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Information in support of a recovery potential assessment of Plains Minnow (*Hybognathus placitus*) in Canada

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Canada

Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

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ABSTRACT

In May 2012, a meeting of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recommended that Plains Minnow (*Hybognathus placitus*) be designated Threatened. The reason given for this designation was that Plains Minnow "has a very limited distribution in Canada at only one or two locations, both of which are small streams subject to drought. The species requires long stretches of flowing water to complete its life cycle. Further threats to water supply from additional irrigation dams and excessive drought would increase risks to this species" (COSEWIC 2012). Plains Minnow has not yet been listed under the *Species at Risk Act* (SARA).

The Recovery Potential Assessment (RPA) provides information and scientific advice needed to fulfill various requirements of the SARA, including informing both scientific and socio-economic elements of the listing decision and permitting activities that would otherwise violate SARA prohibitions and the development of recovery strategies. This Research Document describes the current state of knowledge of the biology, ecology, distribution, population trends, habitat requirements and threats to Plains Minnow. Mitigation measures and alternative activities related to the identified threats, which can be used to protect the species, are also presented. The information contained in the RPA and this document may be used to inform the development of recovery documents and for assessing permits, agreements and related conditions, as per section 73, 74, 75, 77, and 78 of the SARA. The scientific information also serves as advice to the Minister of Fisheries and Oceans Canada regarding the listing of the species under the SARA and is used when analyzing the socio-economic impacts of adding the species to the list as well as during subsequent consultations, where applicable. This assessment considers the available scientific data pertaining to the recovery potential of Plains Minnow in Canada.

Information à l'appui de l'évaluation du potentiel de rétablissement du méné des plaines (*Hybognathus placitus*) au Canada

RÉSUMÉ

En mai 2012, dans le cadre d'une réunion du Comité sur la situation des espèces en péril au Canada (COSEPAC), on a recommandé de désigner le méné des plaines (*Hybognathus placitus*) comme une espèce « menacée ». La raison ayant été donnée pour le désigner ainsi est que le méné des plaines « a au Canada une aire de répartition très limitée, soit à seulement une ou deux localités étant des petits cours d'eau sujets à la sécheresse. L'espèce a besoin de longues étendues d'eau vive pour compléter son cycle de vie. D'autres menaces à l'approvisionnement en eau découlant de barrages d'irrigation additionnels et la sécheresse excessive augmenteraient les risques pour l'espèce » (COSEPAC 2012). Le méné des plaines n'a pas encore été inscrit sur la Liste des espèces en péril en vertu de la *Loi sur les espèces en péril* (LEP).

L'évaluation du potentiel de rétablissement fournit les renseignements et les avis scientifiques nécessaires pour satisfaire à diverses exigences de la LEP; notamment, cette évaluation permet d'éclairer les aspects scientifiques et socio-économiques de la décision relative à l'inscription sur la liste, de réaliser des activités qui autrement enfreindraient les interdictions de la LEP et d'élaborer des stratégies de rétablissement. Le présent document de recherche fournit une description de l'état actuel des connaissances de la biologie, de l'écologie, de la répartition, des tendances démographiques, des besoins en matière d'habitat et des menaces relatives au méné des plaines. Des mesures d'atténuation et d'autres activités associées aux menaces déterminées, qui peuvent être utilisées dans le but de protéger l'espèce, sont également présentées. Les renseignements que renferment l'évaluation du potentiel de rétablissement et ce document peuvent servir de base à l'élaboration de documents relatifs au rétablissement et à l'évaluation des permis, des ententes et des conditions connexes, conformément aux articles 73, 74, 75, 77 et 78 de la LEP. On se sert également de ces renseignements scientifiques pour conseiller le ministre de Pêches et Océans Canada au sujet de l'inscription de l'espèce en vertu de la LEP, analyser les répercussions socio-économiques de l'inscription de l'espèce sur la liste ainsi que pour les consultations subséquentes, le cas échéant. Cette évaluation tient compte de toutes les données scientifiques existantes sur le potentiel de rétablissement du méné des plaines au Canada.

SPECIES INFORMATION

Scientific Name – *Hybognathus placitus*

Common Name – Plains Minnow

Range in Canada - Saskatchewan

Current COSEWIC Status (Year of Designation) – Threatened (2012)

COSEWIC Reason for Designation – This large minnow has a very limited distribution in Canada at only one or two locations, both of which are small streams subject to drought. The species requires long stretches of flowing water to complete its life cycle. Further threats to water supply from additional irrigation dams and excessive drought would increase risks to this species.

Canada *Species at Risk Act* – New Species, No Schedule, No Status

Saskatchewan *The Wildlife Act* – No Status

BACKGROUND

The Plains Minnow (*Hybognathus placitus*) is a large freshwater minnow (Figure 1) that occurs in only one or two locations in Canada. The first assessment of this species by COSEWIC was conducted in 2012. Plains Minnow is now being considered for listing under the *Species at Risk Act* (SARA). This document evaluates the potential for recovery of Plains Minnow in Canada.

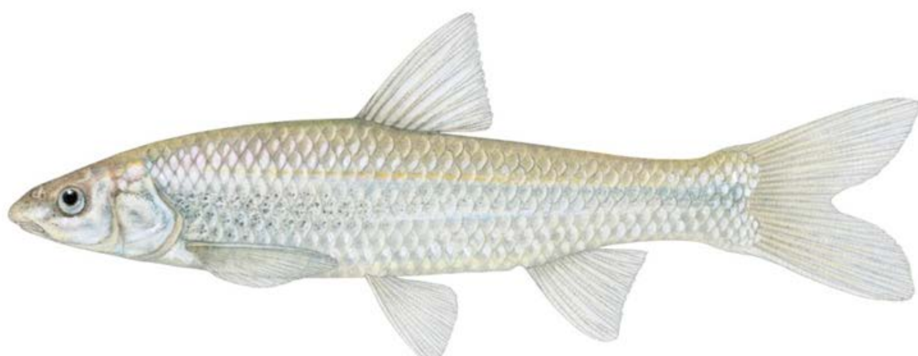

*Figure 1. Plains Minnow (*H. placitus*). Illustration by Joe Tomelleri, reproduced with permission.*

SPECIES DESCRIPTION

This large, silvery minnow is a member of the Cyprinidae family (Figure 1). Cyprinids generally have 1-3 rows of pharyngeal teeth, thin lips, soft fin rays and abdominal pelvic fins. Characteristics of the Plains Minnow include: slightly compressed body, small triangular head with a small subterminal mouth, relatively small eyes located immediately above the midline of the head and a complete lateral line with 34–42 scales (Robison and Buchanan 1988; Sublette et al. 1990; Scheurer et al. 2003). Meristic counts for Plains Minnow are stable across its range (Table 1). Colouration is tan to olive dorsally with a mid-dorsal stripe, silvery sides, a whitish abdomen and black peritoneum (COSEWIC 2012). Plains Minnow is sexually dimorphic with males having longer first dorsal rays, larger heads and caudal peduncles and females having deeper and longer bodies (Ostrand et al. 2001). Breeding males develop small nuptial tubercles on top of the head and back and on the medial side of the pectoral fin (Sublette et al. 1990).

Table 1. Comparison of modal meristic counts for Plains Minnow over its range (COSEWIC 2012). Instances where data was not collected are indicated by a dash (-).

River system	Number in sample	Anal fin rays	Pectoral fin rays	Number of lateral line scales	Number of scale rows above lateral line	Number of scale rows below lateral line	Number of vertebrae
Morgan Creek, SK (Sylvester et al. 2005)	7	8	16 (15–16)	38 (36–39)	13	15 (15–18)	-
Rock Creek, SK (DFO unpubl. data)	20	8 (7–8)	14.5 (13–16)	38 (37–41)	-	-	-
Rock/Morgan creeks Combined	27	8 (7–8)	15 (13–16)	38 (36–41)	-	-	-
Upper Missouri River	64	8 (7–8)	16 (14–18)	38(36–41)	13 (12–16)	18 (15–21)	34 (33–36)
Platte River	80	8 (7–9)	16 (15–18)	37 (35–41)	12 (12–13)	15 (13–18)	34 (33–36)
Kansas and Grand rivers	175	8 (7–9)	16 (14–19)	37 (36–40)	13 (11–16)	15 (12–20)	34 (32–36)
Arkansas River	166	8 (7–10)	16 (15–19)	37 (35–40)	13 (12–15)	15 (13–18)	34 (32–36)
Red River (Texas)	175	8 (6–9)	16 (14–18)	37 (35–41)	14 (13–16)	17 (15–20)	33 (32–35)
Brazos River	75	8 (7–9)	16 (15–18)	37 (35–42)	16 (14–18)	18 (17–21)	34 (32–35)
Colorado River	19	8	16 (15–18)	38 (36–40)	16 (14–17)	21 (17–21)	34 (33–35)

Plains Minnow is morphologically similar to Mississippi Silvery Minnow (*H. nuchalis*) and Western Silvery Minnow (*H. argyritis*) (Smith 2002). It has never been collected with either in Canada, but could potentially co-occur with Western Silvery Minnow in the Rock Creek drainage of Saskatchewan (COSEWIC 2012). Plains Minnow may be distinguished from Western Silvery Minnow and Mississippi Silvery Minnow by their simple basioccipital process, smaller eye, and slightly smaller scales (Smith 2002). It has been collected with Brassy Minnow (*H. hankinsoni*), but adults of the two species are different enough to be separated in the field. Juveniles are difficult to distinguish and typically require dissection to do so (COSEWIC 2012).

TAXONOMY

Four of the seven species belonging to the genus *Hybognathus* occur in Canada – Plains Minnow, Western Silvery Minnow, Eastern Silvery Minnow (*H. regius*) and Brassy Minnow (Schmidt 1994; Nelson et al. 2004). The remaining three species include Rio Grande Silvery Minnow (*H. amarus*), Cypress Minnow (*H. hayi*), and Mississippi Silvery Minnow (*H. nuchalis*). Plains Minnow and Mississippi Silvery Minnow were initially grouped together as *H. nuchalis*, but were later recognized as distinct (Niazi and Moore 1962; Bailey and Allum 1962; Al-Rawi and Cross 1964; Pflieger 1971). Key characters used to identify and distinguish these four species include the shape of the basioccipital process (Plains Minnow and Brassy Minnow similar), the number and appearance of scale radii (overlap in Plains Minnow and Brassy Minnow), orbit diameter, standard length and eye position (Scheurer et al. 2003).

SPECIES BIOLOGY AND ECOLOGY

Growth

Plains Minnow grow to an average of 50–90 mm total length (TL), with a maximum size of 125–130 mm TL (Scheurer et al. 2003). Growth may be rapid with juveniles reaching a total length of 28–43 mm by September of their first year in central areas (Grand River, Missouri) (Pflieger 1997). Both sexes begin to mature at 45–50 mm TL (Taylor and Miller 1990) and typically reach sexual maturity at age 1 (Lehtinen and Layzer 1988). Post-spawning mortality is high, with few living beyond age 2 (Taylor and Miller 1990). A thorough study of growth is not available in the literature and most relevant information is from outside the Canadian range of this species. There may be a large range in size of age-0 fish due to the fact that adults are fractional spawners, reproductively active throughout the summer, spawning from spring to fall when flows and temperatures are optimal (COSEWIC 2012). Durham and Wilde (2005) found hatch date to be negatively related to growth rate in age-0 Plains Minnow in the Canadian River, Texas. Fish hatched later in summer grew slower than those hatched in spring. This may have been caused by water temperatures in excess of the optimum range for growth and/or the size of spawning adults may have affected size at hatching (i.e., larger adults producing larger larvae) (Durham and Wilde 2005 and references therein). The latter fits with the findings of Taylor and Miller (1990) and Bonner (2000) who reported that larger age-2 fish tended to spawn earlier than smaller age-1 fish. Length-frequency and length-weight relationship of Plains Minnow collected in the Rock Creek drainage, Saskatchewan, in September 2006 and 2007 are shown in Figures 2 and 3.

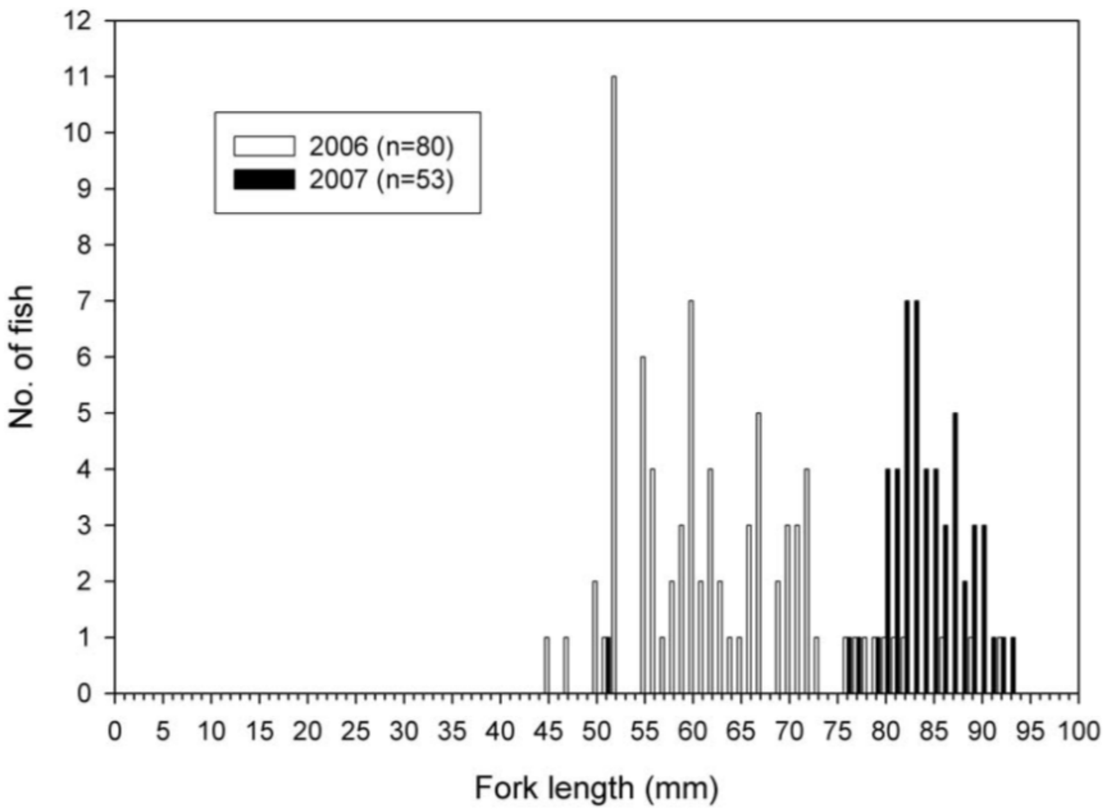

Figure 2. Length frequency plot of Plains Minnow collected in Canada in September 2006 and 2007 (COSEWIC 2012).

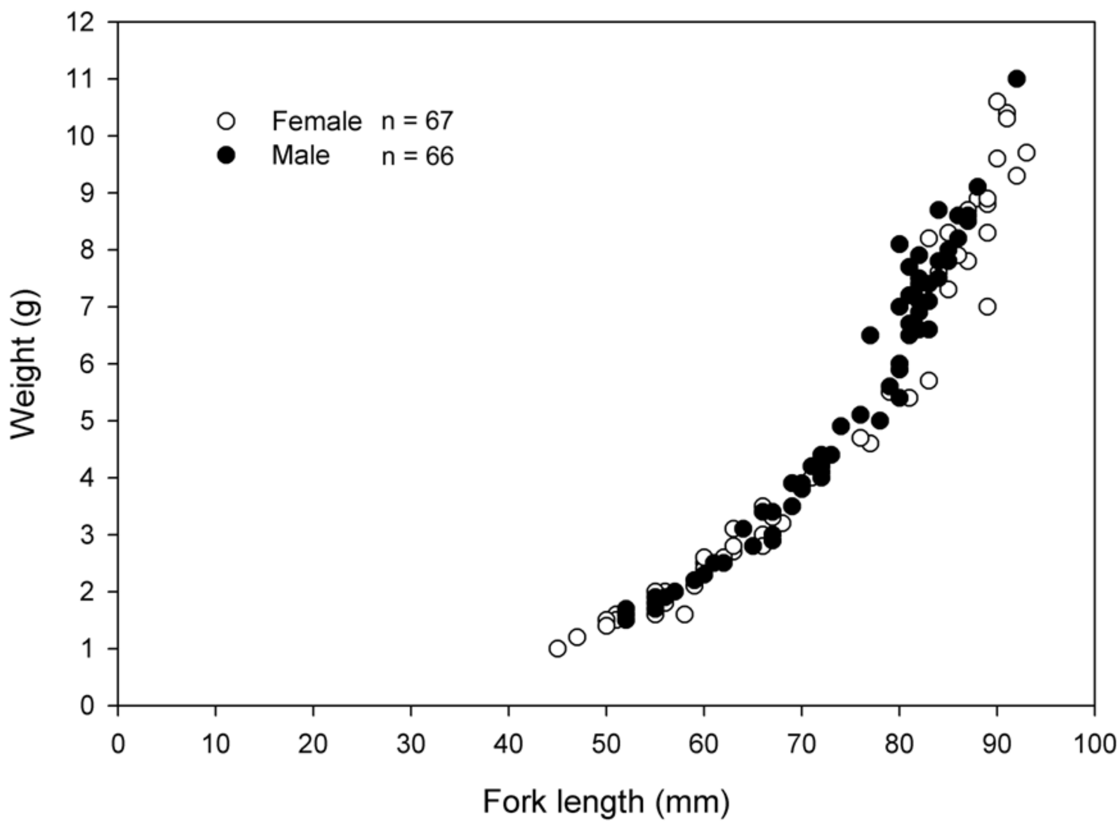

Figure 3. Length (mm) versus weight (g) plot by sex of Plains Minnow collected in Canada in September 2006 and 2007 (COSEWIC 2012).

Diet

Specific diet information based on analysis of gut contents is not available for Plains Minnow in the literature. However, based on the long length of its intestine and pharyngeal teeth structures unique to *Hybognathus*, it is thought to be herbivorous or detrivorous with a diet consisting primarily of benthic algae, diatoms and other microflora (Cross 1967; Miller and Robison 1973; Robison and Buchanan 1988; Hlohowskyj et al. 1989; Sublette et al. 1990; Winston et al. 1991). The diet of Plains Minnow may be similar to that of Western Silvery Minnow as both possess a long gut (COSEWIC 2012). Gut contents of Western Silvery Minnow captured in the Milk River, Alberta in May 2006 were analysed and found to consist of: bacillariophytes (35%), chlorophytes (26%), plant remains (23%) and cyanophytes (10%). Less common items included fungi, chrysophytes, pollen, zooplankton, heterocysts, rotifers and protozoans (COSEWIC 2008).

Fish Community

The fish community of Rock and Morgan creeks is shown in Table 2. Fathead Minnow (n = 2,859), Lake Chub (848), Longnose Dace (521) and White Sucker (444) were more prevalent than Plains Minnow (202) (DFO unpubl. data).

Table 2. Fish community of Rock and Morgan creeks (DFO unpubl. data).

Common Name	Scientific Name
Black Bullhead	*Ameiurus melas*
Brassy Minnow	*Hybognathus hankinsoni*
Brook Stickleback	*Culaea inconstans*
Common Carp	*Cyprinus carpio*
Fathead Minnow	*Pimephales promelas*
Finescale Dace	*Phoxinus neogaeus*
Iowa Darter	*Etheostoma exile*
Lake Chub	*Couesius plumbeus*
Longnose Dace	*Rhinichthys cataractae*
Northern Redbelly Dace	*Phoxinus eos*
Northern Redbelly Dace / Finescale Dace hybrid	*(Not applicable)*
Pearl Dace	*Margariscus margarita*
Plains Minnow	*Hybognathus placitus*
Shorthead Redhorse	*Moxostoma macrolepidotum*
Stonecat	*Noturus flavus*
White Sucker	*Catostomus commersonii*

ASSESSMENT

HISTORIC AND CURRENT DISTRIBUTION AND TRENDS

The Plains Minnow occurs only in North America and is widely distributed across the Great Plains east of the Rocky Mountains and west of the Mississippi River from Texas and New Mexico north to North Dakota, Montana and Saskatchewan (NatureServe 2010; Page and Burr 2011; Figure 4). The Canadian distribution of Plains Minnow is highly restricted. Plains Minnow have only been documented in Saskatchewan in Rock and Morgan creeks (COSEWIC 2012). These creeks are located within the Missouri River watershed (Figure 5) and flow through the East Block of Grasslands National Park and private ranch lands (COSEWIC 2012). Plains Minnow have not been identified from the Milk River (Alberta) or Frenchman River (Saskatchewan) despite extensive sampling (DFO unpubl. data). As this is the only known Canadian population of Plains Minnow, there is no evidence to suggest more than one designatable unit for this species in Canada.

Plains Minnow was first collected in Canada in Morgan Creek (Saskatchewan) in 2003 (Sylvester 2004; Sylvester et al. 2005). Subsequent targeted sampling by DFO confirmed their presence and refined knowledge of the species' range (COSEWIC 2012). The Canadian portion of the global distribution comprises less than 1% and represents the northernmost extent of their range. Plains Minnow has only been documented in Rock Creek (Saskatchewan) from the United States border to the confluence with Morgan Creek (15.5 river km) and the lowermost section of Morgan Creek (11 river km), for a combined distance of 26.5 river km (COSEWIC 2012; Figure 6). Search effort consisted of a total of 5.8 hours of backpack electrofishing, 2,340 m of seining and 17.2 hours of boat electrofishing in the Canadian portion of the Missouri River watershed.

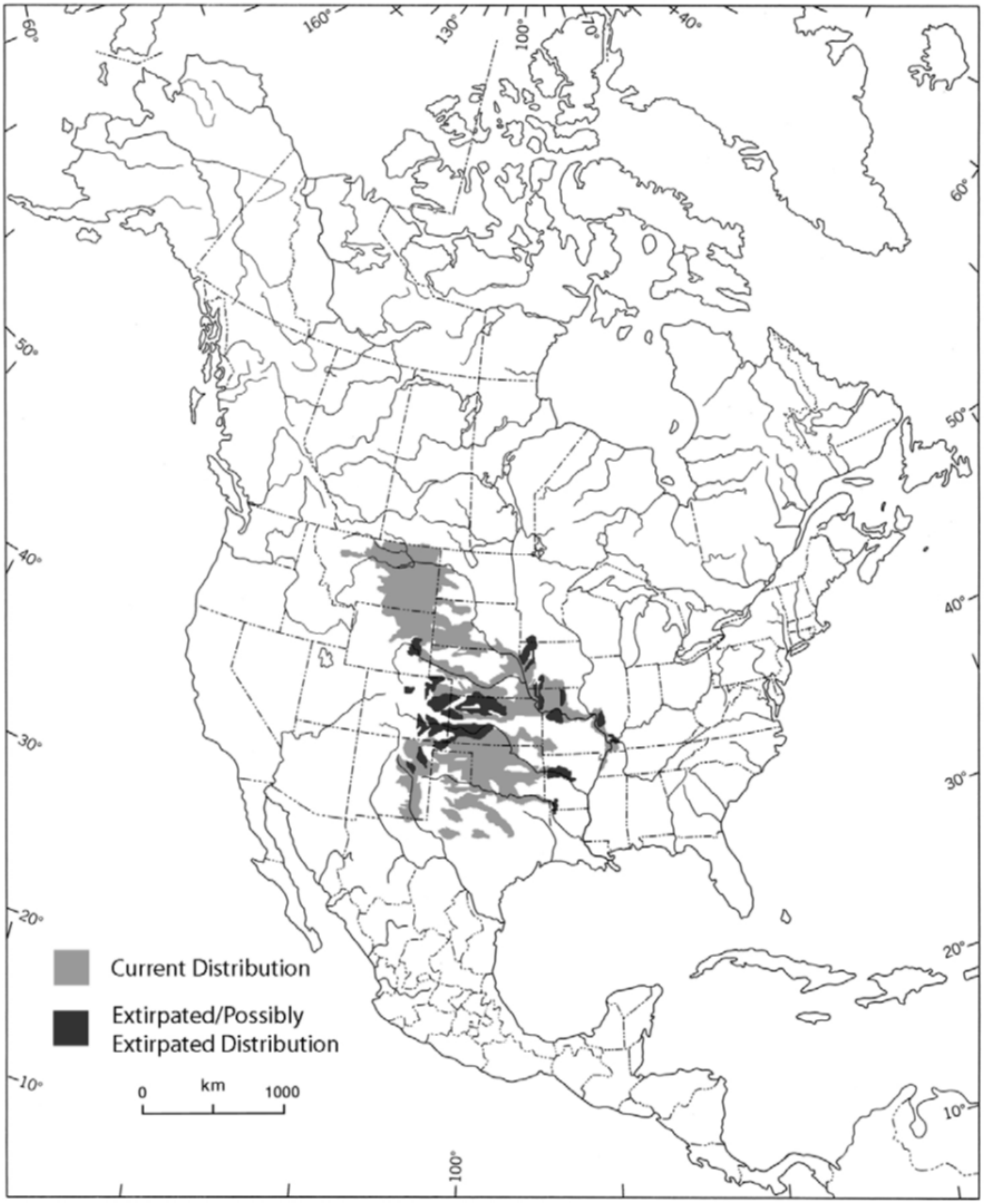

Figure 4. Global distribution of Plains Minnow. Modified from NatureServe (2010; in COSEWIC 2012).

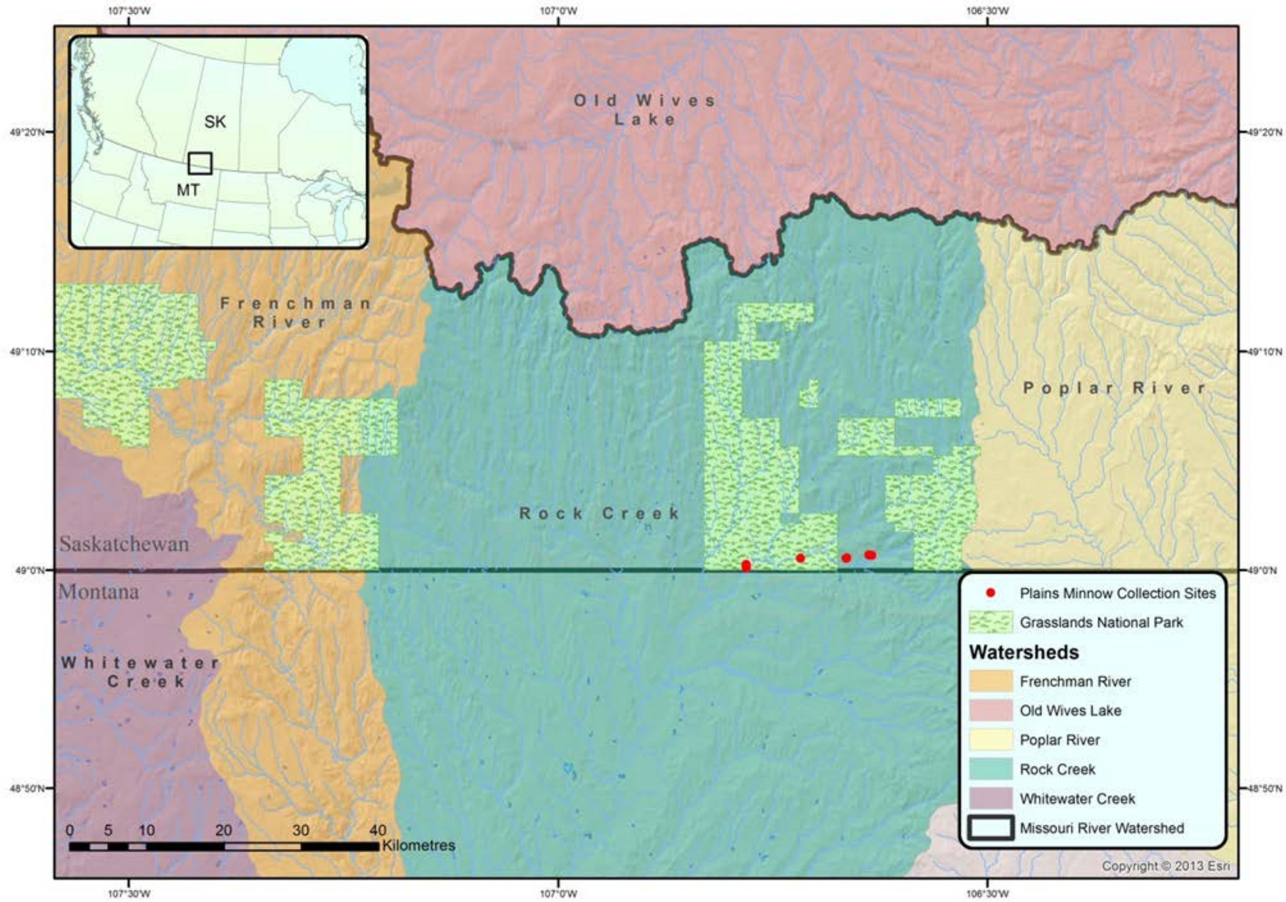

Figure 5. Location of Rock Creek and surrounding watersheds in Saskatchewan and Montana within the larger Missouri River watershed.

Collections by DFO between 2003 and 2007 in the Missouri River watershed in Canada targeted Western Silvery Minnow, Plains Minnow, and Mountain Sucker (*Catostomus platyrhynchus*). A total of 843 sampling collections using seine nets and backpack and boat electrofishers were completed, of these, 61 seine haul collections were made in areas within the known Plains Minnow distribution in Rock and Morgan creeks (average catch per seine haul = 3.3 Plains Minnow). Plains Minnow (n = 202) were captured in 13 collections (COSEWIC 2012) and all were aged ≥ 1 year (DFO unpubl. data). Non-targeted sampling in the Frenchman River watershed (seine or backpack electrofisher) and three sites on Morgan Creek (backpack electrofisher) captured seven Plains Minnow at one site in Morgan Creek (Figure 6; Sylvester 2004; Sylvester et al. 2005).

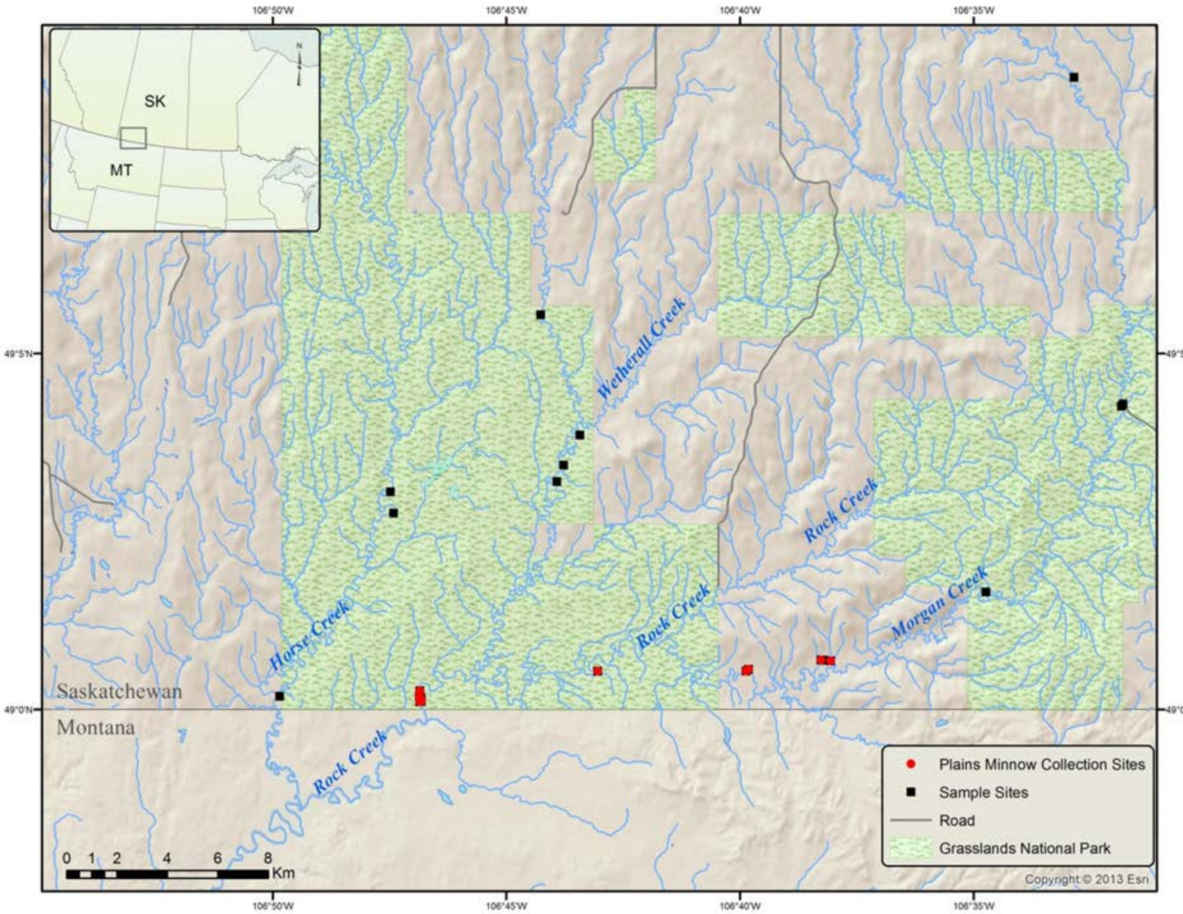

Figure 6. Canadian point distribution of Plains Minnow in Rock and Morgan creeks (in Saskatchewan), and location of sample sites where Plains Minnow were not found (modified from COSEWIC 2012). Note that about 15.5 river km upstream of the Montana/Saskatchewan border, Rock Creek branches into Morgan Creek and Rock Creek. According to the Canadian Gazetteer, Morgan Creek is the name of the upper portion of the mainstem branch as shown in this map. The upper portion of Rock Creek is the tributary that feeds into the mainstem.

HISTORIC AND CURRENT ABUNDANCE AND TRENDS

Due to a lack of historical data, information on population fluctuations and trends for Plains Minnow in the Canadian portion of their range is not available. Natural fluctuations in abundance are likely given the species' short generation time and the varying hydrographs of Rock and Morgan creeks (COSEWIC 2012). Within the United States, Plains Minnow are generally declining throughout their range due to anthropogenic impacts on habitat, particularly impoundments and water diversions (Winston 2002; Rees et al. 2005; Hoagstrom et al. 2007; Hoagstrom et al. 2010; Perkin et al. 2010), although stable populations do exist in some areas (e.g., Missouri River along Kansas border) (Cross and Moss 1987; Chadwick et al. 1997; Rees et al. 2005).

Should Plains Minnow become extirpated in Canada, recovery from populations in the United States is uncertain (COSEWIC 2012). Rock Creek and Milk River in Montana have populations of Plains Minnow (Bramblett 2008; MFISH 2010). The distance from the confluence of Rock Creek and Milk River to the Canada/US border is approximately 157 river km. There are no barriers to movement over this length in the Canadian portion of the range, but diversion dams on both Rock Creek and Milk River are potential barriers in Montana (Figure 7). Furthermore, the conservation status of populations in Montana and North Dakota is unknown and Plains Minnow are listed as NNR (Not Ranked, under review) in both States (NatureServe 2010).

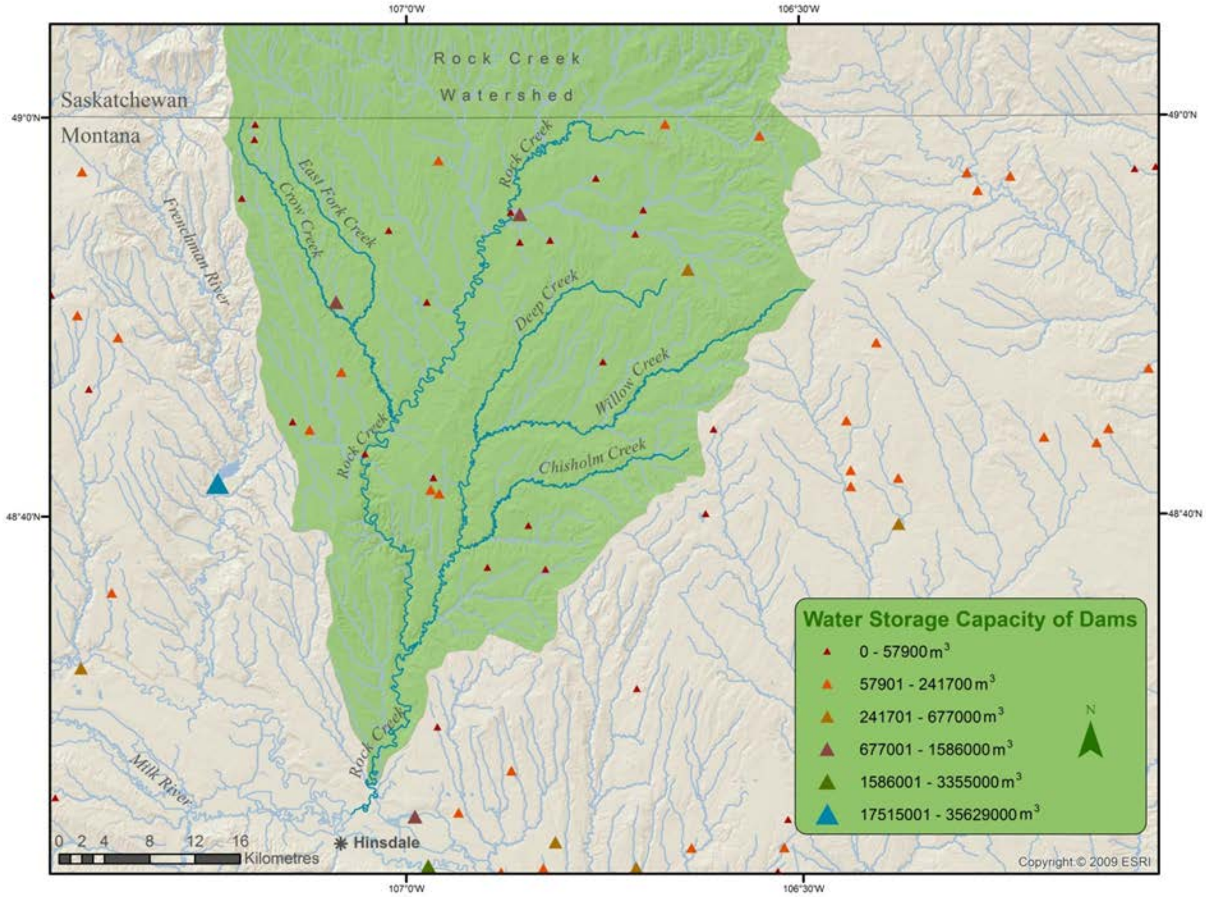

Figure 7. Location of dams in the Montana portion of the Rock Creek watershed and surrounding area. Rivers in which Plains Minnow occur are indicated in dark blue.

POPULATION STATUS ASSESSMENT

To assess the population status of Plains Minnow in Canada, the population was ranked in terms of its abundance (Relative Abundance Index) and trajectory (Population Trajectory) (Table 3). The Relative Abundance Index was assigned as Extirpated, Low, Medium, High or Unknown. Sampling parameters, such as gear used, area sampled, sampling effort, and whether the sampling targeted Plains Minnow, were considered. The number of individual Plains Minnow caught during each sampling period was also considered when assigning the Relative Abundance Index. The Relative Abundance Index is a relative parameter in that the values assigned to each population are relative to the most abundant population. However, in the case of Plains Minnow, there is only one population in Canada and only one crude abundance estimate available. This was compared to an abundance estimate calculated for Plains Minnow in the U.S. portion of the Rock Creek drainage.

The abundance estimate for Plains Minnow in Rock and Morgan creeks in Canada in September 2007 was calculated to be 41,751 adults (80% confidence interval: 2,406–55,379) for the 26.5 river km (approximately 1,575 fish·km^{-1}) where Plains Minnow are expected to occur (COSEWIC 2012). It should be noted that sampling was not random and the procedure used to calculate this estimate may overestimate available habitat and thus abundance, but sampling may have underestimated density (COSEWIC 2012). In the U.S. portion of the Rock

Creek drainage an abundance estimate was calculated based on sampling conducted between 2000 and 2004 in Rock Creek from the Canadian border downstream to the diversion dam near Hinsdale, Montana, including Crow, East Fork, Willow, Deep and Chisholm creeks (Figure 7). Using a mean density for the overall Rock Creek basin for the estimated 339 km of stream occupied by Plains Minnow produced an abundance estimate of 156,547 (approximately 462 fish·km^{-1}), whereas summing the estimated numbers of Plains Minnow in the occupied reaches produced an abundance estimate of 228,532 (approximately 674 fish·km^{-1}) (R. Bramblett, pers. comm.). The U.S. estimates are rough and are subject to the following assumptions: a) the mean number of Plains Minnow captured by seine sampling reaches is a reasonably accurate estimate of the number actually present; b) the capture of Plains Minnow at a sampling site indicates that the stream is occupied from that site downstream to the next stream assumed to be occupied; c) the estimated density from a sampling reach fairly represents the density in the rest of the occupied reach; d) the estimated density from a single sample or from the mean of multiple samples is a reasonably accurate estimate of density across time; and e) the estimated densities from samples taken in 2000–2004 reasonably represent densities currently present (R. Bramblett, pers. comm.).

On the basis of current estimates of abundance, the Relative Abundance Index of Plains Minnow in the Canadian portion of the Rock Creek drainage is rated High relative to the U.S. portion of the drainage (Table 3).

The population trajectory was assessed as Increasing (an increase in abundance over time), Stable (no change in abundance over time), Decreasing (a decrease in abundance over time) or Unknown based on the best available information. The number of individuals caught over time was considered. As no historical data are available for comparison, Population Trajectory of Plains Minnow in Canada is rated Unknown (Table 3).

Table 3. Relative Abundance Index and Population Trajectory of the Plains Minnow population in Canada. The level of Certainty associated with the Relative Abundance Index and Population Trajectory rankings is based on quantitative analysis (1), CPUE or standardized sampling (2) or expert advice (3). Population Status results from an analysis of both the Relative Abundance Index and Population Trajectory.

Population	Relative Abundance Index	Certainty	Population Trajectory	Certainty
Canada (Rock and Morgan creeks, Saskatchewan)	High	2	Unknown	3

The Relative Abundance Index and Population Trajectory values were then combined in the Population Status Matrix to determine Population Status (Poor, Fair, Good, Unknown or Extirpated) (Table 4). The resulting Population Status for Plains Minnow in Canada is Fair (Table 5).

Table 4. The Population Status Matrix combines the Relative Abundance Index and Population Trajectory rankings to establish the Population Status. The resulting Population Status is categorized as Poor, Fair, Good, Unknown or Extirpated.

		Population Trajectory			
		Increasing	**Stable**	**Decreasing**	**Unknown**
Relative Abundance Index	**Low**	Poor	Poor	Poor	Poor
	Medium	Fair	Fair	Poor	Poor
	High	Good	Good	Fair	Fair
	Unknown	Unknown	Unknown	Unknown	Unknown
	Extirpated	Extirpated	Extirpated	Extirpated	Extirpated

Table 5. Population Status for Plains Minnow in Canada, resulting from an analysis of both the Relative Abundance Index and Population Trajectory. Certainty assigned to the Population Status is reflective of the lowest level of certainty associated with either initial parameter (Relative Abundance Index or Population Trajectory).

Population	Population Status	Certainty
Canada (Rock and Morgan creeks, Saskatchewan)	Fair	3

ASSESSING THE HABITAT USE OF PLAINS MINNOW

Knowledge of Plains Minnow habitat in Canada is limited; much of the information presented below is from areas outside of its Canadian range.

Spawning

Little information on Plains Minnow spawning habitat is available in the literature, due in part to their preference for turbid waters making observation in the wild difficult. Plains Minnows are fractional spawners, spawning at different times in spring through summer during periods of high flow. They belong to a guild of pelagic broadcast spawners (Platania and Altenbach 1998). Adults move upstream to spawn (Platania and Altenbach 1998) during periods of moderate to high flows, which are required for successful reproduction (Durham and Wilde 2008, 2009a,b). Groups of Plains Minnow have been observed in spawning season during receding high flows in the Cimarron River, Oklahoma, in quiet water along sandbars and in backwaters (Taylor and Miller 1990) and schools have been observed preparing to spawn in shallow backwaters (Cross and Collins 1995). Drifting eggs have also been collected under similar conditions (Sliger 1967).

Larvae and Juveniles

Little information is available on larval and juvenile habitat, although it is likely similar to that of adults, although not in the same geographical location as adults migrate upstream during spawning season and fertilized eggs drift downstream during development. Eggs hatch in 24–48 hours, depending on temperature (Moore 1944). Continuous entrainment of eggs in the water column until hatching appears to be necessary for successful egg development, which has been calculated to occur over 72–144 km of unimpeded river assuming a conservative flow estimate of 3 km·h^{-1}; developing proto-larvae may be carried an additional 216 km during the swim-up stage (Platania and Altenbach 1998). The estimated minimum threshold in fragment length for Plains Minnow was calculated by Perkin and Gido (2011) to be 115 river km.

Widmer et al. (2010) captured age-0 Plains Minnow over a hard silt-sand substrate overlaid by loose sand in a narrow, deeply incised channel of the Pecos River, New Mexico. In the same study, age-0 fish were also captured over sand substrate in the wide, braided main channel of the river. Backwater areas may be particularly important as nursery areas due to the increased availability of food (Moore 1944).

Adults

The habitat information presented below for Plains Minnow collected in the Rock Creek drainage (DFO unpubl. data) are from fish that were aged ≥ 1 year. Gonads were poorly developed in all fish except one male from 2006 and one female from 2007, so it is unknown if Plains Minnow reach maturity at age-1 in Canada (COSEWIC 2012).

Stream characteristics

Adults typically inhabit large, often turbid, sandy, silty rivers and have been classified as habitat generalists with a preference for both backwaters and embayments while avoiding higher velocity mid-channel habitats (Miller and Robison 1973; Matthews and Hill 1980; Polivka 1999; Kehmeier et al. 2007). They are typically most abundant where sediments accumulate in shallow backwater areas, calm eddies and along edges of shifting dunes in sand-bed rivers with current (Robison and Buchanan 1988; Cross and Collins 1995; Pflieger 1997). Within the Canadian portion of their range, they have been captured in summer in run and pool habitat with a mean wetted width of 2.26-3.24 m and at depths less than approximately 1.2 m (Sylvester et al. 2005). DFO (unpubl. data) collected Plains Minnow in September 2006 and 2007 in Rock and Morgan creeks (Figures 8 and 9) at an average depth of 0.58 m (range: 0.34–1.2 m) and a mean velocity of 0.02 m·s^{-1} (range: 0–0.11 m·s^{-1}).

In other areas of their range, Plains Minnow have been observed exhibiting narrow habitat use (low dissolved oxygen, temperature and velocity) in May, broader habitat use in August with increasing flows, returning to narrow use in October during low water periods, always avoiding shallow areas with strong currents (Matthews and Hill 1980). In Wyoming streams, habitat characteristics associated with abundant Plains Minnow populations were fine substrates, a river reach without impoundments and an absence of exotic piscivores (Quist et al. 2004). In the Platte River, Nebraska, highest densities were observed at depths of 0.2–0.3 m and current velocities of 0.1–0.4 m·s^{-1} (Peters et al. 1989). In the Little Missouri River, North Dakota, Plains Minnow were captured at main channel widths of 25–55 m, most commonly at 0.5 m water depth (Kelsch 1994).

Water temperature and dissolved oxygen

The Plains Minnow has a high Critical Thermal Maxima (39.7 ± 0.7°C) and a low minimum dissolved oxygen tolerance (2.08 ± 0.14 mg·l^{-1}) (Ostrand and Wilde 2001). In the South Canadian River, Oklahoma, the preferred temperature for Plains Minnow acclimated near 21°C was near 30°C at 4.8–9.0 mg·l^{-1} dissolved oxygen and decreased to 17°C at 2 mg·l^{-1} dissolved oxygen (Bryan et al. 1984).

Water quality

Rivers occupied by Plains Minnow may be clear to highly turbid with high dissolved solids (Sublette et al. 1990). Plains Minnow occupy rivers that may dry to intermittent pools during times of low flow, but are also subject to flash floods of turbid water during heavy rains

(COSEWIC 2012). This species is capable of tolerating such conditions and the low water quality that may result (Cross and Moss 1987; Matthews 1987; Quist et al. 2004). In the Little

Figure 8. Rock Creek just upstream of the Canada/United States border. Photo credit: Doug Watkinson.

Figure 9. Morgan Creek near the furthest upstream distribution of Plains Minnow. Photo credit: Doug Watkinson.

Missouri River, North Dakota, Kelsch (1994) captured Plains Minnow at specific conductance ranging from 330–700 $\mu S \cdot cm^{-1}$, Secchi depths ranging from 0.05–0.02 m and pH 7–7.5. In the Rock Creek drainage they have been captured in June in turbid water with total dissolved solids ranging from 740–1,270 ppm, salinity 0.3–0.6 ‰, specific conductance 669–1,150 $\mu S \cdot cm^{-1}$ and pH 8.4–8.9 (Sylvester et al. 2005). In September they have been collected in water with a mean Secchi depth of 0.20 m (range: 0.12–0.32 m) and specific conductance of 1,516 $\mu S \cdot cm^{-1}$ (range: 1,082–2,370 $\mu S \cdot cm^{-1}$) (DFO unpubl. data). Preferred ranges of total dissolved solids and pH could not be found in the literature. Ostrand and Wilde (2001) determined maximum salinity tolerance in the laboratory to be 16 ± 1.94‰.

Vegetation

Little information is available on vegetation presence or absence in habitats utilised by this species. Kelsch (1994) noted that Plains Minnow were commonly caught in vegetated areas in the Little Missouri River, North Dakota. Rooted macrophytes and algae mats were absent in Plains Minnow habitat in the Cimarron River, Oklahoma (Lehtinen and Layzer 1988). In intermittent prairie streams submerged macrophytes are generally absent, but emergent aquatic vegetation is common and abundant; during the dry season, stream beds often support terrestrial vegetation (Zale et al. 1989). Riparian vegetation at the site in Morgan Creek where Plains Minnow were captured consisted of a mixture of grasses, sedges and shrubs (Sylvester et al. 2005).

Substrate

Plains Minnow is most often found over sand substrates (Cross and Moss 1987; Robison and Buchanan 1988; Taylor and Miller 1990; Cross and Collins 1995; Pflieger 1997) and only rarely occurs over rock or mud bottoms (Robison and Buchanan 1988; Cross and Collins 1995; Pflieger 1997; Quist et al. 2004). During high discharge in the Little Missouri River, North Dakota, Plains Minnow was captured over substrates of silt, sand and gravel (in order of decreasing prevalence) (Kelsch 1994). In the Rock Creek drainage the species was captured at sites with silt, sand and gravel substrates, including two areas with 100% silt substrate, one area with 100% sand, three areas of 50% sand and 50% silt, and two areas that were 60% silt and 40% gravel (DFO unpubl. data).

FUNCTIONS, FEATURES AND ATTRIBUTES

A description of the functions, features and attributes associated with Plains Minnow habitat can be found in Table 6. The habitat required for each life stage has been assigned a function that corresponds to a biological requirement of Plains Minnow. For example, individuals in the egg to exogenous feeding life stage require habitat for nursery purposes. In addition to the habitat function, features have been assigned to each life stage. A feature is considered to be the structural component of the habitat necessary for the survival or recovery of the species. Habitat attributes have also been provided, which describe how the features support the function for each life stage. Habitat attributes from the literature, largely from more southerly areas of their distribution, are presented alongside current records within Canada (from 2006 and 2007) to show the maximum range in habitat attributes within which Plains Minnow may be found (see Table 5 and references therein). This information is provided to guide any future identification of critical habitat for this species. It should be noted that habitat attributes associated with current records may differ from optimal habitat as Plains Minnow may be occupying sub-optimal habitat where optimal habitat is not available.

Table 6. Summary of the essential functions, features and attributes for each life stage of Plains Minnow. Habitat attributes derived from the literature (typically outside of the Canadian range) and habitat attributes recorded during collections within Canada (2006 and 2007) have been combined to derive habitat attributes required for the delineation of critical habitat (see text for a detailed description of categories).

Life Stage	Function	Feature(s)	Literature Records		Sampling Records	For Identification of Critical Habitat
			United States	Canada		
Spawning	Reproduction (fractional spawners spring to summer)	• Flowing water of rivers or streams	• Require moderate to high flows[1,2,3,4] • Move to upstream areas to spawn[5] • Have been observed preparing to spawn in shallow backwaters (Kansas)[6]	No published information (requirements would be similar to the US)	None	• Can tolerate variable hydrology; periods of moderate to high flow in spring through summer required for successful reproduction • Unimpeded access to spawning areas
Egg to exogenous feeding	Nursery Cover	• Flowing water of rivers or streams, backwaters	• Moderate to high flows[1,2,4,5] • At a conservative flow rate of 3 $km \cdot h^{-1}$, eggs (hatch in 24 – 48 hours depending on temperature[7]) are transported over 72 – 144 km of unimpeded river; developing protolarvae may be carried an additional 216 km[5] • Estimated minimum threshold in fragment length associated with population persistence: 115 river km[22] • Backwaters may be important as nursery habitat[7]	No published information (attributes would be similar to the US)	None	• Moderate to high flows • Minimum unimpeded length of 115 river km to allow developing eggs and protolarvae to be transported to suitable nursery areas • Specific, optimal habitat characteristics of nursery habitat are unknown
Juvenile	Feeding Cover	• Flowing water of rivers or streams, backwaters, intermittent pools	• Backwaters may be important feeding areas[3] • Captured over sand substrate[8] • Likely similar to adults (see below)	No published information (attributes would be similar to the US and likely similar to adults)	None	• Likely similar to adults (see below)

Life Stage	Function	Feature(s)	Literature Records		Sampling Records	For Identification of Critical Habitat
			United States	Canada		
Adult	Feeding Cover	• Backwater and embayment areas of rivers • Most abundant where sediment accumulates in shallow backwaters, calm eddies and along edges of shifting dunes in sand-bed rivers with current[6,17,18] • Non-impounded river reaches	<u>Captured at:</u> • **Depth:** 0.04 – > 2 m[10,11,12] • **Main Channel Width:** 25 – 55 m[11] • **Mean Wetted Width:** 5.7 m (Montana)[23] • **Velocity:** 0 – 1.25 $m \cdot s^{-1}$ [10,12] • **Discharge:** 0.40 – 0.87 $m^3 \cdot s^{-1}$ at 0.5 m depth[11] • **Temperature:** 15 – 22°C at dissolved oxygen > 5 $mg \cdot l^{-1}$ (North Dakota)[11]; 7.5 – 37°C at dissolved oxygen 3.3 – 19.0 ppm (Oklahoma)[12] • **Specific Conductance:** 330 – 700 $\mu S \cdot cm^{-1}$ [11] • **pH:** 7.0 – 9.6[11,12] • **Secchi Depth:** 0.05 – 0.2 m[11] • **Total Dissolved Solids:** 470 – 1160 ppm[12] • **Salinity:** 2.0 – 8.0 psu[13] • **Turbidity:** 4 – 375 JTU[12]	<u>Captured at[19]:</u> • **Velocity:** < 0.5 $m \cdot s^{-1}$ • Substrate described as generally small (< 2.0 mm) • Run and pool habitat • Turbid water • Riparian vegetation: mixture of grasses, sedges and shrubs	• Sampled in September 2006 and 2007[20] <u>Captured at:</u> • **Depth:** 0.34 – 1.2 m (Avg: 0.58 m) • **Velocity:** 0 – 0.11 $m \cdot s^{-1}$ (Mean: 0.02 $m \cdot s^{-1}$) • **Temperature:** 11.3 – 16.6°C (Mean: 13.8°C) • **Specific Conductance:** 1082 – 2370 $\mu S \cdot cm^{-1}$ (Mean: 1516 $\mu S \cdot cm^{-1}$) • **Secchi Depth:** 0.12 – 0.32 m • **Substrate:** silt, sand, gravel	• Low to mid-velocity flows • Shallow backwaters, eddies • Substrate dominated by sand • Non-impounded turbid river reach with low relative abundance of exotic piscivores

References

1 – Durham and Wilde 2008; 2 – Durham and Wilde 2009a,b; 3 – Lehtinen and Layzer 1988; 4 – Sliger 1967; 5 – Plantania and Altenbach 1998; 6 – Cross and Collins 1995; 7 – Moore 1944; 8 – Widmer et al. 2010; 9 – COSEWIC 2012; 10 – Peters et al. 1989; 11 – Kelsch 1994; 12 – Matthews and Hill 1980; 13 – Anderson et al. 1983; 14 – Ostrand and Wilde 2001; 15 – Cross and Moss 1987; 16 – Taylor and Miller 1990; 17 – Robison and Buchanan 1988; 18 – Pflieger 1997; 19 – Sylvester et al. 2005; 20 – DFO unpubl. data; 21 – Quist et al. 2004; 22 – Perkin and Gido 2011; 23 – Bramblett et al. 2005

RESIDENCE

Residence is defined in the SARA as a “dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating.” Residence is interpreted by DFO as being constructed by the organism. In the context of the above description of habitat requirements during larval, juvenile and adult life stages, Plains Minnow does not construct residences during its life cycle.

THREATS TO SURIVIVAL AND RECOVERY

Threat categories generally considered for Recovery Potential Assessments are provided in the Appendix. Although stable populations exist in some regions, Plains Minnow has declined throughout large areas of its range. In the Arkansas River, Kansas, for example, the once abundant Plains Minnow has declined to less than 1% of the total fish population as a result of impoundments, land use, and diversions of surface flow and mining of groundwater for irrigation (Cross and Moss 1987). Many other studies have documented declines in Plains Minnow and similar Great Plains cyprinids resulting from anthropogenic impacts on natural flow regimes and habitat (e.g., Pflieger and Grace 1987; Wenke et al. 1993; Wilde and Ostrand 1999; Hoagstrom et al. 2011; Perkin and Gido 2011).

Additional threats facing this species primarily include the introduction of exotic piscivores and climate change. Although each threat is discussed independently, they have the potential to occur simultaneously. The resulting cumulative effects may exacerbate the impact on the species. Furthermore, the small and localized distribution of Plains Minnow in Canada increases its susceptibility to stochastic events (COSEWIC 2012).

Habitat Removal and Fragmentation and Alteration of Natural Flow Regimes

In the case of Plains Minnow, these threats are very closely linked, therefore they are discussed together. Across its range, the fragmentation of rivers by impoundments, diversion dams and stream dewatering and the associated habitat changes are the greatest threat to Plains Minnow (Perkin and Gido 2011; COSEWIC 2012). The naturally variable hydrograph of Great Plains streams is integral to the long-term sustainability of obligate riverine species such as the Plains Minnow (Winston et al. 1991; Bonner and Wilde 2000; COSEWIC 2012). It has been estimated that more than 100 km of flowing river habitat is required for the successful development of larvae and thus for the survival of Plains Minnow populations (Platania and Altenbach 1998; Dudley and Platania 2007; Perkin and Gido 2011). Changes to the natural flow regime from a highly fluctuating, turbid river system with out-of-bank flows and occasional drying to intermittent pools to one with a regular and smaller flow of clear water would be detrimental to the population (COSEWIC 2012).

Activities that threaten the persistence of flowing water in the Rock Creek drainage may severely limit Plains Minnow habitat and populations (COSEWIC 2012). Land in the watershed outside of Grasslands National Park is primarily used for cattle ranching. Given that the grazing lands are low quality and cattle density is therefore low, the direct impact is probably localized and limited to cattle drinking, stream bank trampling and non-point source nitrification (COSEWIC 2012). The flow regime may be indirectly impacted, however, by small earthen weirs constructed by local ranchers in swales and dry creek beds in the watershed (COSEWIC 2012). The weirs hold rainwater for livestock in temporary ponds; the water eventually leaks out or evaporates in the days or weeks following a rain event. The effect of these structures is to retard or withdraw water that would normally flow into the intermittent and permanent channels of flowing creeks, however, the influence of existing weirs on the hydrology of Rock and Morgan creeks is not known (COSEWIC 2012). Research to determine the effects of grazing on prairie communities, including impacts on streams, in the East Block of Grasslands National Park was initiated by Parks Canada. Results from this ongoing study are not yet available. Several stream crossings within the park (none within known Plains Minnow habitat) were identified by Parks Canada as needing remediation mainly due to flow being impeded by dirt roads. Three of these crossings were remediated in summer 2012 (P. Fargey, pers. comm.). In the Rock Creek watershed there have not been any new licensed water allocation projects since 2000. All existing licensed water allocation projects are located in the headwaters and none are located on the main stem; the majority are private projects for stock watering purposes (White 2007). There are a total of 12 reservoirs on Rock Creek with a cumulative capacity of 308.9 m^3 which represents a small proportion (1.84%) of the total annual natural flow volume (Figure 10) (White 2007). Future dam building in the Rock Creek watershed would potentially significantly alter the natural flow regime in Plains Minnow habitat. DFO is not aware of any planned dam construction at this time.

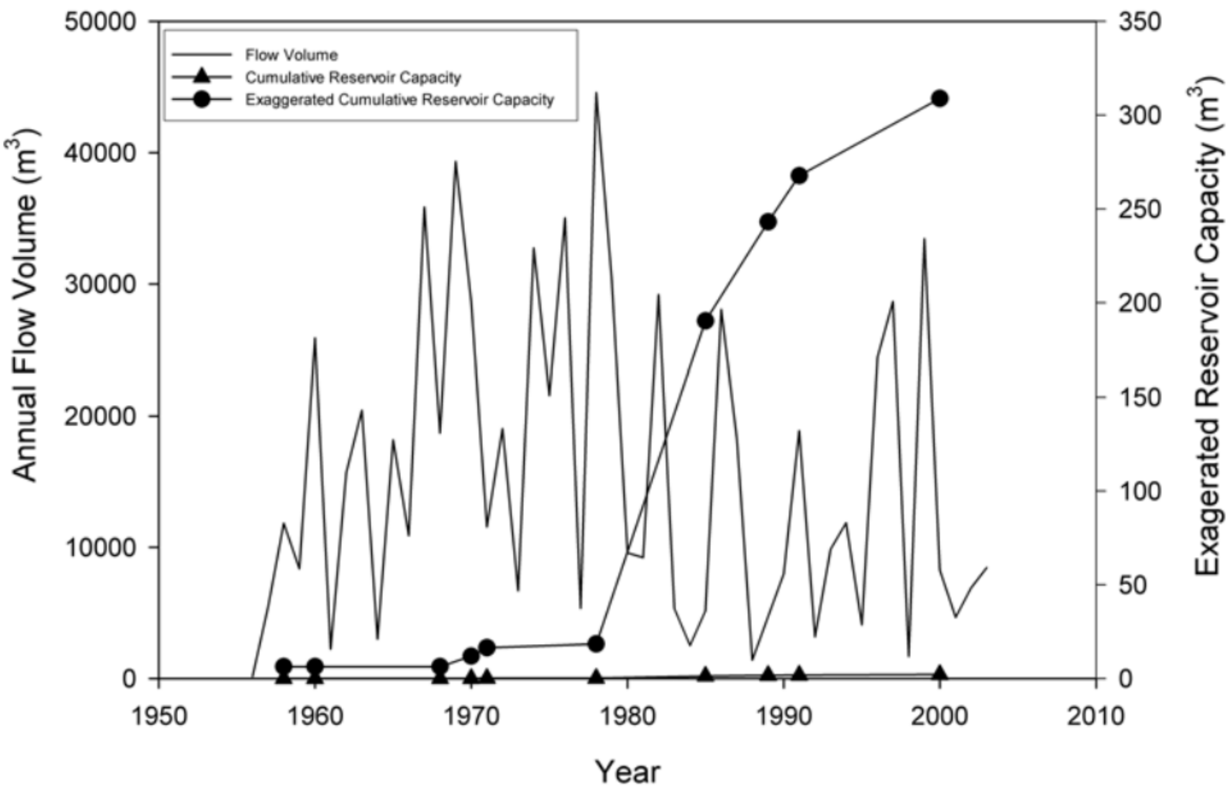

Figure 10. The annual flow volume in Rock Creek measured at the hydrometric gauging station (White 2007).

Introduced Species and Diseases

Exotic Piscivores

In other areas of their range, declines in Plains Minnow abundance have been associated with exotic piscivores (e.g., Kansas River (Wenke et al. 1993), Rio Grande River (Platania and Altenbach 1998), San Juan River (Gido and Propst 1999), Colorado River (Carlson and Muth 1989; Minkley et al. 2003), Missouri River drainage (Quist et al. 2004)). Members of this guild of Great Plains fishes evolved in the absence of abundant piscivores, thus they are sensitive to predation (Quist et al. 2004). By stabilizing flows and substrates, enhancing low flows and decreasing turbidity and frequency of intermittence, large impoundments create favourable conditions for, and act as continual sources of, exotic piscivores in both upstream and downstream reaches (Pringle 1997; Winston et al. 1991; Quist et al. 2004). The Largemouth

Bass (*Micropterus salmoides*) has been introduced into Saskatchewan. Presently, this species occurs about 100 km away from the Rock Creek drainage, thus it is not considered a threat (J. Pepper pers. comm. in COSEWIC 2012). Northern Pike are present in the Milk River basin and may colonize upper Rock Creek at some point in the future (Robert Bramblett, pers. comm.). Game fish introduction into the area would require new dams and reservoirs to provide habitat (COSEWIC 2012). Neither native nor exotic piscivores have been captured in Rock and Morgan creeks (Sylvester 2004; Sylvester et al. 2005; DFO unpubl. data); however, Northern Pike are present in the watershed and could potentially find their way into Rock Creek.

All Introduced Species and Diseases except Exotic Piscivores

An invasive species, Common Carp (*Cyprinus carpio*) has been found in the Rock Creek drainage, indicating that invasions by other aquatic invasive species are possible (COSEWIC 2012). The impacts of Common Carp on Plains Minnow are unknown, but may include habitat disruption (from foraging and spawning) or predation on eggs and young of Plains Minnow (COSEWIC 2012). Common Carp could also potentially be a direct competitor for food with Plains Minnow.

Climate Change

Predicted effects of climate change and variability on the Canadian environment include increases in water and air temperatures, changes in water levels, shortening of the duration of ice cover, increases in the frequency of extreme weather events, emergence of diseases, drought and shifts in predator-prey dynamics, all of which may impact native fishes (Lemmen and Warren 2004). Warm water species at the northern extent of their range, such as Plains Minnow, may benefit from increased water temperature allowing them to expand their distribution northwards (Chu et al. 2005). Furthermore, future climate change scenarios predict northern Great Plains streams in the United States (i.e., Montana, South Dakota) may experience an increased discharge (up to 5%) prior to 2060 (Perkin et al. 2010). The Rock Creek drainage in Saskatchewan is very close to this area. Conversely, streams in the southern Great Plains are predicted to lose up to 20% of their discharge by 2060. This could further imperil Plains Minnow in southern regions due to little connectivity between southern and northern streams (Perkin et al. 2010). It may also increase the conservation value of those in more northerly areas of the distribution. Annual flow volume in Rock Creek increased from the late 1950s, peaked in the early 1970s and declined by 50% from 1977-1995 (Figure 10). This has been correlated with a decrease in the frequency and duration of flooding events (Figure 11) (White 2007). As the total capacity of reservoirs accounts for only a small proportion of the annual flow volume (1.84%), the decrease in annual flow may be the result of climate change (White 2007). The effects of climate change on Plains Minnow are highly speculative making it difficult to determine the likelihood and impact of this threat, therefore it is not included in the Threat Level analysis presented below.

Other threats

Additional threats potentially impacting Plains Minnow include scientific sampling, nutrient loading, contaminants and toxic substances and barriers to movement. Scientific sampling is unlikely to pose a threat as it is controlled by permitting (COSEWIC 2012). The remaining threats are possible due to the type of land use (i.e., ranching) in the surrounding area, but much of the watershed is within the planned boundaries of Grasslands National Park and thus receives some level of protection from pollution and future development.

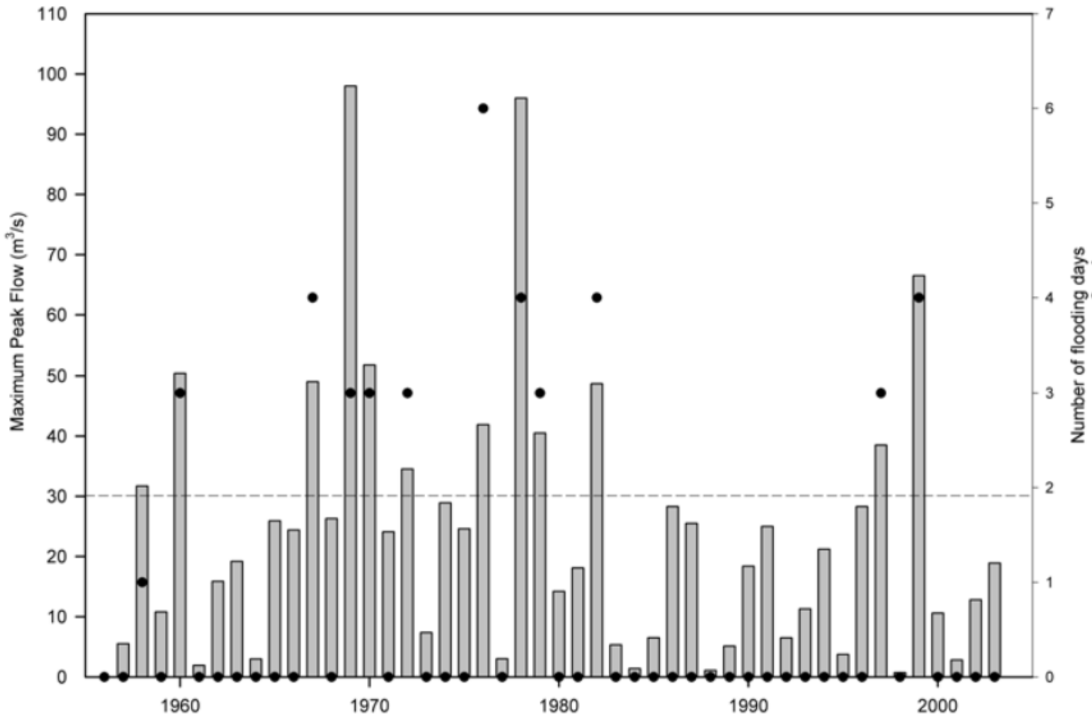

Figure 11. The annual peak flows (bars) in Rock Creek with respect to the flow required for over-bank flooding (30 $m^3 \cdot s^{-1}$, represented by the dashed line) and the number of days (points) the peak flow is maintained at flows greater than 30 $m^3 \cdot s^{-1}$ (White 2007).

THREAT LEVEL

To assess the level and overall effects of threats for Plains Minnow in Canada, each threat was ranked individually. Definitions of terms used to rank threats are provided in Table 7. The Threat Likelihood was assigned as Known, Likely, Unlikely, or Unknown, and the Threat Impact was assigned as High, Medium, Low, or Unknown (Table 8). The Threat Likelihood and Threat Impact were then combined in the Threat Level Matrix (Table 9) resulting in the final Threat Level (Table 10). The Threat Level results were used to assess the overall effect each threat may have on Plains Minnow in Canada. Each threat with a known associated Threat Level was categorized in terms of both Spatial and Temporal Extent (Table 10). (See DFO 2013 for discussion of ratings given for individual threats.)

Table 7. Definition of terms used to describe Threat Likelihood and Threat Impact.

Term	Definition
Threat Likelihood	
Known	This threat has been recorded to occur within Canadian portion of range.
Likely	There is a > 50% chance of this threat occurring within Canadian portion of range.
Unlikely	There is a < 50% chance of this threat occurring within Canadian portion of range.
Unknown	There are no data or prior knowledge of this threat occurring within Canadian portion of range.
Threat Impact	
High	If threat was to occur, it would jeopardize the survival or recovery of this population.
Medium	If threat was to occur, it would likely jeopardize the survival or recovery of this population.
Low	If threat was to occur, it would be unlikely to jeopardize the survival or recovery of this population.
Unknown	There is no prior knowledge, literature or data to guide the assessment of the impact if this were to occur.
Certainty (as it relates to Threat Impact)	
1	Causative study
2	Correlative study
3	Expert opinion
Spatial Extent	
Widespread	Threat is likely to affect a majority of the range.
Local	Threat is not likely to affect a majority of the range.
Temporal Extent	
Chronic	Threat that is likely to have a long-lasting or re-occurring effect on the population.
Ephemeral	Threat that is likely to have a short-lived or non-recurring effect on the population.

Table 8. Threat Likelihood and Threat Impact for Plains Minnow in Canada. Certainty has been associated with the Threat Likelihood (TLH) and Threat Impact (TI) based on the best available data. The Threat Likelihood was assigned as Known, Likely, Unlikely, or Unknown, and the Threat Impact was assigned as High, Medium, Low, or Unknown. Certainty (C) has been classified and is based on: 1 = causative studies; 2 = correlative studies; and 3 = expert opinion. References are provided.

THREAT	TLH	TI	C	References
Turbidity and sediment loading (at very high levels over a long period of time)	Unlikely	Medium	3	
Habitat removal and alteration	Unlikely	High	2	1,2,3,4
Alteration of natural flow regimes from small impoundments and dugouts	Known	Low	3	
Alteration of natural flow regimes from large impoundments	Unlikely	High	2	1,2,3,4,5,6,7,8,9,10
Introduced species and diseases except exotic piscivores	Known	Low	3	
Exotic piscivores	Unlikely	High	2	1,4,11,12,13,14,15,16,17,18
Scientific sampling	Known	Low	3	4,16,17,18
Nutrient loading	Known	Low	3	
Contaminants and toxic substances except from pipeline fractures	Known	Low	3	
Contaminants and toxic substances from pipeline fractures	Unlikely	High	3	
Barriers to movement	Unknown	High	2	1,2,3,4

References:

1 – Platania and Altenbach 1998
2 – Perkin and Gido 2011
3 – Dudley and Platania 2007
4 – COSEWIC 2012
5 – Winston et al. 1991
6 – Bonner and Wilde 2000
7 – Durham and Wilde 2008
8 – Durham and Wilde 2009a,b
9 – Sliger 1967
10 – Lehtinen and Layzer 1988
11 – Wenke et al. 1993
12 – Gido and Propst 1999
13 – Carlson and Muth 1989
14 – Minkley et al. 2003
15 – Quist et al. 2004
16 – Sylvester 2004
17 – Sylvester et al. 2005
18 – DFO unpubl. data

Table 9. The Threat Level Matrix combines the Threat Likelihood and Threat Impact rankings to establish the Threat Level for Plains Minnow in Canada. The resulting Threat Level has been categorized as Low, Medium, High or Unknown.

		Threat Impact			
		Low (L)	**Medium (M)**	**High (H)**	**Unknown (UK)**
Threat Likelihood	**Known (K)**	Low	Medium	High	Unknown
	Likely (L)	Low	Medium	High	Unknown
	Unlikely (U)	Low	Low	Medium	Unknown
	Unknown (UK)	Unknown	Unknown	Unknown	Unknown

Table 10. Threat Level for Plains Minnow in Canada, resulting from an analysis of both the Threat Likelihood and Threat Impact. The number in parentheses refers to the level of certainty associated with the Threat Impact assignment and has been classified as: 1 = causative studies; 2 = correlative studies; and 3 = expert opinion. Certainty associated with the Threat Status is reflective of the lowest level of certainty associated with either Threat Likelihood or Threat Impact.

Threat	Threat Level
Turbidity and sediment loading (at very high levels over a long period of time)	Low (3)
Habitat removal and alteration	Medium (2)
Alteration of natural flow regimes from small impoundments and dugouts	Low (3)
Alteration of natural flow regimes from large impoundments	Medium (2)
Introduced species and diseases except exotic piscivores	Low (3)
Exotic piscivores	Medium (2)
Scientific sampling	Low (3)
Nutrient loading	Low (3)
Contaminants and toxic substances except from pipeline fractures	Low (3)
Contaminants and toxic substances from pipeline fractures	Medium (3)
Barriers to movement	Unknown (2)

Table 11. Overall effect of threats on Plains Minnow in Canada. Spatial extent was categorized as Widespread or Local. Temporal Extent was categorized as Chronic or Ephemeral.

Threat	Spatial Extent	Temporal Extent
Turbidity and sediment loading (at very high levels over a long period of time)	Widespread	Ephemeral
Habitat removal and alteration	Widespread	Chronic
Alteration of natural flow regimes from small impoundments and dugouts	Widespread	Chronic
Alteration of natural flow regimes from large impoundments	Widespread	Chronic
Introduced species and diseases except exotic piscivores	Widespread	Chronic
Exotic piscivores	Widespread	Chronic
Scientific sampling	Widespread	Ephemeral
Nutrient loading	Widespread	Chronic
Contaminants and toxic substances except from pipeline fractures	Widespread	Chronic
Contaminants and toxic substances from pipeline fractures	Widespread	Ephemeral
Barriers to movement	Widespread	Chronic

MITIGATIONS AND ALTERNATIVES

Threats to survival can be minimized by implementing mitigation measures to reduce or eliminate potential harmful effects that could result from works or undertakings associated with projects or activities in Plains Minnow habitat. Plains Minnow are currently not protected under the SARA. The Saskatchewan Conservation Data Centre has assigned a ranking of critically imperiled (NatureServe 2010); however this does not afford protection to the species. Rather, the rankings are considered by government agencies and conservation groups when setting conservation priorities (Saskatchewan Conservation Data Centre 2007).

Research has been completed summarizing the types of works, activities or projects that have been undertaken in habitat known to be occupied by Plains Minnow (Tables 11 and 12). The DFO Program Activity Tracking for Habitat (PATH) database was reviewed to estimate the number of projects that have occurred between September 2002 and October 2010. A total of nine projects and activities were found, but this may not represent a comprehensive list of all activities. Some projects may not have been reported to DFO. The limited number of works, undertakings and activities that may have directly or indirectly affected Plains Minnow habitat include water crossings (e.g., bridges, culverts, open cut or ford crossings); trenchless crossing and pipeline remediation (e.g., punch and bore or high pressure directional drill or pipeline remediation and/or maintenance); well site remediation; aquaculture; and a grazing research project.

As indicated in the Threat Analysis, several threats affecting Plains Minnow are related to habitat loss or degradation. Habitat-related threats to Plains Minnow have been linked to the Pathways of Effects developed by DFO Fish Habitat Management (FHM)[1] (Tables 12 and 13). DFO FHM has developed guidance on mitigation measures for 19 Pathways of Effects for the protection of aquatic species at risk in the Central and Arctic Region (Coker et al. 2010). This guidance should be referred to when considering mitigation and alternative strategies for habitat-related threats. At the present time, we are unaware of mitigation that would apply beyond what is included in the Pathways of Effects.

Additional mitigation and alternative measures, specific to Plains Minnow, related to exotic piscivores and scientific sampling are listed below.

Exotic Piscivores

As discussed in the Threats section, introduction and establishment of exotic piscivores could have significant negative effects on Plains Minnow.

Mitigation

- Physically remove non-native species from areas known to be inhabited by Plains Minnow.
- Monitor Canadian portion of watershed for exotic species that may negatively affect Plains Minnow directly, or affect Plains Minnow preferred habitat.
- Coordinate with Montana/U.S. agencies to evaluate all introductions of exotic species in the Rock Creek basin.
- Develop a plan to address potential risks, impacts and proposed actions if monitoring detects the arrival or establishment of an exotic species.
- Introduce a public awareness campaign and encourage the use of existing exotic species reporting systems.

Alternatives

Unauthorized

- None

Authorized

- Use only native species.
- Follow the National Code on Introductions and Transfers of Aquatic Organisms for all aquatic organism introductions (DFO 2003).

[1] As of 2013, DFO FHM is now referred to as the DFO Fisheries Protection Program.

Table 12. Summary of works, projects and activities that have occurred during the period of September 2002 to October 2010 in and around areas known to be occupied by Plains Minnow. Threats known to be associated with these types of works, projects and activities are identified. Numbers in parentheses beside applicable Pathways of Effects (POEs) refer to the POE number assigned in Coker et al. 2010.

Work or Activity	Applicable Pathway of Effects for Threat Mitigation and Project Alternatives (POE #)	Potential Threats of Work or Activity
Water Crossings (e.g., bridges, culverts, open cut or ford crossings)	• Vegetation clearing (1) • Grading (2) • Excavation (3) • Use of industrial equipment (5) • Cleaning or maintenance of bridges or other structures (6) • Riparian planting (7) • Placement of Materials or Structures in Water (10) • Dredging (11) • Water Extraction (12) • Organic Debris Management (13) • Wastewater Management (14) • Addition or removal of aquatic vegetation (15) • Change in timing, duration, and frequency of flows (16) • Fish Passage Issues (17) • Structure removal (18)	**Turbidity and sediment loading** **Contaminants and toxic substances** **Barriers to movement** **Alteration of natural flow regimes**
Trenchless Crossing & Pipeline Remediation (e.g., punch and bore or high pressure directional drill or pipeline remediation and/or maintenance)	• Vegetation clearing (1) • Grading (2) • Excavation (3) • Use of industrial equipment (5) • Riparian planting (7) • Water Extraction (12) • Organic Debris Management (13) • Wastewater Management (14) • Change in timing, duration, and frequency of flows (16) • Fish Passage Issues (17)	**Turbidity and sediment loading** **Contaminants and toxic substances** **Barriers to Movement**
Well Site Remediation (oil well)	• Vegetation clearing (1) • Grading (2) • Excavation (3) • Riparian planting (7) • Placement of Materials or Structures in Water (10) • Water Extraction (12) • Organic Debris Management (13) • Wastewater Management (14)	**Turbidity and sediment loading** **Barriers to movement**

Work or Activity	Applicable Pathway of Effects for Threat Mitigation and Project Alternatives[1] (POE #)	Potential Threats of Work or Activity
Well Site Remediation (continued)	• Fish Passage Issues (17)	
Aquaculture	• Vegetation clearing (1) • Grading (2) • Excavation (3) • Use of explosives (4) • Use of industrial equipment (5) • Cleaning or maintenance of bridges or other structures (6) • Riparian planting (7) • Placement of Materials or Structures in Water (10) • Dredging (11) • Water Extraction (12) • Organic Debris Management (13) • Wastewater Management (14) • Addition or removal of aquatic vegetation (15) • Change in timing, duration, and frequency of flows (16) • Fish Passage Issues (17)	**Introduced species and diseases** **Alteration of natural flow regimes** **Contaminants and toxic substances**
Grazing Research Project	• Vegetation clearing (1) • Grading (2) • Excavation (3) • Use of industrial equipment (5) • Riparian planting (7) • Streamside Livestock Grazing (8) • Placement of Materials or Structures in Water (10) • Dredging (11) • Water Extraction (12) • Organic Debris Management (13) • Wastewater Management (14) • Addition or removal of aquatic vegetation (15) • Change in timing, duration, and frequency of flows (16) • Fish Passage Issues (17)	**Turbidity and sediment loading** **Barriers to movement** **Contaminants and toxic substances**

[1] Fish Habitat Management (now Fisheries Protection Program) within DFO uses a Risk Management approach to make decisions under the habitat protection provisions of the *Fisheries Act*. Each cause-and-effect relationship is represented by a line, which is known as a pathway, connecting the activity to a potential stressor, and a stressor to some ultimate effect on fish and fish habitat. Pathways of Effects diagrams are used to describe development proposals in terms of the activities that are involved, the type of cause-effect relationships that are known to exist, and the mechanisms by which the stressors ultimately lead to effects in the aquatic environment.

Table 13. Watercourse locations of works, projects and activities that have occurred during the period of September 2002 and October 2010 in areas known to be occupied by Plains Minnow.

Work or Activity	Watercourse/Waterbody	Number of Projects
Water Crossings (e.g., bridges, culverts, open cut or ford crossings)	Rock Creek Wetherall Creek	3 1
Trenchless Crossing & Pipeline Remediation (e.g., punch and bore or high pressure directional drill or pipeline remediation and/or maintenance)	Rock Creek	2
Aquaculture	Rock Creek	1
Well Site Remediation (i.e., oil well repair/remedial work)	Rock Creek	1
Grazing Research Project	Wetherall Creek	1

Scientific Sampling

As discussed in the Threats section, scientific sampling of Plains Minnow was recognized as a potentially low risk threat.

Mitigation

- Collection/sampling licenses are issued by DFO pursuant to Part VII of the General Fisheries Regulations, Section 51.
- In Saskatchewan, under the authority of *The Wildlife Act, 1998*, the Ministry of Environment issues provincial Scientific Research Permits to study and work with wildlife.
- Sampling in National Parks requires a Research and Collection Permit issued by Parks Canada.

Alternatives

- Prohibit lethal scientific sampling of Plains Minnow.

If Plains Minnow is listed under the SARA, it is possible that alternatives in addition to mitigation may be required.

SOURCES OF UNCERTAINTY

Limited monitoring and research has been conducted on Plains Minnow within the Canadian portion of its range. Accordingly, a number of key sources of uncertainty exist for this species. Resolving these uncertainties would greatly enhance our understanding of Plains Minnow in Canada.

To accurately determine population size, current trajectory and trends over time there is a need for continuation of quantitative sampling of Plains Minnow in areas where it is known to occur.

The current distribution and extent of suitable Plains Minnow habitat in the area in and around its current Canadian distribution should be investigated and mapped. These areas should be the focus of future targeted sampling efforts for the species. There is also a need to identify habitat requirements for each life stage. Larval surveys are needed to determine whether spawning or nursery grounds exist in Canada. Given that only 26.5 km of the minimum required river length (115 km) is available in Canada, maintaining connectivity with the U.S. portion of Rock Creek is essential. Knowledge of the current distribution and extent of suitable habitat in the U.S. portion of the watershed would also be useful.

Certain life history characteristics required to inform Plains Minnow population modelling efforts are currently unknown. Studies to determine growth rate, age at maturity and longevity of Plains Minnow in Canada are needed. Further studies should focus on acquiring additional information on fecundity, population growth rate and survival of young of the year. It is uncertain whether Plains Minnow can recruit in years/areas of poor flow.

Numerous threats have been identified for Plains Minnow in Canada, although the severity of these threats is currently unknown. There is a need for more causative studies to evaluate the impact of each threat on Plains Minnow with greater certainty as well as an estimation of the cumulative effects of interactive threats. There is a need to determine threshold levels for additional water quality parameters (e.g., nutrients) and to determine additional physiological parameter limits including pH and pollution tolerance. Quantification of the impact from threats is required for the purposes of calculating allowable harm and for identifying threshold values for specific threats.

PERSONAL COMMUNICATIONS

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APPENDIX

Recovery Potential Assessment Threat Categories

Turbidity and sediment loading

- Agriculture
- Urbanization
- Land management practices
- Industrial development
- Storm events

Contaminants and toxic substances

- Contaminated sediment
- PCB contamination
- Heavy metals
- Acidity
- Salinity
- Ammonia
- Pesticides

Nutrient loading

- Fertilizer release
- Sewage treatment plant loading
- Agricultural practices
- Common carp foraging

Barriers to movement

- Loss of genetic diversity
- Limited access to spawning grounds
- Natural re-colonization/rescue effect

Altered flow regimes

- Impoundment
- Dams
- Water taking
- Water management
- Channelization
- Dredging

Habitat removal and alteration

- Habitat destruction
- Wetland draining/loss
- Loss of habitat through agricultural process
- Shoreline development/modifications/hardening

- Water level manipulation
- Channelization

Exotic species and disease

- Common Carp
- Aquatic vegetation
- Dreissenids, Zebra Mussel, Quagga Mussel
- Viral hemorrhagic septicemia (VHS)

Incidental harvest

- Commercial
- Recreational
- Baitfish

Fish hosts (mussels)

- Barriers to movement
- Decreased water quality
- Any above-mentioned threats

Recreational activities (mussels)

- ATVs
- Boating
- Fly fishing
- Beach maintenance

Predation and harvesting (mussels)

- Human consumption
- Muskrats and raccoons

Climate change (over-arching theme)

- Not classified in terms of threat classifications as the effects of climate change span numerous threat categories