COSEWIC
Assessment and Status Report

on the

Plains Minnow
Hybognathus placitus

in Canada

THREATENED
2012

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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

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Plains Minnow — Photograph of Plains Minnow collected from Rock Creek, Saskatchewan. Photo: D.A. Watkinson.

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COSEWIC
Assessment Summary

Assessment Summary – May 2012

Common name
Plains Minnow

Scientific name
Hybognathus placitus

Status
Threatened

Reason for designation
This small fish 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.

Occurrence
Saskatchewan

Status history
Designated Threatened in May 2012.

COSEWIC
Executive Summary

Plains Minnow
Hybognathus placitus

Wildlife Species Description and Significance

The Plains Minnow (*Hybognathus placitus*) is the most geographically restricted of the four species within its genus in Canada. It is a small, silvery minnow with a slightly compressed body and a blunt, triangular head. Proper identification of the silvery minnows is difficult in the field and definitive identification often requires laboratory dissection of the posterior process of the basioccipital bone, a key character used for separating the species. The Plains Minnow can attain a maximum length and weight of 125 mm and 15 g, respectively, and individuals can live up to 3 years.

The Plains Minnow contributes to the biodiversity of Canada's ichthyofauna especially because its Canadian range is part of the distinctive Missouri River fauna at the most northern portion of a distribution that extends to the Gulf of Mexico.

Distribution

The Plains Minnow is a widespread species in the United States, occurring in the middle of the continent from eastern New Mexico, central Texas and western Arkansas north to North Dakota and Montana. In Canada, it is known from Rock Creek and a portion of one of its tributaries, Morgan Creek. The Rock Creek drainage in southwestern Saskatchewan is a tributary to the Milk River in Montana. After the Plains Minnow was first collected in Morgan Creek in 2003, collections made in 2006 and 2007 in Rock and Morgan creeks confirmed that a population of adults exists in Canada.

Habitat

The Plains Minnow favours moderate to shallow depths in areas of mainly slow, turbid water with sandy or silty substrates. Most of the streams it occupies have naturally unstable hydrographs and vary in size from fairly large rivers to small creeks of the Great Plains. Spawning habitat is close to areas of moderate current to aid in dissipation of the non-adhesive, semi-buoyant, fertilized eggs. Successful reproduction may require >100km of flowing water to complete incubation and hatching of drifting eggs.

Biology

There is limited information on the Canadian population, because it was only discovered in 2003. Information about the species' biology originates principally from research conducted in the southwestern United States. The Plains Minnow breeds for the first time in its second year. Many individuals suffer post-spawning mortality resulting in few fish older than age one in fall samples. The Plains Minnow has an extended spawning period, frequently reproducing after major flow peaks in the stream of residence. Reproduction is both synchronous (usually in spring) and asynchronous with portions of the population spawning throughout the summer. Fecundity is modest, with most females carrying less than 1,000 eggs. Growth rate is rapid with young of year fish approaching adult size by the end of their first summer.

Population Sizes and Trends

There have been two directed surveys conducted since the first capture of the Plains Minnow in Canada in 2003. They were undertaken to learn more about the life history of the population and to delineate its range in the Rock Creek drainage. A population estimate from 2007 suggested that there may be at least 41,751 mature fish in Canada. The population trend of the Plains Minnow in Canada is unknown.

Threats and Limiting Factors

Across the global range of the species, fragmentation of rivers by dams and the subsequent habitat changes that occur are the greatest threat to populations of Plains Minnow as alterations of the natural flow regime and fragmentation of flowing habitat have resulted in extirpation or rarity of Plains Minnow throughout the species' range. The Plains Minnow has semi-buoyant eggs that require long reaches of river (>100 km) habitat to complete development. The Plains Minnow is adapted to the naturally fluctuating environments of Great Plains watersheds, including flow intermittency, water quality degradation, and low oxygen concentrations. At least one exotic fish species exists within the Canadian range of the Plains Minnow, but its effects are unknown.

Protection, Status, and Ranks

The Plains Minnow was assessed by COSEWIC as Threatened in May 2012 but currently has no status under the *Species at Risk Act*. The global status is G4 (apparently secure) and in Canada NNR (NatureServe National Conservation Status Rank—Not Applicable—National conservation status not yet assessed). It is, however, listed as S1 (Critically Imperiled) by Saskatchewan. The status in the two adjacent states with contiguous watersheds, Montana and North Dakota, is NNR. The national rank in the United States is N4 (apparently secure). Aside from these ranks, the Plains Minnow in Canada is afforded the protection of the Canada *National Parks Act* within that portion of its range that in Grasslands National Park.

TECHNICAL SUMMARY

Hybognathus placitus
Plains Minnow Méné des plaines
Range of occurrence in Canada (province/territory/ocean): Saskatchewan

Demographic Information

Generation time (average age of parents in the population) (See section Biology, Life Cycle and Reproduction)	2 yrs
Is there an observed, inferred, or projected continuing decline in number of mature individuals?	Unknown, probably not
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations.	Unknown
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over the last 10 years, or 3 generations.	Unknown
Projected or suspected percent reduction or increase in total number of mature individuals over the next 10 years, or 3 generations.	Unknown
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over any 10 years, or 3 generations period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	Not Applicable
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence	32 km^2
Index of area of occupancy (IAO) *2x2 grid value*	32 km^2
Is the total population severely fragmented?	No
Number of locations *Probably two locations based on tributary-specific threats from existing drought occurrences, possibly one based on climate change projections of increased frequency of droughts*	1-2
Is there an observed, inferred, or projected continuing decline in extent of occurrence?	Unknown
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	Unknown
Is there an observed, inferred, or projected continuing decline in number of populations?	Unknown
Is there an observed, inferred, or projected continuing decline in number of locations*?	Unknown
Is there an observed, inferred, or projected continuing decline in area, extent and/or quality of habitat?	Likely not
Are there extreme fluctuations in number of populations?	Likely not
Are there extreme fluctuations in number of locations∗?	Likely not
Are there extreme fluctuations in extent of occurrence?	Unknown
Are there extreme fluctuations in index of area of occupancy?	Unknown

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Rock/Morgan creeks, SK. (See section Population Size and Trends, Abundance)	Approximately 41,751 (80% CI = 2,406-55,379)
Total (estimate based on samples of density (fish/m^2) extrapolated across available wetted surface area	Approximately 41,751 (80% CI = 2,406-55,379)

Quantitative Analysis

Probability of extinction in the wild is at least 20% within 20 years or 5 generations, or 10% within 100 years.	Not conducted (necessary data unavailable)

Threats (actual or imminent, to populations or habitats)

See Threats section for details

Actual
- Weirs may decrease surface runoff in watershed, affecting discharge
- Temperature (freezing) extremes exacerbated by low water

Potential
- Climate changes that result in decreases in discharge from drought and/or increased evapotranspiration.
- Any dam that acts as a barrier to migration, habitat modifier, flow regulator, or facilitates establishing introduced predatory species in either the Saskatchewan or Montana portions of the Rock Creek watershed.
- Scientific sampling could reduce the size of the population.
- Exotic species (Common Carp)

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? Not considered at risk in the Milk River in Montana.	
Is immigration known or possible?	Possible
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely? *Contingent on the population persisting in the United States portions of Rock Creek upstream of the Rock Creek Diversion Dam in Montana*	Yes

Current Status

COSEWIC: Threatened (2012)

Recommended Status and Reasons for Designation

Recommended Status:	**Alpha-numeric code:**
Threatened	D2

Reason for Designation:
This small fish 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.

Applicability of Criteria

Criterion A: Not applicable. Data required for assessment of criterion not available.
Criterion B: Meets Endangered for B1 and B2 and sub-criterion a as values are below thresholds (EO = 32 km², IAO = 32 km², and number of locations = 1-2), but no evidence of meeting of any further sub-criteria.
Criterion C: Not applicable. Data required for assessment of criterion not available.
Criterion D: Meets Threatened D2 as exists at fewer than 5 locations (1 or 2).
Criterion E: Not applicable. Data required for assessment of criterion not available.

COSEWIC HISTORY

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

COSEWIC MANDATE

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

COSEWIC MEMBERSHIP

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

DEFINITIONS
(2012)

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

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

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

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

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune

Canada

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

COSEWIC Status Report

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Plains Minnow
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2012

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae
Genus: *Hybognathus*
Species: *Hybognathus placitus* Girard, 1856

Common names:
English: Plains Minnow (Nelson *et al.* 2004)
French: Méné des plaines

The Plains Minnow (Figure 1), a small silvery cyprinid, was first collected in Morgan Creek, Saskatchewan, Canada, in 2003 by researchers from South Dakota State University (Sylvester *et al.* 2005). Additional surveys by Fisheries and Oceans Canada (DFO) biologists in 2006 and 2007 have confirmed the presence of this species in, and its apparent limitation to, Rock and Morgan creeks in southern Saskatchewan (Watkinson, unpublished data). Given its morphological similarities to other, co-existing silvery minnows, it was probably overlooked in Canada during previous surveys until those more experienced with this fish in the heart of its range began sampling in Canada.

Figure 1. Photograph of Plains Minnow, *Hybognathus placitus* collected from Rock Creek, Saskatchewan. D.A. Watkinson photo.

The genus *Hybognathus* contains seven species in North America, of which four are found in Canada; the Plains Minnow, the Western Silvery Minnow (*H. argyritis*), the Eastern Silvery Minnow (*H. regius*), and the Brassy Minnow (*H. hankinsoni*) (Schmidt 1994; Nelson *et al.* 2004). The Plains Minnow was initially lumped with Mississippi Silvery Minnow (*H. nuchalis*), but subsequently recognized as a separate species (Niazi and Moore 1962; Bailey and Allum 1962; Al-Rawi and Cross 1964; Pflieger 1971). Following separation of these two species, it was determined that *H. nuchalis* actually comprised three separate species, *H. nuchalis*, *H. argyritis*, and *H. regius* (Al-Rawi and Cross 1964; Pflieger 1971). Discrimination within the silvery minnow group is difficult in the field and definitive identification often requires laboratory dissection of the posterior process of the basioccipital bone, a key character used for separating the species (Niazi and Moore 1962; Bailey and Allum 1962; Al-Rawi and Cross 1964; Pflieger 1971). Dorsal fin profile and position, number and shape of scale radii, and eye diameter and position on the snout may aid in field separation of live Plains Minnow from co-occurring con-generic Mississippi Silvery Minnow, Brassy Minnow, and Western Silvery Minnow in the main parts of their ranges (Al-Rawi and Cross 1964; Pflieger 1971), although dissection may be required to confirm identifications, especially of juveniles.

More recent morphological work aimed at understanding phylogenetic relationships within the genus (Hlohowskyj *et al.* 1989; Schmidt 1994; Scheurer *et al.* 2003) has identified further characteristics that distinguish the species. Two key characters have typically been used to identify and separate *Hybognathus* species; the shape of the basioccipital process, and the number and appearance of scale radii. Scheurer *et al.* (2003), however, asserted that similarities in the shape of the basioccipital process and overlap in the counts of scale radii between Plains Minnow and Brassy Minnow make these characters unreliable for separating these species. Scheurer *et al.* (2003) further suggested that orbit diameter, standard length (SL), and eye position are more reliable for separation and easier to accomplish than the other two characters. Cook *et al.* (1992) using allozyme loci and Moyer *et al.* (2008), using mitochondrial and nuclear DNA loci, provided evidence to substantiate the morphometric taxonomic work (Bailey and Allum 1962; Niazi and Moore 1962; Al-Rawi and Cross 1964; Pflieger 1971; Hlohowskyj *et al.* 1989; Scheurer *et al.* 2003) that resulted in the definition of the seven species of *Hybognathus*.

In Canada, the Plains Minnow potentially co-occurs with the Brassy Minnow and the Western Silvery Minnow in the Rock Creek drainage. To date, the only *Hybognathus* collected with Plains Minnow in Canada is the Brassy Minnow. Body colouration, head shape, and eye diameter of adult Brassy Minnow typically are different enough from adults of either of the other two species to enable their separation in the field. Juveniles of all three species are difficult to distinguish without dissection.

Morphological Description

The Plains Minnow is a terete to sub-terete silvery minnow with a slim, slightly compressed body, a short triangular head with a blunt snout, and relatively small eyes (4.4–5.5 times into the head length) positioned just above the midline of the head (Robison and Buchanan 1988; Scheurer *et al.* 2003). Average adult total length (TL) ranges from 50–90 mm with a maximum size of about 125–130 mm TL (Scheurer *et al.* 2003). Body colour is tan to olivaceous dorsally with a well developed mid-dorsal stripe, silvery sides with no lateral band, a whitish underbody and a black peritoneum. The gut is very long and coiled (Robison and Buchanan 1988; Sublette *et al.* 1990). The lateral line is complete and contains 38 (34–42) scales. The mouth is sub-terminal with an overhanging fleshy snout and a crescent- or C-shaped lower jaw (Sublette *et al.* 1990). Pharyngeal teeth counts are 0.4–4.0 (Page and Burr 1991). The fins tend to be pointed rather than rounded as in the Brassy Minnow (Scheurer 2003) and meristic counts vary geographically (Table 1). Sexual differentiation is indicated at breeding time by males having fine nuptial tubercles on the top of the head and the dorsal surface, as well as on the medial side of the pectoral fin (Sublette *et al.* 1990). Males have longer first dorsal rays, larger heads, and caudal peduncles, whereas females are deeper bodied and have relatively longer bodies from the pelvic fin insertion to the vent (Ostrand *et al.* 2001).

Table 1. Comparison of modal meristic counts for *H. placitus* over its range. Data from Al-Rawi and Cross (1964), Sylvester *et al.* (2005) and Watkinson (unpublished data).

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)	n.a.
Rock Creek, SK (Watkinson)	20	8 (7–8)	14.5 (13–16)	38 (37–41)	n.a.	n.a.	n.a.
Rock/Morgan creeks Combined	27	8 (7–8)	15 (13–16)	38 (36–41)	n.a.	n.a.	n.a.
Upper Missouri	64	8 (7–8)	16 (14–18)	38 (36–41)	13 (12–16)	18 (15–21)	34 (33–36)
Platte	80	8 (7–9)	16 (15–18)	37 (35–41)	12 (12–13)	15 (13–18)	34 (33–36)
Kansas and Grand	175	8 (7–9)	16 (14–19)	37 (36–40)	13 (11–16)	15 (12–20)	34 (32–36)
Arkansas	166	8 (7–10)	16 (15–19)	37 (35–40)	13 (12–15)	15 (13–18)	34 (32–36)
Red (Tx)	175	8 (6–9)	16 (14–18)	37 (35–41)	14 (13–16)	17 (15–20)	33 (32–35)
Brazos	75	8 (7–9)	16 (15–18)	37 (35–42)	16 (14–18)	18 (17–21)	34 (32–35)
Colorado	19	8	16 (15–18)	38 (36–40)	16 (14–17)	21 (17–21)	34 (33–35)

The original Canadian sample of seven Plains Minnows collected from Morgan Creek, Saskatchewan, ranged in fork length from 44–84 mm, with a corresponding range in weight of 0.7 to 5.8 grams (Sylvester *et al.* 2005). A larger sample of 133 fish taken and measured after the original collection (Watkinson, unpublished data) had a range in fork length of 45–93 mm, and a corresponding range in weight of 1–11 grams. Modal meristic values of a Canadian collection (N = 20) varies from areas along the north-south axis of the species' range in the United States (Table 1, data from Al-Rawi and Cross 1964; Sylvester *et al.* 2005; Watkinson, unpublished data).

Population Spatial Structure and Variability

The Canadian population of Plains Minnow is limited to the Rock Creek drainage in Saskatchewan. There are no human-made barriers to movement within the Canadian range of Plains Minnow. During some months in late summer and winter, however, the stream becomes intermittent, thereby limiting movement of fishes longitudinally in the drainage (e.g., there were 37 monthly mean flows of zero discharge from 1979-2009, USGS Gauge 06169500). In Montana there is an irrigation diversion dam on Rock Creek 15.5 kilometres upstream from the Milk River confluence. It is unknown if this structure acts as a barrier to fish movement (Haddix pers. comm. 2011). Rock Creek has a highly variable hydrograph (Figure 2). During most spring freshet conditions there would be opportunity for immigration and emigration by Plains Minnow. At present there are no data on the degree of movement in or out of the Canadian portion of the stream, but it is presumed that it could and does occur. Thus, the Canadian population probably represents a northward extension of a larger Plains Minnow population that exists in the United States portion of Rock Creek and in the Milk River further downstream (Montana Fisheries Information System (MFISH 2010)). Data on the abundance of Plains Minnow in the Milk River in the United States are limited, but it is not considered to be a species of concern in either Montana or North Dakota, the two states adjacent to Saskatchewan (NatureServe 2010).

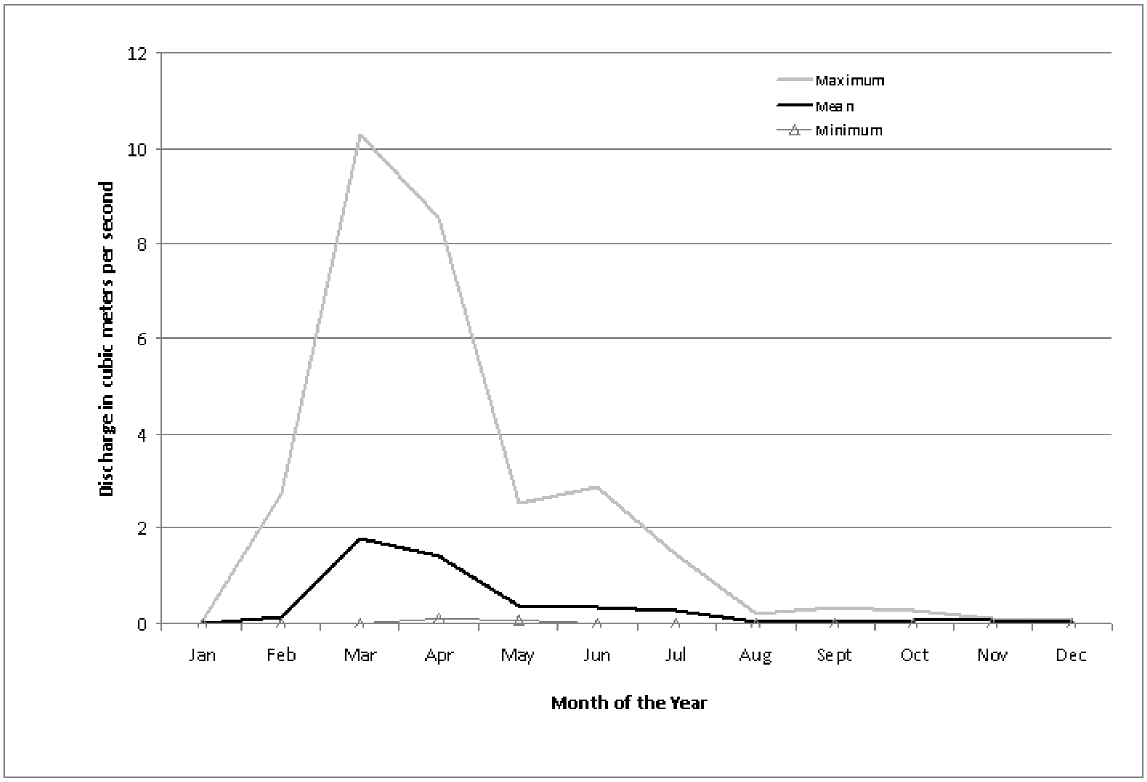

Figure 2. Mean, maximum, and minimum monthly discharge at the USGS gauge 06169500 on Rock Creek below Horse Creek near the International Boundary, 1979–2009.

Designatable Units

There is only one known population of Plains Minnow in Canada, in the Rock Creek drainage of Saskatchewan. There is no evidence to suggest the presence of designatable units below the species level in Canada.

Special Significance

The Plains Minnow is a rare species in Canada inhabiting only a small portion of one second to third order stream located about half in Grasslands National Park and half in private ranch lands of southern Saskatchewan. The stream has about 15 fish species (Sylvester *et al.* 2005; Watkinson, unpublished data); therefore, the Plains Minnow represents a significant part of the biodiversity of the fish fauna of the stream. In addition, the Plains Minnow is found only within the Milk River system in Canada. The Milk River system is unique in that it is part of Canada's smallest National Freshwater Biogeographic Zone and the only one draining to the Gulf of Mexico. Also, because the Plains Minnow is an herbivorous and benthivorous species, one might presume that it is significant ecologically by its transfer of energy and nutrients up the food chain (Moyer *et al.* 2005) of the Rock Creek ecosystem. The distribution in Canada is at the extreme northern portion of the Plains Minnow's North American range and, therefore, Canadian fish may be genetically distinct from other populations. At this time, there is no information available regarding Aboriginal traditional knowledge for the Plains Minnow.

DISTRIBUTION

Global Range

The Plains Minnow is distributed over a large area of the Great Plains of North America east of the Rocky Mountains and west of the Mississippi River from Texas and New Mexico north to North Dakota, Montana, and Saskatchewan (Page and Burr 1991; NatureServe 2010; Figure 3). The species is distributed throughout the Missouri River drainage; in the Mississippi River downstream from the mouth of Missouri River (Smith 2002) to the mouth of the Ohio River (Page and Burr 1991); in the lower Mississippi tributaries such as the Canadian River of Texas and New Mexico, the Arkansas and Red rivers; and in the Colorado (of Texas) and Brazos rivers that drain directly to the Gulf of Mexico (Lee *et al.* 1980). The Plains Minnow's distribution is reduced in many of the river systems in which the species formerly was abundant, primarily due to human alterations such as dam construction, water withdrawal for irrigation, pollution, and introduction of non-native species (Anderson *et al.* 1983; Cross and Moss 1987; Pflieger and Grace 1987; Winston *et al.* 1991; Bonner and Wilde 2000; Quist *et al.* 2004; Haslouer *et al.* 2005; Jelks *et al.* 2008). The Plains Minnow was reported in the Arkansas portions of the Arkansas and Red rivers decades ago, but is now thought to be extirpated from that state (Robison and Buchanan 1988). It also has declined precipitously over its range in most of Kansas (Cross and Collins 1995). The Plains Minnow was introduced into the Pecos River, a tributary of the Rio Grande River, probably as a bait fish and is thought to have contributed to the extirpation of the Rio Grande Silvery Minnow, *H. amarus*, from that river (Sublette *et al.* 1990; Moyer *et al.* 2005; Hoagstrom *et al.* 2010a).

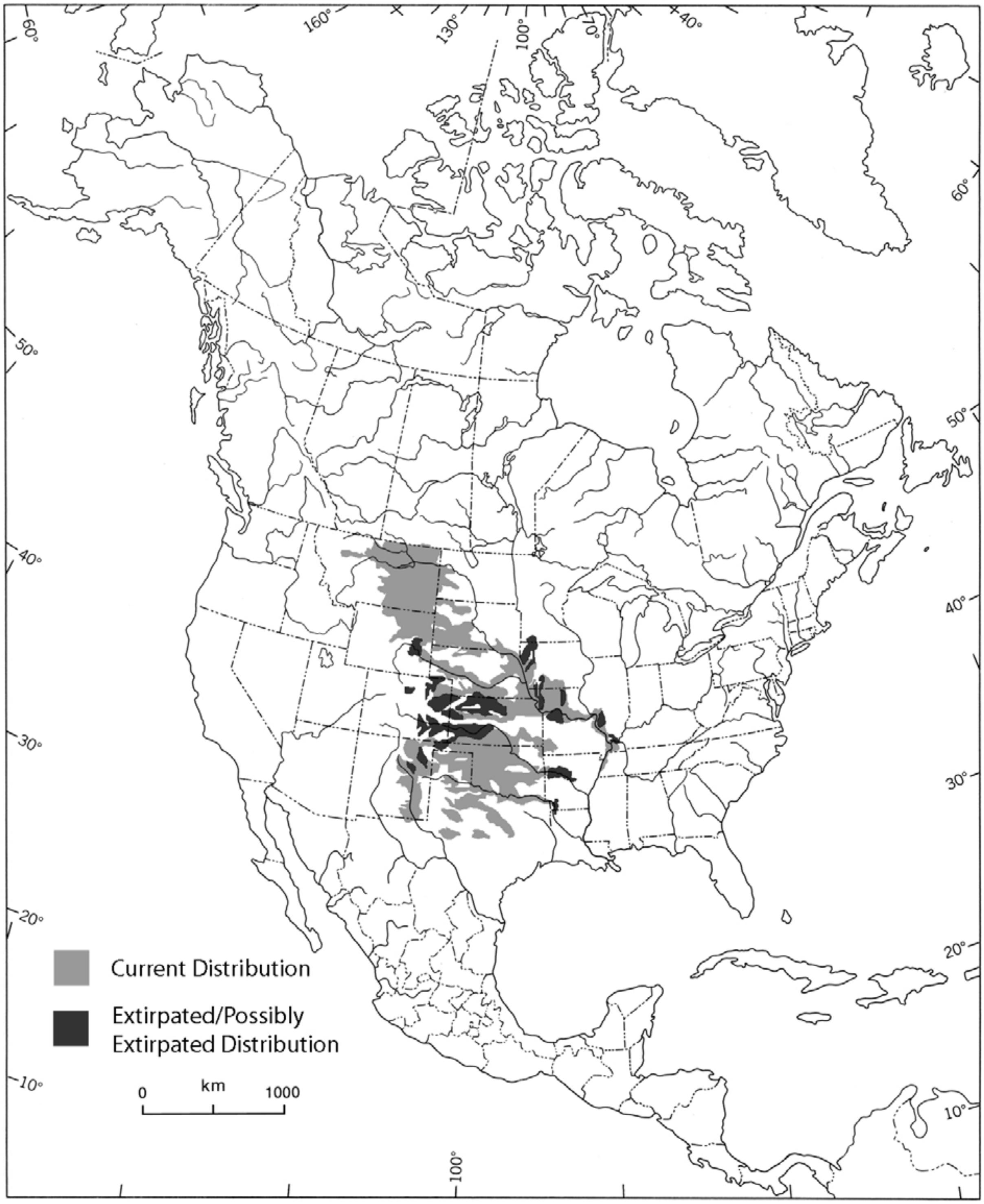

Figure 3. Global distribution of the Plains Minnow. Modified from NatureServe (2010).

The distribution of the Plains Minnow in the Milk River watershed occurs in tributaries downstream of the Dodson Diversion Dam to its confluence with the Missouri River (Bramblett 2008, Figure 4). Plains Minnow have been recorded in the Montana portions of Battle, Lodge, Big Muddy, and Willow creeks, and Frenchman River in addition to Rock Creek, all tributaries flowing south from Saskatchewan into the Milk River (Bramblett 2008; MFISH 2010). Sylvester (2004) found Plains Minnow in Rock and Morgan creeks and the Frenchman River in his survey of Milk River tributaries.

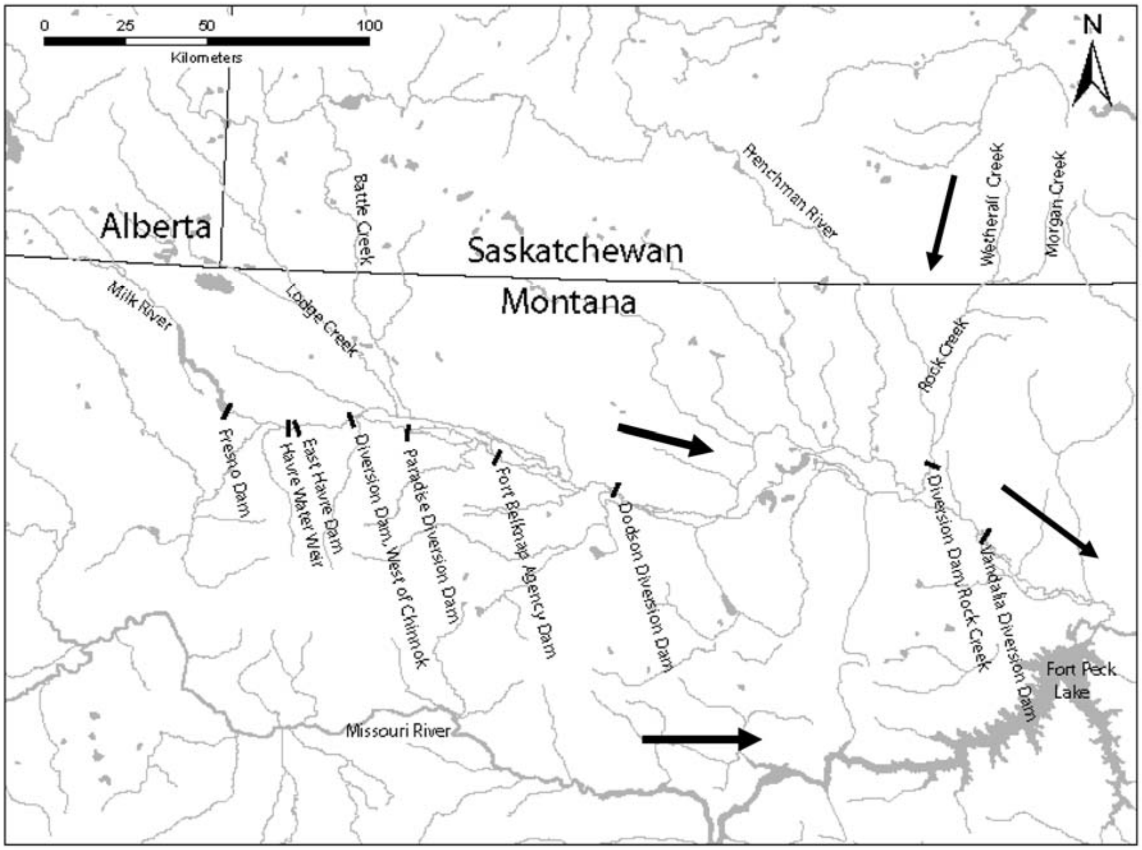

Figure 4. Locations of dams on the Milk River and Rock Creek in Montana. Arrowheads indicate direction of water flow.

Canadian Range

The Canadian range of the Plains Minnow is restricted to Rock Creek from the United States border to the confluence with Morgan Creek (15.5 river km) and the lowermost portion of Morgan Creek (11 river km) for a total of 26.5 km of river length in Canada (Figures 5, 6). Rock Creek is a tributary of the Milk River of Montana. In Canada, Rock and Morgan creeks pass through the East Block of Grasslands National Park, and private ranch lands, all within the Missouri National Freshwater Biogeographic Zone (NFBZ). The Canadian population constitutes less than 1% of the total global range. The Plains Minnow has not been identified from extensive collections in the Milk (Alberta) and Frenchman (Saskatchewan) rivers, Alberta (Watkinson, unpublished data).

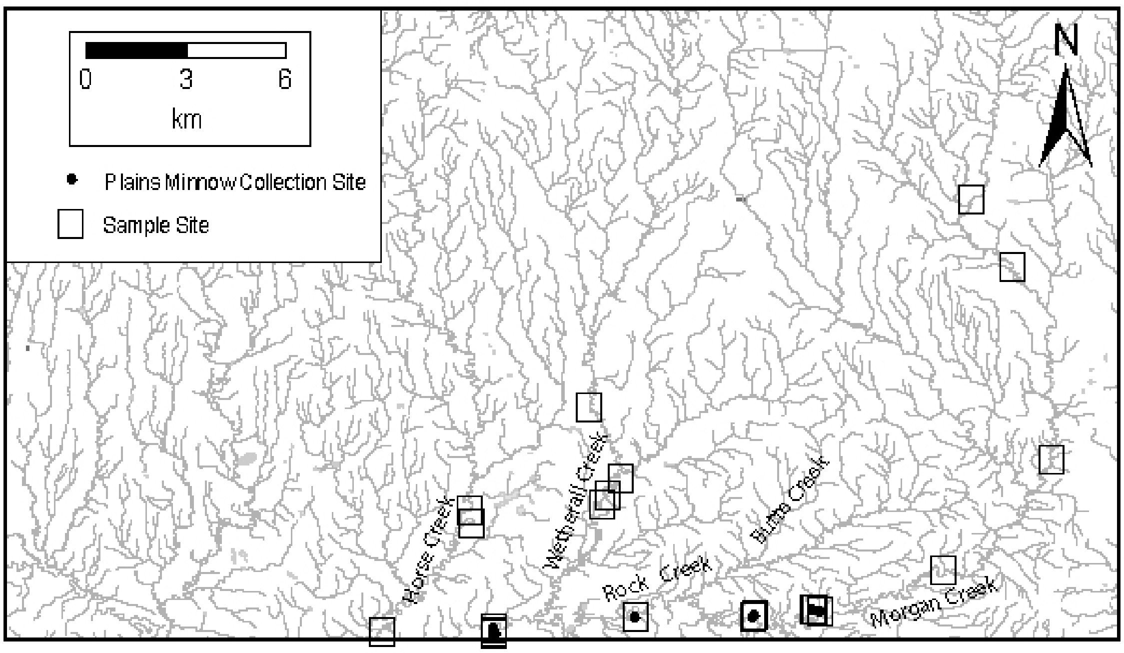

Figure 5. Canadian distribution of Plains Minnow in Rock and Morgan creeks and location of sample sites.

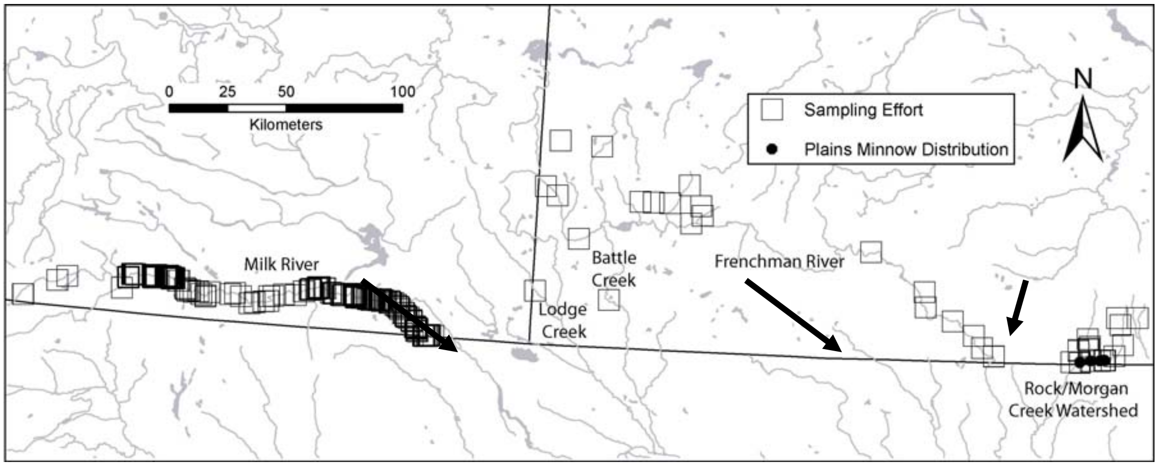

Figure 6. Sampling areas in the Missouri River watershed in Alberta and Saskatchewan (Sylvester *et al.* 2005; Watkinson, unpublished data). Arrowheads indicate direction of water flow.

The extent of occurrence (EO) and index area of occupancy (IAO) of Plains Minnow in Canada are both 32 km^2 based on a 2x2 km grid calculation as the minimum convex polygon calculation was less than the IAO. The IAO based on a 1x1 km grid is 17 km^2.

At present there are no data on expansion and/or contraction of the species' range over time. Given that the area of occupancy is prone to summer droughts and severe winter conditions, it is likely that the population fluctuates naturally in numbers and distribution. For the purpose of this report, the number of locations considered in Canada is between one and two, depending on whether severe droughts are driven by current climate conditions and effects of weirs (two locations) or by future climate change (one location).

Search Effort

Fisheries and Oceans Canada (DFO) has made 843 separate sampling collections in the Missouri River watershed in Canada (Figure 6) (Watkinson, unpublished data). These collections targeted Western Silvery Minnow, Plains Minnow, and Mountain Sucker (*Catostomus platyrhynchus*), in 2003–2007, using seine nets, backpack electrofishers and a boat electrofisher. In total 20,589 seconds (~5.8 hr) of backpack electrofishing, 2,340 m of seining (based on an average recorded haul distance of 23.4 m), and 61,749 seconds (~17.2 hr) of boat electrofishing have been conducted in the Canadian portion of the Missouri River watershed by DFO.

Surveys by DFO collected 1,574 Western Silvery Minnow in 132 collections, 618 Mountain Sucker in 67 collections, and 202 Plains Minnow in 13 collections. Sixty-one seine haul collections were made in the reaches of Rock and Morgan creeks where Plains Minnow are known to occur. The average catch per seine haul within the known species' distribution was 4.3 fish.

A non-targeted survey by researchers from South Dakota State University sampled sixteen sites in the Frenchman River watershed in 2003 using a seine or backpack electrofisher (Sylvester 2004), and an additional three sites in Morgan Creek were sampled by backpack electrofisher (Sylvester *et al.* 2005). Only one of these sites was within the known range of Plains Minnow in Canada and seven Plains Minnow were collected. The three Morgan Creek collections made by Sylvester *et al.* (2005) and 61 seine net collections made by DFO comprise all known sampling effort in the Canadian portion of the Rock Creek watershed.

HABITAT

Habitat Requirements

Across its range, Plains Minnow is most abundant in the sandy, silty rivers of the central Great Plains. They inhabit streams almost exclusively. These streams can be shallow, silty headwaters (Smith 2002), clear to highly turbid rivers and creeks with high dissolved solids and slight to moderately erratic flows (Sublette *et al.* 1990), and the main channels of large turbid silt-laden rivers (Pflieger 1997). They tend to be most abundant where sediments accumulate in shallow backwaters, in gentle eddies, and along the deeper edges of the shifting dunes of sand bed rivers where there is some current (Robison and Buchanan 1988; Cross and Collins 1995; Pflieger 1997). They are seldom are found over rocky or mud bottoms (Robison and Buchanan 1988; Cross and Collins 1995; Pflieger 1997).

Mathews and Hill (1980) completed a year-long study of habitat partitioning in the South Canadian River in Oklahoma. The South Canadian River is a highly fluctuating environment both in discharge and consequent physiochemical conditions. Plains Minnow showed relatively narrow habitat use in May, occupying habitats characterized by low oxygen, low temperature, and low velocity. Habitat use broadened as flow increased in August, and then narrowed again in a period of extended low water in October. At all times Plains Minnow avoided shallow water with significant current. Plains Minnow adapted to habitat availability; expanding habitat breadth when environmental conditions permitted, and converging to the same fewer habitats when conditions became more adverse.

Plains Minnow were more abundant in Wyoming streams without impoundments compared with reaches above or below an impoundment (Quist *et al.* 2004), consistent with the findings of the South Canadian River studies. Quist *et al.* (2004) also showed that the most important habitat determinants of an abundant Plains Minnow population were fine substrates in a river reach without impoundments and an absence of exotic piscivores, typically associated with impoundments. They postulated that the mechanism of this effect is that sediment scouring below dams left only large substrate with relatively clear waters, favouring species that prefer clear waters. Additionally, the successful development of the semi-buoyant, non-adhesive eggs apparently is dependent upon their continued entrainment in the water column until hatching, requiring from 72–144 km of river to complete (Platania and Altenbach 1998). Bonner and Wilde (2000) suggested that the persistence of Plains Minnow between the two South Canadian River dams probably occurred because the large river habitat was partially maintained and the 218 km segment of the river remaining from the tailrace of the upper dam to the beginning of the reservoir above the lower dam was sufficient for completion of egg incubation and hatching.

The small to medium rivers that the Plains Minnow inhabits are prone to drying into intermittent pools during dry summers or cold winters, but also experience flash floods of turbid water in precipitation events. This species, like other members of the obligate riverine group of species, is capable of withstanding challenging water quality and fish community threats during low water periods that are natural features of the streams of the arid and semi-arid Great Plains region (Cross and Moss 1987; Mathews 1987; Quist *et al.* 2004). Rock and Morgan creeks are northern extensions of such an environment.

Plains Minnow Habitat in the Rock Creek Drainage

Minimal habitat data have been accumulated for Rock and Morgan creeks at areas where Plains Minnow were captured. Sylvester *et al.* (2005) recorded habitat observations in June 2003, at the site where the Plains Minnow was captured, as run and pool habitat with mean wetted width of 2.26–3.24 m, small-sized substrate, turbid water with velocities <0.5 m/s, total dissolved solids 740–1270 ppm, salinity of 0.3–0.6 ppt, specific conductance 699–1150 µS/cm, temperature 13.9–16.8°C, pH 8.4–8.9 and dissolved oxygen 0.7–7.6 mg/L. Depths at the site were not recorded, but samples were obtained by backpack electrofishing and seining with a 1.2 m deep seine so depths would have been less than about 1.2 m. The mean monthly flow for June 2003 at the USGS Rock Creek gauge 06169500 was 0.162 cubic metres per second (cms).

Watkinson (unpublished data) recorded the following habitat observations from nine unique collection sites during two visits to Rock and Morgan creeks in September of 2006 and 2007, when fish were collected by seine: averages and ranges were depth 0.58 m (0.34–1.2 m), velocity 0.02 m/s (0–0.11 m/s), Secchi depth 0.20 m (0.12–0.32 m), temperature 13.8°C (11.3–16.6°C) and specific conductance 1516 µS/cm (1082–2370 µS/cm). Substrates at sampling sites were silt, sand, and gravel and included two areas with 100% silt substrate, one area with 100% sand, one area with 90% gravel and 10% sand, three areas of 50% silt and 50% sand, and two areas that were 60% silt and 40% gravel. The mean monthly flows for September 2006 and 2007 at the USGS Rock Creek gauge 06169500 were 0.0013 cms and 0 cms respectively.

Habitat Trends

There are stable populations in some parts of the Plains Minnow range (Chadwick *et al.* 1997; Rees *et al.* 2005), but the literature provides a compelling case that the Plains Minnow and the habitats that support it are in decline throughout its range in the United States due to human alteration of habitat at the watershed scale (Winston 2002; Rees *et al.* 2005; Hoagstrom *et al.* 2007; Hoagstrom *et al.* 2010a; Perkin *et al.* 2010). Impoundments and water diversions have continued to grow in numbers and impact across the Great Plains Ecoregion in North America since the 1950s in response to ever-growing human populations and increasing demand for water for human use, although habitat conditions in Canada appear to be relatively stable.

BIOLOGY

The comprehensive biology of the Plains Minnow cannot be found in one paper in the literature, and there is no prior information on the Canadian population of Plains Minnow beyond the declaration of first capture by Sylvester *et al.* (2005). Work by Lehtinen and Layzer (1988), Taylor and Miller (1990), Platania and Altenbach (1998), and Durham and Wilde (2005, 2006, 2008a, b, and c, 2009a, b) provide most of the available basic reproductive and population biology for the species. The biology of Plains Minnow presented here is derived principally from these studies in the southern part of its range in the southwestern United States, so one would expect that the dates associated with “spring” and “fall” are advanced and retarded, respectively, with respect to the population in the Rock Creek drainage.

Life Cycle and Reproduction

Pflieger (1971, 1997) stated that in Kansas, Plains Minnow lives in schools near the bottom of a stream and frequently is found in association with species such as Western Silvery Minnow, Silver Chub (*Macrhybopsis storerieana*), Sand Shiner (*Notropis stramineus*) and Flathead Chub (*Platygobio gracilis*). Further south in its range Plains Minnow frequently co-occurs with Arkansas River Shiner (*Notropis girardi*), Peppered Chub (*Macrhybopsis tetranema*), Flathead Chub and Speckled Chub (*Macrhybopsis aestivalis*), all of which spawn non-adhesive, semi-buoyant eggs into the water column of a river where there is some current to carry the eggs downstream (Pflieger 1971, 1997; Lehtinen and Layzer 1988; Platania and Altenbach 1998). This reproductive feature of these groups of obligate turbid river cyprinid fishes is the main determinant of where and how they live.

The Plains Minnow has a short life cycle, probably only two years in most populations, with both sexes becoming sexually mature at age one (Lehtinen and Layzer 1988). High mortality occurs post-spawning with only a small proportion of Plains Minnow living to age two (Taylor and Miller 1990).

All the Plains Minnow collected in September 2006 and September 2007 in Rock and Morgan creeks, Saskatchewan, were aged ≥1 year (Watkinson, unpublished data). Only a single male from 2006 and single female from 2007 appeared to have gonads (which were poorly developed). Because these collections contained fish that would be a minimum of two years old in the following year during the spawning period, it is uncertain if fish matured at age 1 in Canada. The sex ratio of this collection was nearly 50:50.

Lehtinen and Layzer (1988) and Taylor and Miller (1990) described a protracted spawning cycle in the Cimarron River of Oklahoma during 1979–80 and 1986–87, respectively. Females in March had relatively undeveloped ovaries, but maturation proceeded rapidly, such that, by April to May females were maturing, and by June most females were mature with some partly spent. While mature ova still were apparent in females in July, ova diameters were less than in June. This was taken as an indication that the main spawning period was during May–June. Mean sizes were not different among sexes. Age 0 fish grew quickly such that by August most were 30–40 mm in length with one reaching 45 mm. None of the age 0 fish reached the minimum observed length of spawning females and Lehtinen and Layzer (1988) judged that no Plains Minnow spawned at age 0. In both studies (Lehtinen and Layzer 1988; Taylor and Miller 1990), age 0 fish were the most abundant age group by late summer or fall and exhibited a bimodal length distribution suggesting that at least two spawning events had taken place in April and May. Lehtinen and Layzer (1988) suggested, and Taylor and Miller (1990) documented, a link between sudden increases in flow and the onset of spawning that was implied from earlier observations. Durham and Wilde (2008a), however, found that the group of turbid river cyprinids in the South Canadian River did not spawn only in response to peak flows, but were reproductively active throughout the summer as indicated by presence of post-ovulatory follicles in ovaries (Bonner 2000).

These minnows, however, reproduce successfully only during periods of moderate to higher flows and there was no reproductive success when there was no flow (Durham and Wilde 2008a, 2009a, b). In addition some species in this group of minnows may spawn both synchronously during periods of elevated stream flow and asynchronously in the same river system at lower flows ensuring that every opportunity for successful reproduction is captured (Durham and Wilde 2008b).

Both Lehtinen and Layzer (1988) and Taylor and Miller (1990) indicated that maturation and cessation of spawning appeared to be positively correlated with day length and temperature, with increasing spawning activity in spring and declining activity in fall as day length and temperature declined. There also was a link between maturation of ovaries and female body length with larger females maturing earlier than smaller females. Both studies suggested that fractional spawning was taking place, but Taylor and Miller (1990) suggested that it seemed likely that larger females were spawning at age two earlier in the season and that smaller age 1 females may have been spawning for the first time during late summer flow peaks. If sufficient flows to induce spawning didn’t occur during the summer, those females would grow to be the larger age 2 females in the following year. Larger females are more fecund than smaller ones, so in spite of significant mortality of age 1 fish the few large females that survived to age 2 compensated by producing more eggs.

Taylor and Miller (1990) estimated the fecundity of 31 mature females. Mean fecundity was 817 with a range of 417–4134 for fish 51–87 mm SL ($r = 0.89$; $P < 0.0001$).

Observation of spawning Plains Minnow in the wild is difficult due to their preference for turbid waters. Taylor and Miller (1990) observed aggregations of Plains Minnow during the spawning season in quiet water along sandbars and in backwaters of the Cimarron River during receding high flows in the same sort of conditions in which Sliger (1967) had collected drifting eggs. Platania and Altenbach (1998) took Plains Minnow and five other minnow species into the laboratory and induced spawning behaviour chemically. They then filmed spawning behaviour with high speed cinematography, successfully capturing two Plains Minnow spawning acts which lasted only about 15 milliseconds each. Eggs were about 1 mm in diameter when ejected from the female, expanding to about 3 mm within 10–30 minutes. Platania and Altenbach (1998) documented the pelagic broadcast of eggs into the water column, the swelling of the eggs with water after fertilization had taken place, and that eggs were semi-buoyant and remained in suspension as long as current was maintained once the perivitelline spaces of the eggs were filled. Egg eating by spawning and non-spawning Plains Minnow in the aquaria was documented repeatedly both before the eggs had expanded and after eggs had fully expanded, confirming suspicions of this practice from observations in the wild.

Age and Growth

No comprehensive study on age and growth of Plains Minnows was found in the literature. The fractional spawning behaviour of Plains Minnow means that age 0 fish in any given year may have a large range in size due to spawning at different times from early spring to midsummer. Durham and Wilde (2005) studied age 0 growth of Plains Minnow from the Canadian River, Texas by examining putative daily growth increments in otoliths over the May–September period of 2000 and 2001. Samples of fish caught and examined bimonthly or weekly, were measured for length, otoliths were removed and daily increments were counted. Mean daily growth in length was highly variable and ranged from 0.22–1.0 mm per day. Mean daily increase in length in both years appeared to be less for individual fish spawned and hatched in summer rather than spring. There was a significant positive ($p < 0.001$) relationship between log length and log age for Plains Minnow in both years, with log-age explaining 46–86% of the variance. Multiple regression analysis to adjust for the effects of age on length were significant indicating that growth rate was related to hatch date. Hatch date was negatively related to growth rate indicating that fish that hatched late in summer grew slower than fish that had hatched in spring. Durham and Wilde (2005) suggested that variation in water temperature may have differentially affected growth (high summer temperatures may have exceeded optimum for growth) and or differences in the size of spawning adults may have affected size of young at hatching. Bonner (2000) and Taylor and Miller (1990) determined that early spawners tended to be larger age 2 fish and later spawners tended to be smaller age 1 fish.

Canadian collections of Plains Minnow from 2006 (N = 80) and 2007 (N = 53) in Rock and Morgan creeks were weighed to the nearest 0.1 g, fork length (FL) measured to the nearest mm, and aged using whole otolith examination. In 2006, Plains Minnow were 45–92 mm FL (mean 63 mm) (Figure 7) and weighed 1–11 g (mean 3 g). In 2007, Plains Minnow were 51–93 mm FL (mean 83.8 mm) and weighed 1.6–10.6 g (mean 7.7 g). Males and females obtained similar weight at length, and the larger fish were mostly female (Figure 8). Ages ranged from 1–2 for both years (45–72 mm age 1, 70–92 mm age 2, 2006), but with only one 51 mm fish in the 2007 collection aged at 1 year (76–93 mm age 2, 2007). It is unknown if the apparent almost complete absence of age 1 year fish in 2007 represents a significant recruitment failure or an artifact of sampling. Similar to the findings of Hoagstrom *et al.* (2010a), the Canadian population of Plains Minnow has individuals that can live to 3 years of age.

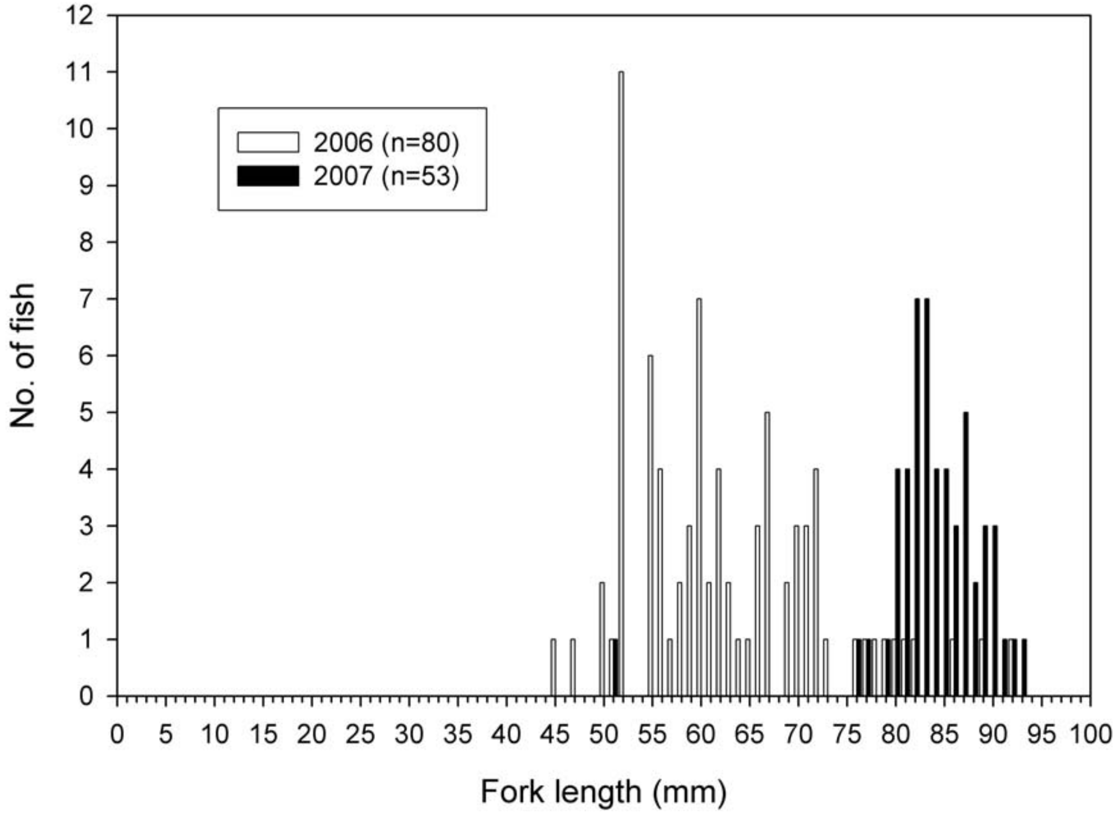

Figure 7. Length frequency plot of Plains Minnow collected in Canada in 2006 and 2007 (Watkinson, unpublished data).

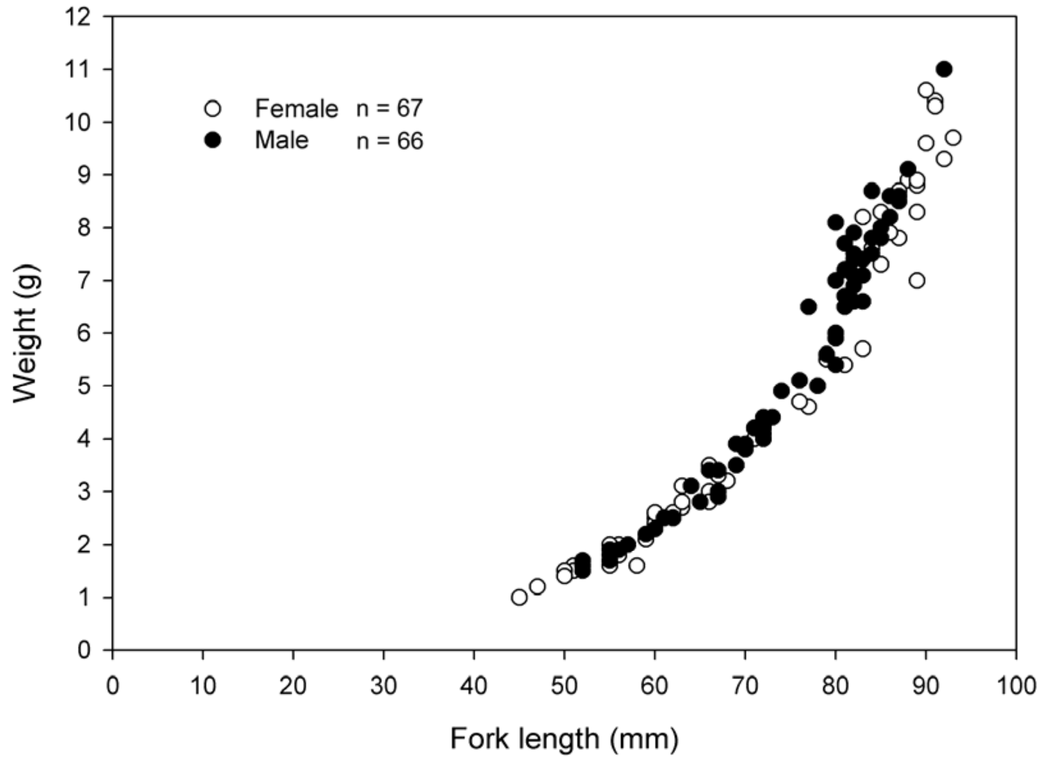

Figure 8. Length (mm) versus weight (g) plot by sex of Plains Minnow collected in Canada in 2006 and 2007 (Watkinson, unpublished data)

Diet and Feeding

Only anecdotal comments were found on the diet of Plains Minnow, mainly based on the length of the intestine and the elaborate pharyngeal teeth structures unique to *Hybognathus*, both of which point to an herbivorous or detritivorous diet (Cross 1967; Hlohowskyj *et al.* 1989; Robison and Buchanan 1990; Sublette *et al.* 1990; Winston *et al.* 1991). No specific gut content identifications were discovered, suggesting that a thorough analysis of the diet remains to be done. Western Silvery Minnow has a similarly long gut. An analysis of the gut contents of Western Silvery Minnow in the Milk River of Alberta in May 2006 indicated major dietary items were bacillariophytes (35%), chlorophytes (26%), plant remains (23%), and cyanophytes (10%), along with smaller quantities of carbon, fungi, chrysophytes, pollen, zooplankton remains, heterocysts, rotifers, and protozoans (COSEWIC 2008).

Physiology and Adaptability

As evidenced by a wide distribution over a large range in stream size, the Plains Minnow tolerates a broad range of water quality. Mathews and Maness (1979) tested Plains Minnow low oxygen tolerance and critical thermal maxima (CTM) in the laboratory and related it to field survival and reproduction in the South Canadian River of Oklahoma. They found that the CTM for two Plains Minnow acclimated to 25°C was near 40°C, a few degrees higher than observed temperatures in the river. Dissolved oxygen tolerance as indicated by mean time to loss of equilibrium during exposure of 10 fish to 1.2 ppm oxygen was close to two hours, longer than three other cyprinid species from the river. These tolerances to high temperatures and low oxygen were sufficient to allow the Plains Minnow population to increase in number during the summer when stream temperatures commonly were 37°C, and dissolved oxygen values were as low as 3.3 mg/L, and other species had ceased reproduction.

Bryan *et al.* (1984) conducted more sophisticated temperature and oxygen tolerance experiments on Plains Minnow from the South Canadian River. They used an experimental chamber in which fish could choose their preferred temperature at different dissolved oxygen levels. The apparatus provided a range in temperature from 13–36°C and oxygen concentration was manipulated from 6 down to 2 mg/L. Plains Minnow selected temperatures near 30°C when dissolved oxygen concentration was above 5 mg/L. The median selected temperature declined by 4.4°C for every 1 mg/L decline in oxygen concentration down to 2 mg/L, at which point Plains Minnow selected 17°C. Bryan *et al.* (1984) suggested that this is an indication that Plains Minnow, when oxygen limited, will select the highest temperature (to a maximum of approx. 37°C) in the environment that will allow routine respiration. Mathews and Hill (1980) came to a similar conclusion based on field observations, again in the South Canadian River. They suggested that Plains Minnow and other cyprinid fishes in the highly fluctuating environment combine two survival strategies: an evolved tolerance for wide limits of physiochemical conditions with a selective response strategy to change habitats in response to water quality factors.

Ostrand and Marks (2000) observed mortality of trapped cyprinids, including Plains Minnow, in drying pools of a tributary of the Brazos River, Texas, in late July, 1998. Five smaller pools nearby were without mortality. Ninety-three percent of Plains Minnow were dying in a pool that had dissolved oxygen at 0.17 mg/L, pH of 7.13, ammonia at 10.81 mg/L, conductivity of 1340 µS/cm, and turbidity of 119 NTU. The pools in which 100% of Plains Minnow were surviving had mean dissolved oxygen at 4.37 mg/L, pH of 7.59, ammonia at 1.87 mg/L, conductivity of 1600 µS/cm and turbidity of 318 NTU. The temperature in all the pools was about equal at 34.7–34.8 C. Temperatures in the pool with mortality were below the critical thermal limit for Plains Minnow, but dissolved oxygen concentration was below the limit indicated by Mathews and Maness (1979). Ammonia concentrations also were high; however, there is no reference value for Plains Minnow ammonia tolerance.

Ostrand and Wilde (2001) related Plains Minnow presence in fish assemblages in the Brazos River, Texas, to laboratory tolerance for temperature, salinity (as indicated by specific conductance), and dissolved oxygen concentration. The Plains Minnow laboratory CTM for 30°C acclimated fish was 39.7 +/-0.7°C. Salinity tolerance expressed as LC50 was 16 mS/cm +/-1.94% and there was a significant positive relationship between salinity and mortality. Plains Minnow tolerance for low dissolved oxygen as determined by loss of equilibrium was 2.08 +/-0.14 mg/L. The values for CTM and dissolved oxygen were very comparable to those determined by Mathews and Maness (1979) for Plains Minnow from the South Canadian River. Ostrand and Wilde (2001) commented that differential tolerances to temperature, salinity, and low dissolved oxygen concentrations contribute to longitudinal fish assemblage changes in prairie rivers with the most tolerant species occupying the most drought-prone headwaters. Many cyprinids including Plains Minnow fall into a slightly less tolerant group and occupy mid-watershed levels, and the least tolerant species are limited to lower reaches of streams that seldom experience severe water quality conditions. Ostrand and Wilde (2004) related their laboratory work reported in 2001 to observations in a series of isolated pools over two years in the upper Brazos River. Sampling was conducted in spring, summer, fall, and winter with water quality measurements taken each time before fish sampling for relative abundance of each species. The Plains Minnow was the most abundant species representing 24.7% of the catch. Presence of the Plains Minnow was inversely related to salinity with no cyprinids present in pools when specific conductance exceeded 30,000 µS/cm. There was a significant relationship between fish presence and pool drying as accounted for in a multiple logistic regression of turbidity, salinity, and pool volume. Plains Minnow abundance declined as turbidity fluctuated and pool volume declined. There was a significant decline in Plains Minnow abundance in summer after six days of pool isolation as specific conductance increased. The Plains Minnow was absent from collections from pools at one site after 3–21 days of pool isolation in response to increased salinity and decreases in turbidity and pool volume. Ostrand and Wilde (2004) reiterated the apparent importance of gradual changes in environmental factors in the structuring of headwater fish communities subject to intermittency in water supply and subsequent potential for pool evaporation. Although the species of fish in pools were all non-piscivorous, they did not mention potential predation by other vertebrates such as mammals, birds and reptiles that also must occur in and around the Brazos River.

Clearly, the security of water supply is an important feature of secure fish habitat for Plains Minnow, although, it is also clear that they can tolerate quite degraded water quality conditions compared to many other potentially co-occurring species.

Dispersal and Migration

Plains Minnow eggs are non-adhesive and semi-buoyant (Platania and Altenbach 1998). During their development, before the larvae begin vertical swimming, there can be a downstream dispersal for up to hundreds of kilometres (Faust and Bestgen 1997; Platania and Altenbach 1998). Because many adult fish die post-spawning, a mechanism is required to repopulate upstream areas. Adult Plains Minnow have been observed travelling upstream in schools in spring and summer, presumably for spawning, and can become aggregated in large numbers at dams that block fish passage in some southern United States rivers (Bestgen and Platania 1991). These behavioural patterns, larval dispersal downstream and adult migratory repopulation of upstream environments, are complementary in that they close a loop, ensuring that Plains Minnow remain distributed throughout the length of a stream (Faust and Bestgen 1997). During non-spawning times of the year, no particular migratory activity has been noted.

Interspecific Interactions

Other members of the fish community co-occurring with Plains Minnow in the Rock Creek drainage include Lake Chub (*Couesius plumbeus*), Brassy Minnow, Northern Pearl Dace (*Margariscus margarita*), Northern Red Belly Dace (*Chrosomus eos*), Fathead Minnow (*Pimephales promelas*), Longnose Dace (*Rhinichthys cataractae*), White Sucker (*Catostomus commersonii*), Shorthead Redhorse (*Moxostoma macrolepidotum*), Black Bullhead, Stonecat (*Noturus flavus*), Brook Stickleback (*Culaea inconstans*), Iowa Darter (*Etheostoma exile*), and the exotic Common Carp (*Cyprinus carpio*) (Sylvester 2004; Watkinson, unpublished data). Several of these species could be considered competitors for benthic space and food organisms, but frequently they are separated by micro-habitat preferences that limit direct interaction. During extreme low flows habitat space for all of these species could be limiting resulting in differential mortality over time in response to water quality degradation. Insufficient data are available to postulate the outcome of such events.

Parasites of the Plains Minnow include the Monogeneans *Dactylogyrus banghami* and *D. hybognathus* and the Trematode *Neascus pyriformis* (Hoffman 1999). Given that the Plains Minnow in Canada co-occurs with Brassy Minnow, the following parasites known from the latter might also be expected: the Protozoans *Elmeria hybognathi*, *Myxobolus transversalis*, *Myxobolus* sp., and *Trichodina* sp.; the Monogeneans *D. hankinsoni*, *Dactylogyrus* sp., *Gyrodactylus* sp. and *Octomacrum* sp.; the Trematodes *Diplostomum spathaceum*, *Neascus* sp., *O. ptychocheilus*, *Posthodiplostomum minimum*, *Rhipidocotyle* sp., *Tetracoytyle* sp., *Uvulifer amblopitis*; the Acanthocephalan *Neoechinorhynchus rutili*; and Molluscan glochidia. Additional potential parasites are the following known from the Mississippi Silvery Minnow: the Protozoan parasite *Hennneguya macrura*, the Trematode *D. nuchalis* and the Cestode *Ligula intestinalis* (Hoffman 1999). It would be reasonable to expect Plains Minnow to harbour any or all of these parasites given the probable co-occurrence of these fish species in some parts of their ranges.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

A crude abundance estimate of Plains Minnow in Canada was calculated from the September 2007 collection data. Site selection, however, was non-random and limited to 11 sites with access less than one kilometre away from a road. Nine of the sites were 20 m long and sampled with barrier nets placed at the up- and downstream ends, held in place with t-bar. Each site was seined with a 9.1 m by 1.8 m seine, with 4.8 mm mesh, starting from the downstream barrier and moving up to the upstream barrier net. The lead line was then lifted against the barrier net, leaving the catch in the bag of the seine. The catch was processed and released downstream of the barrier nets. Seining was then conducted in the opposite direction. A total of five seine hauls were completed at each of these sites. With the exception of one haul, the 45 seine hauls all collected at least one fish. Seven of the seine hauls contained at least one Plains Minnow. Two sites, 14 m in length, were sampled in Morgan Creek near the furthest known upstream distribution of Plains Minnow. At these sites beaver dams acted as the upstream barrier and were only seined once. Both sites contained Plains Minnow. In summary, 113 Plains Minnow were collected at five of the 11 sites in nine of the 47 seine hauls used to estimate density.

At each site, creek width was measured to the nearest 5 cm at three cross-sections positioned at the upstream, middle- and downstream end of the site. At each cross-section depth was measured to the nearest cm and substrate was assessed to percent composition using a modified Wentworth scale at every metre of stream width starting at the left bank looking downstream.

Abundance

The furthest upstream sample site on Morgan Creek from the 2007 sampling was nearly 15 km of creek upstream of the known distribution of the Plains Minnow. Because no Plains Minnow have been sampled this far upstream in the watershed it was omitted from the following calculations. The density of fish collected at the sample sites was highly variable (Figure 9). The mean creek width at the 10 sites was 4.56 m, with a range of 1.2–8.7 m (Figure 9). In total 188 m of creek and 896 m^2 of wetted channel were seined. The mean density of Plains Minnow at the 10 sites was ≥ 0.344 fish/m^2 (values are reported as ≥ as this sampling was unlikely to remove all Plains Minnow from any one site). Based on measurement from a digital topographic map there are approximately 26.5 kilometres of river channel in Rock and Morgan creeks where Plains Minnow are likely present (defined by the U.S. border to the furthest upstream collection point). Using the linear regression equation $y = -0.2478x + 7.9123$ (Figure 9) to calculate creek width at each kilometre, 0 to 27, the mean for these 27 x-sections of creek is 4.58 m. Multiplying creek width (4.58 m) by creek length (26,500 m) yields an estimated 121,370 m^2 of wetted area. Multiplying wetted area by mean density yields an estimated 41,751 Plains Minnow in Rock and Morgan creeks in September 2007.

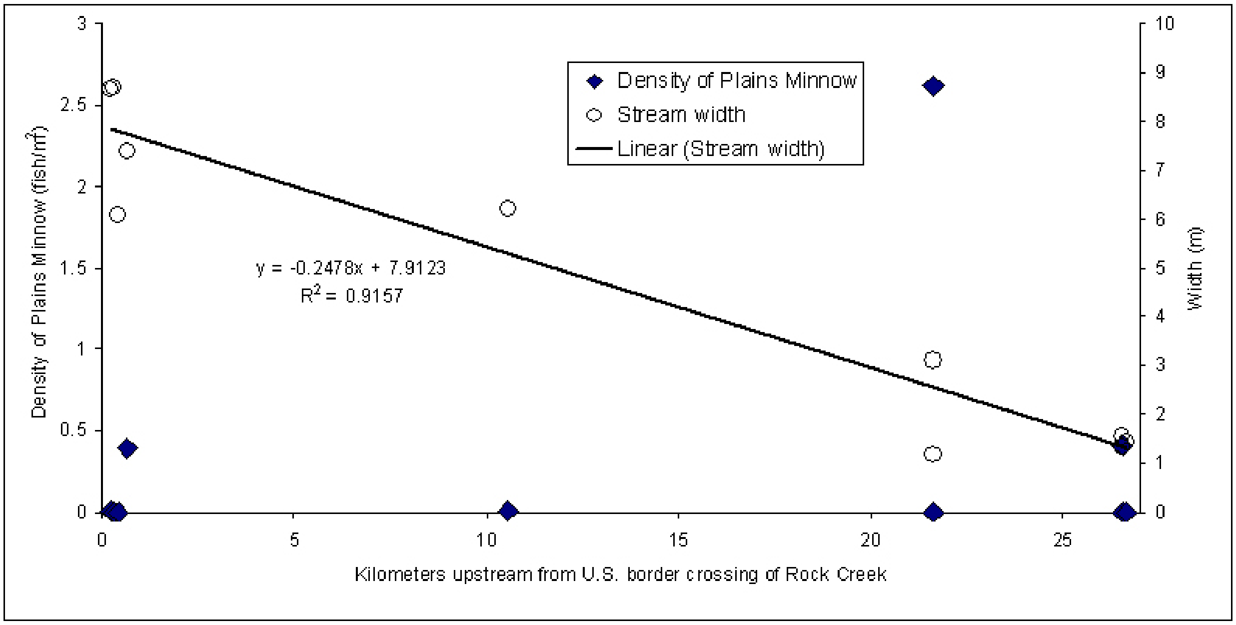

Figure 9. Density of Plains Minnows (fish/m^2) in field collection made in Rock and Morgan creeks in 2007 (Watkinson, unpublished data). Stream width and a trend line are plotted on the second axis.

The mean density of Plains Minnow at the 10 sample sites can also be used to calculate confidence intervals on the abundance estimates. The density of fish at each sample site was calculated, log transformed, log(x+1), and following methods of Elliott (1973) the calculated 80% confidence interval was 2,406 - 55,379 Plains Minnow in Rock and Morgan creeks in September 2007.

This procedure may overestimate available habitat and therefore abundance as Rock Creek was not flowing in the U.S. on September 5–7, 2007 (USGS Rock Creek gauge 06169500) when Watkinson (unpublished data) sampled. This was evident at the sample sites in Rock Creek as some portions of the channel were dry. Upstream, Morgan Creek was flowing indicating flow likely became subsurface in Rock Creek. Conversely, the density of fish at each of the sites is likely underestimated. For example, at one site, after five seine hauls, Plains Minnow were collected with high abundance in all five seine hauls. Also, the two sites that were once seined with a single pass may have missed some fish.

Age and sex data collected for 53 of the Plains Minnow collected in 2007 indicated all but one these fish were mature, suggesting the majority of the population in Canada is mature.

Fluctuations and Trends

No data are available on population fluctuations and trends of Plains Minnow numbers in the Rock Creek drainage, but the population would be expected to fluctuate over time because of the species' short generation time and the fluctuating hydrograph of the creek.

Rescue Effect

The lower portion of Rock Creek south of the International Boundary with the United States to its confluence with the Milk River is approximately 157 river km in length. Both Rock Creek and Milk River are reported to have populations of the Plains Minnow in Montana (Bramlett 2008; MFISH 2010). There are no known barriers to movement within the Canadian portion of the range. There is an irrigation diversion dam on Rock Creek, 15.5 kilometres upstream of the Milk River confluence, in Montana. It is uncertain, however, if this structure is a barrier at all flows (Haddix pers. comm. 2011). The Vandalia Diversion Dam (Figure 4), the furthest downstream dam on the Milk River, is approximately 18 river km downstream (east) of the confluence of Rock Creek and Milk River. The Dodson Diversion Dam is approximately 235 river km upstream (west) of the confluence of Rock Creek and Milk River. Both of these structures on the Milk River are likely impassible under most flows (Nagel pers. comm. 2011; Haddix pers. comm. 2011). Canadian populations of the closely related Western Silvery Minnow in the Milk River have been suggested to be able to recover from local population declines by recolonization from fish that take refuge in downstream portions of the Milk River in the U.S. (Pollard 2003). Therefore, while it remains possible for the Canadian population to be "rescued" from its United States populations the status of those populations is uncertain given the highly fragmented nature of the species' range in Montana. In both Montana and North Dakota, Plains Minnow are listed as NNR (Not Ranked, under review) (NatureServe 2010).

THREATS AND LIMITING FACTORS

Habitat

The most likely limitation to the persistence of Plains Minnow in Canada is its extremely small and localized distribution. It exists in only two small streams with a total inhabited length of 26.5 km making it particularly susceptible to stochastic events. The natural, fluctuating hydrograph of plains streams is important in the long-term sustainability of robust populations of obligate riverine species like the Plains Minnow (Winston *et al.* 1991; Bonner and Wilde 2000). Numerous studies have demonstrated significant declines in Plains Minnow and other similar species following construction of dams and other works that create barriers and alter natural flows and habitats in watersheds, varying in size from the Missouri River (Pflieger and Grace 1987) to many smaller systems (Winston *et al.* 1991; Bonner and Wilde 2000; Patton and Hubert 1993; Platania and Altenbach 1998; Quist *et al.* 2004; Hoagstrom *et al.* 2010b). The alteration of the flow regime, owing to dam construction, from a highly fluctuating, turbid river system with out-of-bank flows and occasional reduction to intermittent pools to one with a consistent and smaller flow of clear water are conditions to which Plains Minnow are presumably not adapted. Studies of the development of larva have concluded that more than 100 km of flowing river habitat may be required to sustain Plains Minnow populations (Platania and Altenbach 1998; Dudley and Platania 2007).

Any threat to the persistence of flowing water in the Rock Creek drainage has the potential to severely limit Plains Minnow habitat and populations. Durham and Wilde (2008a, 2009a, b) found that successful reproduction required flow. There are small earthen weirs in many swales and dry creek beds in much of southwestern Saskatchewan including the Rock Creek drainage. These small structures are made by ranchers to hold rainwater for livestock in temporary ponds that ultimately leak out or evaporate over a period of days or weeks following rain events or to create wet meadow pasture. These weirs do not impact fish habitat directly; however, they do retard or withdraw water that otherwise would flow into the intermittent and permanent channels of normally flowing creeks. Rock Creek had 37 monthly mean flows of zero discharge between 1979 and 2009. Only 11 of those zero monthly mean flows occurred during the open water season, again with no apparent trend during this time period (data from USGS gauge 06169500). This suggests that Rock Creek is a typical prairie intermittent stream with a highly variable hydrograph. The influence of the existing weirs on the hydrology is unknown, but the maintenance of some minimal seasonally varying flow is central to the long-term persistence of the Plains Minnow in Canada.

The main land use in the watershed outside of Grassland National Park is cattle ranching. Because these grazing lands are of relatively low quality, cattle density is low. The impact of cattle on the Rock Creek drainage probably is localized and limited to cattle drinking, stream bank trampling, and non-point source nutrification.

Other threats

Climate change impacts are difficult to predict in local areas of the North American continent. Various scenarios suggest annual temperature in western Canada will increase by one or two degrees in the next 30 years and experience greater evapotranspiration water loss. A recent analysis of projected changes in stream flow according to 12 climate models suggests, however, that the streams of the northern plains of the United States (Montana, South Dakota, for example) might experience increased discharge for the period 2041–2060 (Perkin *et al.* 2010). The Rock Creek drainage is close to that area making any prognosis for long-term stream flow indecisive at this time. Any climate change that reduces flows in the watershed, however, would impact habitat availability and increase mortality of individuals from either stranding in the open water season or winter kill in the under-ice period. Flow (as opposed to standing water) is also required for reproductive success (Durham and Wilde 2008a, 2009a, b).

Scientific sampling may pose a threat to the Plains Minnow. This threat is unlikely to have an effect, as it is controlled by permitting.

Exotic piscivores also have been implicated in Plains Minnow declines elsewhere (Quist *et al.* 2004; Hoagstrom *et al.* 2007). Usually species introduced into reservoirs are piscivorous “lake” species (e.g., Smallmouth Bass (*Micropterus dolomieu*)) adapted to visual predation. These predatory species, once introduced, do not stay in the impoundments and may range well upstream. The Largemouth Bass (*M. salmoides*) has been introduced to Saskatchewan, but at present is not considered a threat because it is found about 100 km away from the Rock Creek drainage (J. Pepper, pers. comm. 2012). Frequently other visual predators, usually salmonids, are introduced into cold tail waters below large impoundments. Neither native nor exotic piscivorous fish were captured in Rock or Morgan creeks (Sylvester 2004; Sylvester *et al.* 2005; Watkinson, unpublished data). New dams and reservoirs would be required to provide habitats to support game fish introduction. Common Carp has invaded the Rock Creek drainage, indicating the possibility of invasions by other aquatic invasive species. The effects of Common Carp on Plains Minnow are unknown, but could include habitat disturbance (from foraging on aquatic plants) or direct predation on eggs and young of Plains Minnow.

Completion of the International Union for the Conservation of Nature’s “Threats Calculator returned an overall threat rating of “High” principally owing to the cumulative impacts of possible extreme drought conditions across the small range of the Plains Minnow (see Appendix).

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

Plains Minnow was assessed as threatened by COSEWIC in May 2012, but it currently has no federal status as a species of any particular interest under legislation other than the general provisions of the *Fisheries Act*. The Saskatchewan *Wildlife Act, 1998* includes provisions to designate and protect species at risk in Saskatchewan; however, Plains Minnow is not listed in Saskatchewan. The *Environmental Assessment Act* and the *Environmental Management and Protection Act, 2002* also provide protection of habitat for aquatic species.

Non-Legal Status and Ranks

The global status of Plains Minnow is G4, apparently secure, and the national rank in the United States is N4, apparently secure (last assessed in 2003, NatureServe 2010). In Canada, the Plains Minnow is listed as NNR (NatureServe National Conservation Status Rank — Not Applicable — National conservation status not yet assessed (NatureServe 2010)). In Saskatchewan, the Plains Minnow is ranked by the Saskatchewan Conservation Data Centre as S1, critically imperiled (NatureServe 2010). This designation affords no protection; however, the rankings are used by government agencies and conservation groups to set conservation priorities (Saskatchewan Conservation Data Centre CDC Wildlife Application Training Manual (2007)).

Habitat Protection and Ownership

The *Canadian Environmental Protection Act* (1999, c. 33), which is in place to prevent pollution and protect the environment and human health, focuses on regulating and eliminating the use of substances harmful to the environment. In addition, habitat of the Plains Minnow receives further protection via the provisions in the *Canadian Environmental Assessment Act* (1992, c.37). The lands of the watershed through which the Rock Creek drainage passes lie within Grasslands National Park and thus are protected under the provisions and conditions of the Canada *National Parks Act* 2000, c. 32. The waters of the Rock Creek drainage that pass through Grasslands National Park and privately held lands upstream and downstream of Grasslands National Park are the resources of the Province of Saskatchewan (Fargey pers. comm. 2010).

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Douglas Watkinson is a Research Biologist with Fisheries and Oceans Canada, in Winnipeg. He obtained a B.Sc. (1998) and M.Sc. (2001) from the University of Manitoba. He has sampled fish in many of the major river systems of the Hudson Bay drainage from northwestern Ontario west to the Rockies. His current research focuses on species at risk, habitat impacts, and aquatic invasive species. He has co-authored four COSEWIC reports and the field guide The Freshwater Fishes of Manitoba.

William G. Franzin joined the Freshwater Institute in Winnipeg as a research scientist with Fisheries and Oceans Canada in 1975, where he worked until retiring in 2008. He was an adjunct professor in the Zoology Department at the University of Manitoba until 2005 where he supervised or co-supervised 10 graduate student theses at the master's and doctoral levels. His broad fish/fisheries research interests have included fish biogeography and diversity, effects of heavy metal toxicity on wild fish populations, fish genetics, walleye stocking, in-stream flow issues, invasive aquatic species and species at risk. Dr. Franzin has authored or co-authored 45 published papers, book chapters, and reports, dozens of presentations at scientific meetings and contributed to countless departmental submissions and reviews. He was president of the American Fisheries Society in 2009. Dr. Franzin continues to be active in fisheries science as a consultant; Laughing Water Arts & Science, Inc.

COLLECTIONS EXAMINED

Fisheries and Oceans Canada, Environmental Science, Winnipeg, Manitoba, R3T 2N6

THREATS ASSESSMENT WORKSHEET

Species or Ecosystem Scientific Name	*Hybognathus placitus*
Element ID	
Elcode	
Date (Ctrl + ";" for today's date):	6/1/2011
Assessor(s):	Doug Watkinson
References:	

Overall Threat Impact Calculation Help:

Threat Impact		Level 1 Threat Impact Counts: high range	low range
A	Very High	0	0
B	High	1	1
C	Medium	0	0
D	Low	0	0
Calculated Overall Threat Impact:		High	High

Assigned Overall Threat Impact:	**B = High**
Impact Adjustment Reasons:	
Overall Threat Comments	Extreme drought is asignificant threat that has been observed in the past and likely to occur in the future and with the potential to impact the entire range in Canada. Livestock farming is also an important threat applying to all known site occurrences, but with variable impacts at each. This watershed has a very low density of people. Although still a modified watershed from agriculture, the intensity of use is low. . Future dam building in either Canada and the United States portions of the Rock Creek watershed could have significant habitat impacts related to migration, reproductive suceess, species introductions, flow change and habitat change. We are not aware of any planned dam construction at this time. Completed by D. Watkinson, June 2011.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Unknown	Small (1-10%)	Unknown	High (Continuing)	
1.1	Housing & urban areas		Not Calculated (outside assessment timeframe)	Small (1-10%)	Unknown	Insignificant/Negligible (Past or no direct effect)	
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas		Not Calculated (outside assessment timeframe)	Small (1-10%)	Unknown	Low (Possibly in the long term, >10 yrs/3 gen)	Within National Park. Tourism is limited.
2	Agriculture & aquaculture		Unknown	Restricted (11-30%)	Unknown	High (Continuing)	
2.1	Annual & perennial non-timber crops		Unknown	Restricted (11-30%)	Unknown	High (Continuing)	Limited row crop agriculture, within watershed but not directly next to distribution of Plains Minnow
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching			Large (31-70%)	Unknown	High (Continuing)	Cattle grazing in the watershed. Observed impacts to stream banks and likely nutrient inputs
2.4	Marine & freshwater aquaculture						
3	Energy production & mining						NA
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy						
4	Transportation & service corridors		Unknown	Small (1-10%)	Unknown	High (Continuing)	
4.1	Roads & railroads		Unknown	Small (1-10%)	Unknown	High (Continuing)	
4.2	Utility & service lines		Unknown	Small (1-10%)	Unknown	High (Continuing)	
4.3	Shipping lanes						NA
4.4	Flight paths						likely limited
5	Biological resource use		Negligible	Negligible (<1%)	Negligible (<1%)	Unknown	
5.1	Hunting & collecting terrestrial animals						NA
5.2	Gathering terrestrial plants						NA
5.3	Logging & wood harvesting						NA

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.4	Fishing & harvesting aquatic resources		Negligible	Negligible (<1%)	Negligible (<1%)	Unknown	likely small as scientific collections controlled by permitting
6	Human intrusions & disturbance		Unknown	Restricted (11-30%)	Unknown	High (Continuing)	
6.1	Recreational activities		Not Calculated (outside assessment timeframe)	Small (1-10%)	Unknown	Insignificant/Negligible (Past or no direct effect)	Very limited visitors to Grasslands National Park and the surrounding private land.
6.2	War, civil unrest & military exercises						NA
6.3	Work & other activities						NA
7	Natural system modifications		Not Calculated (outside assessment timeframe)	Large (31-70%)	Unknown	Low (Possibly in the long term, >10 yrs/3 gen)	
7.1	Fire & fire suppression		Unknown	Large (31-70%)	Unknown	High (Continuing)	Controlled burns are conducted in Grasslands National Park
7.2	Dams & water management/use			Small (1-10%)	Unknown	High (Continuing)	Small dams in watershed in ephemeral portions of the drainage, impact is unknown. NOTE - Future dam building in either Canada or the United States portions of the Rock Creek watershed could have significant habitat impacts related to migration, reproductive success, species introductions, flow change and habitat change. Would be rated: Scope - Pervasive, Severity -Serious/Extreme, and timing - Low. We are not aware of any plans for dams at this time.
7.3	Other ecosystem modifications						
8	Invasive & other problematic species & genes		Unknown	Restricted (11-30%)	Unknown	High (Continuing)	
8.1	Invasive non-native/alien species		Unknown	Restricted (11-30%)	Unknown	High (Continuing)	Common Carp are known from the downstream end of the distribution of Plains Minnow
8.2	Problematic native species						NA
8.3	Introduced genetic material						NA
9	Pollution		Unknown	Small (1-10%)	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Small (1-10%)	Unknown	High (Continuing)	Small number of households in the area
9.2	Industrial & military effluents						NA
9.3	Agricultural & forestry effluents						NA

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.4	Garbage & solid waste						NA
9.5	Air-borne pollutants						NA
9.6	Excess energy						NA
10	Geological events						
10.1	Volcanoes						NA
10.2	Earthquakes/tsunamis						NA
10.3	Avalanches/landslides						NA
11	Climate change & severe weather	B	High	Pervasive (71-100%)	Serious (31-70%)	High - Low	
11.1	Habitat shifting & alteration						
11.2	Droughts	B	High	Pervasive (71-100%)	Serious (31-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Entire Canadian range is susceptible to droughts. The population could undergo a severe decline from prolonged zero flow in both the open water and under-ice period. I consider the severity to be serious based on the definitions; however, it should be noted that this species is adapted to systems that experience severe droughts.
11.3	Temperature extremes	B	High	Pervasive (71-100%)	Serious (31-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	For this species low temperatures combined with low winter flow could result in winter kill. Its upper temperature tolerance is higher than it would experience in Canada.
11.4	Storms & flooding	D	Low	Pervasive (71-100%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Interpreted as channel migration from high flow events

Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).