STANDARDIZED FIELD SAMPLING METHOD FOR MONITORING THE DISTRIBUTION AND RELATIVE ABUNDANCE OF PLAINS SUCKER (*PANTOSTEUS JORDANI*) POPULATIONS IN CANADA

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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 Plains Sucker (*Pantosteus jordani*) populations in Canada. Can. Tech. Rep. Fish. Aquat. Sci. 3316: viii + 35 p.

The Species at Risk Program's objectives for Plains Sucker (*Pantosteus jordani*) are to maintain current population levels throughout its Canadian range and develop a recovery strategy. In an effort to provide science information to meet the Species at Risk (SAR) Program objectives, this report aims to provide a consistent sampling method, including a survey design that informs on changes in the distribution and provides relative abundance of the Plains Sucker in the Milk River system (DU2), where it is listed as Threatened. This report details (1) the sampling gear, (2) recommended sampling effort and timing, and (3) sampling sites for Plains Sucker occurrence and relative abundance. This standardized sampling protocol should 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 Plains Sucker (*Pantosteus jordani*) populations in Canada. Can. Tech. Rep. Fish. Aquat. Sci. 3316: viii + 35 p.

Une des mesures de gestion provenant de la Loi sur les Espèces en Péril (LEP) pour la conservation du meunier des plaines (*Pantosteus jordani*) 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 meunier des plaines 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 meunier des plaines dans les bassins versants de la rivière Milk en Alberta, où elle est menacée. 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 de l'espèce.

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 actions are effective. 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 surveying methods for a given species.

Various field sampling methods for quantifying the occupancy and relative abundance of small-bodied freshwater fishes in wadeable streams can be used. 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. In fact, only relatively few and scattered data records exist for the Canadian distribution of Plains Sucker (*Pantosteus jordani*, Cope 1874), making the task of estimating their current distribution and relative abundance difficult. To date, much is unknown about the Plains Sucker population trends across rivers in Canada.

In an effort to provide science information to meet the Species at Risk Program objective of monitoring population trends within the ten-year cycle, this report provides a consistent sampling method and survey design that may accurately inform on changes in the distribution and relative abundance of the Plains Sucker throughout its Canadian range. This sampling method will also specifically inform management and recovery of Plains Suckers in the Milk River watershed in Canada (DU2), where the species was assessed as *Threatened* (Species at Risk public registry, COSEWIC 2010). Properly designed sampling programs should include knowledge of the biology of the SAR-species and the deployment of the appropriate gear under the direction of experienced personnel (Portt *et al*. 2008). The report does this by detailing which sampling gear to use and how much effort is required, where to sample Plains Sucker populations, and where range extension sampling should be planned as part of a long-term monitoring program for this species. Using existing electrofishing field sampling data records for the species, this report provides information to the Species at Risk Program on baseline Plains Sucker catch-per-unit-effort (CPUE) for the Belly, Oldman, North Milk, and Milk rivers in Alberta. Recommendations on a standardized sampling protocol that also includes the frequency of sampling events over time for monitoring Plains Sucker population and distribution targets for recovery will lead to improved and better informed management of the species, specifically the Milk River populations (DU2) (DFO 2013).

2.0 PLAINS SUCKER

2.1 TAXONOMY

Mountain Sucker (*Pantosteus*), sometimes considered a subgenus of *Catostomus*, recently underwent a molecular study, where deep genetic divergences among allopatric sister lineages were identified and groups were elevated to species (Unmack *et al.* 2014). Although none of the samples used to distinguish species in the Unmack *et al.* (2014) study originated from the Canadian portion of the distribution, what was formally considered Mountain Sucker is now called the Plains Sucker (*Pantosteus jordani*) in Alberta and Saskatchewan, and the Cordilleran Sucker (*Pantosteus bondi*) in British Columbia (Figure 1) (Bangs *et al.* 2018). Plains Sucker morphology and biology will be described using information from studies on *Pantosteus jordani*, but in cases where information is limited, data on *Pantosteus bondi* and *Catostomus platyhynchus* will be used.

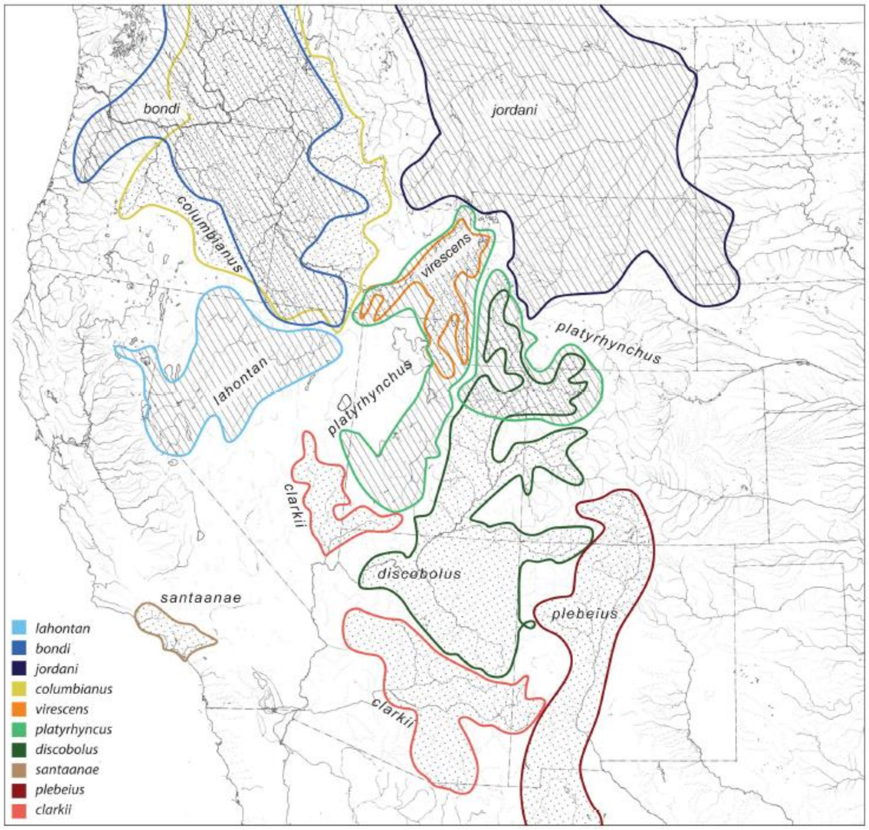

Figure 1. Distribution of the 11 species of *Pantosteus*, including Plains (*P. jordani*) and Cordilleran (*P. bondi*) Sucker distributions in the USA (Unmack *et al.* 2014).

2.2 MORPHOLOGY

The Plains Sucker is a small fish (usually < 250 mm fork length) with a sub-terminal mouth. The mouth has a shallow, incomplete cleft between the lower lips and a notch at each corner and three to five rows of large "fleshy bumps" (papillae) on the lips (Scott and Crossman 1998). The lower jaw has a sharp edge comprised of a cartilaginous sheath and lower lips shaped like a pair of wings (Scott and Crossman 1998). The body is elongate, cylindrical, and somewhat compressed caudally (Figure 2). The snout is broad and heavy, with small eyes. The species can be distinguished from other catostomids by the incomplete cleft of the lower lip. The upper lip of the Plains Sucker is large and the outer surface lacks papillae. The pronounced and deep notches at the corners of the mouth, the absence of papillae on the anterior vertical surface of the lips and lower scale and fin ray counts distinguish it from the Bridgelip Sucker (*Catostomus columbianus*) (Scott and Crossman 1998).

Figure 2. Plains Sucker (image D. Watkinson 2006).

The peritoneum is dark to black, while the intestine is long with six to ten coils anterior to the liver and absent pyloric caeca. The swim bladder is comprised of two chambers reduced in size, where the slender posterior chamber extends up to the point of origin of the pelvic fins. There are from 38–44 post-Weberian vertebrae (usually 40–43) (Scott and Crossman 1998). The body is covered in cycloid scales that usually crowd towards the head. There is one dorsal fin with eight to 13 soft rays, unforked and short caudal fin, an anal fin with seven rays and a pair of pelvic fins that are in line with the middle of the base of the dorsal fin (nine rays) with a developed axillary process. The pelvic fins are long with typically 15 rays (Scott and Crossman 1998). The fish are dark green to grey or brown in colour and finely sprinkled with black (lateral band and/or blotches) on dorsal and lateral surfaces (Scott and Crossman 1998). On the ventral surface, the colour is pale yellow to white (Scott and Crossman 1998).

Spawning/mature fish develop an orange to deep red lateral band and fin rays become more pigmented (Scott and Crossman 1998). Males also develop small nuptial tubercles on the entire body surface and larger tubercles on the lower lobe of the caudal fin, the dorsal surface of paired fins, and on the anal fin during spawning season. Females may also develop nuptial tubercles, although they may be smaller and less abundant than males (Scott and Crossman 1998).

2.3 BIOLOGY

Life Cycle and Reproduction

Spawning occurs in late spring or early summer, in riffles of moderate to fast flowing water, when water temperature is above 10.5 ºC. Eggs are scattered over river or stream bottoms in riffle areas adjacent to pools (Smith 1966). Fecundity is related to fish length and age, with older and larger fish bearing more eggs than smaller fish (Scott and Crossman 1998). Fecundity ranges from 990-3710 eggs in Flathead Creek and East Gallatin River, Montana respectively and between 1239-2863 eggs in Lost Creek Reservoir, Utah (Hauser 1969). Small recruitment eggs, eggs that have not filled out for spawning, may also be found in the ovary, providing evidence of a short spawning season (Hickling and Rutenburg 1936). Eggs generally hatch within 8–14 days and young-of-the-year reach 30–64 mm total length after the first summer (Scott and Crossman 1998). Growth is slow in cold streams but will vary among streams (Hauser 1969; Cannings and Ptolemy 1998). Growth is greatest during the first year, and growth rates decrease until the third year. After the third year, the growth increment is small but constant. Precise age to maturity is still unknown, but males mature before females. Both sexes exhibit secondary sexual characteristics such as tubercles on the fins. Females tend to be larger and live longer (nine years) than males (seven years). Maximum size is in the order of 232 mm (total length) based on Royal Ontario Museum records (ROM 25919). Maturity was generally reached at the end of the second year of life, however, age of maturity of four and five years for males and females, respectively, were found for the Cordilleran Sucker (McPhail 2007).

The diet consists of plankton, small invertebrates, and microscopic organic matter scraped off rocks (COSEWIC 2010). No information is available regarding the physiology, as well as the dispersal and migration of the species. There is no evidence of seasonal migration upstream from a lake/reservoir. Smaller movements between riffles and adjacent pools have been observed at spawning periods. Plains Sucker inhabit a wide range of stream habitats in isolated populations subject to periodic natural disturbances such as fires, droughts, and floods. The species is adapted to these changing environments (Dunham *et al.* 1979) and since it is a multi-year spawning species, they are able to withstand poorer spawning years and take advantage of ideal conditions when they occur (Belica and Nibberlink 2006).

2.4 KNOWN DISTRIBUTION IN CANADA

The Plains Sucker is relatively widespread in the western mountainous regions and westernmost Great Plains of North America. Specific to Canada, they are found in the Saskatchewan River drainage across many tributaries in Alberta and Saskatchewan and in the Missouri River watershed (Figure 3**)**. Plains Suckers have been sampled in the Saskatchewan and upper Missouri river systems of Canada, where they can occur in mountain streams, but are most commonly associated with streams in the foothills and plains (Nelson and Paetz 1992). The species has been sampled from the Milk River drainage in the Cypress Hills region of Alberta and southwestern Saskatchewan, west in southern Alberta to the Waterton Lakes area, and north along the foothills of the Rocky Mountains. Most of the estimated Canadian range (>90%) is located in Alberta. The Cypress Hills population is unlikely to meet Milk River populations on account of the distance from Battle Creek to the Milk River.

The distribution and evolution of Plains Sucker is closely associated with mountains, foothills, and plains, where they are adapted to cool waters, swift currents, and rocky substrates. Mountains pose a barrier to movement between isolated populations, leading to variation among populations. Waterfalls may also create barriers that permit unidirectional gene flow. Furthermore, ecological barriers such as variation in environmental conditions (i.e., warmer water temperatures, sluggish or turbid water, and intermittency of water flows, anoxia, and ice scour) may also limit movement and population viability.

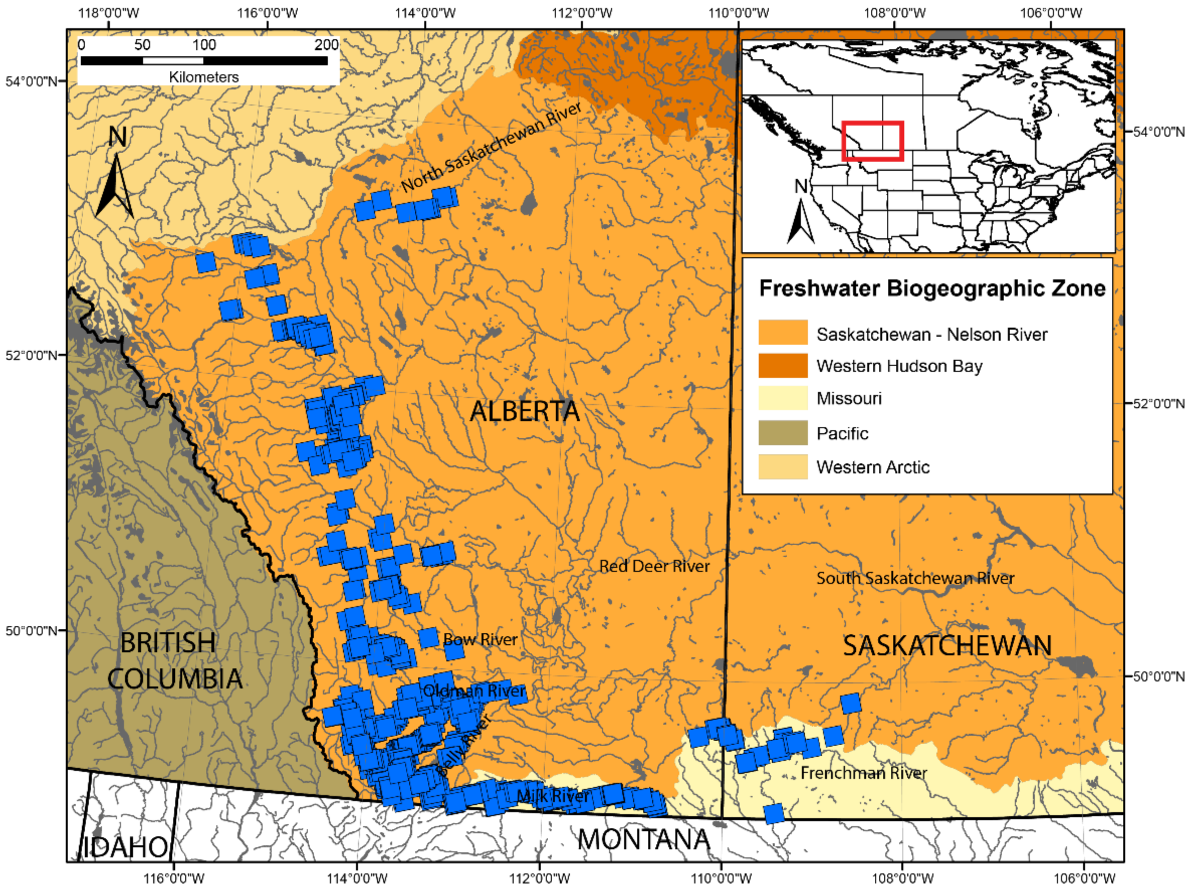

Figure 3. Location of the distribution of the Mountain Sucker in Canada (inset) and known occurrence of Plains Sucker in the Saskatchewan-Nelson and Missouri Biogeographic Zones in Canada.

<u>Known Distribution and Status by Designatable Units (DU)</u>

COSEWIC formerly delineated three DUs for Mountain Sucker in Canada based on the biogeographic zones where they were found; Saskatchewan-Nelson River populations (DU1), Milk River populations (DU2), and Pacific populations (DU3) (COSEWIC 2010). Now that DU3 is considered a different species, Cordilleran Sucker, only two DUs are considered for the Plains Sucker.

Designatable Units (DU)

1- Saskatchewan-Nelson River populations (AB)
2- Missouri populations (AB, SK)

<u>Saskatchewan-Nelson River Populations (DU1) – *Not at Risk* (COSEWIC 2010)</u>

The distribution is relatively widespread in the Saskatchewan River watershed, throughout many tributaries in the provinces of Alberta and Saskatchewan. Threats to the populations are relatively localized and not of imminent concern to the species' persistence across its range. Water use, drought, and climate change are factors thought to impact the extent and quality of aquatic habitat of Plains Sucker within DU1 by increasing the frequency and severity of droughts and water temperature increases. Moreover, major alterations to aquatic habitat in southwestern Alberta were observed with the construction of the Oldman River Dam (Arc Wildlife Services 2004). Negative effects on Plains Sucker habitat and population were compounded by increases in road development and urbanization within the Red Deer River drainage.

<u>Missouri Populations (DU2) – *Threatened* (COSEWIC 2010)</u>

The Plains Sucker Missouri populations are limited to the Milk River basin, tributary to the Missouri River, of southern Alberta and Saskatchewan, where the small area of occupancy and number of locations, make it particularly susceptible to habitat loss and degradation from altered flow regimes and drought. Collections in Saskatchewan found the species in Battle, Caton, and Conglomerate creeks (McCulloch *et al.* 1994), as well as in Ninemile Creek in 2003 and 2004 (Franzin and Watkinson, unpublished data). More recent surveys in 2017-2018 have collected Plains Sucker in Battle, Belanger, Caton, Conglomerate, Davis, Fairwell, and Sucker creeks (Serada and Pollock, unpublished data; Watkinson, unpublished data). The Milk River Fish Species at Risk Recovery Team (2008) identified potential activities related to water use that contributed to habitat loss and threatened the survival of many fishes: changes in flows from the diversion, canal maintenance, water storage, and groundwater and surface water extractions. As a result, the availability of habitat was highly variable among years, because it is dependent on adequate water flows in the late summer, fall, and during the over-wintering period. At the provincial level, the species is listed as Critically Imperiled (S1) in Saskatchewan and Apparently Secure (S4) in Alberta (NatureServe 2008).

2.5 HABITAT

<u>Habitat Features</u>

Plains Sucker are associated with cool, moderately fast-flowing waters of higher gradient reaches (20-800 m above sea level in elevation) of small rivers and streams typified by gravel to cobble substrate types. Plains Sucker were collected in Saskatchewan streams of 2-10 m in width and <1 m deep, with moderate velocities (0.2-0.5 m s^{-1}), over substrates ranging from mud to boulders, with cobble being the most common (Watkinson unpublished data 2003, 2004). Underwater observations indicated that Plains Sucker were found in small groups and most often associated with the bottom of streams in areas of cover (Decker 1989). Water conditions vary from clear to roiled or turbid water, with daytime summer water temperatures ranging from 10-28 ºC and near 0 ºC in the winter (Reed 1959). Fish that were not actively spawning were found along the shorelines associated with cover (i.e., vegetation) (Wydoski and Wydoski 2002).

Habitat Trends and Threats

Both 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). 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 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).

Habitat loss and degradation associated with the expansion of agricultural, commercial, and industrial land use activities, water use and removal, resource extraction, and the introduction of aquatic invasive species are expected to negatively impact the persistence of this species. The greatest risks to the Plains Sucker are in southern Alberta and Saskatchewan, where existing threats on water availability may be further exacerbated by climate change. Imminent threats to fish populations or fish habitats include low flows and high water temperatures resulting from drought and water extractions, along with changes to land use in surrounding areas. Plains Sucker inhabit a wide range of stream habitats in isolated populations and are adapted to fluctuating environments (see Boguski and Watkinson 2013 for definitions of threats-related terms and a description of each threat and its potential impacts).

2.6 POPULATION SIZE AND CPUE TRENDS IN CANADA

Population Trends by Designatable Units (DU)

Although abundant at certain locations, Plains Sucker are at the northern range of their distribution in Canada. Very little demographic information exists for the various Plains Sucker populations (i.e., North Saskatchewan, Red Deer, Bow, Oldman, South Saskatchewan, and Swift Current Creek watersheds (DU1) and the Missouri watershed (DU2)). In the past, Plains Sucker probably went unrecorded because of the lack of directed surveys, inaccessibility, and because of confusion in the taxonomy of the genus and subgenus. Population size and trends in Canada is limited to occurrence data and there have been no targeted abundance estimates to examine temporal trends for the species. Alberta and Saskatchewan are the only provinces where Plains Sucker is known to be moderately abundant where it occurs across broad distributions (Scott and Crossman 1998).

To better understand population trends over time and establish baseline occurrence and abundance estimates by river, we first described sampling effort in terms of catch-per-unit-effort (CPUE) using available data from electrofishing surveys for Battle, Belanger, Caton, Conglomerate, Davis, Fairwell, Sucker, and Ninemile creeks in Saskatchewan (DU2) and the Belly, Oldman, and Milk river watersheds (DU1). Backpack electrofishing surveys conducted in Saskatchewan provided additional data on the baseline sampling effort for monitoring populations trends over time (i.e., CPUE per river).

DU1 - Saskatchewan-Nelson Populations

Collection records of the University of Alberta's Museum of Zoology, Alberta's Fisheries and Wildlife Management Information System (FWMIS), and the National Museum of Natural Sciences count as many as 354 specimens for a given site, but it was more common to find less than 20 individuals at a given site. In Saskatchewan, Plains Sucker have been collected in Battle, Belanger, Caton, Conglomerate, Davis, Fairwell, Sucker, and Ninemile creeks (Figure 4) (McCulloch *et al.* 1994; Watkinson unpublished data 2003, 2004, 2017, 2018; Serada and Pollock unpublished data 2017 and 2018). Catches were as high as 157 individuals in a single seine haul, however, electrofishing surveys indicated much lower catches, reaching an average CPUE of 2.98 fish min^{-1} for Caton Creek and an overall mean CPUE of 0.23 fish min^{-1} for all creeks surveyed in Saskatchewan in July 2003, 2004, 2017, and 2018 combined (

Table **1**). Caton Creek had the greatest available data for Plains Sucker with five data points collected (July 2003, 2004, 2017, and 2018), reaching a maximum of 12.2 fish min^{-1} in Caton Creek in 2017 (average ± SE = 2.98 ± 3.67 fish min^{-1}). Despite the availability of data for Caton Creek and other waterbodies, the existing data is still insufficient to reliably describe population trends for the species across the years. The median effort to detect the occurrence of Plains Sucker was generally quite variable among rivers (702 s (~12 min); Figure 5).

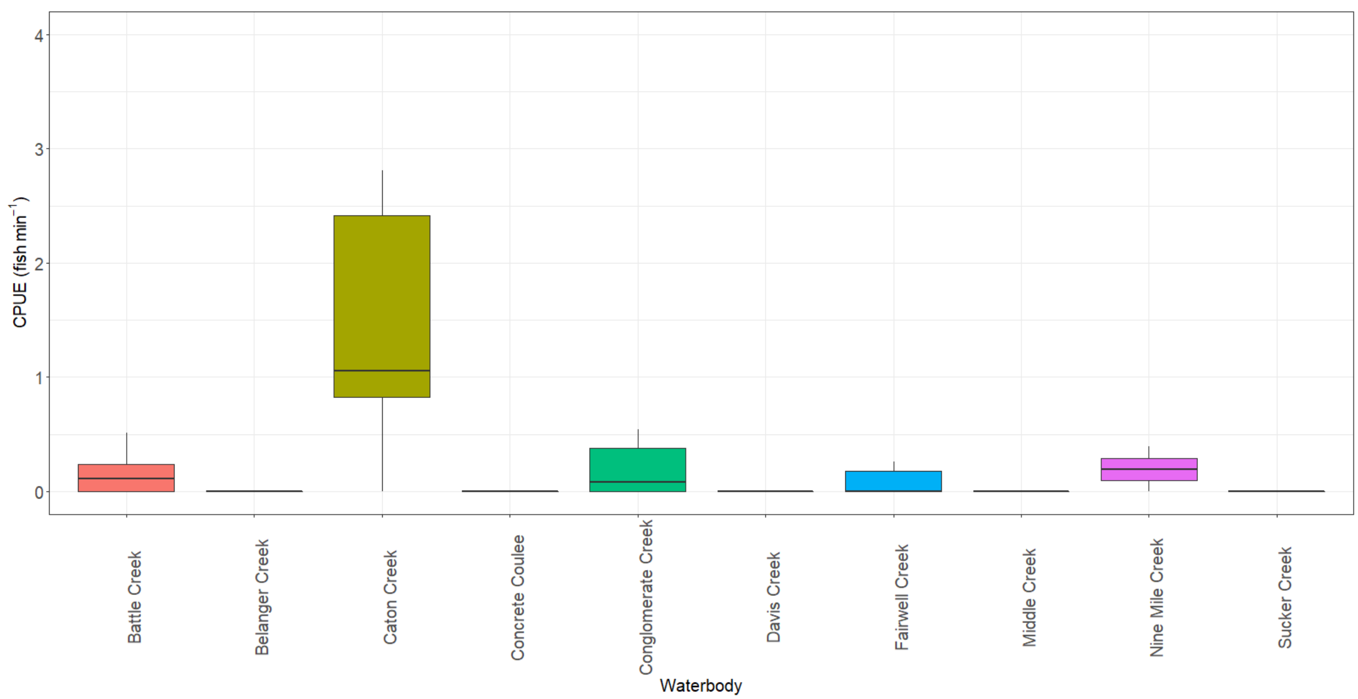

Figure 4. Overall median CPUE (fish min^{-1}) of Plains Sucker surveyed in rivers and creeks within their distribution in Saskatchewan in 2003, 2004, 2017, and 2018 (Watkinson *et al.* unpublished data).

Table 1. Median, Maximum (Max), Minimum (Min), Mean, and Standard Error (SE) catch-per-unit effort (CPUE; fish·min^{-1}) of Plains Sucker surveyed in rivers and creeks in Saskatchewan in 2003, 2004, 2017, and 2018 (Watkinson *et al*. unpublished data).

	CPUE (fish· min^{-1})				
Waterbody	Median	Max	Min	Mean	SE
Battle Creek	0.12	0.52	0	0.16	0.12
Belanger Creek	0	0	0	0	0
Caton Creek	1.06	12.20	0	2.98	3.67
Conglomerate Creek	0.09	0.54	0	0.20	0.22
Davis Creek	0	0	0	0	0
Fairwell Creek	0	0.26	0	0.08	0.10
Nine Mile Creek	0.20	0.39	0	0.20	0.38
Sucker Creek	0	0	0	0	NA

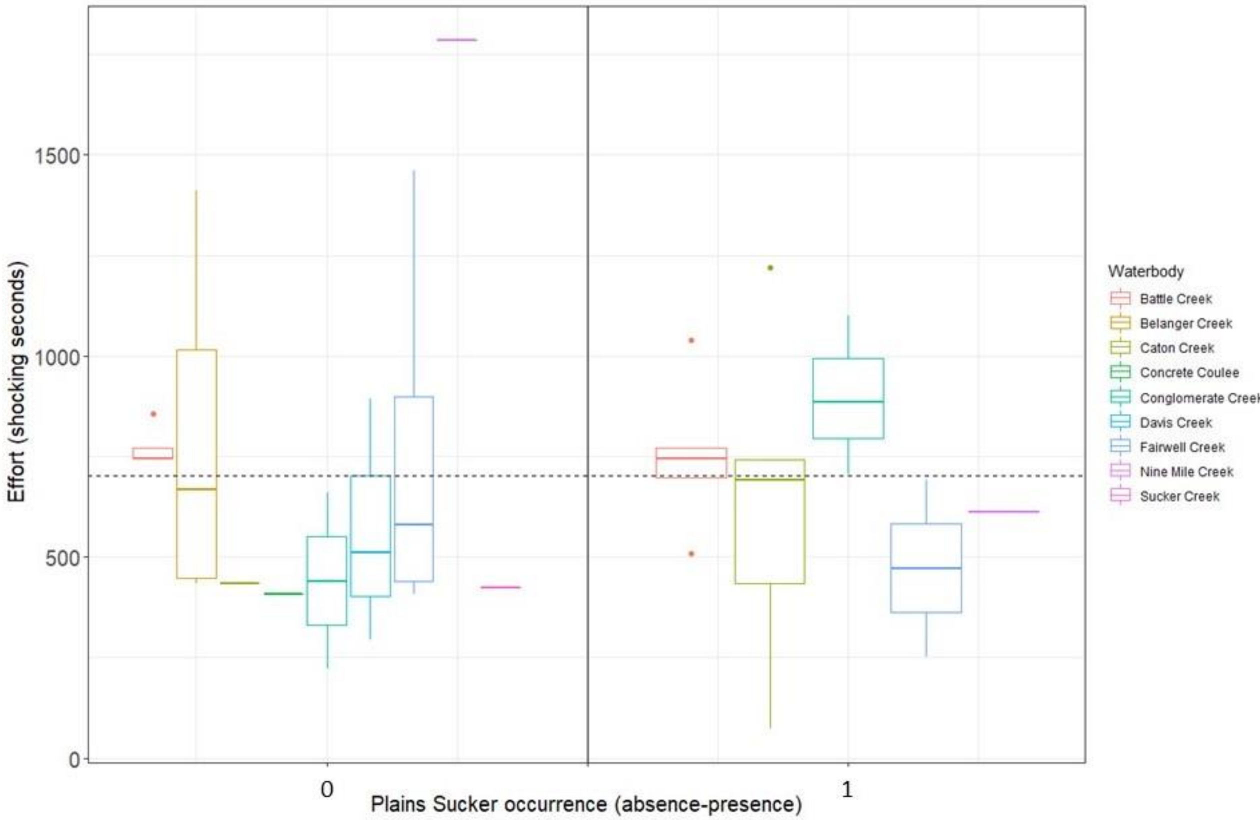

Figure 5. Plains Sucker occurrence by survey effort (shocking seconds) across waterbodies in Saskatchewan. Dashed grey line represents the median effort for detecting the presence of Plains Sucker across these waterbodies (702 s).

DU2- Missouri-Milk River Populations

Plains Sucker are common in the Milk River drainage of Alberta and may be the only fish found in the pseudo-alpine habitat of the Sweetgrass Hills (Willock 1969), with the first record in 1927 (ROM3891). In Alberta, Plains Sucker have been collected in the North Milk and Milk rivers, from as early as 1950 (UAMZF346) to most recently in 2018. The Alberta FWMIS data is only available from 1986 for the species and much of the data is inconsistently collected; with effort measured either in shocking seconds or distance, using different backpack electrofishing units or boat electrofishers and employing different parameters (i.e., voltage, power). CPUE (fish min^{-1}) was only quantified for surveys for which effort was quantified in time (shocking seconds). To accurately represent CPUE for Plains Sucker populations, future surveys should include survey area or distance, as well as time fished.

For the available data collected for the Milk and North Milk rivers, CPUE ± standard error (fish min^{-1}) were very low across years and among rivers (Figure 6), reaching a maximum of 2.49 fish min^{-1} in the Milk River in 2006, however, Plains Sucker were not found in most sites, irrespective of the river surveyed. Plains Sucker abundance data are patchy over time due to inconsistent approaches to sampling effort over time and space. This is compounded by spotty Plains Sucker distribution within the watershed.We relied on the effort required to detect Plains Sucker (i.e., median effort in shocking seconds to determine the presence of Plains Sucker) for recommending minimum surveying effort across river systems (Figure 7). The median effort to detect the presence (825 s) of Plains Sucker across rivers was generally greater than that for absences (560 s), but the effort was quite variable among rivers (Table 2). This discrepancy is likely due to the fact that crews generally quit sampling a site more quickly when fish are not found. As such, the recommended survey time should be 825 s (~14 min) at any given site.

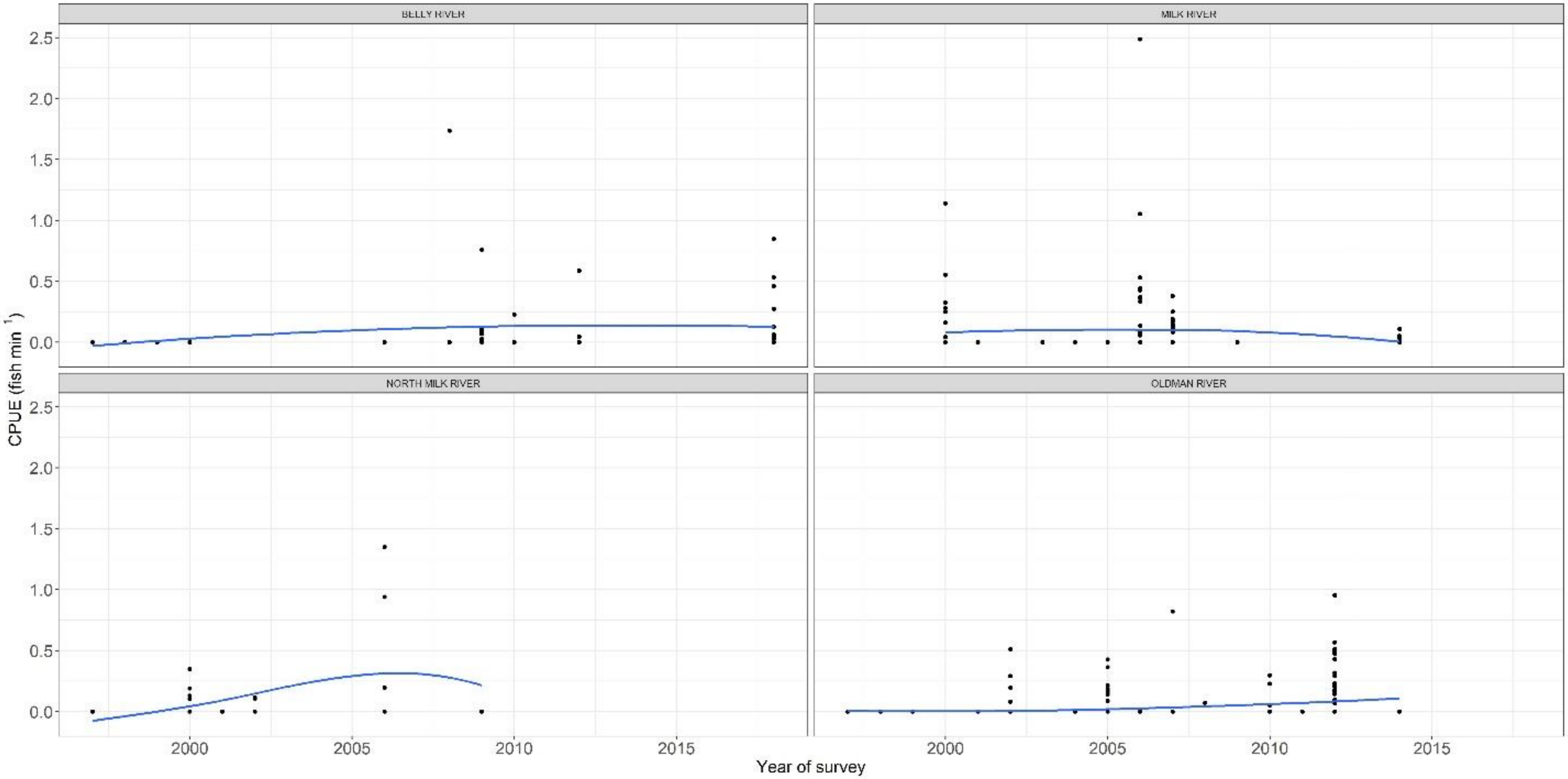

Figure 6. CPUE (fish·min^{-1}) of Plains Sucker by year from 1997-2018, surveyed in the Belly River, Milk River, North Milk River, and Oldman River. Loess smoothers (blue line) represented.

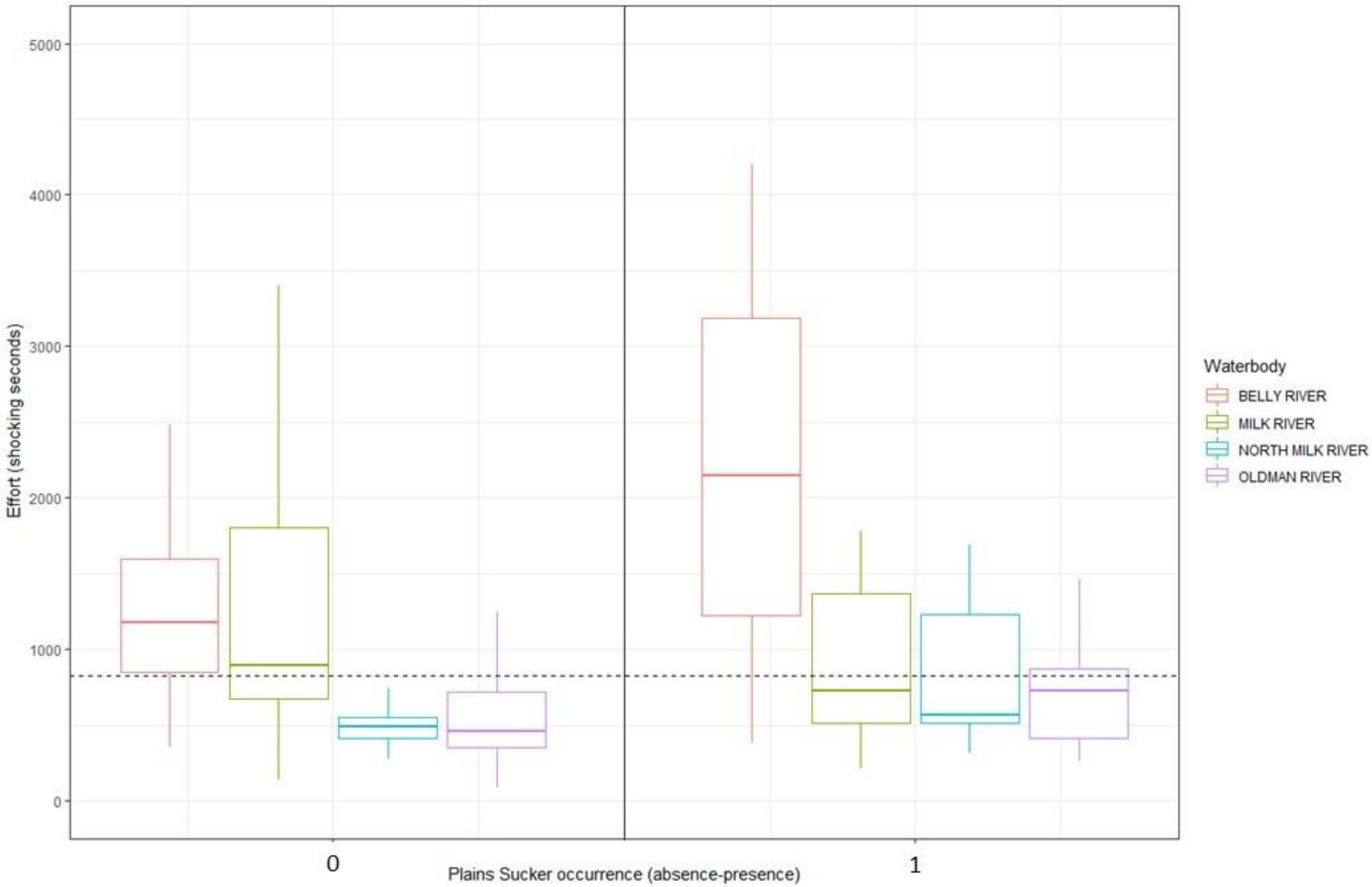

Figure 7. Occurrence of Plains Sucker by survey effort (shocking seconds) for the Belly, Milk, North Milk, and Oldman rivers. Dashed grey line represents the median effort for detecting the presence of Plains Sucker across these waterbodies (825 s).

Table 2. Maximum (Max), minimum (Min), mean, and standard error (SE) catch-per-unit-effort (CPUE; fish·min^{-1}) by survey year and waterbody and electro-fishing effort (shocking seconds) by waterbody.

		CPUE (fish·min^{-1})				Effort (shocking seconds) for all surveys conducted from 2006-2018				
Waterbody	**Year**	**Max**	**Min**	**Mean**	**SE**	**Median**	**Max**	**Min**	**Mean**	**quantile 75%**
Belly River	2006	0	0	0	NA	1316	4205	352	1732	2482
	2008	1.74	0	0.87	1.7					
	2009	0.76	0	0.07	0.08					
	2010	0.23	0	0.05	0.09					
	2012	0.59	0	0.16	0.28					
	2018	0.85	0	0.13	0.10					
Milk River	2006	2.49	0	0.25	0.20	850	6120	140	1323	1770
	2007	0.38	0	0.06	0.04					
	2009	0	0	0	0					
	2014	0.11	0	0.01	0					
North Milk River	2006	1.35	0	0.62	0.62	499	1690	109	625	678
	2009	0	0	0	0					
Oldman River	2006	0	0	0	0	473	21828	86	693	736
	2007	0.82	0	0.27	0.54					
	2008	0.07	0.07	0.07	NA					
	2010	0.30	0	0.07	0.08					
	2011	0	0	0	0					
	2012	0.95	0	0.16	0.07					
	2014	0	0	0	0					

3.0 SAMPLING PROTOCOL

3.1 SAMPLING DESIGN

Seining and electrofishing are considered the most efficient, readily available, sampling gears in wadeable and non-wadeable habitats, however, seining may not be the most effective sampling method in habitats where debris, boulders or other obstacles are present (Mandrak and Bouvier 2014). To obtain consistent fish survey data and ensure that monitoring is effective, a standard sampling protocol using backpack electrofishing has been developed to monitor occurrence and abundance of Plains Sucker. The quality of the data collected via electrofishing may be variable depending on the skill level of the operator. Ample practice prior to conducting surveys is advisable, but the skill level of the electrofishing operator should be indicated with each survey. The Plains Sucker protocol described here uses elements of the existing fish surveying protocol for first-time surveys of small streams in Alberta (FMSC 2008) as a template and the Rocky Mountain Sculpin technical report (Macnaughton *et al.* in revision). This protocol applies to wadeable streams (<1 m in water depth) in Alberta and Saskatchewan, where the distribution of Plains Sucker is currently being monitored.

Access Points

A list of access points has been assembled for river systems in which Plains Sucker occur (see Appendix 1 for the full list of access points and associated coordinates). Recommended access points per river are indicated by triangles and additional access points are illustrated by circles (Figure 8 and 9). A number of these access points are recommended per system for monitoring population trends and should be resampled over time. In Battle Creek, for example, Plains Sucker records indicated a single detection near the Canada-USA border (Figure 9), however, the species has not been collected since, suggesting that it does not occur in southern reaches of Battle Creek, when it should potentially occur anywhere in the system. With each recommended access point, it is necessary to establish sites away from the road crossing or any shore modifications (i.e., riprapping) (Mandrak and Bouvier 2014). Proposed range extension locations will provide information on whether the species' distribution is expanding or contracting (blue squares; Figure 8 and 9). However, baseline data should be collected across river systems in which Plains Sucker are known to occur before range extension sampling is conducted.

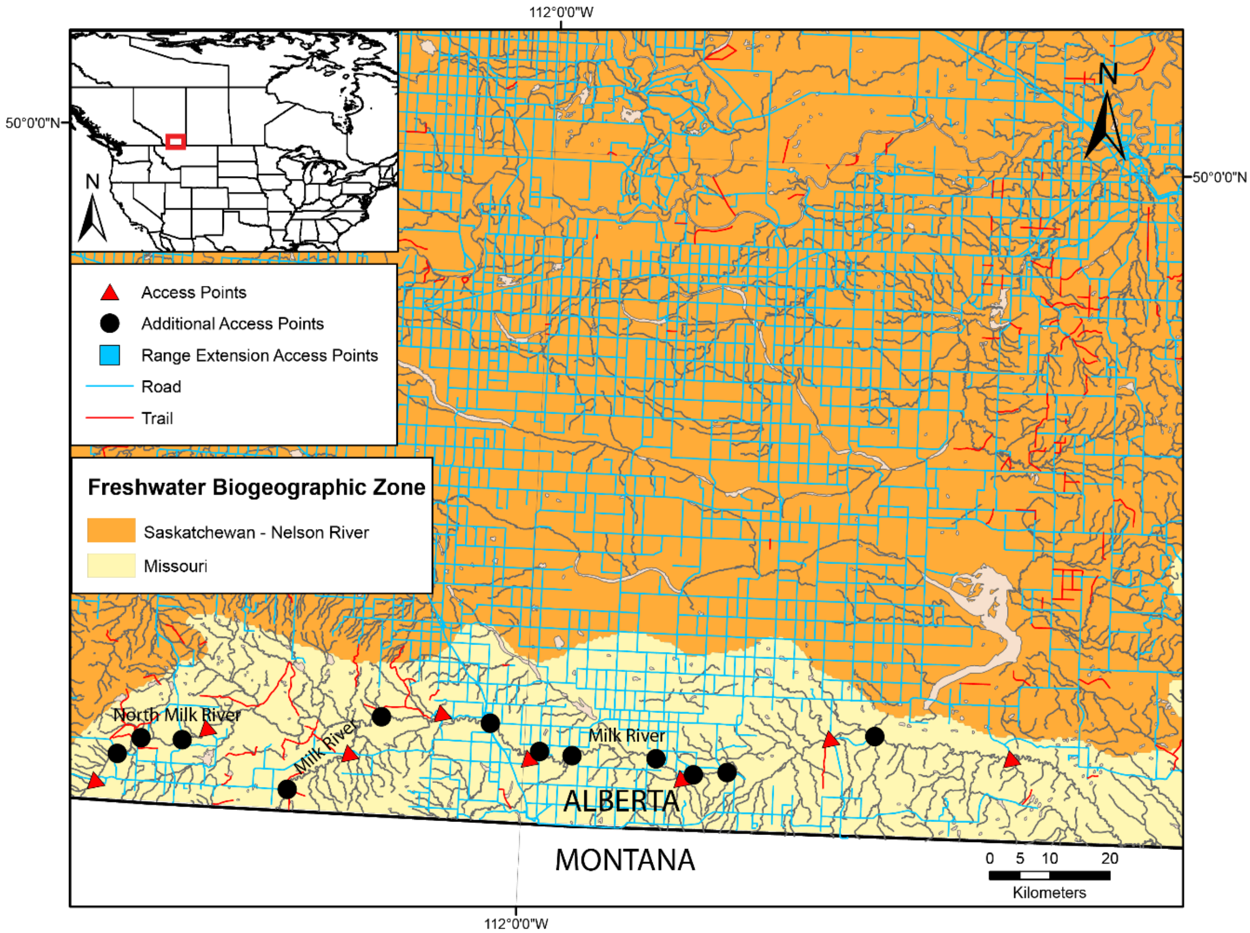

Figure 8. Recommended access points (red triangles and black circles) in the Milk and North Milk rivers, West Missouri watershed in Alberta.

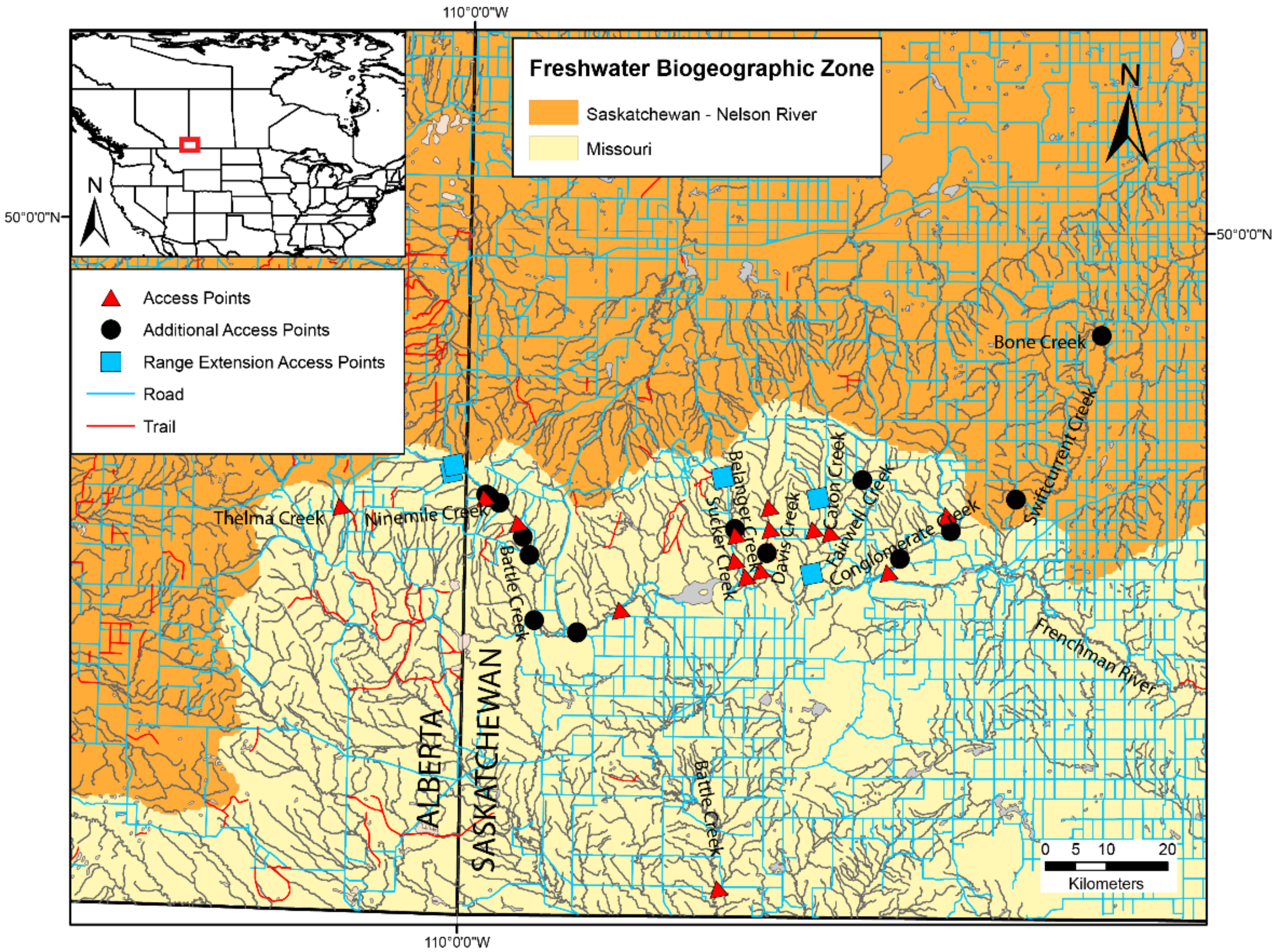

Figure 9. Recommended access points (red triangles and black circles) and range extension access points (blue squares) in Thelma Creek, Ninemile Creek, Battle Creek, Sucker Creek, Belanger Creek, Davis Creek, Caton Creek, Fairwell Creek, Conglomerate Creek, Swiftcurrent Creek, and Bone Creek, East Missouri watershed in Alberta and Saskatchewan.

Sites

For rivers where the average wetted width is ≥5 m, a site represents an area or sampling unit of 300 m^2 (e.g., 5 m wide by 60 m long or 2 m wide by 150 m long). In such cases, sites should be positioned alternating between either stream shore and if the depth allows for it, the middle (i.e., thalweg), according to the schematic (Figure 10). For narrower rivers and creeks <5 m, a site represents a 100 m long segment, making sure to sample both shores. Irrespective of the width of the river surveyed, sites should be evenly distributed among recommended access points along each river, maximizing the spatial extent of the surveying effort. Since there are eight and 15 access points for the West and East Missouri watersheds, respectively (Figures 8 and 9), it is recommended that one or two sites are established per access point, for a total of 23-46 sites throughout the species' known distribution in Saskatchewan and Alberta. The number of sites per access point may vary depending on the sampling resources for a given year (i.e., effort and cost of surveying 23 vs. 46 sites) and water level conditions. In order to balance the spatial distribution of sampling sites with the effort of moving between these sites, we recommend that multiple sites per access point are spaced out no less than two-times the length of a sample site (i.e., 200 m for small width streams and at least 300 m for wide width streams). To avoid disturbing fish habitats during surveys, sampling should commence at the most downstream site at any given access point, moving upstream with each new site.

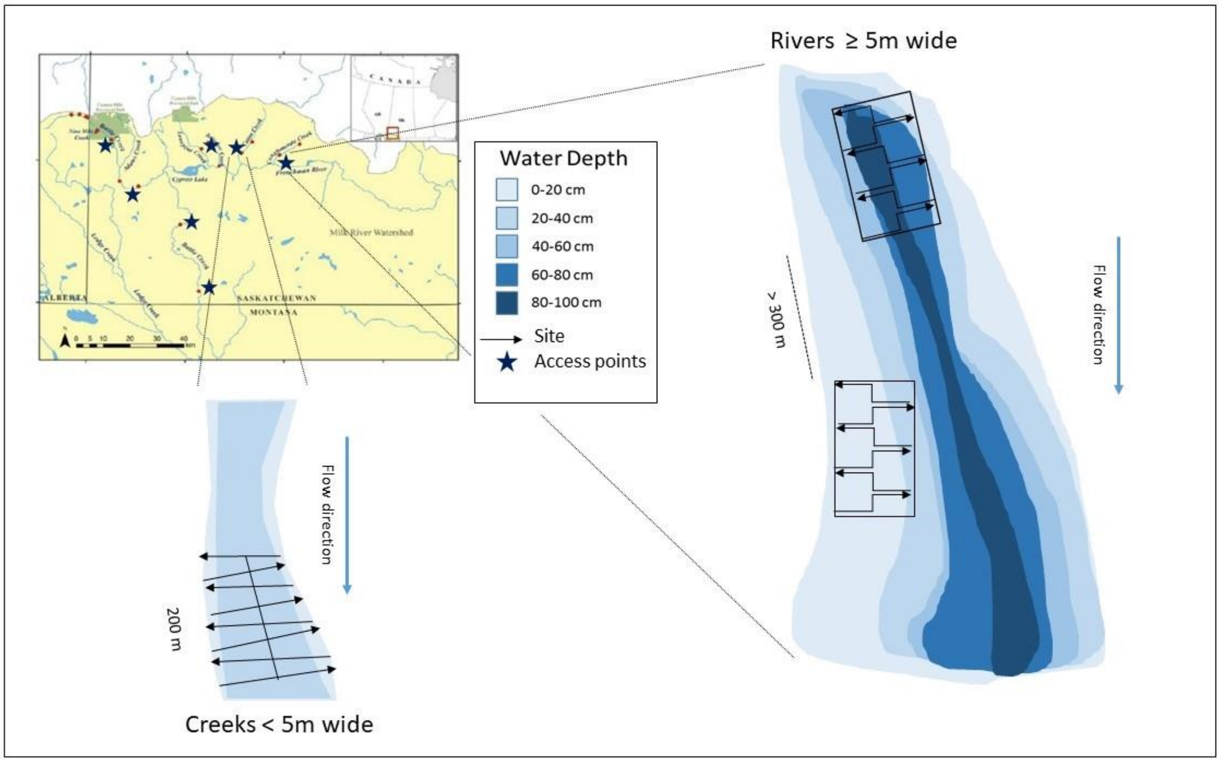

Figure 10. Schematic of the creeks in Saskatchewan, with seven recommended access points (stars) positioned to maximize the spatial extent of backpack electrofishing survey sites (black rectangles).

3.2 TIMING OF SAMPLING

<u>**Seasonality**</u>

To achieve a stream wide assessment of population, it is important that sampling be timed to match the most appropriate conditions every year to reduce environmental variation. In other words, to allow for paired comparisons (site-to-site, reach-to-reach comparisons) in statistical tests (increasing statistical power), the same sites should be sampled during each monitoring period (i.e., month or year). The sampling sites should therefore be georeferenced and photographed in the field to ensure that the same location is used repeatedly across years. The timing of sampling events should also be consistent across years.

Survey feasibility in the Milk River watershed is contingent on seasonal water levels and water temperatures that allow fishing to consistently and predictably occur. Rather than aiming at particular calendar dates each year, annual studies should be conducted for targeted stream flows within a particular calendar period or under a similar flow stage. Real-time hydrometric data for the systems are available from the Water Survey of Canada to inform on seasonal flow and water level variability (Table 3). The North Milk River and Milk River downstream of the North Milk River confluence have been severely impacted by changes in its seasonal flow regimes. Water diverted from the St. Mary River in Montana augments flows in the Alberta portion of the Milk River from late March or early April through late September or mid-October. As such, high flows from mid-September (~Day 271; Figure 11) for the Milk River further reduce the window of time that Plains Sucker surveying can be conducted. Davis and Farwell creeks are ephemeral and fish can be restricted to isolated pools during August and early September. Habitat could be significantly altered if sampling was to occur during this time.

Table 3. List of real-time hydrometric stations and recommended sampling time in rivers for watersheds where Plains Sucker occur.

Waterbody	**Hydrometric station**	**Site description**	**Suggested Sampling time**	**Source**
North Milk River	11AA001	North Milk River near International Boundary	October 1-November 1	Water Survey of Canada
Milk River	11AA031	Milk River at Eastern Crossing of International Boundary	October 1-November 1	Water Survey of Canada
Milk River	11AA025	Milk River at Western Crossing of International Boundary	August 1-October 15	Water Survey of Canada
Frenchman River	11AC017	Frenchman River at Crossing of International Boundary	August 1-October 15	Water Survey of Canada
Battle Creek	11AB027	Battle Creek at Crossing of International Boundary	August 1-October 15	Water Survey of Canada

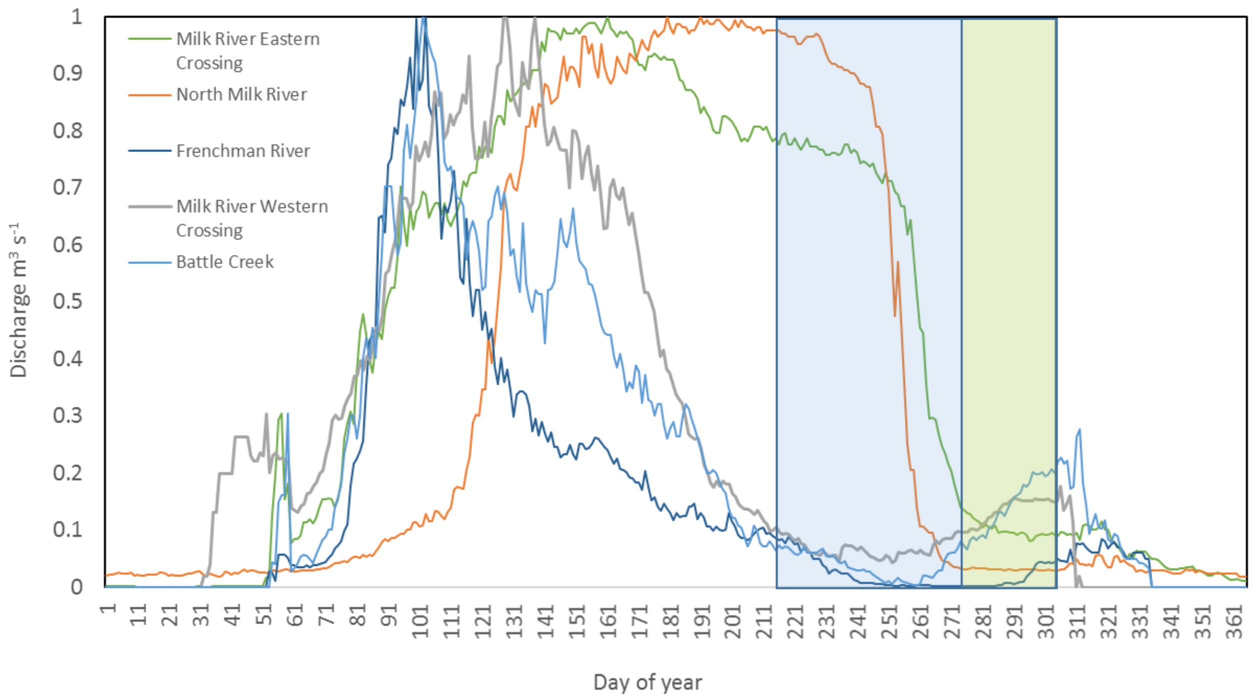

Figure 11. Hydrographs illustrating standardized median discharge ($m^3 s^{-1}$) over a year (Day 1= January 1) for hydrometric data collected by Water Survey of Canada for Milk River Eastern crossing (green), North Milk River (orange), Frenchman River (navy blue), Milk River Western crossing (grey), and Battle Creek (light blue). Windows of time for surveying Plains Sucker for all systems and the Milk River specifically depicted by the blue and green boxes at ~ Days 221 and 271, respectively.

Surveying Frequency

In the absence of consistent Plains Sucker sampling across the species' distribution in Alberta, especially the Milk River watershed, baseline repeat sampling at selected access points is recommended every year. Once baseline CPUE data is available, population trend assessments may be spread over longer periods of time and include range extension sampling to determine whether the populations are expanding or contracting. COSEWIC assessments determine the status of a species on a 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 three people is recommended, one to operate an LR-24 backpack electrofisher and two to net, each using a 60 cm wide by 20 cm high dipnet (Smith-Root; Washington USA). The person with the backpack electrofisher is positioned between the netters, moving in an upstream zigzag fashion and sweeping the anode from left to right throughout the site. Sites located in wider river reaches in the Milk River watershed, measured approximately 50 m in length and took 825 s (~14 min) to survey, while narrower streams in Saskatchewan took ~ 2 min less time to survey for the same length of river. General electrofishing guidelines suggest 2-5 electrofishing seconds m^{-2} (Mandrak and Bouvier 2014), which means that for sites of ~300 m^2, continuous electrofishing surveys should last from 600-1500 s, depending on habitat complexity and fish communities sampled. To accurately represent CPUE for Plains Sucker populations, surveys need to include survey area or distance, as well as time fished. As such, the approximate length and width of the electrofishing site must be recorded to calculate fish density and biomass, which can be compared across sites and between years. Once the electrofishing is finished, fish are placed in a bucket and immediately processed and released at the sampling site.

Many factors affect electrofishing success and the most important environmental factor is the conductivity of the water (i.e., its ability to conduct an electrical current due to the concentration of ions in the water). Other variables, including water temperature, depth, turbidity, and velocity will affect electrofishing efficiency either on their own or via each variable's influence on conductivity. Like for other surveying technical reports, to consistently survey Plains Sucker using an LR24 backpack electrofishing unit (Smith-Root; Washington USA) across the species' distribution, the recommended range of settings for surveys are: 30 Hz, using 15% pulse width in DC, moderating the voltage between 100-400 V (Macnaughton *et al.* in revision).

At each sampling site, habitat data must be recorded to complement fish data and to quantify habitat usability. Water temperature trends (i.e., among and within streams) are thought to drive species' distribution via their cumulative impacts with water flow, dissolved oxygen concentration, 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 the 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). Refer to Appendix 2 for the database templates.

<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 Plains Sucker at any given location. Habitat data collected while sampling for Plains Sucker includes; water velocity, depth, substrate complexity, and plant cover (see items 12, 13, 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 overlay an imaginary grid over the sampled creek/river area, dividing the site into 2 m long sections with the width of the creek/river divided into halves. As an example, 150 potential sampling quadrats may be measured within a 100 m long site. To select the placement of the five quadrats per site, randomly select five numbers from a number generator or a table of numbers. These randomly selected numbers can be used to correspond to five of the 150 potential sampling quadrat locations from the example given above. The habitat data collected from the five quadrats are then entered on the database template shown below (Appendix 2). Habitat data must be collected from each sampled stretch of creek/river regardless of whether Plains Sucker are captured.

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 (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.
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 ($\mu S\ cm^{-1}$, standardized to 25 ºC). Conductivity influences electrofishing efficiency, thus, affects catchability and may provide the means to stratify data.
10. Turbidity – Measure the turbidity within the site using a portable turbidity meter (NTU). Turbidity influences catchability and may provide the means to stratify data.
11. Wetted and rooted width of the cross section – 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 electrofishing 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) at five randomly distributed points within a site using a meter stick, making sure to obtain measurements from the center of the randomly selected quadrat.
14. Water velocity – Measure the water velocity of the water (m s^{-1}) at five randomly distributed 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. Site discharge– Measure the water velocity and depth of the water (m s^{-1}) at three points along the upstream-most cross-section of the site, using a flow meter metre and wading rod (Marsh-McBirney Flo-Mate). Divide the creek/river width into thirds and measure water depth and velocity at each point.
16. Substrate complexity – Calculate the proportion of the substrate within a ~1 m^2 quadrat (visual assessment) that are: bedrock, boulder, cobble, large gravel, small gravel, sand, silt, and clay (modified Wentworth scale). Repeat substrate complexity estimates at five randomly distributed quadrats within a site.
17. Plant cover – Calculate the proportion of plant cover within a ~1 m^2 quadrat (visual assessment), at five randomly distributed points within a site.
18. Site characterization – Characterize the site surveyed based on the pool/riffle/run categories observed to provide a broad idea of productivity and a mechanism for stratifying data.
19. Photo number – Take a picture and record the number of the photograph taken during the stream survey.
20. Photo description – Briefly describe the picture taken for later reference. Indicate whether you are facing upstream (US) or downstream (DS).
21. 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).

Electrofishing Descriptors

22. Time electrofished – Record the time (s) the electrofisher is in use and reset to zero at the start of each survey (quadrat). Electrofishing seconds corresponds to the sampling effort of each survey. This should be standardized for each site (600- 1500 s).
23. Distance/area – Record the distance (m) or area (m^2) of each survey. Electrofishing distance translates to the sampling effort of each survey. This should be standardized for each site (100 m or 300 m^2).
24. Pulse width – Note the pulse width used to target the species. Should be standardized for each site (15% percent of the electrical cycle during which electricity actually flows in Direct current)

25. Frequency – Note the frequency used to target the species. Should be standardized for each site (30 Hz).
26. Voltage/ Power – Note the voltage (V) and power (W) used. Power should be standardized for each site and the voltage will vary based on the water conductivity (100-400 V).

<u>Fishing Descriptors</u>

27. Capture method – Since the recommended capture method for Plains Sucker is electrofishing, write backpack electrofishing (LR24).
28. Sample Number – Sequentially number fish, an entry per fish sampled.
29. Species – Enter the name code for the Plains Sucker sampled (i.e., PLSC).
30. Fork length/total length – Record the fork (tip of the snout to the natural fork of the tail) and 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.
31. Injuries/ comments – Note body condition and injury observations (e.g., lesions or parasite burden).
32. Sample picture – 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- (PLSC-number-date-river).
33. Sample specimen – retain a voucher specimen at each access point, indicating the location, time and date where the specimen was taken.
34. Presence of Brown Trout, Brook Trout and Rainbow Trout in the site.
35. Refer to specimen collections for archives and life history (Macnaughton *et al.* in revision; Appendix 3).
36. 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. Despite the recommendations provided here, studies will invariably be conducted in different years and using different methods (i.e., seining vs. backpack electrofishing), likely increasing the variance in results and reducing the power of any future effort to make conclusions across individual monitoring studies. However, a comparison of surveying methodologies for assessing population trends may improve sampling protocols, once sufficient baseline data is collected.

As previously mentioned, seining and electrofishing are considered the most efficient, readily available, sampling gears for wadeable habitats. A combination of methods can be employed to overcome the limitations of a single method, as a second sampling method may sample different life-history stages and extend sampling into other seasons. 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). Moreover, sampling effort for each method must be sufficient to adequately describe the targeted fish species (i.e., biomass, abundance, habitat use). Although this report describes a protocol for sampling a minimum area based on a single-pass sampling approach, multiple-pass surveys may also be appropriate when the area investigated or the amount of suitable habitat for a targeted species, such as Plains Sucker, is small. Multiple-pass electrofishing surveys tended to yield more precise abundance estimates, as the variance is reduced with each pass and fish are depleted from sites (Dextrase *et al.* 2014).

Plains Sucker are thought to be abundant in the North Milk (1.35 fish m^{-1}) and Milk rivers (2.49 fish m^{-1}) for surveys conducted in 2006, but the absence of consistent survey estimates for both systems since 2006 preclude the assessment of population trends over the last decade and contribute to the uncertainty in population estimates for Plains Sucker in the Central and Arctic Region, specifically in the Missouri watershed (DFO 2013). According to the recovery potential assessment of the Milk River populations of Plains Sucker (DU2), the greatest threats to the survival and persistence of the species are related to the cumulative effects of landscape changes causing habitat loss and degradation, especially as a result of flow alteration. In any given year, the Milk River has very low flow under natural flow conditions and this would be exacerbated during times of drought stemming from climate change. Drought and anoxic conditions in combination with water regulation and extraction may further reduce the quantity and quality of sucker habitat (DFO 2013). In the face of uncertain changes to suitable fish habitat and scarcity of data to derive population trends for Plains Sucker in DU2, especially in Saskatchewan, the need has never been more critical for consistent sampling protocols, frequent assessments, and reporting of fish and habitat collections.

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6.0 APPENDICES

APPENDIX 1. Access points for all Plains Sucker surveying across DUs: Waterbody and ID, Location, Access type, Latitude and Longitude, and Field notes.

Waterbody	Location of Access Site	Access Type	Latitude	Longitude	Province	Notes
North Milk River	HWY 501	Access Point	49.02641	-112.96956	Alberta	Roadside access
North Milk River	Range Rd 212a	Access Point	49.11419	-112.72283	Alberta	Roadside access
Milk River	HWY 501	Access Point	49.0895	-112.39801	Alberta	Roadside access
Milk River	Township Rd 24a	Access Point	49.15694	-112.19241	Alberta	Roadside access
Milk River	Township Rd 20	Access Point	49.09605	-111.98948	Alberta	Goldspring Park
Milk River	Township Rd 20	Access Point	49.07709	-111.64036	Alberta	Writing on Stone picnic area
Milk River	Hwy 880	Access Point	49.14538	-111.30748	Alberta	Roadside access
Milk River	Range Rd 73a	Access Point	49.12597	-110.89433	Alberta	Pinhorn Ranch
Battle Creek	near USA	Access Point	49.041021	-109.42222	Saskatchewan	Roadside access
Battle Creek	Bridge	Access Point	49.446744	-109.64932	Saskatchewan	Roadside access
Battle Creek	Ft. Walsh	Access Point	49.570840	-109.88251	Saskatchewan	Access Cypress Hills Province Park
Belanger Creek	Roadside	Access Point	49.497108	-109.3670	Saskatchewan	Roadside access
Belanger Creek	Intersects with extended driveway	Access Point	49.558104	-109.39245	Saskatchewan	Roadside access
Caton Creek	Culvert	Access Point	49.567351	-109.2170	Saskatchewan	Roadside access
Conglomerate Creek	Provincial Road 614	Access Point	49.58908	-108.91682	Saskatchewan	Roadside access
Conglomerate Creek	Gravel Road	Access Point	49.50573	-109.04913	Saskatchewan	Roadside access
Davis Creek	Bridge	Access Point	49.506481	-109.33482	Saskatchewan	Roadside access
Davis Creek	Culvert	Access Point	49.567260	-109.31512	Saskatchewan	Roadside access
Davis Creek	Near Control Structure	Access Point	49.599472	-109.3171	Saskatchewan	Roadside access
Fairwell Creek	Ranch	Access Point	49.563101	-109.18042	Saskatchewan	Pasture Access

Waterbody	Location of Access Site	Access Type	Latitude	Longitude	Province	Notes
Ninemile Creek	In Cypress hills west block	Access Point	49.606940	-109.95766	Saskatchewan	Short hike through forest
Sucker Creek	Downstream site	Access Point	49.520538	-109.39362	Saskatchewan	Roadside access
Thelma Creek	Access from Range Rd 30	Access Point	49.59019	-110.28153	Alberta	Known sample collection
Boiler Creek	Culvert under highway	Range Extension	49.642510	-109.42205	Saskatchewan	Roadside access
Grabum Creek	In Cypress hills west block	Range Extension	49.643550	-110.03364	Alberta	Park Access
Battle Creek	In Cypress hills west block	Range Extension	49.654400	-110.02725	Alberta	Park Access
Caton Creek	Bridge	Range Extension	49.612906	-109.20622	Saskatchewan	Roadside access
Fairwell Creek	Road Crossing	Range Extension	49.50269	-109.21958	Saskatchewan	Roadside access
North Milk River	Range Rd 225a	Additional Access Point	49.06737	-112.9224	Alberta	Roadside access
North Milk River	HWY 62	Additional Access Point	49.0938	-112.77712	Alberta	Roadside access
Milk River	Range Rd 130a	Additional Access Point	49.08265	-111.61297	Alberta	Writing on Stone Campground
Milk River	Range Rd 154	Additional Access Point	49.10646	-111.96447	Alberta	Near trout ponds
Fairwell Creek	Bridge	Additional Access Point	49.640329	-109.10728	Saskatchewan	Roadside access
Milk River	Township Rd 12	Additional Access Point	49.02963	-112.53237	Alberta	Ford Crossing
Milk River	Twin River Heritage Rangeland	Additional Access Point	49.14592	-112.328	Alberta	Twin River Heritage Rangeland access road

Waterbody	Location of Access Site	Access Type	Latitude	Longitude	Province	Notes
Milk River	Range Rd 150a	Additional Access Point	49.10267	-111.8905	Alberta	Roadside access
Milk River	Township Rd 21a	Additional Access Point	49.10424	-111.6998	Alberta	Roadside access
Milk River	Hwy 500	Additional Access Point	49.08851	-111.53676	Alberta	Roadside access
Milk River	Range Rd 95a	Additional Access Point	49.15118	-111.20523	Alberta	Farm Access
Battle Creek	Under Bridge off HWY	Additional Access Point	49.412155	-109.74428	Saskatchewan	Roadside Access
Battle Creek	Dirt Road Access	Additional Access Point	49.550969	-109.86946	Saskatchewan	Roadside Access
Battle Creek	Bridge	Additional Access Point	49.600423	-109.92352	Saskatchewan	Roadside Access
Battle Creek	Bridge Crossing	Additional Access Point	49.609237	-109.94684	Saskatchewan	Roadside Access
Battle Creek	Road Intersects Creek	Additional Access Point	49.611711	-109.95369	Saskatchewan	Roadside Access
Davis Creek	Downstream site	Additional Access Point	49.532324	-109.32102	Saskatchewan	Farm Access
Bone Creek	Near confluence with Swift Current Creek	Additional Access Point	49.85242	-108.56775	Saskatchewan	Roadside Access
Pine Cree	Pine Cree Regional Park	Additional Access Point	49.612681	-108.76145	Saskatchewan	Roadside Access
Ninemile Creek	Near Confluence to Battle Creek	Additional Access Point	49.608597	-109.94782	Saskatchewan	Roadside Access
Milk River	HWY 4	Additional Access Point	49.14487	-112.08009	Alberta	Town of Milk River

Waterbody	Location of Access Site	Access Type	Latitude	Longitude	Province	Notes
Battle Creek	HWY 615	Additional Access Point	49.413033	-109.74459	Saskatchewan	Roadside Access
Battle Creek	Tractor Crossing	Additional Access Point	49.429739	-109.84057	Saskatchewan	Farm Access
Belanger Creek	intersects with rural road	Additional Access Point	49.567425	-109.3932	Saskatchewan	Roadside Access
Battle Creek	Bridge	Additional Access Point	49.524499	-109.85441	Saskatchewan	Roadside Access
Conglomerate Creek	Roadside	Additional Access Point	49.52556	-109.02183	Saskatchewan	Roadside Access
Conglomerate Creek	Roadside	Additional Access Point	49.56665	-108.90736	Saskatchewan	Roadside Access
North Milk River	Range Rd 222b	Additional Access Point	49.09299	-112.87037	Alberta	Ford Crossing, Nature Conservatory of Canada

APPENDIX 2. Database template developed for the standardized sampling protocol of Plains Sucker in wadeable rivers in Alberta and Saskatchewan.

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

Start Latitude (decimal degrees)	Start Longitude (decimal degrees)	Site #	DS Wetted Width (m)	US Wetted Width (m)	Rooted Width (m)

Discharge (velocity/ depth) at US cross section	1	2	3

Water Temperature (°C)	Conductivity (µS/cm)	Secchi (cm)	Turbidity (NTU)	Max. Depth (m)

ELECTROFISHING

Time Fished (s):	Area (m^2) or Distance Fished (m):	Model Number	Pulse Width (ms)	Frequency (hz)	Volts

	QUADRAT	1	2	3	4	5
	water depth (m)					
	water velocity (m/s)					
SUBSTRATE	Bedrock (>1024 mm)					
SUBSTRATE	Boulder (256-1024 mm)					
SUBSTRATE	Cobble (64-256 mm)					
SUBSTRATE	Large Gravel (34-64 mm)					
SUBSTRATE	Small Gravel (2-34 mm)					
SUBSTRATE	Sand (0.062-2 mm)					
SUBSTRATE	Silt (0.004-0.062 mm)					
SUBSTRATE	Clay (<0.004 mm)					
SUBSTRATE	Plant material					

Photo Number:	Description:

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

Fish #	Species ID	Fork Length (mm)	Picture	Specimen Collected (Y/N)	Comments/ Presence of trout species