STANDARDIZED FIELD SAMPLING METHOD FOR MONITORING THE DISTRIBUTION AND RELATIVE ABUNDANCE OF THE WESTERN SILVERY MINNOW (*HYBOGNATHUS ARGYRITIS*) POPULATION IN CANADA

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

C.J. Macnaughton, Rudolfsen, T., Watkinson, D.A., and Enders, E.C. 2019. Standardized field sampling method for monitoring the distribution and relative abundance of the Western Silvery Minnow (*Hybognathus argyritis*) population in Canada. Can. Tech. Rep. Fish. Aquat. Sci. 3315: vii + 26 p.

The Species at Risk Program's objective for the Western Silvery Minnow (*Hybognathus argyritis*) is to quantify and maintain current population levels throughout its Canadian range. In an effort to provide science information to meet the Species at Risk (SAR) Program objective, this report aims to provide a consistent sampling method and survey design that may accurately inform on changes in the distribution and relative abundance of the Western Silvery Minnow in the Milk River system in Alberta, where it is listed as *Threatened*. This report details (1) the sampling gear, (2) recommended sampling effort and timing, and (3) sampling sites for Western Silvery Minnow occurrence and abundance. This standardized sampling protocol is intended to improve the monitoring of the species throughout its Canadian range, the assessment of population trends, and consequently allow for a better informed management of the species over time.

RÉSUMÉ

C.J. Macnaughton, Rudolfsen, T., Watkinson, D.A., and Enders, E.C. 2019. Standardized field sampling method for monitoring the distribution and relative abundance of the Western Silvery Minnow (*Hybognathus argyritis*) population in Canada. Can. Tech. Rep. Fish. Aquat. Sci. 3315: vii + 26 p.

Une des mesures de gestion provenant de la Loi sur les Espèces en Péril (LEP) pour la conservation du méné d'argent de l'ouest (*Hybognathus argyritis*) consiste à élaborer un plan de surveillance suffisamment solide afin de quantifier l'abondance, la distribution et l'habitat du poisson utilisé par l'espèce. Dans le cadre d'établir des cibles quantitatives pour le méné d'argent de l'ouest en vue d'assurer sa protection et son rétablissement, ce rapport sert à définir un protocole et un design d'échantillonnage qui serviront à faire l'inventaire des populations de méné d'argent de l'ouest dans le bassin versant de la rivière Milk en Alberta. Ce rapport vise à décrire (1) l'engin de pêche recommandé, (2) l'effort et le moment de l'année idéal pour l'échantillonnage, et (3) la localisation des sites d'échantillonnage qui se retrouvent dans l'ensemble de l'aire de répartition de l'espèce, ainsi qu'à l'extérieur de cette zone pour faire le suivi de l'abondance à long-terme. Ce rapport contribue directement à la conservation de l'espèce en mettant en œuvre un plan de surveillance dans les cours d'eau canadiennes pour assurer la viabilité à long-terme du méné d'argent de l'ouest.

ACKNOWLEDGEMENTS

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1.0 INTRODUCTION

The purpose of the *Species at Risk Act* (SARA) is to protect wildlife species at risk of becoming extinct or extirpated in Canada, help with the recovery of extirpated, endangered, and threatened species, and ensure that species of special concern do not become extirpated or threatened as a result of human activity. Under provisions in the *Act*, wildlife species, designatable units (DUs) thereof, and their critical habitats receive protection. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is an independent body of experts tasked with identifying and assessing the status of wildlife species at risk. Once a species' outcome (i.e., designation) has been decided by COSEWIC and subsequent listing pursuant to SARA, assessments on the distribution and relative abundance of the species concerned are necessary for determining population trends and whether recovery strategies are effective or not. COSEWIC assessments determine the status of a species on a ten year cycle, setting the timeline for when the information is required to update a species' status and to ensure the species' recovery is on the anticipated trajectory. The challenge in this process lies in achieving consistent and current population trends by establishing a frequency of sampling events that potentially aligns with COSEWIC status review timelines and standardizes survey methods for a given species.

Various field sampling methods for quantifying the occupancy and relative abundance of small-bodied freshwater fishes in wadeable streams are currently in use. However, different field methods (e.g., beach seining vs. electrofishing) often yield different information, leading to complementary and/or incomplete data records for any given species. Inconsistent sampling effort and survey designs may, therefore, preclude pooling data from different sources for obtaining reliable estimates (e.g., distribution and relative abundance) of target species. The Western Silvery Minnow (*Hybognathus argyritis*; Girard 1856) is a bright-silver coloured, small-bodied, minnow that is found only in the Milk River in southern Alberta, Canada, where it is designated as *Threatened* under Canada's *Species at Risk Act* (Species at Risk public registry designation re-examined in November 2017). The species exhibits a restricted distribution in Canada, which makes it susceptible to anthropogenic impacts including flow augmentation (e.g., irrigation) and climate variability (e.g., drought) (COSEWIC 2017).

In an effort to provide science information to meet the Species at Risk Program objectives of monitoring population trends within a ten year cycle, this report aims to provide a consistent sampling method and survey design to inform on changes in the distribution and relative abundance of the Western Silvery Minnow population in the Milk River in southern Alberta. Properly designed sampling programs should include knowledge of the biology of the species and the deployment of the appropriate gear under the direction of experienced personnel. This report details which sampling gear to use and how much effort is required, where to sample Western

Silvery Minnow populations, and where range extension sampling should be planned as part of a long-term monitoring program for the species. Using existing seining field sampling data records for the species, this technical report provides knowledge on baseline Western Silvery Minnow Catch per Unit Effort (CPUE) throughout the Milk River. Recommendations on a standardized sampling protocol that also includes the frequency of sampling events over time for monitoring Western Silvery Minnow population and distribution targets for recovery will lead to improved and better informed management of the species.

2.0 WESTERN SILVERY MINNOW

2.1 MORPHOLOGY

The Western Silvery Minnow morphology reflects its benthic oriented lifestyle. They have a triangular head with a subterminal mouth and a body that is elongated and moderately compressed. The maximum fork length (FL) recorded for the Western Silvery Minnow is 147 mm, however, most average from 80–85 mm FL (Watkinson, unpublished data; Neufeld, unpublished data). The dorsal fins usually have 8 rays. The lateral line is complete with an average of 38–39 cycloid scales. Approximately 9–11 long gill rakers are located on the first gill arch. The basioccipital process is unique in each *Hybognathus* species and is used to identify the Western Silvery Minnow. For this species, it has a broad shape with a straight or slightly concave back region. The body colouration is primarily bright silver, with a slightly brown or yellow back and white underbelly (Figure 1; Nelson and Paetz 1992). Occasionally, orange and blue or dusky colouration can be seen above the lateral line and the fins are largely colourless. Morphological descriptions were compiled from Scott and Crossman (1973), Pflieger *et al*. (1975), Nelson and Paetz (1992), (Pflieger 1997) and Watkinson (unpublished data). Western Silvery Minnows have a similar morphology to the Plains Minnow (*Hybognathus placitus*). However, it can be distinguished by its larger eyes and pupils, as well as having fewer, larger scales across its belly (Loomis 1997).

Figure 1. Western Silvery Minnow (*Hybognathus argyritis*) (D.A. Watkinson photo).

2.2 BIOLOGY

<u>Life Cycle and Reproduction</u>

Western Silvery Minnow females typically reach maturity at two years (81–127 mm FL) (Watkinson, unpublished data). It is unknown when males reach maturity. Female fecundity (egg counts) varies based on body size, but has been shown to range between 2,924–19,573 eggs (COSEWIC 2017). A generation time for Western Silvery Minnows was estimated to be 2.6 years (Young and Koops 2013). Spawning usually takes place from late May to early-July at water temperatures ranging from 13.6–26.8 °C (COSEWIC 2017). Spawning strategy and behaviour of the Western Silvery Minnow is not explicitly known, but is presumed to be similar to that of closely related species like the Plains Minnow, who are broadcast spawners with semi-buoyant eggs that drift downstream until hatching (Platania and Altenbach 1998, COSEWIC 2017).

Size and Age Structure

Western Silvery Minnow live up to four years and attain lengths of ~150 mm FL; ~50 mm FL by the first fall, 80-90 mm FL by their second fall, and >100 mm FL by their third fall. Based on catch curve analysis, estimated mean survival to the age of 1 year is 1.1%, from 1–2 years is 20.7%, from 2–3 years is 30.2%, and from 3–4 years is 34.7% (Young and Koops 2013). The strength of year classes in the Milk River are relatively variable and highly dependant on reproductive success and overwintering survival (COSEWIC 2017).

Physiology and Adaptability

The Western Silvery Minnow, like other closely related minnows, routinely experience and are therefore physiologically adapted to large variations in temperature, flow, and dissolved oxygen conditions. In Canada, they have been found in water temperatures as high as 29.4 °C (P&E Environmental Consultants Ltd. 2002), as well as isolated pools over the winter (COSEWIC 2017). The physiological capabilities of closely related Plains Minnows (*Hybognathus placitus*) and Brassy Minnows (*Hybognathus hankinsoni*) suggest that the Western Silvery Minnow is capable of withstanding low dissolved oxygen conditions, possibly as low as 0.03 $mg \cdot l^{-1}$ (Scheurer *et al.* 2003). They are also capable of sustained swimming at moderate water flows (>200 min at 0.42 $m \cdot s^{-1}$) and high flows (>1 min at 0.68 $m\ s^{-1}$) (Neufeld 2016). The species has a mostly herbivorous diet of diatoms, algae, and detritus.

Dispersal and Migration

The Western Silvery Minnow is known to travel long distances over a short period of time. In the lower Milk River, one specimen has been documented travelling upwards of 14 km in 16 days (Neufeld 2016). However, it is unlikely Western Silvery Minnow will colonize other nearby waterbodies on account of the St. Mary water diversion structure, which is a barrier to upstream movement by fish (COSEWIC 2017). Human-induced introductions of Western Silvery Minnow to other waterbodies is unlikely, as the collection of minnows in the Milk River is restricted by Alberta Environment and Parks (AEP).

2.3 Known Distribution in Canada

The Western Silvery Minnow has a very limited distribution in Alberta, present only in the Milk River in Alberta, in the Missouri National Freshwater Biogeographic Zone (Figure 2). This range represents the species' most northerly extent of its distribution. The Western Silvery Minnow has a significantly larger distribution in the United States, where it occupies much of the Missouri River Drainage and portions of the Mississippi River Drainage (Pflieger 1980).

Missouri Population– *Threatened* (SARA 2003, COSEWIC 2017)

Based on the COSEWIC National Freshwater Biogeographic Zone (NFBZ) classification, the Western Silvery Minnow only occupies the Missouri National Freshwater Biogeographic Zone, therefore, only one DU is recognized for the species in Canada (COSEWIC 2017). Western Silvery Minnow in the Milk River are considered a single population. In Alberta, they are recorded to be continuously distributed where the Milk River crosses into eastern Alberta (upstream), to approximately 15 km downstream of its confluence to the North Milk River (COSEWIC 2017). While tributaries to the Milk River exist in southern Saskatchewan, sampling has not captured any Western Silvery Minnow (Watkinson, unpublished data; COSEWIC 2017).

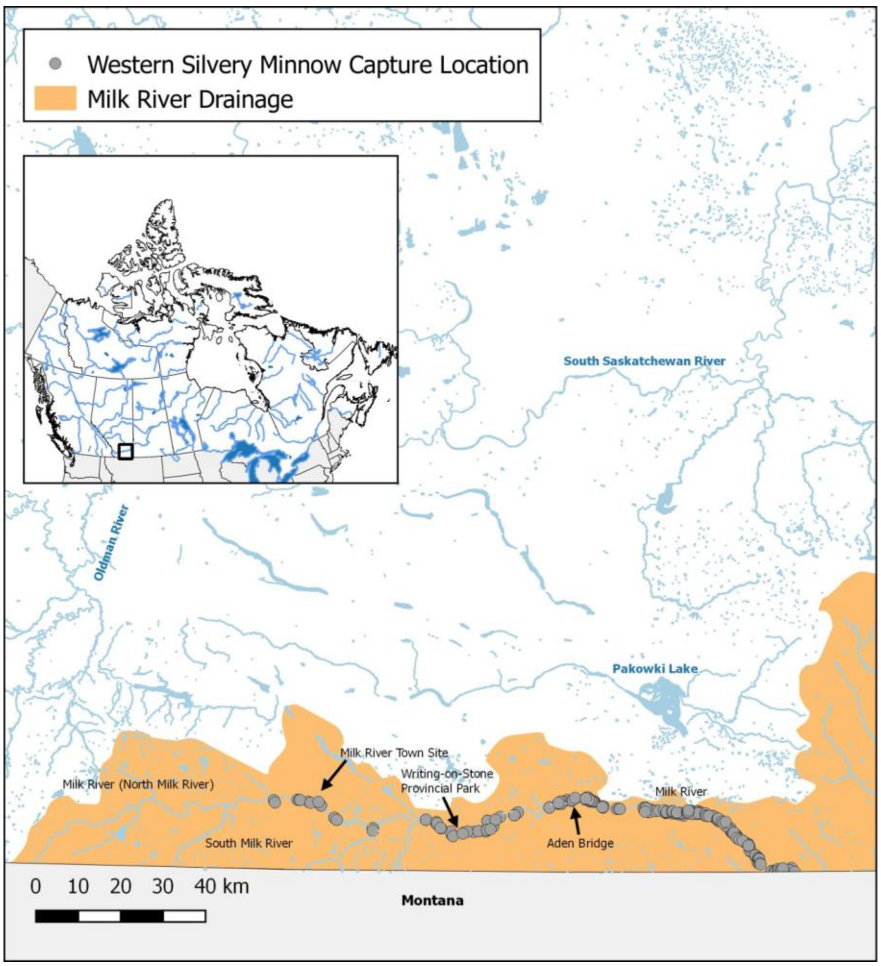

Figure 2. Occurrence of Western Silvery Minnow in the Milk River, southern Alberta. Collective sampling conducted from 2005–2007 (Watkinson, unpublished data) and 2013 (Neufeld, unpublished data). Figure taken from COSEWIC 2017.

2.4 HABITAT

Habitat Features

The Western Silvery Minnow is recognized as a habitat specialist that prefers medium to large prairie streams like the Milk River. The downstream portion of the Milk River provides suitable habitat because it has a relatively flat gradient that consists primarily of runs with sand and silt substrate (RL&L Environmental Services Ltd 1987; COSEWIC 2017). It also meets the species' habitat requirements of high turbidity, high seasonal changes in flow and unstable fine sediments (Pflieger *et al.* 1975; Hoagstrom *et al.* 2007; COSEWIC 2017). They are not found in tributaries draining into the Milk River, but are known to congregate at some of the confluences (Willock 1969; Neufeld, unpublished data). Based on the most recent sampling, Western Silvery Minnow prefer shallow, slow moving water, averaging around 0.38 m deep and 0.24 $m \cdot s^{-1}$, respectively, with high turbidity levels ranging from Secchi depths of 0.13–0.63 m (Watkinson, unpublished data) (Figure 3).

Figure 3. Picture of the Milk River, Alberta sampled in 2007 (D.A. Watkinson photo).

Habitat Trends and Threats

The Milk and St. Mary rivers are intensively managed for irrigation use both in Canada and the United States. As such, they are subject to provisions in the Boundary Waters Treaty of 1909 (the Treaty) between Canada and the United States, which is administered by a binational organization called the International Joint Commission (IJC) (https://ijc.org/en/aosmmr). The IJC has members appointed by both Canadian and American governments and the Treaty itself provides the principles and mechanisms to resolve disputes concerning shared water.

The context of the apportionment is best considered temporally regarding the irrigation season (April 1 to October 31 annually) and the non-irrigation season (November 1 to March 31). The management approach in the Milk River watershed and the St. Mary River has essentially been to divert water from the St. Mary River (~ 18.4 $m^3 \cdot s^{-1}$) into the North Milk River, starting April 1 (or earlier). The natural winter flow in the Milk River is generally very low at this time of year (<1 $m^3 \cdot s^{-1}$), thus, the increase in water flow is significant, rising up to ≥ 15 $m^3 \cdot s^{-1}$ in a relatively short period of time. This higher water flow continues in the Milk River until September or October, when water flow is reduced to natural or close to natural conditions, as the end of the irrigation season approaches. Both rivers have low winter flows, however, water flow in the Milk River watershed in the winter is natural, whereas it is managed in the St. Mary River via storage facilities in Montana (Sherburne Reservoir and St. Mary Lake)

The St. Mary Diversion moves water into the Milk River for withdrawal and irrigation purposes, which consequently impacts the Western Silvery Minnow habitat by altering the river's flow regime and morphology. Based on a study of two locations in the lower Milk River, the increase in discharge during the augmentation period was estimated to reduce suitable habitat from 40.2% and 28.3% of wetted area to 9.5% and 3.9% wetted area, respectively (Neufeld 2016). A prior study by Golder Associates (2010) estimated suitable habitat to be 30–40% wetted area in the lower Milk River and 40–50% near the town of Milk River from April to October. Both studies emphasized a reduction in suitable habitat for Western Silvery Minnows during periods of flow augmentation. As a result, it is possible that suitable habitat was more abundant before 1917, prior to implementation of the diversion (COSEWIC 2017).

Despite these changes to habitat suitability, the St. Mary Diversion may be important in improving habitat availability and overwintering survival of the Western Silvery Minnow in the Milk River. During ice-over months, natural water levels decline substantially, leaving mostly standing or low-flow pools as refugia for overwintering fish. This, exacerbated by increased drought frequency, could greatly limit the winter survival and contribute to the range contraction of Western Silvery Minnow (Mainstream Aquatics Ltd. 2005; Hoagstrom *et al.* 2006; COSEWIC, 2017). Should drought events become prolonged, they have the potential to extirpate the species, with no source of natural downstream recolonization due to the Fresno Dam (COSEWIC 2017). As a result, the St. Mary Diversion could be crucial in maintaining sufficient water levels and flow for Western Silvery Minnow survival in the Milk River (McLean and Beckstead 1980; COSEWIC 2017). Furthermore, global climate warming and drying may exacerbate these negative impacts on habitat quantity and quality.

2.5 Population Size and CPUE Trends in Canada

Population Trends

There is only one known population of Western Silvery Minnow in Canada, in the Milk River drainage in Southern Alberta and there has been no evidence of a decline in abundance since the previous assessment in 2008 (COSEWIC 2017). Since 1966 (RL&L Environmental Services Ltd. 1980), sampling for Western Silvery Minnows has primarily been executed using seine nets, occasionally supplemented by electrofishing. A temporal comparison of abundance across surveys cannot be made due to lack of standardization in sampling effort. For example, earlier surveys were focussed on community structure and consistently yielded a percent composition of <1% Western Silvery Minnow, whereas later surveys (after 2002) were largely targeted for Western Silvery Minnow, thereby producing percent compositions as high as 43.7% (COSEWIC 2017). While lower historical catch rates suggested an abundance of only a few thousand, as much as 528 fish (0.45 fish·m^{-2}) were captured in 2006 (Watkinson, unpublished data) and 3,882 fish (~46 fish·m^{-2}) in 2013, near Pinhorn Ranch, Alberta (Neufeld, unpublished data). For samples collected using similar methods, average CPUE and abundance across sites in the Milk River ranged from 0–0.35 fish·m^{-2} and 0–98 fish, respectively (Table 1). The potential for the population to dramatically fluctuate among years and the schooling behaviour of Western Silvery Minnow emphasizes the need for a standardized monitoring protocol.

Table 1. Average seining survey effort, Western Silvery Minnow CPUE, and abundance per year surveyed in the Milk River.

Waterbody	Year	Mean Effort (area m^2)	Mean Site CPUE (fish·m^{-2})	Mean Site Abundance (# fish)	Survey (source)
Milk River	2005	360.12	0.06	20	Watkinson, unpublished data
	2006	335.13	0.35	98	
	2007	182.80	0.00	0	
	2013	80.14	0.20	18	Neufeld, unpublished data

Distribution patterns indicated that Western Silvery Minnow occurred more abundantly near the U.S. border (Lower Milk River) and decreased in abundance moving upstream as the distance from the U.S. border increased (Figure 4). Sharp habitat changes between upstream and downstream portions of the Milk River (i.e., at ~160 km from the U.S. border) were thought to drive this species' distribution pattern throughout the watershed. Specifically, differences in water flow and substrate complexity between upstream (Upper Milk River) and downstream portions of the Milk River are thought to affect the amount of suitable habitat available along the river for Western Silvery Minnow (Golder Associates 2010; Neufeld 2016). As such, critical habitat for the Western Silvery Minnow has been identified as extending upstream from the U.S. border on the Milk River, into Writing-on-Stone Provincial Park in Alberta (Fisheries and Oceans Canada 2018).

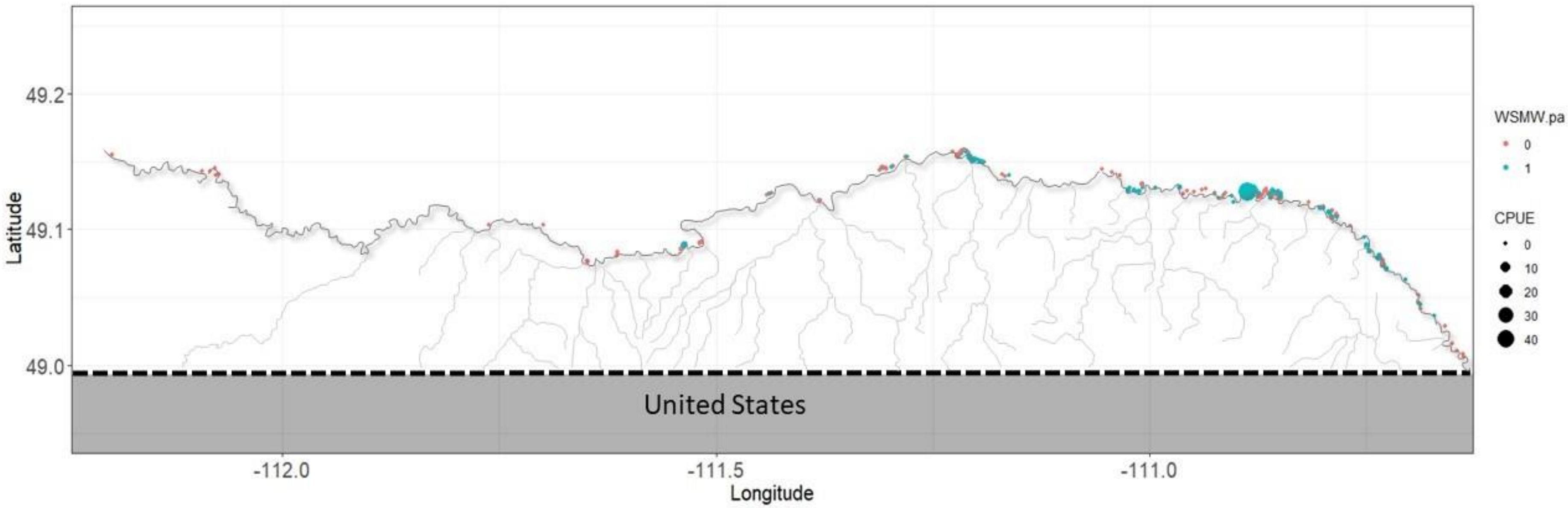

Figure 4. CPUE (fish·m^{-2}) of Western Silvery Minnow seining surveys in the Milk River from years 2005–2007 and in 2013 (Watkinson, unpublished data; Neufeld, unpublished data). Absences are in orange and presences are in blue. Large blue point represents the largest catch (~46 fish·m^{-2}) of Western Silvery Minnow (Site 198 at Pinhorn Ranch, Alberta in October 2013).

To better understand the required sampling effort in terms of the numbers of sites and seine passes for monitoring species occurrence and CPUE, presence-absence and abundance data were used from the targeted surveys, where each of the 215 sites was seined from 1–6 times (seine pass) in 2013 (Neufeld, unpublished data). CPUE estimates were calculated for each seine pass (Figure 5). Results indicated that no more than a single seine pass per site is required to obtain a site CPUE, as CPUE estimates and variance were close to zero for seine passes 2–6.

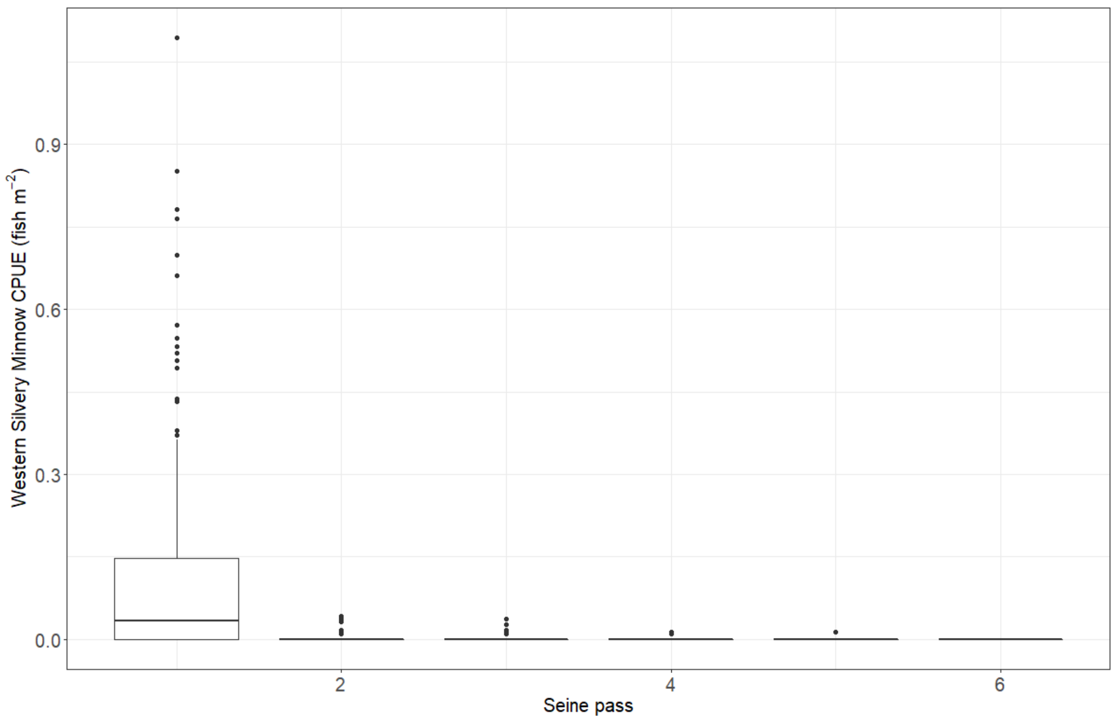

Figure 5. Western Silvery Minnow CPUE (fish·m^{-2}) sampled per seine pass (1–6 passes) for 215 sites in the Milk River (June to October 2013; Neufeld, unpublished data).

For each number of sites from 1 to ~60, the occurrences (presence = 1; absence = 0) of Western Silvery Minnow were calculated by taking the average (from 100 iterations) of the sums of fish collected for X number of sites. At five sites, for example, the sum of fish occurring in five randomly selected sites was calculated. The sum of fish occurring in another five randomly selected sites was then calculated and this step was repeated 100 times. The average occurrence was calculated from 100 iterations (i.e., sums) and converted to a presence = 1 or absence = 0 score, which was plotted over the number of sites sampled (Figure 6). Since a single seine pass per site was deemed sufficient to obtain mean site CPUE, focus centered on determining the number of sites required to confidently determine the presence of Western Silvery Minnow in the Milk River using a single seine pass. Results suggested a minimum effort of ~25 sites is needed to confidently determine the presence of Western Silvery Minnow in the Milk River (Figure 6).

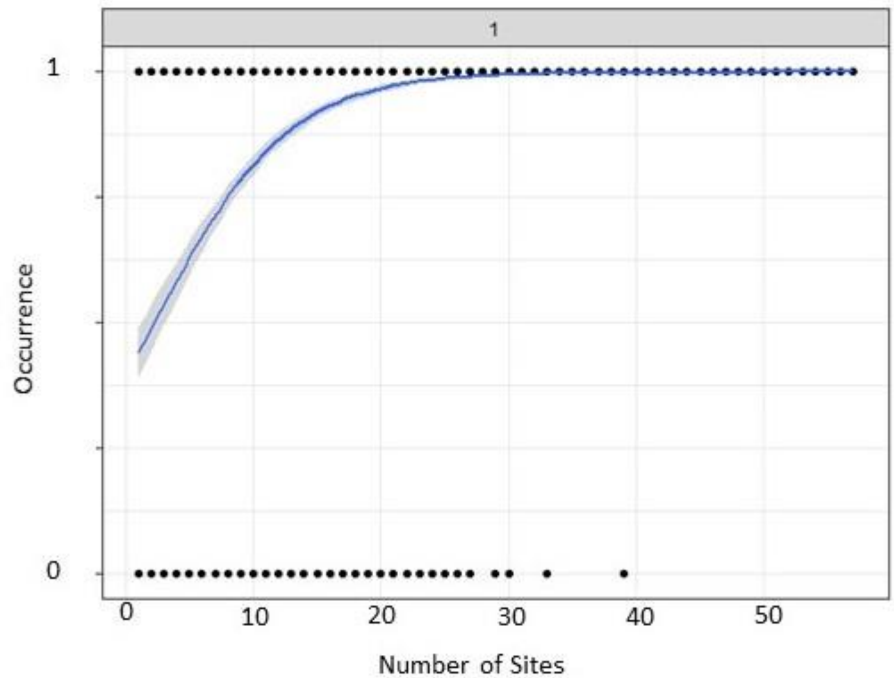

Figure 6. Occupancy (presence = 1; absence = 0) of Western Silvery Minnow as a function of the number of sites (x-axis) surveyed in the Milk River, in 2013. Binomial smoother and standard error (blue line and grey shaded area, respectively) are represented.

3.0 SAMPLING PROTOCOL

3.1 Sampling Design

To obtain consistent fish survey data and ensure that monitoring is effective, a standard sampling protocol using beach seining has been developed to monitor the distribution and abundance of Western Silvery Minnow in the Milk River.

Access Points

Eight access points are limited to the downstream portions of the Milk River in which Western Silvery Minnow are known to occur (Lower Milk River (red triangles; Figure 7)). All of these access points are recommended for monitoring population trends over time and proposed range extension locations (blue squares; Figure 7) will provide information on whether the species' distribution is expanding or contracting (see Appendix 1 for the full list of the ten access points and associated coordinates in both the upstream and downstream portions of the Milk River).

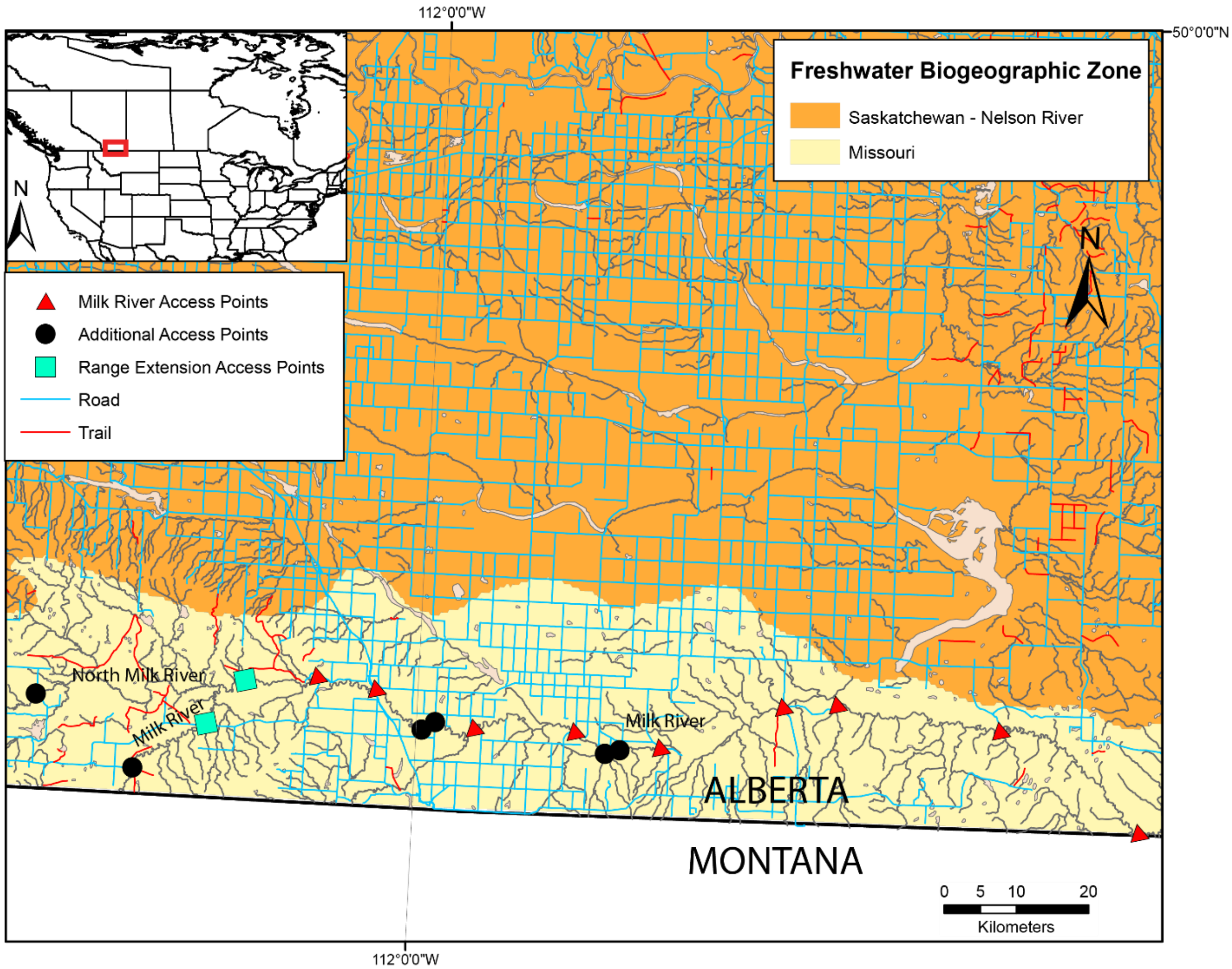

Figure 7. Map of the ten access points on the Milk River and additional access points and range extension points on the Milk and North Milk rivers in Alberta.

Sites

A site represents the sampling unit (i.e., area) where surveying takes places. Sampling area for a given site in the Milk River will be quite variable on account of fluctuating water flows and access to fish habitats (e.g., backwaters, river margins). Therefore, consistent sampling based on the length of a site in the Milk River is unlikely, consequently, the sampling area should correspond to the product of the width of the seine net deployed in the river by the length of the seine haul. To determine the occurrence of the species in the Milk River, ~25 sites should be evenly distributed among recommended access points (2–3 sites per access point). The number of sites per access point should increase to five sites per access point for estimating the relative abundance and CPUE, maximizing the spatial extent of the surveying effort along the Milk River (~ 45 sites throughout the known distribution of the species). With the exception of specialized habitats, sites should be randomly situated along the shores of each access point using a random number generator (1–100) that corresponds to the distance of the first most downstream site from the access point. In order to balance the spatial distribution of sampling sites with the effort of moving between these sites, we recommend that sites are spaced from 50–100 m apart from one another. To avoid disturbing fish during surveys, sampling should commence at the most downstream site at any given access point, moving upstream with each new site. At every access point, if there is a sandy bar, creating a backwater or side channel, one of the surveyed sites should target the specialized habitat (Figure 8). In such cases, the length and width of the of the backwater is measured to establish sampling area for the site.

Figure 8. Image of a backwater site sampled at river km 22 on the Milk River (D. A. Watkinson photo).

3.2 TIMING OF SAMPLING

It is important that sampling be timed to match the most appropriate conditions every year to reduce environmental variation. The sampling sites should therefore be georeferenced and photographed to ensure that the same location is used repeatedly across years. The timing of sampling events should also be consistent across appropriate conditions. Due to the mobile nature of the river substrate, the placement of sites positioned within specialized habitats (i.e., sand bars and backwaters) as well as randomly distributed sites will likely vary inter-annually.

Seasonality

Survey feasibility is contingent on seasonal water levels and water temperatures, specifically for the Milk River, where high flows due to the water diversion on the Milk River prevent seining surveys for much of the year. Sampling should not be conducted during times of extreme high water temperatures, as the stress of handling may increase mortality rates. Real-time hydrometric data for the system are available from the Government of Alberta River Basins network and the Water Survey of Canada to inform on seasonal flow and water level variability (Figure 9). The Milk River has been severely impacted by changes in its seasonal flow regimes on account of water diverted from the St. Mary River in Montana, which augments flows in the Alberta portion of the Milk River from late-March or early-April through to late-September or mid-October (Table 2). As such, high flows from mid-September (~Day 271; Figure 9) for the Milk River further reduce the window of time that Western Silvery Minnow surveying can be conducted. To ensure that seining is consistent among sites, it should occur during periods of unaugmented flow (i.e., low-flow) rather than during summer augmented flows. However, catches of Western Silvery Minnow may be more variable during periods of unaugmented flows, contributing to greater patchiness of catches among sites (Neufeld, personal communication).

Table 2. List of real-time hydrometric stations and recommended sampling time in the Milk River where Western Silvery Minnow occur.

Waterbody	Hydrometric Station	Site Description	Suggested Sampling Time	Source
Milk River	11AA031	Milk River at Eastern Crossing of International Boundary	October 1-November 1	Water Survey of Canada
North Milk River	11AA001	North Milk River at Western Crossing of International Boundary	October 1-November 1	Water Survey of Canada

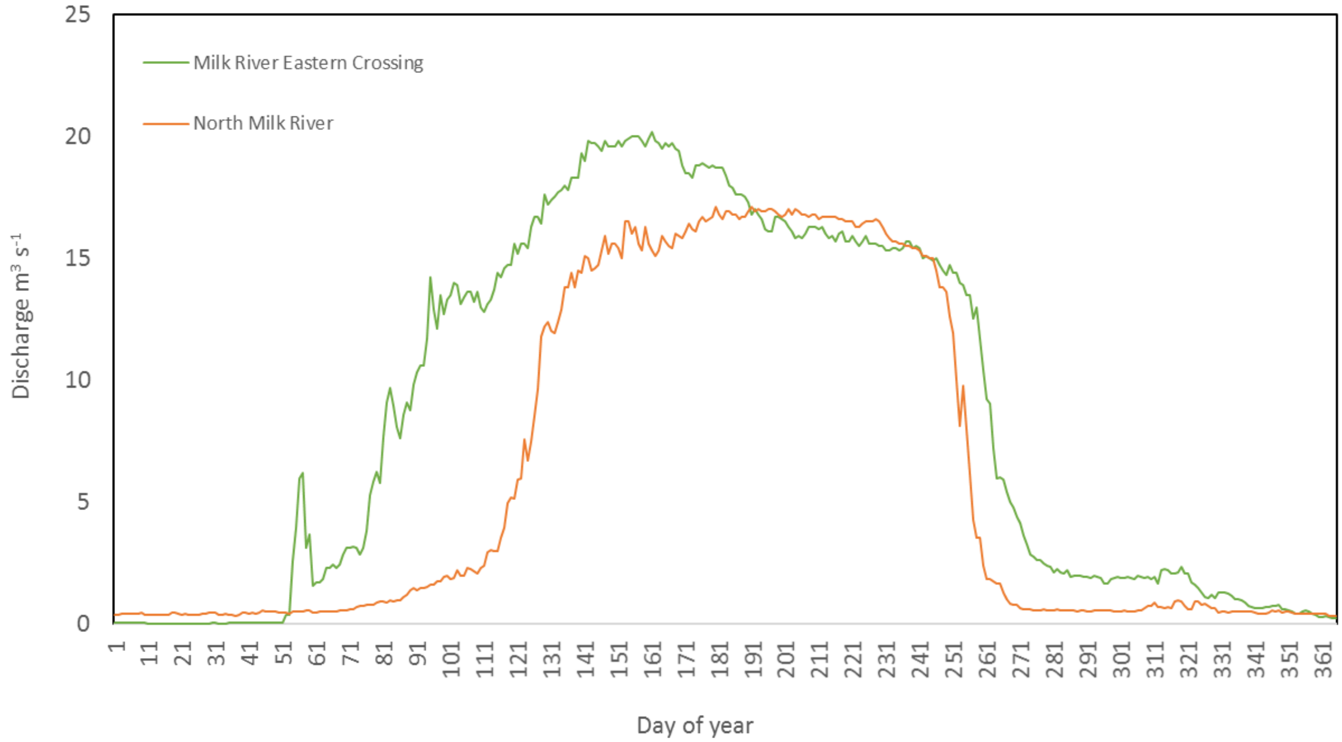

Figure 9. Hydrographs illustrating standardized median discharge ($m^3 \cdot s^{-1}$) over a year (Day 1= January 1) for hydrometric data collected by Water Survey of Canada for the Milk River Eastern crossing (green) and North Milk River Western crossing (orange).

Surveying Frequency

Baseline CPUE data is available for Milk River and to determine whether the Western Silvery Minnow population is expanding or contracting, population trend assessments require more frequent surveying of the same sites and should include range extension sampling. COSEWIC assessments determine the status of a species on a ten year cycle, setting the timeline for when the information is required to update a species' status. To maximize the temporal extent of surveys and to provide a minimum of two estimates of the distribution and relative abundance of the species, sampling should be conducted twice in the ten year cycle. Ideally, sites should be sampled once every five years, preferably not in consecutive years, once baseline data has informed the survey effort necessary to achieve reliable population trends.

3.3 Sampling Gear and Method

A minimum crew size of two people is required to pull a seine net (length = 9.14 m by width = 1.82 m, mesh size = 4.76 mm, and 1.82 m^3 center pocket) over ~20 m distance for standard river sampling or whatever distance is needed to cover the entire length of the backwater or channel. To efficiently sample fish within a site where water turbidity limits visibility, there are a couple techniques for efficiently seining sites. Using one side of the seine net as the pivot, the other crew member extends the net along the shore, upstream from the pivot, and sweeps it out along the river margin, following the direction of the flow. Once the sweep is completed, the pivot and other crew member join each other on the shore and pull the lead and float lines together, trapping the fish in the seine bag. For targeted sampling of backwaters and channel margins, both seine net crew members commence at the downstream side, effectively blocking fish access to the main river and move in tandem upstream to the point where there is no water, then pull the lead and float lines together, trapping the fish in the seine bag. Since block nets are not used for closing sites in the Milk River due to the width of the river and water flow, the speed at which seining is conducted is quicker than for block netted sites. Sampling effort corresponds to the width of the deployed net in the river multiplied by the distance over which the seine is pulled. For targeted sampling, the sampling effort corresponds to the product of the average wetted width taken at the upstream and downstream extents of the site by the distance over which the seine is pulled. Since sites and sampling area are variable throughout the watershed on account of seasonal water level changes, it is essential that sampling effort is measured consistently for each site, ensuring that fish density and biomass estimates may be compared among sites and between years.

At each sampling site, habitat data must be recorded to complement fish data and to quantify habitat availability. Water temperature trends (i.e., among and within streams) are thought to drive species' distribution via their cumulative impacts with water flow, dissolved oxygen, and other habitat variables. Along with the habitat descriptors collected for each site, temperature loggers programmed for long-term monitoring of thermal trends at each access point should be considered to better understand population trends over time. Not included in this report is an approach for quantifying thermal trends in rivers, however, details on launching temperature loggers and their placement in streams may be found in Chu *et al.* (2009) and Mandrak and Bouvier (2014).

Many factors affect beach seining success, namely water turbidity, substrate complexity, and the presence of woody debris that can snag the lead line and allow fish to escape under the net. Other variables, including water depth and velocity, may also affect seining efficiency, which is why habitat variables must be recorded to complement fish data and to quantify habitat availability at each sampling site. The Western Silvery Minnow protocol described here uses elements of the existing fish surveying protocol for first-time surveys of small streams in Alberta (Fisheries Management Standards Committee 2008) as a template. This protocol applies to wadeable rivers or stream margins (<1 m in water depth) in Alberta, where the distribution of Western Silvery Minnow is currently being monitored. Refer to Appendix 2 for the database template.

<u>Collecting Habitat Data</u>

Collecting habitat data from sampling locations is an important activity as changes to habitat through time may help explain the future presence/absence or changes in the abundance of Western Silvery Minnow at any given location. Habitat data collected while sampling for Western Silvery Minnow includes; water velocity, depth, substrate complexity, and plant cover (see items 13, 14, 15 & 16 in list below environmental/habitat descriptors). There are inherent biases to sampling habitat conditions and what one perceives as similar or different may not be so if sites are not selected randomly for collecting habitat data. In an attempt to capture the variability within a site and to aid in the random sampling of habitat variables/conditions/features at each site, it is recommended to divide the site into thirds, resulting in three potential sampling zones where 1 m^2 quadrats may be placed (Figure 10). To select the placement of the three quadrats per site, place quadrats approximately in the middle of each third. The habitat data collected from the three quadrats are then entered on the database template shown below (Appendix 2). Habitat data must be collected from each sampled stretch of the creek/river regardless of whether Western Silvery Minnow are captured.

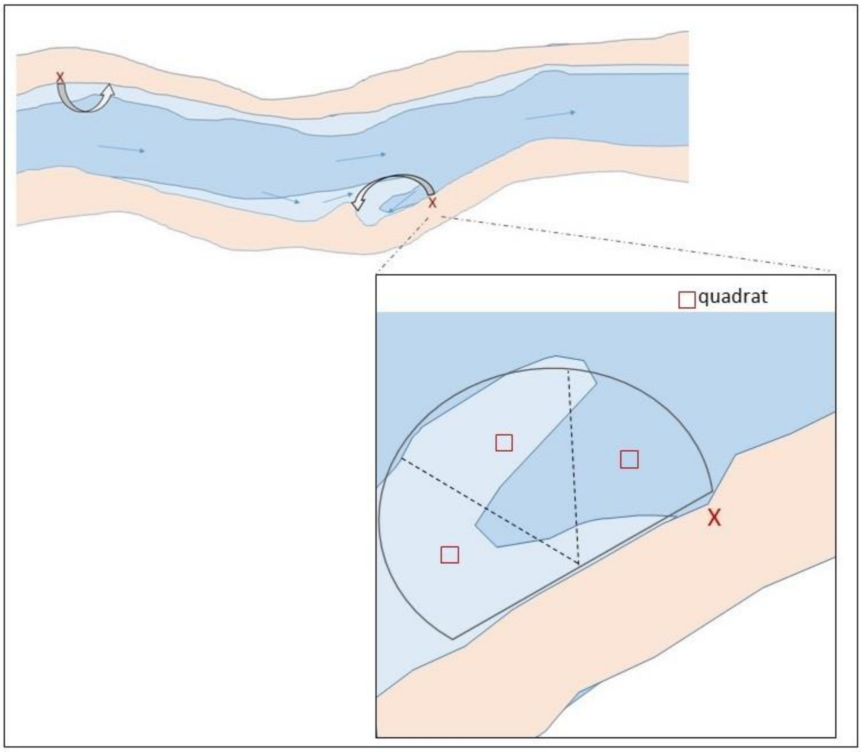

Figure 10. Schematic of Milk River sites and the direction of sampling. Three quadrats (red squares) are positioned approximately in the middle of each third of the site surveyed, labelling each quadrat: upstream, middle, and downstream.

__Environmental/Habitat Descriptors__

1. Waterbody name – List the name of the river surveyed (e.g., Milk River).
2. Waterbody ID – List a unique number assigned to water bodies in Alberta (e.g., 2136) (Fish and Wildlife Management Information System (FWMIS)).
3. Date of surveying – Use the format (dd/mm/yyyy). Do not abbreviate.
4. Crew – List the names of crew members so that appropriate persons may be contacted to verify data.

5. Latitude and longitude coordinates – Units should be in decimal degrees (WGS84). Provide geographic reference locations of each sample site (pivot).
6. Site location notes – Give concise description of the geographic location of the reach or site surveyed using map and site observations (e.g., 10 m upstream from confluence with tributary X).
7. Site number – Give a unique number to the cross section/site surveyed.
8. Water temperature – Measure the water temperature (ºC) where the water column is thoroughly mixed using an appropriately calibrated thermometer. Temperature influences the distribution of biota and the catchability of certain species. Avoid taking measurements in stream margins, outflows from tributaries or stagnant pools (unless the site is located in these habitats). Record the time of day (24 h).
9. Conductivity – Measure the conductivity, the capacity of transmitting electricity, within the site using a portable conductivity meter ($\mu S \cdot cm^{-1}$, standardized to 25 ºC). Conductivity influences catchability and may provide the means to stratify data.
10. Turbidity – Measure the turbidity within the site using a portable turbidity meter (NTU) and Secchi disk (cm). Turbidity influences catchability and may provide the means to stratify data.
11. Wetted and rooted width of the cross section – If possible, measure the channel wetted and rooted widths (m) using a tape measure at the downstream (DS) and upstream (US) locations of the river reach surveyed. Wetted width corresponds to the width of the channel at the surface of the water at the time of survey. Wetted width influences seining effort and efficiency, affecting catchability and CPUE. Rooted or bank-full width corresponds to the channel width at the base of permanently rooted vegetation. For braided channels, the measurement should include any islands not covered by permanent vegetation.
12. Maximum depth – Measure the depth of the water at the deepest point between the wetted banks using a meter stick.
13. Water depth – Measure the depth of the water (m) in three quadrats within a site, making sure to obtain measurements from the center of selected quadrats.
14. Water velocity – Measure the water velocity of the water ($m \cdot s^{-1}$) in three quadrats within a site using a flow meter metre and wading rod (Marsh-McBirney Flo-Mate), making sure to obtain measurements from the center of the randomly selected quadrat.
15. Substrate complexity – Calculate the proportion of the substrate within each quadrat (visual or if need be tactile assessment) that are: bedrock, boulder, cobble, large gravel, small gravel, sand, silt, and clay (modified Wentworth scale). Repeat substrate complexity estimates at three quadrats within a site.
16. Plant cover – Calculate the proportion of plant cover within each quadrat (visual assessment), at the three quadrats within a site.
17. Site characterization – Characterize the site surveyed based on the pool/riffle/run/ backwater categories observed to provide a broad idea of productivity and a mechanism for stratifying data.

18. Photo number – Take a picture and record the number of the photograph taken during the stream survey.
19. Photo description – Briefly describe the picture taken for later reference. Indicate whether you are facing upstream (US) or downstream (DS).
20. Comments – Briefly describe any details relating to surveying, location, and sources of error (e.g., outflow from tributary) or change (e.g., seepage or barrier).

Beach Seine Descriptors

21. Distance/effort – Record the distance (m) over which the seine net is pulled within a site. Seining effort corresponds to the product of the distance covered by the average wetted width of the site.
22. Pass – Record the number of the pass or seine haul if conducting multiple seine passes.

Fishing Descriptors

23. Capture method – Since the recommended capture method for Western Silvery Minnow is beach seining, write beach seining specifications (Seine 9.14 m/1.82 m/4.76 mm).
24. Sample Number – Sequentially number fish, an entry per fish sampled.
25. Species – Enter the name code for the Western Silvery Minnow sampled (WSMW).
26. Fork length/total length – Record the fork (tip of the snout to the natural fork of the tail) or total (tip of the snout to the end of the tail) lengths (mm) for each fish sampled. Ensure that fish are placed on a flat measuring board.
27. Injuries/comments – Note body condition and injury observations (e.g., lesions or parasite burden).
28. Sample picture (one per species) – Place the fish on a flat, non-reflective surface and take a photograph of the fish on its left side, next to a ruler. Identify the picture number (WSMW-number-date-river). Fish viewers are an alternative method for obtaining photos of fish without the added handling stress.
29. Sample specimen – retain a voucher specimen at each access point, indicating the purpose of the voucher, the location, time, and date where the specimen was taken.
30. Refer to specimen collections for archives and life history (Macnaughton *et al.* in revision; Appendix 3).
31. Refer to eDNA sampling protocol (Macnaughton *et al.* in revision; Appendix 4).

4.0 SUMMARY AND RECOMMENDATIONS FOR FUTURE SAMPLING INVESTIGATIONS

The basis of any effective monitoring program is reliable baseline data against which to monitor and compare future conditions. Generally, a couple of years of data should be collected to establish baseline trends for targeted species and monitoring should continue for several years with the same methods, sites, and timing of sampling (Lewis *et al.* 2013). Adopting monitoring programs that include integrated and consistent surveying protocols provide more efficient, comparable, and powerful assessments of population trends over time.

The appropriate method for a particular project, or combination of methods for fish sampling, will require consideration of the capture probability of the species/life stages of interest, as well as the physical conditions of the site (Lewis *et al.* 2013). Although this report describes a protocol for sampling a minimum area based on seining, the timing of surveys will dictate whether seining can take place. Specifically, changes to river habitats due to natural climate variability and/or augmented flows in the Milk River watershed will drive the fish distribution throughout the system. As such, the timing of surveys should consider annual flow conditions as well as inter-annual flow trends to ensure that surveys are conducted for similar flow stages.

Recommendations from the current report directly inform on quantifying CPUE from comparable seining methods and proposing a standardized sampling protocol that will assist with monitoring the extent and abundance of Western Silvery Minnow within the population's natural range (Fisheries and Oceans 2018). Western Silvery Minnow are thought to be moderately abundant in downstream portions of the Milk River, according to two surveys conducted in 2005–2007 and in 2013. By recommending that surveys be conducted ~ every 5 years, data from two survey events align with the COSEWIC assessment timeline (i.e., 10 years) and allow for better management of the species over time.

The greatest alterations to fish habitat in the Milk River are related to water diversions, reservoirs, and water removal for irrigation. Frequent droughts experienced in southern Alberta, further affect the availability of fish habitat in the river. Not only do these alterations impact the availability of suitable Western Silvery Minnow habitat in the Milk River, they reduce the window of time when surveys may be conducted. In the face of uncertain changes to suitable fish habitat and limited data to derive population trends for Western Silvery Minnow, the need has never been more critical for consistent sampling protocols, frequent assessments, and reporting of fish and fish habitat data collections. By increasing our understanding of how human activities affect Western Silvery Minnow survival, potential threats to the species can be mitigated.

5.0 LITERATURE CITED

Chu, C., Jones, N., Piggott, A., and Buttle, J. 2009. Evaluation of a simple method to classify the thermal characteristics of streams using a nomogram of daily maximum air and water temperature. North American Journal of Fisheries Management 29: 1605–1619.

COSEWIC. 2017. COSEWIC assessment and status report on the Western Silvery Minnow *Hybognathus argyritis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 47 pp.

Fisheries Management Standards Committee (FMSC). 2008. Standard for the initial sampling of small streams in Alberta. Small Streams Inventories. Fish and Wildlife Alberta. 04/21/2008.

Fisheries and Oceans Canada. 2018. Action Plan for the Milk River and St. Mary River Drainage Basins in Canada. Species at Risk Act Action Plan Series. Fisheries and Oceans Canada, Ottawa. iii + 24 pp.

Golder Associates. 2010. Milk River instream flow needs study. Submitted to: Milk River Watershed Council Canada. 147 pp.

Hoagstrom, C.W., DeWitte, A.C., Gosch, N.J., and Berry, C.R., Jr. 2006. Perennial warmwater fish communities of the Cheyenne River drainage: a seasonal assessment. Proceedings of the South Dakota Academy of Science 85: 213–245.

Hoagstrom, C.W., Gosch, N.J.C., DeWitte, A.C., Berry, C.R., Jr., and Duehr, J.P. 2007. Biodiversity, biogeography, and longitudinal fish faunal structure among perennial, warmwater streams of the Cheyenne River drainage. The Prairie Naturalist 39(3/4): 117–144.

Lewis, F.J.A., Harwood, A.J., Zyla, C., Ganshorn, K.D., and Hatfield, T. 2013. Long term aquatic monitoring protocols for new and upgraded hydroelectric projects. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/166. ix + 88 p.

Loomis, T.M. 1997. Survey of the fishes and habitat in the upper Moreau River, Perkins County, South Dakota. Thesis (MSc), South Dakota State University, Brookings, South Dakota. 115 pp.

Macnaughton, C.J., Rudolfsen, T., Watkinson, D.A., and Enders, E.C. (in revision). Standardized field sampling method for monitoring the occurrence and relative abundance of Rocky Mountain Sculpin, *Cottus* sp. in Canada. Can. Tech. Rep. Fish. Aquat. Sci.

Mainstream Aquatics Ltd. 2005. Milk River habitat photograph interpretation study. Provided to Fisheries and Oceans Canada. 6 pp.

Mandrak, N.E., and Bouvier, L.D. 2014. Standardized data collection methods in support of a classification protocol for the designation of watercourses as municipal drains. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/077. v + 27 pp.

McLean, D.G., and Beckstead, G.R. 1980. Long term effects of a river diversion on the regime of the Milk River. Alberta Research Council Contribution Series No. 1054. 21 pp.

Nelson, J.S., and Paetz, M.J. 1992. The Fishes of Alberta. University of Alberta Press, Edmonton, AB. 465 pp.

Neufeld, K.R. Unpublished data from 2013 fisheries surveys in the Milk River of southern Alberta. Masters Student, University of Alberta, Edmonton, Alberta.

Neufeld, K.R. 2013. Western Silvery Minnow surveys in the Milk River. Retrieved April-2019 from the Fish and Wildlife Management Information System (FWMIS). 2019. Alberta Environment and Parks.

Neufeld, K.R. 2016. Improving our ability to assess the impacts of hydrologic alteration on stream fishes: An interdisciplinary approach to assess the Threatened Western Silvery Minnow *Hybognathus argyritis* in Canada. Thesis (MSc), University of Alberta, Edmonton, AB. 116 pp.

P&E Environmental Consultants Ltd. 2002. Fish species of concern survey on the Milk River, October 2002. Prepared for Alberta Sustainable Resource Development, Fish and Wildlife Division and Alberta Conservation Association. P&E Environmental Consultants Ltd., Edmonton, AB. 53 pp.

Pflieger, W.L. 1980. *Hybognathus argyritis* Girard, Western silvery minnow. *In* Atlas of North American Freshwater Fishes. *Edited by* D.S. Lee, C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer Jr. North Carolina State Museum of Natural History, Raleigh, NC. 174 pp.

Pflieger, W.F. 1997. The Fishes of Missouri. Missouri Department of Conservation, Jefferson City. 372 pp.

Pflieger, W.L., Sullivan, M., and Taylor, L. 1975. The Fishes of Missouri. Missouri Department of Conservation, Jefferson City, MO.

Platania, S.P., and Altenbach, C.S. 1998. Reproductive strategies and egg types of seven Rio Grande basin cyprinids. Copeia 1998(3): 559–569.

RL&L Environmental Services Ltd. 1980. A fisheries overview study of the Milk River basin. Prepared for Alberta Environment. RL&L Environmental Services Ltd., Edmonton, AB. 120 pp.

RL&L Environmental Services Ltd. 1987. An inventory of aquatic habitats and fish resources in the Milk River, Alberta. Prepared for Alberta Environment, Planning Division. RL&L Environmental Services Ltd, Edmonton, AB. 146 pp.

Scheurer, J.A., Fausch, K.D., and Bestgen, K.R. 2003. Multiscale processes regulate Brassy Minnow persistence in a Great Plains river. Transactions of the American Fisheries Society 132(5): 840–855.

Scott, W.B., and Crossman, E.J. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada Bulletin 184, Ottawa, ON. xx + 966 p.

Water Survey of Canada. 2016. Historical Hydrometric Data: Environment Canada, Government of Canada. www.wateroffice.ec.gc.ca/search/real_time_e.html

Watkinson, D.A. Unpublished data from fisheries surveys in the Milk River of southern Alberta, 2005–2007. Research Biologist, Fisheries and Oceans Canada, Winnipeg, MB.

Willock, T.A. 1969. The ecology and zoogeography of fishes in the Missouri (Milk River) drainage of Alberta. Thesis (MSc), Carleton University, Ottawa, ON. 224 pp.

Young, J.A.M., and Koops, M.A. 2013. Recovery potential modelling of Western Silvery Minnow (*Hybognathus argyritis*) in Canada. Can. Sci. Adv. Sec. Res. Doc. 2013/084. 23 pp.

6.0 APPENDICES

APPENDIX 1. Access points for Western Silvery Minnow surveying sites in the Milk River: Waterbody, Location, Access type, Latitude and Longitude, and notes.

Waterbody	Location of Access Site	Access Type	Latitude	Longitude	Notes
Milk River	Township Rd 24a	Access Point	49.15694	-112.19241	Roadside access
Milk River	HWY 4	Access Point	49.14487	-112.08009	Town of Milk River
Milk River	Range Rd 150a	Access Point	49.10267	-111.8905	Bridge
Milk River	Township Rd 21a	Access Point	49.10424	-111.6998	Bridge
Milk River	Hwy 500	Access Point	49.08851	-111.53676	Bridge
Milk River	Hwy 880	Access Point	49.14538	-111.30748	Bridge
Milk River	Range Rd 95a	Access Point	49.15118	-111.20523	Farm Access
Milk River	Range Rd 73a	Access Point	49.12597	-110.89433	Pinhorn Ranch
Milk River	Landowner Road	Access Point	49.0047	-110.62594	Access uncertain
Milk River	Township Rd 12	Access Point	49.02963	-112.53237	Ford Crossing
Milk River	Township Rd 20	Additional Access Point	49.07709	-111.64036	Writing on Stone Picnic
Milk River	Range Rd 130a	Additional Access Point	49.08265	-111.61297	Writing on Stone Campground
Milk River	Township Rd 20	Additional Access Point	49.09605	-111.98948	Goldspring Park
Milk River	Range Rd 154	Additional Access Point	49.10646	-111.96447	Near trout ponds
North Milk River	Range Rd 212a	Additional Access Point	49.11419	-112.72283	Bridge

Waterbody	Location of Access Site	Access Type	Latitude	Longitude	Notes
Milk River	HWY 501	Range Extension Access Point	49.0895	-112.39801	Bridge
Milk River	Twin River Heritage Rangeland	Range Extension Access Point	49.14592	-112.328	Twin River Heritage Rangeland access road

APPENDIX 2. Database template developed for the standardized sampling protocol of Western Silvery Minnow in wadeable rivers in Alberta.

Waterbody Body		Activity Date (day/month/year)	
Waterbody ID		Time of Day	
Access Point		Crew	

Pivot Latitude (decimal degrees)	Pivot Longitude (decimal degrees)	Site #	Wetted Width (m)	Rooted Width (m)

Water Temperature (°C)	Conductivity (µS·cm^{-1})	Secchi (cm)	Turbidity (NTU)	Max. Depth (m)

Seine dimensions	Pass number	Time Fished (s)	Area (m²) or Distance Fished (m)

QUADRAT	1 (upstream)	2 (middle)	3 (downstream)
water depth (m)			
water velocity (m^{-1})			
Bedrock (>1024 mm)			
Boulder (256-1024 mm)			
Cobble (64-256 mm)			
Large Gravel (34-64 mm)			
Small Gravel (2-34 mm)			
Sand (0.062-2 mm)			
Silt (0.004-0.062 mm)			
Clay (<0.004 mm)			
Plant material			

Photo Number:	Description:

Experience of crew for seining and identifying species (name/experience):

Fish #	Species ID	Total Length (mm)	Picture	Specimen Collected (Y/N)	Comments