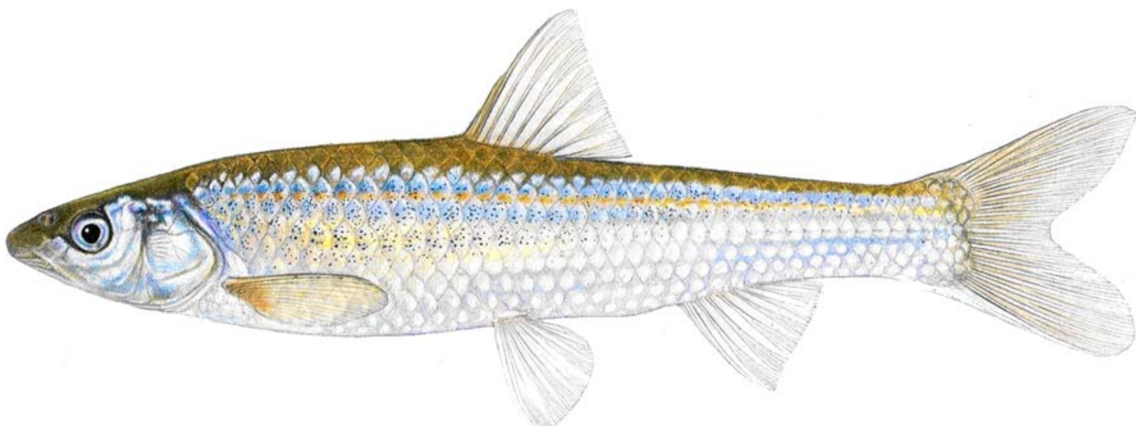
COSEWIC
Assessment and Update Status Report

on the

Western Silvery Minnow
Hybognathus argyritis

in Canada



ENDANGERED
2008

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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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
Ontario

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.

COSEWIC
Executive Summary

Western Silvery Minnow
Hybognathus argyritis

Species information

The western silvery minnow (*Hybognathus argyritis* Girard, 1856) is a small cyprinid and is one of the four species of the genus *Hybognathus* occurring in Canada. It was first discovered in the Milk River in Montana by Girard in 1856. Scott and Crossman later treated the species as a subspecies (*H. nuchalis nuchalis*) of the central silvery minnow (*H. nuchalis* Agassiz, 1855). Currently, the species has again been recognized as the western silvery minnow (*H. argyritis*). This decision was made based on differences in the shape of the basioccipital process between species and has been accepted by the American Fisheries Society.

Distribution

The western silvery minnow is found throughout the Missouri River basin in the United States and in the Mississippi River as far south as the confluence with the Ohio River. In Canada its most northerly distribution occurs only in the Milk River in southern Alberta. A single specimen reported from the South Saskatchewan River near Medicine Hat in 1963 is the only record of a western silvery minnow in the Saskatchewan River system and the only occurrence outside the Missouri/Mississippi drainage system. Additional samplings have not confirmed its presence there.

Habitat

Western silvery minnows occur primarily in slow, turbid habitats commonly found in backwaters and pools of large, silty, plains streams. Spawning habitats and the habitats of the young of the year western silvery minnows are not known.

Biology

Of the *Hybognathus* species found in Canada, the western silvery minnow has the longest life span, reaches the greatest lengths, and is the most fecund. This cyprinid species lives for approximately 4+ years, obtains lengths of 140 mm FL (fork length), and reaches sexual maturity during its third year of life. The spawning period begins in late May and continues until early July. Large fecund females can produce up to 20 000 eggs. The diet of the western silvery minnow is primarily algae, diatoms, and organic matter filtered out from the sediments they ingest.

Population sizes and trends

The population size of western silvery minnows in Canada is unknown. Abundance may have declined in the early 1900s in the Milk River as a result of the combination of water removal for irrigation and extreme drought conditions after the construction of the St. Mary Canal. Since the first collection in 1961 by Grant Campbell there is no evidence that the western silvery minnow population has declined. In 2003, Pollard estimated the population to be no more than a few thousand individuals. This estimate was based on limited records with only 192 specimens sampled. Recent surveys collected a total of 2232 western silvery minnows at several new sites; however, due to its limited distribution the species may be sensitive to future anthropogenic and environmental disturbances.

Limiting factors and threats

The Milk River is unique in that it receives significant flow augmentation in the summer from the St. Mary River, a South Saskatchewan River tributary (Hudson Bay drainage). Water is diverted from the Lake Sherburne Reservoir on the Swift Current Creek in Montana via two siphons and a canal to the North Milk River in Montana. The North Milk then flows into Alberta and joins with the Milk River. The Milk River flows out of Alberta back into Montana and eventually into the Fresno Reservoir in Montana. The Fresno Reservoir restricts upstream fish movement.

Western silvery minnow persistence within the Milk River is dependent on maintaining flow and sediment transport. Current water management infrastructure supplements flow and increases available habitat from March to October. During the shut down period western silvery minnow are exposed to natural low flow amplified by water withdrawals, low dissolved oxygen, and extreme low (freezing) water temperatures. Historically, the siphon has been shut down for repairs in the summer months.

Special significance of the species

The western silvery minnow is probably an important forage species where abundant. The species has economic importance in the United States as a valuable bait fish. In Alberta the species has been banned as live and dead bait. The western silvery minnow also has special significance and interest to the scientific community in relation to the zoogeographic history and distribution of the species subsequent to the Wisconsin Period of glaciation.

Existing protection or other status designations

In Canada, the western silvery minnow was designated as “Threatened” in 2001 by COSEWIC and is listed as such under the *Species at Risk Act* (SARA). In Alberta, the western silvery minnow is currently ranked as “At Risk”. Although this listing does not provide additional protection, it does increase the awareness of the species as possibly threatened and may result in additional research with the goal of obtaining a more detailed status determination.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2008)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as “Vulnerable” from 1990 to 1999, or “Rare” prior to 1990.

** Formerly described as “Not In Any Category”, or “No Designation Required.”

*** Formerly described as “Indeterminate” from 1994 to 1999 or “ISIBD” (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment Canada
Canadian Wildlife Service

Environnement Canada
Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

Update
COSEWIC Status Report

on the

Western Silvery Minnow
Hybognathus argyritis

in Canada

2008

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SPECIES INFORMATION

Name and classification

Class:	Actinopterygii
Order:	Cypriniformes
Family	Cyprinidae
Genus:	*Hybognathus*
Species	*argyritis*
Scientific name:	*Hybognathus argyritis*
Common names:	
English:	western silvery minnow (Nelson *et al.* 2004)
French:	*méné d'argent de l'Ouest* (Conseil canadien pour la conservation des espèces en péril, 2006)

The western silvery minnow (*Hybognathus argyritis* Girard, 1856) is a small cyprinid of the genus *Hybognathus* first discovered in Canada by Grant Campbell in 1961 (UAMZ 5320, University of Alberta Museum of Zoology) (Figure 1).
The *Hybognathus* genus contains seven species in North America, of which four are found in Canada, i.e., the western silvery minnow, the eastern silvery minnow (*H. regius* Girard, 1856), the brassy minnow (*H. hankinsoni* Hubbs, 1929), and the plains minnow (*H. placitus* Girard, 1856) (Robins *et al.* 1991; Schmidt 1994). Along with the eastern silvery minnow, the western silvery minnow was formerly treated as a synonym of the central silvery minnow (*H. nuchalis* Agassiz, 1855) (Pflieger 1980a, b). Scott and Crossman (1973) treated them as subspecies, namely *H. nuchalis nuchalis* in the west and *H. nuchalis regius* in the east. Pflieger (1971) recommended that *H. nuchalis*, *H. argyritis*, and *H. regius* be considered distinct species based on the differences in the shape of the basioccipital process (Pflieger 1971). This decision has been accepted by the American Fisheries Society (Nelson *et al.* 2004).

Figure 1. Western silvery minnow, *Hybognathus argyritis* (92 mm FL) male, collected May 28, 2006 (49.00537, -110.58744).

Morphological description

The average size of the western silvery minnow in Canada is approximately 86 mm fork length (FL) with a maximum FL of 140 mm (Watkinson *et al.* MS 2007). The body is elongate, moderately compressed laterally, and has a stout caudal peduncle. The head is short, bluntly triangular with a moderately large eye; the snout is rounded and overhangs the mouth, which is subterminal. The distance between eyes is about 2 times the eye diameter. The isthmus is very narrow, less than a ¼ width of the head. The pharyngeal teeth (0, 4-4, 0) are not hooked and have a distinct grinding surface. The dorsal fin has eight rays and originates slightly in advance of the origin of the pelvic fins, which have eight rays, but sometimes seven. The caudal fin is forked; the anal fin originates behind the posterior margin of the depressed dorsal fin and usually has eight rays, sometimes nine [eight in Alberta (Nelson and Paetz 1992)]; the pectoral fins are relatively short with 15 or 16 rays. The anterior tips of the dorsal and pectoral fins are pointed. The lateral line is complete and decurved. Lateral-line scales are 36–40. The scales are cycloid with 8 to 11 long radii (Nelson and Paetz 1992). The peritoneum is black and the elongate intestine is coiled on the right side; vertebrae number 36–38 (see Scott and Crossman 1973; Trautman 1957), but 39–41 in Alberta specimens (Nelson and Paetz 1992).

Small nuptial tubercles may be found on the head, back, sides, and on the fins of breeding individuals (sparse on females, more numerous on males). Both sexes are silvery in colour, hence the common name, with a broad, slaty mid-dorsal stripe. Alberta specimens are brownish-yellow dorsally and silver laterally, no lateral band is obvious, but dusky spots may be present (Nelson and Paetz 1992). During spawning the males are light yellow along the sides and the lower fins (Scott and Crossman 1973; Trautman 1957).

Live specimens of the western silvery minnow can be distinguished from the sympatric brassy minnow by a pointed dorsal fin and silvery colour (Scott and Crossman 1973; Nelson and Paetz 1992), a larger body size, four scales between the lateral line and the pelvic fins, a thin black line along the side of the body partly over the dark lateral band, and 5 to 12 radiating grooves on scales lateroventral to the dorsal fin (McAllister and Coad 1974). Close examination of the scales shows the circuli to be much more sharply angulated at the basal corner of the scales in the western silvery minnow than in the brassy minnow.

Genetic description

The genetic population structure of the western silvery minnow in Canada is unknown. Given the lack of obvious barriers between the lowest section of the Milk River in Alberta and the section immediately south of the United States border the potential for gene flow throughout this entire section in most years could be high, likely preventing the development of genetically distinct subpopulations. Thus, the Alberta population of western silvery minnows is a part of the genetic population found in Montana upstream of the Fresno Reservoir. However, this potential is limited; in drought years, such as 2001–2002, the river has been known to be completely dry from the Fresno Reservoir north to the international border and the reservoir itself, at low (< 4%) capacity (K. Gilge, pers. comm. 2002).

Designatable units

This report deals with the species; there is no evidence to support the existence of units below the species level in Canada.

Eligibility

The western silvery minnow is a recognized species (Nelson *et al.* 2004) that is considered to be native to Alberta, although the earliest record dates from 1961 (Nelson and Paetz 1992). It has undoubtedly been there for some time; unnoticed because of the lack of earlier sampling effort, or perhaps misidentified since the species has been known from the Milk River in Montana since 1856. There is no evidence to suggest that the species was introduced.

DISTRIBUTION

Global range

In North America, the western silvery minnow is distributed in large, lowland plains streams of the Mississippi River system, extending from the mouth of the Ohio River north to the Missouri River basin and the Milk River in Alberta, Canada (Pflieger 1980b) (Figure 2). Western silvery minnows are found in the mainstem of the Missouri River and in the mainstem of the Mississippi River only below the mouth of the Missouri River (Burr and Page 1986). Within these systems, distribution appears to be fairly continuous (Pflieger 1980b), although the creation of reservoirs and dams has fragmented some rivers. The distribution of the western silvery minnow in the Milk River extends from its northern limits within Alberta downstream to the Fresno Reservoir in Montana, located approximately 80 km downstream of the border (Stash 2001). Further downstream, populations are fragmented by a series of seven impassable irrigation diversions and dams (from Fresno Reservoir downstream to the Vandalia diversion dam in Montana) before the confluence with the Missouri River (K. Gilge, pers. comm.). Willock (1968 1969a) indicated that western silvery minnow distribution in the United States has declined from the extensive areas it once occupied, but no specific locations were provided. These older studies suggest that changes in extent of distribution likely occurred much earlier in the century, but no specific records for western silvery minnow were available.

Figure 2. The distribution of western silvery minnow in North America. From Pflieger (1980b), U.S. Fish and Wildlife Service (1995), Houston (1998b), and United States Geological Survey (2001).

Canadian range

The western silvery minnow's range in Canada appears to be restricted to the Milk River, the northwestern most tributary of the Missouri River system (Figure 3). Although Henderson and Peter (1969) documented a single specimen of a western silvery minnow from the South Saskatchewan River within the city limits of Medicine Hat in 1963, a series of sampling efforts in 1974–1975 and during 1994–1996 in this area, as well as upstream and downstream of this section, did not detect any additional specimens (W. Roberts, pers. comm.). The specimen collected by Henderson and Peter (1969) is believed to be a spurious account and not representative of a breeding population. Its presence is thought to be the result of an accidental release of bait fish (Henderson and Peter 1969) rather than a misidentification, because its identification was confirmed by experts in the field (W. Roberts, pers. comm. 2002). If confirmed, this would be the only known occurrence of the species outside of the Missouri/Mississippi drainage. However, additional samplings have not confirmed its presence there (Clayton pers. comm. 2008).

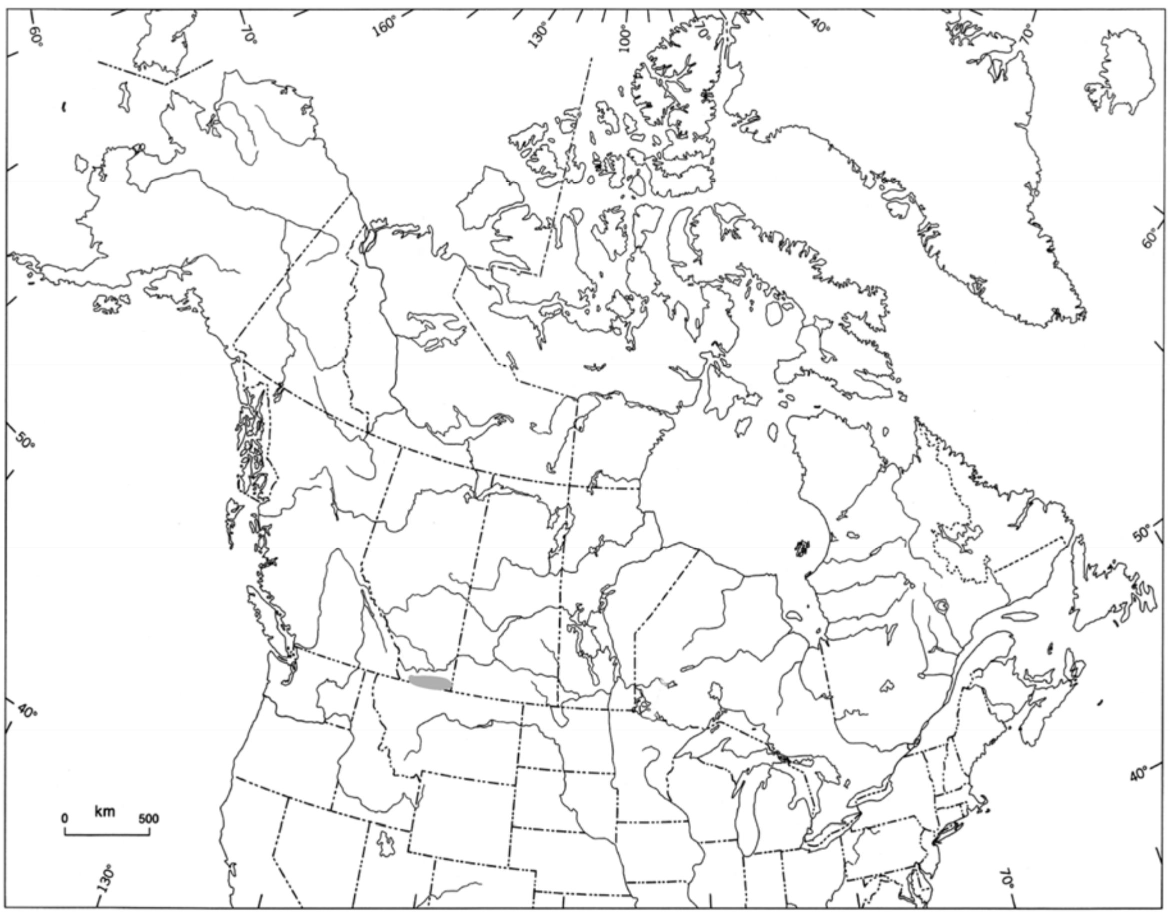

Figure 3. Canadian distribution of the western silvery minnow, *Hybognathus argyritis*.

The previous distribution of western silvery minnow within the Milk River was thought to be limited to the lower section of the river from Police Creek (approximately 140 km upstream) to the United States border (Figure 4) (Scott and Crossman 1973; Pflieger 1980b, Sikina and Clayton 2005). Watkinson *et al.* (MS 2007) extended the western silvery minnow distribution to approximately 15 km downstream of the North Milk River and Milk River confluence (223 km upstream from the United States border). Western silvery minnow distribution downstream of Aden Bridge (approximately 100 river kilometres from the United States border) was confirmed and extended in 2005 and 2006 (Watkinson *et al.* MS 2007). The extent of occurrence of the western silvery minnow in Canada was estimated to be 1200 km^2 (estimated from a convex hull around the river stretch from the U.S. border to one km past the last distribution point upstream), the area of occupancy at 244 km^2 [based on overlaid grid of cells one km^2, total area of occupancy is the number of squares that are intersected by the river from the U.S. border to one km past the last upstream distribution point]. The biological area of occupancy was estimated at 13.4 km^2 [based on occupied riverine habitat assuming average river width of 60 m from the U.S. border to 1 km past the last distribution point upstream].

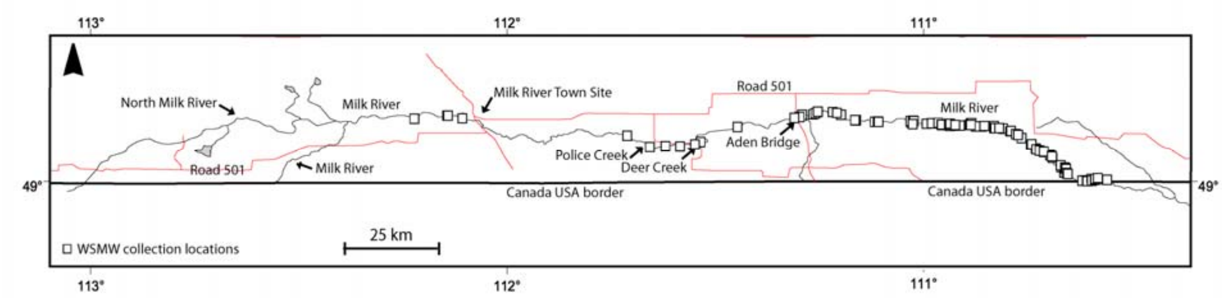

Figure 4. Canadian distribution of western silvery minnow (*Hybognathus argyritis*) in the Milk River, Alberta.

Occurrences are based on evidence of historic and/or current likely recurring presence at a given location. Occupied sites separated by a gap of 15 km or more of any aquatic habitat that is not known to be occupied are taken to represent different locations. Thus, western silvery minnow in Canada occur within one location, although the gap of approximately 42 km between sites above the Town of MilK River, and those downstream of the town, might imply two. Further sampling is required to confirm the lack of silvery minnow in the area. Dams, impassble falls and upland habitat constitute separation barriers (Hammerson 2004 as cited in NatureServe 2007). Data on dispersal and other movements are generally not available, and separation distances (in aquatic kilometres) for cyprinids are arbitrary, but do take into consideration that movements and separation distances generally increase with fish size.

HABITAT

Habitat requirements

Adult western silvery minnows inhabit the lower sections of the Milk River where the river is described as low gradient and even-flowing, with many backwater areas and shallow flat and run habitats. Within this section of river, adult presence was strongly associated with backwaters and pool habitats where velocities are minimal, ranging from 0–1.1 m/s with a mean velocity of 0.22 m/s, temperatures ranging from 13.6°C in May to 27.2°C in July, average depths of 0.32 m with a maximum depth of 1.0 m, and silt as the dominant substrate (Watkinson *et al.* MS 2007). Western silvery minnows were captured in habitats with high turbidity, with Secchi disk transparency ranging from 0.13−0.16 m in May 2006, and 0.12−0.18 m in July 2005, downstream of Aden Bridge (Watkinson *et al.* MS 2007). Watkinson *et al.* (MS 2007), and Quist *et al.* (2004) found that western silvery minnows are positively correlated with percentage of fine substrate in reaches of the Missouri River drainage and favour habitats with increased turbidity and silt deposition. In addition, given the lack of other refugia in the lower Milk River, Sikina and Clayton (2005) suggest western silvery minnows utilize turbidity as a means of protection and cover.

In total, only five specimens have been collected from three sites in the Milk River upstream of the Town of Milk River (208, 213 and 223 km upstream of the U.S. border) (Watkinson *et al.* MS 2007). At these sites, the river flows through erosion-resistant sandstone formations and is characterized by increased runs, riffles and rapids (RL&L 2001). This data suggests only limited or marginal use of such habitats. Velocities ranged from 0.41–0.65 m/s, depth ranged from 0.42–1.2 m, Secchi disk transparency was 0.63 m, and June water temperature was 17.7°C (Watkinson *et al.* MS 2007). Sand was the dominant substrate at two of the sites while the third site was dominated by gravel (Watkinson *et al.* MS 2007).

In the United States the presence and abundance of the western silvery minnow is strongly associated with a number of habitat features including bottom type, gradient, and turbidity (Quist *et al.* 2004). The western silvery minnow occurs in the Mississippi River proper only below the mouth of the Missouri River, a transitional area with increased turbidity, increased velocity, shifting sands, and silty substrates providing suitable habitat for the western silvery minnow (Burr and Page 1986). These characteristics also are common in the Missouri River, where western silvery minnow is common to dominant throughout the system (Cross *et al.* 1986). In particular, the lower Missouri River has extreme fluctuations in water flow throughout the year, high silt loads, and unstable streambeds devoid of vegetation (Cross *et al.* 1980). These same conditions generally occur in the lower reaches of the Milk River.

Abundant rearing and feeding habitat for the western silvery minnow are thought to be present in the lower Milk River in Alberta (RL&L 2001). With the exception of extreme drought conditions, such as occurred between 1998 and 2004, quiet waters with low to moderate velocities are usually prevalent (RL&L 2002a).

Overwintering requirements of the western silvery minnow are unknown (Clayton and Ash 1980). Limited data from the Milk River suggest water depths and oxygen levels would not appear to limit overwinter use (Clayton and Ash 1980).

Spawning habitat of western silvery minnows has not been determined. Areas rich in aquatic vegetation have been listed as a key feature for spawning habitat for the Mississippi silvery minnow and the eastern silvery minnow (Scott and Crossman 1973; Ramshaw and Mandrak 1997). Western silvery minnows must utilize different spawning habitat or strategy, as the Milk River is devoid of aquatic vegetation due to high silt loads and unstable stream beds. Although flooded quiet backwaters were proposed as possible spawning habitat in the Milk River, recent sampling efforts in these areas failed to observe any eggs, larvae or fecund females (Clayton and Pollard pers comms. 2008). It is more likely that they are pelagic broadcast spawners similar to the Rio Grande silvery minnow (*Hybognathus amarus* (Girard, 1856)) and plains minnow with semi-buoyant eggs (Platania and Altenbach 1998). These species rely on adequate water flows and intact stretches of river to passively disperse eggs to downstream habitats. As such, impoundment and changes to hydrology seriously undermine this spawning strategy.

Habitat trends

The greatest changes to western silvery minnow habitat in Alberta have been associated with irrigation needs. In 1917, the St. Mary Canal (Figure 5) was completed in Montana to divert water from the St. Mary River to the North Milk River for irrigation purposes. In most years, the canal diverts water from March to October, increasing the water volume in the North Milk River and the Milk River proper. The water in the Milk River (and St. Mary River) is shared by Canada and the United States via the order in the Boundary Waters Treaty. During the augmentation period in the Milk River in Canada (March to October), Canada must leave the majority of that water for the U.S., so it is not available irrigation water. According to the agreement, the U.S. is able to use the Milk River in Canada simply for conveyance of water (Petry, pers comm. 2008).

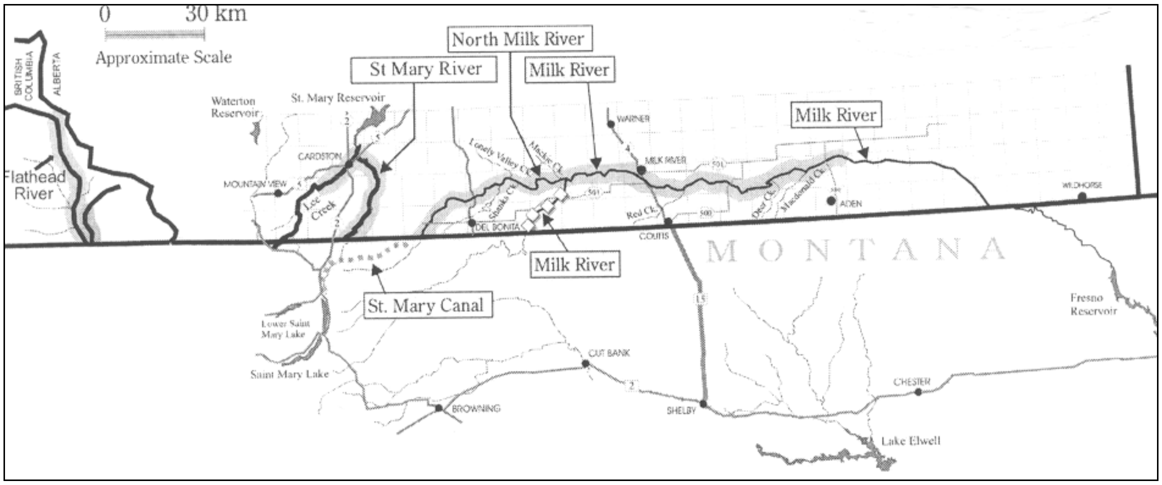

Figure 5. Milk River system, upstream of the Fresno Reservoir.

Before the construction of the diversion, the Milk River was probably a typical small prairie stream, possibly intermittent in times of drought, and generally less turbid (Willock 1969b). The even-flowing waters now observed in the lower Milk River in Alberta were probably mainly restricted to downstream of the international border before the diversion was constructed (Willock 1969b). The significant increase in water volume since the canal went into use is believed to have extensively altered the ecological regime of the Milk River (with the exception of the Milk River upstream of its confluence with the North Milk River. The result has been the creation of a more turbid, higher-flow system in the North Milk and Milk rivers in Alberta (Willock 1969b).

Since the construction of the St. Mary Canal, no major losses or changes in habitat have occurred. Rather, the availability of habitat is highly variable from year to year, and mainly dependent on adequate water flows, particularly in the late summer and fall, as well as for overwintering. During periods of very low flows, the western silvery minnow may experience temporary reductions in available habitat and under extreme drought conditions, such as those of fall and winter 2001/2002, temporary habitat fragmentation. The extent of the drought during this period was such that the lower section of the Milk River in Alberta, where most minnows have been documented, was reduced to a series of isolated pools, many of which were not deep enough to support overwintering fish (RL&L 2002a). A winter survey of a subset of these pools did not find any minnows present (RL&L 2002a). Furthermore, south of the international border, the Milk River was completely dry to the Fresno Reservoir from September 2001 to February 2002, and the reservoir was only at 4% of its capacity (K. Gilge, pers. comm.). Western silvery minnows may also be present in the Fresno Reservoir but this has not been confirmed by surveys (K. Gilge, pers. comm.). Therefore, limited re-colonization potential from upstream and downstream sections in the system exists. Downstream of the Fresno Reservoir in Montana, six more impassable dams upstream of the confluence with the Missouri River prevent any upstream dispersal of western silvery minnow (Stash 2001, K. Gilge, pers. comm.).

Southern Alberta is susceptible to extreme drought conditions during the summer, and naturally low flows at this time of year may be exacerbated by the seasonal operation of the St. Mary Canal, and by water removal for irrigation (Pollard 2003). In 2001, the August, October and December discharges were 50%, 7% and 6% of historic values, and the October, December rates in 2002 were 11% and 20%. Such low flows could seriously limit overwintering habitat, and in fact, during the late fall and winter of 2001/2002 the lower Milk River dried up completely, except for a number of isolated pools (R.L. & L. 2002a,b). This severity of drought conditions in southern Alberta is not uncommon (Pollard 2003) and may be more common given predicted changes in aquatic ecosystems associated with global climate change (Poff *et al.* 2002). This may prevent populations from expanding, and even more significantly, the higher temperatures that accompany the summer drought would expose all fish species, including the silvery minnow, to increased risk which may be exacerbated by ongoing maintenance of the St. Mary Canal that results in closures of the canal for extended periods.

Conserving western silvery minnows in Canada is likely dependent on maintaining flows and sediment erosion and deposition within the Milk River. While rearing and feeding habitat for the western silvery minnow in Alberta appears to be abundant in most years, the availability of overwintering habitat may be limited in some years, depending on flow conditions. In particular, the combination of extreme drought conditions and water removal could severely reduce or even eliminate winter refugia for the western silvery minnow in the lower Milk River.

Habitat protection/ownership

The federal *Fisheries Act* of Canada (R.S. 1985, c F-14) provides protection for the habitat of western silvery minnow by prohibiting the harmful alteration, disruption or destruction of fish habitat unless authorized by the Minister (S 35). It also prohibits the deposit of deleterious substances into waters frequented by fish (Ss. 36.3).

The *Canadian Environmental Protection Act* (1999, c. 33), which is in place to prevent pollution and protect the environment and human health, focuses on regulating and eliminating the use of substances harmful to the environment. In addition, habitat of the western silvery minnow receives further protection via the provisions in the *Canadian Environmental Assessment Act* (1992, c.37). When certain regulatory duties are exercised under the *Fisheries Act*, a mandatory environmental review is undertaken that considers a broader scope of environmental effects including species at risk.
The *Species at Risk Act* (SARA) [2002, c.29] makes it an offence in section 33 to damage or destroy the residence of one or more individuals of a listed endangered or threatened species (Ss.58.1; SARA 2007).

In Alberta, the western silvery minnow is currently ranked as “At Risk” according to The General Status of Alberta Wild Species 2005. Although this listing does not provide additional protection, priority may be given to this species in order to conduct additional research to obtain a more detailed status determination. In 2003, the species was approved for listing as “Threatened” provincially, and since 2002 the species is no longer allowed for use as live or dead bait in Alberta. Western silvery minnow are currently in the Alberta *Wildlife Act* under "Endangered Fish". The Act lists both Threatened and Endangered species as "Endangered Fish" -but such listed species can be further defined in law as E or T (Court, pers. comm. 2008). Despite being listed as Threatened, there exist no prohibitions/protections for silvery minnows in Alberta.
A draft set of regulations has been prepared, but have yet to become law.

Provincially, as federally, various legislation and regulations provide protection for species at risk. The Alberta *Wildlife Act* (R.S.A. 2000, W-10) requires the responsible Minister to establish an Endangered Species Conservation Committee that will advise on issues relating to species at risk in Alberta. The *Environmental Protection and Enhancement Act* (Chapter/Regulation: E-12 RSA 2000) protects land, water, and air through a legislated environmental assessment process. The *Alberta Public Lands Act* (R.S.A. 2000, c. P-40) enables the regulation of the use of Crown Lands, and the *Alberta Water Act* (Chapter/Regulation: W-3 RSA 2000) provides for the management, protection and allocation of provincial water resources.

Currently, approximately 56% of the land bordering the Milk River mainstem and North Milk River is publicly owned; the rest is held privately. Only 11% of the public and 14% of the private lands have conservation plans that include riparian protection (Milk River Species at Risk Recovery Team 2007). The remaining land has been traditionally 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 has been designated park land, for public use and access during the summer months.

Other agencies that may be associated with aspects of watershed conservation include: Environmental Farm Planning, Alberta Riparian Habitat Management Society (Cows and Fish), Operation Grassland Community, Ducks Unlimited, MULTISAR, Nature Conservancy, Agriculture Canada, and Alberta Agriculture (Milk River Species at Risk Recovery Team 2007).

BIOLOGY

General

The western silvery minnow is a small cyprinid species that generally lives to an age of 4+ years and attains FLs of up to 140 mm (Watkinson *et al.* MS 2007). Size of fish caught in the Milk River in 2005 and 2006 with estimated ages of 1+, 2+, and 3+ had corresponding FLs of 51−63, 67−88 mm, and 95−114 mm (Watkinson *et al.* MS 2007). During this same study, 100 western silvery minnows were collected from the

Milk River in Montana in May 2006. These minnows had a multi-modal distribution in length over the sample range with the suggestion of two peaks in the 26–74 mm (FL) range. The maximum frequency observed was for fish of 58–60 mm FL. The length-weight relationship for these specimens was expressed by the equation: Log W = 3.3878 (Log L) - 5.6199, where W is weight in grams and L is fork length in millimetres. Both sexes appear to reach sexual maturity at 2+ years or at the beginning of their third year of life. Female eastern silvery minnow start spawning at age one, 50 to 55 mm standard length (SL) and males start spawning during their second year of life (Raney 1939).

The growth rate of the Milk River western silvery minnow was slower than reported for the Mississippi silvery minnow (Becker 1983; Taylor and Miller 1990) but more rapid than reported for the eastern silvery minnow (Raney 1942), and similar to the plains minnow (Taylor and Miller 1990). The growth of young-of-the-year (YOY) Mississippi silvery minnows is rapid, reaching an average length of 52−69 mm total length (TL) by September in two Wisconsin rivers (Becker 1983; Taylor and Miller 1990). Becker (1983) reported only one female Wisconsin fish of 107 mm TL that lived to 3 years. Eastern silvery minnow (*H. regius* Girard, 1856) hatched in late April were 31 mm TL on 20 June and 45 mm TL by 15 July (Raney 1942). By the end of their second summer the average TL was 80 mm and by the end of their third summer the average TL was 82 mm for males and 88 mm for females (Raney 1942). The 140 mm FL western silvery minnows caught by Watkinson *et al.* (MS 2007) were the largest reported FL for a western silvery minnow sampled in Canada. The ages obtained for western silvery minnows were higher than those of closely related *Hybognathus* species (Watkinson *et al.* MS 2007). This is not an uncommon observation for fish species sampled at the extreme northern extent of its range.

Sizes for newly hatched western silvery minnow larvae have not been determined. Raney (1939) found newly hatched eastern silvery minnow larvae to be 6 mm TL in July and about 51 mm by August. Larvae stages for the eastern silvery minnows have been described and illustrated by Mansueti and Hardy (1967).

Reproduction

In Canadian waters, spawning for the western silvery minnow appears to take place between late May and early July when water temperatures range between 13.6 and 26.8°C (Watkinson *et al.* MS 2007). Females with mature eggs were collected from the Milk River in May 2006 (Watkinson *et al.* MS 2007). In July of 2005, when water temperatures were >20°C, large females were collected, but had limited numbers of bound mature eggs. Eddy and Underhill (1974) also reported that *Hybognathus nuchalis* (= *argyritis*) spawn in May and June in Montana.

Spawning in the plains minnow is protracted from April to August (Gilbert 1980) and there is evidence to suggest that the same may be the case for the eastern silvery minnow (Scott and Crossman 1973) and the central silvery minnow (Forbes and Richardson 1920).

In the previous western silvery minnow status report, Houston (1998a) suggested that like the eastern silvery minnow (Raney 1939), the western silvery minnow may spawn in heavily vegetated backwaters in slower moving reaches of the Milk River. It is possible that the western silvery minnow utilizes shallow backwaters with little or no current and silt substrate for spawning, which is similar to the spawning habitat of pond-raised eastern silvery minnows that Raney (1942) propagated, or as reported for the Mississippi silvery minnow (Eddy and Underhill 1974). However, unlike the spawning habitat of the eastern silvery minnow, the Milk River is a hydrologically dynamic, turbid prairie river with little or no aquatic vegetation due to the highly mobile bed. The western silvery minnow is more likely to have a similar spawning strategy to that of the Rio Grande silvery minnow or the plains minnow. Both of these closely related species are pelagic, broadcast spawners (pelgophils) that produce nonadhesive, semi-buoyant eggs that remain in suspension as long as there is current (Platania and Altenbach 1998).

Of the western silvery minnows collected in the Watkinson *et al.* (MS 2007) study, the smallest mature female was age 2+ with a FL of 81 mm collected in July 2005. Other mature females collected ranged in size from 82–127 mm FL. The fecundities of 11 of these fish varied based on female size with the smallest female of 81 mm FL having 2924 eggs and the largest female of 127 mm FL having 19 573 eggs. Compared to the fecundity counts of the eastern silvery minnow in Raney (1942), the larger western silvery minnow produced a significantly greater number of eggs.

Physiology

Species tolerances of poor water quality, high or low temperatures, high turbidity, and low dissolved oxygen levels for the western silvery minnows are not known. However, due to the types of the habitats they inhabit, western silvery minnows appear to be very tolerant of high turbidity and possibly of high temperatures and low dissolved oxygen levels. Matthews and Maness (1979) found the plains minnow, a closely related *Hybognathus* species, to be more tolerant of low dissolved oxygen levels and higher temperatures (40°C) than many other cyprinid species. The brassy minnow has been found to be tolerant of water temperature up to 35.5°C and dissolved oxygen levels of 0.03 mg/L (Scheurer *et al.* 2003). In addition, Buhl (pers. comm. 2007) found the Rio Grande silvery minnow was able to tolerate living in 100% effluent for extended periods of time (21–28 days) with 0% mortality. In general, these findings suggest that most *Hybognathus* species are very hardy fish and can tolerate extreme conditions.

Dispersal/migration

No information regarding movement patterns or dispersal ability is available for the western silvery minnow. Raney (1939) noted that adult eastern silvery minnows migrated to inshore waters of lakes and larger rivers in the spring to spawn, but it is not clear how far these fish migrated. As broadcast spawners they probably move up river to spawn, allowing the eggs to disperse some distance downstream (Pollard, pers. comm. 2008). Similarly, no information is available regarding the ability of the species to disperse and recolonize new or empty habitats. The fact that the western silvery minnow has likely undergone fairly regular drought conditions in the past and still persists in the Milk River suggests that it has the ability to disperse short distances into reaches of the river that may have temporarily been devoid of water.

Diet

All species of the genus *Hybognathus* have pharyngeal taste buds or papillae arranged in a pattern that suggests a filtering apparatus for trapping diatoms and other small food items (Hlohowskyj *et al.* 1989). Stomach content analysis of Milk River specimens (Watkinson *et al.* MS 2007) found that western silvery minnows fed largely on bacillariophytes (35%), chlorophytes (26%), plant remains (23%), and cyanophytes (10%) in May 2006. Smaller quantities of carbon, fungi, chrysophytes, pollen, zooplankton remains, heterocysts, rotifers, and protozoans were also found. Similar gut contents were found for the eastern silvery minnow (Gascon and Leggett 1977), the Mississippi silvery minnow (Forbes and Richardson 1920), and the plains minnow (Gilbert 1980). All species apparently ingest silt and bottom ooze from the backwaters and pools that they inhabit, filtering out and digesting the algae, diatoms, and organic matter.

The diet of YOY western silvery minnows is unknown. In Lac Memphremagog, Quebec the diet of 0+ eastern silvery minnow was found to change from cladoceran (82% by volume), rotifers (8.4%) and chironomids (7%) to organic detritus (95%) and cladocerans (3%), as the average FL increased from 32 to 44 mm (Gascon and Leggett 1977). Individuals greater than 40 mm FL fed almost exclusively on organic detritus, except in June when 46% of their diet consisted of cladocerans.

Interspecific interactions

The predators, parasites, and diseases of the western silvery minnow are not known. The silvery minnows in North America were found to have three species of parasites associated with them including three trematode species, one protozoan, and the larval form of the cestode, *Ligula intestinalis*. (Hoffman 1967). Seventeen fish species have been documented as co-occurring with western silvery minnow in the Milk River (Table 1). Piscivore species such as sauger (*Sander canadensis* (Griffith & Smith, 1834)), burbot (*Lota lota* (Linnaeus, 1758)), northern pike (*Esox lucius* Linnaeus, 1758), and yellow perch (*Perca flavescens* (Mitchill, 1814)) may negatively impact western silvery minnow populations in the Milk River. In addition, if a low flow condition occurred during the summer western silvery minnows could be exposed to aquatic, avian, and terrestrial predators.

Table 1. Fishes species of the Milk River watershed occurring within the range of the western silvery minnow (Alberta Sustainable Resource Development 2003: Milk River Fish Species at Risk Recovery Team 2007).

Common Name	Scientific Name
Brassy minnow	*Hybognathus hankinsoni*
Brook stickleback	*Culaea inconstans*
Burbot	*Lota lota*
Fathead minnow	*Pimephales promelas*
Flathead chub	*Hybopsis gracilis*
Lake chub	*Couesius plumbeus*
Longnose dace	*Rhinichthys cataractae*
Longnose sucker	*Catostomus catastomus*
Mountain sucker	*Catostomus platyrhynchus*
Northern pike	*Esox lucius*
Sauger	*Sander canadensis*
Eastslope sculpin	*Cottus sp.*Y
Stonecat	*Noturus flavus*
Trout-perch	*Percopsis omiscomaycus*
White sucker	*Catostomus commersonii*
Walleye	*Sander vitreum*
Yellow perch	*Perca flavescens*

Behaviour/adaptability

The western silvery minnow is a schooling fish and has been found to school with flathead chubs (*Platygobio gracilis* (Richarson, 1836)) (Watkinson *et al.* MS 2007). They have maintained populations in the Milk River, where drought, low and high water temperatures, and low dissolved oxygen concentrations are common.

POPULATION SIZES AND TRENDS

Fluctuations and trends

There is little information available to establish population size or trends (Houston 1998a). The western silvery minnow appears to be native to the Alberta fish fauna and has been there for some time; unnoticed or perhaps misidentified. The species was first described as *Hybognathus argyritis* by C.P. Girard in 1856 from specimens collected in the Milk River in Montana (Nelson and Paetz 1992). Grant Campbell collected the first western silvery minnow in Canada in 1961 (UAMZ 5320, University of Alberta Museum of Zoology). Over the next four decades sporadic collections were made verifying the presence of the western silvery minnow in the Milk River. Watkinson *et al.* (MS 2007) reported the furthest upstream western silvery minnow distribution in the Milk River approximately 15 km downstream of the Milk River and North Milk River confluence, where five western silvery minnows were collected.

It is suspected that both the extent of distribution and abundance of western silvery minnow within the Milk River may have been altered significantly prior to this time (in the early 1900s), when the St. Mary Canal was constructed to divert irrigation water from the St. Mary River to the Milk River. Since it was first identified in the early 1960s the known western silvery minnow distribution in the Milk River has been expanded with additional sampling effort.

It is uncertain if abundance in the Milk River has changed since it was first identified in Alberta in the 1960s as limited sampling has been conducted in the Milk River. Based on historical records from 1961–2003, Pollard (2003) estimated the western silvery minnow population to be no more than a few thousand individuals. Recent findings suggest that the populations of western silvery minnows in the Milk River are much higher than was previously believed (Sikina and Clayton 2005; Watkinson *et al.* MS 2007). Watkinson *et al.* (MS 2007) and Sikina and Clayton (2005) caught a total of 2232 western silvery minnows in the Milk River in 2005 and 2006. Sikina and Clayton (2005) caught 88 western silvery minnows seine netting with a catch per unit effort (CPUE) of 0.4 and 0.9 fish/100 m^2 in the summer and fall of 2005, respectively. Total CPUE was 0.6 fish/100 m^2. Minnows were caught at all sample sites (N = 12) with the largest sample consisting of 16 individuals. They also witnessed a school of approximately 150 western silvery minnows near Deer Creek confluence with the Milk River in October of 2004 (Sikina and Clayton 2005). Watkinson *et al.* (MS 2007) caught an additional 2 144 western silvery minnows from the backwaters and pools in the lower section of the Milk River downstream of Aden Bridge to the United States Border in 2005 and 2006. Catch per unit effort (CPUE) electroshocking produced 0.004 fish/s in July 2005 and 0.007 fish/s in May 2006 (Watkinson *et al.* MS 2007). While seine netting, total CPUE was 19.59 fish/100m^2 in July 2005 and 72.15 fish/100m^2 in May 2006 (Watkinson *et al.* MS 2007). Within these samples, large numbers of 1+ fish were caught suggesting the Milk River western silvery minnow population is stable. The largest catch, 578 western silvery minnows was sampled near the mouth of Deer Creek in October 2006.

Watkinson *et al.* (MS 2007) found western silvery minnows comprising 29% of the total catch in the Milk River. Stash (2001) reported that all *Hybognathus* species combined comprised a large portion of the fish community, making up 5.78% of the total fish species composition, but made no attempt to identify the *Hybognathus* specimens to species level. The western silvery minnow is common throughout the Missouri River, where it is a dominant species in the lower reaches (Cross *et al.* 1986). Pflieger (1980b) stated that where they still occur in the United States, the western silvery minnow is considered common. Unfortunately, no specific information was available to establish population sizes or trends for any of these areas (Houston 1998a).

In the absence of historical information, it is not clear what impact increased flows associated with the diversion of the St. Mary River after 1917 have had on western silvery minnow populations in the Milk River. Although the diversion has significantly increased summer flows, baseline conditions are restored during the late fall and winter months after the diversion has been terminated possibly limiting any benefit that might be derived from increased summer habitats.

Rescue effect

The available habitat for the western silvery minnow in Alberta is restricted to the portions of the Milk River in Canada. Re-colonization is only possible from that portion of the Milk River in Montana upstream of the Fresno reservoir where there are no impediments to migration or exchange with Canadian populations. Any populations downstream of this have been effectively isolated. However, re-colonization may be temporarily restricted by drought conditions (*see* Habitat Tends).

LIMITING FACTORS AND THREATS

Habitat loss/degradation

Habitat loss, either through degradation or fragmentation, is a serious threat to the survival of western silvery minnow in the Milk River. The Milk River Fish Species at Risk Recovery Team (2007) identified a number of existing or potential activities related to water use contributing to this threat, including: 1) changes in flow associated with the diversion, 2) canal maintenance, 3) water storage projects, 4) groundwater extraction, and 5) surface water extraction.

Southern Alberta is susceptible to extreme drought conditions; water diverted from the St. Mary River has reduced the effects of drought during the augmentation period (March to October) when water is not available for irrigation. There have been discussions of maintenance and re-construction of the St. Mary Canal system. Proposed changes run the gamut of options from abandonment to increasing the capacity (Alberta Environment 2004; U.S. Bureau of Reclamation 2004) of the reservoir and flow rates. Whatever the results of these discussions, any change in the flow of the canal system will undoubtedly impact the available habitat in the Milk River (Milk River Fish Species at Risk Recovery Team 2007). It is difficult to comment on the precise nature of such impacts associated given the uncertainty of the canal's future. However, three likely scenarios can be expected depending on the change. Increased flows could further impact channel morphology where the river banks are already prone to erosion during the high spring and summer flows. Although increased siltation and turbidity arising from bank erosion might benefit the species, increased water velocities might threaten spawning and rearing habitat. Specifically, it is predicted that any increase of flow above the existing 650 cfs capacity of the canal will significantly reduce the likelihood that drifting eggs settle in suitable riverine habitat; settlement in the reservoir could effectively act as a population sink for Alberta's minnow population (Milk River

Fish Species at Risk Recovery Team 2007; Clayton, pers. comm. 2008). On the other hand, abandonment of the canal could, combined with extreme drought conditions, reduce the lower Milk River, and much of the species habitat, to a series of isolated pools in late summer, as happened twice over the last 30 years (Milk River Fish Species at Risk Recovery Team 2007). As the canal continues to age, the threat of structural failure increases, and repair rate will undoubtedly increase (Clayton and Pollard, pers. comms. 2008). The severity of drought conditions in southern Alberta is not uncommon (Pollard 2003) and may be more common given predicted changes in aquatic ecosystems associated with global climate change (Poff *et al.* 2002; Schindler and Donahue 2006). In particular, given that the Milk River is situated in one of the most arid regions of Canada, continuing trends in reduced snow pack in the Rocky Mountains suggest that the frequency of drought conditions will increase (Rood *et al.* 2005). These conditions will be acerbated by increasing water requirements for irrigation.

The feasibility of developing a dam on the Milk River upstream of the Town of Milk River has been, and continues to be investigated. The potential impacts on the western silvery minnow will need to be taken into consideration, particularly in regard to flow regimes. Changes associated with irrigation and impoundments may be a significant limiting factor to the western silvery minnow.

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). Elsewhere in the Great Plains, modifications to habitat, particularly those associated with impoundments, have become a serious limiting factor for the western silvery minnow (Cross *et al.* 1986). Impoundments have probably had the greatest cumulative effects on fish fauna of the western Mississippi Basin, including *H. argyritis* (Cross *et al.* 1986; United States Geological Survey 2002). These impoundments alter habitat type, stimulate introductions of exotic species and alter flow regimes, sediment loads, and microbiota (small, often microscopic organisms), resulting in streams that are generally narrower, less turbid, less subject to discharge and temperature variations (Cross *et al.* 1986), and less productive. Such changes to streams have resulted in changes to habitat diversity, and several species have declined, including the western silvery minnow, as they are adapted to shallow sandy streams with widely fluctuating flows, high turbidity and extreme summer temperatures (Cross *et al.* 1986). Such species that were once abundant and widespread are now out-competed by pelagic planktivores and sight-feeding carnivores, including introduced salmonids (Cross *et al.* 1986).

Ground and surface water extraction

Groundwater and surface water are connected, but their relationships are complex. An ongoing study on these relationships is expected to be completed in 2008 (Clayton and Pollard, pers. comms. 2008). Grove (1985) found that there was a natural loss of surface flow to groundwater in the Milk River. During winter when low flow conditions can persist, excessive diversion of groundwater could affect the availability and quality of western silvery minnow overwintering habitat (Milk River Fish Species at Risk Recovery Team 2007). However, at this time no information on overwintering habitat exists. Currently, there is no licence requirement for groundwater extraction.

Surface water extraction for irrigation could reduce habitat in the Milk River, but the threat is considered low as only a small portion of the available flow is withdrawn as it occurs during the augmentation period and these withdrawals are regulated (Milk River Fish Species at Risk Recovery Team 2007). In contrast, Temporary Diversion Licenses (e.g. for oil and gas related activities) are issued throughout the year including critical low flow periods, although they can be (and have been) suspended under extreme low flow conditions, such as when the canal has been shut down for repairs. Western silvery minnow overwintering habitat may be vulnerable to this type of extraction at a time when low flow conditions are already in effect. In addition to loss of flowing water and physical habitat, reduced dissolved oxygen levels during the winter could seriously impact the survival of western silvery minnow and other fish species (Milk River Fish Species at Risk Recovery Team 2007). Noton (1980) concluded that the most important water quality parameter potentially not meeting fish needs in the Milk River was dissolved oxygen.

Water withdrawal for irrigation for farming and ranching is currently the 4th largest consumptive use of water in Canada, and over 70% of irrigation withdrawals occur in southern Alberta and Saskatchewan. Over 18,000 ha are served from the Milk River, part of the larger St. Mary irrigation district, servicing 210,000 ha of southern Alberta farmland (Great Canadian Rivers 2007; Schindler and Donahue 2006). Recent studies (Dash 2008) indicate that total water withdrawals have almost doubled since the 1950s, principally in response agricultural demands. Water levels in the Milk River aquifer declined by over 30 m between the 1950s and 1980s, and ongoing data collection indicates that water levels continue to drop.

Grazing/agricultural and urban practices

The Milk River is characterized by heavy silt load associated with continuous erosion of the surrounding grasslands and river banks (Willock 1968). Willock (1968) stated that the increased rate of erosion associated with channelization for irrigation and overgrazing could result in the decline or extirpation of the western silvery minnow from its Canadian range, and may be the reason for its extirpation in some rivers in the United States. Similarly, Trautman (1957) believed that the western silvery minnow, like its eastern counterpart, has a limited tolerance for suspended sediment. However, given its abundance in highly turbid waters, high sediment loads do not likely limit western silvery minnow distribution in Alberta. The silt content and/or channel type does appear to be correlated with differences in abundance in the lower Milk River versus immediately upstream near the town of Milk River. Upstream, where minnow abundance is relatively low, the Milk River is characterized by a single meandering channel having more runs, riffles, rapids, and lower turbidity (RL&L 2001) flowing through more erosion-resistant sandstone formations (Willock 1969b). Immediately downstream of this section the river is more characteristic of the braided, shifting sand bottomed Missouri River. There is no information available to compare silt loads over time for the Milk River (T. Clayton, pers. comm.).

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 at present (Milk River Fish Species at Risk Recovery Team 2007). Point sources of pollution include any stormwater and sewage releases, as well as accidental spills and gas leaks particularly at river and tributary crossings. The accidental 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. No such spills have been documented for the Milk River, but the possibility, although quite low, exists; traffic flow is significant at some crossings (e.g., average of 2,700 crossings per day on the Highway 4 bridge in 2003, 25% by trucks). A number of gas leaks have also occurred in recent years (Milk River Species at Risk Recovery Team 2007). Contamination of water from seismic or drilling activities is also a possibility. Uncapped groundwater wells may also pose a problem, although licensing and well-capping programs help to minimize this threat (Alberta Environment 2001).

Non-point sources of pollution in the vicinity of the Milk River, limited mainly to runoff of agricultural pesticides and fertilizers, are not considered to be of major concern. Most of the cropland irrigated in the Milk River basin is located within 50 km of the Town of Milk River, although there is another smaller area located upstream on the North Milk River near Del Bonita. Usually, crops in most areas cannot be grown within 400 m of the river because of the rough terrain along the banks, thus 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 (Milk River Species at Risk Recovery Team 2007). Nevertheless, nutrient concentrations can become elevated at downstream sites, and water quality in the mainstem also changes seasonally in response to flow augmentation, with increases in the total dissolved solids, conductivity and salt (sodium) concentrations when the diversion is shut off in the winter months (Milk River Species at Risk Recovery Team 2007).

Natural processes

The Milk River, Alberta is situated in a geographic region that is subject to extreme yearly and seasonal weather fluctuations that are likely to be exacerbated by climatic change. This variability, in addition to anthropogenic influences on the river system, may be responsible for limiting the distribution and abundance of western silvery minnow.

Although Canada is considered to have abundant fresh water (Gleick 2002), this can be misleading because of regional variability in supply. Southern Alberta, for example, lying in the shadow of the Rocky Mountains has relatively low annual rates of precipitation, and is one of the driest parts of the country (Schindler and Donahue 2006). Additionally the area is subject to periodic drought and has been identified as a prime area for further environmental degradation resulting from global warming (MEA 2005).

Archaeological evidence (*see* Schindler and Donahue 2006) suggests that severe and long-lasting droughts (lasting several decades) are not uncommon to the western prairies. The droughts of the 1930s, and the more recent warmer temperatures and lower precipitation of the 1998-2004 period were mild compared to droughts of the 18th and 19th centuries. Despite the apparently milder historic conditions of the 20th century, the average annual evapotranspiration exceeded average precipitation (Schindler and Donahue 2006). Annual precipitation has decreased by 14-24% in the southern prairies since the 1980s, while at the same time the area has experienced warming of 1-4 º C, most of which has occurred since the 1970s.

Several researchers (Déry and Wood 2005; Rood *et al.* 2005; Barnett *et al.* 2005), have determined long-term trends in flows of the major rivers of the area, but the analyses do not reflect trends during seasons of peak water demand, i.e., the summer months of May through August, when agricultural and urban use is at a maximum. Needs of aquatic flora and fauna are also greatest during this period. Warmer water temperatures, lower oxygen levels and low flows adversely affect the colder water organisms that inhabit the rivers and reproduce in the spring or fall (Schindler and Donahue 2006). Although annual flows in major drainages of the southwestern prairies have shown modest declines during the 20th century (Déry and Wood 2005; Rood *et al.* 2005), Schindler and Donahue (2006) have demonstrated that current summer flows are 20-84% lower than they were in the early 20th century. The longer-term trend for many rivers in southern Alberta over the summer is “stressed” or reduced below natural levels (Alberta SOE 2008). Damming, water withdrawals, and increased warming are attributed as causes of the decline. Watersheds without dams and/or water withdrawals showed less decline (20-30%), while those where impoundments and large-scale water withdrawals were in place demonstrated larger declines (40-80%) depending on the scale of impact (Schindler and Donahue 2006). All of the major rivers flow through semiarid and sub-humid zones where average annual evapotranspiration exceeds annual precipitation. Support of agriculture in these regions depends on reservoirs that trap spring snowmelt from the eastern Rocky Mountains and only about 20% of the runoff is returned to the rivers (Schindler and Donahue 2006).

Most climate models predict further warming of 1-2º C and slight increases in precipitation by the end of the 21st century (CCIS 2007). The forecasted increases are much lower than the predicted increase of 55% in evapotranspiration due to rising temperatures. The southern prairies are likely to be much drier (Schindler and Donahue 2006), and there will be less snowmelt to capture in the reservoirs. As a result it may become increasingly more difficult to maintain current summer flow regimes, and fish habitat.

Species introductions

Species introductions could threaten the native fish fauna of the Milk River through various mechanisms including: predation, hybridization, competition for resources, the introduction of exotic diseases and parasites, and habitat degradation (Milk River Fish Species at Risk Recovery Team 2007). So far, the yellow perch is the only non-native species that has been observed in western silvery minnow habitat, but the Fresno Reservoir contains a number of introduced predatory species, including: rainbow trout (*Onchorhynchus mykiss*), walleye (*Sander vitreus*), 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). Some of these species have specific habitat requirements that may not be met in the lower Milk River; others are generalists that might expand into Alberta.

Other threats

Scientific sampling may also pose a threat to the western silvery minnow. This threat is rated as low as it usually involves live-sampling and has a high potential for mitigation as it is regulated through the issuance of permits under *S*ARA (Milk River Fish Species at Risk Recovery Team 2007).

SPECIAL SIGNIFICANCE OF THE SPECIES

The western silvery minnow is probably an important forage species where abundant. In the U.S. it may have some value as a bait fish (Eddy and Underhill 1974), but in Canada (Alberta) since it has been listed as “Threatened” it is no longer allowed for use as bait. The recent identification in Canada and its distribution and habitat requirements are of interest to science in relation to the zoogeographic history and distribution of species subsequent to the Wisconsin Period of glaciation.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The western silvery minnow was first designated by COSEWIC as “Special Concern” in April 1997. Status was re-examined and designated “Threatened” in 2001. In June 2003 the western silvery minnow was officially listed on Schedule 1 of the federal *Species at Risk Act (*SARA*)* as “Threatened”. SARA makes it an offence in section 32 to kill, harm, harass, capture, possess, collect, buy, sell or trade or take an individual of a listed species that is threatened (SARA 2007). The Minister of Fisheries and Oceans must prepare recovery strategies for species listed as extirpated, endangered or threatened fish within three years of the species being listed. Recovery teams use the information gathered by COSEWIC to begin developing a recovery strategy. The recovery strategy for western silvery minnow is in its final review stage and sets out the population goals and objectives and broad approaches to respond to the known threats to the survival of the species, identifies the species' critical habitat, if possible, and sets time lines (2009) for the preparation of an action plan or action plans (Milk River Fish Species at Risk Recovery Team 2007; SARA 2007). The proposed recovery strategy is also intended to benefit other species in the Milk River, including the eastslope sculpin (*Cottus* sp.), and the stonecat (*Noturus flavus*). Both species are considered “Threatened” in Alberta, and the eastslope sculpin was recently listed as such under SARA. Measures directed at maintaining stream flows, preventing habitat destruction and avoiding species introductions should benefit these and other species. Habitat protection measures were further described under the section on Habitat protection above.

The national ranking for the United States is N4 (as of August 28, 1998) (NatureServe Explorer 2007). In the United States, the western silvery minnow was formerly considered a candidate for the federal rare and endangered species list, but as of February 28, 1996 was removed from this list, although it remains a “species of management concern.” The western silvery minnow is ranked “S1” in Iowa, “S2” in Wyoming, Kansas, Missouri and Illinois, “S4” or “S5” in Montana, Nebraska and South Dakota, and is unranked in North Dakota (NatureServe Explorer 2007). Globally, the Nature Conservancy gave this species a status of “G4” (as of November 1998).

The western silvery minnow is currently ranked as “At Risk” in Alberta, according to The General Status of Alberta Wild Species 2005 (Alberta Sustainable Resource Development 2005). The Alberta Natural Heritage Information Centre (2002b) tracks provincial and global rankings. Provincially, the western silvery minnow is ranked as “S1” (as of April 2000), which is the highest “S” rank.

No specific management for western silvery minnow exists in Alberta; however, the species was removed from the allowable baitfish list under Alberta’s Baitfish Regulations in order to protect the species. The extremely limited distribution of this species in the Milk River also prompted the Fish and Wildlife Division of Alberta Sustainable Resource Development to commission recent and ongoing surveys in the Milk River. The surveys are intended to help determine the status of the western silvery minnow in Alberta and to provide recommendations with regards to protection.

Recommendations include the maintenance of monitoring studies on a regular basis at specific index sites to track abundance, and more detailed studies on the distribution, abundance, and habitat preferences of the western silvery minnow (RL&L 2002b). The identification and protection of critical habitat requirements for juvenile and adult western silvery minnow in the lower Milk River is crucial to the continued existence of this rare species in Alberta.

TECHNICAL SUMMARY

Hybognathus argyritis

Western silvery minnow — Méné d'argent de l'Ouest

Range of occurrence in Canada: Alberta

Extent and Area Information

• *Extent of occurrence (EO)(km²)* (Estimated from a convex hull around the river stretch from the U.S. border to 1 km past the last distribution point upstream)	1200 km²
• *Specify trend in EO*	Stable?
• *Are there extreme fluctuations in EO?*	No
• *Area of occupancy (AO) (km²)* (based on overlaid grid of cell size one km^2, total AO is the number of squares that are intersected by the river from the U.S. border to 1 km past the last distribution point upstream) • *Area of occupancy (AO) (km²)* (based on occupied riverine habitat assuming average river width of 60 m from the U.S. border to 1 km past the last distribution point upstream)	244 km² 13.4 km²
• *Specify trend in AO*	Fluctuates with water flow regimes
• *Are there extreme fluctuations in AO?*	Yes - during drought conditions
• *Number of known or inferred current locations*	1 possibly 2
• *Specify trend in #*	Stable?
• *Are there extreme fluctuations in number of locations?*	No
• *Specify trend in area, extent or quality of habitat*	Fluctuates with water flow regimes

Population Information

• *Generation time (average age of parents in the population)*	3+
• *Number of mature individuals*	unknown
• *Total population trend:*	unknown
• *% decline over the last/next 10 years or 3 generations.*	unknown
• *Are there extreme fluctuations in number of mature individuals?*	Possibly – in drought conditions
• *Is the total population severely fragmented?*	no
• *Specify trend in number of populations*	Stable
• *Are there extreme fluctuations in number of populations?*	No
• List populations with number of mature individuals in each:	Unknown

Threats (actual or imminent threats to populations or habitats)

Immediate

1. Low flows and high water temperatures resulting from drought and surface water extractions
2. Introduced exotic species
3. Anoxia in overwintering habitat related to water diversions

Potential

1. Surface and ground water extraction
2. Low flows and high water temperatures resulting from drought exacerbated by climate change
3. Dam and reservoir construction
4. Livestock and agricultural uses of the floodplain
5. Canal maintenance and drought

Rescue Effect (immigration from an outside source) Limited

• *Status of outside population(s)?* USA: See current status below	
• *Is immigration known or possible?*	Possible under limited conditions
• *Would immigrants be adapted to survive in Canada?*	yes
• *Is there sufficient habitat for immigrants in Canada?*	yes
• *Is rescue from outside populations likely?*	no

Quantitative Analysis

No data

Current Status

Nature Conservancy Ranks (NatureServe 2007)

Global – G5 (Secure)

National

US – N4 (Secure)

Canada N3N4 (May be at Risk)

Regional

US – IL – S2 (Vulnerable), IA – S1 (Critically Imperilled), KS – S2, MO – S2, MT – S4S5 (Possibly Secure). NE – S5 (Secure), ND – SNR (Not Ranked), SD – S5, WY – S2.

Canada - AB – S1

Wild Species 2005 (Canadian Endangered Species Conservation Council 2006)

Canada – 2 (May Be At Risk)

Alberta – 1 (At Risk)

COSEWIC

Threatened 2001

Endangered 2008

SARA

Schedule 1 Part 3 – TH

Status and Reasons for Designation

Status: Endangered	**Alpha-numeric code:** B1ab(iii)+2ab(iii)
Reasons 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.	

Applicability of Criteria

Criterion A (Declining Total Population): Not Applicable – no evidence of decline in the total number of mature individuals.
Criterion B (Small Distribution, and Decline or Fluctuation): Met criteria for Endangered B1ab(iii)+2ab(iii), as the EO (1200 km²) and AO (244 km²) are below threshold values, there is only one known location, and the area, extent and/or quality of habitat is impacted by water flow regimes resulting from water extraction for irrigation, and predicted increase in frequency and severity of drought conditions.
Criterion C (Small Total Population Size and Decline): Not Applicable – number of mature individuals is unknown and there is no evidence of decline in the number of mature individuals.
Criterion D (Very Small Population or Restricted Distribution): Met criteria for Threatened D2 – only one location.
Criterion E (Quantitative Analysis): Not Applicable – no data.

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Mark Lowdon, M.Sc., is a fisheries biologist with the Department of Fisheries and Oceans (DFO) Canada. He completed his Masters studying the impacts introduced wild rice (*Zizania palustris*) had on fish and invertebrate communities in Northern Manitoba in 2005. For the last two years he has been involved in a number of projects examining distribution, life history, and the biology of fish species at risk in Canada including the carmine shiner (*Notropis percobromus*), western silvery minnow (*Hybognathus argyritis*), and the eastslope sculpin (*Cottus* sp.).

Douglas Watkinson is a Research Biologist with Fisheries and Oceans Canada in Winnipeg. He obtained a B.Sc. (1998) and M.Sc. (2001) from the University of Manitoba. He has sampled fish in most of the major river systems of the Hudson Bay drainage. His current research focuses on species at risk and habitat impacts. He is also the co-author of the Freshwater Fishes of Manitoba.

Dr. William G. Franzin obtained a B.Sc. (1967) from the University of BC and M.Sc. (1970) and Ph.D. (1974) degrees from the University of Manitoba. He started his career as a biologist in 1973 with the Environment Canada. In 1975, he joined the Freshwater Institute in Winnipeg as a research scientist with Fisheries and Oceans Canada where he continues to work. He was an adjunct professor in the Zoology Department at the University of Manitoba until 2005 and has supervised or co-supervised 10 graduate student theses at the master's and doctoral levels. His broad fish/fisheries research interests have included fish biogeography and diversity, effects of heavy metal toxicity on wild fish populations, fish genetics, walleye stocking, instream flow issues, invasive aquatic species and recently, species at risk. Franzin has authored

or co-authored 45 published papers and reports, dozens of presentations at scientific meetings and contributed to countless departmental submissions and reviews.
Dr. Franzin also has had significant management experience: a few years as a section manager and more than a year as an acting division manager. He is involved as an officer in the American Fisheries Society as well. Bill presently is a research scientist and manager, Habitat Impacts Research Section in Environmental Sciences Division, Central and Arctic Science. His interdisciplinary research is focused on fish use of habitat in relation to flow in rivers across the Prairies.

COLLECTIONS EXAMINED

The collection by Watkinson *et al.* (MS 2007) was the only collection examined as part of this work.