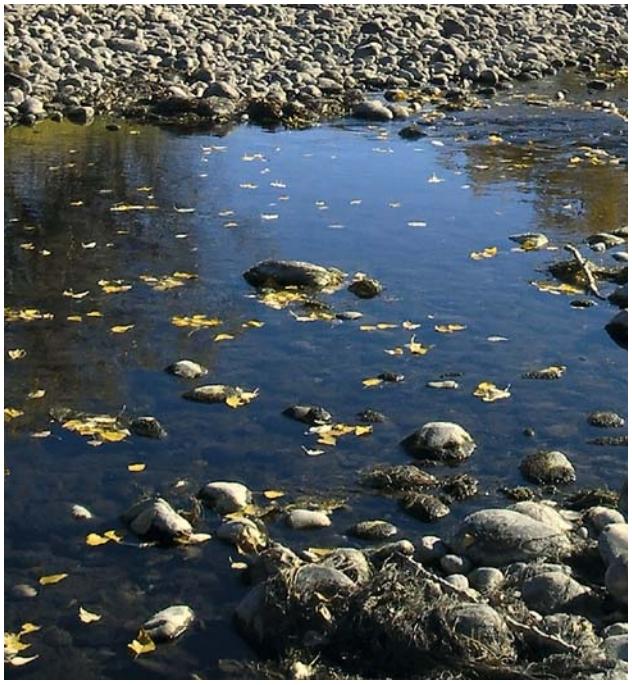
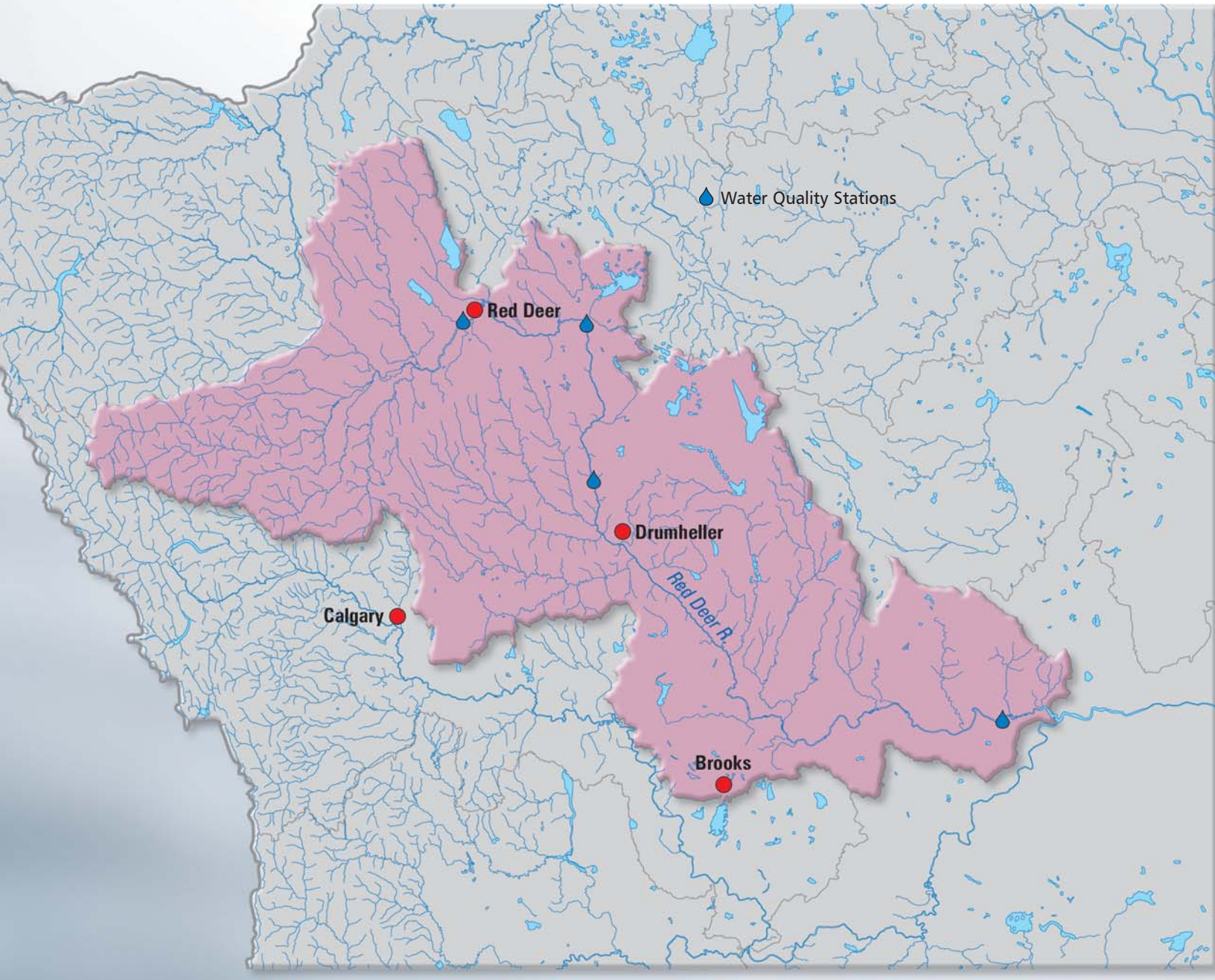


CHAPTER SEVEN

THE RED DEER RIVER SUB-BASIN

Figure 7.1. *Red Deer River Sub-basin*



CHAPTER SEVEN

THE RED DEER RIVER SUB-BASIN

The Red Deer River rises in Banff National Park near Lake Louise. The origin of the name is the Cree 'was ka soo', meaning elk. Leaving the mountains, the river flows northeast through the foothills forest of the boreal plain towards the city of Red Deer. It then turns southeast through the prairie ecozone to Dinosaur Provincial Park then turns east, joining the South Saskatchewan River 16 km inside the Saskatchewan boundary.[1] The sub-basin is shown in Figure 7.1.

Sub-basin Summary

Characteristics
- high alpine to plains
- length 806 km
- gross drainage area 50 445 km^2
- effective drainage area 29 139 km^2

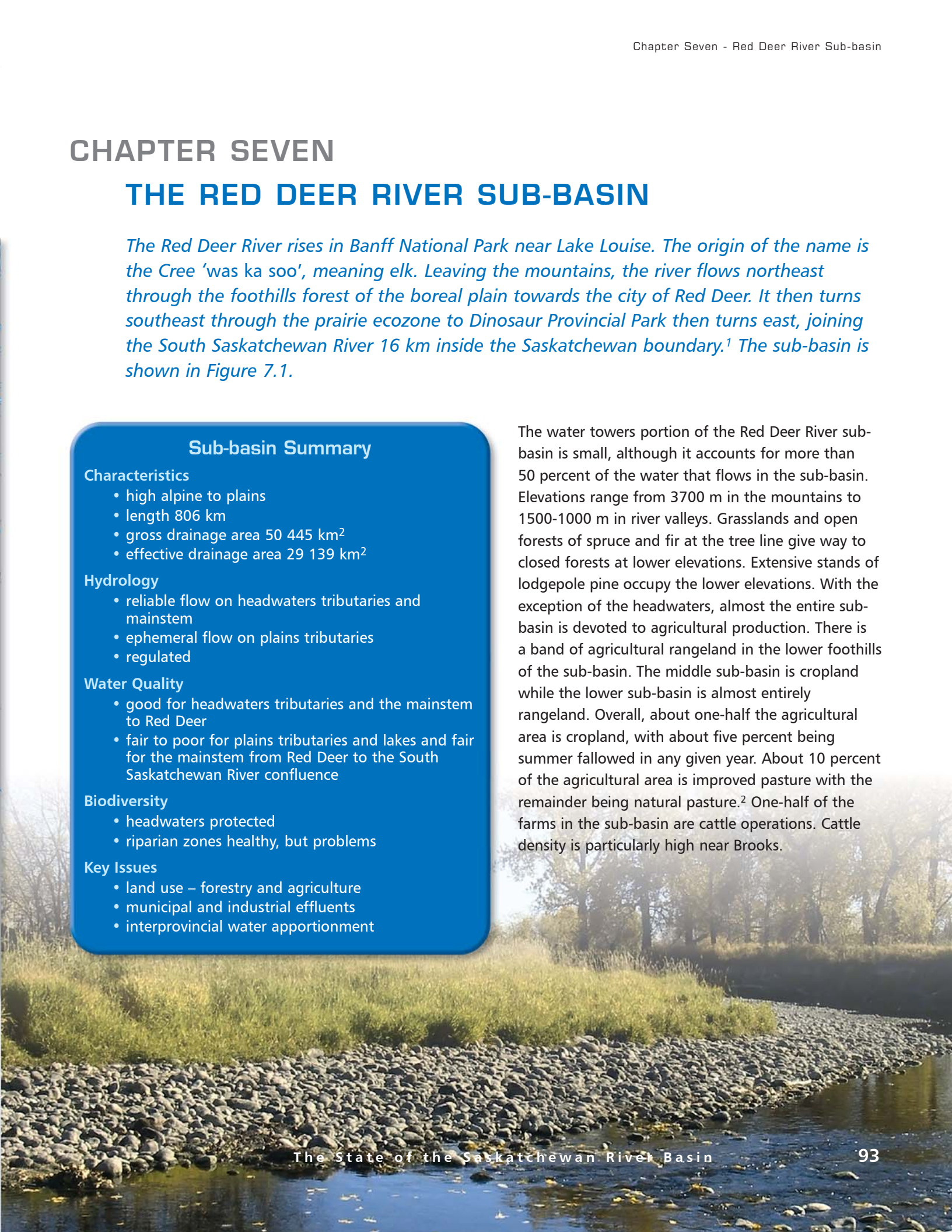
Hydrology
- reliable flow on headwaters tributaries and mainstem
- ephemeral flow on plains tributaries
- regulated

Water Quality
- good for headwaters tributaries and the mainstem to Red Deer
- fair to poor for plains tributaries and lakes and fair for the mainstem from Red Deer to the South Saskatchewan River confluence

Biodiversity
- headwaters protected
- riparian zones healthy, but problems

Key Issues
- land use – forestry and agriculture
- municipal and industrial effluents
- interprovincial water apportionment

The water towers portion of the Red Deer River sub-basin is small, although it accounts for more than 50 percent of the water that flows in the sub-basin. Elevations range from 3700 m in the mountains to 1500-1000 m in river valleys. Grasslands and open forests of spruce and fir at the tree line give way to closed forests at lower elevations. Extensive stands of lodgepole pine occupy the lower elevations. With the exception of the headwaters, almost the entire sub-basin is devoted to agricultural production. There is a band of agricultural rangeland in the lower foothills of the sub-basin. The middle sub-basin is cropland while the lower sub-basin is almost entirely rangeland. Overall, about one-half the agricultural area is cropland, with about five percent being summer fallowed in any given year. About 10 percent of the agricultural area is improved pasture with the remainder being natural pasture.[2] One-half of the farms in the sub-basin are cattle operations. Cattle density is particularly high near Brooks.



The Red Deer River sub-basin contains a portion of one national park, eight Alberta provincial parks, and one First Nations reserve. The middle sub-basin is well known for both archaeological and palaeontological resources.

The population of the sub-basin in 2006 was about 270 000 persons. Cities in the sub-basin include Red Deer, Brooks and an extremely small portion of Calgary. The larger towns include Strathmore, Sylvan Lake, Drumheller, Innisfail and Olds. The population of the larger urban centres is increasing rapidly while that of rural areas is stable.

Oil and gas exploration and development and refining operations are extensive, particularly in the lower sub-basin near Brooks. Only the Rocky Mountain headwaters lack oil or gas resources. The sub-basin has significant coal deposits used to support thermal power generation.

HYDROLOGY

The Red Deer River is 806 km long. The mountain headwaters area of the sub-basin is relatively small. The only significant upper sub-basin tributaries are the James and Raven rivers. Important plains tributaries include Medicine, Kneehill and Rosebud creeks. The gross drainage area is 50 445 km^2 and the effective drainage area is 29 139 km^2. Most of the non-contributing area lies in the lower sub-basin.

The annual precipitation in the headwaters valleys of the sub-basin is almost 600 mm, with half of that falling as snow. Precipitation at higher elevations is greater, and a greater percentage of that precipitation falls as snow. Where the river reaches the plains at Red Deer, annual precipitation is less than 500 mm, about 80 percent falling as rain. Annual precipitation continues to decline moving eastward in the sub-basin. Annual precipitation at Empress near the Saskatchewan boundary is only 290 mm, with 72 percent of this falling as rain. Snowmelt and rain during the snowmelt period are the key factors determining annual runoff. Summer rains, while sustaining crops, produce little runoff.

Although the headwaters portion of the Red Deer River accounts for much of the flow in the sub-basin, there is a significant contribution from prairie runoff, as shown by the naturalized flows in Figure 7.2. The first of two flow peaks occurs in April, caused by runoff from the plains tributaries of the sub-basin. The later and higher peak in June or July is from mountain runoff. The contribution of prairie runoff to the annual flow of the Red Deer River means that the flow is not as reliable as that of an almost exclusively mountain-fed stream, such as the North Saskatchewan River.

The Red Deer River is regulated by Dickson Dam in the foothills upstream of Red Deer, constructed in 1983 to provide increased winter flows and some flood control for the city of Red Deer. Since the

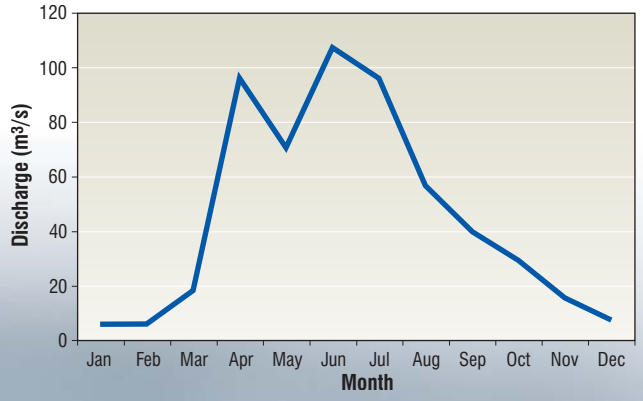


Figure 7.2. Median Monthly Naturalized Flows at Interprovincial Boundary.

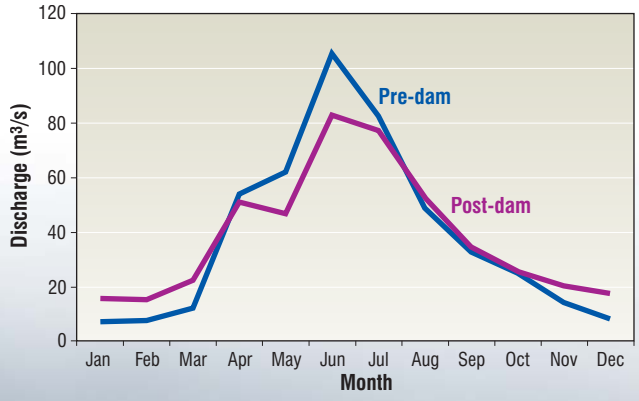


Figure 7.3. Effects of River Regulation on Flows at Red Deer.

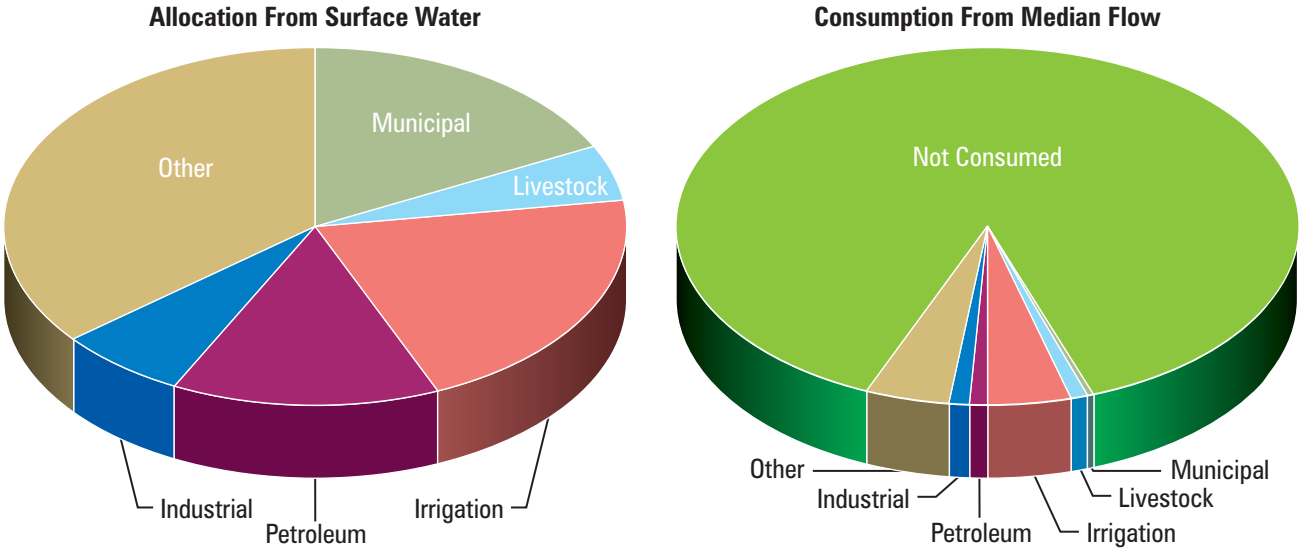


Figure 7.4. Licensed Allocation and Water Consumption from Surface Water.

purpose of the reservoir is water management rather than hydroelectric generation, the flow pattern tends to mimic the natural hydrograph. Generally, winter flows are slightly greater than they would be under natural conditions, while the spring peaks are slightly lower. The reservoir created by the dam, Glennifer Lake, provides recreational uses. The effect of the reservoir on annual flows is shown in Figure 7.3.

Streamflows are monitored at 43 sites in the sub-basin and lake or reservoir levels at 9 sites. The program is carried out by the Water Survey of Canada under a cost-sharing arrangement with Alberta Environment.

WATER USE

The licensed annual water allocation for the Red Deer River sub-basin in 2005 was 335 504 dam^3, and 37 325 dam^3 of this was from groundwater. Under the terms of Alberta's South Saskatchewan Water Management Plan, an initial maximum allocation of 600 000 dam^3 from the Red Deer sub-basin is identified. When allocations in the Red Deer sub-basin reach 550 000 dam^3, a thorough review aimed at identifying the allocation limit will be conducted.[3] Actual consumption from groundwater is 27 380 dam^3. Surface water consumption is now 190 455 dam^3, which is 12 percent of the median naturalized annual flow.[4] Water allocations from surface water and annual water consumption compared to the median are shown in Figure 7.4.

Agricultural water represents about 45 percent of the surface water consumed in the Red Deer sub-basin. Stockwatering makes up 10 percent and private irrigation about 35 percent of total consumption. Water for stockwatering is primarily groundwater, while irrigators use surface water. Almost all of the irrigators are producing forage to support cattle operations. Crawling Valley Reservoir in the lower sub-basin near Bassano was constructed on a glacial meltwater channel in 1983. The reservoir is filled from the Bow River by means of the Eastern Irrigation District North Branch Canal.[5] This diversion from the Bow River is a net increase in the flow of the Red Deer River.

The next largest consumer is the 'other' category, at 35 percent. This represents water used by projects related to flood control, lake stabilization and habitat enhancement. Many of this last group are Ducks Unlimited Canada projects. The next largest water consumer in the sub-basin is the petroleum sector. Much of that consumption is surface water required by gas and petrochemical plants. Water use by the petroleum sector is declining.

Industrial water consumption from surface water is modest. The largest water allocation is for cooling water for the coal-fired generating station at Sheerness. Cooling water for the 760 MW Sheerness station is pumped from the Red Deer River to a cooling pond that also provides the municipal supply for Hanna, which is outside the sub-basin. Most of the water is recycled through the cooling pond.

Municipal water consumption is small. Water allocated to the municipal sector is significant, but consumption is small and most of the water withdrawn returns to the stream. Urban centres depend on surface water while rural and other users rely on groundwater. Brooks and Bassano, while in the Red Deer sub-basin, draw their water from the Bow River. Stettler in the Battle River sub-basin draws its water from the Red Deer River.

The largest single consumer of groundwater is water for livestock, accounting for three-quarters of all groundwater consumption. Groundwater use by other sectors is small.

Any application for a water licence from the Red Deer River received after May 1, 2005 is subject to water conservation objectives. Some licences granted prior to this time contain a 'retrofit provision' that may be used to make the licences subject to water conservation objectives. In the reach from Dickson Dam to the confluence with the Blindman River, immediately downstream of the city of Red Deer, a flow of 45 percent of the natural flow or 16 m^3/s, whichever is greater, must be maintained. Downstream of the Blindman River confluence, the water conservation objective is the same for the November to March period and drops to 45 percent of the natural flow or 10 m^3/s, whichever is less, for the April to October period. These objectives can be compared to the values shown in Figures 7.2 and 7.3. The highest priority for the operation of Dickson dam is to provide a year-round release of 16 m^3/s.[6]

The flows in the Red Deer River are also subject to the PPWB *Master Agreement on Apportionment*. Under the agreement, the waters of the South Saskatchewan River, including the Red Deer River, are treated as one stream for apportionment purposes. The specific arrangements pertaining to the South Saskatchewan River are discussed in Chapter 9.

WATER QUALITY

The waters of the Red Deer River to Glennifer Lake and its headwaters tributaries are mostly unaffected by human activity. The waters are naturally hard and nutrient poor. The water quality is considered as good, although total phosphorous levels are naturally elevated. Downstream of the Glennifer Lake, effects of river regulation are evident. Winter flows are higher than natural and have higher oxygen levels and so are better able to assimilate waste from point and non-point sources. The clear water released from the reservoir scours the stream channel immediately downstream of the dam. The partial suppression of spring peak flows means that flushing flows are reduced. The releases from Dickson Dam also affect the thermal regime of the river.

Water quality is affected by wastewater effluents from Red Deer and Drumheller and by industrial effluents from petrochemical plants near Joffre. Nutrient loading in the lower reaches of the river is significant, primarily from agricultural sources in the plains tributary sub-basins such as the Little Red Deer, Medicine and Blindman rivers. Smaller streams such as Hayes, Ray, Renwick, and Threehills creeks are also affected by nutrient loads. Despite these nutrient inputs, overall water quality is considered to be good upstream of Drumheller and fair downstream to the confluence with the South Saskatchewan River. The lower Red Deer River also receives irrigation return flows from the Western Irrigation District and the Eastern Irrigation District. Pine, Sylvan and Gull lakes, major recreational lakes, are also affected by nutrients originating from septic leachate, recreational use and urban runoff, as well as from agricultural sources. Agricultural runoff also affects the wetlands of the sub-basin.[7]

Table 7.1. Long Term Water Quality Monitoring Sites.

Stream	Location	Agency	Remarks
Red Deer River	at Highway 2	Alberta Environment	Upstream of Red Deer
Red Deer River	Nevis	Alberta Environment	Downstream of Red Deer
Red Deer River	Morrin Bridge	Alberta Environment	Upstream of Drumheller
Red Deer River	Bindloss	Environment Canada	Near Saskatchewan boundary

Based on nutrient levels, the Red Deer River is low in nutrients, or oligotrophic, upstream of Glennifer Lake, oligotrophic to mesotrophic from Glennifer Lake to Drumheller and high in nutrients, or eutrophic, downstream of Drumheller. The natural lakes of the sub-basin tend to be eutrophic or hypereutrophic, particularly in the lower sub-basin.[8]

Water quality is monitored at four locations on the Red Deer River as shown in Table 7.1. Historical monitoring data are available for the reach at Sundre, upstream of Glennifer Lake. There are no long-term monitoring sites on tributary streams, although periodic assessments have been carried out. Assessments of water quality of recreational lakes are also conducted.

Alberta produces a water quality index based on monitoring upstream and downstream of Red Deer. Results drawn from several years of data are shown in Figure 7.5. The effect of improvements to the Red Deer effluent treatment in 2000 is apparent. The principal factor contributing to reduced index values remains elevated nutrient concentrations.

The Prairie Provinces Water Board has developed water quality objectives for the reach from Bindloss to the confluence with the South Saskatchewan River, based on physical, chemical and biological variables. Water samples obtained throughout the year are tested against these objectives. About one percent of the samples have concentrations exceeding the objectives. Although nutrients are the major water quality concern in the Red Deer sub-basin, pesticides are frequently detected.

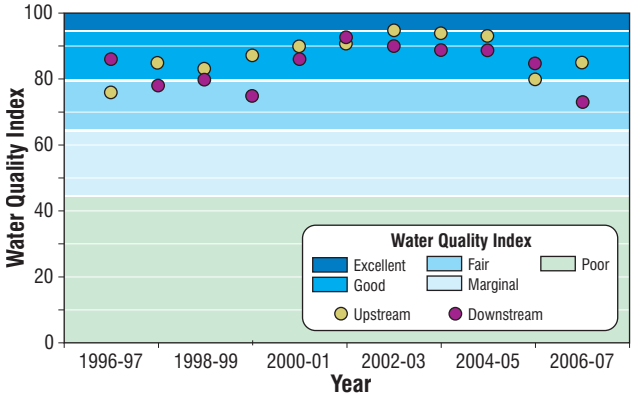


Figure 7.5. Water Quality Index Upstream and Downstream of Red Deer.

BIODIVERSITY AND ECOSYSTEMS

The headwaters of the Red Deer River lie in the relatively undisturbed landscape of Banff National Park and the Bighorn Forest Management Unit. The forests of the upper sub-basin provide important habitant for many mammals and migratory songbirds. The sub-basin then passes through parts of the Sundre and Spray Lake Forest Management Areas. In these areas, timber harvesting leads to younger and more fragmented forests that lead to the decline of some species. Petroleum exploration also leads to habitat fragmentation through seismic line cutting, road and pipeline construction. The only part of the sub-basin where riparian health assessments have been carried out is the reach from Glennifer Lake to immediately downstream of Red Deer. Riparian health is deemed to be fair to poor.

Table 7.2. Fish Species in the Red Deer Sub-basin.

Species Type	Common Name
Coldwater Species (5-18°C) **** Introduced Species***	Brook Trout Brown Trout* Bull Trout Lake Whitefish Mountain Whitefish Rainbow Trout
Coolwater Species (10-25°C)	Goldeye Mooneye Northern Pike Sauger Walleye Lake Cisco Yellow Perch Burbot Lake Sturgeon
Non-game Species	Brook Stickleback Emerald Shiner Fathead Minnow Flathead Chub Iowa Darter Lake Chub Longnose Dace Longnose Sucker Mountain Sucker Northern Redbelly Dace Shorthead Redhorse Sucker Pearl Dace Quillback Sucker River Shiner Spottail Shiner Trout-Perch White Sucker

Overall aquatic ecosystem health in the Red Deer sub-basin can be considered as good in the upper portion of the sub-basin and fair in the lower portion. Ecosystem health in the lower sub-basin is degraded by agricultural runoff and irrigation return flows. Full assessment of sediment quality and non-fish biota is not possible because of lack of data.

Fish species of the sub-basin are shown in Table 7.2. Fish populations are generally stable. The conservation flows discussed earlier in this chapter are based in part on the temperature and dissolved oxygen requirements for fish.

The agricultural rangeland and cropland extending from the forested upper sub-basin through to the city of Red Deer is a non-point source of pollutants, particularly nutrients. In general, however, the composition and diversity of benthic invertebrate communities is consistent with a healthy ecosystem upstream of Glennifer Lake. Downstream of the lake, the effects of river regulation are evident as are the effects of municipal and industrial effluents at Red Deer. The species downstream of Red Deer and Joffre tend to include those that are more tolerant of nutrient enrichment. Very sensitive species are not present. Even so, the condition of aquatic communities in the lower sub-basin is reasonably good.[9]

ENDNOTES

[1] Ecological Stratification Working Group 1996. *A National Ecological Framework for Canada.* Canadian Soil Information System (CanCIS), Agriculture and Agrifood Canada. Ottawa, ON.

[2] Alberta Environment 2007a. *Current and Future Water Use in Alberta.* Prepared by AMEC Earth & Environmental. Alberta Environment. Edmonton, AB.

[3] Alberta Environment 2006. *Approved Water Management Plan for the South Saskatchewan River Basin (Alberta).* Alberta Environment. Edmonton, AB.

[4] Alberta Environment 2007a. *supra.*

[5] Prepas, E. and P. Mitchell 1990. *Atlas of Alberta Lakes.* University of Alberta Press. Edmonton, AB.

[6] Alberta Environment 2006. *supra.*

[7] Alberta Environment 2007b. *Information Synthesis and Initial Assessment of the Status and Health of Aquatic Ecosystems in Alberta.* Technical Report 278/279-01. Alberta Environment, Edmonton, AB.

[8] Alberta Environment 2007b. *supra.*

[9] Alberta Environment 2007b. *supra.*