PROPOSED

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Western Silvery Minnow (*Hypognathus argyritis*) in Canada

Western Silvery Minnow

July 2007

Fisheries and Oceans Canada
Pêches et Océans Canada
Canada

About the *Species at Risk Act* Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003 and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (http://www.sararegistry.gc.ca/the_act/) outline both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the *Species at Risk Act* and recovery initiatives, please consult the SARA Public Registry (http://www.sararegistry.gc.ca/) and the Web site of the Recovery Secretariat (http://www.speciesatrisk.gc.ca/recovery/).

Recovery Strategy for the Western Silvery Minnow (*Hybognathus argyritis*) in Canada [Proposed]

July 2007

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Additional copies:

Additional copies can be downloaded from the *SARA* Public Registry (http://www.sararegistry.gc.ca/)

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Également disponible en français sous le titre
« Programme de rétablissement du méné d'argent de l'Ouest (*Hybognathus argyritis*) au Canada (Projet) »

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DECLARATION

This proposed recovery strategy for the western silvery minnow has been prepared in cooperation with the jurisdictions described in the Preface. Fisheries and Oceans Canada has reviewed and accepts this document as its recovery strategy for the western silvery minnow as required by the *Species at Risk Act (SARA)*. This recovery strategy also constitutes advice to other jurisdictions and organizations on the recovery goals, approaches and objectives that are recommended to protect and recover the species.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries and Oceans Canada or any other jurisdiction alone. In the spirit of the National Accord for the Protection of Species at Risk, the Minister of Fisheries and Oceans invites all Canadians to join Fisheries and Oceans Canada in supporting and implementing this strategy for the benefit of the western silvery minnow and Canadian society as a whole. Fisheries and Oceans Canada will support implementation of this strategy to the extent possible, given available resources and its overall responsibility for species at risk conservation. Implementation of the strategy by other participating jurisdictions and organizations is subject to their respective policies, appropriations, priorities and budgetary constraints.

The goals, objectives and recovery approaches identified in the strategy are based on best existing knowledge and are subject to modifications resulting from new findings and revised objectives. The Minister of Fisheries and Oceans will report on progress within five years.

This strategy will be complemented by one or more action plans that will provide details on specific recovery measures to be taken to support conservation of the species. The Minister will take steps to ensure that, to the extent possible, Canadians interested in or affected by these measures will be consulted.

RESPONSIBLE JURISDICTIONS

Under the *Species at Risk Act*, the responsible jurisdiction for the western silvery minnow is Fisheries and Oceans Canada. The Government of Alberta (Alberta Sustainable Resource Development and Alberta Environment) cooperated in the production of this recovery strategy.

AUTHORS

The Western Silvery Minnow Recovery Strategy was developed by the Milk River Fish Species at Risk Recovery Team, comprised of the following individuals:

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ACKNOWLEDGMENTS

The Milk River Fish Species at Risk Recovery Team extends its sincere appreciation to the many organizations that supported the development of this recovery strategy with financial and/or in-kind contributions, and to the people who contributed their knowledge and hard work. This report was written by S. Pollard who was secretariat to the Recovery Team, and by D.B. Stewart of Arctic Biological Consultants, Winnipeg, MB. Funding to support Recovery Team meetings was provided by Fisheries and Oceans Canada (DFO) and Alberta Sustainable Resource Development (ASRD). Shane Petry of DFO and Terry Clayton (ASRD) provided facilities for Recovery Team meetings in Lethbridge. J.R. Tomelleri drew the illustration of the western silvery minnow, and kindly permitted its use on the report cover. Blair Watke of ASRD prepared the fine drainage basin maps. The Recovery Team would especially like to thank the Town of Milk River for providing facilities for one of its meetings and a workshop in their community; Doug Watkinson of Fisheries and Oceans Canada who travelled from Winnipeg to participate in Recovery Team meetings and share his knowledge on the western silvery minnow; and Karen Scott for providing the photo composite of the western silvery minnow. Lastly, the team is indebted to Sue Cotterill, Becky Cudmore, Bruce McColloch, Richard Orr, Sam Stephenson, and Doug Watkinson who provided constructive reviews of the manuscript.

STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

In accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*, the purpose of a Strategic Environmental Assessment (SEA) is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally-sound decision making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats.

This recovery strategy describes a number of research, monitoring, management, regulatory and public education approaches required for the conservation and recovery of the western silvery minnow. Aside from the acquisition of further knowledge, the recovery strategy focuses on eliminating or mitigating threats to the species including species introductions, habitat loss or degradation, and pollution. In addition to generally improving environmental conditions, the reduction or elimination of these threats may benefit other co-occurring species (see Section 5.6). The recovery strategy also recommends rationalizing existing or proposed stocking programs in the Milk River with potential impacts of any changes considered within that process. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not have significant adverse effects.

RESIDENCE

SARA defines residence as: "*a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating*" [SARA S2(1)].

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the *SARA* public registry:
http://www.sararegistry.gc.ca/plans/residence_e.cfm

PREFACE

The responsible jurisdiction for the western silvery minnow under the *Species at Risk Act* (SARA) is Fisheries and Oceans Canada. Section 37 of SARA requires the competent minister to prepare recovery strategies for listed extirpated, endangered and threatened species. The western silvery minnow was listed as threatened under *SARA* in June 2003. Fisheries and Oceans Canada – Central and Arctic Region co-led the development of this recovery strategy. The proposed

strategy meets *SARA* requirements in terms of content and process (Sections 39-41). It was developed in cooperation or consultation with:

- The Province of Alberta – Alberta Sustainable Resource Development (ASRD) and Alberta Environment (AENV).
- Milk River Rancher's Association;
- Milk River Watershed Council of Canada;
- Southern Alberta Environmental Group;
- The Counties of Warner, Cardston, and Forty Mile; and
- The Villages of Coutts and Warner, and the Town of Milk River.

Also refer to Appendix B for a full record of public consultations.

EXECUTIVE SUMMARY

In June 2003 the western silvery minnow (*Hybognathus argyritis*) was officially listed on Schedule 1 of the federal *Species at Risk Act (SARA)* as "**Threatened**[1]", requiring the completion of a recovery strategy within four years. Similarly, the Province of Alberta will also require a recovery plan for this species within two years after listing it as "Threatened" under Alberta's *Wildlife Act*. In March 2004, the Milk River Fish Species at Risk Recovery Team was assembled to develop a joint federal/provincial recovery strategy for the western silvery minnow addressing the requirements of both the federal and provincial processes. This team was comprised of representatives from the federal (Fisheries and Oceans Canada) and provincial (Alberta Sustainable Resource Development and Alberta Environment) agencies responsible for fisheries and natural resource management, as well as four members representing the Milk River Watershed Council of Canada (MRWCC), the Southern Alberta Environmental Group, the Milk River Ranchers' Association and lastly, the Counties of Cardston, Forty Mile and Warner, the Villages of Coutts and Warner, and the Town of Milk River. The team members were selected to represent the broad range of interests for both the conservation of the species and potential implications to the local community imposed by the recovery plan.

While the Canadian distribution and abundance of the western silvery minnow have remained relatively stable since the species was first identified in the Milk River, the species continues to be at risk due to its extremely limited range in Canada. Consequently, the goal and objectives of the recovery strategy are directed towards the protection and maintenance of the existing population in its current range rather than population recovery and habitat restoration.

The recovery strategy describes the species and its needs, incorporates a threats assessment, and outlines a broad recovery approach for the western silvery minnow based on the available information. Its goal is "***To protect and maintain a self-sustaining population of western silvery minnow within its current range in the Milk River***". Key objectives of the strategy are to:

1) quantify and maintain current population levels;
2) identify and protect critical habitat; and
3) to identify potential threats from human activities and ecological processes and develop plans to avoid, eliminate or mitigate these threats.

To help achieve this goal and meet the objectives, four general approaches are proposed: research, monitoring, management and regulatory actions, and education and outreach. Within each of these, a number of individual strategies are outlined that capture the range of tools available to protect and manage the species and to reduce or eliminate threats to its survival

The Western Silvery Minnow Recovery Strategy will be subject to an annual review by the Recovery Team. The strategy has a designated life span of five years, after which it will be reviewed and revised as needed by the Recovery Team.

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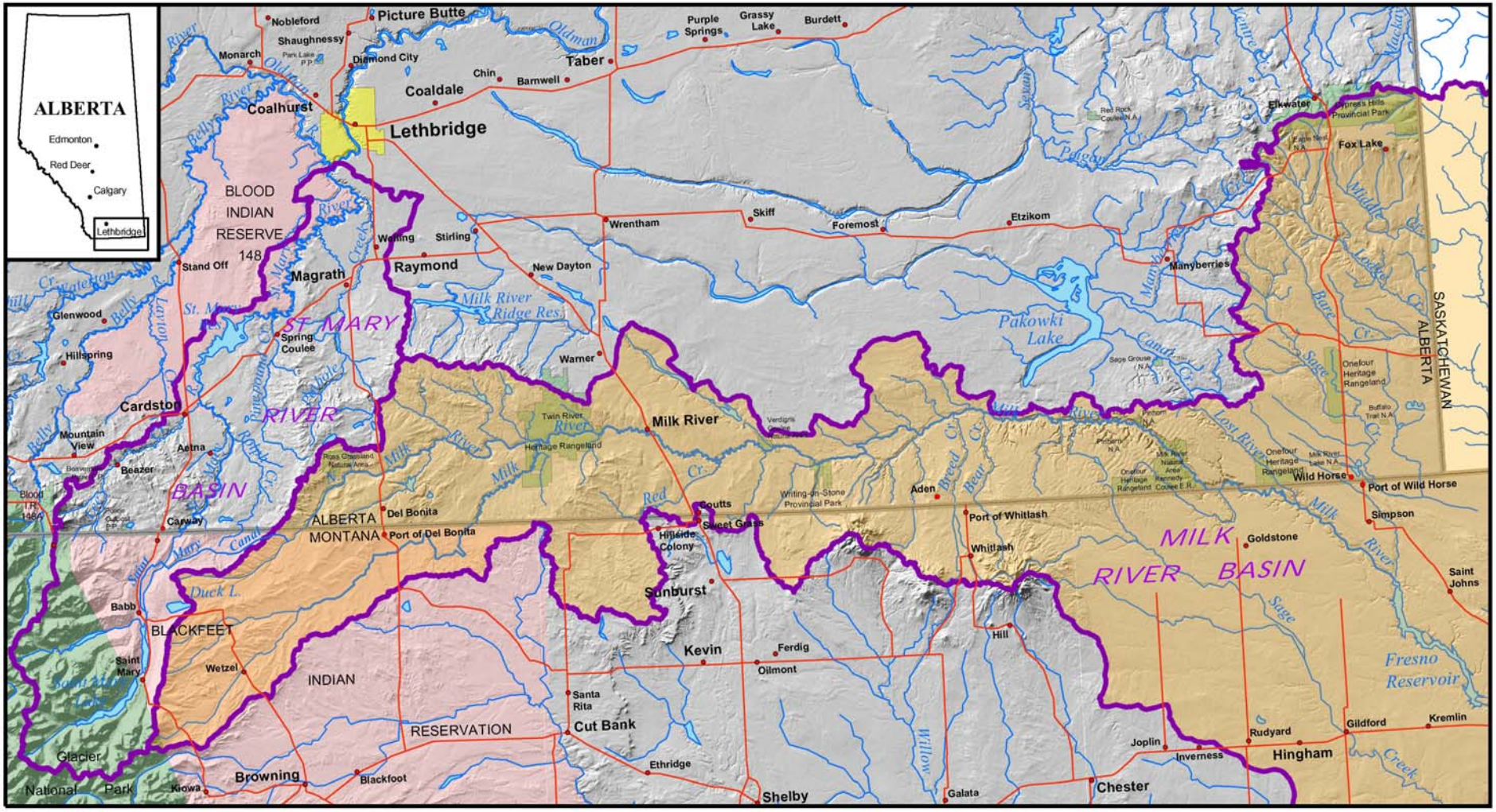

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Produced by Alberta Sustainable Resource Development, Prairies Area, Resource Information Unit, Lethbridge, February 2007.
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Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

Figure 1. Location of the Milk River Basin in Alberta.

1. INTRODUCTION

The western silvery minnow (*Hybognathus argyritis*) is a small **cyprinid**[1] species native to large plains streams in northwestern North America. It was first documented in Canada in 1961 from the lower Milk River, Alberta (UAMZ 5320, University of Alberta Museum of Zoology), and its presence has not been verified in any other Canadian river systems since (Alberta Sustainable Resource Development 2003) (Figure 1-facing page). There is very little historical information on the western silvery minnow in the Milk River, but this fish has probably persisted at naturally low numbers without significant changes in abundance or range since it was first observed in Alberta (Alberta Sustainable Development 2003). Natural rarity in terms of both distribution and abundance in Canada makes the minnow vulnerable to extirpation, so it requires protection.

In June 2003, the western silvery minnow was listed as "Threatened" under Schedule 1 of the Species at Risk Act (SARA), which required its immediate protection and the development of a recovery strategy within four years. Also in 2003, the species was approved for listing as "Threatened" provincially by Alberta's Minister of Sustainable Development.

In 2004, a joint federal/provincial recovery team was established for the western silvery minnow to produce a recovery strategy that would meet the needs of both Canada and Alberta. Membership on the Milk River Fish Species at Risk Recovery Team (the Recovery Team) includes representatives from each of the responsible jurisdictions (Fisheries and Oceans Canada, Alberta Environment, Alberta Sustainable Resource Development) and from key stakeholders including local municipalities, the Milk River Ranchers' Association, the Milk River Watershed Council of Canada, and the Southern Alberta Environmental Group. The first recovery team meeting was held in March 2004, in Lethbridge, Alberta.

This document presents the recovery strategy for the western silvery minnow in Canada in fulfillment of the SARA requirements. It proposes a maintenance and protection approach for the species and its habitat, and follows the two-step model developed by the National Recovery Working Group (2004). Development of the recovery strategy is the first step, followed by the development of an action plan to implement its recommendations.

2. BACKGROUND

Recovery efforts should be based on a sound understanding of the species, including its biology, ecology, and the environmental conditions under which it exists. The following sections describe the environmental setting of the Milk River, what is known about the western silvery minnow, and what can be inferred from other closely related species.

[1] Terms in bold type are defined in the Glossary.

2.1 Species Assessment Information from COSEWIC and Alberta

COSEWIC ASSESSMENT SUMMARY

Common Name: Western Silvery Minnow

Scientific Name: *Hybognathus argyritis*

Status: Threatened
Last Examination: November 2001 (In a higher risk category)
Canadian Occurrence: AB
Reason for Designation: This species is known in Canada from two rivers in Alberta, one of which flows through short-grass prairie that is subject to continuous erosion leading to increased siltation.
Status History: Designated Special Concern in April 1997. Status re-examined and designated Threatened in November 2001. Last assessment based on an existing status report with an addendum.

Note: The above summary is based on information available to COSEWIC at the time of the initial species assessment and is included for reference purposes. The identified threats must be considered in the development of a recovery strategy under the Species at Risk Act (SARA). However, subsequent review and analysis of all available information by the Recovery Team has led to different conclusions regarding the species' distribution (i.e., occurs only in the Milk River) and some of the identified threats.

ALBERTA SUMMARY

Common Name: Western Silvery Minnow
Scientific Name: *Hybognathus argyritis*
Rank: Threatened
Designated: 2003
Reason for Designation: This species is moderately abundant, but its distribution is very restricted. The only location in Canada where this species is found is in the Milk River of southern Alberta.

STATUS HISTORY: **DESIGNATED "MAY BE AT RISK" IN 2000. UPGRADED TO THREATENED IN 2003 BASED ON A NEW STATUS REPORT (ALBERTA SUSTAINABLE RESOURCE**

2.2 Environmental setting

The Milk River is the northernmost tributary of the Missouri River and the only watershed in Canada where populations of the western silvery minnow have been found (Figure 1). The Milk River is situated in the Dry Mixedgrass Natural Subregion of Alberta (Natural Regions Committee 2006), where it flows within the confines of a defined valley with limited road access. The surrounding land is semi-arid, short grass prairie that is used primarily for cattle grazing. The river is shallow and turbid, with a dynamic hydrology and poorly developed **riparian zone** that lacks higher aquatic plants due to the highly mobile stream bed (D. Watkinson, pers. com.). Rainfall in the Milk River basin averages only 333 mm annually, 72% of which falls during the growing season (Natural Regions Committee 2006). Periods of high runoff occur briefly in late March and April due to snowmelt and in June and July due to intensive, localized rain storms (McLean and Beckstead 1980).

The Milk River has been severely impacted by changes in its seasonal flow regimes. Since 1917, Montana has diverted water from St. Mary River in northwestern Montana via the St. Mary Canal into the North Milk River (ISMMRAMTF 2006). This water flows eastward through southern Alberta before entering northeastern Montana, where it is used for irrigation. These augmented flows occur in the Alberta portion of the Milk River from late March or early April through late September or mid-October. During the rest of the year natural flows prevail within a somewhat modified river channel (McLean and Beckstead 1980). Flow augmentation of the Milk River is actively managed at the Saint Mary Diversion Dam in Montana in response to major runoff events to prevent or reduce erosion, scouring and risk of canal failure, and to optimize use of the water for irrigation.

Since 1917, the diversion of flow from the St. Mary River has augmented summer flows in the Milk River. Under natural conditions summer flows in Canada ranged from 1 to 2 m^3/s in the North Milk River to between 2 and 10 m^3/s at the Milk River's eastern crossing of the international border. Since the diversion, flows in the Milk River at the Town of Milk River have ranged from 10 to 20 m^3/s from May to September, and have averaged 15 m^3/s between June and August. The flow augmentation is much greater in relative terms in the North Milk River, which has a relatively small drainage area (238 km^2 at the North Milk River gauge 11AA001), than it is further downstream at the eastern crossing of the international border, where the river receives runoff from a much larger area (6,800 km^2 at gauge 11AA031) (McLean and Beckstead 1980).

When the diversion of water from the St. Mary River is terminated in late September to mid-October, the river reverts to natural flow conditions for the remainder of the winter season (ISMMRAMTF 2006). Ramping down of the diverted flow occurs over about a week, and flows in the river decline over the next several weeks. The decline is most rapid in upstream reaches of the river. Under severe drought conditions, such as those of 2001-2002, there may be little or no surface flow and the lower Milk River can be reduced to a series of isolated pools until spring, although subsurface flows may continue (K. Miller, pers. com.). Indeed, during much of the non-augmented fall and

winter period the natural flow at the Town of Milk River is low enough to flow through a 4 foot diameter culvert--a 2 foot culvert in dry years (K. Miller, pers. com.). At the Town, the average flow rate over the period 1912 to 2005 was less than 2 m^3/s (cubic metres per second) in November and February, and less than 1 m^3/s in December and January (WSC 2006).

Water management within the Milk and St. Mary rivers is governed by the 1909 Boundary Waters Treaty (the Treaty) between the United States and Canada, which is administered by the International Joint Commission (IJC) (ISMMRAMTF 2006). Over the past two decades, the St. Mary Canal has transported an average of about 208 ha^3 (cubic hectares; 169,000 acre-feet) of water annually into the North Fork of the Milk River (U.S. Bureau of Reclamation 2004). In 2003, Montana requested that the Treaty be re-opened to reconsider how the diverted water is apportioned. However, at the time of writing, this issue had not yet been resolved. At present the operating capacity of the St. Mary Canal is about 18.4 m^3/s (650 cfs), significantly less than its original design capacity of 24.1 m^3/s (850 cfs). Montana is considering whether to rehabilitate the aging canal infrastructure and return the canal to its original capacity, or whether to increase its capacity to 28.3 m^3/s (1000 cfs) (Alberta Environment 2004; U.S. Bureau of Reclamation 2004).

2.3 Species Description

The western silvery minnow belongs to the minnow family (F. Cyprinidae). It is a small fish native to the large plains streams of the Missouri and Mississippi drainages in midwestern North America. The head is characterized by a blunt snout with a subterminal mouth and relatively large eyes (Scott and Crossman 1973). Specimens in Alberta tend to be brownish-yellow on the back with silvery sides (Nelson and Paetz 1992) (Figure 2). Fork lengths (tip of snout to fork of tail) of up to 140 mm have been recorded in the Milk River (R L&L 2002)

Originally, the western silvery minnow and eastern silvery minnow *(Hybognathus regius*) were considered subspecies of the central silvery minnow (*H. nuchalis*) (Scott and Crossman 1973), but they are now considered distinct species based on morphological differences (Hlohowskyj *et al.* 1989, Schmidt 1994, Pfliefer 1997). This distinction was accepted by the American Fisheries Society in 1991 (Robins *et al.* 1991). Recent taxonomic studies have verified that fish in the Canadian reaches of the Milk River are western silvery minnows (D. Watkinson, pers. com.).

Figure 2. Western silvery minnow (Photo Credit: Karen Scott, DFO).

2.4 Distribution and Population

2.4.1 Distribution

The western silvery minnow is only found in North America, where it occurs in large lowland plain streams of the Mississippi River system, from the mouth of the Ohio River north to the Missouri River basin and the Milk River in Alberta. It has adapted to the highly variable spring-summer flows characteristic of plains streams and occurs in small, naturally-intermittent streams far upstream of confluences with larger rivers, where it has likely adapted to access habitat under limited flow conditions (R. Bramblett, pers. com.). In the Mississippi River, it has only been found downstream of the confluence with the Missouri River. The species' distribution in the Milk River appears to be continuous from Writing-on-Stone Provincial Park in Alberta downstream to the confluence with Missouri River, although fragmentation has occurred with the construction of seven storage and diversion dams in Montana (Stash 2001; T. Clayton and D. Watkinson, pers. com.). Upstream movement past these dams is not possible. There are no barriers to fish movement above the Fresno Dam, which is located approximately 80 km downstream of the eastern border crossing.

The distribution of the western silvery minnow has declined significantly in extensive areas in the United States over the past century (Willock 1969). The species is listed by most Missouri River basin states, including North Dakota, South Dakota, Iowa, Kansas and Missouri, as "Threatened" or as a "Species of Concern" (Welker and Scarnecchia 2004). Its Canadian range represents <1% of the species' global range.

In Canada, the distribution of western silvery minnow has only been confirmed in the mainstem of the Milk River in southern Alberta (Figure 3). This is the northwestern limit of the species' known range. A single specimen was also documented in the South Saskatchewan River near Medicine Hat in 1963 (Henderson and Peter 1969). This fish may have been a western silvery minnow introduced as bait, since a series of recent surveys have not found additional specimens that would support the existence of a resident population in the system (Alberta Sustainable Resource Development 2003).

Within Alberta, the western silvery minnow distribution appears to be limited to the lower 220 km of the mainstem Milk River, from about 20 km upstream of the Town of Milk River downstream to the Alberta/Montana border (Figure 3). Within this stretch of river, the species' distribution appears to be continuous downstream of the confluence with Police Creek (Willock 1969; P&E 2002; T. Clayton and D. Watkinson, pers. com.). Recent upstream range extensions likely reflect improved sampling techniques rather than a recent change in the species' distribution. The use of Milk River tributaries has not been documented despite numerous surveys of many tributaries (Alberta Sustainable Resource Development 2003).

The distribution of the western silvery minnow may have been significantly different prior to 1917, when the Saint Mary Canal was constructed (Willock 1969). However, the effects of increased seasonal flows on its distribution and abundance are unknown. On the one hand they may have enabled the minnow to expand upstream into the Alberta portion of the Milk River; on the other they may be limiting its abundance and distribution in Alberta (R. Bramblett, pers. com.).

2.4.2 Population Size and Trends

Very little information is available on population size or trends in abundance of the western silvery minnow in Alberta. Since it was first identified in the Milk River in 1961, the species has remained common in small, local areas of the river from downstream of Writing-on-Stone Provincial Park to the Montana border (T. Clayton, pers. com.). In 2000 and 2001, it was one of the more abundant species caught in fall surveys of the Milk River, where its abundance was highest downstream of Pinhorn Ranch, probably reflecting the increased availability of preferred habitat. It was the second most abundant fish species taken in mid-July 2005 by a DFO survey of the Milk River downstream of its confluence with Breed Creek (D. Watkinson, pers. com.).

2.4.3 Nationally Significant Populations

The western silvery minnow has no direct economic importance and limited importance as a forage species (Scott and Crossman 1973). However, it does have intrinsic value as a contributor to Canada's biodiversity and as a forage fish.

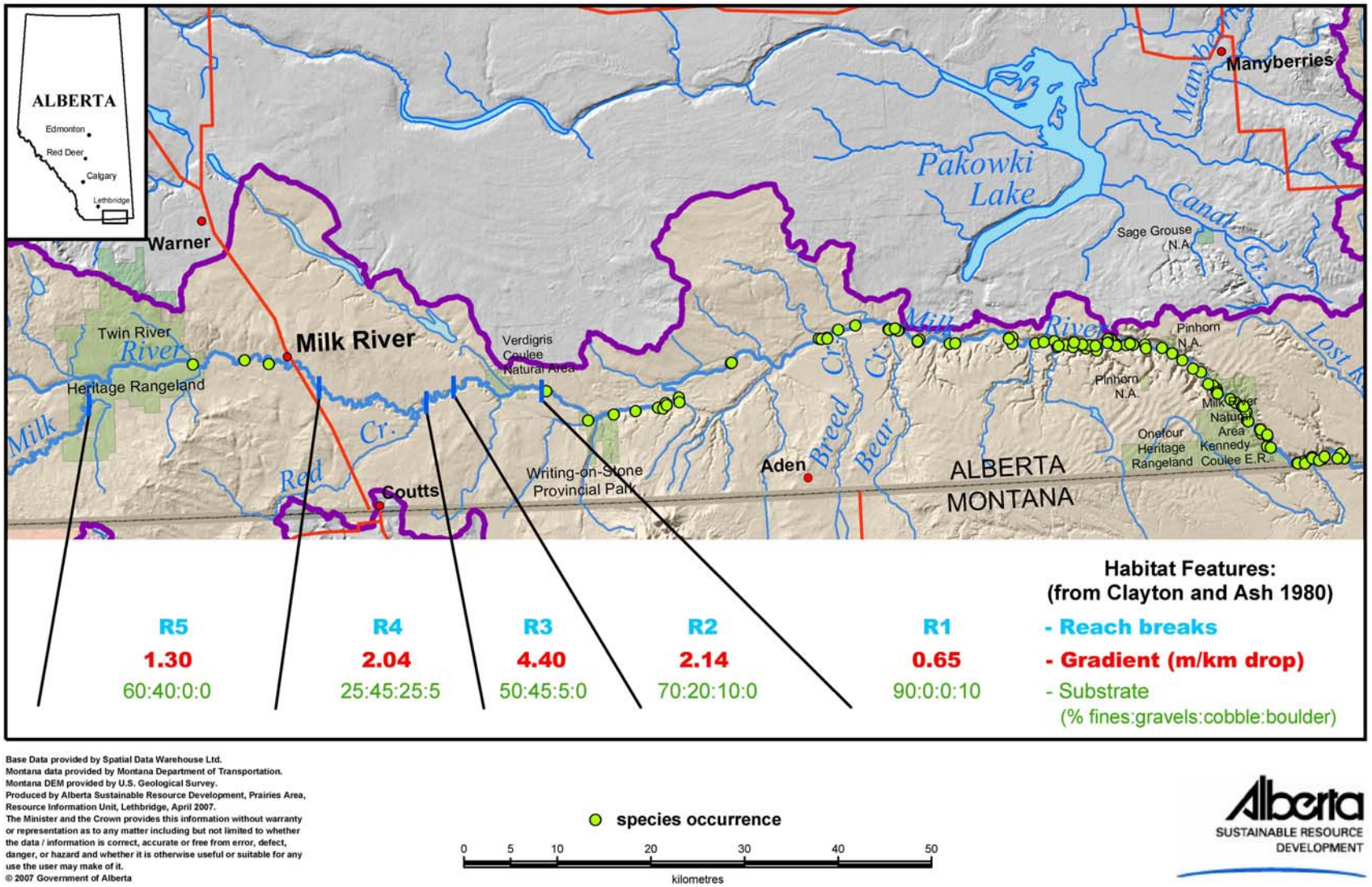

Figure 3. Canadian distribution of the western silvery minnow showing key habitat features of the Milk River, Alberta. Distribution records are from the ASRD Fisheries Management Information System as of January 2005.

2.5 Species' Needs

2.5.1 Biology and Life History

Until recently, very little was known of the biology and life history of the western silvery minnow. Consequently information from the eastern silvery minnow in New York (Raney 1939) was often cited instead. This may not have been appropriate, since the eastern silvery minnow lives in lakes and the western silvery minnow inhabits rivers (D. Watkinson, pers. com.). Fortunately, since it was listed by COSEWIC in 2003, ongoing studies by T. Clayton (Alberta Sustainable Resource Development) and D. Watkinson (Fisheries and Oceans Canada) have filled some important gaps in knowledge of the western silvery minnow. Where gaps remain, information from other minnow species that inhabit similar Great Plains river habitats has been cited, rather than that from the eastern silvery minnow.

Growth

Western silvery minnows in the Milk River can grow to at least 140 mm in **fork length** (FL) (D. Watkinson, pers. com.). Both sexes mature at age 2+ years, and can live to at least age 4+ years (Sikina and Clayton 2006). In Missouri, adult western silvery minnows of ages 3 to 5 years are common, with a maximum age of 5.5 years (Pflieger 1997).

Reproduction

Species within the genus *Hybognathus* exhibit a range of spawning strategies, and the strategy used by the western silvery minnow is unknown. It is likely a broadcast spawner, like other Great Plains stream minnows such as the central silvery minnow, Rio Grande silvery minnow (*H. amarus*), and plains minnow (*H. placitus*) which release non-adhesive, semi-buoyant **pelagic** eggs into open water to develop as they drift downstream in the current (Platania and Altenbach 1998; Cowley 2002; R. Bramblett, pers. com.). Sediment-laden waters keep the eggs of the Rio Grande silvery minnow afloat and modest currents transport them downstream (Cowley 2002). The embryos develop quickly as they drift in the current, hatching within 24 to 48 hours depending upon the water temperature. These broadcast spawners require extensive stretches of connected habitat to enable the fish born from eggs that drift downstream to return upstream to suitable habitats.

Western silvery minnows in the Milk River spawn in June or July (D. Watkinson, pers. com.). Their fecundity increases with size, from less than 2,000 eggs in an 80 mm (FL) female to 19,500 eggs in one that is 130 mm (FL). Fish caught during an extremely warm spring had not spawned in late May, and some still contained mature eggs in mid-July. Adult western silvery minnows in Missouri have been observed in breeding condition in late June (Pflieger 1997).

Ecological Role

During the summer, western silvery minnows in the Milk River consume diatoms, higher plant material, blue-green algae, green algae, cyanobacteria, fungus, pollen, protozoa, dinoflagellates, zooplankton, cryptophyceae, and rotifers (D. Watkinson, pers. com.). Given the paucity of aquatic vegetation, the higher plant material may have come from the leaves of trees or the undigested feces of herbivores. Charcoal, likely from bottom sediments, and a sponge spicule were also found in their stomachs.

Sauger (*Sander canadensis*), northern pike (*Esox lucius*) and burbot (*Lota lota*) are likely the major predators of all life stages of the minnow, while other species may opportunistically consume eggs and larvae. Twenty-two fish species, including the western silvery minnow, have been documented in the Milk River mainstem and tributaries (Table 1) (Alberta Sustainable Resource Development 2003; T. Clayton, pers. com.). Seventeen of these species occur within the western silvery minnow's range in the Milk River. The MULTISAR (Multi-Species at Risk) Program, a basin-wide terrestrial and aquatic species identification and stewardship program,

Table 1. Fish species that occur in the Milk River watershed.

Common Name	Scientific Name	Occurs within minnow's range?
Brassy minnow	*Hybognathus hankinsoni*	Y
Brook stickleback	*Culaea inconstans*	Y
Burbot	*Lota lota*	Y
Fathead minnow	*Pimephales promelas*	Y
Flathead chub	*Hybopsis gracilis*	Y
Iowa darter	*Etheostoma exile*	N
Lake chub	*Couesius plumbeus*	Y
Lake whitefish	*Coregonus clupeaformis*	N
Longnose dace	*Rhinichthys cataractae*	Y
Longnose sucker	*Catostomus catastomus*	Y
Mountain sucker	*Catostomus platyrhynchus*	Y
Mountain whitefish	*Prosopium williamsoni*	N
Northern pike	*Esox lucius*	Y
Northern redbelly dace	*Phoxinus eos*	N
Sauger	*Sander canadensis*	Y
East slope sculpin (or St. Mary sculpin)	*Cottus sp.*	Y
Stonecat	*Noturus flavus*	Y
Trout-perch	*Percopsis omiscomaycus*	Y
White sucker	*Catostomus commersonii*	Y
Walleye	*Sander vitreum*	Y
Yellow perch	*Perca flavescens*	Y

recently identified trout-perch (*Percopsis omiscomaycus*), a yellow perch (*Perca flavescens*), a walleye (*Sander vitreum*), and lake whitefish (*Coregonus clupeaformis*) in the Milk River system (T. Clayton, pers. com.), suggesting movement from Montana or illegal introductions.

2.5.2 Habitat

The western silvery minnow is most commonly found in large, silty prairie streams, generally in areas with little or no current and sandy, muddy or debris-covered bottom (Pflieger 1980; Trautman 1957, Missouri Fish and Wildlife Information System 2002). Within these systems, gradient, bottom type and turbidity appear to be strongly associated with minnow presence. In North Dakota, 98% of all western silvery minnows were captured in water less than 1 m deep and current velocities of less than 0.5 m/s (Welker and Scarnecchia 2004). Eighty-five percent of these fish were in areas of relatively low turbidity (<250 NTU; nephelometric turbidity units), where summer temperatures were relatively high (18°-22°C). A habitat model (using logistic regression) that incorporated water velocity, depth, and percentage sand predicted minnow presence in river segments during the open water period in North Dakota with 97% accuracy (Welker and Scarnecchia 2004), indicating that these habitat variables are key determinants of the species' presence.

In the Milk, Missouri and Mississippi river mainstems the western silvery minnow occurs in transitional areas characterized by elevated velocity and turbidity, an unstable streambed with shifting sand and silt substrates, and flows that fluctuate through the year (Burr and Page 1986, Alberta Sustainable Resource Development 2003). Welker and Scarnecchia (2004) referred to the species' preferred habitat as channel border habitat. These minnows tolerate a wide range in turbidity (Missouri Fish and Wildlife Information System 2002). They occur in areas that are rich in phytoplankton (Trautman 1957) and in streams devoid of aquatic vegetation, such as the lower Missouri River (Cross *et al.* 1986) and the Milk River (D. Watkinson, pers. com.).

The open water distribution of western silvery minnow in the Milk River is strongly correlated with gradient and substrate type (Figure 3). During the summer in the lower Milk River, the species shows preference for water velocities less than 0.3 m/s, depths of less than 0.3 m, and silt bottom substrate (R.L.&L. 2002; D. Watkinson, pers. com.). However, it also occurs in water velocities of at least 1.2 m/s, at depths of at least 1.4 m, and over sand and gravel substrates. Upstream of the confluence with Police Creek, where the species is present in lower abundance, there is an abrupt increase in both gradient and the size of substrate. The species winter distribution is unknown. Some fish likely overwinter in the same areas they occupy in summer, while others may move elsewhere to find suitable habitat that does not freeze or become **anoxic**.

Key Habitat

For the purposes of this document, we define "key habitat" as the habitat believed to be important to the survival of specific life stages of the western silvery minnow based on

knowledge of the minnow's distribution in the Milk River and the physical state of the river at certain periods in the year. The following sections describe potential key overwintering, spawning, and rearing habitat.

Little is known about the characteristics or availability of overwintering habitat for the western silvery minnow in the Milk River. When diversion from the St. Mary River ceases in the fall, the river reverts back to its natural flow conditions until spring. In normal years, flow is maintained within a reduced channel. Under severe drought conditions, such as those in 2001, the river may be reduced to a series of isolated pools suggesting that these may be important to the species survival. While, previous winter sampling efforts have not documented western silvery minnow from such pools (R.L.&L. 2002), this may be an artefact of limited sampling effort. Alternatively, the species may seek refuge in areas where flowing water is still available.

Small areas of open water along the shoreline of the lower Milk River during the winter months may be maintained in part by small springs or re-emerging subsurface flows (R. Audet, pers. com.). Minnows (species unknown) have been observed at these sites, which may provide winter refugia for the western silvery minnow.

Periodic re-colonization of western silvery minnow from downstream habitats is also a possibility, although dam construction on the lower reaches of the Milk River may limit that option. Elsewhere in the United States, the western silvery minnow persists in the upstream portions of many small intermittent streams where it may find overwintering refuges rather than re-colonize annually (R. Bramblett, pers. com.) More detailed studies are required to characterize and evaluate overwintering habitat in the Milk River, as this habitat is likely to be important to the species' survival and may be vulnerable to human disturbance.

Spawning habitat of the western silvery minnow has not been described. If the species is a pelagic-broadcast spawner (pelagophil), like other minnow species found in Great Plains streams (see Section 2.5.1), it may require significant stretches of connected habitat with turbid, sediment-laden water of moderate flow velocity for spawning (Cowey 2002, Platania and Altenbrach 1998). The distance that larvae are displaced, the habitat where displaced larvae are deposited, and their ability to move unimpeded to upstream reaches of sustained flow are important determinants of spawning success in these species (Platania and Altenbrach 1998).

In the Milk River, rearing and feeding habitat is probably not a limiting habitat feature for western silvery minnow under the current flow regime (R.L.&L. 2002). After flows peak, usually in June at the Town of Milk River, the water level drops, providing backwater areas in the main channel of the river where minnows may seek refuge (T. Clayton, pers. com.). A fish habitat survey in June 2004 noted significant erosion and inter-annual movement of sandbars in the lower Milk River in response to changes in flow conditions (T. Clayton, internal memorandum). This variation may benefit the species by providing the necessary dynamic habitats that result from constant erosion and deposition processes, provided that quiet backwater habitats persist. Sustained,

increased discharges resulting in bank to bank flows, on the other hand, could be energetically costly to the species and limit its available habitat (D. Watkinson, pers. com.).

Habitat Trends and Limitations

While the channel pattern and character of the river have remained essentially unchanged since 1917, the augmented flows have widened the channel and increased cutoff activity and sediment yield (McLean and Beckstead 1980). These effects are most prominent in the North Milk River, where the flood frequency has also doubled since diversion and the magnitude of the flood flows has increased. Flow augmentation continues to erode river banks and reduce fine-sediment bottom habitats in the Milk River (McLean and Beckstead 1980; D. Watkinson, pers. com.). Habitat availability varies from year to year depending on flow, particularly in late summer, fall, and winter. Drought and premature or temporary canal closure for emergency maintenance work during the augmentation period can have a significant impact on flows and water levels in the Milk River. Potential changes for the future include a water storage dam 30 km upstream of the Town of Milk River and altered flow regimes through the St. Mary Canal (Alberta Environment 2004; U.S. Bureau of Reclamation 2004).

Habitat Protection

The western silvery minnow is afforded varying degrees of direct or indirect habitat protection through existing statutes and programs.

Federally, the *Fisheries Act* (R.S. 1985, c. F-14) prohibits the harmful alteration, disruption or destruction of fish habitat except as authorized by the Minister (S. 35) and similarly prohibits the deposit of deleterious substances into waters frequented by fish (i.e. fish habitat) (Ss.36.3). The *Canadian Environmental Protection Act* (1999, c. 33), which is in place to prevent pollution and protect the environment and human health, focuses on regulating and eliminating the use of substances harmful to the environment. The *Canadian Environmental Assessment Act* (1992, c.37) ensures that prescribed federal regulatory actions including the authorized destruction of fish habitat are subjected to an environmental review process. The *Species at Risk Act* (2002, c.29) prohibits the destruction of any part of critical habitat once it has been identified in a recovery strategy or action plan for any listed endangered, threatened or extirpated wildlife species (Ss.58.1).

At the provincial level, Alberta's *Wildlife Act* (R.S.A. 2000, W-10), requires that the Minister (responsible for this act) establish an Endangered Species Conservation Committee that will advise on issues relating to species at risk in Alberta, such as assigning status and preparing and adopting recovery plans. The *Environmental Protection and Enhancement Act* (Chapter/Regulation: E-12 RSA 2000) protects land, water, and air by requiring those operating or proposing developments to meet their environmental responsibilities. It includes a legislated environmental assessment process. The *Alberta Public Lands Act* (R.S.A. 2000, c. P-40) enables the designation

of different types of Crown land use including agricultural, oil and gas and other resource uses. The *Alberta Water Act* (Chapter/Regulation: W-3 RSA 2000) focuses on managing and protecting the province's water, and regulates the allocation of water resources.

Under the "Water for Life" strategy, Alberta supports the formation of Watershed Planning and Advisory Councils and the development of Watershed Management Plans. These plans identify water needs, including those of fish, and may influence the licensing of water diversions by the Government of Alberta. The Milk River Watershed Council of Canada plans to complete a State of the Watershed Report in 2007, and the Basin Management Plan 2 years later (K. Miller, pers. com.).

At writing, 56% of the land bordering the Milk River mainstem and North Milk River was publicly owned; the rest was held privately. Only 11% of the public and 14% of the private lands had conservation plans associated with them that included riparian protection (T. Clayton, pers. com.). The remaining land was used mainly for grazing, or for small areas of municipal development (e.g. Town of Milk River). Six percent of the public land along the river was designated park land, for public use and access during the summer but with restrictions on development. Municipal approval is required for shoreline development on any municipal environmental easements. Other initiatives or agencies that make recommendations affecting water quality and/or water flows, management of shorelines, and other aspects of watershed conservation include: Environmental Farm Planning, Alberta Riparian Habitat Management Society (Cows and Fish), Operation Grassland Community, Ducks Unlimited, MULTISAR, Nature Conservancy, Agriculture Canada, and Alberta Agriculture.

2.5.3 Limiting Factors

Too little is known of the western silvery minnow's physiology or ability to adapt to different conditions to identify factors that might limit population survival and maintenance. The minnow is typical of many large plains streams fish species in that it has adapted to a system with a high sediment load and naturally fluctuating flow conditions. While these river conditions may seem harsh, species that have evolved under them may only survive if these conditions persist. Changes such as flow regulation or increased water clarity might, for example, cause them to lose their advantage to competitors or increase their vulnerability to sight-dependent predators (e.g. sauger and northern pike). Flow changes might also alter downstream drift by western silvery minnow eggs and fry, decreasing their viability or increasing their risk of predation.

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3. THREATS TO THE SURVIVAL OR RECOVERY OF THE SPECIES

3.1 Overview

A number of threats to the western silvery minnow have been identified throughout its range, including those believed to be responsible for its extirpation from some systems. The most significant threats may be those that alter the natural flow regime of a river causing habitat loss or impairment. Such threats may include water removal (e.g. for irrigation and domestic use), impoundment, bank stabilization, channelization, and flow augmentation. Habitat alterations, particularly the reduction in seasonal fluctuations in discharge and declines in turbidity related to channelization and impoundment, have been correlated with the precipitous decline of the western silvery minnow in the lower Missouri River (Pflieger and Grace 1987). Other threats to the species' habitat and survival include pollution and degradation of riparian areas. Some of the above threats may also act indirectly by altering faunal communities which in turn threaten the minnow's existence.

In Canada, COSEWIC identified continuous erosion and siltation as a threat to the western silvery minnow. Upon more detailed evaluation, the Recovery Team has determined that under current conditions, this is a natural occurrence in prairie streams and one to which the minnow has likely adapted. However, changes to water flow resulting in habitat loss and degradation can pose a significant threat to minnow habitat. The following sections summarize these and other sources of threats to the species' survival and habitat.

3.2 Threats assessment

The Recovery Team undertook a detailed assessment of threats to the species based on both published information and local knowledge. Four primary categories of threat were identified:

- species introductions,
- habitat loss/degradation,
- pollution, and
- natural processes.

A brief description of the methods and assessment of threats to the western silvery minnow is provided in Appendix A. The results are discussed below and summarized in Table 2.

3.2.1 Species Introductions

Introduced species can threaten native fish fauna through various mechanisms including: predation, hybridization, competition for resources, the introduction of exotic diseases and parasites, and habitat degradation. To date, yellow perch is the only exotic fish species that has been observed in the lower Milk River where the western

silvery minnow occurs (D. Watkinson, pers. com.). Further downstream, the Fresno Reservoir contains a number of introduced predatory species, including: rainbow trout (*Onchorhynchius mykiss*), walleye (*Sander vitreum*), yellow perch, northern pike and black crappie (*Pomoxis nigromaculatus*), as well as other introduced species such as lake whitefish and spottail shiner (*Notropis hudsonius*) (Montana Fish, Wildlife and Parks 2004). Spottail shiners have also been observed in the river section between the international border and the reservoir (Stash 2001). While some species listed here have specific habitat requirements that may not be met in the lower Milk River of Alberta, others are generalists that might expand into Alberta. Given that there are no migration barriers upstream of the Fresno Reservoir in Montana, and that illegal fish transfers within the province can be difficult to control, the Recovery Team rated the likelihood of this threat occurring as moderate.

Fishes such as the western silvery minnow have adapted to the highly variable natural flow conditions and elevated turbidity that characterize the native prairie streams they inhabit. Elevated turbidity levels have less effect on the prey consumption of plains fish species adapted to turbid conditions than that of species not adapted to turbid conditions (Bonner and Wilde 2002). Activities such as water regulation and impoundment that alter these flow regimes and trap sediments, reducing turbidity downstream, can favour sight-feeding exotic **piscivores** such as bass, perch and salmonids, which historically were absent from these streams (McAllister et al. 2000; Quist *et al.* 2004). Consequently, these activities may alter the faunal community and dynamics by encouraging the establishment of introduced species or by increasing the abundance of native predators that currently exist at very low levels (e.g. sauger, northern pike).

The Alberta Fish and Wildlife Division does not plan to introduce sportfish species into the lower Milk River, and is unlikely to do so in the future (T. Clayton, pers. com.). The Milk River proper and its tributaries in Alberta have not been stocked for at least 15 years, although Goldsprings Park Pond, an old oxbow of the river with no connection to the mainstem is stocked annually with rainbow trout (T. Clayton, pers. com.). Whether unauthorized introductions have occurred in the Milk River (e.g. bait fish releases) is unknown.

The significance of possible species introductions is unknown at present but would depend upon the species introduced. Under the worst case scenario, an introduced species could have serious implications to the survival of the western silvery minnow. The creation of reservoirs can raise interest in stocking non-native sportfish for recreational fishing, and might facilitate the introduction of these species into habitats up and down stream.

Table 2. Detailed threats assessment for western silvery minnow.

Identified Threat	Source	Likelihood of Occurrence*	Extent of Occurrence*	Severity of Impact*	Immediacy of Impact**	Threat Significance *	Mitigation Potential*	Comments
Species Introductions	Legal or illegal stocking	**M**	**H**	**L-H**	**C, F**	**L-H**	**L**	Depends on species involved.
Habitat Loss/ Degradation	Changes in Flow	**H**	**H**	**H**	**F**	**H**	**L**	Possible canal options include achieving current design capacity, capacity increase (24.1-28.3 m^3/s; 850-1,000 cfs) or abandonment.
	Canal Maintenance	**H**	**H**	**H**	**F**	**H**	**M**	Recommend to Alberta Environment that canal maintenance or repairs be delayed until the non-augmented period whenever possible.
	Dam construction and operation	**M**	**H**	**H**	**F**	**H**	**L**	This complex issue cannot be fully evaluated until proposal details are available; however general problems associated with dams elsewhere are recognized here.
	Groundwater Extraction	**H**	**H**	**L?**	**P**	**L?**	**L**	Could be significant during non-augmented period, but difficult to evaluate due to inability to quantify natural losses or needs of minnow.
	Surface Water Extraction - Irrigation	**H**	**M**	**L**	**P**	**L**	**M**	Irrigation only occurs during the augmentation period.
	Surface Water Extraction - Non-irrigation	**H**	**H**	**H**	**P**	**H**	**M**	Fish most vulnerable during non-augmented period. Restriction of Temporary Diversion Licences during critical low flows could help mitigate impacts.
	Livestock Use of Flood Plain	**M**	**M**	**L**	**P mainly, C**	**M?**	**H**	Agricultural practices along rivers are generally conservative but some cattle access still occurs and impacts are unknown. The Alberta Riparian Habitat Management Society (Cows and Fish) has been advising producers on best practices, with positive results.

Identified Threat	Source	Likelihood of Occurrence*	Extent of Occurrence*	Severity of Impact*	Immediacy of Impact**	Threat Significance *	Mitigation Potential*	Comments
Pollution	Point Source	**M**	**H**	**H**	**F**	**M**	**L**	Includes accidental spills associated with road/rail and pipeline crossings, depends in part on substance released, location of spill and potential to mitigate the impacts, gas leaks are known to have occurred at river crossings in recent years
	Non-Point Source	**L**	**L**	**L**	**P**	**L**	**M**	Because of the high flows during growth period, unlikely that agricultural run-off has a big impact
	Anoxia	**H**	**?**	**?**	**P**	**?**	**L**	Extent and severity unknown but could be significant during the winter depending on availability of open water areas
Natural Processes	Drought	**H**	**H**	**H**	**P, F**	**H**	**L**	Depends on the length and severity of drought
	Climate change	**?**	**H**	**?**	**?**	**?**	**L**	Impossible to evaluate at this time, mitigation not possible at local level
Other Threats	Scientific sampling	**H**	**H**	**L**	**P**	**L**	**H**	The threat from further sampling is likely low and can be controlled.

*H= High, M=moderate, L=Low. **P=Past, C=Current, F=Future

3.2.2 Habitat Loss/Degradation

Habitat loss, either through degradation or fragmentation, is a significant threat to the survival of western silvery minnow in the Milk River. A number of existing or potential activities related to water use contribute to this threat, including: 1) changes in flow regulation associated with the diversion canal, 2) canal maintenance, 3) water storage projects, 4) groundwater extraction; and 5) surface water extraction. Degradation of shoreline habitat and water quality associated with livestock use of the flood plain may also impact minnow habitat.

Changes in Flow Regulation Associated with the Diversion Canal

Diverting water from the St. Mary River has reduced the effects of drought in the Milk River and may have extended the availability of suitable summering habitat for the western silvery minnow further upstream than under natural flow conditions (Willock 1969). The net effect of this change on the population is unknown, since upstream habitat gains may be offset by downstream losses, and other aspects of the species' life history may be affected. Increased water velocities due to flow augmentation might, for example, adversely affect the species' reproductive success by increasing larval drift downstream into unsuitable habitats such as the Fresno Reservoir (R. Bramblett, pers. com.). Winter flows in the Milk River are considered natural and despite frequent low flow conditions there is no evidence of stranding (T. Clayton, pers. com.). The likelihood of stranding, however, could increase if the rate at which flows are ramped down increases.

The St. Mary Canal is in need of maintenance and re-construction, and proposed changes include everything from abandonment to significantly increasing its flow capacity (Alberta Environment 2004; U.S. Bureau of Reclamation 2004). Due to its poor structural condition, the canal is not operating at its design capacity of 24.1 m^3/s (850 cfs=cubic feet per second) but at a capacity of about 18.4 m^3/s (650 cfs). Simply bringing the structure up to design capacity would increase flows by almost 27%. In addition, Montana has proposed increasing flow capacity to 28.3 m^3/s (i.e. 1,000 cfs) during the irrigation period, and possibly extending the augmentation period. In either case, increased flows could have major implications for channel morphology, particularly in the lower Milk River where banks are already highly susceptible to erosion during high flow periods in the spring and summer. These changes could threaten western silvery minnow spawning and rearing habitat by increasing water velocities and thereby the drift rates of eggs and fry (R. Bramblett, pers. com.). Changes to the flow regime of the Milk River should be preceded by detailed studies to determine how the various options might affect river morphology and western silvery minnow habitat.

Canal Maintenance

Unexpected problems associated with the ageing canal can lead to temporary or premature closure to allow for maintenance activities. This has led to two interruptions

to flow during the augmented period over that past 30 years; both were emergency situations where the integrity of the canal was at stake (K. Miller, pers. com.). One of these interruptions occurred in 2001 when the canal was closed in mid-August to allow for emergency repairs. Combined with the extreme drought conditions, this reduced the lower Milk River and much of the minnow's habitat to a series of isolated pools from August until the spring freshet.

Dam Construction and Operation

Although there is no proposal at this time, the feasibility of developing a dam on the Milk River upstream of the Town of Milk River has been, and continues to be investigated. In reviewing any future proposal, the potential impacts on the western silvery minnow will need to be thoroughly considered. Particular attention should be paid to any modification of the flow regime. Changes associated with irrigation and impoundment may be a significant limiting factor to the western silvery minnow (Pfleiger and Grace 1987; Quist *et al.* 2004). More information on western silvery minnow ecology is likewise required for assessing such project impacts.

Impoundments alter habitat types, flow regimes, sediment loads, microbiota and water temperatures, and may also increase the risk of species introductions (Quist *et al*. 2004). These changes often produce systems that are narrower, less turbid, less subject to fluctuations in temperature and flow, and less productive with less substrate movement (Cross *et al.* 1986; Pleiger and Grace 1987; Quist *et al.* 2004). Water released from storage reservoirs is often withdrawn from near the bottom of the reservoir (hypolimnetic withdrawals), creating significantly cooler water conditions in downstream areas. In a recent study of an impounded river system in North Dakota, significantly more western silvery minnows of a broader size range were observed in natural river segments compared to the moderately altered segments downstream of a large dam (Welker and Scarnecchia 2004). Impoundments have had significant cumulative effects on fish fauna in the western Mississippi (Cross *et al.* 1986) and lower Missouri watersheds (Pfleiger and Grace 1987). In systems that were historically turbid, impoundment led to a shift in species abundance that favoured fishes that were not characteristic of turbid water (Pfleiger and Grace 1987; Quist *et al.* 2004). Instream habitats also changed, with the fine substrate typical of large plains streams being replaced by gravel, cobble and boulder. The effects of winter flow augmentation on western silvery minnow, through the release of impounded water, are not known at this time.

The loss of connectivity associated with dams may be responsible for the decline and highly endangered status of the Rio Grande minnow (Cowey 2002; Alò and Turner 2005), and for the upstream extirpation of several other prairie minnow species that follow a similar semi-buoyant, broadcast spawning strategy (Winston et al. 1991; Pringle 1997; Platania and Altenbrach 1998). Elevated sustained flows from the upstream Santa Rosa Reservoir in the Pecos River of New Mexico, combined with the relatively short reach length (89 km) to the Sumner Reservoir, have likely resulted in semi-buoyant eggs of these species being transported downstream into unsuitable reservoir

habitat (Platania and Altenbrach 1998). Habitats in the lower Milk River have been fragmented by the Fresno Dam in Montana and numerous diversion dams downstream. The Fresno Dam prevents western silvery minnow populations downstream from re-colonizing habitats in Canada. Augmented summer flows may also reduce the species reproductive success in the lower Milk River by transporting eggs downstream into unsuitable habitat in the Fresno Reservoir.

Groundwater Extraction

Loss of surface water flow to groundwater occurs naturally between Writing-On-Stone Park and Pendant d'Oreille, along a section of the Milk River from Black Coulee (MacDonald Creek approx. 8 km upstream of Aden Bridge) to approximately 3 km downstream of the Aden Bridge (Highway 880 crossing) (Grove 1985). Subsurface losses may also occur in the lower Milk River downstream of the park to the eastern border crossing, but these losses are probably not permanent except for evapotranspiration.

Linkages between groundwater and surface water flow may have implications for western silvery minnow and other small fishes, especially during winter, low flow conditions. Excessive diversion of groundwater during this time could affect western silvery minnow habitat. More information regarding the species' overwintering habitats is needed to determine the significance of this threat.

Surface Water Extraction - Irrigation

While water extraction for irrigation could seriously reduce habitat available for western silvery minnow, the threat in the Milk River within Alberta is considered low, since only a small proportion of the available flow is withdrawn and these withdrawals are regulated. Extraction of water for irrigation purposes only occurs while flows are augmented, from late-March or early April through to late September or mid-October. During this period about 5% (15,000 dam^3 = cubic decametres) of the total flow (292,000 dam^3) is licensed for use in Alberta, most of which (93%) is used for irrigation (T. Clayton, pers. com.). Water removals under temporary diversion licenses (TDLs) are not included in this total. When the diversion is closed for maintenance, or during reduced flow conditions, withdrawals for irrigation are terminated.or suspended on a priority use basis. Alberta Environment has initiated installing water meters on all irrigation pumps drawing water from the Milk River (K. Miller, pers. com.). These meters would measure water removal four times a day to provide an accurate and up-to-date measure of water withdrawals.

Surface Water Extraction - Non-irrigation

In contrast to water licenses for irrigation, Temporary Diversion Licences (TDLs) for non-irrigation purposes are issued throughout the year, including during critical low flow periods. Oil and gas companies, for example, may be licensed to remove water from the river for activities related to well-drilling. Overwintering habitat for western silvery minnow may be particularly vulnerable to this type of extraction for reasons similar to

those outlined under “Groundwater Extraction”. This kind of extraction also occurs during the augmented flow period, when it may not be an issue unless the diversion is prematurely or temporarily closed down. Under such conditions some TDLs may be revoked, as they were during the drought conditions in 2001 (S. Petry, pers. com.). During the flow augmentation period, the Town of Milk River diverts about 0.3% of the total available flow for domestic purposes.

Livestock Use of Flood Plain

The Alberta Riparian Habitat Management Society (”Cows and Fish") has been actively engaged in the issue of livestock management in the Milk River flood plain. Several riparian and grazing management workshops, involving many ranchers along the river, have been held. There is a growing understanding of the value and vulnerability of the riparian area to degradation and a greater understanding and adoption of management solutions by ranchers, including off-stream water development (Lorne Fitch, pers. com). Several riparian benchmark inventories have been completed, but there has not been any follow-up monitoring to date. Demonstration sites have been established and have shown riparian vegetation recovery, especially with woody vegetation. Riparian recovery usually becomes evident in three to five years after the first management changes are made, and it may be ten years before significant physical changes can be measured.

3.2.3 Pollution

The likelihood of point source and non-point source pollution entering the Milk River at levels that would threaten western silvery minnow survival is considered low. Point sources of pollution include any stormwater and sewage releases, as well as accidental spills and gas leaks particularly at river and tributary crossings. The Town of Milk River has not released sewage into the Milk River for 20 years, and stormwater is surface run-off (K. Miller, pers. com.) making both of these a minimal risk. However, the inadvertent release of a toxic substance at any one of the river crossings including bridges or pipelines could have serious consequences. The extent and severity of any damage to the aquatic community including western silvery minnow would depend on the substance released, the location of spill, time of year (flow augmentation or not), and the potential to mitigate the impacts. To date, no such spills have been documented for the Milk River. However, the possibility, although quite low, exists because traffic flow is significant at some crossings (e.g. average of 2,700 crossings per day on the Highway 4 bridge in 2003, 25% by trucks). A number of gas leaks have also occurred in recent years (S. Petry, pers. com.). Contamination of water from seismic or drilling activities is also a possibility. Uncapped groundwater wells may also pose a problem although licensing and well capping programs help to minimize this threat (Alberta Environment 2001).

Non-point sources of pollution in the vicinity of the Milk River are limited mainly to the runoff of agricultural pesticides and fertilizers. Overall, this threat is considered low. Most of the approximately 8,000 acres of cropland that is irrigated in the Milk River basin is located within 50 km of the Town of Milk River, but there is another small

section located upstream on the North Milk River near Del Bonita (K. Miller, pers. com.). The rough terrain near the river channel prevents crops in most areas from being grown within about 400 m of the river (K. Miller, pers. com.) and acts as a buffer, reducing the potential for direct contamination of the river. The growth period for most crops also coincides with the diversion period, when flows are usually at their highest, creating a significant dilution effect. Leaching of fertilizer residues has declined significantly in recent years due to the high costs of fertilizing and pumping of water (K. Miller, pers. com.), but nutrient concentrations can become elevated at downstream sites such as the Highway 880 crossing (W. Koning, pers. com.). Water quality in the mainstem also changes seasonally in response to flow augmentation, with increases in the total dissolved solids, conductivity and salt (sodium) concentrations when the diversion is shut off in the winter months (W. Koning, pers. com.).

3.2.4 Anoxia

Reduced dissolved oxygen levels during the winter could seriously impact the survival of western silvery minnow and other fish species. A water quality study by Noton (1980) concluded that the most important water quality parameter potentially not meeting fish needs in the Milk River was dissolved oxygen. In one of the five winters sampled, oxygen concentrations under ice in the lower reach of the river were as low as 1.6 mg/L in January. Possible reasons for reduced oxygen concentrations at this time included an accumulation of organic debris which might oxidize or the inflow of anoxic ground water during low flows (Noton 1980). Further evaluation is required.

3.2.5 Natural Processes

The preceding sections outline threats to western silvery minnow survival and habitat caused by human activities. Two natural processes, drought and climate change, also have the potential to significantly impact these fish.

Drought

Southern Alberta is susceptible to extreme drought conditions, particularly during the summer and early fall. The severity of this threat will depend on the severity and duration of the drought but overwintering habitat is the habitat most likely to be threatened. Drought conditions in combination with water regulation, canal maintenance and extraction practices significantly reduce the amount of summer and overwintering habitat available to the minnow. In 1988 and 2001, for example, the surface flow of the Milk River was virtually eliminated in the fall and winter due to severe drought conditions, and the lower river was reduced to a series of standing pools (WSC 2006). Natural drought conditions alone may seriously stress minnow populations, but the combination with other anthropogenic stresses could compound the severity of drought effects significantly.

Climate Change

Climate change has the potential to impact water availability, temperature, and a broad range of other issues thereby affecting the availability and quality of western silvery minnow habitat. The extent to which this might affect the species is unknown.

3.2.6 Other Threats

Scientific sampling may also pose a threat to the western silvery minnow. This threat is rated as low as it usually involves live-sampling and has a high potential for mitigation as it is regulated through the issuance of permits under *SARA*.

4. KNOWLEDGE GAPS

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4.1 Biology

Very little information is available on some key aspects of the life history and biology of the western silvery minnow. Studies have not, for example, been conducted to describe the species' reproductive strategy or overwintering requirements. Because accurate threats assessments and critical habitat identifications depend upon knowledge of the species' reproductive strategy and its overwintering requirements, such studies should be a priority. There is also little or no information available on population structure, movements, or early life stages.

4.2 Habitat

The specific habitat needs of the western silvery minnow, particularly for eggs and fry, remain unknown. Spawning has not been documented in the Milk River, nor has the presence of larval and early juvenile stages. Overwintering habitats also have not been documented and the relationship between sediment load, turbidity, and the abundance of minnows remains unresolved.

4.3 Abundance

To date, there are no reliable abundance estimates for the western silvery minnow within the Milk River. As such, it is not yet possible to set a conservation population target size, or to confirm whether changes in abundance have occurred. The magnitude of natural variability in population size is also unknown, making it difficult to determine if changes in abundance over the short term are related to normal fluctuations or a real change in population status. However, recent studies suggest that abundance of western silvery minnow may be significantly greater than previously assumed (D. Watkinson, pers. com.).

4.4 Threats

Some potential threats cannot be fully evaluated because detailed information on the stressors and the mechanisms by which they might affect the minnow are not well understood. To accurately predict the effects of impoundment, for example, requires better knowledge of how changes in the physical conditions of the river, such as an altered flow regime, may interact with the species given its life history and habitat requirements. Further study of these relationships is warranted.

5. SPECIES RECOVERY

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In addition to describing the species and threats to its survival or recovery, species recovery planning must consider:

1. the biological and technical feasibility of recovery;
2. an appropriate long term goal for the species recovery;
3. recovery objectives for the species;
4. strategies to address identified threats and to guide appropriate research, and management activities needed to meet the identified recovery objectives;
5. identification of critical habitat or studies to identify such;
6. potential effects on non-target species;
7. actions already completed or currently underway;
8. evaluation and performance of the recovery strategy; and
9. the development of action plans.

A recovery strategy for the western silvery minnow described in these terms is provided below:

5.1 Recovery Feasibility

The following criteria and analyses were used to evaluate the biological and technical feasibility of recovery for the carmine shiner.

Reproductive Potential: There is currently no impediment to the reproductive potential of the western silvery minnow populations in Canada. Viable populations exist within the lower Milk River where the species has been documented since 1961. Despite its apparently limited distribution there is no evidence that the distribution and/or abundance of the western silvery minnow is declining or has declined in recent years. One important consideration for the species persistence in Canada is its continuous distribution south of the international border to the Fresno Reservoir. Currently, there are no barriers upstream of the reservoir to prevent fish movement across the border and interchange between Alberta and Montana populations may be an important consideration in recovery planning. Upstream migration could have a rescue effect on Canadian populations. Whereas, if downstream migration occurs, fish found in Canada

might be exposed to threats in Montana, which currently does not protect the western silvery minnow or recognize it as a species at risk.

Habitat Availability: The occurrence of viable populations documented over a number of years from the lower Milk River suggests that there is adequate habitat to support all life stages for the species at least in these locations. Habitat availability is currently not limiting for maintenance of the species.

Threat Mitigation: The potential for mitigating threats identified for the western silvery minnow (Section 3, Table 2) ranges from low to moderate, except for livestock access and scientific sampling, for which the mitigation potential is high. At present, the latter are not believed to be influencing the species' survival; the future impacts of climate change remain speculative. While future species introductions may have the potential to disrupt Alberta's western silvery minnow populations, these impacts may be avoided by applying appropriate regulatory controls and management actions to prevent inadvertent introductions. The potential impact from most of the habitat related threats may also be reduced, or eliminated, if appropriate regulatory reviews and management actions are exercised, and best management practices are applied to existing or proposed projects. There are viable populations within the lower Milk River in Canada and downstream in the United States. Conservation and threat mitigation efforts targeted at these populations should be able to secure and maintain their continued viability. Threat mitigation may be complicated in some instances by the fact that Montana controls the flows diverted through the St. Mary Canal, subject to the provisions of the *1909 Boundary Waters Treaty* and administration by the IJC. Changes in flow conditions could influence potential recovery options, and recovery options should influence future recommended changes in flow regimes. Continued international cooperation is crucial on trans-boundary issues. Overall, the identified threats are not likely to impede the survival or recovery of the species. However, any improvement in our knowledge base for the species would improve our understanding of the potential impact of threats to it, and of the efficacy of any proposed mitigation measures.

Technical Capabilities: The techniques likely to be contemplated for the conservation of the western silvery minnow populations are well founded in current science and management practices. Given the relative abundance of the species within its limited distribution, the focus of recovery efforts should be on the mitigation of habitat impacts and the exclusion of unwanted species. The technical knowledge on how to deal with potential habitat impacts is well documented and applied globally. The avoidance of species introductions is best afforded through public education and management programs, both of which are entirely within the competency of the responsible jurisdictions. No impediments to the recovery of the western silvery minnow have been identified by any of the responsible agencies.

Biological and Technical Feasibility: Given the above analysis, recovery of the western silvery minnow is deemed to be biologically and technically feasible.

5.2 Recovery Goal

No evidence to date suggests that the Milk River population of western silvery minnow has suffered a serious decline or that the range has been reduced significantly since it was first identified in the Milk River. The population appears to persist naturally in this single Canadian location. Given its limited distribution, the species may always be at some level of risk. The focus of recovery planning should be to ensure a self-sustaining population by reducing or eliminating existing threats. Given that population numbers and habitat do not appear to require recovery or restoration, a conservation approach based on protecting and maintaining existing populations and their habitats is recommended. As such, the recovery goal for the western silvery minnow is:

> ***"To protect and maintain a self-sustaining population of western silvery minnow within its current range within the Milk River in Canada."***

5.3 Recovery Objectives

A number of recovery objectives are proposed to meet the recovery goal and address any threats to the survival of the species. The objectives take into consideration the uncertainty associated with our knowledge of the species' biology, life history, abundance, and habitat requirements as well as the impact of identified threats to its survival in the Milk River. The recovery objectives are to:

1. **quantify and maintain current population levels of western silvery minnow in the Milk River (within the population's range of natural variation),**

2. **identify and protect critical habitat of the western silvery minnow; and to**

3. **identify potential threats to the western silvery minnow from human activities and ecological processes and develop plans to avoid, eliminate, or mitigate these threats.**

5.4 Recovery Approaches and Strategies

Strategies proposed to address the identified threats, and to guide appropriate research and management activities to meet the recovery goal and objectives, are discussed under the broader approaches of:

1. **Research,**
2. **Monitoring,**
3. **Management and regulatory actions, and**
4. **Education and outreach.**

Each strategy has been designed to assess, mitigate or eliminate specific threats to the species; to address information deficiencies that might otherwise inhibit species recovery; or to contribute to the species recovery in general. These strategies are summarized by approach in Table 3, which lists them in order of priority and relates them to specific recovery objectives.

5.4.1 Research

Sound scientific knowledge must form the basis of any recovery efforts for the western silvery minnow. Currently, many of the conclusions drawn for western silvery minnow in the Milk River are speculative and rely on very limited and often inferred information. Information gaps regarding basic life history, biology, habitat requirements, population structure and abundance, and threats exist and need to be addressed to refine the recovery strategy and ensure that the species is adequately protected in Canada. To address the need for scientific research the following strategies are recommended:

R1. **Clarify life history requirements:** Conduct scientific studies to understand the life history, ecology, population dynamics and population structure of the western silvery minnow.

R2. **Clarify habitat requirements:** Conduct scientific studies to determine biophysical attributes of habitat required seasonally by each life stage of the western silvery minnow with a specific focus on identifying critical habitat for the species.

R3. **Develop population models:** Conduct scientific studies to establish reliable population models including population viability estimates, as well as appropriate surrogate measures relying on relative abundance, presence/absence and population structure data.

R4. **Identify limiting factors:** Conduct scientific studies to better understand the potential threats associated with human activities including water regulation (e.g. dam, canal operations), land use practices, species introductions, and climate change.

Table 3. Recovery objectives, the strategies to address them, and their anticipated effects.

Strategy	Priority*	Anticipated Effect
Objective 1: *To quantify and maintain current population levels of western silvery minnow in the Milk River (within the population's range of natural variation), as measured by relative abundance determined from a standardized survey program.*		
R3. Develop population models	Urgent	Provide trend through time data. Improve knowledge of natural variability and population viability. Improve ability to identify anthropogenic impacts.
M1. Population monitoring	Urgent	
Objective 2: *To increase knowledge of the life history, basic biology and habitat requirements of the western silvery minnow, with a view towards identifying and protecting critical habitat.*		
R1. Clarify life history	Necessary	Enable identification of important or critical habitat. Better knowledge of life history parameters will help determine population targets.
R2. Clarify habitat requirements	Urgent	Enable identification of important or critical habitat. Better knowledge of habitat use will help focus impact mitigation and recovery efforts.
M1. Population monitoring	Urgent	Provide trend through time data. Improve knowledge of natural variability and population viability. Improve ability to identify anthropogenic impacts.
MR1. Water management and conservation	Urgent	Avoid unnecessary degradation of western silvery minnow habitat and mortality of western silvery minnows.
MR2. Development impact mitigation		
MR3. Stocking program rationalization		
MR4. International cooperation		
MR5. Data conservation	Necessary	Ensure data and samples can be revisited if necessary. Avoid loss of important information and unnecessary duplication of effort.
E1. Improve awareness of the species	Necessary	Improve awareness of the western silvery minnow and its habitat. Encourage understanding and communication with respect to the species. Reduce inadvertent harvesting and habitat destruction.
E2. Encourage stakeholder participation	Necessary	Improve awareness of this species and its habitat and local support for species recovery initiatives.
E3. Facilitate information exchange	Necessary	Improve accessibility and security of data.
E4. Discourage species introductions	Beneficial	Reduce potential for damage to western silvery minnow populations by introduced predators and competitors.
Objective 3: *To increase our understanding of how human activities affect western silvery minnow survival, so that potential threats to the species can be avoided, eliminated, or mitigated.*		
R4. Identify limiting factors	Urgent	Enable the assessment and mitigation of threats to the species or its habitat from anthropogenic activities.
M2. Habitat monitoring	Urgent	Provide trend through time data. Improve knowledge of natural variability in habitat parameters. Improve ability to identify anthropogenic impacts.
MR1-MR5 and E1-E4	Urgent	See above.

- Urgent = High priority for immediate species conservation, initiate as soon as possible. Necessary = Medium priority for long term species conservation. Beneficial = Lower priority, primarily directed at potential future activities.

5.4.2 Monitoring

Regular monitoring is necessary to establish trends in relative abundance of western silvery minnow, as well as to describe the availability and permanency of habitats

including critical habitats once identified. Furthermore, the physical and biological parameters of river water should be monitored regularly to track water quality. The following strategies are recommended to address monitoring needs:

M1. **Population monitoring:** Develop an appropriate monitoring protocol to track relative abundance, distribution and habitat use for the western silvery minnow.

M2. **Habitat monitoring:** Routinely monitor physical environmental parameters including flow conditions, turbidity, water temperature, dissolved oxygen, nutrient loading and salinity.

5.4.3 Management and Regulation

Some management and regulatory actions are necessary to protect the western silvery minnow and its habitat. Such actions will assist in reducing or eliminating identified threats including habitat loss and degradation, pollution, and the introduction of exotic species. Because the recovery strategy is focused on maintenance, approaches should focus on ways to maintain and protect the species rather than rebuild the population or create new habitat. Recommended strategies include:

MR1. **Water management and conservation:** Reduce the effects of water extraction on the western silvery minnow through appropriate water use management and conservation measures.

MR2. **Development impact mitigation:** The development of any project proposals for the Milk River must consider the potential environmental effects on the western silvery minnow as early as practical in the planning stages, and must focus on the elimination or mitigation of any potential adverse impacts on the species. Early recognition of the need for mitigation and the incorporation of appropriate measures within the project design will help to expedite project reviews and assessments.

MR3. **Stocking program rationalization:** Reduce the potential for species introductions and stocking-related impacts to western silvery minnow.

MR4. **International cooperation:** Work with US agencies to avoid unscheduled flow interruptions in the Milk River during flow augmentation.

MR5. **Data conservation:** To provide continuity and future reference, all samples and information (current and future) must be appropriately preserved and/or archived within known repositories.

5.4.4 Public Education and Outreach

Public education is essential to gain acceptance of, and compliance with the overall recovery strategy. Public support can be gained through increased awareness of the western silvery minnow and involvement in stewardship programs. The following strategies are recommended:

E1. **Improve awareness of the species:** Develop and distribute information describing the species and its needs, as well as implications of the recovery strategy.

E2. **Encourage stakeholder participation:** Promote and support stakeholder involvement in stewardship initiatives.

E3. **Facilitate information exchange:** The exchange of information among researchers, stakeholders and fisheries agencies from Canada and the United States, with regard to research, recovery and management activities related to the western silvery minnow should be facilitated.

E4. **Discourage species introductions:** To prevent species introductions – intentional or otherwise, education programs that heighten awareness on this issue should be supported.

5.5 Critical Habitat

Critical habitat, as defined by *SARA,* is the "habitat necessary for the survival or recovery of a listed wildlife species". Its identification requires a fundamental understanding of the relationship between the species and its physical environment (or habitat), and of how changes in that habitat may affect the species' survival. This requires basic knowledge of the habitat requirements for all life stages of the species along with information on the function, distribution, and abundance of each of these habitat types. To date, few studies have examined the biology, life history or habitat requirements of the western silvery minnow in the Milk River or elsewhere. Consequently, critical habitat for the western silvery minnow cannot be identified at this time. Nonetheless, critical habitat must eventually be described and protected to ensure the conservation of the species. To address this requirement, a proposed schedule of studies laying out the foundation for identifying critical habitat is provided in Table 4. Many of these studies have already been highlighted in the preceding section. They include work to address gaps in knowledge of the species' biology, life history, and habitat and to describe, locate, and inventory existing habitat types. The prescribed schedule of studies is, of necessity, a long term planning document and will be revised periodically or refined on an ongoing basis as further information warrants.

Table 4. Studies required to identify critical habitat for western silvery minnow in the Milk River. Note that many of these studies can be conducted concurrently.

Study	Time Frame	Comment
Description of life history characteristics	Should be initiated immediately, expected time frame 2007-2010	This is the first step necessary to address all other questions regarding habitat and should receive high priority
Description of habitat use by life stage	Should be initiated in concert with the first study, expected time frame 2007-2010	Such studies should include a biophysical description of habitat used by spawning, rearing, feeding and overwintering stages
Identification, location and inventory of habitat	Should be initiated immediately, expected time frame 2007-2011	To locate all areas within the range of the minnow that have similar features to those described in above studies, this will assist in determining the importance of habitat
Movement studies	Should be initiated as soon as practical, expected time frame 2007-2010	To help determine the extent of movement for this species, particularly for spawning and overwintering purposes
Population viability analysis/modeling	Likely deferred during the life of this plan (>5 years) (2012-)	Such studies are necessary to provide population trend data and ultimately to establish levels of acceptable risk
Rationalization of potential critical habitat	Contingent on all of the above, potential time frame >5 years (2012-)	Final step in determining what part of habitat should be considered “critical”

The above schedule of studies is designed to provide a comprehensive analysis of the critical habitat requirements of the western silvery minnow, but some specific elements of the species’ critical habitat may be identified earlier in the process. Such elements could include spawning and over-wintering habitats once their locations have been determined. The early and incremental identification of such habitats would help conserve the species until a more comprehensive analysis has been completed.

5.6 Effects on Non-Target Species

The proposed recovery strategy may have positive impacts on other fish species in the Milk River including the east slope sculpin (*Cottus* sp.) and the stonecat (*Noturus flavus*). Both species are considered “Threatened” in Alberta, and the east slope sculpin was recently listed as such under *SARA*. Measures directed at maintaining stream flows, preventing habitat destruction and avoiding species introductions should benefit these and other species.

5.7 Actions Completed or Underway

A number of activities related to recovery of the western silvery minnow have already been completed. These include:

- In 2002, the western silvery minnow was removed as an eligible baitfish from the *Alberta Fishery Regulations*, 1998 (SOR/98-246).

- In June 2004, an early summer habitat survey was conducted on the lower Milk River (Highway 880 bridge to Pinhorn Ranch) to identify possible spawning and early rearing habitat. Possible suitable habitat locations were described but fish sampling was not conducted to confirm minnow presence.

- Fall fish and habitat surveys were conducted opportunistically at selected sites on the lower Milk River in October and November 2004 to sample for western silvery minnow presence in potential overwintering habitat. .

- A water conservation plan was developed by the Town of Milk River in 2004. The plan incorporates the economics of town planning while recognizing the need for water conservation in the Milk River basin. Generally, water conservation is addressed through timing of operations and water storage.

- Fall aerial photography was completed in October and November 2004 to document key macro-habitat sections for the entire Milk and North Milk rivers, including the entire section of river in which the minnow is found. This survey geo-referenced and mapped key habitat features for evaluation. Limited habitat analysis has also been conducted.

- Signage at Writing-On-Stone Park identifying species at risk and including the western silvery minnow was completed.

- A Milk River watershed basin advisory committee, the Milk River Watershed Council of Canada, has been established.

- Alberta Environment conducts regular water quality monitoring on the Milk River and Environment Canada has resumed water quality monitoring at the international border, where the North Milk River enters Canada and the Milk River exits (W. Koning, pers. com.).

- Collaboration with the Milk River MULTISAR Program is ongoing.

- A fact sheet describing the western silvery minnow has been completed by Fisheries and Oceans Canada.

- Water Survey of Canada sites are well established and tracking flows (via HYDAT).

- Fisheries and Oceans Canada sampled fish populations in the Milk River in the summer (July) of 2005 and spring (May), summer (August) and fall (October) of 2006 (D. Watkinson, pers. com.). New data were collected on the diet, population age structure, population size structure, juvenile and adult habitat use, and distribution range of the western silvery minnow in the Milk River.

- Fisheries and Oceans Canada has verified the taxonomic identity of western silvery minnows throughout the species' known Canadian distribution.

5.8 Evaluation and Performance

The Milk River Fish Species at Risk Recovery Team will monitor the implementation of the recovery strategy and any associated action plans for the western silvery minnow on an ongoing basis. The Team will be responsible for reviewing and evaluating the performance and implementation of recovery strategy and associated action plans, and their success in achieving the stated recovery goals and objectives. It will meet annually over a period of five years to evaluate the success of the strategy and to recommend any changes in direction. During the fifth year, the overall recovery strategy will be re-visited to determine whether:

- the goals and objectives are still being met;
- the goals and objectives need to be amended; or
- a fundamental change in approach to addressing the goals and objectives may be warranted.

Appropriate action, including amending or rewriting the strategy, will be considered at that time. Evaluations shall be based on the comparison of specific performance measures to the stated recovery objectives. Whenever possible, scientific studies will also be peer reviewed.

5.9 Action Plan Development

Implementation of the recovery strategy for the western silvery minnow shall be effected by subsequent development of an action plan, which shall be completed by 2009. The current recovery team will develop the action plan to ensure continuity and efficiency. The action plan will be reviewed on a five-year basis or as needed to respond to new information.

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6. CONSULTATIONS

Upon completion of the draft recovery strategy, a public meeting was conducted in Milk River, Alberta to allow members of public to review and provide comments on the document. A list of participants at the meeting is provided in Appendix B.

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8. PERSONAL COMMUNICATIONS

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9. GLOSSARY

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Anoxic water is too low in oxygen to support fish life and causes winterkill.

A **cyprinid** is a member of the minnow family, Family Cyprinidae.

Fork length is the distance from the tip of the snout to the fork in the tail.

Pelagic eggs are found in the water column below the surface and above the bottom.

Piscivores are species that eat fish.

The **riparian zone** is the vegetated corridor along the banks of streams and rivers

A **Threatened** species is likely to become endangered if limiting factors are not reversed.

APPENDIX A. THREATS ASSESSMENT ANALYSIS

Knowledge of the threats to a species and potential to mitigate those threats is fundamental to a species' recovery. In this assessment, the Recovery Team identified the following threats for consideration:

- **Species introductions**
  - Predation
  - Competition
  - Food chain disruption
- **Habitat Loss/Degradation**
  - Dam installation and operation
  - Changes in flow regulation
  - Canal maintenance
  - Groundwater extraction
  - Surface water extraction — irrigation
  - Surface water extraction — non-irrigation
  - Livestock use of the flood plain
- **Pollution**
  - Point Sources
  - Non-point Sources
  - Anoxia
- **Natural Processes**
  - Drought
  - Climate change

Because so little is known of the species' life history and habitat requirements, the assessment of each potential threat was qualitative rather than quantitative, with each factor being rated as "low", "moderate" or "high". These assessments were based on the best professional judgement of the Recovery Team, and determined by consensus following discussions. For each potential threat at each location where the species is known to occur, the following factors were considered:

- **Likelihood of Occurrence –** The probability of a threat occurring. Those that presently affect the species were rated "high".
- **Extent of Occurrence -** The spatial range of each identified threat. Those that affect most or all of the area occupied by the species were rated "high".
- **Severity of Impact –** The severity of the direct or indirect impact of a threat on the survival or recovery of the species. Impacts with the potential to extirpate the species were rated "high".
- **Immediacy of Impact -** The immediacy of the anticipated impact from a threat was denoted with a "P" for past impacts; "C" for current, ongoing impacts; and an "F" for possible future impacts.
- **Threat Significance –** The risk of damage to the western silvery minnow population from a particular threat, based on its likelihood and extent of occurrence and on the severity and immediacy of its impacts. Threat significance

was rated “low” where severity of the impact was deemed low, and otherwise was difficult to predict given present knowledge.

- **Mitigation Potential -** The biological and technical feasibility of mitigating a threat. Where there are no biological impediments and proven technology exists to successfully mitigate threats, the mitigation feasibility was rated “high”.

In the tables, questions marks (?) denote uncertainty, and the need for research. Comments provide background on each threat or its assessment.

APPENDIX B. LIST OF CONSULTATIONS

Individuals and groups that were consulted during development of the western silvery minnow recovery strategy included:

Date	Location	Meeting Type	Attendees/Issues
May 6, 2004	Milk River	Local Government	Representatives from the Town of Milk River, Warner County and the Village of Coutts were present, including Emma Hulitt who later joined the Recovery Team. Invited parties that did not attend included representatives of the counties of Cardston, Forty Mile and Cypress. Presentation on Species at Risk Act and western silvery minnow.
March 14, 2007	Milk River	Public	Attendees included: Mike Brown, Pam Nielsen, Doreen Nielsen, Ken Brown, Austin Hook, Christy Audet and Don Welsh from Milk River, and Sandy Reimersma from Mossleigh, AB. Presentation of current draft recovery strategy. Provided copies of draft recovery strategy for comment.

APPENDIX C. RECORD OF COOPERATION AND CONSULTATIONS

Aboriginal Organizations and First Nations:
A draft of the proposed recovery strategy was circulated to identified Aboriginal Organizations and First Nations for comment prior to the strategy being posted on the SARA Registry. Letters, plain language summaries of the recovery strategy and factsheets were sent to the following Aboriginal Organizations and First Nations:
Assembly of First Nations, Blood Tribe, Métis Nation of Alberta, Métis National Council, and Treaty 7 Management Corporation. To date no comments have been received.

Other Jurisdictions: The Province of Alberta participated jointly with the DFO in the development of the proposed recovery strategy. Comments were received on a draft version on the strategy.

General:
Concurrent with posting of the proposed recovery strategy on the SARA Public Registry, announcements will be placed in local newspapers inviting public comment. In addition, information packages will be forwarded to specific stakeholders with an identified interest in the recovery strategy including resource users, non-government organizations and local government inviting their comment. All comments received will be considered prior to posting of the final recovery strategy.