Appendix A

Fisheries Management Objectives for Rivers within the South Saskatchewan River Basin (DRAFT)

BACKGROUND INFORMATION

POLICY AND LEGISLATIVE FRAMEWORK

Conservation and protection of Alberta's fish resource is the responsibility of the Fish and Wildlife Division, Alberta Sustainable Resource Development. This stewardship role is addressed in the following mission statement, as extracted from "*A Fish Conservation Strategy for Alberta*":

> "*The mission for fisheries management is to sustain the abundance, distribution and diversity of fish populations at the carrying capacity of their habitats. Biodiverse and productive ecosystems maintain healthy fish populations and support social and economic benefits for Albertans*"

Furthermore, the management of the fish resources involves the following three primary components:

> *HABITAT MAINTENANCE - sustain or achieve a net gain in the quality and quantity of fish habitat;*
>
> *FISH CONSERVATION - regulate fish harvest in line with, and not exceeding, the productive capacity of fish populations; and*
>
> *FISH USE ALLOCATION – manage fish populations in a manner that meets the present expectations of Albertans without compromising the ability of future generations to meet their expectations.*

The legal basis for managing the above components is housed within various federal and provincial statutes. The Federal *Fisheries (Canada) Act* addresses the harmful alteration of fish habitat by stating in Section 35 (1):

> "*No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat*"

Furthermore, Section 34 (1) of this Act defines fish habitat as:

> "*spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes.*"

The *Fisheries (Alberta) Act* and regulations, proclaimed in 1997, provide for the development and implementation of regulations to manage the harvest and allocation of use of the fish resources.

Since water is an integral component in the habitat for fish, the *Water (Alberta) Act (Statutes of Alberta 1996*) provides additional direction by providing definitions for the following terms:

1(1)(h) "aquatic environment" means the components of the water related to living or located in or on water or beds or shores of a water body, including but not limited to :

i. all organic and inorganic matter, and
ii. living organisms and their habitat, including fish habitat, and their interacting natural systems.

(s) "environment" means the components of the earth and includes

i. air, land and water
ii. all layers of the atmosphere, and
iii. all organic and inorganic matter and living organisms

and the interacting natural systems.

(iii) "water conservation objective" means the amount and quality of water established by the Director under Part 2, based on information available to the Director, to be necessary for the

i. protection of a natural water body or its aquatic environment,or any part of them,
ii. protection of tourism, recreational, transportation or water assimilation uses of water, or
iii. management of fish or wildlife

Aquatic environment protection strategy

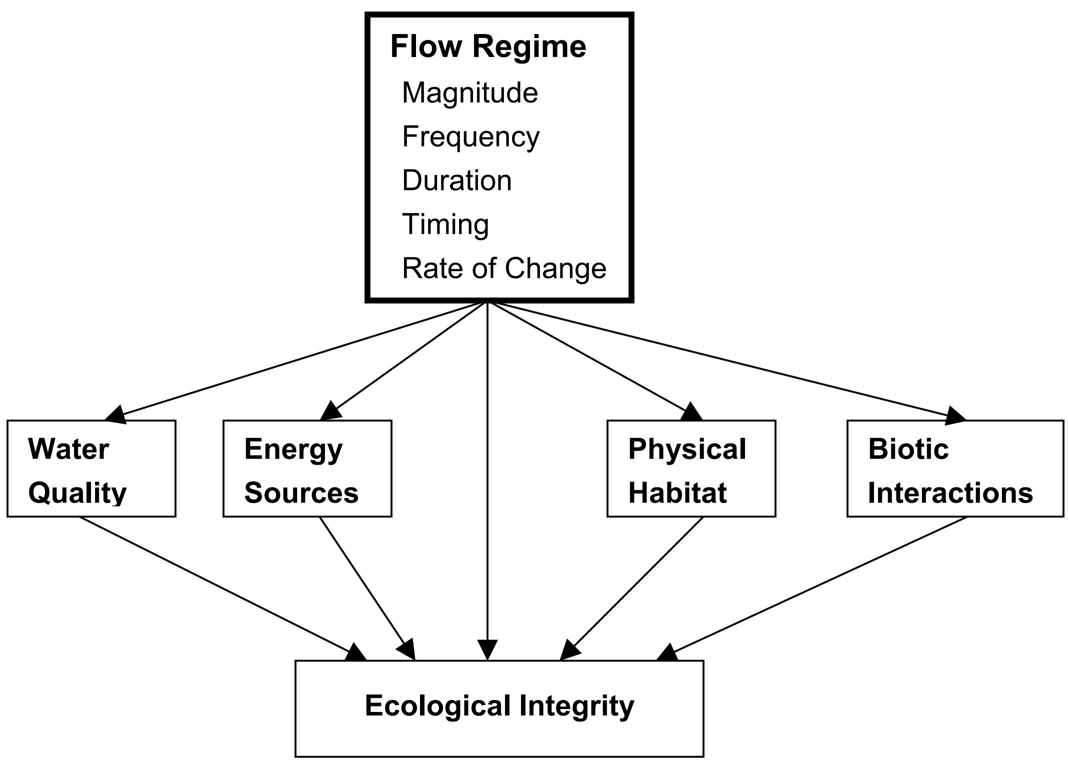
8(1) In this section, "biological diversity" means the variability among living organisms and the ecological complexes of which they are a part, and includes diversity within and between species and ecosystems.

Fundamental to the *Water Act* is the recognition that the protection of the aquatic environment is an important element of sustainable water management. The Act requires that a strategy for the protection of the aquatic environment be developed as part of the provincial water management-planning framework. This strategy is a reflection of the government's commitment to maintaining, restoring and enhancing current conditions in the aquatic environment throughout the province (Alberta Environment 2002).

ECOLOGICAL PRINCIPLES – RIVERINE ENVIRONMENTS

To appreciate and understand the fish resources within the major watersheds of Alberta, some discussion on the natural processes that provide for fish habitats and fish populations is imperative. The presence of specific fish habitats involves the dynamics of the physical and chemical processes associated with the flowing (riverine) system. Riverine fish habitats are a function of the flow regime of the system. The linkage of flow to the other processes is illustrated in Figure 1.

Figure 1. Flow regime is of central importance in sustaining the ecological integrity of flowing water systems (After Karr 1991).



Poff et al. (1997) provide a detailed discussion of the role of flow as the “master variable” in lotic (flowing) systems. The following key points have been extracted from that document:

- *The natural flow regime plays a critical role is sustaining native biodiversity and ecosystem integrity in rivers.*
- *In rivers, the physical structure of the environment and thus, of the habitat is defined largely by physical processes, especially the movement of water and sediment within the channel.*
- *For many riverine species, completion of the life cycle requires an array of different habitat types, whose availability over time is regulated by the flow regime. The timing, or predictability, of flow events is critically ecologically because the life cycles of many aquatic and riparian species are timed to either avoid or exploit flows of variable magnitudes.*
- *Modification of the natural flow regime dramatically affects both aquatic and riparian species in streams and rivers.*
- *A focus on one or a few species and on minimum flows fails to recognize that what is “good” for the ecosystem may not consistently benefit individual species and that what is good for individual species may not be of benefit to the ecosystem.*
- *Recognizing the natural variability of river flow and explicitly incorporating the five components of the natural flow regime (i.e., magnitude, frequency, duration, timing, and rate of change) into a broader framework would constitute a major advance over most present management, which focuses on minimum flows and on just a few species.*

In summary, the protection of fisheries must include protection of hydrological and physical processes that maintain the natural structure and function of flowing water as well as protecting biological components. A fishery consists not only of fish, but all other ecosystem elements that are necessary to support them as well as societal uses and preferences.

RED DEER RIVER FISHERIES MANAGEMENT OBJECTIVES

(that portion of the river upstream from the Saskatchewan Border to the Dickson Dam.)

SPECIFIC REACHES:

1. That portion of the Red Deer River upstream from the Saskatchewan Border to Drumheller.
2. From Drumheller upstream to the confluence with the Blindman River.
3. From the confluence with the Blindman River upstream to the confluence with the Medicine River.
4. From the confluence with the Medicine River upstream to the Dickson Dam.

Future fisheries management strategies to improve fish production in the above specified reaches of the Red Deer River will be based on the following objectives:

- Monitor and evaluate the aquatic habitat configuration (pools, riffles, refugia, substrate composition and bank stability) and assess what impact the regulated flow has on the quality and quantity of these habitats.
- Investigate the role that flow has on maintaining channel configuration and sediment transport and how these processes maintain fish habitats.
- Maintain an unobstructed channel in the Red Deer River to allow spawning walleye and northern pike to migrate from the river to important fish-spawning habitats in the Little Red Deer, Medicine and Blindman Rivers.
- Install and maintain fish screens in diversion gates and intake systems to prevent the loss of all life cycle stages of the fish community.
- Ensure that water quality criteria, specifically water temperature and dissolved oxygen, remain within the range necessary to sustain the specific life cycles of the various fish species.

- Develop Biologically Significant Period (BSP's) Tables for all species within the fish community; however, as an interim measure, the BSP's for lake sturgeon, walleye, goldeye, brown trout and mountain whitefish will be used to evaluate future water management strategies.
- Manage the fishery from the Dickson Dam to the Tolman Bridge with a zero bag limit for trout and walleye, a restricted size fishery for mountain whitefish (> 30 cm) and northern pike (> 63 cm). Below the Tolman Bridge the fishery will have size restrictions for walleye (> 50 cm) and northern pike (> 63 cm)

Further to the specific fisheries management objectives, resources are required to address the following data gaps:

- Develop water temperature and dissolved oxygen criteria for protection of specific life stages of lake sturgeon and goldeye.
- Information on the life history of sauger in the Red Deer River needs to be collected.
- Assess the impact of the storm water management strategy developed by the City of Red Deer.
- More information is needed as to the role of backwater areas in providing critical rearing areas and what impact regulated flows will have on these habitats.

APPROVAL OF OBJECTIVES:

Regional Fisheries Biologist: ______________________ **Date:** ___________

Regional Head - Fisheries: ______________________ **Date:** ___________

Director - Fisheries Management: ______________________ **Date:** ___________

Assistant Deputy Minister - FWD: ______________________ **Date:** ___________

THE RIVER ENVIRONMENT

The general features of the Red Deer River are provided in Longmore and Stenton (1981). Prior to the construction of the Dickson Dam, the river below Red Deer provided warm water aquatic habitats, supporting warm water fish species and mountain whitefish.

Prior to the operations of the dam, the channel width at Red Deer was 89 m, whereas at Drumheller it was 96 m. The river was shallow at Red Deer, with a mean depth of 0.8 m; at Drumheller the mean depth of the river is 1 m (Kellerhals et al 1972).

Warmer water temperatures, and additional nutrients derived from the City of Red Deer significantly increased biological productivity in the section of the river below Red Deer. Summer water temperatures frequently reached 24^0 C; maximum summer temperatures approached 27^0 C, occasionally exceeding the tolerance of lake whitefish.

The decomposition of the nutrients introduced into the river consume oxygen. During low winter discharges, the biochemical oxygen demand reduced the amount of dissolved oxygen available to the aquatic community.

Baker et al. (1982) noted that dissolved oxygen (DO) levels in the Red Deer River fall dangerously low during the winter months caused by heavy loading of oxygen-demanding organic substances in the water, particularly during ice over. The operations of the Dickson Dam are designed to address the issues of low winter oxygen by sustaining a winter flow of 16 cms.

THE FISH COMMUNITY

Fish species collected to date in the Red Deer River system are as follows:

Mountain whitefish	- *Prosopium williamsoni*
Brown trout	- *Salmo trutta*
Rainbow trout	- *Oncorhynchys mykiss*
Lake whitefish	- *Coregonus clupeaformis*
Northern pike	- *Esox lucius*

Goldeye	- *Hiodon alosoides*
Mooneye	- *Hiodon tergisus*
Walleye	- *Stizostedion vitreum vitreum*
Sauger	- *Stizostedion canadense*
Yellow perch	- *Perca flavescens*
Burbot	- *Lota lota*
Lake sturgeon	- *Acipenser fulvescens*
White sucker	- *Catostomus commersoni*
Longnose sucker	- *Catostomus catostomus*
Quillback sucker	- *Carpiodes cyprinus*
Shorthead redhorse	- *Moxostoma macrolepidotum*
Lake chub	- *Couesius plumbeus*
Pearl dace	- *Semotilus margarita*
River shiner	- *Notropis blennius*
Emerald shiner	- *Notropis atherinoides*
Spottail shiner	- *Notropis hudsonius*
Longnose dace	- *Rhinichthys cataractae*
Trout-perch	- *Percopsis omiscomaycus*
Brook stickleback	- *Culaea inconstans*
Spoonhead sculpin	- *Cottus ricei*

Upon completion of the Dickson Dam, an attempt was made to establish a tail-water fishery for rainbow trout. During the period 1985 – 1988, over 250,000 rainbow trout were stocked below the dam (Table 1).

Table 1. Rainbow trout (RNTR) and Brown trout (BNTR) stocked into the Deer River, below Dickson Dam during the period 1985 –1992.

Year	No. RNTR Stocked	No. BNTR Stocked
1985	65,000	
1986	68,079	
1987	50,000	
1988	67,018	
1991		950
1992		969
Total	250,097	1919

Although rainbow trout initially survived the stocking and were reported in angler's creels, successful reproductive was not adequate to establish and sustain a viable population. Brown trout, which were already present in the Red Deer River basin (Fallentimber Creek, Little Red Deer River and Raven River), were starting to increase in numbers below the Dickson Dam in the late 1980s. Stocking of adult brown trout was done in 1991 and 1992 to aid in the development of this fishery (Table 1). These stocks of brown trout were successful in finding spawning habitat and recruitment was documented (Wieliczko et al 1992). The future potential of this population of brown trout will be dependent upon the spawning and early rearing habitats available within the Red Deer River system.

ENVIRONMENTAL ISSUES

In 1983, the Dickson Dam was closed on the Red Deer River and thus this river became a regulated system. Of immediate concern was to determine the instream flow needs, or how much water must be left in the river, to protect the physical fish habitat of the Red Deer River between the Dickson Dam and the Saskatchewan order. Golder Associates Ltd. (1999) initiated a study in 1991to examine the physical characteristics of the river and collected physical data to input into simulation programs to predict the habitats that would be present for fish throughout the range of flow found in each river segment.

The simulation modeling exercises required the declaration of the timing of biologically significant periods and critical species life stages (Tables 2 - 5). For the purposes of the IFN initiative, different fish species were selected as the surrogate fish species for the various reached. Once the surrogate species for each specific reach were identified, water quality criteria specific criteria for the fish species and specified life stages were developed (Tables 6 - 9).

Land use changes, particularly within the major tributaries of the Red Deer River, are continuing to impact the fish habitats within the system. The release of nutrients from feedlots and the run-off of herbicides and pesticides are of significant concern. Management of storm water by the City of Red Deer is of concern and additional attention to the impact of this activity is required.

Extraction of gravel and the associated activities is of concern in the Medicine River flats. Some of these activities cause instability in the floodplains resulting in additional silt loads to the river.

Table 2. Species Periodicity Chart for Reach 1 (Empress upstream to Drumheller) of the Red Deer River.

Reach	Date (Julian Week)	BSP	Lake Sturgeon				Walleye				Goldeye			
			F	J	A	S	F	J	A	S	F	J	A	S
1	2 April – 15 April (14-15)	1		?	X			X	X			X	X	
	16 April – 10 June (16-23)	2		?	X			X	X			X	X	?
	11 June – 16 Sep (24-37)	3	?	X	X	X		X	X	X		X	X	
	17 Sep – 4 Nov (38-48)	4	?	X	X		X	X	X		X	X	X	

? Data gaps

Table 3. Species Periodicity Chart for Reach 2 (Drumheller upstream to Blindman River confluence) of the Red Deer River.

Reach	Date (Julian Week)	BSP	Walleye				Goldeye			
			F	J	A	S	F	J	A	S
2	2 April – 15 April (14-15)	1		X	X			X	X	
	16 April – 15 July (16-28)	2		X	X	X		X	X	?
	16 July – 4 Nov (38-48)	3	X	X	X		X	X	X	

? Data gaps

Table 4. Species Periodicity Chart for Reach 3 (Blindman River confluence upstream to Medicine River confluence) of the Red Deer River.

Reach	Date (Julian Week)	BSP	Brown Trout				Mountain Whitefish				Walleye			
			F	J	A	S	F	J	A	S	F	J	A	S
3	2 April – 1 July (14-26)	1		X	X		X	X	X			X	X	
	2 July – 16 Sep (27-37)	2		X	X		X	X	X		X	X	X	
	17 Sep – 4 Nov (38-48)	3		X			X	X		X	X	X	X	

Table 5. Species Periodicity Chart for Reach 4 (Medicine River confluence upstream to Dickson Dam) of the Red Deer River.

Reach	Date (Julian Week)	BSP	Brown Trout				Mountain Whitefish				Walleye			
			F	J	A	S	F	J	A	S	F	J	A	S
4	2 April – 16 Sep (14-37)	1	X	X	X		X	X	X				X	
	17 Sep – 4 Nov (38-48)	2	X	X		X	X	X		X			X	

Table 6. Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of lake sturgeon, walleye and goldeye for Reach 1 and for walleye and goldeye in Reach 2 the Red Deer River. Source: Taylor and Barton (1992).

LAKE STURGEON: Criteria Require Development

WALLEYE

Temperature

Fry-Acute	daily maximum $29^{\circ}C$
Fry-Chronic	7-day mean < $24^{\circ}C$
Juvenile and Adult-Acute	daily maximum 29° C
Juvenile and Adult-Chronic	7-day mean < $24^{\circ}C$
Spawning	7 consecutive days with: daily minimum $\geq 5^{\circ}C$ daily maximum $\leq 12^{\circ}C$

Dissolved Oxygen

Early life-Acute	daily minimum 5.0 mg/L
Early life-Chronic	7-day mean minimum 6.0 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L
Adult-Acute	daily minimum 3.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

GOLDEYE: Criteria Require Development

Table 7. Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of brown trout, mountain whitefish and walleye (see table 7) in Reach 3 and Reach 4 of the Red Deer River. Source: Taylor and Barton (1992).

BROWN TROUT	
Temperature	
Fry-Acute	daily maximum 23^{o}C
Fry-Chronic	7-day mean < 15^{o}C
Juvenile and Adult-Acute	daily maximum 25^{o} C
Juvenile and Adult-Chronic	7-day mean < 20^{o}C
Spawning	7 consecutive days with: daily minimum $\geq$ 5^{o}C daily maximum $\leq$ 11^{o}C
Dissolved Oxygen	
Early life-Acute	daily minimum 8.0 mg/L
Early life-Chronic	7-day mean minimum 9.5 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L
MOUNTAIN WHITEFISH	
Temperature	
Fry-Acute	daily maximum 24^{o}C
Fry-Chronic	7-day mean < 18^{o}C
Juvenile and Adult-Acute	daily maximum 22^{o} C
Juvenile and Adult-Chronic	7-day mean < 18^{o}C
Spawning	7 consecutive days with: daily minimum $\geq$ 1^{o}C daily maximum $\leq$ 6^{o}C
Dissolved Oxygen	
Early life-Acute	daily minimum 5.0 mg/L
Early life-Chronic	7-day mean minimum 6.5 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.5 mg/L
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

RED DEER RIVER REACH DELINEATION

For Instream Flow Needs or water management purposes, the Red Deer River is divided into the following four reaches (See Figure 2):

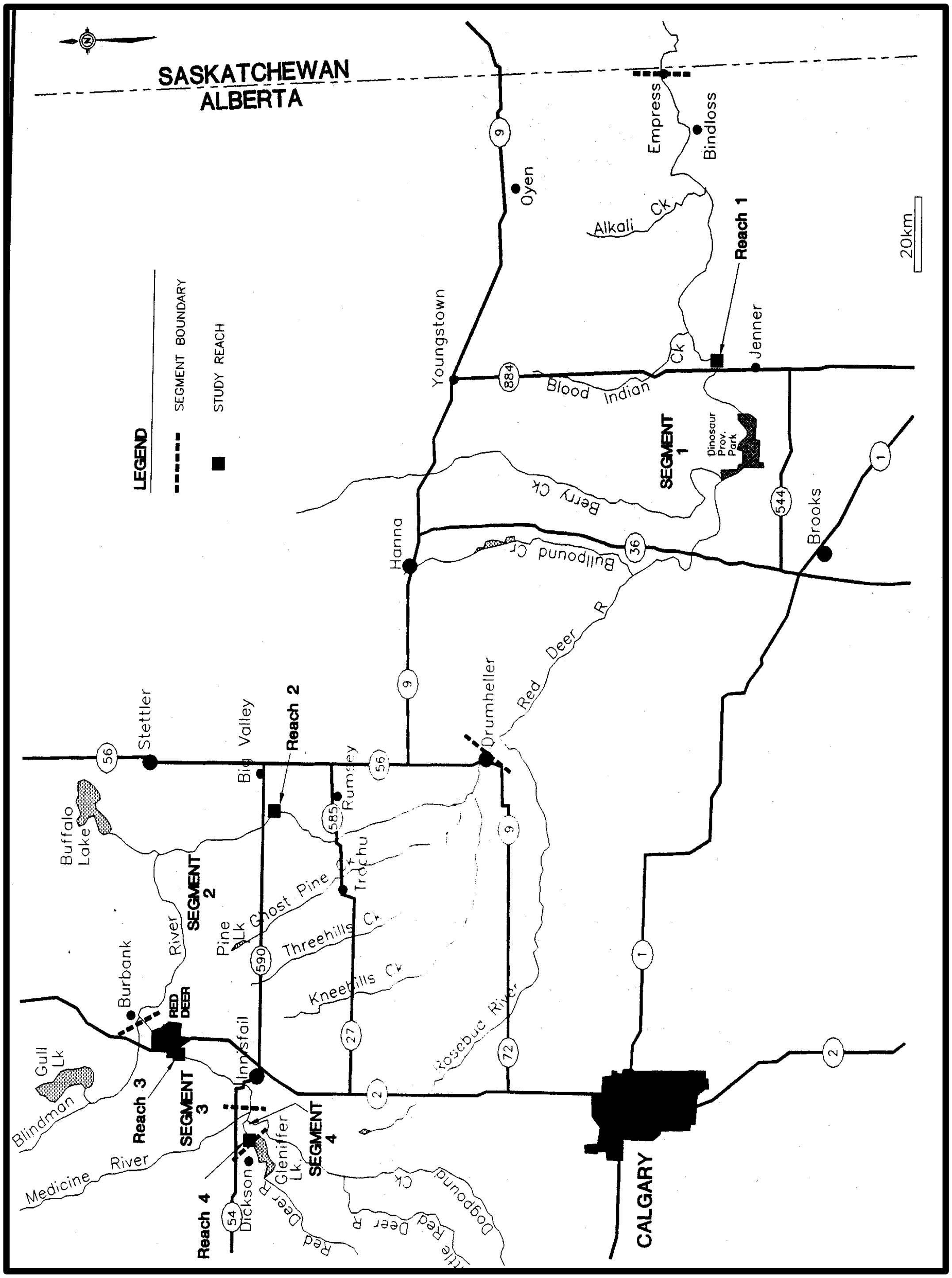


Figure 2. Locations of Reaches on Red Deer River (From Golder 1999).

Reach 1. That Portion of the Red Deer River upstream from the Saskatchewan Border (near Empress) to Drumheller.

Golder (1999) described the characteristics of this reach as generally open river valley with low gradient, infrequent hydraulic controls and fairly uniform channel cross-sections. High turbidity levels occur; fines dominated the substrates and sand bars are common at low stages of discharge.

Fish collections to date (Nelson & Paetz 1992, EMA 1983, Pisces 1995) are as follows:

Lake sturgeon	Northern pike
Walleye	Sauger
Goldeye	Longnose sucker
White sucker	Shorthead redhorse
Quillback sucker	Lake chub
Emerald shiner	Trout-perch
River shiner	Spottail shiner
Pearl dace	Longnose dace

Reach 2. From Drumheller upstream to the confluence with the Blindman River.

This reach is 183 km in length and is characterized by having deeply incised valley at the origin of the reach. The channel is single, wide, with uniform width and pattern (EMA 1983, Golder 1999). River progresses from bedrock control and boulder substrate at reach origin to sand substrate and minor gradient at Drumheller.

Fish collections conducted by EMA (1983), R.L.& L. 1996) collected the following species in this reach:

Mountain whitefish	Northern pike
Walleye	Sauger
Goldeye	Burbot
Longnose sucker	Shorthead redhorse
White sucker	Quillback sucker
Emerald shiner	Longnose dace
Lake chub	Trout-perch
Pearl dace	River shiner

Reach 3. From the confluence with the Blindman River upstream to the confluence with the Medicine River.

The 56 km of this reach of river consists of primarily a single channel, but several major side channels with permanent, vegetated islands do occur (EMA 1983, Golder 1999). The side channels are typically dry in the fall. Gravel/silt were the dominant bottom substrates, Gravel bars were few. Major influence in this reach includes inflow from the Medicine River and the City of Red Deer sewage effluent.

Fish collections conducted by EMA (1983), Rees & Buchwald (1992b) collected the following species in this reach:

Mountain whitefish	Northern pike
Walleye	Sauger
Goldeye	Mooneye
Lake whitefish	Yellow perch
Burbot	Longnose sucker
Shorthead redhorse	White sucker
Longnose dace	Lake chub
Trout-perch	Spoonhead sculpin
Pearl dace	Slimy sculpin

Reach 4. From the confluence with the Medicine River upstream to the Dickson Dam.

EMA (1983) described the general “pre-dam” characteristics of this 13 km (7.8 mi) reach. The channel was generally single, some braiding and side channels with gravel substrates. Gravels bars were common.

Fish collections conducted by EMA (1983), Buchwald (1992a), Buchwald (1992b) Rees (1992), Rees & Buchwald (1992a) and Rees & Buchwald (1992b) provided the following species list:

Mountain whitefish	Brown trout
Northern pike	Walleye
Burbot	Longnose sucker

Shorthead redhorse	White sucker
Longnose dace	Lake chub
Trout-perch	Spoonhead sculpin

MANAGEMENT OF THE SPORT FISHERY

The present and future management strategies for the sport fishery in the Red Deer River have received significant input from the public. In January 1992 the inaugural meeting of the Red Deer River Fisheries Management Advisory Committee (RDRFMAC) was held. The RDRMAC was set up to both develop a sport fishery management strategy and to monitor and evaluate that strategy's implementation. After numerous meetings and public discussions, the RFRMAC released in 1994 the report titled **"A Sport Fish Management Plan-**For Dickson Dam to Joffre Bridge, Red Deer River.**"**

BOW RIVER FISHERIES MANAGEMENT OBJECTIVES

(that portion of the river from the confluence with the Oldman River upstream to the Western Irrigation District (WID) Weir)

SPECIFIC REACHES:

1. From the Confluence with the Oldman River upstream to the Bassano Dam.
2. Bassano Dam upstream to the Carseland Weir.
3. From the Carseland Weir upstream to the WID Weir.

Future fisheries management strategies to improve fish production in the above specified reaches of the Bow River will be based on the following objectives:

- Inventory, monitor and evaluate the aquatic habitat configuration (pools, riffles, refugia, substrate composition and bank stability) and assess what impact the regulated flow has on the quality and quantity of these habitats.
- Maximize available fish habitat and production through habitat protection, restoration, and enhancement. Set flow determinations for full protection of the aquatic ecosystem including: channel structure forming flows, flushing flows, riparian vegetation, fish habitat and water quality using the most recent information that is available.
- Ensure that the fish migration and movement is not impeded within the Bow River or tributary streams. Critical periods include spring and fall spawning migrations and migrations to over-wintering habitat for rainbow trout, brown trout, mountain whitefish and bull trout.
- Ensure that larval, juvenile, and adult life stages of the fish community are prevented from entering and becoming entrained in irrigation canals and diversions.
- Ensure that total suspended solid levels do not exceed the criteria described in the Canadian Water Quality Guidelines relative to natural background conditions.
- Ensure that water quality criteria, specifically water temperature and dissolved oxygen, remain within the range necessary to sustain the specific life cycles of the various fish species.

- Develop Biologically Significant Period (BSP's) Tables for all species within the fish community; however, as an interim measure, the BSP's for walleye, lake sturgeon, goldeye, rainbow trout, brown trout and mountain whitefish will be used to evaluate future water management strategies.
- Rehabilitate the sport fish production capability of the section of the Bow River below the Bassano Dam by increasing flows.
- Manage the fishery with bag limits and size restrictions consisting of 1 <35 cm for trout, 5 > 30 cm for mountain whitefish. No size limit for northern pike upstream of Hwy 24 Bridge (bag limit 3) whereas a size restriction of > 63 cm for northern pike (bag limit 3) will apply to that section of the Bow River between the Hwy 24 Bridge and the Bassano Dam (including the Bassano Reservoir). For the Bow River below the Bassano Dam the bag and size restriction for walleye is 3 >50 cm whereas for northern pike it is 3 >63 cm. Bag limits for burbot are 10; goldeye 10.

Further to the specific fisheries management objectives, resources are required to address the following data gaps:

- Identification of spawning, feeding and over wintering habitats for mountain whitefish.
- Identify timing of major movements of mountain whitefish.
- Extent to which Bow River mountain whitefish use the Highwood system.
- Develop water temperature and dissolved oxygen criteria for lake sturgeon and goldeye.
- Assess the impact of catch and release angling on spawning and staging fish, spawning success and immediate mortality in the Bow River.
- Monitor the age of recruitment for the trout species.
- Conduct spawning redd surveys for the trout species.
- For those areas of the lower Bow River where little or no fisheries data exist, notably the portion of the river that runs through the Siksika First Nation, be inventoried with the active cooperation and participation of the First Nation's environmental managers.

- Monitor potential land use activities and land use changes to determine the effect on the health of the river and sustainability of fish populations.
- When changes in land use are anticipated, their cumulative impact on fisheries must be considered.
- Water flow in the lower Bow River should be continuously monitored to ensure that sufficient flow is maintained to sustain a healthy fishery.

APPROVAL OF OBJECTIVES:

Regional Fisheries Biologist: ______________________ **Date:** ___________

Regional Head - Fisheries: ______________________ **Date:** ___________

Director - Fisheries Management: ______________________ **Date:** ___________

Assistant Deputy Minister - FWD: ______________________ **Date:** ___________

THE RIVER ENVIRONMENT

The general features of the Bow River are provided in Kellerhals et al (1972), Longmore and Stenton (1981), Martin J. Paetz Enterprises (1986) and Fernet (1990). The Bow River flows for 498 km from the edge of Banff National Park to the Grand Forks where it joins the Oldman River to form the South Saskatchewan River. The upper 42% (214 km) of the river's length outside the Banff National Park is a cold-water aquatic habitat and extends from the park boundary to the Carseland weir. The main stem of the Bow River from Banff Park boundary to the Bearspaw dam exhibits marked daily fluctuations in discharges as a result of variable water releases at hydroelectric dams located upstream. Habitat instability resulting form these regular fluctuations is discharge limit fish production.

Discharges are re-regulated at the Bearspaw dam, and the amplitude of fluctuations is greatly moderated. More stable discharges, and the addition of treated sewage at Calgary, increases biological and fish production in the river between Bearspaw dam the Carseland weir.

The Highwood River, which joins the Bow River between Calgary and the Carseland weir, is eutrophic. Eutrophication is enhanced by irrigation water abstractions, which substantially reduce discharges, limiting fish habitats and consequently fish production. Water temperatures in the shallow, eutrophic lower reaches of both the Highwood and Sheep Rivers occasionally exceed fish tolerance levels causing die-offs.

The upper tributaries to both the Sheep and Highwood Rivers are clear and cold, and their resident fish populations – particularly cutthroat trout, provide regionally important sport fishing opportunities. Mountain whitefish and rainbow trout migrate seasonally from the Bow River to spawning habitat in these cold upper tributaries.

Between the Carseland weir and the Eastern Irrigation dam at Bassano, the Bow River is gradually transformed from a cold to cool-water aquatic habitat. The diversion of up to 90% of the streamflow to irrigation at the EID dam at Bassano has drastically reduced discharges, and consequently the fish producing capability of the remaining 34% (167 km) of the river. The Bow River between the Bassano and the Grand Forks is a cool-water aquatic habitat, but water temperatures of up to 30 ^{0}C exceed the tolerance of even cool-water fish species. During low discharges, vegetative processes in the warm, shallow, eutrophic river produce low dissolved oxygen concentrations, fluctuations in pH, and high levels of ammonia. All these factors combine to stress, and occasionally kill fish.

THE FISH COMMUNITY

Fish species collected to date (Henderson & Peter 1969; Wiebe & Konynenbelt 1980; Nelson & Paetz 1992; R.L. & L. 1996b; R.L. & L. 1999 and R.L. & L. 2000a) in the Bow River system are as follows:

Lake sturgeon	- *Acipenser fulvescens*
Cutthroat trout	- *Oncorhynchus clarki*
Rainbow trout	- *Oncorhynchus mykiss*
Brown trout	- *Salmo trutta*
Bull trout	- *Salvelinus confluentus*
Lake trout	- *Salvelinus namaycush*
Brook trout	- *Salvelinus fontinalis*
Mountain whitefish	- *Prosopium williamsoni*
Lake whitefish	- *Coregonus clupeaformis*
Northern pike	- *Esox lucius*
Walleye	- *Stizostedion vitreum vitreum*
Sauger	- *Stizostedion canadense*
Yellow perch	- *Perca flavescens*
Burbot	- *Lota lota*
Goldeye	- *Hiodon alosoides*
Mooneye	- *Hiodon tergisus*
White sucker	- *Catostomus commersoni*
Longnose sucker	- *Catostomus catostomus*
Mountain sucker	- *Catostomus platyrhynchus*
Quillback	- *Carpiodes cyprinus*
Shorthead redhorse	- *Moxostoma macrolepidotum*
Silver redhorse	- *Moxostoma anisurum*
Longnose dace	- *Rhinichthys cataractae*
Lake chub	- *Couesius plumbeus*
Trout-perch	- *Percopsis omiscomaycus*
Flathead chub	- *Hybopsis gracilis*
Emerald shiner	- *Notropis atherinoides*

Spottail shiner	- *Notropis hudsonius*
Brook stickleback	- *Culaea inconstans*
Spoonhead sculpin	- *Cottus ricei*
River shiner	- *Notropis blennius*

Mountain whitefish are the most abundant species, although rainbow trout, brown trout and bull trout are common. Numerous fisheries surveys designed to quantitative and qualify the fish community have been conducted on the Bow River (McDonald 1975; Wiebe and Konynenbelt 1981; Sosiak, A.J. and W.E. Griffiths 1983; Sosiak 1987; Courtney and Fernet 1990a and Courtney and Fernet 1990b).

The salmonid species exhibit some degree of predictable annual movement through the Bow River system. Mountain whitefish over winter in the lower reaches of the Highwood River and in the main stem of the Bow River. In the spring, they move throughout the Highwood River to summer feeding grounds in the upper main stem and tributaries; in the fall these fish move downstream to spawn. Mountain whitefish spawn in suitable habitat throughout the Highwood River from its mouth to slightly beyond its confluence with Pekisko Creek.

In the spring, rainbow trout take advantage of natural high discharges and move from the Bow River into the Highwood River. Known rainbow spawning grounds include the main stem of the Sheep River from its confluence with Threepoint Creek upstream to Coal Creek (Stelfox 1981), and its tributaries; Threepoint Creek (Stelfox 1981; Monenco 1983; Sosiak 1984; Sosiak 1986), Ware Creek (McDonald 1975; Wiebe and Konynenbelt 1979; Stelfox 1981; Monenco 1983; Sosiak 1984; Sosiak 1986), and Fisher Creek (Stelfox 1981). Rainbow trout also spawn in parts of the main stem of the Highwood River and in the lower portions of its tributaries, Sullivan Creek (Monenco 1983; Sosiak 1984; Sosiak 1986), Flat Creek, Cataract Creek and Pekisko Creek (Monenco 1983; Sosiak 1984; Sosiak 1986). Most of the major tributaries and main stem of the Highwood River are important rearing areas for young-of-year (y-o-y), yearling and juvenile rainbow trout (Sosiak 1986).

The true value of the Highwood River is the migration corridor that it provides for maintaining the “world” renowned rainbow trout fishery in the Bow River below Calgary. As already indicated, the spawning movements of adult rainbow trout from the Bow River to the upper main stems of the Highwood and Sheep Rivers and their tributaries, provides the recruitment stock to replenish the rainbow trout populations in the Bow River. Since this spawning movement occurs during the rising spring discharges in the

Highwood River, these flows undoubtedly serve as cues to stimulate the mature rainbow adults to commence the upstream migration.
Furthermore, the downstream dispersal of y-o-y and yearling rainbow trout also seems to be associated with high flows (Sosiak 1986). Although the specifics of the out migration of y-o-y's and yearlings has not been investigated, data indicates the y-o-y's remain within the Highwood River mainstem since recruitment of rainbow trout to the Bow River occurs predominately as one year olds (Sosiak and Griffiths 1983).

Unlike the rainbow trout, the distribution of brown trout tends to be restricted to the mainstem Bow River. Some brown trout are found in the Bow River downstream of the Carseland Weir, but their distribution is limited to the upper region where the water temperatures are cooler. Major spawning areas for brown trout have been identified downstream of the Bearspaw Reservoir, and at the following locations within the City of Calgary: adjacent to the Inglewood Bird Sanctuary; in the side channel of St. George's Island; and along the length of the Elbow River between Glenmore Reservoir and the Bow River confluence (Courtney and Fernet 1990a).

ENVIRONMENTAL ISSUES

Adequate water flows within the Bow River is a major concern for the future management of this important sport fishery. Significant diversions of water for agricultural/irrigation and municipal demands occur at the Western Irrigation District (WID) weir, the Bow River Irrigation District (BRID) weir at Carseland and from the EID at Bassano.

In addition to the impact of water diversion, the weirs and dam are obstacles to fish movement. The WID weir is a partial obstacle to fish movement although a fish ladder does allow a significant amount of upstream movement of trout. The original fish ladder incorporated into the BRID weir provided for the passage of fish under certain flow conditions (Thompson 1975 and McDonald 1975). Migrating fish were not strongly attracted to the entrance of the fishway during low flow periods. Modification to the fishway , specifically the location of the outlet for the attraction water to the fishway have been made; however, effective passage of fish during a variety of flow conditions has still not been evaluated. The EID has no provisions for fish passage and thus is a barrier to upstream movements of fish.

The water diversion channels, originating from the weirs and dams, entrain a variety of life stages of various fish species. Specific monitoring of the entrainment issue has been conducted on the Carseland-Bow River Headworks Canal (Allaire 1999; R.L. & L. 1999 and R.L.& L. 2000). This entrainment represents a net loss of fish stocks that normally would have contributed to recruitment and the food chain within the Bow River; however, the direct effect on the fish community in the Bow River has not been evaluated.

The urban environment is also having an impact on the aquatic habitat of this section of the Bow River. Runoff from city streets containing sediment, salt, grease and oils is collected in storm sewers and storm-water retention ponds and eventually is discharged into the river. The construction of bridge and pipeline crossings, channelization, bank stabilization and similar instream activities promote temporary siltation and erosion problems.

The addition of nutrients, from urban, industrial and agricultural sources, creates conditions of high productivity, particularly in the lower section of the Bow River. Rooted plants and algae are abundant resulting in marked changes in dissolved oxygen, ie from above saturation values during bright sunlight to critically low levels. Relatively high ammonia levels have also been reported in the river below Bassano (Exner 1979).

Irrigation return water enters the Bow River at several places downstream of the Bassano Dam. This water carries soil particles from the land and from canal banks contributing silt to the river. Turbidity is increased and silt smothers bottom life and degrades spawning grounds of fishes which spawn on or in gravel substrates.

The effects of flow regulation and fluctuation on the fisheries values of the Bow River, especially between the Ghost and Bassano dam, were examined by Golder Associates Ltd. (1994). This study reviewed the fisheries component and the water quality, river regime and flushing flow issues associated with the Bow River. Using a sediment transport model, which recognized the channel flows, erosion and substrate conditions, channel regime, channel geometry, recommended maintenance flows, durations and frequencies were provided. A similar study is required for the section of the Bow River below the Bassano Dam.

The above modeling exercise required the declaration of the timing of biologically significant periods and critical species life stages with the specific reaches (Table 8 and 9). For the purposes of the IFN initiatives, rainbow trout, brown trout and mountain whitefish were selected as the surrogate fish species. This in turn provided for the development of water quality criteria specific to the fish species and specified life stages (Table 10 and 11).

Table 8. Species Periodicity Chart for Reach 1 (Confluence with Oldman River upstream to Bassano Dam) of the Bow River.

Reach	Date		Walleye				Goldeye				Lake Sturgeon				Mountain Whitefish			
	(Julian Week)	BSP	F	J	A	S	F	J	A	S	F	J	A	S	F	J	A	S
1	2 April - 10 June (14 - 23)	1	X	X	X	X		X	X	?		?	X	?	X	X	X	
	17 June - 23 Sept. (24-38)	2	X	X	X			X	X			X	X		X	X	X	
	24 Sept. - 4 Nov. (39-44)	3	X	X	X			X	X			X	X		X	X	X	X

? Data Gaps

Table 9. Species Periodicity Chart for Reach 2 (Bassano Dam upstream to the Carseland Weir) and Reach 3 (Carseland Weir upstream to the WID Weir) of the Bow River.

Reach	Date (Julian Week)	BSP	Brown Trout				Rainbow Trout				Mountain Whitefish			
			F	J	A	S	F	J	A	S	F	J	A	S
2 & 3	April – 17 June (14-24)	1	X	X	X		X	X	X	**X**	X	X	X	
	18 June – 23 September (25-38)	2	X	X	X		X	X	X		X	X	X	
	24 September – 4 November (39-44)	3	X	X	X	X	X	X	X		X	X	X	X

Table 10. Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of walleye, goldeye, lake sturgeon and mountain whitefish in Reach 1 of the Bow River. Source: Taylor and Barton (1992).

WALLEYE	
Temperature	
Fry-Acute	daily maximum 29^{o}C
Fry-Chronic	7-day mean < 24^{o}C
Juvenile and Adult-Acute	daily maximum 29^{o} C
Juvenile and Adult-Chronic	7-day mean < 24^{o}C
Spawning	7 consecutive days with:
	daily minimum $\geq$ 5^{o}C
	daily maximum $\leq$ 12^{o}C
Dissolved Oxygen	
Early life-Acute	daily minimum 5.0 mg/L
Early life-Chronic	7-day mean minimum 6.0 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L
Adult-Acute	daily minimum 3.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L
GOLDEYE: Criteria Require Development	
LAKE STURGEON: Criteria Require Development	
MOUNTAIN WHITEFISH	
Temperature	
Juvenile and Adult-Acute	daily maximum 22^{o} C
Juvenile and Adult-Chronic	7-day mean < 18^{o}C
Fry-Acute	daily maximum 24^{o}C
Fry-Chronic	7-day mean < 18^{o}C
Spawning	7 consecutive days with:
	daily minimum $\geq$ 1^{o}C
	daily maximum $\leq$ 6^{o}C
Dissolved Oxygen	
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L

Table 11. Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of brown trout, rainbow trout and mountain whitefish (See table 10) in Reach 2 & 3 of the Bow River. Source: Taylor and Barton (1992).

BROWN TROUT	
Temperature	
Fry-Acute	daily maximum 23°C
Fry-Chronic	7-day mean < 15°C
Juvenile and Adult-Acute	daily maximum 25° C
Juvenile and Adult-Chronic	7-day mean < 20°C
Spawning	7 consecutive days with: daily minimum ≥ 5°C daily maximum ≤ 11°C
Dissolved Oxygen	
Early life-Acute	daily minimum 8.0 mg/L
Early life-Chronic	7-day mean minimum 9.5 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L
RAINBOW TROUT	
Temperature	
Juvenile and Adult-Acute	daily maximum 24° C
Juvenile and Adult-Chronic	7-day mean < 19°C
Fry-Acute	daily maximum 24°C
Fry-Chronic	7-day mean < 19°C
Spawning	7 consecutive days with: daily minimum ≥ 5°C daily maximum ≤ 10°C
Dissolved Oxygen	
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L

BOW RIVER REACH DELINEATION

For Instream Flow Needs or water management purposes, the Bow River is divided into three reaches.

Reach 1. Confluence with the Oldman River (Grand Forks) upstream to the Bassano Dam.

Fish species collected to date (Nelson & Paetz 1992; R.L. & L. 1996b) in this reach of the Bow River are as follows:

Lake sturgeon	Brown trout
Brook trout	Rainbow trout
Mountain whitefish	Lake whitefish
Northern pike	Walleye
Sauger	Yellow perch
Burbot	Goldeye
Mooneye	White sucker
Longnose sucker	Quillback
Shorthead redhorse	Silver redhorse
Longnose dace	Lake chub
Trout-perch	Flathead chub
Emerald shiner	Spottail shiner
River shiner	

Reach 2. Bassano Dam upstream to the Carseland Weir.

Fish species collected to date (Wiebe & Konynenbelt 1980; Nelson & Paetz 1992) in this reach of the Bow River are as follows:

Mountain whitefish	Rainbow trout
Brown trout	Northern pike
Walleye	Burbot
White sucker	Longnose sucker
Trout-perch	Spottail shiner

Reach 3. From the Carseland Weir upstream to the WID Weir.

Fish species collected to date (Wiebe & Konynenbelt 1980; Nelson & Paetz 1992; R.L. & L. 1999; R.L. & L. 2000a) in this reach of the Bow River are as follows:

Mountain whitefish	Rainbow trout
Cutthroat trout	Brown trout
Bull trout	Brook trout
Northern pike	Burbot
Longnose sucker	White sucker
Mountain sucker	Lake chub
Longnose dace	Brook stickleback
Spoonhead sculpin	Trout perch

STATUS OF SPORT FISHERY

The Bow River is well-known as world class trout fishery and contributes significantly to the Alberta economy (Bodden & Fernet 1988).

The management of the sport fishery on the lower Bow River received a major review, with a focus on public consultation, in 2000 (Equus Consulting Group 2000). The report, in addition to providing specific recommendations on regulations to manage the sport fishery, also provided guidance on monitoring and data collection, “Health of the River” and adequate flow management.

OLDMAN RIVER FISHERIES MANAGEMENT OBJECTIVES

SPECIFIC SEGMENT:

1. Grand Forks upstream to a location 13 km downstream of confluence with Willow Creek.
2. 13 km downstream of confluence with Willow Creek to Oldman River Dam.

Future fisheries management strategies to improve fish production in the above specified segments of the Oldman River will be based on the following objectives:

- Monitor and evaluate the aquatic habitat configuration (pools, riffles, refugia, substrate composition and bank stability) and assess what impact the regulated flow has on the quality and quantity of these habitats.
- Investigate the role that flow has on maintaining channel configuration and sediment transport and how these processes maintain fish habitats.
- Assess the feasibility of implementing and monitoring the impact of a range of flow alternatives on the physical, chemical and biological components of the river environment.
- Maintain an unobstructed channel in the Oldman River and thereby provide for connectivity of fish movement between the Oldman River and the lower sections of the Bow River and the upper South Saskatchewan River.
- Install and maintain fish screens in diversion head gates and intake systems to prevent the loss of all life cycle stages of the fish community.
- Ensure that water quality criteria, specifically water temperature and dissolved oxygen, remain within the range necessary to sustain the specific life cycles of the various fish species.
- Develop Biologically Significant Period (BSP's) Tables for all species within the fish community inhabiting specific reaches; however, as an interim measure future water management strategies should be evaluated based on the BSP's for brown trout, walleye, sauger, mountain whitefish and lake sturgeon in Segment 1. Brown trout, mountain whitefish and rainbow trout will be used for Segment 2.

- Monitor and assess the status of the brown trout population to determine whether recruitment from the observed spawning is adequate to sustain the population at a level adequate to support the recreational sport fishery.
- Manage the fishery with size restrictions consisting of >35 cm for cutthroat and rainbow trout, >40 cm for brown trout and >30 cm for mountain whitefish. Zero bag limits for trout and mountain whitefish will continue during the spring period (April 1 to June 15) and fall period (Sept 1 to March 31 for area below dam to Cottonwood Campground bridge; Nov 1 to March 31 downstream of Cottonwood Campground bridge to Sec Rd. 509). From Sec Rd 509 downstream to the South Saskatchewan River the fishery will be managed as a restricted size fishery of > 30 cm for mountain whitefish, > 50 cm for walleye, > 63 cm. for northern pike and > 130 cm for lake sturgeon (limit of one per year).

Further to the specific fisheries management objectives, resources are required to address the following activities:

- Monitor the new fish passage device that has been incorporated into the City of Lethbridge water intake weir.
- Develop water temperature and dissolved oxygen criteria for lake sturgeon.
- Investigate the early life history for lake sturgeon, sauger and walleye.
- Continue to count the rainbow trout redds and monitor the development and subsequent survival of the eggs, fry and young-of-year to determine whether dam induced spawning failures occurs.
- Conduct fisheries inventory within the Peigan Indian Reserve.
- Monitor the effectiveness of the fish passage system at the LNID weir.
- Monitor non-sport fish species as well as sport fish species.

APPROVAL OF OBJECTIVES:

Regional Fisheries Biologist: ______________________ **Date:** ___________

Regional Head - Fisheries: ______________________ **Date:** ___________

Director - Fisheries Management: ______________________ **Date:** ___________

Assistant Deputy Minister - FWD: ______________________ **Date:** ___________

THE RIVER ENVIRONMENT

The general features of the Oldman River are provided in Kellerhals et al (1972), Longmore and Stenton (1981) and English (1988).

In 1984, the Government of Alberta announced plans to construct the Oldman River Dam at a site approximately 10 km northeast of Pincher Creek. The resulting reservoir inundated sections of three rivers: the Crowsnest, Castle and Oldman rivers. The reservoir began filling in the fall of 1991 and the facility was officially opened in 1992.

The primary function of the Oldman River Dam and its reservoir is to store water for multiple uses, particularly agricultural/irrigation and to meet municipal demands. The operation of the Oldman River Dam has altered the historical flow regime of the Oldman River by affecting both discharge and temperature patterns. Water flows tends to be more stable and water temperatures are cooler in summer and warmer in winter (Hazewinkel & Saffran 2001). The altered flow regime will affect fish populations residing downstream of the dam; however, it is unclear as to how these changes will be manifested.

Mitigation for the dam included an enhancement program on the Oldman River downstream of the Oldman River Dam. One project was designed to provides high quality habitat for adult brown trout by the use of boulders placed in existing deep-water areas. It is anticipated that hatchery brown trout, which were stocked during the period 1992 – 1997 (Table 12), would utilize these areas, thereby facilitating the development of a self-sustaining brown trout population downstream of the reservoir.

Table 12. Brown trout (BNTR) stocking program for Oldman River, below Oldman River Dam, 1992 –1997.

Year	No. of BNTR Stocked
1992	110,775
1993	145,285
1995	121,241
1996	99,903
1997	119,659
Total	**596,863**

THE FISH COMMUNITY

The fish community within the Oldman River system below the Oldman River dam demonstrates a temperature related gradient (R.L. & L. 2000b and 2000c). Rainbow trout and bull trout are confined to the upper reach whereas in the transition zone, northern pike, lake sturgeon and walleye (cool-water species) are found in association with the cold-water species.

The results suggest that the distribution and relative abundance of fish species are influenced by changes in the water temperature and habitat types and availability. For example, bull trout, a cold-water species, is restricted to the area immediately below the Oldman River Dam. In contrast, cool-water species such as sauger and lake sturgeon are restricted to downstream areas.

Mountain whitefish provide a good example of a species that is influenced by the transition between cold and cool water habitats. This cold-water species is present in all sections; however, catch per unit effort (CPUE) values decreased from upstream to downstream. Mountain whitefish dominate the fish community in the upper sections, exhibit reduced abundance indices in the mid sections, and are largely absent from the sample in lower section. In addition to the influence of temperature, changes in river gradient, flow velocities and bed substrates could contribute to the distribution of mountain whitefish.

Conversely, the cyprinids increase as one moves downstream. Relative abundance of sport fish also decreases as one moves downstream (R.L. & L. 2000b and 2000c).

Fish species collected to date (English 1988, R.L. & L. 1996b, 1997, 2000a and 2000b) in specific segments of the Oldman River system are as follows:

Segment 1. Grand Forks upstream to location 13 km downstream of confluence with Willow Creek. (Stations II, III, IV, V and V1 in English 1988; Sites 01, 02, 03 and 04 in R.L. & L. 1996b, and Sites 01, 02, 03 and 04 in R.L. & L. 1997b and Section 4, 5, 6 and 7 in R.L. & L. 2000b and Section 5 and 6 in R. L. & L. 2000c and R.L. & L. 2000d)

Lake sturgeon	- *Acipenser fulvescens*
Lake whitefish	- *Coregonus clupeaformis*
Mountain whitefish	- *Prosopium williamsoni*

Rainbow trout	- *Oncorhynchus mykiss*
Brown trout	- *Salmo trutta*
Northern pike	- *Esox lucius*
Walleye	- *Stizostedion vitreum vitreum*
Sauger	- *Stizostedion canadense*
Yellow perch	- *Perca flavescens*
Burbot	- *Lota lota*
Goldeye	- *Hiodon alosoides*
Mooneye	- *Hiodon tergisus*
White sucker	- *Catostomus commersoni*
Longnose sucker	- *Catostomus catostomus*
Mountain sucker	- *Catostomus platyrhynchus*
Quillback	- *Carpiodes cyprinus*
Shorthead redhorse	- *Moxostoma macrolepidotum*
Silver redhorse	- *Moxostoma anisurum*
Longnose dace	- *Rhinichthys cataractae*
Lake chub	- *Couesius plumbeus*
Emerald shiner	- *Notropis atherinoides*
River shiner	- *Notropis blennius*
Spottail shiner	- *Notropis hudsonius*
Brook stickleback	- *Culaea inconstans*
Trout-perch	- *Percopsis omiscomaycus*
Spoonhead sculpin	- *Cottus ricei*

Segment 2. 13 km downstream of confluence with Willow Creek to Oldman River Dam. (Station I in English 1988; Section 1, 2 and 3 in R.L. & L. 2000b; Section 1 and 3 in R.L. & L. 2000c, and RLL 2000d)

Lake whitefish	- *Coregonus clupeaformis*
Mountain whitefish	- *Prosopium williamsoni*
Rainbow trout	- *Oncorhynchus mykiss*
Bull trout	- *Salvelinus confluentus*
Brown trout	- *Salmo trutta*
Northern pike	- *Esox lucius*
Walleye	- *Stizostedion vitreum vitreum*
Burbot	- *Lota lota*
Mooneye	- *Hiodon tergisus*
White sucker	- *Catostomus commersoni*
Longnose sucker	- *Catostomus catostomus*

Mountain sucker	- *Catostomus platyrhynchus*
Shorthead redhorse	- *Moxostoma macrolepidotum*
Longnose dace	- *Rhinichthys cataractae*
Lake chub	- *Couesius plumbeus*
Emerald shiner	- *Notropis atherinoides*
Spottail shiner	- *Notropis hudsonius*
Pearl dace	- *Semotilus margarita*
Trout-perch	- *Percopsis omiscomaycus*
Spoonhead sculpin	- *Cottus ricei*
Brook stickleback	- *Culaea inconstans*

ENVIRONMENTAL ISSUES

Prior to the construction of the Oldman River Dam, water abstraction for irrigation water was a major cause for fish habitat reduction. In Reach 6, the water abstraction by the Lethbridge Northern Irrigation District (LNID) weir considerably reduces the downstream water discharges in the Oldman River. Further reductions in discharges in the main stem are caused by additional water withdrawals at Fort Macleod and Lethbridge for municipal use.

The LNID weir has a fish passage incorporated into the structure; however the effectiveness of the system is unknown. Since the discharge channel is not screened, fish are also lost into the irrigation system. The City of Lethbridge water intake weir was also considered a barrier; however, a fish passage system was built into the weir in 2001.

Between Lethbridge and the Grand Forks, the water quality in the Oldman River is impacted by agricultural practices on land surrounding the river. Biochemical decomposition of cattle wastes added to the river at feedlots may locally impact water quality. Turbidity in the river can also be high due to continuous input of silty inflow from irrigation canals. The impact of the Oldman Dam on the water quality of the Oldman River below the dam was investigated by Golder Associates (1995).

Every major tributary to the Oldman River downstream of the Oldman Dam is regulated by dams and/or diversion structures. In 1900, the first irrigation water was diverted from the St. Mary River. The St. Mary River Dam on the St. Mary River became operational in 1952 and construction was completed on Travers Reservoir (Little Bow River) in 1954.

The Waterton Dam on the Waterton River and Chain Lake Reservoir and Pine Coulee on Willow Creek were both completed in 1965. The Mountain View and United Irrigation Districts both have diversion structures on the Belly River.

The commencement of operation of the Oldman River Dam in 1991 was predicted to have significant effects on riverine fish species in the Oldman River Basin. The predicted effects included the disruption of fish migration patterns, displacement of stream-dwelling fish in the inundated areas, and the alteration of the distribution of downstream fish populations due to flow and temperature alterations (Dominion Ecological 1988; Dominion Ecological 1990). Environmental Management Associates (1990) suggested that moderation of contemporary low-flow events augmented by flows from the Oldman Reservoir would benefit downstream fish populations, particularly the species of concern: walleye, sauger, brown trout and rainbow trout.

The impact of the disruption of the fish migration patterns will only become evident over time; however, during construction of the dam, fish that had congregated below the dam were collected and moved upstream past the structure (Table 13).

Table 13. Number of sport fish captured below the diversion tunnels at the Oldman River Dam and Transported past the Damsite, April to October 1989 and April to August 1990. (From E.M.A. & R.L. & L. 1992)

	1989		1990	
Species	Total Captured	Total Transported	Total Captured	Total Transported
Rainbow trout	903	876	354	354
Mountain whitefish	5792	5266	2278	1058
Bull trout	76	71	12	12
Brown trout	3	3	0	0
Cutthroat trout (inc hybrids)	3	3	2	2
Total	6777	6219	2646	1426

With commencement of the Oldman River Fisheries Monitoring Program, additional fish transport occurred in 1991, 1992, 1996, 1997 and 1999. The transfer of fish over the dam provided an opportunity to radio tag individual fish and monitor their upstream movements (Golder Associates Ltd. 1996; Golder Associates Ltd. 1998a and Golder Associates Ltd. 1998b).

The fisheries monitoring program has also focussed extensively on the spawning activities of bull trout, rainbow trout, brown trout and mountain whitefish (Bryski 2000;

Bryski 2001a; Bryski 2001b; Bryski and Collyer 2000; Bryski and Genereux 2001; Gerrand and Watmough 1999; R.L. & L. 1999a and R.L. & L. 1999b.)

To address the impact of changes in flow patterns and the alterations of water temperatures, numerous investigations were initiated to collect data for input into predictive models (Fernet and Matkowski 1986a; Fernet and Matkowski 1986b; Fernet and Matkowski 1987; Locke 1988 and Environmental Management Associated 1990).

Future modeling exercises will need to recognize the known timing of biologically significant periods and critical species life stages (Table 14 and 15). Delineation of the BSP's and the critical species life stages are necessary to develop water quality criteria specific to the fish species and specified life stages (Table 16 and 17).

Table 14. Species Periodicity Chart for Segment 1 (Reaches 1, 2 and 3) of the Oldman River. (Taken from EMA IFN Report 1990)

Reach	Date		Brown Trout				Walleye and Sauger*				Mountain Whitefish				Lake Sturgeon			
	(Approx. Julian Week)	BSP	F	J	A	S	F	J	A	S	F	J	A	S	F	J	A	S
1, 2, 3	1 April - 31 May (14 - 22)	1	X	X	X	.	?	X	X	X	X	X	X	.	.	?	X	.
	1 June - 30 Sept (23-39)	2	X	X	X	.	X	X	X	.	X	X	X	.	.	X	X	?
	1 October - 30 Nov. (40-48)	3	X	X	X	X	X	X	X	.	X	X	X	X	.	X	X	.

Reach 1 – Grand Forks upstream to St. Mary R. confluence
Reach 2 – St. Mary R. confluence upstream to Belly R. confluence
Reach 3 – Belly R. confluence upstream to location approx. 13km downstream of Willow Creek (change in river form)

Walleye * and Sauger * the ? for fry in BSP 1 - information I have suggests these species likely spawn on average about the 3rd week in April, and given 2 to 3 weeks for eggs to hatch, it is likely the fry are present by the end of May

Lake sturgeon - Grand Forks is in Reach 1 and LKST congregate there in spring prior to spawning time.
Junvenile and adults are present in BSPs.

Table 15. Species Periodicity Chart for Segment 2 (Reaches 4, 5 and 6) of the Oldman River. (Taken from EMA IFN Report 1990)

Reach	Date		Brown Trout				Mountain Whitefish				Rainbow Trout			
	(Approx. Julian Week)	BSP	F	J	A	S	F	J	A	S	F	J	A	S
4, 5, 6	1 April - 15 June (14 - 23)	1	X	X	X	.	X	X	X	.	.	X	X	X
	16 June - 30 Sept. (24-39)	2	X	X	X	.	X	X	X	.	X	X	X	.
	1 October - 30 Nov. (40-48)	3	X	X	X	X	X	X	X	X	X	X	X	.

Reach 4 – d/s of Willow Creek upstream to LNID weir
Reach 5 – LNID weir upstream to approx. 6km downstream of the Oldman Dam
Reach 6 – Approx. 6km d/s of dam upstream to the Oldman Dam

Table 16. Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of mountain whitefish, brown trout, walleye, and sauger and for Segment 1 (Reaches 1, 2 and 3) of the Oldman River. Source: Taylor and Barton (1992).

MOUNTAIN WHITEFISH	
Temperature	
Juvenile and Adult-Acute	daily maximum 22^{o} C
Juvenile and Adult-Chronic	7-day mean < 18^{o}C
Fry-Acute	daily maximum 24^{o}C
Fry-Chronic	7-day mean < 18^{o}C
Spawning	7 consecutive days with: daily minimum $\geq 1^{o}$C daily maximum $\leq 6^{o}$C
Dissolved Oxygen	
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L

Table 16 (continued). Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of brown trout, walleye, sauger and mountain whitefish for Segment 1 (Reaches 1, 2 and 3) of the Oldman River. Source: Taylor and Barton (1992).

BROWN TROUT	
Temperature	
Fry-Acute	daily maximum 23°C
Fry-Chronic	7-day mean < 15°C
Juvenile and Adult-Acute	daily maximum 25° C
Juvenile and Adult-Chronic	7-day mean < 20°C
Spawning	7 consecutive days with: daily minimum ≥ 5°C daily maximum ≤ 11°C
Dissolved Oxygen	
Early life-Acute	daily minimum 8.0 mg/L
Early life-Chronic	7-day mean minimum 9.5 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L
WALLEYE & SAUGER	
Temperature	
Fry-Acute	daily maximum 29°C
Fry-Chronic	7-day mean < 24°C
Juvenile and Adult-Acute	daily maximum 29° C
Juvenile and Adult-Chronic	7-day mean < 24°C
Spawning	7 consecutive days with: daily minimum ≥ 5°C daily maximum ≤ 12°C
Dissolved Oxygen	
Early life-Acute	daily minimum 5.0 mg/L
Early life-Chronic	7-day mean minimum 6.0 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L
Adult-Acute	daily minimum 3.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

Table 17. Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of rainbow trout for Segment 2 (Reaches 4, 5 and 6) of the Oldman River. Brown trout and mountain whitefish criteria are same as shown in Table 5. Source: Taylor and Barton (1992).

RAINBOW TROUT	
Temperature	
Fry-Acute	daily maximum 24^{o}C
Fry-Chronic	7-day mean < 19^{o}C
Juvenile and Adult-Acute	daily maximum 24^{o} C
Juvenile and Adult-Chronic	7-day mean < 19^{o}C
Spawning	7 consecutive days with: daily minimum ≥ 5^{o}C; daily maximum ≤ 10^{o}C
Dissolved Oxygen	
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

STATUS OF SPORT FISHERY

The Government of Alberta made a commitment that there would be “no net loss of sport fishing opportunities” as a result of the Oldman River Dam. Creel surveys have been conducted on the downstream portion of the Oldman River (Wainman 1996; Gerrand 1999 and Bryski 1999). Gerrand (1999) recorded very low catch rates for brown trout for the area from the dam downstream to Fort Macleod. Bryski (1999) indicated the predicted improvements in downstream (from the Oldman River Dam) fish populations due to moderation of low flow events were not apparent during the survey. Furthermore, most experienced (> 10 years) anglers observed that angling quality has either declined or remained relatively stable during their years of angling.

Additional creel survey work is required to ascertain what impact the dam has had on the recreational fishing opportunities. Population inventory is also required on such species as walleye, sturgeon etc. particularly in the lower reaches of the Oldman River.

OLDMAN RIVER REACH DELINEATION

For future Instream Flow Needs or water management purposes, the two segments of the Oldman River should be divided into the following reaches:

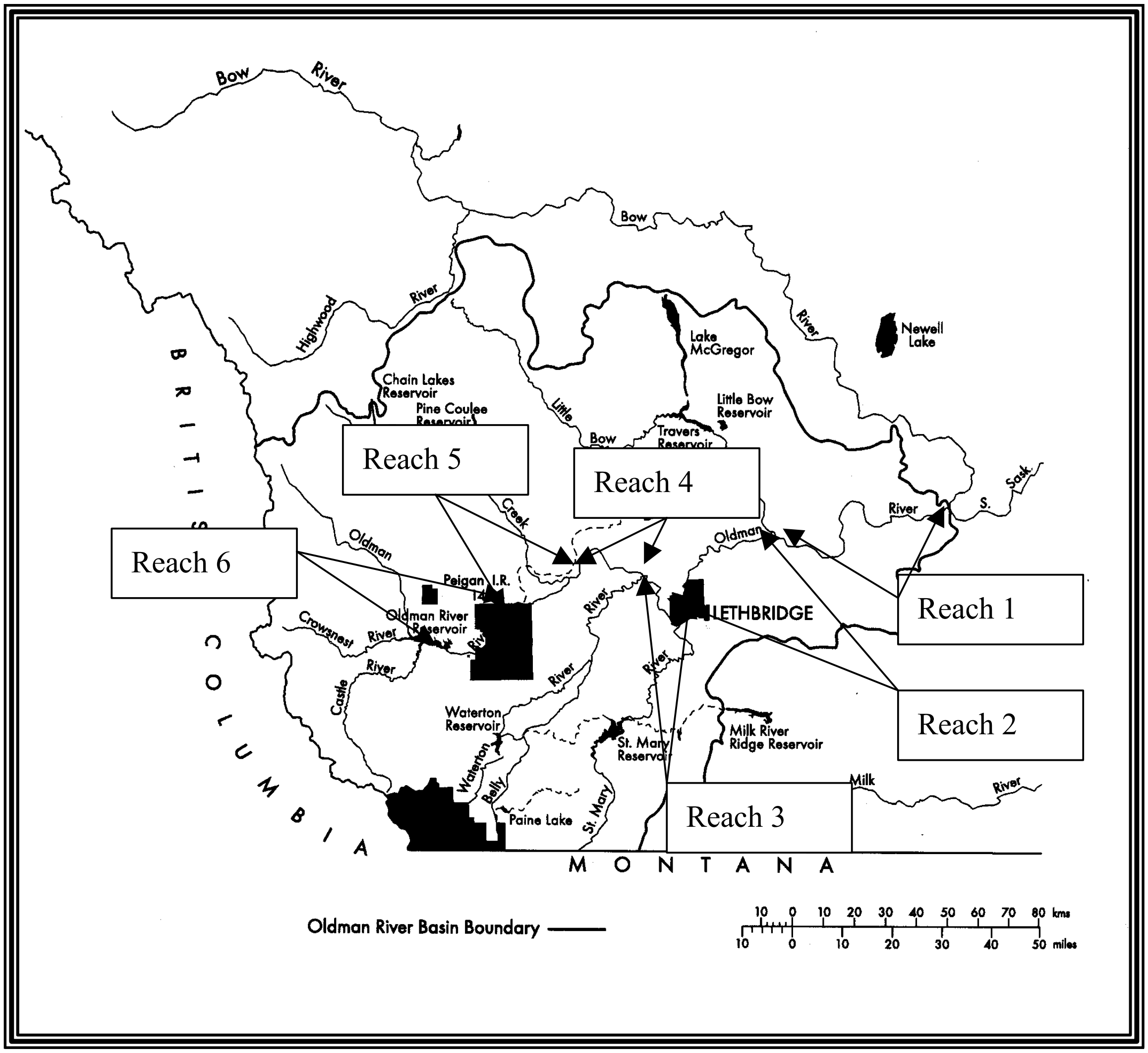


Figure 3. The Oldman River System Showing Specific Reaches. (Modified from AEP 1999.)

SEGMENT 1. Grand Forks upstream to a location 13 km downstream of the confluence with Willow Creek.

Specific Reaches:

1. Grand Forks upstream to confluence with the Little Bow River.

2. Little Bow River confluence upstream to confluence with the St.Mary River.

3. St. Mary River confluence upstream to the confluence with the Belly River.

4. Belly River confluence upstream to confluence with Willow Creek.

SEGMENT 2. 13 km downstream of confluence with Willow Creek to Oldman River Dam.

Specific Reaches:

5. Willow Creek confluence upstream to LNID weir.

6. LNID weir upstream to Oldman River Dam.

BELLY RIVER FISHERIES MANAGEMENT OBJECTIVES

(that portion of the river upstream from the confluence with the Oldman River to the Mountain View Irrigation District [MVID] weir)

SPECIFIC REACHES:

1. From the confluence of the Belly and Oldman rivers upstream to the confluence with the Waterton River.
2. From confluence of the Waterton and Belly rivers upstream to 125 km above the confluence of the Belly and Oldman rivers.
3. From 125 km above the confluence of the Belly and Oldman rivers upstream to the canal to St. Mary Reservoir.
4. From start of canal to St. Mary Reservoir to 157 km upstream of the confluence of the Belly and Oldman rivers.
5. From 157 km upstream of the confluence of the Belly and Oldman rivers to the MVID weir.

Future fisheries management strategies to improve fish production in the above specified reaches of the Belly River will be based on the following objectives:

- Monitor and evaluate the aquatic habitat configuration (pools, riffles, refugia, substrate composition and bank stability) and assess what impact the regulated flow has on the quality and quantity of these habitats.
- Investigate the role that flow has on maintaining channel configuration and sediment transport and how these processes maintain fish habitats.
- Install and maintain fish screens in diversion head gates and intake systems to prevent the loss of all life cycle stages of the fish community.
- Establish fish passage facilities at the Waterton-St. Mary Headworks weir to enable fish movement through the river.
- Restore adequate discharges to enhance the present levels of fish production.
- Ensure that water quality criteria, specifically water temperature and dissolved oxygen, remain within the range necessary to sustain the specific life cycles of the various fish species.

- Develop Biologically Significant Period (BSP's) Tables for all species within the fish community; however, as an interim measure, the BSP's for brown trout, walleye, mountain whitefish and rainbow trout will be used to evaluate future water management strategies.
- The sport fishery upstream of Sec. Rd. 800 will be managed with a zero bag limit for trout, Arctic grayling, and mountain whitefish whereas the fishery downstream of Sec. Rd. 800 will have a restricted size regulation for cutthroat (> 35 cm), rainbow (> 35 cm) and mountain whitefish (> 30 cm) for the time period June 16 to Aug. 31. For the period Sept. 1 to Oct 31, the trout limit is zero and the bag limit for mountain whitefish is 5 over 30 cm.

Further to the specific fisheries management objectives, resources are required to address the following data gaps:

- Further study is required of the full impact of low discharges on the ecology of the Belly River.
- The efficiency and rate of fish passage through the fish way in the United Irrigation District (UID) weir should be examined: means of enhancing fish movements through the fish way should be identified and evaluated.
- The fish community and the fish producing capability of the Belly River above the Waterton-St. Mary Headworks weir should be evaluated.
- Biological information on the fry life stages of brown trout and walleye is required.
- Information on specific spawning conditions (spawning habitat, incubating temperatures, etc.) for brown trout, walleye, northern pike and mountain whitefish needs to be collected.

APPROVAL OF OBJECTIVES:

Regional Fisheries Biologist: ______________________ **Date:** ___________

Regional Head - Fisheries: ______________________ **Date:** ___________

Director - Fisheries Management: ______________________ **Date:** ___________

Assistant Deputy Minister - FWD: ______________________ **Date:** ___________

THE RIVER ENVIRONMENT

The general features of the Belly River are provided in Longmore and Stenton (1981). The Belly River flows for approximately 199 km of which 181 km is in Canada, and 170 km occur downstream of the Waterton National Park/Blood Timber Reserve. The river flows through foothills and prairie to its confluence with the Oldman River. Over this distance, the physiography and ecology of the river change dramatically. A distinct transition from cold to coolwater aquatic habitat is apparent, and the Belly River therefore supports a diverse game fish population composed of both cold and coolwater species.

The Belly River is also an important source of irrigation water for southern Alberta farmers. Agricultural water and land use negatively impacts the river environment in two ways: water from the river for irrigation reduces aquatic habitat, and the location of feedlots near the river and tributary streams results in degradation of local water quality.

In the foothills between the international border and the UID weir, the Belly River flows north through open rangeland and forest. The steep slope and rocky substrate produce a swift, turbulent river. At the MVID weir (near the edge of Waterton Lakes National Park), the channel of the Belly River averages 23 m (76 ft) in width: mean depth of the water is 0.6 m (2 ft). The streambed consists mainly of gravel with rock outcrops, and the channel is interspersed with islands and mid-channel bars (Kellerhals et al 1972). The water is cold, and has few dissolved mineral nutrients. Summer temperatures averaged 10.6 ^{o} C (64.4^{0}F) (Fitch, 1980). The coldwater salmonid fish population is moderately productive.

Between the UID weir and the confluence of the Belly and Waterton Rivers, intensive agriculture is apparent: the land surrounding the river is irrigated and cultivated, or used for feedlots. As it flows from the foothills, the channel of the Belly River broadens, and winds across the flat, arid prairie. At Stand Off, the river averages 26 m (86 ft) in width: mean depth of the water is only 0.5 m (1.5 ft) (Kellerhals et al 1972). Water temperatures slightly downstream of the UID weir indicate a warmer aquatic environment: summer temperatures in 1980 averaged 13^{0}C (55.4^{0}F), reaching a maximum of 21^{0}C (68.8^{0}F) (Fitch 1980). The actual zone of transition from cold to coolwater aquatic habitat occurs between the UID weir and the Waterton-St. Mary Headworks weir.

Below the confluence of the Belly and Waterton Rivers, the flat, arid prairie surrounding the river is partly cultivated or left as open range. Slower flows and open exposure to the sun raise water temperatures in this portion of the Belly River. In 1980, the average summer temperatures exceeded 15^{0}C (59^{0}F), while the maximum temperatures exceeded 24^{0}C (75.2^{0}F) (Fitch 1980). Productivity of the predominately coolwater fish population is low due to a severe reduction of habitat caused by water abstractions at the three irrigation weirs, and at numerous pump sites along the river.

THE FISH COMMUNITY

The three irrigation weirs can be used to delineate three distinct, naturally occurring fish habitat within the Belly River.

Between the MVID weir and the UID weir, the river is clear, cold and fast flowing. This upper portion of the Belly River is habitat for a moderately productive coldwater salmonid fish population composed of mountain whitefish, brook trout, rainbow trout and bull trout. Northern pike have been observed, but are considered rare (Radford, pers. comm.; Alberta Fish and Wildlife Habitat Maps, 1980).

Only a few mountain and lake whitefish, trout and northern pike inhabit the warmer, shallower Belly River between the UID weir and the SMRID weir. Bull trout have been captured below the UID weir, and one was radio-tracked about 4 km below the weir. Within this portion of the Belly River there is a zone of transition from cold to coolwater aquatic habitat. Despite warmer temperature, productivity of the fish population in this middle portion of the Belly River is low due to habitat reduction caused by irrigation water abstraction at the UID weir.

Between the SMRID weir and its confluence with the Oldman River, the Belly River is considered a coolwater aquatic habitat and supports a mixed warm and coldwater fish population. Although mountain whitefish are common in this portion of the Belly River, other coldwater species like bull trout and trout are rare. Coolwater species include northern pike, sauger, and a few lake whitefish. Pike are especially numerous in the lower reaches of the river near the mouth. Although water discharges are somewhat greater through this lower portion of the Belly River, fish production is still relatively low.

In summary, the fish species collected to date (EMA 1989; Paetz 1989; English 1995; Clayton 1998 & 1999; Derksen & Sherburn 2000) in the Belly River system are as follows:

Lake whitefish	- *Coregonus clupeaformis*
Mountain whitefish	- *Prosopium williamsoni*
Arctic grayling	- *Thymallus arcticus*
Rainbow trout	- *Oncorhynchys mykiss*
Cutthroat trout	- *Oncorhynchus clarki*
Bull trout	- *Salvelinus confluentus*
Brown trout	- *Salmo trutta*
Brook trout	- *Salvelinus fontinalis*
Northern pike	- *Esox lucius*
Sauger	- *Stizostedion canadense*
Burbot	- *Lota lota*
White sucker	- *Catostomus commersoni*
Longnose sucker	- *Catostomus catostomus*
Mountain sucker	- *Catostomus platyrhynchus*
Shorthead redhorse	- *Moxostoma macrolepidotum*
Silver redhorse	- *Moxostoma anisurum*
Longnose dace	- *Rhinichthys cataractae*
Spottail shiner	- *Notropis hudsonius*
Trout-perch	- *Percopsis omiscomaycus*
Spoonhead sculpin	- *Cottus ricei*
Flathead minnow	- *Pimephales promelas*

ENVIRONMENTAL ISSUES

Of the three weirs on the Belly River, the Waterton-St. Mary Headworks weir is the oldest, built in 1923 to divert water from the Belly River to the St. Mary Reservoir. Irrigation water has been abstracted from the river at the MVID weir and the UID weir since 1930 (Kellerhals et al 1972).

So much water is diverted from the Belly River at these weirs that the overall size of the river shrinks dramatically. Regulation of discharges through the river according to irrigation demand caused substantial seasonal fluctuation if fish habitat. Such fluctuations do not correspond to the natural flow regime (Radford 1975). Fish production below the UID weir is very low, due to lack of habitat.

Fish cannot escape unproductive habitat. The Waterton-St. Mary Headworks weir blocks upstream movement, as it does not have fish passage facilities. The MVID weir does not have fish passage facilities, but it is low enough that fish can usually cross it. The UID weir does have fish passage facilities, but its efficiency has not been established.

The combination of reduced flows and the associated high water temperatures have stimulated numerous investigations to model the relationship of flows to temperature, dissolved oxygen and physical fish habitats (Fernet 1988a; EMA 1989; Fernet et al 1990; Water Quality Associates Ltd. 1989; HydroQual 1990).

Many of the above modeling exercises required the declaration of the timing of biologically significant periods and critical species life stages (Table 18). For the purposes of the IFN initiatives, brown trout, walleye, mountain whitefish and rainbow trout were selected as the surrogate fish species. This in turn provided for the development of water quality criteria specific to the fish species and specified life stages (Tables 19 & 20).

Table 18. Species Periodicity Chart for Reaches of the Belly River (Modified from EMA IFN Report 1994).

Reach	Date (Approx. Julian Week)	BSP	Brown Trout				Walleye				Mountain Whitefish*				Rainbow Trout			
			F	J	A	S	F	J	A	S	F	J	A	S	F	J	A	S
1, 2	1 April - 31 May (14 - 22)	1	?	X	X		?	X	X	?	X	X	X					
	1 June - 30 Sept (23-39)	2	?	X	X		?	X	X		X	X	X					
	1 October - 30 Nov. (40-48)	3	?	X	X	?	?	X	X		X	X	X	?				
4, 5	1 April - 15 June (14 - 23)	1	X	X	X						X	X	X			X	X	X
	16 June - 30 Sept. (24-39)	2	X	X	X						X	X	X		X	X	X	
	1 October - 30 Nov. (40-48)	3	X	X	X	X					X	X	X	X	X	X	X	

Belly River Reach 1,2 - Mouth upstream to just downstream of Irrigation Canal
Belly River Reach 3,4 - Irrigation Canal upstream to Payne Lake

Mountain Whitefish* - the ? under spawning is whether they spawn in these reaches or fry captured there drift downstream from upper reaches

? - Data gaps

Table 19. Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of brown trout, walleye and mountain whitefish from reaches 1 & 2 of the Belly River. Source: Taylor and Barton (1992).

BROWN TROUT

Temperature

Fry-Acute	daily maximum 23^{o}C
Fry-Chronic	7-day mean < 15^{o}C
Juvenile and Adult-Acute	daily maximum 25^{o} C
Juvenile and Adult-Chronic	7-day mean < 20^{o}C

Dissolved Oxygen

Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

Table 19 (con't). Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of brown trout, walleye and mountain whitefish from reaches 1 & 2 of the Belly River. Source: Taylor and Barton (1992).

WALLEYE	
Temperature	
Juvenile and Adult-Acute	daily maximum 29^{o} C
Juvenile and Adult-Chronic	7-day mean < 24^{o}C
Dissolved Oxygen	
Adult-Acute	daily minimum 3.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L
MOUNTAIN WHITEFISH	
Temperature	
Fry-Acute	daily maximum 24^{o}C
Fry-Chronic	7-day mean < 18^{o}C
Juvenile and Adult-Acute	daily maximum 22^{o} C
Juvenile and Adult-Chronic	7-day mean < 18^{o}C
Dissolved Oxygen	
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

Table 20. Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of rainbow trout from reaches 3 & 4 of the Belly River. Brown trout and mountain whitefish criteria same as presented in Table 19 Source: Taylor and Barton (1992).

RAINBOW TROUT	
Temperature	
Fry-Acute	daily maximum 24^{o}C
Fry-Chronic	7-day mean < 19^{o}C
Juvenile and Adult-Acute	daily maximum 24^{o} C
Juvenile and Adult-Chronic	7-day mean < 19^{o}C
Spawning	7 consecutive days with:
	daily minimum $\geq$ 5^{o}C
	daily maximum $\leq$ 10^{o}C
Dissolved Oxygen	
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

BELLY RIVER REACH DELINEATION

For water management purposes, the Belly River is divided into the following five reaches (Figure 4).

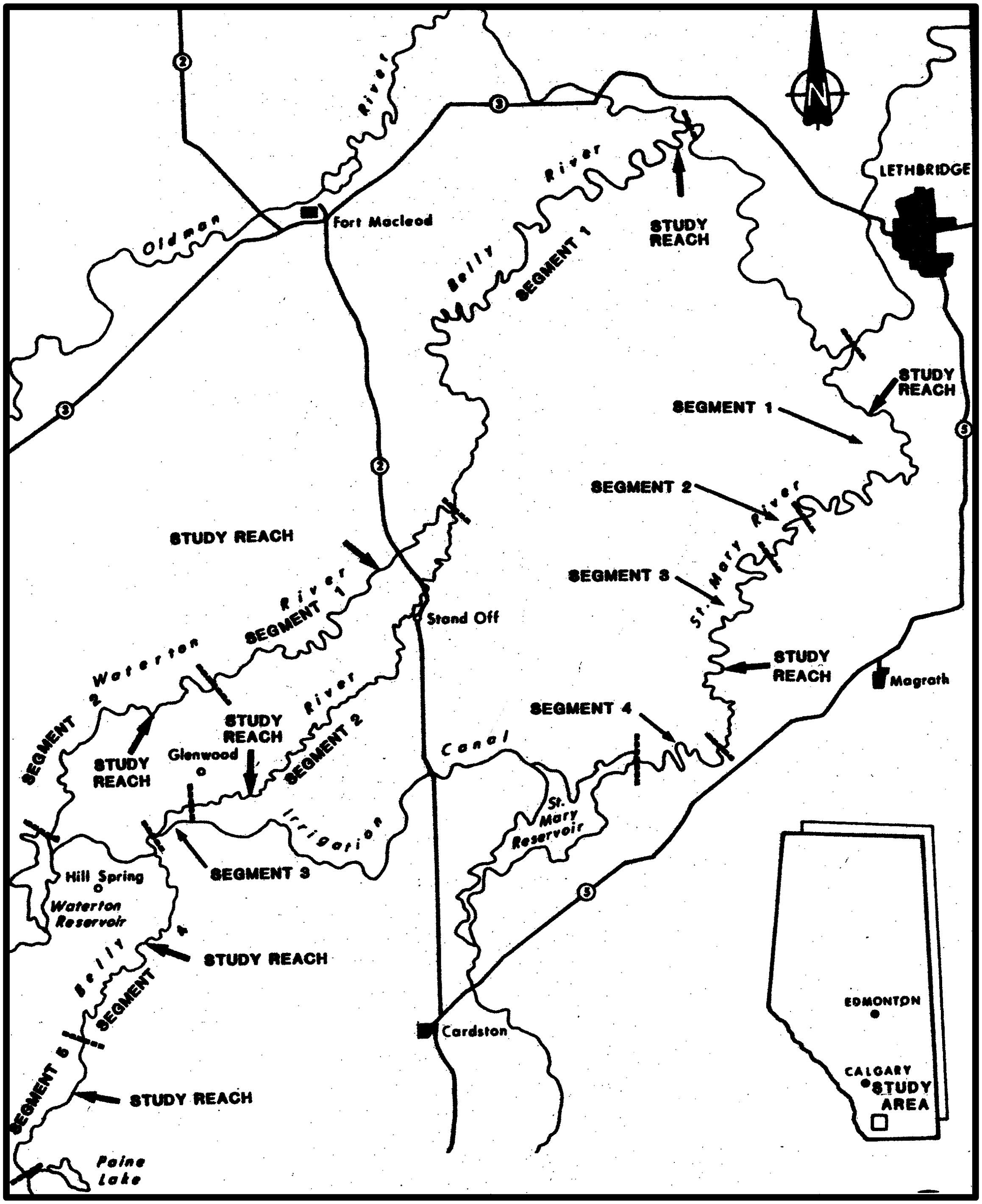


Figure 4: Location of reaches for the Belly, Waterton and St. Mary Rivers (From EMA 1989).

Reach 1. From the confluence of the Belly and Oldman rivers upstream to the confluence with the Waterton River.

The physical characteristics reach 1 are low gradient, moderate meandering, gravel substrate, riffle/run habitat, side channels and gravel bars present and wide gravel floodplain (EMA 1989).

The following species have been collected in this reach (English 1995; Derksen & Sherburn 2000):

Mountain whitefish	Northern pike
Sauger	White sucker
Longnose sucker	Shorthead redhorse
Silver redhorse	Longnose dace
Spottail shiner	Trout-perch
Flathead minnow	Spoonhead sculpin
Trout-perch	

Reach 2. From confluence of the Waterton and Belly rivers upstream to 125km above the confluence of the Belly and Oldman rivers.

The general physical characteristics of reach 2 are low gradient, tortuously meandering, gravel substrate, riffle/run habitat and wide treed valley (EMA 1989).

Fish collections conducted by English (1995) yielded the following fish species:

Lake whitefish	Mountain whitefish
Bull trout	Northern pike
Mountain sucker	Longnose dace
Trout-perch	

Reach 3. From 125 km above the confluence of the Belly and Oldman rivers upstream to the canal to St. Mary Reservoir.

The general physical characteristics of reach 3 are low gradient, moderate meandering, gravel substrate but significant sedimentation, and largely run habitat (EMA 1989).

EMA (1988) collected the following fish species in this reach:

Mountain whitefish	Rainbow trout
Bull trout	Burbot
White sucker	Longnose sucker
Mountain sucker	Longnose dace
Trout-perch	

Reach 4. From start of canal to St. Mary Reservoir to 157 km upstream of the confluence of the Belly and Oldman rivers.

Low gradient, moderate meandering, cobble substrate, riffle/run habitat and some bedrock control with pools characterizes the general physical features of reach 4 (EMA 1989).

To date, a directed survey to determine the species composition of the fish community has not been conducted on this reach.

Reach 5. From 157 km upstream of the confluence of the Belly and Oldman rivers to the MVID Weir.

Moderate gradient, minimal meandering, gravel substrate, riffle/run habitat, some pools and large gravel floodplain describes the general physical characteristics of reach 5 (EMA 1989).

Fish collections conducted by EMA (1988), English (1995) and Paetz (1989) yielded the following fish species:

Mountain whitefish	Rainbow trout
Brook trout	White sucker
Longnose sucker	Mountain sucker
Longnose dace	Spoonhead sculpin

WATERTON RIVER FISHERIES MANAGEMENT OBJECTIVES

(that portion of the river from the confluence with the Waterton and Belly rivers upstream to the Waterton dam.

SPECIFIC REACHES:

1. From the confluence of the Waterton and Belly rivers upstream for 45 km.
2. From 45 km above confluence to Waterton Dam.

Future fisheries management strategies to improve fish production in the above specified reaches of the Waterton River will be based on the following objectives:

- Monitor and evaluate the aquatic habitat configuration (pools, riffles, refugia, substrate composition and bank stability) and assess what impact the regulated flow has on the quality and quantity of these habitats.
- Investigate the role that flow has on maintaining channel configuration and sediment transport and how these processes maintain fish habitats.
- Install and maintain fish screens in diversion head gates and intake systems to prevent the loss of all life cycle stages of the fish community.
- Ensure that water quality criteria, specifically water temperature and dissolved oxygen, remain within the range necessary to sustain the specific life cycles of the various fish species.
- Develop Biologically Significant Period (BSP's) Tables for all species within the fish community; however, as an interim measure, the BSP's for brown trout mountain whitefish and rainbow trout will be used to evaluate future water management strategies.
- Using an adaptive management approach, assess the opportunities to restore fish habitats by releasing channel structure flows.
- The sport fishery will be managed with restricted size regulation of > than 35 cm for cutthroat and rainbow trout and > 30 cm for mountain whitefish for the time period June 16 to Aug. 31. From Sept. 1 to Oct 31 the bag limit for trout is zero.

Further to the specific fisheries management objectives, resources are required to address the following data gaps:

- Information on specific spawning conditions and early rearing habitats for brown trout needs to be collected.
- Assessment of impact of passage of water thru turbines on fish fauna is required.

APPROVAL OF OBJECTIVES:

Regional Fisheries Biologist: ______________________ **Date:** ___________

Regional Head - Fisheries: ______________________ **Date:** ___________

Director - Fisheries Management: ______________________ **Date:** ___________

Assistant Deputy Minister - FWD: ______________________ **Date:** ___________

THE RIVER ENVIRONMENT

The general features of the Waterton River are provided in Longmore and Stenton (1981). Two distinct fish habitats are apparent in the Waterton River as it flows from Montana's Rocky Mountains through the foothills and prairie of Alberta to its confluence with the Belly River. With about one-third of the river lying in the U.S. and Waterton Lakes National Park, only 96.5 km (60 mi) flows through provincial territory. Open range land borders the Waterton River in the foothills; irrigated, cultivated fields surround the Waterton Reservoir and the river below it. Above the reservoir, the Waterton River is a clear, cold, fast-flowing unregulated mountain stream. Below the reservoir, the river is warmer, slower, and eutrophic. Discharges are regulated at the Waterton Dam according to local irrigation demands.

The steep slope, and rock outcrops in the channel produce a swift, turbulent flow in the river above the reservoir. At the Waterton Lakes National Parks boundary, the channel is approximately 59 m (195 ft) wide and interspersed with occasional islands; mean depth of the water is 0.6 m (1.8 ft) (Kellerhals et al 1972). Summer water temperatures in 1980 averaged 12.6^0 C (54.7^0 F) (Fitch 1980). Productivity of the coldwater salmonid fish population is moderate

Below the reservoir, the Waterton River winds across the flat, arid prairie. Water flows slowly in pools and riffles through a broad, gravel-bottomed channel interspersed with occasional islands and bars. Near its mouth, the Waterton River is approximately 67 m (220 ft) in width; mean depth of the water is 0.8 m (2.6 ft) (Kellerhals et al 1972). Slower flows and open exposure to the sun raise water temperatures, and a gradual transition from cold to warmwater aquatic habitat is apparent in the river below the reservoir. Near the dam, summer water temperatures averages only 13.3^0 C (55.9^0 F) in 1980, but near the confluence of the Waterton and Belly rivers, average summer water temperatures exceeded 16^0 C (60.8^0 F)

THE FISH COMMUNITY

Above the Waterton Reservoir, the Waterton River is inhabited predominately by coldwater salmonid fish. Mountain whitefish, rainbow trout, brown trout and bull trout are the most abundant sportfish species in the main stem of the river.

The Waterton Reservoir contains northern pike, rainbow trout mountain whitefish and lake whitefish, bull trout and a few migrant cutthroat trout and lake trout (English 1978).

Warmer water temperatures and slower flows in the Waterton River below the reservoir result in a mixed warm and coldwater species population: mountain whitefish are the most abundant species, but northern pike and lake whitefish are also common. A few trout also inhabit this section of the river.

Fish species collected to date (Clements 1986; Clements 1987; EMA 1989; Paetz 1989) in the Waterton River system are as follows:

Lake whitefish	- *Coregonus clupeaformis*
Mountain whitefish	- *Prosopium williamsoni*
Rainbow trout	- *Oncorhynchys mykiss*
Cutthroat trout	- *Oncorhynchus clarki*
Brown trout	- *Salmo trutta*
Bull trout	- *Salvelinus confluentus*
Lake trout	- *Salvelinus namaycush*
Brook trout	- *Salvelinus fontinalis*
Northern pike	- *Esox lucius*
Burbot	- *Lota lota*
White sucker	- *Catostomus commersoni*
Longnose sucker	- *Catostomus catostomus*
Mountain sucker	- *Catostomus platyrhynchus*
Longnose dace	- *Rhinichthys cataractae*
Lake chub	- *Couesius plumbeus*
Emerald shiner	- *Notropis atherinoides*
Trout-perch	- *Percopsis omiscomaycus*
Spoonhead sculpin	- *Cottus ricei*

ENVIRONMENTAL ISSUES

Water is released to the Waterton River and the Belly River diversion canal at the Waterton dam. Regulated discharges to the Waterton River during the irrigation season are considerably less than natural discharges. Irrigation water abstractions at individual pump sites along the river further reduce discharges. Habitat available during these extremely low discharges is not adequate to maintain a productive fish poulation.

The Waterton Dam, completed in 1964, is a permanent blockage to fish movements through the river. During periods when water is not spilled, all the stream flow passes thru turbines.

Agricultural practices, and to a lesser extent gravel extractions operations, are mainly responsible for degradation of water quality in the Waterton River. These effects are particularly noticeable in the river below the reservoir. Cattle in feedlots produce large quantities of waste, which is added to the river directly, or in runoff water. Decomposition of this waste consumes oxygen, which would otherwise be available to fish, and invertebrates.

Water returned to the river from irrigated fields carries massive amounts of silt eroded from unprotected earth irrigation canals. The continuous infusion of silty water during the irrigation season maintains high turbidity in the river below the reservoir. The silt gradually settles, and can negatively affect the fish populations if it covers food sources or spawning areas.

The combination of reduced flows and the associated high water temperatures have stimulated numerous investigations to model the relationship of flows to temperature, dissolved oxygen and physical fish habitats (Fernet 1988b; EMA 1989; Water Quality Associates Ltd. 1989; Fernet and al. 1990; HydroQual 1990; EMA 1994). Using field data collected in 1988, HydroQual (1990) modelled the temperatures for the lower Waterton River and determined that the water temperatures in this section on the river would exceed the conservative criterion of 22.5^{0}C, but with a relatively low frequency of 4 %. The Fish Rule Curve that was generated as a product of the model recommended that to achieve a reduction in the frequency of the high water temperatures a discharge value of 8m^3/s would be required.

Many of the above modeling exercises required the declaration of the timing of biologically significant periods and critical species life stages (Table 21). For the purposes of the IFN initiatives, brown trout, mountain whitefish and rainbow trout were selected as the surrogate fish species. This in turn provided for the development of water quality criteria specific to the fish species and specified life stages (Table 22).

Table 21. Species Periodicity Chart for Reaches of the Waterton River. (Taken from EMA IFN Report 1990)

Reach	Date (Approx. Julian Week)	BSP	Brown Trout				Mountain Whitefish				Rainbow Trout			
			F	J	A	S	F	J	A	S	F	J	A	S
Waterton 1, 2	1 April - 31 May (14 - 22)	1	?	X	X		X	X	X			X	X	X
	1 June - 30 Sept (23-39)	2	?	X	X		X	X	X		X	X	X	
	1 October - 30 Nov. (40-48)	3	?	X	X	?	X	X	X	X	X	X	X	

Waterton River Reach 1,2 - Mouth upstream to Waterton Reservoir

? - Data gaps.

Table 22. Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of rainbow trout, brown trout, and mountain whitefish from the Waterton River. Source: Taylor and Barton (1992).

RAINBOW TROUT

Temperature	
Fry-Acute	daily maximum 24^{o}C
Fry-Chronic	7-day mean < 19^{o}C
Juvenile and Adult-Acute	daily maximum 24^{o} C
Juvenile and Adult-Chronic	7-day mean < 19^{o}C
Spawning	7 consecutive days with:
	daily minimum ≥ 5^{o}C
	daily maximum ≤ 10^{o}C
Dissolved Oxygen	
Early life-Acute	daily minimum 8.0 mg/L
Early life-Chronic	7-day mean minimum 9.5 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L
Adult-Acute	daily minimum 4.0 mg/L

Table 22 (Continured). Source: Taylor and Barton (1992).

BROWN TROUT

Temperature	
Juvenile and Adult-Acute	daily maximum 25^{o} C
Juvenile and Adult-Chronic	7-day mean < 20^{o}C
Dissolved Oxygen	
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

MOUNTAIN WHITEFISH

Temperature	
Fry-Acute	daily maximum 24^{o}C
Fry-Chronic	7-day mean < 18^{o}C
Juvenile and Adult-Acute	daily maximum 22^{o} C
Juvenile and Adult-Chronic	7-day mean < 18^{o}C
Spawning	7 consecutive days with: daily minimum ≥ 1^{o}C daily maximum ≤ 6^{o}C
Dissolved Oxygen	
Early life-Acute	daily minimum 5.0 mg/L
Early life-Chronic	7-day mean minimum 6.5 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.5 mg/
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

WATERTON RIVER REACH DELINEATION

For water management purposes, the Waterton River is divided into the following two reaches (See Figure 4 in Belly River FMO):

Reach 1. From the confluence of the Waterton and Belly rivers upstream for 45 km.

The physical characteristics in reach 1 are low gradient, minimal meandering, gravel substrate, floodplain in wide valley, riffle/run habitat and pools uncommon (EMA 1989).

Mountain whitefish	Northern pike
Burbot	White sucker
Mountain sucker	Longnose dace
Lake chub	Trout-perch

Reach 2. From 45 km above confluence upstream to Waterton Dam.

The general physical characteristics of reach 3 are moderate slope, moderate meandering, gravel substrate, pool/riffle/run habitat, some bedrock control with pools, incised valley and narrow floodplain (EMA 1989).

Lake whitefish	Mountain whitefish
Rainbow trout	Northern pike
Burbot	White sucker
Longnose sucker	Mountain sucker
Longnose dace	Lake chub
Emerald shiner	Trout-perch
Spoonhead sculpin	

ST. MARY RIVER FISHERIES MANAGEMENT OBJECTIVES

(that portion of the river upstream from the confluence with the Oldman River to the St. Mary Dam)

SPECIFIC REACHES:

1. From confluence of the St. Mary and Oldman Rivers upstream for 37 km.
2. From 37 km above confluence to 45 km upstream of the confluence.
3. From 45 km above the confluence to 81 km upstream of the confluence.
4. From 81 km above the confluence upstream to the St. Mary River Dam.

Future fisheries management strategies to improve the existing low level of fish production in the above-specified reaches of the St. Mary River will be based on the following objectives:

- Monitor and evaluate the aquatic habitat configuration (pools, riffles, refugia, substrate composition and bank stability) and assess what impact the regulated flow has on the quality and quantity of these habitats.
- Investigate the role that flow has on maintaining channel configuration and sediment transport and how these processes maintain fish habitats.
- Maintain an unobstructed channel in the St. Mary River.
- Install and maintain fish screens in diversion head gates and intake systems to prevent the loss of all life cycle stages of the fish community.
- Ensure that water quality criteria, specifically water temperature and dissolved oxygen, remain within the range necessary to sustain the specific life cycles of the various fish species.
- Develop Biologically Significant Period (BSP's) Tables for all species within the fish community; however, as an interim measure, the BSP's for brown trout, walleye, mountain whitefish and rainbow trout will be used to evaluate future water management strategies.

- Manage the fishery as a non-consumptive recreational use of trout and a restricted size fishery for mountain whitefish (> 30 cm), walleye (>50 cm) and northern pike (>63 cm).

Further to the specific fisheries management objectives, resources are required to address the following data gaps:

- Determine the extent to which brown trout from the Oldman River system have populated the St. Mary River and whether successful reproduction is occurring.
- Document the timing, location and level of walleye spawning.
- Assess the level of rainbow trout spawning and early rearing.
- Determine what role rainbow trout escapees from the stocking of other water bodies in the drainage have in providing some recruitment to the St. Mary River.
- Assessment of impact of passage of water thru turbines on fish fauna is required.

APPROVAL OF OBJECTIVES:

Regional Fisheries Biologist: ______________________ **Date:** ___________

Regional Head - Fisheries: ______________________ **Date:** ___________

Director - Fisheries Management: ______________________ **Date:** ___________

Assistant Deputy Minister - FWD: ______________________ **Date:** ___________

THE RIVER ENVIRONMENT

The general features of the St. Mary River are provided in Longmore and Stenton (1981). Two ecologically distinct aquatic habitats and a transition zone between them are apparent in the St. Mary River as it flows 160 km from the international border to its confluence with the Oldman River.

Between the international border and the St. Mary Reservoir, the clear, cold, river flows through the foothills onto the prairie. Occasional islands and bars intrude into the steep, winding channel, which averages 32 m in width (Kellerhals et al 1972).

Below the reservoir, the St. Mary River flows through broad loops across the flat, arid prairie as it slowly progresses to its confluence with the Oldman River. Occasional islands and side-bars intrude into the gravel-bottomed channel. The river averages 57 m in width near Lethbridge. Due to flow regulation and irrigation abstractions, mean water depth is only 0.6 m near Lethbridge (Kellerhals et al 1972).

In contrast to the cold (summer average of 10.6 ^{0}C) water temperatures (Fitch 1980) in the upper section, the St. Mary River is slightly warmer below the reservoir. Near the mouth of Pinepound Creek, summer water temperatures averaged 12 ^{0}C in 1980. Further downstream near the confluence of the St. Mary and the Oldman Rivers, summer water temperatures average 12.6 ^{0}C (Fitch 1980). Even higher average summer water temperatures of 19.1 ^{0}C and 19.9 ^{0}C were recorded in 2000 and 2001 (Clayton 2000 & 2001).

THE FISH COMMUNITY

Fish species collected to date (EMA 1989; Fitch 1980) in the St. Mary River system are as follows:

Lake whitefish	- *Coregonus clupeaformis*
Mountain whitefish	- *Prosopium williamsoni*
Rainbow trout	- *Oncorhynchus mykiss*
Northern pike	- *Esox lucius*
Walleye	- *Stizostedion vitreum vitreum*
Sauger	- *Stizostedion canadense*

Burbot	- *Lota lota*
White sucker	- *Catostomus commersoni*
Longnose sucker	- *Catostomus catostomus*
Mountain sucker	- *Catostomus platyrhynchus*
Shorthead redhorse	- *Moxostoma macrolepidotum*
Longnose dace	- *Rhinichthys cataractae*
Lake chub	- *Couesius plumbeus*
Emerald shiner	- *Notropis atherinoides*
Spottail shiner	- *Notropis hudsonius*
Brook stickleback	- *Culaea inconstans*
Trout-perch	- *Percopsis omiscomaycus*
Spoonhead sculpin	- *Cottus ricei*
Pearl dace	- *Semotilus margarita*

ENVIRONMENTAL ISSUES

The most obvious effect of current water management practices is a substantial reduction in the size of the St. Mary River below the dam during the irrigation season. Regulated discharges during the irrigation season are frequently less than the calculated natural discharges. Lower water levels greatly reduce fish living space, shelter areas, food sources, and spawning sites (Radford 1975). The extensive loss of habitat accordingly lowers fish productivity. Low discharges also lessen the capability of the river to flush away accumulating silt, nutrients, and pollutants. Furthermore the St. Mary River Dam, built in 1946, is a permanent blockage to upstream fish movements. During periods when water is not spilled, all the stream flow passes thru turbines.

To assess the impact of reduced flows, numerous investigations have been initiated to collect field data to model the relationship of flows to temperature, dissolved oxygen and physical fish habitats (Fernet 1988b; EMA 1989; Water Quality Associates Ltd. 1989; Fernet, Courtney and Bjornson 1990; HydroQual 1990; EMA 1994).

Using field data collected in 1988, HydroQual (1990) modelled the temperatures for the lower St. Mary River and determined that the water temperatures in this section on the river would exceed the conservative criterion of 22.5^{0}C, but with a relatively low frequency of 2 %. The Fish Rule Curve that was generated as a product of the model also recommended that to achieve a reduction in the frequency of the high water temperatures a discharge value of 15m^3/s would be required.

Many of the above modeling exercises required the declaration of the timing of biologically significant periods and critical species life stages (Table 23). For the purposes of the IFN initiatives, rainbow trout and mountain whitefish were selected as the surrogate fish species. This in turn provided for the development of water quality criteria specific to the fish species and specified life stages (Table 24).

Table 23. Species Periodicity Chart for Reaches of the St. Mary River. (Modified from EMA IFN Report 1994).

Reach	Date	BSP	Brown Trout				Walleye				Mountain Whitefish				Rainbow Trout			
	(Approx. Julian Week)		F	J	A	S	F	J	A	S	F	J	A	S	F	J	A	S
St. Mary 1, 3	1 April - 31 May (14 - 22)	1	?	X	X		? *	X	X	X	X	X	X			X	X	?
(Mouth upstream	1 June - 30 Sept (23-39)	2	?	X	X		X	X	X		X	X	X		?	X	X	
to St. Mary Res.)	1 October - 30 Nov. (40-48)	3	?	X	X	?	X	X	X		X	X	X	X	?	X	X	

? - Data gaps

?* - Information suggests walleye likely spawn on average about the 3rd week in April and given 2 to 3 weeks for eggs to hatch, it is likely the fry are present by the end of May.

Table 24. Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of brown trout, walleye, mountain whitefish and rainbow trout from the St. Mary River. Source: Taylor and Barton (1992).

BROWN TROUT

Temperature

Juvenile and Adult-Acute	daily maximum 25° C
Juvenile and Adult-Chronic	7-day mean < 20°C

Dissolved Oxygen

Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

WALLEYE

Temperature

Fry-Acute	daily maximum 29°C
Fry-Chronic	7-day mean < 24°C
Juvenile and Adult-Acute	daily maximum 29° C
Juvenile and Adult-Chronic	7-day mean < 24°C
Spawning	7 consecutive days with: daily minimum ≥ 5°C daily maximum ≤ 12°C

Dissolved Oxygen

Early life-Acute	daily minimum 5.0 mg/L
Early life-Chronic	7-day mean minimum 6.0 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L
Adult-Acute	daily minimum 3.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

Table 24 (Continued). Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of brown trout, walleye, mountain whitefish and rainbow trout from the St. Mary River. Source: Taylor and Barton (1992).

MOUNTAIN WHITEFISH

Temperature

Fry-Acute	daily maximum 24°C
Fry-Chronic	7-day mean < 18°C
Juvenile and Adult-Acute	daily maximum 22° C
Juvenile and Adult-Chronic	7-day mean < 18°C
Spawning	7 consecutive days with: daily minimum ≥ 1°C daily maximum ≤ 6°C

Dissolved Oxygen

Early life-Acute	daily minimum 5.0 mg/L
Early life-Chronic	7-day mean minimum 6.5 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.5 mg/L
Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

RAINBOW TROUT

Temperature

Juvenile and Adult-Acute	daily maximum 24° C
Juvenile and Adult-Chronic	7-day mean < 19°C

Dissolved Oxygen

Adult-Acute	daily minimum 4.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

ST. MARY RIVER REACH DELINEATION

For water management purposes, the St. Mary River is divided into the following reaches (See Figure 4 in the Belly River FMO):

REACH 1. From confluence of the St. Mary and Oldman Rivers upstream for 37 km

The physical characteristics throughout the 37 km of this reach are low gradient, minimal meandering, gravel/silt substrate with riffle/run habitat (EMA 1989). Fish surveys in this reach (EMA 1989; Fitch 1980) have collected the following species:

Mountain whitefish
Burbot
Longnose sucker
Shorthead redhorse
Lake chub
Brook stickleback
Pearl dace
Sauger
White sucker
Mountain sucker
Longnose dace
Emerald shiner
Trout-perch

REACH 2. From 37 km above confluence to 45 km upstream of the confluence.

In contrast to reach 1, the physical characteristics of the habitat within the 5 miles (8 km) of reach 2 is described as steep slopes, tortuously meandering, cobble and some boulder substrate, largely riffle/rapids and very few pools (EMA 1989). The following fish species have been collected in this reach (EMA 1989):

Mountain whitefish
Longnose sucker
Longnose dace
Emerald shiner
Trout-perch
White sucker
Mountain sucker
Lake chub
Brook stickleback
Pearl dace

REACH 3. From 45 km above the confluence to 81 km upstream of the confluence.

Moderate slopes, tortuously meandering, gravel/cobble riffles, some bedrock control with pool habitats describes the general physical characteristics of the 35 km of the river in reach 3 (EMA 1989). Fish collections conducted by EMA (1989) yielded the following fish species:

Mountain whitefish	Rainbow trout
Northern pike	Burbot
White sucker	Longnose sucker
Mountain sucker	Shorthead redhorse
Longnose dace	Lake chub
Emerald shiner	Brook stickleback
Trout-perch	Pearl dace

REACH 4. From 50 miles (81 km.) above the confluence upstream to the St. Mary River Dam.

The general physical characteristics of reach 4 are low gradient, minimal meandering and gravel substrate (EMA 1989). Fish collections conducted by EMA (1989) and Fitch (1980) yielded the following fish species:

Lake whitefish	Mountain whitefish
Northern pike	Walleye
Burbot	White sucker
Longnose sucker	Longnose dace
Spottail shiner	Trout-perch
Spoonhead sculpin	Pearl dace

SOUTH SASKATCHEWAN RIVER FISHERIES MANAGEMENT OBJECTIVES

SPECIFIC REACHES:

1. Confluence with the Red Deer River upstream to Medicine Hat.
2. Medicine Hat upstream to Grand Forks

Future fisheries management strategies to improve fish production in the above specified reaches of the South Saskatchewan River will be based on the following objectives:

- Complete a site-specific Instream Flow Needs (IFN) study for fish habitat and for healthy riparian flows.
- Monitor and evaluate the aquatic habitat configuration (pools, riffles, refugia, substrate composition and bank stability) and assess what impact the regulated flow has on the quality and quantity of these habitats.
- Investigate the role that flow has on maintaining channel configuration and sediment transport and how these processes maintain fish habitats.
- Maintain an unobstructed channel in the South Saskatchewan River to allow spawning walleye, sauger and lake sturgeon to migrate into the lower sections of the Red Deer, Bow and Oldman rivers.
- Ensure that water quality criteria, specifically water temperature and dissolved oxygen, remain within the range necessary to sustain the specific life cycles of the various fish species.
- Develop Biologically Significant Period (BSP's) Tables for all species within the fish community; however, as an interim measure, the BSP's for lake sturgeon, walleye, sauger and northern pike will be used to evaluate future water management strategies.
- Manage the fishery as a restricted size and daily limit fishery for walleye (3 > 50 cm.) and northern pike (3 > 63 cm.). Fishing for lake sturgeon will require a Sturgeon Fishing Licence in addition to the Sportfishing Licence. Only one sturgeon (> 130 cm in length) per year can be kept.

Further to the specific fisheries management objectives, resources are required to address the following data gaps:

- Identify spawning, feeding and over wintering habitats for lake sturgeon.
- Collect early life history information on sauger.
- Determine the timing and locations of spawning of northern pike.
- Identify specific destinations of fall migrations of mooneye.
- Continue to evaluate the importance (from a fish community perspective) of the connectivity between the Red Deer, Bow, Oldman and South Saskatchewan rivers.
- Develop water temperature and dissolved oxygen criteria for lake sturgeon and northern pike.
- Conduct more intensive sampling on the critical habitat units (riffles, snyes, backwaters) to determine the importance of these sites to the fish communities.
- Collect additional fisheries inventory from the section of the South Saskatchewan River bordering the Canadian Forces Base Suffield.

APPROVAL OF OBJECTIVES:

Regional Fisheries Biologist: ______________________ **Date:** ___________

Regional Head - Fisheries: ______________________ **Date:** ___________

Director - Fisheries Management: ______________________ **Date:** ___________

Assistant Deputy Minister - FWD: ______________________ **Date:** ___________

THE RIVER ENVIRONMENT

The general features of the South Saskatchewan River are provided in Kellerhals et al (1971) and Longmore and Stenton (1981). From its origin at the confluence of the Bow and Oldman Rivers, the South Saskatchewan River flows northeast for about 286 km (178 mi) to the Saskatchewan border. The river flows down a gradient of only 0.5 m/km (2.5 ft/mi) across the flat, arid prairies. Surrounding land is partly cultivated or left as open range. The river is interspersed with occasional islands and bars.

THE FISH COMMUNITY

Fish habitat inventories were conducted and reported in R.L & L. 1996 & 1997. Fish species collected to date in the South Saskatchewan River system are as follows:

Reach One: Border with Saskatchewan upstream to Medicine Hat:

Lake sturgeon	- *Acipenser fulvescens*
Lake whitefish	- *Coregonus clupeaformis*
Mountain whitefish	- *Prosopium williamsoni*
Brown trout	- *Salmo trutta*
Northern pike	- *Esox lucius*
Walleye	- *Stizostedion vitreum vitreum*
Sauger	- *Stizostedion canadense*
Yellow perch	- *Perca flavescens*
Burbot	- *Lota lota*
Goldeye	- *Hiodon alosoides*
Mooneye	- *Hiodon tergisus*
White sucker	- *Catostomus commersoni*
Longnose sucker	- *Catostomus catostomus*
Quillback	- *Carpiodes cyprinus*
Shorthead redhorse	- *Moxostoma macrolepidotum*
Silver redhorse	- *Moxostoma anisurum*
Longnose dace	- *Rhinichthys cataractae*
Lake chub	- *Couesius plumbeus*
Flathead chub	- *Hybopsis gracilis*
Flathead minnow	- *Pimephales promelas*
Emerald shiner	- *Notropis atherinoides*

River shiner	- *Notropis blennius*
Spottail shiner	- *Notropis hudsonius*
Trout-perch	- *Percopsis omiscomaycus*
Spoonhead sculpin	- *Cottus ricei*

Reach 2: Medicine Hat upstream to Grand Forks

Lake sturgeon	- *Acipenser fulvescens*
Lake whitefish	- *Coregonus clupeaformis*
Northern pike	- *Esox lucius*
Walleye	- *Stizostedion vitreum vitreum*
Sauger	- *Stizostedion canadense*
Yellow perch	- *Perca flavescens*
Burbot	- *Lota lota*
Goldeye	- *Hiodon alosoides*
Mooneye	- *Hiodon tergisus*
White sucker	- *Catostomus commersoni*
Longnose sucker	- *Catostomus catostomus*
Quillback	- *Carpiodes cyprinus*
Shorthead redhorse	- *Moxostoma macrolepidotum*
Silver redhorse	- *Moxostoma anisurum*
Longnose dace	- *Rhinichthys cataractae*
Lake chub	- *Couesius plumbeus*
Flathead chub	- *Hybopsis gracilis*
Emerald shiner	- *Notropis atherinoides*
River shiner	- *Notropis blennius*
Spottail shiner	- *Notropis hudsonius*
Trout-perch	- *Percopsis omiscomaycus*
Spoonhead sculpin	- *Cottus ricei*

The South Saskatchewan River provides the major portion of the habitat for lake sturgeon in Alberta. Currently the Grand Forks area is the only "known" lake sturgeon spawning area in the South Saskatchewan River (R.L. & L. 1994). Radio telemetry studies conducted with lake sturgeon have indicated major over wintering habitats are provided in the Rattlesnake and Boundary areas (R.L. & L. 1997a). Additional critical habitats may also occur within that portion of the river contained within the boundaries of the Canadian Forces Base Suffield; however, to date this area has not received sufficient sampling. Protection of nursery habitats for young-of-year sturgeon may be as important as protecting spawning sites. Information on the transboundary (Alberta/Saskatchewan) movements of all stages of the life cycle of lake sturgeon is required for proper future management of this unique species.

Sauger and walleye also utilize major over wintering habitats in the South Saskatchewan River. During the spawning period, they move throughout the system and migrations into the lower sections of the Red Deer River and the Bow River have been recorded (R.L.& L. 1997).

ENVIRONMENTAL ISSUES

Since there are no dams, weirs, or other sites of major water abstractions on the South Saskatchewan River, and no tributaries capable of providing significant inflow, the size of the river is almost totally dependent on discharges from the Bow and Oldman Rivers. Consequently, summer discharges are limited by upstream water abstractions in both rivers.

Although IFN sampling sites have not been established on the South Saskatchewan, future modeling exercises will need to acknowledge the timing of biologically significant periods and critical species life stages (Table 25). Water quality criteria specific to walleye and sauger and their specified life stages have been defined (Table 26). The definition of water quality criteria for lake sturgeon and northern pike is required.

Table 25. Species Periodicity Chart for Specific Reaches of the South Saskatchewan River.

Reach	Date (Approx. Julian Week)	BSP	Lake Sturgeon F	Lake Sturgeon J	Lake Sturgeon A	Lake Sturgeon S	Walleye * F	Walleye * J	Walleye * A	Walleye * S	Sauger * F	Sauger * J	Sauger * A	Sauger * S	Northern Pike F	Northern Pike J	Northern Pike A	Northern Pike S
1	1 April - 31 May (14 - 22)	1	.	?	X	.	?	X	X	X	?	X	X	X	X	X	X	?
	1 June - 30 Sept (23-39)	2	?	X	X	X	X	X	X	.	X	X	X	.	X	X	X	.
	1 October - 30 Nov. (40-48)	3	?	X	X	.	X	X	X	.	X	X	X	.	X	X	X	.
2	1 April - 15 June (14 - 23)	1	.	?	X	.	?	X	X	X	?	X	X	X	X	X	X	X
	16 June - 30 Sept. (24-39)	2	?	X	X	X	X	X	X	.	X	X	X	.	X	X	X	.
	1 October - 30 Nov. (40-48)	3	?	X	X	.	X	X	X	.	X	X	X	.	X	X	X	.

Reach 1 - Saskatchewan border to downstream border of Medicine Hat
Reach 2 - Downstream border of Medicine Hat to Grand Forks (confluence)

Walleye * and Sauger * the ? for fry in BSP 1 - information suggests these species likely spawn on average about the 3rd week in April, and given 2 to 3 weeks for eggs to hatch, it is likely the fry are present by the end of May

Table 26. Summary of water temperature and dissolved oxygen criteria for protection of specific life stages of walleye and sauger the Saskatchewan River. Source: Taylor and Barton (1992).

WALLEYE & SAUGER

Temperature	
Fry-Acute	daily maximum 29^{o}C
Fry-Chronic	7-day mean < 24^{o}C
Juvenile and Adult-Acute	daily maximum 29^o C
Juvenile and Adult-Chronic	7-day mean < 24^{o}C
Spawning	7 consecutive days with: daily minimum $\geq$ 5^{o}C daily maximum $\leq$ 12^{o}C
Dissolved Oxygen	
Early life-Acute	daily minimum 5.0 mg/L
Early life-Chronic	7-day mean minimum 6.0 mg/L
Fry-Acute	daily minimum 5.0 mg/L
Fry-Chronic	7-day mean minimum 5.0 mg/L
Adult-Acute	daily minimum 3.0 mg/L
Adult-Chronic	7-day mean minimum 5.0 mg/L

SOUTH SASKATCHEWAN RIVER REACH DELINEATION

For water management purposes, the South Saskatchewan River is divided into the following two reaches (See Figure 5):

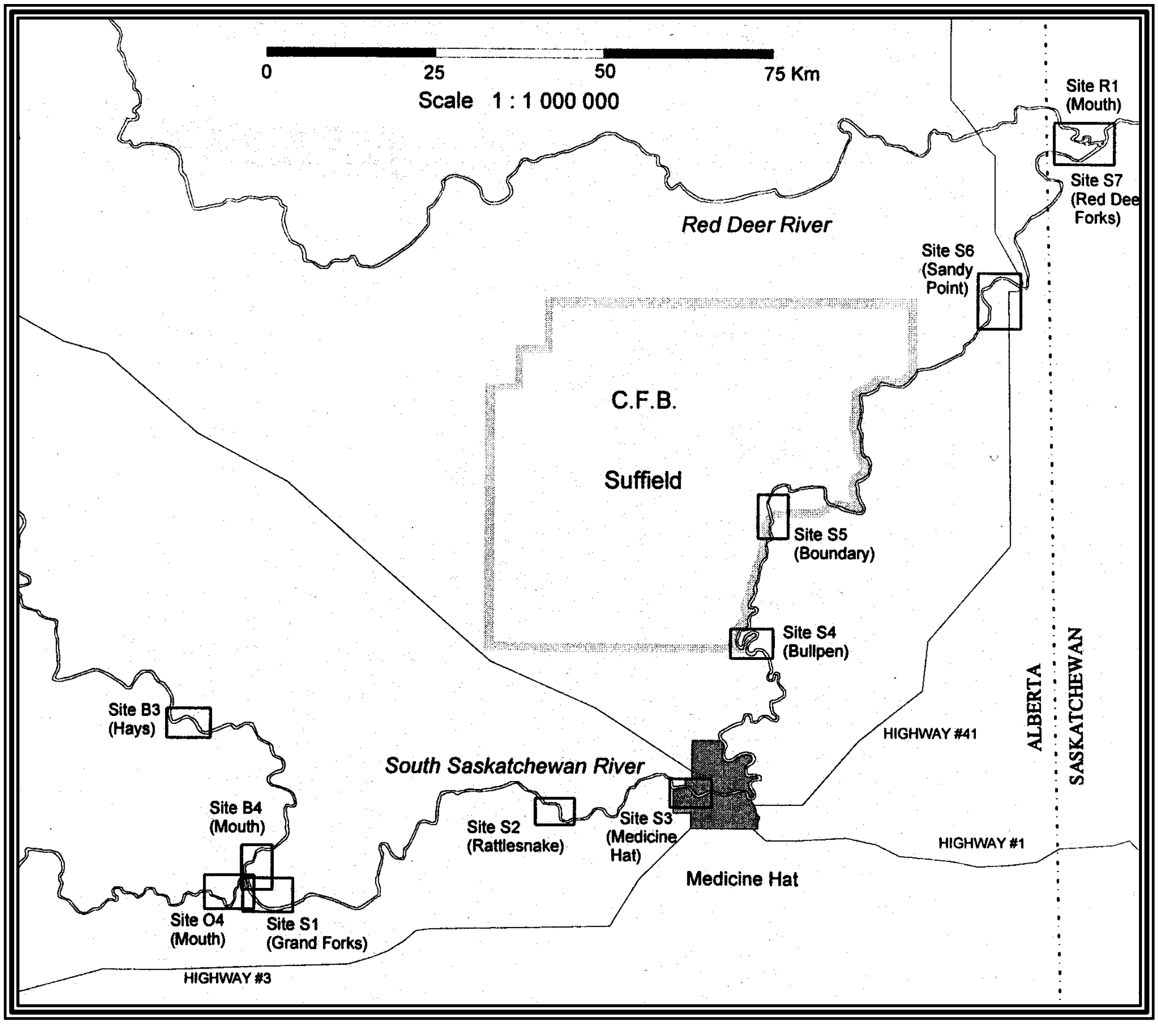


Figure 5. Map of the South Saskatchewan River system (Modified from R.L.& L. 1997)

Reach 1: Confluence with Red Deer River upstream to Medicine Hat.

This section of the South Saskatchewan River covers approximately 200 river kilometres. Detailed habitat characteristics and fish species composition of specific sampling sites within this reach are reported in R.L. & L. 1991 (Sites 3, 4 and 5); 1996 (Sites S4, S5, S6 and S7). Below the City of Medicine Hat occasional small rapids are encountered, upon reaching the Drowning Ford area the river narrows and becomes more canyon-like. This section exhibits the only major set of rapids in the river. The steepest gradient (approximately 0.7 m/km) occurs in this section. The highest water velocities (> 0.7 m/s) were encountered at sites S4 and S5 (Bullpen and Boundary).

Below the canyon-like section, the river channel gradually widens, the gradient decreases (0.2 m/km) and sand bottoms predominate for the remainder of the section prior to reaching the Red Deer River confluence.

Critical habitats for lake sturgeon are provided within this section of river. Feeding and over wintering habitats are provided at the “sturgeon holes” located near Miners Flats/Bullpen and near Drowning Ford. The Drowning Ford “hole” is estimated to be approximately 15 ha. In 1985, 103 lake sturgeon were collected at this site in 14 days; in 1986 a total of 84 fish were sampled in 22 days. This data illustrates the abundance and concentration of sturgeon that can occur in a relatively small section of suitable habitat (R.L. & L. 1991). Potential spawning habitat may also occur in the rapid sections near Miners Flats/Bullpen and Drowning Ford.

The fish inventory conducted in 1995 (R.L. & L. 1996) indicated lake whitefish were the predominant sport fish species followed by sauger. Walleye were capture in low numbers. Walleye tagged with radio transmitters indicated this species over winters in this section. Goldeye were captured mainly in the downstream section of the river.

Reach 2: Medicine Hat upstream to Grand Forks.

This section of the South Saskatchewan River is approximately 100 kilometres in length. Detailed habitat characteristics and fish species composition of specific sampling sites within this reach are reported in R.L. & L. 1991 (Sites 1 and 2), 1996 (Sites S1, S2 and S3). The mean gradient within this reach ranged from 0.36 m/km to 0.54 m/km. The predominant habitat type in this reach is runs with water depths ranging from < 0.5 m to > 1.0 m.

The rapids section at the Grand Forks is likely the major spawning area for lake sturgeon (Radford 1980 and R.L. & L. 1991). The Rattlesnake “hole”, like the Drowning Ford “hole”, represents significant feeding and over wintering habitat for lake sturgeon.

Mooneye were the predominant sport fish collected in the Grand Fords area in 1995 (R.L. & L. 1996) whereas lake whitefish were dominate at the other sites within this reach. Walleye and sauger were the next most common sport fish species.

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