Species at Risk Act
Recovery Strategy Series

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

Western Silvery Minnow

2017

Canada

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For copies of the recovery strategy, or for additional information on species at risk, including COSEWIC Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk Public Registry (SAR Public Registry).

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Amended Recovery Strategy for the Western Silvery Minnow (*Hybognathus argyritis*), in Canada

Final

2017

PREFACE

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years.

The Minister of Fisheries and Oceans Canada, the competent minister for the recovery of Western Silvery Minnow, has prepared this strategy, as per section 37 of SARA. The Government of Alberta (Alberta Environment and Parks) cooperated in the production of this recovery strategy. A recovery strategy was completed for the Western Silvery Minnow and posted on the Species at Risk Registry in 2008. This recovery strategy amends the 2008 strategy to include the identification of critical habitat. The development of this recovery strategy was co-led by Fisheries and Oceans Canada – Central and Arctic Region and Alberta Environment and Parks, in cooperation and consultation with many individuals, organizations and government agencies, including the:

- Milk River Rancher's Association;
- Milk River Watershed Council of Canada;
- Southern Alberta Environmental Group;
- Blood Tribe;
- Counties of Warner, Cardston, and Forty Mile;
- Villages of Coutts and Warner; and
- The Town of Milk River.

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. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Western Silvery Minnow and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Fisheries and Oceans Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

ACKNOWLEDGMENTS

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

Roy Audet	Milk River Ranchers' Association
Michael Bryski	Senior Fisheries Biologist, Fish and Wildlife Division, Alberta Environment and Parks
Warren Cunningham	Councillor for the County of Warner and member of the Milk River Watershed Council of Canada
Ashley Gillespie (co-chair)	Species at Risk Biologist, Fisheries and Oceans Canada, Central and Arctic Region
Lori Goater	Southern Alberta Environmental Group
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Shane Petry (co-chair)	Senior Fisheries Biologist, Fish and Wildlife Division, Alberta Environment and Parks
Richard Quinlan	Provincial Species at Risk Specialist, Fish and Wildlife Division, Alberta Environment and Parks
Doug Watkinson	Research Biologist, Fisheries and Oceans Canada

The Recovery Team extends its sincere appreciation to the many organizations that supported the development of this recovery strategy and to the people who contributed their knowledge and hard work. This report was written by D.B. Stewart of Arctic Biological Consultants (Winnipeg, MB) and by S. Pollard (currently with the BC Ministry of the Environment), who at different times acted as secretariat to the Recovery Team. Prior to their retirements, Fred Hnytka of Fisheries and Oceans Canada (DFO) and Terry Clayton of Alberta Environment and Parks (AEP) co-chaired the Recovery Team and Emma Hulit represented the Counties of Cardston, Forty Mile and Warner, the Villages of Coutts and Warner, and the Town of Milk River. They made many worthwhile contributions to this strategy and their efforts are most appreciated. Funding to support Recovery Team meetings was provided by DFO and AEP. Shane Petry (AEP) and Terry Clayton (AEP) 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 AEP 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; 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 and Sam Stephenson who provided constructive reviews of the manuscript.

EXECUTIVE SUMMARY

In June 2003 when the *Species at Risk Act* (SARA) came into force, the Western Silvery Minnow (*Hybognathus argyritis*) was officially listed on Schedule 1 of SARA as "**Threatened**", requiring the completion of a recovery strategy within four years. Similarly, the Province of Alberta has listed the Western Silvery Minnow as "Threatened" under Alberta's Wildlife Act and has completed a recovery plan for the species.

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 (DFO) and provincial (AEP) departments 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. The recovery strategy 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. Refine knowledge on the essential functions, features and attributes of critical habitat for various life stages of the Western Silver Minnow; and

3. Identify potential threats from human activities and ecological processes and develop plans to avoid, eliminate or mitigate threats.

To help achieve this goal and meet the objectives, four general approaches are proposed: 1) Research, 2) Monitoring, 3) Management and Regulatory Actions, and 4) 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.

RECOVERY FEASIBILITY SUMMARY

Recovery of the Western Silvery Minnow is considered possible because it meets the four criteria of technical and biological feasibility.

1. Individuals of the wildlife species that are capable of reproduction.

   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.

2. Sufficient suitable habitat is available to support the species.

   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.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

   The potential for mitigating threats identified for the Western Silvery Minnow (Section 4, 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 and proposed projects.

4. Recovery techniques exist to achieve the population and distribution objectives.

   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.

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1. COSEWIC SPECIES ASSESSMENT INFORMATION

2001 COSEWIC Assessment Summary

Assessment Summary – November 2001

Common name Western Silvery Minnow

Scientific name *Hybognathus argyritis*

Status Threatened

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.

Occurrence Alberta

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

2008 COSEWIC Assessment Summary

Assessment Summary – April 2008

Common name
Western silvery minnow

Scientific name
Hybognathus argyritis

Status
Endangered

Reason for designation
This small minnow species is restricted to the Milk River in Southern Alberta, a region characterized by drought conditions of increasing frequency and severity. While the future of flow regimes associated with the St. Mary's diversion canal and proposed water storage projects are uncertain, consequences of these activities have the potential to significantly affect the survival of the species. Rescue effect from U.S. populations is not possible.

Occurrence
Alberta

Status history
Designated Special Concern in April 1997. Status re–examined and designated Threatened in November 2001. Status re–examined and designated Endangered in April 2008. Last assessment based on an update status report.

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 (Figure 1)) and some of the identified threats.

ALBERTA SUMMARY (*Wildlife Act)*

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 (AEP 2003). Studies are underway to determine the present status of the species in Alberta.

2. SPECIES STATUS INFORMATION

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 under Alberta's *Wildlife Act*.

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 (DFO, AEP) 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 one or more action plans to implement its recommendations.

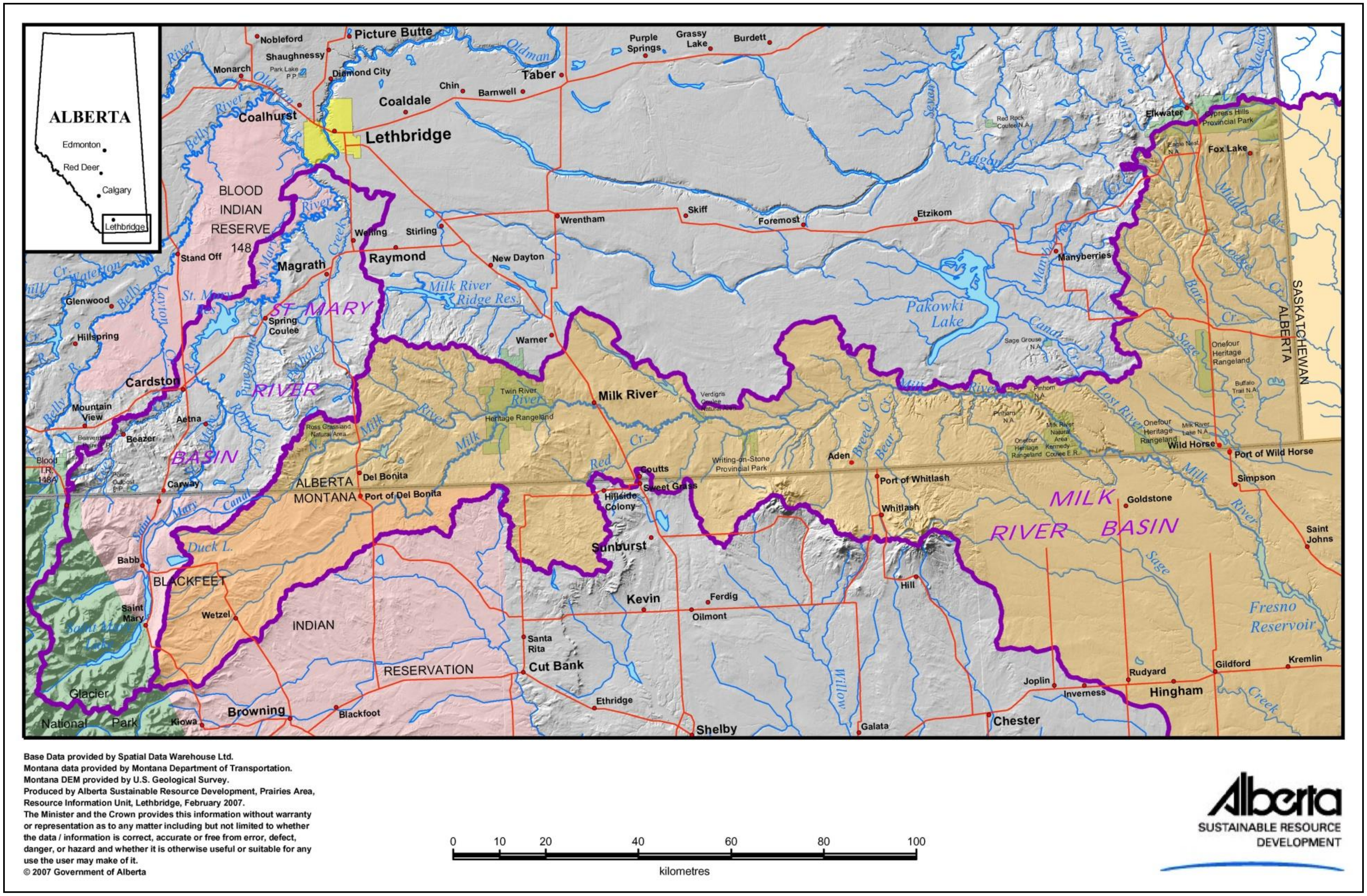

Figure 1. Location of the Milk River Basin in Alberta

3. SPECIES INFORMATION

3.1 Species Description

The Western Silvery Minnow (*Hybognathus argyritis*) is a small **cyprinid** 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 (AEP 2003). There is very little historical information on the Western Silvery Minnow in the Milk River, but this fish has probably persisted without significant changes in abundance or range since it was first observed in Alberta (AEP 2003). 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** of up to 140 mm have been recorded in the Milk River (R L&L 2002). The Western Silvery Minnow 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 habitat that has limited flow conditions (R. Bramblett, pers. comm.).

Figure 2. Western Silvery Minnow (Photo Credit: Karen Scott, DFO)

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; Pflieger 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 Minnow (DFO, unpub. data).

3.2 Population and 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. 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; DFO, unpub. data). 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 Milk River in southern Alberta (Figure 3), but also may occur in the province of Saskatchewan (DFO, unpub. data). 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 rather than an authentic record. Alternatively, the fish may have been misidentified (Nelson and Paetx 1992).

Within Alberta, the Western Silvery Minnow distribution appears to be limited to the lower 220 km of the 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; DFO, unpub. data). 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 (AEP 2003).

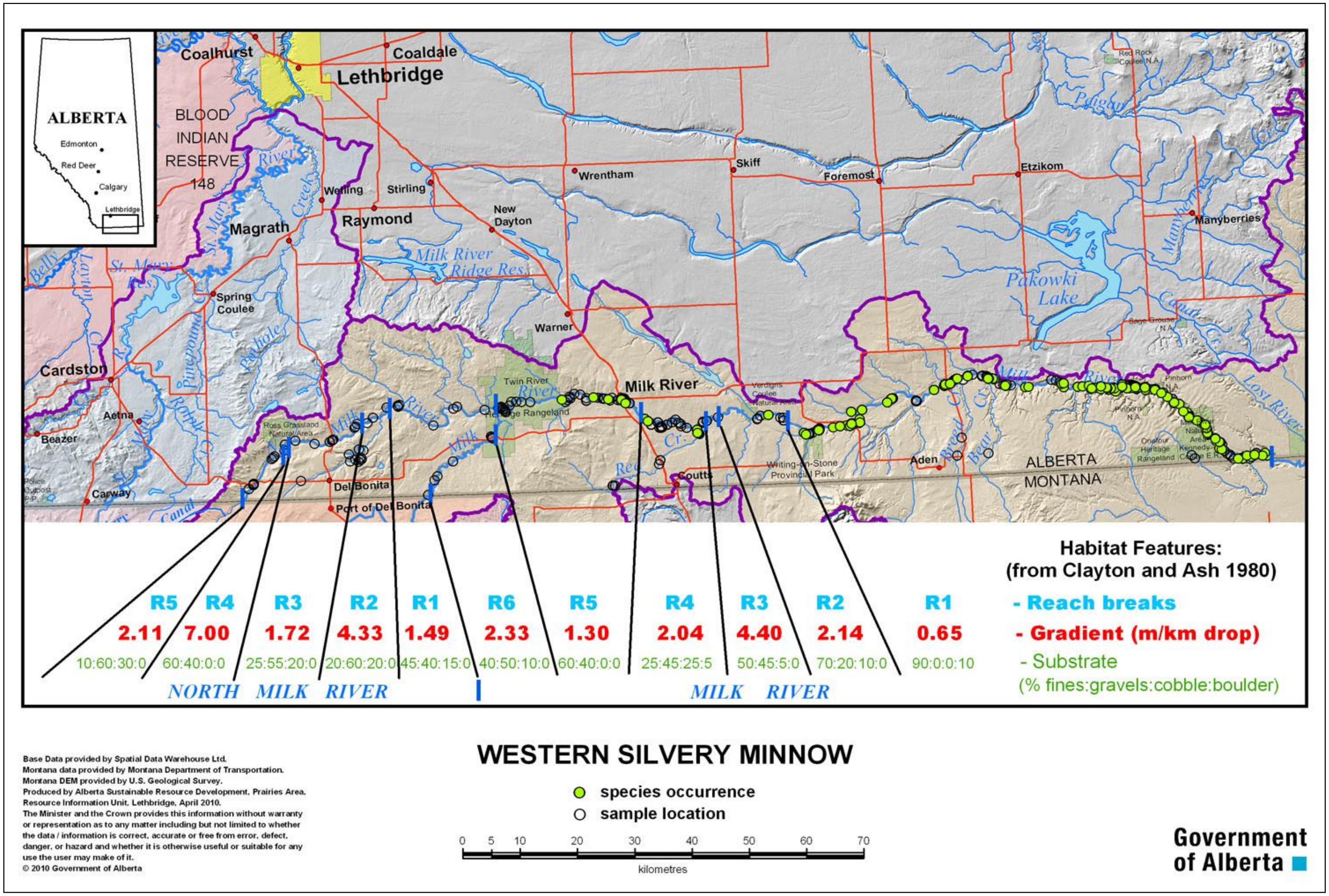

Figure 3. Canadian distribution of the Western Silvery Minnow showing key habitat features of the Milk River, Alberta. Distribution records are from the AEP Fisheries and Wildlife Management Information System as of May 2010.

The distribution of the Western Silvery Minnow may have been significantly different prior to 1917, when the St. Mary Canal was constructed (Willock 1969). However, the effects of increased seasonal flows and potentially associated lower water temperature upstream on its distribution and abundance are unknown (DFO, unpub. data). 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. comm.).

3.2.1 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 (DFO, unpub. data). 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 is known that numbers in the Canadian portion of the Milk River generally increase with distance downstream (DFO, unpub. data). Based on surveys directed at Western Silvery Minnow downstream of the confluence of the North Milk and Milk rivers in 2005, 2006 and 2007, DFO found this species was the second most abundant fish species downstream of the town of Milk River (DFO, unpub. data).

3.2.2 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.

3.3 Needs of the Western Silvery Minnow

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.

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 (DFO, unpub. data). Fortunately, since it was assessed by COSEWIC in 2003, ongoing studies by T. Clayton (AEP) and D. Watkinson (DFO) 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) (R L & L 2002; DFO, unpub. data). 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. comm.). 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 >100 km stretches of connected habitat to enable the fish born from eggs that drift downstream to return upstream to suitable habitats (Platania and Altenbach 1998; Dudley and Platania 2007).

Western Silvery Minnows in the Milk River spawn in June or July (DFO, unpub. data). 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 (DFO, unpub. data). 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) (AEP 2003). Seventeen fish 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, recently identified Trout-perch (*Percopsis omiscomaycus*), Yellow Perch (*Perca flavescens*), Walleye (*Sander vitreus*), and Lake Whitefish (*Coregonus clupeaformis*) in the Milk River system (DFO, unpub. data), suggesting movement from Montana or illegal introductions.

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
Rocky Mountain Sculpin (or St. Mary or Eastslope Sculpin)	*Cottus sp.*	Y
Stonecat	*Noturus flavus*	Y
Trout-perch	*Percopsis omiscomaycus*	Y
White Sucker	*Catostomus commersonii*	Y
Walleye	*Sander vitreus*	Y
Yellow Perch	*Perca flavescens*	Y

3.3.1 Habitat

Habitat Preferences

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 and absence in river segments during the open water period in North Dakota with 80% accuracy (Welker and Scarnecchia 2004), indicating that these habitat variables are key determinants of the species' presence.

In the mainstem Milk, Missouri and Mississippi river systems, 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; AEP 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 (DFO, unpub. data).

The open water distribution of Western Silvery Minnow in the Milk River is strongly correlated with gradient and substrate type (Figure). Western Silvery Minnow have been collected in the Milk River in water velocities of at least 1.2 m/s, at depths of at least 1.4 m, and over sand and gravel substrates, however, its abundance is highest when velocities are < 0.3 m/s, depth is < 0.3 m, and the substrate is silt. 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**.

Habitat Availability

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 artifact 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. comm.). Minnows (species unknown) have been observed at these sites, which may provide winter refugium 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 impede movement. 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-colonizing the upper reaches of these streams annually (R. Bramblett, pers. comm.). 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 velocity for spawning (Cowey 2002, Platania and Altenbrach 1998). This type of habitat would be necessary because pelagic-broadcast spawners release buoyant eggs into open water. The distance that eggs (and larvae when hatched) 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 water 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 (DFO, unpub. data). 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 (DFO, unpub. data).

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; DFO, unpub. data). Habitat availability varies from year to year depending on flow, particularly in late summer, fall, and winter when there is no flow augmentation and the flows in the Milk River are natural flows. 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 may include the construction of a water storage dam upstream of the Town of Milk River and altered flow regimes in the St. Mary Canal.

Relevant Habitat Legislation

The Western Silvery Minnow is afforded varying degrees of direct or indirect habitat protection through existing statutes and programs.

The *Canadian Environmental Protection Act, 1999* (S.C. 1999, c. 33), which is an Act respecting pollution prevention and the protection of the environment and human health in order to contribute to sustainable development, provides for, among other things, regulating and eliminating the use of substances harmful to the environment. Under the *Canadian*

Environmental Assessment Act, 2012 (S.C. 2012, c. 19) the environmental effects that are to be taken into account in relation to an act or thing, a physical activity, a designated project or a project include, among other things, any change that may be caused to aquatic species as defined in s. 2(1) of the *Species at Risk Act.* The *Species at Risk Act* (S.C. 2002, c. 29) itself prohibits the destruction of any part of critical habitat of an aquatic species (s. 58(1)).

At the provincial level, Alberta's *Wildlife Act* (R.S.A. 2000, c. W-10) requires that the Minister responsible for that Act establishes an Endangered Species Conservation Committee, whose functions are to advise the Minister on endangered species and to make recommendations to the Minister with respect to (among other things):

(a) the preparation and the adoption by the Minister of recovery plans for endangered species;
(b) organisms that should be established as endangered species; and
(c) endangered species and biodiversity conservation.

The Western Silvery Minnow was formally listed as Threatened on Schedule 6 of the Alberta *Wildlife Regulation* (Alberta *Wildlife Act*) in 2007.

The purpose of Alberta's *Environmental Protection and Enhancement Act* (R.S.A. 2000, c. E-12) is to support and promote the protection, enhancement and wise use of the environment. It includes an environmental assessment process. Most of Alberta's economic activities (recreation, forestry, agriculture, oil and gas) occur on public land. The Alberta *Public Lands Act* (R.S.A. 2000, c. P-40) governs the use of most of the approximately 60 percent of public land in Alberta and is used to better manage the long term health of these public lands. The purpose of the Alberta *Water Act* (R.S.A. 2000, c. W-3) is to support and promote the conservation and management of water, including the wise allocation and use of water.

As of 2008, 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 (general plans created to protect an agricultural way of life and the environment) associated with them that included **riparian zone** protection (DFO, unpub. data). The remaining land (both public and private) 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 and Agri-Food Canada, and Alberta Agriculture.

3.3.2 Limiting Factors

Too little is known of the Western Silvery Minnow's physiology or ability to adapt to different conditions to identify exhaustively the factors that might limit population survival and maintenance or to quantify precisely their potential impacts. 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.

3.3.3 Environmental setting

The Milk River is a northern tributary of the Missouri-Mississippi Basin, with a 6,500 km^2 watershed (Alberta's River Basins, AEP). It flows north from Montana into Alberta, eastward through the southern portion of the province, and then south back into Montana. The average annual flow entering Alberta is 1.06×10^8 m^3 and leaving Alberta is 1.67×10^8 m^3. The Town of Milk River is one of the few communities in the Milk River watershed.

As the Milk River in Alberta flows east from the Montana Border, it crosses the Foothills Fescue, Mixedgrass, and Dry Mixedgrass subregions of the Grassland Natural Region (Natural Regions Committee 2006; Milk River Watershed Council Canada 2008). 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 dynamic hydraulic conditions and lacks higher aquatic plants due to the highly mobile stream bed (DFO, unpub. data). 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).

In order to fully understand the implications of the information in the following pages, it is important to understand the context in which the water use within the Milk River watershed is managed, which is through an international agreement. The agreement discussed below does not likely negatively affect recovery of the Western Silvery Minnow, since the population and distribution objective is one of maintenance and protection of self-sustaining populations. However, water management through the agreement may potentially inhibit the types and scale of activities that could occur within the Milk River watershed.

The Milk River watershed is shared between Canada and the United States (U.S.) and as such, it is subject to provisions in the Boundary Waters Treaty of 1909 (the Treaty) between Canada and the United States. The Treaty is administered by a binational organization called the International Joint Commission (IJC) (ISMMRAMTF 2006; see also Dolan 2007; Halliday and Faveri 2007a,b; Rood 2007). The IJC has appointed members from both Canadian and U.S. governments and the Treaty itself provides the principles and mechanisms to resolve disputes concerning shared water. The Milk River watershed was historically, and is currently, intensively managed for agricultural purposes (largely irrigation of crops).

In 1921, an order was made by the IJC, defining the apportionment of the water in the Milk River watershed. The context of the apportionment is best considered temporally as regarding the irrigation season (April 1 to October 31 annually) and the non-irrigation season (November 1 to March 31). It was agreed that, for the purposes of irrigation and power, both Canada and the U.S. would treat the management of water in the Milk River as one stream for the benefit of both countries. Generally, it was resolved that during the irrigation season, Canada is entitled to three fourths of the natural water flow in the Milk River. During the non-irrigation season both countries are to share the flows of the river equally. In addition, it was agreed that the channel of the Milk River may be used at the convenience of the U.S. for conveyance of water from western Montana to reservoirs in eastern Montana. There are numerous rules and caveats to this water use (e.g. timing and baseline volume of flow, shared tributaries, record keeping etc.) and reference to the Treaty and 1921 Order should be made for more specific information (International Joint Commission Order 1921).

To supply additional water to irrigators in the Milk River watershed, a large canal and siphon was constructed to divert water from the St. Mary River in northwestern Montana via the "St. Mary Canal" into the North Milk River (ISMMRAMTF 2006) and subsequently the mainstem Milk River. The diverted water flows eastward in the mainstem Milk River through southern Alberta before entering northeastern Montana, where it is used for irrigation. Canada has limited access to the additional water provided by the St. Mary Canal in the Milk River, as per the Treaty and 1921 Order. Canada must let much of the diverted water from the St. Mary Canal pass into the U.S. for their use.

The Milk River has been severely impacted by changes in its seasonal flow regimes. Water diverted from the St. Mary River in Montana augments flows in the Alberta portion of the Milk River from late March or early April through late September or mid-October (ISMMRAMTF 2006). Under natural pre-diversion 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 (McLean and Beckstead 1980). 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 effects of flow augmentation are much greater in the North Milk River, which has a relatively small drainage area (238 km^2 at the North Milk River gauge 11AA001), compared to 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). As the Milk River flows through Alberta, the concentration of suspended sediment in the water increases, and with it the turbidity (Spitzer 1988). These levels tend to decline over the augmentation period despite flows that remain fairly constant.

When the diversion of water from the St. Mary River is terminated in late September to mid-October, the river reverts to natural flows for the remainder of the winter season (ISMMRAMTF 2006), albeit within a somewhat modified river channel (McLean and Beckstead 1980; Milk River Watershed Council Canada 2008). 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. comm.

2006). At the Town of Milk River, the average flow rate over the period 1912 to 2006 was <2 m^3/s in November and February, and <1 m^3/s in December and January (WSC 2008b).

Over the past two decades, the St. Mary Canal has transported an average volume of about 2.08 x 10^8 m^3 of water annually into the North Milk River (U.S. Bureau of Reclamation 2004). At present, the operating capacity of the St. Mary Canal is about 18.4 m^3/s (<650 cfs), which is significantly less than its original design capacity of about 24 m^3/s. These lower flows and overall volume of water are issues for Montana, and the U.S. hopes to replace or rehabilitate the aging canal infrastructure and thereby return the canal to its original capacity of 24 m^3/s (K. Miller, pers. comm. April 2010; see also AEP 2004; U.S. Bureau of Reclamation 2004). This increased capacity would likely only be used during the period of peak runoff each year. However, its use will lead to a surge of flow in the North Milk and Milk rivers in June. Studies are planned to examine the effects of higher flows on erosion in Canadian reaches of both rivers. Sites of particular interest for restoration and/or protection are located at Hilmer Bridge, north of Del Bonita on the North Milk River, and at Goldsprings Park and Weir Bridge on the Milk River.

Some areas of the Milk River experience protracted periods with little or no surface flow during the non-irrigation period (K. Miller, pers. comm.). Upstream from its confluence with the North Milk River to the Montana Border, surface flow in the Milk River occasionally dries up from July or August until March. The Milk River mainstem east of Aden Bridge dries up less frequently, perhaps on the order of every 15 or 20 years; most recently in 1988 and 2001.

In summary, the waters in the Milk and St. Mary rivers are intensively managed for irrigation use both in Canada and the United States. The approach to the management of water in the Milk River watershed and St. Mary River is essentially that water is diverted from the St. Mary River into the North Milk River commencing by April 1 (or earlier) in any given year with variances of approximately 18.4 m^3/s. The natural winter flows in the Milk River are generally very low at this time (can be <1 m^3/s) so the increase in flows is significant, rising up to 15 m^3/s or more in a relatively short period of time. These higher flows continue in the Milk River until September or October when the flows are reduced to natural or close to natural flows as the end of the irrigation season approaches. Both rivers have low winter flows; however, the Milk River watershed flows in the winter are natural flows whereas the flows in the St. Mary River are managed via storage facilities in Montana (Sherburne Reservoir and St. Mary Lake).

4. THREATS

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.

4.1 Threat Assessment

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

- Species introductions,
- Habitat loss/degradation,
- Pollution, and
- Natural processes.

A brief description of the methods and assessment of threats to the species is provided in Appendix A. The results are summarized in Table 2 and described in greater detail in the next section.

Table 2. Detailed threats assessment for Western Silvery Minnow.

Identified Threat	Source/Stressor	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 m³/s; 850-1,000 cfs) or abandonment.
	Canal Maintenance	**H**	**H**	**H**	**F**	**H**	**M**	Recommend to AEP 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 Licenses during critical low flows could help mitigate impacts.
	Livestock Use of Flood Plain	**H**	**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/Stressor	Likelihood of Occurrence*	Extent of Occurrence*	Severity of Impact*	Immediacy of Impact**	Threat Significance*	Mitigation Potential*	Comments
Pollution	Point Source	**M**	**H**	**H**	**F**	**L**	**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 crop 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.
Other Threats	Scientific Sampling	**H**	**H**	**L**	**P**	**L**	**H**	The threat from further sampling is likely low and can be controlled.
	Climate Change	**?**	**H**	**?**	**?**	**?**	**L**	Impossible to evaluate at this time, mitigation not possible at local level.

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

4.2 Description of Threats

4.2.1 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 and Walleye are the only introduced species that have been observed in the lower Milk River where the Western Silvery Minnow occur (DFO, unpub. data). Further downstream, the Fresno Reservoir contains a number of introduced predatory species, including: Rainbow Trout (*Onchorhynchius mykiss*), Walleye, 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 (the intentional and illegal placing of fish into a waterbody prohibited by the *Alberta Fishery Regulations, 1998*) 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 characterizes 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 flow regimes and trap sediments, can reduce turbidity downstream and 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 increasing the abundance of introduced species (e.g., Northern Pike) and native predators that currently exist at low levels (e.g., Sauger).

The Alberta Fish and Wildlife Division do not plan to introduce sportfish species into the lower Milk River, and is unlikely to do so in the future (DFO, unpub. data). The Milk River proper and its tributaries in Alberta have not been stocked for at least 10 years, although Goldsprings Park Pond, an old oxbow of the river with no connection to the mainstem is stocked annually with rainbow trout (DFO, unpub. data). 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 upstream and downstream of the reservoir.

4.2.2 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 and flow surges 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. comm.). Winter flows in the Milk River are considered natural and despite frequent low flow conditions there is no evidence of stranding (DFO, unpub. data). 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. 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) (AEP 2004; U.S. Bureau of Reclamation 2004). Work has begun to restore the diversion to the design capacity which would increase flows by almost 27% and could lead to flow surges during periods of peak runoff in June. 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. comm.). 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 aging St Mary Canal can lead to temporary or premature closure to allow maintenance activities. This has led to two interruptions to flow during the augmented period over the past 30 years; both were emergency situations where the integrity of the canal was at stake (K. Miller, pers. comm.). One of these interruptions occurred in 2001 when the canal was closed in mid-August 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. Impacts to Western Silvery Minnow as a result of this drought are not known.

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 considered by Alberta. 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 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 characteristically found in 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 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 and other low flow periods. 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 by AEP and governed largely by the Treaty of 1909 (and 1921 Order). Extraction of water for irrigation purposes only occurs while flows are augmented, from late-March or early April to early 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 (DFO, unpub. data). 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. AEP has initiated installing water meters on all irrigation pumps drawing water from the Milk River (K. Miller, pers. comm.). 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 in 2001 (S. Petry, pers. comm.). 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 (pasture water systems so that livestock will not have enter the river to drink) (Lorne Fitch, pers. comm.). Several riparian benchmark inventories have been completed, but there has not been any follow-up monitoring. Demonstration sites to show positive land management practices, such as off-stream water developments, 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.

4.2.3 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. 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. comm.) making both of these a low 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 from historic wells have also occurred in recent years (S. Petry, pers. comm.). 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 (AEP 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. comm.). 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. comm.) 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. comm.), but nutrient concentrations can become elevated at downstream sites such as the Highway 880 crossing (W. Koning, pers. comm.). Water quality in the mainstem also changes seasonally in response to flow augmentation, while increases in the total dissolved solids, conductivity and salt (sodium) concentrations occur when the diversion is shut off in the winter months (W. Koning, pers. comm.).

4.2.4 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.

4.2.5 Natural Processes

The preceding sections outline threats to Western Silvery Minnow survival and habitat caused by human activities. Drought is a limiting factor that also has the potential to significantly impact the Western Silvery Minnow population.

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, and anthropogenic stresses could compound the severity of the effects of drought significantly.

4.2.6 Other Threats

Scientific Sampling

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.

Climate Change

Climate change has the potential to impact water availability, temperature, and a broad range of other factors, thereby, affecting the availability and quality of Western Silvery Minnow habitat. The extent to which this might affect the species is unknown.

5. POPULATION AND DISTRIBUTION OBJECTIVES

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."***

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;**

2. **Refine knowledge on the essential functions, features and attributes of critical habitat for various life stages of the Western Silver Minnow; and**

3. **Identify potential threats from human activities and ecological processes and develop plans to avoid, eliminate or mitigate threats.**

6. BROAD STRATEGIES AND GENERAL APPROACHES TO MEET OBJECTIVES

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, eliminate or mitigate 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 identifies their priority and relates them to specific recovery objectives.

6.1 Actions Already Completed or Currently 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 the Milk 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, including the Western Silvery Minnow, was completed.

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

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

- A fact sheet describing the Western Silvery Minnow has been completed by DFO.

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

- DFO sampled fish populations in the Milk River in the summer (July) of 2005 and spring (May), summer (August) and fall (October) of 2006 (DFO unpub. data). 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.

- DFO has verified the taxonomic identity of Western Silver Minnow throughout the species' known Canadian distribution.

- In 2012, DFO held an advisory meeting to assess the recovery potential of the Western Silvery Minnow in Canada.

6.2 Strategic Direction for Recovery

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

Strategy	Priority*	Anticipated Effect
Objective 1: *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: *Increase our 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	Better knowledge of life history parameters will help determine population targets and refine critical habitat identification.
R2. Clarify habitat requirements	Urgent	Better knowledge of habitat use will help focus impact mitigation and recovery efforts, and refine critical habitat identification.
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 introduction	Beneficial	Reduce potential for damage to Western Silvery Minnow populations by introduced predators and competitors.
Objective 3: *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.*		

Strategy	Priority*	Anticipated Effect
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.

* 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.

6.3 Narrative to Support the Recovery Planning Table

6.3.1 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 refining knowledge of 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.

6.3.2 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. 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 and implement 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.

6.3.3 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:** Under the *Canadian Environmental Assessment Act, 2012* the environmental effects that are to be taken into account in relation to an act or thing, a physical activity, a designated project or a project include, among other things, any change that may be caused to aquatic species as defined in s. 2(1) of the *Species at Risk Act.*

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.

6.3.4 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.

7. CRITICAL HABITAT

7.1 General Identification of the Species' Critical Habitat

Critical habitat is defined in the Species at Risk Act (2002) section 2(1) as:

> *"…the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species."* [s. 2(1)]

SARA defines habitat for aquatic species as:

> *"… spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced."* [s. 2(1)]

The critical habitat identified in this recovery strategy describes the geospatial area that contains habitat necessary for the survival or recovery of the species. The current area identified may be sufficient to achieve the population and distribution objectives for the species, however, it may need to be further refined in terms of its biophysical functions/features/attributes or its spatial extent. The schedule of studies outlines the activities required to refine the description of critical habitat in order to support its protection.

7.1.1 Information and Methods Used to Identify Critical Habitat

Using the best available information, critical habitat has been identified using a modified 'bounding box' approach for the Milk River. The bounding box approach is useful when features and their attributes can be described but their location varies or when knowledge of their specific location is unknown. Critical habitat is not comprised of the entire area within the identified boundaries, but rather only those areas within the identified geographical boundaries where the described biophysical features occur.

For Western Silvery Minnow, critical habitat was identified using the bounding box approach, modified by an ecological reach criteria and **catch per unit effort** (CPUE). Boat electrofishing transect data provide comparable CPUE data for large portions of the Milk River (Figure 4). The consistently higher CPUE downstream of river km 140 (river km zero is the downstream end at the eastern crossing of the Milk River from Alberta into Montana) on the Milk River corresponds to the R1/R2 reach break suggesting that the species is most abundant in the lower reach of the river (Figure 4). Water temperature, substrate and gradient may restrict the species' upstream distribution and abundance. Reach 1 is characterized by a lower gradient and higher proportion of fine substrate than other reaches of the Milk River.

Additional areas could be identified and/or additional information may be obtained to allow further clarification of the functional descriptions. Areas of critical habitat identified at some locations may overlap with critical habitat identified for other co-occurring species at risk; however, the specific habitat requirements within these areas may vary by species.

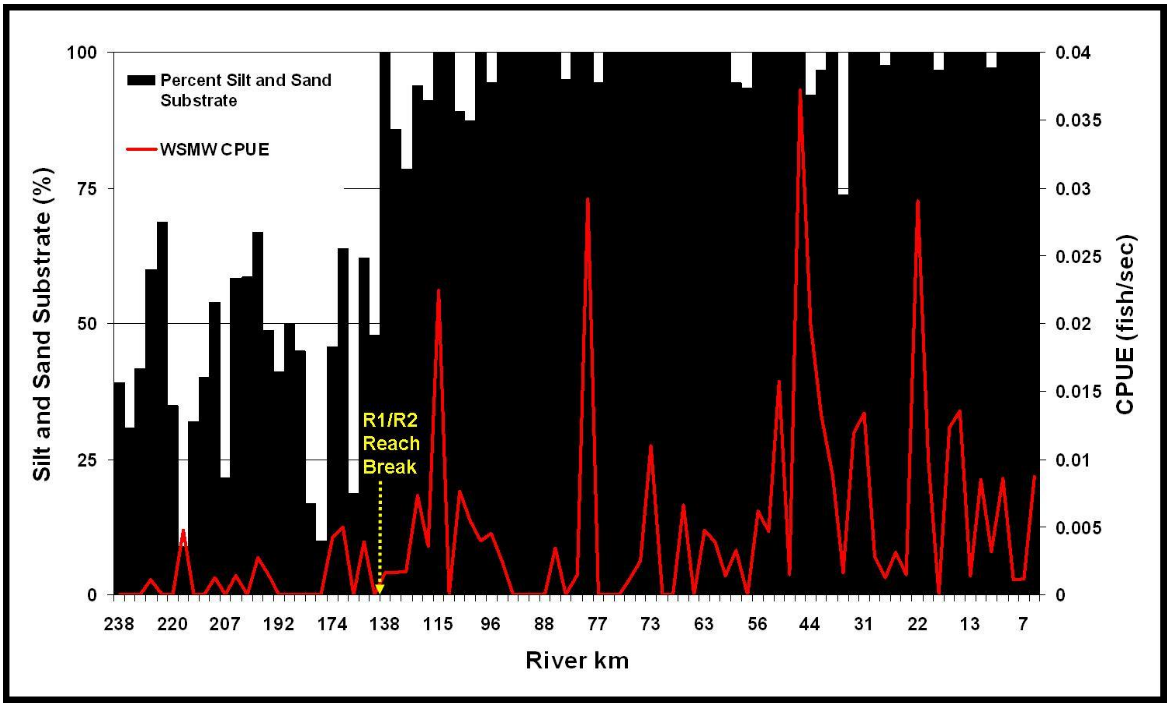

Figure 4. Catch of Western Silvery Minnows per unit of boat electrofishing effort relative to the location on the Milk River (river km) and fines (%) in the bottom substrate (D. Watkinson, DFO, unpubl. data). The R1/R2 reach break is at river km 140.

DFO modelled a population abundance recovery target for Western Silvery Minnow, based on an objective of demographic sustainability, as part of a Recovery Potential Assessment. Demographic sustainability was defined as the minimum adult population size that results in a desired probability of persistence over 100 years (approximately 38 generations). The modelling results showed that the population abundance recovery target necessary for persistence of a stable Western Silvery Minnow population over the long term could range from 12,000 – 236,000 adults, requiring 25 - 497 ha of suitable habitat (DFO, unpub. data). The analysis assumed a 15% probability of catastrophic decline in population size, defined as a 50% reduction in abundance, per generation (0.06% annually), as well as extinction thresholds ranging from 2 to 50 Western Silvery Minnow and a 50:50 sex ratio. The approach used to identify critical habitat for the Western Silvery Minnow (bounding box approach) is independent of the modelled population abundance recovery target. Because there is no evidence to suggest that the Milk

River population of Western Silvery Minnow has declined or that its range has been reduced, recovery objectives focus on maintaining current population levels in the Milk River, identifying and protecting critical habitat, identifying threats and developing plans to avoid, eliminate or mitigate threats.

7.1.2 Identification of Critical Habitat

Critical habitat for Western Silvery Minnow in Alberta is identified using the bounding box approach. It has an overall gradient of <1 m/km, substrate consisting of >75% sand or smaller, and CPUE of >0.0075 fish per second of electrofishing. The features, functions and attributes found within the **bankfull channel** should be considered part of the critical habitat. These are areas that the Minister of Fisheries and Oceans considers necessary to achieve the species' population and distribution objectives required for the survival or recovery of the species.

Permanent existing anthropogenic features such as marinas, road crossing, infiltration galleries, outfalls, canals, etc. that require periodic maintenance and are within the areas identified as critical habitat are excluded and not considered to be critical habitat for the Western Silvery Minnow.

7.1.3 Biophysical Functions, Features and Attributes

1. Western Silvery Minnow likely release semi buoyant pelagic eggs into open water, which develop as they drift downstream. Eggs are vulnerable to increased mortality if they reach standing water and sink before reaching the free-swimming larval stage. Spawning and larval development is thought to occur in **runs** and **flats** (features). In similar species, a distance greater than 100 kilometres (attribute) of barrier free riverine habitat (feature) is required for spawning and larval development (function) (Platania and Altenbach 1998; Dudley and Platania 2007).

2. **Backwater**, flats and runs (features) are used for feeding and cover (functions) by juvenile and adult Western Silvery Minnow. Turbid, sediment-laden and flowing riverine habitat with silt and sand substrates (attributes) offer a suitable environment for feeding and cover for Western Silvery Minnow.

Table 4 summarizes the limited available knowledge of the functions, features and attributes for each life-stage of the Western Silvery Minnow. Areas within which critical habitat is found in Figure 5 must be capable of supporting one or more of these habitat functions. Note that not all attributes described in Table 4 must be present in order for a feature to be identified as critical habitat. If the features as described in Table 4 are present and capable of supporting the associated functions, the feature is considered critical habitat for the species, even though some of the associated attributes might be outside of the range indicated in the table.

Table 4. General description of essential functions, features and attributes of critical habitat for each life stage of the Western Silvery Minnow.

Life Stage	Habitat Requirement (Function)	Feature(s)	Attribute(s)
Eggs and Larvae	• Spawning and rearing • Dispersion	• Flat • Run	• >100 km of barrier free riverine habitat • Turbid, sediment-laden water, **Secchi Disk** <65 cm
Juvenile and Adult (Age 1 and greater)	• Feeding and cover	• Backwater • Flat • Run	• Turbid, sediment-laden water, Secchi Disk <65 cm • Riverine (flowing) habitat (<70 cm/sec) • Silt and sand substrate (0.004-2 mm diameter)

Habitat that falls outside the current description of critical habitat might be identified as critical habitat in subsequent action plans if it is known to provide a critical function and, therefore, is necessary for the survival or recovery of the species, as per the definition of critical habitat in SARA.

Studies to further refine knowledge on the essential functions, features and attributes for various life-stages of the Western Silvery Minnow are described in section 7.2 (Schedule of studies to identify critical habitat).

7.1.4 Geographic Identification

The following locations of the critical habitat's functions, features and attributes have been identified using the modified bounding box approach. Critical habitat for the Western Silvery Minnow is identified within the Milk River in Alberta that extends from point A on Figure 5 (49.08638 degrees North -111.65707 degrees West) downstream to the United States border, point B on Figure 5 (49.00000 degrees North -110.54699 degrees West). The map at Figure 5 depicts the location of this reach. Critical habitat is comprised of those areas within the identified reach where the features described in Table 4 occur. The bankfull channel is considered part of the critical habitat.

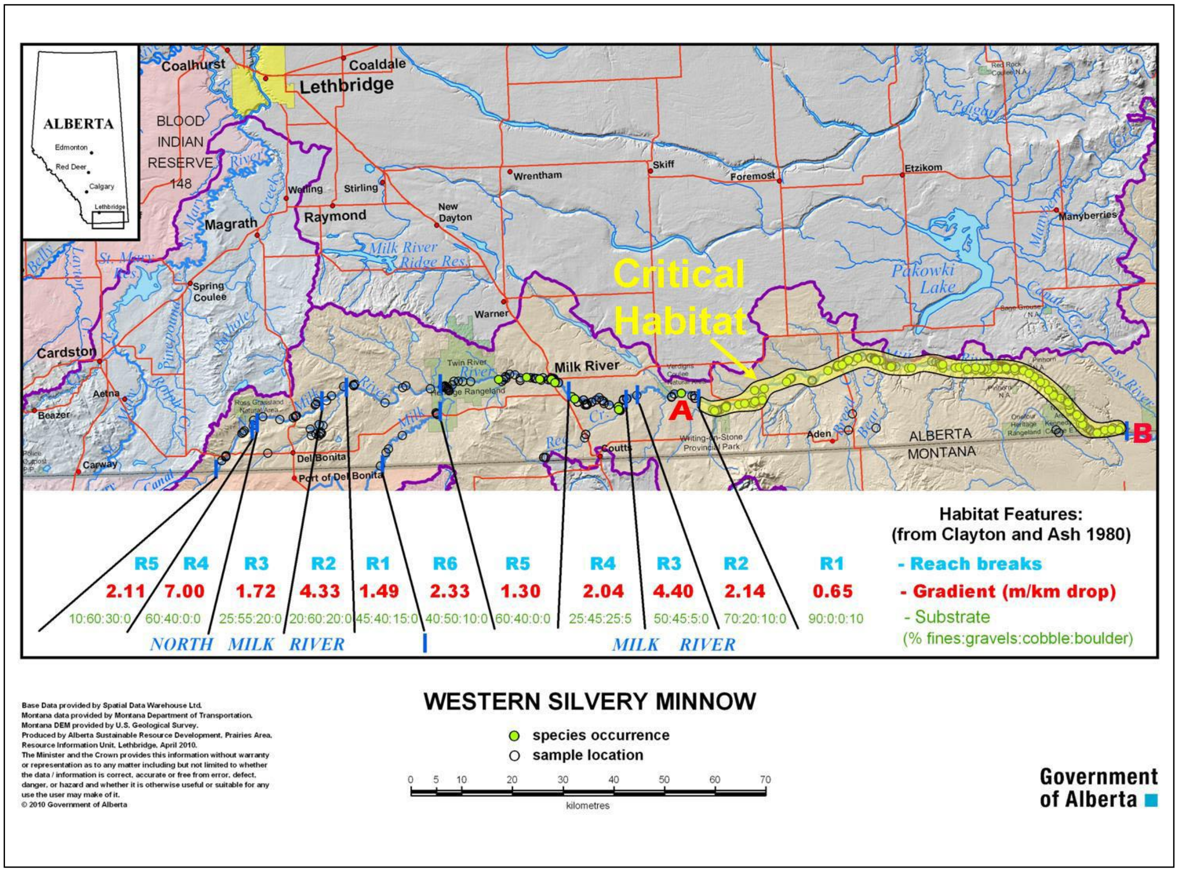

Figure 5. Critical habitat for the Western Silvery Minnow in Canada.

7.2 Schedule of Studies to Identify Critical Habitat

Further research is required to identify and/or refine additional critical habitat necessary to support the species' population and distribution objectives and protect the critical habitat from destruction. This additional work includes the following studies listed in Table 5:

Table 5. Schedule of studies required to refine critical habitat for Western Silvery Minnow in the Milk River.

Description of Study	Rationale	Timeline
Studies to identify and characterize habitat use by life stages of Western Silvery Minnow	There is limited information about the reproductive strategy of adults, specific habitat needs for early life-stages and overwintering requirements. These studies will help refine critical habitat and link habitat use to life stage and season.	2017-2022
Identify availability and location of habitat	Additional areas of occupancy may be identified or further refined for the Western Silvery Minnow. These studies will locate areas within the range of the minnow that have similar features to those described in the above studies and will assist in determining the importance of habitat.	2017-2022
Movement studies	The seasonal movements and area required by individual fish and the population are unknown. These studies will determine the extent of movement for this species, particularly for spawning and overwintering purposes. They may also help refine areas of critical habitat by better understanding distribution.	2017-2022

These studies are designed to provide a more complete picture of the critical habitat requirements of the Western Silvery Minnow. A precautionary approach to the identification of critical habitat was utilized to help meet the population and distribution objective until a more comprehensive analysis has been completed. 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.

7.3 Examples of Activities Likely to Result in the Destruction of Critical Habitat

Under SARA, critical habitat must be legally protected from destruction within 180 days of being identified in a recovery strategy or action plan. For Western Silvery Minnow critical habitat, it is anticipated that this will be accomplished through a SARA Critical Habitat Order made under subsections 58(4) and (5), which will invoke the prohibition in subsection 58(1) against the destruction of the identified critical habitat.

The activities described in Table 6 are neither exhaustive nor exclusive and have been guided by the threats described in Section 4.2 of this document. The absence of a specific human activity does not mean that, when carried out, it will not destroy critical habitat. Furthermore, the inclusion of an activity does not mean that it is automatically prohibited, as an activity that impacts critical habitat short of destruction is not prohibited. The prohibition against the destruction of critical habitat is engaged if a critical habitat order is made. Since habitat use is often temporal in nature, every activity is assessed on a case-by-case basis, and site-specific mitigation measures are applied where they are available and reliable. In every case, where information is available, thresholds and limits are associated with attributes to better inform decision-making. However, there may instances when the information associated with a species' or habitat's threshold of tolerance to disturbance from human activities is lacking and must be acquired prior to determining whether the destruction of critical habitat will occur.

Table 6. Examples of activities likely to result in the destruction of critical habitat for the Western Silvery Minnow

Threat	Activity	Effect –Pathway	Function Affected	Feature Affected	Attribute Affected
Habitat Loss or Degradation	Changes in flow regulation (diversion canal)	Increase in flow from the St. Mary Canal into the Milk River, especially during high spring and summer flows, increases larval drift downstream into unsuitable habitats (reservoirs downstream) and increases erosion of stream banks.	• Spawning and rearing • Dispersion • Feeding and cover	• Backwater, flats and runs	• >100 km of barrier free riverine habitat • Turbid, sediment-laden water, Secchi Disk <65 cm • Riverine (flowing) habitat (<70 cm/sec) • Silt and sand substrate (0.004-2 mm diameter)
Habitat Loss or Degradation	Canal maintenance	Temporary or premature closure of the canal for maintenance activities, especially during low flow periods, can severely reduce the flow of the river or result in isolated pools.	• Spawning and rearing • Dispersion • Feeding and cover	• Backwater, flats and runs	• >100 km of barrier free riverine habitat • Riverine (flowing) habitat (<70 cm/sec)
Habitat Loss or Degradation	Dam construction (water impoundment or reservoir creation) and operation (flow modification)	Impoundments can alter the habitat type, flow regime, sediment load, microbiota, water temperature and increase the risk of species introductions. Instream habitat may become narrower, less turbid, result in fewer fluctuations in temperature and flow and have less substrate movement. Loss of connected riverine habitat and sustained and elevated flows from a reservoir may increase larval drift into unsuitable habitats (reservoirs downstream).	• Spawning and rearing • Dispersion • Feeding and cover	• Backwater, flats and runs	• >100 km of barrier free riverine habitat • Turbid, sediment-laden water, Secchi Disk <65 cm • Riverine (flowing) habitat (<70 cm/sec) • Silt and sand substrate (0.004-2 mm diameter)
Habitat Loss or Degradation	Surface water extraction (non-irrigation)	Temporary Diversion Licenses issued during critical low flow periods could affect Western Silvery Minnow habitat.	• Feeding and cover	• Backwater, flats and runs	• Turbid, sediment-laden water, Secchi Disk <65 cm • Riverine (flowing) habitat (<70 cm/sec)

Point Source Pollution	Release of harmful substances	Stormwater and sewage releases, accidental spills and gas leaks at river and tributary crossings, river crossings at bridges or pipelines, and contamination of water from seismic or drilling activities could affect habitat.	• Spawning and rearing • Dispersion • Feeding and cover	• Backwater, flats and runs	• >100 km of barrier free riverine habitat • Turbid, sediment-laden water, Secchi Disk <65 cm • Riverine (flowing) habitat (<70 cm/sec) • Silt and sand substrate (0.004-2 mm diameter)

8. MEASURING PROGRESS

Upon completion of this recovery strategy, the Western Silvery Minnow Recovery Team may meet periodically or when new information is available. At that time, the performance and implementation of the recovery strategy and the development of any associated action plans for achieving the stated population and distribution objective will be considered and/or reviewed. During the fifth year, the overall recovery strategy will be re-visited to determine whether:

- the population and distribution objective is still valid or needs to be amended; or
- a fundamental change in approach to addressing the population and distribution objective may be warranted.

Any recommendations by the Recovery Team will be forwarded to DFO and AEP through the respective chairs. 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.

9. STATEMENT ON ACTION PLANS

The recovery strategy for the Western Silvery Minnow shall be complemented by subsequent development of a multi-species action plan which will include the Western Silvery Minnow and shall be completed in 2017. To ensure continuity and efficiency, the current Recovery Team will provide advice towards the development of an action plan. The action plan will be reviewed on a five-year basis or as needed to respond to new information.

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12. GLOSSARY

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

Backwater is a still water section of a stream or river beside the main flow but separated by a ridge of land, or habitat at the margin of a riffle or run. Backwaters are often separated from the source during dry seasons.

Bankfull channel is the maximum width the stream attains and is typically marked by a change in vegetation, topography, or texture of sediment.

Catch per unit effort (CPUE) – A measure of the density or population size of an animal that is targeted by fishing. Large CPUEs indicate large populations since many individuals are caught for every unit of fishing effort.

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

Flat - Area of channel characterized by low current velocities; near-laminar (i.e., non-turbulent) flow. Depositional area dominated by sand/silt substrates.

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.

Run - Portion of channel characterized by moderate to high current velocity relative to Pool and Flat habitats; water surface largely unbroken.

Secchi Disk – An instrument for measuring the clarity of water. The disk is lowered into the water and the depth at which it is no longer visible from the surface is recorded.

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 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”.

The results of the threats assessment are summarized in **Table 2**. In that table, questions marks (?) denote uncertainty, and the need for research. Comments provide background on each threat or its assessment.