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Information in support of a recovery potential assessment of Rocky Mountain Sculpin (*Cottus* sp.), Eastslope populations, in Alberta

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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 Canada, the Rocky Mountain Sculpin (*Cottus* sp.) is distributed east of the Rocky Mountains in the St. Mary and Milk river systems, Alberta, and west of the Rocky Mountains in the Flathead River system, British Columbia. In August 2006, the two populations of Rocky Mountain Sculpin from the St. Mary and Milk river systems of Alberta—also referred to as “Eastslope” Sculpin—were officially listed as Threatened under the *Species at Risk Act* (SARA). In December 2007, this species, identified as the St. Mary Shorthead Sculpin, was similarly listed as Threatened under Alberta’s *Wildlife Act*. This small, bottom-dwelling fish is considered to be at risk of extinction in Alberta due to its very restricted area of occurrence in the St. Mary and Milk river systems where it has been impacted by habitat loss and degradation from water diversion, conditions that have been exacerbated in recent years by drought. Fisheries and Oceans Canada (DFO) has undertaken a Recovery Potential Assessment that summarizes our current understanding of the distribution, abundance, and population trends of Rocky Mountain Sculpin, Eastslope populations, in Alberta. Identification of threats to both sculpin and its habitat, and measures to mitigate these impacts, are also reported. This information may be used to inform the development of recovery documents, and to support decision-making with regards to the issuance of permits, agreements and related conditions under the SARA.

Information à l'appui d'une évaluation du potentiel de rétablissement du chabot des montagnes Rocheuses (*Cottus* sp.) (populations du versant est) en Alberta

RÉSUMÉ

Au Canada, le chabot des montagnes Rocheuses (*Cottus* sp.) est réparti à l'est des montagnes Rocheuses dans le réseau hydrographique des rivières St. Mary et Milk, en Alberta, et à l'ouest des montagnes Rocheuses dans le réseau hydrographique de la rivière Flathead, en Colombie-Britannique. En août 2006, les deux populations de chabot des montagnes Rocheuses – connu aussi sous le nom de « chabot du versant est » – des réseaux hydrographiques des rivières St. Mary et Milk, en Alberta, ont été inscrites officiellement sur la liste des espèces menacées en vertu de la *Loi sur les espèces en péril* (LEP). En décembre 2007, cette espèce, aussi désignée par le terme « chabot à tête courte de la rivière St. Mary », a également été inscrite sur la liste des espèces menacées en vertu de la *Wildlife Act* en vigueur en Alberta. Ce petit poisson de fond est considéré comme à risque de disparaître de l'Alberta parce que sa zone d'occurrence est très limitée dans le réseau hydrographique des rivières St. Mary et Milk au Canada. La perte et la dégradation de l'habitat causées par les déviations de cours d’eau, des conditions qui ont été aggravées au cours des dernières années par la sécheresse, ont eu des conséquences néfastes pour l'espèce à ces endroits. Pêches et Océans Canada (MPO) a entrepris une évaluation du potentiel de rétablissement qui résume les connaissances actuelles à propos de l'aire de répartition, de l'abondance et des tendances des populations de chabot des montagnes Rocheuses, populations du versant est, en Alberta. L'évaluation fait également état des menaces qui pèsent sur le chabot et son habitat, et de mesures pouvant atténuer leurs répercussions. Ces renseignements peuvent servir de base à l'élaboration de documents relatifs au rétablissement et éclairer la prise de décisions en ce qui a trait à l'émission de permis, aux ententes et aux conditions connexes conformément à la LEP.

SPECIES INFORMATION

Scientific Name – *Cottus* sp.
Common Name – Rocky Mountain Sculpin
Range in Canada
Eastslope populations (St. Mary and Milk river systems, Alberta)
Westslope populations (Flathead River system, British Columbia)
Current COSEWIC Status and Year of Designation
Eastslope populations – Threatened, 2005
Westslope populations – Special Concern, 2010

COSEWIC Reason for Designation for the Eastslope populations – "This species has a very restricted area of occurrence in the St. Mary and Milk rivers in Canada where it has been impacted by habitat loss and degradation from water diversion, conditions that have been exacerbated in recent years by drought." (COSEWIC 2005)

Canada *Species at Risk Act* – Listed, Schedule 1, Threatened, 2006
Alberta *Wildlife Act* – Listed, Threatened, 2007

BACKGROUND

The Rocky Mountain Sculpin is a small freshwater fish found in Canada in the St. Mary and Milk river systems of Alberta (Eastslope populations) and the Flathead River system of British Columbia (Westslope populations). This document evaluates the potential for recovery of the Eastslope populations of Rocky Mountain Sculpin.

TAXONOMY

The taxonomy of sculpins in western Canada is far more complex than previously thought, and remains unresolved. The Rocky Mountain Sculpin appears to be an unrecognized taxon belonging to the family Cottidae within the Mottled Sculpin (*C. bairdii*) complex. There is a lack of consensus among scientists concerning taxonomic designation, however, the Rocky Mountain Sculpin was first recognized as the Mottled Sculpin, but later described as the Shorthead Sculpin, *C. confusus*, based on morphological studies (Roberts 1988). Subsequent taxonomic study revealed two morphologically distinct forms of *C. confusus* from the Flathead River system, British Columbia and another from the Columbia and Kettle rivers, Washington (Peden et al. 1989). In 1998, the Flathead River form was listed as the Mottled Sculpin and the lower Columbia and Kettle form as *C. confusus* (Canning and Ptolemy 1998).

Identification of the Flathead form as *C. bairdii* was later found to be consistent morphologically and genetically to that of the St. Mary and Milk river systems (Troffe 1999; Taylor and Gow 2008, as cited in COSEWIC 2010). However, *C. bairdii* is an eastern species named from Ohio, and there is a substantial range disjunction between eastern and western North American Mottled Sculpin (Lee 1980). These distinctions are further supported by McPhail and Taylor (in preparation) who identified a relatively large amount of genetic variation between eastern and western C. *bairdii* using mitochondrial DNA sequence data. The depth of divergence suggests eastern and western *C. bairdii* have been separated since the Pliocene (about 3-5 Ma) and argue that the Flathead form is not *C. bairdii* (McPhail 2007).

Subsequenct genetic work on the *C. bairdii* complex (D. Neely, unpubl. data) suggested that the Flathead form is an unrecognized species, the Rocky Mountain Sculpin. Currently, sculpins occurring in the Flathead, St. Mary, and Milk river systems of Canada that are not the Slimy Sculpin (*C. cognatus)*—easily distinguishable from the Rocky Mountain Sculpin (see 'Distinguishing Characteristics' below)—are recognized as the Rocky Mountain Sculpin (*Cottus* sp.) until a formal taxonomic revision is completed (Nelson et al. 2004). Hence, for the remainder of this document, the generic Rocky Mountain Sculpin name will be used for populations in the Flathead, St. Mary and Milk river systems.

SPECIES BIOLOGY AND ECOLOGY

Sculpins, in general, are small, large-headed fishes with no air bladder making them morphology conducive to their benthic life history (Peden 2000). The Rocky Mountain Sculpin is a slender fish with a short head relative to its body size (3.0–3.8 times into standard length) and has small papillae on the head (McPhail 2007). The Rocky Mountain Sculpin can be differentiated from other closely-related species based on several morphological features; the most notable discrepancy being the incomplete lateral line (21–26 lateral line pores), absence of prickles behind the pectoral fin, and 13–15 pectoral fin rays (Troffe 1999; McPhail 2007). In the Gallatin River (Gallatin County, Montana), Rocky Mountain Sculpin have reached up to 141 mm total length (TL) (MSU3248).

Mature, ripe males are darker than females, with a yellow-orange band on the first dorsal fin; whereas breeding females retain their colour but have noticeably swollen abdomens (McPhail 2007). The sex of mature adults can often be differentiated by examining the urogenital papillae. Although this structure changes seasonally, in males it appears triangular or blunt and rounded immediately behind the anus, while in non-breeding females it is an inconspicuous mound or tube-like structure (McPhail 2007).

In Alberta, Rocky Mountain Sculpin do not co-occur with other Sculpin species (Fisheries and Oceans Canada (DFO), unpubl. data). Spoonhead Sculpin occur in the St. Mary River downstream of the St. Mary Reservoir, outside of the known range of the Rocky Mountain Sculpin (DFO, unpubl. data). However, Rocky Mountain Sculpin in the Flathead River system in British Columbia is known to co-occur with the Slimy Sculpin (McPhail 2007). These two species can be distinguished based on their palatine teeth (absent in Slimy Sculpin and weak, but present in Rocky Mountain Sculpin), anal fin ray number (usually less than 12 in Slimy Sculpin and more than 12 in Rocky Mountain Sculpin), the width of the isthmus (usually wider than the eye in Slimy Sculpin), and the presence of papillae on the head of Rocky Mountain Sculpin (absent in Slimy Sculpin) (McPhail 2007).The Spoonhead Sculpin (*C. ricei*) is recognized by the broad, flat head; elongate and strongly curved upper preopercular spines; a deeply wrinkled chin; a single median chin pore; and a complete lateral line to the caudal peduncle without deflection.

Life history information for the Rocky Mountain Sculpin is somewhat limited, and much of the information available is based on a number of studies of populations from other western systems. Information on the biology and life history of the Rocky Mountain Sculpin in Alberta, specifically, is available from studies of the St. Mary River and Lee Creek (Roberts 1988) and the Milk and North Milk rivers (R.L. & L. Environmental Services Ltd. 2002), and from ongoing work on both systems (T. Clayton, Alberta Sustainable Resource Development and D. Watkinson, DFO).

Age, Growth and Maturity

In Alberta, Rocky Mountain Sculpin young-of-the-year (YOY) were 30–40 mm TL by the end of their first summer, and yearlings achieved a length of at least 50 mm TL (Roberts 1988). These data are similar to data from the Flathead River, where YOY were on average 37.0 mm standard length (SL)[1] by late summer (Hughes and Peden 1984). In the Flathead River, one-year-old males were on average 64.4 mm SL and one-year-old females were 48.6 mm SL by

[1] SL can be converted to TL for Rocky Mountain Sculpin using a conversion factor of 0.86 that was derived from a sample of 100 specimens collected in Montana (D. Neely, unpubl. data).

October (Hughes and Peden 1984). Rocky Mountain Sculpin in the North Milk River can grow to at least 114 mm TL (R.L. & L. Environmental Services Ltd. 2002).

The Rocky Mountain Sculpin is believed to be sexually mature at the age of 23 months (DFO, unpubl. data). McPhail (2007) suggests that most males reach sexual maturity by their third summer (age 2+), and most females, by their fourth summer (age 3+) in the Flathead River. The only mature two-year-old female collected from the Flathead River system was 71.4 mm SL (Hughes and Peden 1984). The smallest mature female examined from the St. Mary River system was 52.3 mm in TL, but age was not estimated (Roberts 1988). These observations are consistent with data collected for Slimy Sculpin and Mottled Sculpin elsewhere. Similarly, all specimens of Rocky Mountain Sculpin in southwestern Montana found to be sexually mature were at least 2 years old and 57 mm TL (Bailey 1952). Rocky Mountain Sculpin from the St. Mary River can live to 8 years (DFO, unpubl. data). These ages are somewhat older than the oldest male Rocky Mountain Sculpin collected in Howell Creek, British Columbia that was in its seventh growing season (age 6+; McPhail 2007).

Reproduction

The spawning season for *Cottus* species is highly variable and may range from February to August, depending on location (summarized by Bailey 1952). A fairly detailed study on spawning ecology was conducted for Rocky Mountain Sculpin in southwestern Montana by Bailey (1952). In general, males arrived earlier than females at the breeding sites, and were ripe earlier. In addition, these males were considered highly polygamous, usually spawning with one to four females, but sometimes up to 12 females. Single egg clusters are deposited by the female and the single male remains near the nest site for up to several weeks during oviposition, incubation and early embryo stages (Peden 2000; Bailey 1952). Rather than behaving as guardians of these nest sites, Bailey (1952) believed that these males kept the nests clean of silt and other debris.

Nests are constructed under rocks or sometimes on aquatic vegetation, wood or debris. Since more than one female may be attracted to lay eggs, single nests have been found with up to 1,884 eggs (Bailey 1952). The pale yellow to orange-yellow eggs are about 2.5 mm in diameter. Males fan the developing eggs to keep them silt-free. The incubation period is temperature dependent, with observed spawning and hatching dates in the West Gallatin River ranging from 21 to 28 days, at afternoon water temperatures of 7.8−17.2°C. Eggs removed to an incubator and held at temperatures between 8.9 and 10.0°C, began hatching 30 days after fertilization and continued for another 10 days. It takes approximately two weeks for the egg sac to be absorbed (Bailey 1952). Lotic populations of eastern *Cottus* do not exhibit a pelagic larval stage, and males may stay in the nest until the yolk sac is resorbed. Males of the subgenera *Cottus* and Uranidea remain with the eggs and larvae for 2-4 weeks post-hatching (Simon and Brown 1943; Bailey 1952).

Little is known about the reproduction of Rocky Mountain Sculpin in Alberta. Fecundity is directly related to size, and ranges from 68 to 368 eggs for females 57 to 87 mm TL in the St. Mary River (DFO, unpubl. data). Peden and Hughes (1984) noted a female of 55 mm SL with 128 eggs and a female of 99 mm SL with 690 eggs from the Flathead River, British Columbia. Depending on temperature, eggs of the Rocky Mountain Sculpin in Alberta likely hatch within 2 to 3 weeks (Roberts 1988). Roberts (1988) reported gravid pre-spawning female Rocky Mountain Sculpin in the St. Mary River of Alberta in mid-May at a water temperature of 8.1°C, and later reported males guarding eggs in 15°C water near the same location. Rocky Mountain Sculpin in Alberta spawn every year once they are mature (DFO, unpubl. data).

Parental care appears to play a large role in survival and hatching; all *C. cognatus* nests that were deserted by males failed (Mousseau 1983). Morris (1954) observed that male *C. gobio* with eggs fanned them with the pectoral fins during incubation, and the rate of fanning was proportional to water temperature; Savage (1963) noted fanning by male *C. girardi* only at temperatures above 10°C. Males also protect the eggs and fry from predators (Downhower and Yost 1977; Staples 1980).

The skin of many cottids (*C. asper, C. bairdii, C. cognatus, C. gobio, C. ricei, Myoxocephalus quadricornis, M. thompsonii* and others) has antimicrobial properties (Kallner and Bernander 2001). Several species of cavity-nesting percids also have antimicrobial secretions (Knouft et al. 2003) which function in reducing mortality of eggs. The compounds in cottids likely serve a similar function.

Hybridization has been found between Rocky Mountain Sculpin and Slimy Sculpin in an area of the Flathead River below a hydroelectric dam where the release of hypolimnetic water has altered thermal regimes and habitat structure (Zimmerman and Wooten 1981; Taylor and Gow 2008, as cited in COSEWIC 2010).

Diet

Cottids are generalist and opportunistic ambush predators that engulf prey items whole. Although this strategy restricts prey items to those smaller than gape size, the gape of freshwater sculpins is relatively large; gape width of 30 Rocky Mountain Sculpin from Montana ranged from 14-22% of SL (mean of 16.6) (D. Neely, unpubl. data).

Sculpins forage at night and eat mostly bottom-dwelling invertebrates. YOY Rocky Mountain Sculpin feed mainly on chironomid larvae, but as the fry grow, the larvae of other bottom dwelling aquatic insects are added to their diet (Bailey 1952; Hughes and Peden 1984). An examination of the diet of 60 Rocky Mountain Sculpin collected in the St. Mary and Milk rivers systems found 88% of the diet by abundance was composed of chironomid larvae (48%), trichopteran nymphs (32%) and ephemeropteran nymphs (9%). They also consumed nematodes, invertebrate eggs, one Trout-Perch (*Percopsis omiscompaycus*), coleopteran larvae, tipulid larvae and plecopteran nymphs (DFO, unpubl. data). Other taxa that have been reported from the adult diet include the molluscs *Physa* spp. and *Pisidium* spp., and two other fish species, Longnose Dace (*Rhinichthys cataractae*) and Rainbow Trout (*Oncorhynchus mykiss*) up to 64 mm TL (Bailey 1952; Hughes and Peden 1984; Paetz 1993; Alberta Sustainable Resource Development 2004). Adults will eat fry and eggs of their own species (Bailey 1952).

ASSESSMENT

HISTORIC AND CURRENT DISTRIBUTION AND TRENDS

The Rocky Mountain Sculpin is only found in North America. It occurs in the upper Missouri River system in the Milk and North Milk rivers in Alberta south to southern Montana and probably the Bighorn system of Wyoming (McPhail 2007; D. Neely, pers. comm.). They are also found in the Columbia River system in the lower 24 km of British Columbia's Flathead River system, extending into Montana (Peden and Hughes 1984; McPhail 2007) as well as Lee and Aetna creeks and the St. Mary River in the Nelson River system (R.L. & L. Environmental Services Ltd. 2002; COSEWIC 2005, DFO, unpubl. data).

There is insufficient information to identify Rocky Mountain Sculpin in the six waterbodies (i.e., St. Mary River, Lee Creek, Aetna Creek, North Milk River, Milk River above the confluence and Milk River below the confluence) as genetically-discrete populations, and currently there are no barriers to movement within the St. Mary system or the Milk River system, so each waterbody is referred to as a stock rather than a population in this assessment.

Good information on the historical distribution of this species is not available. The species' current distribution has likely been determined by postglacial dispersal and preference for cool waters (Alberta Sustainable Resource Development 2004; Fullerton et al. 2004).

St. Mary River system

Rocky Mountain Sculpin is known to occur in the St. Mary River above the St. Mary Reservoir and in the lower 300 m of Aetna Creek and lower 35 km of Lee Creek, tributaries of the St. Mary River system (Figure 1). Whether this species occurred farther downstream in the St. Mary River before the St. Mary Reservoir Dam was constructed in the late 1940s is unknown.

The St. Mary River has a total drainage area of about 3,600 km², of which about 2,400 km² is in Alberta (ISMMRAMTF 2006). The river begins at Gunsight Lake in Montana's Glacier National Park and flows northeast about 65 km through St. Mary and Lower St. Mary lakes before crossing the international border. It then meanders north about 46 km through mainly shrub-grassland to the St. Mary Reservoir in Alberta. In the United States, the drainage basin receives about 1,200 mm of precipitation on average annually, mostly as snow (ISMMRAMTF 2006). Within Alberta the average annual precipitation in this drainage ranges from 470 mm in the Foothills Fescue Natural Subregion in the south to 394 mm in the Mixed-grass Natural Subregion in the north (Natural Regions Committee 2006).

Flow in the St. Mary River is maintained during the summer by meltwater from the high elevations of Glacier National Park (ISMMRAMTF 2006). At the international border, the average monthly flow is <6 $m^3{\cdot}s^{-1}$ from December through March (WSC 2011a). Flow increases abruptly in the spring to an average peak in June of 73.0 $m^3{\cdot}s^{-1}$. It then decreases abruptly over the summer and gradually over the fall. Winter flow is sustained by ground-water flow. Land use practices that may negatively impact fish habitat are limited in the St. Mary River drainage in both Montana (Mogen and Kaeding 2005b) and Alberta.

The natural flow regime of the St. Mary River has been altered since ca. 1900, when a diversion canal with a capacity of 14.2 $m^3{\cdot}s^{-1}$, was constructed to carry water from near the crossing of the international boundary to the vicinity of Magrath, Alberta (ISMMRAMTF 2006). By 1921, the canal capacity had been increased to 22.7 $m^3{\cdot}s^{-1}$. Known as the Canadian St. Mary Canal, it generally operated from April through to the end of October until it was replaced by the St. Mary Reservoir and a larger canal in the early 1950s (see also Clements 1973; English 1977; Gilpin 2000). Since 1917, water has also been diverted from the St. Mary River in northwestern Montana via the St. Mary Canal into the North Milk River (ISMMRAMTF 2006). This water flows eastward via the North Milk River and then the Milk River through southern Alberta before entering northeastern Montana, where it is used for irrigation.

Milk River system

Occurrences of Rocky Mountain Sculpin has been reported in the North Milk River from the Alberta/Montana border downstream to its confluence with the Milk River, and within the Milk River downstream to within 85 km of the Montana border (Willock 1969; Clayton and Ash 1980; R.L. & L. Environmental Services Ltd. 1987, as cited in COSEWIC 2005; R.L. & L. Environmental Services Ltd. 2002; Paetz 1993; Alberta Sustainable Resource Development 2004; COSEWIC 2005; T. Clayton and DFO, unpubl. data) (Figure 1). Tributaries may be used opportunistically as most tributaries of the North Milk River are ephemeral (T. Clayton, pers. comm. 2007). Since the species was first reported in the Milk River in the 1960s (Willock 1969), records of its occurrence have extended downstream at least 130 km (Clayton and Ash 1980) although it is not known if this represents a shift in distribution or a sampling artifact.

The Milk River has a total drainage area of 61,642 km^2, of which 6,500 km² is located in Alberta. The North Milk and Milk rivers flow north from Montana into Alberta, where the North Milk joins the Milk River and flow eastward through the southern portion of the province, and

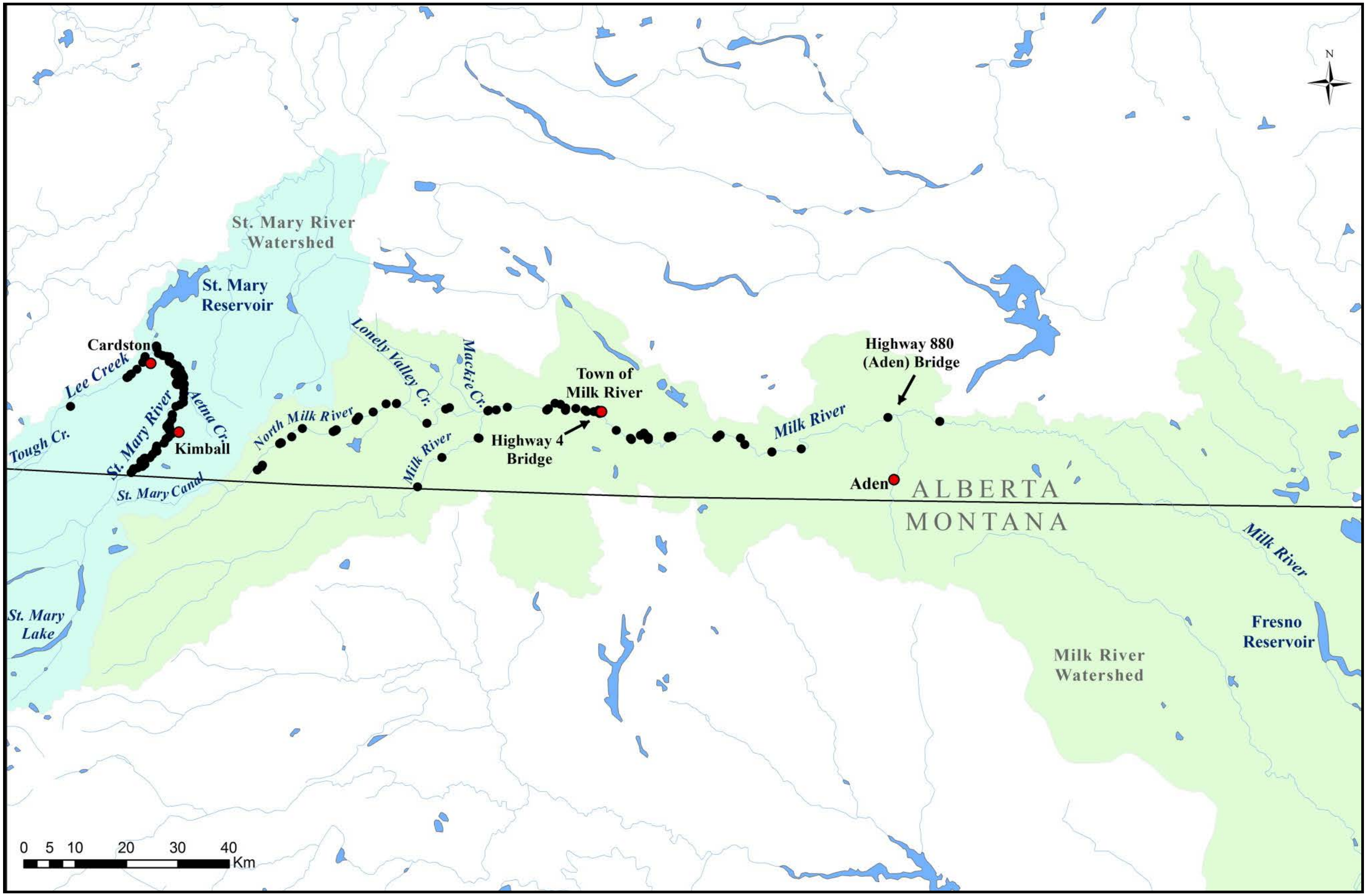

Figure 1. Distribution of Rocky Mountain Sculpin in Alberta.

then south back into Montana. The Town of Milk River is one of the few communities in the Milk River system.

As the North Milk and Milk rivers in Alberta flow east from the Montana Border, they cross the Foothills Fescue, Mixed-grass, and Dry Mixed-grass subregions of the Grassland Natural Region (Natural Regions Committee 2006; Milk River Watershed Council Canada 2008). Both flow within the confines of a defined valley with limited road access. The surrounding land is semi-arid, short grass prairie that is used primarily for cattle grazing. The lower reaches of the Milk River is shallow and turbid, with dynamic hydraulic conditions and a poorly-developed riparian zone that lacks higher aquatic plants due to the highly mobile stream bed (D. Watkinson, pers. comm. 2006). Rainfall in the Milk River system averages only 333 mm annually, 72% of which falls during the growing season (Natural Regions Committee 2006). Periods of high runoff occur briefly in late March and April due to snowmelt and in June and July due to intensive, localized rain storms (McLean and Beckstead 1980). Above the Town of Milk River, the substrate in both rivers is dominated by gravel and cobble and the channel has a moderate gradient. The lower 130 km of the Milk River has a low gradient and sand/silt dominate the substrate.

The North Milk and Milk rivers have been severely impacted by changes in their seasonal flow regimes. Water diverted from the St. Mary River in Montana augments flows in the Alberta portion of the North Milk and Milk rivers from late March or early April through late September or mid-October (ISMMRAMTF 2006). Under natural pre-diversion conditions, summer flows in Canada ranged from 1 to 2 $m^3 \cdot s^{-1}$ in the North Milk River and between 2 and 10 $m^3 \cdot s^{-1}$ in the Milk River at its eastern crossing with the international border (McLean and Beckstead 1980). Since the diversion, flows in the Milk River at the Town of Milk River have ranged from 10 to 20 $m^3 \cdot s^{-1}$ between May and September, and have averaged 15 $m^3 \cdot s^{-1}$ between June and August. The effects of flow augmentation are much greater in the North Milk River, which has a relatively small drainage area (238 km^2 at the North Milk River gauge 11AA001), than they are downstream at the eastern crossing of the international border, where the river receives runoff from a much larger area (6,800 km^2 at gauge 11AA031) (McLean and Beckstead 1980). As the Milk River flows through Alberta the concentration of suspended sediment in the water increases, and with it the turbidity (Spitzer 1988). These levels tend to decline over the augmentation period despite flows that remain fairly constant. Flow augmentation of the North Milk and Milk rivers is actively managed at the St. Mary Diversion Dam in Montana in response to major runoff events to prevent or reduce erosion, scouring and risk of canal failure, and to optimize use of the water for irrigation.

When the diversion of water from the St. Mary River is terminated in late September to mid-October, the river reverts to natural flows for the remainder of the winter season (ISMMRAMTF 2006), albeit within a somewhat modified river channel (McLean and Beckstead 1980; Milk River Watershed Council Canada 2008). Ramping down of the diverted flow occurs over about a week, and flows in the river decline over the next several weeks. The decline is most rapid in upstream reaches of the river. Under severe drought conditions, such as those of 2001-2002, there may be little or no surface flow and the lower Milk River can be reduced to a series of isolated pools until spring, although subsurface flows may continue (K. Miller, pers. comm. 2006). At the Town of Milk River, the average flow rate over the period 1912 to 2011 was less than 2 $m^3 \cdot s^{-1}$ in November and February, and less than 1 $m^3 \cdot s^{-1}$ in December and January (WSC 2011b).

Upstream from its confluence with the North Milk River to the Montana Border, surface flow in the Milk River is occasionally reduced to zero in the months of July to March resulting in isolated pools. The flow in the Milk River mainstem east of Aden Bridge only declines to zero flow occasionally from December to March. Zero flow in the North Milk River is rare having occurred on only two days (in March 1940) since recording began in 1909 (WSC 2011c).

HISTORIC AND CURRENT ABUNDANCE AND TRENDS

No studies have been completed specifically on the abundance of Rocky Mountain Sculpin, Eastslope populations, so it is not possible to discuss quantitative estimates of abundance. However, repetitive sampling at some sites does allow a comparison between stocks. To assess the status of Rocky Mountain Sculpin stocks in Canada, each was ranked in terms of its abundance (Relative Abundance Index) and trajectory (Trajectory).

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 study was targeting Rocky Mountain Sculpin, were considered. The number of individual Rocky Mountain Sculpin caught during each sampling period was then considered when assigning a rating. The Relative Abundance Index is a relative parameter in that the values assigned to each stock are relative to what is considered the most abundant stock. In the case of Rocky Mountain Sculpin, all stocks were assigned an Abundance Index relative to the North Milk River sculpin stock.

Trajectory was assessed as Decreasing, Stable, Increasing or Unknown for each stock based on the best available information about the current trajectory of the stock. The number of individuals caught over time for each stock was considered. Trends over time were classified as Increasing (an increase in abundance over time), Decreasing (a decrease in abundance over time) or Stable (no change in abundance over time). If insufficient information was available to identify the trajectory, the Trajectory was listed as Unknown.

The Relative Abundance Index and Trajectory values were then combined using the status matrix (Table 1) to determine the Status for each stock (Table 2). Each Status was subsequently ranked as Poor, Fair, Good, Unknown or Extirpated.

Table 1. The status matrix combines the Relative Abundance Index and Trajectory rankings to establish the Status for each Rocky Mountain Sculpin stock in Alberta. The resulting Stock Status has been categorized as Extirpated, Poor, Fair, Good or Unknown.

		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 2. Relative Abundance Index, Trajectory and Status of each Rocky Mountain Sculpin stock in Alberta. The level of Certainty associated with the Relative Abundance Index and Trajectory rankings is based on quantitative analysis (1), CPUE or standardized sampling (2) or expert advice (3). Stock Status results from an analysis of both the Relative Abundance Index and Trajectory. Certainty assigned to each Stock Status is reflective of the lowest level of certainty associated with either initial parameter (Relative Abundance Index or Trajectory).

Location	Relative Abundance Index	Certainty	Trajectory	Certainty	Stock Status	Certainty
St. Mary River	High	2	Stable	2	Good	2
Lee Creek[1,2]	Unknown	3	Unknown	3	Unknown	3
Aetna Creek[1]	Unknown	3	Unknown	3	Unknown	3
North Milk River	High	3	Stable	3	Good	3
Milk River – above confluence with the North Milk River	Low	3	Unknown	3	Poor	3
Milk River – below confluence with the North Milk River[1,3]	Low-High	3	Stable	3	Fair	3

[1] Limited targeted or quantitative sampling.

[2] Fish abundance declined upstream close to zero near the Canada/U.S. border.

[3] Near the confluence abundance is high. Downstream of there, abundance declines to near zero in accordance with a declining gradient in habitat quality.

St. Mary River

The Rocky Mountain Sculpin is abundant in the St. Mary River upstream of the St. Mary Reservoir. Beginning in 2007, Rocky Mountain Sculpin have been sampled in the St. Mary River using a 1 m^2 quadrate-based sampling unit at a mean discharge of 14.6 $m^3 \cdot s^{-1}$. A total of 2,787 quadrats have been sampled with an average density of 0.62 Rocky Mountain Sculpin per quadrat. Mean river width was calculated as 36.9 m from a Google Earth, high-resolution satellite image taken on July 7, 2005 by measuring river width at the 14 cross sections spaced one kilometer apart that corresponded with sampling locations. The mean discharge on that day (20.4 $m^3 \cdot s^{-1}$) multiplied by the 46 river kilometers in the St. Mary River where Rocky Mountain Sculpin are known to occur results in approximately 1,700,000 m^2 of wetted habitat. Multiplying wetted habitat by the density of Rocky Mountain Sculpin equals approximately 1,000,000 fish in the St. Mary River. This estimate is likely high as the area of available habitat is over-estimated at the higher discharge. Recalculating the abundance estimate assuming a linear relationship between discharge and available habitat—which overestimates habitat loss at lower flows, therefore is more conservative—produces an estimate of 750,000 Rocky Mountain Sculpin (all age classes) in the St. Mary River. Both estimates warrant a Relative Abundance Index of High. The estimate of fish per quadrat has been consistent between years and based on the limited data collected to date appears stable thus the Population Trajectory is deemed Stable. Population status for the St. Mary River is Good.

Lee Creek

Lee Creek is a small tributary of the St. Mary River (Mogen and Kaeding 2005a). Lee Creek originates in Montana and flows north 13 km before crossing the international border (Mogen and Kaeding 2005a). It then meanders 64 km through the mostly shrub-grassland habitat of southern Alberta before entering the St. Mary River, upstream from the St. Mary Reservoir, near the Town of Cardston. The average monthly flow in Lee Creek at Cardston rarely exceeds 1 $m^3 \cdot s^{-1}$ from August through February (WSC 2011d). Flow increases over the spring to peak average in June of 5.77 $m^3 \cdot s^{-1}$ and then declines abruptly back to the seasonal low flow values by August. Timber is harvested from parts of the Lee Creek drainage on the Blackfeet Reservation in Montana, and along its Tough Creek tributary in Alberta (Mogen and Kaeding 2005a; T. Clayton, pers. comm. 2008). Sculpin have not been sampled with a consistent gear or effort. They are abundant in the 13 km of Lee Creek closest to the confluence with the St. Mary River but decline with distance upstream. It is not known why they do not travel farther upstream. No abundance or trend data are available. The Relative Abundance Index and Population Trajectory for Lee Creek are currently Unknown, resulting in a Population Status of Unknown.

Aetna Creek

Aetna Creek is a small tributary of the St. Mary River. Sculpin were sampled there once in 2009. Sampling only occurred in the lower 300 m of the creek. The Relative Abundance Index and Population Trajectory for Aetna Creek are currently Unknown, resulting in a Population Status of Unknown.

North Milk River

The Rocky Mountain Sculpin is abundant in the 89 km of the North Milk River from the Montana border downstream to its confluence with the Milk River. No studies have used consistent data collection techniques that would allow estimates of abundance or trend in the North Milk River, however three decades of various studies have not revealed an increase or decrease in sculpin abundance. The Relative Abundance Index is High and Population Trajectory is Stable, producing a Population Status of Good.

Milk River

The abundance of Rocky Mountain Sculpin in the Milk River from the upstream Montana border crossing downstream to the confluence with the North Milk River is very low with only a few specimens collected in the last 20 years. No studies have used consistent data collection techniques that would allow for estimates of abundance or trend in the upper portion of the Milk River. The Relative Abundance Index is Low and Population Trajectory is Unknown, producing a Population Status of Poor.

In the Milk River immediately downstream of its confluence with the North Milk River the abundance of Rocky Mountain Sculpin is high but decreases progressively in a downstream direction to its last known distribution 85 river kilometers upstream of the Montana border. No studies have used consistent data collection techniques that would allow estimates of abundance or trend. The Relative Abundance Index likely ranges from Low to High and Population Trajectory is Stable. Using the mid-point of the Relative Abundance Index produces a Population Status of Fair.

HABITAT REQUIREMENTS

Rocky Mountain Sculpin occupy cool, clear headwater rivers and tend to be more common in silt-free rocky substrates near stream margins with low to moderate water velocities than in mid-stream areas where velocities are higher (Paetz 1993). The distribution of Rocky Mountain

Sculpin in the St. Mary and Milk river systems has been strongly correlated with stream gradient and substrate type (Clayton and Ash 1980; R.L. & L. Environmental Services Ltd. 2002; DFO, unpubl. data). Rocky Mountain Sculpin have been sampled in rivers with water temperature as high 23.6°C, basic pH in the typical range of 8.0 to 8.6, conductivity of 100 to 920 µS/cm, turbidity of 0.34 to 10.3 NTU (but typically less than 3.5 NTU), and dissolved oxygen levels of at least 7.4 mg/L (R.L. & L. Environmental Services Ltd. 2002). Most sampling for Rocky Mountain Sculpin is conducted in water less than 1 m deep.

St. Mary River

Habitat in the St. Mary River is relatively homogenous from where it enters Alberta from Montana to the St. Mary Reservoir, dominated by gravel and cobble substrate and generally moderate water velocity. Whether the species inhabited lower reaches of the St. Mary River prior to construction of the reservoir is unknown. However, the absence of the species in the reservoir, suggests that it may have been extirpated from the reservoir, and possibly from areas downstream. As such the St. Mary Reservoir likely represents a major obstacle to downstream dispersal of sculpins in the St. Mary River. The reservoir has very steep banks and almost no littoral zone (English 1977). Given that multiple cohorts of Rocky Mountain Sculpin are present down the length of the St. Mary River above the reservoir it is likely that the habitat available is sufficient to provide for all aspects of their life history. Little is known about overwintering habitat in the St. Mary River. Low flow conditions do occur, but surface flow is uninterrupted year-round.

Lee Creek

Habitat in Lee Creek is not well understood, but from the few sites that have been sampled the majority of the substrate was gravel and cobble with moderate to low gradient.

Aetna Creek

No habitat data exist for Aetna Creek other than the channel is narrow, less than 2 m in width.

North Milk River

Habitat in the North Milk River is dominated by gravel and cobble with moderate gradient (Clayton and Ash 1980). Habitat assessment in the river is limited, most often associated with road access points. In November 1979, sculpins were found overwintering at most sites surveyed on the North Milk River from 14 to 80 km upstream of the confluence with the Milk River (Clayton and Ash 1980). Overwintering habitat may not be limiting for Rocky Mountain Sculpin in the North Milk River under normal winter flow conditions (R.L. & L. Environmental Services Ltd. 2002). However, the availability of this habitat type during periods of drought is less certain. Droughts are a frequent occurrence in the Milk River system and species that occur there may be adapted to such conditions.

Milk River

Habitat in the Milk River from the Montana border downstream to the confluence with the North Milk River is dominated by gravel with a moderate gradient. Surface flow in the Milk River upstream of the North Milk River confluence occasionally declines to zero in the months of July through to March. This is likely a limiting habitat condition in this reach. In the 100 river km downstream of its confluence with the North Milk River, the Milk River transitions to a system characterized by silt and sand substrate and a low gradient. The reduction in larger substrate corresponds with decreasing Rocky Mountain Sculpin abundance.

Spawning

Nests are constructed under rocks or sometimes on aquatic vegetation, wood or debris. Water depth at their nests was over 0.3 m, and surface water velocities ranged from 0 to 1.4 $m \cdot s^{-1}$. The nests were typically located under rocks that were 0.12 to 0.38 m in diameter (Bailey 1952).

Heavy silt loads also can reduce the number of available spawning sites; in some cases, clay tiles have been used to increase production of imperiled populations of sculpins by augmenting available crevices (*C. gobio*, Knaepkens et al. 2004). This approach was deemed ineffective by Grossman et al. (1995), based on the observation of a greater response of sculpin density in habitat patches to prey densities rather than to habitat quality (Petty and Grossman 1996). However, these authors did not examine population dynamics during the spawning season. Given the high degree of territoriality and relatively low proportion of adult males contributing to reproduction, we feel that this approach merits further examination.

Young-of-the-Year (YOY) and Juvenile

Juvenile Rocky Mountain Sculpin in the St. Mary River prefer water depths of 0.1-0.6 m, mean water column velocities of 0.1-0.4 $m \cdot s^{-1}$ and silt or gravel substrate (DFO, unpubl. data). This distribution may be a response to predation by and competition with adults in the deeper, faster waters rather than a habitat preference, since both small and large fish prefer deep microhabitat (Freeman and Stouder 1989). In autumn, YOY in the Flathead River were associated with sand and detritus substrates in quiet water areas such as pools, root-wads, back-channels and shallow embayments (McPhail 2007).

Adult

Adult Rocky Mountain Sculpin in the St. Mary River prefer waters of 0.3-0.8 m deep, mean water column velocities of 0.5-1.3 $m \cdot s^{-1}$ water velocity, and gravel or cobble substrate. Adults in the Flathead River were abundant in summer at similar water depths and velocities as those used by sculpins in the St. Mary and North Milk rivers (McPhail 2007). During the day they sheltered in the substrate and at night emerged to forage along river edges in the shallows (<0.3 m) where there was little surface current (<0.1 $m \cdot s^{-1}$). In September, movement by larger males in the Flathead River to areas with faster surface velocities (>0.6 $m \cdot s^{-1}$), coupled with their association with large rocks and boulders, and spawning colouration suggest that breeding territories may be established in the autumn (McPhail 2007). During the winter, fish in the West Gallatin River of southwestern Montana lived in water with temperatures ranging from 0 to 2.2°C (Bailey 1952).

Rocky Mountain Sculpin in Alberta may be quite sedentary during the non-breeding season. The estimated home range of this species in a small Montana stream was less than 46 m of longitudinal stream channel, with maximum observed dispersal upstream of 180 m and downstream of 153 m (McCleave 1964; see also Bailey 1952). Schmetterling and Adam (2004) found that Rocky Mountain Sculpin moved as far as 209 m with a median of 26 m, in 23 days during July and August in Chamberlain Creek, Montana. Most of those movements were at night. During one-hour observation periods both small (<50 mm TL) and large (≥ 55 mm TL) Mottled Sculpin in a small Appalachian stream moved within an area less than 0.50 m^2 (Freeman and Stouder 1989). Movement data from both studies should be interpreted with caution as the studies were limited in both geographical scope and methodology.

RESIDENCE

During the spawning season, male Rocky Mountain Sculpin construct nests under rocks or sometimes on aquatic vegetation, wood or debris. Single males remain near the nest sites for up to several weeks during oviposition, incubation and early embryo stages (Bailey 1952). Males fan the developing eggs to keep the nests clean of silt and other debris, and may protect the eggs and fry from predators. The nests may be occupied until the yolk sac is resorbed.

SARA defines a *residence* 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”. Nests are created and used by Rocky Mountain Sculpin for spawning and development up until the eggs hatch. Eggs, alevins and fry are critical components in the life cycle, therefore the nests meet the SARA definition of residence.

THREATS

A number of threats to the Rocky Mountain Sculpin have been identified throughout its range. The most significant threats may be those that alter the natural flow regime of a river causing habitat loss or impairment. Such threats may include water removal (e.g., for irrigation, municipal, recreational, industrial and domestic use), impoundment, bank stabilization, the construction of channels and changes in flow conditions. Drought is a natural occurrence in this region. Other threats to the species' habitat and survival include pollution and degradation of riparian areas. Some of the above threats may also act indirectly by altering faunal communities which in turn threaten the sculpin's existence. It is important to note that these threats may not always act independently on Rocky Mountain Sculpin stocks; rather, one threat may directly affect another, or the interaction between two threats may introduce an interaction effect. It is quite difficult to quantify these interactions and; therefore, each threat is discussed independently.

To assess the status of threats with respect to the Eastslope stocks of Rocky Mountain Sculpin, each threat was ranked in terms of its Threat Likelihood, Threat Impact and Threat Level on a stock by-stock basis, and overall effect on the species in terms of its Spatial Extent and Temporal Extent. Definitions for these terms are presented in Table 3. Threat Likelihood was rated as Known, Likely, Unlikely or Unknown, and the Threat Impact was rated as High, Medium, Low or Unknown for each stock (Table 4). The level of Certainty associated with each rating for Threat Impact was identified on the basis of causative studies, correlative studies or expert opinion (Table 4). The Threat Likelihood and Threat Impact ratings for each stock were subsequently combined in the Threat Level Matrix (Table 5) resulting in the final Threat Level for each stock (Table 6). The Spatial Extent of each threat was categorized as Widespread or Local and the Temporal Extent as either Chronic or Ephemeral (Table 7).

Habitat Loss/Degradation

Habitat loss or degradation has been identified as a threat to the survival of Rocky Mountain Sculpin. A number of existing or potential activities may result in habitat loss or degradation. They are presented in decreasing order of importance to Rocky Mountain Sculpin.

Drought

Southern Alberta is susceptible to extreme drought conditions, particularly during the late summer, fall and winter. The impact of this threat to Rocky Mountain Sculpin will depend on the severity and duration of the drought. Drought conditions in combination with water regulation and extraction practices have the potential to reduce the quantity and quality of sculpin habitat. The severity of the combined effect could be significant. In 2001, for example, the surface flow of the Milk River east of Aden Bridge and upstream of the confluence with the North Milk River was virtually eliminated in the fall and winter due to severe drought conditions with the lower reaches of the Milk River reduced to a series of standing pools (WSC 2011b).

The threat level of drought to Rocky Mountain Sculpin is High for all six waterbodies (Table 6). The spatial and temporal extent of drought is Widespread and Ephemeral, respectively (Table 7).

Table 3. Definitions of terms used to describe threats.

Term	Definition
Threat Likelihood	
Known (K)	This threat has been recorded to occur at site X.
Likely (L)	There is a > 50% chance of this threat occurring at site X.
Unlikely (U)	There is a < 50% chance of this threat occurring at site X.
Unknown (UK)	There are no data or prior knowledge of this threat occurring at site X.
Threat Impact	
High (H)	Currently, the threat is jeopardizing the survival or recovery of the population. OR If the threat was to occur, it would jeopardize the survival or recovery of the population.
Medium (M)	Currently, the threat is likely jeopardizing the survival or recovery of the population. OR If threat was to occur, it would likely jeopardize the survival or recovery of the population.
Low (L)	Currently, the threat is unlikely jeopardizing the survival or recovery of the population. OR If threat was to occur, it would be unlikely to jeopardize the survival or recovery of the population.
Unknown (UK)	There is no prior knowledge, literature or data to guide the assessment of the impact if it 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 the majority of stocks (i.e., four or more) at a medium or high level.
Local	Threat is likely to not affect the majority of stocks (i.e., less than four) at a medium or high level.
Temporal	
Chronic	Threat is likely to have a long-lasting or reoccurring effect on the population.
Ephemeral	Threat is likely to have a short-lived or non-recurring effect on the population.

Table 4. Threat Likelihood (TLH) and Threat Impact (TI) for each Rocky Mountain Sculpin stock in Alberta based on the best available data. The Threat Likelihood was assigned as Known (K), Likely (L), Unlikely (U), or Unknown (UK), and the Threat Impact was assigned as High (H), Medium (M), Low (L), or Unknown (UK). The level of Certainty (C) associated with Threat Impact was based on causative studies (1), correlative studies (2) or expert opinion (3).

THREATS	St. Mary River			Lee Creek			Aetna Creek			North Milk River			Milk River above confluence			Milk River below confluence		
	TLH	**TI**	**C**	**TLH**	**TI**	**C**	**TLH**	**TI**	**C**	**TLH**	**TI**	**C**	**TLH**	**TI**	**C**	**TLH**	**TI**	**C**
Habitat Loss/Degradation																		
Drought	K	H	3	K	H	3	K	H	3	K	H	3	K	H	3	K	H	3
Changes in flow (diversion)	K	H	3	U	H	3	U	H	3	K	H	3	U	H	3	K	H	3
Surface water extraction: non-irrigation	K	L	3	K	L-H	3	K	L-H	3	K	L-H	3	UK	H	3	K	L-H	3
Livestock use of flood plain	K	L	3	K	M	3	K	M	3	K	L	3	K	M	3	K	L	3
Groundwater extraction	K	L	3	K	L-H	3	UK	L-H	3	K	L-H	3	K	L-H	3	K	L-H	3
Dam construction	K	H	2	U	H	2	U	H	2	U	H	2	UK	H	2	UK	H	2
Dam operation	K	M-H	2	U	M-H	2	U	M-H	2	K[1]	M-H	2	UK	M-H	2	UK	M-H	2
Surface water extraction: irrigation	K	L	3	K	L-H	3	K	L-H	3	K	L	3	UK	H	3	K	L	3
Anoxia	UK	H	3	UK	H	3	UK	H	3	UK	H	3	L	H	3	K	H	3
Species Introductions																		
Fish and invertebrate species	K	L-H	3	K	L-H	3	UK	L-H	3	K	L-H	3	U	L-H	3	K	L-H	3
Didymosphenia geminata	K	UK	3	K	UK	3	UK	UK	3	UK	UK	3	UK	UK	3	K	UK	3
Contaminants and Toxic Substances																		
Non-point source contamination	K	L	3	K	M	3	K	M	3	K	L-H	3	K	L-M	3	K	L-H	3
Point source contamination	K	L-H	3	K	L-H	3	UK	L-H	3	UK	L-H	3	U	L-H	3	K	L-H	3
Other Threats																		
Scientific sampling	K	L	3	K	L	3	K	L	3	K	L	3	K	L	3	K	L	3

[1] Related to water management operations in Montana.

Table 5. The Threat Level Matrix combines the Threat Likelihood and Threat Impact rankings to establish the Threat Level for each Rocky Mountain Sculpin stock in Alberta. 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 6. The Threat Level for each Rocky Mountain Sculpin stock in Alberta, resulting from an analysis of both the Threat Likelihood and Threat Impact. H=high, M=medium, L=low, UK=unknown.

Threats	**St. Mary River**	**Lee Creek**	**Aetna Creek**	**North Milk River**	**Milk River above confluence**	**Milk River below confluence**
Drought	H	H	H	H	H	H
Changes in flow (diversion)	H	M	M	H	M	H
Non-point source contamination	L	M	M	L / M / H	L / M	L / M / H
Fish and invertebrate species introductions	L / M / H	L / M / H	UK	L / M / H	L / M	L / M / H
Surface water extraction: non-irrigation	L	L / M / H	L / M / H	L / M / H	UK	L / M / H
Livestock use of flood plain	L	M	M	L	M	L
Groundwater extraction	L	L / M / H	UK	L / M / H	L / M / H	L / M / H
Dam construction	H	M	M	M	UK	UK
Dam operation	M / H	L / M	L / M	M / H	UK	UK
Point source contamination	L / M / H	L / M / H	UK	UK	L / M	L / M / H
Surface water extraction: irrigation	L	L / M / H	L / M / H	L	UK	L
Anoxia	UK	UK	UK	UK	H	H
Scientific sampling	L	L	L	L	L	L
Didymosphenia geminata	UK	UK	UK	UK	UK	UK

Table 7. Overall effects of threats on Rocky Mountain Sculpin in Alberta.

Threat	Spatial Extent	Temporal Extent
Drought	Widespread	Ephemeral
Changes in flow (diversion)	Widespread	Chronic
Non-point source contamination	Widespread	Chronic
Fish and invertebrate species introductions	Widespread	Chronic
Surface water extraction: non-irrigation	Widespread	Chronic
Livestock use of flood plain	Local	Chronic
Groundwater extraction	Widespread	Chronic
Dam construction	Widespread	Chronic
Dam operation	Widespread	Chronic
Point source contamination	Widespread	Ephemeral
Surface water extraction: irrigation	Local	Chronic
Anoxia	Local	Ephemeral
Scientific sampling	Local	Ephemeral
Didymosphenia geminata	Local	Chronic

Changes in Flow (St. Mary Diversion)

Diverting water from the St. Mary River has reduced the effects of drought in the Milk River (Willock 1969) from April to October, and may have extended the availability of suitable summer habitat for the Rocky Mountain Sculpin further downstream than under natural flow conditions. The net effect of this change is unknown. Winter flows in the Milk River, while low, are considered natural and taken alone are unlikely to threaten the Rocky Mountain Sculpin.

The St. Mary Canal in the United States is in need of maintenance and re-construction, and proposed changes include everything from abandonment to significantly increasing its flow capacity (Alberta Environment 2004; U.S. Bureau of Reclamation 2004). The canal is currently not operating at its design capacity of 24.1 $m^3 \cdot s^{-1}$ but at a capacity of about 18.4 $m^3 \cdot s^{-1}$. Simply bringing the structure up to design capacity would increase flows by almost 27%. In addition, Montana has proposed further increasing flow capacity to 28.3 $m^3 \cdot s^{-1}$ during the irrigation period, and possibly extending the augmentation period. In either case, increased flows could alter channel morphology, particularly in the lower Milk River where banks are already highly susceptible to erosion during high flow periods.

Unexpected maintenance has led to temporary or premature closures of the canal in the past. Two such interruptions have occurred over that past 30 years (K. Miller, pers. comm. 2006). One of these interruptions occurred in 2001 when the canal was closed in mid-August to allow for emergency repairs. The Milk River upstream from its confluence with the North Milk River has lower flows, and lack of surface flow in this channel during winter is not uncommon.

The threat level of changes in flow resulting from the St. Mary Diversion is High in the St. Mary River, North Milk River and Milk River below the confluence and Moderate elsewhere (Table 6). This threat is Widespread and Chronic (Table 7).

Surface Water Extraction: Non-irrigation

Temporary Diversion Licences (TDLs) for non-irrigation purposes are issued throughout the year, including during critical low flow periods. Oil and gas companies, for example, may be licensed to remove water from the river for activities related to well-drilling. Overwintering habitat for Rocky Mountain Sculpin may be particularly vulnerable to this type of extraction for reasons similar to those outlined under "Groundwater Extraction". This kind of extraction also occurs during the augmented flow period, when it may not be an issue unless the St. Mary diversion is prematurely or temporarily closed down. Under such conditions some TDLs may be revoked, as they were during the drought conditions in 2001 (S. Petry, pers. comm. 2006). TDLs are more prevalent for oil and gas development near the Milk River watershed than they are near the St. Mary River system. Fish in the Milk River system are most vulnerable during the non-augmented period. Restriction of TDLs in areas that would reduce sculpin habitat during critical low flows could be used to mitigate impacts.

During the flow augmentation period, the Town of Milk River diverts about 0.3% of the flow for domestic purposes (S. Petry, pers. comm.). The Town of Cardston draws its water from Lee Creek. In 2008, about 3.3% (1.500×10^6 m^3; D. Hunt, pers. comm. 2008) of the average annual flow in Lee Creek at Cardston (4.433×10^7 m^3; WSC 2011d) was licensed for municipal use. This constituted about 91% of the total licensed annual water withdrawal from Lee Creek. Water is not withdrawn for municipal use from reaches of the St. Mary River that are inhabited by Rocky Mountain Sculpin, unless flow in Lee Creek is insufficient to meet the needs of the Town of Cardston.

The threat level of surface water extraction for non-irrigation purposes to Rocky Mountain Sculpin is Low for the St. Mary River (Table 6) since only a small proportion of the available flow is withdrawn (D. Hunt, pers. comm.), and these withdrawals are regulated. If water withdrawals were to increase significantly in future relative to the available flow in the St. Mary River, the impact of this potential threat to Rocky Mountain Sculpins should be reassessed. The level of this threat ranges from Low to High for Lee and Aetna creeks, the North Milk River, and the Milk River below the confluence because extraction for purposes other than irrigation could occur during periods of low flow. Above the confluence in the Milk River, the threat level is Unknown. The overall effect of this threat is Widespread and Chronic (Table 7).

Livestock Use of Flood Plain

The Alberta Riparian Habitat Management Society ("Cows and Fish") has been working to improve livestock management practices in the Milk River floodplain. Several riparian and grazing management workshops have been held, involving many ranchers along the Milk River. There is a growing understanding of the value and vulnerability of the riparian area to degradation, and a greater understanding and adoption of management solutions by ranchers, including off-stream water development (L. Fitch, pers. comm. 2006). Several riparian benchmark inventories have been completed, but there has not been any follow-up monitoring to date. Demonstration sites have been established and have shown riparian vegetation recovery, especially with woody vegetation. Riparian recovery is usually evident within three to five years after the first management changes are made, but it may be ten years before significant physical changes can be measured. The Society has also conducted some work on Lee Creek and its tributary, Tough Creek. An aerial reconnaissance of the upper St. Mary River has been conducted (T. Clayton, pers. comm. 2008).

Most Rocky Mountain Sculpin habitat is situated upstream of areas with cattle crossings (T. Clayton and M. Bryski, pers. comm. 2008). These crossings are more prevalent in the Milk River system and Lee Creek (i.e., downstream of Beazer) than in the St. Mary River. Outside the canyon sections (approximately 4 km in length) much of the St. Mary River valley (approximately 42 km in length) is relatively broad and accessible to cattle. Ranching is a primary agricultural activity and access to the St. Mary River by cattle is generally unrestricted. Balanced against this access is the natural resilience of the bed and shores of the river, where the gravel and cobble bed and underlying bedrock provide natural armour. While much of the shoreline is in good condition, some areas have been overused, resulting in shoreline degradation and man-made armouring that may reduce the habitat value for sculpins and other fish.

Continuing efforts to improve livestock management practices on the flood plains are likely the best method of mitigating any potential threat these practices pose to Rocky Mountain Sculpin. Focusing these efforts on local areas that have been overused may be beneficial.

The threat level of livestock use of the floodplain to Rocky Mountain Sculpins and their habitat in Lee and Aetna creeks and the Milk River above the confluence is considered Medium as flow in these waterbodies is lower making them more accessible to cattle (Table 6). The threat level is considered Low in the St. Mary River, North Milk River and the Milk River below the confluence where flows are greater. The overall effect of this threat is Local but Chronic (Table 7).

Groundwater Extraction

Groundwater is used for domestic purposes in the St. Mary and Milk river systems, although its use in Aetna Creek is unknown. The threat level of groundwater extraction in the St. Mary River is probably Low (Table 6). Base flows are significantly lower in the remaining waterbodies, at least during winter and periods of extreme drought, thus the impact of groundwater extraction could be greater there than in the St. Mary River depending on the season and year. For that reason, the threat level ranges from Low to High for Lee Creek, North Milk River and Milk River above and below the confluence. The threat level for Aetna Creek is Unknown. Groundwater connectivity testing is currently underway so more information may be available in the future to better assess this threat. The overall effect of this threat is Widespread and Chronic (Table 7).

Dam Construction

Dam construction would pose a threat to Rocky Mountain Sculpin in the St. Mary and Milk river systems. The apparent absence of this species from the St. Mary Reservoir and reaches of the river downstream suggests that Rocky Mountain Sculpin could be extirpated from within the impoundment and possibly for some distance downstream. The barrier posed by the reservoir might limit subsequent re-colonization by the upstream portion of a population.

While there is no proposals at this time, the feasibility of developing a dam on the Milk River upstream of the Town of Milk River has been, and continues to be investigated as well as on the St. Mary River upstream of the town of Kimball. The reservoir that would be created on the St. Mary River could back flood almost to the Canada-U.S. border. The purposes of a dam would be to improve the security of the water supply for existing withdrawals, and to provide water for the irrigation of additional hectares. Dam construction on either river would affect Milk River populations by reducing their range (T. Clayton, pers. comm. 2007).

The threat level of dam construction to Rocky Mountain Sculpin is High in the St. Mary River and Moderate in Lee and Aetna creeks and the North Milk River (Table 6). As the likelihood of dam construction in the Milk River above and below the confluence is Unknown (Table 4), this results in an overall threat level of Unknown for those two waterbodies (Table 6). Regardless, this threat is rated as Widespread and Chronic (Table 7).

Dam Operation

Impoundments alter habitat types, flow regimes, sediment loads, microbiota and water temperatures, and may also increase the risk of species introductions (McAllister et al. 2000; Quist et al. 2004). These changes often produce systems that are narrower, less turbid, less subject to fluctuations in temperature and flow, and less productive with less substrate movement (Cross et al. 1986; Pflieger and Grace 1987; Quist et al. 2004). Water released from storage reservoirs is often withdrawn from near the bottom of the reservoir (hypolimnetic withdrawals), creating significantly cooler water conditions in downstream areas. The effect of an impoundment on sculpin habitat downstream would depend on how water releases are managed.

The threat of dam operation to Rocky Mountain Sculpin is Medium to High in the St. Mary and North Milk rivers and Low to Medium in Lee and Aetna creeks (Table 6). As the likelihood of dam operation in the Milk River above and below the confluence is Unknown (Table 4), this results in an overall threat level of Unknown for those two waterbodies (Table 6). Regardless, this threat is rated as Widespread and Chronic (Table 7).

Surface Water Extraction: Irrigation

Water is extracted from the Milk River for irrigation only while flows are augmented, from late-March or early April through to late September or mid-October. In 2008, Alberta irrigators were licensed to remove a total of up to 1.186 x 10^7 m^3 of water from the Milk River (D. Hunt, pers. comm. 2008). This constituted about 92% of the total licensed annual water withdrawal, but only about 5% of the average annual flow at the Town of Milk River from April through September (2.423 x 10^8 m^3; period of record 1909 to 2007 (WSC 2011b).

The withdrawals allowable under water licenses are typically approached only during drought years (K. Miller, pers. comm.). When the diversion is closed for maintenance, or during reduced flow conditions, withdrawals for irrigation are terminated, or suspended on a priority use basis. Alberta Environment has begun installing water meters on all irrigation pumps drawing water from the Milk River (K. Miller, pers. comm. 2006). These meters measure water removal four times a day to provide an accurate and up-to-date measure of water withdrawals.

Sculpin in the St. Mary River are unlikely to be affected by water withdrawals for irrigation at this time. There is little irrigation currently and further development is unlikely due to the high elevation, topography, short growing season and higher rainfall (Government of Alberta 2005). The North Milk River and Milk River downstream of the confluence receive augmentation flows from the St. Mary River that exceed natural flows so irrigation withdrawals are unlikely to impact sculpin. So the threat level for these three stocks is Low (Table 6). The threat level in Lee and Aetna creeks ranges from Low to High because these waterbodies are relatively small. The Milk River upstream of the North Milk River confluence would be susceptible to irrigation withdrawals but currently this impact is Unknown. The overall effect of this threat is Local but Chronic (Table 7).

Anoxia

Low dissolved oxygen levels during the winter could seriously impact the survival of Rocky Mountain Sculpin and other fish species in the Milk River. In January, oxygen concentrations under the ice in the lower Milk River can decline to 1.6 mg/L, perhaps due to oxidization by organic debris or inflow of anoxic ground water (Noton 1980; R.L. & L. Environmental Services Ltd. 2002). The sculpin population as a whole is unlikely to be threatened by anoxia as similar declines have not been observed further upstream in the North Milk River, where measured winter levels are at or above 8.4 mg/L (Noton 1980), or at a number of isolated pools in the lower Milk River, where March levels are at or above 10.2 mg/L (R.L. & L. Environmental

Services Ltd. 2002). This suggests that oxygen exchange in these reaches, where there is continuous flow and possibly open water, is adequate to support sculpin. Anoxia is unlikely in the St. Mary River and Lee Creek for the same reasons. This parameter should be evaluated in future winter habitat surveys to confirm this conclusion.

The threat level of anoxia on Rocky Mountain Sculpin is Unknown in the St. Mary River, Lee and Aetna creeks and the North Milk River but High in the Milk River below the confluence and also likely High above the confluence (Table 6). This threat is Local and Ephemeral in terms of its overall effect on Rocky Mountain Sculpin in Alberta (Table 7).

Species Introductions

Fish and Invertebrate Species

Non-indigenous species may be introduced into waters occupied by Rocky Mountain Sculpin either intentionally by stocking, or unintentionally in bilge water, on boat hulls, as bait, or by other unidentified means. Introduced species can threaten native fish fauna through various mechanisms including: predation, hybridization, competition for resources, the introduction of exotic diseases or parasites, and habitat degradation (Taylor et al. 1984; Lassuy 1995; Courtenay 2007). The degree to which this threat is likely to occur depends on the suitability of sculpin habitats to potential invading species.

In Montana, authorized stocking of non-native fishes into the St. Mary River system began early in the 20th century and continued in Glacier National Park until mid-century (Marnell 1988; Mogen and Kaeding 2005b). It continues today in some waters of the Blackfeet Reservation, mainly in isolated ponds and lakes. Non-native fishes that have established self-sustaining populations in the St. Mary River system in Montana include Brook Trout (*Salvelinus fontinalis*), Rainbow Trout (*Oncorhynchus mykiss*), Yellowstone Cutthroat Trout (*O. clarkii bouvieri*) and their hybrids. Brook Trout have not been reported from Canadian reaches of the St. Mary River.

In Alberta, Kokanee (*Oncorhynchus nerka*), Rainbow Trout, and Walleye (*Sander vitreus*) have been stocked into the St. Mary Reservoir but only Walleye established a self-sustaining population (Clements 1973). The Milk River and its tributaries have not been stocked for at least 10 years, although Goldsprings Park Pond, an old oxbow of the river with no connection to the mainstem is stocked annually with Rainbow Trout (T. Clayton, pers. comm. 2006). The Alberta Fish and Wildlife Division does not plan to introduce sportfish species into the Milk River or St. Mary River systems, and is unlikely to do so in the future (T. Clayton, pers. comm. 2008). Unauthorized introductions have not been documented in these rivers. Such introductions are difficult to control and might increase the severity of this threat if a new species were introduced.

The effects of historical species introductions from the St. Mary River into the Milk River system via the diversion are unknown, and likely ongoing. Over the course of a five-year entrainment investigation (2002-2006), 17 species of fish from the St. Mary River were caught from diverted flows by entrainment nets installed on the St. Mary Canal headgates (Mogen et al. 2011). The magnitude of the annual transfer is unknown and likely varies, but some of these fish may eventually move downstream into the North Milk and Milk rivers. Two of the entrained species, Bull Trout (*Salvelinus confluence*) and Pearl Dace (*Margariscus margarita*), have not been reported from the Milk River. Some sculpins from the St. Mary River are entrained into the diversion and lost from the St. Mary River stock. Increasing the annual flow in the diversion might further facilitate movement of biota from the St. Mary River into the Milk River system. The potential impacts of controlling the entrainment of biota by the St. Mary Diversion on Rocky Mountain Sculpin in the Milk River system are unknown.

To date, Trout-Perch and Walleye are the only introduced fish species that have been observed in the upper Milk River system where the Rocky Mountain Sculpin occurs (T. Clayton and D.

Watkinson, pers. comm. 2007). Further downstream, the Fresno Reservoir contains a number of introduced predatory species, including: Rainbow Trout, Walleye, Yellow Perch (*Perca flavescens*), Northern Pike (*Esox lucius*) and Black Crappie (*Pomoxis nigromaculatus*), as well as other introduced species such as Lake Whitefish (*Coregonus clupeaformis*) and Spottail Shiner (*Notropis hudsonius*) (Stash 2001; Montana Fish, Wildlife and Parks). Spottail Shiners have been observed between the international border and the reservoir (Stash 2001). While some species listed here have specific habitat requirements that may not be met in the upper Milk River system of Alberta, others are generalists that might expand into Alberta.

Introductions to the Fresno Reservoir only affect the Milk River, whereas introductions to Lower St. Mary Lake in Montana can affect Rocky Mountain Sculpin in both the Milk and St. Mary systems. There are no physical barriers to fish migration between the Fresno Reservoir in Montana, and areas of the Milk River in Alberta that support Rocky Mountain Sculpin. The creation of new reservoirs can raise interest in stocking non-native sportfish for recreational fishing, and might facilitate the introduction of these species elsewhere.

The significance of species introductions would depend upon the species introduced. Introduction of the New Zealand Mud Snail (*Potamopyrgus antipodarum*), for example, can disrupt indigenous invertebrate populations and may cause a marked dietary shift in both sculpin and trout (Cada 2004). The potential impact of such an introduction into the Saskatchewan River system was assessed as unknown (Golder Associates Ltd. 2003). Crayfish have not been reported from the St. Mary River system above the St. Mary Reservoir or the Milk River system in Canada (T. Clayton, pers. comm. 2008). Introduction of a crayfish (e.g., Virile Crayfish *Orconectes virilis*) into these areas could modify the aquatic macrophyte, macroinvertebrate and, ultimately, fish communities (Chambers et al. 1990; Hanson et al. 1990; McCarthy et al. 2006). These effects would likely be greatest in detritus-based littoral food webs (Usio and Townsend 2002, 2004).

Depending on the species introduced, the overall level of this threat for Rocky Mountain Sculpin ranges from Low to High, except for the Milk River above the confluence which was rated Low to Medium (Table 6). The threat of species introductions in Aetna Creek is Unknown. The overall effect of this threat is Widespread and Chronic (Table 7).

Didymosphenia geminata

Blooms of the diatom *Didymosphenia geminata* (Bacillariophyceae) are an emerging threat to headwater rivers in Alberta with high water quality (i.e., low turbidity and nutrient levels) (Kirkwood et al. 2007). These blooms can create dense algal mats that cover the river bottom, impacting ecosystem structure and function and negatively affecting other trophic levels. The environmental factors and conditions that promote bloom events are not well understood. However, studies on the Bow and Red Deer rivers have found a negative relationship between the mean flow regime and diatom biomass. Flow regulation by dams may create the stable flow environment preferred by *Didymosphenia geminata*. Together with other environmental factors such as water clarity, temperature, pH, conductivity and total phosphorus this may promote diatom blooms.

If these algal blooms occur in river habitat occupied by the Rocky Mountain Sculpin they would alter the cover, food, and spawning habitats available to these fish and might displace them from these habitats. It is not known whether the occurrence of blooms would negatively affect Rocky Mountain Sculpin. Any impacts are likely to be periodic and to affect local areas, so the population as a whole is not likely at risk. The ability to prevent or mitigate the blooms themselves may depend upon altering the flow regime (Kirkwood et al. 2007).

Didymosphenia geminata is known to occur in the St. Mary River, Lee Creek and Milk River below the confluence but its impact on Rocky Mountain Sculpin is currently unknown, thus its threat level is Unknown in all six waterbodies (Table 6). The overall effect of this threat would likely be Local and Chronic (Table 7).

Contaminants and Toxic Substances

Non-point Source Contamination

Pollutants carried in runoff that could affect the species include farm fertilizers, herbicides, and pesticides. A limited amount of row crops are grown within about 400 m of the Milk River system (K. Miller, pers. comm.) and St. Mary River system near sculpin habitat. The potential to mitigate, through environmental licensing and public education, is moderate to high except where long-range transport is the main source of pollutants, since these substances are ubiquitous.

The threat level of non-point source pollution to Rocky Mountain Sculpin in the North Milk River and Milk River below the confluence ranges from Low to High, and above the confluence in the Milk River likely from Low to Medium, for the augmented and non-augmented flow periods (Table 6). The threat level is Low for the St. Mary River but Medium for Lee and Aetna creeks where there would be less dilution (Table 6). This threat is Widespread and Chronic (Table 7).

Point Source Contamination

Point sources of pollution include feedlots, stormwater and sewage releases, as well as accidental spills and gas leaks at river and tributary crossings. The Town of Milk River has not released sewage into the Milk River for 20 years, and stormwater is surface run-off (K. Miller, pers. comm.) making both of these a minimal risk. However, the inadvertent release of a toxic substance at any one of the river crossings including bridges or pipelines could have serious consequences. The extent and severity of any damage to the aquatic community including Rocky Mountain Sculpin would depend on the substance released, the location of spill, amount of flow in the river, and the potential to mitigate the impacts. To date, no spills have been documented for the Milk River, however a low possibility exists as traffic flow is significant at some crossings (e.g., average of 2,700 crossings per day on the Highway 4 bridge in 2003, 25% by trucks). Contamination of groundwater from drilling activities is also a possibility.

The threat level of point source pollution to Rocky Mountain Sculpin ranges from Low to High in the St. Mary River, Lee Creek, and Milk River below the confluence, and from Low to Medium in the Milk River above the confluence (Table 6). In Aetna Creek and the Milk River above the confluence the threat level is Unknown. This threat is Widespread but Ephemeral (Table 7).

Other Threats

Scientific Sampling

Rocky Mountain Sculpin undergo routine scientific sampling but this activity is carefully regulated through the issuance of scientific collection permits under SARA. Thus the threat level of scientific sampling to Rocky Mountain Sculpin is Low for all waterbodies (Table 6), and its overall effect is Local and Ephemeral (Table 7).

Climate Change

Climate change has the potential to impact water availability, temperature, and a broad range of other issues (Schindler 2001), thereby affecting the availability and quality of Rocky Mountain Sculpin habitat. Through discussion on the effects of climate change on Canadian fish populations, impacts such as increases in water and air temperatures, changes (decreases) in water levels, shortening of the duration of ice cover, increases in the frequency of extreme weather events, emergence of diseases, and shifts in predator-prey dynamics have been highlighted, all of which may negatively impact native fishes (Lemmen and Warren 2004). The effects of climate change on Rocky Mountain Sculpin in Alberta are unclear but as the distribution of this species in Canada is limited, it is particularly susceptible to habitat loss and degradation, which climate change is expected to exacerbate. Climate Change as a threat was not included in the population-specific threats analysis.

MITIGATION AND ALTERNATIVES

Habitat Loss/Degradation

Numerous threats affecting Rocky Mountain Sculpin are related to habitat loss or degradation. Habitat-related threats have been linked to the Pathways of Effects developed by DFO Fish Habitat Management (FHM). Guidance on generic mitigation measures have been developed for 19 Pathways of Effects for the protection of aquatic species at risk in DFO's Central and Arctic Region (Coker et al. 2010), some of which are relevant for the St. Mary and Milk river systems. These mitigation measures should be referred to when considering mitigation and alternative strategies for habitat-related threats. They were developed to mitigate, limit or minimize threats, however, since they were not developed to specifically consider species at risk so they may need to be modified for this purpose. Additionally, site-specific mitigations may be warranted and should be discussed with local conservation managers. Table 8 identifies the relevant Pathways of Effects for Rocky Mountain Sculpin.

Contaminants and Toxic Substances

The DFO mitigation guide (Coker et al. 2010) also provides guidance on generic mitigation measures for Pathways of Effects related to contaminants and toxic substances from point and non-point sources. Table 8 identifies the relevant Pathways of Effects for Rocky Mountain Sculpin. These measures combined with legislative control/licensing at the provincial and federal levels, public education and developing plans to contain and clean up spills and other releases of pollutants have the potential to mitigate this threat. Alternative measures, such as reductions in pesticides, are market driven.

Table 8. Threats to Rocky Mountain Sculpin stocks in Alberta and the Pathways of Effects associated with each threat as per Coker et al. 2010. 1 – Vegetation clearing; 2 – Grading; 3 – Excavation; 4 – Use of explosives; 5 – Use of industrial equipment; 6 – Cleaning or maintenance of bridges or other structures; 7 – Riparian planting; 8 – Streamside livestock grazing; 9 – Marine seismic surveys; 10 – Placement of material or structures in water; 11 – Dredging; 12 – Water extraction; 13 – Organic debris management; 14 – Wastewater management; 15 – Addition or removal of aquatic vegetation; 16 – Change in timing, duration and frequency of flow; 17 – Fish passage issues; 18 – Structure removal; 19 – Placement of marine finfish aquaculture site.

Threats	Pathways of Effects
Changes in flow	10, 16, 17
Surface water extraction: irrigation and non-irrigation	12, 16
Groundwater extraction	12, 16
Livestock use of flood plain	1, 8, 13
Dam construction and operation	1, 2, 3, 4, 5, 6, 7, 10, 11, 13, 14, 15, 16, 17, 18
Non-point source contamination	1, 4, 7, 8, 11, 12, 13, 15, 16, 18
Point source contamination	1, 4, 5, 6, 7, 11, 12, 13, 14, 15, 16, 18

Pathways of Effects were not developed for species introductions or other threats like scientific sampling so the following specific mitigation measures and alternatives are provided for those types of threats.

Species introductions

Non-native aquatic vegetation and fish species introduction and establishment could have negative effects on Rocky Mountain Sculpin stocks.

Mitigation

- Physically remove non-native species from areas known to be inhabited by Rocky Mountain Sculpin.
- Monitor systems for exotic species that may negatively affect Rocky Mountain Sculpin stocks directly, or negatively affect their preferred habitat.
- Coordinate with Montana/U.S. agencies to evaluate all introductions of exotic species in the St. Mary and Milk rivers systems.
- 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

- There are no alternatives to unauthorized introductions.
- For authorized introductions use only native species of the same genetic stock.
- For authorized introductions follow the National Code on Introductions and Transfers of Aquatic Organisms for all aquatic organism introductions (DFO 2003).

Scientific sampling

Targeted and incidental harvest of Rocky Mountain Sculpin may occur while undertaking scientific sampling. It was recognized as a low risk threat.

Mitigation

- Non-lethal sampling
- Sampling under a SARA permit.

Alternatives

- Sample Rocky Mountain Sculpin in areas where they are not protected (e.g., Montana).

LIMITING FACTORS FOR RECOVERY

Too little is known of the physiology or ability of the Rocky Mountain Sculpin to adapt to different conditions to identify factors that might limit population survival and maintenance. However, because it is a riverine species that has adapted to survive in cool, clear, running waters changing these conditions will likely have an adverse effect on survival of the species. Flow regulation or increased sedimentation might, for example, cause them to lose their advantage to competitors or increase their vulnerability to predators. Many sculpin species do not survive the transition to a lake habitat when their streams are impounded, although the reasons are unclear (Peden 2000).

Although it is somewhat uncertain, Rocky Mountain Sculpin from Montana may have colonized the Milk River system via the St. Mary Canal, and may continue to do so in the future in the event that sculpin in the Alberta portion of the Milk River system were to become extirpated. However, the sedentary habit of closely-related sculpin species (Bailey 1952; McCleave 1964; Peden 2000) suggests limited potential for re-colonization of upstream habitats such as Lee Creek or the Milk River upstream of its confluence with the North Milk River. Re-colonization of the St. Mary River from the Milk River is not feasible given five drop structures (30 m long with 30° slopes) and two inverted siphons that create an impassable barrier to upstream migration (K. Miller, pers. comm. 2007). The apparent absence of this species in the Missouri River system downstream from the Milk River precludes re-colonization from within that drainage system (Stash 2001).

SOURCES OF UNCERTAINTY

Very little information is available on some key aspects of the life history and biology of the Rocky Mountain Sculpin in Alberta such as YOY and juvenile survival and population growth rates. There is also little or no information available on population structure in the Milk River system and Lee or Aetna creeks. Studies to describe the species' reproductive strategy or overwintering requirements are limited, as are data on seasonal movements. The specific habitat needs of the Rocky Mountain Sculpin in Alberta, particularly for eggs and fry, are unknown. Overwintering habitats also have not been described and the response of this species to potentially limiting environmental factors, including temperature extremes, turbidity, and flow are also uncertain. While the change from lotic to lentic habitat has been implicated in the decline or extirpation of fluvial sculpin populations (Knaepkens et al. 2004) elsewhere, the causative mechanisms are unclear. Because accurate threats assessments and critical habitat identifications depend upon knowledge of the species' life history, such studies should be a priority. Knowledge of the frequency and magnitude of catastrophic events and true extinction thresholds of Rocky Mountain Sculpin in Alberta are also needed for population modelling to assess allowable harm, determine population-based recovery targets and conduct long-term projections of population recovery. Finally, microsatellite research of Rocky Mountain Sculpin in the St. Mary and Milk river systems should be undertaken to assess recent demographic changes that have occurred in these systems.

OTHER CONSIDERATIONS

The 1909 Boundary Waters Treaty (the Treaty), which is administered by the International Joint Commission (IJC), provides principles for Canada and the United States to follow for the management of shared waters including the St. Mary and Milk rivers (ISMMRAMTF 2006; see also Dolan 2007; Halliday and Faveri 2007a,b; Rood 2007). In 1917, the United States constructed a canal to divert water from the St. Mary River in northwestern Montana through the Milk River system, across southern Alberta, to northeastern Montana for irrigation. An average of about 2.08 x 10^8 m^3 of water has flowed annually through the St. Mary Canal into the North Milk River over the past two decades (U.S. Bureau of Reclamation 2004). In 2003, Montana requested that the treaty be re-opened to reconsider how the diverted water is apportioned. However, at the time of writing, this issue had not yet been resolved. At present the operating capacity of the St. Mary Canal is about 18.4 $m^3 \cdot s^{-1}$, significantly less than its original design capacity of 24.1 $m^3 \cdot s^{-1}$. Montana is considering whether to rehabilitate the aging canal infrastructure and return the canal to its original capacity, or whether to increase its capacity to 28.3 $m^3 \cdot s^{-1}$ (Alberta Environment 2004; U.S. Bureau of Reclamation 2004).

Additionally, there may be implications of species introductions by U.S. jurisdictions to Rocky Mountain Sculpin in Canadian waters as there is no joint agreement currently in place between Alberta and Montana regarding species introductions in the Milk and St. Mary rivers.

PERSONAL COMMUNICATIONS

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