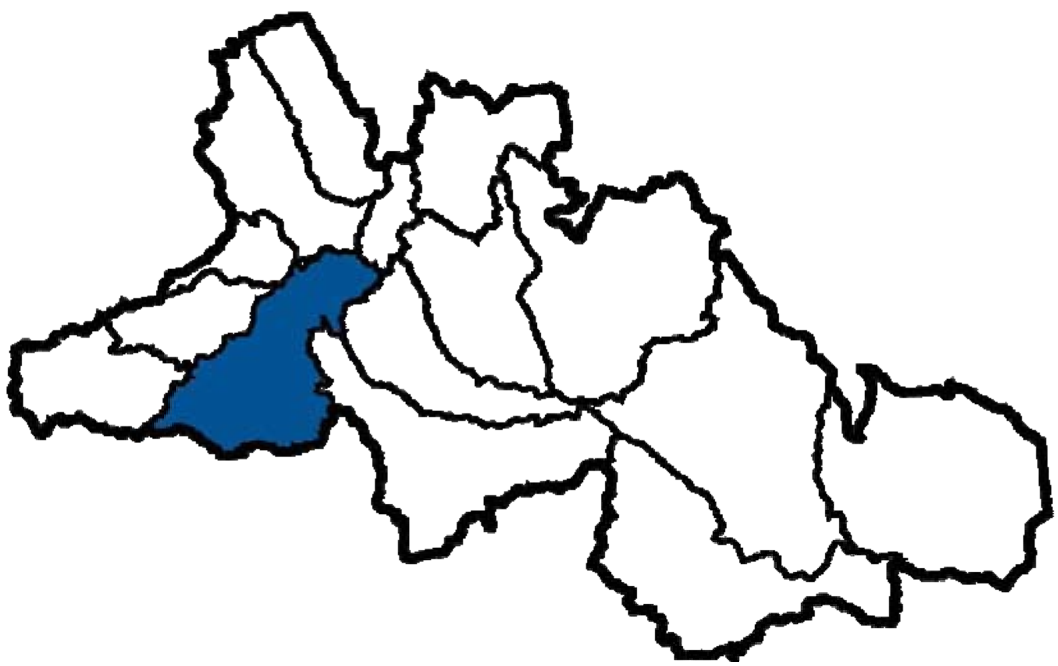
Little Red Deer Subwatershed



Red Deer River Watershed Alliance

State of the Watershed

4.4 Little Red Deer River Subwatershed

4.4.1 Watershed Characteristics

The Little Red Deer River subwatershed encompasses about 397,166 ha and is located in the Counties of Mountain View and Red Deer and the Municipal Districts of Bighorn No. 8 and Rocky View No. 44 (Figure 112).

The Little Red Deer River subwatershed is located south of Gleniffer Lake Reservoir and east of the upper reaches of the Red Deer River. The subwatershed lies in the Subalpine, Upper and Lower Foothills, Foothills Parkland, Dry Mixedwood and Central Parkland Subregions (Figure 113). Soils vary widely, reflecting the great diversity in parent materials and ecological conditions. The vegetation consist of lodgepole pine (*P. contorta*), Engelmann spruce (*P. engelmannii*), subalpine fir (*A. lasiocarpa*) and whitebark pine (*P. albicaulis*). High elevation grasslands also occur in the Subalpine Subregion. The Upper Foothills Subregion occurs on strongly rolling topography along the eastern edge of the Rocky Mountains. Upland forests are nearly all coniferous and dominated by white spruce (*P. glauca*), black spruce (*P. mariana*), lodgepole pine (*P. contorta*) and subalpine fir (*A. lasiocarpa*). The Lower Foothills Subregion is dominated by mixed forests of white spruce (*P. glauca*), black spruce (*P. mariana*), lodgepole pine (*P. contorta*), balsam fir (*A. balsamea*), aspen (*Populus* spp.), balsam poplar (*P. balsamifera*) and paper birch (*B. papyrifera*). The Foothills Parkland is dominated by aspen (*Populus* spp.), balsam poplar (*P. balsamifera*) and Bebb willow (*S. bebbiana*), with a lush understory dominated by a variety of herbaceous plants. Forests in the Dry Mixedwood Subregion are dominated by aspen (*Populus* spp.), balsam poplar (*P. balsamifera*), white spruce (*P. glauca*) and, in some areas, balsam fir (*A. balsamea*). Pure deciduous stands are common in the southern part of the Subregion, and dry, sandy sites are usually occupied by jack pine (*P. banksiana*). Peatlands are common and may be extensive. The Central Parkland Subregion is dominated by grassland with groves of aspen (*Populus* spp.), with the grassland vegetation being dominated by rough fescue (*F. campestris*) (Heritage Community Foundation, 2008).

The geology of the Little Red Deer River subwatershed is dominated by the Paskapoo Formation. In addition, the Brazeau and Coalspur Formations as well as the Alberta Group (Blackstone, Cardium and Wapiabi Formations) and geologic deposits from the Lower Mesozoic-Lower Cretaceous are present in isolated pockets in the upper reaches of the subwatershed. These formations formed in the Paleocene epoch (56-65 million years ago), the Cretaceous period (65-145 million years ago) and the Lower Mesozoic era (200-251 million years ago). The geology of the Lower Mesozoic-Lower Cretaceous Formation consists of various siltstones, dolomites, sandstones, shales, cherts and feldspars. Coal deposits occur in the central and northern foothills (Luscar Group). The Coalspur formation consists of sandstones, siltstones/mudstones, claystone, volcanic tuff deposits and thin coal beds. The Cretaceous Formations (Brazeau and the Alberta Group) consist of shales, sandstone, mudstone, ironstone, some tuff and thin coal deposits. The youngest of the formations from the Paleocene, Paskapoo, consists of diverse sandstones, siltstones/mudstones and minor shale deposits (Alberta Geological Survey, 2006).

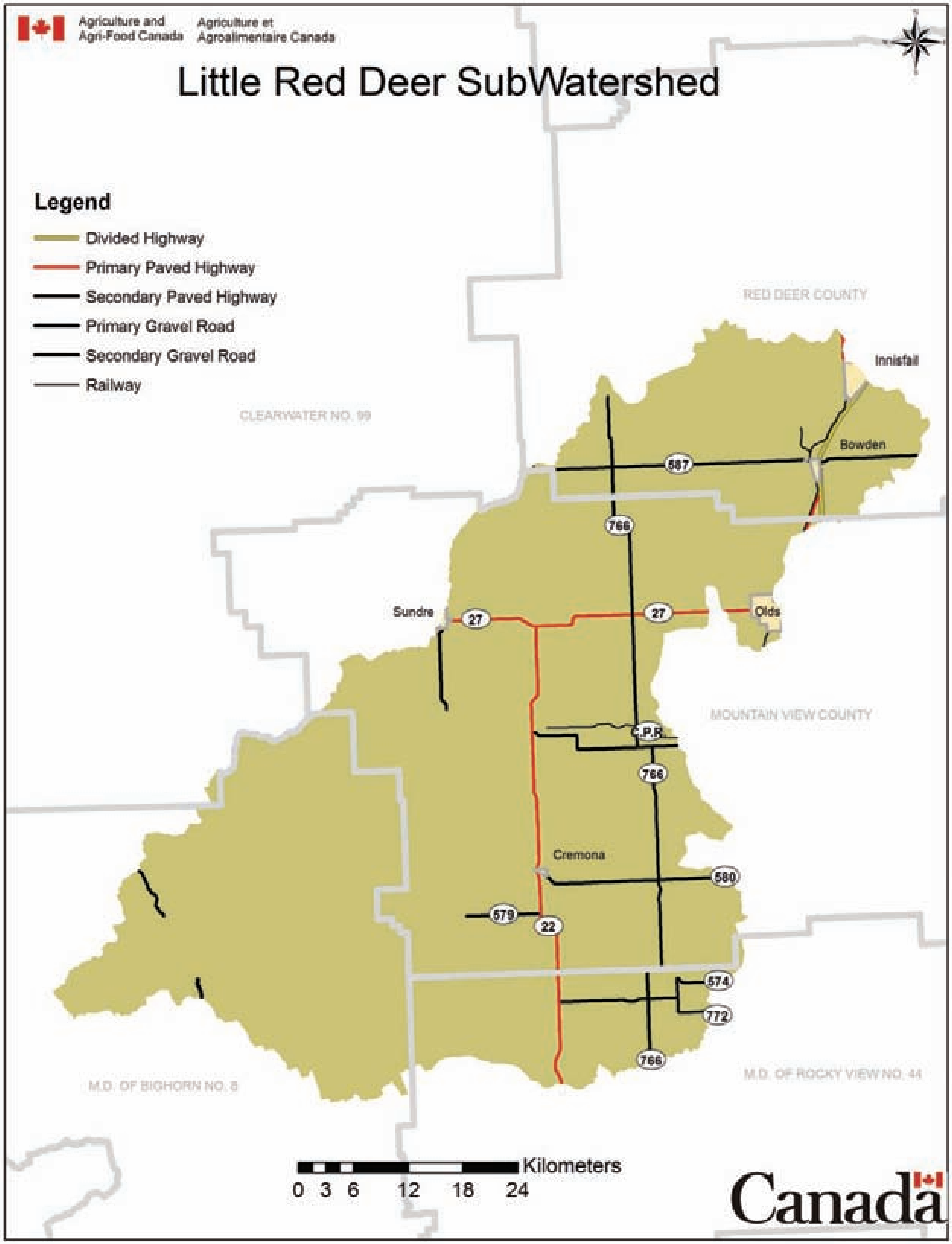


Figure 112. Location of the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

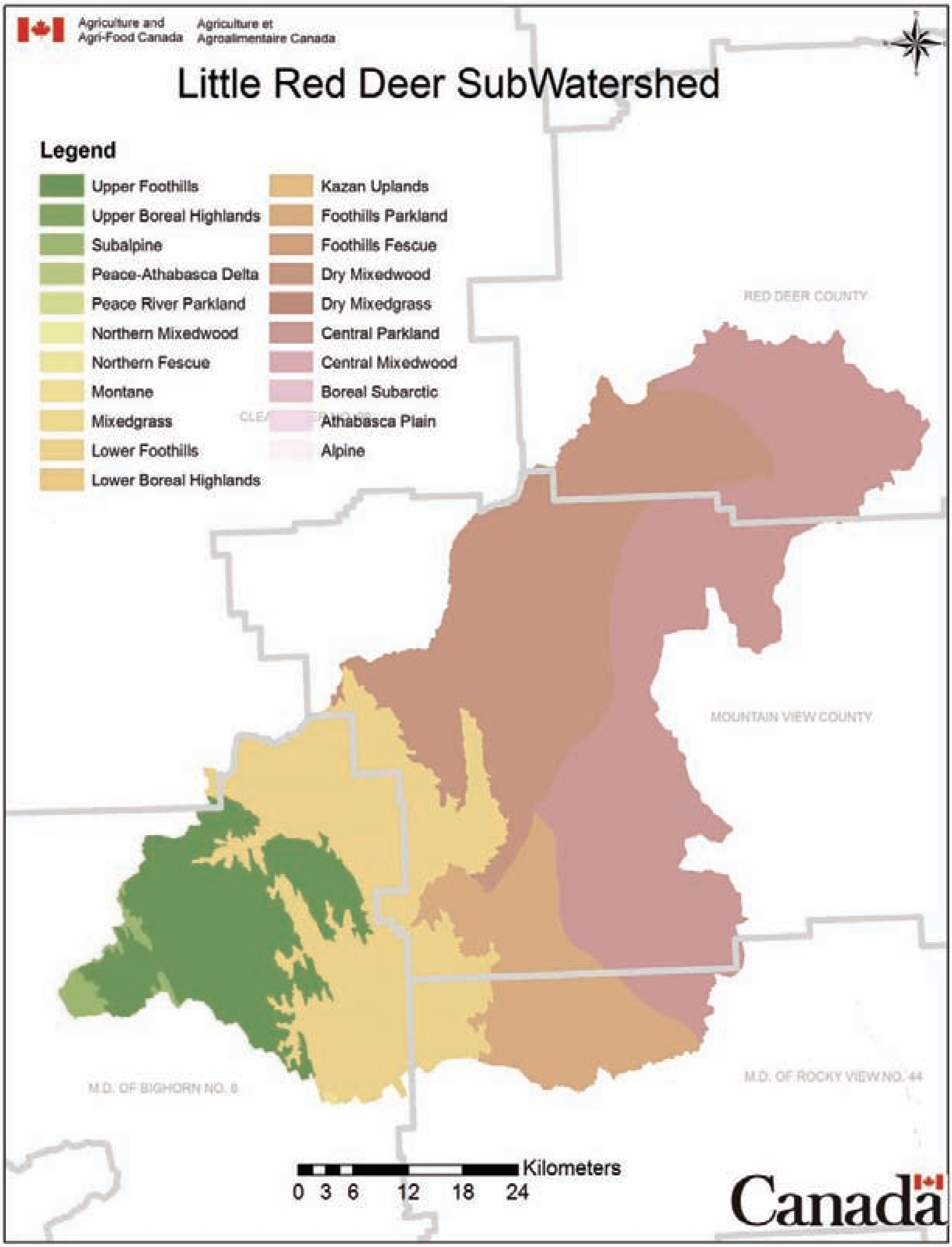


Figure 113. Natural subregions of the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

The climate of the Little Red Deer River subwatershed is highly variable, ranging from subalpine in the southwest to subhumid and continental towards the northeast. Mean annual temperatures generally increase from about -1 °C in the southwest to 3 °C in the northeast. Similarly, mean May-September temperatures increase from about 6 °C in the southwest to 10-15 °C in the northeast of the subwatershed. Total annual precipitation is similarly variable, ranging from 420-1,400 mm with up to 2,000 mm of snowfall in the winter in the southwest to 350-650 mm in the northeast (Environment Canada, 2006).

4.4.2 Land Use Indicators

Changes in land use patterns reflect major development trends, such as forested lands converted to agriculture and agricultural lands developed and lost to urban sprawl. Land use changes and the subsequent changes in management practices impact both the quantity and quality of water within the Red Deer River watershed. Six metrics were used to indicate changes in land use and land use practices in the Red Deer River watershed and its 15 subwatersheds:

- Wetland Loss – Condition Indicator
- Riparian Health – Condition Indicator
- Livestock Manure Production – Risk Indicator
- Urban, Rural and Recreational Developments – Risk Indicator
- Linear Developments – Condition Indicator
- Oil and Gas Activities – Risk Indicator

These six land use change indicators also reflect socioeconomic growth in a region. Hence, while human activities in a region can have negative environmental impacts, it is important to strive for a balance between socioeconomic growth and the sustainable management of natural ecosystems to ensure their long-term health and enjoyment by future generations.

4.4.2.1 Wetland Loss

Wetlands serve many functions in the natural landscape including water storage, flood attenuation, wildlife habitat, groundwater recharge and general water quality improvements (e.g., nutrient uptake, degradation of pesticides, sediment retention). Additionally, wetlands provide a cost effective and sustainable alternative to engineered treatment options. The loss of wetlands to development and/or agriculture can be deleterious to surface and groundwater quantity and quality.

Land cover data indicate the presence of 2,632 ha of wetlands (0.66% of the total subwatershed area) in the Little Red Deer River subwatershed (AAFC-PFRA, 2008). Open, sedge-dominated fens occur near Boggy Lake (Twp. 30, Rge. 6, W 5) (Lamoureaux et al., 1983; Geowest Environmental Consultants Ltd., 1995). There are no data on any other classes, forms and types of wetlands (*sensu* National Wetlands Working Group, 1997) within the subwatershed; however, given the presence of lentic (lakes) and lotic (streams and rivers) systems, marshes and shallow open water wetlands are likely also present in the subwatershed. Ephemeral, temporary, seasonal and semi-permanent wetlands (*sensu* Stewart and Kantrud, 1971) are likely present in the subwatershed as well.

The Prairie Habitat Joint Venture program (a partnership between federal and provincial governments, organizations and conservation groups in Manitoba, Saskatchewan and Alberta) has assessed the loss of wetlands in the Parkland Natural Region (specifically the Central Parkland Subregion) from 1985-2001 (Watmough and Schmoll, 2007). In Alberta, the Central Parkland Subregion has lost 7% of its total wetland area and 8% of its total number of wetlands due to anthropogenic disturbances in that 16-year period. There appears to be no change in the rate of wetland loss in the Prairie Parkland Region over the past 50-70 years. Caution must be taken when extrapolating these data to the entire subwatershed, since only one transect from the Prairie Habitat Joint Venture program was located in the entire subwatershed (Watmough and Schmoll, 2007).

4.4.2.2 Riparian Health

Riparian areas are an important transition zone between uplands and water. They act as buffer zones, protecting water quality and attenuating floods. Contaminants are adsorbed onto sediments, assimilated by vegetation and transformed by soil microbes into less harmful forms. They have long been proven effective in reducing nutrients, sediments and other anthropogenic pollutants that enter surface waters via overland and subsurface flow.

Numerous riparian health assessments have been conducted in the Little Red Deer River subwatershed (Table 54). These health assessments indicate an overall condition of healthy with problems for the riparian areas in the subwatershed. The majority of riparian health problems are caused by noxious and invasive weedy plant species and free access to shores by animals, which often results in loss of desirable woody plant species due to grazing pressure, pugging and hummocking and streambank instability and erosion.

Table 54. Riparian health assessment of waterbodies in the Little Red Deer River subwatershed.

Waterbody	Location	Primary health issues	Ranking
Little Red Deer River, Dogpound Creek, Trail Creek, Olds Creek, Bowden Creek [1]	Selected areas along major rivers and creeks	Invasive plant species, heavy grazing of woody plants, lack of regeneration of desired woody plant species	Healthy with problems
Little Red Deer River to confluence with Red Deer River, Bowden Creek [2]	Selected locations along the river, 2 locations on Bowden Creek	Invasive plant species, disturbance caused herbaceous species, low utilization of preferred trees and shrubs	15 sites, 5 healthy, 9 healthy but with problems, 1 unhealthy
Little Red Deer River [3]	NW9-33-3-W5	Noxious and disturbance-caused weeds, bare and compacted soils, channel incisions, poor stream rock volume, low regeneration of woody plants	Unhealthy
Little Red Deer River [3]	NE8-33-3-W5	No issues	Healthy

Little Red Deer River [3]	SW9-33-3-W5	Noxious and disturbance-caused weeds, heavy grazing of woody plants, bare and compacted soils, slumping creek banks	Unhealthy
Little Red Deer River [4]	Cremona to downstream of confluence with Dogpound Creek	Noxious and disturbance-caused weeds, low canopy cover, grazing of woody plants, susceptibility to erosions, high access to stream by animals	9 locations: 1 healthy 2 healthy with problems, 6 unhealthy
Little Red Deer River [5]	NW36-32-4-W5	Concern of weeds in upland areas	Healthy
Little Red Deer River [6]	Cremona to downstream of confluence with Dogpound Creek	Noxious and disturbance-caused weeds, grazing of woody plants, low streambank deep-root mass	8 locations: 4 healthy with problems, 4 unhealthy
Little Red Deer River and Dogpound Creek [7]	Middle reach of Little Red Deer River (8 sites) and lower reach of Dogpound Creek (2 sites)	Noxious and disturbance-caused weeds, unrestricted grazing, bare soil	10 locations: 4 healthy, 5 healthy with problems, 1 unhealthy
Big Prairie Creek/Graham Creek [8]	N9-30-5-W4 & N10-30-5-W5	Loss of woody plants, noxious and disturbance-caused weeds, pugging and hummocking	Healthy to healthy with problems
Tributary to Dogpound Creek [9]	9-31-3-W5	Noxious and disturbance-caused weeds, streambank damage, susceptibility to erosion, desirable woody plants at risk, pugging and hummocking	Unhealthy
Tributary to Little Red Deer River [10]	NW28-30-4-W5	Noxious and disturbance-caused weeds, grazing of desirable woody plants	Healthy with problems
Small creek in headwaters of Little Red Deer River [11]	NE26-29-6-W5	Undesirable plants, some bare soil, impacts from dam construction	Healthy with problems
Small lake near Fallentimber Creek [12]	S24/N13-32-5-W5	Noxious and disturbance-caused weeds in upland, some overgrazing by livestock, pugging and hummocking, reduction of woody plants	Healthy with problems

Note: 1 = Cows and Fish (2005b), 2 = Cows and Fish (2002), 3 = Alberta Conservation Association (2002a), 4 = Alberta Conservation Association (2002b), 5 = Anon. (2002e), 6 = Alberta Conservation Association (2002c), 7 = Dovichak (2002), 8 = Anon. (2002f), 9 = Anon. (2002g), 10 = Anon. (2002h), 11 = Anon. (2002i), 12 = Anon. (2002j).

Management options for riparian areas in this subwatershed include fencing off creeks for optimal control of livestock, developing off-site watering or graveled access for livestock to creeks, control of weeds to reduce competition with desirable plants, and the planting of herbaceous and woody vegetation to reduce soil erosion.

4.4.2.3 Livestock Manure Production

Areas of higher livestock density within a subwatershed, and their associated higher manure production, are expected to have greater impacts on downstream water quality. Streams that drain land with high intensity livestock operations have higher nutrient concentrations, dissolved nutrients, mass loads, fecal bacteria and exports of total dissolved phosphorus than streams with medium or low intensity livestock operations and manure production.

There are 17 feedlots/intensive livestock operations in the Little Red Deer River subwatershed (Figure 114). Most of these are located in the northeast of the subwatershed, finishing cattle/cows (10 feedlots), swine (3 feedlots), turkey (2 feedlots) and poultry (2 feedlots) (AAFC-PFRA, 2008).

Cattle density ranges from 0-0.20 cattle/ha in the south-western area of the subwatershed to 0.21-0.40 cattle/ha in the central area of the subwatershed and 0.41-1.00 cattle/ha towards the north-eastern area of the subwatershed (Figure 115) (AAFC-PFRA, 2008). Manure production by all livestock operations ranges from 2.6-5.0 tonnes manure/ha throughout most of the subwatershed, although it increases to 5.1-7.5 tonnes manure/ha in the north-eastern area of the subwatershed (Figures 116) (AAFC-PFRA, 2008). Manure production is considered low for the Little Red Deer River subwatershed relative to the remainder of the Red Deer River watershed.

Agricultural intensity, expressed as the percent land cover used as croplands, is low in the southwestern area of the Little Red Deer River subwatershed (0-20%) but progressively increases towards the northeastern area, peaking at 60-80% in the northern and western areas (Figure 117) (AAFC-PFRA, 2008).

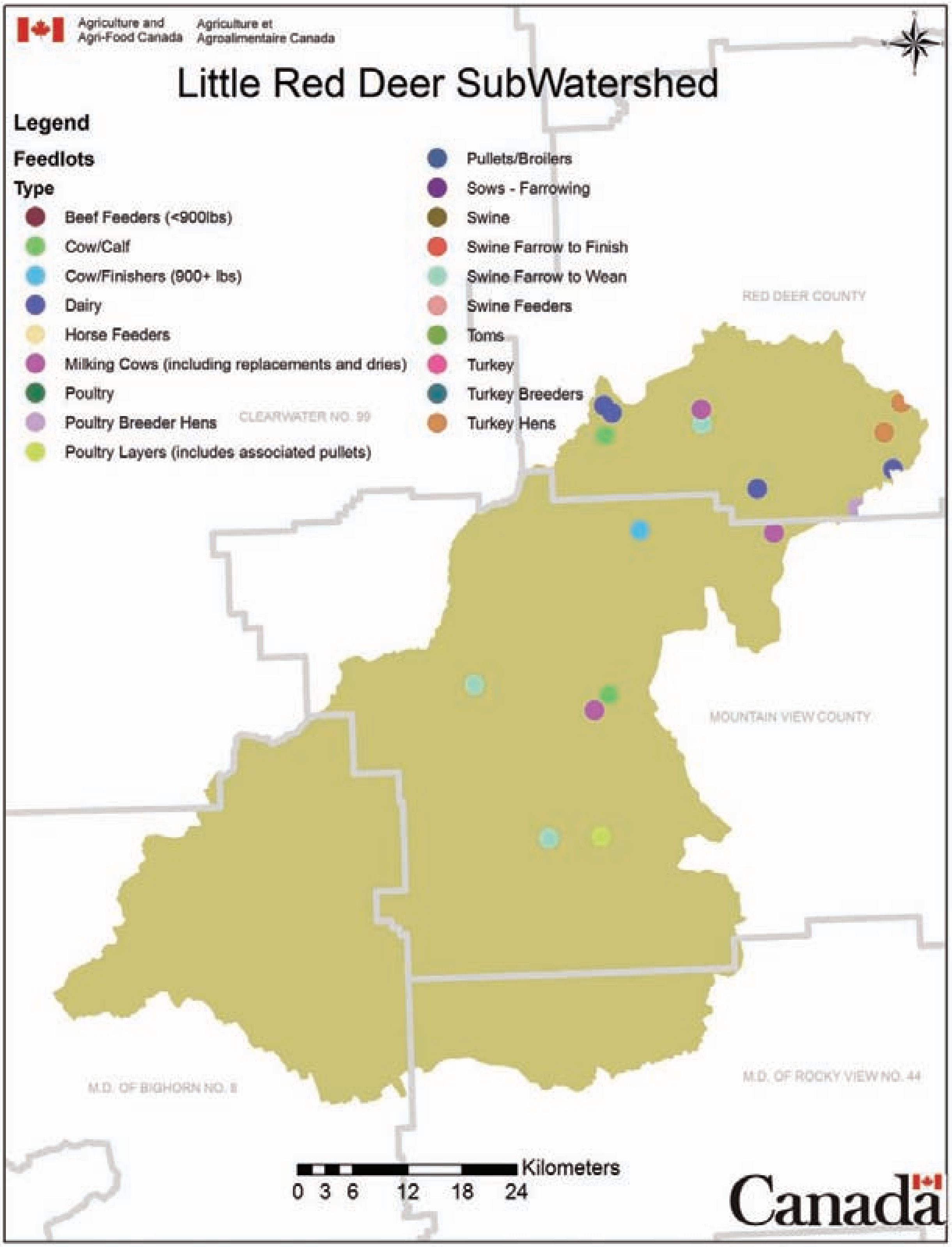


Figure 114. Feedlots and intensive livestock operations in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

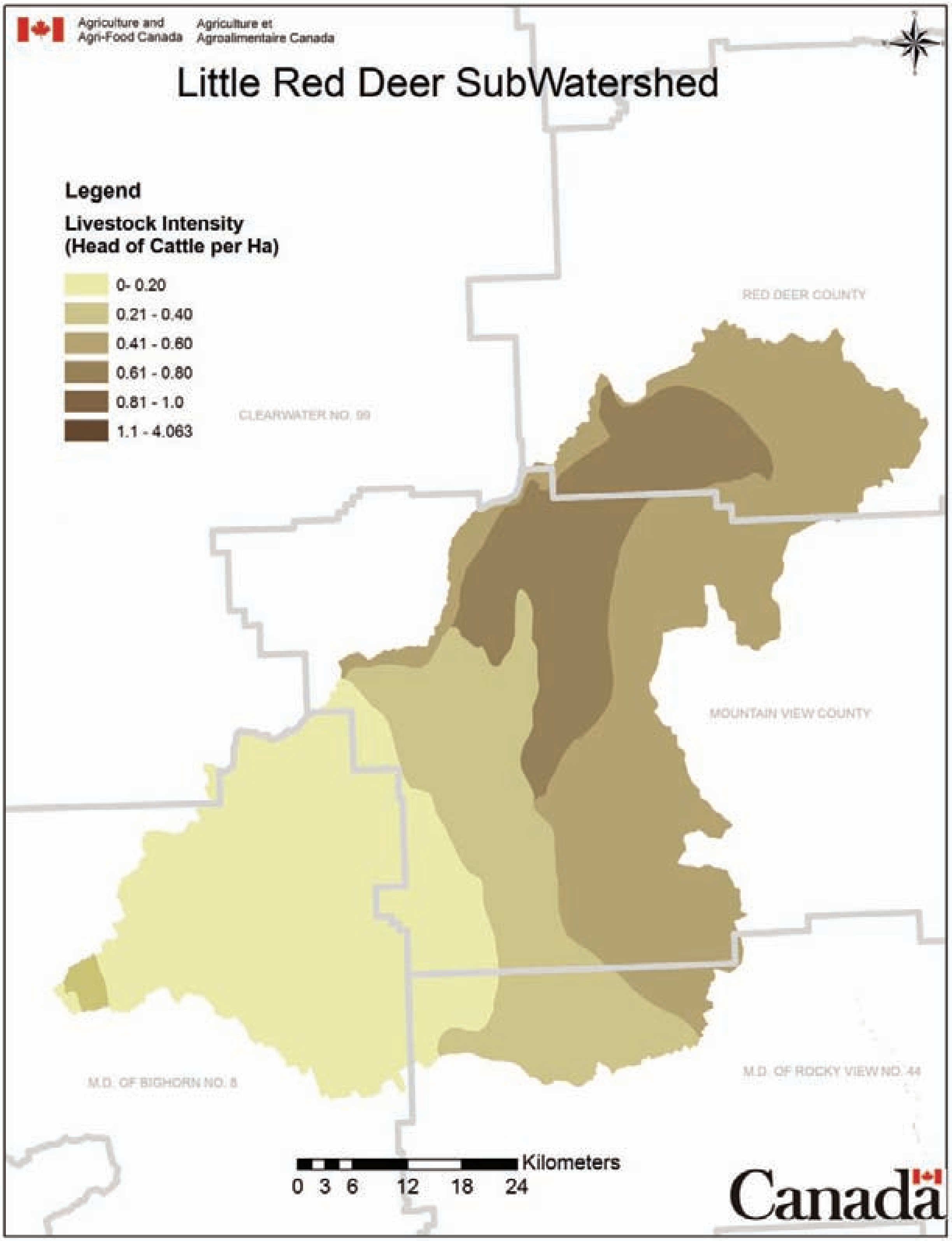


Figure 115. Cattle density (cattle/ha) in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

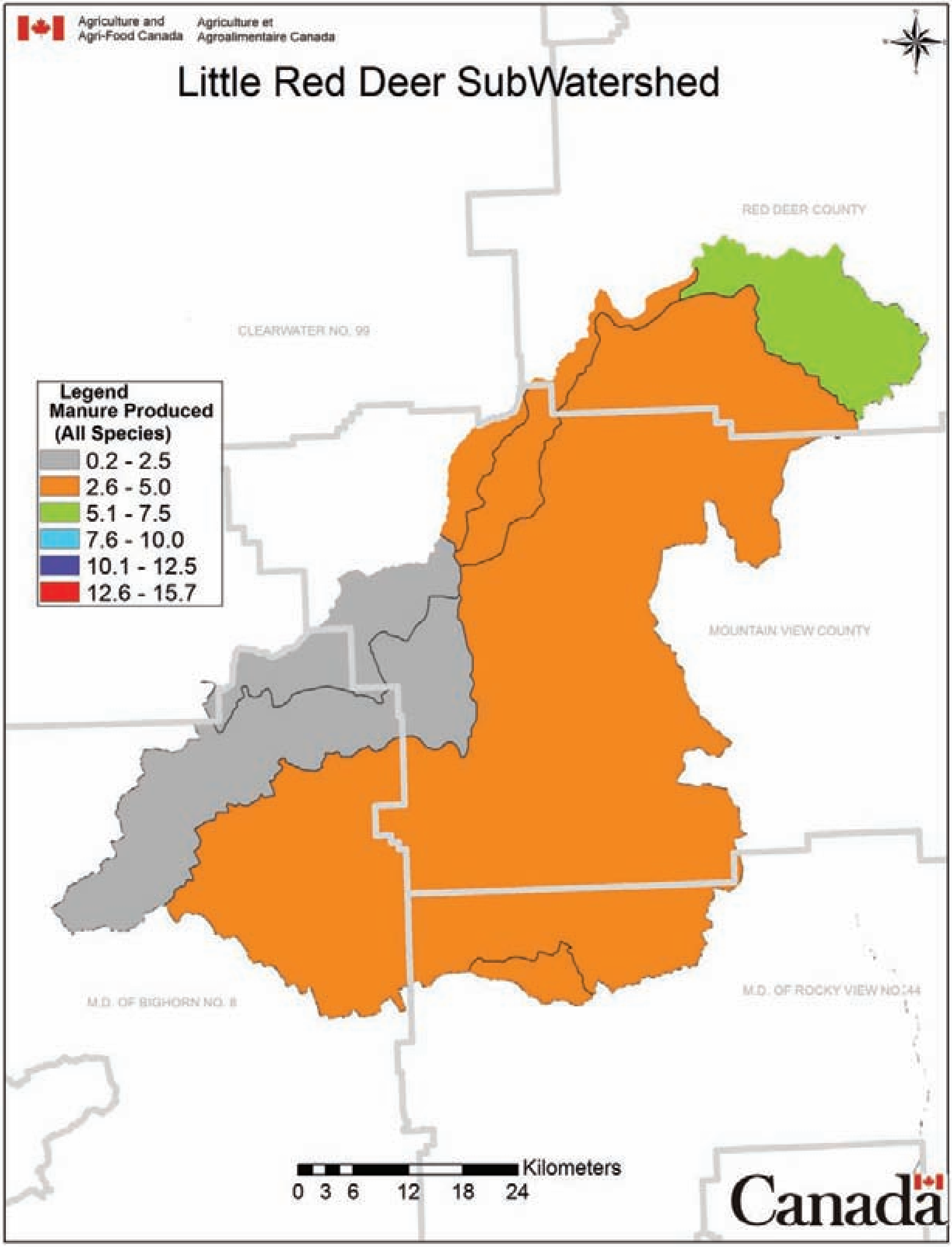


Figure 116. Manure production (tonnes/ha) in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

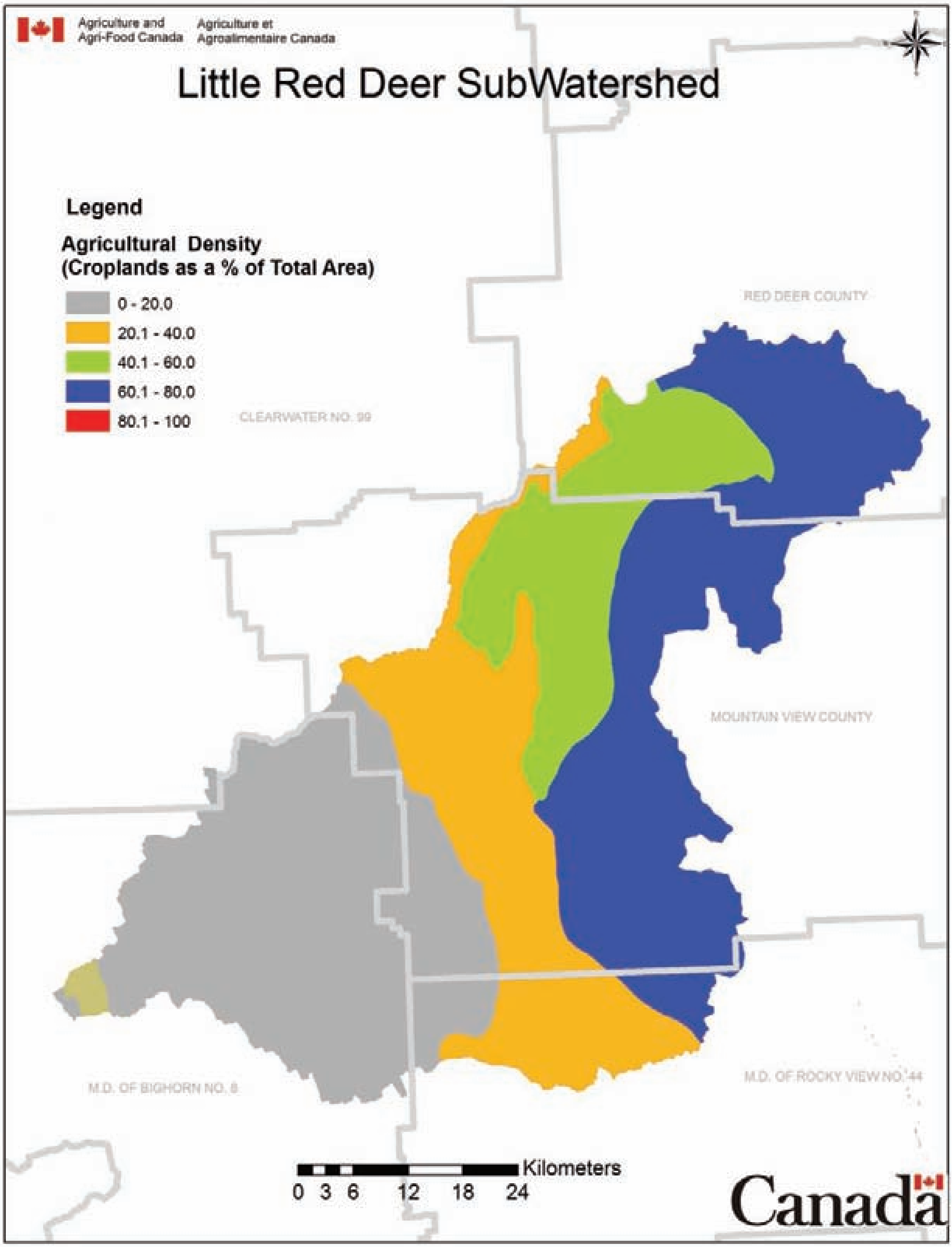


Figure 117. Agricultural intensity (% cropland) in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

4.4.2.4 Urban, Rural, Agricultural and Recreational Developments

Urban sprawl, rural and recreational development is the expansion of urban areas, rural subdivisions and recreational areas into surrounding landscape. This expansion can have many negative effects on the environment, including the loss of wetlands, riparian areas, intermittent streams and wildlife habitat, as well as increased surface runoff into neighboring creeks, rivers and lakes.

Communities in the subwatershed include the Towns of Bowden, Carstairs and Olds, the Village of Cremona and as well as numerous hamlets, including Bergen, Bottrel, Dogpound, Eagle Hill, Elkton, Garrington, Harmattan, Madden, Mound, Shantz, Water Valley, Westerdale and Westward Ho (Government of Canada, 2006).

Table 55. Recreational facilities in the Little Red Deer River subwatershed (Alberta Tourism, Parks and Recreation, 2008b.

Facility	Characteristics
Dickson Dam-South Dyke PRA	• 36.33 ha on Gleniffer Lake Reservoir • 20 unit campgrounds, 150 unit group camp sites
Dickson Dam-South Valley PRA	• 15.55 ha on Gleniffer Lake Reservoir • day use sites
Fallentimber Creek PRA	• 2.64 ha on Fallentimber Creek • 34 unit campgrounds
Fallentimber South PFRA	• 50.02 ha on Fallentimber Creek • 62 unit campgrounds, day use sites
Harold Creek Road Corridor WS	• 129.08 ha on the Little Red Deer River • 120 unit campgrounds (25 with electrical hookups), 17 unit group campgrounds, day use areas
Red Lodge PP	• 129.08 ha on the Little Red Deer River • 120 unit campgrounds (25 with electrical hookups), 17 unit group campgrounds, day use areas
Snakes Head PNA	• 53.82 ha • day use sites
Sundre North PNA	• 10.4 ha on the Red Deer River • day use sites
Waiparous Creek PFRA	• 102.26 ha on Waiparous Creek • 56 unit campgrounds, 22 unit group campgrounds • off-highway motor vehicle (OHV) access; developed OHV trails
William J. Bagnell WP	• Dump site for local methamphetamine labs

Note: PFRA = provincial forest recreation area, PNA = provincial natural area, PP = provincial park, PRA = provincial recreation area, WP = wilderness park, WS = wildlife sanctuary.

There are ten recreational facilities located within the subwatershed, including Provincial Recreation Areas (PRA), Provincial Forest Recreation Areas (PFRA), Provincial Natural Areas (PNA), one Wilderness Park (WP), one Wildlife Sanctuary (WS) and one Provincial Park (PP) (Table 55) (Alberta Tourism, Parks and Recreation, 2008b).

Visitation statistics for two recreation facilities in the subwatershed with available data indicate that the number of visitors to these facilities varies considerably on an annual basis (Figure 118). For those years with available data, the average number of visitors per year was 454 in Dickson Dam-South Dyke PRA and 8,755 in Red Lodge PP. An average 9,136 visitors have used these two recreation facilities annually from 1994-2003; however, there are numerous years with incomplete visitation data (lack of group camping data), and the number of visitors to these facilities is likely substantially higher (Alberta Tourism, Parks and Recreation, 2008b).

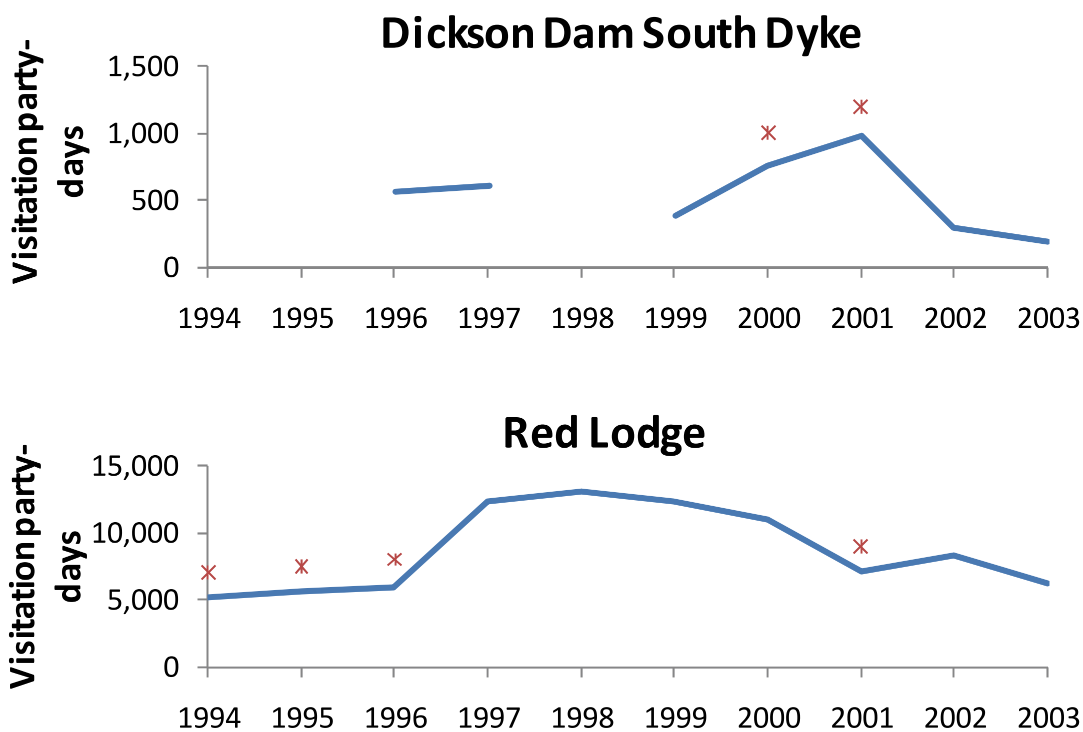


Figure 118. Visitation statistics for two recreation facilities in the Little Red Deer River subwatershed (Alberta Tourism, Parks and Recreation, 2008b). Asterisks indicate years for which group camp data were not available.

4.4.2.5 Linear Developments

Linear developments include seismic lines, pipelines, roads, railways and utility right of ways. Quantifying linear development will help us understand potential changes in water quality and fish and wildlife populations, e.g., wildlife corridors can be interrupted by roads, and watersheds can have their drainage patterns permanently altered by increases in impervious or compacted surfaces.

The most prominent linear developments in the Little Red Deer River subwatershed are urban and rural roads, which have a total length of 4,300 km and cover 68.80 km^2 of the subwatershed's landbase. Other major linear developments include cutlines/trails and pipelines (Table 56). In total, all linear developments cover an area of 139.7 km^2, or 3.5% of the total area of the subwatershed (Figure 119) (AAFC-PFRA, 2008).

Table 56. Linear developments in the Little Red Deer River subwatershed (AAFC-PFRA, 2008). The dominant linear development is highlighted.

Linear Development	Length (km)	Width (m)	Area (km^2)	Proportion of total linear disturbances (%)
All roads	4,300	16	68.80	49.24
Cutlines/trails	4,100	6	24.60	17.60
Pipelines	2,600	15	39.00	27.91
Powerlines	205	30	6.15	4.40
Railways	79	15	1.19	0.85
Total	**11,284**		**139.74**	

In addition to linear developments, the Little Red Deer River subwatershed has 421 bridges that cross waterbodies, mostly streams and creeks, or culverts that connect waterbodies (Figure 120) (AAFC-PFRA, 2008). The majority of pipeline crossings in the Little Red Deer River subwatershed are located in the central area of the subwatershed near Westward Ho, Eagle Hill, Shantz and MacBeth and in the Beaverdam Creek and Little Red Deer River headwaters (Figure 121) (AAFC-PFRA, 2008).

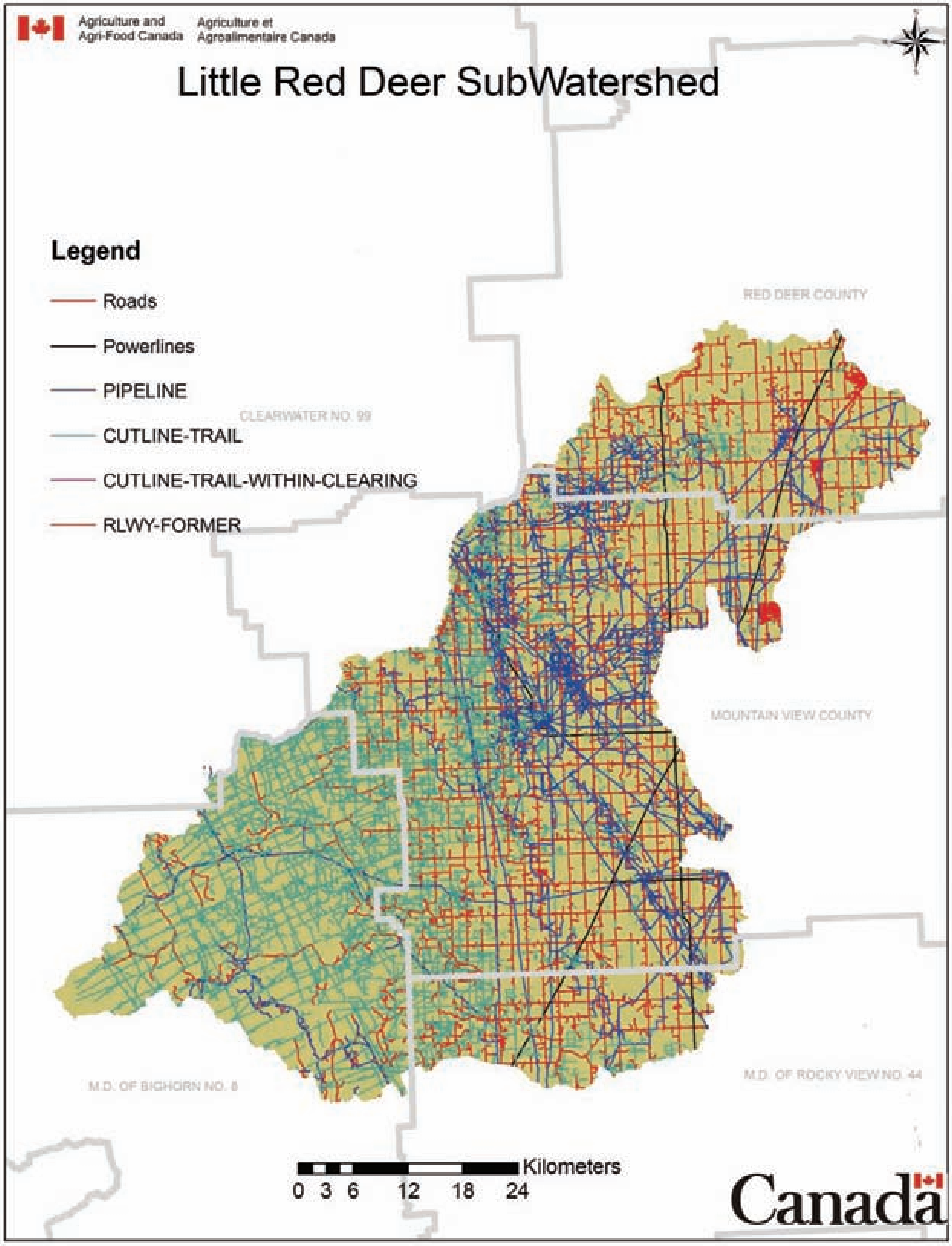


Figure 119. Linear developments in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

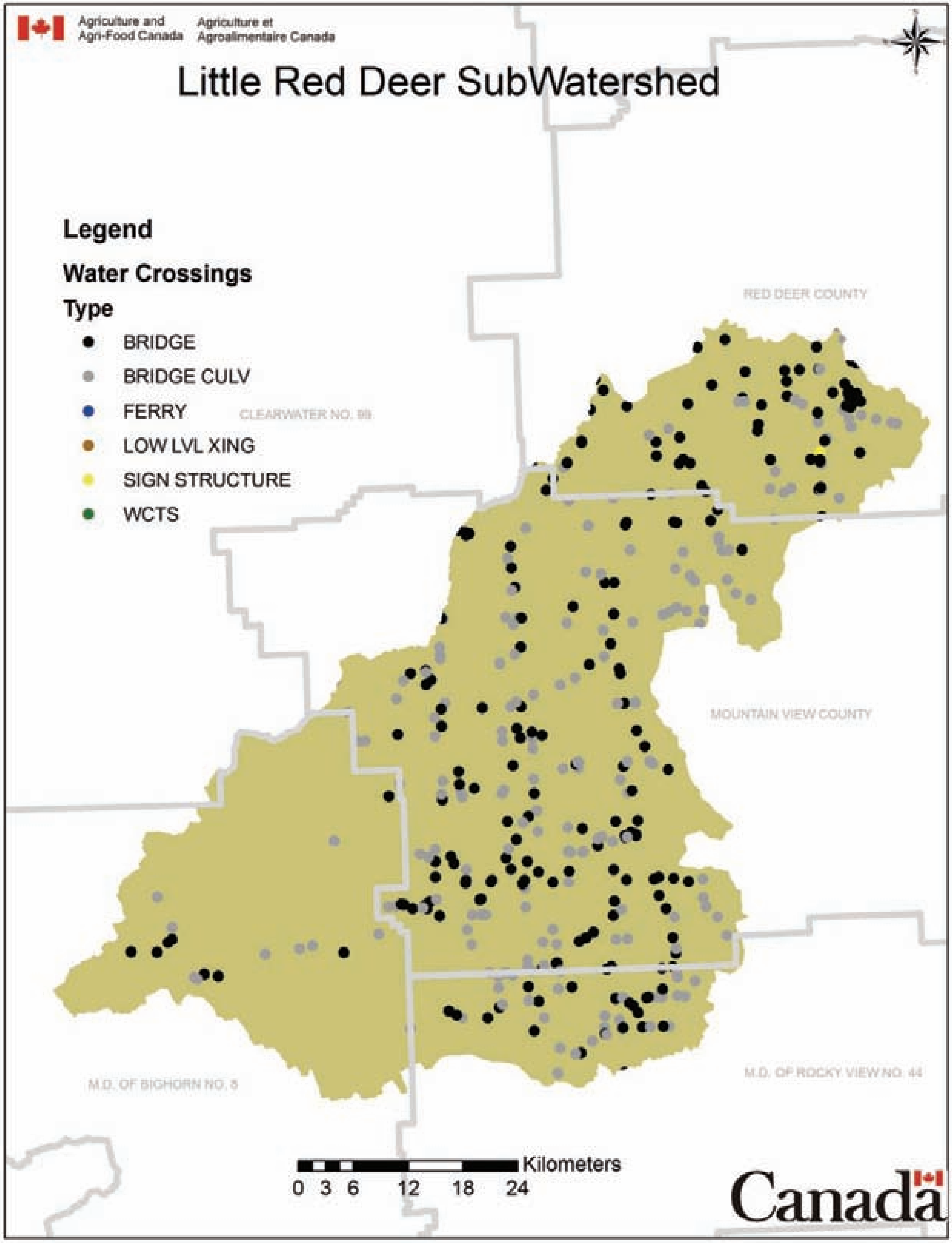


Figure 120. Waterbody crossings in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

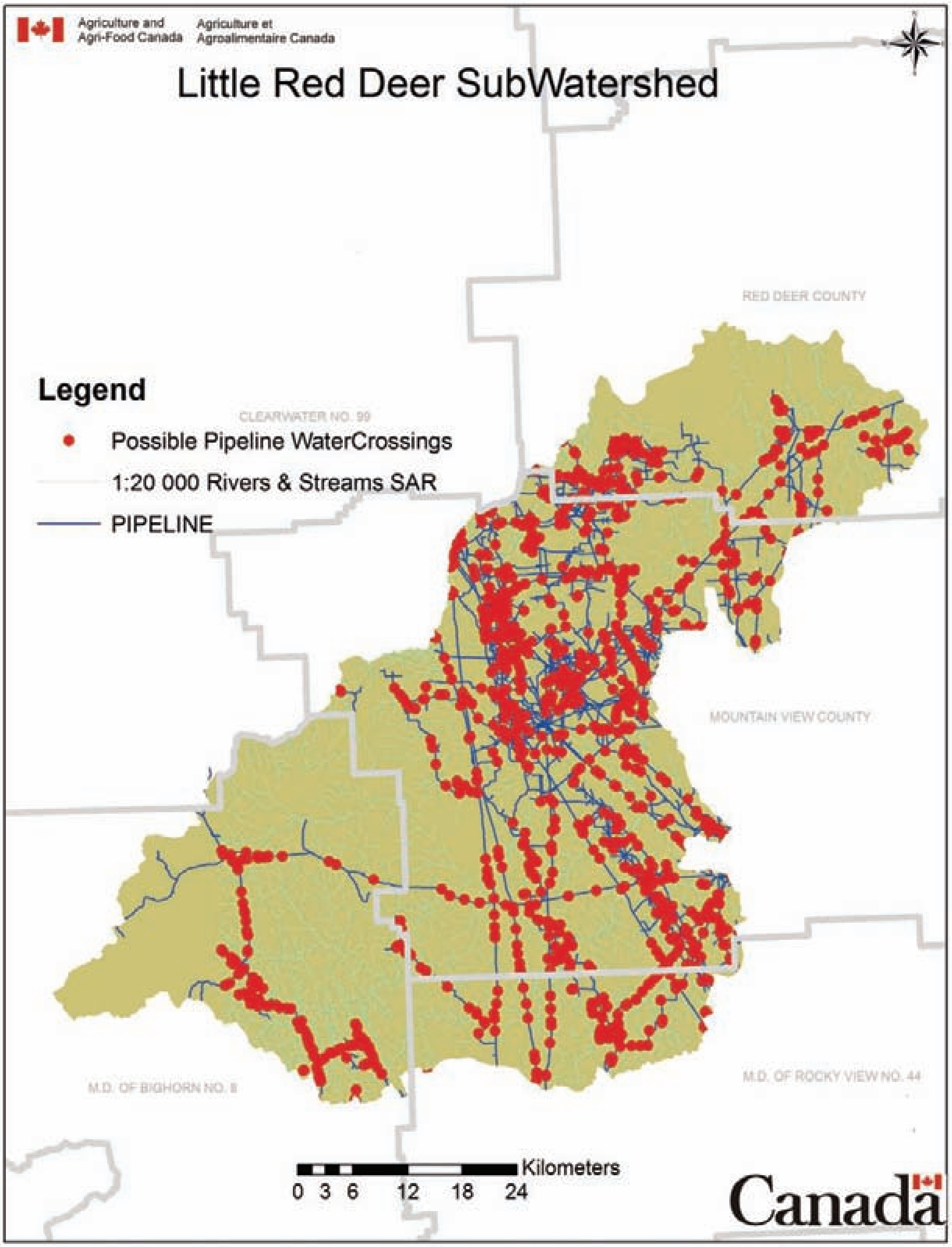


Figure 121. Pipeline crossings over waterbodies in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

4.4.2.6 Oil and Gas Activities

Oil and gas activity is very common throughout the province of Alberta. With oil and gas development there can be a number of associated impacts, including loss of wetlands, habitat fragmentation, increased water use and surface water and groundwater contamination (Alberta Centre for Boreal Studies, 2001).

The Little Red Deer River subwatershed has an average well density of 0.68 wells/km^2; however, well density increases up to 10 wells/km^2 near Innisfail and Bowden east of Gleniffer Lake Reservoir and in the Eagle Hill-Shantz-Macbeth area. About 62% of all wells are active, with the majority being oil wells, followed by gas and unspecified wells (Table 57). Oil/gas well density is low in the upper reaches of the Little Red Deer River and Fallentimber Creek, i.e., in the south-western area of the subwatershed (Figure 122) (AAFC-PFRA, 2008).

Table 57. Number of known active and abandoned oil, gas, water and other wells in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

Well type	**Quantity**
Wells – active *	364
Wells – abandoned *	588
Total	**952**
Gas wells – active	528
Gas wells – abandoned	57
Total	**585**
Oil wells – active	731
Oil wells – abandoned	349
Total	**1,080**
Water wells – active	59
Water wells – abandoned	34
Total	**93**
Total active wells in subwatershed	**1,682**
Total abandoned wells in subwatershed	**1,028**
Total wells in subwatershed	**2,710**

* The purpose of these wells is undefined and may include standing, newly licensed, flowing coalbed methane, testing coalbed methane, carbon dioxide injector or general exploration wells.

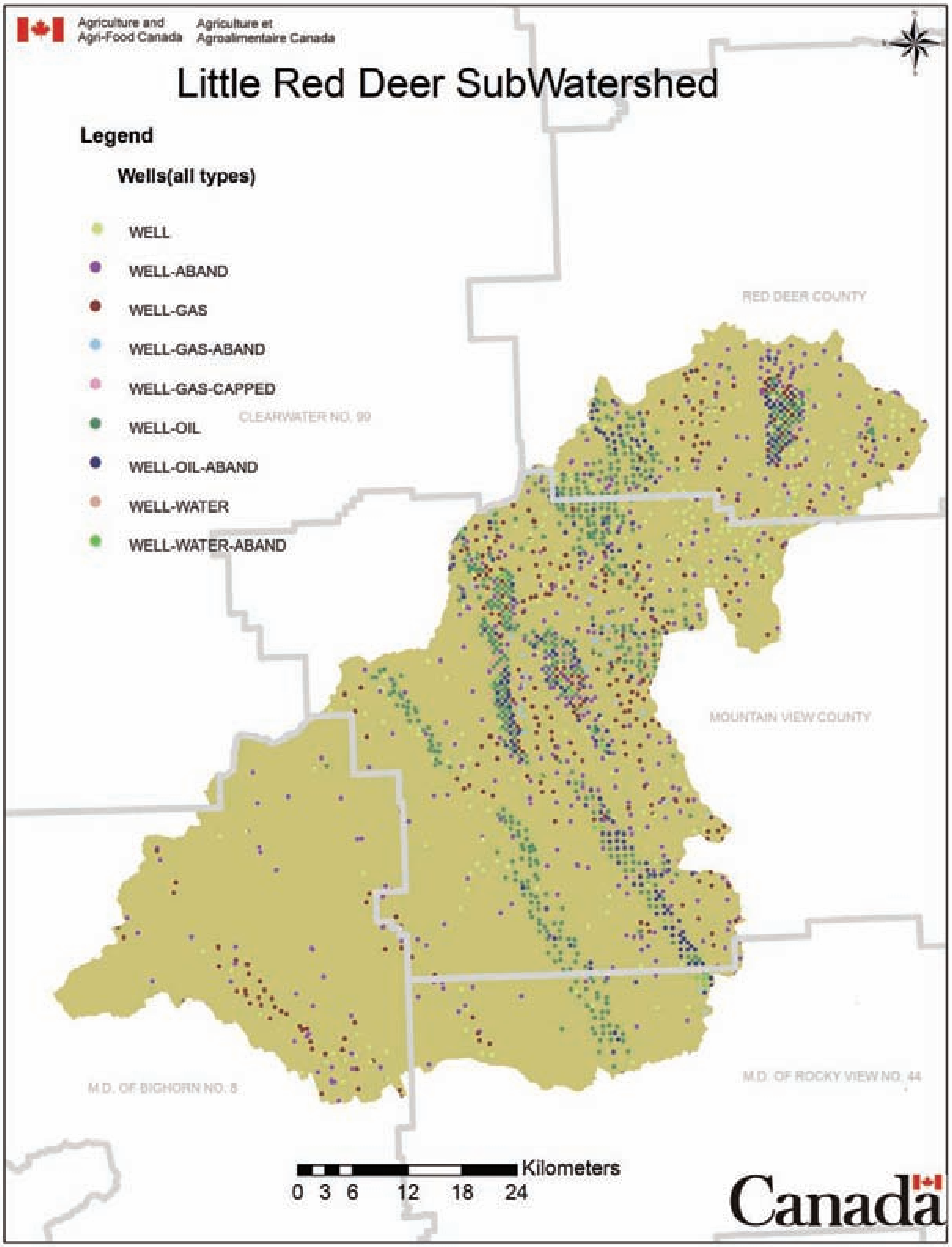


Figure 122. Known active and abandoned oil, gas, water and other wells in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

Coal bed methane (CBM) is natural gas that is found within coal formations. It has received attention recently as an additional source of energy; however, it brings with it potential environmental impacts, some of which are similar to conventional oil and gas exploration and production endeavors. Conversely, some potential impacts it brings with it are new, including an increased intensity in wells, compressors, pipeline infrastructure and completion and production of natural gas from formations above the base of groundwater protection. Some CBM wells are estimated to produce over 65,000 L of waste water per day (Lennon, 2008). In addition, common to oil, gas and unconventional gas (CBM and Shale gas) production is the risk of groundwater contamination through fracturing. Fracturing results from pumping fluids or gases into bedrock formations at high rates and pressures to 'fracture' the bedrock and increase gas or oil production. Fracturing fluids may contain toxic or carcinogenic compounds, which may leach into groundwater sources and pose a threat to human health through contaminated drinking water (Natural Resources Defense Council, 2002).

4.4.3 Water Quality Indicators

Changes in water quality indicate either a deterioration or improvement in the condition of the watershed and demonstrate specific areas that require further attention or protection. Changes in water quality result from changes in land use or land management practices, landscape disturbance and natural events. The major anthropogenic impacts on water quality result from natural resource extraction and processing, wetland drainage, dredging, dam construction, agricultural runoff, industrial wastes, municipal wastes, land erosion, road construction and land development. Five metrics were used to indicate changes in water quality in the Red Deer River watershed and its 15 subwatersheds:

- Nutrients – Condition Indicator
- Bacteria – Condition Indicator
- Parasites – Condition Indicator
- Pesticides – Condition Indicator
- Point Source Inputs

These five water quality indicators reflect socioeconomic growth in a region. Hence, while human activities in a region can have negative impacts on aquatic ecosystems, it is important to strive for a balance between socioeconomic growth and the sustainable management of these aquatic ecosystems to ensure their long-term health and enjoyment by future generations.

4.4.3.1 Nutrients

Nitrogen and phosphorus are essential nutrients for most aquatic plants, whereby excess nutrients can lead to eutrophication, i.e., an excessive amount of aquatic plant and phytoplankton growth. Concomitant with increased plant and phytoplankton growth, oxygen levels may significantly decrease in the water column, which may negatively impact aquatic organisms, including fish. In addition, excessive phytoplankton growth, particularly of cyanobacteria, can lead to the release of toxins into the water column, which may be harmful to aquatic organisms, waterfowl, livestock and humans.

The most comprehensive water quality assessment has been done in Fallentimber Creek. Here, TP concentrations are generally low and rarely exceed the ASWQG PAL limit of 0.05 mg/L (Figure 123).

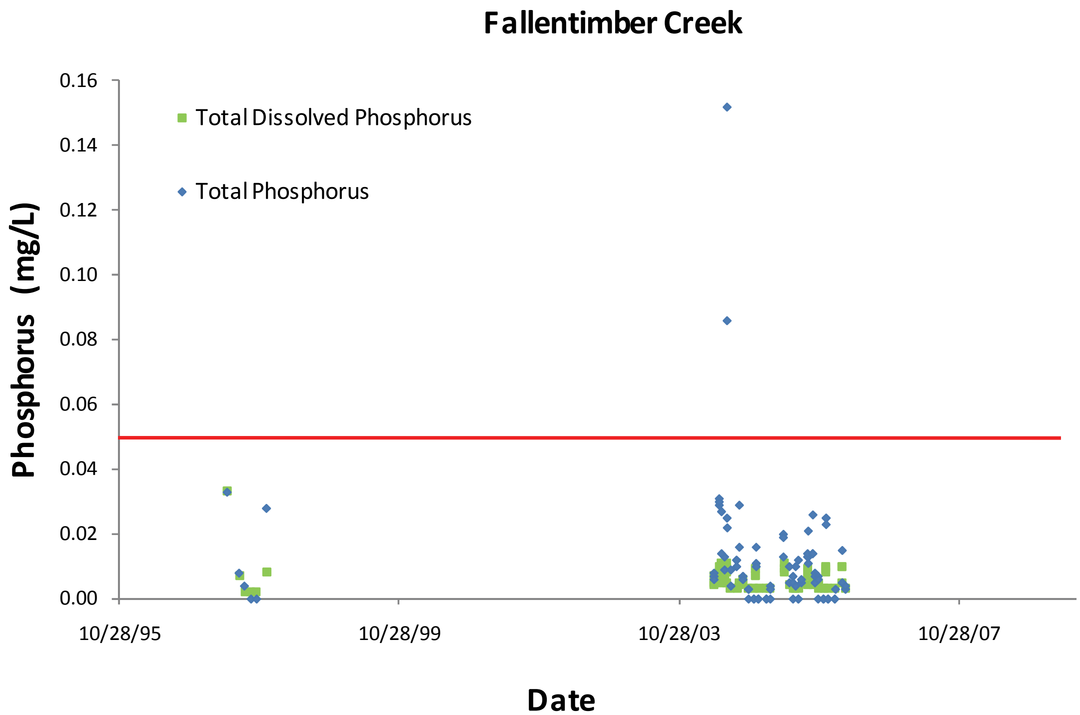


Figure 123. Total phosphorus (TP) and total dissolved phosphorus (TDP) concentrations in Fallentimber Creek (data from Alberta Environment, 2008). The ASWQG PAL for TP (0.05 mg/L) is indicated by the red line.

For the remainder of the Little Red Deer River subwatershed, relatively limited water quality assessments have been performed since 1987. Mean TP concentrations were above ASWQ and CCME PAL guidelines(0.05 mg/L) in Graham Creek, Little Dogpound Creek and the Little Red Deer River (0.066 mg/L, 0.148 mg/L and 0.093 mg/L, respectively) (Table 58). Sources of phosphorus include surface application of manure and/or fertilizer by agricultural producers (Carpenter et al., 1998; Chambers et al., 2001), municipal wastewater effluents (Servos et al., 2001) and urban run-off (Marsalek et al., 2001), all of which have been demonstrated to be a source of excess nutrients to surface waterbodies. Both agricultural and livestock operations occur in the vicinity of Dogpound Creek and the Little Red Deer River in the subwatershed.

Table 58. Water quality in creeks and rivers in the Little Red Deer subwatershed. n = sample size. All concentrations in mg/L unless otherwise noted. Concentrations exceeding water quality guidelines are highlighted *.

Parameter	Beaverdam Creek		Graham Creek		Little Dogpound Creek		Little Red Deer River		Silver Creek		Stony Creek	
	Mean	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**
TP	0.029	3	0.066	1	0.148	1	0.093	107	0.041	1	---	---
TDP	0.011	1	---	---	---	---	0.030	107	---	---	---	---
TN	---	---	---	---	---	---	0.891	107	---	---	---	---
NO_3^--NO_2^-	0.481	3	< 0.02	1	0.780	1	0.085	107	< 0.02	1	< 0.02	1
NH_3	0.025	2	0.012	1	0.023	1	0.090	107	---	---	---	---
DO	9.5	3	---	---	8.6	1	---	---	9.0	1	---	---
Chl. *a* (µg/L)	---	---	---	---	---	---	---	---	---	---	---	---
pH	7.97	3	7.30	1	8.30	1	8.16	108	8.15	2	8.20	2
Specific Conductivity (µS/cm)	560	3	440	1	499	1	330	102	288	1	398	2
TDS	331	3	---	---	305	1	--	--	174	1	230	1
Total coliforms (CFU/100 mL)	---	---	---	---	---	---	---	---	---	---	---	---
Fecal coliforms (CFU/100 mL)	330	1	---	---	---	---	242	102	---	---	---	---
E. coli (CFU/100 mL)	---	---	---	---	---	---	231	100	---	---	---	---

* TN from ASWQG PAL chronic exposure guideline; fecal and total coliforms from CCME-Agriculture/Irrigation guideline; all others from CCME PAL. The Beaverdam Creek samples were collected in April 1987 and October 1997; the Graham Creek and Dogpound Creek samples were collected in April 1987; the Silver Creek and Stony Creek samples were collected in August 1987; the Little Red Deer River samples were collected from 1999-2002 (data from Alberta Environment). Variable abbreviations as in Table 10.

4.4.3.2 Bacteria

Coliforms are a broad class of bacteria found in human and animal wastes. Total coliforms include *Escherichia coli*, fecal bacteria and other coliforms that occur naturally in warm blooded animals. *E. coli* is one of three bacteria commonly used to measure the direct contamination of water by human or other mammal wastes. Ingestion of or exposure to fecal bacteria can have negative health impacts. Sources of this type of bacteria include agricultural and municipal runoff, wildlife, faulty septic systems and septic fields.

Fecal coliform concentrations in Fallentimber Creek are variable, with the majority of samples below both the CCME Agriculture/Irrigation and Health Canada Recreation water quality guidelines (Figure 124). Due to the occasional elevated fecal coliform concentrations in this creek, further sampling is recommended to identify the source(s) of these bacteria in the creek. Additionally, data on bacterial concentrations in other waterbodies in the subwatershed are uncommon. A series of water samples has been collected and analyzed for fecal coliform bacteria and *E. coli* concentrations in the Little Red Deer River, and one water sample has been collected and analyzed for fecal coliform bacterial concentrations in Beaverdam Creek. Fecal coliform bacterial concentrations were above CCME Agriculture/Irrigation guidelines in both waterbodies (Table 58), suggesting possible contamination of the creek water from agricultural runoff.

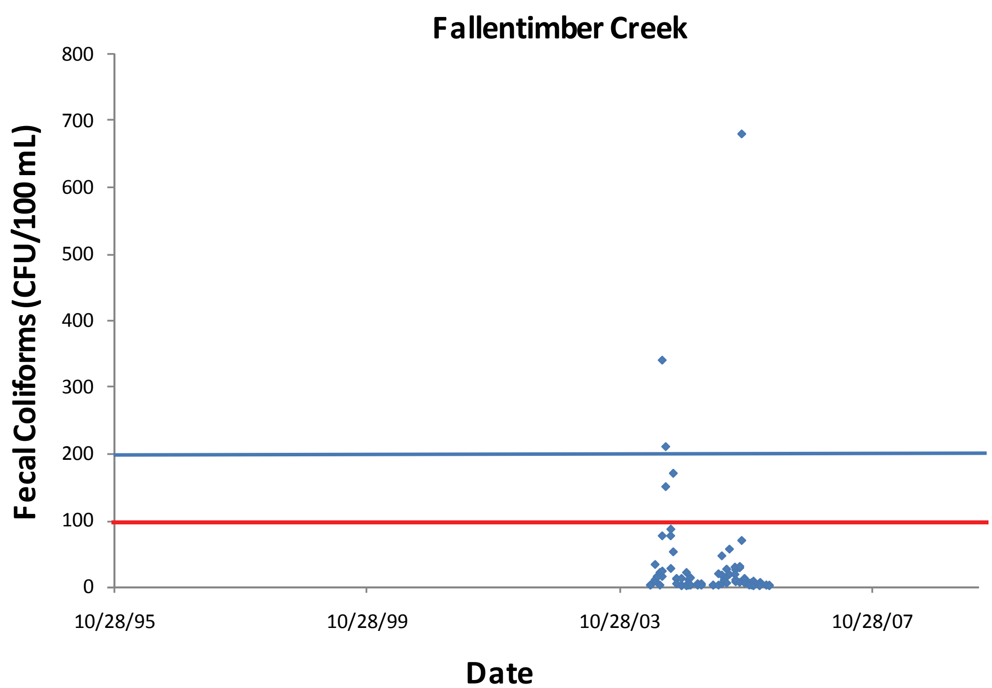


Figure 124. Fecal coliform concentrations in Fallentimber Creek (data from Alberta Environment, 2008). The CCME Agriculture/Irrigation guideline for fecal coliforms (100 CFU/100 mL) is indicated by the red line, and the Health Canada Guideline for Recreational Water Quality for fecal coliforms (200 CFU/100 mL) is indicated by the blue line.

4.4.3.3 Parasites

Waters that are polluted may contain several different disease-causing organisms, commonly called parasites. Enteric parasites, those that live in the intestine of warm blooded animals, can carry or cause a number of infectious diseases. *Cryptosporidium* and *Giardia* spp. are two such parasites. Both occur in almost all environments, including lakes, rivers, reservoirs and groundwater. They come from the feces of rodents, birds, cows, pigs and humans, and the ingestion of these parasites causes gastrointestinal conditions known as cryptosporidiosis and giardiasis.

Parasite data were not located for any waterbody in the Little Red Deer River subwatershed.

4.4.3.4 Pesticides

Pesticides are a group of chemicals, including herbicides, insecticides, rodenticides and fungicides, used for many purposes, including pest control and aesthetics in urban areas, golf courses and in forestry and agricultural production. Pesticides are a common contaminant of streams and dugouts in the high intensity agricultural areas of Alberta.

In the Little Red Deer River subwatershed, 11 different pesticides have been detected in the Little Red Deer River and two have been detected in Dogpound Creek (Table 59). None of them exceeded CCME PAL guidelines; however, there are no guidelines for four of the 11 pesticides. Only 2,4-D and MCPA, both herbicides to control broadleaf plants, occurred in both waterbodies.

Table 59. Pesticide concentrations in the Little Red River and Dogpound Creek. n = sample size. All concentrations in µg/L. The most common pesticides are highlighted.

Waterbody	Pesticide	Mean range *	Maximum	CCME PAL	n
Little Red Deer River	2,4-D	0.011-0.014	0.084	4.0	53
	Aldicarb	0.009-0.100	0.100	1.0	11
	Bromoxynil	0.0001-0.0049	0.005	5.0	53
	Dicamba	0.0001-0.0049	0.003	10.0	21
	Diuron	0.003-0.200	0.174	---	53
	Imazamethabenz-methyl	0.002-0.050	0.080	---	53
	MCPA	0.004-0.008	0.074	2.6	53
	MCPP	0.002-0.006	0.031	---	53
	Picloram	0.009-0.013	0.201	29.0	53
	Triallate	0.0001-0.0050	0.007	0.24	53
	Triclopyr	0.0002-0.0096	0.004	---	19
Dogpound Creek	2,4-D	0.007-0.009	0.013	4.0	2
	MCPA	0.006-0.009	0.012	2.6	2

* A precise mean could not be determined because the analytical methods used do not distinguish between values of zero and values that are below the detection limit (BDL). The range of the mean was calculated by first assuming that all BDL samples were equal to zero (providing the lower end of the range), and then by assuming that all BDL samples were equal to the detection limit (providing the upper end of the range). Where no values below the detection limit were present, a single average value was calculated. In the Little Red Deer River, water samples were collected July 1970-December 2006; in Dogpound Creek, water samples were collected in August 2002 (data from Alberta Environment).

4.4.3.5 Point Source Inputs

Point source inputs include effluents from waste water treatment plants (WWTP), stormwater outfalls and industry. Effluent from WWTP's, although regulated, generally has higher concentrations of certain compounds (e.g., nutrients, solids, pharmaceuticals, metals, etc.) than the receiving environment. Similarly, stormwater outfalls contain elevated levels of nutrients, salts and solids compared to the receiving environment, and industrial effluents can contribute elevated levels of a suite of different contaminants, such as metals, solids, hydrocarbons and/or salts, as well as other chemicals used in processing or manufacturing, to aquatic ecosystems.

At least 19 upstream oil/gas facilities, one federal institution and two commercial facilities have released pollutants continuously or sporadically into the air in the Little Red Deer River subwatershed since 1995. The pollutants from the oil/gas processing facilities include nitrous oxide (N_2O), carbon monoxide (CO) and volatile organic compounds (VOCs). The federal institution has released lead (Pb) and its compounds onto land, while the commercial facilities have released VOCs, CO, N_2O, particulate matter < 10 µm in size, ammonia (NH_3), sulphuric acid (H_2SO_4), phosphorus, and heavy metals (chromium, zinc) into the air or into landfills following treatment (NPRI, 2008). The location of the landfill is unknown. No pollutants were released directly into aquatic ecosystems according to the National Pollution Release Inventory.

4.4.4 Water Quantity Indicators

Water quantity is important for the maintenance of aquatic habitat, it has functions related to water quality and it is essential for the treatment and production of sufficient volumes of drinking water to meet current demands. Irrigation, industry and livestock production are highly dependent on a minimum amount of water. Sufficient water quantity is necessary for many recreational activities, and in recent years many cottagers and recreational lake users across Alberta have voiced concerns about the decreasing volumes of water seen across the province. Five metrics were used as water quantity indicators in the Red Deer River watershed and its 15 subwatersheds:

- Volume
- Minimum Flows to Maintain Ecological Integrity – Condition Indicator
- Contributing Areas to the Watershed
- Allocations
- Groundwater Recharge/Discharge

Water discharge rates, allocations and minimum flow rates to maintain ecological integrity can reflect socioeconomic growth in a region. Human activities in a region frequently reduce available water quantities required to maintain healthy aquatic ecosystems. It is important to balance socioeconomic growth and the sustainable management of these aquatic ecosystems to ensure their long-term health and enjoyment by future generations.

4.4.4.1 Volume

Water volume is the amount of water flowing past one point over a given time, or in the case of lakes or other standing waterbodies, the total amount of water present in the waterbody at a given time. This amount varies seasonally and annually with shifts in weather patterns. Water withdrawals for consumptive uses have increased dramatically in recent years and have resulted in some watersheds within the province being closed to new water licenses.

The total length of all water sources in the Little Red Deer River subwatershed is about 2,806 km (Figure 125) (AAFC-PFRA, 2008). The major streams in the subwatershed include the Little Red Deer River, Atkinson Creek, Beaverdam Creek, Benjamin Creek, Bergen Creek, Big Prairie Creek, Bowden Creek, Dogpound Creek, Eagle Creek, Elkton Creek, Fair Creek, Fallentimber Creek, Graham Creek, Grease Creek, Harold Creek, Highland Creek, Mouse Creek, Nitichi Creek, Nuisance Creek, Olds Creek, Salter Creek, Silver Creek, Stony Creek, Stormy Creek, Trail Creek and Turnbull Creek. The major lakes include Boggy Lake, Hicklon Lake, Salter Lake and Waterstreet Lake. In addition, there are numerous small creeks and sloughs in the subwatershed (Government of Canada, 2006).

Alberta Environment has been monitoring water discharge rates in the Little Red Deer River subwatershed at four locations: Little Red Deer River near the confluence with Red Deer River (real-time active, 05CB001), Little Red Deer River near Water Valley (real-time active, 05CB002), Fallentimber Creek near Sundre (real-time active, 05CA012) and in the headwaters of Beaverdam Creek (discontinued, 05CB005) (Government of Alberta, 2008c). Near the confluence of Little Red Deer River and Red Deer River, average water discharge rates are relatively consistent from April to the end of June, ranging from 4-7 m^3/sec. Thereafter, discharge rates decrease from about 4 m^3/sec to less than 2 m^3/sec towards the end of October. Historically, the trend from April to October is similar to water discharge rates seen in 2008. Discharge maxima of 30-50 m^3/sec and higher have been reached between April and July in response to rain events (Figure 126) (Government of Alberta, 2008c).

Water discharge rates in Fallentimber Creek near Sundre increased from 1 m^3/sec to 5 m^3/sec from April to early June. Thereafter, discharge rates decrease from about 5 m^3/sec to less than 2 m^3/sec towards the end of October. Historically, the trend from April to October is similar to water discharge rates seen in 2008. Discharge maxima of 10 m^3/sec occur in mid-summer and minima of < 1 m^3/sec occur in late winter and early spring (Figure 127) (Government of Alberta, 2008c).

In the headwaters of the Little Red Deer River near Water Valley, water discharge rates increased from < 1 m^3/sec to 4 m^3/sec from April to early June. Thereafter, discharge rates decrease from about 4 m^3/sec to less than 1 m^3/sec towards the end of October. Historically, the trend from April to October is similar to water discharge rates seen in 2008. Discharge maxima of 8 m^3/sec occur in mid-summer and minima of < 1 m^3/sec occur in late fall and early spring (Figure 128) (Government of Alberta, 2008c).

Water discharge rates at all three stations were well above historical levels in the spring and early summer 2008, when they exceeded 100 m^3/sec on at least one occasion (Figures 126, 127, 128). They remained well above average discharge rates at both Little Red Deer River stations for the remainder of year (Government of Alberta, 2008c).

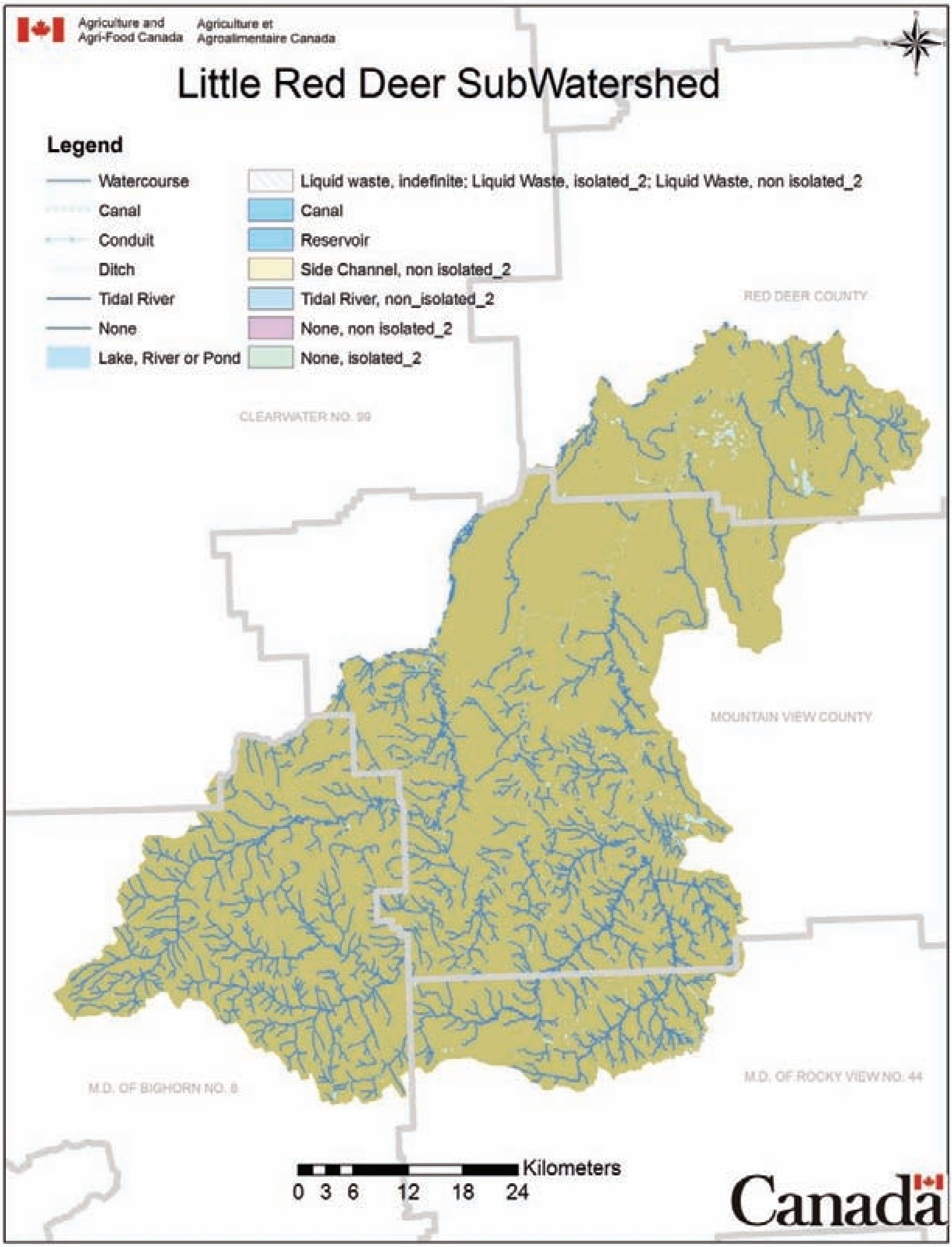


Figure 125. Waterbodies in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

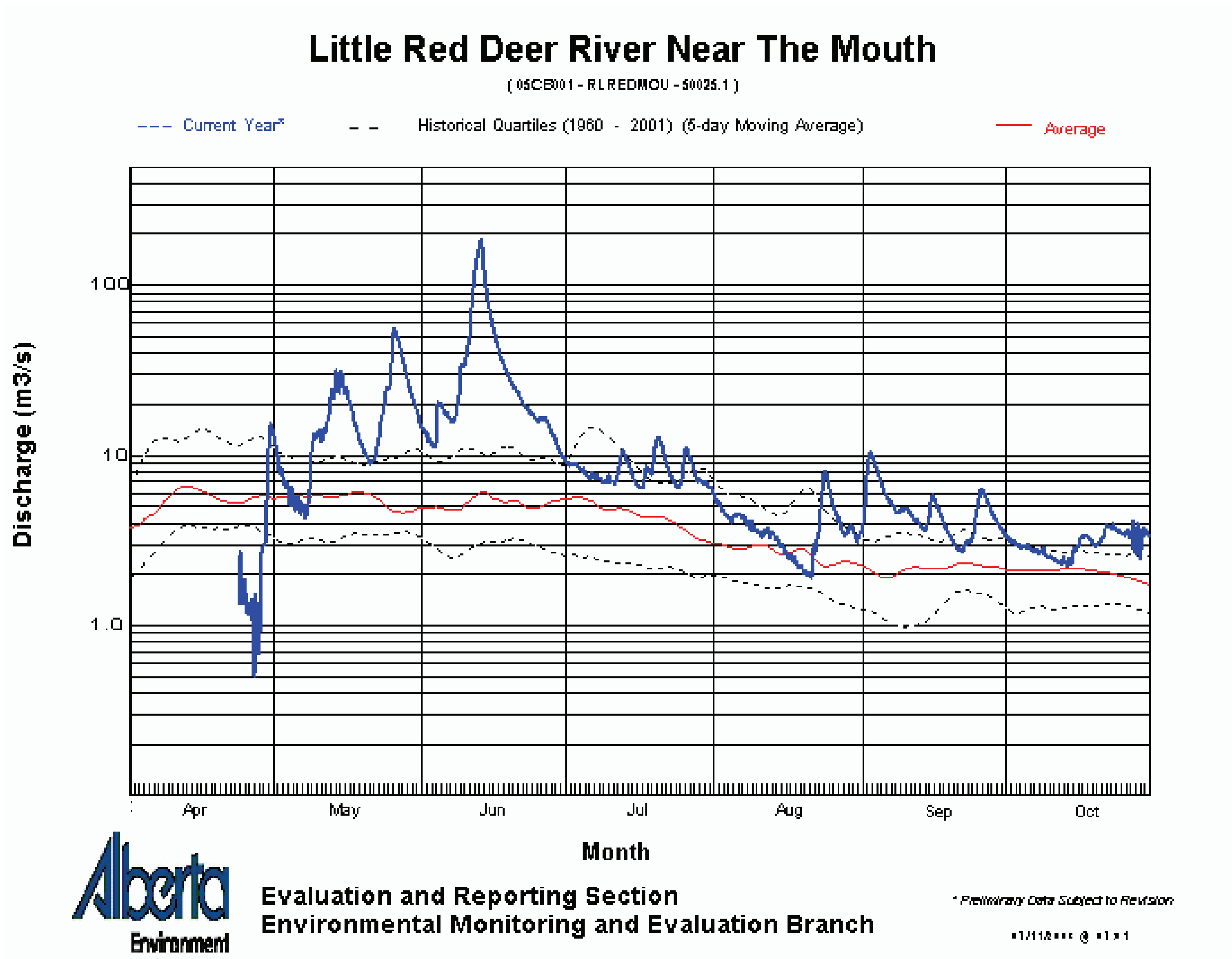


Figure 126. Discharge rates of the Little Red Deer River near the confluence with the Red Deer River (Government of Alberta, 2008c). “Current year” indicates water discharge rates in 2008.

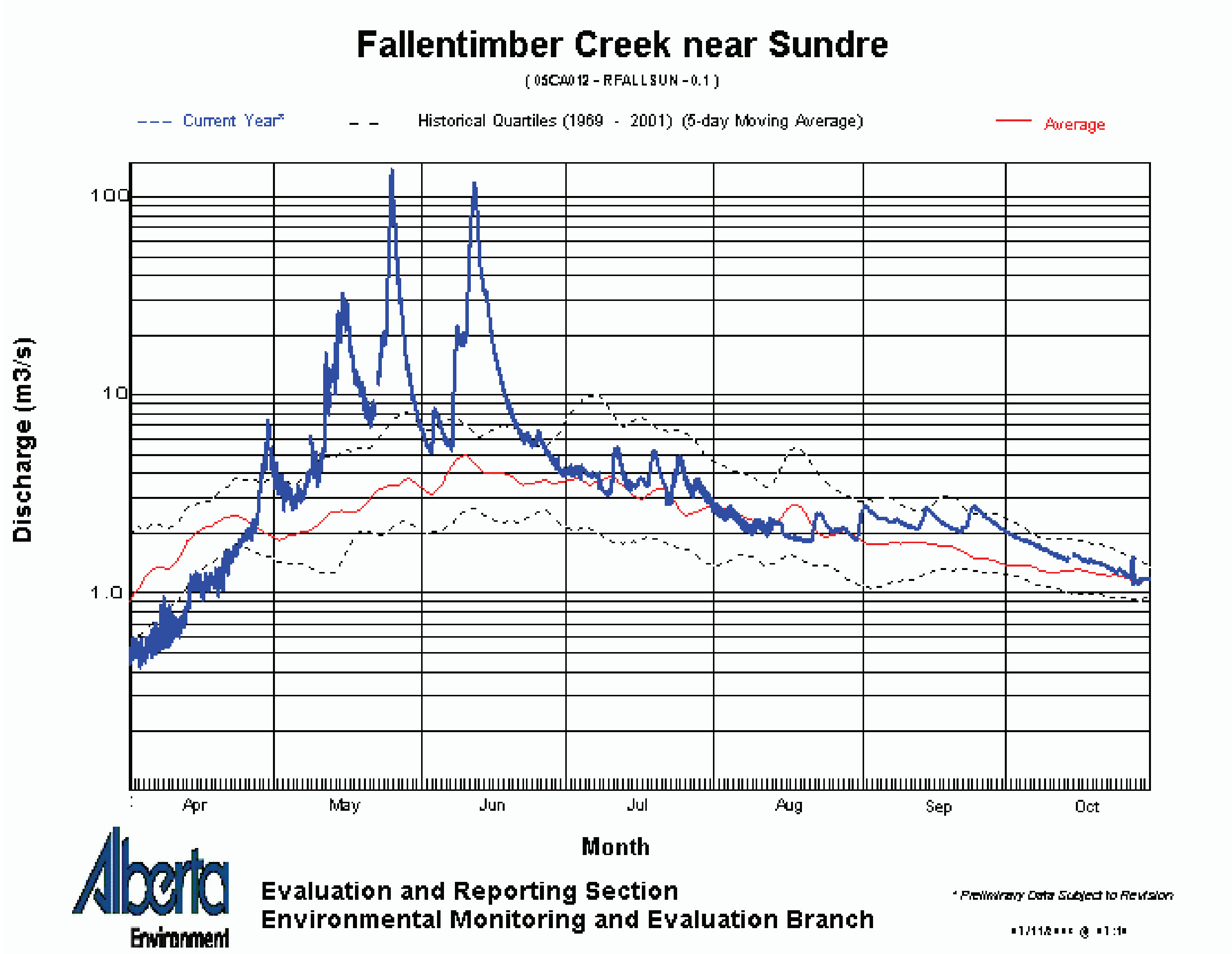


Figure 127. Discharge rates of Fallentimber Creek near Sundre (Government of Alberta, 2008c). "Current year" indicates water discharge rates in 2008.

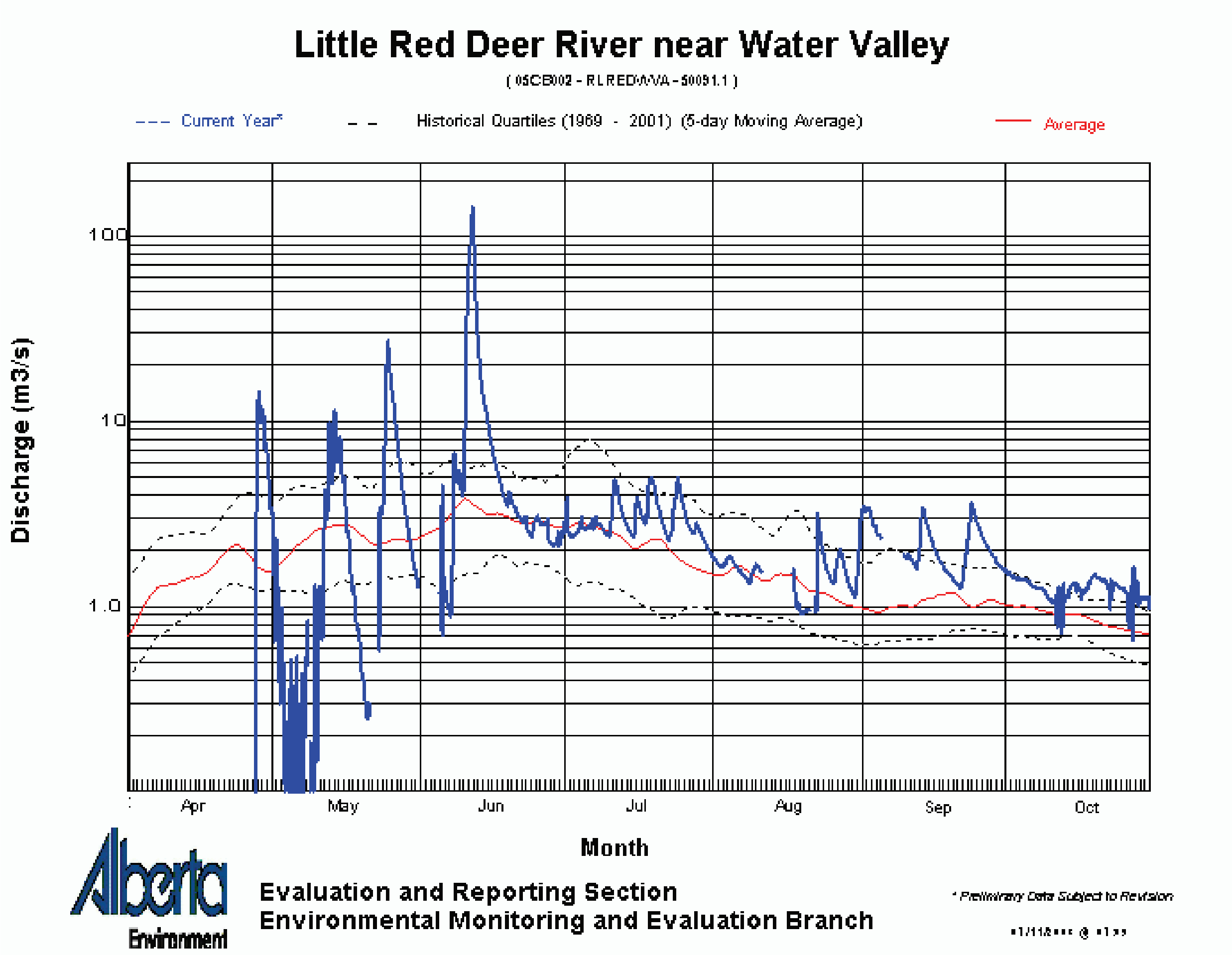


Figure 128. Discharge rates of the Little Red Deer River near Water Valley (Government of Alberta, 2008c). "Current year" indicates water discharge rates in 2008.

Four major dams are located in the Little Red Deer River subwatershed (Figure 129). These are Harmattan Dams West and East in the central area of the subwatershed and Dickson Dam on Gleniffer Lake Reservoir and a series of spillways belonging to the Dickson Drainage District in the northern area of the subwatershed. Dickson Dam is located on the Red Deer River 20 km west of Innisfail. The dam is a hydroelectric facility and has been in commercial operation since January 16, 1992. The Alberta Minister of Energy controls the water management of the sites upper reservoir, Gleniffer Lake Reservoir. All water control structures at the site (i.e., dam, intake, headgates and spillway) are owned by the Province of Alberta and administered by the Alberta Minister of Energy. In addition, there are numerous smaller water infrastructures in the subwatershed, e.g., small dams, sluices, weirs and dykes, which control water flow.

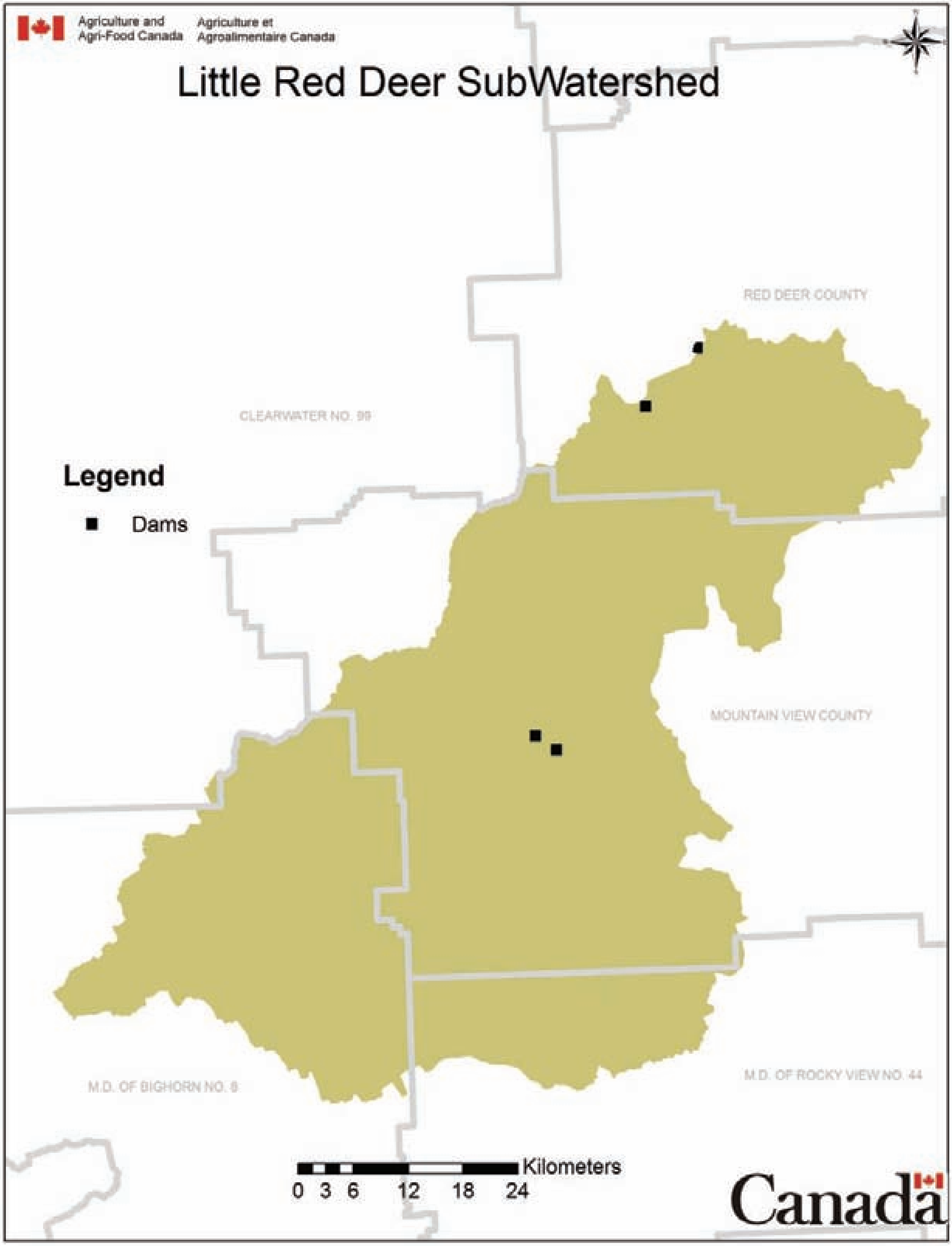


Figure 129. Major dams in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

4.4.4.2 Minimum Flows to Maintain Ecological Integrity

Minimum flows to maintain ecological integrity are the lowest flows or volumes (lakes) required to sustain native aquatic species and natural ecosystem functions. Minimum flows must be determined before allocation of water can safely take place to preserve the ecological functionality of aquatic ecosystems.

Minimum flow requirements for the maintenance of ecological integrity have not been determined in the Little Red Deer River subwatershed.

4.4.4.3 Contributing Areas to the Watershed

Contributing areas to the watershed are areas from which runoff flows into the lakes, creeks and rivers of the watershed. These data are used to determine an estimated volume of water contributed to the river on an annual basis.

In the Little Red Deer River subwatershed, 148,412 ha (or 3.2% of the total area of the subwatershed) of land do not contribute to the drainage of the subwatershed (Figure 130) (AAFC-PFRA, 2008). These areas are located primarily between Beaverdam Creek and Dogpound Creek and south of Madden in the southern area of the subwatershed and between Olds Creek and Bowden Creek in the northeastern area of the subwatershed. Additionally, there are isolated pockets of non-contributing drainage areas between Eagle Creek and the Little Red Deer River south of Gleniffer Lake Reservoir. The increasing prevalence of non-contributing drainage areas in the northeastern area is likely a result of a flatter topography in that region (Figure 131) (AAFC-PFRA, 2008).

Both the Little Red Deer River and Fallentimber Creek have had several high streamflow, flood watch/warning and ice jam advisories since 2005 in response to snow melt early in the year and high precipitation events throughout the summer months (June-September) (Table 60) (Alberta Environment, 2008c).

Table 60. Advisories and warnings in the Little Red Deer River subwatershed since 2001 (Alberta Environment, 2008c).

Advisory	Waterbody	Date
High streamflow	Little Red Deer River	June 06, 2005 August 23, 2005 September 10, 2005 June 15, 2006 May 21, 2007 May 14, 2008 June 10, 2008
	Fallentimber Creek	May 21, 2007
Flood watch/warning	Little Red Deer River	June 17, 2005 June 10, 2008
Ice jam	Little Red Deer River	March 14, 2007

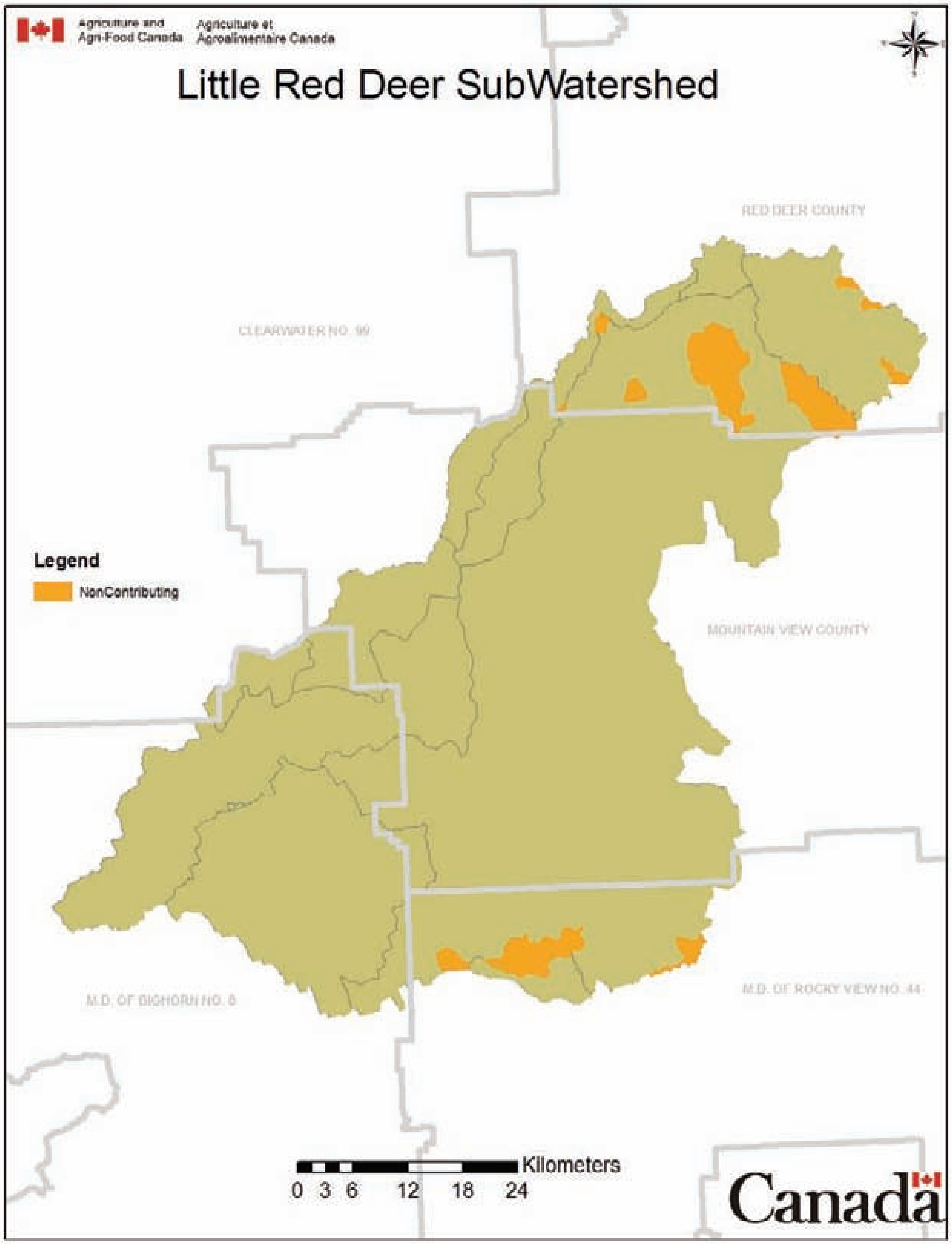


Figure 130. Non-contributing drainage area in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

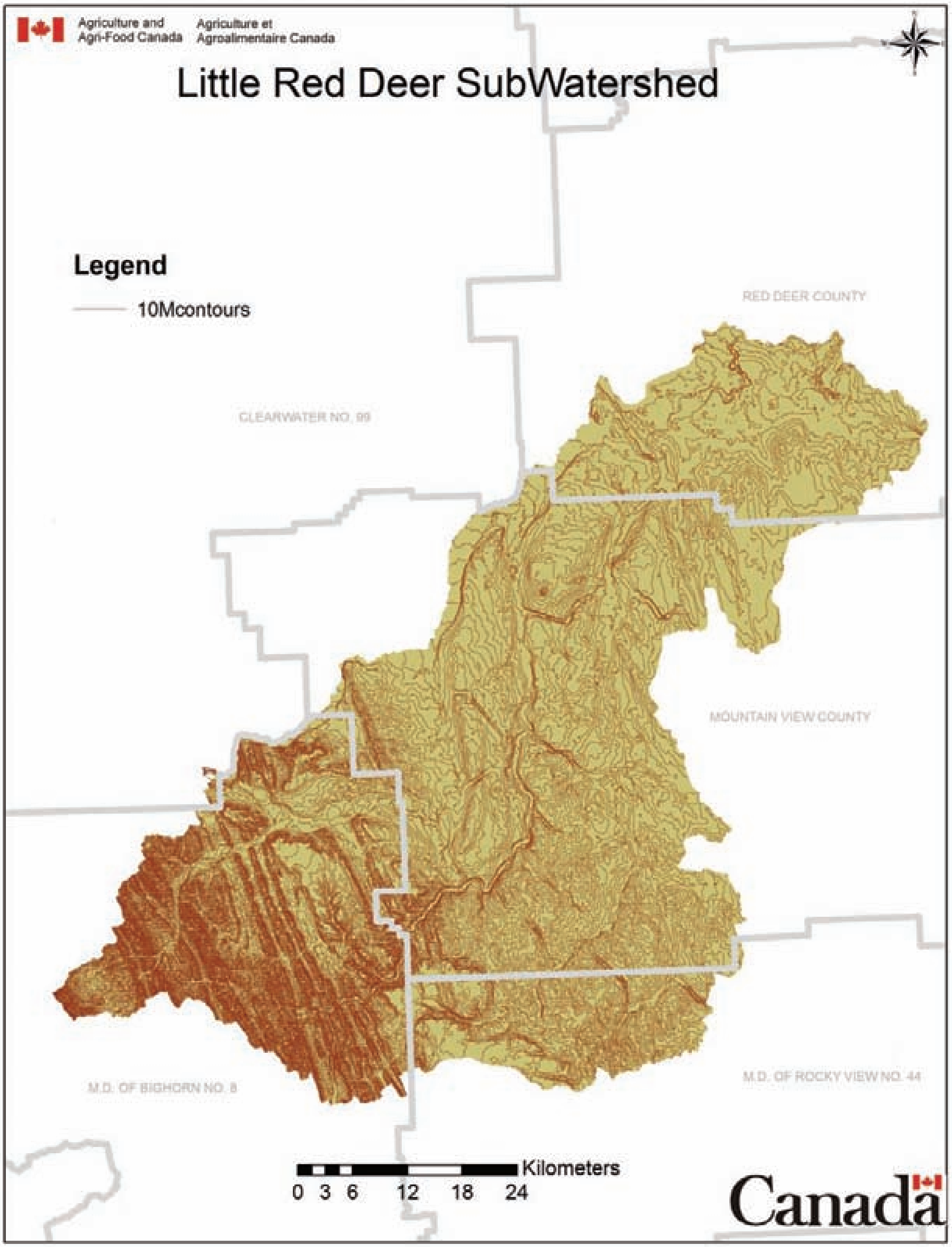


Figure 131. Topography (10-m contour intervals) of the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

4.4.4.4 Allocations

Surface and groundwater water withdrawal permits for the watershed are quantified by user sector along with information on licenses, consumption and return flows. This information will be used along with water flow data to identify areas of potential future constraints on surface water availability, which may have implications for future development.

In the Little Red Deer River subwatershed, 2,518 surface water licenses and 1,898 groundwater licenses have been issued for water diversion projects (Figures 132, 133, respectively) (AAFC-PFRA, 2008). While surface water licenses have been issued for water diversions throughout the entire subwatershed, few groundwater licenses have been issued in the Municipal District of Bighorn No. 8. in the south-western area of the subwatershed.

Nearly 6.62 million m^3 of surface and groundwater are diverted annually in the Little Red Deer River subwatershed (Government of Alberta, 2008d). The most prominent uses of surface water are for industrial (58% of total surface water diversions) and commercial operations (18% of total surface water diversions) and irrigation (17% of total surface water diversions), while the most prominent users for groundwater are agricultural operations (62% of total groundwater diversions) and municipalities (29% of total groundwater diversions) (Table 61). The majority of water diverted in the entire subwatershed comes from surface water sources, e.g., lakes, streams and rivers (73%) (Government of Alberta, 2008d). Additional groundwater diversion information is provided in HCL (2000a, 2002, 2005).

Table 61. Surface and groundwater diversions in the Little Red Deer River subwatershed (Government of Alberta, 2008d). The highest uses for water have been highlighted. Data reported exclude any water diverted from the Red Deer River mainstem.

Purpose	Surface water (m^3/yr)	Groundwater (m^3/yr)
Agriculture	286,783	1,098,362
Commercial	871,702	19,822
Habitat enhancement	51,810	
Industrial	2,813,560	
Irrigation	808,400	28,370
Management of fish	10,700	512
Municipal	1,220	513,276
Other purpose specified by the Director	5,000	15
Recreation	12,350	4,078
Total	**4,861,525**	**1,784,075**
Grand total		**6,615,600**

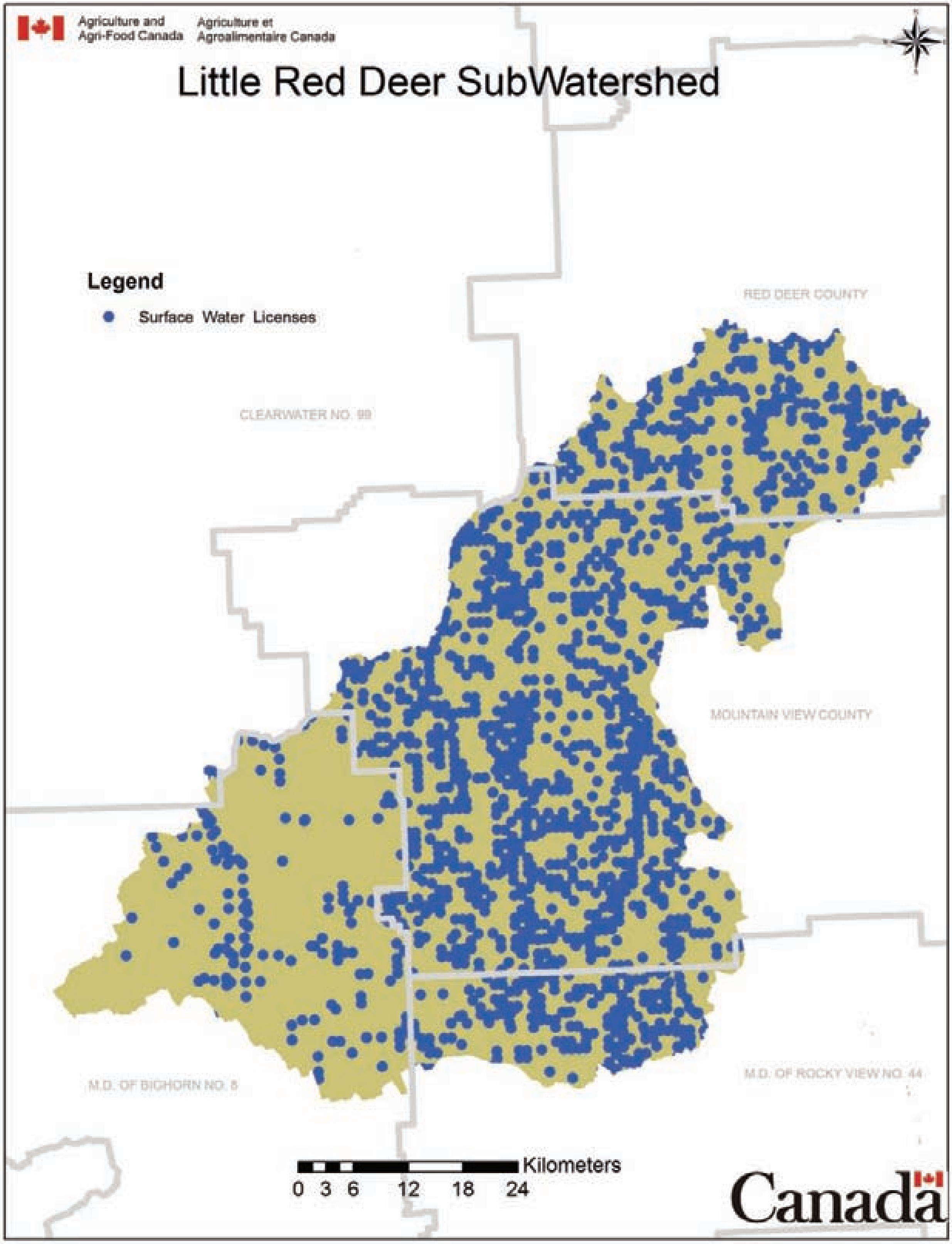


Figure 132. Surface water licenses in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

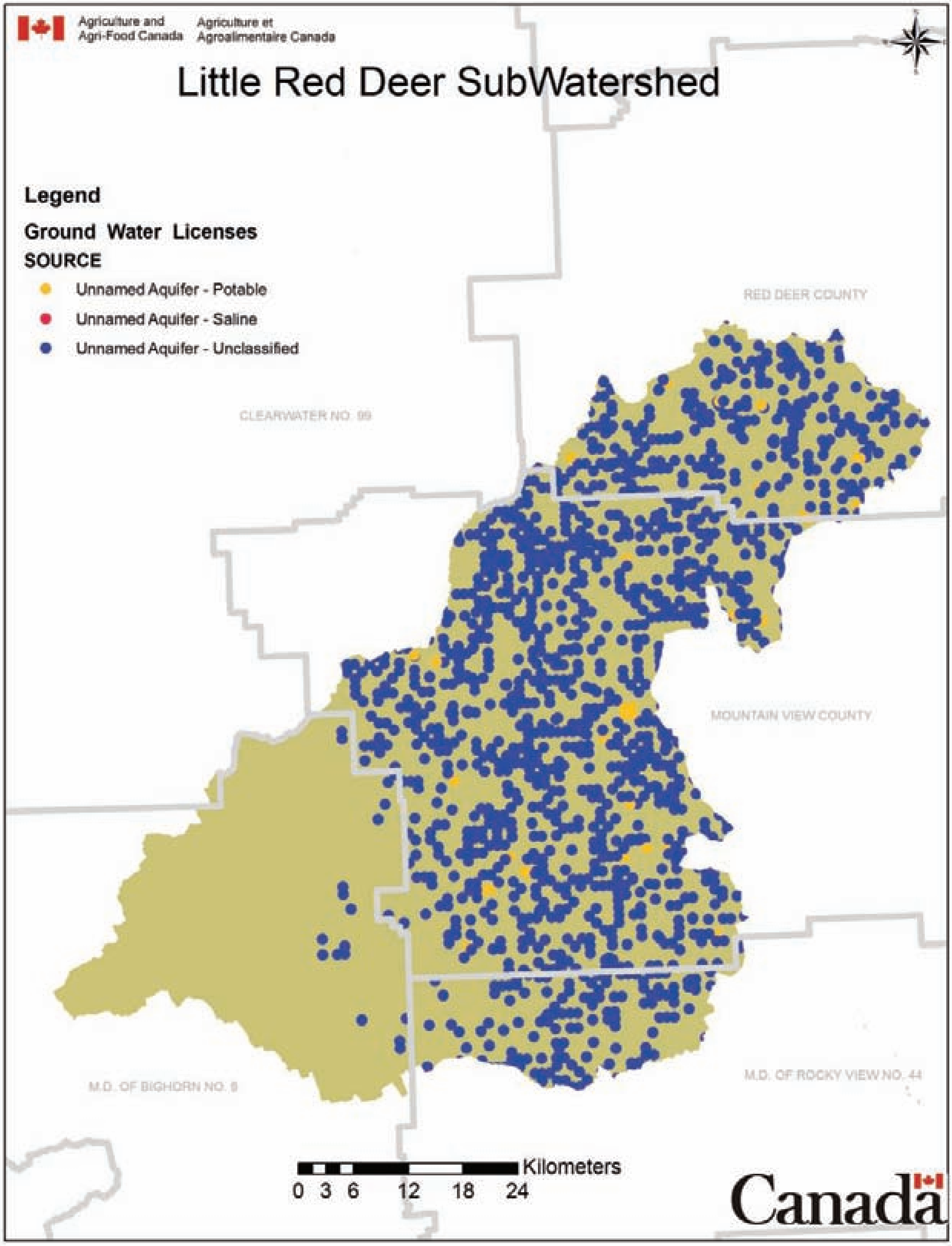


Figure 133. Groundwater licenses in the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

4.4.4.5 Groundwater Recharge/Discharge

Areas where groundwater gets recharged or discharges to the surface indicate areas where the groundwater table is close to the surface and the soils are generally more permeable. These areas are at greater risk of becoming negatively impacted from development or agricultural and/or industrial activities. Knowing where groundwater recharges and discharges occur will help to identify areas requiring special protection and limitations to land use.

Freshwater springs are points in the landscape where the aquifer surface meets the ground surface, i.e., freshwater springs are areas of groundwater discharge. The Little Red Deer River subwatershed has about 75 freshwater springs, of which most are located in southern area of the subwatershed in the vicinity of Silver Creek, Grease Creek, Lower Dogpound Creek and the Little Red Deer River. The Hamlet of Water Valley is the closest human settlement to the majority of these freshwater springs.

The Little Red Deer River subwatershed lies in the Counties of Mountain View and Red Deer and the Municipal Districts of Bighorn No. 8 and Rocky View No. 44. Groundwater assessment has been conducted for Mountain View and Red Deer counties and the Municipal District of Rocky View No. 44 by HCL (2000a, 2002, 2005). The assessment indicated a complex mosaic of discharge and recharge areas within the subwatershed. The headwaters of the Little Red Deer River, Dogpound Creek and Beaverdam Creek are primarily groundwater recharge areas (i.e., water moves from the surface into groundwater reservoirs), where the middle and lower reaches of the Little Red Deer River to the confluence with the Red Deer River are primarily discharge areas (i.e., water moves from groundwater reservoirs to the surface). Specific areas of groundwater recharge include small depressions in the landscape and temporary and ephemeral wetlands, which collect rainwater and snow melt and release a proportion of this accumulated water into shallow groundwater and regional aquifers (van der Kamp and Hayashi, 1998; Hayashi et al., 2003). Additional information on aquifers, water quantity and quality of the groundwater associated with each aquifer, hydraulic relationship among aquifers and possible groundwater depletion areas associated with each upper bedrock aquifer is provided in HCL (2000a, 2002, 2005).

4.4.5 Biological Indicators

Bioindicators are biological (plant and animal) data from which various aspects of ecosystem health can be determined or inferred. The presence, absence and abundance of such data can be linked to water quality, quantity and ultimately to overall watershed health. Four metrics were used as biological indicators in the Red Deer River watershed and its 15 subwatersheds:

- Wildlife Biodiversity
- Fish
- Land Cover – Condition Indicator
- Species at Risk

Changes in biological populations often reflect socioeconomic growth in a region. Human settlement and the subsequent exploration and extraction of natural resources alters the landscape and with it the habitat of the indigenous flora and fauna. It is important to balance socioeconomic growth with the preservation of natural habitat integrity to ensure the long-term health of natural biological populations.

4.4.5.1 Wildlife Biodiversity

Wildlife inventories to determine the biodiversity within the watershed will indicate changes in environmental conditions (e.g., habitat fragmentation, loss of nesting and breeding sites, nutrient enrichment, etc.). A loss of biodiversity can cause an ecosystem to become less stable and more vulnerable to environmental change. A change in diversity may also affect nutrient cycling and/or energy flow through the ecosystem.

Wildlife biodiversity assessment data have not been located for the Little Red Deer River subwatershed.

4.4.5.2 Fish

Inventories of selected fish populations may show increases or declines through introductions or changes in environmental conditions. Indicator species sensitive to environmental pollution may show areas of concern through their absence, while others may show similar with their presence. Invasive species, if present, will indicate areas of concern requiring future monitoring.

Fish populations have been assessed in five streams in the Little Red Deer River subwatershed: Little Red Deer River, Dogpound Creek, Fallentimber Creek, Beaverdam Creek and Big Prairie Creek. The predominant species in the Little Red Deer River include mountain whitefish, longnose dace and brown trout (Figure 134). There have been no significant changes in these populations over the sampling period ($p > 0.8$, 0.6 and 0.5, respectively). The predominant species in the Dogpound Creek include white sucker, brown trout and longnose dace (Figure 135). There were no significant changes in the fish populations during this time period ($p > 0.8$, 0.6 and 0.8, respectively). The “Buck for Wildlife” initiative started in the 1970s, when landowners in Alberta with riparian areas on their properties negotiated conservation agreements with the province to construct and maintain stream bank fencing and livestock crossings. The goal was to create riparian corridors protected from livestock grazing. In the Dogpound area, the “Buck for Wildlife” initiative started in 1985 and focused on conserving fish habitat and providing angler access. Today, more than 45 km of riparian areas are fenced for conservation along Dogpound Creek. The predominant species in Fallentimber Creek are brook trout, brown trout and mountain whitefish. There have been no significant changes in the populations of these species over the sampling period ($p > 0.8$, 0.4 and 0.2 respectively). Mountain whitefish and brown trout are the species found most consistently through the sampling period (Figure 136). The predominant species in Beaverdam Creek are longnose dace and white sucker. There are not enough sampling events to determine if there have been any significant changes in the populations of these species over the sampling period. The species that is the most consistently found during the sampling period is the brook stickleback (Figure 137). The predominant species in Big Prairie Creek are longnose dace and white sucker. There have not been any significant changes in the populations of the longnose dace over the sampling period ($p > 0.3$). The longnose dace, lake chub and trout-perch are the species most consistently found during the sampling period (Figure 138).

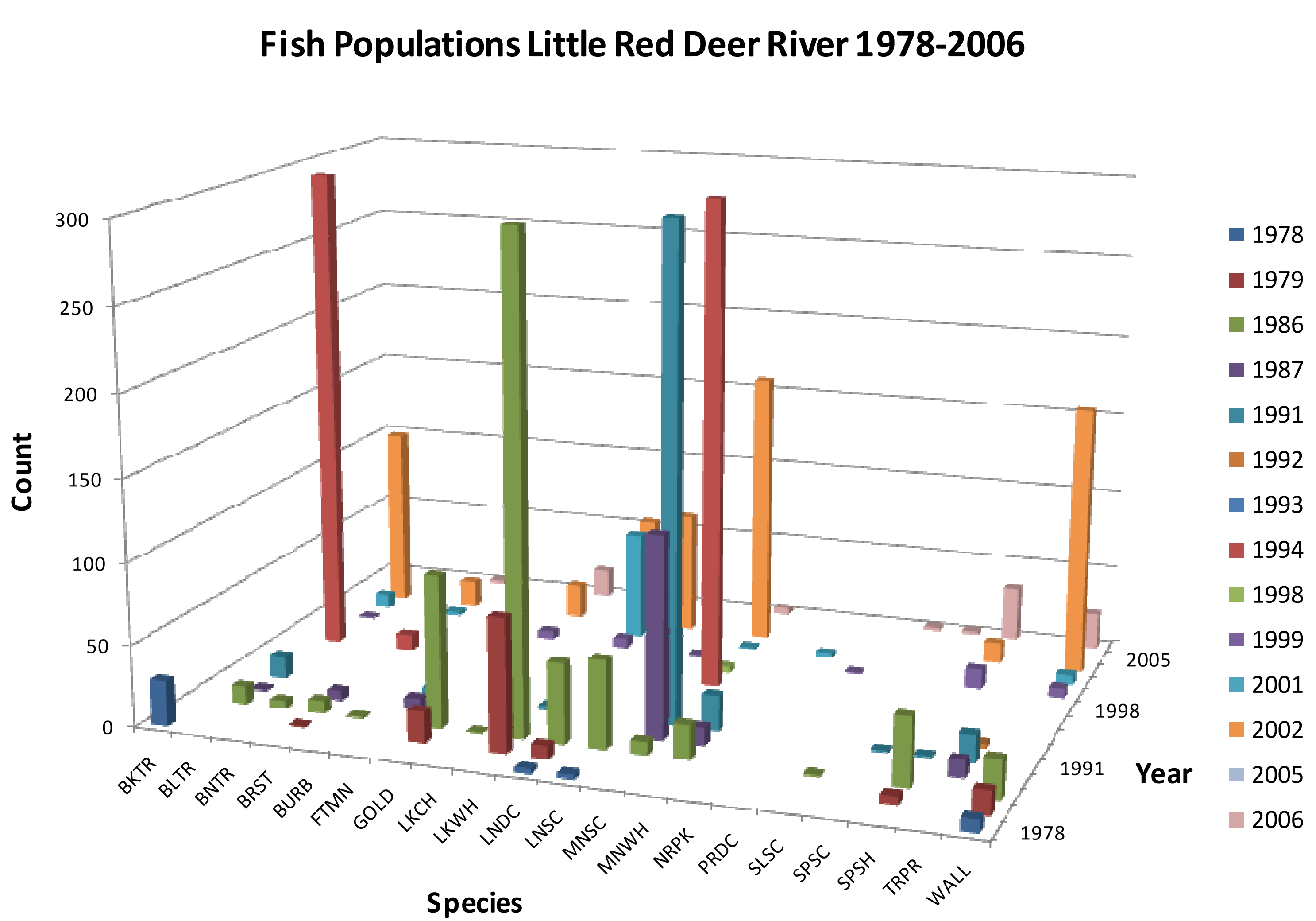


Figure 134. Fish populations in the Little Red Deer River from 1978-2006 (data from Alberta Sustainable Resource Development, 2008). For full names of fish species, please refer to Table 23.

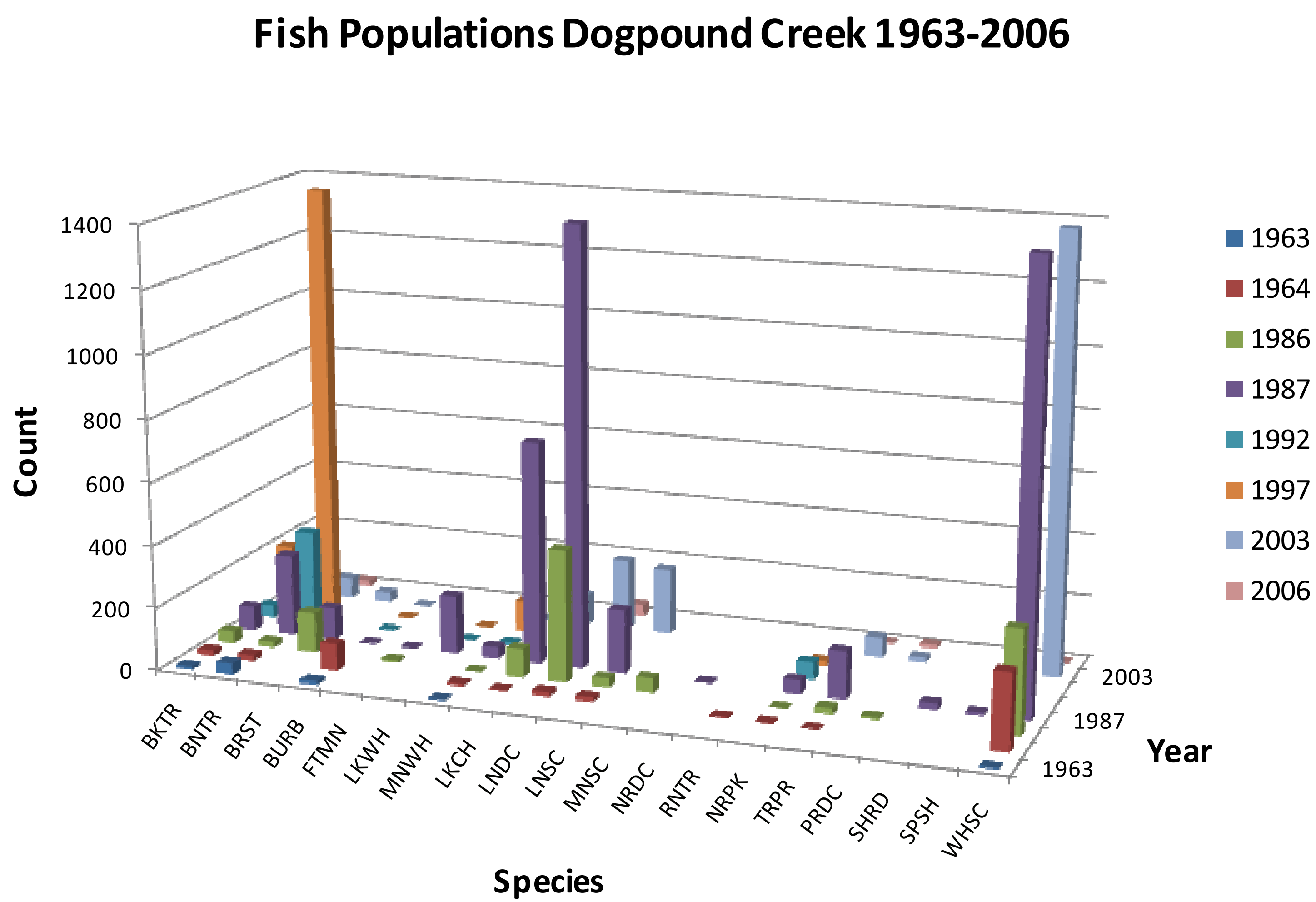


Figure 135. Fish populations in Dogpound Creek from 1963-2006 (data from Alberta Sustainable Resource Development, 2008). For full names of fish species, please refer to Table 23.

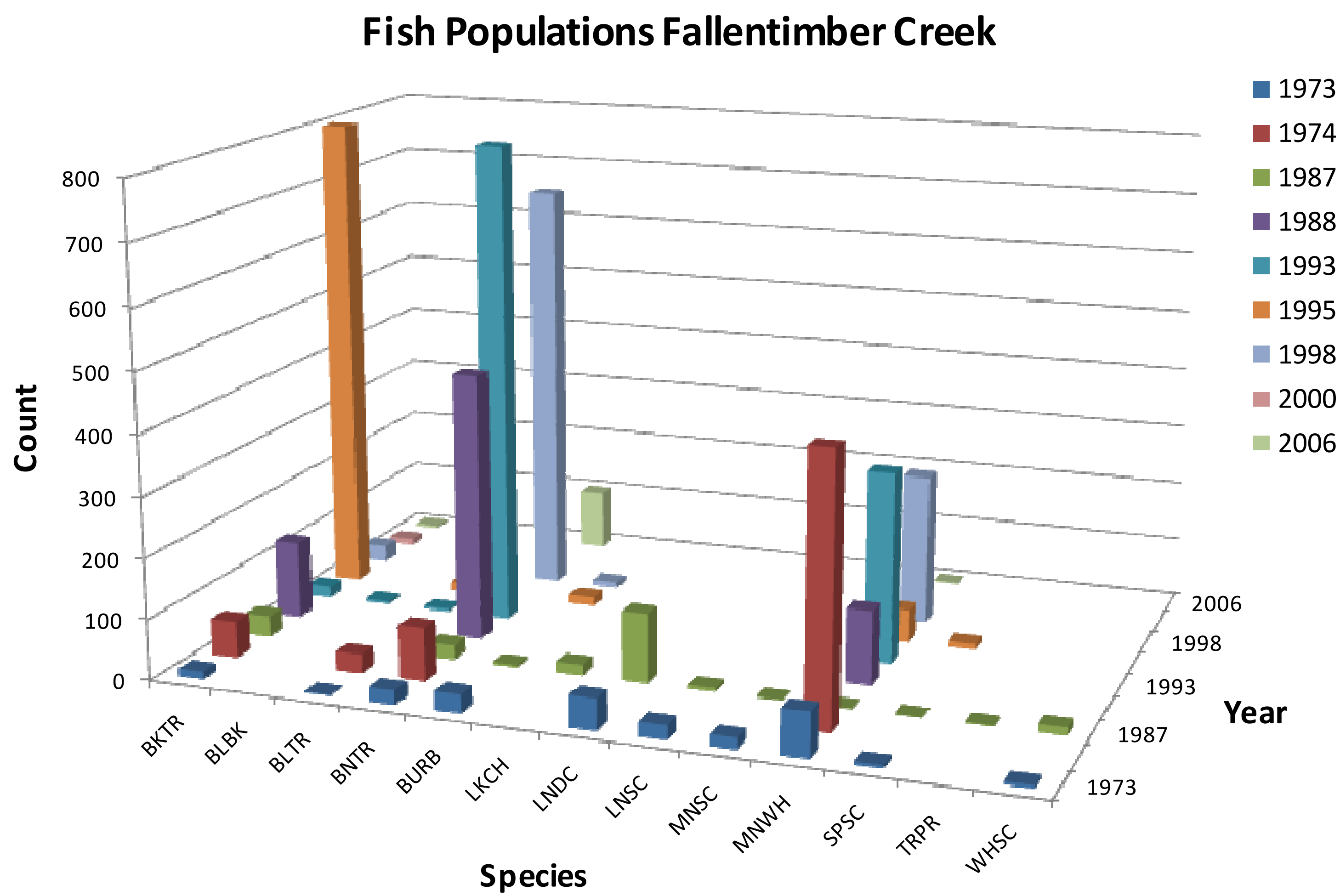


Figure 136. Fish populations in Fallentimber Creek in 1973-1974, 1987-1988, 1993, 1995, 1998, 2000 and 2006 (data from Alberta Sustainable Resource Development, 2008). The y-axis has been modified for better data representation. For full names of fish species, please refer to Table 23.

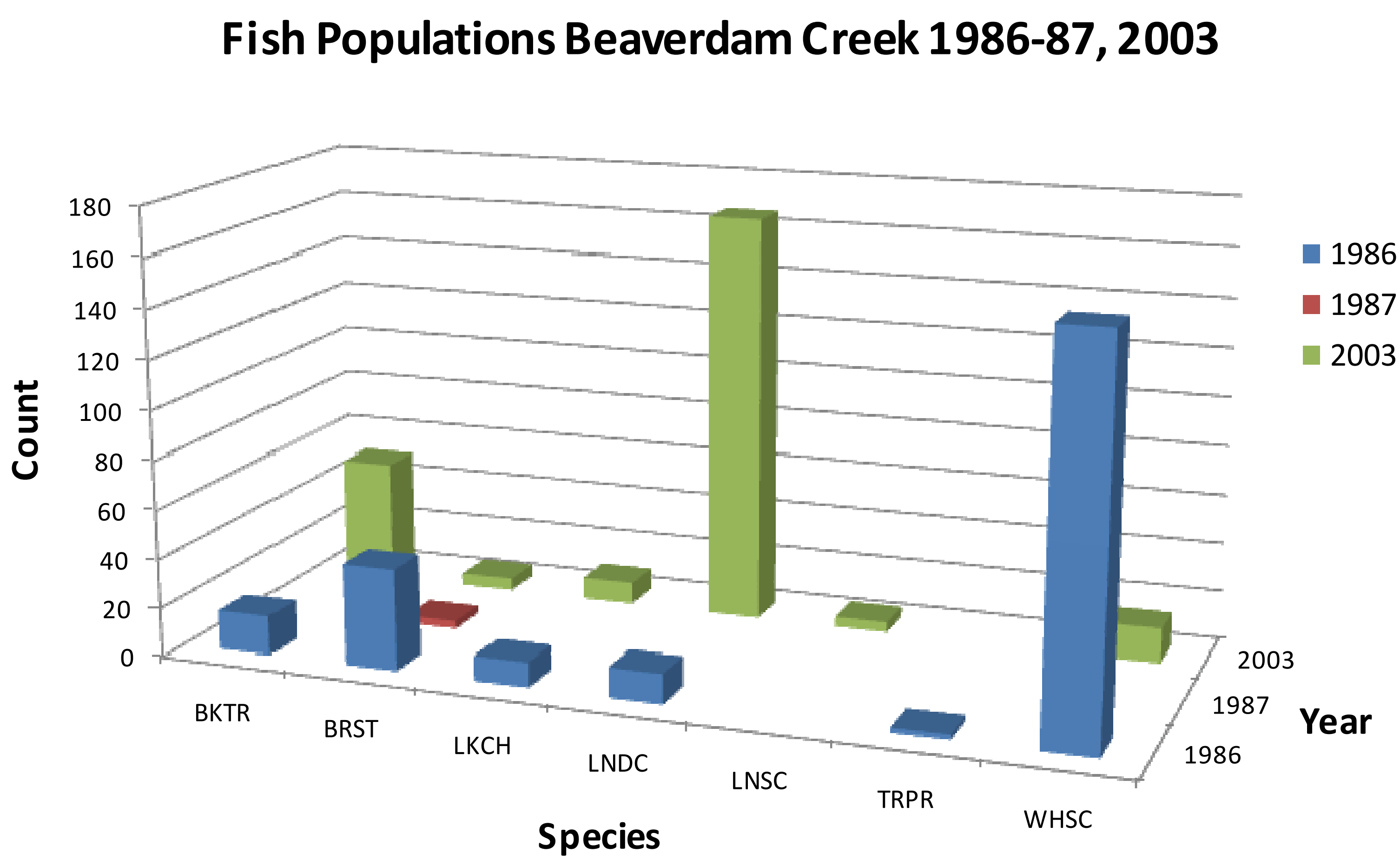


Figure 137. Fish populations in Beaverdam Creek (data from Alberta Sustainable Resource Development, 2008). For full species names, please refer to Table 23.

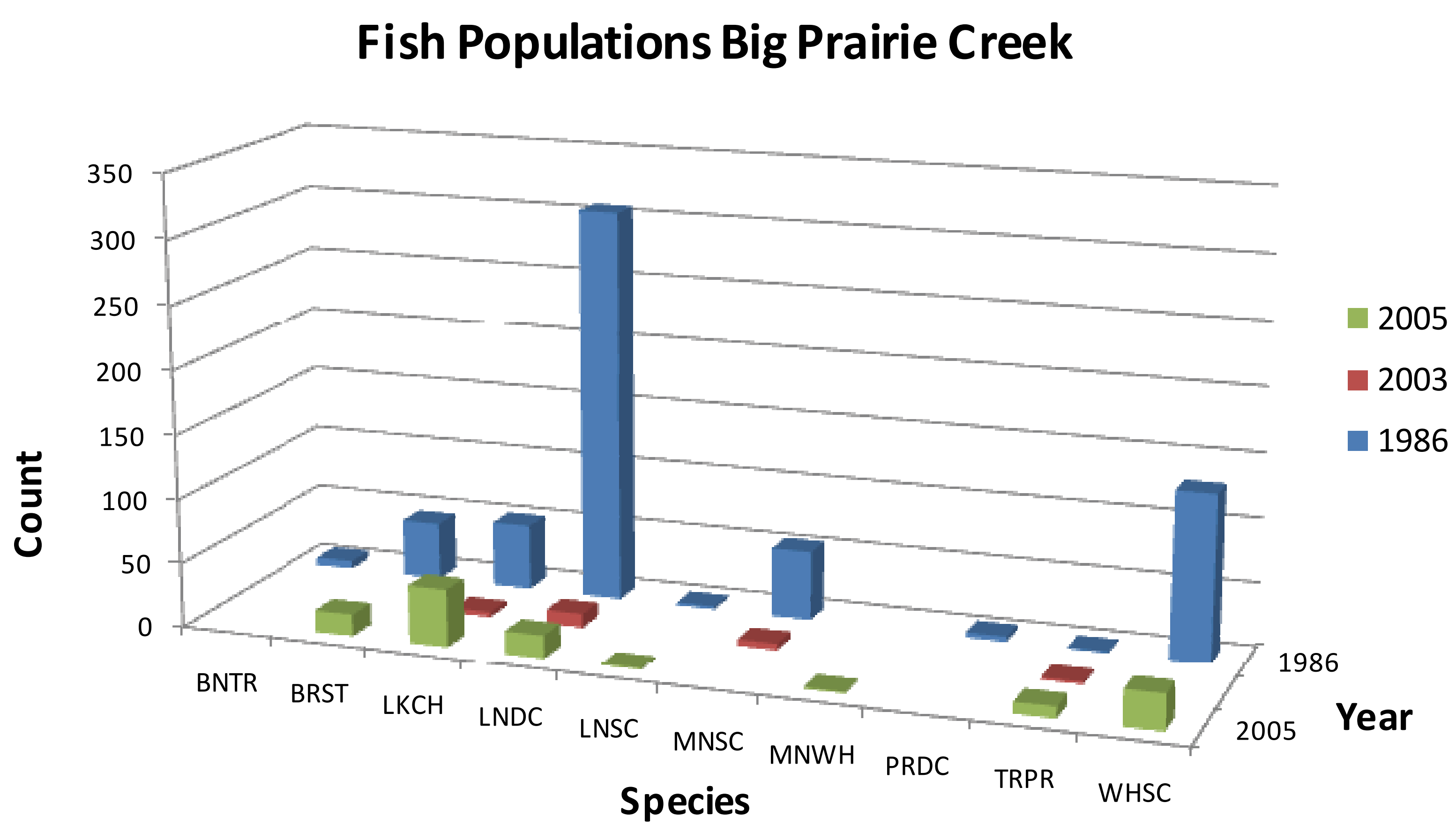


Figure 138. Fish populations in Big Prairie Creek in 1986, 2003 and 2005 (data from Alberta Sustainable Resource Development, 2008). For full species names, please refer to Table 23.

The mountain whitefish lives in mountain streams and lakes, favoring clear cold water and large deep pools at least 1 m deep. They are bottom feeders, stirring up the substrate with pectoral and tail fins to expose insect larvae and other invertebrates, including snails, crayfish and amphipods. Their main feeding time is in the evening, but they will also take drifting prey during the day. The mountain whitefish frequently feeds in the lower strata of streams, but populations may rise to the surface to prey on hatching insects, including mayflies. The spawning season is from October to early December, when water temperatures are 2-6 °C. The fish seek out areas of coarse gravels or cobbles at depths of at least 75 cm, and scatter the non-adhesive eggs so that they sink into the interstices. The eggs then develop slowly through the winter (6-10 weeks), hatching in the early spring. They are considered to be a barometer of good water quality (Nelson and Paetz, 1992; Scott and Crossman, 1998).

The longnose dace is found in muddy and warm, clear and cold, streams and lakes. The largest longnose dace are about 15 cm long. They are well-adapted for living on the bottom of fast-flowing streams among stones. Longnose dace eat mostly immature aquatic insects, and they are important forage minnows for larger predatory fish (Nelson and Paetz, 1992; Scott and Crossman, 1998).

Brown trout prefers cold, well-oxygenated upland waters, especially large streams in mountainous areas. Cover is important to them, and they are more likely to be found where there are submerged rocks, undercut banks and overhanging vegetation. Brown trout are active both by day and by night and are opportunistic feeders. While in fresh water, the diet will frequently include invertebrates from the streambed, small fish, frogs and insects flying near the water's surface. The high dietary reliance upon insect larvae, pupae, nymphs and adults is what allows trout to be a favoured target for fly fishing (Nelson and Paetz, 1992; Scott and Crossman, 1998).

The brook trout is native to small streams, creeks, lakes and spring ponds. It prefers cool, clear waters of high purity and a narrow pH range in lakes, rivers and streams, being sensitive to poor oxygenation, pollution and changes in pH caused by environmental effects, such as acid rain. Its diverse diet includes crustaceans, frogs and other amphibians, insects, molluscs, smaller fish, and even small aquatic mammals, such as voles, worms and flys (Nelson and Paetz, 1992; Scott and Crossman, 1998).

The white sucker is a bottom feeding fish and spend most of its time in shallow, warm waters, where it searches for aquatic plants, algae and small invertebrates, particularly worms and crustaceans. It makes its homes in holes and areas around windfalls or other underwater obstructions. White suckers lay their eggs among pebble and gravel beds in lake and river shallows during the spring. They have been accused of consuming large quantities of eggs from more desirable fish species, but there is no conclusive evidence to support this contention (Nelson and Paetz, 1992; Scott and Crossman, 1998).

The brook stickleback prefers cool, clear, heavily weeded, spring-fed creeks, small rivers, lakes and ponds. They are occasionally found in brackish water. Its diet is quite varied and consists of nearly any organism small enough to be captured and swallowed. It is an opportunistic species, eating eggs and larvae of various aquatic invertebrates and fish as well as plants (Nelson and Paetz, 1992; Scott and Crossman, 1998).

The trout perch prefers stream habitats with high water quality and is most commonly found in streams that have deep pools and bottoms of sand and gravel. Lake populations avoid mud-filled bays. During the day, trout perch live in deeper water or in piles of sticks, leaves or other debris. It feeds over shallow bottoms on aquatic insects and other small invertebrates primarily at night. Where abundant, it is an important prey species for northern pike, yellow perch and walleye (Nelson and Paetz, 1992; Scott and Crossman, 1998).

4.4.5.3 Land Cover

Land cover is the type of vegetation, or lack thereof, covering the landscape. Inventory of vegetation populations may show increases or declines through introductions or changes in environmental conditions. Indicator species that are sensitive to environmental pollution may show areas of concern with their absence, while others may show areas of concern with their presence. Changes in land cover can indicate a change in land use and identify areas that need restoration, are at risk of erosion and/or areas with rare plant species that need protection. Land cover is a separate measurement from land use even though these two terms are sometimes used interchangeably.

The majority of the land base of the Little Red Deer River subwatershed is covered by annual croplands (28%) and coniferous forests (26%), with less area covered by perennial croplands/pastures (18%) and grasslands (14%). There are very few exposed and developed lands, shrublands, wetlands, waterbodies and mixed forests in the subwatershed (Figure 139, Table 62) (AAFC-PFRA, 2008).

Table 62. Land cover in the Little Red Deer River subwatershed (AAFC-PFRA, 2008). The most prominent land cover types are highlighted.

Land cover type	Area (ha)	Proportion of subwatershed area (%)
Waterbodies	2,066	0.52
Exposed land	636	0.16
Developed land	4,238	1.07
Shrubland	2,906	0.73
Wetland	2,632	0.66
Grassland	57,008	14.35
Annual cropland	109,532	27.58
Perennial cropland/pastures	69,640	17.53
Coniferous forests	104,995	26.44
Deciduous forests	13,152	3.31
Mixed forests	5,374	1.35
No data	24,986	6.29
Total	**397,166**	

One Ecologically Significant Area has been identified in the Little Red Deer River subwatershed, namely Beaverdam Creek valley (Twp. 28, Rge. 3, W 5) (Alberta Environmental Protection, 1997). It is located in the Municipal District of Rocky View No. 44 and covers an area of 1,182 ha. The valley provides provincially significant great blue heron breeding habitat. There are no nationally or internationally designated Ecologically Significant Areas in the subwatershed (Alberta Environmental Protection, 1997).

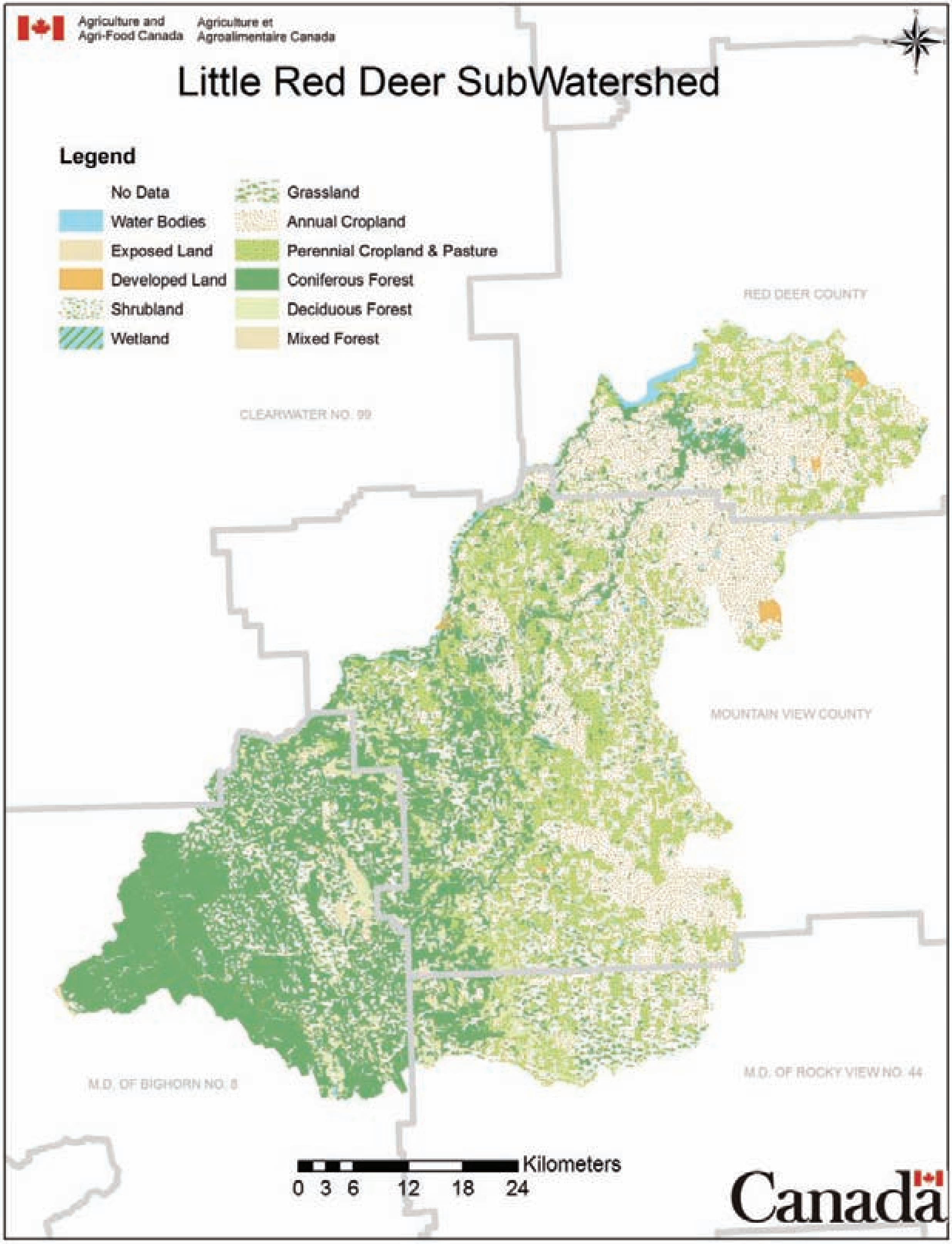


Figure 139. Land cover of the Little Red Deer River subwatershed (AAFC-PFRA, 2008).

4.4.5.4 Species at Risk

Identifying species at risk and their habitats will help to determine sensitive areas and level of protection required. The *Species at Risk Act* (*SARA*) was introduced in June 2003 to provide legal protection of wildlife species and conservation of biological diversity. The Act aims to prevent Canadian indigenous species, subspecies and distinct populations from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species and encourage the management of other species to prevent them from becoming at risk. Currently, there are 363 species listed as either endangered (169 species), threatened (110 species) or of special concern (84 species) (Species at Risk, 2008).

“Endangered species” are those species that face imminent extirpation or extinction, while “threatened species” are those that are likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction. “Species of special concern” are those species that warrant special attention to ensure their conservation.

The Little Red Deer River subwatershed is home to one endangered species (piping plover, *C. melodus circumcinctus*), two threatened species (loggerhead shrike, *L. ludovicianus excubitorides*; Sprague’s pipit, *A. spragueii*) and three species of special concern (yellow rail, *C. noveboracensis*; western toad, *B. boreas*; monarch butterfly, *D. plexippus*). Detailed descriptions of these species can be found in section 3.1.3.7.

4.4.6 Subwatershed Assessment

The Little Red Deer River subwatershed lies in the Subalpine, Upper and Lower Foothills, Foothills Parkland, Dry Mixedwood and Central Parkland Subregions, which contribute to its complex biogeophysical characteristics. Livestock and agricultural density is low to medium relative to the Alberta average, although both increase towards the northern regions of the subwatershed. Urban settlements include the towns of Bowden, Carstairs and Olds as well as the Village of Cremona and several hamlets. Recreational facilities occur throughout the subwatershed. Resource exploration and extraction activities have resulted in a complex network of linear developments, with roads being the dominant development type. In total, 1,682 active wells exist in the Little Red Deer River subwatershed; most are oil wells. This increased level of land use activities relative to the Panther, James and Raven River subwatershed has resulted in substantial impacts to riparian zones. Although riparian zones are overall rated as healthy with problems, there are numerous riparian areas along the Little Red Deer River with an unhealthy rating. This has resulted in poorer water quality in various streams in the subwatershed, with TP occasionally exceeding CCME PAL guidelines and fecal coliform bacterial concentrations occasionally exceeding CCME Agriculture/Irrigation guidelines. In addition, 11 different pesticides have been detected in aquatic ecosystems in the subwatershed, although none exceeded water quality guidelines where they existed. Parasite data were not located for any waterbody in the subwatershed. Water discharge rates in the Little Red Deer River, reaching 100 m^3/sec, are highest following the spring freshet and heavy precipitation events, having resulted in numerous high water flow advisories. Throughout the subwatershed, 4,416 water diversion licenses have been issued, permitting the diversion of up to 6.62 million m^3 of water annually. The primary users of water resources are industrial and agricultural operations. Annual croplands and coniferous forests cover most of the subwatershed's land base and provide habitat for several SARA species: 1 endangered species, 2 threatened species and three species of special concern. Mountain whitefish and several trout species are the dominant fish species in the subwatershed's rivers and creeks. Biodiversity assessment data were not located for the Little Red Deer River subwatershed.

An Indicator Workshop held in March 2008 identified a total of 20 indicators to be used to assess the overall health of the Red Deer River watershed and its 15 subwatersheds. These indicators included land use, water quality, water quantity and biological indicators. In November 2008, a subset of these indicators was selected to indicate the overall condition of, or risk to, the individual subwatersheds. There were nine "condition indicators" and three "risk indicators". The condition indicators were ranked "good", "fair" or "poor" based on existing guidelines, while risk indicators were ranked "low", "medium" or "high" relative to the other subwatersheds. The overall subwatershed ranking is based on an "A"-"B"-"C" ranking system with "+" and "-" subrankings. The overall ranking system is based on a subjective evaluation of the combined rankings of the condition and risk indicators.

Based on the available data, the Little Red Deer River subwatershed receives a rating of "fair" for the condition indicators and a rating of "low" for the risk indicators (Tables 63, 64). Overall, this subwatershed receives a ranking of "B". There are substantial data gaps, and several of the condition rankings are based on limited data. Consequently, it is recommended to implement a detailed water quality sampling program, conduct a wetland inventory and regularly monitor riparian health conditions along the major waterbodies in the subwatershed. Of particular concern are (1) the extensive network of linear developments (roads), primarily due to natural resource exploration and extraction activities throughout the subwatershed, (2) nutrient and bacterial concentrations that occasionally exceed water quality guidelines, likely due to widespread impaired riparian area health conditions and excessive agricultural runoff, municipal effluent and urban runoff that reach waterbodies throughout the subwatershed and (3) the loss of wetlands, which likely occurred as a result of agricultural land conversions, drainage, infilling and the disruption of their hydrology following linear developments.

Table 63. Condition and risk indicator summary for the Little Red Deer River subwatershed. Gray logos indicate data gaps.

Condition Indicators

Risk Indicators

Table 64. Condition and risk assessments of the Little Red Deer River subwatershed. Indicators with a "poor" ranking are highlighted.

Indicators		**Rating**
Condition	Wetland loss	POOR
	Riparian health	FAIR
	Linear developments	POOR
	Nutrients	
	Total phosphorus	FAIR
	Total nitrogen	GOOD
	Bacteria	POOR
	Parasites	---
	Pesticides	GOOD
	Minimum flows to maintain ecological integrity	---
	Land cover	FAIR
Overall		**FAIR**
Risk	Livestock manure production	LOW
	Urban, rural, agricultural and recreational developments	LOW
	Oil/gas wells	LOW
Overall		**LOW**

