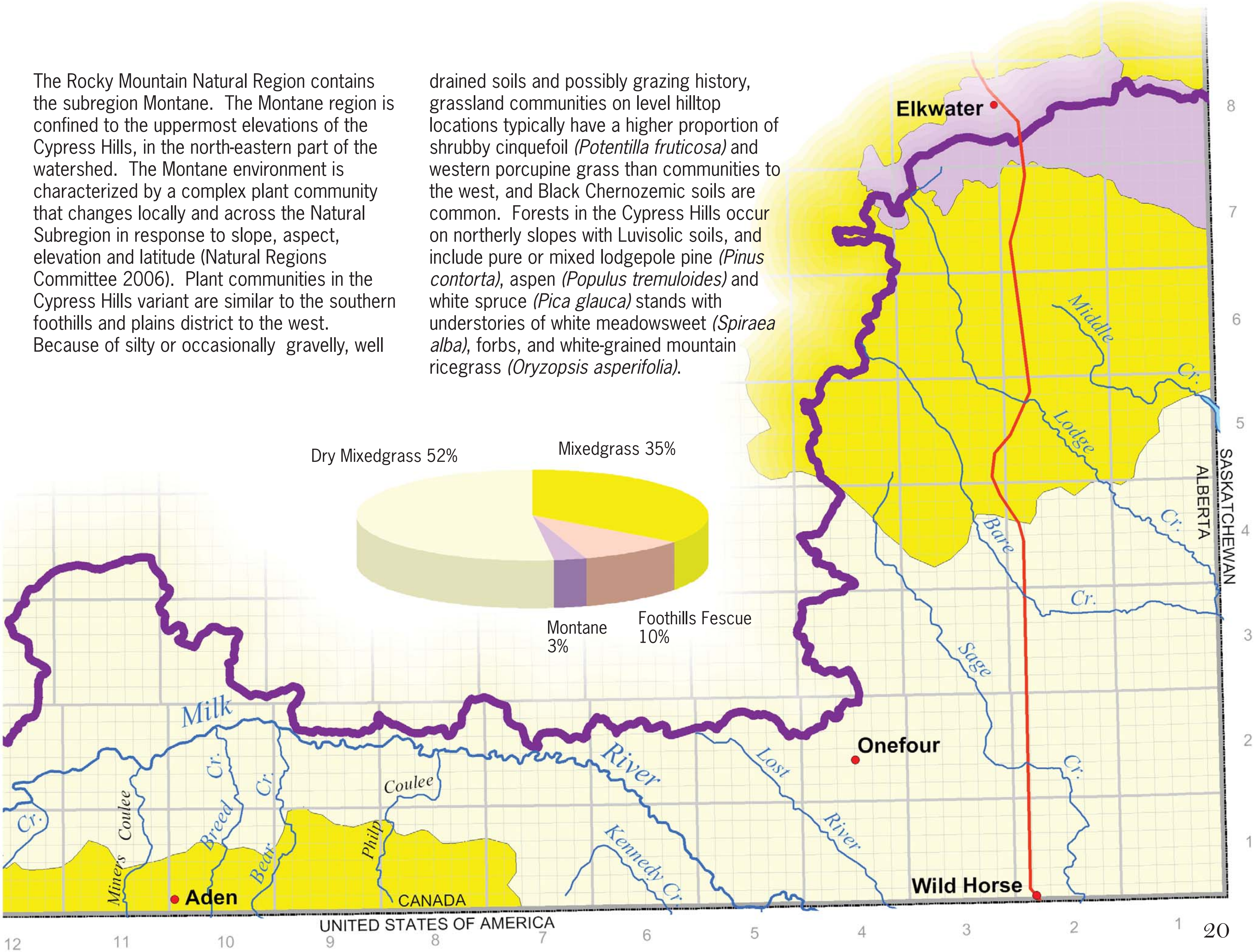
The Mixedgrass subregion covers 35.2% of the watershed. This subregion is comprised of the Dark Brown soil zone. Vegetation types include needle-and-thread grass *(Stipa comata)*, western porcupine grass *(Stipa curtriseta)*, western wheat grass *(Agropyron smithii)*, northern wheat grass *(Agropyron dasystachym)* and green needle grass *(Stipa viridula)*. Blue grama *(Boutelua gracilis)* may also be part of this community but normally occurs at 1 to 2% cover. Where abundant, it is an indicator of past heavy grazing pressure (Adams et al. 2004a).

The Dry Mixedgrass subregion is the second largest natural subregion in Alberta (Natural Regions Committee 2006). It covers 51.6% of the watershed. This subregion is dominated by Brown Chernozemic soils and vegetation consisting of Blue grama and needle-and-thread grass (Adams et al. 2005).

Map 2.5. Natural Subregions



The Rocky Mountain Natural Region contains the subregion Montane. The Montane region is confined to the uppermost elevations of the Cypress Hills, in the north-eastern part of the watershed. The Montane environment is characterized by a complex plant community that changes locally and across the Natural Subregion in response to slope, aspect, elevation and latitude (Natural Regions Committee 2006). Plant communities in the Cypress Hills variant are similar to the southern foothills and plains district to the west. Because of silty or occasionally gravelly, well drained soils and possibly grazing history, grassland communities on level hilltop locations typically have a higher proportion of shrubby cinquefoil *(Potentilla fruticosa)* and western porcupine grass than communities to the west, and Black Chernozemic soils are common. Forests in the Cypress Hills occur on northerly slopes with Luvisolic soils, and include pure or mixed lodgepole pine *(Pinus contorta)*, aspen *(Populus tremuloides)* and white spruce *(Pica glauca)* stands with understories of white meadowsweet *(Spiraea alba)*, forbs, and white-grained mountain ricegrass *(Oryzopsis asperifolia)*.



2.10 Land Cover

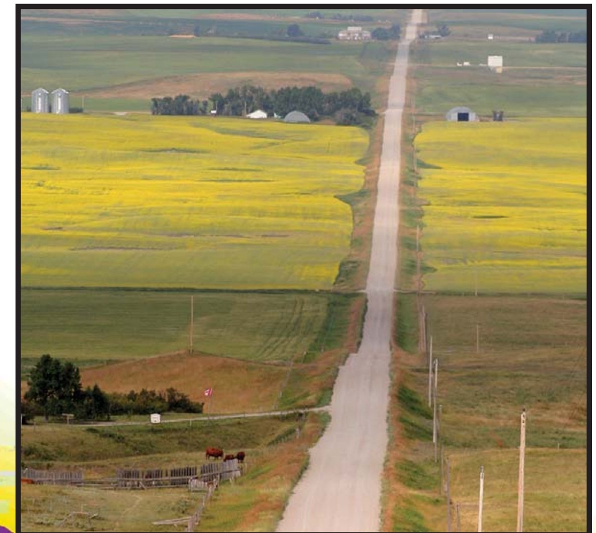
The Milk River watershed is diverse in its land cover types. The most abundant land cover is native grassland, representing an area of 4,782 km^2 or 71% of the watershed area.

Crops comprise the second largest land cover type, covering an area of 856 km^2 or 13% of the watershed area. Refer to Section 4.3 for more information regarding agriculture in the watershed. Tame grass, such as crested wheat grass *(Agropyron pectiniforme)*, covers 5.7% of the watershed area.

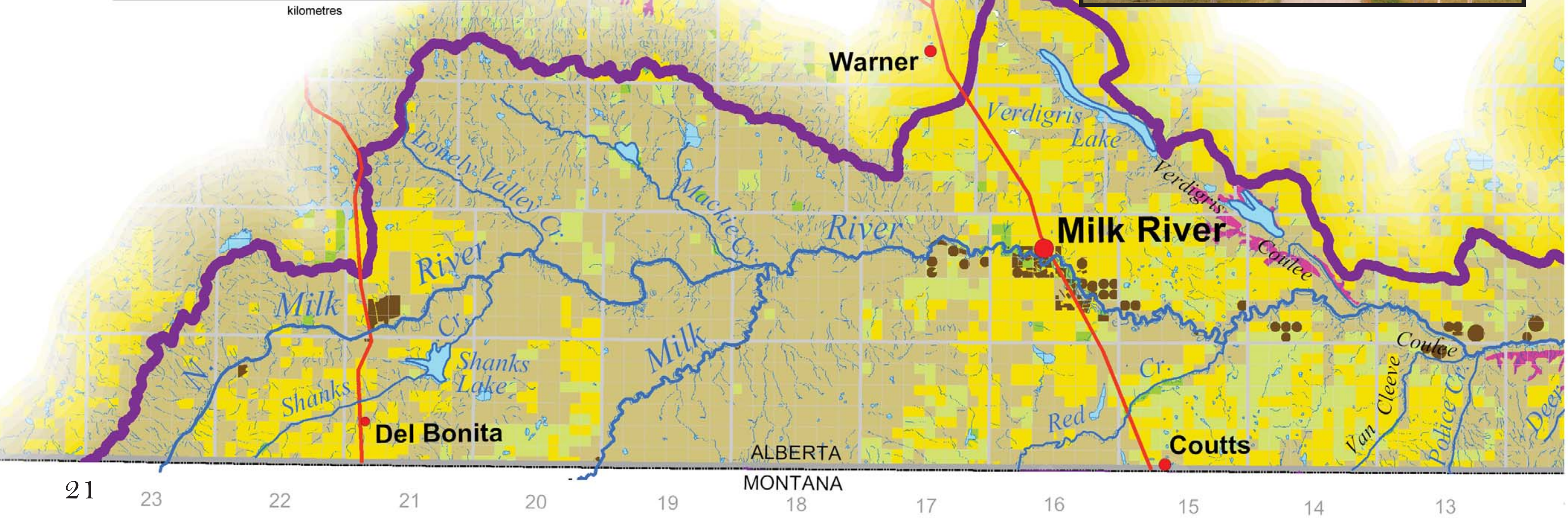
Only 3% of the Milk River watershed is covered by shrubs and forests. Although shrubs are commonly found in coulees, riparian areas and adjacent to wetlands, forests are confined to the Montane region of the watershed, in the Cypress Hills.

Water is a limited resource in the watershed as less than 2% of the area is covered by lakes, rivers, creeks and open-water wetlands. A lack of water in this semi-arid environment has influenced every aspect of the watershed, from the unique vegetation and wildlife found in the area to land use, population, culture and economy.

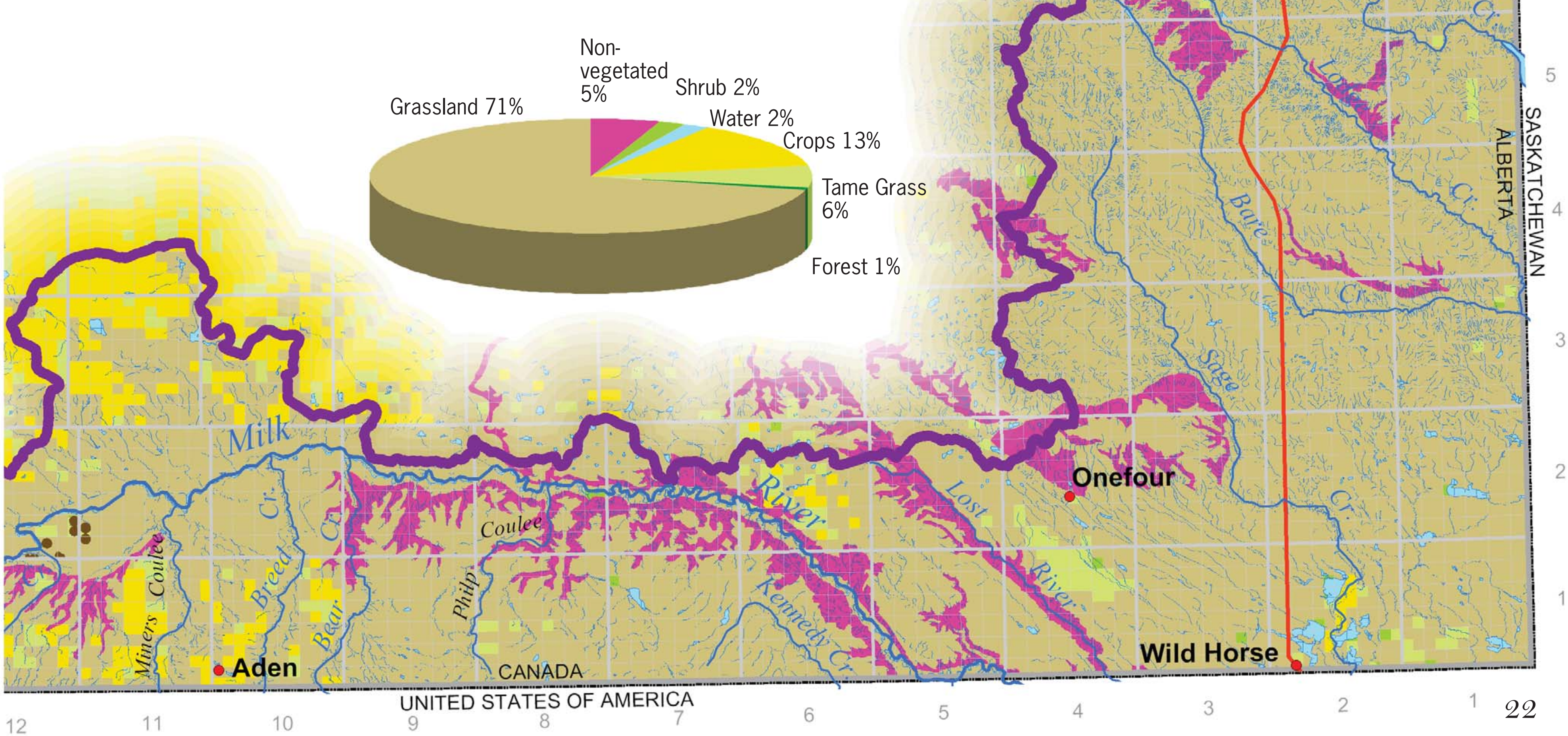
Nearly 5% of the watershed is non-vegetated and considered part of the Alberta badlands. Badlands are restricted mainly to areas of semi-arid to arid climate in which relatively weak bedrock is horizontally layered and the



Map 2.6. Land Cover



vegetation cover extremely sparse or completely absent (Beaty 1975). Badlands or bedrock outcrops apply to all inclined to steeply sloping landscapes with greater than 10% bedrock exposures of soft rock or hard rock less than 1 m deep. Slopes generally range from 15% to 60%, but in isolated cases can range from 7% to 100% (AGRASID 3.0). Most badlands development in the southern plains has been in rocks of the Late Cretaceous age (Beaty 1975).



2.11 Native Vegetation

Historically, native prairie vegetation (i.e., Tallgrass, Mixedgrass and Shortgrass) covered an area of approximately 29.2 million hectares across the Canadian prairie provinces. Approximately 6.7 million hectares remained in 1997, corresponding to a loss of about 77%.

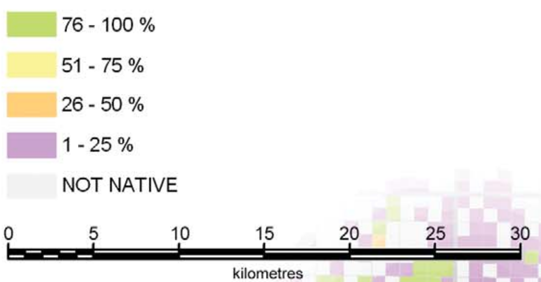
Generally, contiguous tracts of native grassland is replaced by numerous small prairie patches distributed across the landscape. Isolation of prairie patches can alter the structure and function of native plant communities. Local populations of rare and uncommon plant species tend to naturally phase in and out, relying on adjacent populations for recolonization (Klohn Crippen Consultants Ltd. 2003).

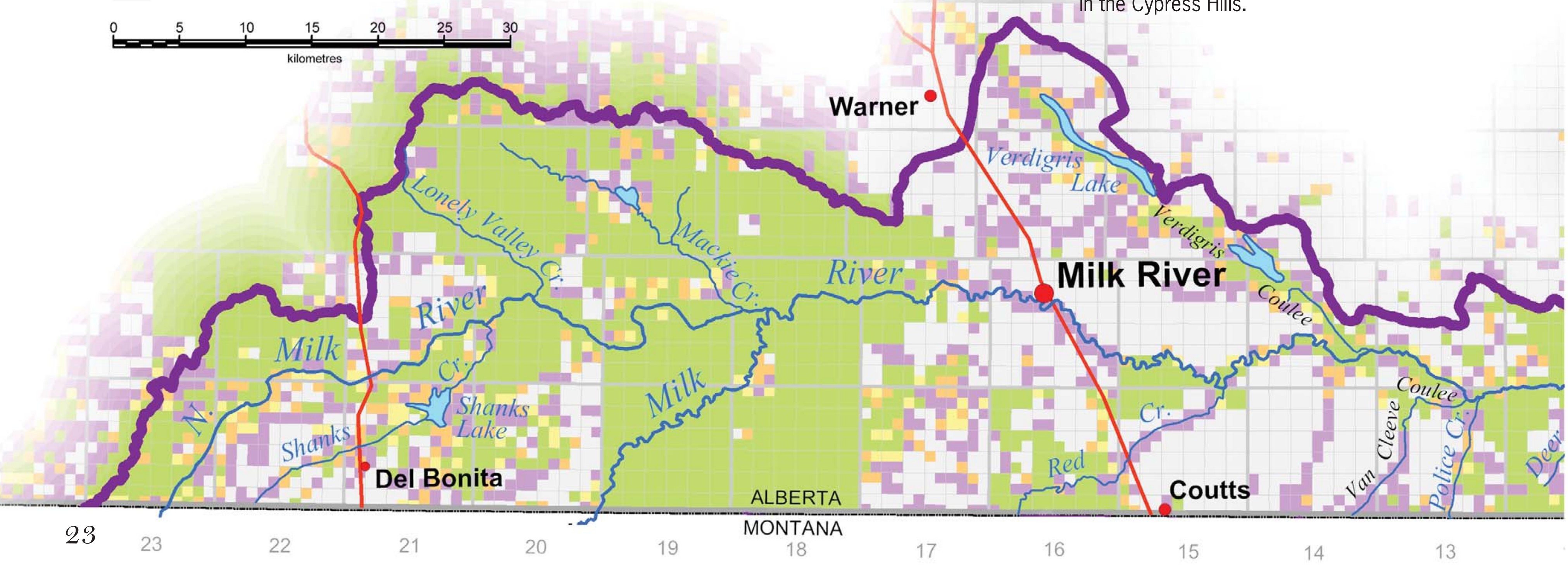
An estimated 5,421 km^2 or 81% of the Milk River watershed remains covered by native vegetation (i.e. grasslands, badlands, shrubs and forest). This is a large percentage compared to other areas in Alberta that have seen a continuing decrease in the amount of native vegetation present. Much of the native prairie vegetation is maintained on crown lands which comprises 60% of the watershed (refer to Map 3.2, page 30).

The current native prairie vegetation inventory was compiled from aerial surveys conducted from 1991 to 1993. In 2005, the Grassland Vegetation Inventory (GVI) was undertaken to replace this data set. Once complete, GVI will capture and display in a mapped form trees, grasslands, wetlands, riparian areas and land use activities for the prairies (J. Leger, ASRD, pers.comm.)

Foothills Natural Subregion - Foothills rough fescue in the Cypress Hills.

Map 2.7. Native Prairie Vegetation

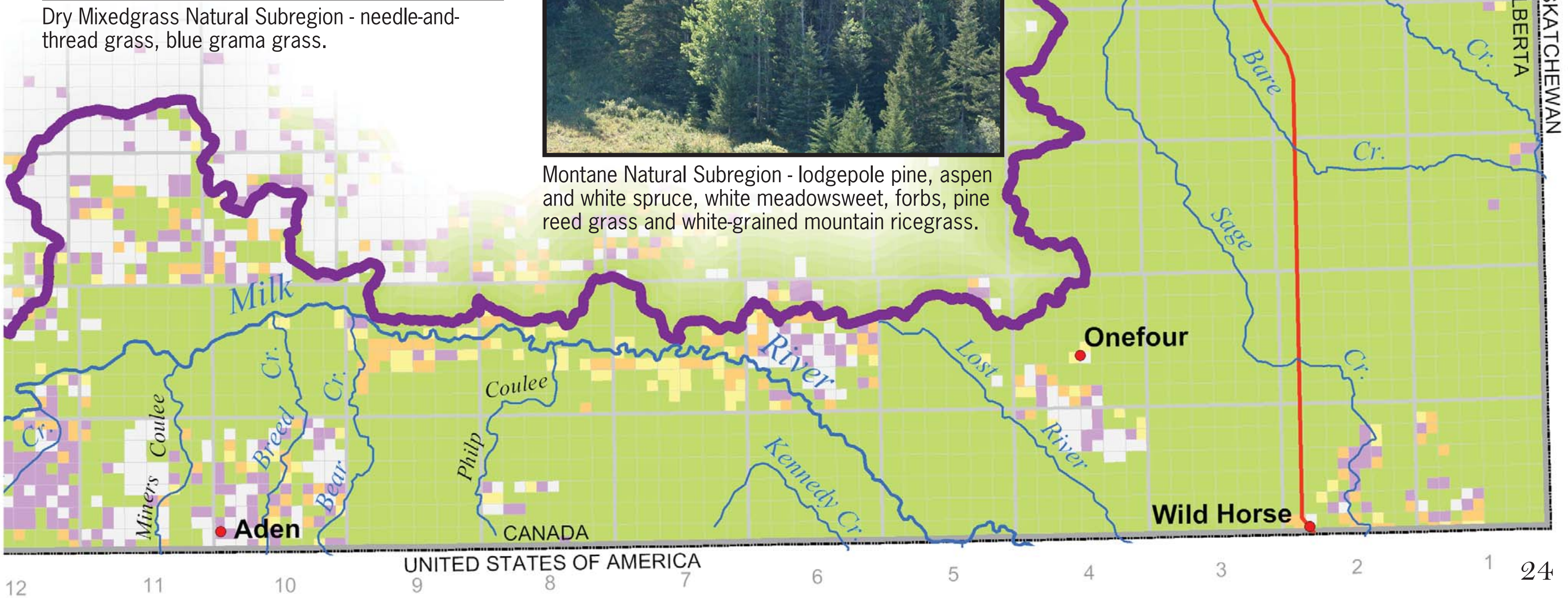




Dry Mixedgrass Natural Subregion - needle-and-thread grass, blue grama grass.

Mixedgrass Natural Subregion - western porcupine grass, western wheat grass, northern wheat grass and green needle grass.

Montane Natural Subregion - lodgepole pine, aspen and white spruce, white meadowsweet, forbs, pine reed grass and white-grained mountain ricegrass.



3.0 Social History

3.1 First Nations

The area of land between the Sweetgrass Hills and the Cypress Hills was considered "neutral territory" and is the heartland of the region known as the traditional territory of the Blackfoot/Blackfeet people.

Within this traditional land are the Kainaai (Blood), Siksika (Blackfeet) and the Piikani (Peigan), the member tribes of the Nitsiapii (Real People). The Piikani consist of two groups, the South Peigan who refer to themselves as the Blackfeet residing in Montana, and the north Peigan in Southern Alberta (Reeves and Peacock 1995). The Sweetgrass Hills lie in the territory of the Blackfeet and Atsina. To the east, the Cypress Hills mark the western edge of the Assiniboine and Plains Cree territories (Rees 1995). For the area between, historical records indicate that the Stoney, Cree, Saulteaux and Shoshone have also used the region.

Three Bulls, Sitting on an Eagle Tail Feathers, Crowfoot, and Red Crow, 1884. (Glenbow Museum, Reprinted with permission).

> Any band of any affiliation was welcome to hunt the buffalo, the wolf or the grizzly anywhere between the Sweetgrass and Cypress hills. No permission was needed; no common interest truces were negotiated. Anyone could hunt the Milk River country, but to do so was to accept a set of conditions so fundamental that they were probably subconscious.
>
> (Rees 1995)

Uhlenbeck (1912) noted a seasonal cycle of movement for First Nations people that included Peigan travel into Milk River country as the bison moved north to the Alberta border. Usually, the Peigan were able to hunt the animals in the areas of the Sweetgrass or Cypress Hills, after which they moved along the Milk River for greater bison hunting. From here, the Peigan moved to the area of Pakowki Lake, south of the current Manyberries, on the edge of the Cypress Hills. Bison hunting and berries were collected at this site. The South Peigan moved back toward the Cypress Hills to an area identified as "Green Lake". Graspointer (1981) interprets this as being the area of Verdigris Lake (literally "grey-green" in its translation). In this area, the people hunted for stray bulls whose hair and hide were made into ropes. The South Peigan were then noted as moving into the area of Writing-On-Stone, where camping for chokecherry collection was made to supplement winter stores. In fall, the South Peigan traveled west along the Milk River, to a place known as "Women's Point" which is believed to be close to the Milk River Ridge (Graspointer 1981). Here, the people hunted for bison, antelope, wolves, badgers and skunks. The seasonal cycle would then take the South Peigan south into territories of the Cut Bank River, and later to wintering areas along the Marias River in Montana.

Members of the Blackfoot Nation used the area now known as Writing-On-Stone", which they called Aisinai'pi ("it has been written"). Evidence of their presence is seen in the form of petroglyphs and pictographs dating back within the last 500 years. Groups which may have contributed to the work include Shoshone, Kutenai and Atsina, as well as the Blackfoot Nations.

The Metis also used the corridor of the Cypress-Sweetgrass Hills, focusing their settlements along the Red River to the east. The Metis reflected the heritage of Chippewa, Cree and French. They used hunting areas far to the west in regions along the Missouri River and its tributaries, particularly along the Milk River in Montana.

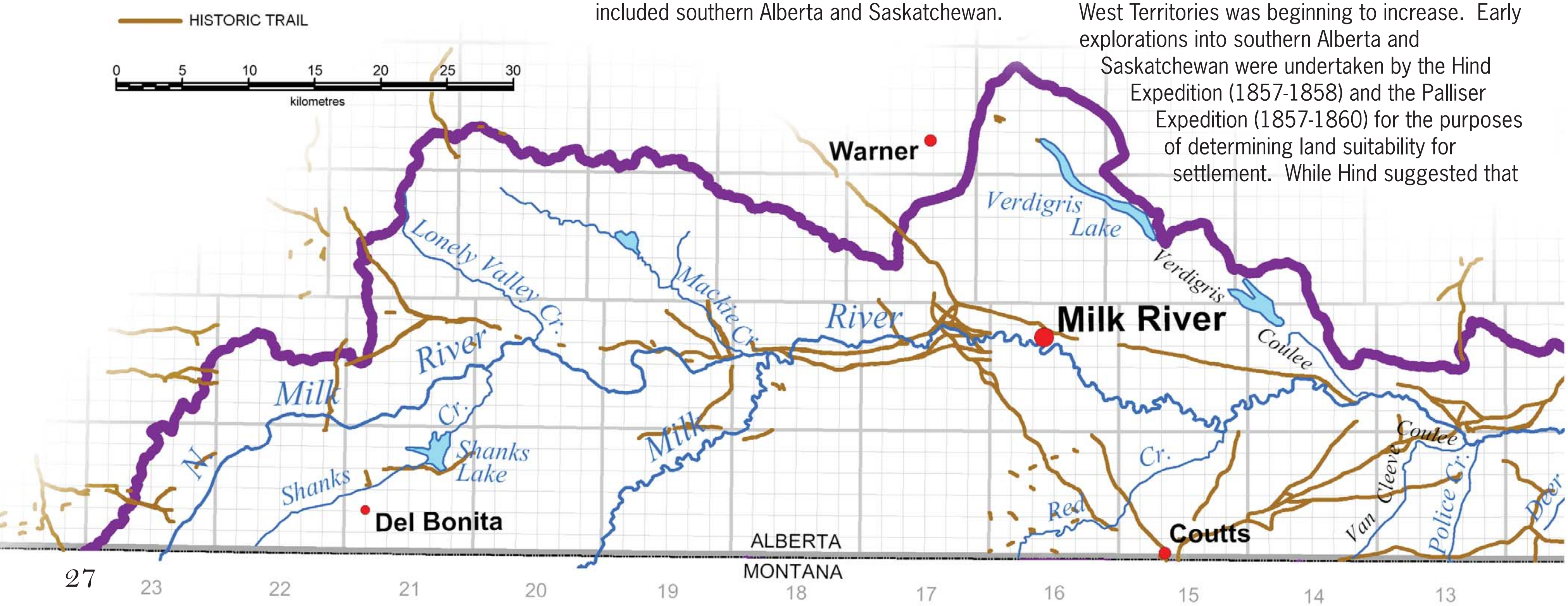
By the 1870s, the Metis formed a large part of the population of southeastern Alberta and southwestern Saskatchewan. As the diminishing buffalo herd began to collect in the areas of southern Alberta and the southwestern tip of Saskatchewan, large Metis settlements began to appear in the Cypress Hills, at Wood Mountain, on the Milk River, at Frenchman River and along the Marias River (Hildebrandt and Huber 1994).

By 1877, Treaty 7 was concluded between Canada and members of the Blackfeet, Blood, Peigan, Sarcee, Stoney and others. At that time, the Blood First Nation occupied the area of the Milk River. All groups were assured that their rights to hunt over the open prairie would not be taken away from them (Morris 1979). In addition to monetary payments and a yearly stipend, the Blood were given the option of seed and implements or cattle, the latter being preferred. Today, the Blood Reserve (Kainaiwa) is the closest First Nations settlement to the Milk River watershed (Klohn Crippen Consultants Ltd. 2003).

3.2 European Settlement

The first historical record of the Milk River was made by Lewis and Clark in 1805. The name they applied to the muddy, milky water still persists today (Graspointer 1980).

Map 3.1. Historic Trails



The earliest Europeans to penetrate the vast interior of Canada were the French fur traders (Mackenzie 1966; Morton 1973; Innis 1977). There tends to be a gap in the historical record from 1805 to the mid-nineteenth century as few written records of these early exploits exist (Graspointer 1980).

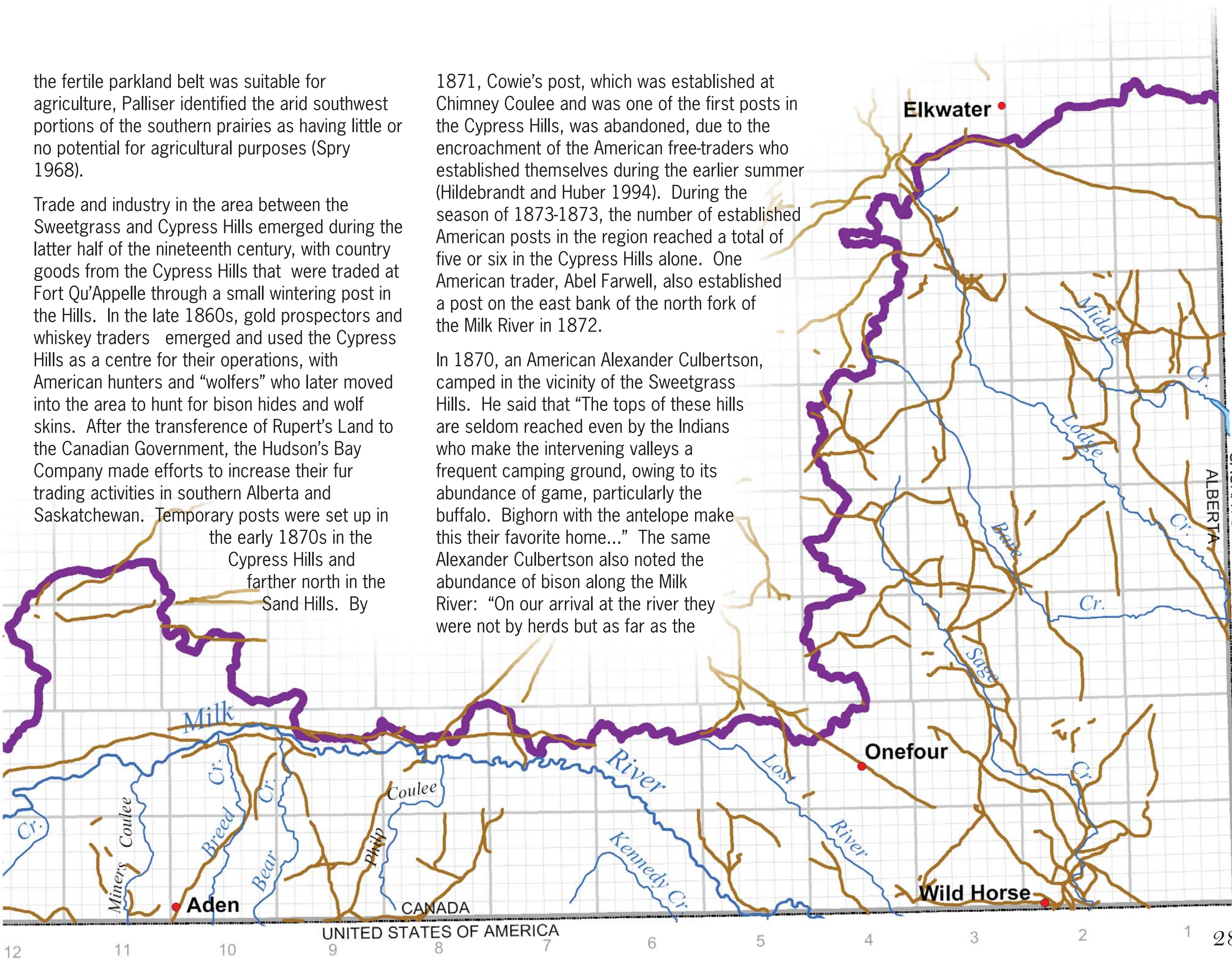
Henry Kelsey was one of the first non-native people reported to have seen the Canadian prairies. As a result of their fur trade interests in the interior of Canada, the Hudson's Bay Company was granted a charter by Charles II to the exclusive trading rights in Rupert's Land (Smith 1985). Rupert's Land was comprised of the lands lying within the entire Hudson Bay drainage. The lands lying westward to the Pacific were known as the North West Territory, and included southern Alberta and Saskatchewan.

The Hudson's Bay Company lost the rights to a fur trade monopoly in 1869 when the territories controlled by the Company were transferred to the Dominion of Canada. With the transfer of these lands, the fledgling Canadian Government faced the task of settling the vast area between the Great Lakes and the Pacific Ocean. To this end, measures dealing with the native people, the survey of land, the Metis settlements, the development of a transportation system, the establishment of a law enforcement body and the encouragement and control of immigration were implemented (Morton and Martin 1938). Between 1871 and 1876, seven treaties were signed with the First Nations of western Canada.

At the time that much of this was happening, non-native exploration and settlement of the North West Territories was beginning to increase. Early explorations into southern Alberta and Saskatchewan were undertaken by the Hind Expedition (1857-1858) and the Palliser Expedition (1857-1860) for the purposes of determining land suitability for settlement. While Hind suggested that the fertile parkland belt was suitable for agriculture, Palliser identified the arid southwest portions of the southern prairies as having little or no potential for agricultural purposes (Spry 1968).

Trade and industry in the area between the Sweetgrass and Cypress Hills emerged during the latter half of the nineteenth century, with country goods from the Cypress Hills that were traded at Fort Qu'Appelle through a small wintering post in the Hills. In the late 1860s, gold prospectors and whiskey traders emerged and used the Cypress Hills as a centre for their operations, with American hunters and "wolfers" who later moved into the area to hunt for bison hides and wolf skins. After the transference of Rupert's Land to the Canadian Government, the Hudson's Bay Company made efforts to increase their fur trading activities in southern Alberta and Saskatchewan. Temporary posts were set up in the early 1870s in the Cypress Hills and farther north in the Sand Hills. By 1871, Cowie's post, which was established at Chimney Coulee and was one of the first posts in the Cypress Hills, was abandoned, due to the encroachment of the American free-traders who established themselves during the earlier summer (Hildebrandt and Huber 1994). During the season of 1873-1873, the number of established American posts in the region reached a total of five or six in the Cypress Hills alone. One American trader, Abel Farwell, also established a post on the east bank of the north fork of the Milk River in 1872.

In 1870, an American Alexander Culbertson, camped in the vicinity of the Sweetgrass Hills. He said that "The tops of these hills are seldom reached even by the Indians who make the intervening valleys a frequent camping ground, owing to its abundance of game, particularly the buffalo. Bighorn with the antelope make this their favorite home..." The same Alexander Culbertson also noted the abundance of bison along the Milk River: "On our arrival at the river they were not by herds but as far as the



eye could reach they were one solid mass of living animals…" (Graspointer 1980).

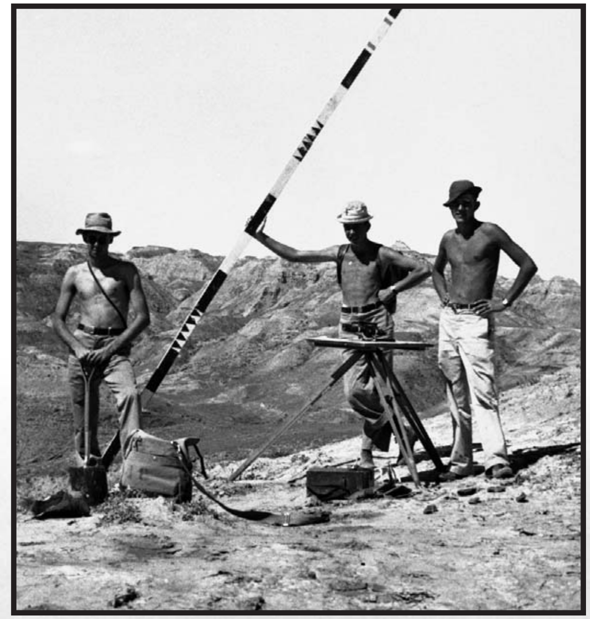
Following the "Cypress Hills Massacre" in 1873 of a band of Stoney by American hunters, however, no forts remained, although four or five are reported to have been re-established during 1874. With the arrival of the North West Mounted Police in 1874, however, the American trade in the region had ended (Hildebrandt and Huber 1994).

In 1874, the Sweet Grass Hills were considered to be the center of the feeding ground of the great northern buffalo herd, but by 1878, major prairie fires west of the Cypress Hills forced the main herd south of the Milk River. Around this time, the extinction of the bison was nearly complete.

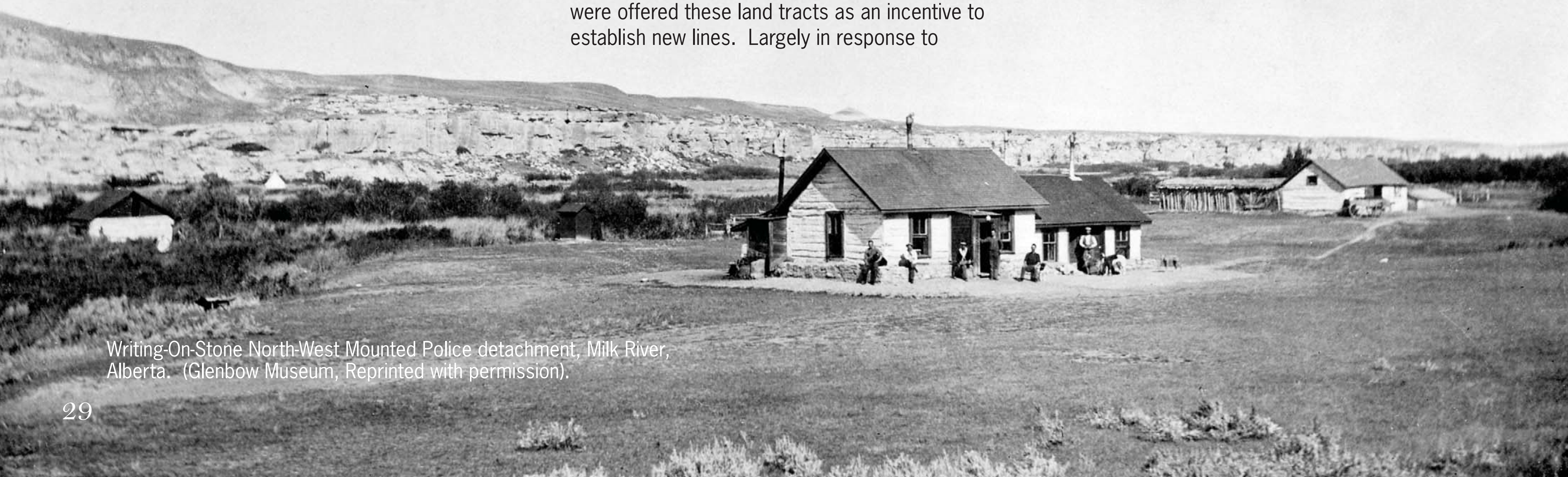
In 1872, the Dominion Lands Act was passed and the Dominion Land Survey laid out the baselines of latitude and the meridians of longitude that govern Alberta's land holdings. The basic grid was formed by the intersection of township lines running east and west and range lines running north and south, with an attempt to space the lines so as to form squares of approximately equal area. The meridians were determined by survey observations, measurements and in reference to other benchmarks on the continent by estimating the position of the sun and stars. Although measurements were accurate at the time, today they are known to have an error of several hundred metres.

Canada plunged into a major economic depression during the 1870s, which limited government funds for surveys. Survey teams finally set foot within the boundaries of the future province of Alberta in 1876.

Under the auspices of the Dominion Lands Act, free homesteads were offered to heads of households and immigration policies were implemented whereby large land reserves were made available to individuals and societies who would sponsor immigrants. Railway companies were offered these land tracts as an incentive to establish new lines. Largely in response to



Land survey in the Milk River watershed (Glenbow Museum, Reprinted with permission).



Writing-On-Stone North-West Mounted Police detachment, Milk River, Alberta. (Glenbow Museum, Reprinted with permission).

increased settlement, the Numbered Treaties were signed between 1871 and 1921 with the First Nations. With the construction of the railway, the major population centres in southern Alberta were established.

Initially, settlement was related to cattle ranching, which developed in conjunction with the demise of the buffalo. In the last part of the century, ranching was at its peak. Much of the region was still open range, despite the efforts of the North West Mounted Police to curb American cattlemen from exploiting southern Alberta (Graspointer 1980).

Fort Macleod became the primary trading centre serving these ranching interests. In 1875, the North West Mounted Police built Fort Calgary. With the arrival of the first transcontinental railway at Fort Calgary, new lands became available for immigrant farmers and Calgary became a major trade and service centre (Klohn Crippen Consultants Ltd. 2003).

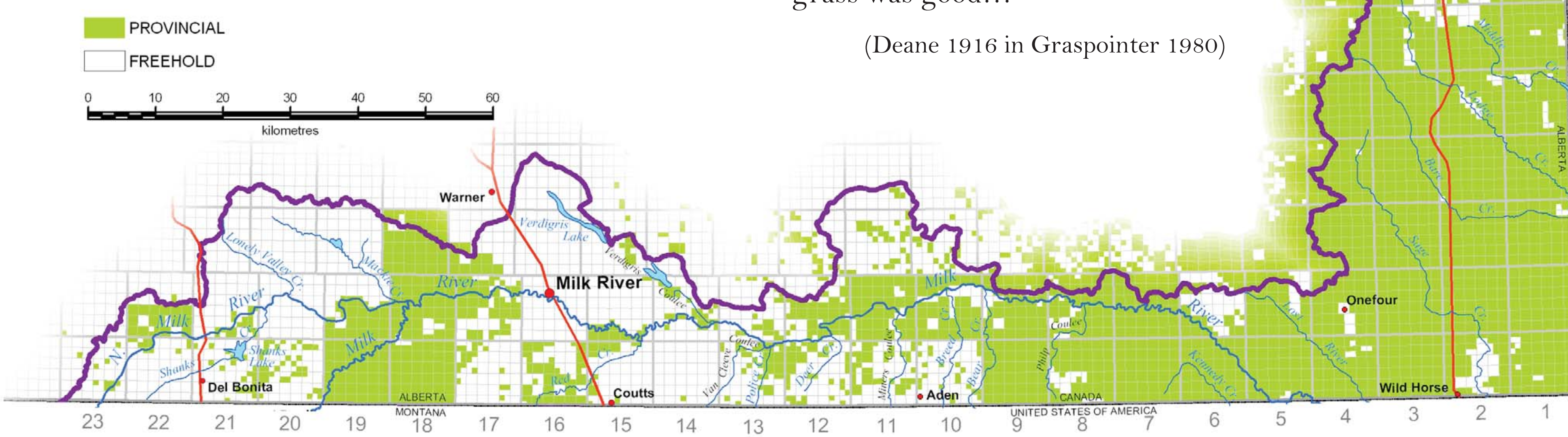
Today, 60% of the Milk River watershed area remains the property of the Crown and 40% is held in private ownership (Map 3.2).

First automobile in Milk River, Alberta. (Glenbow Museum, Reprinted with permission).

"During the winter of 1901 a great many American cattle had drifted into Canada. The range in Northern Montana had been largely burnt off by prairie fires, and the only feed available for some 15,000 head of cattle was in the neighborhood of the Sweet Grass Hills, where the grass was good…"

(Deane 1916 in Graspointer 1980)

Map 3.2. Land Ownership



3.3 History of Water Management

In 1882, the Canadian Northwest Irrigation Company was given most of the land south of Lethbridge. Land was sold to farmers with the guarantee of the irrigation to raise crops in times of low rainfall. One group of settlers attracted by the promise of irrigation water were the Mormons from Utah (Dormaar 2005). One settler was Ora Card, who constructed a canal from the St. Mary River beginning west of Kimbal northeast to Spring Coulee to irrigate lands in Magrath, Raymond and Lethbridge. Water reached Lethbridge in 1900. At the same time, several projects were designed in the United States to provide more water for the Milk River valley downstream of Havre, Montana. The source of additional water for Montana was the St. Mary River flowing out of Lower St. Mary Lake and into the Oldman River in Alberta. Construction began in 1903 on the diversion works at Babb, Montana to divert most of the spring and summer flow of the St. Mary into the Milk River. Alberta irrigators were now faced with the possibility of water shortages.

The Government of Canada responded to the new diversion works in Montana by constructing several miles of canal that could divert an amount of water equivalent to the St. Mary diversion. The Canadian Milk River Canal became locally known as the Spite Ditch. Its headworks were situated approximately eight miles west of Milk River. The canal flowed in an eastern direction, north of the Town of Milk River, crossing a ridge in a natural indentation and ending five miles northwest of there, toward Ridge Reservoir. Although the canal revealed seepage problems, it held water once (Dormaar 2005).

The actions of Canada brought the construction in Montana to a halt. Negotiations between Canada and the United States finally settled the dispute. Article VI of the Boundary Waters Treaty of 1909 was put in place to apportion the flows of water to be used by both countries. The Treaty also established the International Joint Commission (IJC) to administer the Treaty and resolve disputes that might arise. The wording of the Article VI was such that agreement could not be reached on its interpretation. The problem was resolved in 1921 when the IJC issued an order detailing an apportionment formula allowing Canada to use, during the irrigation season, more than half of the natural flow of the St. Mary River and the United States to use more than half of the natural flow of the Milk River (Figure 3.1).

The rules established by the 1921 IJC Order for sharing the waters are based on flow volumes and seasons. The IJC Order also established that apportionment was to be carried out at the International Boundary, and provided a prior appropriation, not subject to equal sharing, from the St. Mary River to Canada and from the Milk River to the United States. The prior appropriation in part reflects water use by the two countries prior to the Treaty, and was consistent with the water allocation principle of "first in time, first in right" which was being applied in both the American and Canadian west at that time.

The Order also clarified the practical approach Treaty negotiators devised for sharing prior appropriations. Recognizing the impracticality of forcing each country to wait until the other received its full appropriation, each country was allowed 25 percent of the water, even at low flows.

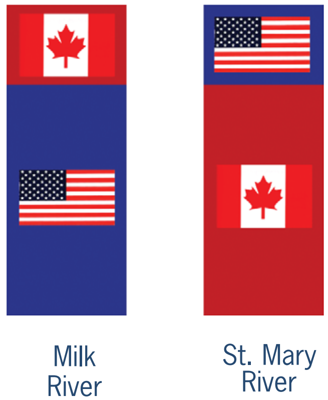
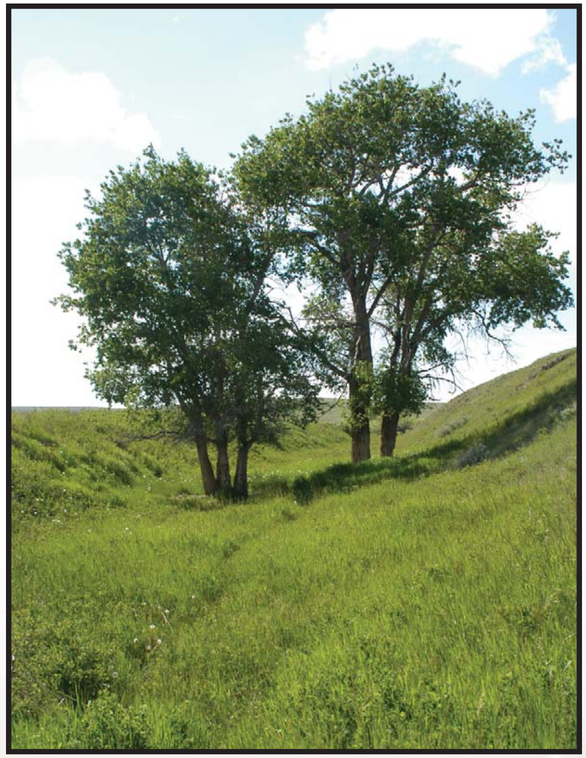


Figure 3.1. In the irrigation season, Canada is entitled to one-quarter of the flow in the Milk River up to 666cfs and three-quarters of the flow in the St. Mary River.

Because Canada had already allocated most of the water from the St. Mary River and the U.S. had significant allocations from the Milk River, The Treaty and the IJC Order allowed Canada, during the irrigation season, a prior appropriation of three quarters of the St. Mary up to 666 cubic feet per second (cfs). The U.S. received the same during the irrigation season for the Milk River (Figure 3.1). All flows outside the irrigation season and above these prior appropriations were shared equally. The St. Mary has a flow greater than 666 cfs more often than the Milk River, so Canada's prior appropriation is less likely to fall short.

Based on the rules of the 1921 Order, Canada and the United States successfully share the waters of the Milk River and St. Mary River. Accredited Officers and Field Officers from each country measure the flow in each river and calculate each country's entitlement every two weeks. If there are shortfalls, Montana and Alberta are notified so that they can be remedied in the subsequent month. At the end of each year the Accredited Officers sign off a report to the IJC confirming that the order was implemented properly.

The Apportionment Order was applied to the St. Mary and Milk rivers from 1921 to the present. Montana had reservations about the application of the Order not providing for equal sharing of the combined flow of both rivers. The Governor of Montana, by letter on April, 10, 2003, asked the IJC to investigate the apportionment of flows, and



The Canadian Milk River Canal or "Spite Ditch" is still visible today.

if not being apportioned equally, determine how the flows could better be apportioned. The IJC responded with a call for public input on the issue. A Task Force was established to hear input and report to the Commission. Considerable detailed work was completed by Alberta and Montana to substantiate their positions regarding the volumes received by both parties. Montana receives about 41% of the combined flow but is unable to divert all of its apportioned volume because of ageing diversion works and canal capacity.

The Task Force Report was not filed with the IJC until mid November 2006. The report provides a very good understanding of the flow patterns of the rivers, their apportionment and the volumes that are passed downstream. The inability of both countries to divert their apportioned share is the major issue. Alberta lacks storage capacity and Montana uses an antiquated diversion system. The major issue is the interpretation of the 1921 Order. The Canadian interpretation is instantaneous apportionment of flow with as short a balance period as practical. The Montana interpretation is apportionment of volume with as long a balance period as possible, preferably one year or seasonal. The members of the Task Force could not find a resolution to that issue. The report did make several recommendations for improvement to administrative procedures, including a cross-border watershed council. The IJC now has the task of replying to Montana's letter that asked the IJC to open the apportionment section of the 1921 Order. Although there is no time limit to the IJC's deliberations, the answer will be an important issue affecting water management for the Milk River in Alberta. Surface water supply, allocation and use is discussed further in Section 5.1, page 57).

State of the Watershed Report 2008

4.0 Land Use, Development and Economics

4.1 Socio-Economic Conditions

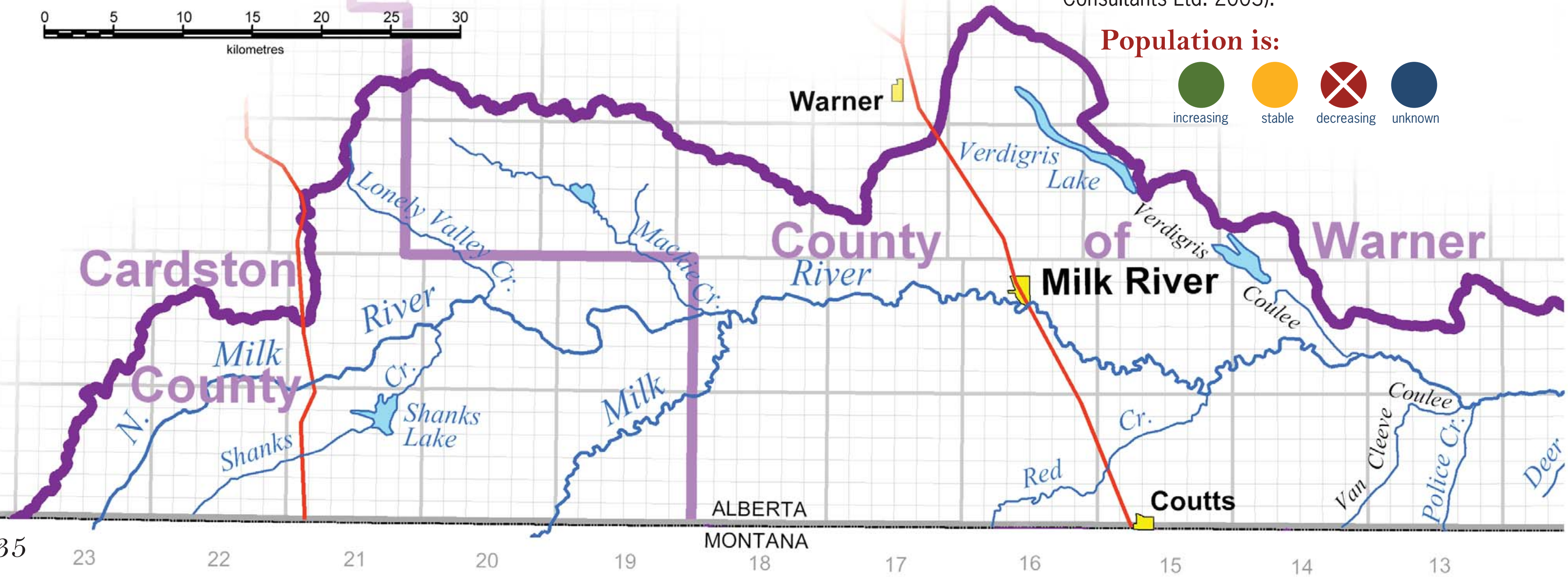
The Milk River watershed is a sparsely populated area located at the southern end of the province. Four rural municipalities share jurisdiction in the watershed, which are from west to east: Cardston County, County of Warner, County of Forty Mile and Cypress County (Map 4.1). Cardston County spans the smallest area of the watershed (842 km^2 or 12%) and is located at the headwaters where the North Fork Milk River and the Milk River enter Alberta. Cypress County covers the largest area in the watershed (2,719 km^2 or 41%) on the eastern edge of the boundary where the Milk River re-enters Montana. The County of Warner is the second largest in area (2,048 km^2 or 31%) while the County of Forty Mile is responsible for 1,051 km^2 (16 %).

The Town of Milk River is the largest urban centre in the watershed, spanning an area of 2.3 km^2. The Village of Coutts occupies an area slightly more than half that of the Town of Milk River (1.3 km^2). Del Bonita, Aden, Onefour and Wildhorse are four historic settlements located in the watershed. Although Del Bonita has a post-office and general store, Aden has a community hall, and Wildhorse is a border-crossing station, there is essentially no population associated with them.

Population

Population is an indicator of economic growth and prosperity. The population in the Milk River watershed has remained relatively static since the 1960s. There are an estimated 2,403 people living in the Milk River watershed, of which about 1,252 are considered rural residents and 48% (1,151) are considered urban residents. The population estimates for the rural municipalities within the watershed boundaries are Cardston (55), Warner (974), Forty Mile (95) and Cypress (128) (Rural Municipalities, pers. comm.). The population within the Town of Milk River remains stable at about 846 people, while a slow decline in population can be seen in the Village of Coutts (current population is 305) (Figure 4.1) (Alberta Municipal Affairs and Housing 2007). School enrollments and rural population continue to decline (Klohn Crippen Consultants Ltd. 2003).

Map 4.1. Administrative Boundaries



Economics

The economy in the Milk River watershed is largely driven by the agricultural sector, with 59% of all employment in this sector and some employment in the oil and gas sector. Almost all of the remaining employment is in the agricultural service (or tertiary) sector including retail businesses, transportation and utilities, health, education and social services and public sector employment. Growth in the service sector is heavily dependent upon growth in the primary agricultural sector. There is very little manufacturing or construction activity in the region (Klohn Crippen Consultants Ltd. 2003).

Although employment rates are relatively high, economic activity in the watershed has remained relatively static during a period of generally rapid growth elsewhere in the province. Dryland farms have gradually become larger in order to survive and supporting services have become increasingly distant. There are now almost no agricultural services in the Town of Warner and Village of Coutts. Milk River still has two traditional grain elevators, two machinery dealerships and a few other basic agricultural support services. The closest high-throughput grain elevators are located just south of Lethbridge. Slaughter cattle must either be sold into the United States or go to major plants at High River or Brooks. Most economic activity in Coutts (e.g., brokers, insurance agents) facilitates trade and traffic flows to and from the United States (Klohn Crippen Consultants Ltd. 2003).

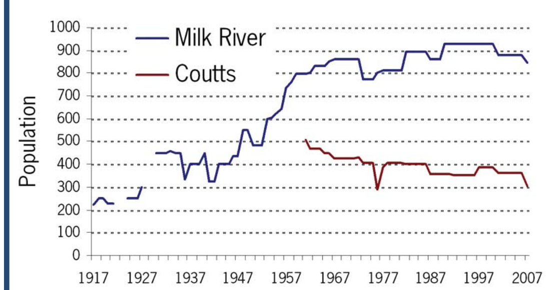
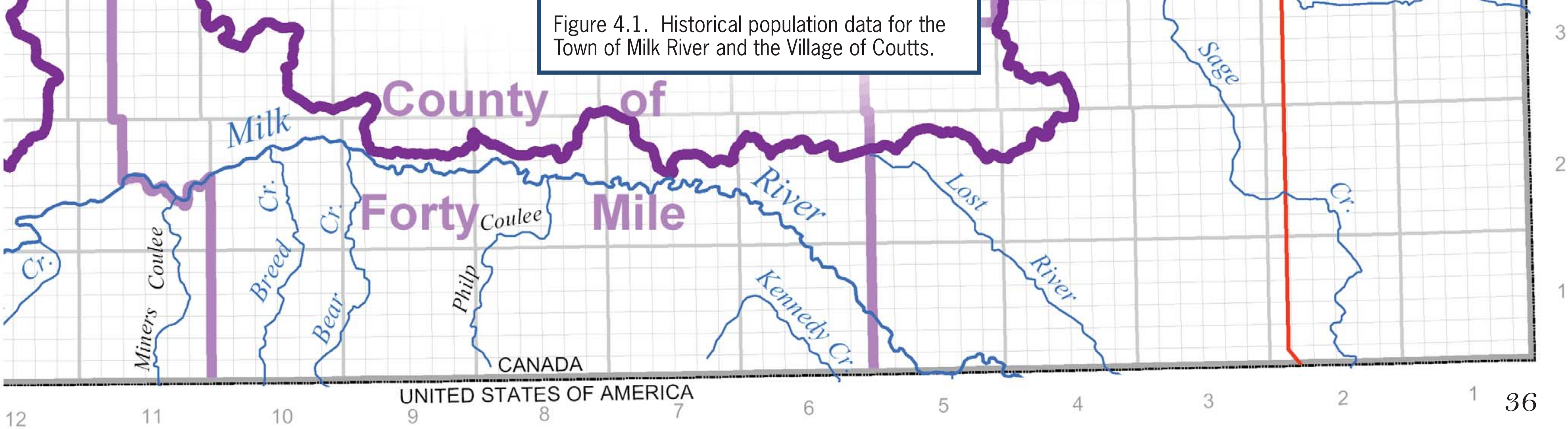


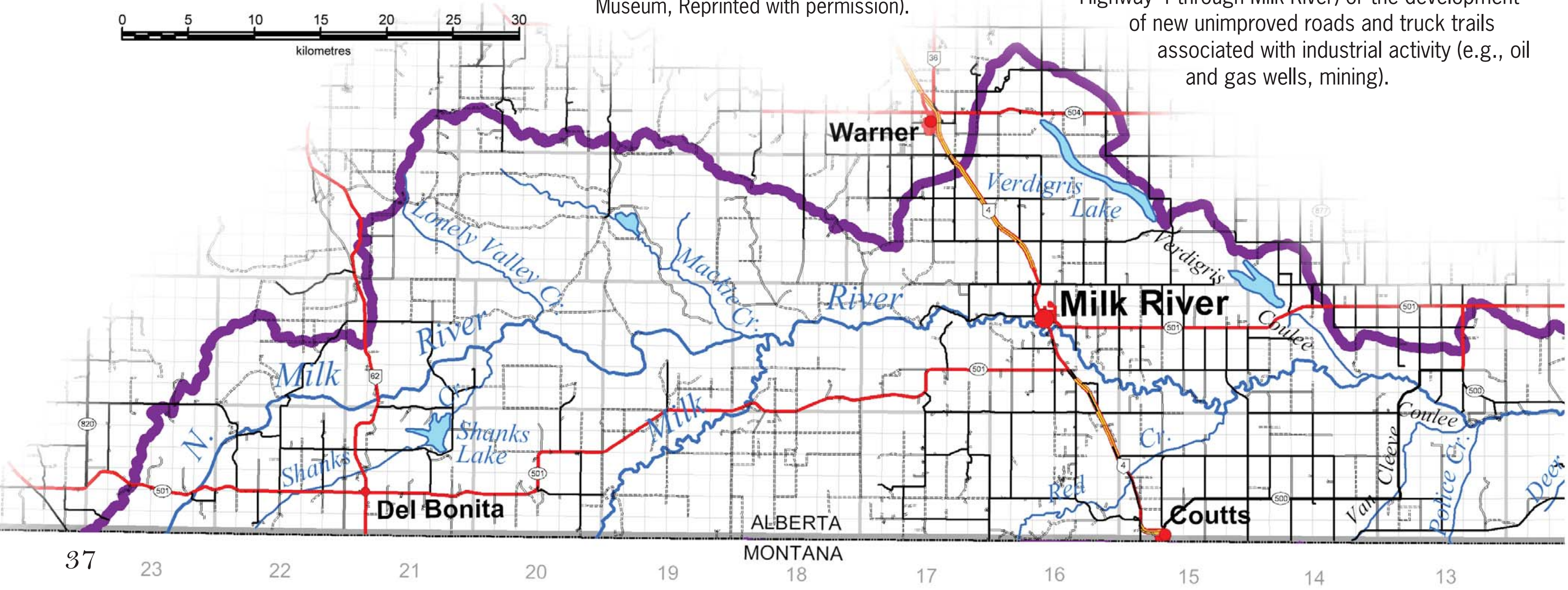
Figure 4.1. Historical population data for the Town of Milk River and the Village of Coutts.



4.2 Access

Although the southern region remains largely rural, there is a well-developed road network throughout the Milk River watershed that provides access mainly for residents, agricultural producers, the oil and gas industry, tourists, travellers and truck drivers crossing the international border.

Map 4.2. Access



In total, there are 3,869 km of roadways in the watershed. Highway 4, a four-lane divided highway for 19 km, bisects the watershed from north to south (Map 4.2). It is the most heavily traveled road in the watershed. This highway provides access across the border into Montana at the Coutts border crossing.

Wagon crossing Milk River, Alberta. (Glenbow Museum, Reprinted with permission).

Two-lane paved roads provide access for 261 km. These are Highway 501 that spans the watershed from west to east, Highway 62 that crosses into Montana near Del Bonita in the west and Highway 41 in the east that spans from Elkwater to Wildhorse.

One and two lane gravel roads provide 1,174 km of access to the majority of the watershed.

Unimproved roads provide 590 km of access to remote areas within the watershed and truck trails provide an additional 1,825 km of access mainly to Public Lands.

The current road network provides access to the majority of the watershed. Future expansion will likely be associated with the extension or upgrading of existing roadways (i.e., twinning of Highway 4 through Milk River) or the development of new unimproved roads and truck trails associated with industrial activity (e.g., oil and gas wells, mining).

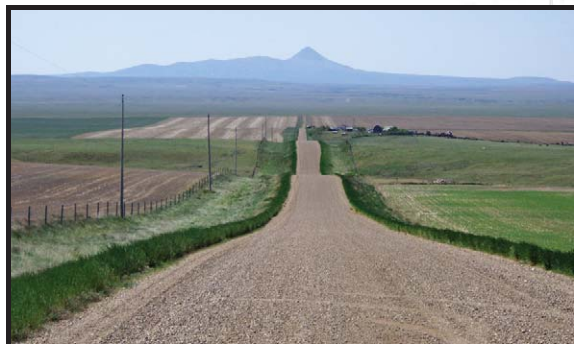
Although they are a necessary component of the watershed, roadways contribute to fragmentation of the landscape and create hazards for wildlife. For example, studies have shown that improvements made to roads (e.g., paving) may be linked to mortality rates in the prairie rattlesnake (Watson and Russell 1997).

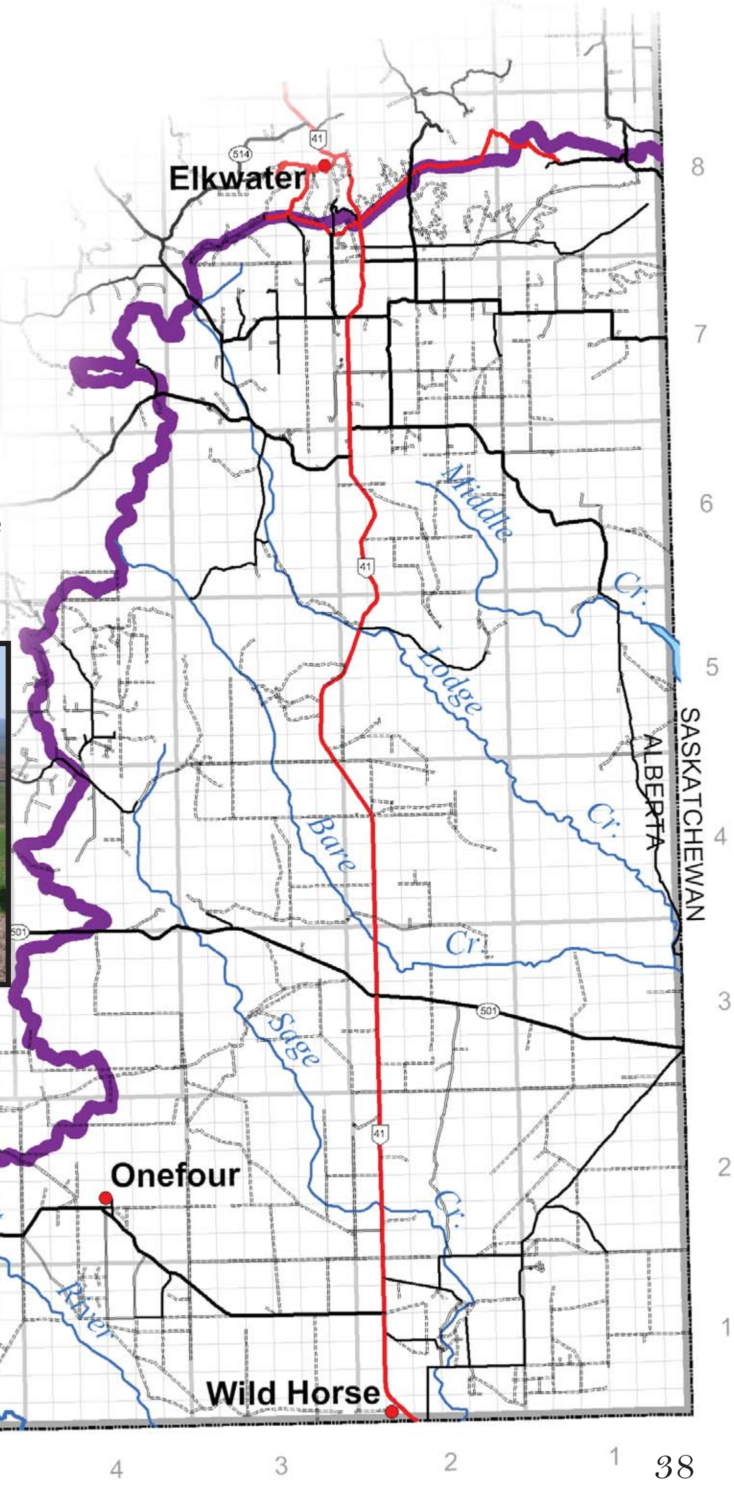
Road Density is:

increasing | stable | decreasing | unknown

Data Gaps and Recommendations

Wildlife can be vulnerable to the numerous roads in the region. Placement of new roads, better use of existing roads or roads designed for wildlife safety may help reduce mortalities in the future. Further studies should be undertaken to determine the impact of road mortality on wildlife in the watershed.





4.3 Agriculture

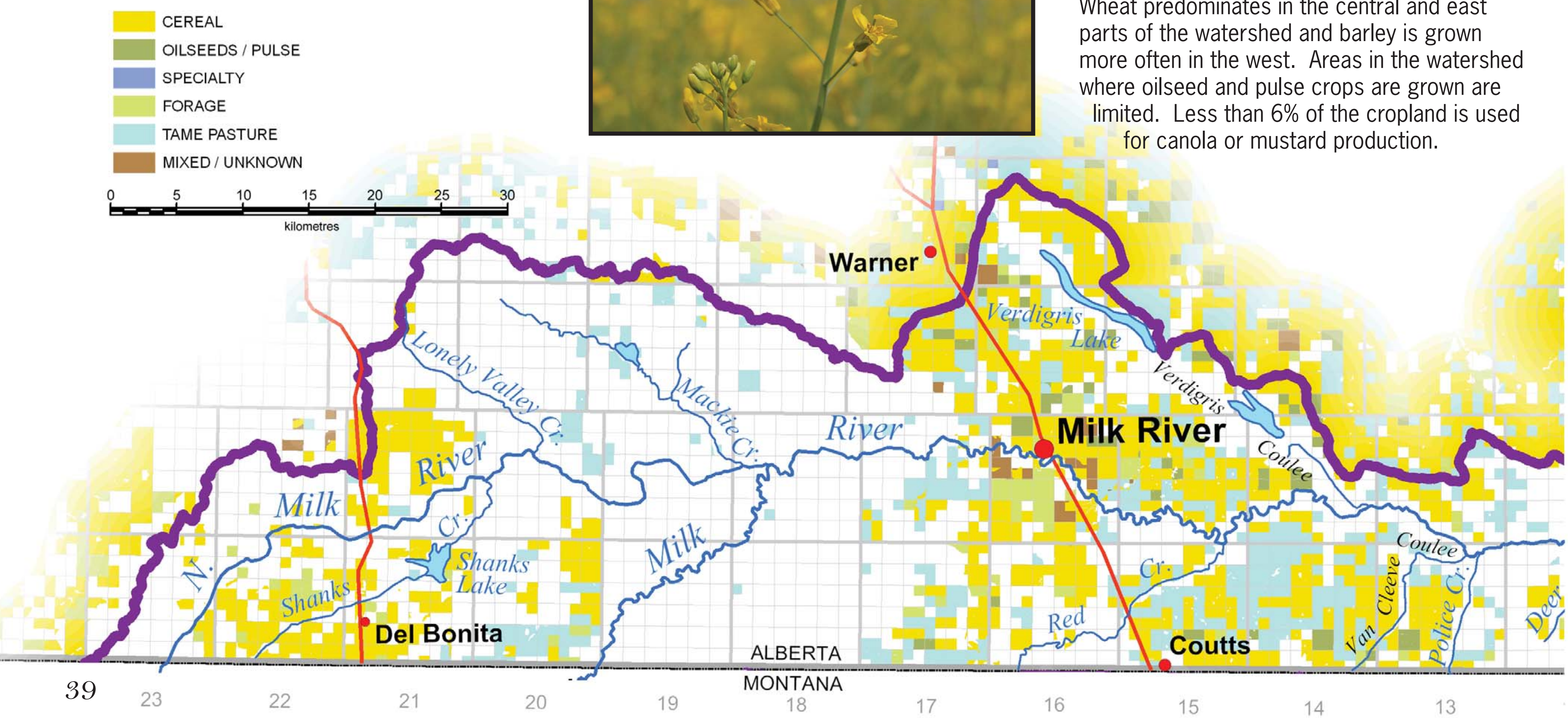
There are approximately 400 commercial farms and ranches in the Milk River watershed, which is approximately 2% of the Alberta total. Commercial farms, those classified in terms of product gross revenue exceeding 51% of total gross farm revenue, are predominantly beef ranches in the west and grain farms in the central-east (Klohn Crippen Consultants Ltd. 2003).

Farming

Dryland farms are generally between 560 ha and 770 ha in size. This includes both owned land and leased land. Farms and ranches tend to be smaller in the more humid west and larger in the more arid east. Most of the land in the far eastern part of the watershed is Crown-owned grazing land (Klohn Crippen Consultants Ltd. 2003).

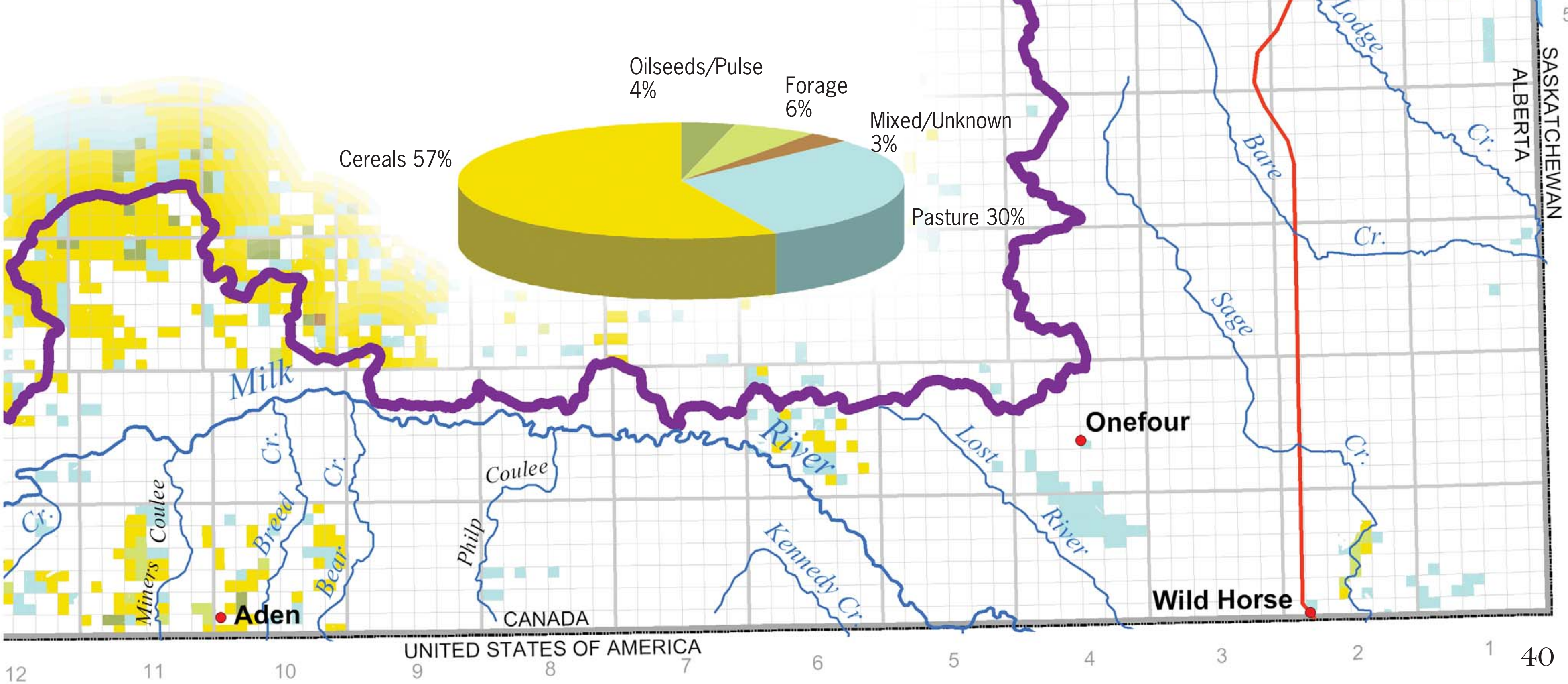
Cereals (i.e., wheat and barley) are the predominant crop type in the watershed, representing 81.8% of total crop production. Wheat predominates in the central and east parts of the watershed and barley is grown more often in the west. Areas in the watershed where oilseed and pulse crops are grown are limited. Less than 6% of the cropland is used for canola or mustard production.

Map 4.3. Crops



Irrigation is used to augment forage and cereal production. There are 66 water licences issued to 33 licence holders, allowing for withdrawals from the North Milk and Milk Rivers for irrigation purposes.

Summerfallow is relatively insignificant in the west, but is still important in the more arid areas to the east. A 1:4 year summerfallow rotation is typical in the County of Warner, although this is decreasing due largely to economic reasons (i.e., increased returns for cereal crops) (J. Meeks, County of Warner, pers. comm.).



Ranching

Ranching remains a way of life for many in the Milk River watershed, with 40% of all commercial farms and ranches specializing in beef production. There is an estimated 70,000 head of cattle in the watershed under the management of 160 beef producers. These livestock operations are largely cow-calf operations (Klohn Crippen Consultants Ltd. 2003).

Rangeland in the watershed varies from very poor (34 ha/animal unit/year) on saline soils at the extreme eastern end of the watershed to excellent (9.7 ha/animal unit/year) at the more humid western edge of the watershed, based on a 12 month grazing season (Klohn Crippen Consultants Ltd. 2003).

A forage deficit in the watershed implies strong crop-livestock inter-dependency, as well as a need to generally import livestock feed into the watershed. More productive and stable crop-forage production in the watershed would strengthen the local crop-livestock interdependency as well as reduce import requirements.

Agricultural Intensity Indices

Fertilizer use, chemical use and manure production are components of an Agricultural Intensity Index developed through the Alberta Environmentally Sustainable Agriculture (AESA) Water Quality Monitoring Program (Anderson et al. 1999; Johnson and Kirtz 1998). Information on these three aspects of agriculture was obtained from the 2001 Census of Agriculture and processed to derive the volume in tonnes for each Soil Landscapes of Canada (SLC) polygon. That amount was divided by the SLC area (square km) to result in a ratio of the fertilizer and chemical used, or the amount of manure produced per unit area for each SLC (Alberta Agriculture and Food 2005). The Census of Agriculture does not collect data regarding how much manure is actually produced, rather it calculates a best estimate of manure production per animal unit based on the numbers of livestock raised in the province.

The identification of agricultural intensity was conducted on a provincial scale to provide an estimate of the degree to which agriculture may affect nutrient levels in surface and groundwater (fertilizer and chemical use). It also provides an estimate of the degree to which livestock production may contribute to nutrient loading, pathogens and odour. The classes shown on the maps are ranked between 0 (lowest) and 1 (highest) (Alberta Agriculture and Food 2005).

The relative expense of fertilizer and lime, and farm chemicals (e.g., herbicides, insecticides and fungicides) in the Milk River watershed are presented in Figures 4.2 and 4.3.

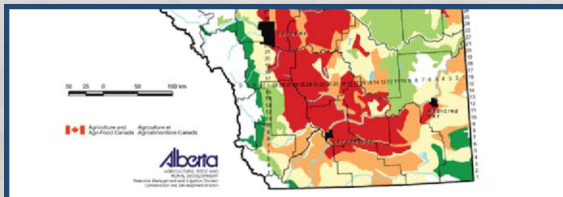


Figure 4.2. Chemical expense index. Green indicates low, yellow indicates moderate and red indicates high intensity.

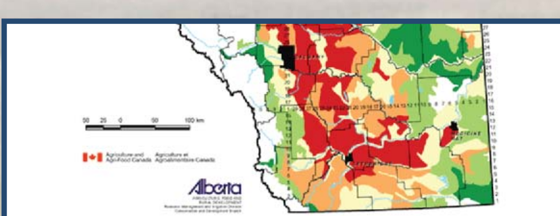


Figure 4.3. Fertilizer expense index. Green indicates low, yellow indicates moderate and red indicates high intensity.

Compared to areas to the north, producers in the Milk River watershed use a lesser amount of fertilizer and farm chemicals. Within the watershed, a greater amount of fertilizer and chemical was generally applied in the western and central part of the watershed surrounding the Town of Milk River, with low use occurring in the eastern parts of the watershed. This corresponds to the areas of greatest crop production (refer to Map 4.3, page 39).

Manure production in the watershed is relatively low compared to the rest of the province. The greatest amount of manure is produced toward the western edge of the watershed (Figure 4.4). Livestock density per unit area is relatively low and stocking rates are limited by the dry climate and low forage production.

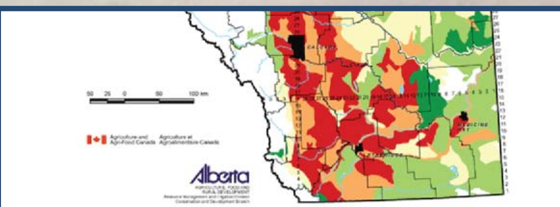


Figure 4.4. Manure production index. Green indicates low, yellow indicates moderate and red indicates high intensity.

Data Gaps and Recommendations

There is limited recent data available on crop production in the watershed. This information should be updated to reflect current conditions. In addition, the scale of information presented in the agricultural intensity index maps provides a broad comparison of fertilizer and chemical use, and manure production among the different areas within the watershed. The maps, as presented here, are appropriate for assessing general trends, but more detailed information should be collected to describe specific trends and more local fertilizer and chemical use, and manure production.

Achieving secure water supplies in time of drought should continue to be a priority in the watershed. More productive and stable crop-forage production in the watershed would strengthen the local crop-livestock interdependency, as well as reduce the need to import additional resources.

Unique economic attributes in the watershed should be identified and used to develop a sustainable growth strategy for the watershed. Opportunities that exist include: use of existing surface water, unique agri-climatic features (e.g., soil and climate for specialized crop and livestock production), close proximity to United States markets and the strategic location serviced by Alberta-Montana Highway 4 and the CP railway (Klohn Crippen Consultants Ltd. 2003).

Local workshops and courses should be made available for agricultural producers in the Milk River watershed as new management practices become available and advances in crop and livestock production are achieved.

4.4 Oil and Gas Activity

The oil and gas industry in Alberta contributes significantly to the Alberta economy. By the end of 2000, more than 260,000 oil and gas wells had been drilled in the province (Sinton 2001). Impacts from oil and gas activity may include fragmentation of the prairie landscape into increasingly smaller areas of undisturbed land, introduction of invasive non-native plants, disturbance to landscapes, soils and native vegetation, disturbance of heritage resources, disturbance of wildlife and potential for spills of oil, gas, diesel or salty produced water (Sinton 2001).

The Upper Cretaceous Milk River Formation in southeastern Alberta is a prolific producer of natural gas from relatively shallow depths (Fishman and Hall 2004), refer to Map 2.1 (page 7) for location of the Milk River Formation. There are approximately eight oil and gas companies operating in the Milk River watershed, including EnCana, Canadian Natural Resources Ltd. (CNRL), Eagle Rock, Advantage, True Energy, Alta Gas, Regent and Visions (D. Lloyd, CNRL, pers. comm.). Three main distribution lines direct natural gas into the United States.

There are a total of 2,493 wells associated with oil and gas activity in the watershed. Of these, 121 are active oil wells, 409 are active gas wells, and 1,624 are abandoned wells (Map 4.4).

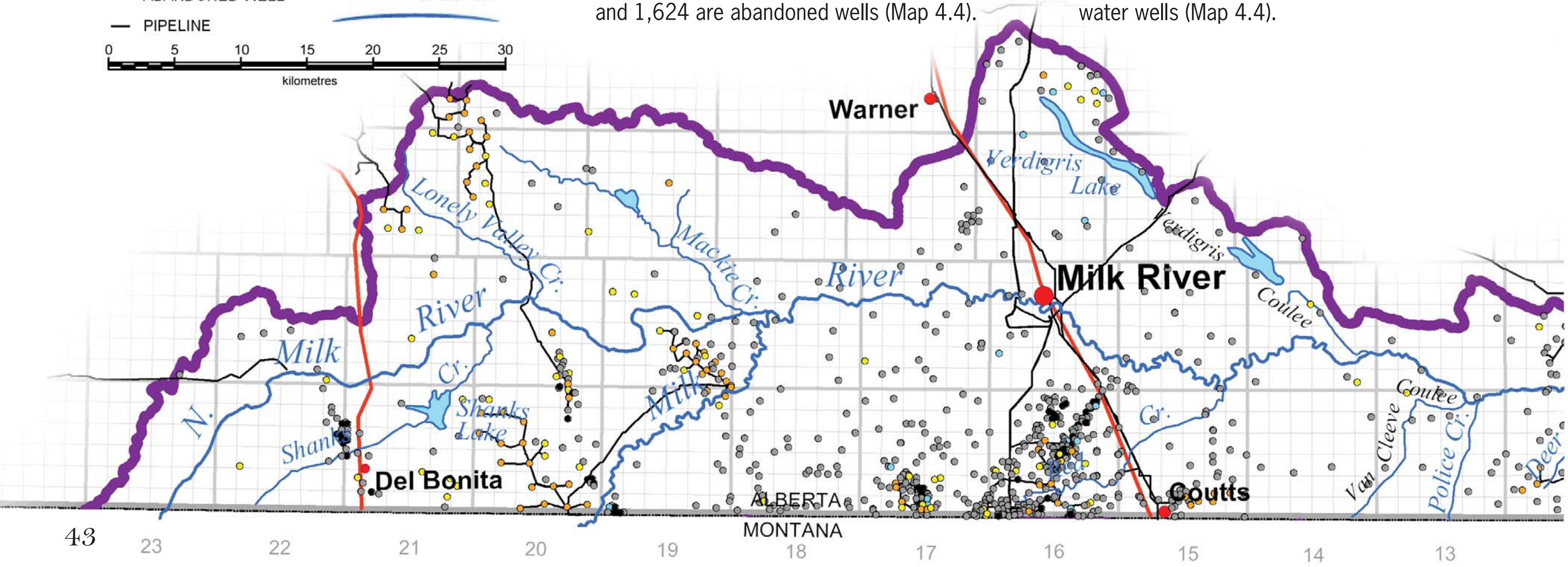
Abandoned wells make up 66% of the total number of wells that are present in the watershed (Map 4.4). Wells are abandoned when they are at the end of their life and have no other potential to produce. Well abandonment must now adhere to more strict environmental protocol. Only 3% of wells associated with the oil and gas industry are water wells (Map 4.4).

Map 4.4. Oil and Gas Activity

ACTIVE OIL WELL
ACTIVE GAS WELL
WATER WELL
MISCELLANEOUS WELL
ABANDONED WELL
PIPELINE

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

0 5 10 15 20 25 30
kilometres



EnCana is one of the larger companies operating in the watershed. EnCana's operations have been changing somewhat since the 1960s. While the number of wells drilled in deeper zones has been decreasing since the 1960s, the number of shallow gas wells drilled has been increasing since about 1997. The shallow gas interval is finer grained or "tighter", therefore, more wells are required to access the resource (M. Dubord, EnCana, pers. comm.). Currently, EnCana anticipates about 100 new wells in the watershed in 2008 (M. Dubord, EnCana, pers. comm.).

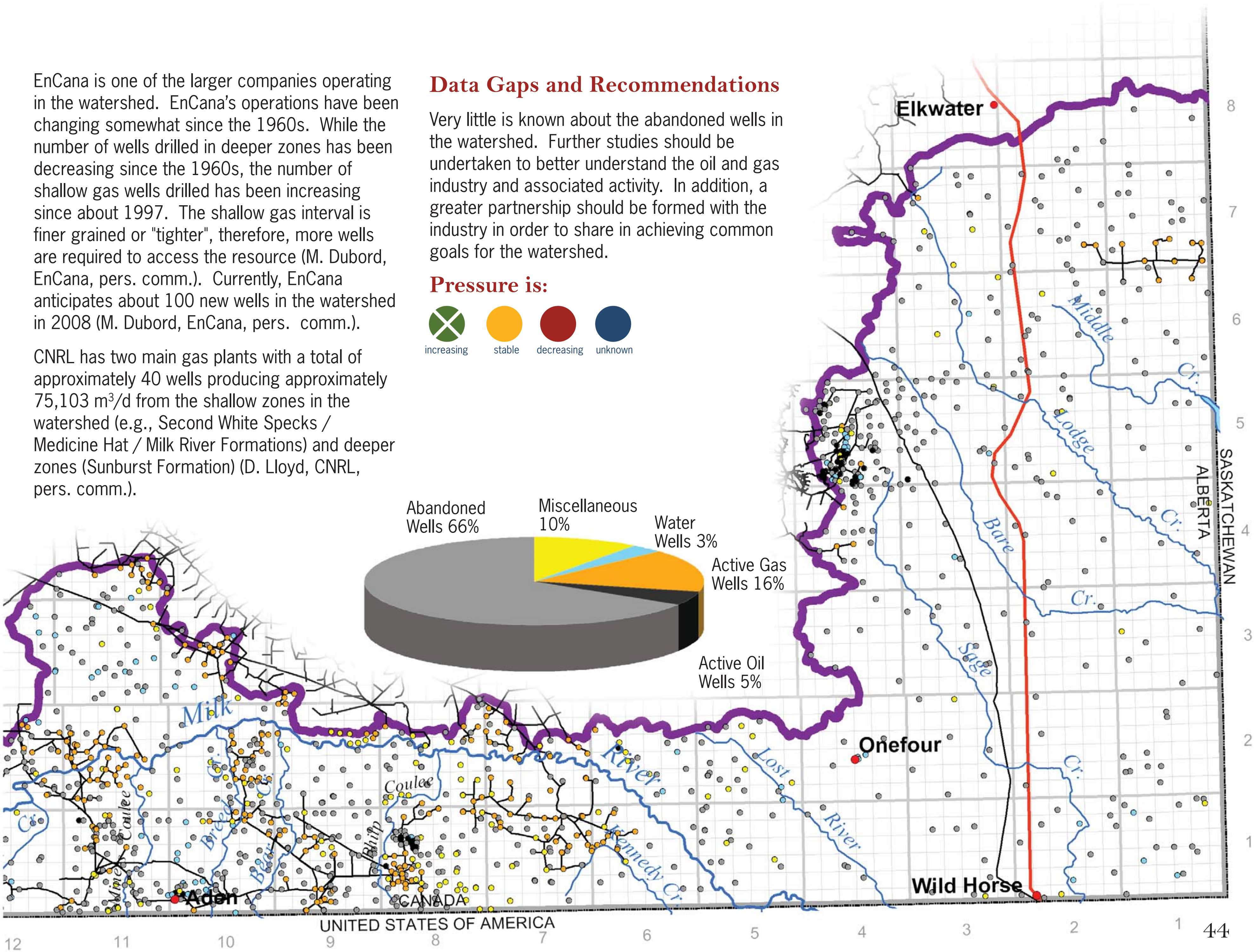
CNRL has two main gas plants with a total of approximately 40 wells producing approximately 75,103 m³/d from the shallow zones in the watershed (e.g., Second White Specks / Medicine Hat / Milk River Formations) and deeper zones (Sunburst Formation) (D. Lloyd, CNRL, pers. comm.).

Data Gaps and Recommendations

Very little is known about the abandoned wells in the watershed. Further studies should be undertaken to better understand the oil and gas industry and associated activity. In addition, a greater partnership should be formed with the industry in order to share in achieving common goals for the watershed.

Pressure is:

increasing | stable | decreasing | unknown



4.5 Parks, Protected and Environmentally Significant Areas

Although the Milk River watershed is the smallest in Alberta, it is one of international significance and importance. The undulating grasslands and interspersed farmed lands offer a natural diversity not common in many places. To preserve these open spaces, Provincial Parks, natural areas and heritage rangelands have been established.

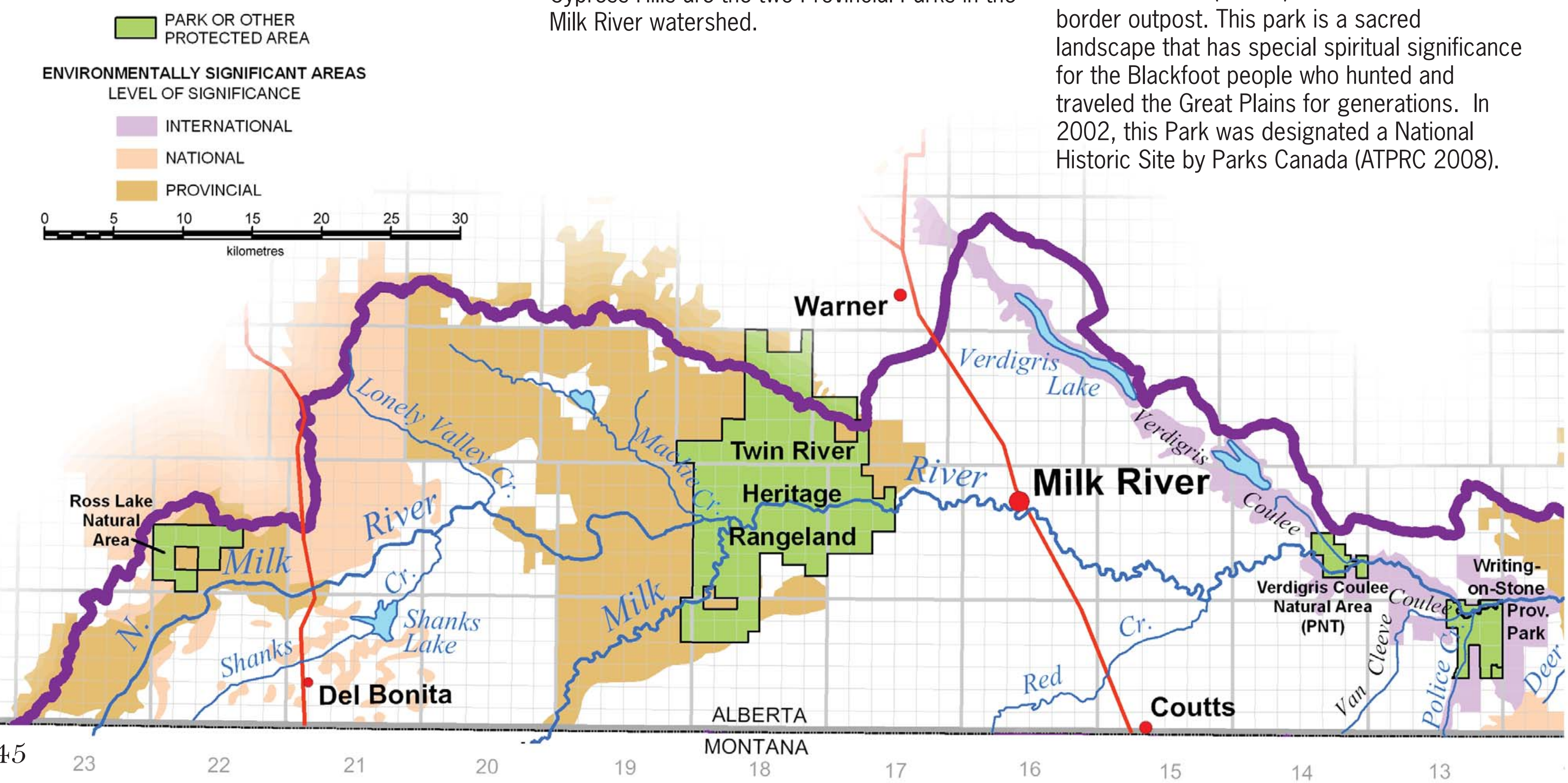
Provincial Parks

Provincial Parks preserve natural heritage and support outdoor recreation, heritage tourism and natural heritage appreciation activities that depend on, and are compatible with environmental protection. They are distinguished from wild land parks by their greater range of outdoor recreation facilities, the extent of road access, and the interpretive and educational programs and facilities that are available to visitors. Writing-On-Stone and Cypress Hills are the two Provincial Parks in the Milk River watershed.

Writing-On-Stone Provincial Park

Writing-On-Stone Provincial Park is one of the largest areas of protected prairie in Alberta, spanning an area of 17.2 km^2. Writing-On-Stone Provincial Park was founded in January 1955, and an archaeological preserve was established in 1977 to protect significant archaeological values in native rock art paintings and carvings, as well as historical resources from the days of the Northwest Mounted Police (NWMP) when it served as a border outpost. This park is a sacred landscape that has special spiritual significance for the Blackfoot people who hunted and traveled the Great Plains for generations. In 2002, this Park was designated a National Historic Site by Parks Canada (ATPRC 2008).

Map 4.5. Parks and Protected Areas



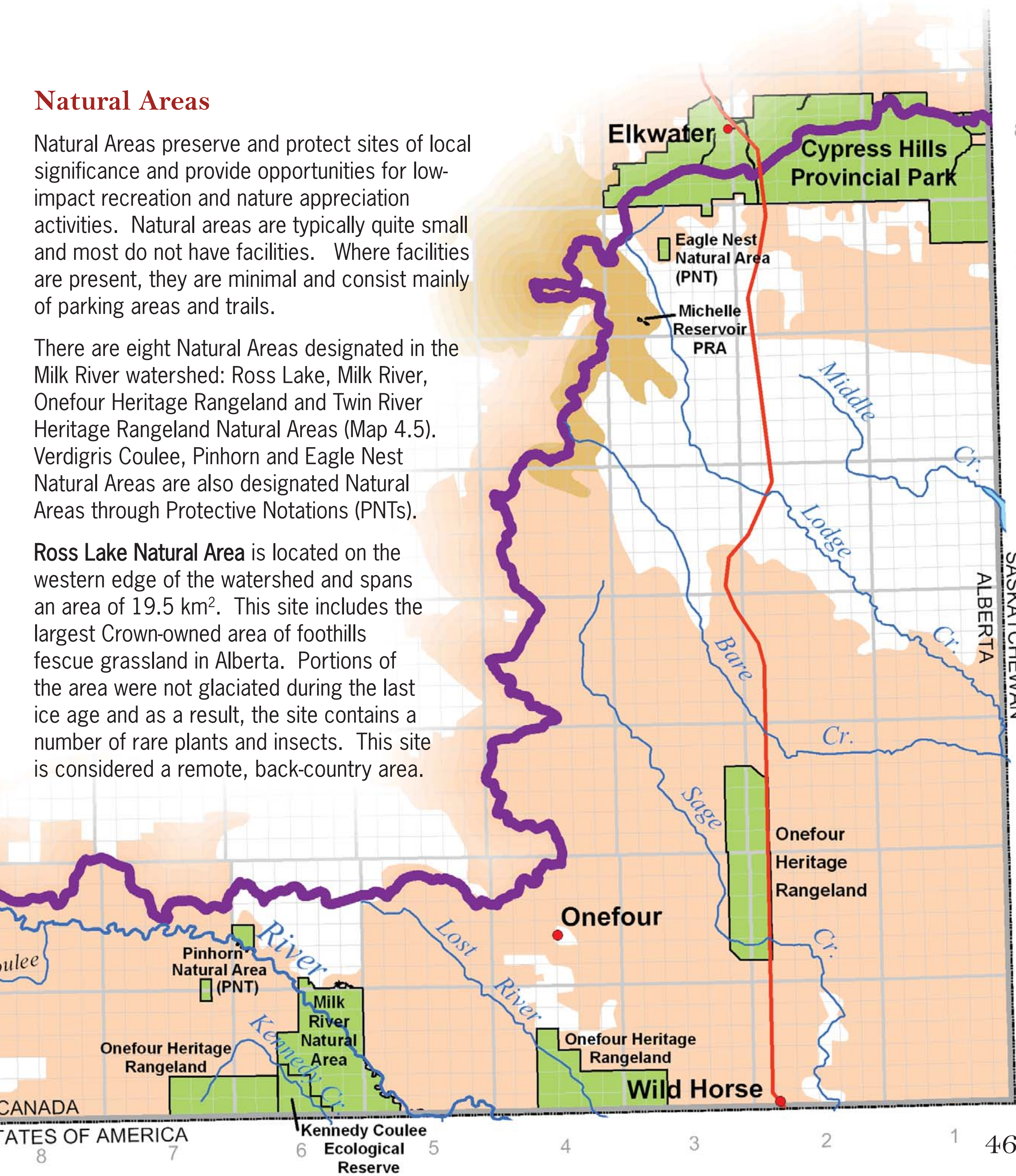
Cypress Hills Provincial Park
Cypress Hills has been a significant habitation site in North America for more than 8,000 years. Digs on the north slope of the Cypress Hills have found stone and bone tools, and butchered and charred bone scraps, artifacts of the Besant, Pelican Lake, Oxbow and Bitterroot cultures. Prior to 1870, five Indian groups, including Cree, Assiniboine, Gros Venture, Blood and some Peigan, made frequent use of the hills, particularly in winter months for wood, water, horse pasture, shelter, and game (ATPRC 2008).

Natural Areas

Natural Areas preserve and protect sites of local significance and provide opportunities for low-impact recreation and nature appreciation activities. Natural areas are typically quite small and most do not have facilities. Where facilities are present, they are minimal and consist mainly of parking areas and trails.

There are eight Natural Areas designated in the Milk River watershed: Ross Lake, Milk River, Onefour Heritage Rangeland and Twin River Heritage Rangeland Natural Areas (Map 4.5). Verdigris Coulee, Pinhorn and Eagle Nest Natural Areas are also designated Natural Areas through Protective Notations (PNTs).

Ross Lake Natural Area is located on the western edge of the watershed and spans an area of 19.5 km^2. This site includes the largest Crown-owned area of foothills fescue grassland in Alberta. Portions of the area were not glaciated during the last ice age and as a result, the site contains a number of rare plants and insects. This site is considered a remote, back-country area.



Verdigris Coulee Natural Area (PNT) is a glacial meltwater channel surrounded by sandstone hoodoos and cliffs. The site contains historical resources of provincial significance, including petroglyphs, buffalo jumps, tipi rings and burial caves. Local vegetation is characteristic of the dry mixed grassland, although the valley bottom contains unique halophytic vegetation due to an alkaline intermittent stream. The coulee is a known historical Peregrine Falcon nesting area.

The Verdigris Coulee Natural Area was recommended for a natural area reservation in 1972, following concerns expressed by the Archaeological Society of Alberta regarding damage to the area. The area has the potential to offer a unique educational opportunity as it was historically a paleontology research site. Currently, no surface access is permitted (ATPRC 2008a).

The **Milk River Natural Area** is the largest of the five areas spanning an area of 55.4 km^2. This site contains expanses of gently rolling grassland dissected by deeply-cut stream valleys, coulees and rugged badlands, permanent streams, springs and oxbow lakes. The site also contains many geological features, including one of only five igneous rock dykes known on the Canadian plains. Milk River Natural Area includes part of Milk River Canyon, the deepest canyon on the Canadian prairies. Small, isolated populations of short-horned lizards, the only lizard native to Alberta, are found along the coulee rim where grassland meets exposed bedrock.

Milk River Natural Area

Pinhorn Natural Area (PNT) is characterized by an undulating prairie deeply cut by the Milk River and its tributaries. The uplands are comprised of mixed grassland and of sagebrush flats in the lowlands. The river valley is formed by eroding slopes with sparse badland vegetation. The area provides habitat for a variety of rare and unusual wildlife species, including the hognose snake, short-horned lizard, great plains toad and pronuba moth, and it contains one of two known colonies of the rare plant, soapweed *(Yucca glauca)*, in Canada (ATPRC 2008b).

The **Eagle Nest Natural Area** was established in 1992. It contains diverse wildlife habitat and is a significant breeding area for leopard frogs. The site contains several rare species of plants and unique geological features. Currently, no surface access is permitted (ATPRC 2008c).

Soapweed

Heritage Rangeland Natural Areas

Heritage Rangelands preserve and protect natural features that are representative of Alberta's prairies; grazing is used to maintain the grassland ecology. Recreational access to lands under grazing lease is permitted only with permission from the leaseholder. Section 6.1 discusses grazing management on public lands in more detail.

There are two Heritage Rangeland Natural Areas within the Milk River watershed. The Twin River Heritage Rangeland Natural Area is located west of the Town of Milk River and spans an area of 171.1 km^2.

There is a protection notation (PNT) for the Twin River Heritage Rangeland Natural Area. It states that grazing leases, other surface dispositions, subsurface mineral agreements and subsurface freehold mineral titles existing at the date of site establishment will be honoured, with conditions for access. New surface applications that are not associated with an existing commitment will not be approved (Klohn Crippen Consultants Ltd. 2003).

The **Onefour Heritage Rangeland Natural Area** is located in the eastern part of the watershed near the Alberta-Montana border and spans an area of 111.6 km^2 that is divided into three separate units. This area is characterized by extensive grasslands, ephemeral wetlands, minor badlands and riparian shrublands. Various landscape features include hummocky moraine, exposed slopes, wet meadows, alkali wetlands, shallow marsh and springs. This site also contains two of the five igneous rock dykes known on the Canadian plains. This site contains many rare wildlife species including Ferruginous Hawk, Baird's Sparrow, Mountain Plover, Burrowing Owl, Loggerhead Shrike, plains hognose snake, leopard frog, great plains toad, western painted turtle, short-horned lizard, stonecat minnow, brassy minnow and silvery minnow. Nesting birds of prey include golden eagle and prairie falcon. The area contains key habitat for pronghorn antelope, mule deer and white-tailed deer and important swift fox habitat.

Ecological Preserves

Ecological preserves are established to preserve and protect natural heritage in an undisturbed state for scientific research and education. Ecological preserves contain representative, rare and fragile landscapes, plants, animals and geological features. The primary intent of this class is strict preservation of natural ecosystems, habitats and features, and associated biodiversity. Public access to ecological reserves is by foot only; public roads and other facilities do not normally exist and will not be developed. Most ecological preserves are open to the public for low-impact activities such as photography and wildlife viewing.

Kennedy Coulee Ecological Preserve is 10.7 km^2 in size and is located on the Alberta-Montana border (Map 4.5). Kennedy Coulee is the only ecological preserve in the Milk River watershed. It was established in 1987 by Order-in-Council to maintain a rich array of plant and wildlife communities found in the area, including: blue grama, June grass, northern wheat grass, lichens, deep rooted shrubs, white and purple prairie-clovers, aspen and hybrid poplars, water birch, Saskatoon, wild rose and gooseberry. The Brown Thrasher, Black-billed Cuckoo, Gray Catbird, Weidmeyers Admiral butterfly, Golden Eagle, Ferruginous Hawk, Prairie Falcon, bull snake, prairie rattlesnake, short-horned lizard, pronghorn antelope and mule deer rely on the diversity of the vegetation for habitat.

Michelle Reservoir Provincial Recreation Area was constructed by the Prairie Farm Rehabilitation Administration in the late 1950s to provide water to ranchers in the winter months (Space Maps Incorporated 2002). The reservoir has a surface area of 0.32 km^2, a storage capacity of 990,000 m^3 of water and drains south into Lodge Creek. The riparian outlet at the dam is operated by the province at the request of downstream ranchers for livestock use. The reservoir is stocked with rainbow trout and has a day use facility for anglers (Jacques Whitford Ltd. 2005).

Current State of Parks and Protected Areas

Currently, 8% of the watershed is maintained in the form of parks and protected areas for the preservation of significant geological, social, cultural and ecological significance.

4.6 Historical Resources

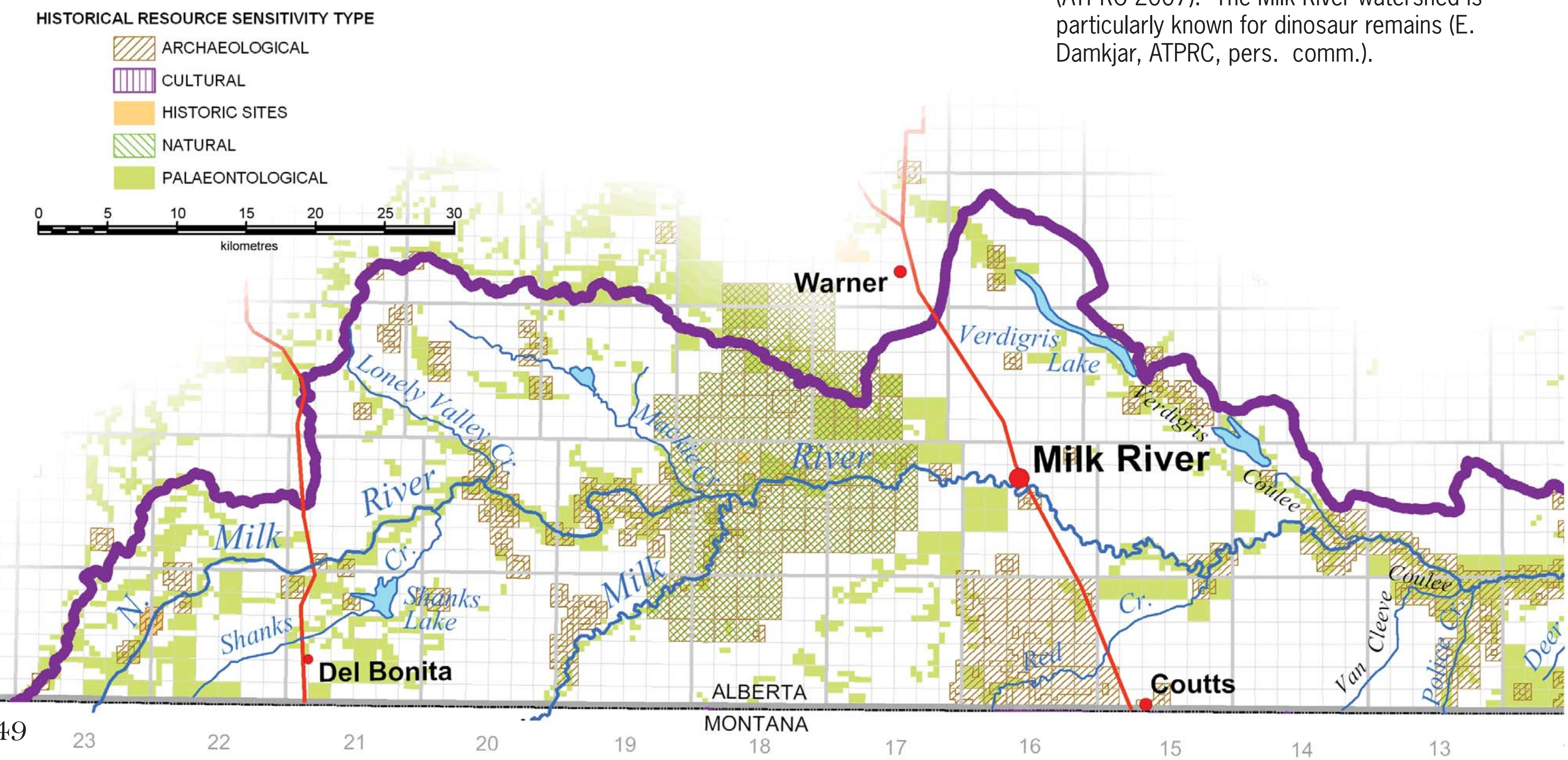
The Milk River watershed is a region in Alberta that has been used for thousands of years and is abundant in historical resources. The *Historical Resources Act* defines historical resources as “any work of nature or of humans that is primarily of value for its palaeontological, archaeological, prehistoric, historic, cultural, natural, scientific or aesthetic interest” (ATPRC 2007).

Prehistoric archaeological sites include campsites, stone features such as tipi rings, cairns and medicine wheels, workshop sites where stone tools were manufactured, kill-sites, such as buffalo jumps and wooden corrals (pounds), and rock art, including pictographs and petroglyphs (ATPRC 2007). Prehistoric archaeological sites vary in size and complexity from the location of a single stone tool to complex areas occupied by many different groups over thousands of years.

Historic sites include trading posts, police posts, early settlements, homesteads and industrial sites. In some cases there are archaeological remains while, in others, standing structures are still present (ATPRC 2007).

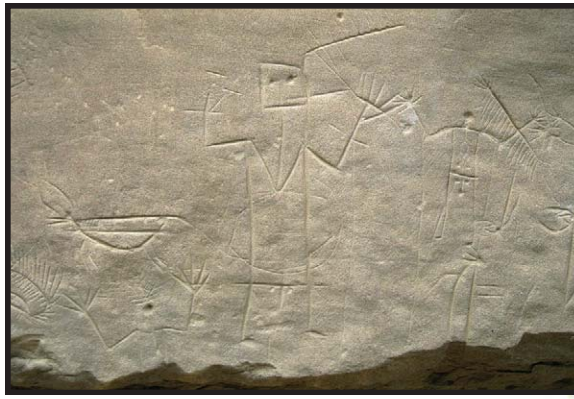
Palaeontological resources refer to evidence of ancient multicellular organisms, for example, where fossilized animal bones have been preserved in rock. Palaeontological remains are usually found in bedrock exposures or associated talus in deeply incised river valleys (ATPRC 2007). The Milk River watershed is particularly known for dinosaur remains (E. Damkjar, ATPRC, pers. comm.).

Map 4.6. Historical Resource Sensitivity Types



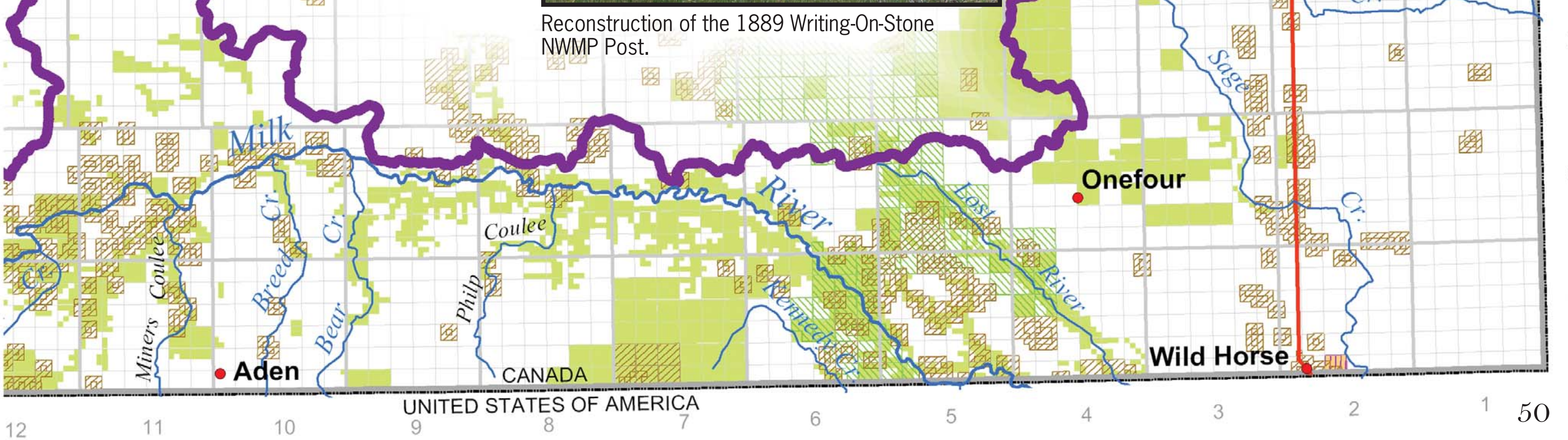
Each historical resource and the land parcel on which it is located have been assigned a historical resource value (HRV), ranging from 1 through 5. The highest value, an HRV of 1, is assigned to the most important historical resources in the Province, those that have been designated as Provincial Historic Resources under the *Historical Resources Act* (ATPRC 2007). Developments are restricted on lands of this type, whether publicly or privately owned. The HRV of 1 also applies to lands that are owned by Alberta Tourism, Parks, Recreation and Culture for historical resources protection and promotion purposes (e.g., Writing-On-Stone Provincial Park).

A HRV of 5 indicates that lands are considered to have high potential for historical resources but none have been recorded. Table 4.1 describes all HRV values and their historical resource sensitivities.



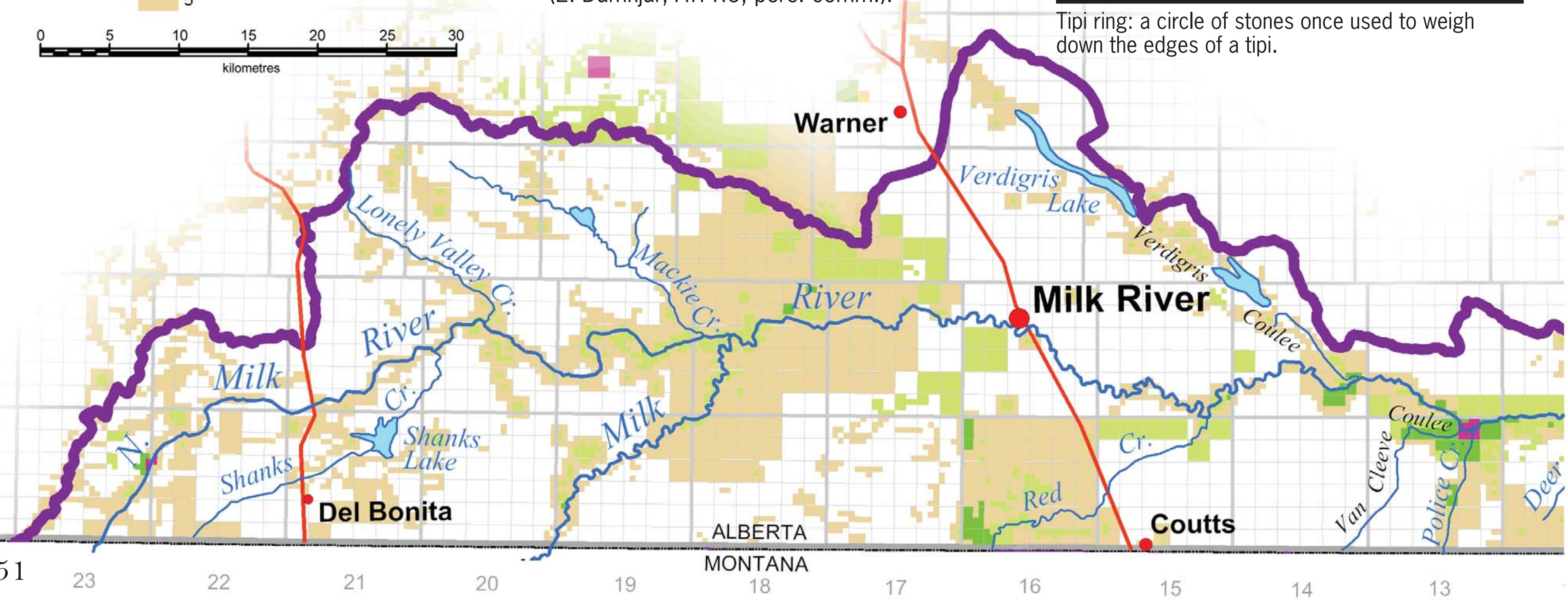
Rock art in the watershed.

Reconstruction of the 1889 Writing-On-Stone NWMP Post.



There are currently three historic site areas that are assigned an HRV of 1 within the Milk River watershed (Map 4.7). The most well-known is at Writing-On-Stone Provincial Park, which contains the greatest concentration of First Nations rock art on the North American Great Plains and is recognized as a National Historic Site. The Writing-On-Stone Police Post is also assigned an HRV of 1 because of its archaeological and historical significance.

Map 4.7. Historical Resource Values



The Drewry House, built of local sandstone in the early 20th century, is located in the north-east part of the watershed. The heritage value of the Drewry House lies in its long association with southern Alberta's ranching and farming life and its fine representation of a rural Alberta sandstone ranch home.

Landowners Are Important to Preservation of Historic Resources

The Hoyt Tipi Ring site is a large tipi ring complex on the Milk River containing dozens of stone circles where tipis once stood. The Hoyt family encouraged the designation of this important site on their land because they wanted the tipi rings preserved. Landowner cooperation of this sort is important when designating sites to Level 1 – if on private land (E. Damkjar, ATPRC, pers. comm.).

There are more than 15 sites in the watershed that have been assigned HRVs of 3. Included are several rock art sites, in addition to the main concentration at Writing-On-Stone Provincial Park, as many as five medicine wheel sites, a campsite, a kill site with associated rock art, two other NWMP outposts,

Tipi ring: a circle of stones once used to weigh down the edges of a tipi.

and several sections of the Whoop-Up Trail (E. Damkjar, ATPRC, pers. comm.).

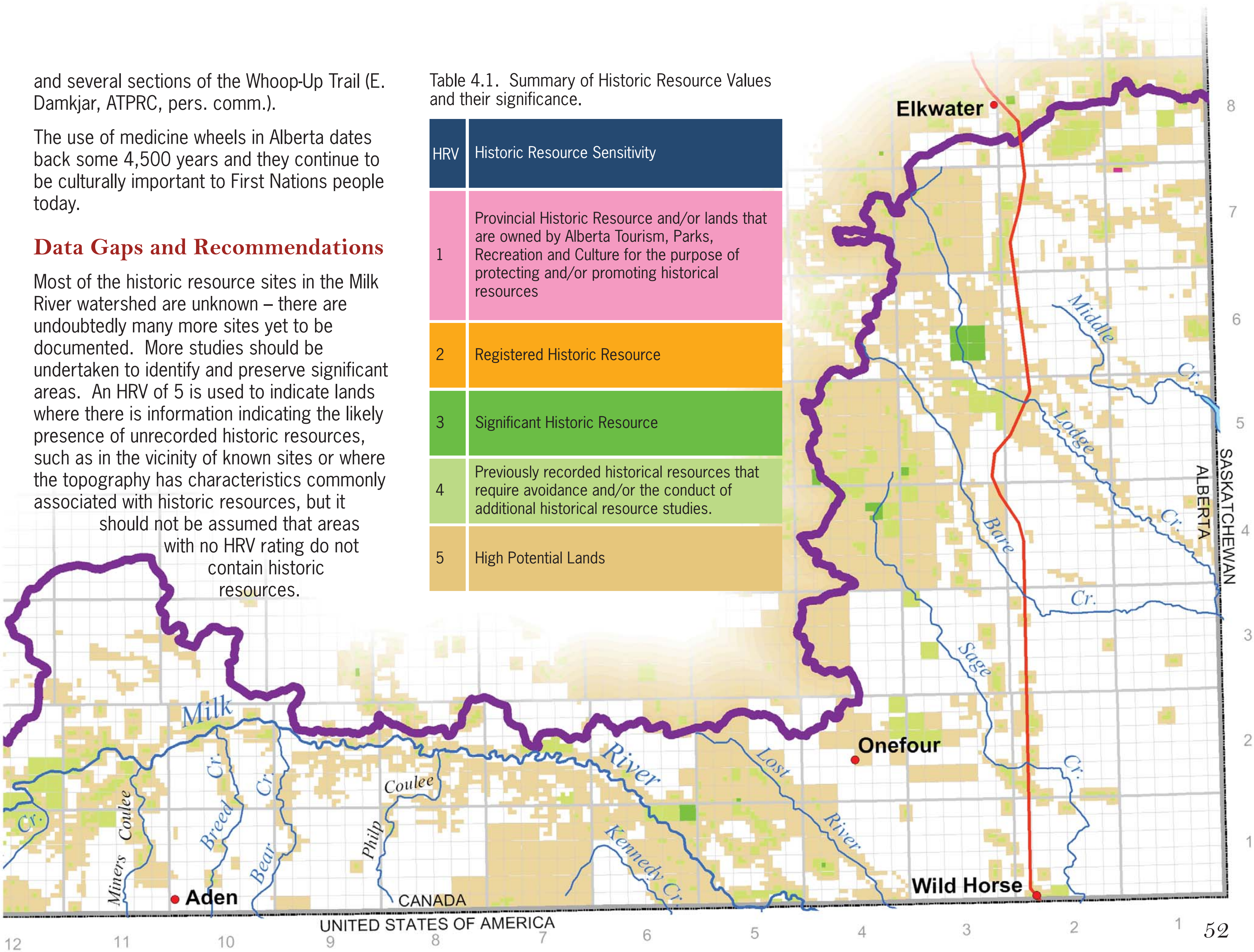
The use of medicine wheels in Alberta dates back some 4,500 years and they continue to be culturally important to First Nations people today.

Data Gaps and Recommendations

Most of the historic resource sites in the Milk River watershed are unknown – there are undoubtedly many more sites yet to be documented. More studies should be undertaken to identify and preserve significant areas. An HRV of 5 is used to indicate lands where there is information indicating the likely presence of unrecorded historic resources, such as in the vicinity of known sites or where the topography has characteristics commonly associated with historic resources, but it should not be assumed that areas with no HRV rating do not contain historic resources.

Table 4.1. Summary of Historic Resource Values and their significance.

HRV	Historic Resource Sensitivity
1	Provincial Historic Resource and/or lands that are owned by Alberta Tourism, Parks, Recreation and Culture for the purpose of protecting and/or promoting historical resources
2	Registered Historic Resource
3	Significant Historic Resource
4	Previously recorded historical resources that require avoidance and/or the conduct of additional historical resource studies.
5	High Potential Lands



4.7 Tourism and Recreation

Early River History

The Milk River has long been a playground for all sorts of rafts built by local children. It was also the local swimming hole before a swimming pool was built in the Town of Milk River. Canoeing on the Milk River became popular in the early 1970s when several local people started an annual overnight canoe trip and a local canoe club was formed.

The Canoe Club grew as members began to invite friends from other places to join them on their trips. However, local landowners became increasingly concerned about people camping and trampling on their land, frightening cattle and destroying the fragile grass along the river. In response to these concerns, the local Canoe Club developed several places to put in or take out canoes (termed egresses). In addition, several designated camping areas were established along the most popular canoeing reaches and signs were posted indicating distance to the next egress and where camping was permitted. The Canoe Club also established outhouses at the Coffin Bridge and Weir Bridge egress points. An overnight shelter was constructed at Poverty Rock – a popular, privately owned resting place between Coffin Bridge and Weir Bridge.

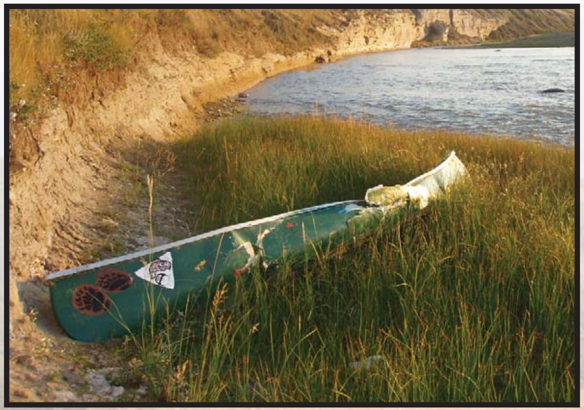
Many of the campers at Writing-On-Stone Provincial Park, especially children, swam and floated in tubes, air mattresses and life jackets from the day use area to the beach area of the campground. Unfortunately, no statistics were compiled that would indicate how many people were using the Milk River for water activities.

In the early 1980s, the first outfitter offering day trips down the river on whitewater rafts appeared. The business was sold several years later and the new operators offered canoe rentals as well as guided daily float trips along the river.

The popularity of the Milk River as a canoeing destination also increased as a result of several newspaper articles that were published in daily newspapers such as the Calgary Herald and the Calgary Sun. It likely helped that a photo journalist for the Calgary Sun was a young man who grew up in Milk River.

The Calgary Canoe Club and the Bow Waters Canoe Club began to bring their beginner paddlers to the Milk River for their first river experience. The Milk River was used because most of the river has Class I water with a few Class II sections. Although sections of the river are more easily navigated than others, it is a surprisingly challenging river in some reaches.

Most of the articles published about the Milk River suggest that even the inexperienced canoeist could navigate it easily. This has led to an increase of novice paddlers along the river. Some have left their wrecked canoes in the rocks that they could not navigate around and, every year, six to ten canoes are picked up in pieces along the river. The Milk River changes from year to year, depending on spring runoff and the ice break up. The greatest hazard along the river is the “milky” colour of the water. Rocks, hidden by the milky water, are an ever present hazard and the cause of many mishaps.



Milk River Recreation

Several businesses and organizations offer canoeing, kayaking and rafting opportunities on the river. The Milk River is sensitive to precipitation and water management (i.e., high or low water levels). Canoeing on the Milk River requires a discharge rate of 12 m^3/s, which is generally found between the months of May and August, with variations from less than 12 m^3/s to 25 m^3/s (Klohn Crippen Consultants Ltd. 2003). During periods of drought or when repairs to the St. Mary River diversion canal are necessary, water levels may decrease to depths unsuitable for recreation. Examples of this occurred in 2002 and in 2007, when the St. Mary canal was shut down for repairs for approximately a one week period in August 2002 and a one week period in each of July and August 2007 (K. Brown, Milk River Raft Tours, pers. comm.).

In the most recent years, there has been an increase in the number of individuals bringing canoes to the Milk River as noted by the increase in requests for a local shuttle service (K. Brown, Milk River Raft Tours, pers. comm.). In 2007, a Lethbridge-based outfitter had clients from Edmonton, Calgary, and as far away as Trail and Victoria, B.C. rent canoes and kayaks to spend six to ten days on the Milk River (M. Isaac, High Level Canoes and Kayaks, pers. comm.). The Milk River is also a popular destination for Calgary's Bow Waters Canoe

Club members early in the season (A. Magotiaux, Bow Waters Canoe Club, pers. comm.). Although there are numerous other clubs and groups that have not been accounted for here (e.g., Scout's Canada, University of Calgary), the Great Canadian Rivers website has estimates that up to 10,000 canoeists, kayakers and rafters of all skill levels enjoy the Milk River annually (Great Canadian Rivers 2007). The most popular reaches lie between Del Bonita and Deer Creek Bridge in the east, just downstream of Writing-On-Stone Provincial Park.

Table 4.2. Number of people recreating on the Milk River (K. Brown, Milk River Raft Tours, pers. comm.). Note that this table only represents recorded numbers by one outfitter.

Year	Days on River	Canoeists	Rafters	Floaters
2000	111	459	450	Unknown
2001	-	-	-	-
2002		420	320	
2003	115	512	300	
2004	120	600	320	
2005	135	650	260	300
2006	115	630	220	238

Camping opportunities are provided at Del Bonita campground operated by the Lions Club, the privately operated Gold Springs Park near Milk River and at Writing-On-Stone Provincial Park. Hiking, canoeing, kayaking, rafting, tubing and wildlife viewing can all be enjoyed on the Milk River.

Poverty Rock

The overnight facilities at Poverty Rock were taxed on most weekends in 2004. On one weekend, there were over 60 people camped at this site.

Gold Springs Park

Gold Springs Park offers a number of recreational opportunities including a fish pond, paddle boats and access to the Milk River. It is conveniently located on Highway 4 between Milk River and Coutts. The Park offers 100 campsites of which 60 sites are maintained for campers and 40 sites are rented by the season. An estimated 7,100 people use Gold Springs Park throughout the May through September period for camping. The 100 campsites are occupied every weekend from June through August and about half of the sites are occupied in May and September. Occasionally overflow sites are occupied. Approximately 10 to 12 sites are occupied every night during the week (S. Heather-Kalau, Gold Springs Park, pers. comm.).

Writing-On-Stone Provincial Park

Writing-On-Stone Provincial Park offers many recreational opportunities including hiking, canoeing, tubing and wildlife viewing amidst a unique badland landscape. The historical significance of the park has been captured in the new Interpretive Centre that was opened in 2007. Since 1994, total daily visitors to the Park have ranged from 45,992 to 63,555 people, with the largest number of people visiting in the year 2000 (Table 4.3).

Overall, it appears as though the total number of visitors has remained fairly stable for the past 13 years, with a slight decrease since 2000. However, statistics were not available for 2007 when the new Interpretive Centre opened.

Pressure is:

increasing (marked) | stable | decreasing | unknown

Data Gaps and Recommendations

Limited information is available that can be used to estimate the total number of people recreating in the watershed. It is understood that pressure is increasing through observation and minimal data. A study should be undertaken to better understand recreation in the watershed by activity (e.g., hunting, canoeing, hiking).

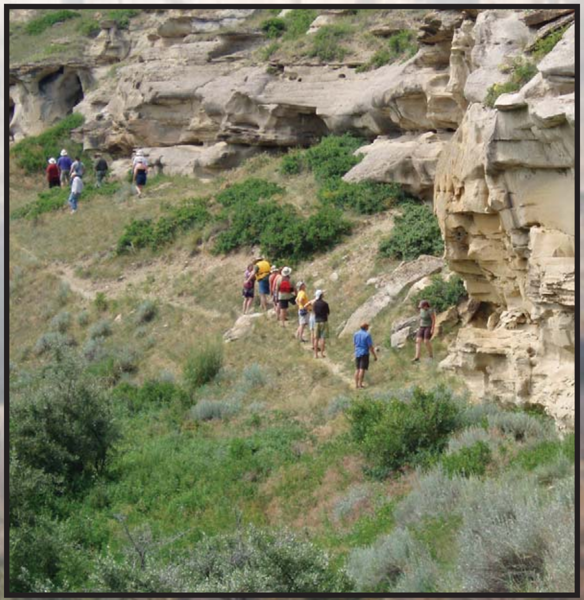


Table 4.3. Summary of recreational use at Writing-On-Stone Provincial Park for the period from 1994 through 2006. (Data provided by ACD 2004, updated in 2007). Camping use statistics are based on camping permit sales analysis, and/or reasonable estimates of camping use and camper surveys. Day use statistics are collected through automatic traffic counter readings and traffic surveys. Group Camping Use Statistics are based on group use permit sales analysis.

Year	Occupied Campsite Nights	Campers	Group Unit Nights	Group Campers	Day Use Party Visits	Day Use Visitors	Total Parties	Total Visitors
1994	6,290	21,655	584	2,229	9,100	30,865	15,974	54,749
1995	6,187	21,199	520	2,013	10,125	33,558	16,832	56,770
1996	5,913	20,210	521	1,959	10,225	34,153	16,659	56,322
1997	6,004	20,522	483	1,839	8,525	29,095	15,012	51,455
1998	5,324	18,138	416	1,596	8,875	30,543	14,615	50,277
1999	6,117	20,855	426	1,644	10,375	35,320	16,918	57,819
2000	6,265	21,399	373	1,455	11,971	40,701	18,609	63,555
2001	5,593	19,134	380	1,471	7,487[1]	25,456	13,460	46,061
2002	4,735	16,222	3452	1,346	8,360	28,424	16,547	45,992
2003	5,461	18,648	427	1,665	8,140	27,128	14,028	47,441
2004	5,561	19,008	436	1,700	9,599	32,637	15,596	53,345
2005	4,873	16,659	667	2,601	8,084	27,486	13,624	46,746
2006	3,691	12,620	681	2,656	-	-	-	-

[1]Data missing for one or more months

5.0 Aquatic Resources

5.1 Surface Water

Surface Water Supply

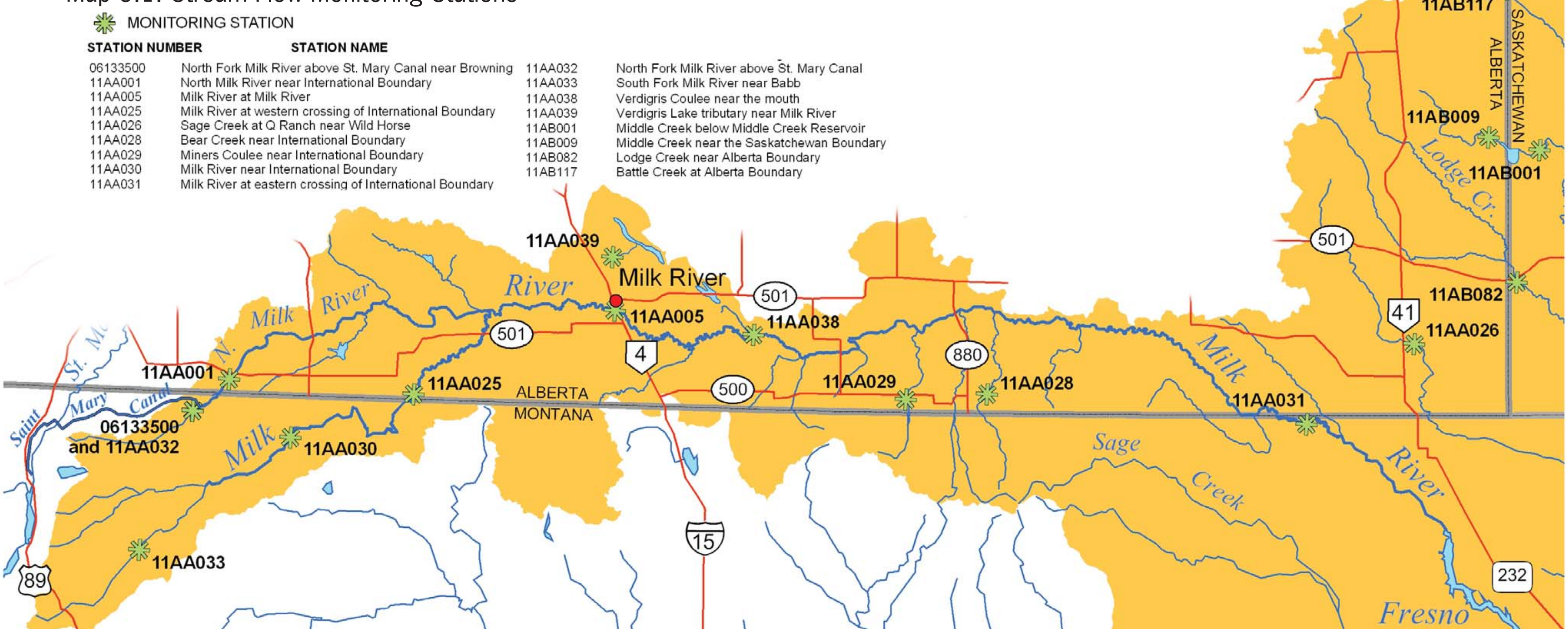
The Milk River is the smallest of Alberta's major river basins with a drainage area of about 6,664 km^2. The Milk River rises from snowpack and rainfall in the foothills along the eastern slopes of the Rocky Mountains in Montana before crossing into Alberta. The river runs parallel to the border for about 180 km before returning to Montana. Upstream of the Eastern Crossing of the International Boundary, the Milk River drainage basin has a mean annual precipitation of about 350 mm and a mean lake evaporation of 770 mm.

The Southern Tributaries of the Milk River, which include Bear Creek, Breed Creek and Miners Coulee, are intermittent streams that flow north from the Sweetgrass Hills of northern Montana into Canada. Two northern tributaries that arise within Alberta are Sage Creek and the Lost River, both of which are also intermittent streams.

Battle, Middle and Lodge creeks arise in the east from the Cypress Hills and are known collectively as the Eastern Tributaries. These tributaries flow into Saskatchewan before joining the Milk River in Montana.

There are 17 gauges installed across the Milk River watershed to measure streamflow (Map 5.1). These include four in the headwaters in Montana, one at each border crossing between Alberta and Montana, and between Alberta and Saskatchewan.

Map 5.1. Stream Flow Monitoring Stations



Historical stream flows in the Milk River have averaged about 292,000,000 m^3 per year. Of that volume, approximately 22% originates from the mainstem Milk River watershed in Montana, 8% originates from the North Milk watershed in Montana, and only 10% is from runoff from the Milk River watershed within Canada (Figure 5.1). The majority (61%) of the present observed stream flow, is water diverted from the St. Mary River via the St. Mary Canal during the irrigation season.

The Milk River in a dry year, 2001.

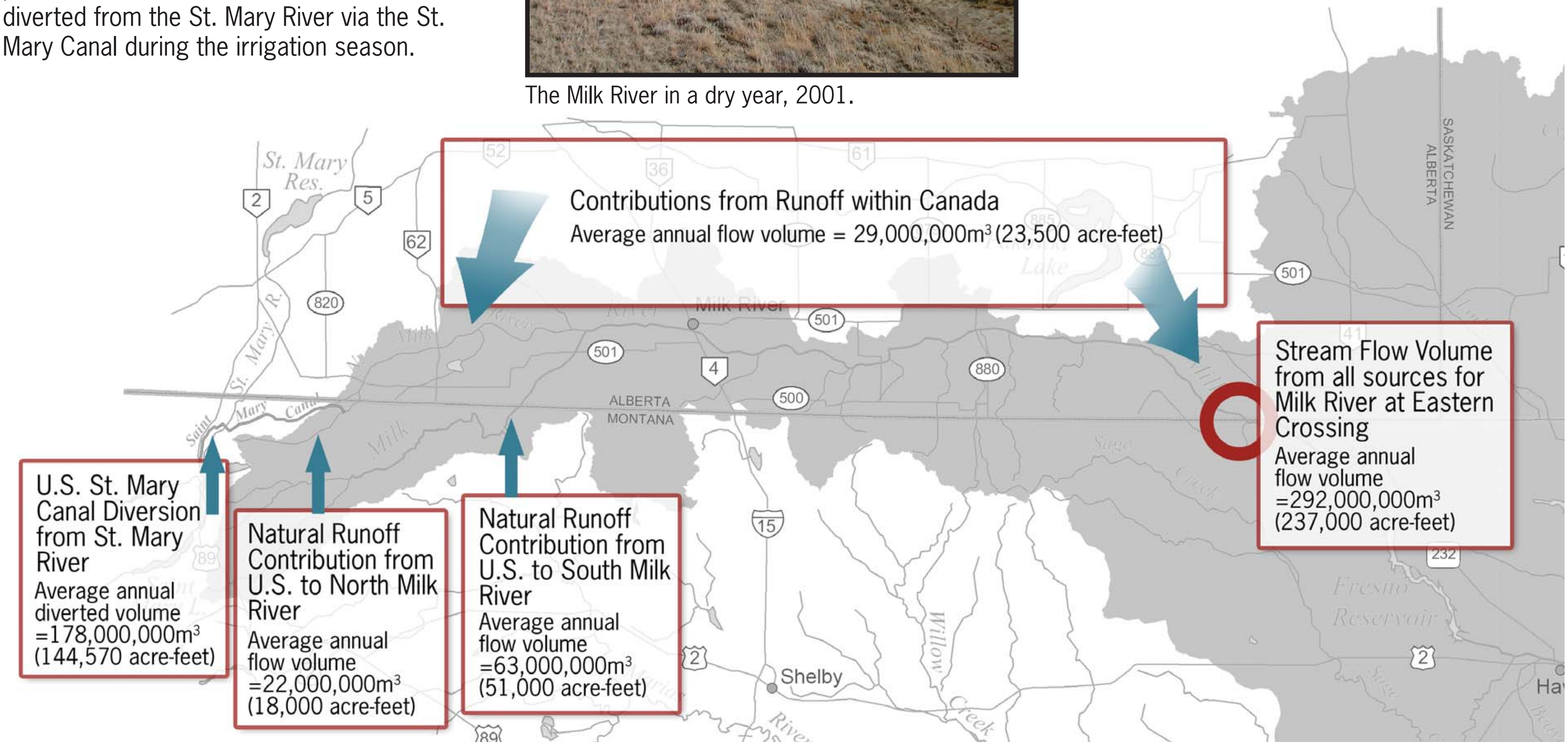


Figure 5.1. Historical runoff/diversion contributions to average annual stream flow volumes in the Milk River for the period 1912 to 2001.

In an average year, streamflows vary from less than 0.7 m^3/sec in winter to about 20 m^3/sec in June, and then remain above 12 m^3/sec until September (Figure 5.2). The effect of the St. Mary River diversion is to significantly raise the average flow throughout the summer months above natural flow levels.

Without the St. Mary River diversion, the average flow in the Milk River would reach 11 m^3/sec by April, remain between 6 and 12 m^3/sec until June, then fall to 1.5 m^3/sec by August. In many years, there have been periods with no flow recorded in the river at the eastern crossing. This high variability in water supply, both within a year and between years, means that while the average Canadian entitlement to the water supply for the period 1912 to 2001 was approximately 45,900,000 m^3, annually it has ranged from a low of 6,630,000 m^3 in 2001 to as high as 168,000,000 m^3 in 1927.

The tributaries of the Milk River which flow from the Cypress Hills in Alberta, including Battle, Middle and Lodge creeks, are collectively referred to as the Eastern Tributaries. The natural flows of these tributaries are highly variable on an annual basis (Figure 5.3) and with the exception of Battle Creek, are ephemeral in nature, their stream flows being dependent on snowmelt runoff and rainfall in the spring and early summer (Figure 5.4). Figure 5.4 shows a typical hydrograph for Lodge Creek.

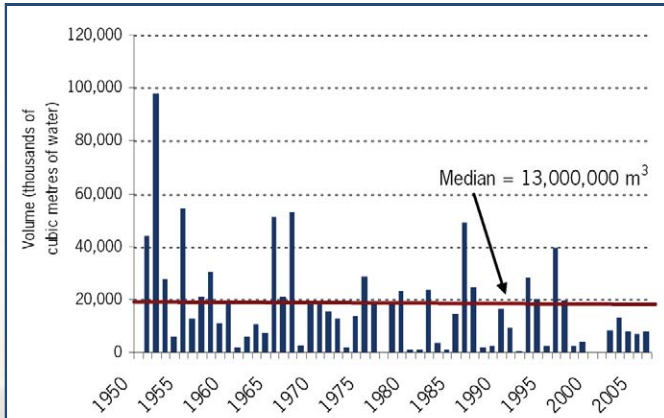


Figure 5.3. Annual flow volumes recorded at the Water Survey of Canada gauge station, Lodge Creek near Alberta Border, for the period 1951 to 2006.

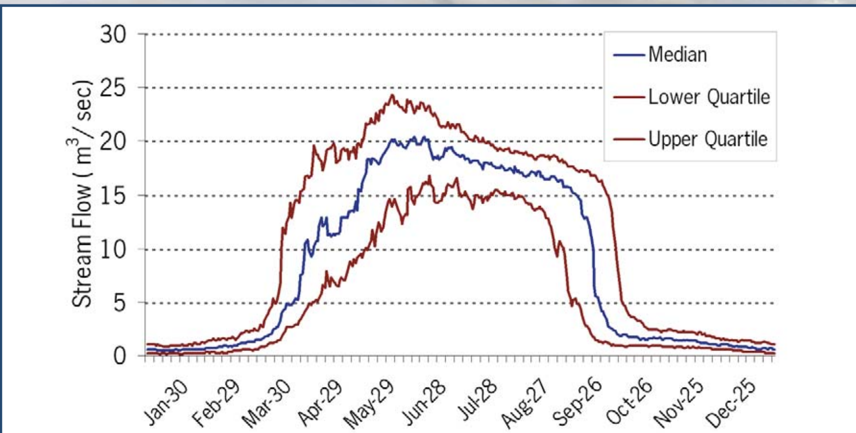


Figure 5.2. Daily hydrograph from recorded flows for Water Survey of Canada Milk River at Milk River gauge station for the period 1912 to 2006 showing median, 25% and 75% quartile flows.

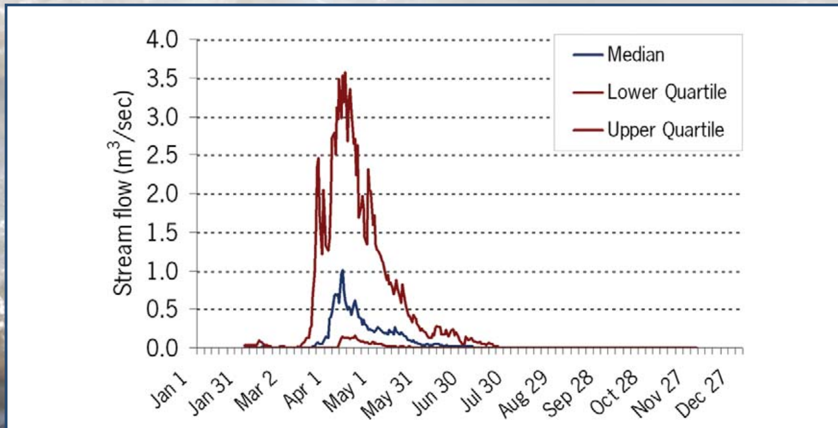


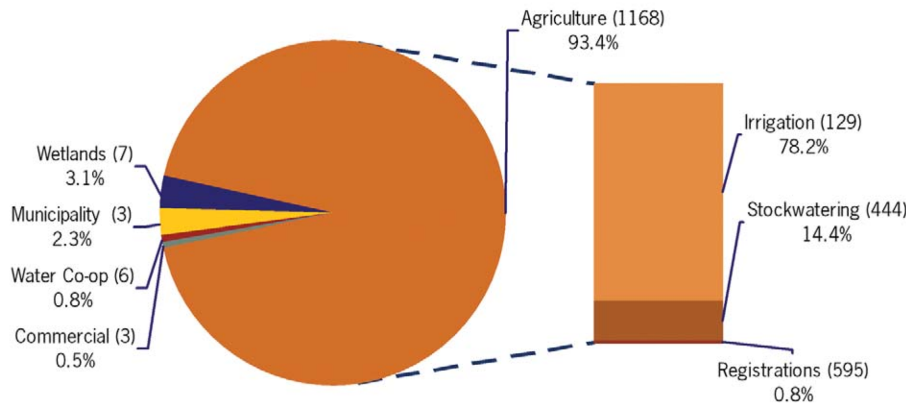
Figure 5.4. Daily flow hydrograph for Water Survey Canada gauge station, Lodge Creek near Alberta Boundary, showing the calculated median, 25% and 75% quartile daily flows for the period 1951 to 2006.

Surface Water Allocation and Use

The use of water has been regulated in Alberta since prior to its formation as a province. The first legislation was the federal *Northwest Irrigation Act* of 1894, which established the "first in time, first in right" priority system that has been carried forward to the present. With the creation of the province of Alberta and then the transfer of the ownership of its natural resources from the federal government to the province, the *Northwest Irrigation Act* was replaced with the provincial *Water Resources Act* in 1934. The *Water Resources Act* was subsequently replaced by the *Water Act* in 1999. Under all the legislation, there has been a requirement for an authorization in the form of a licence for the diversion and use of all water, except for small quantities required for individual household uses and the watering of domestic animals from a source of water that is on or under land the user owns. The *Water Act* introduced a 'registration of traditional agricultural use' that allows a water user to obtain a priority number for the use of up to 6,250 m^3 of water annually for the watering of domestic livestock and/or application of pesticides on crops.

A total of 31,571,000 m^3 of surface water has been allocated through 1,187 licences and registrations of traditional agricultural use in the Milk River watershed (not including the eastern tributaries area). The largest percentage of the allocations is for agriculture purposes, with irrigation in particular having the highest allocations (Figure 5.5).

On an annual basis, approximately 15,000,000 m^3 of water is allocated for diversion directly from the Milk and North Milk Rivers (Figure 5.6). Of this, 93% is for irrigation, 6% for municipal use, and 1% for commercial and agricultural uses.



Total Allocated Volume in watershed excluding the Eastern Tributaries = 31,571,112 m^3
Number in parentheses after the listed purpose is the number of authorizations for that purpose
Source = Alberta Environment EMS database records to November 2007

Figure 5.5. Percentage of surface water allocations by volume for different purposes of use in the Milk River watershed, not including those in the Battle, Lodge and Middle creek sub-watersheds.

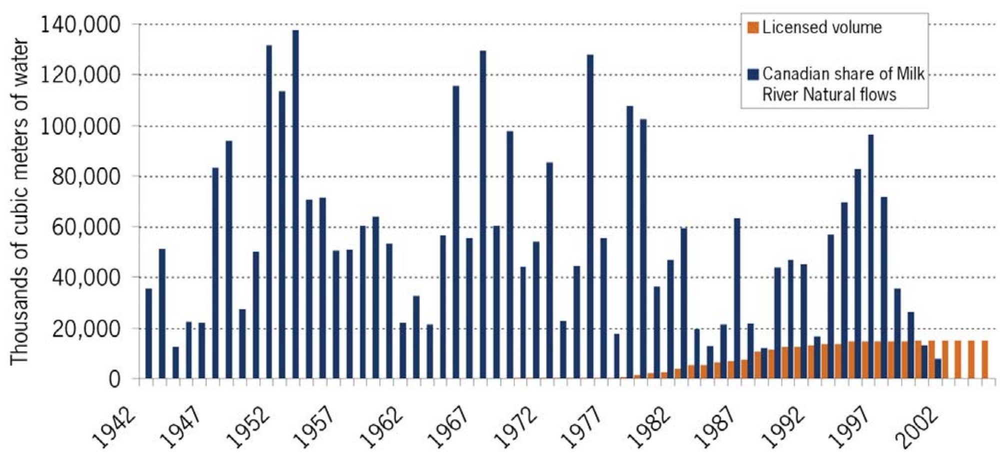


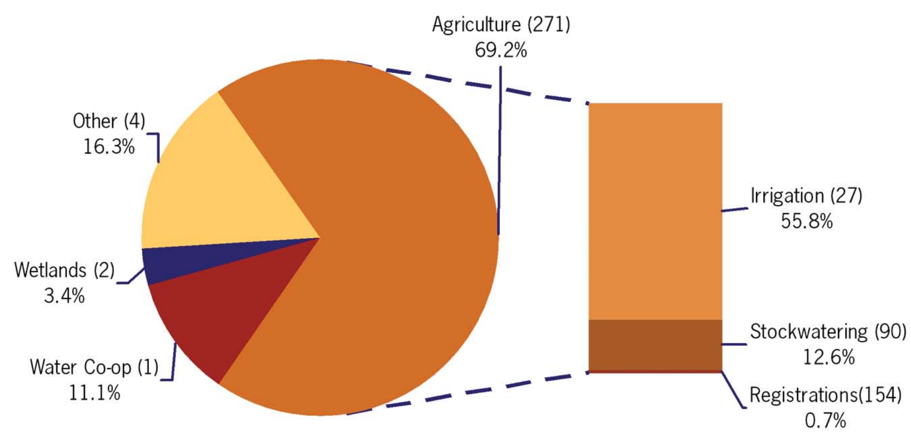
Figure 5.6. Total water allocations diverted directly from the North Milk, South Milk and mainstem Milk rivers in Alberta compared to the available Canadian share for the period 1942 to 2006.

In comparison to the amount of water allocated, information on the amount of water actually being used from the Milk River is sparse. Through the 1980s and 1990s, water use for the international apportionment agreement was estimated based on a calculation that included the amount of irrigation acreage, the crop mix and the time of year relative to crop water demand for an average, dry or wet year. It is estimated that through the 1990s the average annual water use in Alberta was approximately 8,900,000 m^3 or 19% of the average annual entitlement of 45,904,000 m^3 based on the flow record 1912-2001.

In 2005, Alberta Environment and Alberta Agriculture began a pilot program with the cooperation of water users to install water meters with telemetry equipment on 33 irrigation systems along the Milk River to obtain real-time water use information. The program has faced a number of technological hurdles, so that August 2007 was the first month that most meters were working properly and consistently reporting actual water use. It is expected that 2008 will be the first complete year when actual real-time water use will be collected.

A further 8,858,944 m^3 of water has been allocated in the portion of the watershed supplied by the eastern tributaries in the Cypress Hills area (Figure 5.7). The allocated amount of water in the Lodge/Middle Creek subwatershed is equal to about 60% of the median natural runoff volume available in that subwatershed for the period 1985 to 2004 (calculated from Prairie Province Water Board annual reports). Under the Apportionment Agreement with Saskatchewan and the *International Boundary Waters Act*, Alberta is only entitled to 25% of the natural runoff from these waters. During the 21 year period, 1985 to 2004, Alberta failed to meet the apportionment requirements for Lodge Creek in five of those years. Based solely on the allocation numbers, apportionment deficits should be even more frequent, but annual telephone surveys of water users indicate that often the runoff occurs too early to be used, particularly for irrigation purposes (I. Franks AENV, pers. comm.).

As a result of the level of allocation combined with the unreliability of water supplies in the Milk River watershed, in 1989, Alberta Environment placed a moratorium on the acceptance of any further applications for the diversion of surface water for the purposes of irrigation, or industrial/commercial uses from sources within the main Milk River subwatershed. Applications for domestic/municipal uses are still accepted and reviewed. In the Lodge Creek watershed, there has been a moratorium in place since 1983 on the acceptance of any further applications for any type of project that would divert from the mainstems of Lodge, Middle or Bare creeks. Applications for new, small agricultural stockwatering projects may be considered from contributing tributaries.



Total allocated volume in Battle, Middle and Lodge creek sub-watershed = 8,858,944 m^3
Number in parentheses after the listed purpose is the number of authorizations for that purpose
Source = Alberta Environment EMS database records to November 2007.

Figure 5.7. Percentage of surface water allocations by volume for different purposes of use in the Battle, Lodge and Middle creek sub-watersheds.

Summary

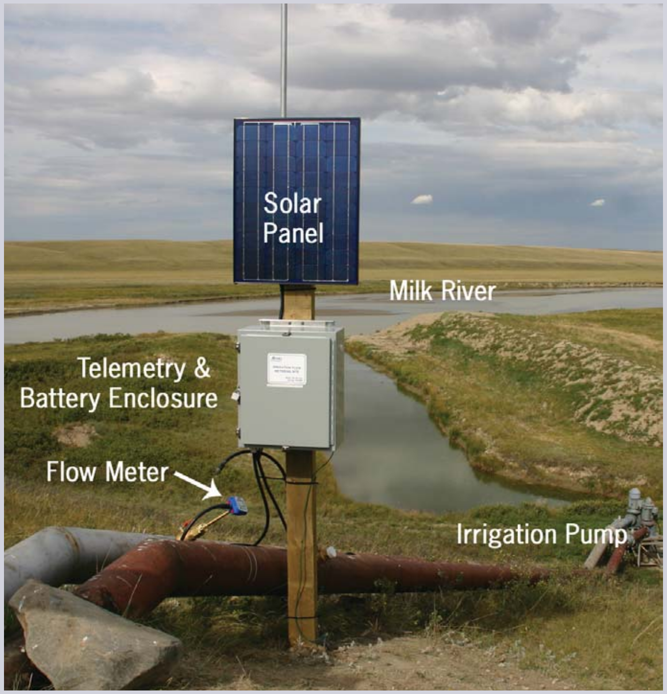
The available water supply in the Milk River watershed exhibits a high degree of variability within each year and between years. Observed flows in the Milk River during the open water period are enhanced by diversions from the St. Mary River by the United States, which somewhat mask this natural variability. When flows are not being enhanced by St. Mary River diversions, low natural flows places stress on the aquatic environment and also on the ability to supply water for human use. The level of water allocation for human use exceeds the water supply during extremely dry years throughout the watershed.

Data Gaps and Recommendations

Although surface water supply and allocations are relatively well understood, there is poor understanding of actual water use. A better understanding of water use by all sectors through projects like the Milk River Water Metering Project is required to enable informed decisions on implementing beneficial management practices for water use efficiencies and water conservation. This will ensure the most effective use of the limited water supply.

Along with better understanding of the human uses, better understanding of the aquatic ecosystem requirements are needed to allow decisions to be made in the future that balance the aquatic ecosystem needs with human needs. This may be accomplished through an instream flow needs study that considers aquatic life as well as other ecosystem components (e.g., riparian area).

Remote Metering Assists with Water Management – The Milk River Pilot Project



Under the Water for Life Strategy, Alberta Environment in partnership with Alberta Agriculture and Food and the cooperation of irrigation water users established a pilot project on the Milk River (mainstem) to investigate the viability of monitoring water use for private irrigation projects. The Milk River is an international stream whose waters are shared between Canada (Alberta) and the U.S. (Montana), thus reliable water use information is required to assist with apportionment calculations and ensure timely water management decisions are made for this watershed. The Milk River pilot project will provide a set of specifications and standards for metering and transmitting of water use information using real-time flow metering and reporting equipment.

Since initiating the project in 2005, four types of meters and three types of telemetry devices have been tested at 33 field sites during the irrigation season (typically April to September). The 2005 and 2006 field seasons were required to assess monitoring sites, install equipment and establish fully functioning systems. By the beginning of August, 2007, more than 95 % of the combinations of flow meters and telemetry devices being tested were reporting data. The very dry period in late summer and subsequent low river flows resulted in a relatively early end of the irrigation season, thus providing only one month of continuous results from the pilot project. It is, therefore, proposed that the pilot project be extended for one to two more years beyond 2007 now that the project is fully operational.

Once the Milk River metering project is completed, a full review of how near real-time water use reporting can supply accurate and timely water use information will be undertaken. This will support better water management decisions in other watersheds in the province as well, especially during a water shortage or drought year.

Surface Water Quality

Good water quality is important for aquatic life and for human health and enjoyment. Ongoing water quality monitoring programs can help identify changes in a watershed that is useful for watershed management planning. Water quality monitoring can also identify "hotspots" and areas in a watershed that may require better land use practices to improve watershed health or identify areas that may pose a risk to human health.

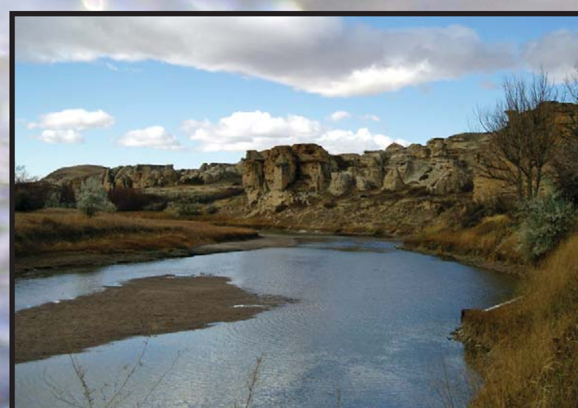
Nutrients, such as nitrogen and phosphorus, are essential for plant growth. Phosphorus is often the limiting nutrient in freshwaters, meaning that even small additional amounts can cause increased algae and aquatic plant growth. This can lead to nutrient enrichment, or eutrophication, which results in nuisance algal blooms and weed growth, taste and odour problems, and oxygen depletion, which in turn can cause fish kills.

Nitrogen can also contribute to eutrophication. Nitrate-nitrogen, a common form of nitrogen, can lead to health problems in humans and livestock, while ammonia-nitrogen can be toxic to fish and aquatic organisms.

Fecal coliform bacteria may indicate potential health risks to swimmers and may affect the suitability of water for crop irrigation and livestock watering. Certain bacteria, including fecal coliforms and *E. coli*, can be used as indicators of fecal contamination. While they are not themselves harmful, they are often related to the presence of other pathogenic or disease-causing bacteria, such as Salmonella or *E. coli* O157:H7.

Water quality is influenced by a variety of factors including the volume of river flow, local geology, climatic conditions, the degree of development along rivers, non-point sources of runoff (e.g., agricultural fields), and point sources of effluent that discharge into rivers (e.g., stormwater pipes).

One of the main influences on water quality is flow volume, or how much water is in a river. High flows can benefit water quality by reducing nutrient concentrations through dilution, however, large flows may also increase concentrations when surface runoff enters a river. Flow volumes and concentrations are used to calculate the load, or the total amount of a substance in a stream. These loads can then be used to assess the impact on receiving water bodies. Rivers with large flow volumes often have greater loads and a larger potential impact on receiving water bodies than smaller streams.



Writing-On-Stone water quality monitoring site.

Water Quality Monitoring

Surface water quality has been monitored since 1960 at various locations in the Milk River watershed. Historically, Environment Canada has monitored the eastern and western boundary crossings from 1960 to 1993, and Alberta Environment has monitored various locations along the mainstem of Milk River from 1986 to 1988 and from 2004 to present. In recent years, only one sampling point remained in the watershed at the Highway 880 Bridge.

Few reports have documented water quality in the watershed and those that have been prepared are limited in scope.

In 2006, a comprehensive water quality monitoring program was designed and initiated by the Milk River Watershed Council Canada (MRWCC) in collaboration with Cardston County, the County of Warner, the County of Forty Mile, Cypress County, Writing-On-Stone Provincial Park and Alberta Environment. Water samples were analyzed for a number of different chemical constituents that may pose a risk to aquatic life and/or human health. In addition, flow data was retrieved from existing flow measurement stations (Map 5.2).

Miner's Coulee water quality monitoring site.

Western boundary of the North Fork water quality monitoring site.

The Surface Water Quality Index

The Canadian Council of Ministers of the Environment Water Quality Index (WQI) was developed as a way to summarize complex physical, chemical, and biological data into a simple descriptor of water quality. The Index provides a "snap-shot" of annual water quality conditions that can easily be compared across years (Map 5.2).

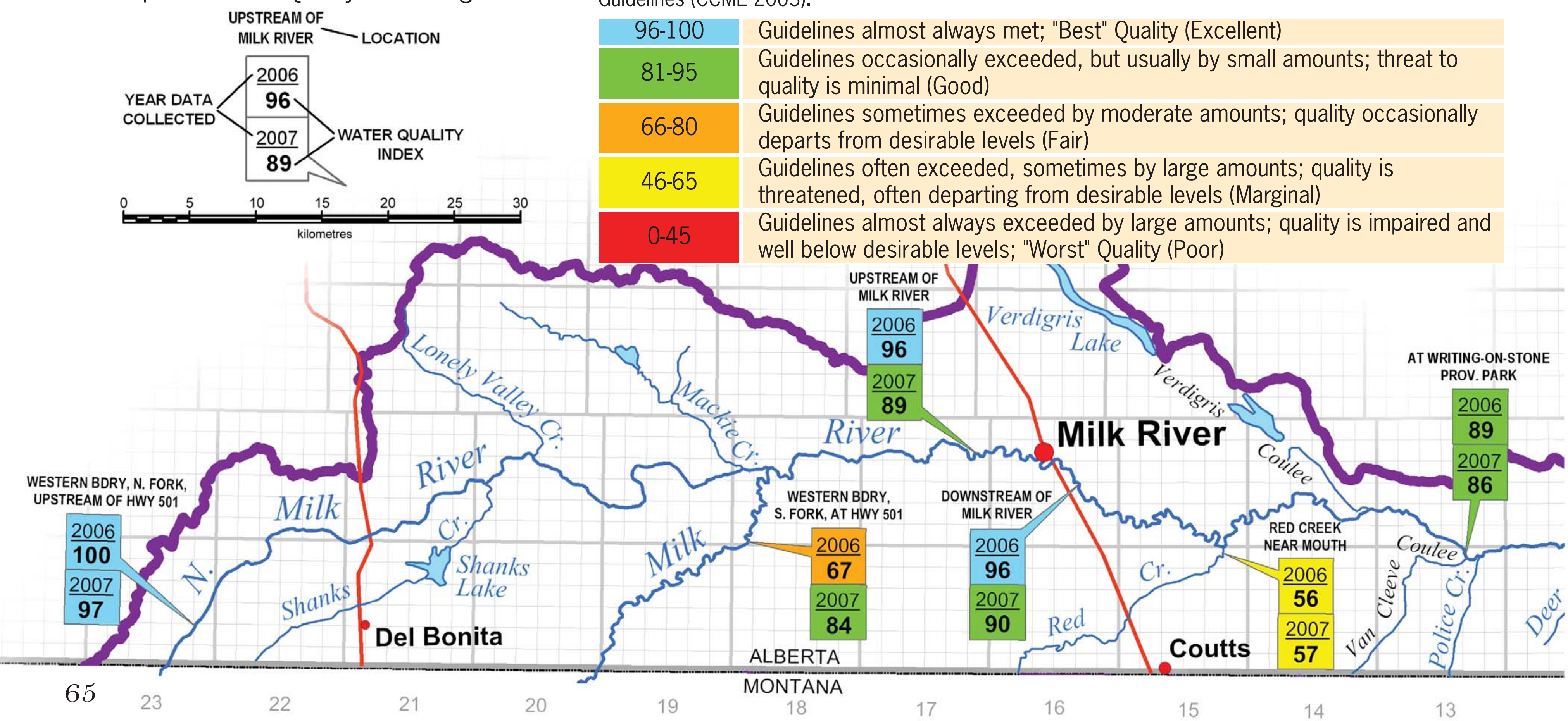
The Alberta model uses nutrients, pesticides, metals and bacteria to calculate the WQI. This model has been modified for the Milk River watershed and follows a similar protocol as used in the Oldman River watershed (W. Koning, AENV, pers. comm.). Variables included in the calculation of the WQI for the Milk River included pH, sodium adsorption ratio (SAR), nutrients (total phosphorus, ammonia, total kjeldahl nitrogen, nitrite-nitrogen and nitrate plus nitrite-nitrogen), and bacteria (fecal coliforms and *E.coli*).

Water quality index values are calculated based on the number of variables that exceed the guidelines, how often they exceed the guidelines, and by how much they exceed the guidelines. Index results are reported as a number between 0 and 100, where 100 represents the best quality, relative to the objectives. The numbers are divided into 5 categories representing excellent, good, fair, marginal and poor water quality (Table 5.1).

Table 5.1. Water Quality Index rating system. Surface water quality guidelines are found in the Surface Water Quality Guidelines for Use in Alberta (AENV 1999) and the Canadian Environmental Quality Guidelines (CCME 2003).

96-100	Guidelines almost always met; "Best" Quality (Excellent)
81-95	Guidelines occasionally exceeded, but usually by small amounts; threat to quality is minimal (Good)
66-80	Guidelines sometimes exceeded by moderate amounts; quality occasionally departs from desirable levels (Fair)
46-65	Guidelines often exceeded, sometimes by large amounts; quality is threatened, often departing from desirable levels (Marginal)
0-45	Guidelines almost always exceeded by large amounts; quality is impaired and well below desirable levels; "Worst" Quality (Poor)

Map 5.2. Water Quality Monitoring Sites



The WQI values for the Milk River represent the period from June through October (9 samples) for 2006 and the period April through October in 1986-1988, 2005 and 2007 (approximately 15 samples). In general, water quality ranged from excellent to good in the headwaters downstream to the Town of Milk River. Downstream of the Town of Milk River, water quality index scores were slightly lower than the headwater sites but was still of good quality (Map 5.2).

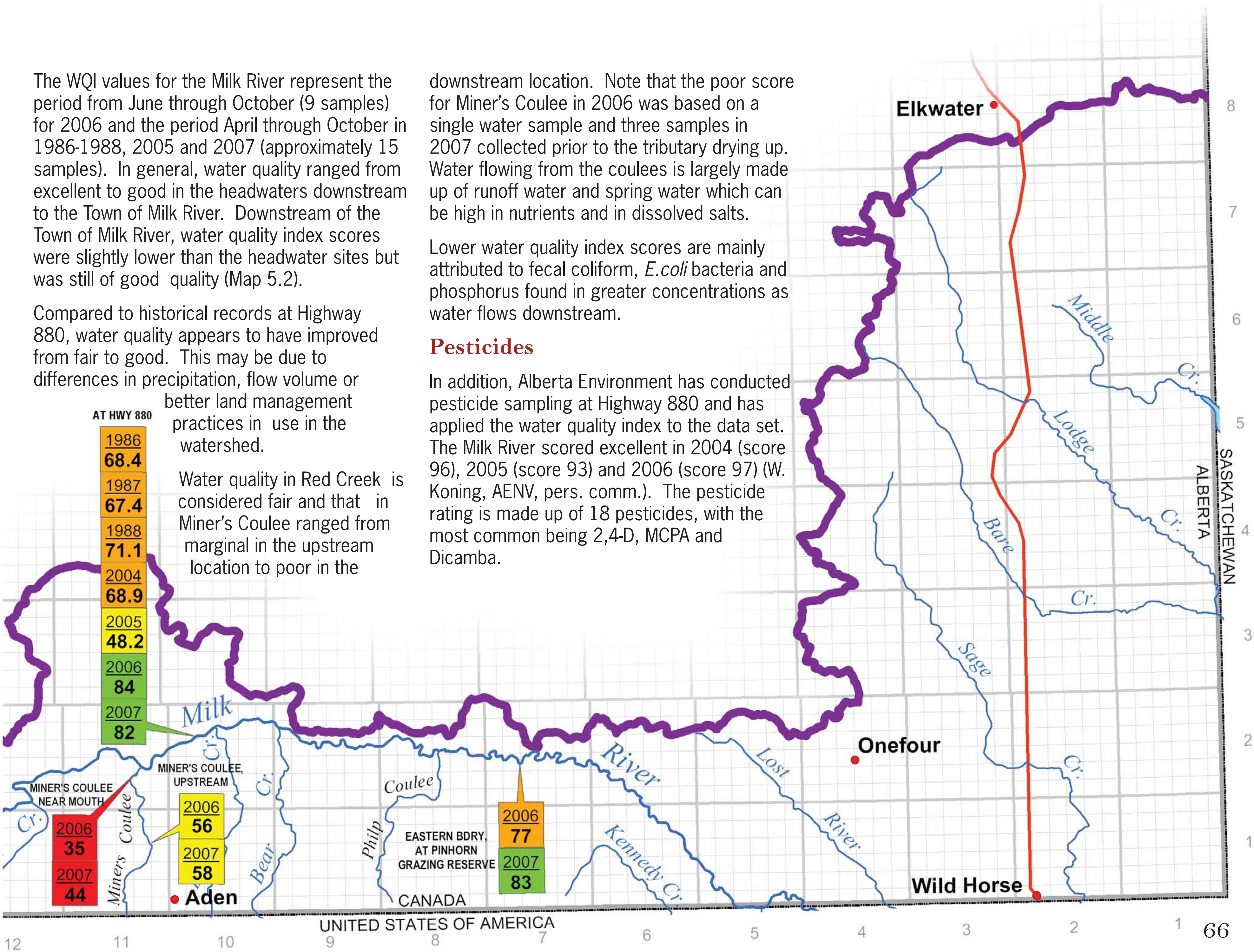
Compared to historical records at Highway 880, water quality appears to have improved from fair to good. This may be due to differences in precipitation, flow volume or better land management practices in use in the watershed.

Water quality in Red Creek is considered fair and that in Miner's Coulee ranged from marginal in the upstream location to poor in the downstream location. Note that the poor score for Miner's Coulee in 2006 was based on a single water sample and three samples in 2007 collected prior to the tributary drying up. Water flowing from the coulees is largely made up of runoff water and spring water which can be high in nutrients and in dissolved salts.

Lower water quality index scores are mainly attributed to fecal coliform, *E.coli* bacteria and phosphorus found in greater concentrations as water flows downstream.

Pesticides

In addition, Alberta Environment has conducted pesticide sampling at Highway 880 and has applied the water quality index to the data set. The Milk River scored excellent in 2004 (score 96), 2005 (score 93) and 2006 (score 97) (W. Koning, AENV, pers. comm.). The pesticide rating is made up of 18 pesticides, with the most common being 2,4-D, MCPA and Dicamba.



Trends in Water Quality 2006 and 2007

Flow

Flow data from 2006 and 2007 is presented for 5 sites on the mainstem Milk River. Generally, flows in the Milk River increase dramatically in the springtime when water from the St. Mary River diversion is "turned on" and decreases in September when flows are "turned off". Flows were generally greater in 2006 compared to 2007, particularly in June and July. Flows remained at 20 m^3/s from April 12 to July 5 with a major peak flow on June 16, 2006 (43.6 m^3/s). Flows were much lower and erratic during the same period in 2007. On June 29, 2007 the flow at Milk River had decreased to 10.5 m^3/s.

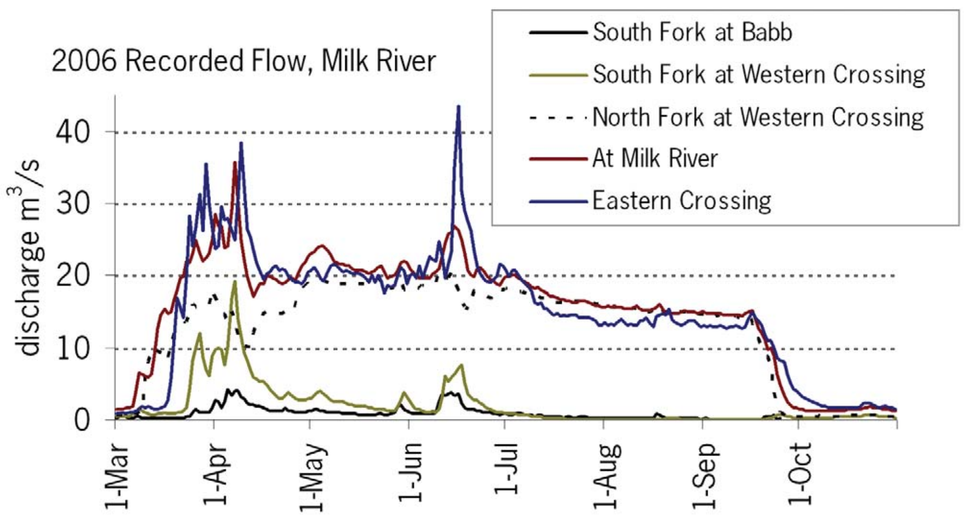


Figure 5.8. Comparison of recorded flow for the Milk River at various locations in the watershed, 2006. From AENV, Water Survey of Canada and United States Geological Survey. (note: 4 to 5 day lag from west to east crossing/ use or evaporation losses)

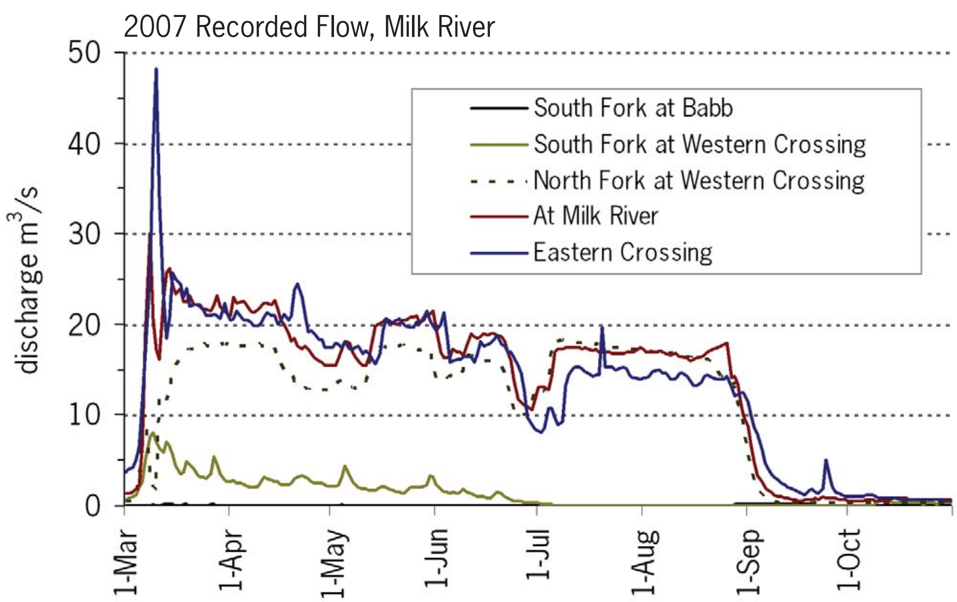


Figure 5.9. Comparison of recorded flow for the Milk River at various locations in the watershed, 2007. From AENV, Water Survey of Canada and United States Geological Survey. (note: 4 to 5 day lag from west to east crossing/ use or evaporation losses)

Phosphorus

In 2006 and 2007, total phosphorus concentrations were generally below the Alberta Surface Water Quality Guidelines for the protection of aquatic life (0.05 mg/L) at all upstream sampling locations on the mainstem Milk River (Figure 5.10). At Highway 880 and at the Pinhorn Ranch, total phosphorus concentrations nearly always exceeded the guideline.

Red Creek contained relatively low concentrations of phosphorus throughout the entire sampling period (0.01 mg/L). During periods of flow, Miner's Coulee always exceeded phosphorus guidelines (> 0.2 mg/L).

In 2006, total phosphorus concentrations in the lower reaches of the Milk River decreased according to volume of flow in the river. In October, when flows from the St. Mary River diversion ceased, total phosphorus concentrations decreased to well below the water quality guideline (0.01 mg/L) at Highway 880 and at the Pinhorn Ranch. Historical data collected at the Western Boundary and Eastern Boundary, Milk River confirms that total phosphorus concentration is a largely a function of flow (discharge) volume (AMEC 2008) (Figure 5.11).

The most common form of phosphorus in the Milk River is the particulate form. Particulate phosphorus is bound to sediment particles. Increased discharge in the Milk River increases suspended sediment transport and, therefore, mobilizes phosphorus. This is most prevalent in the downstream reaches, where the streambank material is largely composed of sand compared to the upstream gravel reach.

Particulate phosphorus contributed between 40% and 98% of the total phosphorus concentrations in the Milk River in 2006 (Riemersma et al. 2007). Particulate phosphorus increased as water flowed downstream from the western sites (i.e., the headwaters) to the eastern most site (i.e., the Pinhorn Ranch).

In comparison to the mainstem of the Milk River, the tributaries contained a higher proportion of dissolved phosphorus than particulate phosphorus. Dissolved phosphorus is readily available for plant uptake and can cause nuisance algae blooms. Approximately 50% of the total phosphorus in Red Creek was in dissolved form, while the samples collected in Miner's Coulee showed only 20% of the total phosphorus was in particulate form (Riemersma et al. 2007).

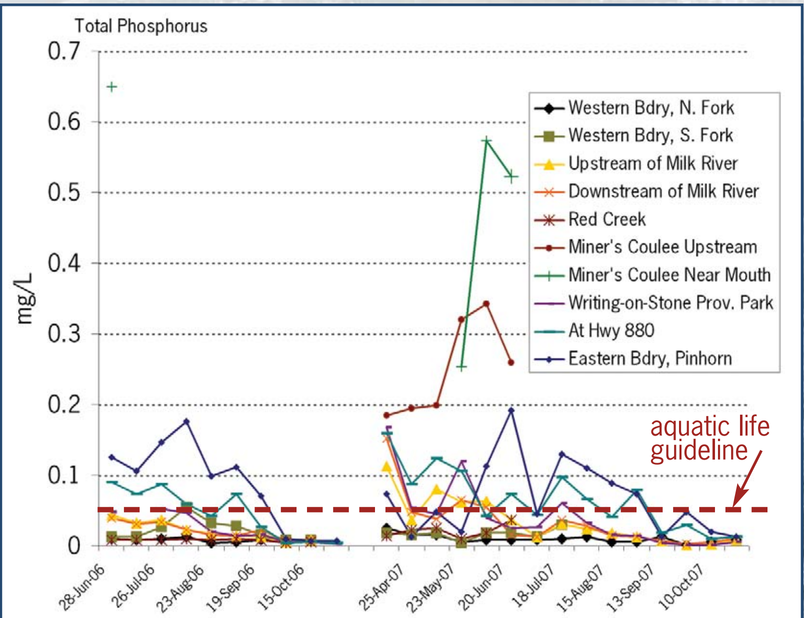


Figure 5.10. Total phosphorus concentrations in the Milk River and tributaries, 2006 and 2007.

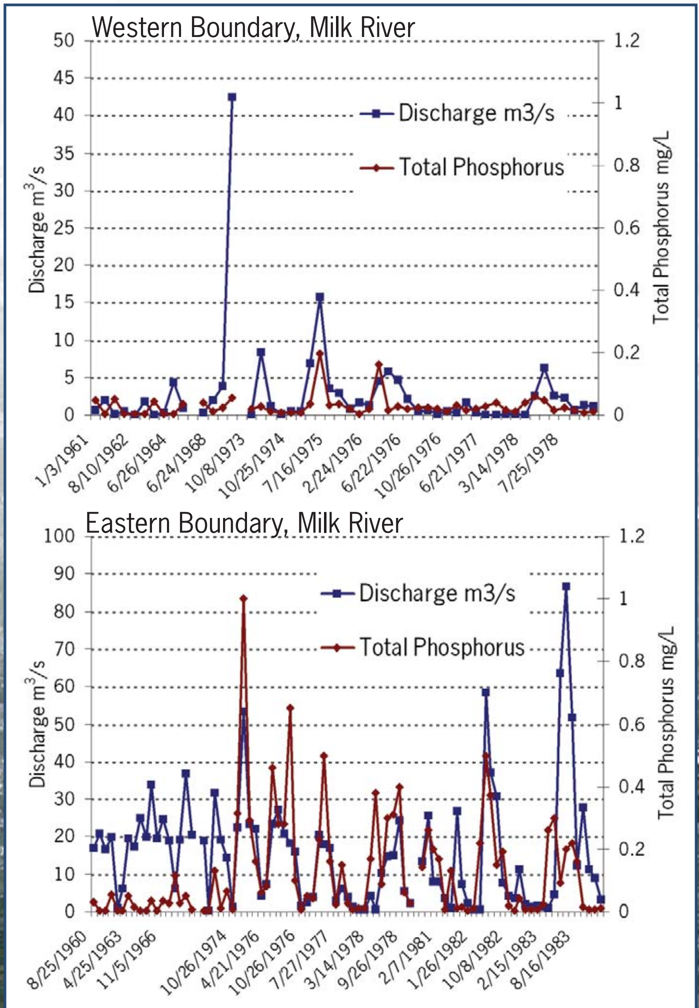


Figure 5.11. Historical relationship between river discharge and total phosphorus concentrations.

Nitrogen

In 2006 and 2007, total nitrogen concentrations were always less than the Alberta Surface Water Quality Guidelines for aquatic life (1.0 mg/L) at all sample locations. In both years, total nitrogen concentrations at all locations, except the South Fork, increased substantially in October concurrently with the decrease in flow from the St. Mary River diversion (Riemersma et al. 2007). This is opposite of the observed trend in phosphorus concentrations, which decreases when flows are low.

On the mainstem Milk River, the highest concentrations of nitrogen were observed at the South Fork and Pinhorn sites in 2006 and 2007. At the South Fork site, concentrations increased substantially from the beginning of June through the middle of July. This corresponded with decreasing flows during the same period.

In 2007, the tributaries contained the highest concentration of total nitrogen. Total nitrogen concentrations in Miner's Coulee decreased from April to the beginning of May, but increased again in June before flows ceased.

Fecal Coliform Bacteria

Fecal coliform concentrations often exceeded the Alberta Surface Water Quality Guidelines for contact recreation (200 colonies per mL), particularly throughout the summer months (Figure 5.13). Fecal coliform concentrations were generally greatest in the tributaries, in the Western Boundary, S. Fork at Highway 501 and at Highway 880 (Figure 5.13). In 2007, concentrations were also quite high upstream of the Town of Milk River.

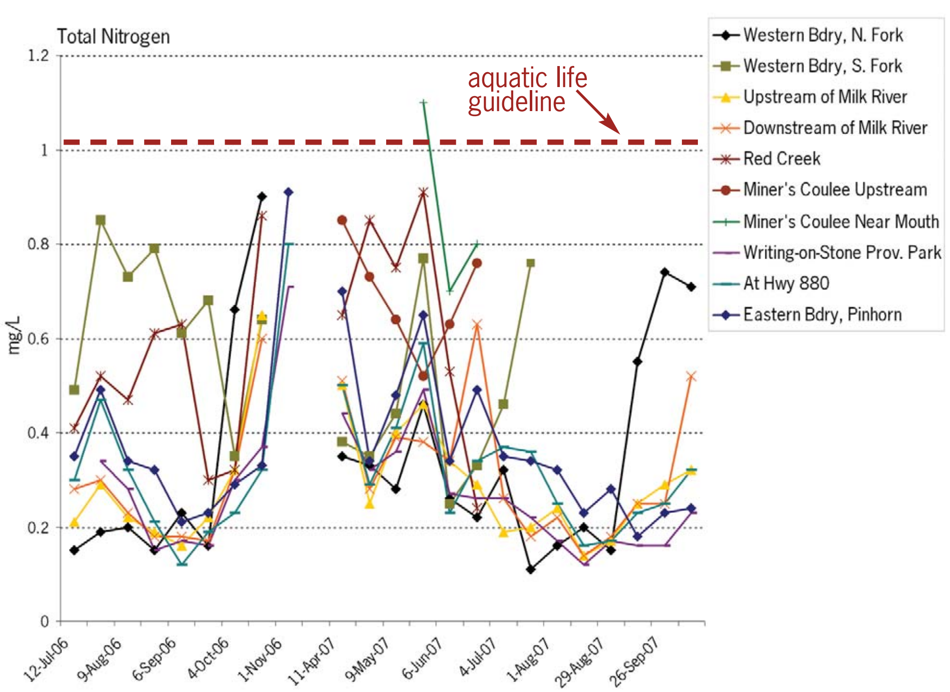


Figure 5.12. Total nitrogen concentrations in the Milk River and tributaries, 2006 and 2007.

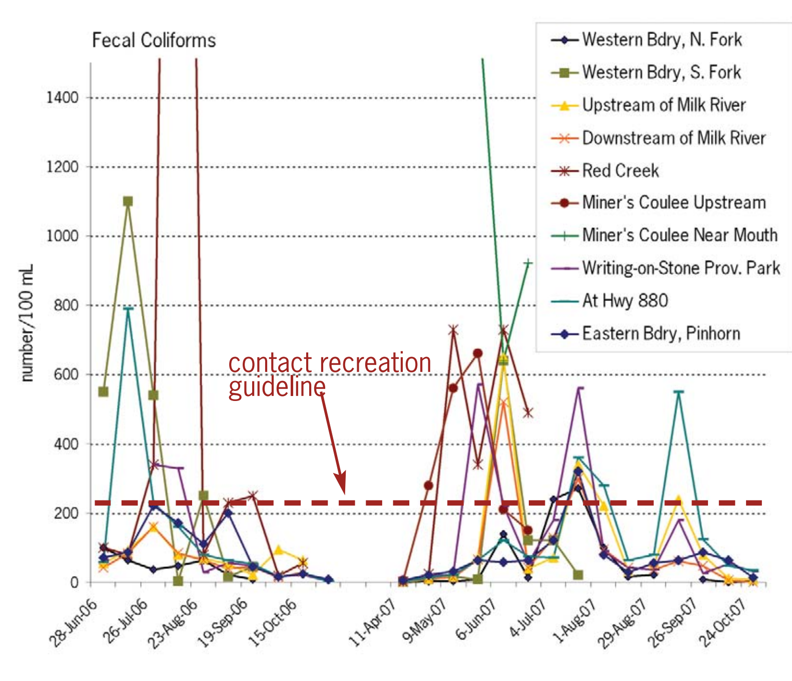


Figure 5.13. Fecal coliform concentrations in the Milk River and tributaries, 2006 and 2007.

Discussion

Water management and climate may be the most influential factors affecting water quality in the Milk River watershed. When the water is "turned on" in the spring (e.g., when the St. Mary River Diversion Canal begins its annual operation) improvements in some water quality parameters, such as nitrogen and salts, and impairments in other water quality parameters (e.g., phosphorus) are observed. When water is "turned off", noted by decreasing flows in Figure 5.8 and 5.9, nitrogen and salt concentrations tend to increase, while phosphorus concentrations decrease.

Nitrogen and salts are generally dissolved in the water column and may be diluted by the increase in flows from the St. Mary River. This annual diversion can result in an increase in flows much greater than the natural flow of the Milk River. Nitrogen and salts in St. Mary River water is likely lower compared to the Milk River water, which may be naturally high in dissolved salts.

Although dilution may decrease nitrogen and salt concentrations dissolved in the water column, phosphorus was found mainly in the particulate form. Phosphorus binds to sediment and can be trapped and stored long-term if sediments settle from the water column. Increased flows above natural, may increase suspended sediment transport in the river and mobilize particulate phosphorus. This is clearly the occurrence in Milk River as particulate phosphorus concentrations increase as flow moves downstream. In a study on erosion and deposition in the Milk River, AMEC (2008) found that total suspended solids concentrations increase in the Milk River as water flows downstream due to unconsolidated streambank material that is susceptible to erosion. The authors reported a strong positive relationship between total suspended solids and total phosphorus.

Climate is also a factor that generally influences surface water quality. In other watersheds, runoff water from storm events can potentially contribute to high pollutant loadings in a waterbody. It is not clear if this is true for the Milk River watershed at this time. Runoff volumes in the Milk River watershed may be quite small due to semi-arid conditions and the fact that a large percentage of the watershed remains in native vegetation with low urbanization. However, the badlands that are located in the downstream reaches may contribute significant sediment loads to the Milk River.

Although flows may be small in the tributaries, the water quality can impact downstream water use. It is unclear to what extent Red Creek and Miner's Coulee are contributing to poor water quality downstream, but future monitoring will likely assist interpretation of water quality in the Milk River watershed.

High temperatures, combined with livestock and waterfowl/wildlife access during the summer months, may contribute to the proliferation of fecal coliform bacteria at some locations in the watershed.

Data Gaps and Recommendations

Water quality monitoring in the Milk River watershed has been conducted sporadically since the early 1960s. Inconsistencies in water quality parameters evaluated and sample frequency among years makes it difficult to compare data through time. The Milk River Watershed Council Canada and partners should continue with the monitoring program and expand to including additional monitoring in the tributaries (e.g., the eastern tributaries, include flow monitoring). AMEC (2008) also identified the potential for increased monitoring in the headwaters in cooperation with the United States Geological Survey.

Linking water quality with aquatic life (e.g., benthic invertebrates) and understanding sources of nutrients, sediment and bacteria (e.g., runoff from the badlands, streambank erosion and nutrient storage in river sediments) will help to interpret water quality in future.

5.2 Groundwater

Groundwater Supply

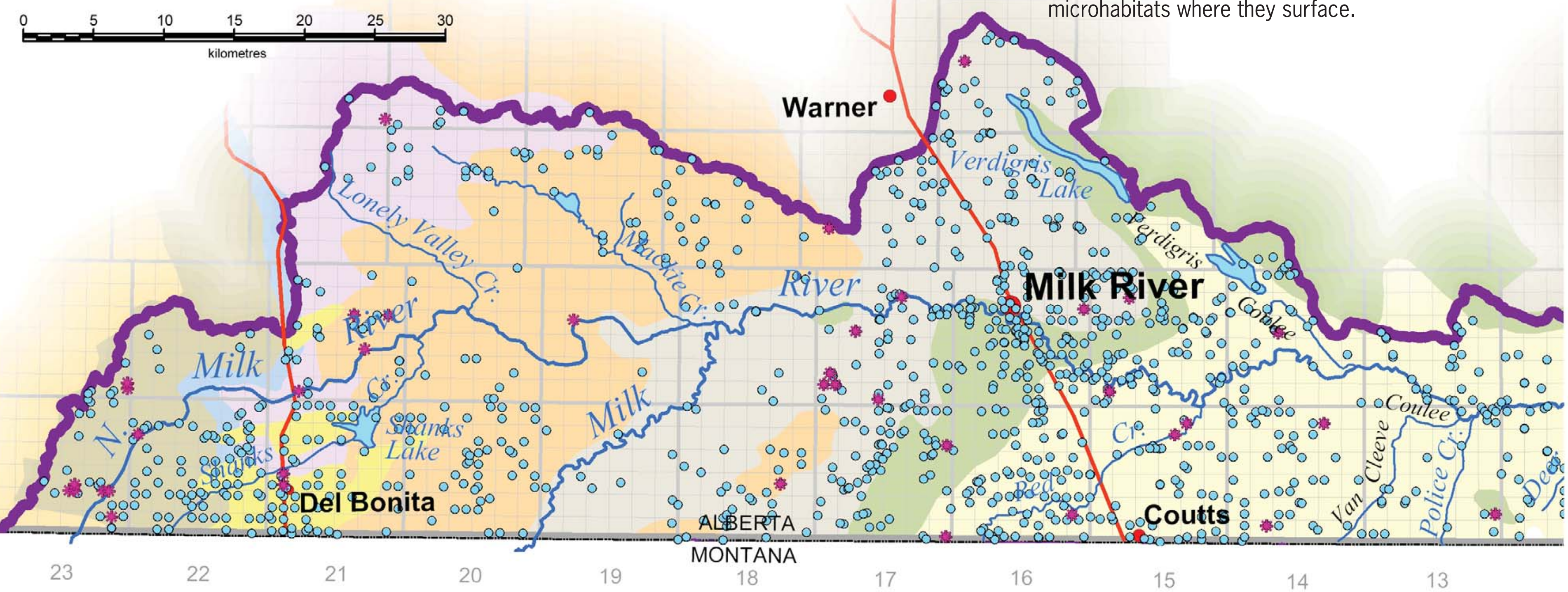
In addition to surface water, groundwater is an important water source within the Milk River watershed. Groundwater is found in varying quantity and quality as springs, or in the form of shallow intertill sand and gravel, pre-glacial buried valleys or bedrock formations (Map 5.3).

Springs

Alberta Environment's groundwater database identifies 90 springs within the Milk River watershed. Borneuf (1983) observed 15 springs in the Milk River watershed and reported that springs in the Whisky Gap and Del Bonita areas had yields ranging from 340 to 680 m^3/d. There were no yields reported for Red Creek or Deer Creek. Other significant springs in the area include those in Verdigris Coulee, Kennedy Coulee, and Cypress Hills.

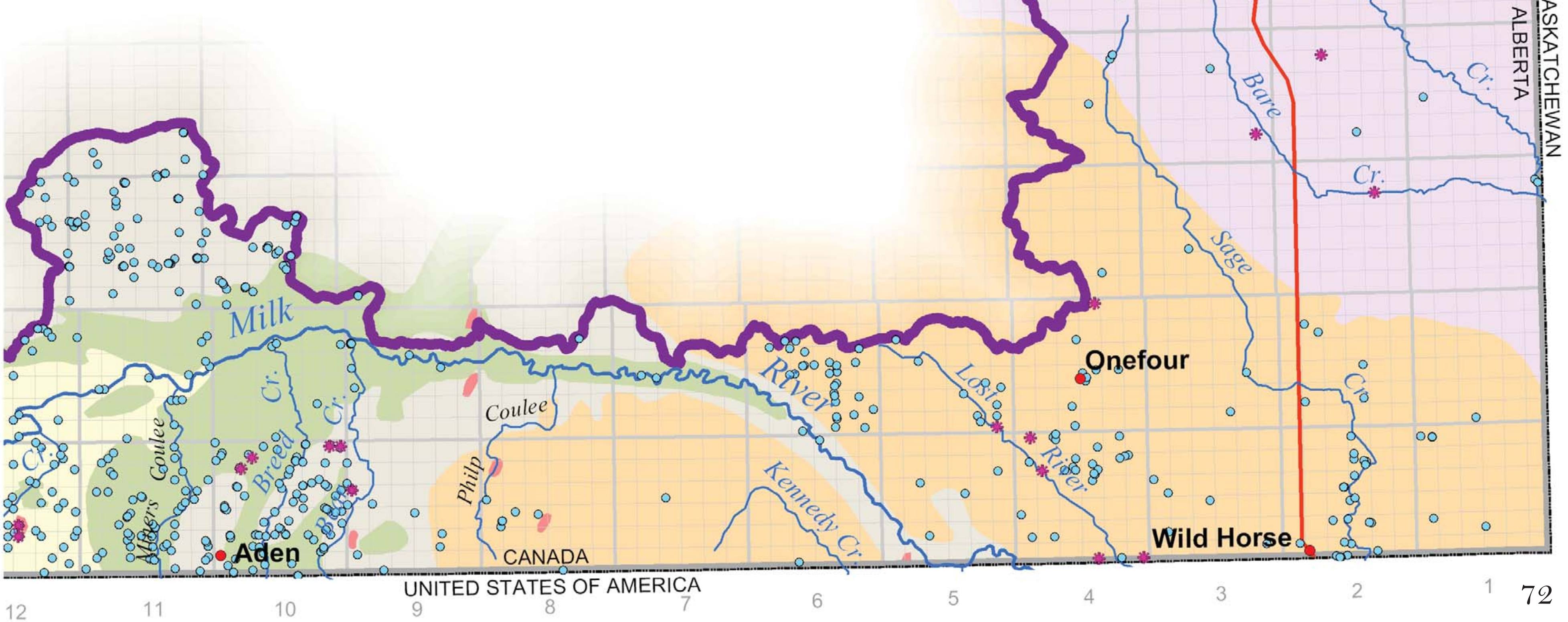
Springs in the Milk River watershed create wetland microhabitats where they surface.

Map 5.3. Water Wells, Springs and Bedrock Geology



In order to understand the contributions of groundwater to base flow in the river, Meyboom (1960) provided this description. “The Milk River Sandstone is exposed for a distance of 32.2 km along the Milk River, and discharge from the aquifer into the river takes place in ranges 14 and 15, over a distance of 16.1 km. Red Creek which flows into the Milk River from the south is fed entirely by a spring issuing from the Milk River sandstone”. Meyboom (1960) concluded that “even if discharge took place along the entire length of the outcrop, springs from the Milk River sandstone should contribute only 0.3% of the total stream flow”.

Red Creek is spring-fed.

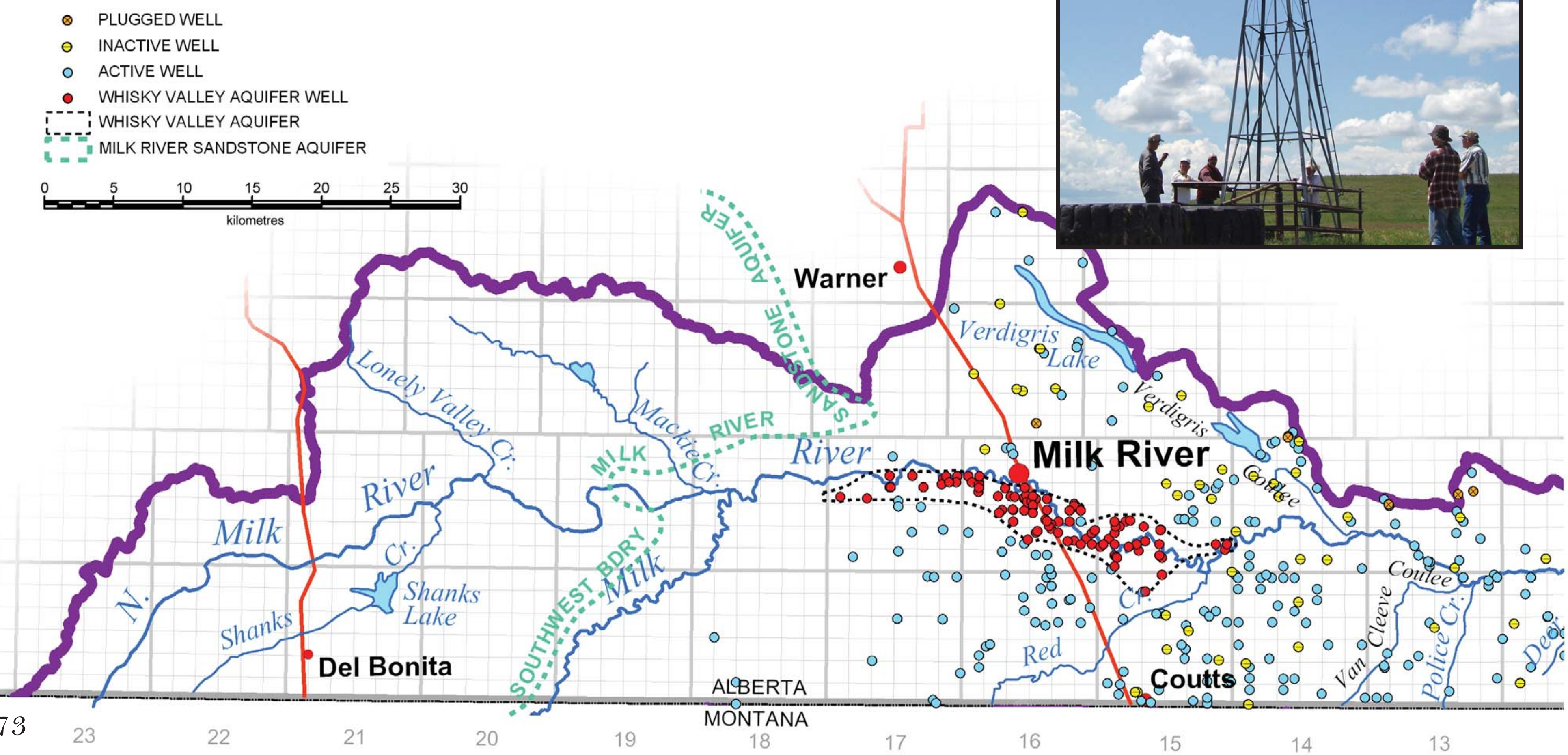


Aquifers

The two main aquifers that provide for municipal and agricultural uses in the watershed are the Milk River Sandstone Aquifer (Milk River Aquifer) and the Whisky Valley Aquifer. The Whisky Valley Aquifer is a regional sand and gravel aquifer that extends approximately 30 km along the river in the vicinity of the Town of Milk River (Map 5.4).

The Whisky Valley aquifer is a "surficial deposit" that is generally less than 50 m below ground (Stantec Consulting Ltd. 2002; Hydrogeological Consultants Ltd. 2004). The Milk River Aquifer is an extensive formation that underlies much of the watershed. The formation outcrops at ground surface along the Milk River in Ranges 13 and 15, near

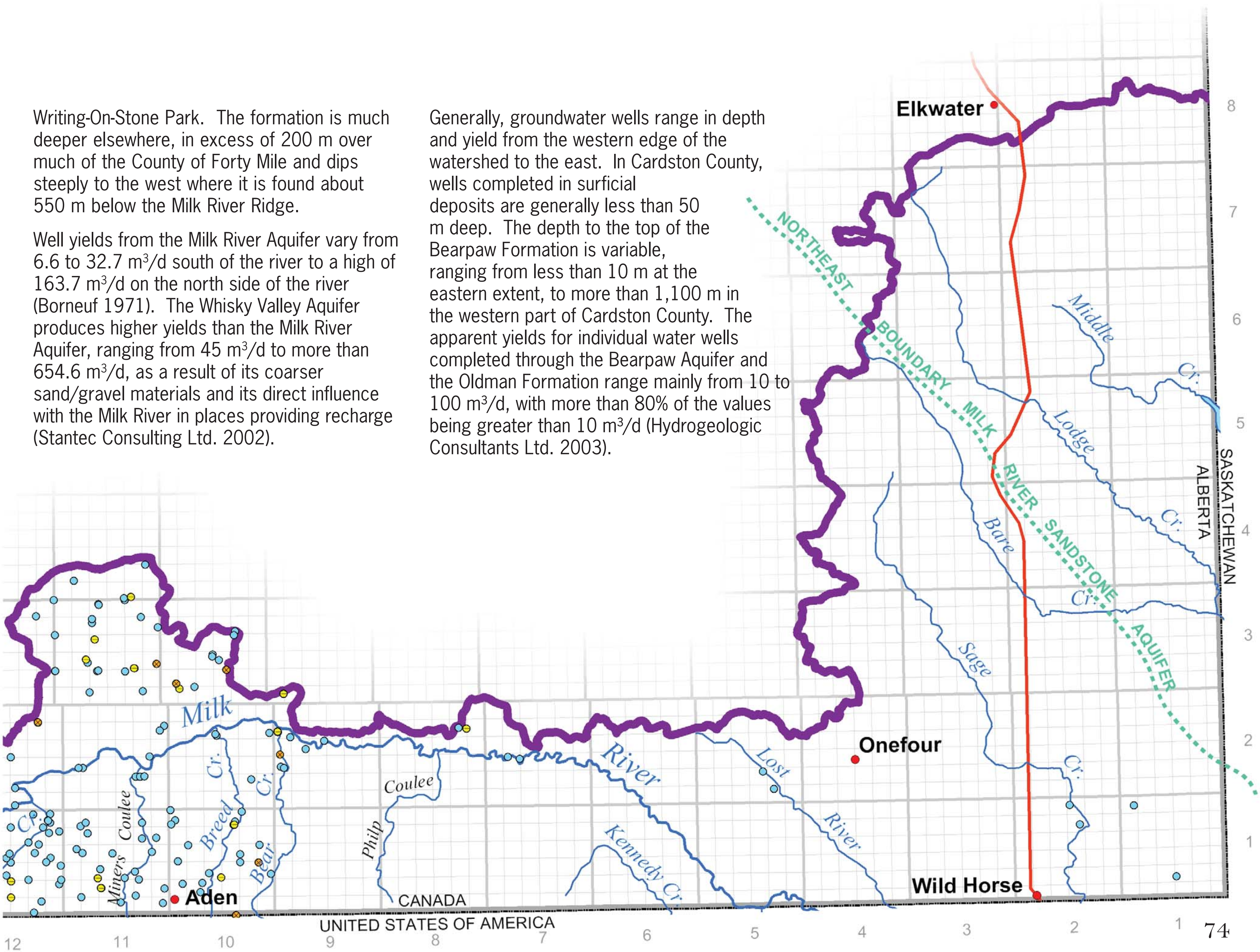
Map 5.4. Milk River Sandstone and Whisky Valley Aquifers



Writing-On-Stone Park. The formation is much deeper elsewhere, in excess of 200 m over much of the County of Forty Mile and dips steeply to the west where it is found about 550 m below the Milk River Ridge.

Well yields from the Milk River Aquifer vary from 6.6 to 32.7 m^3/d south of the river to a high of 163.7 m^3/d on the north side of the river (Borneuf 1971). The Whisky Valley Aquifer produces higher yields than the Milk River Aquifer, ranging from 45 m^3/d to more than 654.6 m^3/d, as a result of its coarser sand/gravel materials and its direct influence with the Milk River in places providing recharge (Stantec Consulting Ltd. 2002).

Generally, groundwater wells range in depth and yield from the western edge of the watershed to the east. In Cardston County, wells completed in surficial deposits are generally less than 50 m deep. The depth to the top of the Bearpaw Formation is variable, ranging from less than 10 m at the eastern extent, to more than 1,100 m in the western part of Cardston County. The apparent yields for individual water wells completed through the Bearpaw Aquifer and the Oldman Formation range mainly from 10 to 100 m^3/d, with more than 80% of the values being greater than 10 m^3/d (Hydrogeologic Consultants Ltd. 2003).



In the County of Warner, well depths range from 1 to 342 m for domestic, stock, municipal, irrigation and the majority of industry wells (Stantec Consulting 2002). The majority of wells have depths of less than 100 m. Well depths completed in surficial deposits are generally less than 20 m deep, but can range up to 61 m deep (Stantec Consulting Ltd. 2002). Yields for wells completed in surficial deposits are relatively low, in the range of 10 to 30 m^3/day, although yields of 30 to 100 m^3/d are not uncommon, probably associated with localized sand and gravel deposits. Higher yields may be expected for wells completed in alluvial sands and gravels of present day rivers as well as buried sand and gravel deposits (e.g., Whisky Valley Aquifer).

Wells completed in the Oldman and Foremost Formations generally yield less than 30 to 100 m^3/day. Local yields of 10 to 30 m^3/day are more common in the Foremost Formation than in the Oldman Formation. The Milk River Aquifer may yield 10 to 70 m^3/day, although local yields in areas with high transmissivities could range from 229 to 818 m^3/day.

Aqua Terre Solutions Inc. (2002) conducted a desktop study to determine well yields in the County of Forty Mile –Aden area of the watershed. The principal aquifer units for the study area included the Milk River Aquifer (regional aquifer), Foremost, Oldman and surficial units (located mainly along creeks). Approximately 80% of the wells were completed in bedrock at relatively shallow depths. Based on limited data, it was estimated that long-term yields typically ranged from 30 to 60 m^3/day. Higher well yields were generally from wells completed in the Milk River Aquifer (Aqua Terre Solutions Inc. 2002).

The few wells (less than about 20) completed in the surficial deposits in the area within the County of Forty Mile and Aden, were generally located along creeks. Reported well yields varied from less than 5 to 65 m^3/day. Borneuf (1976) reported that potential well yields of up to 100 m^3/day may be possible from gravel deposits along Breed Creek (Aqua Terre Solutions Inc. 2002).

Groundwater Allocations and Use

In comparison to surface water allocations, there are few large users relying on groundwater for supply. Generally, the aquifers in the Milk River watershed cannot provide the large quantities (i.e., daily pumping rates) required by commercial and municipal users. Currently, there are 2,087 well records pertaining to the Milk River watershed on file with the Alberta Environment Groundwater Information Center (GIC). It is unknown how many of these wells are still active.

One hundred and twenty-five wells have been identified in the Whisky Valley Aquifer, 27 of which were reported for household use and the remainder for livestock water (Golder Associates Ltd. 2004). In addition, the aquifer serves as a water source for three water co-ops, the Milk River East Water Co-op, the Milk River West Water Co-op and the Warner West Water Co-op.

Municipal water licences[1] account for the majority (62%) of licenced groundwater use in the Milk River watershed, amounting to 575,057 m^3 annually (Figure 5.14). There are no municipal groundwater licences allocated for the eastern tributaries sub-basin.

There are currently 28 groundwater licences and 228 groundwater registrations designated for agricultural use in the watershed, totaling 311,604 m^3. Twenty of the groundwater registrations for agricultural use are located in the eastern tributaries sub-basin, totaling 14,281 m^3. Agricultural use includes feedlots and stockwatering. There are currently no allocations of groundwater licenced for irrigation in the Milk River watershed.

The number of commercial groundwater licences account for 4.8% of the allocated use in the watershed, totaling 45,179 m^3. Much of the commercial groundwater volume used is located in the eastern tributaries sub-basin.

[1]Note that municipal water licenses, in this context, refers to multiple water users rather than municipal water as only treated water provided by a municipality.

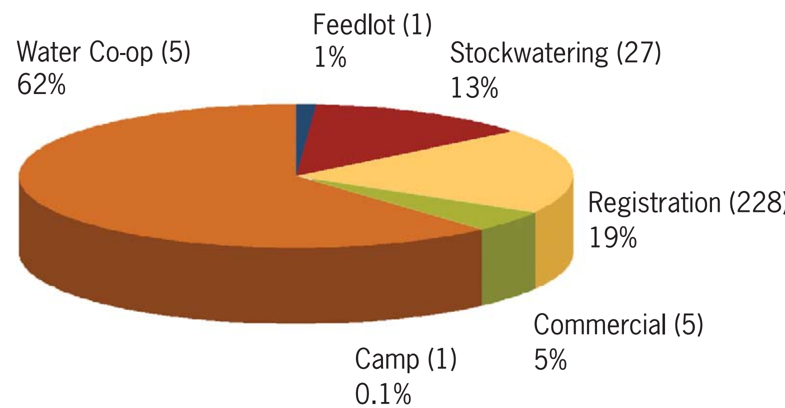


Figure 5.14. Total Groundwater allocations in the Milk River watershed. The total volume allocated equals 931,840 m3.
Number in parentheses = number of authorizations for that purpose. Source: Alberta Environment EMS data records, November 2007

The Milk River Aquifer – A Depleting Resource?

The Milk River Aquifer is an extensive groundwater formation in southern Alberta and is the primary source of water for over 800 farms and ranches, a number of Hutterite Colonies and several small communities (Printz 2004). Although the aquifer extends beyond the Milk River watershed boundaries, water use can impact quantity throughout the entire region.

The Milk River Aquifer is a sandstone bedrock unit within the Milk River Formation. The formation outcrops along the Milk River at Writing on Stone Park, and dips in a generally north, northwest, or northeast direction away from the main recharge area, the Sweetgrass Hills. Development of groundwater supplies in the Milk River Aquifer first began in the early 1900s (Hendry et al. 1991). Fifty millimeter diameter well casings were commonly used in these early wells and often resulted in artesian wells that flowed at the ground surface. In 1923, D.B. Dowling of the Geologic Survey of Canada catalogued 164 wells that had been completed into the aquifer (Dowling 1923). The static pressure in most areas of the formation has been decreasing over the years and flowing wells are now usually only found in valleys and lowlands.

Water level declines exceeding 30 m were noted in a 22 year period between 1937 and 1959 due to water usage by the Village of Foremost (Printz 2004). Hendry et al. (1991) reported that, by the 1960s, long-term withdrawals of groundwater had lowered the piezometric surface and reversed gradients in the areas of heaviest use. More recently declines in the Milk River Aquifer have been attributed to increasing livestock numbers.

In 1998, the counties of Forty Mile, Warner, Cypress and Taber along with Prairie Farm Rehabilitation Administration – Agriculture and Agri-Food Canada and Alberta Environment formed the Milk River Aquifer Groundwater Management Advisory Council to implement management initiatives to benefit groundwater resources. These included an extensive survey of wells in the aquifer, and a program to plug unused wells.

Under the well identification component of the Milk River Aquifer Reclamation and Conservation Program (MRARC), 1,027 wells were located in the field. Of these, 585 were determined to be active wells and 442 were determined to be inactive. A total of 218 wells were identified as flowing to surface (Printz 2004).

A total of 101 unused Milk River Aquifer wells were cemented during the five years of the program in collaboration with landowners and government agencies. Of these, 22 were flowing noticeably to the surface, generally at rates of 1 gpm or less. The 22 wells represent approximately half of the inactive, flowing wells identified in the landowner survey (Printz 2004).

Records show that 459 of the 1,027 wells identified in the landowner survey were located in the Milk River watershed. Of these, 79 wells were reported as inactive and 12 have been cemented. The remainder of these wells are still flowing or are active wells.

Older wells that are no longer being used can provide a direct path for undesirable surface or shallow groundwater to mix with the Milk River Aquifer, thus affecting the water's quality. Mixing can occur from one aquifer to another through corroded well casing or through unsealed gaps along the outside of the well casing. Flowing wells that are not in use result in wastage of water (Printz 2004). Thus far, there has been no noticeable change in the groundwater level as a result of the 101 wells that have been cemented. The 22 flowing wells that were cemented had been wasting approximately 59,735 m^3 of water per year based on what could be observed at surface (Printz 1994).

Groundwater Quality

Groundwater supplies numerous households, towns and villages and domestic livestock with water. Although generally safe to drink with proper treatment, groundwater supplies are often high in total dissolved solids, sodium, fluoride and bicarbonate. Iron has also been found to be a problem in some areas.

Some of the most common chemical contaminants that are found in groundwater are nitrate nitrogen, lead, cadmium and mercury (Table 5.2) These contaminants can cause problems to human health in the form of blue baby syndrome (methanoglobanemia), urinary and reproductive system illness, renal disease and disruption to the central nervous system (Table 5.2).

Table 5.2. Summary of selected contaminants found in groundwater supplies, the drinking water guideline and associated disease.

Chemical	Maximum Allowable Concentration (Health Canada 2007)	Disease
Nitrate-Nitrogen	10 mg/L	Blue Baby Syndrome
Lead	0.010 mg/L	Urinary & Reproductive System Illness
Cadmium	0.005 mg/L	Renal Disease
Mercury	0.001 mg/L	Central Nervous System & Renal Illness

In Cardston County, groundwater from aquifers in the surficial deposits are generally chemically hard, having a total hardness of at least 300 mg/L, and a dissolved iron concentration such that the groundwater must be treated before being used for domestic needs. High nitrate + nitrite (as N) concentrations were evident in 12% of the available chemical data for the surficial aquifers and 8% of the available chemical data for the upper bedrock aquifer(s). (Hydrogeologic Consultants Ltd. 2003).

Water from the Milk River Aquifer is generally high in sodium, fluoride and bicarbonate. Untreated, the concentration of total dissolved solids (TDS) typically exceeds the Canadian Drinking water standard. It is suitable for livestock and is very soft and preferred for washing.

The water quality in the Whisky Valley Aquifer can be high in manganese and iron, but all other parameters meet the Canadian drinking water standard for potable water (Golder Associates 2004).

Borneuf (1983) noted that TDS concentrations from springs in the Whisky Gap and Del Bonita area had TDS concentrations ranging from 403 to 418 mg/L, while TDS was much higher further east, ranging from 1,070 near Red Creek to 7,016 mg/L at Deer Creek. Spring water near Deer Creek also contained high concentrations of sulfate (Borneuf 1983).

Groundwater quality in the Forty Mile-Aden study area is generally acceptable, with groundwater samples from bedrock sources generally containing less than 1,500 mg/L in TDS, and between 1,000 and 2,000 mg/L TDS from the surficial deposits (Aqua Terre Solutions Inc. 2002). Sodium concentrations varied from 250 to 950 mg/L, which exceeds the drinking water objective of 200 mg/L. Iron was reported by a local well driller to be a rising concern (Aqua Terre Solutions Inc. 2002).

Natural gas (mainly methane) is present in many of the Milk River Aquifer wells in the area. Wells with significant amounts of gas have been noted in the various surveys conducted in the area (AGRA 1998).

Synoptic Groundwater Study 2007

In March 2007, the Milk River Watershed Council Canada commissioned a study to investigate 40 private groundwater wells to measure groundwater quality across the watershed. Ten wells were selected in each of the counties of Cypress, Forty Mile, Warner and Cardston.

Samples were analyzed for nutrients, dissolved metals, salts and bacteria. Selected results from this synoptic survey are presented here. Similar to what has previously been reported, TDS and sodium concentrations in groundwater across the watershed generally exceed the drinking water guideline of 500 mg/L and 200 mg/L, respectively (Figure 5.15 and Figure 5.16). TDS and sodium concentrations are slightly higher in Cypress County and the County of Forty Mile than in the other two municipalities. Similarly, manganese is found in higher concentrations in the eastern municipalities compared to the west. Generally, mean concentrations exceed the drinking water quality guideline of 0.05 mg/L (Figure 5.17).

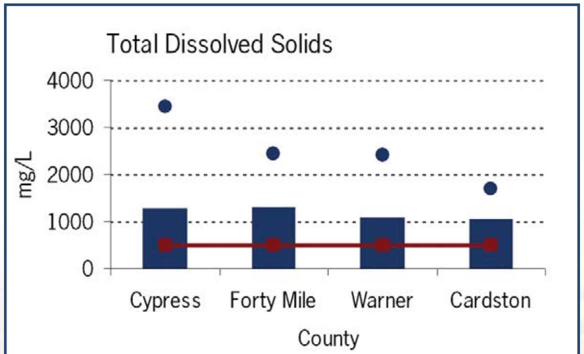


Figure 5.15. Summary of mean and maximum total dissolved solids concentrations in groundwater across the Milk River watershed.

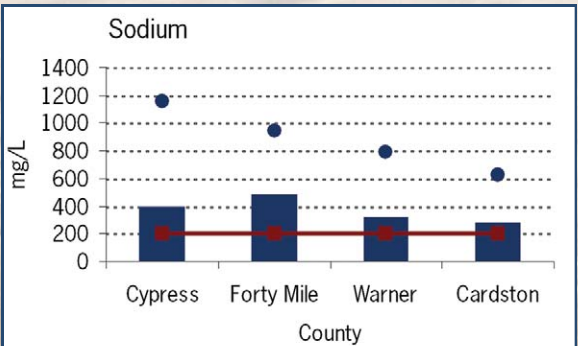


Figure 5.16. Summary of mean and maximum sodium concentrations in groundwater across the Milk River watershed.

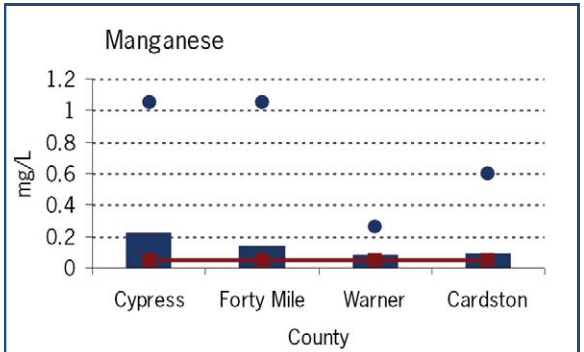


Figure 5.17. Summary of mean and maximum manganese concentrations in groundwater across the Milk River watershed.

In general, chloride mean and maximum concentrations were below the recommended drinking water guideline of 250 mg/L (Figure 5.18). Chloride concentrations were highest in Cypress County.

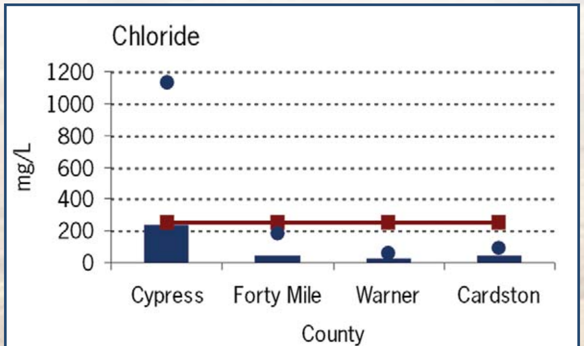


Figure 5.18. Summary of mean and maximum chloride concentrations in groundwater across the Milk River watershed.

Nitrate-nitrogen concentrations were generally below the drinking water quality guideline of 10 mg/L across the watershed (Figure 5.19). However, nitrate-nitrogen concentrations were highest in Cardston County, with the maximum concentration being twice the recommended drinking water quality guideline. This is similar to the nitrate-nitrogen findings reported by Hydrogeologic Consultants Ltd. (2003).

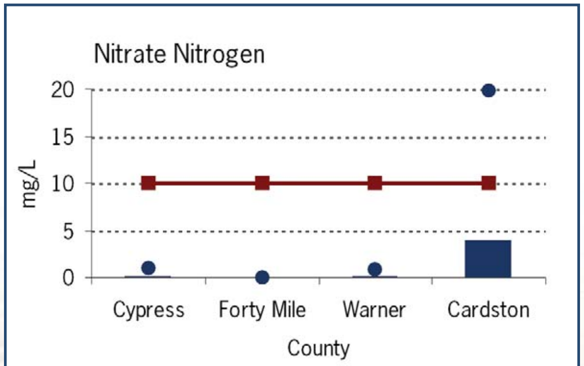


Figure 5.19. Summary of mean and maximum nitrate-nitrogen concentrations in groundwater across the Milk River watershed.

In addition to TDS, sodium, manganese and nitrate-nitrogen, there are some dissolved metals that may be a concern within the Milk River watershed. Dissolved cadmium concentrations were generally higher than the recommended drinking water quality guideline of 0.005 mg/L within the County of Warner and to a lesser extent in Cardston County and the County of Forty Mile (Figure 5.20). In the County of Warner, the maximum concentration exceeded the drinking water quality guideline by a factor of more than 200 times.

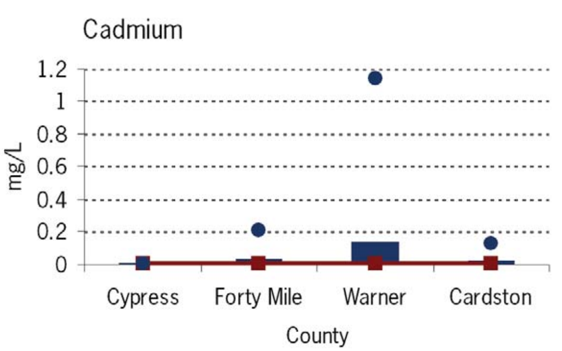


Figure 5.20. Summary of mean and maximum dissolved cadmium concentrations in groundwater across the Milk River watershed.

Generally, mean dissolved lead concentrations were less than recommended drinking water quality guidelines of 0.01 mg/L across the watershed (Figure 5.21). Mean and maximum lead concentrations were highest in the County of Forty Mile.

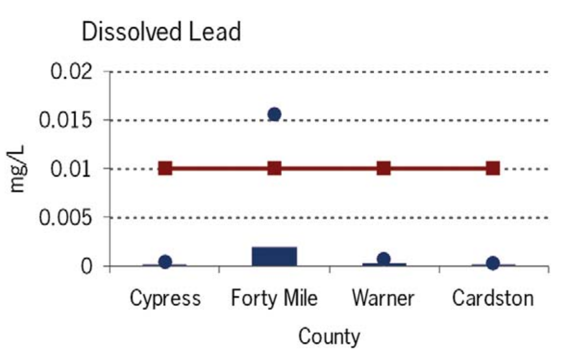


Figure 5.21. Summary of mean and maximum dissolved lead concentrations in groundwater across the Milk River watershed.

Current State of the Groundwater Resource

Depletion in the Milk River Aquifer occurs when water is removed from the aquifer faster than it is replaced. Uncontrolled flowing wells may be contributing to aquifer depletion, while the inactive wells may be a potential source of contamination to groundwater quality.

There are 2,087 groundwater well records in the Milk River watershed. One hundred and ninety-three Milk River Aquifer wells were field verified under the MRARC project, while only 125 wells within the Whisky Valley Aquifer were field verified (Golder 2004) for a total of 318 field verified wells in the watershed.

The number of flowing wells in the watershed can be an indication of depletion. Less than half of the total number of Milk River Aquifer wells in the watershed was surveyed under the MRARC project (i.e., 193 of 459 wells). Of those wells that were surveyed, 28 were reported to be active and flowing and 6 of these were flowing with no control. All 28 flowing wells and 68 other wells were reported to be in active use. Conversely, 97 wells were reported as inactive. The remaining 266 wells identified in the Milk River Aquifer study have not been surveyed and their current status is unknown. Unused wells pose a potential contamination or cross aquifer mixing hazard when they are not decommissioned properly. Although there are 2,087 groundwater wells recorded across the watershed, the status of only 318 wells have been verified.

Area residents are also concerned that depletion of the Milk River Aquifer may occur from water flood oil recovery processes in Montana. However, this has not been substantiated and is considered anecdotal at this time. Recently, cross boundary discussions with Montana resolved a concern about water from the Milk River Formation (Eagle Formation in Montana) being used as a source of flood water to enhance oil well production.

Aquifer Vulnerability Index

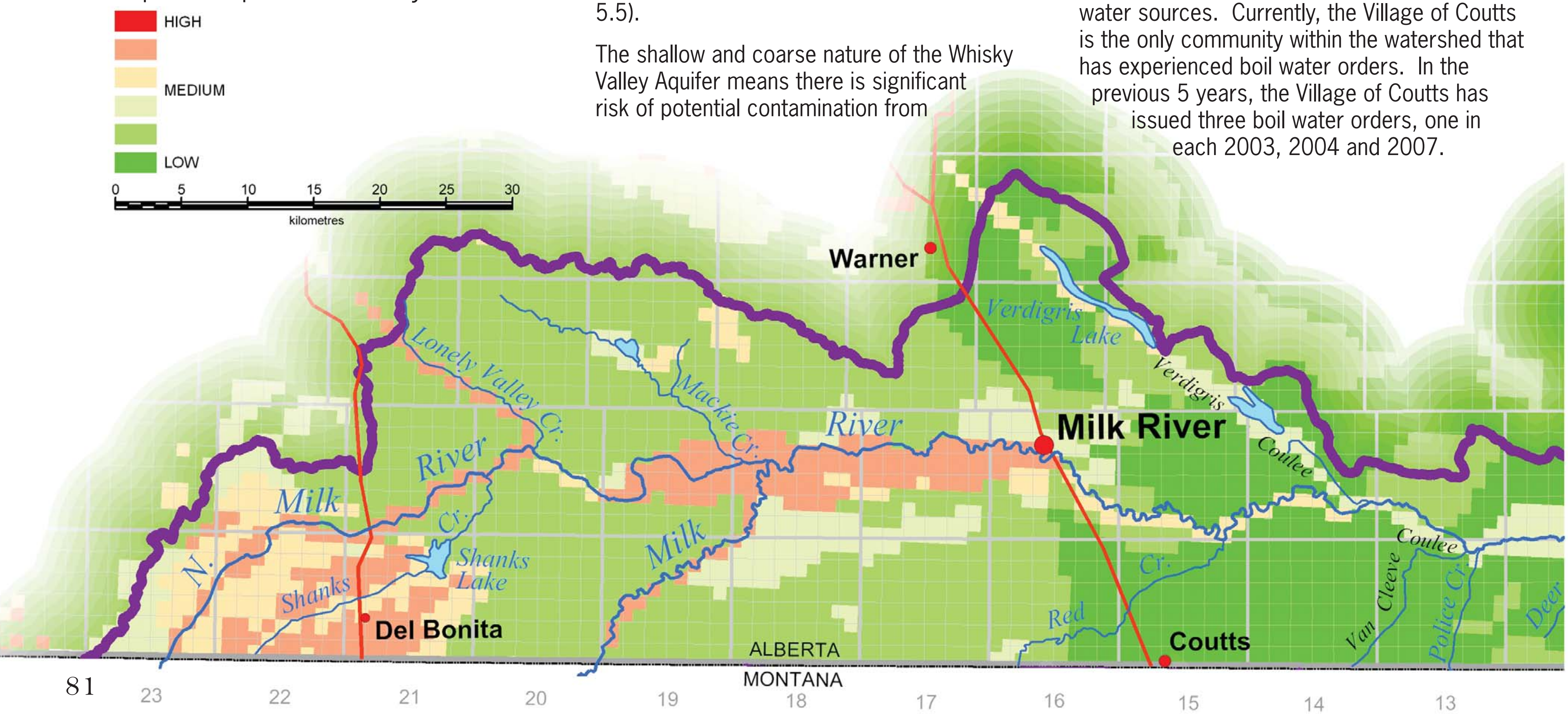
The Aquifer Vulnerability Index (AVI) (Map 5.5) is a method for assessing the vulnerability of aquifers to surface contaminants. In the assessment of aquifer vulnerability, the depth to the aquifer and the types of geological materials above them are considered. The AVI ratings indicate the potential of surficial materials to transmit water with contaminants to the aquifer over a period of time. The AVI ratings are displayed on the map in classes ranging from low to high. An area with a low class rating implies that water percolating through the surficial materials in this area takes a long time (in the range of thousands of years) to reach the aquifer. In an area with a high rating, contaminated water is predicted to reach the aquifer within "tens" of years (AAFRD 2005).

The potential risk for groundwater contamination is low to moderate across most of the Milk River watershed. However, the area defined as Del Bonita gravels (Map 2.1, page7) and the Whisky Valley Aquifer are two key areas that show high risk for contamination (Map 5.5).

The shallow and coarse nature of the Whisky Valley Aquifer means there is significant risk of potential contamination from various sources. In addition to domestic and agricultural related risks, other risks related to petroleum storage, petroleum pipelines, ammonia storage, gravel extraction operations, a golf course, and two campgrounds have been identified (Golder 2004).

The risk of groundwater contamination further relates to public health. While private landowners are responsible for insuring the potability of household water supplies, towns and co-ops are responsible for the quality of municipal supplies. Boil water orders within a community is an indicator of the quality of water sources. Currently, the Village of Coutts is the only community within the watershed that has experienced boil water orders. In the previous 5 years, the Village of Coutts has issued three boil water orders, one in each 2003, 2004 and 2007.

Map 5.5. Aquifer Vulnerability



Data Gaps and Recommendations

Future groundwater management activities will ensure a quality resource for future generations. There are a number of activities that should take place to help protect and maintain the groundwater supply and quality in the Milk River watershed.

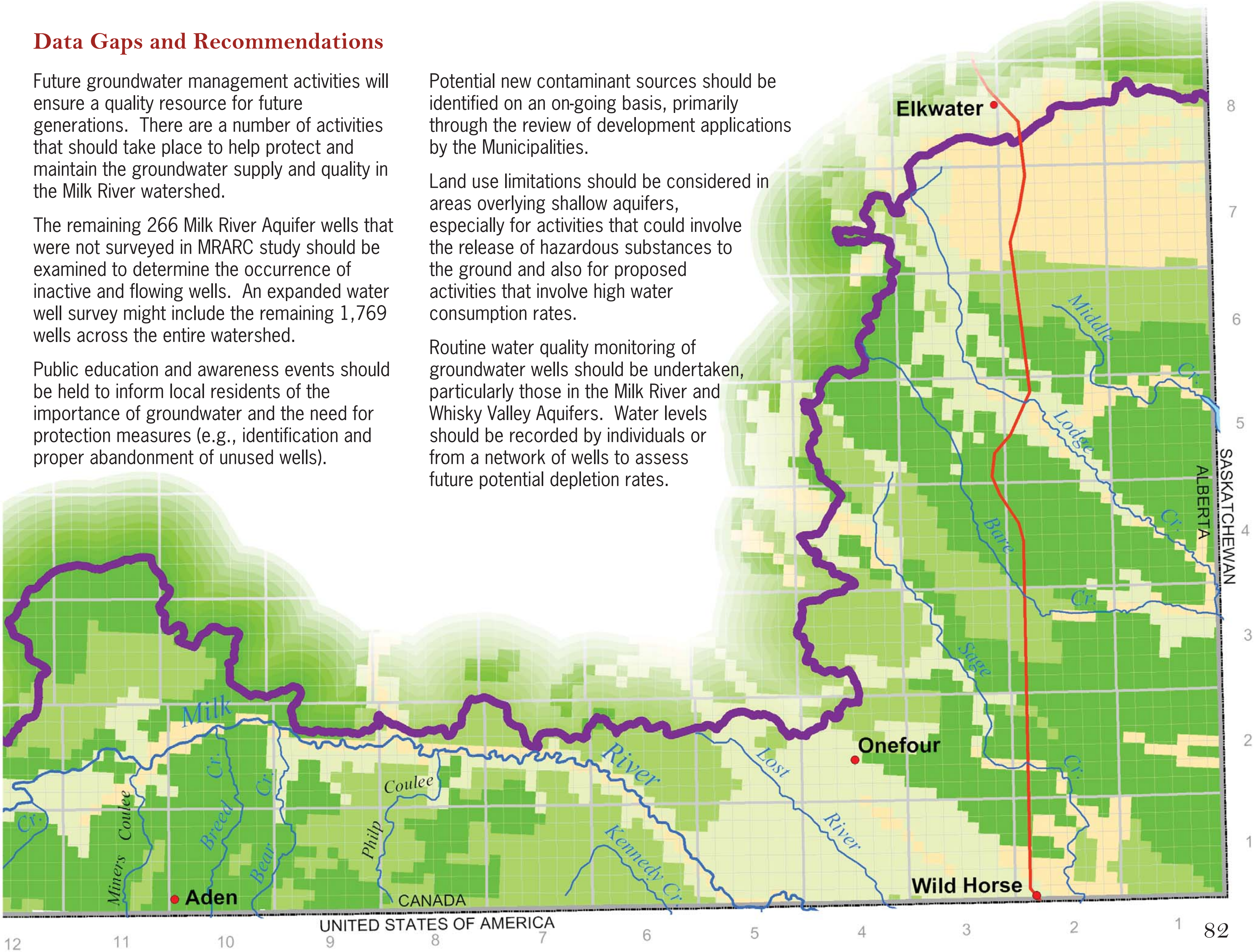
The remaining 266 Milk River Aquifer wells that were not surveyed in MRARC study should be examined to determine the occurrence of inactive and flowing wells. An expanded water well survey might include the remaining 1,769 wells across the entire watershed.

Public education and awareness events should be held to inform local residents of the importance of groundwater and the need for protection measures (e.g., identification and proper abandonment of unused wells).

Potential new contaminant sources should be identified on an on-going basis, primarily through the review of development applications by the Municipalities.

Land use limitations should be considered in areas overlying shallow aquifers, especially for activities that could involve the release of hazardous substances to the ground and also for proposed activities that involve high water consumption rates.

Routine water quality monitoring of groundwater wells should be undertaken, particularly those in the Milk River and Whisky Valley Aquifers. Water levels should be recorded by individuals or from a network of wells to assess future potential depletion rates.



5.3 Fisheries and Benthic Invertebrates

The first synoptic survey of the fish in the Milk and North Milk rivers was made by Willock in the late 1960s. Willock (1969) undertook fish collections in the mainstem and North Milk rivers, plus most of creeks in the Alberta portion of the Missouri drainage. Over the last four decades there have been a number studies that were undertaken for specific purposes and thus not synoptic in nature. Studies completed in the 1970s and 1980s were undertaken in relation to water storage project proposals; these studies tended to focus primarily on areas identified as likely dam sites. Studies completed since 2000 have primarily been to assess the status of species at risk. There have not been any collections comparable to Willock's, and as such, it is difficult to compare the various studies to determine how the fishery has changed since the 1960s.

Capture methodology differed between Willock's collections and most of the later studies. Willock's sampling was done primarily with a beach seine, although set lines were used at some locations. An electric shocker was tried with little success in the Milk and North Milk rivers. Both traps and gill-nets were used but current and debris rendered them impractical for most of the field season. In comparison, most of the studies done since then have employed backpack or boat electrofishers and seines as the key gear. Downstream of Writing-On-Stone Provincial Park the substrate is much finer, thus lending itself better to employing seine nets.

Another variable that has changed has been fish species stocked into Fresno Reservoir in Montana. This reservoir is the farthest upstream impoundment on the Milk River, and there is approximately 75 kilometres of lotic (flowing) habitat between the International Boundary and it. There are not any physical barriers to upstream movement into Alberta for fish in Fresno Reservoir. Fish species occurring in Fresno Reservoir that have not been reported from the Milk River in Alberta are listed on subsequent pages.

Longnose Dace

Species Composition

One method that can be used to describe the state of the watershed is change over time in species composition. Willock (1969) reported that he captured 20 fish species in the Milk River and tributaries. These included five species that are considered today as sport fish, and 15 non-sport fish species. Table 5.3 lists the species reported by Willock (1969), and captured in recent studies (i.e., since 2000).

In comparison, studies conducted since 2000 have resulted in the capture of 22 species. Two species were collected by Willock (1969) that were not captured recently; these were cutthroat trout *(Oncorhynchus clarki)* and finescale dace *(Phoxinus neogaeus)*. In Willock's study, both of these species were represented by one fish, and as such, it is not surprising that these very rare species were not collected recently. The cutthroat trout most likely originated from the St. Mary River, was diverted into the St. Mary Canal and ended up in the North Milk River. There were four fish species taken in the last few years that were not collected by Willock (1969). These included: trout-perch *(Percopsis omiscomaycus)*, yellow perch *(Perca flavescens)*, lake whitefish *(Coregonus clupeaformis)*, and walleye *(Sander vitreus)*. Both lake whitefish and walleye were represented by single specimen captures, while only a few yellow perch were collected. Trout-perch are becoming more common in collections undertaken near the Town of Milk River.

Table 5.3. Fish species that occur in the Milk River and tributaries.

Common Name	Scientific Name	Willock (1969)	Recent Studies
Brassy minnow	*Hybognathus hankinsoni*	X	X
Brook stickleback	*Culaea inconstans*	X	X
Burbot	*Lota lota*	X	X
Cutthroat trout	*Oncorhynchus clarki*	X	
Fathead minnow	*Pimephales promelas*	X	X
Finescale dace	*Phoxinus neogaeus*	X	
Flathead chub	*Hybopsis gracilis*	X	X
Iowa darter	*Etheostoma exile*	X	X
Lake chub	*Couesius plumbeus*	X	X
Lake whitefish	*Coregonus clupeaformis*		X
Longnose dace	*Rhinichthys cataractae*	X	X
Longnose sucker	*Catostomus catastomus*	X	X
Mountain sucker	*Catostomus platyrhynchus*	X	X
Mountain whitefish	*Prosopium williamsoni*	X	X
Northern pike	*Esox lucius*	X	X
Northern redbelly dace	*Phoxinus eos*	X	X
Sauger	*Sander canadensis*	X	X
Eastslope sculpin (or St. Mary sculpin)	*Cottus sp.*	X	X
Stonecat	*Noturus flavus*	X	X
Trout-perch	*Percopsis omiscomaycus*		X
Walleye	*Sander vitreus*		X
Western silvery minnow	*Hybognathus argyritis*	X	X
White sucker	*Catostomus commersonii*	X	X
Yellow perch	*Perca flavescens*		X

Selected Species Collected from the Milk and North Milk Rivers

In the Milk and North Milk rivers, the four most common species collected by Willock (1969) were white sucker (27%), longnose sucker (21%), longnose dace (19%), and flathead chub (9%); in total Willock captured 18 species.

RL&L (2002) undertook collections for species at risk in the Milk and North Milk rivers in 2000 and 2001. In these rivers they captured a total of 14 species, and the four most common species were flathead chub (74%), longnose dace (14%), white sucker (3%), and longnose sucker (3%).

Species collected by Willock (1969) but not by RL&L (2002) included mountain whitefish, cutthroat trout, northern pike, northern redbelly dace, fathead minnow, and Iowa darter. Brassy minnow and trout-perch were captured by RL&L, but not by Willock.

The differences in most abundant species between the late 1960s and the early 2000s can be explained by capture methods. Willock (1969) primarily utilized seining, whereas backpack electrofishing and seining were both employed by RL&L. Backpack electrofishing is the most suitable methodology for sampling cobble/boulder habitats, which are common in the North Milk River and riffle habitat around the Town of Milk River.

Nonetheless, the top four species collected in the late 1960s and early 2000s had not changed, just the percentages of each species. This suggests that over the three decades between the studies, there had not been any substantial changes in the most abundant species.

Selected Species Collected from Writing-On-Stone Provincial Park to Eastern Border Crossing

Clayton and Ash (1980) divided the mainstem Milk River into 6 reaches, based on stream gradient and substrate size. The farthest downstream reach of the mainstem Milk River began upstream of Writing-On-Stone Park and extended to the Eastern International Border Crossing. The gradient in this reach was approximately 0.65 m/km, and the substrate was dominated by fines (i.e., silt and sand). The gradient was substantially lower than in upstream reaches, and the substrate had a much higher percentage of fines than upstream reaches. As such, it was dominated by different species than were collected farther upstream. Also, it has had more consistent sampling in the last decade, due to concern over the status of some fish species at risk.

The earliest records of fish collection in this reach are those of Willock (1969). Downstream of Police Creek, which is located

Mountain Sucker

near the western edge of Writing-On-Stone Park, Willock (1969) reported the four most common species were flathead chub (42%), fathead minnow (18%), mountain sucker (12%), and longnose sucker (11%). Overall, he caught 12 species.

RL&L (2002) conducted surveys on the lower Milk River in 2000 and 2001, with the principal collection techniques being backpack electrofishing and seining. The four most common species collected were flathead chub (79%), longnose dace (12%), white sucker (3%), and longnose sucker (2%). In these surveys they captured 14 species.

Sikina and Clayton (2006) reported on a survey undertaken from June to October 2005 in the mainstem Milk River, downstream of Police Creek, and the four most common species collected were flathead chub (38%), lake chub (37%), longnose sucker (10%) and longnose dace (4%). The principal collection method was seining, similar to Willock's study. The 2005 survey resulted in the capture of 17 species, in comparison with Willock's 12 species downstream of Police Creek. Species captured downstream of Police Creek in 2005 that were not taken in the late 1960s included trout-perch, burbot, St. Mary sculpin, brassy minnow, and brook stickleback. There were never any more than four individuals of the aforementioned five species captured, so these species are relatively rare downstream of Police Creek.

Fisheries and Oceans Canada (DFO) conducted surveys in July 2005, and May, August and October of 2006. The collections from July 2005 and May 2006 were from the Highway 880 bridge (near Aden), approximately 40 river kilometres downstream of Police Creek, to the Eastern International Border Crossing. The primary collection method was boat electrofishing, and the secondary method was seining. In the July survey, the four most common species collected were flathead chub (38%), western silvery minnow (19%), longnose sucker (15%), and white sucker (3%). In the May study, the four most common species collected were western silvery minnow (52%), flathead chub (42%), sauger (2%), and white sucker (2%). There were 10 fish species collected in July 2005, and 9 species taken in May 2006.

Over the last four decades flathead chub have remained as the most numerous species downstream of Police Creek. Surveys conducted recently by DFO would seem to suggest that western silvery minnow numbers have been increasing, since this species appears to be contributing a larger percentage to the catch over time. However, a substantial amount of survey effort by DFO was in the farthest downstream part of the river, and this section had relatively little sampling effort in surveys conducted by Willock (1969), RL&L (2002), and Sikina and Clayton (2006). In addition, the primary sampling method by DFO was boat electrofishing, in comparison to the two other studies, which relied mainly on seining. It appears that boat electrofishing is the preferred methodology for capturing western silvery minnow in the Milk River. Differences in the relative ranking (i.e., percentage abundance) for other species between years probably reflects the physical habitat present at the time of sampling.

Sauger

Introduced Species

For the purposes of this report, all of the fish species captured by Willock in the late 1960s will be considered as native fish, regardless of whether they entered and became established in Alberta via the St. Mary Canal, were present in headwaters since glacial times, or they arrived by some other method.

Two fish species, lake whitefish and trout-perch, likely reached the Milk River drainage by downstream movement, via the St. Mary Canal. (Mogen and Kaeding 2001) reported that trout-perch are native to the St. Mary River, and that lake whitefish were stocked into waters within the drainage and have become self-sustaining. Walleye have likely moved upstream from Fresno Reservoir into the Milk River in Alberta, and although yellow perch were also stocked into Fresno Reservoir, how the original source of yellow perch in the Alberta portion of the drainage arrived remains uncertain.

Other species present in Fresno Reservoir that have yet to be collected in the Milk River in Alberta include rainbow trout (Onchorhynchus mykiss), black crappie (Pomoxis nigromaculatus), emerald shiner (Notropis atherinoides), and spottail shiner (Notropis hudsonius). There are no migration barriers upstream of Fresno Reservoir in Montana. Predatory species that live in Fresno Reservoir, and that could move upstream into Alberta, include walleye, sauger, northern pike, yellow perch, burbot, rainbow trout, and black crappie.

Species at Risk in the Milk River Watershed

In Alberta there are five fish species that have been listed as of 2007 under the *Wildlife Act* as "Threatened". These are western silvery minnow, St. Mary/eastslope sculpin, stonecat, lake sturgeon, and shortjaw cisco. Of these five, three occur in the Milk River drainage.

Western Silvery Minnow

This species is a small fish that grows to a total length of approximately 15 cm. These minnows live for about four years, and it spawns in its second summer. It feeds mainly on microscopic organisms such as diatoms, green algae, blue-green algae, and plant remains. The spawning habits of the western silvery minnow are unknown, and has not been determined where young-of-the-year minnows rear. It is native to large plains streams in west-central North America, and in Canada, it only occurs in the Milk River drainage. Its known distribution in the Alberta portion of the Milk River is from the Eastern International Border Crossing to about 20 river km above the Town of Milk River. The abundance of western silvery minnows in the Milk is not known, but greater numbers are found in the lower portion of the river.

In 2003, the western silvery minnow was listed in the Federal *Species At Risk Act*, under Schedule I, as "Threatened". Provincially, it was listed in 2007 as "Threatened". The Milk River Fish Species at Risk Recovery Team was formed in 2004 to develop a joint federal/provincial recovery strategy for the western silvery minnow which would address the requirements of both the federal and provincial recovery processes. The species is at risk due to its extremely limited range in Canada. The goals and objectives of the recovery strategy are directed at the protection and maintenance of the existing population, rather than increasing abundance and restoring habitat. The key objectives are to quantify and maintain current population levels, identify and protect critical habitat, and to determine potential threats from human activities and ecological processes and then develop plans to eliminate or mitigate these threats.

Eastslope/St. Mary Sculpin

The eastslope/St. Mary sculpin is a small, benthic (bottom-dwelling) fish that occurs in southern Alberta only in the Milk and St. Mary rivers. It occurs in the Saint Mary River in Montana, and may inhabit the Flathead River drainage in British Columbia. Another species, the spoonhead sculpin, occurs in the Oldman, Belly, and lower St. Mary rivers (i.e., below the St. Mary Dam). It grows to a total length of about 11.5 cm, and does not have a swim bladder. It is a nocturnal feeder, consuming aquatic insects, molluscs and fish eggs. It prefers habitats with gravel, cobble or boulder substrates, and they usually avoid sand or silt substrates. The Eastslope/St. Mary sculpin spawns in the late spring. In various collections and writings about the fish species present in the Milk River, it has also been called the mottled sculpin and the shorthead sculpin.

The eastslope/St. Mary sculpin was listed as “Threatened” in Alberta in 2007. In 2006 it was listed in the Federal *Species At Risk Act*, under Schedule I, as “Threatened”. This sculpin was one of the fish species reviewed by the Milk River Fish Species at Risk Recovery Team, formed in 2004 to develop a joint federal/provincial recovery strategy for Milk River fish species at risk which would address the requirements of both the federal and provincial recovery processes. The species is at risk due to its extremely limited range in Canada.

Stonecat

The stonecat is the only member of the Catfish Family that occurs in Alberta, where it is found only in the Milk River. Stonecats are found in southern Manitoba, Ontario and Quebec. The maximum size recorded in Alberta is 25 cm . They have spines in the pectoral and dorsal fins, and the pectoral fins have an associated venom gland. Stonecats have eight long barbels, with four being found on the chin, two in the corners of the mouth, and the remaining two in front of the nostrils.

Stonecats are primarily associated with cobble or boulder substrates. They feed at night, mainly on aquatic insects and small fish. They are occasionally caught by anglers. They are reported to spawn in late spring and summer, although some reports suggest they spawn later, during the peak summer water temperatures. Some degree of parental guarding of the eggs is thought to occur. It is not known where the young rear.

The stonecat was listed as "Threatened" in Alberta in 2007. It is unlikely to have a future "at-risk" listing under SARA, since it occurs in a number of other provinces where its numbers are higher than in Alberta. It was one of the fish species reviewed by the Milk River Fish Species at Risk Recovery Team. The stonecat is at risk due to its extremely limited range in Alberta.

Tributaries

The mainstem Milk River has a number of tributaries which support fish populations. Some of the tributaries enter the Milk River mainstem outside of Alberta, and these will not be discussed in this document. Table 5.4 provides a listing of the tributaries in which fish collections have occurred, and the fish species they are known to support. Kennedy Creek does join the Milk River a few hundred metres south of the International Boundary, and the species listed below occur in the Alberta portion of the creek.

Red Creek is the largest tributary in terms of discharge, and it supports the most diverse fish assemblage. One uncommon fish species inhabits Red Creek and some of the other tributaries; it is the brassy minnow. Brassy minnow have a sporadic distribution pattern in Alberta, since they occur in south-eastern Alberta, in the House and Athabasca rivers near Ft. McMurray, and in Musreau Lake near Grande Prairie. Brassy minnow are often found in conjunction with fathead minnow, and the juveniles of the two species are difficult to distinguish. It has been proposed that the provincial government complete a status report on the species, given its distribution and relative rarity in waters it does inhabit. This small minnow grows to about 8 cm (3.2 inches) in total length, and feeds on algae.

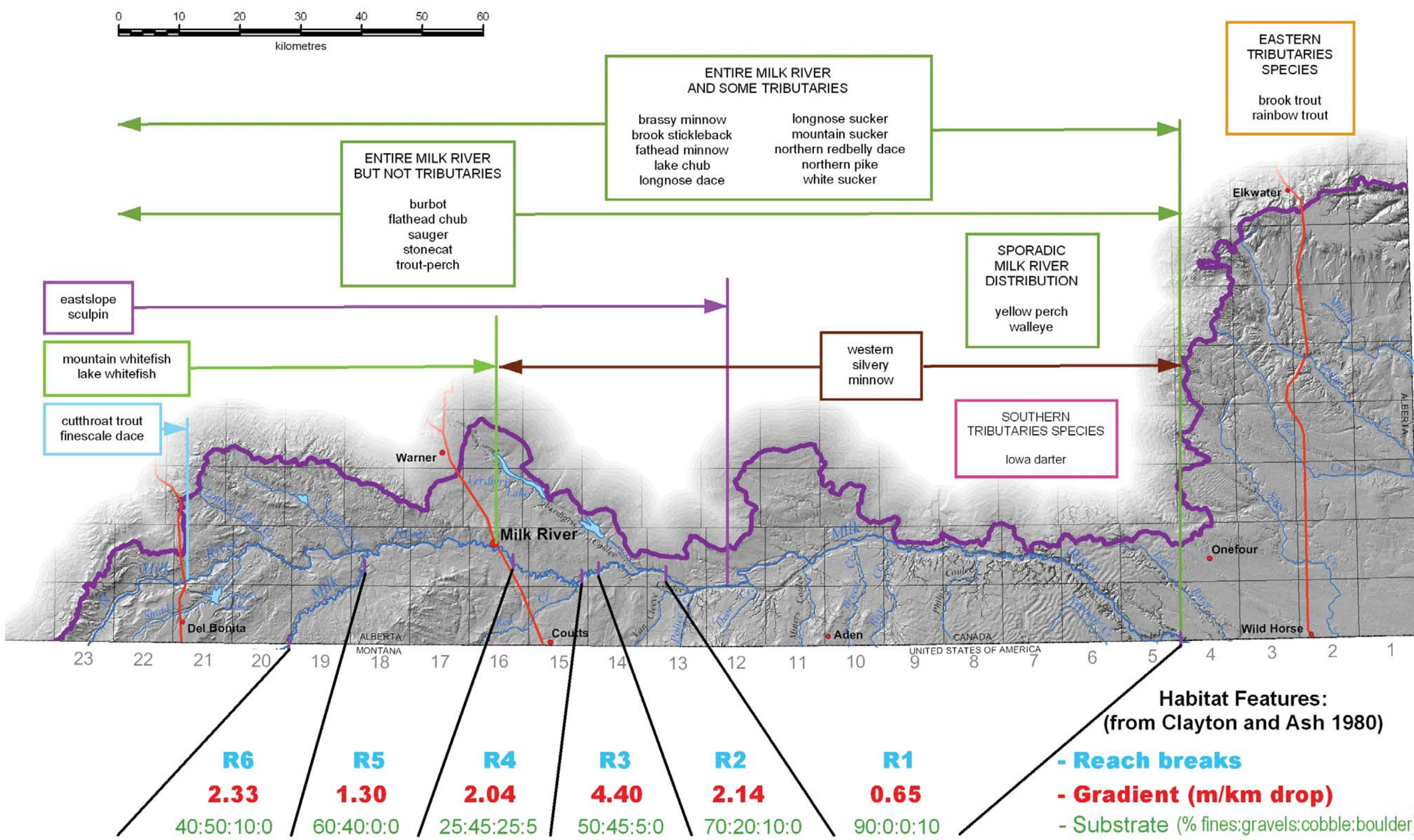
The occurrence of yellow perch in Red Creek is puzzling. They are often plentiful in lentic (standing) waters such as lakes and ponds, and do occur in slow-moving lotic (flowing) waters, such as the margins of larger rivers. They are, however, much less common in creeks. In the latter instance they are usually found in the confluence area with mainstem rivers, but in Red Creek they were collected a fair distance from the Milk River. Nelson and Paetz (1992) in the Fishes of Alberta did not report yellow perch occurred in the Milk River drainage.

There have been very few systematic collections of fish from Milk River tributaries. As such it is difficult to determine if the species composition has changed over time. All of the species in these creeks are native fish to Alberta, although as mentioned above, the origin of yellow perch in Red Creek is unclear.

Table 5.4. Fish species collected in selected tributaries of the Milk River.

Tributary	Fish Species Collected
Shanks	fathead minnow, lake chub, white sucker
Lonely Valley	fathead minnow, northern pike, white sucker
Red	brassy minnow, brook stickleback, fathead minnow, Iowa darter, lake chub, longnose sucker, northern redbelly dace, white sucker, yellow perch
Van Cleeve	brook stickleback, fathead minnow, lake chub, longnose dace, white sucker
Police	fathead minnow, lake chub, white sucker
Breed	brook stickleback, Iowa darter, lake chub, longnose dace, longnose sucker, white sucker
Bear	lake chub
Kennedy	brassy minnow, fathead minnow, Iowa darter, lake chub, white sucker

Map 5.6. River Reaches and Fish Distribution



Benthic Invertebrates

Apparently there has only been one study of Milk River benthic invertebrates, which was conducted inn the spring and fall of 1986. The results of the study were contained in a report titled "Benthic invertebrate communities in the Milk River, Alberta and potential effects of a proposed impoundment", authored by B. Cornish in 1988.

Cornish (1988) reported that the invertebrates collected in the North Milk and Milk rivers were ecologically tolerant and typical of taxa found in areas with high sediment deposition. Less tolerant families, such a mayflies and stoneflies, occurred at all sites but in lower numbers. The less tolerant families occurred in higher abundance in the North Milk River, where water temperatures were cooler due to the input of St. Mary River water from the canal. In the spring, the highest abundance of invertebrates was found at the Weir Bridge, and the second highest abundance was at the Aden Bridge. The lowest abundance in the spring and fall occurred below the town in the Gold Springs Park Pond vicinity.

The most common taxa were Crustacea (crustaceans), Chironomidae (midges), Oligochaeta (freshwater earthworms), and Nematoda (roundworms). As H.F. Clifford said in the Aquatic Invertebrates of Alberta, "the word worm has no taxonomic significance. In fact anything that is round, wriggles, and too small to be hit with a club is sometimes called a worm." The most common crustaceans were cycloplod copepods.

Data Gaps and Recommendations

An instream flow needs study has not been completed for the Milk River. Completion of this type of study will identify impacts of water management on the fisheries resource. Studies designed to understand population estimates for various fish species could be undertaken and habitat assessments completed. In addition a survey of benthic invertebrates could be done to link aquatic organisms to water quality and fish habitat.

5.4 Green Zones: Riparian Areas and Wetlands

Riparian Areas

What are Riparian Areas?

Riparian areas are the portions of the landscape that are strongly influenced by water and are characterized by water-loving vegetation along rivers, streams, lakes, springs, ponds and seeps. When in a properly functioning condition or healthy state, these green zones are one of the most ecologically diverse ecosystems in the world. Healthy riparian areas sustain fish and wildlife populations, provide good water quality and supply, forage for livestock, and support people on the landscape. Although riparian areas make up a small portion of the landscape, they play a role that is disproportionately important to the amount of area they encompass. In the Milk River watershed, riparian areas make up less than two percent of the land base. In order to be healthy, riparian areas need to perform certain functions: trap sediment to maintain and build streambanks, recharge groundwater supplies, provide stable flows, flood protection, habitat for fish and wildlife, as well as, shelter and forage for livestock and wildlife.


Typical large riparian area supporting thorny buffaloberry and peach-leafed willow.

Riparian Plants along the Milk River: A Rich Biodiversity

The riparian areas within the Milk River watershed support an abundance of different plant species. Plant inventories conducted along the Milk River alone document 184 different plant species.

The Woody Plants

Three tree species are present in the Milk River watershed. These are plains cottonwood *(Populus deltoides)*, narrow-leaf cottonwood *(Populus angustifolia)* and balsam poplar *(Populus balsamifera)*. Shrub diversity is excellent with over 30 different species present within the riparian areas alone. Shrub species vary greatly from the 'tree-like' peach-leaved willow *(Salix amygdaloides)* to the highly palatable, red-osier dogwood *(Cornus stolonifera)*. Three grazing resistant shrubs, snowberry *(Symphoricarpos occidentalis)*, common wild rose *(Rosa woodsii)* and silverberry *(Elaeagnus commutata)* are the dominant shrub species. Other 'less grazing resistant' shrubs like thorny buffaloberry *(Shepherdia argentea)*, sandbar willow *(Salix exigua)* and yellow willow *(Salix lutea)* are also quite abundant. Russian olive *(Elaeagnus angustifolia)* is an introduced, fast growing shrub from Europe and is present along the Milk River. This large shade providing shrub, although often considered a welcoming patch of habitat, is invasive and its growth in riparian areas should be monitored closely.

Grasses and Broad-Leaved Flowering Plants

Approximately 65 grass or 'grass-like' species are found along the riparian areas in the watershed. Two introduced 'disturbance-caused' grasses are found in abundance. These are Kentucky bluegrass *(Poa pratensis)* and smooth brome *(Bromus inermis)*. Sand grass *(Calamovilfa longifolia)*, western wheat grass *(Agropyron smithii)* and needle-and-thread *(Stipa comata)* are also commonly found in the riparian areas. At least 80 different species of broad-leaved flowering plants are also found on the streambanks and in the floodplains of the Milk River. Wild licorice *(Glycyrrhiza lepidota)*, Canada goldenrod *(Solidago canadensis)*, plains wormwood *(Artemisia campestris)* and prairie sagewort *(Artemisia ludoviciana)* are examples of broad-leaved flower plants commonly found.


Canada goldenrod, one of 80 species of broad-leaved flowering plants found in the watershed.


Smooth brome, a non-native, disturbance-caused species; one of 65 species of grasses found in the watershed.

What is Riparian Health?

Riparian areas are like a jigsaw puzzle and each individual piece or component is critical to the successful function of the entire system. How the individual pieces (e.g. vegetation composition, especially deep-rooted plant species, soils and wildlife) function together affects the health of the riparian ecosystem including the stream, its watershed, and overall landscape health and productivity.

A healthy riparian area has:

- successful reproduction and establishment of seedling, sapling and mature trees and shrubs (if the site has potential to grow them),
- floodplains with abundant plant growth,
- stream banks and shore areas with deep-rooted plant species (e.g., trees and shrubs),
- very few, if any, invasive plants (e.g., Canada thistle),
- very few structurally altered or eroded stream banks,
- the ability of regular (i.e., approximately 1-3 years) high flow levels to access a floodplain appropriate to the size of the stream or river.

When riparian health is compromised it usually means that one or more of the pieces has been impacted by natural or human-caused disturbances such as development, recreation, grazing, flooding or fire. Riparian areas with extensive impacts are usually rated as unhealthy, because of modification of the pieces mentioned above. Riparian areas with moderate levels of impacts will typically fall within the healthy but with problems category, while those with very few or no impacts will normally be rated as healthy.

Riparian Health in the Milk River Watershed

The Milk River watershed is comprised of small tributary streams, wetlands and rivers. The smaller ephemeral streams include Lost River, Red Creek, Sage Creek, Lodge Creek, Bare Creek, Breed Creek, Bear Creek and Middle Creek. All of these streams, rivers and wetlands have riparian areas and the Alberta Riparian Habitat Management Society (Cows and Fish) has collected riparian health information on some of them. The majority of the riparian assessments have been conducted on the Milk River (Table 5.5), thus the following information on riparian health pertains exclusively to data collected along the Milk River and the North Milk River.

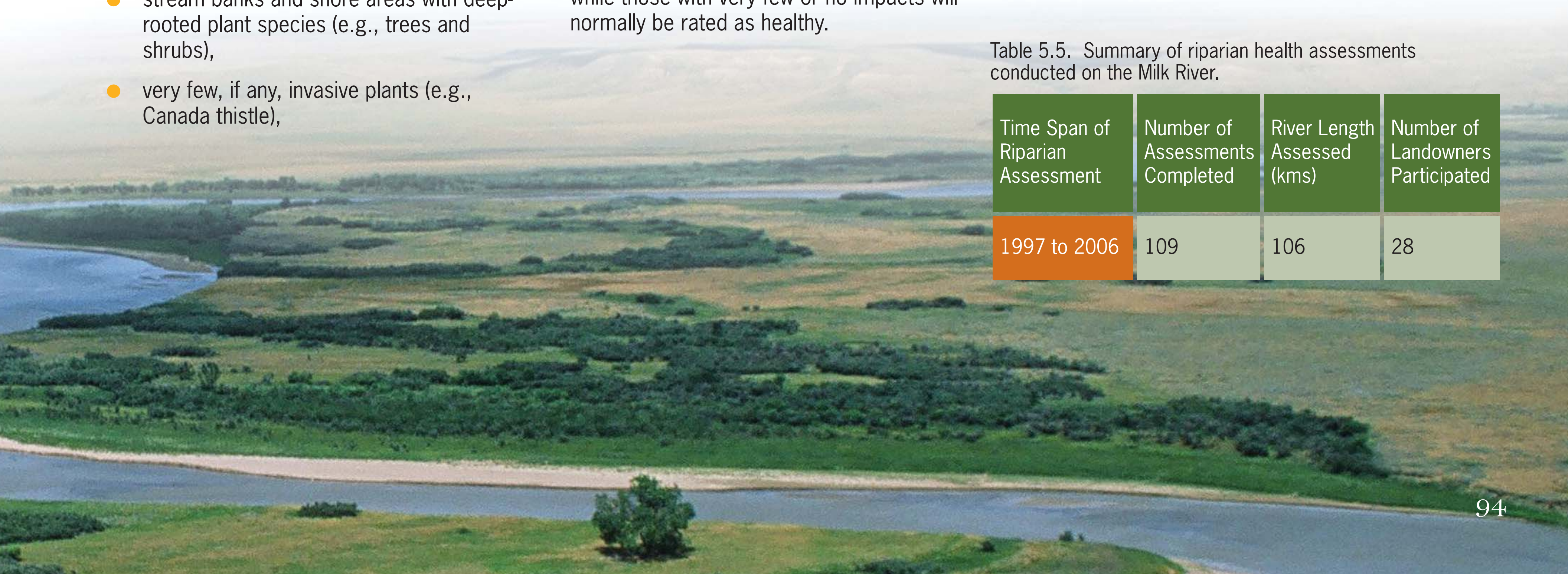


Table 5.5. Summary of riparian health assessments conducted on the Milk River.

Time Span of Riparian Assessment	Number of Assessments Completed	River Length Assessed (kms)	Number of Landowners Participated
1997 to 2006	109	106	28

Riparian Health Indicators

Riparian health inventories and riparian health assessments are two tools used to determine the ecological function or health of riparian ecosystems. A riparian health inventory is a detailed assessment of the vegetative, soil and hydrological characteristics of riparian areas. Riparian health assessments, on the other hand, are derived from the riparian health inventory and provide comprehensive information about the diversity, structure and health of plant communities within a project area. The riparian health assessment generates a score, rating riparian areas either healthy (score 80 to 100%), healthy but with problems (score 60 to 79%) or unhealthy (score less than 60%) (Table 5.6). This examination provides a better understanding of the health of riparian areas, where to concentrate efforts if improvements in riparian management are required, and what land use practices are currently maintaining riparian health.

Table 5.6. Summary of the Riparian health rating system.

Health Category	Score Ranges	Description
Healthy	80-100%	All riparian functions are being performed
Healthy, but with problems	60-79%	Many functions are being performed but signs of stress are apparent
Unhealthy	<60%	Many functions are impaired or have been lost

Vegetative Cover of Streambanks and Floodplain

Health Status:

Native plants provide riparian functions including deep, binding root masses and summer and winter forage production for livestock and wildlife.

Almost all of the riparian areas inventoried in the Milk River watershed have adequate amounts of plant cover along the streambanks and floodplains. The Milk River watershed has a rich biodiversity of plant life with no less than 136 native plants along the riparian areas of the Milk River.

Non-native Plants (Invasive and Disturbance-caused)

Health Status:

Disturbance-caused plants typically do not have a deep, binding root mass and do not provide streambank protection as well as native species. Disturbance-caused plants are also not as palatable to wildlife and livestock.

Like almost all riparian areas and rangelands in southern Alberta, the prevalence of invasive plants and disturbance-caused plants is a concern. Most riparian areas assessed along the Milk River have continuous occurrences of introduced plants. Canada thistle *(Cirsium arvense)* and perennial sow-thistle *(Sonchus arvensis)* are the most commonly occurring invasive plants. Spotted knapweed *(Centaurea maculosa)*, an aggressive invasive plant on the restricted weed list, has also been observed in the watershed. A total of five invasive plants and 18 disturbance-caused plants have been recorded.

Due to the influence of the St. Mary River in Montana, and the origin of the Milk River in Montana, there is a significant influx of invasive exotic weed species. For instance, spotted knapweed is found along the river as far west as the south fork of the Milk River and at a number of locations east of Del Bonita. There is also a significant acreage of invasive agronomic species within the watershed, including crested wheat, brome grass, and cheat grass but at this time there is insufficient data to comment on area and abundance. Invasive weed species have been identified by numerous sources as the second leading threat to the ecological integrity of native plant communities, second only to development.

Complete elimination of invasive and disturbance-caused plants is not realistic; however, with a combination of sound land management practices and weed control measures, the prevalence of these plants could be reduced. Weed control is primarily the responsibility of the landowner or lease holder with the majority of control coordination originating with the local Municipal District or County.

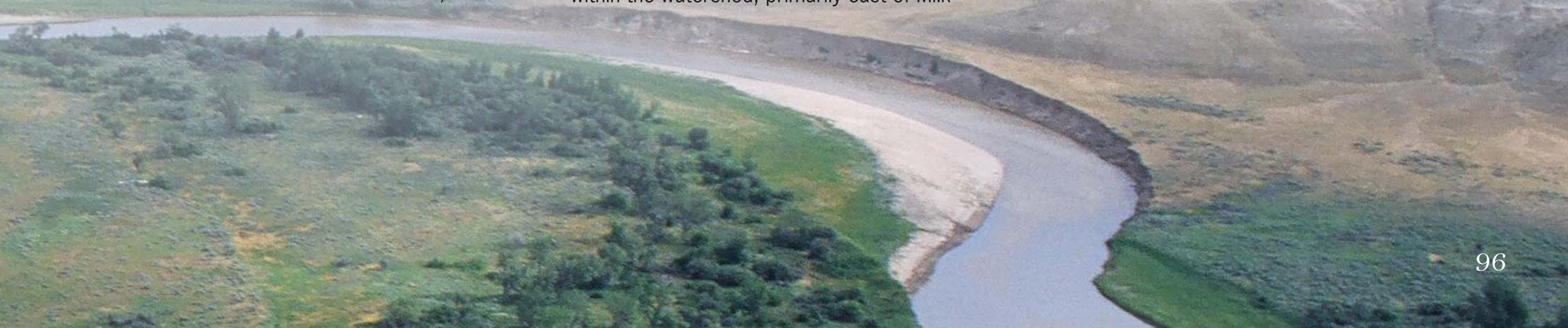
Although only five key invasive species within the watershed are discussed in detail, there are more weed species present in the watershed. In 2008, spotted knapweed, leafy spurge, dalmatian toadflax, Russian olive and salt-cedar are believed to be of the greatest concern in the Milk River watershed. Crested wheat grass is an introduced species that is prevalent throughout the watershed.

Leafy Spurge *(Euphorbia esula)*

Provincial Designation: Noxious

Leafy spurge is an aggressive, persistent, deep-rooted perennial, growing to a height of 0.75 m in the Milk River watershed. Leafy spurge reproduces both vegetatively, spreading from rhizomanous spreading roots, and by the production of large quantities of seeds that are often dispersed by birds, wildlife, humans, and in rivers and streams. Leafy spurge produces a milky latex that is poisonous to some animals and can cause blistering and irritation on skin. The digestive tract is similarly affected when this plant is eaten by humans and some animals. In cattle it causes scours and weakness. When ingested in larger amounts it can cause death. There are only a few areas infested with leafy spurge within the watershed, primarily east of Milk River. Although currently not a major threat in the Milk River watershed, the economic impact of leafy spurge can be staggering. In the northern United States it is estimated that range managers lose over 100 million dollars annually in lost production. The impacts of leafy spurge cannot be measured in dollars alone. Leafy spurge crowds out native vegetation, resulting in a monoculture that reduces biodiversity and threatens both abundant and sensitive species.

Leafy Spurge



Spotted Knapweed *(Centaurea maculosa)*

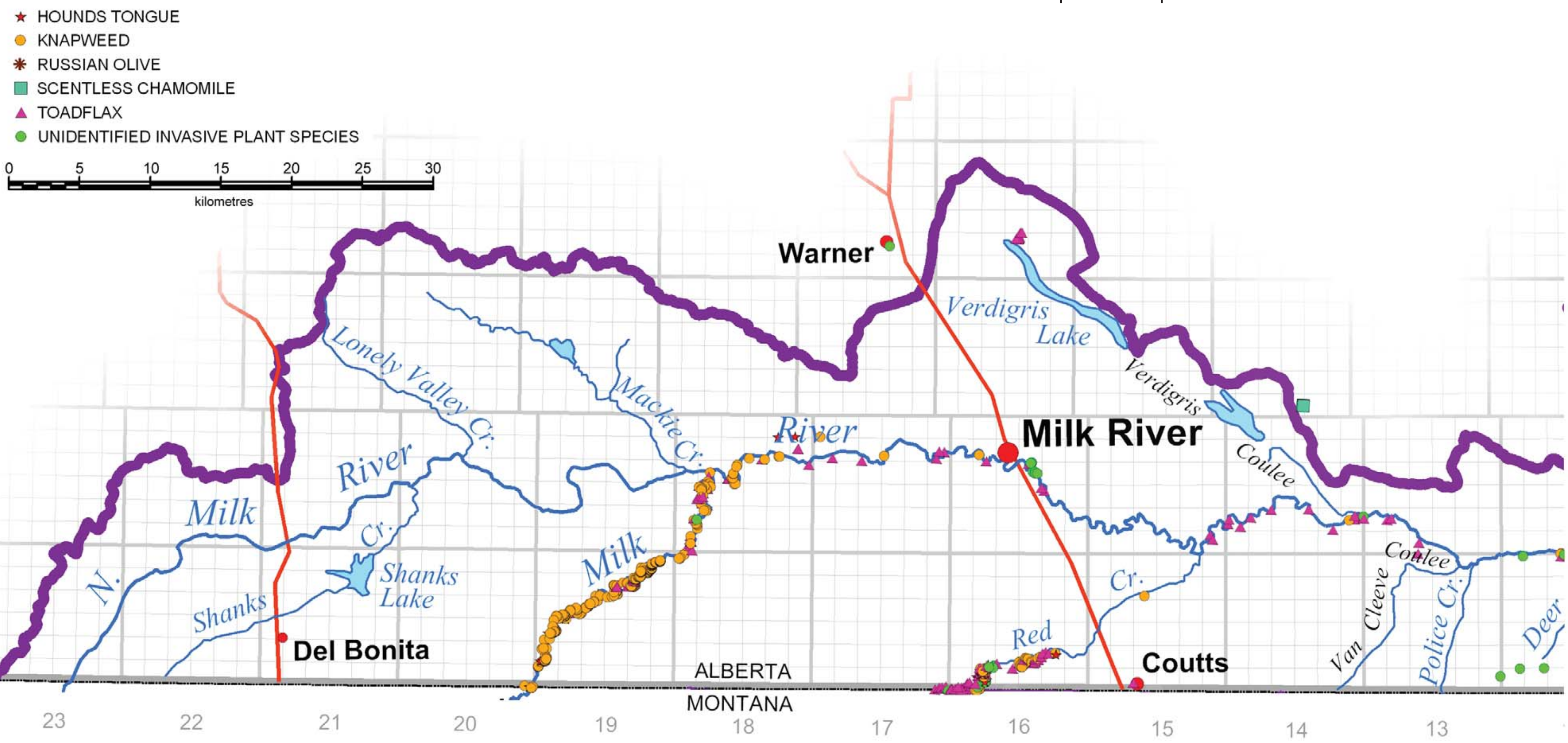
Provincial Designation: Restricted

Description: Primarily a biennial plant – producing a rosette the first year and a flowering bolt the second – but can also be a short-lived perennial, blooming for a few years before dying.

Stems are often upright and branched, growing up to 1.5 m tall. Knapweeds have become well known because of their almost wholesale degradation of large tracts of rangeland in the northwestern US and parts of southern BC. While livestock and wildlife will graze knapweed early in its growth form, it becomes unpalatable and can out-compete a native range community. Knapweed in the Milk River watershed is primarily moved along disturbed watercourses but can also be found in contaminated hay, or spread by plant skeletons caught in vehicle undercarriages.

Spotted Knapweed

Map 5.7. Locations of Known Invasive Plant Species
Data from Municipal Districts, Counties, and Public Lands.



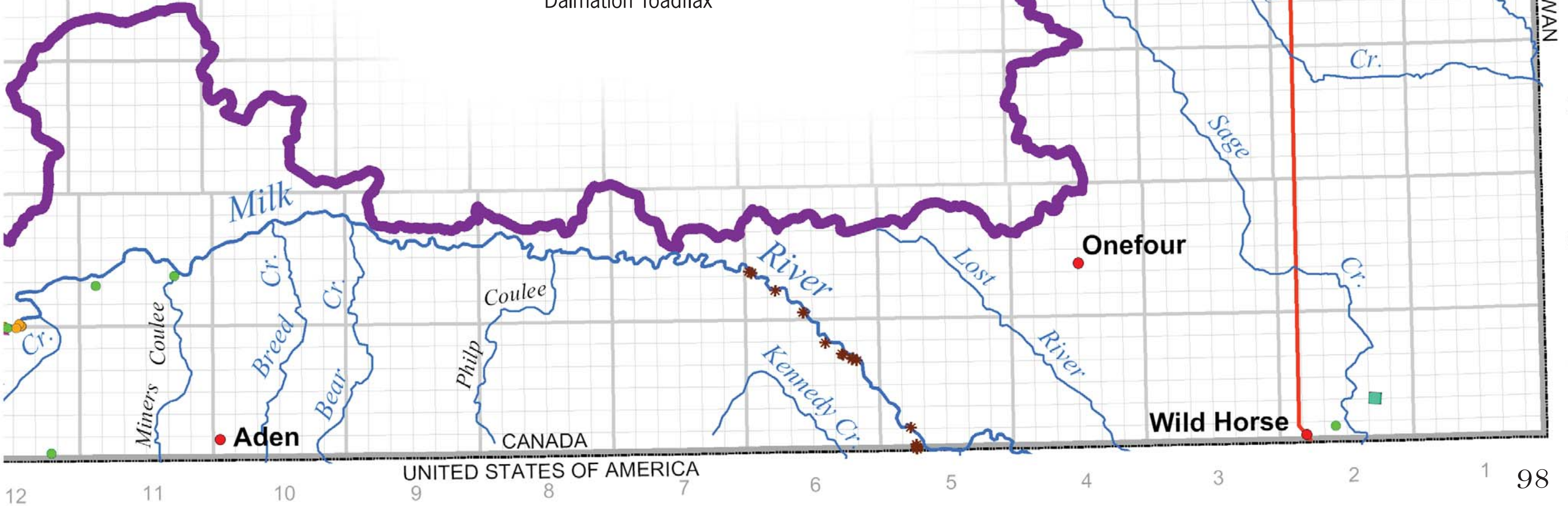
Dalmatian Toadflax *(Linaria dalmatica)*

Provincial Designation: Nuisance

Description: A perennial plant that reproduces both by seed and creeping rhizomes.

First year plants develop a rosette of leaves and a deep root system. The main taproot may grow 1.2 m deep and lateral rhizomes can extend up to 3.7 m . Flowers are yellow, similar to ornamental snapdragons and are very showy. Dalmatian toadflax prefers warmer sites particularly along open south facing coulees and along exposed gravel bars in the Milk River watershed. Leaves are broad, hairless, heart-shaped and clasp the stem. Dalmatian toadflax contains compounds toxic to livestock, but since the plant is generally unpalatable, reports of poisoning are rare. Dalmation toadflax is well adapted to dry, coarse textured soils. A mature plant can produce up to 500,000 seeds annually, which may remain viable up to 10 years.

Dalmation Toadflax



Salt Cedar - Tamarisk *(Tamarix spp.)*

Provincial Designation: Unlisted

Description: Eight species of salt-cedar were introduced into the United States and Canada from Asia in the 1800s. Three of these species are now invasive. It was first reported out of cultivation in the 1870s and the greatest degree of invasion in the United States has occurred between 1935 and 1955. By 2001, salt cedar had reached the Canadian border.

Salt-cedar is a deciduous shrub/small tree that grows most successfully along riparian areas. Its roots extend deeply into the soil to access the groundwater. These trees can consume as much as 757 L of water per day. Where groundwater is not present, salt-cedar sends out lateral roots to access other sources of water. Scale-like leaves remove salt from the atmosphere which is then released into the soil. The increased salinity in the soil makes it unsuitable for many native plants and shrubs. Salt-cedar, like many other invasive plant species, has a great reproductive capability. A mature salt-cedar plant can produce 600,000 seeds annually. Seeds are easily dispersed by wind and water, and severed stems and shoots of salt-cedar readily root in moist soil.

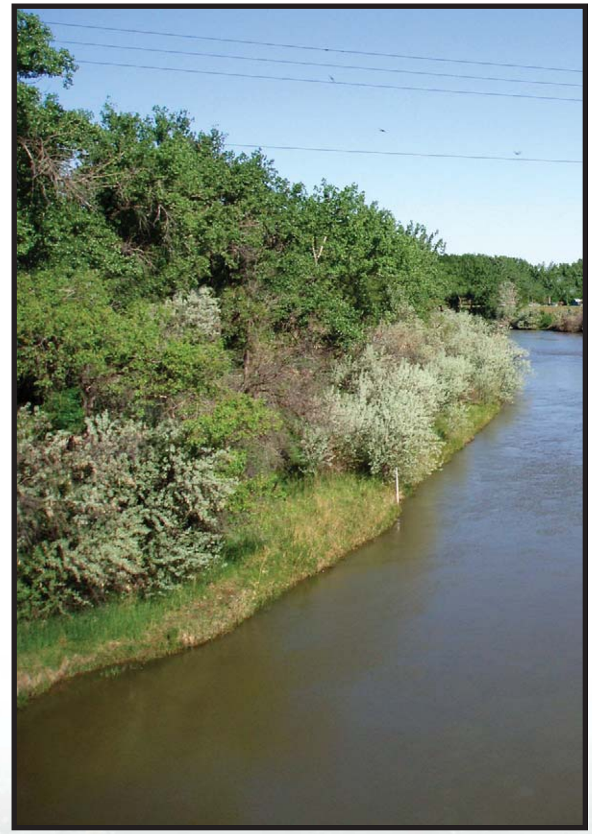
Salt-cedar is not known to occur in the Milk River watershed in Canada, but there are reports that it has been found in the watershed south of the eastern Canadian Border.

Russian Olive *(Elaeagnus angustifolia)*

Provincial Designation: Unlisted

Description: Russian olive is a Eurasian import (1930s – probably as an ornamental and to stabilize soil) that can grow to 20 m. It is fast growing and favored as a windbreak tree. It thrives is poor soils because it is capable of fixing nitrogen from the atmosphere. It will grow in dry soils but does best in sandy riparian areas. Admired for its silvery foliage, Russian olive produces large amounts of leaf litter.

In the Milk River watershed, Russian olive has invaded native riparian communities from Milk River to below Writing-On-Stone Park. In a short period of time it is replacing the cottonwood community, simplifying the riparian community and decreasing the diversity of habitat available for wildlife. In north-central Montana, Russian olive is replacing cottonwoods below dams and other water impoundments. Russian olive also has a competitive advantage as it does not require a disturbance event such as floods to spread.



Russian Olives establishing along the banks of the Milk River in Montana.

Crested Wheat Grass *(Agropyron pectiniforme)*

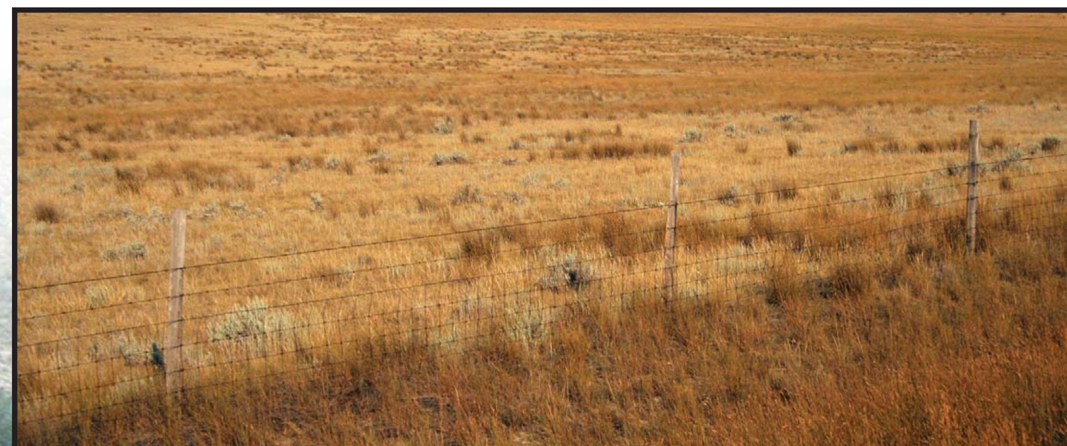
Provincial Designation: Unlisted

Description: Crested wheat grass is an introduced agronomic species which was widely seeded and used in complementary and deferred grazing systems as well as for reclamation on disturbed sites in the past. Its qualities include excellent establishment, even on poor soils, early spring growth, high nutrient quality in the spring and hay production.

Despite these attributes, research indicates serious negative consequences to sites containing crested wheat grass. It releases less carbon into the soil, produces less litter, reduces soil organic matter content of the site, decreases biodiversity, and aggressively uses available soil moisture. An increase in bare ground on crested wheat grass dominated sites can lead to accelerated soil erosion. Crested wheat grass is very competitive, produces an abundance of seed and subsequently invades into adjacent native prairie. This invasion creates significant grazing management issues due to selective and preferential grazing of native species over crested wheat grass.

In the Milk River watershed, although crested wheat grass is no longer used as a reclamation species, the impact of past use is evident. Crested wheat grass is invading native plant communities throughout the watershed from adjacent tame pastures and from disposition rights of way. New seeding of crested wheat grass should be discouraged and research is required to determine the level of infestation and its impact on the watershed.

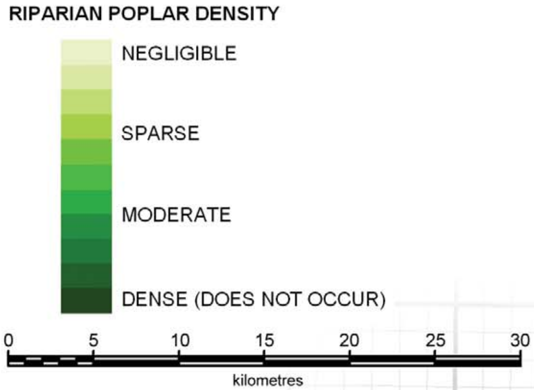
Crested Wheatgrass



Tree and Shrub Establishment and Regeneration

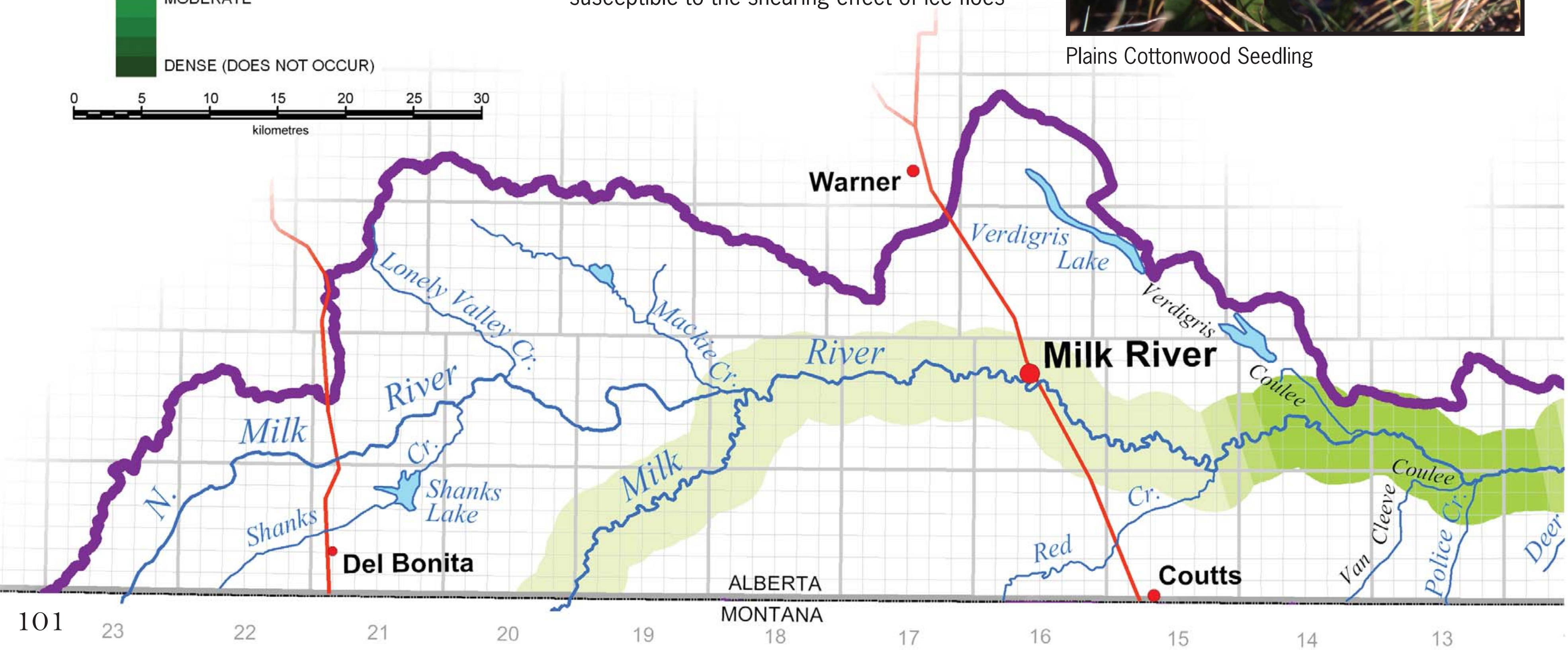
Health Status:

Map 5.8. Plains Cottonwood Distribution



The root systems of woody species are excellent bank stabilizers, while their spreading canopies provide protection to soil, water, wildlife and livestock.The Milk River watershed has many limitations for supporting robust riparian cottonwood forests. Some are natural (e.g., geographic range, ice floes, beavers, wildlife browse, salinity) and some are human-caused (e.g., livestock grazing, water extraction, flood control, recreation, industry). The establishment of plains cottonwood also requires bare mineral substrate, full sunlight, freedom from competition and an abundant and stable supply of water. These conditions are limited to newly-formed river point bars. Cottonwood seedlings are particularly susceptible to the shearing effect of ice floes and browse by beavers, cattle and deer. Human-regulated water levels in the Milk River pose additional challenges for the creation of these ideal growing conditions. Despite these challenges, mature stands of riparian cottonwoods along the Milk River do exist.

Plains Cottonwood Seedling

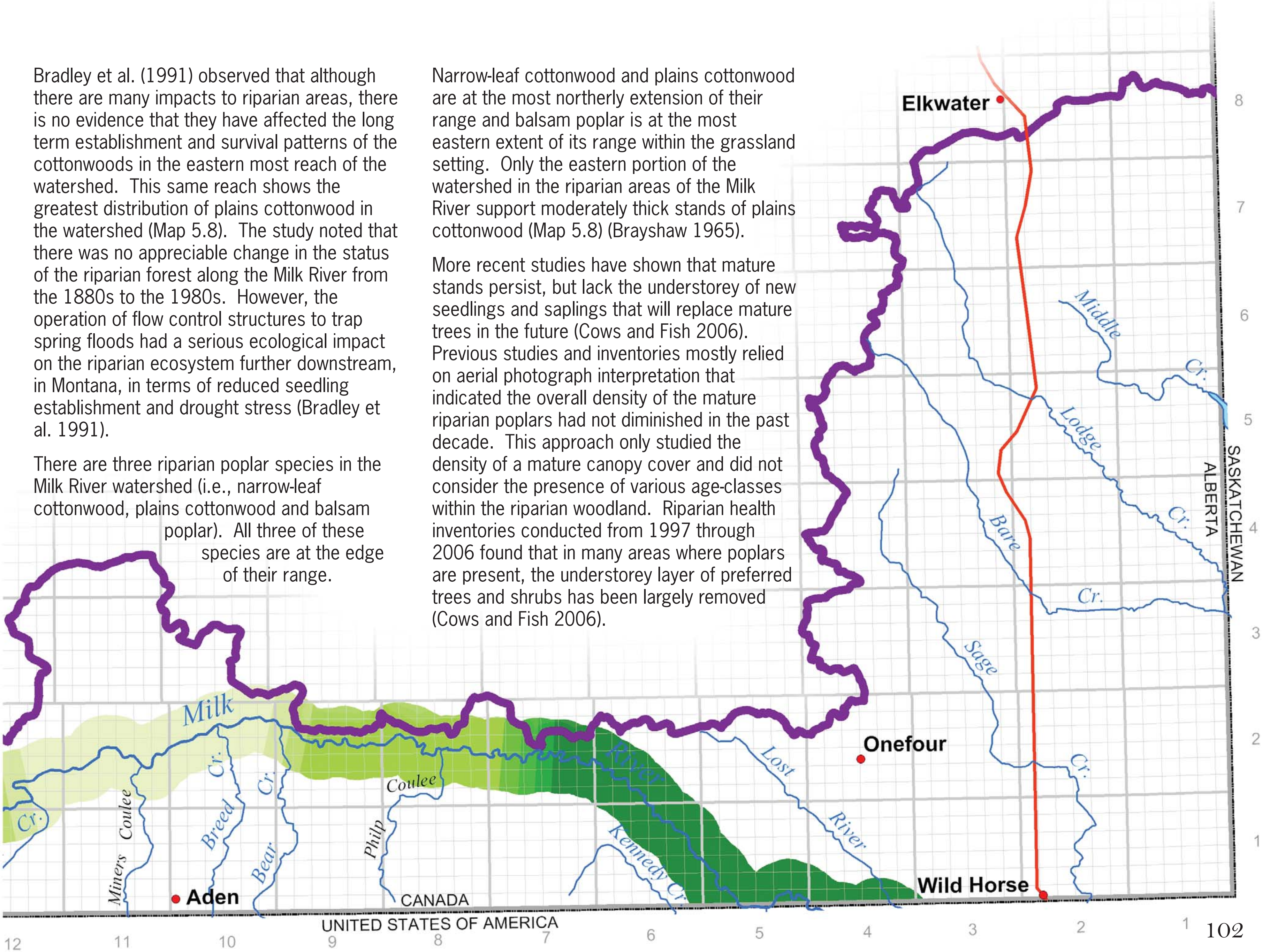


Bradley et al. (1991) observed that although there are many impacts to riparian areas, there is no evidence that they have affected the long term establishment and survival patterns of the cottonwoods in the eastern most reach of the watershed. This same reach shows the greatest distribution of plains cottonwood in the watershed (Map 5.8). The study noted that there was no appreciable change in the status of the riparian forest along the Milk River from the 1880s to the 1980s. However, the operation of flow control structures to trap spring floods had a serious ecological impact on the riparian ecosystem further downstream, in Montana, in terms of reduced seedling establishment and drought stress (Bradley et al. 1991).

There are three riparian poplar species in the Milk River watershed (i.e., narrow-leaf cottonwood, plains cottonwood and balsam poplar). All three of these species are at the edge of their range.

Narrow-leaf cottonwood and plains cottonwood are at the most northerly extension of their range and balsam poplar is at the most eastern extent of its range within the grassland setting. Only the eastern portion of the watershed in the riparian areas of the Milk River support moderately thick stands of plains cottonwood (Map 5.8) (Brayshaw 1965).

More recent studies have shown that mature stands persist, but lack the understorey of new seedlings and saplings that will replace mature trees in the future (Cows and Fish 2006). Previous studies and inventories mostly relied on aerial photograph interpretation that indicated the overall density of the mature riparian poplars had not diminished in the past decade. This approach only studied the density of a mature canopy cover and did not consider the presence of various age-classes within the riparian woodland. Riparian health inventories conducted from 1997 through 2006 found that in many areas where poplars are present, the understorey layer of preferred trees and shrubs has been largely removed (Cows and Fish 2006).



In addition to riparian cottonwoods, a great diversity of shrubs is commonly found within all of the riparian areas in the watershed. In some areas, these shrubs form a dense layer of vegetation shading the grasses and broad-leaved plants underneath. The presence of many different shrub species is often a good indicator that there is a healthy amount of diversity. This diversity is important because it provides structure and habitat layers (i.e., understorey, mid-storey and canopy layers) benefiting wildlife, livestock and streambank stability.

Similar to riparian plains cottonwood stands, the understorey layer of preferred shrubs has been largely removed in riparian areas along the Milk River. In all areas where shrubs are present, the grazing-resistant, disturbance-increaser shrubs (e.g., snowberry, common wild rose and silverberry) are out-competing preferred shrubs (e.g., willows). In some areas, a significant portion of the shrub canopy cover is comprised of only grazing-resistant, disturbance-increaser shrubs.

Overall, trees and shrubs are receiving moderate to heavy browse pressure from livestock and wildlife, and in areas, this browse pressure is removing new growth and preventing seedlings and saplings from reaching a mature age class. Moderate to heavy browse levels are not sustainable in woody plant communities, and will eventually reduce or eliminate preferred trees and shrubs, leaving the less palatable and more browse resistant plants to dominate in the riparian area.

Streambanks: Root Mass Protection and Alterations

Health Status:

Like rebar in concrete, deeply rooted vegetation is critical in holding streambanks together, preventing erosion and limiting lateral cutting.

Almost two thirds of streambanks inventoried along the Milk River are considered unstable. Many factors contribute to poor streambank stability, some are natural and some are human-caused. The bedrock in the watershed is composed of poorly cemented sandstones, siltstones and shale which are highly susceptible to erosion. Natural runoff varies greatly from periods of high discharge due to snowmelt in the spring, to very low levels in late summer. In more recent history, the flow of water in the Milk River is being controlled by water diversions. As with establishment of cottonwood seedlings, fluctuating water flows pose challenges for streambank stability. In light of these conditions it is the deep roots of trees and shrubs that provide the 'glue' to hold streambanks together, preventing erosion and lateral cutting.

To rate in the healthy category, river banks should be about 85% covered by vegetation with deep, binding roots. Unfortunately, many of the riverbanks inventoried along the Milk River lack adequate amounts of deep, binding roots and accordingly about a third of the streambank length is being eroded laterally.

Streambanks that are structurally altered (e.g., mechanically broken down by cattle activity or by vehicle traffic) is another factor contributing to bank instability along the Milk River. These altered sections of streambank increase the potential for erosion while inhibiting the establishment of riparian plant species. In extreme cases, where all the natural and human-caused factors coincide, the streambanks are experiencing severe slumping.

Although streambanks currently rate unhealthy, there are some signs of recovery occurring in the form of sediment deposition along the banks, and vegetation is establishing and stabilizing in these areas.

Typical river section with limited potential for cottonwood regenerating due to lack of new point bar formation. Meander lobes covered with sandbar willow and grazing resistant shrubs. Riparian area is well vegetated and near side has limited root mass protection.

Bare Ground and Physical Alterations to Riparian Area

Health Status:

healthy | healthy, but with problems | unhealthy | unknown

Bare ground is the ground surface not protected from erosional forces by plants, litter or duff, woody material or large rocks.

Compared to the narrow streambank area, the Milk River has very large meander lobes and the impacts due to livestock, recreation and other human activity is relatively minimal over these large areas. Accordingly, exposed soil surface or bare ground was minimal in the majority of inventoried riparian areas. Three quarters of the bare ground that was observed was considered naturally occurring and was attributed to depositional material (i.e., sediment) from recent floods. Floods form the point bars that willow and cottonwood seedlings rely on for establishment. Bare ground was also associated with human activity, primarily caused by livestock hoof action and trampling.

Stream Channel Incisement (Down-cutting) and Stability

Health Status:

healthy | healthy, but with problems | unhealthy | unknown

Incisement can increase stream energy by reducing sinuosity, water retention, storage, and by increasing erosion.

The Milk River transports 292,000,000 m^3 of water each year through the Canadian portion of the watershed. With the bedrock material comprised of primarily sandstones, and other easily eroded material, the Milk River also transports a large amount of sediment. This was noted by the American explorers Lewis and Clark in their journal entry for May 8, 1805, which states:

'The waters of the river possess a peculiar whiteness being about the colour of a cup of tea with the admixture of a tablespoon of Milk. From the colour of its waters, we called it Milk River.'

Spitzer (1988) observed that the sediment load increases dramatically from the upper reach to the lower reach of the Milk River. In 1981, the recorded sediment discharge at North Milk River near the International Boundary was 2,500 tonnes, at Milk River it was 31,000 tonnes and at the Eastern Crossing it was 287,000 tonnes. The greatest contribution to the suspended sediment load arises between the Town of Milk River and Eastern Crossing (Spitzer 1988).

The Milk River has experienced very little downward stream channel incisement to date and periodic high water events can still access broad floodplains along most of the river length. High flood waters that periodically access the highest terraces of the floodplain are important to disperse moisture throughout the riparian area for the maintenance of riparian vegetation. Flooding also spreads the energy of moving water over the riparian area, allowing sediment to be deposited and the creation of new areas for seedling establishment.

Typical river section with broad valley, and stable channel with floodwaters able to access the active floodplain. Meander migration is occurring via ongoing lateral cutting on streambanks opposite the meander lobes. Note sediment load and new point bar formation.

Although little incisement has occurred, the transport of material by the Milk River and by gravity results in lateral cutting of streambanks and sediment deposition on the point bars of meander lobes. This process drives the natural meander migration and subsequent point bar formation along the Milk River.

The Milk River is a highly active system as evidenced by meander migration observed since 1915 (Figure 5.22). A recent study compared Milk River migration from 1915 (pre-diversion of St. Mary River water into the Milk River) with current conditions (AMEC 2008).

Although the study only dated back to 1915, it is evident through old meander scars, that the Milk River has been meandering across its floodplain for a much longer period of time (Figure 5.22).

The width of the Milk River has been increasing through time as water flow regulation and natural erosion continue to change the course of the river. AMEC (2008) estimated that since the diversion of water from the St. Mary River in 1917, the width of the Milk River has increased by 15 m on the North Milk River, by 10.5 m in the centre Milk River gravel bed reach and by 21 m in the most downstream Milk River sand bed reach. Estimated rates of erosion range from 0.18 m per year to 2.5 m per year (AMEC 2008).

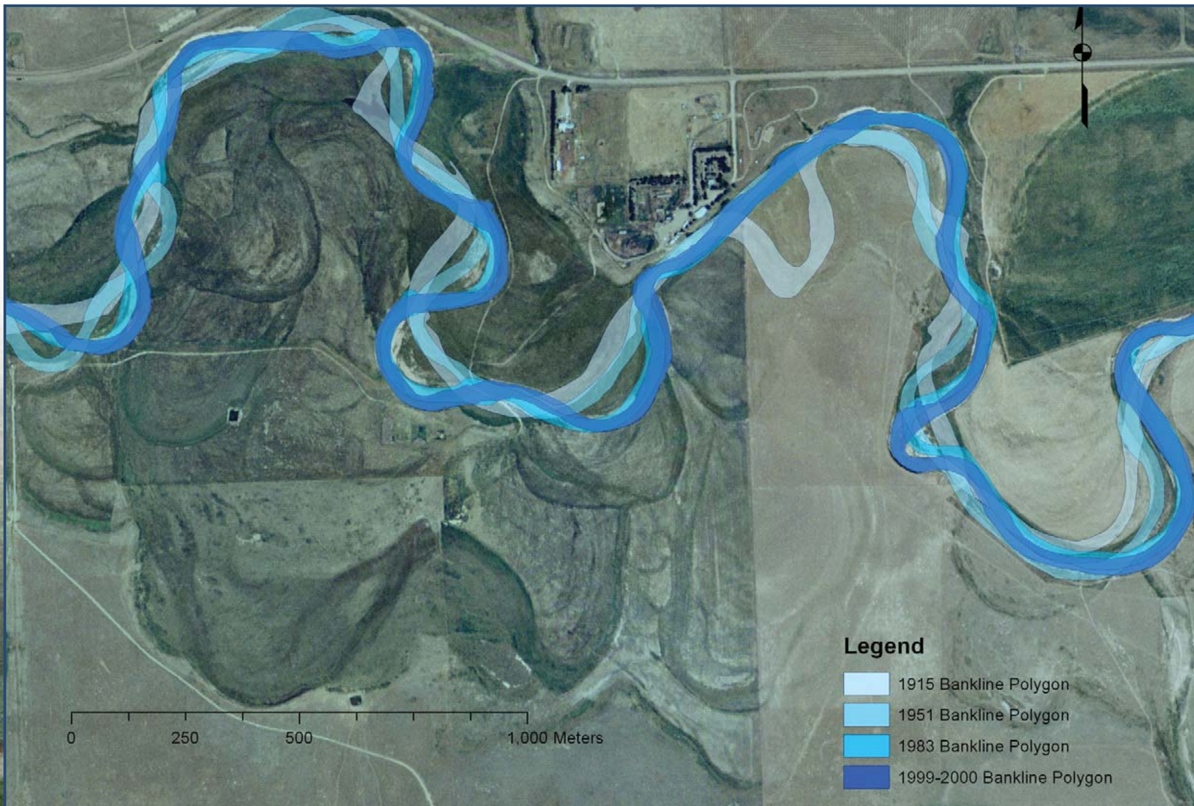


Figure 5.22. Migration of the Milk River since 1915 (provided by R. Powley, PFRA).

The unconsolidated streambank material of the Milk River provides little resistance to the erosive power of moving water. Meander migration will always be a significant factor in the management of adjacent lands. As the river widens, water depths will become shallower and evaporative losses will increase. Degradation of habitat for fish populations and diminishing water supplies may result. Maintaining and improving streambank stability is perhaps the biggest challenge posed to landowners and land managers along the Milk River.

Data Gaps and Recommendations

Monitoring riparian vegetation is essential to understanding long term impacts of water regulation and management in the future. Monitoring may include aerial photography interpretation, as well as riparian health assessments. Further, increased understanding of sedimentation rates, rates of erosion and plains cottonwood survival would be important aspects in riparian management.

Table 5.7. Summary of beneficial management practices for maintenance of healthy riparian areas.

Riparian Health Component	Beneficial Management Practices
Vegetative Cover of Streambanks and Floodplain	Native plant communities require rest from grazing or other disturbances during the growing season to regrow, reduce the amount of bare ground and to out-compete disturbance-caused and invasive plants for nutrients and water.
	Other human activities such as recreation, transportation and industrial development should be managed to preserve native plant communities and reclaim disturbed areas with native vegetation.
Non-native Plants (Invasive and Disturbance-caused)	Livestock grazing strategies should consider distribution, timing and stocking rates that fall within the carrying capacity of each pasture. Providing maximum rest during the growing season, skim grazing and time-controlled grazing management practices can be applied as a means to reduce the potential for an increase in invasive and disturbance-caused species and maintain an abundance of native species.
	Other land-uses management plans (e.g., industrial development, road construction, sand and gravel extraction) should have reclamation plans and sites should be monitored closely until reclamation is complete.
Tree and Shrub Establishment and Regeneration	Watershed managers should consider water management strategies that aim to mimic the elements of natural flows necessary for healthy riparian ecosystems.
	Maintain existing preferred tree and shrub communities (e.g., poplars, buffaloberry, willows) and prevent the increase of browsing-resistant shrub communities (e.g., snowberry, rose, silverberry) resulting from excessive livestock browse.
	Providing adequate rest from continuous browse pressure promotes regeneration of existing preferred trees and shrub communities and improves future reproduction and establishment.
	Attention to livestock management options such as distribution, timing, rotation, and stocking rate should maintain and increase preferred trees and shrubs.
Streambanks: Root Mass Protection and Alterations	Rotational grazing, off-stream water developments and other distribution techniques disperse livestock over large areas of rangeland, while preventing cattle from loitering along the river.
	In many areas within the Milk River watershed, it is not practical to use exclusion fencing. Rather, some producers use fencing to create riparian pastures. These pastures, with complementary off-stream water systems, allow seasonal skim grazing in riparian areas, thus increasing tree and shrub cover and improving streambank stability.
	Rest is needed during sensitive times such as winter and early spring to promote recovery of riparian vegetation.
Bare Ground and Physical Alterations to Entire Riparian Area	Improvements in industrial reclamation standards and monitoring for disturbed areas should continue to be encouraged and mandated by provincial, municipal and industrial regulators.
	Good distribution of livestock throughout the range, effective rest during the growing season and avoiding vulnerable periods are important to maintain well-vegetated and stable riparian areas. Avoiding the use of riparian pastures as wintering areas, and skim grazing these pastures during summer months is preferred.
Stream Channel Incisement (Down Cutting) and Stability	Maintain and increase the amount of vegetation with deep binding root mass along the river banks through the successful regeneration of riparian vegetation, especially trees and shrubs.
	Water management should consider the erosive potential of excessive flows in the Milk River and the timing of these flows during various times of the year.

Wetlands

What are Wetlands?

Wetlands share many of the same characteristics as riparian areas and are considered lentic (non-flowing) riparian zones. Definitions of wetlands vary, but all generally refer to three defining features, which are:

- Poorly drained or un-drained soils that are either organic or mineral in nature,
- Vegetation adapted to wet conditions, referred to as "hydrophytes", and
- The presence of water that saturates the land or is shallow surface water (Mitsch and Gosselink 1993).

The term wetland is often used to describe marshes, swamps, sloughs, bogs, fens and shallow ponds. The freshwater edges of lakes and rivers, the marine waters of estuaries, and the tidal ocean shore zone may also be included in the wetland description.

The Milk River watershed is located in the regionally significant area known as the prairie pothole region. Prairie potholes, often referred to as sloughs, occur in those parts of the North American prairies that were covered with glacial drift deposits in the Grassland Prairie Wetland District (Kantrud et al. 1989). Numerous prairie potholes reside on the surface of this landscape as unconnected and saucer-like depressions. Each of the depressions contains a wetland similar to a shallow pond or marsh, characterized by emergent herbaceous vegetation adapted to saturated soil conditions, including cattails *(Typha spp..)* and bulrushes *(Scirpus spp..)*.

Most of the prairie potholes are less than 0.01 km^2 in size, are shallow and lack a well-developed outlet, although they may overflow during wet springs (Kantrud et al. 1989). The amount of water that they contain is dependent on the amount of recent precipitation, but often these wetlands are primarily dependent on spring runoff (Kantrud et al. 1989).

Importance of Wetlands

Wetlands perform ecological functions that are essential to people, wildlife and our economies. Three main functions that wetlands provide are:

- Hydrological (water quantity): such as water storage, velocity reduction, groundwater recharge and base flow maintenance,
- Water quality: such as removal of nutrients, toxicants and sediment, and
- Habitat: for plants, mammals, birds, fish, reptiles, amphibians and invertebrates. Wetlands are habitat for about one third of Canada's species at risk.

Wetland values and benefits refer to the worth or importance of these functions to people. Wetlands are valued for flood control, clean water, grazing and forage value, recreational activities like hunting, bird watching, and sport fishing.

Wetland Vegetation

The vegetation found in prairie wetlands is often determined by its water regime, salinity and human-caused disturbance. Within a pothole, water depth and water permanency determines the types of plant species that exist (Kantrud et al. 1989). Open water wetlands are potholes deep enough to have standing water even during droughts. These are dominated by submerged vegetation species. Deep marshes are wetlands that go dry during periods of drought or annually. The centre of deep marshes is dominated by either tall emergent species (deep marsh) or midheight emergent species (shallow marsh). Potholes that are only flooded briefly in the spring are dominated by grasses, sedges and forbs are known as wet meadows.

Prairie wetlands are adapted to periodic droughts and wet periods and many wetlands undergo vegetation cycles associated with these water level changes (Kantrud et al. 1989).

Open wetlands can be temporarily or permanently flooded, emergent hydrophytes are generally absent; can include irrigation reservoirs, lakes and temporary flooded wetlands.

Deep marshes are persistently flooded ponds, periodically exposed bottom; emergent hydrophytes typically present.

Shallow marshes are shallow, temporarily and seasonally flooded ponds; emergent hydrophytes generally present

Wetland Inventories in the Milk River Watershed

There is an increasing need for wetland inventories throughout Alberta. Several resource inventories of wetlands in the Milk River watershed have already been completed or partially completed by various government and non-government organizations (Table 5.8).

Table 5.8. Wetland inventories completed in the Milk River watershed, Alberta.

Organization	Date	Coverage	Format	Digital Availability
Canadian Wildlife Service, Canada Land Inventory (CLI)	1968-1970	Milk River watershed	Air photo interpretation – hard copy map	Survey used for Canada Land Inventory maps (CLI) Wildlife – Waterfowl
Ducks Unlimited Canada	1985-1989	Milk River watershed	Land Sat 5 by 1:50,000 NTS map sheet	DUC internal use only. (Table 5.9)
Ducks Unlimited Canada – internal study	2003	Milk River Ridge Area	Photo interpretation/ GIS	Drained and altered wetlands only
Government of Alberta/Ducks Unlimited Canada	2007	Milk River Ridge - underway	Digital	Intact, impacted, and drained wetlands

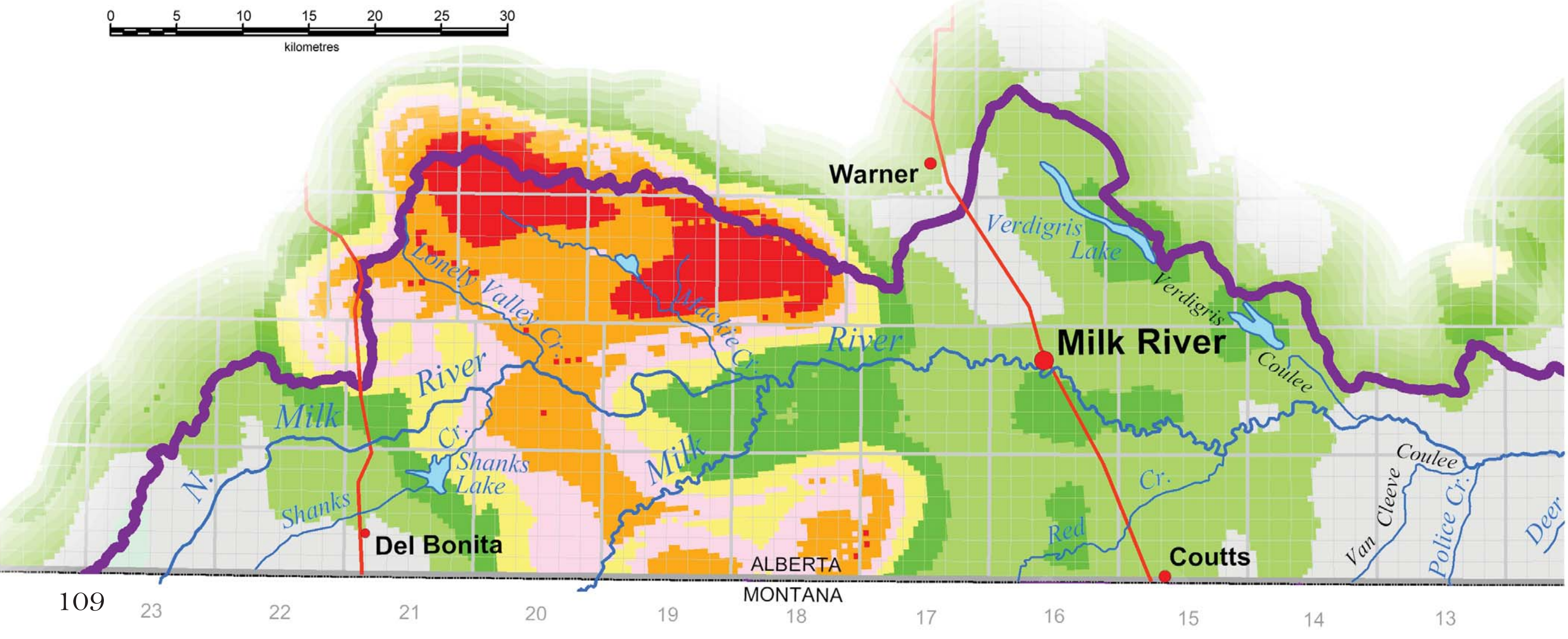
Loss of wetlands has been occurring at a rapid rate. Before the European settlement in the prairie pothole region, there were an estimated 8 million hectares of potholes in the area. It has been documented that well over half have been converted to other uses, primarily agriculture (Leitch 1989). Drainage has eliminated many potholes, while grazing, mowing and burning have altered vegetation composition.

The most comprehensive and recent data available for wetlands in the Milk River watershed was collected by Ducks Unlimited Canada in 1985-1986. This inventory used remote sensing (i.e., Land Sat 5 imagery) to enumerate wetlands in the Milk River watershed (Table 5.9; Map 5.9). This inventory corresponds to wetland conditions in the particular satellite scene date and is representative of that point in time and does not represent long term average conditions. The 1985 and 1986 scene dates are generally considered part of a drier hydrological cycle. In addition, only portions of the surveyed area of this Land Sat scene have been ground truthed to verify size and wetland type.

In total, 34,773 large wetlands (>0.049 km^2) and small wetlands (0.0001 to 0.049 km^2) were identified in the watershed, totaling an area of 89.7 km^2 (Table 5.9). This represents 0.14% of the watershed (Map 5.9).

In 2007, Alberta Environment and Ducks Unlimited Canada undertook a comprehensive wetland resource inventory of a portion of the Milk River watershed. The inventory will be digital and spatially correct and will include drained wetlands. It is expected that the results of this project will be available in 2008. The new Grassland Vegetation Inventory, described in Section 2.11, page 23 will also contain valuable wetland information when complete.

Map 5.9. Wetland Distribution Summarized by Predicted Pintail Breeding Pairs

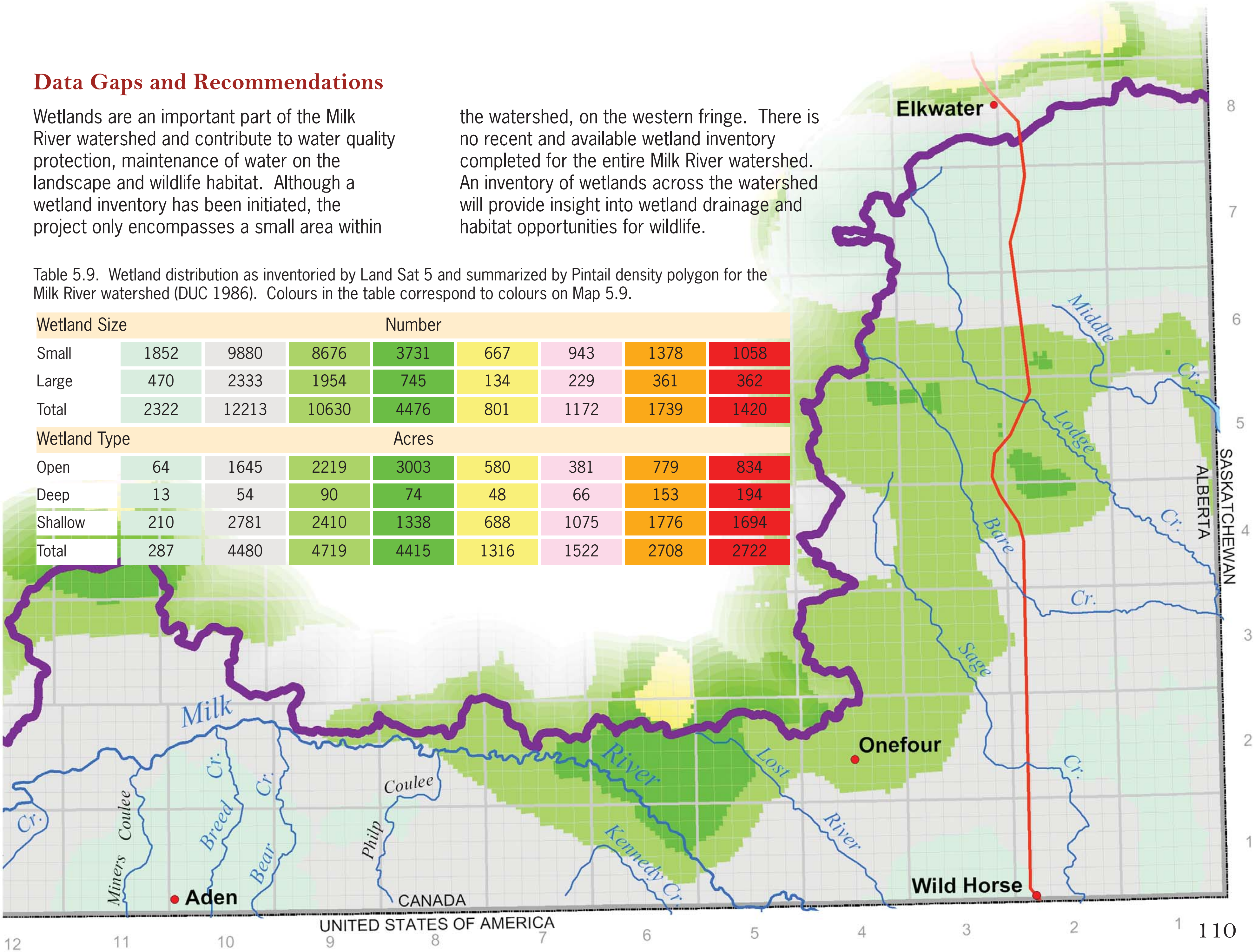


Data Gaps and Recommendations

Wetlands are an important part of the Milk River watershed and contribute to water quality protection, maintenance of water on the landscape and wildlife habitat. Although a wetland inventory has been initiated, the project only encompasses a small area within the watershed, on the western fringe. There is no recent and available wetland inventory completed for the entire Milk River watershed. An inventory of wetlands across the watershed will provide insight into wetland drainage and habitat opportunities for wildlife.

Table 5.9. Wetland distribution as inventoried by Land Sat 5 and summarized by Pintail density polygon for the Milk River watershed (DUC 1986). Colours in the table correspond to colours on Map 5.9.

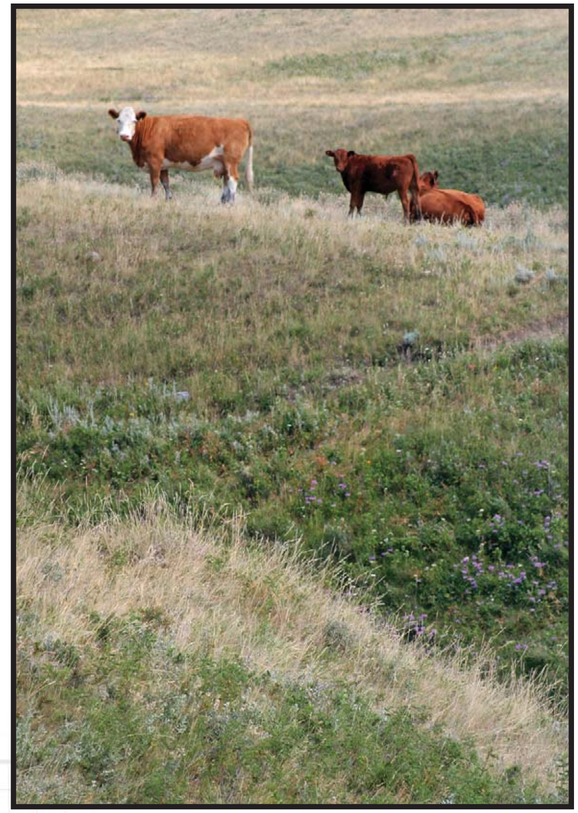
Wetland Size	Number							
Small	1852	9880	8676	3731	667	943	1378	1058
Large	470	2333	1954	745	134	229	361	362
Total	2322	12213	10630	4476	801	1172	1739	1420
Wetland Type	**Acres**							
Open	64	1645	2219	3003	580	381	779	834
Deep	13	54	90	74	48	66	153	194
Shallow	210	2781	2410	1338	688	1075	1776	1694
Total	287	4480	4719	4415	1316	1522	2708	2722



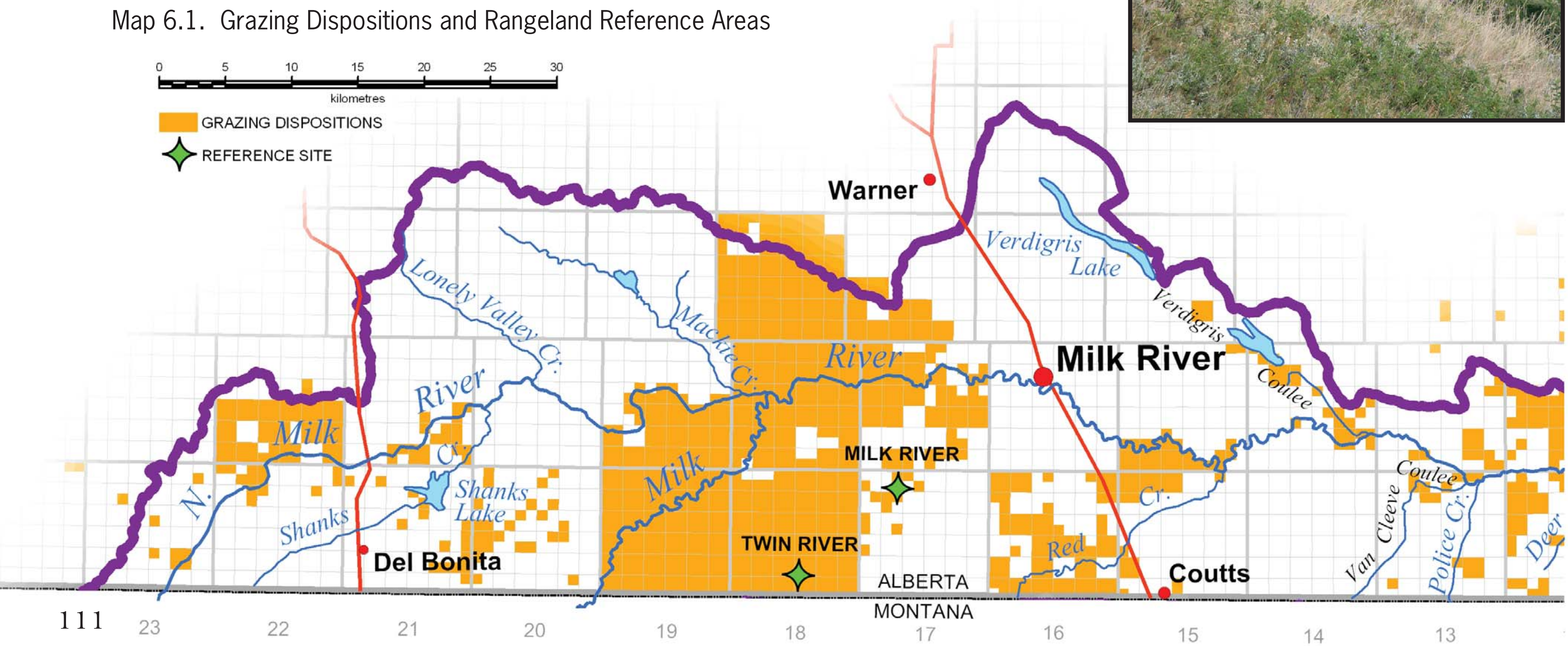
6.0 The Uplands

6.1 Public Range Health

Sustainable rangeland resource management begins with the effective application of range management principles and practices by the grazing lease holder. Many ranching families reflect multi-generational knowledge in their stewardship practices. Further commitment to a high standard of rangeland resource management is established through a system of periodic and renewal inspections carried out by Lands Division of Alberta Sustainable Resource Development. Professional Rangeland Agrologists inspect and assess rangeland health on leases (Map 6.1) and engage in management discussions with lease holders. Management agreements and tenure conditions are employed to ensure desirable management practices are in effect to achieve sustainable rangeland use. Compliance tools and measures are also available where stewardship goals are not attained.

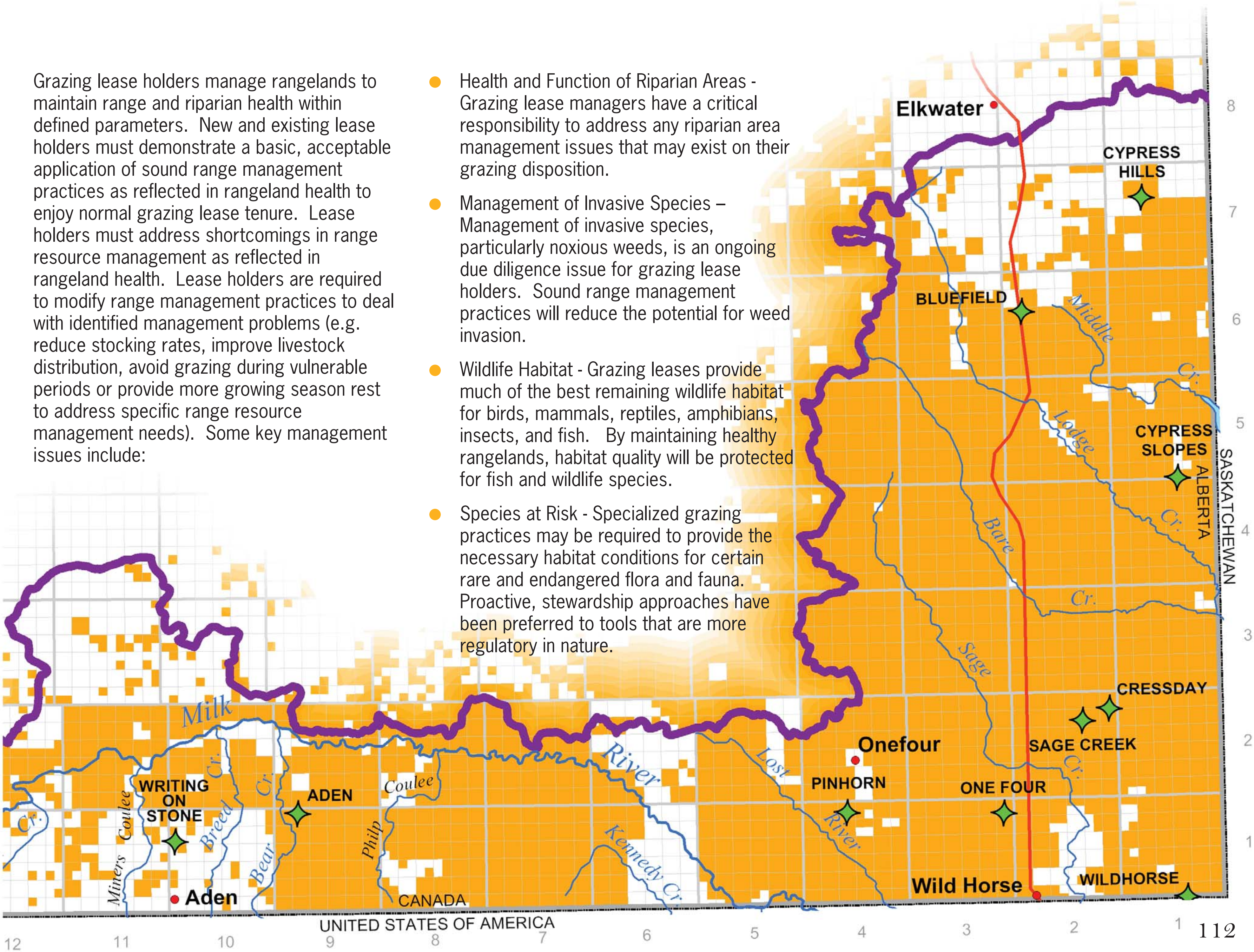


Map 6.1. Grazing Dispositions and Rangeland Reference Areas



Grazing lease holders manage rangelands to maintain range and riparian health within defined parameters. New and existing lease holders must demonstrate a basic, acceptable application of sound range management practices as reflected in rangeland health to enjoy normal grazing lease tenure. Lease holders must address shortcomings in range resource management as reflected in rangeland health. Lease holders are required to modify range management practices to deal with identified management problems (e.g. reduce stocking rates, improve livestock distribution, avoid grazing during vulnerable periods or provide more growing season rest to address specific range resource management needs). Some key management issues include:

- Health and Function of Riparian Areas - Grazing lease managers have a critical responsibility to address any riparian area management issues that may exist on their grazing disposition.
- Management of Invasive Species – Management of invasive species, particularly noxious weeds, is an ongoing due diligence issue for grazing lease holders. Sound range management practices will reduce the potential for weed invasion.
- Wildlife Habitat - Grazing leases provide much of the best remaining wildlife habitat for birds, mammals, reptiles, amphibians, insects, and fish. By maintaining healthy rangelands, habitat quality will be protected for fish and wildlife species.
- Species at Risk - Specialized grazing practices may be required to provide the necessary habitat conditions for certain rare and endangered flora and fauna. Proactive, stewardship approaches have been preferred to tools that are more regulatory in nature.



Public Rangelands and Environmental Performance Measures

Environmental performance of rangelands has traditionally been measured with vegetation and soil indicators. Prior to 2002, the Province of Alberta applied a variety of systems to rate rangeland condition including the "Stocking Guide" first published in 1966. Since, the new range health assessment system (Adams et al. 2003) has been adopted across the province to address developments in range science and the need for a more robust and transparent set of indicators for rating rangeland health. The core measure of sustainable rangeland management applied to public grazing leases is rangeland health with associated evaluation criteria of riparian health assessment. With background knowledge about the local soils and vegetation, range health is rated for an ecological site type in relation to the reference plant community and by scoring five questions that address selected indicators of range health. These include:

a). Integrity and Ecological Status – Each ecological site will produce a characteristic kind and amount of vegetation, called a reference plant community. Is the plant community native or modified to non-native species? Has grazing management maintained the plant community or are there shifts in species composition to less desirable or weedy plant species?

b). Plant Community Structure – Are the expected plant layers present or are any missing or significantly reduced, revealing a possible reduction in plant vigor?

c). Hydrologic Function and Nutrient Cycling – Are the expected amounts of organic residue present to safeguard hydrologic processes and nutrient cycling? When functioning properly, a watershed captures stores and beneficially releases the moisture associated with normal precipitation events. Uplands make up the largest part of the watershed and are where most of the moisture is captured and stored during precipitation events. Live plant material and litter (either standing, freshly fallen or slightly decomposed on the soil surface) is important for infiltration (slowing runoff and creating a path into the soil), reducing soil erosion from wind and water, reducing evaporative losses and reducing raindrop impact. Litter also acts as a physical barrier to heat and water flow at the soil surface. Litter conserves moisture by reducing evaporation making scarce moisture more effective.

d). Site Stability – Is the site stability maintained or is the ecological site subject to accelerated erosion? This indicator is applied to recognize situations where management practices may have increased soil erosion beyond levels that may be considered normal for the site.

e). Noxious Weeds – Are noxious weeds present on the site?

When a site is rated, the combined score of all five indicators is expressed as percent health score ranking the site as healthy, healthy with problems or unhealthy.

Rangeland health applies 5 indicators of health and function including an estimate of plant community composition and litter (mulch). Sample quadrats are employed in the sampling process.

Rangeland Health Scores in the Milk River Watershed

ASRD implemented the new system of rangeland health assessment in 2003 and as data accumulates from grazing lease inspections and range surveys, we are able to obtain a broad impression of overall rangeland health on the public lands base. Figure 6.1 shows that overall 62% of the landscape is rated healthy, about 33% is healthy but with problems and 5% is unhealthy (data from 1,400 sites).

While SRD manages for an overall "healthy class" on public rangelands, a presence of lower health scores on the landscape is desirable. Rangelands evolved under the impact of large herbivores especially bison. Many species like prairie birds may have specific habitat requirements that are reflective of lower health classes. The grazing lease holder may be requested to manage for a particular level of rangeland health that addresses range resource issues and objectives providing for the habitat requirements of one or more species at risk (e.g. patch grazed habitat adjoining the nesting sites of Burrowing Owls).

Riparian Health Assessment - Riparian plant communities are also rated using a similar health assessment protocol, but with a set of indicators that are appropriate to the functioning of riparian systems (Fitch et al. 2001, Ambrose et al. 2004).

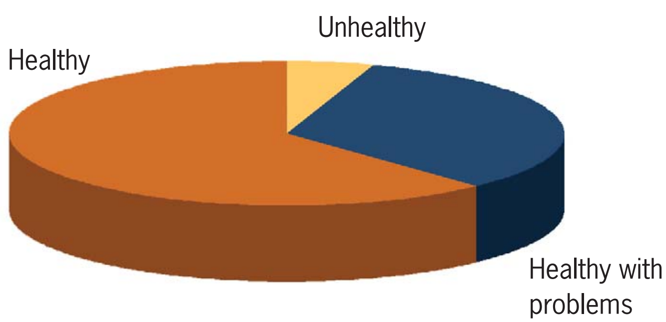


Figure 6.1. Pooled rangeland health assessment data for the Lethbridge South District for the period 2003 to 2007, Rangeland Management Branch, Alberta Sustainable Resource Development.

Alberta Rangeland Reference Areas

Another very important environmental monitoring tool for rangelands is the Rangeland Reference Areas Network. In the province as a whole, ASRD maintains 180 rangeland reference area monitoring sites. Twelve of these sites are located within the Milk River watershed. RRAs allow Lands Division staff to understand how the overall range landscape is likely to be performing relative to climatic variability and general stewardship practices. For example, reference area data will show the year to year variation in grass yields and in the residual amount of litter that is likely to be present under moderate levels of grazing. If forage yields or litter reserves show a sharp decline at one or more reference sites, it alerts resource managers to the need for special drought management practices to safeguard rangeland health and minimize the negative impacts of drought. There are currently 12 rangeland reference areas in the Milk River watershed (Map 6.1).

Figure 6.2 is from the Onefour rangeland reference area and shows the decline in grass yields and litter reserves during the severe drought conditions of 2000 and 2001 and then the sharp recovery of grass yields and litter reserves in the subsequent years. Very similar patterns of drought and recovery are evident at the Aden and Milk River Ridge reference areas in Figures 6.3 and 6.4.

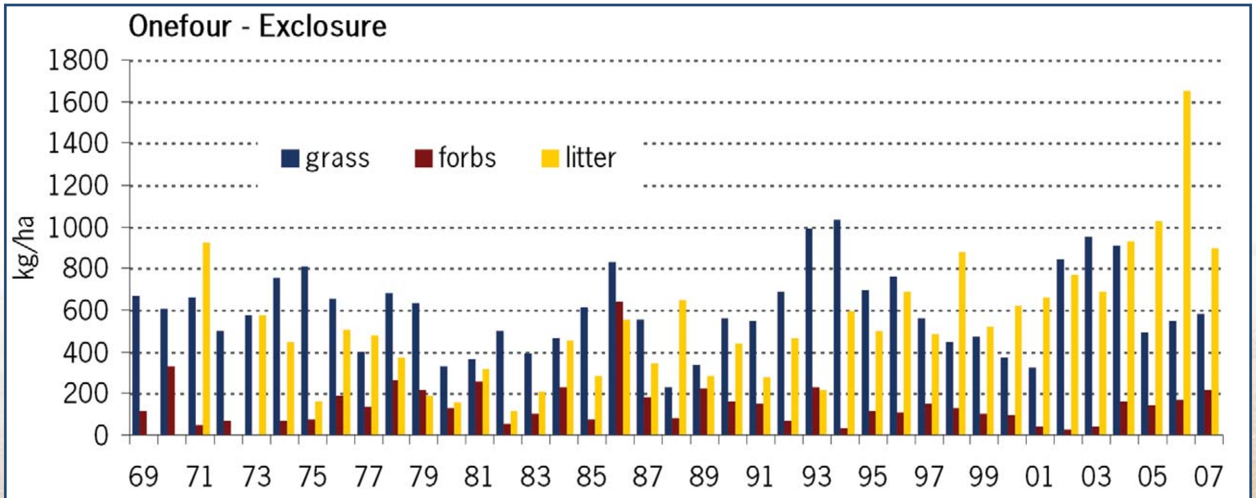


Figure 6.2. Trend in yield of grasses, forbs and litter at the Onefour Rangeland Reference Area at the Onefour Agricultural Research Substation for the period 1969 to 2007.

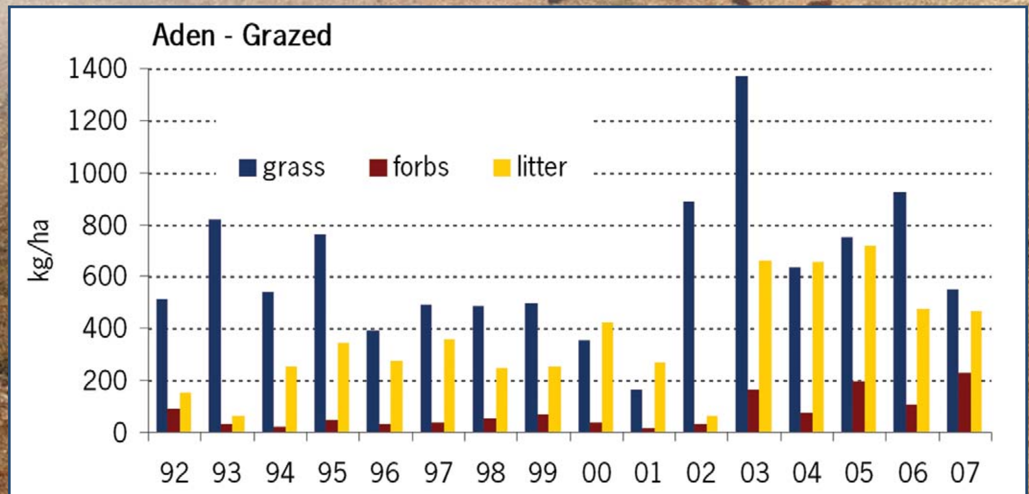


Figure 6.3. Trend in yield of grasses, forbs and litter at the Aden Rangeland Reference Area for the period 1992 to 2007.

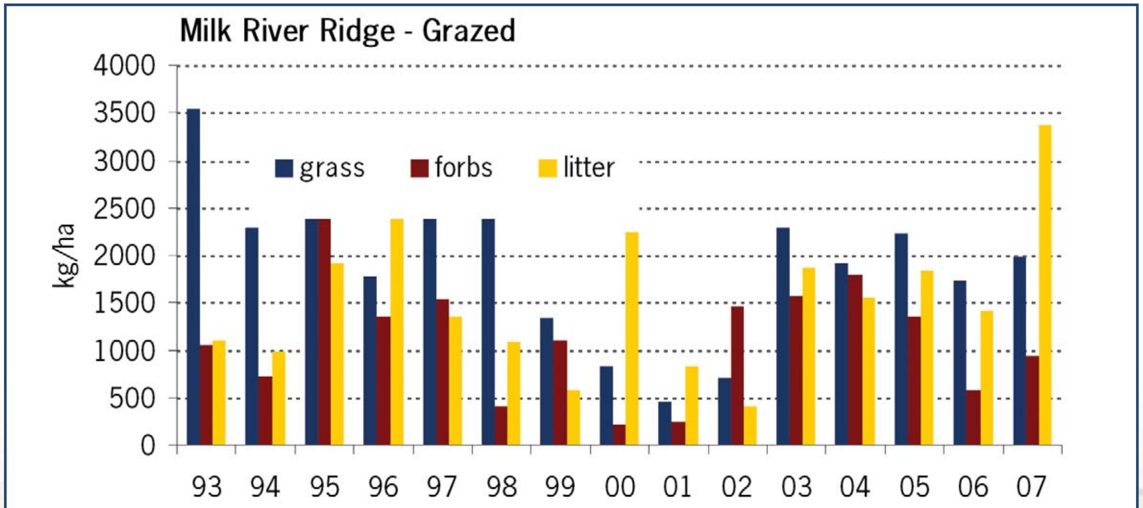


Figure 6.4. Trend in yield of grasses, forbs and litter at the Milk River Ridge Rangeland Reference Area for the period 1993 to 2007.

The four images show three levels of rangeland health in the Mixedgrass prairie. Photos above are both healthy, lower left is healthy with problems and lower right is unhealthy.

Data from the rangeland reference areas show that grass, forbs and litter yields vary significantly from the western side of the watershed to the east, depending on precipitation and drought events. The average grass and litter yield at Milk River Ridge for a 15-year period was 1,970 kg/ha and 1,572 kg/ha, respectively (Figure 6.4). The grass and litter yield at Aden for a similar time period was less than half that observed at Milk River Ridge (i.e., 633 kg/ha and 355 kg/ha, respectively) (Figure 6.3).

Data Gaps and Recommendations

Alberta Sustainable Resource Development currently monitors the health of public rangelands. Additional information on the health of range land could be obtained by initiating a program to encourage monitoring on private lands. More grassland tours to increase landowner and industry understanding of range health would encourage innovative management of range lands to achieve multiple benefits in the watershed.

6.2 Wildlife

The Milk River watershed supports a diverse and unique assemblage of wildlife species. This results from the watershed's geographic location on the southern-most edge of Alberta as well as from the presence of numerous unique habitat structures in the watershed including hoodoos, cliffs, badlands, cottonwoods, and sagebrush. The large parcels of native prairie in which most of these unique habitat structures are found also provides essential habitat for many wildlife species. Several wildlife species such as the short-horned lizard, mountain plover, sage grouse and swift fox (all Endangered species) are at the northern limit of their North American distribution within the Milk River watershed. Given the high human population and land-use pressures in the core of their continental ranges, it is now being recognized that maintenance of such peripheral populations is highly important ecologically, if we are going to be successful in retaining these species well into the future. From the Alberta perspective, it is very important to most Albertans that prairie species, including species at risk, be properly managed within our province.

The Milk River watershed provides several large blocks of habitat, including:

- Native Grasslands, which provide habitat for many grassland birds, pronghorn antelope, sharp-tailed grouse, small mammals, and a few remaining prairie carnivores (e.g. coyote, swift fox).
- Badlands, which provide habitat for prairie rattlesnake, short-horned lizard, and golden eagle.
- Coulees, often with extensive sandstone outcroppings and shrub cover, providing habitat for mule deer, prairie falcon, and elk.
- River valley (riparian) habitats, important for amphibians (e.g. northern leopard frog), western painted turtle, loggerhead shrike, and other species associated with shrub lands, cottonwood stands, and oxbow ponds.

The Milk River watershed wildlife populations and their habitats are highly significant ecologically at the provincial, national, and international level. Provincially, the area supports about 80% of Alberta's species at risk, as well as providing an important contribution to the provincial populations of mule deer and pronghorn. Nationally, the Milk River watershed is the most important landscape in Canada for prairie species at risk. Internationally, the watershed is a source area for the re-colonization of Swift fox back into northern Montana, provides key habitat for such international species as pronghorn and sage grouse, and is a key part of the range of many migratory bird species which reside elsewhere at other times of the year. The number of different species that occur within the Milk River watershed ranges from 230 - 280 depending on the time of season. Seven species of amphibians, seven species of reptiles, 50 species of mammals, and ~ 200 species of birds use the Milk River watershed. A list of species that occur in the watershed can be found on the enclosed CD.

The wildlife and wildlife habitats of the Milk River watershed provide many social and recreational benefits to Albertans. Areas such as Writing-On-Stone and Cypress Hills Provincial Parks are destinations for people wishing to experience the unique ecological and landscape features of the region. Many hunters value the abundance of upland game birds and the trophy quality of big game that are available in the Milk River watershed.

The economic values of wildlife and wildlife habitats are partially represented by the financial benefits to local communities provided by influxes of hunters, but the full economic value of ecologically sound wildlife and habitat management is much higher than that. The natural processes that are sustained through rural stewardship provide many advantages, both monetary and social. While these benefits need further study, and are difficult to quantify, it is unlikely that the standard of living, nor the quality of life in rural communities, could be sustained at the level they are without them.

Selection of Wildlife Indicators

Species selected as indicators for the Milk River watershed were selected based on several criteria. These were:

1. Current information (baseline data) on the species is available,
2. There is potential for monitoring the species in the future,
3. The species is a focal species for a particular habitat,
4. The watershed provides a unique habitat for the species, and
5. An increase or decrease in the species population can be tied directly to the overall health of the watershed.

Resident species such as sage grouse, sharp-tailed grouse, northern leopard frogs, prairie toads, prairie rattlesnake, and pronghorn where selected as they rely on a healthy watershed throughout the year. Migratory species such as burrowing owls, grassland birds, and ferruginous hawks were also selected as the watershed provides important and unique habitat for these migratory species during the spring and summer months. Comparison of the numbers between the watershed and the rest of the province will provide a clear picture on how migratory populations are doing. A decrease in a migratory species in Alberta, but a subsequent increase or maintenance of the species in the watershed can indicate good health for our watershed as conditions are optimal for that species success. On the other hand the maintenance of populations outside the watershed coupled with a decrease in the watershed should be concerning and action may need to be taken to improve the watershed's health. Baseline trend information was available for most species through Alberta Sustainable Resource Development, Alberta Conservation Association, MULTISAR Program, Operation Grassland Community, and Ducks Unlimited Canada.

Northern Leopard Frog

Residence: Year-round

Indicator: Riparian. A reduction in the population or loss of a once active site could indicate a significant change in the watershed and should be investigated as they can be affected by both water quality and quantity.

Status: Threatened under Alberta's *Wildlife Act* and considered a species of Special Concern nationally (COSEWIC 2004).

Characteristics: Northern leopard frogs are large 4 - 10 cm green, brown, or tan colored frogs. They have two white stripes that run down each side of their back, a white belly, and dark spots with pale borders on their back (ASRD 2003).

Habitat requirements: Northern leopard frogs depend on a variety of habitats to meet their annual life history requirements; including breeding, upland foraging and over-wintering habitats. Permanent ponds, marshes, springs, rivers, or creeks with deep water and high dissolved oxygen are selected as over-wintering sites. Breeding sites are usually in shallow, standing water (e.g., ponds, marshes, ditches, dugouts, oxbows, etc.) or occasionally along quiet backwaters and slow sections of creeks. Upland habitat near water bodies provides important foraging areas as well as dispersal routes. Northern leopard frogs are found in the Milk River as well as its tributaries. Ponds and wetlands along the river valley and ponds on the uplands are also used. Healthy emergent and submergent aquatic vegetation provide important cover for all age classes of frogs as well as egg laying sites. Leopard frog tadpoles rely on algae and aquatic vegetation to feed on and as they grow into adults their diet switches to insects (such as mosquitoes) and arachnids (spiders) (ASRD 2003; Rangeland Conservation Service 2004).

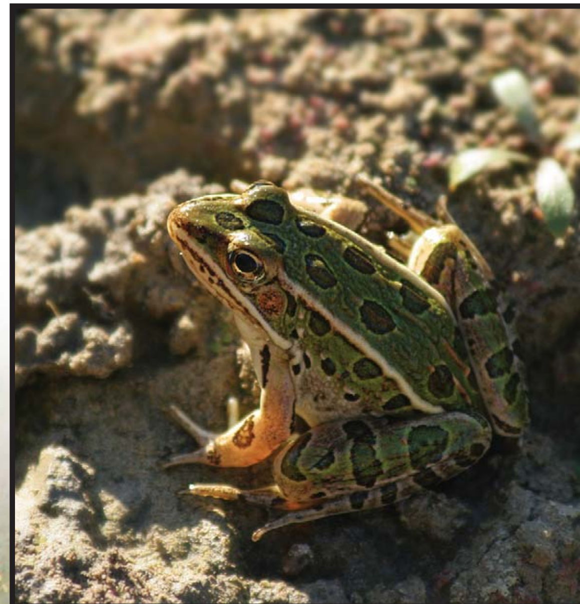
Known Stressors: Drought conditions affect egg and tadpole development and survivorship, and may contribute to over-winter mortality. Other stressors include intensive grazing near wetlands resulting in loss and degradation of shoreline and aquatic vegetation and decreased water quality due to soil erosion and nutrient influx from livestock waste, disease, introduction of pesticides and other biocides to water (ASRD 2003).

Possible Stressors: Introduction of exotic game fish, which can prey on all age classes of frogs and transmit diseases; climate change, which can lead to extreme weather events (i.e. flooding); prevalence of organisms that can cause disease in amphibians; and increase in ultra-violet radiation that can be harmful to eggs (ASRD 2003).

Beneficial Practices: 1) Provide alternative cattle watering sites away from water bodies that support leopard frog populations to improve water quality, shoreline vegetation and reduce the possibility of egg masses being trampled in the spring; 2) Place salt blocks away from water to reduce impacts to the riparian zone and summer foraging habitat; 3) Avoid draining wetlands and restore where possible; 4) Avoid winter grazing near leopard frog ponds as excess feces and urine can create low oxygen levels leading to winter kills; 5) Avoid application of pesticides to wetlands or to adjacent lands; 6) avoid water diversion and draw downs during the spring, fall and winter in those waters that support over-wintering frogs (Rangeland Conservation Service 2004).

The recovery strategy for Northern Leopard Frogs can be found at: http://www.srd.gov.ab.ca/fishwildlife/speciesatrisk/recoveryteams.aspx

Data Required: 1) Detailed inventory of historic and active northern leopard frogs ponds within the watershed to grasp a better understanding of their population and identify differences in habitat between active and non-active sites.



Population: There was a sharp decline in populations by 1979 resulting in the extirpation of the species in most of central Alberta and greatly reduced numbers in southern Alberta. Surveys conducted in 1991 identified leopard frogs as locally abundant in the Cypress Hills and parts of the Milk River watershed. However, a subsequent survey in 2000-2001 found that out of 290 historical and recent sites, northern leopard frogs where found at only 54. In 2001 there were only four geographical areas with major populations of 10 or more adult frogs, two of these were in the Cypress Hills and the Milk River watershed. This shows the importance of the Milk River watershed in providing habitat for northern leopard frogs (ASRD 2003).

increasing stable decreasing unknown

Plains Spadefoot and Great Plains Toad

Residence: Year-round

Indicator: Ephemeral wetlands. A decrease in the number of sites containing toads could indicate a reduction in the number of wetlands or an increase in water contamination (ex: pesticides or herbicides), which would negatively impact the overall health of the Milk River watershed.

Status: Plains spadefoot and great plains toad are considered “May be at Risk” under Alberta’s General Status Report. Great plains toads are also recognized as a species that is “Data Deficient” in Alberta and of “Special Concern” in Canada (COSEWIC 2004; ASRD 2005).

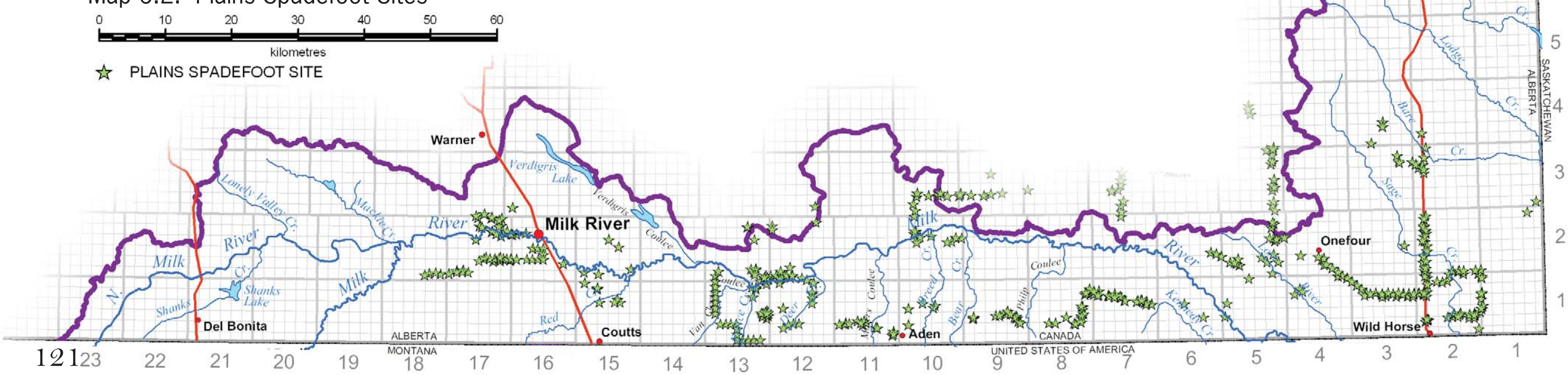
Characteristics: Plains spadefoot have a vertical eye pupil similar to a cat and small black spades on their hind feet. They can measure up to 6.4cm in length and can range from pale gray, brown, to dull green in color (Lauzon 1999). The plains spadefoot call is a short duck like sound repeated every 5-10 seconds. Great plains toads are one of the largest toads in Alberta, up to 11.2cm in length, and have green spots outlined with a light green border. Their call is a harsh trill lasting up to 50 seconds (James 1998).

Habitat requirements: Both species are generally found in and near ephemeral wetlands in native prairie with sandy soils. Great plains toads prefer wetlands with clear water and are found in the SE corner of the Milk River watershed. Plains spadefoot can be found throughout most of the central and eastern portions of the watershed, but become less abundant as you head west onto the Milk River Ridge. A few locations with toads have been found in areas with cultivation and where ephemeral wetlands have been left undisturbed (James 1998; Lauzon 1999; Rangeland Conservation Service 2004).

In order to find refuge from summer drought and freezing winter temperatures, both species burrow deeply underground and can remain underground for several years. Heavy precipitation events are often required to stimulate the emergence of the toads and breeding activity. Both toads feed on spiders and insects (flies, moths, ants, beetles, etc) (James 1998; Lauzon 1999; Rangeland Conservation Service 2004).

Plains Spadefoot

Map 6.2. Plains Spadefoot Sites



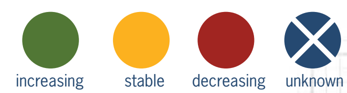
Known Stressors: Draining and cultivation of ephemeral wetlands during dry years removes important breeding habitat. Road kills are also a major concern during mass migration events as toads migrate between habitats following heavy rain or when young emerge from ephemeral breeding wetlands and disperse into adjacent lands. Water contamination and consumptive use of ephemeral wetland water can also impact the population (Rangeland Conservation Service 2004).

Possible Stressors: Drought conditions that eliminate breeding habitat and the conversion of ephemeral ponds into permanent ponds (although toads may be found in permanent ponds), could compromise recruitment of young because aquatic invertebrate predators are able to over-winter in the pond, resulting in an increase predation of tadpoles (Rangeland Conservation Service 2004).

Beneficial Practices: 1) Avoid cultivating or draining ephemeral wetlands and re-establish if possible; 2) Avoid converting ephemeral wetlands into permanent wetlands as permanent ponds may contain amphibian predators (i.e. fish and aquatic invertebrate predators); 3) Leave buffer of natural vegetation around wetlands; 4) Avoid using pesticides or herbicides around wetlands; 5) avoid heavy cattle use around wetlands in spring and early summer; 6) Place salt blocks at least 1 km away from natural water bodies which will encourage cattle to make better use of the range; 7) Consider off-site water systems to draw cattle away from water bodies (Rangeland Conservation Service 2004; Saunders et al. 2006).

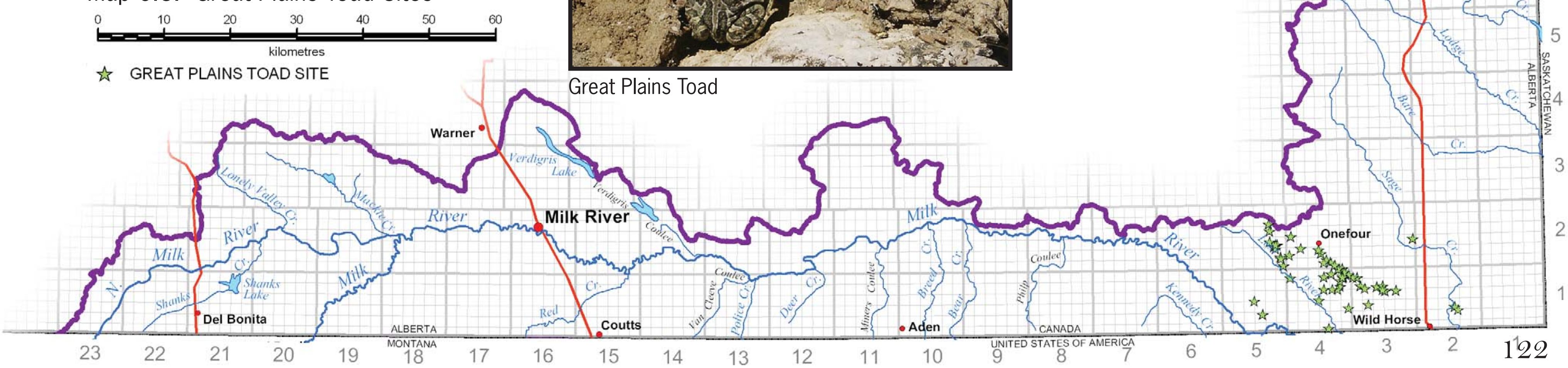
Data Required: 1) Identify and map current and historical ephemeral wetlands; 2) Study on the impact of road mortality of toads in Alberta; 3) Initiate a monitoring program during high and low precipitation years as there is limited information on the population of these species; 4) Evaluate the effect of water management projects on reproductive success and over wintering survival; 5) Evaluate the effect of water quality on reproductive success (Rangeland Conservation Service 2004).

Population: There is limited information on the extent of the toad population as they are very elusive and can remain underground for years at a time. A survey in 2002 after a heavy precipitation event in the Milk River watershed found 253 breeding ponds containing plains spadefoot where previous records had only 50 ponds. Similarly the number of known great plains toad ponds increased from 10 to 19 ponds. However, this may be a result of more intensive surveys then were conducted in the past and ongoing surveys are needed to grasp a better understanding of population size (Quinlan et al. 2003).



Great Plains Toad

Map 6.3. Great Plains Toad Sites



Northern Pintail

Residence: Breeding Season

Indicator: Loss of Northern Pintail populations is an indication of habitat availability (i.e., prairie potholes).

Status: Surveys of primary breeding grounds in Canada show a dramatic decrease in Northern Pintail numbers since 1955. Since the drought years of the 1980s, and with a return of favorable pond conditions, Northern Pintail breeding populations have shown little recovery, while other waterfowl species have shown impressive recovery during the same period. This declining trend for Northern Pintails is a concern in Canada, United States and Mexico (US Fish and Wildlife Service 2007).

Characteristics: The Northern Pintail (Anas acuta) is a medium sized duck with a slim profile, long narrow neck and pointed tail. Males have a chocolate brown head, white foreneck, blue-grey bill with black stripe and a long “pin” tail. Wings are grey with an iridescent green speculum. Females are mottled brown and have bluish bills with dark spots or mottling (Ducks Unlimited Canada ND).

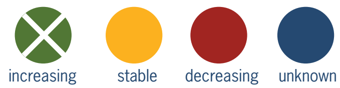
Habitat Requirements: Shallow, fast-warming seasonal or permanent wetlands and prairie habitat.

Known Stressors: About 80% of factors affecting Northern Pintail populations and survival are related to breeding grounds of the mid-continent and prairie pothole areas (Ducks Unlimited Canada, unpublished data). Females nest in open areas, typically on the ground in low or sparse vegetation and cropland stubble. Crops in summerfallow provide for safe nesting grounds. Since the 1970s, there has been an increasing trend to convert land from summerfallow to annual crops to address soil erosion. This change in land use compels Northern Pintails to nest in cropland that will likely be disturbed by farm machinery. Pintails will not re-nest as persistently as other duck species (Guyn 2004).

Beneficial Practices: Two Canadian studies found that conversion of cropland to perennial forages (e.g., hay) and the use of fall-seeded crops (e.g., winter wheat) benefit Pintails by increasing nesting success. Pintails, on average, hatched one nest every 0.58 km^2, nearly 10 times the ratio that is typically observed in spring-seeded cropland (Guyn 2004). Pintails on average hatched one nest every 0.29 km^2 in fall-seeded crops in contrast to one nest every 5.39 km^2 in spring-seeded cropland. Improved Northern Pintail numbers resulted from higher nest densities and higher hatching rates (Guyn 2004).

Data Required: Detailed inventories of wetlands, drained wetlands and cropping practices in the Milk River watershed.

Population: Northern Pintail numbers dropped dramatically during the drought of the 1960s, but rebounded when better water conditions returned in the 1970s. Pintail populations declined again during the drought of the 1980s, but their numbers did not significantly increase with the improved water conditions during the 1990s. In 2002, Pintail numbers were at a record low. In 2003, Pintail numbers increased slightly, but they remain much below their long-term average. As of 2007, Northern Pintails remain a key waterfowl indicator species in the Milk River watershed but breeding pair numbers are a concern even though a modest increase from 2000 through 2007 has been observed (Figure 6.5).



Although the Northern Pintail population appears to be increasing in the short-term, the long-term trend suggests that numbers still remain far below historical records.

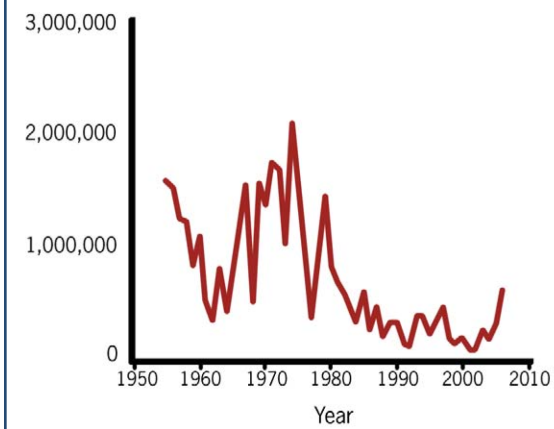
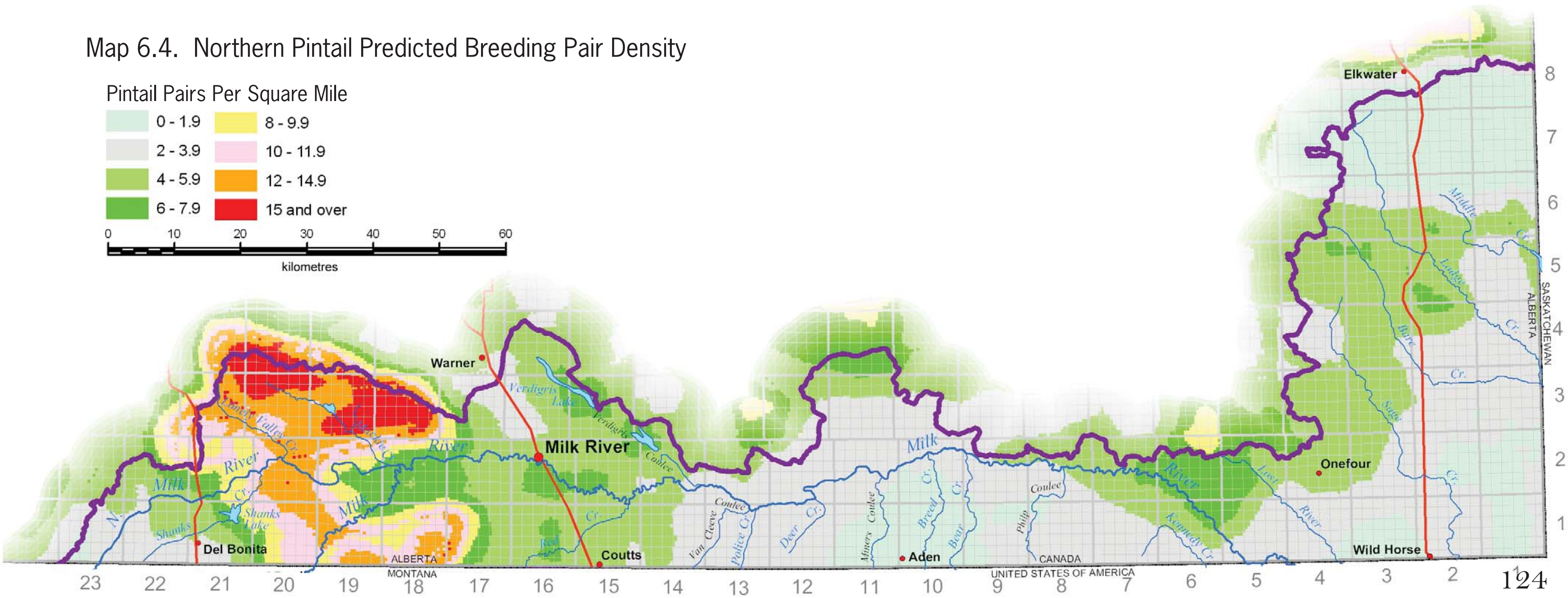


Figure 6.5. Northern Pintail breeding population estimates for southern Alberta survey transects 1955-2007 (USFWS 2007).

Map 6.4. Northern Pintail Predicted Breeding Pair Density



Pronghorn

Residence: Year-round and Migratory

Indicator: Health of sagebrush communities and connectivity of native prairie habitat.

Status: Considered "Sensitive" in the Alberta General Status Report (ASRD 2005).

Characteristics: Both females and males have horns consisting of a bony core and a black sheath. They are the only mammal in Alberta that sheds their horns yearly. The male's horns are larger (12-18 inches) and pronged, whereas females rarely have pronged horns. Pronghorn are tan on the back and neck and have a white rump and belly. The males have black patches on the lower jaw below the eye and a black mask extending back from the nose. Pronghorn rely on native forbs and shrubs for much of their diet (Autenrieth et al. 2006).

Habitat Requirements: Pronghorn prefer flat open native prairie with abundant forbs and sagebrush / shrubs. Pronghorn can also be found in cultivated areas, but their densities and reproductive success are not known. Winter habitat that contains abundant sagebrush and experiences chinooks, to reduce snow depth, is crucial for their survival (Alberta Forestry, Lands, and Wildlife 1990).

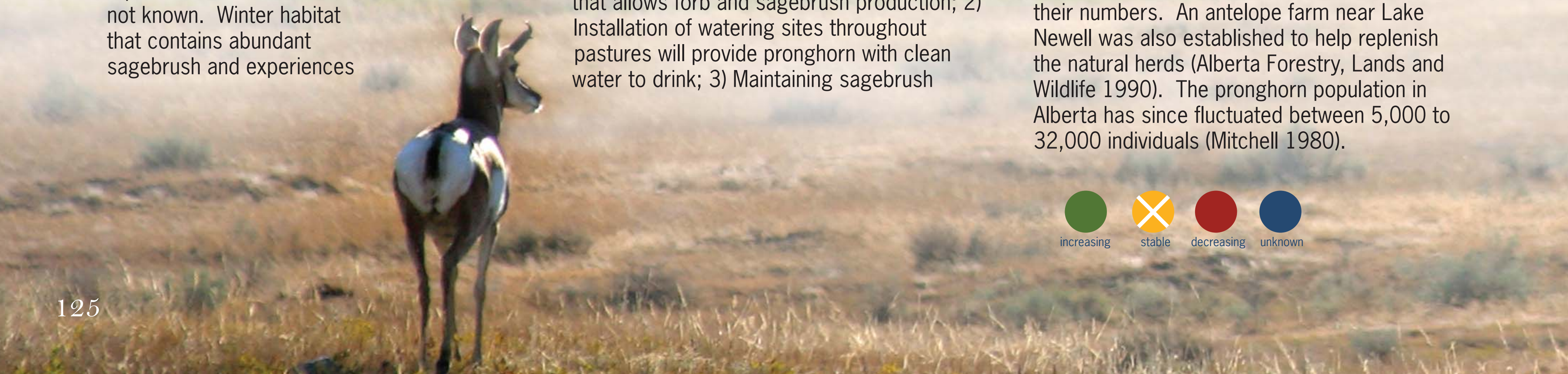
Known Stressors: Low quality and quantity of forage (forbs, shrubs, grasses), quality of winter habitat, severe winters, droughts, access to water, habitat fragmentation, road mortality, and fences (low bottom wire) (Autenrieth et al. 2006).

Possible Stressors: Disease and predators (Autenrieth et al. 2006).

Beneficial Practices: 1) Grazing management that allows forb and sagebrush production; 2) Installation of watering sites throughout pastures will provide pronghorn with clean water to drink; 3) Maintaining sagebrush communities, which are relied upon during deep snow and droughts; 4) Fences should have a bottom wire >18" above the ground and preferably smooth (not barbed) (Autenrieth et al. 2006).

Data Required: 1) Long-term detailed range assessments on native grasslands looking at forb and shrub abundance in relation to fluctuations in pronghorn number; 2) Population demographics for pronghorns inhabiting native prairie and those in agricultural areas; 3) Beneficial management practices for reclaiming silver sagebrush; 4) Sight ability model for pronghorn antelope to assist with aerial surveys (Alberta Forestry, Lands, and Wildlife 1990, Adams et al. 2004b, Autenrieth et al. 2006).

Population: Pronghorn numbers where significantly reduced from 10,000 in 1900 to 1,000 in 1907 due to extreme winter conditions, human settlement and illegal shooting led to further reductions (Mitchell 1980, Alberta Forestry, Lands and Wildlife 1990). National Parks near Wawaskesey and Nemiskam were founded in 1914 and 1915 to help provide refugia for pronghorn and increase their numbers. An antelope farm near Lake Newell was also established to help replenish the natural herds (Alberta Forestry, Lands and Wildlife 1990). The pronghorn population in Alberta has since fluctuated between 5,000 to 32,000 individuals (Mitchell 1980).



Prairie Rattlesnake

Residence: Year-round

Indicator: Loss of hibernacula can indicate that a threshold has been crossed such as too much habitat fragmentation or habitat loss.

Status: Considered "May be at Risk" in Alberta's General Status Report and as a data-deficient non-game species in Alberta's *Wildlife Act* (ASRD 2005).

Characteristics: This is a venomous snake with a diamond-shaped head and rattled tail. The body is tan colored with dark blotches. Prairie Rattlesnakes range in size from 34 -140 cm (Fisher et al. 2007).

Habitat Requirements: Hibernacula, "snake dens", are crucial for prairie rattlesnakes and other snakes to survive the winter. Prairie rattlesnake hibernacula tend to be found on south facing slopes along drainages. These sites consist of stable slumps, rocks, mammal burrows, and sometimes shrubs. Prairie rattlesnakes use native uplands containing small mammals to forage on. They also eat eggs and young of ground nesting birds, amphibians, and other reptiles. Rattlesnakes are found along several drainages within the watershed, but have not been reported in the west on the Milk River Ridge or in the northeast around Cypress Hills (Watson and Russell 1997; Rangeland Conservation Service 2004).

Known Stressors: Loss of native habitat and habitat fragmentation. Direct mortality from persecution, intensive agriculture, roads, urbanization, and pipeline construction (Watson and Russell 1997).

Possible Stressors: Effects of widespread land use activities (Rangeland Conservation Service 2004).

Beneficial Practices: 1) Use fencing or salt placement to redirect cattle away from important habitat; 2) Avoid grazing near hibernacula in the spring when snakes would be congregating; 3) Use light, moderate, and heavy grazing to produce patchy cover on uplands; 4) Avoid spring grazing near slopes when soils are moist and susceptible to slumping; 5) Install signs in key areas where rattlesnakes cross roads to encourage motorists to slow down (Rangeland Conservation Service 2004).

Data Required: 1) Use road mortality information to identify areas of high mortality of rattlesnakes; 2) Identification of hibernacula in highly suitable areas to better understand the population (Rangeland Conservation Service 2004).

Population: There is a suspected decline in the prairie rattlesnake population however; more research is needed on this subject. Currently there are 11 known hibernacula in the watershed.

increasing stable decreasing unknown

Greater Sage-grouse

Residence: Year-round in the southeast portion of the Milk River Watershed.

Indicator: Health of sagebrush communities. Decrease in natural drainage may result in a decrease in silver sage brush habitat and subsequently greater sage-grouse populations (McNeil and Sawyer 2001, 2003).

Status: Designated as an "Endangered" species in Canada and endangered under the *Alberta Wildlife Act* (COSEWIC 2004; Alberta Queen's Printer 2007).

Characteristics: The greater sage-grouse is a large bird with black belly; brownish mottled

body with white lining in wings. Males have yellow air sacs when they are displaying.

Habitat Requirements: Habitat is limited to silver sagebrush and surrounding area. Leks (dancing grounds) have sparser vegetation adjacent to larger areas of sagebrush habitat. Most dense silver sagebrush habitat in Alberta occurs along drainages (winter habitat). Nesting habitat consists of less dense sagebrush on uplands. Greater sage-grouse nest under sagebrush and feed on sagebrush leaves, forbs and insects within the sagebrush community. Greater sage-grouse broods feed in taller vegetation, with lower shrub density, where food is more plentiful (Adams et al. 2004; Alberta Sage Grouse Recovery Action Group 2005).

Known Stressors: Habitat alterations resulting in loss of sagebrush habitat or water impediments that reduce overflows which are needed for silver sagebrush habitat can negatively affect greater sage-grouse (McNeil and Sawyer 2001). Greater sage-grouse are also affected by fragmentation of habitat by industrial activity. The recent appearance of West Nile Virus, which is a known stressor, could impact populations further if it becomes more prevalent. Increases in traffic and auditory disturbances during the breeding and nesting season have also been shown to negatively impact the grouse populations (Adams et al. 2004; Alberta Sage Grouse Recovery Action Group 2005).

Possible Stressors: Predators (Alberta Sage Grouse Recovery Action Group 2005).

Beneficial Practices: 1) Avoid placing salt or minerals within 0.8 km of leks; 2) Protect maintain, and encourage regeneration of silver sagebrush habitat; 3) Defer grazing near leks until late spring; 4) Construct new livestock facilities away from leks; 5) Avoid supplemental feeding of livestock in key greater sage-grouse wintering habitat; 6) Maintain high range health in greater sage-grouse habitat (Adams et al. 2004; Alberta Sage Grouse Recovery Action Group 2005).

The recovery strategy for Greater Sage-grouse can be found at:
http://www.srd.gov.ab.ca/fishwildlife/speciesatrisk/recoveryteams.aspx

Data Required: 1) Identify beneficial management practices for silver sagebrush reclamation; 2) Study the impact and transmission of the West Nile Virus in greater sage-grouse; 3) Determine viability of population (Adams et al. 2004; Alberta Sage Grouse Recovery Action Group 2005).

Population: There has been a dramatic decline in the Alberta population and the population is currently at an extremely low level. The greater sage-grouse may soon be extirpated from the province unless special efforts are made by the Milk River watershed residents, wildlife managers, and land managers. Any additional detrimental effects could reduce the population even further and cause them to be extirpated from Alberta (Alberta Sage Grouse Recovery Action Group 2005).

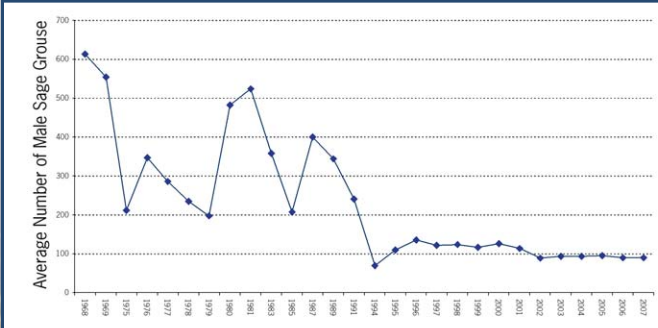


Figure 6.6. Fish and Wildlife Annual Sage Grouse Survey (1968-2007).

Sharp-tailed Grouse

Residence: Year-round.

Indicator: Upland shrubby habitat.

Status: Ranked as a sensitive species in the Alberta General Status Report (ASRD 2005).

Characteristics: The sharp-tailed grouse has a mottled back with white spots on the wings, pointed tail with white side and purple air sacs visible when displaying (Rangeland Conservation Service 2004).

Habitat requirements: Sharp-tails are omnivorous and eat fruits, buds, green leaves, and insects. They require native prairie containing shrubby patches in which to nest, raise their brood, and to over-winter. Sharp-tailed grouse nest generally within 1.1 km of their lek. Leks are dancing grounds located on knolls or flat open areas that allow for good visibility. Sharp-tailed grouse habitat is found throughout the Milk River Watershed with highest concentrations on the Milk River Ridge and around Writing On Stone Provincial Park (Rangeland Conservation Service 2004).

Known Stressors: Cultivation of native prairie, loss of native prairie habitat, and heavy livestock grazing for long periods in both the uplands and riparian areas. Disturbance near nesting areas and leks during breeding and nesting season can also impact populations (Rangeland Conservation Service 2004).

Possible Stressor: In heavily impacted habitats (reduced cover) predation may have a greater impact on the population (Rangeland Conservation Service 2004).

Beneficial Practices: 1) Maintain native prairie uplands; 2) Zero tillage of croplands and retain stubble fields within 1km of woody draws; 3) Limit disturbance from March-June around nesting areas and leks; 4) Defer grazing in key sharp-tailed grouse habitat until mid June; 5) Protect riparian areas; 6) Strategically place salt blocks away from leks between March and June (Rangeland Conservation Service 2004).

Data Required: 1) Evaluation of using a Resource Selection Function model to predict lek locations; 2) Evaluation of the beneficial management practices used by MULTISAR for sharp-tailed grouse (Rangeland Conservation Service 2004).

Population: Appears to be declining provincially over the last 40 years (Glasgow 2007). The Milk River Basin contains some of the highest densities of leks in Alberta, yet trends from leks in the watershed indicate a lower population in 2006 compared to 1996 (Glasgow 2007).

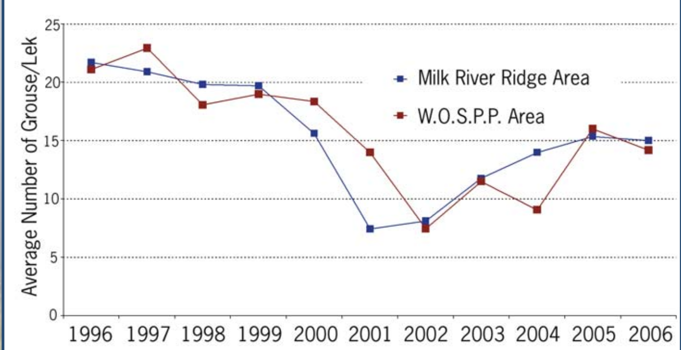


Figure 6.7. Fish and Wildlife Sharp-tailed Grouse Survey (1996-2006).

Burrowing Owl

Residence: Seasonal/migratory

Indicator: A decrease in the number of sites where burrowing owls occur may indicate an environmental problem with the integrity of the native grassland ecosystem in the Milk River watershed.

Status: Designated as “Endangered” under the *Alberta Wildlife Act* (Alberta Queen’s Printer 2007) and ranked as an “At Risk” species in the Alberta General Status Report (Anonymous 2005). Nationally designated as “Endangered” under the *Species at Risk Act* (Government of Canada 2007).

Characteristics: Small ground-dwelling brownish owl with a round head lacking ear tufts, yellow eyes, a short tail, and long legs. Wings and head have white spots and abdomen has brown streaks (ASRD and ACA 2005; COSEWIC 2006).

Habitat requirements: Burrowing owls live in relatively flat open grasslands or arid regions devoid of trees or dense shrubs. They nest in areas of short (< 10 cm) and sparse vegetation, where they also feed predominantly on insects. They hunt for small mammals within 1-2 km of their nest burrow, in tall (> 30 cm) and dense vegetation such as ditches and low lying wetland areas. They are completely dependent on burrowing mammals such as badgers and grounds squirrels to create the burrows in which they nest and roost (ASRD and ACA 2005; COSEWIC 2006).

Known Stressors: Loss and degradation of native prairie habitat, increased predation, decreased prey availability, vehicle collisions, starvation, decreased burrowing mammal populations, inclement weather conditions, and pesticide use at or near nesting sites (ASRD and ACA 2005; COSEWIC 2006).

Possible Stressor: Climate change, wet-dry cycles, decreased frequency in prey population peaks, grazing intensity, all of the above known and possible stressors during migration and over winter.

Beneficial Practices: 1) Maintain native prairie habitat and prevent its fragmentation; 2) Encourage greater grazing intensity in proximity (< 100 m) of nest burrows from July to April; 3) Use moderate to low grazing intensity within 2 km of nest burrows; 4) Minimize ground-squirrel and badger control, especially in nesting areas; 5) Avoid using pesticides within 800 m of nesting areas; 6) Avoid the planting of trees or shrubs on native range or within 1.6 km of nesting areas (RCS 2004; Anonymous 2007b).

Data Required: 1) Survival rates of burrowing owls at various stages of life cycle; 2) Extent and impact of between-year dispersal by juveniles and adults; 3) Effect of various grazing practices on prey species populations; 4) Effect of environmental contaminants on survival and reproduction; 5) Migratory route used and winter range of Milk River Watershed owls; 6) Upper development threshold.

Population is:

There are currently no accurate large-scale surveys for the burrowing owl in the Milk River Watershed and throughout the Canadian range of the species. In addition, Breeding Bird Survey data are unreliable to detect trends for this rare species (C. Downes, National Wildlife Research Centre, pers. comm.). However, local surveys and annual reports from producers can provide relative indices of population change.

The Canadian Wildlife Service has been conducting surveys at the Onefour Agricultural Research Station since 2002 (Figure 6.8). These data indicate a slightly positive trend in the number of burrowing owl sites detected over the 6 year period, with a decrease in numbers since 2005.

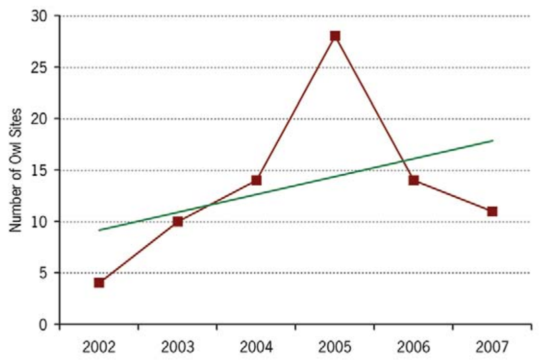


Figure 6.8. Number of burrowing owl sites at the Onefour Agricultural Research Station.

Unpublished data from Geoff Holroyd and Helen Trefry, Canadian Wildlife Service, Environment Canada; green line = trend.

Operation Grassland Community (OGC) has conducted an annual census with its program members since 1989 in the Milk River Watershed and throughout the Grassland Natural Region (Figures 6.9 and 6.10). This more extensive assessment based on a small number of landholders for the watershed shows a long-term negative trend in the population index. It depicts a major decline in the early 1990's and a spike in numbers in 2004 and 2005 (Figure 6.10) corresponding to the recent Onefour peak (Figure 6.8). For the entire Grassland Natural Region (Figure 6.10), an important decline was also observed throughout the 1990s and until 2001, with a population that appears to have rebounded slightly in recent years and stabilized at the 2004 level.

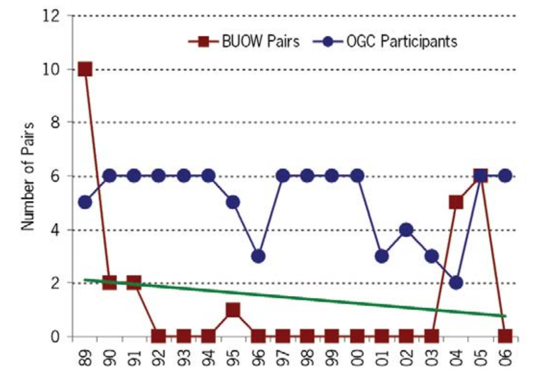


Figure 6.9. Index of burrowing owl population in the Milk River Watershed.

Data from Operation Grassland Community; green line = long term trend.

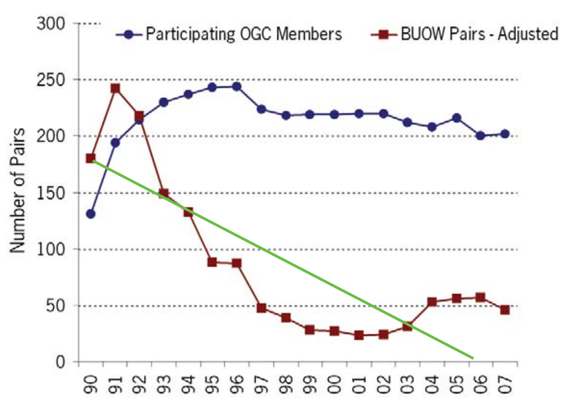


Figure 6.10. Index of burrowing owl population throughout the Grassland Natural Region.

Data from Operation Grassland Community; green line = long term trend.

Other surveys using electronic call playbacks were conducted in suitable habitats as part of the MULTISAR program between 2001 and 2005 (Table 6.1). Combined with data from the Canadian Wildlife Service in Onefour (Figure 6.8), they represent an annual minimum number of active sites for the watershed. However, these cannot currently be used for trend data, as the apparent increase in the number of active burrowing owl sites parallels the growing number of participating landowners with MULTISAR each year.

Table 6.1. Burrowing owls sites identified by MULTISAR staff (a) (data supplied by MULTISAR) and minimum number of active burrows known in the Milk River Watershed (b) (derived from MULTISAR data and Onefour data - Figure 6.8).

	2004	2005	2006	2007
*Number of active burrows (MULTISAR project) (a)	4	5	11	16
Minimum number of active burrows in Milk River Watershed (b)	18	33	25	27

Overall, despite a recent increase in 2004 and 2005, it appears that the long term trend in the Milk River Watershed burrowing owl population is still downward, reflecting the situation in the entire Grassland Natural Region.

Ferruginous Hawk

Residence: Seasonal/migratory

Indicator: As a wide-ranging top predator specific to short grass prairie habitat, a negative trend in the number of breeding pairs of ferruginous hawks may be indicative of a change in the "health" of the short grassland ecosystem in the Milk River watershed.

Status: Designated as "Endangered" under the *Alberta Wildlife Act* (Alberta Queen's Printer 2007) and ranked as an "At Risk" species in the Alberta General Status Report (Anonymous 2005). Nationally listed as a species of "Special Concern" (Government of Canada 2007).

Characteristics: Large hawk with broad wings, large head, wide gape and robust cheSt. Light-morph adults have a white or grey tail, almost all white underparts, except for sparse rufous or grey specks on belly and the characteristic rufous V formed by the dark legs held under the rump in flight. Dark-morph adults have a plain light-coloured tail and light area on upper and lower sides of primary wing feathers. The rest of the body is dark except for rufous fringe on upper wing and back feathers Bechard and Schmutz 1995). Dark morphs occur in less than 10% of the population (Sibley 2000).

Habitat requirements: Hawk of the "open country" (Bechard and Schmutz 1995). Occupies flat rolling terrain in grassland or shrub-steppe regions. Nests in areas where grazing is the dominant land use or in relatively wild open landscapes. Highly dependent on native prairie habitat and on ground squirrels; its main prey in Alberta (ASRD and ACA 2006). Nests in lone trees or shrubs, on cliffs, on ground outcrops, or on artificial nest structures including utility towers (Bechard and Schmutz 1995; ASRD and ACA 2006; Blouin 2006).

Known Stressors: Habitat loss, fragmentation, or degradation, increased inter-specific competition, decreased prey availability (through direct control or conservative range management practices), loss of nesting structures, human disturbance and persecution, industrialization and human development (ASRD and ACA 2006).

Possible Stressor: Climate change (indirect effect on main prey, (J. Schmutz, University of Saskatoon, pers. comm.), cumulative effect of human development and industrialization (ASRD and ACA 2006).

Beneficial Practices: 1) Maintain and protect native prairie habitat; 2) Prevent habitat fragmentation and restore marginal farmland areas to native grassland; 3) Encourage ranching lifestyle on large tracts of rangeland; 4) Maintain nesting trees or shrubs and fence those threatened by cattle rubbing; 5) Protect cliff areas (especially the North Milk and Milk Rivers between the U.S. border and the town of Milk River) from development or increased human disturbance; 6) Minimize human disturbance near known nest sites (especially between March 15 to July 15); 7) Conduct pre-development wildlife surveys and abide by setback distance and timing restrictions recommended by Alberta Sustainable Resource Development, Fish and Wildlife Division for human activities and industrial development near nests; 8) In suitable soil areas for ground squirrels, apply moderate to heavy grazing in productive mixedgrass and fescue prairie, light grazing in dry mixedgrass prairie or during drought conditions; 9) Avoid controlling ground squirrels within 15 km of known nests (RCS 2004; Blouin 2006).

Data Required: 1) Impact of climate change on ground squirrel populations and on ferruginous hawk nesting success; 2) status of non-breeding population; 3) impact of habitat fragmentation on nesting success and threshold level.

Population is:

Based on short term trend data from block surveys conducted in the Milk River watershed through the MULTISAR program, it appears that the number of breeding pairs of ferruginous hawks may be increasing modestly (Figure 6.11). Comparatively, the 5-year block surveys conducted by the provincial government throughout the range of the species shows a substantial decrease in the number of nesting pairs from 1987 to 2005 (Figure 6.12).

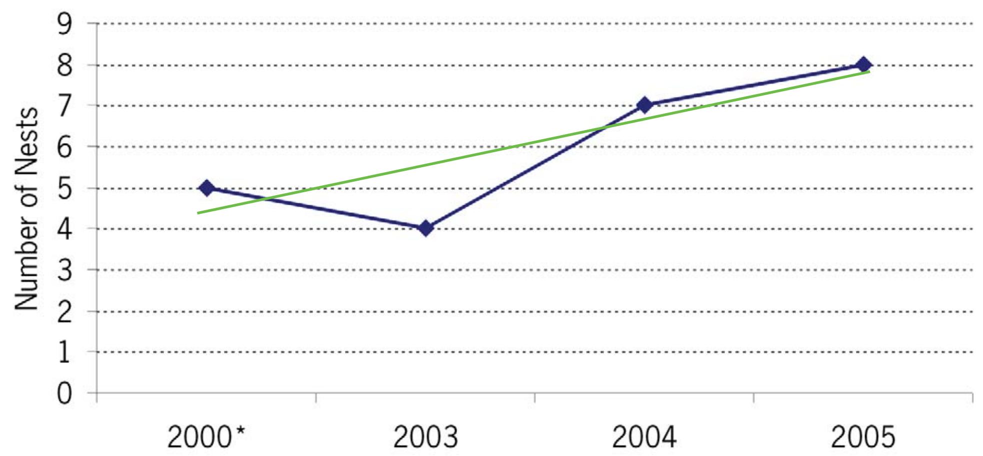


Figure 6.11. Ferruginous hawk pairs in Milk River Watershed survey blocks

*Data supplied by Alberta Sustainable Resource Development (trend line in green)

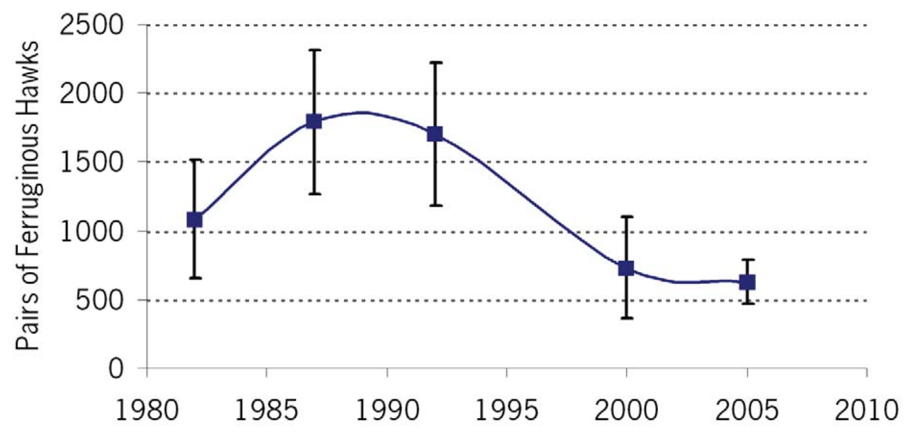


Figure 6.12. Ferruginous hawk pairs in Alberta survey blocks.

Loggerhead Shrike

Residence: Seasonal/migratory

Indicator: As a shrub-dependent species, a change in loggerhead shrike densities may indicate an environmental problem with shrubland habitat in the Milk River watershed.

Status: Listed as a "Non-Game Animal" under the *Alberta Wildlife Act* (Alberta Queen's Printer 2007) and ranked as a "Sensitive" species in the Alberta General Status Report (Anonymous 2005). Prairie sub-species designated as "Threatened" nationally (Government of Canada 2007).

Characteristics: Slightly smaller than a robin, the loggerhead shrike is recognized by its black facial mask, its stout conical black hooked bill, and its white markings on black wings and tail and on its throat. It is grey on its back and head and greyish-white below (Yosef 1996; Sibley 2000).

Habitat requirements: Prefers open areas in a diverse habitat matrix (Prescott and Bjorge 1999). Found in prairies, pastures, sagebrush deserts, farmsteads, agricultural fields with hedgerows or shelterbelts, riparian areas, suburban areas, road or railroad rights-of-way, cemeteries, golf courses and reclaimed strip mines (Dechant et al. 2003). Vegetation composition includes a matrix of tall and low grasses and forbs interspersed with bare ground and shrubs or low trees (Prescott and Collister 1993; Cade and Woods 1997; Dechant et al. 2003). In the Milk River Watershed, this species has been found using farmyards in a sea of cultivation to riparian zones adjacent to native pasture (Downey 2005). Common among those habitats was the amount of shrubs available for nesting, which made up between 12.5% - 12.9% of the areas (Table 6.2).

Table 6.2. Loggerhead shrike main habitat characteristics based on 69 individual sites from 2002 – 2004 in MULTISAR project area (from Downey 2005).

All Sites (n = 69)		Sites with Farmyards (n = 32)		Sites without Farmyards (n = 37)	
Native Pasture	34.0%	Cultivation (dryland)	25.4%	Native Pasture	45.5%
Cultivation (dryland)	17.5%	Native Pasture	20.0%	Riparian	23.3%
Riparian	14.0%	Farmyard	17.6%	Shrubs	12.9%
Shrubs	12.5%	Shrubs	12.9%	Cultivation (dryland)	11.5%

Known Stressors: Habitat loss and fragmentation, vehicle collisions, inclement weather, increased predation, West Nile virus, human disturbance at nest.

Possible Stressor: Climate change, alien species invasion (competitors), use of pesticide (indirect impact on prey abundance).

Beneficial Practices: 1) Maintain or reclaim areas of native prairie; 2) Protect riparian, silver sagebrush, and upland shrubland habitats, including abandoned railroad right-of-ways, 3) In modified habitats, plant clumps (preferably) of thorny buffaloberry or willow or similar native shrubs at the interface tame and native pastures, along road allowances, power lines and fences and around graveyards; 4) Maintain existing shelterbelts as well as trees and shrubs in abandoned farmyards; 5) Avoid planting threes or shrubs in linear strips and within 200 m of a busy road; 6) Leave a 2-4 m strip of vegetation along existing shelterbelts; 7) Fence nesting trees or shrubs that are susceptible to cattle damage; 8) Graze lightly, in dry mixedgrass, to moderately in mixedgrass and fescue prairie, to promote heterogeneous vegetation heights with patches > 20 cm. Adjust grazing regime according to local range characteristics and changing environmental factors (Dechant et al. 2003; RCS 2004; Blouin 2006; Anonymous 2007a).

Data Required: 1) Identify areas along the Milk River with potential for shrike habitat (e.g., using habitat suitability index models and air photo interpretation); 2) Conduct canoe surveys along stretches of the Milk River in order to confirm these unique habitats and identify sites previously unrecorded; 3) Assess how riparian health relates to loggerhead shrike habitat characteristics, abundance and nesting success; 4) Improve methodology to derive trend data.

Population is:

increasing stable decreasing unknown

Detailed road-side and canoe surveys using call playbacks were conducted between 2002 and 2004 to increase the amount of coverage in the MULTISAR project area. These revealed 69 sites that were used by the loggerhead shrike in high potential habitat of the Milk River Basin (Table 6.2). Between 2004 and 2006, a 350 km road transect was surveyed annually between Verdigris Coulee and Cypress Hills to monitor the trend in shrike population. Along the transect shrike numbers peaked in 2005 and decreased in 2006 (Figure 6.13). This index of loggerhead shrike population shows a decrease over the time interval. However the reliability of this method to monitor the shrike population is questionable. It also represents a very short time frame and very limited area coverage.

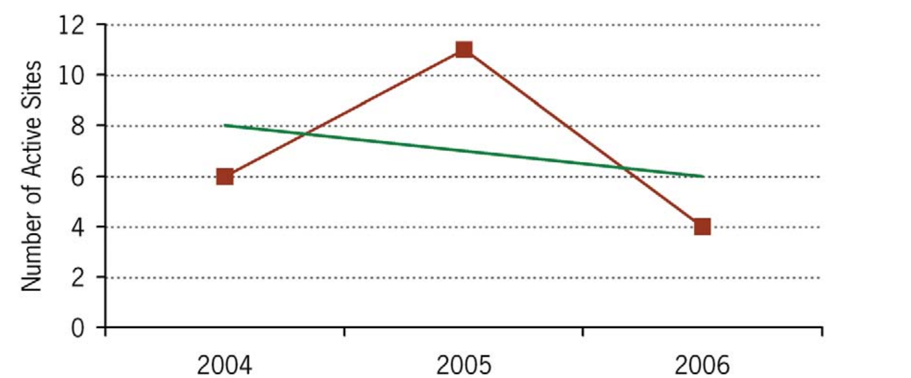


Figure 6.13. Loggerhead Shrike Sites on the Verdigris Coulee - Cypress Hills Transect (2004-2006).

Grassland Breeding Birds

Residence: Seasonal/migratory/residents

Indicator: Long-term negative trends in grassland bird density and diversity as derived from the North American Breeding Bird Survey (BBS) or other grassland bird surveys may be indicative of a decrease in the "health" of the grassland ecosystem in the Milk River Basin.

Characteristics: This Grassland Habitat group of the North American Breeding Bird Survey in Canada is characterized by "obligate" grassland species as established by the National Wildlife Research Centre of the Canadian Wildlife Service (Downes and Collins 2007; C. Downes, pers. comm.). In the Milk River Basin, it includes the following species: Baird's Sparrow, Bobolink, Chestnut-collared Longspur, Ferruginous Hawk, Grasshopper Sparrow, Horned Lark, Lark Bunting, Le Conte's Sparrow, Long-billed Curlew, McCown's Longspur, Northern Harrier, Ring-necked Pheasant, Savannah Sparrow, Sharp-tailed Grouse, Short-eared Owl, Sprague's Pipit, Upland Sandpiper, Vesper Sparrow, Western Meadowlark. These had sufficient data for calculation of an individual species trend.

Habitat requirements: Grassland birds evolved in a grassland ecosystem shaped by recurring fire, floods, droughts, and the action of large herds of grazers. They adapted to the mosaic of habitats created by these dynamic processes and each species occupies a particular niche along the gradient of vegetation height and density and within

Upland Sandpiper

different plant communities (Bradley and Wallis 1996). As a group, grassland birds benefit from heterogeneity in the horizontal and vertical vegetation structure and composition at various spatial scales (Fuhlendorf et al. 2006).

Known Stressors: Habitat loss and degradation, including loss of "wilderness" and habitat fragmentation, uniform grazing distribution, woody vegetation encroachment, weather conditions, increased predation, decreased food availability, collision with vehicles, powerlines, fencelines, or wind turbines, electrocution, fire suppression, and West Nile virus (Johnson et al. 2004).

Possible Stressor: Pesticide use, climate change, increased noise levels, alien species invasion (plants and animals) resulting in change in species composition and associated levels of food availability, competition, and predation.

Beneficial Practices: 1) Preserve native prairie areas, including large blocks of intact sagebrush with a healthy understorey of native grasses and forbs; 2) Prevent habitat fragmentation; 3) Use an appropriate grazing regime and cattle distribution, controlled burns or haying treatments, to create heterogeneity in vegetation structure, composition, and in litter accumulation, and to prevent or reduce woody vegetation encroachment; 4) Adjust timing and intensity of grazing in accordance with local environmental conditions (e.g., soil type, vegetation type, climate, and precipitation); 5) Delay mowing (including road allowances) until after the breeding season (July 15th or later); 6) Where necessary to control rodent populations, lower cyclic peak highs rather than completely exterminating prey populations; 7) Avoid the use of pesticides; where necessary, use rapidly degrading chemicals of low toxicity to non-target species or bio-control agents; 8) Maintain range in good condition; overgrazed and drought-affected areas are more prone to pest outbreaks; 9) Use fall seeding or zero-tillage in cultivated areas; 10) Avoid planting of trees on or near native grasslands; 11) Conduct pre-development surveys and abide by government-recommended setback distances and timing restrictions for human activities (Johnson et al. 2004; RCS 2004, Blouin 2006).

Data Required: 1) Effect of pesticide use, habitat fragmentation, various grazing regimes, and climate change on abundance, diversity, and nesting success of grassland birds; 2) Survey data for a greater coverage of the Milk River Watershed; 3) rates of cowbird parasitism and rates of predation with increasing habitat fragmentation and decreasing patch size; 4) Relationship between grassland birds and the health of different vegetation communities.

Group Population and Diversity is:

Long term data from the BBS Milk River route (#003) indicate a decrease in density (Figure 6.14) and a small decrease in diversity (Figure 6.15) of birds from the BBS Grassland Habitat group between 1970 and 2005 (derived from USGS Patuxent Wildlife Research Center 2007). Comparatively, the overall diversity of bird species (all habitat groups) has been on the rise for the same period on that route (Figure 6.16). More recent (2000-2005) trends in density and diversity has been positive for the Grassland Habitat group. However, the total number of grassland birds detected was still well below the long term average, and the species diversity was slightly below it. The BBS Milk River route runs on a 39.2 km of secondary Highway #501 west of the Cardston County – County of Warner boundary, and thus BBS data may represent conditions on this route only.

Seven to eight 32 km routes have also been surveyed from 2001-2005 for selected grassland birds through the MULTISAR program

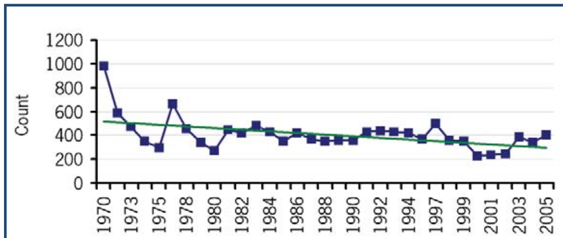


Figure 6.14. Total grassland birds on Milk River BBS Route (1970-2005).

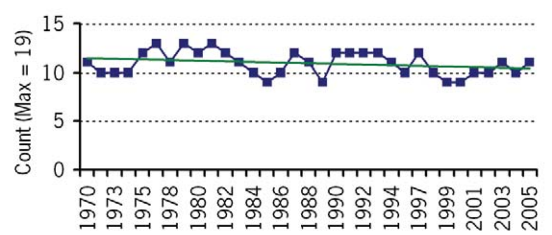


Figure 6.15. Number of grassland bird species on Milk River BBS Route (1970-2005).

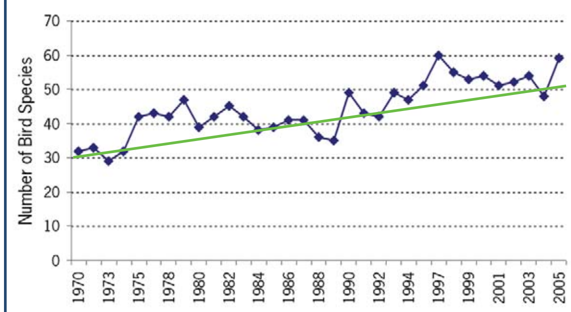


Figure 6.16. Total number of bird species detected on Milk River BBS Route (1970-2005).

in the Milk River watershed (Downey 2006). These include long-billed curlew (LBCU), Sprague's pipit (SPPI), short-eared owl (SEOW), Baird's sparrow (BDSP), and upland sandpiper (UPSA) (Table 6.3).

Table 6.3. Results of surveys for selected grassland birds (after Downey 2006).

Year	# of routes	LBCU	SPPI	SEOW	BDSP	UPSA
2001	8	22	14	0	N/A*	3
2002	8	7	57	0	9	0
2003	7	25	54	4	7	3
2004	7	24	108	0	1	6
2005	7	28	99	1	6	0
Average		21.2	66.4	1	5.75	2.4

*Baird's sparrows were not originally included in the monitoring programs and were added in 2002

For the three species (LBCU, SPPI, and UPSA) that had sufficient data on the 5 routes that have been completed every survey year, the long-billed curlew and the upland sandpiper remained at stable densities, while the Sprague's pipit increased significantly.

Richardson's Ground Squirrel

Residence: Year-round

Indicator: As a vital prey source for several bird, mammal, and reptile species and a critical excavator for several secondary burrow users, changes in its populations may preclude important changes in the integrity of the prairie ecosystem in the Milk River watershed.

Status: Listed as a "Non-license animal" under the *Alberta Wildlife Act* (Albert Queen's Printer 2007) and ranked as a "Secure" species in the Alberta General Status Report (Anonymous 2005).

Characteristics: Medium-sized rodent with small ears closely appressed to the head, a furry tail with dark hair down the middle, and large eyes placed high on the head. Fur colour varies with age and season but adults are buffy grey to sandy-brown, turning light grey prior to entering hibernation. It is an obligate hibernator, and adults spend up to three quarters of their life in hibernation (Michener 2007).

Habitat requirements: Typically occurs in loose matriarchal colonies in open, flat, and dry upland grasslands, with short (< 10 cm; Downey et al. 2006) vegetation to allow detection of predators from a distance (Michener and Schmutz 2002; Michener 2007). They are found in greater abundance in native prairie than in modified habitats (Downey et al. 2006). However, they fare well on the margin of cultivated or perennial crop lands, in ditches and in urban parks (Michener 2007). They avoid areas of loose sand and heavy clay (Reynolds et al. 1999).

Known Stressors: Habitat loss, human persecution, range management for tall (> 30 cm) grass (low grazing pressure).

Possible Stressor: Climate change (impact on hibernation pattern and parasitism), increase in predator or parasite populations.

Beneficial Practices: 1) In suitable soil areas, apply moderate to heavy grazing in productive mixedgrass and fescue prairie, light grazing in dry mixedgrass prairie or during drought conditions (RCS 2004); 2) Prevent conversion of native grassland to cultivation; 3) If controlling ground squirrels is essential to reduce economic loss, lower the peaks of cyclic highs rather than eliminating entire local populations; 4) If necessary, use rapidly degrading chemicals of low toxicity to non-target species or bio-control agents, or reduce grazing pressure to encourage taller vegetation (RCS 2004; Michener and Schmutz 2002).

Data Required: 1) Economic impact of controlling ground squirrels versus agricultural losses; 2) Actual impact of ground squirrel herbivory on cattle weight gains; 3) Economic assessment of environmental goods and services generated by ground squirrels; 4) Cattle grazing behaviour (selectivity, indifference, or avoidance) in proximity of ground squirrel colonies; 5) Impact of habitat fragmentation on ground squirrel densities; 6) Impact of climate change on hibernation pattern and on parasites distribution and abundance.

Population is:

Population densities of Richardson's ground squirrels can fluctuate up and down by 10-fold over the span of a decade or more. In the Milk River watershed, road-side surveys have been conducted between 2004 and 2006 on six 12.8 km transects as part of annual ferruginous hawk surveys (Figure 6.17). These surveys were part of the MULTISAR program and included the Pakowki basin. Short term results so far have shown a peak density of adults in 2005 followed by an important decrease in 2006. However this time frame is too short to provide an accurate assessment of the population in the watershed.

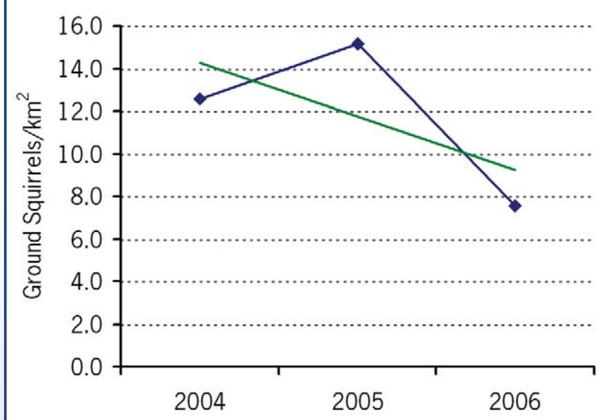


Figure 6.17. Density of Adult Richardson's Ground Squirrels in Milk River watershed (2003-2007).

7.0 Community Awareness And Involvement

Residents of the Milk River watershed have long had a tradition of community involvement and maintain a heightened awareness of the greater landscape. The agricultural landscape in the watershed has been carved by extreme drought, flood, violent storms and the threat of fire. Because of these extremes, agricultural producers have been on the forefront of adaptive management. Soil and water conservation is a ways of life, and stocking rates are matched with grass production from native rangeland dependent on the precious winter snow melt and erratic spring rains.

There are several measurable indicators of community involvement that reflect the state of the watershed. Although the Milk River watershed is one of the smallest major watersheds in the province, there are a number of organizations operating within its boundaries who are committed to maintaining and improving environmental sustainability. The following is a list of organizations and projects underway at the time of this report that have measurable impact regarding awareness and involvement in the watershed.

Alberta Environmental Farm Plan Program Participation

The Alberta Environmental Farm Plan (EFP) Process helps producers identify and address environmental risks and opportunities in their operations. This plays a key part in safeguarding the local environment, and a healthy environment is essential to the success of Alberta's agricultural producers. The completion of the EFP process results in the producer receiving a certificate for a deemed appropriate farm plan. These numbers are tracked provincially for record keeping processes. Since 2004, more than 60 producers have completed the program in the watershed managing nearly 809.4 km^2 of land (including deeded, leased, rented, and share cropped) (Figures 7.1 and 7.2).

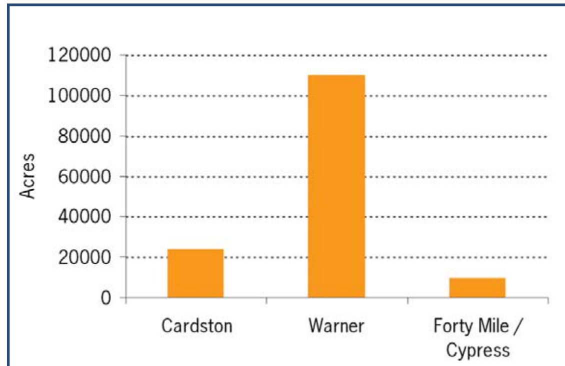


Figure 7.1. Acres under EFP management in the Milk River watershed.

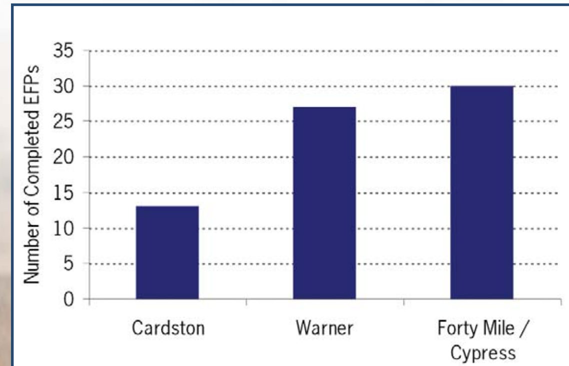


Figure 7.2. Completed Farm Plans in Milk River watershed by Municipality.

Best Management Practice Adoption and the Canada Alberta Farm Stewardship Program (CAFSP)

By completing an environmental farm plan, producers become eligible to apply to the Canada-Alberta Farm Stewardship Program (CAFSP) to make environmental improvements on their operations that increase efficiency and decrease the risk of health and safety concerns to their family and the environment. There are 26 different categories of beneficial management practices (BMP) that are eligible for funding under the program. Table 7.1 summarizes the number of applications and payments made for various categories under CAFSP. One of the more popular categories of BMP's implemented in the Milk River watershed is improved wintering site management. Here, producers can access funding for projects that reduce the buildup of bedding and manure from wintering sites located near watercourses and riparian areas. Another category that is popular is improved cropping systems; this allows producers to purchase tools such as GPS guidance systems and chaff spreader systems to improve residue management for no-till crop management. One of the categories that has not been accessed is biodiversity.

This program is conducted on a cost-share basis between the producer and CAFSP. The program results in clear practice change on the operational farm scale with significant contribution to projects coming from producers.

Municipal farm based extension program in cooperation with Alberta Environmentally Sustainable Agriculture (AESA)

The municipal farm based program is an extension program that encourages on farm adoption of beneficial management practices that are cost effective, practical farm management methods, which minimize environmental impacts. All four municipalities within the Milk River watershed participate in the extension program. Rural Extension Staff are based in municipal district offices and work directly with local producers and communities to provide technical assistance and encouragement for land managers. Extension staff often coordinates workshops and field tours for landowners within the Milk River watershed that promote the goals of the farm based extension program. Highlights of these events are included below.

Table 7.1. Summary of the number of applications and payments made for various categories under CAFSP in the Milk River watershed. (CAFSP BMP projects by municipality as of November 2007)

Action	Municipality	Category						
		Crops	Waste	Erosion	Livestock	Manure	Water	Biodiversity
Applications	Cardston	45	5	7	11	<5	5	<5
	Warner	62	10	<5	<5	<5	8	<5
	Forty Mile	147	14	<5	<5	0	12	<5
	Cypress	19	7	6	8	0	7	5
Payments	Cardston	106268	28754	21419	6287	0	19219	0
	Warner	107205	11487	0	6100	35000	11633	0
	Forty Mile	315392	34090	0	1985	0	12941	0
	Cypress	66576	27996	698	4465	0	1673	0
	Total	595441	102327	22117	18837	35000	45466	0

Workshops/ Field Tours

Milk River Watershed Stockman's Grazing School

A Three Day Milk River Watershed Stockman's Grazing School was held in partnership with the Milk River Watershed Council Canada, Cardston County, County of Warner, County of Forty Mile and Cypress County, from June 19 to 21, 2006. Nearly 70 participants over the three days participated in the School. The course addressed topics such as range plant identification, calculation of stocking rates, grazing management strategies, riparian health, stockwater options, living with species at risk, livestock health issues, and managing for environmental sustainability.

The School highlighted studies, research, and demonstration projects that have been conducted and/or implemented in southern Alberta with regard to range management. The information delivered at the Grazing School has increased local knowledge with respect to new techniques, technologies and management of range resources in the Milk River watershed.

Stockman's grazing school, June 2006

Alternative Stock Water and Riparian Management Tour

An alternative stock water and riparian management tour was hosted by Cardston County in the Watershed June 2005. The tour highlighted existing innovative stock water options and looked at other new technologies that producers could use to improve stock water quality and riparian areas on their operations; a total of 27 local producers attended.

Landowner Participation

Cows and Fish

Cows and Fish (Alberta Riparian Habitat Management Society) has had a long relationship with landowners in the Milk River watershed. In 1998, the County of Forty Mile and County of Warner invited Cows and Fish to talk to landowners and provide detailed health assessments of the riparian areas along the Milk River.

Cows and Fish staff quickly became aware of the cumulative knowledge and respect that local producers have for water, the Milk River and the lush ribbon of green bordering the river. Many producers take pride in riparian zones since they comprise only a very small portion of the landscape, but are some of the most valuable and productive areas, particularly for agriculture. As resource managers, Cows and Fish couples local knowledge of riparian areas with riparian health monitoring to build ecological literacy.

Over the past nine years, Cows and Fish have conducted over 100 riparian health assessments along 106 km of the Milk River. In all, 28 individual landowners representing a vast land base have participated in the riparian health assessment initiative. Each landowner has received their own riparian health assessment report and many community meetings have been held to share the overall results from the watershed. This riparian health data is one part of the cumulative body of knowledge that has been built to enable individual landowners and the community to make practical and sustainable land-use decisions.

Cows and Fish have learned that people living in the Milk River watershed are interested in understanding landscape health. The community has taken ownership of issues that face them, acknowledged challenges and developed land use management plans for their watershed. This process allows them to take a voluntary, proactive approach to address issues and concerns that may arise in the future. Taking a community-based approach is one that achieves shared goals as a group rather than addressing similar issues one landowner at a time. In addition, community ownership of challenges means that that a community will take responsibility for any problems they face and also take credit for solutions and successes they achieve.

Ducks Unlimited Canada

Ducks Unlimited Canada conserves, restores and manages wetlands and associated habitats for North America's waterfowl. These habitats also benefit other wildlife and people. DUC works with landowners and other organizations in various capacities, providing financial assistance, technical expertise and stewardship advice. Currently, DUC has many project agreements with landowners and managers in the Milk River watershed totaling an area of 64.5 km^2.

Milk River Watershed Council Canada

The Milk River Watershed Council Canada (MRWCC) is a registered, non-profit society and Watershed Planning and Advisory Council established under Alberta's Water for Life Strategy. The MRWCCs vision is a watershed where community well being is supported by a vibrant economy and sustained by a healthy environment that will endure as our legacy for future generations. The MRWCC is responsible for reporting on the State of the Milk River Watershed and for developing a Milk River Watershed Management Plan. In addition, the Council is involved in a variety of research projects and stewardship initiatives that promote knowledge and understanding of watershed processes amongst its members. Since forming, MRWCC individual and organizational memberships have increased from 85 members in 2005 to 103 members in 2007.

MULTISAR Program

The MULTISAR conservation program is a cooperative and voluntary initiative between landholders, Sustainable Resource Development- Fish and Wildlife (SRD-F&W), Alberta Conservation Association (ACA), and Sustainable Resource Development- Lands (SRD-Lands). MULTISAR strives to promote wildlife values in landholders by providing information and tools to assist recovery efforts for species at risk and the conservation of native prairie habitat. The program's vision is "that multiple species of wildlife including species at risk, are effectively conserved at the landscape level, through a process that integrates range and landuse management with fish and wildlife management principles and in a manner that contributes to the sustainability of the rural economy". MULTISAR is working collaboratively with landowners on approximately 505.9 km^2 in the Milk River watershed.

Nature Conservancy of Canada

The Nature Conservancy of Canada (NCC) works with landowners, farmers, and ranchers to conserve Canada's diversity of native plants and animals by stewarding ecologically significant natural areas that are secured through land purchases, donations, and conservation easements. Within the Milk River watershed, NCC has been working with over 50 individuals to steward approximately 16.2 km^2, both owned and with conservation easements.

Operation Grassland Community

Operation Grassland Community (OGC) is a grassroots habitat stewardship program of the Alberta Fish & Game Association that has been active in the Milk River Watershed and throughout the Grassland Natural Region since 1989. OGC works one-on-one with private landholders to secure and enhance prairie wildlife habitats for species at risk and associated wildlife and to increase awareness of the grassland ecosystem. Through its individualized farm management plans and habitat enhancement projects, OGC and landholders work together toward finding practical and compatible management solutions and projects that are financially viable and provide benefits to grassland species and the people who draw their living from the land.

OGC has 28 members in the Milk River watershed. They are under 5 year renewable voluntary stewardship agreements to maintain at total of 222.9 km^2 of habitat, 172.1 km^2 acres of which is native prairie.

The Milk River Ranchers Group

The Milk River Ranchers is the only watershed stewardship group actively working within the Milk River watershed to promote sustainable riparian management and overall healthy watersheds. The stewardship group was formed in 2003 when a group of concerned ranchers met with the extension specialist from the County of Warner. Soon after forming, the Milk River Ranchers were successful in accessing funding for stewardship projects and began a series of demonstration projects throughout the watershed. There are currently four directors of the group. The group has since expanded to include two demonstration projects within Cardston County.

8.0 Summary

Land use, wildlife, plants, soil, riparian areas, and human activity are intricately interconnected. At the root of this connection is water as all aspects of life rely on quality water in ample supply. The Milk River State of the Watershed Report brought together a multi-disciplinary team to describe the current state of the watershed. Background information related to geology, land cover and social history set the context for developing indicators appropriate for measuring the health of the watershed in terms of land use, aquatic resources, riparian systems and upland areas, including range land and wildlife. Data gaps were identified and recommendations were developed to help provide focus for the next phases of activity for the MRWCC and its partners. Greater understanding of the linkages among all aspects of the watershed will be essential for the long-term health and viability of the Milk River watershed. The following provides a summary of findings in 2008.

Population

The Milk River watershed, in comparison to others in the province, is a sparsely populated area, having a density of about 1 person per 2 km^2, that is defined by farming, ranching and large tracts of open space. The population in rural areas is generally decreasing, including the population of the Village of Coutts. The population in the Town of Milk River appears stable.

Land Use

The low intensity of land use provides for many of the habitat requirements for the large numbers of wildlife found in the watershed, including numerous species at risk. Only 51% of the land base in the watershed is deeded, with the remainder held as Crown lands, much of which is leased to cattle producers. Agriculture in the watershed consists of dryland or irrigated farming and ranching. The greatest density of cropland is located in the central part of the watershed, and to a lesser extent on the western edge. Cereals are the predominant crop type grown, namely wheat and barley. Ranching is comprised of mainly cow-calf operators with some more integrated yearling operations and several purebred herds. Compared to other areas in Alberta, livestock production is achieved at a fairly low intensity across the watershed due to low precipitation.

There are currently 2,493 oil and gas wells in the watershed, of which 66% are considered abandoned. Oil and gas activity is not well understood at this time, however, new developments tend to focus on shallow zones rather than the deep zones that were historically more dominant. A better understanding of oil and gas processes and future activity in the watershed should be sought. This may be accomplished by developing partnerships with the industry.

Parks and Protected Areas

While much of the Crown land is leased for grazing, about 8% is officially preserved in the form of either parks or other protected areas that range in significance from provincial to international. The long history of human settlement in the Milk River (dating back 8,000 years), has left the area rich in historical resources representing cultures past. Historical Resource Values have been assigned to specific sites to preserve history and culture, particularly well known is the Police Post at Writing-On-Stone Provincial Park and significant rock art, medicine wheels and tipi ring sites that have been identified in the watershed. Much of the Milk River is designated a Historical Resource Value of 5, where a significant resource is assumed but remains unknown.

Tourism and Recreation

Due to the low population density, large tracts of open space and abundant wildlife, the Milk River has become a very popular destination for people seeking outdoor recreation opportunities, such as canoeing, kayaking, hiking, wildlife watching and hunting. Each year, approximately 10,000 people canoe the Milk River. In addition, more than 60,000 people visit Writing-On-Stone Provincial Park and Gold Springs Park. As the Milk River watershed is discovered, the numbers of people visiting the area and the pressure on the Milk River and upland areas is expected to increase. The new interpretive center located at Writing-On-Stone Provincial Park will enhance visitor enjoyment as well.

Surface Water

Surface water supply continues to be an outstanding concern for local water users in times of drought. Available water supplies display a high degree of variability within each year and among years. The level of water allocation for human use exceeds the water supply during extremely dry years throughout the watershed.

Continued effort must be exerted to resolve the Milk River water supply issue during drought years. The impact of the IJC apportionment rules regarding the Canadian share of the river need to be fully understood by all concerned as well as the significance of a failure of the St. Mary Milk River diversion works. Consideration should be given to monitoring the water levels in licensed off stream storages (dugouts and reservoirs) in order to fully understand drought impact in the watershed.

Surface water quality is largely influenced by water management and climate. Increased flows from the St. Mary River diversion generally results in an increase in phosphorus concentrations and a decrease in nitrogen and salt concentrations. In addition, in wet years, the quality of surface water runoff degrades some reaches of the river by increasing concentrations of nutrients and bacteria above acceptable water quality guidelines. Low flows and high water temperatures in late summer have resulted in beach closures at Writing-On-Stone Provincial Park.

The water quality monitoring program initiated in 2006 should continue and the program expanded to include additional monitoring in the tributaries (e.g., the eastern tributaries, including flow monitoring). Additional monitoring in the headwaters may be sought in cooperation with the United States Geological Survey. Further investigations should be undertaken to determine sources of nutrients (i.e., river sediments) and identify management strategies to mitigate water quality concerns.

Groundwater

Many residents in the watershed rely on groundwater for household use. The two main aquifers, the Whisky Valley Aquifer and the Milk River Sandstone Aquifer provide the majority of this water. Studies have shown that in some areas of higher use, such as around Towns and intensive livestock operations, water levels in the Milk River Aquifer are declining. Water conservation is also a concern as uncontrolled flowing wells waste water and unused wells pose a contamination risk. Most of the groundwater licenses (62%) are allocated to Water Co-ops that supply rural households with potable water and stock water.

The quality of groundwater resources in the Milk River watershed is highly variable depending on the source. Although water from the Milk River Sandstone Aquifer may be high in sodium and not suitable as drinking water, it is an excellent soft water source for household use and is suitable for livestock. Water from the Whisky Valley Aquifer is of good quality and supplies potable water to 200 agricultural operations.

Future efforts should focus on implementing a management protection plan for the Whisky Valley Aquifer and other shallow aquifers in the watershed. This includes holding public education and awareness events to discuss the importance of groundwater, protection measures and water treatment options. In addition, recommendations should be developed for land use limitations that should be considered in areas overlying shallow aquifers, including the Whisky Valley Aquifer. In the Milk River Aquifer, wells should be surveyed to determine whether they are in use, inactive or flowing. A program should be re-established to plug or control flowing wells.

Fisheries and Benthic Invertebrates

Since 1969, twenty-four species of fish have been captured in the Milk River. Fish captured included both forage fish (e.g., fathead minnow) and sport fish (i.e., mountain whitefish). Comparison of fish populations in the Milk River and its tributaries are limited since most of the fish studies that have been conducted were in relation to specific projects (i.e., dam investigations, status of species at risk) rather than specifically undertaken to produce population estimates. Water management in the Milk River has altered the fish present in the Milk River system. For example, the St. Mary River diversion likely introduced the lake whitefish and trout-perch into the Milk River drainage. Walleye in the Alberta portion of the Milk River likely migrated upstream from Fresno Reservoir in Montana. Although the three species at risk, western silvery minnow, eastslope/St. Mary sculpin and stonecat, are relatively abundant in the Milk River, they are considered “Threatened” under Alberta’s *Wildlife Act* due to their limited distribution in Canada (i.e., Milk River).

Future water management in the Milk River can have a direct impact on aquatic life. An instream flow needs assessment for fish and invertebrates should be undertaken. To increase understanding, population estimates and habitat assessments for fish species deemed at risk in the watershed should be undertaken. Benthic invertebrate surveys should be conducted to link aquatic life to water quality and fish habitat.

Green Zones: Riparian Areas and Wetlands

Riparian health indicators show that preferred tree and shrubs are not regenerating and that invasive weeds are competing with native vegetation in some areas within the watershed. Furthermore, unstable streambanks are eroding at rates ranging from 0.2 m per year to 2.5 m per year on the Milk River. Processes that contribute to erosion include unconsolidated streambank material that erodes during prolonged periods of above natural flow (i.e., diverted flow) and ice laden flows.

Monitoring riparian vegetation is essential to understanding long term impacts of water regulation and management in the future. Monitoring may include aerial photography interpretation, as well as riparian health assessments. Water management and flow regulation strategies that reduce the potential for erosion should be evaluated. Further, increased understanding of rates of erosion, sedimentation and plains cottonwood survival will be important aspects in riparian management. Although some reaches of the Milk River are naturally vulnerable to limited growth of preferred trees and shrubs, grazing strategies that promote tree and shrub regeneration should be encouraged in areas that have that potential.

There is little recent information available on wetlands density and drainage in the Milk River watershed. A comprehensive wetland inventory should be undertaken in the watershed that will document the occurrence of wetlands, the number of drained wetlands and classify each wetland by type. The wetland inventory would also provide a better understanding of wildlife habitat, particularly for species such as the plains spadefoot toad, Great Plains toad and Northern Pintail.

Public Range Health

Rangelands make up a significant portion of the watershed and maintaining upland health and function is critical for achieving overall health and function in the watershed. Most precipitation is captured and stored in upland vegetation. Live plant material and litter is important to slow runoff water, reduce soil erosion from wind and water, and reduce evaporative losses. Healthy range areas provide greater forage opportunities for livestock and wildlife. Healthy rangelands also provide an important buffering effect for forage resources and wildlife during drought periods.

Sixty percent of the sites visited by Alberta Sustainable Resource Development, Public Lands were considered healthy, while 33% were considered healthy but with problems. Remedial management actions are developed to address rangelands that are in an unhealthy class. The health assessment sites will require ongoing monitoring and reassessment to establish and monitor trend, thereby identifying areas of concern when range health scores decline below acceptable levels.

Ranchers and resource managers need to continue to work together to ensure basic rangeland health is maintained, supporting a stable forage supply and quality habitat for a variety of wildlife species.

Wildlife

The Milk River watershed is unique in that it contains a large diversity of wildlife and the highest density of species at risk in Alberta, if not all the prairie provinces. Unique climate and vegetation as well as large tracks of native habitats help support a number of different species in Southern Alberta, including the pronghorn, swift fox, and prairie rattlesnake.

Detailed inventories are required of historic and active habitats for many species, including the northern leopard frog and greater sage-grouse. Understanding road mortalities for herptiles (e.g., toads and rattlesnakes) and habitat fragmentation for the ferruginous hawk and greater sage-grouse will be essential in order to maintain these populations.

Community Awareness and Involvement

There are a number of organizations that provide opportunities for residents, landowners and industry to learn more about the management of aquatic resources, wildlife and upland rangeland in the Milk River watershed, including MULTISAR, Operation Grassland Community and Nature Conservancy Canada. There has been a high participation rate in all of the programs that have been offered across the watershed and this is reflected in the current state of the watershed. Organizations should continue to offer innovative programs in the Milk River watershed.

9.0 Looking Ahead

"When one tugs at a single thing in nature, he finds it attached to the whole world". John Muir

The completion of this State of the Watershed Report is the first phase in a cyclic watershed management planning system. It identifies watershed resources and comments on the current state of health of each component that defines the Milk River environment. The State of the Watershed Report identifies gaps in our knowledge and recommends further studies to clarify certain aspects of the watershed's resources. In the next phase, decision makers, resource managers and landowners will use this report to begin the watershed management planning process. A watershed management plan is an integrated approach to land and water management that develops management recommendations that will provide the greatest benefit for humans and the environment.

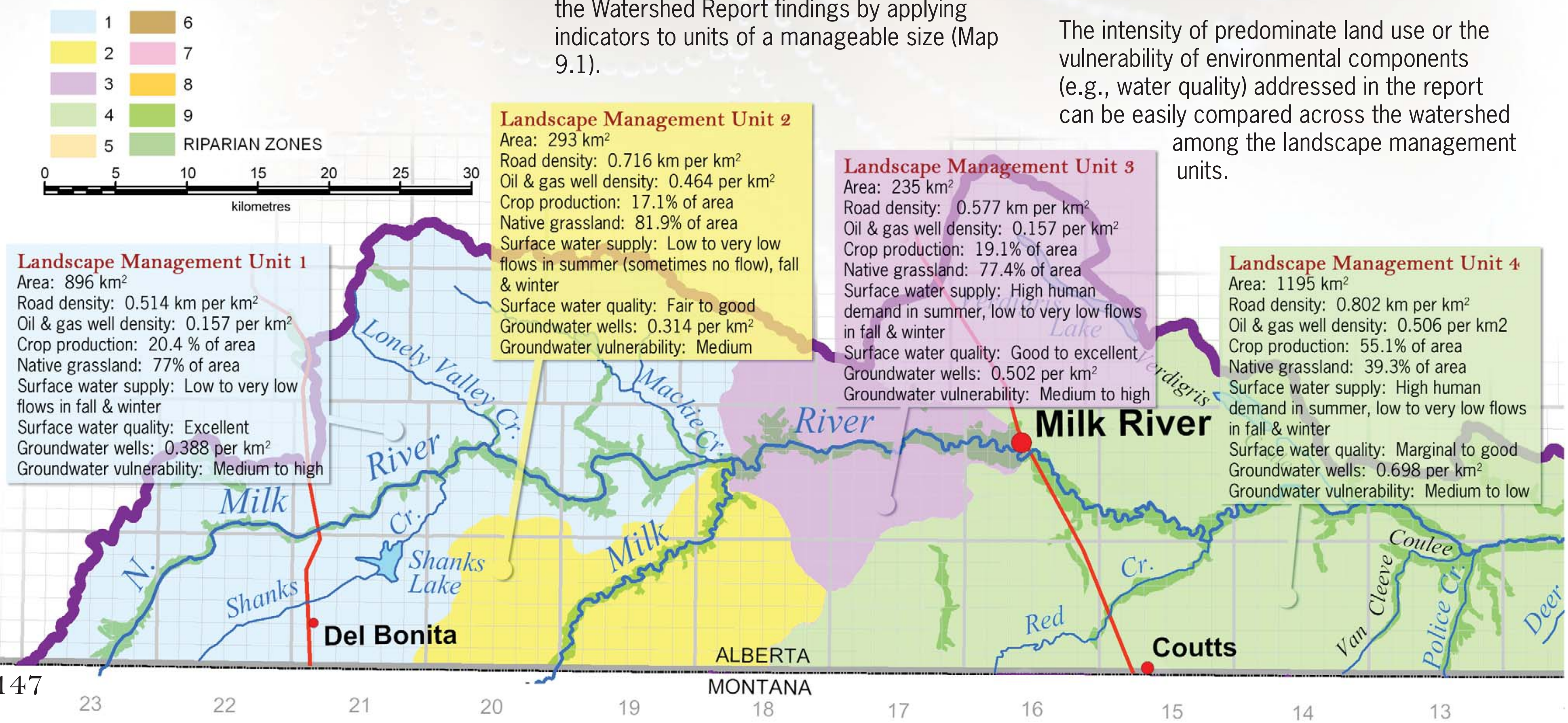
To provide focus for watershed management planning, the State of the Watershed Team has delineated nine landscape management units (LMUs) within the Milk River watershed. These units help to summarize the Milk River State of the Watershed Report findings by applying indicators to units of a manageable size (Map 9.1).

The delineation of these units was based on:

- Watershed geography, including topography and landform characteristics,
- Three river channel characteristics (i.e., North Milk River, Milk River gravel reach and Milk River sand reach),
- Land management practices (e.g., farm land vs. ranch land),
- Location of main tributaries, and
- Known fish and wildlife ranges.

The intensity of predominate land use or the vulnerability of environmental components (e.g., water quality) addressed in the report can be easily compared across the watershed among the landscape management units.

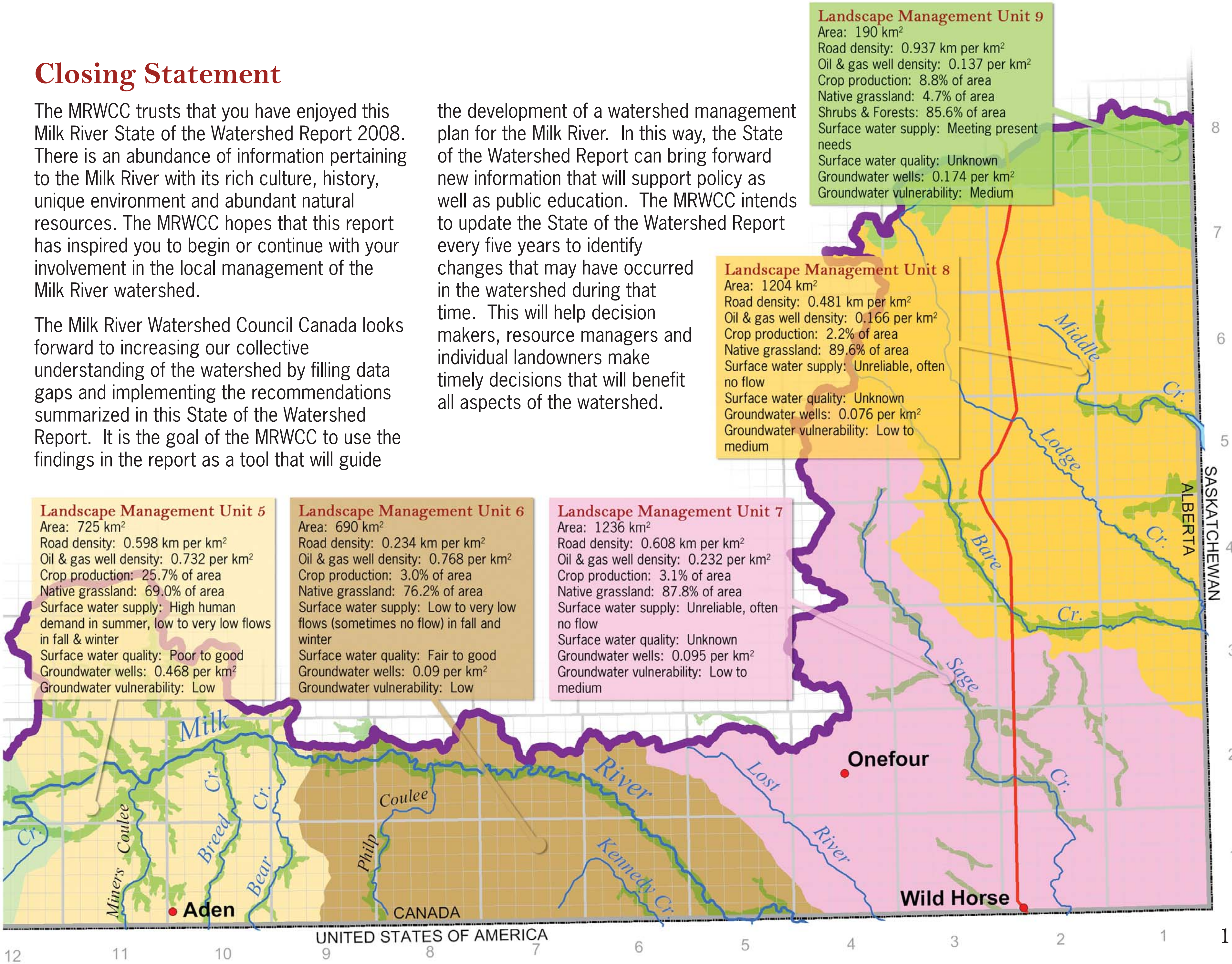
Map 9.1. Landscape Management Units



Closing Statement

The MRWCC trusts that you have enjoyed this Milk River State of the Watershed Report 2008. There is an abundance of information pertaining to the Milk River with its rich culture, history, unique environment and abundant natural resources. The MRWCC hopes that this report has inspired you to begin or continue with your involvement in the local management of the Milk River watershed.

The Milk River Watershed Council Canada looks forward to increasing our collective understanding of the watershed by filling data gaps and implementing the recommendations summarized in this State of the Watershed Report. It is the goal of the MRWCC to use the findings in the report as a tool that will guide the development of a watershed management plan for the Milk River. In this way, the State of the Watershed Report can bring forward new information that will support policy as well as public education. The MRWCC intends to update the State of the Watershed Report every five years to identify changes that may have occurred in the watershed during that time. This will help decision makers, resource managers and individual landowners make timely decisions that will benefit all aspects of the watershed.



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M. Dubord, EnCana, March 4, 2008.

S. Heather-Kalau, Gold Springs Park, Milk River, AB. November 27, 2007.

W. Koning, Alberta Environment (AENV). March 6, 2008.

10.3 Map Information

Map Disclaimer

Map 1.1 Milk River Watershed
Base Data provided by Montana Department of Transportation. Base Data for Inset Map provided by Spatial Data Warehouse Ltd. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 2.1 Bedrock Geology
Base Data provided by Spatial Data Warehouse Ltd. Bedrock Geology from Alberta Research Council, 1972. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 2.2 Surficial Geology
Base Data provided by Spatial Data Warehouse Ltd. Surficial Geology from: Quaternary Geology, Southern Alberta by Irina Shetson: Alberta Energy and Utilities Board / Alberta Geological Survey, EUB/AGS Map 207D. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 2.3 Physiography, Relief and Drainage
Base Data provided by Spatial Data Warehouse Ltd. Digital Surface Model obtained from Landuse Framework. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 2.4 Soils
Base Data provided by Spatial Data Warehouse Ltd. Soils obtained from AGRASID 3.0, 2001, Alberta Soil Information Centre, Agriculture and Agri-Food Canada (AAFC) and Alberta Agriculture and Food. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 2.5 Natural Subregions
Base Data provided by Spatial Data Warehouse Ltd. Natural Regions and Subregions derived from the report, Natural Regions and Subregions of Alberta, compiled by Downing and Pettapiece, Edmonton for the Alberta Natural Region Committee, Government of Alberta, 2006. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 2.6 Landcover
Base Data provided by Spatial Data Warehouse Ltd. Land Cover Classification produced by Alberta Sustainable Resource Development, Prairies Area, Resource Information Unit, Lethbridge, (revised September 2004). The Land Cover Classification depicted on this map is divided into two major spatial model partitions:

1. The Forest Vegetation Spatial Model Partition was compiled using Alberta Vegetation Inventory (2001), RIMB, Strategic Corporate Services, ASRD; Banff National Park Forest Inventory and Waterton Lakes National Park Ecological Land Classification, Parks Canada.
2. The Grassland Vegetation Spatial Model Partition was compiled using Ecological Range Sites and Reference Plant Communities (2003), LandWise Inc., RIU, and Rangeland Management Branch, ASRD, Lethbridge, derived from AGRASID 3.0, 2001. Alberta Soil Information Centre, Agriculture and Agri-Food Canada (AAFC) and Alberta Agriculture, Food and Rural Development (AAFRD); Native Prairie Vegetation Inventory (NPVI), RIMB, Strategic Corporate Services, ASRD; Central Parkland Native Vegetation (PNV) produced by RIU, RIMB, Strategic Corporate Services, ASRD, Red Deer; Central Alberta Woodlot Inventory (CAWI), RIMB, Strategic Corporate Services, ASRD; Crop Insurance Database (2001), Agriculture Financial Services Corporation (AFSC); Irrigated Quarter Sections, Irrigation Branch, AAFRD.

Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 2.7 Native Prairie Vegetation
Base Data provided by Spatial Data Warehouse Ltd. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 3.1 Historic Trails
Base Data provided by Spatial Data Warehouse Ltd. Historic Trails provided by Historic Resources Management Branch, Parks, Conservation, Recreation and Sport Division, Alberta Tourism, Parks, Recreation and Culture, and were derived from early surveyor's Township Plats obtained from Surveys and Technical Services Section, Lands Division – Land Dispositions Branch, Alberta Sustainable Resource Development. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 3.2 Land Ownership
Base Data provided by Spatial Data Warehouse Ltd. Land Ownership Status obtained from Land Status Automated System, Alberta Energy, 2004. Provincial includes all Crown Land (land owned by the Provincial Government) which includes but is not limited to Provincial Parks, Wilderness Areas, Ecological Reserves, and Natural Areas. Freehold is land privately owned by an individual or company (not owned by the Crown). Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 4.1 Administrative Boundaries
Base Data provided by Spatial Data Warehouse Ltd. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 4.2 Access
Base Data provided by Spatial Data Warehouse Ltd. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 4.3 Crops
Base Data provided by Spatial Data Warehouse Ltd. Land Cover Classification produced by Alberta Sustainable Resource Development, Prairies Area, Resource Information Unit, Lethbridge, (revised) September, 2004. The Land Cover Classification depicted on this map was compiled using: Ecological Range Sites and Reference Plant Communities (2003), LandWise Inc., RIU, and Rangeland Management Branch, ASRD, Lethbridge, derived from AGRASID 3.0, 2001. Alberta Soil Information Centre, Agriculture and Agri-Food Canada (AAFC) and Alberta Agriculture, Food and Rural Development (AAFRD); Native Prairie Vegetation Inventory (NPVI), RIMB, Strategic Corporate Services, ASRD; Central Parkland Native Vegetation (PNV) produced by RIU, RIMB, Strategic Corporate Services, ASRD, Red Deer; Central Alberta Woodlot Inventory (CAWI), RIMB, Strategic Corporate Services, ASRD; Crop Insurance Database (2001), Agriculture Financial Services Corporation (AFSC); Irrigated Quarter Sections, Irrigation Branch, AAFRD.
Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 4.4 Oil and Gas Activity
Base Data provided by Spatial Data Warehouse Ltd. Pipelines and Well Site data provided by IHS Energy (Canada) Ltd. Well Sites date: October 2007. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 4.5 Parks and Protected Areas
Base Data provided by Spatial Data Warehouse Ltd. Parks and Protected Areas and Environmentally Significant Areas supplied by Alberta Tourism, Parks, Recreation and Culture – Parks and Protected Areas Division. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 4.6 Historical Resource Sensitivity Types
Base Data provided by Spatial Data Warehouse Ltd. Historical Resource Sensitivity Types provided by Historic Resources Management Branch, Parks, Conservation, Recreation and Sport Division, Alberta Tourism, Parks, Recreation and Culture. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 4.7 Historical Resource Values
Base Data provided by Spatial Data Warehouse Ltd. Historical Resource Values provided by Historic Resources Management Branch, Parks, Conservation, Recreation and Sport Division, Alberta Tourism, Parks, Recreation and Culture. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 5.1 Stream Flow Monitoring Stations
Base Data provided by Spatial Data Warehouse Ltd. and Montana Department of Transportation. Stream Flow Monitoring Stations from Water Survey of Canada, Environment Canada. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 5.2 Water Quality Monitoring Sites
Base Data provided by Spatial Data Warehouse Ltd. Water quality monitoring data provided by the Milk River Watershed Council Canada, 2006 and 2007. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 5.3 Water Wells, Springs and Bedrock Geology
Base Data provided by Spatial Data Warehouse Ltd. Bedrock Geology from Alberta Research Council, 1972. Well data compiled from County Regional Groundwater Studies (1999-2004), and AENV Groundwater Information Centre Database. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 5.4 Milk River Sandstone and Whisky Valley Aquifers
Base Data provided by Spatial Data Warehouse Ltd. Bedrock Geology from Alberta Research Council, 1972. Well data compiled from County Regional Groundwater Studies (1999-2004), and AENV Groundwater Information Centre Database. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 5.5 Aquifer Groundwater Vulnerability Map
Base Data provided by Spatial Data Warehouse Ltd. Aquifer Vulnerability provided by Alberta Agriculture and Food. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 5.6 River Reaches and Fish Distribution
Base Data provided by Spatial Data Warehouse Ltd. Digital Surface Model obtained from Landuse Framework. Fisheries data provided by Alberta Sustainable Resource Development. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 5.7 Invasive Plant Species
Base Data provided by Spatial Data Warehouse Ltd. Invasive plant data supplied by Cardston County, County of Warner, County of Forty Mile, Cypress County and Rangeland Management, Alberta Sustainable Resource Development. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 5.8 Plains Cottonwood Distribution
Base Data provided by Spatial Data Warehouse Ltd. Plains Cottonwood distribution/density based on work by Bradley (1991). Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 5.9 Wetland Density Distribution
Base Data provided by Spatial Data Warehouse Ltd. Northern Pintail data source – Northern Pintail DSS, Ducks Unlimited Canada, 2005. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 6.1 Grazing Dispositions and Rangeland Reference Areas
Base Data provided by Spatial Data Warehouse Ltd. Grazing dispositions obtained from Land Status Automated System, Alberta Energy, 2004. Rangeland Reference Areas provided by Alberta Sustainable Resource Development. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 6.2 Plains Spadefoot
Base Data provided by Spatial Data Warehouse Ltd. Plains Spadefoot data provided by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 6.3 Great Plains Toad
Base Data provided by Spatial Data Warehouse Ltd. Great Plains Toad data provided by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 6.4 Northern Pintail Predicted Breeding Pair Density
Base Data provided by Spatial Data Warehouse Ltd. Northern Pintail data source – Northern Pintail DSS, Ducks Unlimited Canada, 2005. Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008.

Map 9.1 Milk River Watershed Landscape Management Units
Base Data provided by Spatial Data Warehouse Ltd. Landscape Management Units delineated by the Milk River Watershed Council Canada State of the Watershed Team. Riparian zones compiled using Ecological Range Sites and reference plant communities (2003), LandWise Inc., Resource Information Units and Rangeland Management Branch, ASRD, Lethbridge, derived from AGRASID 3.0, 2001, Alberta Soil Information Centre, Agriculture and Agri-Food Canada (AAFC) and Alberta Agriculture Food and Rural Development (AAFRD). Produced by Alberta Sustainable Resource Development. Prairies Area. Resource Information Unit, Lethbridge, January 2008

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10.5 Useful Conversions

Multiply	by	To obtain
Length		
cm	0.394	inches
m	3.2808	ft
km	0.6214	miles
Area		
acres	0.004046856	km^2
hectares	2.471	acres
hectares	0.01	km^2
inch2	6.452	cm^2
km2	247.1	acres
km2	100.0	ha
Volume		
acre-ft	1234.0	m^3
acre-ft	1.234	dam^3
dam^3	0.810713182	acre-ft
m^3	0.000810713	acre-ft
m^3	0.001	dam^3
m^3	35.32	ft^3
Yield		
kg/ha	0.892	lb/acre
lb/acre	1.12	kg/ha
Discharge		
ft^3/s	0.028	m^3/s
m^3/d	0.152756420	igpm
m^3/s	35.32	ft^3/s

Printed in Canada
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